BATCH UPDATED 10/17/80 TODAY IS 10/21/80

SCIENTIFIC COMPUTING DIVISION FY-81 CYBER RATES AND NOS/BE SCHEDULER MODIFICATIONS

EFFECTIVE OCTOBER 20, 1980 THE FOLLOWING SCHEDULER MODIFICATIONS WILL BECOME OPERATIONAL ON THE INEL DUAL CYBER 176 SYSTEM

1) THE MAXIMUM USER-SPECIFIED JOB CARD PRIORITY WILL BE P=2. ANY JOB SUBMITTED AT P=3 OR HIGHER WILL BE LOWERED BY THE SYSTEM TO P=2.

2) INTERCOM SYSTEM SECOND CHARGES WILL BE BILLED AT THE EQUIVALENT OF FY-80 P=3 RATES, RATHER THAN P=2.

3) ANY REFERENCE TO P=3 IN PREVIOUS SCIENTIFIC COMPUTING DIVISION SERVICE LEVEL CONTRACTS SHOULD BE CHANGED TO P=2.

THE FOLLOWING IS A BRIEF SUMMARY OF TEMPORARY FY-81 VERSUS FY-80 CYBER COMPUTER RATES. THEY WILL BE IN EFFECT UNTIL FURTHER NOTICE.

	FY-80	TEMPORARY FY-81
CCU RATE	$ 1.45 / CCU	$ 1.45 / CCU
CONNECT TIME	$10.00 / HOUR	$10.00 / HOUR
DISK STORAGE	$ .06 / RB / DAY	$ .06 / RB / DAY
MICROFORM	$ .007 / 108 WORDS	$ .007 / 108 WORDS
TAPE MOUNT	-- NO CHARGE --	-- NO CHARGE --
TAPE STORAGE	$ .50 / REEL MO.	$ .50 / REEL / MO.
LINE PRINTER	$.1420 / 1000 LINES	$ .60 / 1000 LINES
CARDS READ	$ .12 / 1000 CARDS	$.2533 / 1000 CARDS
CARDS PUNCHED	$ 1.12 / 1000 CARDS	$.2533 / 1000 CARDS

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CCRE     *CALL REALCM                                                    CCRE          12
CCRE     *CALL INTGCM                                                    CCRE          13
CCRE     *CALL INPRCM                                                    CCRE          14
CCRE     *CALL INPICM                                                    CCRE          15
CCRE     *CALL PHYPRO                                                    CCRE          16

CLDF     *CALL MATCNS                                                    CLDF          39

CPLE     *CALL MATCNS                                                    CPLE           4

FRAC     *CALL REALCM                                                    FRAC          11
FRAC     *CALL INTGCM                                                    FRAC          12
FRAC     *CALL INPRCM                                                    FRAC          13
FRAC     *CALL INPICM                                                    FRAC          14
FRAC     *CALL PHYPRO                                                    FRAC          15

FRPCON   *CALL PELPT                                                     FRPCON        28
FRPCON   *CALL REALCM                                                    FRPCON        29
FRPCON   *CALL INTGCM                                                    FRPCON        30
FRPCON   *CALL INPRCM                                                    FRPCON        31
FRPCON   *CALL INPICM                                                    FRPCON        32
FRPCON   *CALL PHYPRO                                                    FRPCON        33

FSIG     *CALL MATCNS                                                    FSIG          30

FSTP     *CALL MATCNS                                                    FSTP           3

INIT     *CALL REALCM                                                    INIT          13
INIT     *CALL INTGCM                                                    INIT          14
INIT     *CALL INPRCM                                                    INIT          15
INIT     *CALL INPICM                                                    INIT          16
INIT     *CALL PHYPRO                                                    INIT          17

MELT     *CALL PHYPRO                                                    MELT          19
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POINTR   *CALL PELPT                                                    POINTR      53


PRT1     *CALL REALCM                                                   PRT1        12
PRT1     *CALL INTGCM                                                   PRT1        13
PRT1     *CALL INPRCM                                                   PRT1        14
PRT1     *CALL INPICM                                                   PRT1        15
PRT1     *CALL PHYPRO                                                   PRT1        16


PRT2     *CALL REALCM                                                   PRT2        12
PRT2     *CALL INTGCM                                                   PRT2        13
PRT2     *CALL INPRCM                                                   PRT2        14
PRT2     *CALL INPICM                                                   PRT2        15
PRT2     *CALL PHYPRO                                                   PRT2        16
PRT2     *CALL PELPT                                                    PRT2        17


SETUP    *CALL REALCM                                                   SETUP       13
SETUP    *CALL INTGCM                                                   SETUP       14
SETUP    *CALL INPRCM                                                   SETUP       15
SETUP    *CALL INPICM                                                   SETUP       16
SETUP    *CALL PHYPRO                                                   SETUP       17


UDRIVER  *CALL DESNBL                                                   UDRIVER     16

UREADIN  *CALL DESNBL                                                   UREADIN      8

UDESIGN  *CALL DESNBL                                                   UDESIGN      9

UDIALOT  *CALL DESNBL                                                   UDIALOT     20

URUNFRP  *CALL DESNBL                                                   URUNFRP     16

UNAMES   *CALL DESNRL                                                   UNAMES       8
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UANSWER *CALL DESNBL UANSWER 8

UWRITER *CALL DESNBL UWRITER 12

CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY	REALCM	INTGCM	INPRCM	INPICM	PHYPRO	DESNBL	MATCNS
PELPT	AN554	ASSIGN	AXHF	BDTR	BFRC	BNUP	BRST
CCRE	CCRK	CDTR	CEXP	CHECK	CLAD	CLDF	CLDG
CLOS	COND	COOL	CPLE	CRAK	CRAP	CREP	CRER
CRPR	DDLF	DFRC	DLGA	EFFCON	EMDNSF	EMFTCN	EMFTC
EMRLOC	EMS2	ENRG	EUMT	FALU	FBLK	FCMI	FENTHL
FEXP	FGRL	FLMD	FLOB	FLUXD	FRAC	FRPCON	FRAL
FSIG	FSTP	FSTR	FTBNUL	FXDP	GAPP	GAPRS	GAPT
GASPLT	GASP	GASREL	HCFF	INIT	LACE	LCFF	MELT
MSET	NDTR	NEWG	NSET	PGHD	PLNT	PLTI	PLTO
PLTW	POINTR	POLA	PRTI	PRT2	PWRD	REPK	RESTFS
RMESH	SCC	SETUP	SIMQ	STOR	STRN	STRS	SWEL
TAPE	TERP	TMPSUB	TOTG	UDRIVER	UREADIN	UDESIGN	UPROD
UIDEA	UDIALOT	URUNFRP	UNAMES	UANSWER	UWRITER	UECHOI	VOLM
WNR10I780							

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$	TIDY	REALCM	INTGCM	INPRCM	INPICM	PHYPRO	DESNBL
MATCNS	PELPT	AN554	ASSIGN	AXHF	BDTR	BFRC	BNUP
BRST	CCRE	CCRK	CDTR	CEXP	CHECK	CLAD	CLDF
CLDG	CLOS	COND	COOL	CPLE	CRAK	CRAP	CREP
CRER	CRPR	DDLF	DFRC	DLGA	EFFCON	EMDNSF	EMFTCN
EMFTC	EMRLOC	EMS2	ENRG	EUMT	FALU	FBLK	FCMI
FENTHL	FEXP	FGRL	FLMD	FLOB	FLUXD	FRAC	FRPCON
FRAL	FSIG	FSTP	FSTR	FTBNUL	FXDP	GAPP	GAPRS
GAPT	GASPLT	GASP	GASREL	HCFF	INIT	LACE	LCFF
MELT	MSET	NDTR	NEWG	NSET	PGHD	PLNT	PLTI
PLTO	PLTW	POINTR	POLA	PRTI	PRT2	PWRD	REPK
RESTFS	RMESH	SCC	SETUP	SIMQ	STOR	STRN	STRS
SWEL	TAPE	TERP	TMPSUB	TOTG	UDRIVER	UREADIN	UDESIGN
UPROD	UIDEA	UDIALOT	URUNFRP	UNAMES	UANSWER	UWRITER	UECHOI
VOLM							

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

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YANK$$$  TIDY    REALCM  INTGCM  INPRCM  INPICM  PHYPRO  DESNBL
MATCNS   PELPT   AN554   ASSIGN  AXHF    BDTR    BFRC    BNUP
BRST     CCRE    CCRK    CDTR    CEXP    CHECK   CLAD    CLDF
CLDG     CLOS    COND    COOL    CPLE    CRAK    CRAP    CREP
CRER     CRPR    DDLF    DFRC    DLGA    EFFCON  EMDNSF  EMFTCN
EMFTC    EMRLOC  EMS2    ENRG    EUMT    FALU    FBLK    FCMI
FENTHL   FEXP    FGRL    FLMD    FLOB    FLUXD   FRAC    FRPCON
FRAL     FSIG    FSTP    FSTR    FTBNUL  FXDP    GAPP    GAPRS
GAPT     GASPLT  GASP    GASREL  HCFF    INIT    LACE    LCFF
MELT     MSET    NDTR    NEWG    NSET    PGHD    PLNT    PLTI
PLTO     PLTW    POINTR  POLA    PRTI    PRT2    PWRD    REPK
RESTFS   RMESH   SCC     SETUP   SIMQ    STOR    STRN    STRS
SWEL     TAPE    TERP    TMPSUB  TOTG    UDRIVER UREADIN UDESIGN
UPROD    UIDEA   UDIALOT URUNFRP UNAMES  UANSWER UWRITER UECHOI
VOLM
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COMMON DECKS ENCOUNTERED

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REALCM   INTGCM   INPRCM   INPICM   PHYPRO   DESNBL   MATCNS   PELPT
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DECKS WRITTEN TO COMPILE FILE

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TIDY     AN554    ASSIGN   AXHF     BDTR     BFRC     BNUP     BRST
CCRE     CCRK     CDTR     CEXP     CHECK    CLAD     CLDF     CLDG
CLOS     COND     COOL     CPLE     CRAK     CRAP     CREP     CRER
CRPR     DDLF     DFRC     DLGA     EFFCON   EMDNSF   EMFTCN   EMFTC
EMRLOC   EMS2     ENRG     EUMT     FALU     FBLK     FCMI     FENTHL
FEXP     FGRL     FLMD     FLOB     FLUXD    FRAC     FRPCON   FRAL
FSIG     FSTP     FSTR     FTBNUL   FXDP     GAPP     GAPRS    GAPT
GASPLT   GASP     GASREL   HCFF     INIT     LACE     LCFF     MELT
MSET     NDTR     NEWG     NSET     PGHD     PLNT     PLTI     PLTO
PLTW     POINTR   POLA     PRTI     PRT2     PWRD     REPK     RESTFS
RMESH    SCC      SETUP    SIMQ     STOR     STRN     STRS     SWEL
TAPE     TERP     TMPSUB   TOTG     UDRIVER  UREADIN  UDESIGN  UPROD
UIDEA    UDIALOT  URUNFRP  UNAMES   UANSWER  UWRITER  UECHOI   VOLM
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THIS UPDATE REQUIRED 35400B WORDS OF CORE.

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      SUBROUTINE ANS54 (NT,BURNUP,DFS,JPOW,NPOW,NTIME,RV,DV,NF,TIME,B,Q,  ANS54    2
     +RC,RDOT,NA,QMPY,JST,RELEAS,DEN,DCO,NREG,ANSD,FLXFAC,PF,ANSR,F,DT,D  ANS54    3
     +ECAY,HALF,PFAVE)                                                   ANS54    4
C                                                                        ANS54    5
C                                                                        ANS54    6
C  THIS SUBROUTINE CODED BY F E PANISKO AND W N RAUSCH OF BATTELLE       ANS54    7
C  PACIFIC NORTHWEST LABORATORIES, AUGUST 1979              PNL-3077     ANS54    8
C                                                                        ANS54    9
C                                                                        ANS54   10
C  THE FISSION GAS RELEASE IS CALCULATED INSIDE THE TIME STEP AND        ANS54   11
C  GAS PRESSURE LOOPS FOR EACH AXIAL REGION                              ANS54   12
C  THE FUEL TEMPEPATURES ARE CALCULATED INSIDE THE AXIAL LOOP.           ANS54   13
C  ONLY THE DIFFUSION PARAMETER, ANSD, NEED BE SAVED FOR EACH RADIAL     ANS54   14
C  AND AXIAL REGION EVERY TIME STEP                                      ANS54   15
C  BUT INSTEAD OF MAKING ANSD TRI-DIMENSIONED (TIMESTEP,RADIAL,AXIAL)    ANS54   16
C  FOR EXAMPLE ANSD(50,10,10) IT IS SINGLY DIMENSIONED ANSD(5000).       ANS54   17
C  A CODE INTERNAL POINTER KEEPS PROPER IDENTIFICATION OF EACH TIME STE  ANS54   18
C  VALUE FOR EACH RADIAL AND AXIAL REGION.                               ANS54   19
C  ALTHOUGH THE LOCAL GAS PRODUCTION RATE AND BURNUP ARE ALSO            ANS54   20
C  NEEDED THEY ARE CALCULATED AS THEY ARE NEEDED.                        ANS54   21
C                                                                        ANS54   22
C  *   ANS54 IS CALLED FROM FGASRE   ***                                 ANS54   23
C                                                                        ANS54   24
C  THE ANS STANDARD CALLS FOR AT LEAST SIX RADIAL REGIONS AND TEN OR     ANS54   25
C  MORE AXIAL REGIONS.   THE SUBROUTINE ESTABLISHES THE RADIAL           ANS54   26
C  DIVISIONS BUT THE NUMBER OF AXIAL REGIONS IS A USER INPUT.  ALSO,     ANS54   27
C  THE TIME STEP SIZE SHOULD BE 2000 MWD/MTM BURNUP OR SHORTER.          ANS54   28
C                                                                        ANS54   29
C  THE DIFFUSION PARAMETERS FOR IODINE, CESIUM, AND TELLURIUM ARE        ANS54   30
C  NOT CALCULATED BY THE CODE.                                           ANS54   31
C                                                                        ANS54   32
C  ***   ***   ***   ***   ***   ***   ***   ***   ***   ***   ***     ANS54   33
C                                                                        ANS54   34
C  INPUT ARGUMENTS                                                       ANS54   35
C                                                                        ANS54   36
C  NT IS THE CURRENT TIME STEP NUMBER                                    ANS54   37
C  BURNUP IS THE AXIAL LOCAL MID STEP VALUE IN MWD/MTM                   ANS54   38
C  DCO IS THE FABRICATED CLAD OD, INCHES                                 ANS54   39
C  DFS IS THE FABRICATED FUEL DIA.,INCHES                                ANS54   40
C  DV IS THE DIAMETER ARRAY ASSOCIATED WITH RV                           ANS54   41
C  FLOW IS THE FRACTION RELEASE PREDICTED BY THE LOW TEMP STABLE MODEL    ANS54   42
C  FLOWR IS THE FRACTION RELEASE PREDICTED BY THE LOW TEMP RADIOACTIVE    ANS54   43
C  MODEL                                                                 ANS54   44
C  FRDEN IS THE FRACTION OF THEORETICAL DENSITY                          ANS54   45
C  J IS AXIAL REGION COUNTER FOR FRAPCON                                 ANS54   46
C  JPOW IS AXIAL REGION COUNTER FOR ANS54                                ANS54   47
C  JST IS POINTER FOR TIME DEPENDENT AXIAL PROFILE                       ANS54   48
C  NA IS THE TOTAL NUMBER OF AXIAL NODES                                 ANS54   49
C  NPOW IS THE TOTHL NO. OF AXIAL REGIONS                                ANS54   50
C  NREG IS NUMBER OF RADIAL REGIONS IN THE FUEL, USER INPUT AS NGASR     ANS54   51
C  NTIME IS THE TOTAL NO. OF STEPS                                       ANS54   52
C  RV IS THE FUEL FLUX DEPRESSION ARRAY                                  ANS54   53
C  NF IS THE NUMBER OF FLUX DEPRESSION REGIONS IN THE FUEL               ANS54   54
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      C   TIME IS THE TIME HISTORY ARRAY, CUMULATIVE IN SECONDS                ANS54     55
55    C   Q IS AXIAL POWER PROFILE ARRAY                                        ANS54     56
      C   QMPY IS TIME DEPENDENT POWER ARRAY                                    ANS54     57
      C   SP IS THE SPECIFIC POWER(MEGAWATTS PER METRIC TON OF FUEL)            ANS54     58
      C   B IS ARRAY OF COEFFICIENTS FROM DDLF                                  ANS54     59
      C   POWR(QC) IS THE FUEL SURFACE HEAT FLUX FOR AN AXIAL REGION            ANS54     60
60    C   PF IS THE PRODUCTION FACTOR FOR FISSION GAS                           ANS54     61
      C   RC IS THE RADIUS OF THE ANNULUS                                       ANS54     62
      C   TT AND TS ARE THE FUEL RADIAL TEMP(F) AND DIMENSION (IN) ARRAYS       ANS54     63
      C   WF IS THE WEIGHTING FACTOR FOR THE RADIOACTIVE GAS RELEASE FRACTION   ANS54     64
      C   TO COMPENSATE FOR DIFFERENT PRODUCTION RATES IN DIFFERENT REGIONS     ANS54     65
65    C                                                                         ANS54     66
      C   OUTPUT ARGUMENTS                                                      ANS54     67
      C                                                                         ANS54     68
      C   RDOT IS THE GAS RELEASE FRACTION PER AXIAL NODE PER CUMULATIVE TIME   ANS54     69
      C   RELEAS IS THE FRACTION RELEASED FOR THE RADIOACTIVE GASES             ANS54     70
70    C                                                                         ANS54     71
      C   ***   ***   ***   ***   ***   ***   ***   ***   ***   ***   ***     ANS54     72
      C                                                                         ANS54     73
        DIMENSION QMPY(NTIME), Q(1), JST(NTIME)                                 ANS54     74
        DIMENSION TIME(NTIME)                                                   ANS54     75
75      DIMENSION RV(NF),DV(NF)                                                 ANS54     76
        DIMENSION B(6)                                                          ANS54     77
        DIMENSION TAU(2),GTAU(2)                                                ANS54     78
        DIMENSION ANSR(NREG), F(NREG), DT(NTIME), FLXFAC(NREG),                 ANS54     79
       +   PF(NREG,NPOW), ANSD(NREG)                                            ANS54     80
80      DIMENSION DECAY(11), RELEAS(11), HALF(11)                               ANS54     81
      C                                                                         ANS54     82
        FRDEN = DEN/100.                                                        ANS54     83
      C                                                                         ANS54     84
        RFS = DFS/2.                                                            ANS54     85
85      PI = 3.141592654                                                        ANS54     86
        PI2 = PI*PI                                                             ANS54     87
        PI4 = PI2*PI2                                                           ANS54     88
        FNREG = FLOAT(NREG)                                                     ANS54     89
        DVOIDZ = 2.*RC                                                          ANS54     90
90    C                                                                         ANS54     91
      C   THE FOLLOWING CALCULATIONS NEED BE DONE ONLY ONCE                     ANS54     92
        IF (NT.GT.1) GO TO 130                                                  ANS54     93
        IF (JPOW.GT.1) GO TO 130                                                ANS54     94
        IF (NPOW.LT.10) WRITE (6,350) NPOW                                      ANS54     95
95      ISTOP = 5000/(NREG*NPOW)                                                ANS54     96
        IF (NTIME.GT.ISTOP) GO TO 340                                           ANS54     97
        FLXTOT = 0.                                                             ANS54     98
        ANSDA = (DFS*DFS-DVOIDZ*DVOIDZ)/4./FNREG                                ANS54     99
        ROUTR = DFS/2.                                                          ANS54    100
100   C   CALCULATE RELATIVE PRODUCTION RATES IN EACH NREG FUEL REGION           ANS54    101
      C                                                                         ANS54    102
      C   ALL THE RADIAL REGIONS FORMED HERE HAVE EQUAL AREAS, NOT              ANS54    103
      C   EQUAL WIDTHS.                                                         ANS54    104
      C   ANSR = RADIUS TERM                                                    ANS54    105
105   C   ANSDIA = DIAMETER TERM                                                ANS54    106
      C   ANSDA = AREA TERM                                                     ANS54    107
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      C   ROUTR = RADIUS TERM                                                    ANS54   108
      C   ROUTR2 = AREA TERM                                                     ANS54   109
            DO 100 II=1,NREG                                                    ANS54   110
110         ROUTR2 = ROUTR*ROUTR                                                ANS54   111
            ANSR(II) = SQRT(ROUTR2-ANSDA/2.)                                    ANS54   112
            ANSDIA = ANSR(II)*2.                                                ANS54   113
            FLXFAC(II) = TERP(ANSDIA,DV,RV,NF)                                  ANS54   114
            IF (II.EQ.NREG) GO TO 100                                           ANS54   115
115         ROUTR = SQRT(ROUTR2-ANSDA)                                          ANS54   116
      100   FLXTOT = FLXTOT+FLXFAC(II)                                          ANS54   117
      C                                                                         ANS54   118
      C   NORMALIZE THE PRODUCTION RATE SO THEIR SUM EQUALS 1                   ANS54   119
            DO 110 II=1,NREG                                                    ANS54   120
120   110   FLXFAC(II) = FLXFAC(II)/FLXTOT                                      ANS54   121
        DT(1) = 0.                                                              ANS54   122
            DO 120 NI=2,NTIME                                                   ANS54   123
      C                                                                         ANS54   124
      C   DT(NI) IS THE TIME INCREMENT FOR STEP NI  UNITS ARE SECONDS          ANS54   125
125         DT(NI) = TIME(NI)-TIME(NI-1)                                        ANS54   126
      120   CONTINUE                                                            ANS54   127
      130   CONTINUE                                                            ANS54   128
      C                                                                         ANS54   129
      C   JPOW AND NOW II ARE THE LOCAL AXIAL REGION NUMBERS                    ANS54   130
130     II = JPOW                                                               ANS54   131
      C                                                                         ANS54   132
      C                                                                         ANS54   133
      C   CHECK ON THE SIZE OF PROBLEM                                         ANS54   134
      C                                                                         ANS54   135
135   C   ** TOP OF THE RADIAL REGION GAS RELEASE LOOP ******************        ANS54   136
            DO 200 I2=1,NREG                                                    ANS54   137
            PRDCT = FLXFAC(I2)*FNREG                                            ANS54   138
      C                                                                         ANS54   139
      C   JI IS THE POINTER FOR RADIAL REGION I2 FOR AXIAL REGION II FOR STEP   ANS54   140
140         JI = I2+NREG*(II-1)+NPOW*(NT-1)*NREG                                ANS54   141
            X = ANSR(I2)/RFS                                                    ANS54   142
            TEMPK = B(1)+X*B(2)+X*X*B(3)+X**3*B(4)+X**4*B(5)+X**5*B(6)          ANS54   143
            TEMPK = TEMPK+273.                                                  ANS54   144
      C                                                                         ANS54   145
145   C   ANSD AT 1400 DEG.C =2.2E-10=D*EXP(-72300./(1673R))                    ANS54   146
      C   SOLVING FOR D GIVES 0.61377                                          ANS54   147
      C   SO ANSD(JI) = 0.61377*EXP(-72300./(1.987*TEMPK))                     ANS54   148
            ANSD(JI) = 0.61377*EXP(-36386./TEMPK)                               ANS54   149
            BUP = BURNUP*PRDCT                                                  ANS54   150
150   C   CALCULATE DIFFUSION COEFFICIENT FOR LOCAL BURNUP                      ANS54   151
            ANSD(JI) = ANSD(JI)*100.**(BUP/28000.)                              ANS54   152
            A6 = 0.                                                             ANS54   153
            PREEX = 0.                                                          ANS54   154
            F(I2) = 0.0                                                         ANS54   155
155   C                                                                         ANS54   156
      C   WHEN NT EQ 1 TIME IS ASSUMNED TO BE ZERO SO SKIP GAS RELEASE         ANS54   157
            IF (NT.EQ.1) GO TO 210                                              ANS54   158
      C                                                                         ANS54   159
      C                                                                         ANS54   160
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      C   *** TOP OF THE TIME STEP LOOP *********                                  AN554   161
            IF (DT(NT).LT.86400.) GO TO 190                                       AN554   162
              DO 180 I3=2,NT                                                      AN554   163
              IF (DT(I3).LT.86400.) GO TO 180                                     AN554   164
      C   CONVERT SURFACE HEAT FLUX TO KW/FT                                      AN554   165
      165     POWR = QMPY(I3)*Q(IPOW+(JST(NT)-1)*NA)*DCO/13037.                   AN554   166
              TAU(1) = 0.                                                         AN554   167
                DO 140 I4=I3,NT                                                   AN554   168
                JZ = I2+NREG*(I1-1)+NPOW*(I4-1)*NREG                              AN554   169
      140       TAU(1) = TAU(1)+ANSD(JZ)*DT(I4)                                   AN554   170
      170     TAU(2) = 0.                                                         AN554   171
              JY = I2+NREG*(I1-1)+NPOW*(I3-1)*NREG                                AN554   172
              TAU(2) = TAU(1)-ANSD(JY)*DT(I3)                                     AN554   173
              A1 = 0.0                                                            AN554   174
      C                                                                           AN554   175
      175 C   THE FOLLOWING CARDS ARE FOR THE FINITE SUM                          AN554   176
                DO 170 I5=1,2                                                     AN554   177
                GTAU(I5) = 0.                                                     AN554   178
                IF (I5.EQ.2.AND.I3.EQ.NT) GO TO 170                               AN554   179
                IF (TAU(I5).GT.0.1) GO TO 150                                     AN554   180
      180       GTAU(I5) = 1.-4.*SQRT(TAU(I5)/PI)+1.5*TAU(I5)                     AN554   181
                GO TO 170                                                         AN554   182
      150       SUMM = 0.                                                         AN554   183
                  DO 160 I6=1,3                                                   AN554   184
                  X = FLOAT(I6)                                                   AN554   185
      185         X = X*X                                                         AN554   186
                  Y = -(X*PI2*TAU(I5))                                            AN554   187
                  IF (Y.LT.-200.) GO TO 160                                       AN554   188
                  SUMM = SUMM+EXP(Y)/(X*X*PI4)                                    AN554   189
      160         CONTINUE                                                        AN554   190
      190       GTAU(I5) = (1./(15.*TAU(I5))-(6.*SUMM/TAU(I5)))                   AN554   191
      170       CONTINUE                                                        AN554   192
              A1 = TAU(1)*GTAU(1)-TAU(2)*GTAU(2)                                  AN554   193
              JW = I2+NREG*(I1-1)+NPOW*(I3-1)*NREG                                AN554   194
              A5 = A1*PRDCT*POWR/ANSD(JW)                                         AN554   195
      195     DELEX = PRDCT*DT(I3)*POWR                                           AN554   196
      C   THE FOLLOWING CARD IS TO OBVIATE THE NEED FOR DOUBLE PRECISION          AN554   197
              IF (A5.GT.DELEX) A5 = DELEX                                         AN554   198
              A6 = A6+A5                                                          AN554   199
              PREEX = PREEX+DELEX                                                 AN554   200
      200 180 CONTINUE                                                            AN554   201
      C   *** BOTTOM OF THE TIME STEP LOOP *********                             AN554   202
      C                                                                           AN554   203
            F(I2) = 1.-A6/PREEX                                                   AN554   204
            RDOT = RDOT+F(I2)*FLXFAC(I2)                                          AN554   205
      205 190 CONTINUE                                                            AN554   206
          200 CONTINUE                                                            AN554   207
      C   BOTTOM OF THE RADIAL REGION GAS RELEASE LOOP ********************       AN554   208
      C   LOW TEMPERATURE RELEASE                                                 AN554   209
          FLOW = 1.E-7*BURNUP                                                     AN554   210
      210 IF (FLOW.GT.RDOT) RDOT = FLOW                                           AN554   211
      C                                                                           AN554   212
      210 CONTINUE                                                                AN554   213
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      C     ********************************************************************** ANS54   214
      C                                                                            ANS54   215
215   C     THE REMAINDER OF THE SUBROUTINE IS FOR THE CALCULATION OF THE          ANS54   216
      C     RADIOACTIVE GAS RELEASE FRACTION                                       ANS54   217
      C     FOR A SERIES OF DIFFERENT HALF-LIVES                                   ANS54   218
      C     THE STATEMENTS CALCULATE THE RELEASE AVERAGED OVER THE WHOLE ROD       ANS54   219
      C                                                                            ANS54   220
220   C     THE ANS SHORT HALF-LIVED RELEASE STANDARD IS VALID ONLY FOR WHEN       ANS54   221
      C     NO PREVIOUS BUILDUP IS PRESENT.  THIS REQUIRES A SHUTDOWN OF A         ANS54   222
      C     4*HALF-LIFE PERIOD OF TIME.  THE SUBROUTINE DOES NOT CONSIDER THIS     ANS54   223
      C     PROBLEM.                                                               ANS54   224
      C                                                                            ANS54   225
225         IF (JPOW.NE.1) GO TO 260                                               ANS54   226
            IF (NT.GT.1.AND.JST(NT).EQ.1) GO TO 240                                ANS54   227
      C     CALCULATE GAS PRODUCTION FACTORS TO USE AS WEIGHTING FACTORS FOR       ANS54   228
      C     AVERAGE RELEASE FRACTION FOR THE ROD                                   ANS54   229
            PFTOT = 0.0                                                            ANS54   230
230             DO 230 JJ=1,NPOW                                                   ANS54   231
                  DO 220 I=1,NREG                                                  ANS54   232
                  PF(I,JJ) = Q(JJ-1+(JST(NT)-1)*NA)*FLXFAC(I)                      ANS54   233
                  PFTOT = PFTOT+PF(I,JJ)                                           ANS54   234
220               CONTINUE                                                         ANS54   235
235   230       CONTINUE                                                           ANS54   236
            PFAVE = PFTOT/(NPOW*NREG)                                              ANS54   237
240   CONTINUE                                                                     ANS54   238
      C                                                                            ANS54   239
            DELTIM = 0.5                                                           ANS54   240
240         DO 250 I=1,11                                                          ANS54   241
            RTIME = 1.+(I-1)*DELTIM                                                ANS54   242
      C     HALF IS THE HALF LIVES OF THE ISOTOPES RANGING ON A LOG SCALE FROM     ANS54   243
      C     10 TO 1000000 SECONDS                                                  ANS54   244
            HALF(I) = 10.**RTIME                                                   ANS54   245
245         DECAY(I) = 1./HALF(I)                                                  ANS54   246
            RELEAS(I) = 0.0                                                        ANS54   247
250         CONTINUE                                                               ANS54   248
260   CONTINUE                                                                     ANS54   249
            IF (TIME(NT).LT.86400.) RETURN                                         ANS54   250
250         DO 320 I=1,NREG                                                        ANS54   251
            JI = I+NREG*(JPOW-1)+NPOW*(NT-1)*NREG                                  ANS54   252
            WF = PF(I,JPOW)/PFAVE                                                  ANS54   253
                  DO 310 JX=1,11                                                   ANS54   254
                  XMU = DECAY(JX)/ANSD(JI)                                         ANS54   255
255               TAUT = ANSD(JI)*TIME(NT)                                         ANS54   256
                  ARG = TAUT*XMU                                                   ANS54   257
                  IF (ARG.GT.675.) ARG = 675.                                      ANS54   258
                  IF (TAUT-0.1) 270,270,280                                        ANS54   259
270               CONTINUE                                                         ANS54   260
260   C     IF TAU IS LESS THAN OR EQUAL TO 0.1                                    ANS54   261
                  A = 3./(1.-EXP(-ARG))                                            ANS54   262
                  Z = ERF(SQRT(XMU*TAUT))                                          ANS54   263
                  C = 2.*SQRT(XMU*TAUT/PI)*EXP(-ARG)                               ANS54   264
                  P = (Z-C)/SQRT(XMU)                                              ANS54   265
265               E = (1.+XMU*TAUT)*EXP(-ARG)                                      ANS54   266
```

```
                      G = (1.-E)/XMU                                                ANS54     267
                      FRAC = A*(P-G)                                                ANS54     268
                      GO TO 300                                                     ANS54     269
            280       CONTINUE                                                      ANS54     270
270         C   IF TAU IS GREATER THAN 0.1                                          ANS54     271
                      A = 1./TANH(SQRT(XMU))                                        ANS54     272
                      Z = 3.*(A/SQRT(XMU)-1/XMU)                                    ANS54     273
                      C = 6.*XMU/(EXP(ARG)-1.)                                      ANS54     274
                      P = 0.0                                                       ANS54     275
275                       DO 290 IN=1,3                                             ANS54     276
                          N2 = IN*IN                                                ANS54     277
                          ARG2 = N2*PI2*TAUT                                        ANS54     278
                          IF (ARG2.GT.675.) ARG2 = 675.                             ANS54     279
                          H = 1.-EXP(-ARG2)                                         ANS54     280
280                       O = N2*PI2*(N2*PI2+XMU)                                   ANS54     281
                          P = P+H/O                                                 ANS54     282
            290           CONTINUE                                                  ANS54     283
                      FRAC = Z-C*P                                                  ANS54     284
            C   FRAC IS THE RELEASE FRACTION AT ANY ONE NODE(RADIAL,AXIAL,TIME STEP) ANS54     285
285         300       CONTINUE                                                      ANS54     286
                      FRAC = FRAC*WF                                                ANS54     287
            C   RELEASE SUMS THE FRACTION RELEASED FOR EACH AXIAL NODE DURING A      ANS54     288
            C   TIME STEP                                                          ANS54     289
                      RELEAS(JX) = RELEAS(JX)+FRAC                                  ANS54     290
290         310       CONTINUE                                                      ANS54     291
            320     CONTINUE                                                        ANS54     292
                  IF (JPOW.NE.NPOW) RETURN                                          ANS54     293
            C   THE FOLLOWING STATEMENTS WILL BE EXECUTED ONLY ONCE EACH TIME STEP  ANS54     294
                  TOTAL = NREG*NPOW                                                 ANS54     295
295                   DO 330 I=1,11                                                 ANS54     296
                      RELEAS(I) = RELEAS(I)/TOTAL                                   ANS54     297
            C   CONVERT SURFACE HEAT FLUX TO KW/FT                                 ANS54     298
                      POWR = QMPY(NT)*DCO/13037.                                    ANS54     299
            C   CONVERT KW/FT TO MW/MTM (SPECIFIC POWER)                           ANS54     300
300                   SP = POWR*0.001*(1./(12.*((DFS/2.)**2*PI))*1./(FRDEN*10.96))*1 ANS54     301
             +        .E6*6.102E-2                                                 ANS54     302
                      FLOWR = (1.E-7*SQRT(DECAY(I))+2.E-12*SP)/DECAY(I)            ANS54     303
                      IF (FLOWR.GT.RELEAS(I)) RELEAS(I) = FLOWR                    ANS54     304
            330       CONTINUE                                                      ANS54     305
305         C   THE RESULTS ARE OUTPUT BY A CALL TO GASPLT                         ANS54     306
            C   ********************************************************************* ANS54     307
            C                                                                       ANS54     308
                  RETURN                                                            ANS54     309
            C                                                                       ANS54     310
310         340   WRITE (6,360)                                                     ANS54     311
                  STOP " THIS STOP IS IN ANS54"                                     ANS54     312
            C                                                                       ANS54     313
            350   FORMAT (1X,100(1H*)/5X,"PROBLEM MAY NOT SATISFY CONDITIONS FOR ANS ANS54     314
                 +-5.4 FISSION GAS RELEASE STANDARD"/5X,"NUMBER OF AXIAL REGIONS ONL ANS54     315
315              +Y",I3/1X,100(1H*))                                                ANS54     316
            360   FORMAT (1H ,"THE PRODUCT OF NREG, NPOW, AND NTIME IS .GT. 5000.  " ANS54     317
                 +)                                                                 ANS54     318
                  END                                                               ANS54     319
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 ANS54 1 249 292 308

VARIABLES	SN	TYPE	RELOCATION										
1277	A	REAL			REFS	267	272	DEFINED	261	271			
0	ANSD	REAL	ARRAY	F.P.	REFS	78	151	169	172	194	254	255	
					DEFINED	1	148	151					
1231	ANSDA	REAL			REFS	111	115	DEFINED	98				
1235	ANSDIA	REAL			REFS	113	DEFINED	112					
0	ANSR	REAL	ARRAY	F.P.	REFS	78	112	141	DEFINED	1	111		
1276	ARG	REAL			REFS	257	261	263	265	273			
					DEFINED	256	257						
1310	ARG2	REAL			REFS	278	279	DEFINED	277	278			
1254	AI	REAL			REFS	194	DEFINED	173	192				
1262	[illegible]	REAL			REFS	197	198	DEFINED	194	197			
1245	[illegible]	REAL			REFS	198	203	DEFINED	152	198			
0	B	REAL	ARRAY	F.P.	REFS	76	6*142	DEFINED	1				
1244	BUP	REAL			REFS	151	DEFINED	149					
0	BURNUP	REAL		F.P.	REFS	149	209	DEFINED	1				
1301	C	REAL			REFS	264	283	DEFINED	263	273			
0	DCO	REAL		F.P.	REFS	165	298	DEFINED	1				
0	DECAY	REAL	ARRAY	F.P.	REFS	80	254	2*302	DEFINED	1	245		
1263	DELEX	REAL			REFS	2*197	199	DEFINED	195				
1270	DELTIM	REAL			REFS	241	DEFINED	239					
0	DEN	REAL		F.P.	REFS	82	DEFINED	1					
0	DFS	REAL		F.P.	REFS	84	2*98	99	300	DEFINED	1		
0	DT	REAL	ARRAY	F.P.	REFS	78	161	163	169	172	195		
					DEFINED	1	121	125					
0	DV	REAL	ARRAY	F.P.	REFS	75	113	DEFINED	1				
1226	DVOIDZ	REAL			REFS	2*98	DEFINED	89					
1303	E	REAL			REFS	266	DEFINED	265					
0	F	REAL	ARRAY	F.P.	REFS	78	204	DEFINED	1	154	203		
1264	FLOW	REAL			REFS	2*210	DEFINED	209					
1315	FLOWR	REAL			REFS	2*303	DEFINED	302					
0	FLXFAC	REAL	ARRAY	F.P.	REFS	78	116	120	137	204	232		
					DEFINED	1	113	120					
1230	FLXTOT	REAL			REFS	116	120	DEFINED	97	116			
1225	FNREC	REAL			REFS	98	137	DEFINED	88				
1305	FRAC	REAL			REFS	286	289	DEFINED	267	283	286		
1220	FRDEN	REAL			REFS	300	DEFINED	82					
1304	G	REAL			REFS	267	DEFINED	266					
1320	GTAU	REAL	ARRAY		REFS	77	2*192	DEFINED	177	180	190		
1311	H	REAL			REFS	281	DEFINED	279					
0	HALF	REAL	ARRAY	F.P.	REFS	80	245	DEFINED	1	244			
1267	I	INTEGER			REFS	2*232	233	241	244	2*245	246	251	
					252	2*296	2*302	2*303	DEFINED	231	240	250	
					295								
1306	IN	INTEGER			REFS	2*276	DEFINED	275					
1227	ISTOP	INTEGER			REFS	96	DEFINED	95					
1233	II	INTEGER			REFS	111	112	113	114	116	2*120	140	

VARIABLES	SN	TYPE		RELOCATION								
					168	171	193	DEFINED	109	119	130	
1237	I2	INTEGER			REFS	137	140	141	154	168	171	193
					203	2*204	DEFINED	136				
1247	I3	INTEGER			REFS	163	165	167	171	172	178	193
					195	DEFINED	162					
1251	I4	INTEGER			REFS	168	169	DEFINED	167			
1255	I5	INTEGER			REFS	177	178	179	3*180	186	3*190	
					DEFINED	176						
1257	I6	INTEGER			REFS	184	DEFINED	183				
1266	JJ	INTEGER			REFS	2*232	233	DEFINED	230			
0	JPOW	INTEGER		F.P.	REFS	93	130	165	225	251	252	292
					DEFINED	1						
0	JST	INTEGER	ARRAY	F.P.	REFS	73	165	226	232	DEFINED	1	
1261	JW	INTEGER			REFS	194	DEFINED	193				
1273	JX	INTEGER			REFS	254	2*289	DEFINED	253			
1253	JY	INTEGER			REFS	172	DEFINED	171				
1252	JZ	INTEGER			REFS	169	DEFINED	168				
1241	JI	INTEGER			REFS	148	2*151	254	255	DEFINED	140	251
0	NA	INTEGER		F.P.	REFS	165	232	DEFINED	1			
0	NF	INTEGER		F.P.	REFS	2*75	113	DEFINED	1			
0	NPOW	INTEGER		F.P.	REFS	78	2*94	95	140	163	171	193
					230	236	251	292	294	DEFINED	1	
0	NREG	INTEGER		F.P.	REFS	5*78	88	95	109	114	119	136
					2*140	2*168	2*171	2*193	231	236	250	2*251
					294	DEFINED	1					
0	NT	INTEGER		F.P.	REFS	92	140	157	161	162	165	167
					178	2*226	232	249	251	255	298	
					DEFINED	1						
0	NTIME	INTEGER		F.P.	REFS	2*73	74	78	96	122		
					DEFINED	1						
1236	N1	INTEGER			REFS	3*125	DEFINED	122				
1307	N2	INTEGER			REFS	277	2*280	DEFINED	276			
1312	O	REAL			REFS	281	DEFINED	280				
1302	P	REAL			REFS	267	281	283	DEFINED	264	274	281
0	PF	REAL	ARRAY	F.P.	REFS	78	233	252	DEFINED	1	232	
0	PFAVE	REAL		F.P.	REFS	252	DEFINED	1	236			
1265	PFTOT	REAL			REFS	233	236	DEFINED	229	233		
1222	PI	REAL			REFS	2*86	180	263	300	DEFINED	85	
1223	PI2	REAL			REFS	2*87	186	277	2*280	DEFINED	86	
1224	PI4	REAL			REFS	188	DEFINED	87				
1250	POWR	REAL			REFS	194	195	300	DEFINED	165	298	
1240	PRDCT	REAL			REFS	149	194	195	DEFINED	137		
1246	PREEX	REAL			REFS	199	203	DEFINED	153	199		
0	Q	REAL	ARRAY	F.P.	REFS	73	165	232	DEFINED	1		
0	QMPY	REAL	ARRAY	F.P.	REFS	73	165	298	DEFINED	1		
0	RC	REAL		F.P.	REFS	89	DEFINED	1				
0	RDOT	REAL		F.P.	REFS	204	210	DEFINED	1	204	210	
0	RELEAS	REAL	ARRAY	F.P.	REFS	80	289	296	303	DEFINED	1	246
					289	296	303					
1221	RFS	REAL			REFS	141	DEFINED	84				
1232	ROUTR	REAL			REFS	2*110	DEFINED	99	115			
1234	ROUTR2	REAL			REFS	111	115	DEFINED	110			
1271	RTIME	REAL			REFS	244	DEFINED	241				

VARIABLES	SN	TYPE	RELOCATION									
0	RV	REAL	ARRAY	F.P.	REFS	75	113	DEFINED	1			
1314	SP	REAL			REFS	302	DEFINED	300				
1256	SUMM	REAL			REFS	188	190	DEFINED	182	188		
1316	TAU	REAL	ARRAY		REFS	77	169	172	179	2*180	186	2*190
					2*192	DEFINED	166	169	170	172		
1275	TAUT	REAL			REFS	256	258	262	263	265	277	
					DEFINED	255						
1243	TEMPK	REAL			REFS	143	148	DEFINED	142	143		
0	TIME	REAL	ARRAY	F.P.	REFS	74	2*125	249	255	DEFINED	1	
1313	TOTAL	REAL			REFS	296	DEFINED	294				
1272	WF	REAL			REFS	286	DEFINED	252				
1242	X	REAL			REFS	6*142	2*185	186	2*188	DEFINED	141	184
					185							
1274	XMU	REAL			REFS	256	262	263	264	265	266	271
					2*272	273	280	DEFINED	254			
1260	Y	REAL			REFS	187	188	DEFINED	186			
1300	Z	REAL			REFS	264	283	DEFINED	262	272		

FILE NAMES	MODE				
TAPE6	FMT	WRITES	94	310	

EXTERNALS	TYPE	ARGS	REFERENCES						
ERF	REAL	1 LIBRARY	262						
EXP	REAL	1 LIBRARY	148	188	261	263	265	273	279
SQRT	REAL	1 LIBRARY	111	115	180	262	263	264	271	272	302
TANH	REAL	1 LIBRARY	271						
TERP	REAL	4	113						

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES	
FLOAT	REAL	1	INTRIN	88	184

STATEMENT LABELS			DEF LINE	REFERENCES		
122	100		116	109	114	
0	110		120	119		
0	120		125	122		
151	130		127	92	93	
0	140		169	167		
346	150		182	179		
372	160		189	183	187	
404	170		191	176	178	181
444	180		200	162	163	
460	190		205	161		
0	200		206	136		
473	210		212	157		
0	220		234	231		
0	230		235	230		
543	240		237	226		
0	250		247	240		
570	260		248	225		
0	270	INACTIVE	259	2*258		
713	280		269	258		
0	290		282	275		
776	300		285	268		

STATEMENT LABELS			DEF LINE	REFERENCES
0	310		290	253
0	320		291	250
0	330		304	295
1065	340		310	96
1133	350	FMT	313	94
1153	360	FMT	316	310

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
70	100	I1	109 116	37B		EXT REFS		
131	110	I1	119 120	5B	INSTACK			
142	120	N1	122 126	6B	INSTACK			
155	200	I2	136 206	306B		EXT REFS	EXITS	NOT INNER
243	180	I3	162 200	204B		EXT REFS	NOT INNER	
262	140	I4	167 169	14B	OPT			
317	170	I5	176 191	70B		EXT REFS	NOT INNER	
351	160	I6	183 189	24B		EXT REFS		
510	230	JJ	230 235	25B		NOT INNER		
512	220	I	231 234	20B	OPT			
547	250	I	240 247	20B		EXT REFS		
576	320	I	250 291	213B		EXT REFS	NOT INNER	
613	310	JX	253 290	173B		EXT REFS	NOT INNER	
740	290	IN	275 282	31B		EXT REFS		
1022	330	I	295 304	41B		EXT REFS		

STATISTICS

PROGRAM LENGTH 1461B 817

140000B SCM USED

```
      SUBROUTINE ASSIGN (LOCIDX,NPSTRT,MECHAN,LOCMEC)
C
C     IMPLICIT  REAL * 8 (A-H,O-Z)
C
C     ******************************************************************
C
C     ASSIGN IS CALLED FROM POINTR AND ASSIGNS THE CORRECT LOCATION ID
C     TO THE POINTERS OF THE POINTER COMMON BLOCK
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     LOCIDX - THE NUMBER OF DYNAMICALLY DIMENSIONED VARIABLES PLUS
C     NPSTRT
C     LOCMEC - THE NUMBER OF DYNAMICALLY DIMENSIONED VERIABLES FOR
C     FRACAS-2 OR PELET
C     MECHAN - MECHANICAL SUBCODE INDEX = 0 - MISTAKE
C     = 1 - PNL(PELET)
C     = 2 - INEL(FRACAS-1)
C     = 3 - INEL(FRACAS-2)
C     NPSTRT - THE NUMBER OF VARIABLES IN THE FRONT OF THE A-ARRAY USED
C     TO STORE SPECIAL INTEGERS
C
C     ******************************************************************
C
      COMMON / POINT /  IVAL
C
      COMMON / PNTINL / INELVL
C
C
      COMMON  / FAST / A
C
      DIMENSION  A(1)  , IA(1)
      DIMENSION IVAL(1), INELVL(1)
C
      EQUIVALENCE  ( A(1) , IA(1) )
C
      LOCID = LOCIDX-NPSTRT-LOCMEC
C
C     THE FOLLOWING ASSIGNS A-ARRAY POINTERS FOR THE BASIC VARIABLES
C     COMMON TO PNL AND INEL
C
          DO 100 I=1,LOCID
C
          IVAL(I) = IA(I+NPSTRT)
C
  100     CONTINUE
C
C
      IF (MECHAN.EQ.1.OR.MECHAN.EQ.2) GO TO 120
C
C
```

```
ASSIGN    2
ASSIGN    3
ASSIGN    4
ASSIGN    5
ASSIGN    6
ASSIGN    7
ASSIGN    8
ASSIGN    9
ASSIGN   10
ASSIGN   11
ASSIGN   12
ASSIGN   13
ASSIGN   14
ASSIGN   15
ASSIGN   16
ASSIGN   17
ASSIGN   18
ASSIGN   19
ASSIGN   20
ASSIGN   21
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ASSIGN   42
ASSIGN   43
ASSIGN   44
ASSIGN   45
ASSIGN   46
ASSIGN   47
ASSIGN   48
ASSIGN   49
ASSIGN   50
ASSIGN   51
ASSIGN   52
ASSIGN   53
ASSIGN   54
```

```
                C                                                                    ASSIGN     55
                C   THE FOLLOWING ASSIGNS ADDITIONAL POINTERS FOR FRACAS-2 OR AXISYM ASSIGN     56
55              C                                                                    ASSIGN     57
                      DO 110 I=1,LOCMEC                                              ASSIGN     58
                C                                                                    ASSIGN     59
                      INELVL(I) = IA(I+LOCID)                                        ASSIGN     60
60              C                                                                    ASSIGN     61
                110   CONTINUE                                                       ASSIGN     62
                C                                                                    ASSIGN     63
                C                                                                    ASSIGN     64
                120   CONTINUE                                                       ASSIGN     65
65              C                                                                    ASSIGN     66
                C                                                                    ASSIGN     67
                      RETURN                                                         ASSIGN     68
                      END                                                            ASSIGN     69
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	ASSIGN	1	67

VARIABLES

	SN	TYPE		RELOCATION						
0	A	REAL	ARRAY	FAST	REFS	32	34	37		
45	I	INTEGER			REFS	2*46	2*59	DEFINED	44	57
0	IA	INTEGER	ARRAY	FAST	REFS	34	37	46	59	
0	INELVL	INTEGER	ARRAY	PNTINL	REFS	29	35	DEFINED	59	
0	IVAL	INTEGER	ARRAY	POINT	REFS	27	35	DEFINED	46	
44	LOCID	INTEGER			REFS	44	59	DEFINED	39	
0	LOCIDX	INTEGER		F.P.	REFS	39	DEFINED	1		
0	LOCMEC	INTEGER		F.P.	REFS	39	57	DEFINED	1	
0	MECHAN	INTEGER		F.P.	REFS	2*51	DEFINED	1		
0	NPSTRT	INTEGER		F.P.	REFS	39	46	DEFINED	1	

STATEMENT LABELS

		DEF LINE	REFERENCES
0	100	48	44
0	110	61	57
43	120	64	51

LOOPS

	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
15	100	I	44 48	7B	INSTACK
33	110	I	57 61	7B	INSTACK

COMMON BLOCKS

	LENGTH
POINT	1
PNTINL	1
FAST	1

STATISTICS
PROGRAM LENGTH 51B 41
SCM LABELED COMMON LENGTH 3B 3
140000B SCM USED

```
      SUBROUTINE AXHEF (AVGQI,DELTAZ,FNZ,Q,QFI,XI,IQ,IRI,JJC,JN,JPEAK,NT  AXHF        2
     +,CODEID,NUNITS,MODLOP,QEND,NA,NXP,DLH,HA,HL,TITLE)                  AXHF        3
C                                                                         AXHF        4
C     IMPLICIT REAL*8 (A-H,O-Z)                                           AXHF        5
C                                                                         AXHF        6
      DIMENSION  AVGQI(1)    ,DLH(NA)     ,HA(NA)      ,HL(NA)      ,JN(1)  AXHF        7
     +          ,Q(NA,NXP)   ,QF(41)      ,QFI(1)      ,X(41)       ,XI(1)  AXHF        8
     +          ,CODEID(1)   ,QEND(NXP)   ,DELTAZ(NA)                       AXHF        9
      DIMENSION TITLE(12)                                                 AXHF       10
C                                                                         AXHF       11
C                                                                         AXHF       12
C     THIS SUVROUTINE IS CALLED FROM SETUP AND CALCULATES THE AXIAL       AXHF       13
C     POWER SHAPE FACTORS                                                 AXHF       14
C                                                                         AXHF       15
C     ********************************************************************AXHF       16
C     INPUT ARGUMENTS                                                     AXHF       17
C     ********************************************************************AXHF       18
C                                                                         AXHF       19
C     DELTAZ - LENGTH OF EACH AXIAL INCREMENT (FT)                        AXHF       20
C     FNZ    - AXIAL HOT CHANNEL FACTOR - RATIO OF PEAK TO AVE POWER      AXHF       21
C     QFI    - POINTWISE AXIAL HEAT FLUX NORMALIZATION FACTORS            AXHF       22
C     XI     - AXIAL STATIONS CORRESPONDING TO QFI ENTRIES (FT)           AXHF       23
C     IQ     - AXIAL POWER SHAPE INDEX, = 0, USER INPUT PROFILE           AXHF       24
C     = 1, CHOPPED COSINE PROFILE USED                                    AXHF       25
C     IRI    - NUMBER OF AXIAL INCREMENTS PLUS ONE                        AXHF       26
C     JJC    - TOTAL NUMBER OF AXIAL SHAPES                               AXHF       27
C     JN     - NUMBER OF POINTS DESCRIBING INPUT AXIAL SHAPE              AXHF       28
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                              AXHF       29
C     NT     - NUMBER OF AXIAL INCREMENTS                                 AXHF       30
C     NUNITS - UNIT INPUT INDEX,  = 0 , SI UNITS USED                     AXHF       31
C     = 1 , BRITISH UNITS USED                                            AXHF       32
C     NXP    - MAXIMUM NUMBER OF AXIAL POWER SHAPES                       AXHF       33
C     QEND   - NORMALIZED HEAT FLUX AT THE TOP OF THE STACK               AXHF       34
C                                                                         AXHF       35
C     ********************************************************************AXHF       36
C     OUTPUT ARGUMENTS                                                    AXHF       37
C     ********************************************************************AXHF       38
C                                                                         AXHF       39
C     AVGQI  - AVERAGE OF THE Q"S FOR EACH AXIAL SHAPE                    AXHF       40
C     DLH    - WORK ARRAY                                                 AXHF       41
C     HA     - WORK ARRAY                                                 AXHF       42
C     HL     - WORK ARRAY                                                 AXHF       43
C     Q      - UNNORMALIZED AXIAL INCREMENT POWER FACTORS                 AXHF       44
C     JPEAK  - PEAK POWER INCREMENT INDICATOR                             AXHF       45
C                                                                         AXHF       46
C     ********************************************************************AXHF       47
C                                                                         AXHF       48
C                                                                         AXHF       49
      K = 0                                                               AXHF       50
      DO 270 M=1,JJC                                                      AXHF       51
C                                                                         AXHF       52
      IF (IQ.GT.0) GO TO 170                                              AXHF       53
C                                                                         AXHF       54
```

```
                      JNM = JN(M)                                                                    AXHF       55
55                        DO 100 I=1,JNM                                                             AXHF       56
                          K = K+1                                                                    AXHF       57
                          X(I) = XI(K)                                                               AXHF       58
               100        QF(I) = QFI(K)                                                             AXHF       59
                      XCA = 0.0                                                                      AXHF       60
60                    QMAX = 0.0                                                                     AXHF       61
                      JT = 2                                                                         AXHF       62
                      QL = QF(1)                                                                     AXHF       63
                      XL = X(1)                                                                      AXHF       64
                        DO 160 J=2,IRI                                                               AXHF       65
65                      XCA = XCA+DELTAZ(J-1)                                                        AXHF       66
                        Q(J-1,M) = 0.0                                                               AXHF       67
               110      IF (XCA.LT.X(JT)) GO TO 120                                                  AXHF       68
                        QR = QF(JT)                                                                  AXHF       69
                        XR = X(JT)                                                                   AXHF       70
70                      IF (XR.GT.0.0) GO TO 130                                                     AXHF       71
                        XR = XL                                                                      AXHF       72
                        GO TO 130                                                                    AXHF       73
               120      QR = QF(JT-1)+(XCA-X(JT-1))*(QF(JT)-QF(JT-1))/(X(JT)-X(JT-                   AXHF       74
                    +   1))                                                                          AXHF       75
75                      XR = XCA                                                                     AXHF       76
               130      Q(J-1,M) = Q(J-1,M)+(QL+QR)*(XR-XL)/2.0                                      AXHF       77
                        QL = QR                                                                      AXHF       78
                        XL = XR                                                                      AXHF       79
                        JT = JT+1                                                                    AXHF       80
80                    C                                                                              AXHF       81
                      IF (X(JT-1).LE.0.0) GO TO 150                                                  AXHF       82
                      C                                                                              AXHF       83
                      IF (XCA-X(JT-1)) 140,150,110                                                   AXHF       84
                      C                                                                              AXHF       85
85             140      JT = JT-1                                                                    AXHF       86
               150      Q(J-1,M) = Q(J-1,M)/DELTAZ(J-1)                                              AXHF       87
                        IF (Q(J-1,M).LT.QMAX) GO TO 160                                              AXHF       88
                        QMAX = Q(J-1,M)                                                              AXHF       89
                        JPEAK = J                                                                    AXHF       90
90                    C                                                                              AXHF       91
                      C                                                                              AXHF       92
                      160      CONTINUE                                                              AXHF       93
                            GO TO 250                                                                AXHF       94
                      C                                                                              AXHF       95
95                    C                                                                              AXHF       96
                      C   CALCULATION OF CHOPPED COSINE AXIAL SHAPE                                   AXHF       97
                      C                                                                              AXHF       98
                      170      IF (FNZ.GE.1.5708) GO TO 180                                          AXHF       99
                               ALFZ = -6.3676150+FNZ*(7.9078237+FNZ*(2.3783171+FNZ*(-4.894014        AXHF      100
100                         +   7+FNZ*1.4154868)))                                                   AXHF      101
                               CSA = COS(ALFZ)                                                       AXHF      102
                               FZC = ALFZ/SIN(ALFZ)                                                  AXHF      103
                               GO TO 190                                                             AXHF      104
                      180      ALFZ = -1996.04088+FNZ*(4312.13343+FNZ*(-3140.42333+FNZ*(663.4        AXHF      105
105                         +   85456+FNZ*(77.9300994+FNZ*(83.4741199+FNZ*(-82.2246027+FNZ*15.       AXHF      106
                            +   4145631))))))                                                        AXHF      107
```

```
                      CSA = COS(ALFZ)                                          AXHF   108
                      CSI = 1.0/(1.0-CSA)                                      AXHF   109
                      FZC = ALFZ*(1.0-CSA)/(SIN(ALFZ)-ALFZ*CSA)                AXHF   110
110                   CS2 = FZC*CSA*CSI                                        AXHF   111
          190             DO 200 L=1,IR1                                       AXHF   112
                          HL(L) = 0.0                                          AXHF   113
          200             HA(L) = 0.0                                          AXHF   114
                      DTRM = 1.0/NT                                            AXHF   115
115                   DAF = 2.0*ALFZ*DTRM                                      AXHF   116
                      RDAF = 1.0/DAF                                           AXHF   117
                      SHA = 0.0                                                AXHF   118
                      AF2 = -ALFZ                                              AXHF   119
                C                                                              AXHF   120
120                   DO 220 L=1,NT                                            AXHF   121
                C                                                              AXHF   122
                          AF1 = AF2                                            AXHF   123
                          AF2 = AF1+DAF                                        AXHF   124
                          HLL = FZC*COS(AF1)                                   AXHF   125
125                       HAL = FZC*(SIN(AF2)-SIN(AF1))*RDAF                   AXHF   126
                          IF (FNZ.LT.1.5708) GO TO 210                         AXHF   127
                          HLL = CSI*HLL-CS2                                    AXHF   128
                          HAL = CSI*HAL-CS2                                    AXHF   129
          210             SHA = SHA+HAL                                        AXHF   130
130                       HL(L) = HLL                                          AXHF   131
                          HA(L) = HAL                                          AXHF   132
          220             CONTINUE                                             AXHF   133
                C                                                              AXHF   134
                      HL(1) = AMAX1(HL(1),0.E+0)                               AXHF   135
135                   HL(IR1) = AMAX1(FZC*CSA,0.E+0)                           AXHF   136
                      DLH(1) = 0.0                                             AXHF   137
                          DO 230 L=1,NT                                        AXHF   138
          230             DLH(L+1) = DLH(L)+HA(L)*DTRM                         AXHF   139
                      Q(1,M) = HA(1)/FZC                                       AXHF   140
140                   QMAX = 0.0                                               AXHF   141
                          DO 240 I=2,IR1                                       AXHF   142
                          Q(I,M) = HA(I)/FZC                                   AXHF   143
                          IF (Q(I-1,M).LE.QMAX) GO TO 240                      AXHF   144
                          QMAX = Q(I-1,M)                                      AXHF   145
145                       JPEAK = I                                            AXHF   146
                C                                                              AXHF   147
          240             CONTINUE                                             AXHF   148
                C                                                              AXHF   149
          250         SUMQ = 0.0                                               AXHF   150
150                       DO 260 I=1,NT                                        AXHF   151
                          SUMQ = SUMQ+Q(I,M)                                   AXHF   152
          260             CONTINUE                                             AXHF   153
                      AVGQI(M) = SUMQ/NT                                       AXHF   154
                C                                                              AXHF   155
155       270         CONTINUE                                                 AXHF   156
                  CALL PGHEAD (CODEID,MODLOP,TITLE)                            AXHF   157
                  WRITE (6,360)                                                AXHF   158
                  IF (IQ.EQ.0) WRITE (6,370) NT                                AXHF   159
                  IF (NUNITS.EQ.0) WRITE (6,390)                               AXHF   160
```

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      IF (NUNITS.EQ.1) WRITE (6,380)                                    AXHF  161
      IF (IQ.NE.0) GO TO 330                                            AXHF  162
      IF (NUNITS.EQ.1) GO TO 290                                        AXHF  163
          DO 280 II=1,328                                               AXHF  164
280       XI(II) = XI(II)*0.3048E+0                                     AXHF  165
290   CONTINUE                                                          AXHF  166
      JN1 = 1                                                           AXHF  167
      JN2 = JN(1)                                                       AXHF  168
          DO 300 M=1,JJC                                                AXHF  169
          WRITE (6,400) M                                               AXHF  170
          WRITE (6,410) (I,XI(I),I=JN1,JN2)                             AXHF  171
          WRITE (6,420) (I,QFI(I),I=JN1,JN2)                            AXHF  172
          JN1 = JN(M)+JN1                                               AXHF  173
300       JN2 = JN2+JN(M+1)                                             AXHF  174
      IF (NUNITS.EQ.1) GO TO 320                                        AXHF  175
          DO 310 II=1,328                                               AXHF  176
310       XI(II) = XI(II)/0.3048E+0                                     AXHF  177
320   CONTINUE                                                          AXHF  178
330   CONTINUE                                                          AXHF  179
      IF (IQ.EQ.0) GO TO 340                                            AXHF  180
      WRITE (6,430) FNZ,NT                                              AXHF  181
340   CONTINUE                                                          AXHF  182
      WRITE (6,440)                                                     AXHF  183
C                                                                       AXHF  184
      XC = -DELTAZ(2)/2.E0                                              AXHF  185
C                                                                       AXHF  186
          DO 350 J=2,IR1                                                AXHF  187
          XC = XC+(DELTAZ(J-1)+DELTAZ(J))/2.E0                          AXHF  188
          XCSI = XC*0.3048E+0                                           AXHF  189
          INCR = J-1                                                    AXHF  190
350       WRITE (6,450) INCR,XC,XCSI,(Q(J-1,M),M=1,JJC)                 AXHF  191
      WRITE (6,460) (AVGQI(M),M=1,JJC)                                  AXHF  192
      WRITE (6,470) (QEND(M),M=1,JJC)                                   AXHF  193
C                                                                       AXHF  194
      RETURN                                                            AXHF  195
C                                                                       AXHF  196
360   FORMAT (35X,63HXXXXXXXXXXXXXXX  AXIAL POWER SHAPE INFORMATION  XXX AXHF  197
     +XXXXXXXXXXXX)                                                     AXHF  198
370   FORMAT (/5X,27HAXIAL DISTRIBUTION IS INPUT,10X,26HROD AVERAGE POWE AXHF  199
     +R IS INPUT,10X,22HNUMBER OF AXIAL NODES=,I3)                      AXHF  200
380   FORMAT (60X,15HX'S  IN FEET   )                                   AXHF  201
390   FORMAT (59X,15HX'S  IN METERS )                                   AXHF  202
400   FORMAT (/32X,48HXXXXXXXXXXXXXXXXXXXXXX  INPUT AXIAL SHAPE NUMBER  ,I AXHF  203
     +3,23H  XXX XXXXXXXXXXXXXX /)                                      AXHF  204
410   FORMAT (7(4H  X(,I3,2H)=,F8.4,1X))                                AXHF  205
420   FORMAT (7(4H QF(,I3,2H)=,F8.4,1X))                                AXHF  206
430   FORMAT (/5X,45HAXIAL DISTRIBUTION IS CHOPPED COSINE FUNCTION,5X,29 AXHF  207
     +HPEAK TO AVERAGE POWER RATIO =,F7.4,5X,22HNUMBER OF INCREMENTS =,I AXHF  208
     +3)                                                                AXHF  209
440   FORMAT (/,3X,50HINCREMENT     AXIAL STATION          UNNORMALIZED AXHF  210
     +,/,15X,37HFEET       METERS          HEAT FLUX )                  AXHF  211
450   FORMAT (5X,I3,4X,F8.4,3X,F9.5,8X,8(3X,F8.4))                      AXHF  212
460   FORMAT (/,37X,7HAVGQI =,2X,F8.6,7(3X,F8.6))                       AXHF  213
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                470   FORMAT (/,6X,38HNORMALIZED HEAT FLUX AT TOP OF STACK =,F7.4,7(4X,F AXHF      214
                     +7.4))                                                              AXHF      215
    215              END                                                                 AXHF      216
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 AXHEF 1 194

VARIABLES	SN	TYPE	RELOCATION										
1163	AFI	REAL			REFS	123	124	125	DEFINED	122			
1162	AF2	REAL			REFS	122	125	DEFINED	118	123			
1150	ALFZ	REAL			REFS	101	2*102	107	3*109	115	118		
					DEFINED	99	104						
0	AVGQI	REAL	ARRAY	F.P.	REFS	6	191	DEFINED	1	153			
0	CODEID	REAL	ARRAY	F.P.	REFS	6	156	DEFINED	1				
1151	CSA	REAL			REFS	108	2*109	110	135	DEFINED	101	107	
1153	CSI	REAL			REFS	110	127	128	DEFINED	108			
1154	CS2	REAL			REFS	127	128	DEFINED	110				
1157	DAF	REAL			REFS	116	123	DEFINED	115				
0	DELTAZ	REAL	ARRAY	F.P.	REFS	6	65	86	184	2*187			
					DEFINED	1							
0	DLH	REAL	ARRAY	F.P.	REFS	6	138	DEFINED	1	136	138		
1156	DTRM	REAL			REFS	115	138	DEFINED	114				
0	FNZ	REAL		F.P.	REFS	98	4*99	7*104	126	180			
					DEFINED	1							
1152	FZC	REAL			REFS	110	124	125	135	139	142		
					DEFINED	102	109						
0	HA	REAL	ARRAY	F.P.	REFS	6	138	139	142	DEFINED	1	113	
					131								
1165	HAL	REAL			REFS	128	129	131	DEFINED	125	128		
0	HL	REAL	ARRAY	F.P.	REFS	6	134	DEFINED	1	112	130	134	
					135								
1164	HLL	REAL			REFS	127	130	DEFINED	124	127			
1137	I	INTEGER			REFS	57	58	2*142	143	144	145	151	
					2*170	2*171	DEFINED	55	141	150	170	171	
1167	II	INTEGER			REFS	2*164	2*176	DEFINED	163	175			
1174	INCR	INTEGER			REFS	190	DEFINED	189					
0	IQ	INTEGER		F.P.	REFS	52	158	161	179	DEFINED	1		
0	IR1	INTEGER		F.P.	REFS	64	111	135	141	186			
					DEFINED	1							
1145	J	INTEGER			REFS	65	66	2*76	3*86	87	88	89	
					2*187	189	190	DEFINED	64	186			
0	JJC	INTEGER		F.P.	REFS	50	168	190	191	192			
					DEFINED	1							
0	JN	INTEGER	ARRAY	F.P.	REFS	6	54	167	172	173			
					DEFINED	1							
1136	JNM	INTEGER			REFS	55	DEFINED	54					
1170	JN1	INTEGER			REFS	170	171	172	DEFINED	166	172		

VARIABLES	SN	TYPE		RELOCATION									
1171	JN2	INTEGER			REFS	170	171	173	DEFINED	167	173		
0	JPEAK	INTEGER		F.P.	DEFINED	1	89	145					
1142	JT	INTEGER			REFS	67	68	69	6*73	79	81	83	
						85	DEFINED	61	79	85			
1134	K	INTEGER			REFS	56	57	58	DEFINED	49	56		
1155	L	INTEGER			REFS	112	113	130	131	3*138			
					DEFINED	111	120	137					
1135	M	INTEGER			REFS	54	66	2*76	2*86	87	88	139	
						142	143	144	151	153	169	172	173
						190	191	192	DEFINED	50	168	190	191
						192							
0	MODLOP	INTEGER		F.P.	REFS	156	DEFINED	1					
0	NA	INTEGER		F.P.	REFS	5*6	DEFINED	1					
0	NT	INTEGER		F.P.	REFS	114	120	137	150	153	158	180	
					DEFINED	1							
0	NUNITS	INTEGER		F.P.	REFS	159	160	162	174	DEFINED	1		
0	NXP	INTEGER		F.P.	REFS	2*6	DEFINED	1					
0	Q	REAL	ARRAY	F.P.	REFS	6	76	86	87	88	143	144	
						151	190	DEFINED	1	66	76	96	139
						142							
0	QEND	REAL	ARRAY	F.P.	REFS	6	192	DEFINED	1				
1175	QF	REAL	ARRAY		REFS	6	62	68	3*73	DEFINED	58		
0	QF1	REAL	ARRAY	F.P.	REFS	6	58	171	DEFINED	1			
1143	QL	REAL			REFS	76	DEFINED	62	77				
1141	QMAX	REAL			REFS	87	143	DEFINED	60	88	140	144	
1146	QR	REAL			REFS	76	77	DEFINED	68	73			
1160	RDAF	REAL			REFS	125	DEFINED	116					
1161	SHA	REAL			REFS	129	DEFINED	117	129				
1166	SUMQ	REAL			REFS	151	153	DEFINED	149	151			
0	TITLE	REAL	ARRAY	F.P.	REFS	9	156	DEFINED	1				
1246	X	REAL	ARRAY		REFS	6	63	67	69	3*73	81	83	
					DEFINED	57							
1172	XC	REAL			REFS	187	188	190	DEFINED	184	187		
1140	XCA	REAL			REFS	65	67	73	75	83			
					DEFINED	59	65						
1173	XCSI	REAL			REFS	190	DEFINED	188					
1144	XL	REAL			REFS	71	76	DEFINED	63	78			
1147	XR	REAL			REFS	70	76	78	DEFINED	69	71	75	
0	XI	REAL	ARRAY	F.P.	REFS	6	57	164	170	176			
					DEFINED	1	164	176					

FILE NAMES	MODE									
TAPE6	FMT	WRITES	157	158	159	160	169	170	171	180
			182	190	191	192				

EXTERNALS	TYPE	ARGS		REFERENCES		
COS	REAL	1	LIBRARY	101	107	124
PGHEAD		3		156		
SIN	REAL	1	LIBRARY	102	109	2*125

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
AMAX1	REAL	0	INTRIN		134	135

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100		58	55	
62	110		67	83	
101	120		73	67	
112	130		76	70	72
0	140	INACTIVE	85	83	
142	150		86	81	83
163	160		92	64	87
170	170		98	52	
212	180		104	98	
245	190		111	103	
0	200		113	111	
325	210		129	126	
0	220		132	120	
0	230		138	137	
413	240		147	141	143
417	250		149	93	
0	260		152	150	
0	270		155	50	
0	280		164	163	
502	290		165	162	
0	300		173	168	
0	310		176	175	
567	320		177	174	
570	330		178	161	
575	340		181	179	
0	350		190	186	
761	360	FMT	196	157	
772	370	FMT	198	158	
1005	380	FMT	200	160	
1011	390	FMT	201	159	
1015	400	FMT	202	169	
1027	410	FMT	204	170	
1033	420	FMT	205	171	
1037	430	FMT	206	180	
1055	440	FMT	209	182	
1071	450	FMT	211	190	
1076	460	FMT	212	191	
1103	470	FMT	213	192	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
15	270	M	50 155	424B	EXT REFS NOT INNER
24	100	I	55 58	12B	INSTACK
52	160	J	64 92	114B	OPT
246	200	L	111 113	6B	INSTACK
273	220	L	120 132	45B	EXT REFS
353	230	L	137 138	6B	INSTACK
371	240	I	141 147	25B	OPT
422	260	I	150 152	10B	INSTACK
474	280	II	163 164	5B	INSTACK
510	300	M	168 173	44B	EXT REFS NOT INNER
516		I	170 170	7B	EXT REFS
533		I	171 171	7B	EXT REFS

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
561	310	II	175 176	5B	INSTACK
604	350	J	186 190	34B	EXT REFS NOT INNER
622		M	190 190	11B	EXT REFS

STATISTICS
PROGRAM LENGTH 1407B 775
140000B SCM USED

```
      C                                                                     BDTR       2
      C     ................................................................  BDTR       3
      C                                                                     BDTR       4
      C     SUBROUTINE BDTR                                                 BDTR       5
      C                                                                     BDTR       6
      C     PURPOSE                                                         BDTR       7
      C     COMPUTES P(X) = PROBABILITY THAT THE RANDOM VARIABLE U,         BDTR       8
      C     DISTRIBUTED ACCORDING TO THE BETA DISTRIBUTION WITH             BDTR       9
      C     PARAMETERS A AND B, IS LESS THAN OR EQUAL TO X.  F(A,B,X),      BDTR      10
      C     THE ORDINATE OF THE BETA DENSITY AT X, IS ALSO COMPUTED.        BDTR      11
      C                                                                     BDTR      12
      C     USAGE                                                           BDTR      13
      C     CALL BDTR(X,A,B,P,D,IER)                                        BDTR      14
      C                                                                     BDTR      15
      C     DESCRIPTION OF PARAMETERS                                       BDTR      16
      C     X   - INPUT SCALAR FOR WHICH P(X) IS COMPUTED.                  BDTR      17
      C     A   - BETA DISTRIBUTION PARAMETER (CONTINUOUS).                 BDTR      18
      C     B   - BETA DISTRIBUTION PARAMETER (CONTINUOUS).                 BDTR      19
      C     P   - OUTPUT PROBABILITY.                                       BDTR      20
      C     D   - OUTPUT DENSITY.                                           BDTR      21
      C     IER - RESULTANT ERROR CODE WHERE                                BDTR      22
      C     IER= 0 --- NO ERROR                                             BDTR      23
      C     IER=-1,+1  CDTR HAS BEEN CALLED AND AN ERROR HAS                BDTR      24
      C     OCCURRED.  SEE CDTR.                                            BDTR      25
      C     IER=-2 --- AN INPUT PARAMETER IS INVALID.  X IS LESS            BDTR      26
      C     THAN 0.0 OR GREATER THAN 1.0, OR EITHER A OR                    BDTR      27
      C     B IS LESS THAN 0.5 OR GREATER THAN 10**(+5).                    BDTR      28
      C     P AND D ARE SET TO -1.E75.                                      BDTR      29
      C     IER=+2 --- INVALID OUTPUT.  P IS LESS THAN ZERO OR              BDTR      30
      C     GREATER THAN ONE.  P IS SET TO 1.E75.                           BDTR      31
      C                                                                     BDTR      32
      C     REMARKS                                                         BDTR      33
      C     SEE MATHEMATICAL DESCRIPTION.                                   BDTR      34
      C                                                                     BDTR      35
      C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                   BDTR      36
      C     DLGAM                                                           BDTR      37
      C     NDTR                                                            BDTR      38
      C     CDTR                                                            BDTR      39
      C                                                                     BDTR      40
      C     METHOD                                                          BDTR      41
      C     REFER TO R.E. BARGMANN AND S.P. GHOSH, STATISTICAL              BDTR      42
      C     DISTRIBUTION PROGRAMS FOR A COMPUTER LANGUAGE,                  BDTR      43
      C     IBM RESEARCH REPORT RC-1094, 1963.                              BDTR      44
      C                                                                     BDTR      45
      C     ................................................................  BDTR      46
      C     ***  PART OF FRAIL FAILURE PACKAGE   ***                        BDTR      47
      C                                                                     BDTR      48
            SUBROUTINE BDTR (X,A,B,P,D,IER)                                 BDTR      49
            DOUBLE PRECISION XX,DLXX,DL1X,AA,BB,G1,G2,G3,G4,DD,PP,X0,FF,FN, BDTR      50
           +X1,SS,CC,RR,DLBETA                                              BDTR      51
      C                                                                     BDTR      52
      C     TEST FOR VALID INPUT DATA                                       BDTR      53
      C                                                                     BDTR      54
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```
                IF (A-1.E+5) 100,100,710                                  BDTR       55
55        100   IF (B-1.E+5) 110,110,710                                  BDTR       56
          110   IF (X) 680,120,120                                        BDTR       57
          120   IF (1.-X) 700,130,130                                     BDTR       58
                C                                                         BDTR       59
                C   COMPUTE LOG(BETA(A,B))                               BDTR       60
60              C                                                         BDTR       61
          130     AA = DBLE(A)                                            BDTR       62
                  BB = DBLE(B)                                            BDTR       63
                  CALL DLGAM (AA,G1,IOK)                                  BDTR       64
                  CALL DLGAM (BB,G2,IOK)                                  BDTR       65
65                CALL DLGAM (AA+BB,G3,IOK)                               BDTR       66
                  DLBETA = G1+G2-G3                                       BDTR       67
                C                                                         BDTR       68
                C   TEST FOR X NEAR 0.0 OR 1.0                            BDTR       69
                C                                                         BDTR       70
70                IF (X-1.E-8) 150,150,140                                BDTR       71
          140   IF ((1.-X)-1.E-8) 200,200,210                             BDTR       72
          150   P = 0.0                                                   BDTR       73
                IF (A-1.) 160,170,190                                     BDTR       74
          160   D = 1.E+75                                              BDTR       75
75                GO TO 730                                               BDTR       76
          170   DD = -DLBETA                                            BDTR       77
                IF (DD+1.68D02) 190,190,180                               BDTR       78
          180   DD = DEXP(DD)                                           BDTR       79
                D = SNGL(DD)                                            BDTR       80
80              GO TO 730                                                 BDTR       81
          190   D = 0.0                                                 BDTR       82
                GO TO 730                                                 BDTR       83
          200   P = 1.0                                                 BDTR       84
                IF (B-1.) 160,170,190                                     BDTR       85
85              C                                                         BDTR       86
                C   SET PROGRAM PARAMETERS                               BDTR       87
                C                                                         BDTR       88
          210   XX = DBLE(X)                                            BDTR       89
                DLXX = DLOG(XX)                                         BDTR       90
90              DLIX = DLOG(1.D0-XX)                                      BDTR       91
                XO = XX/(1.D0-XX)                                       BDTR       92
                ID = 0                                                  BDTR       93
                C                                                         BDTR       94
                C   COMPUTE ORDINATE                                     BDTR       95
95              C                                                         BDTR       96
                DD = (AA-1.D0)*DLXX+(BB-1.D0)*DLIX-DLBETA                 BDTR       97
                IF (DD-1.68D02) 220,220,230                               BDTR       98
          220   IF (DD+1.68D02) 240,240,250                               BDTR       99
          230   D = 1.E75                                               BDTR      100
100             GO TO 260                                                 BDTR      101
          240   D = 0.0                                                 BDTR      102
                GO TO 260                                                 BDTR      103
          250   DD = DEXP(DD)                                           BDTR      104
                D = SNGL(DD)                                            BDTR      105
105             C                                                         BDTR      106
                C   A OR B OR BOTH WITHIN 1.E-8 OF 1.0                    BDTR      107
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                C                                                                  BDTR      108
                260   IF (ABS(A-1.)-1.E-8) 270,270,280                             BDTR      109
                270   IF (ABS(B-1.)-1.E-8) 290,290,300                             BDTR      110
110             280   IF (ABS(B-1.)-1.E-8) 330,330,360                             BDTR      111
                290   P = X                                                        BDTR      112
                      GO TO 730                                                    BDTR      113
                300   PP = BB*DLIX                                                 BDTR      114
                      IF (PP+1.68D02) 310,310,320                                  BDTR      115
115             310   P = 1.0                                                      BDTR      116
                      GO TO 730                                                    BDTR      117
                320   PP = DEXP(PP)                                                BDTR      118
                      PP = 1.D0-PP                                                 BDTR      119
                      P = SNGL(PP)                                                 BDTR      120
120                   GO TO 670                                                    BDTR      121
                330   PP = AA*DLXX                                                 BDTR      122
                      IF (PP+1.68D02) 340,340,350                                  BDTR      123
                340   P = 0.0                                                      BDTR      124
                      GO TO 730                                                    BDTR      125
125             350   PP = DEXP(PP)                                                BDTR      126
                      P = SNGL(PP)                                                 BDTR      127
                      GO TO 670                                                    BDTR      128
                C                                                                  BDTR      129
                C   TEST FOR A OR B GREATER THAN 1000.0                           BDTR      130
130             C                                                                  BDTR      131
                360   IF (A-1000.) 370,370,380                                     BDTR      132
                370   IF (B-1000.) 400,400,390                                     BDTR      133
                380   XX = 2.D0*AA/XO                                              BDTR      134
                      XS = SNGL(XX)                                                BDTR      135
135                   AA = 2.D0*BB                                                 BDTR      136
                      DF = SNGL(AA)                                                BDTR      137
                      CALL CDTR (XS,DF,P,DUMMY,IER)                                BDTR      138
                      P = 1.0-P                                                    BDTR      139
                      GO TO 740                                                    BDTR      140
140             390   XX = 2.D0*BB*XO                                              BDTR      141
                      XS = SNGL(XX)                                                BDTR      142
                      AA = 2.D0*AA                                                 BDTR      143
                      DF = SNGL(AA)                                                BDTR      144
                      CALL CDTR (XS,DF,P,DUMMY,IER)                                BDTR      145
145                   GO TO 740                                                    BDTR      146
                C                                                                  BDTR      147
                C   SELECT PARAMETERS FOR CONTINUED FRACTION COMPUTATION           BDTR      148
                C                                                                  BDTR      149
                400   IF (X-.5) 410,410,450                                        BDTR      150
150             410   IF (AA-1.D0) 420,420,430                                     BDTR      151
                420   RR = AA+1.D0                                                 BDTR      152
                      GO TO 440                                                    BDTR      153
                430   RR = AA                                                      BDTR      154
                440   DD = DLXX/5.D0                                               BDTR      155
155                   DD = DEXP(DD)                                                BDTR      156
                      DD = (RR-1.D0)-(RR+BB-1.D0)*XX*DD+2.D0                       BDTR      157
                      IF (DD) 490,490,500                                          BDTR      158
                450   IF (BB-1.D0) 460,460,470                                     BDTR      159
                460   RR = BB+1.D0                                                 BDTR      160
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                      GO TO 480                                                  BDTR      161
                470   RR = BB                                                    BDTR      162
                480   DD = DLIX/5.D0                                             BDTR      163
                      DD = DEXP(DD)                                              BDTR      164
                      DD = (RR-1.D0)-(AA+RR-1.D0)*(1.D0-XX)*DD+2.D0              BDTR      165
                      IF (DD) 500,500,490                                        BDTR      166
                490   ID = I                                                     BDTR      167
                      FF = DLIX                                                  BDTR      168
                      DLIX = DLXX                                                BDTR      169
                      DLXX = FF                                                  BDTR      170
                      XO = 1.D0/XO                                               BDTR      171
                      FF = AA                                                    BDTR      172
                      AA = BB                                                    BDTR      173
                      BB = FF                                                    BDTR      174
                      G2 = G1                                                    BDTR      175
                C                                                                BDTR      176
                C   TEST FOR A LESS THAN 1.0                                     BDTR      177
                C                                                                BDTR      178
                500   FF = 0.D0                                                  BDTR      179
                      IF (AA-1.D0) 510,510,540                                   BDTR      180
                510   CALL DLGAM (AA+1.D0,G4,IOK)                                BDTR      181
                      DD = AA*DLXX+BB*DLIX+G3-G2-G4                              BDTR      182
                      IF (DD+1.68D02) 530,530,520                                BDTR      183
                520   FF = FF+DEXP(DD)                                           BDTR      184
                530   AA = AA+1.D0                                               BDTR      185
                C                                                                BDTR      186
                C   COMPUTE P USING CONTINUED FRACTION EXPANSION                  BDTR      187
                C                                                                BDTR      188
                540   FN = AA+BB-1.D0                                            BDTR      189
                      RR = AA-1.D0                                               BDTR      190
                      II = 80                                                    BDTR      191
                      XI = FLOAT(II)                                             BDTR      192
                      SS = ((BB-XI)*(RR+XI))/((RR+2.D0*XI-1.D0)*(RR+2.D0*XI))    BDTR      193
                      SS = SS*XO                                                 BDTR      194
                         DO 550 I=1,79                                           BDTR      195
                         II = 80-I                                               BDTR      196
                         XI = FLOAT(II)                                          BDTR      197
                         DD = (XI*(FN+XI))/((RR+2.D0*XI+1.D0)*(RR+2.D0*XI))      BDTR      198
                         DD = DD*XO                                              BDTR      199
                         CC = ((BB-XI)*(RR+XI))/((RR+2.D0*XI-1.D0)*(RR+2.D0*XI)) BDTR      200
                         CC = CC*XO                                              BDTR      201
                         SS = CC/(1.D0+DD/(1.D0-SS))                             BDTR      202
                550      CONTINUE                                                BDTR      203
                      SS = 1.D0/(1.D0-SS)                                        BDTR      204
                      IF (SS) 720,720,560                                        BDTR      205
                560   CALL DLGAM (AA+BB,G1,IOK)                                  BDTR      206
                      CALL DLGAM (AA+1.D0,G4,IOK)                                BDTR      207
                      CC = G1-G2-G4+AA*DLXX+(BB-1.D0)*DLIX                       BDTR      208
                      PP = CC+DLOG(SS)                                           BDTR      209
                      IF (PP+1.68D02) 570,570,580                                BDTR      210
                570   PP = FF                                                    BDTR      211
                      GO TO 590                                                  BDTR      212
                580   PP = DEXP(PP)+FF                                           BDTR      213
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                590   IF (1D) 610,610,600                                    BDTR  214
                600   PP = 1.D0-PP                                           BDTR  215
215             610   P = SNGL(PP)                                           BDTR  216
                      C                                                      BDTR  217
                      C   SET ERROR INDICATOR                                BDTR  218
                      C                                                      BDTR  219
                            IF (P) 620,640,640                               BDTR  220
220             620   IF (ABS(P)-1.E-7) 630,630,720                          BDTR  221
                630   P = 0.0                                                BDTR  222
                            GO TO 730                                        BDTR  223
                640   IF (1.-P) 650,670,670                                  BDTR  224
                650   IF (ABS(1.-P)-1.E-7) 660,660,720                       BDTR  225
225             660   P = 1.0                                                BDTR  226
                            GO TO 730                                        BDTR  227
                670   IF (P-1.E-8) 680,680,690                               BDTR  228
                680   P = 0.0                                                BDTR  229
                            GO TO 730                                        BDTR  230
230             690   IF ((1.0-P)-1.E-8) 700,700,730                         BDTR  231
                700   P = 1.0                                                BDTR  232
                            GO TO 730                                        BDTR  233
                710   IER = -2                                               BDTR  234
                            D = -1.E75                                       BDTR  235
235                         P = -1.E75                                       BDTR  236
                            GO TO 740                                        BDTR  237
                720   IER = +2                                               BDTR  238
                            P = 1.E75                                        BDTR  239
                            GO TO 740                                        BDTR  240
240             730   IER = 0                                                BDTR  241
                740   RETURN                                                 BDTR  242
                      END                                                    BDTR  243
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	BDTR	48	241

VARIABLES		SN	TYPE	RELOCATION								
0	A		REAL	F.P.	REFS	54	61	73	108	131		
					DEFINED	48						
1512	AA		DOUBLE		REFS	49	63	65	96	121	133	136
						142	143	150	151	153	164	171	179
						180	181	184	188	189	205	206	207
					DEFINED	61	135	142	172	184			
0	B		REAL	F.P.	REFS	55	62	84	109	110	132		
					DEFINED	48							
1514	BB		DOUBLE		REFS	49	64	65	96	113	135	140	
						156	158	159	161	172	181	188	192
						199	205	207	DEFINED	62	173		
1544	CC		DOUBLE		REFS	49	200	201	208	DEFINED	199	200	

VARIABLES	SN	TYPE	RELOCATION								
				207							
0	D	REAL	F.P.	DEFINED	48	74	79	81	99	101	104
				234							
1526	DD	DOUBLE		REFS	49	77	78	79	97	98	103
				104	155	156	157	163	164	165	182
				183	198	201	DEFINED	76	78	96	103
				154	155	156	162	163	164	181	197
				198							
1555	DF	REAL		REFS	137	144	DEFINED	136	143		
1550	DLBETA	DOUBLE		REFS	49	76	96	DEFINED	66		
1506	DLXX	DOUBLE		REFS	49	96	121	154	168	181	207
				DEFINED	89	169					
1510	DLIX	DOUBLE		REFS	49	96	113	162	167	181	207
				DEFINED	90	168					
1556	DUMMY	REAL		REFS	137	144					
1534	FF	DOUBLE		REFS	49	169	173	183	210	212	
				DEFINED	167	171	178	183			
1536	FN	DOUBLE		REFS	49	197	DEFINED	188			
1516	G1	DOUBLE		REFS	49	63	66	174	205	207	
1520	G2	DOUBLE		REFS	49	64	66	181	207		
				DEFINED	174						
1522	G3	DOUBLE		REFS	49	65	66	181			
1524	G4	DOUBLE		REFS	49	180	181	206	207		
1560	I	INTEGER		REFS	195	DEFINED	194				
1553	ID	INTEGER		REFS	213	DEFINED	92	166			
0	IER	INTEGER	F.P.	REFS	137	144	DEFINED	48	233	237	240
1557	II	INTEGER		REFS	191	196	DEFINED	190	195		
1552	IOK	INTEGER		REFS	63	64	65	180	205	206	
0	P	REAL	F.P.	REFS	137	138	144	219	220	223	224
				227	230	DEFINED	48	72	83	111	115
				119	123	126	138	215	221	225	228
				231	235	238					
1530	PP	DOUBLE		REFS	49	114	117	118	119	122	125
				126	209	212	214	215	DEFINED	113	117
				118	121	125	208	210	212	214	
1546	RR	DOUBLE		REFS	49	2*156	2*164	3*192	2*197	3*199	
				DEFINED	151	153	159	161	189		
1542	SS	DOUBLE		REFS	49	193	201	203	204	208	
				DEFINED	192	193	201	203			
0	X	REAL	F.P.	REFS	56	57	70	71	88	111	149
				DEFINED	48						
1540	XI	DOUBLE		REFS	49	4*192	4*197	4*199	DEFINED	191	196
1532	XO	DOUBLE		REFS	49	133	140	170	193	198	200
				DEFINED	91	170					
1554	XS	REAL		REFS	137	144	DEFINED	134	141		
1504	XX	DOUBLE		REFS	49	89	90	2[illegible]	134	141	156
				164	DEFINED	88	133	140			

EXTERNALS	TYPE	ARGS	REFERENCES							
CDTR		5	137	144						
DEXP	DOUBLE	1 LIBRARY	78	103	117	125	155	163	183	212
DLGAM		3	63	64	65	180	205	206		
DLOG	DOUBLE	1 LIBRARY	89	90	208					

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES						
ABS	REAL	1	INTRIN		108	109	110	220	224		
DBLE	DOUBLE	1	INTRIN		61	62	88				
FLOAT	REAL	1	INTRIN		191	196					
SNGL	REAL	1	INTRIN		79	104	119	126	134	136	141	143
					215						

STATEMENT LABELS			DEF LINE	REFERENCES		
0	100	INACTIVE	55	2*54		
0	110	INACTIVE	56	2*55		
0	120	INACTIVE	57	2*56		
0	130	INACTIVE	61	2*57		
0	140	INACTIVE	71	70		
71	150		72	2*70		
77	160		74	73	84	
103	170		76	73	84	
0	180	INACTIVE	78	77		
122	190		81	73	2*77	84
125	200		83	2*71		
134	210		88	71		
0	220	INACTIVE	98	2*97		
226	230		99	97		
232	240		101	2*98		
235	250		103	98		
243	260		108	100	102	
0	270	INACTIVE	109	2*108		
257	280		110	108		
265	290		111	2*109		
271	300		113	109		
0	310	INACTIVE	115	2*114		
307	320		117	114		
323	330		121	2*110		
0	340	INACTIVE	123	2*122		
341	350		125	122		
350	360		131	110		
0	370	INACTIVE	132	2*131		
360	380		133	131		
415	390		140	132		
443	400		149	2*132		
0	410	INACTIVE	150	2*149		
0	420	INACTIVE	151	2*150		
463	430		153	150		
467	440		154	152		
534	450		158	149		
0	460	INACTIVE	159	2*158		
551	470		161	158		
555	480		162	160		
623	490		166	2*157	165	
661	500		178	157	2*165	
0	510	INACTIVE	180	2*179		
0	520	INACTIVE	183	182		
742	530		184	2*182		
750	540		188	179		

STATEMENT LABELS			DEF LINE	REFERENCES						
0	550		202	194						
0	560	INACTIVE	205	204						
0	570	INACTIVE	210	2*209						
1304	580		212	209						
1314	590		213	211						
0	600	INACTIVE	214	213						
1324	610		215	2*213						
0	620	INACTIVE	220	219						
0	630	INACTIVE	221	2*220						
1340	640		223	2*219						
0	650	INACTIVE	224	223						
0	660	INACTIVE	225	2*224						
1354	670		227	120	127	2*223				
1360	680		228	56	2*227					
1363	690		230	227						
1370	700		231	57	2*230					
1374	710		233	54	55					
1404	720		237	2*204	220	224				
1412	730		240	75	80	82	112	116	124	222	226	229
				230	232					
1414	740		241	139	145	236	239			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
1040	550	I	194 202	137B	OPT

STATISTICS

PROGRAM LENGTH 1561B 881

140000B SCM USED

```
      SUBROUTINE BFRAC (CTMAX,DOXIDE,HSTRES,HYDRO,IODINE,STRESS,TCLAD,TI BFRC
     +MEF,BPFR,HSTRAN,STRANR,HSTSTE,IFBSW)                               BFRC
C                                                                        BFRC
C     IMPLICIT REAL*8(A-H,O-Z)                                           BFRC
C                                                                        BFRC
C     SUBROUTINE BFRAC PREDICTS THE PERCENTAGE OF FUEL RODS IN A SYSTEM  BFRC
C     THAT WILL FAIL DUE TO AN OVERSTRESS CONDITION                      BFRC
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                           BFRC
C                                                                        BFRC
C     --  INPUT ARGUMENTS  --                                            BFRC
C                                                                        BFRC
C     DOXIDE     DEPTH OF OXIDE LAYER ( PER CENT OF CLAD THICKNESS )     BFRC
C     HSTRES     ENGINEERING HOOP STRESS ( N/M2 )                        BFRC
C     HSTSTE     EFFECTIVE TRUE HOOP STRESS                              BFRC
C     HYDRO      CLADDING HYDROGEN CONTENT ( PPM )                       BFRC
C     IODINE     CLADDING IODINE CONTENT ( KG/ M3 )                      BFRC
C     STRESS     ENGINEERING EFFECTIVE STRESS ( N/M2 )                   BFRC
C     TCLAD      CLADDING TEMPERATURE ( DEG K )                          BFRC
C     TIMEF      TIME AT FLUX ( SEC )                                    BFRC
C                                                                        BFRC
C     -- OUTPUT ARGUMENTS  --                                           BFRC
C                                                                        BFRC
C     BFFR       FRACTION OF RODS THAT FAIL DUE TO OVERSTRESSING         BFRC
C                                                                        BFRC
C     REAL*8 IODINE                                                      BFRC
C        REAL IODINE                                                     BFRC
C                                                                        BFRC
      BPFR = 0.D0                                                        BFRC
      BPFR = 0.                                                          BFRC
      CALL FSIGT (CTMAX,HSTRES,TCLAD,TIMEF,BPFR,HSTRAN,STRANR,HSTSTE,IFB BFRC
     +SW)                                                                BFRC
C                                                                        BFRC
      RETURN                                                             BFRC
      END                                                                BFRC
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	BFRAC	1	34

VARIABLES	SN	TYPE		RELOCATION					
0	BPFR	REAL		F.P.	REFS	31	DEFINED	1	30
0	CTMAX	REAL		F.P.	REFS	31	DEFINED	1	
0	DOXIDE	REAL	*UNUSED	F.P.	DEFINED	1			
0	HSTRAN	REAL		F.P.	REFS	31	DEFINED	1	
0	HSTRES	REAL		F.P.	REFS	31	DEFINED	1	
0	HSTSTE	REAL		F.P.	REFS	31	DEFINED	1	
0	HYDRO	REAL	*UNUSED	F.P.	DEFINED	1			

VARIABLES	SN	TYPE	RELOCATION					
0	IFBSW	INTEGER		F.P.	REFS	31	DEFINED	1
0	IODINE	REAL	*UNUSED	F.P.	REFS	27	DEFINED	1
0	STRANR	REAL		F.P.	REFS	31	DEFINED	1
0	STRESS	REAL	*UNUSED	F.P.	DEFINED	1		
0	TCLAD	REAL		F.P.	REFS	31	DEFINED	1
0	TIMEF	REAL		F.P.	REFS	31	DEFINED	1

EXTERNALS	TYPE	ARGS	REFERENCES
FSIGT		9	31

STATISTICS
PROGRAM LENGTH 418 33
140000B SCM USED

```
      SUBROUTINE BURNUP (BU,BUI,BU2,CFV,DCO,FA,J,M,NA,NXP,Q,QMPY,RHOUO2,  BNUP       2
     +TOTL,IT,IM,BUIN,DELH,TIME,BUP,DELBU,DELBP,BUOLD,PI,ITT)             BNUP       3
C                                                                         BNUP       4
C     IMPLICIT  REAL * 8 ( A-H,O-Z )                                      BNUP       5
C                                                                         BNUP       6
C     ***************************************************************** BNUP       7
C                                                                         BNUP       8
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES THE BURNUP FOR     BNUP       9
C     NODE J DURING THE POWER-TIME STEP.                                  BNUP      10
C     BURNUP WAS CODED BY G A BERNA NOVEMBER 1977.                        BNUP      11
C                                                                         BNUP      12
C     ***************************************************************** BNUP      13
C     INPUT  ARGUMENTS                                                    BNUP      14
C     ***************************************************************** BNUP      15
C                                                                         BNUP      16
C     BUIN   - PROBLEM INITIAL BURNUP (MWD/MTU)                           BNUP      17
C     BUI    - BEGINING OF STEP BURNUP FOR NODE J (MWD/MTU)               BNUP      18
C     BUOLD  - ROD BURNUP TO BEGINNING OF POWER-TIME STEP (MWD/MTU)       BNUP      19
C     CFV    - COLD STATE FUEL VOLUME (CU.IN.)                            BNUP      20
C     DCO    - AS FABRICATED CLADDING OUTSIDE DIAMETER (IN)               BNUP      21
C     DELH   - TIME STEP SIZE (HOURS)                                     BNUP      22
C     FA     - RATIO OF PEAK TO AVERAGE POWER                             BNUP      23
C     IM     - TOTAL NUMBER OF POWER-TIME STEPS                           BNUP      24
C     IT     - POWER-TIME STEP INDEX                                      BNUP      25
C     ITT    - FIRST TIME THROUGH INDEX                                   BNUP      26
C     J      - AXIAL NODE INDEX                                           BNUP      27
C     M      - AXIAL POWER SHAPE INDEX                                    BNUP      28
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                              BNUP      29
C     NXP    - MAXIMUM NUMBER OF AXIAL POWER SHAPES                       BNUP      30
C     PI     - THE CONSTANT 3.1415926                                     BNUP      31
C     Q      - NORMALIZED AXIAL NODE POWER                                BNUP      32
C     QMPY   - ROD AVERAGE HEAT FLUX FOR POWER-TIME STEP (BTU/HR-FT**2)   BNUP      33
C     RHOUO2 - FUEL DENSITY (GM/IN**3)                                    BNUP      34
C     TIME   - TIME STEP ARRAY (SEC)                                      BNUP      35
C     TOTL   - FUEL STACK HEIGHT (FT)                                     BNUP      36
C                                                                         BNUP      37
C     ***************************************************************** BNUP      38
C     OUTPUT ARGUMENTS                                                    BNUP      39
C     ***************************************************************** BNUP      40
C                                                                         BNUP      41
C     BU     - ROD BURNUP FOR POWER-TIME STEP (MWD/MTU)                   BNUP      42
C     BUP    - ROD BURNUP FOR NODE J (MWS/KG)                             BNUP      43
C     BU2    - END OF STEP BURNUP FOR NODE J (MWD/MTU)                    BNUP      44
C     DELBP  - BURNUP DURING THE POWER-TIME STEP FOR NODE J (MWD/MTU)     BNUP      45
C     DELBU  - BURNUP DURING THE POWER-TIME STEP FOR THE ROD (MWD/MTU)    BNUP      46
C                                                                         BNUP      47
C     ***************************************************************** BNUP      48
C                                                                         BNUP      49
      DIMENSION     BUI(NA)       ,BU2(NA)       ,Q(NA,NXP)             BNUP      50
     +             ,QMPY(IM)      ,TIME(IM)                            BNUP      51
C                                                                         BNUP      52
C                                                                         BNUP      53
C     CALCULATION OF ROD AVERAGE HEAT FLUX AND BURNUP                     BNUP      54
```

```
      C                                                                     BNUP       55
55          IF (ITT.GT.1) GO TO 120                                         BNUP       56
            ITT = 2                                                         BNUP       57
      C                                                                     BNUP       58
            QBAR = (QMPY(1)*TIME(1))/(TIME(IM)*FA)                          BNUP       59
            IF (IM.LE.1) GO TO 110                                          BNUP       60
60              DO 100 I=2,IM                                               BNUP       61
100             QBAR = QBAR+(QMPY(I)*(TIME(I)-TIME(I-1)))/(TIME(IM)*FA)     BNUP       62
110         AMWDT = (DCO/12.*PI*TOTL*QBAR*TIME(IM)*1.2208E-8)/((238.0/270.0)*R BNUP       63
           +HOUO2*CFV*1.0E-6*3600.0)+BUIN                                   BNUP       64
            WRITE (6,140) AMWDT,QBAR                                        BNUP       65
65    C                                                                     BNUP       66
120         CONTINUE                                                        BNUP       67
      C                                                                     BNUP       68
            IF (J.GT.2) GO TO 130                                           BNUP       69
      C                                                                     BNUP       70
70          DELBU = (DCO/12.*PI*TOTL*QMPY(IT)*DELH*1.2208E-8)/(FA*(238.0/270.0 BNUP       71
           +)*RHOUO2*CFV*1.00E-6)                                           BNUP       72
            BU = BUOLD+DELBU                                                BNUP       73
      C                                                                     BNUP       74
130         CONTINUE                                                        BNUP       75
75    C                                                                     BNUP       76
            DELBP = DELBU*Q(J-1,M)*FA                                       BNUP       77
            BU2(J) = BU1(J)+DELBP                                           BNUP       78
            BUP = BU2(J)*86.4E0                                             BNUP       79
      C                                                                     BNUP       80
80          RETURN                                                          BNUP       81
      C                                                                     BNUP       82
140         FORMAT (///,27X,41H ROD AVE BURNUP AT END OF LIFE (AMWDT) = ,F9.1, BNUP       83
           +/27X,32H ROD TIME AVE HEAT FLUX (QBAR) =,F9.0,//)               BNUP       84
            END                                                             BNUP       85
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	BURNUP	1	80

VARIABLES	SN	TYPE		RELOCATION								
171	AMWDT	REAL			REFS	64	DEFINED	62				
0	BU	REAL		F.P.	DEFINED	1	72					
0	BUIN	REAL		F.P.	REFS	62	DEFINED	1				
0	BUOLD	REAL		F.P.	REFS	72	DEFINED	1				
0	BUP	REAL		F.P.	DEFINED	1	78					
0	BU1	REAL	ARRAY	F.P.	REFS	49	77	DEFINED	1			
0	BU2	REAL	ARRAY	F.P.	REFS	49	78	DEFINED	1	77		
0	CFV	REAL		F.P.	REFS	62	70	DEFINED	1			
0	DCO	REAL		F.P.	REFS	62	70	DEFINED	1			
0	DELBP	REAL		F.P.	REFS	77	DEFINED	1	76			
0	DELBU	REAL		F.P.	REFS	72	76	DEFINED	1	70		

VARIABLES SN TYPE RELOCATION

0	DELH	REAL		F.P.	REFS	70	DEFINED	1			
0	FA	REAL		F.P.	REFS	58	61	70	76	DEFINED	1
170	I	INTEGER			REFS	3*61	DEFINED	60			
0	IM	INTEGER		F.P.	REFS	2*49	58	59	60	61	62
					DEFINED	1					
0	IT	INTEGER		F.P.	REFS	70	DEFINED	1			
0	ITT	INTEGER		F.P.	REFS	55	DEFINED	1	56		
0	J	INTEGER		F.P.	REFS	68	76	2*77	78	DEFINED	1
0	M	INTEGER		F.P.	REFS	76	DEFINED	1			
0	NA	INTEGER		F.P.	REFS	3*49	DEFINED	1			
0	NXP	INTEGER		F.P.	REFS	49	DEFINED	1			
0	PI	REAL		F.P.	REFS	62	70	DEFINED	1		
0	Q	REAL	ARRAY	F.P.	REFS	49	76	DEFINED	1		
167	QBAR	REAL			REFS	61	62	64	DEFINED	58	61
0	QMPY	REAL	ARRAY	F.P.	REFS	49	58	61	70	DEFINED	1
0	RHOUO2	REAL		F.P.	REFS	62	70	DEFINED	1		
0	TIME	REAL	ARRAY	F.P.	REFS	49	2*58	3*61	62	DEFINED	1
0	TOTL	REAL		F.P.	REFS	62	70	DEFINED	1		

FILE NAMES MODE

TAPE6 FMT WRITES 64

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		61	60
43	110		62	59
65	120		66	55
113	130		74	68
143	140	FMT	82	64

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
31	100	I	60 61	11B	INSTACK

STATISTICS

PROGRAM LENGTH 200B 128

140000B SCM USED

```
      SUBROUTINE BURST (CTEMP,STRESS,BSTRES,BTEMP,DEVS,DEVT)
C
C   SUBROUTINE BURST PREDICTS THE BURST STRESS FOR STRESSES LESS
C   THAN 2000 PSI, AND THE BURST TEMPERATURE FOR STRESSES GREATER
C   THAN 2000 PSI. THESE AVERAGE VALUES ARE FOUND FROM A LEAST
C   SQUARES FIT OF ALL AVAILABLE TRANSIENT TEMPERATURE BURST DATA.
C   NO HEATING RATE OR ENVIRONMENT EFFECTS WERE FOUND. THE CORRELA-
C   TION IS FOR RUPTURE STRESS VS. RUPTURE TEMPERATURE.
C
C   ***  PART OF FRAIL FAILURE PACKAGE   ***
C
C   -- INPUT ARGUMENTS --
C
C   CTEMP      CLADDING TEMPERATURE ( DEG K )
C   STRESS     ENGINEERING HOOP STRESS ( N/M2 )
C
C
C   --OUTPUT ARGUMENTS --
C
C   BSTRES     AVERAGE BURST STRESS AT CTEMP ( N/M2 )
C   BTEMP      AVERAGE BURST TEMPERATURE AT STRESS ( DEG K )
C   DEVS       STANDARD DEVIATION OF BURST STRESS
C   DEVT       STANDARD DEVIATION OF BURST TEMPERATURE
C
C
      DATA A1, A2, A3, A4, A5 / 5.018866387E4, -3.71488713E0,
     +          7.0817526E-1, -2.580377E-2, -6.91874687555E4 /
      DATA A, B1, C1 / -1.827359E-2, 1.19190606E3, 2.563317625E5 /
C
      DATA CONVS, CONVT1, CONVT2 / 6.8947572E3, 4.5967E2, 1.8E0 /
C
C
      STRS = STRESS/CONVS
      TEMP = CONVT2*CTEMP-CONVT1
C
C   CALCULATE AVERAGE BURST TEMPERATURE
C
      IF (STRS.LT.2000.) GO TO 100
      TEMPB = (A1*STRS)/(A2+A3*STRS)+A4*STRS+A5
      BTEMP = (TEMPB+CONVT1)/CONVT2
      GO TO 110
C
C   CALCULATE AVERAGE BURST STRESS
C
100   B = B1-A3*TEMP
      C = C1-A2*TEMP
      SIG1 = (-B-SQRT(B*B-4.0*A*C))/(2.0*A)
      BSTRES = SIG1*CONVS
C
C
110   CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	BURST	1	52

VARIABLES	SN	TYPE	RELOCATION							
72	A	REAL			REFS	2*47	DEFINED	28		
65	A1	REAL			REFS	39	DEFINED	26		
66	A2	REAL			REFS	39	46	DEFINED	26	
67	A3	REAL			REFS	39	45	DEFINED	26	
70	A4	REAL			REFS	39	DEFINED	26		
71	A5	REAL			REFS	39	DEFINED	26		
106	B	REAL			REFS	3*47	DEFINED	45		
73	B1	REAL			REFS	45	DEFINED	28		
0	BSTRES	REAL		F.P.	DEFINED	1	48			
0	BTEMP	REAL		F.P.	DEFINED	1	40			
107	C	REAL			REFS	47	DEFINED	46		
74	C1	REAL			REFS	46	DEFINED	28		
75	CONVS	REAL			REFS	33	48	DEFINED	30	
76	CONVT1	REAL			REFS	34	40	DEFINED	30	
77	CONVT2	REAL			REFS	34	40	DEFINED	30	
0	CTEMP	REAL		F.P.	REFS	34	DEFINED	1		
0	DEVS	REAL	*UNUSED	F.P.	DEFINED	1				
0	DEVT	REAL	*UNUSED	F.P.	DEFINED	1				
110	SIG1	REAL			REFS	48	DEFINED	47		
0	STRESS	REAL		F.P.	REFS	33	DEFINED	1		
103	STRS	REAL			REFS	38	3*39	DEFINED	33	
104	TEMP	REAL			REFS	45	46	DEFINED	34	
105	TEMPB	REAL			REFS	40	DEFINED	39		

EXTERNALS	TYPE	ARGS		REFERENCES
SQRT	REAL	1	LIBRARY	47

STATEMENT LABELS		DEF LINE	REFERENCES
35	100	45	38
61	110	51	41

STATISTICS

PROGRAM LENGTH 111B 73

140000B SCM USED

```
      SUBROUTINE CCREEP (DVHPRS,TTT,EPS22,EPP2,FVFRO,SIG2,REPS2,EPS02,EP
     +2,GAP2,R22,ECREP2,PREPS2,PEPP2,OLDT2,PEP2,OLDPG2,OLDPC2,OLIGP2,IGA
     +P2,EPS0,MNR,MNA)
C
C   IMPLICIT REAL * 8 (A-H,O-Z)
C
      REAL  NU , KRYIN
C
      COMMON  / FAST / A
C
C
C
C   THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY
C   DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL
C
C
C
C   ( NA )      -  ARRAYS
C
      COMMON  / POINT /
     +       LDCIH    ,LURC     ,LCREP1   ,LDLH     ,LHA      ,LHL
     +      ,LPOROS   ,LUFS     ,LAXGAP   ,LAXLEN   ,LBU1     ,LBU2
     +      ,LARAD    ,LCPDLT   ,LDELBP   ,LDENMX   ,LDLPGE
     +      ,LDZ      ,LDZH     ,LDZHP    ,LECREP   ,LEP
     +      ,LGAP     ,LGPTP    ,LHCOEF   ,LOLAXG   ,LOLDPC
     +      ,LOLDPG   ,LOLDTC   ,LOLDUR   ,LOLEPS   ,LOLFEP
     +      ,LPAXGP   ,LPC      ,LPECRP   ,LPEP     ,LPG
     +      ,LPINT    ,LPLDPC   ,LPLDPG   ,LPLDTC   ,LPLDUR   ,LPOAXG
     +      ,LPOFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR
     +      ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF
     +      ,LVCH     ,LVCH1    ,LVCR     ,LVDH     ,LVFH     ,LVGH
     +      ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEP1
     +      ,LHGAPS   ,LTRTRN   ,LIGAP    ,LOLIGP   ,LQDP
     +      ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO
     +      ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO
C
C   ( NA X 2 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG
     +      ,LREPS2
C
C   ( NA X 3 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS
     +      ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS
     +      ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPP1
     +      ,LSIG1    ,LEPS1
C
C   ( NR )      -  ARRAYS
C
      COMMON  / POINT /
     +       LAK1     ,LAK2     ,LCRL     ,LDPL     ,LDPLH    ,LDPN
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      +       ,LFMA     ,LFMGPR   ,LHRL     ,LTFB     ,LTFR     ,LTFRK    REALCM     45
55    +       ,LVPL                                                       REALCM     46
      C                                                                   REALCM     47
      C     ( NR X 2 )  -  ARRAYS                                         REALCM     48
      C                                                                   REALCM     49
            COMMON  / POINT /                                             REALCM     50
60    +        LF       ,LFH      ,LFN                                    REALCM     51
      C                                                                   REALCM     52
      C     ( NR X NA ) -  ARRAYS                                         REALCM     53
      C                                                                   REALCM     54
            COMMON  / POINT /                                             REALCM     55
65    +        LCC1     ,LCC2     ,LDENSF   ,LDENSP   ,LDPW     ,LDPWPP   REALCM     56
      +       ,LGNSIZ   ,LPORS1   ,LPORS2   ,LTMPDS   ,LUO2LL   ,LTMPMX   REALCM     57
      +       ,LR       ,LRAD                                             REALCM     58
      C                                                                   REALCM     59
      C     ( NA X 6 )  -  ARRAYS                                         REALCM     60
70    C                                                                   REALCM     61
            COMMON  / POINT /                                             REALCM     62
      +        LB       ,LBR      ,LBTOLD   ,LCHEM                        REALCM     63
      C                                                                   REALCM     64
      C     ( NA X 8 )  -  ARRAYS                                         REALCM     65
75    C                                                                   REALCM     66
            COMMON  / POINT /                                             REALCM     67
      +        LQ                                                         REALCM     68
      C                                                                   REALCM     69
      C     ( IT )      -  ARRAYS                                         REALCM     70
80    C                                                                   REALCM     71
            COMMON  / POINT /        LACMFG    ,LACMHE   ,LACMH2   ,LACMN2 REALCM     72
      +                    ,LAMGPT   ,LGASMO   ,LHMGPT   ,LPIT     ,LPRT10 REALCM     73
      +       ,LPRT11   ,LPRT12   ,LPRT13   ,LPRT14   ,LPRT15   ,LPRT16   REALCM     74
      +       ,LPRT17   ,LPRT18   ,LPRT2    ,LPRT20   ,LPRT3    ,LPRT4    REALCM     75
85    +       ,LPRT5    ,LPRT6    ,LPRT7    ,LPRT8    ,LPRT9    ,LTAC     REALCM     76
      +       ,LTAFA    ,LTAGA    ,LTSF                                     REALCM     77
      C                                                                   REALCM     78
      C                                                                   REALCM     79
      C     ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME           REALCM     80
90    C                                                                   REALCM     81
            COMMON / POINT /                                              REALCM     82
      +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,        REALCM     83
      +   LDECAY,   LHALF,    LRLEAS                                      REALCM     84
      C                                                                   REALCM     85
95    C     BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME                  REALCM     86
      C                                                                   REALCM     87
            COMMON / POINT /                                              REALCM     88
      +   IRDOT,    ISAVGS,   LSTHIF,   IX                              REALCM     89
      C                                                                   REALCM     90
100   C     RADIAL MODEL ARRAYS                                           REALCM     91
      C                                                                   REALCM     92
            COMMON / POINT /                                              REALCM     93
      +   ICFAC     ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF       REALCM     94
      +  ,ITRAMP    ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV                 REALCM     95
105   +  ,IHLDN     ,IPLSTC   ,ISTRNN   ,ISTRSS                           REALCM     96
      C                                                                   REALCM     97
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      C                                                                                                  REALCM     98
      C                                                                                                  REALCM     99
      C                                                                                                  REALCM    100
110         COMMON / REALS /  AAA(20)  ,AAN       ,AIRIN     ,AMGP(2) ,AMGPH(2)                       REALCM    101
     +                     ,AMGR(2)  ,AMGRM(2)  ,AMGRN2(2),AMWDT    ,ANGI                          REALCM    102
     +           ,ANGT     ,AN2IN    ,ARGIN     ,ARING     ,AVGQI(8) ,B(6)                          REALCM    103
     +           ,BP       ,BPP      ,BR(6)     ,BU        ,BUOLD    ,CDG                           REALCM    104
     +           ,CFV      ,CFVA     ,CMOL      ,CODEID(15),CONVC,CONVER(10)                       REALCM    105
115  +           ,CPV      ,CRDTT    ,CRN       ,CVV       ,DCIH                                    REALCM    106
     +           ,DCIHP    ,DELBP    ,DELBU     ,DELH      ,DELT                                    REALCM    107
     +           ,DELTCR   ,DELTDB   ,DELTFC    ,DELTJL    ,DHIC     ,DLREL                         REALCM    108
     +           ,DLROD    ,DLTGC(26),DPH       ,DPHF      ,DPHFP    ,DPWP                          REALCM    109
     +           ,DRS      ,ENRICH   ,EOLSR     ,FC(1)     ,FGIN     ,FGPAVP                        REALCM    110
120   C                                                                                                  REALCM    111
      COMMON / REALS /  FGPAVX  ,FH2O     ,FJJ(2)    ,FJJH(2)  ,FMGP(2)                             REALCM    112
     +                 ,FPOR    ,FPORI    ,FRD       ,FRDH     ,FRDN                               REALCM    113
     +           ,G        ,GASES(7) ,GASIN    ,GDEN    ,GPTH(26) ,GPTHE(26)                       REALCM    114
     +           ,GPTHM    ,GPTHP    ,GPTHPG(26) ,GR     ,HCRV     ,HCV                           REALCM    115
125  +           ,HDSHV    ,HEIN     ,HFLL      ,HFLMDB    ,HFLMP    ,HFPER                         REALCM    116
     +           ,HFV      ,HGAPT    ,HGV       ,HI        ,HMGP(2)  ,HP                            REALCM    117
     +           ,HGAP     ,HSOLID   ,HGAPR                                                          REALCM    118
     +           ,HPL      ,HPORV    ,HPV       ,HUPTAK    ,H2OMI    ,KRYIN                         REALCM    119
     +           ,NU       ,OXDROP   ,OXIDE     ,PECDH     ,PI       ,PIN(26)                       REALCM    120
130  +           ,PINP     ,PORO     ,PR        ,PRESS     ,PRTY     ,PRT19                         REALCM    121
     +           ,QC       ,QP       ,QSP       ,RCI       ,RCO                                     REALCM    122
     +           ,QAV      ,QPEAK                                                                    REALCM    123
      C                                                                                                  REALCM    124
      COMMON / REALS /  RFNUFF  ,RHO      ,RHOF      ,RHOG     ,RHOU02                               REALCM    125
135  +                 ,RMH     ,RP       ,RSTRAN    ,RSTRES   ,RTRAN                              REALCM    126
     +           ,SKTC     ,SKTS     ,STRN      ,SUMCK     ,SUMDH    ,SUMEXP                        REALCM    127
     +           ,SUMGP    ,SUMPLR   ,SUMRG     ,SUMTF     ,T        ,TCAC                          REALCM    128
     +           ,TCI      ,TCO      ,TFBC      ,TFC       ,TFGFR    ,THEFR                         REALCM    129
     +           ,TH2OFR   ,TITLE(12),TM        ,TN2FR     ,TOXO     ,TP                            REALCM    130
140  +           ,TPA      ,TPAC     ,TPLEN     ,TRANST    ,TSAT     ,TT                            REALCM    131
     +           ,TX       ,TXA      ,TXAL      ,TXC       ,VISC     ,VPLT                          REALCM    132
     +           ,VSS      ,W        ,WT        ,WTRAN     ,XEIN     ,XK6                           REALCM    133
     +           ,XK7      ,YY       ,Z         ,ZRO2WG    ,VX       ,CLOS                          REALCM    134
     +           ,FNCK     ,FNCN     ,CWKF      ,CWNF      ,COLDWK                                  REALCM    135
145  +           ,DISH                                                                               REALCM    136
      C                                                                                                  REALCM    137
      C                                                                                                  INTGCM      2
      COMMON / INTEG /                                                                                  INTGCM      3
     +     IQUIT      ,IRI      ,IT        ,ITER      ,J                                             INTGCM      4
150  +    ,JJC       ,JPEAK    ,K         ,KINDOR    ,KOXI                                          INTGCM      5
     +    ,LMN       ,M        ,MODLOP    ,NAB       ,NPLAST                                        INTGCM      6
     +    ,NRMI      ,NSTEP    ,NWRITE    ,N2        ,IMDONE                                        INTGCM      7
     +    ,ICLOSE    ,NSH      ,NF        ,NC                                                       INTGCM      8
      C                                                                                                  INTGCM      9
155   C                                                                                                  INPRCM      2
      COMMON / INPTR /ACOR      ,AFAL     ,AFCR      ,AFDN                                          INPRCM      3
     +               ,AFGR      ,AFSW     ,AFTC      ,AGPC                                          INPRCM      4
     +    ,AMFAIR    ,AMFARG   ,AMFFG    ,AMFHE     ,AMFH2                                         INPRCM      5
     +    ,AMFH2O    ,AMFKRY   ,AMFN2    ,AMFXE                                                    INPRCM      6
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      +    ,BUIN(22)   ,CATEXF                                                    INPRCM     7
      +    ,CLDWKD     ,CPL        ,CRDT       ,CRDTR      ,CTMAX(22)            INPRCM     8
      +    ,DCI(22)    ,DCO(22)    ,DE(22)     ,DELTAZ(22) ,DEN                  INPRCM     9
      +    ,DENG       ,DISHSD     ,DP(22)     ,DSPG       ,DSPGW                INPRCM    10
      +    ,ENRCH      ,EXO        ,FA         ,FGPAV      ,FLUX                 INPRCM    11
      +    ,FLXDP      ,FQE        ,GO(101)    ,GRNSIZ     ,HDISH                INPRCM    12
      +    ,HPLT       ,PPMH2O     ,PPMN2      ,P2(101)    ,QEND(8)              INPRCM    13
      +    ,QF(328)    ,QMPY(101)  ,RAPOW(11)  ,RC         ,RDISH                INPRCM    14
      +    ,ROUGHC     ,ROUGHF     ,SGAPF                                        INPRCM    15
      +    ,TCC        ,TIME(101)  ,TOTL       ,TSINT      ,TW(101)              INPRCM    16
      +    ,UBFS       ,UMELT      ,UOFD       ,VS         ,X(328)               INPRCM    17
      +    ,RSNTR      ,FOTMTL     ,TREF       ,CREPHR     ,ANRIN                INPRCM    18
      +    ,CLDWKS                                                               INPRCM    19
      +    ,CP         ,CR                                                       INPRCM    20
      C                                                                          INPICM     2
       COMMON / INPTI /ICM        ,ICOR       ,IDBG       ,IDXGAS               INPICM     3
      +               ,IM         ,IPLANT     ,IQ         ,ISW                  INPICM     4
      +    ,JDLPR     ,JN(8)      ,JST(101)   ,MDBG       ,NHEAL                INPICM     5
      +    ,MODE      ,MODES      ,MTAPE      ,NDBG       ,NFROD                INPICM     6
      +    ,NGAPC     ,NGASR      ,NOFAIL     ,NOPT       ,NPCYCL               INPICM     7
      +    ,NPLTAS    ,NREAD      ,NRESTR     ,NROLL      ,NSP                  INPICM     8
      +    ,NSTART    ,NSTOP      ,NT         ,NTAPE      ,NUCFC                INPICM     9
      +    ,NUNITS    ,LACMOD     ,LACE(13)   ,NAFAIL     ,NNFAIL(22)           INPICM    10
      +    ,NXP       ,NPLOT      ,NTPLOT     ,NROD       ,NA                   INPICM    11
      +    ,NR        ,NEWPRB     ,MECHAN     ,NCRACK     ,NELPST               INPICM    12
      +    ,NCREEP    ,IAXSYM     ,IVARDM     ,NOFRAC     ,ITREST               INPICM    13
      +    ,NWORDS    ,IWORDS     ,NWRDS      ,NPRINT                           INPICM    14
      C                                                                          INPICM    15
      C                                                                          INPICM    16
       COMMON  /EMFLGS/   IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO                  INPICM    17
      +                ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG                    INPICM    18
      +         ,IMFGAS   ,IMSWCH                                               INPICM    19
      C                                                                          INPICM    20
      C                                                                          INPICM    21
      C                                                                          INPICM    22
       COMMON/PFRCS2/     MODPG2          ,MODPC2          ,MGAP2                INPICM    23
      +  ,MIGAP2          ,MOIGP2          ,MREPS2          ,MPEPS2              INPICM    24
      +  ,MTTT            ,MEREP2          ,MEP2            ,MR22                INPICM    25
      +  ,MOLDT2          ,MFUFRO          ,MDHPRS          ,MPEP2               INPICM    26
      +  ,MEPS22          ,MEPP2           ,MSIG2           ,MEPS02              INPICM    27
      +  ,MPEPP2          ,MEPS0           ,NNNCRP                               INPICM    28
      C                                                                          INPICM    29
       COMMON /MATCNS/ AAHA(12)                                                  INPICM    30
      C                                                                          INPICM    31
      C                                                                          INPICM    32
       COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                                     INPICM    33
      C                                                                          INPICM    34
       COMMON /VER/ VERS                                                         INPICM    35
      C                                                                          PHYPRO     2
       COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB             PHYPRO     3
      +              ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP              PHYPRO     4
      +              ,DELOXY                                                     PHYPRO     5
      C                                                                          PHYPRO     6
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C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                          PHYPRO      7
C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)                       PHYPRO      8
C   CTMELT - ZR CLAD MELTING POINT (K)                                           PHYPRO      9
C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                                      PHYPRO     10
C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)                    PHYPRO     11
C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)                      PHYPRO     12
C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)                    PHYPRO     13
C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)                      PHYPRO     14
C   BU     - BURNUP (MW-S/KG-U)                                                  PHYPRO     15
C   COMP   - PUO2 CONTENT (WT-PERCENT)                                           PHYPRO     16
C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED                 PHYPRO     17
C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                         PHYPRO     18
C                                                                                PHYPRO     19
      COMMON/PFCMI2/          NPIN                                               CCRE       17
     +                        ,NPOUT      ,NPI        ,NP2                       CCRE       18
     +                        ,NTSAVE     ,NDCHCK     ,NOLSGF                    CCRE       19
     +                        ,NDEP       ,NSLOPE     ,NCOEF                     CCRE       20
     +                        ,NDSIGF     ,NFI        ,NF2                       CCRE       21
     +                        ,NEP2       ,NECRP2     ,NT2                       CCRE       22
     +                        ,NTN        ,NE         ,NV                        CCRE       23
     +                        ,NEPP2      ,NSTRTT     ,NALFDT                    CCRE       24
     +                        ,NOLDPP     ,NNUDPP     ,NHH                       CCRE       25
     +                        ,NNN        ,NMN        ,NBB                       CCRE       26
     +                        ,NMM        ,NGG        ,NDD                       CCRE       27
     +                        ,NW         ,NNU        ,NEE                       CCRE       28
     +                        ,NLL        ,NAA        ,NEI                       CCRE       29
     +                        ,NCC        ,NNFF                                  CCRE       30
C                                                                                CCRE       31
      INTEGER  OLIGP2                                                            CCRE       32
C                                                                                CCRE       33
      DIMENSION TTT(MNA,MNR),EPS22(MNA,MNR,3),EPP2(MNA,MNR,3)                    CCRE       34
     + ,SIG2(MNA,MNR,3),REPS2(MNA,2),EPS02(MNA,MNR,3)                            CCRE       35
     + ,EP2(MNA,MNR),GAP2(MNA),R22(MNA,MNR),ECREP2(MNA,MNR)                      CCRE       36
     + ,OLDT2(MNA,MNR)                                                           CCRE       37
     + ,OLDPG2(MNA),OLDPC2(MNA),OLIGP2(MNA),IGAP2(MNA)                           CCRE       38
     + ,EPS0(MNA,MNR,3)                                                          CCRE       39
     + ,PEP2(MNA,MNR),PEPP2(MNA,MNR,3),PREPS2(MNA,2)                             CCRE       40
     + ,FVFRO(MNA,MNR) ,DVHPRS(MNA,MNR)                                          CCRE       41
C                                                                                CCRE       42
      DIMENSION AFCMI2(1)                                                        CCRE       43
      DIMENSION  INTGR(10)                                                       CCRE       44
C                                                                                CCRE       45
      DIMENSION  A(1)                                                            CCRE       46
      EQUIVALENCE (A(1),AFCMI2(1))                                               CCRE       47
C                                                                                CCRE       48
C                                                                                CCRE       49
      RPP = RP                                                                   CCRE       50
          DO 100 I=1,NT                                                          CCRE       51
          III = I-1                                                              CCRE       52
          A(LAXGAP+III) = A(LPAXGP+III)                                          CCRE       53
          A(LOLAXG+III) = A(LPOAXG+III)                                          CCRE       54
          A(LOLDTC+III) = A(LPLDTC+III)                                          CCRE       55
                                                                                 CCRE       56
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                    A(LOLDPG+III) = A(LPLDPG+III)                                  CCRE      57
                    A(LOLDPC+III) = A(LPLDPC+III)                                  CCRE      58
                    A(LOLDUR+III) = A(LPLDUR+III)                                  CCRE      59
                    A(LOLIGP+III) = A(LPLIGP+III)                                  CCRE      60
270                 A(LOLEPS+III) = A(LPOLEP+III)                                  CCRE      61
                    A(LOLFEP+III) = A(LPOFEP+III)                                  CCRE      62
                    A(LEP+III) = A(LEPSAV+III)                                     CCRE      63
                        DO 100 II=1,3                                              CCRE      64
                        IIJ = (II-1)*NA+III                                        CCRE      65
275                     A(LEPP+IIJ) = A(LEPPSV+IIJ)                                CCRE      66
                        A(LREPS+IIJ) = A(LREPSV+IIJ)                               CCRE      67
                        A(LRFEPS+IIJ) = A(LRFPSV+IIJ)                              CCRE      68
            100         CONTINUE                                                   CCRE      69
                IF (ICM.EQ.1) GO TO 230                                            CCRE      70
280             IF (MECHAN.EQ.2.AND.DELH.LE.1.E0) GO TO 230                        CCRE      71
            C                                                                      CCRE      72
            C   ***************************************************************** CCRE      73
            C   CREEP CALCULATIONS START HERE                                     CCRE      74
            C   ***************************************************************** CCRE      75
285             IHERE = 0                                                          CCRE      76
                NRELAX = 1                                                         CCRE      77
                X11 = DELH                                                         CCRE      78
                X22 = CREPHR                                                       CCRE      79
                IF (IT.EQ.1) ATIME = 0.E+0                                         CCRE      80
290             IF (IT.GT.1) ATIME = TIME(IT-1)/3600.E+0                           CCRE      81
                DTIME = X22                                                        CCRE      82
                CREP = X11/X22                                                     CCRE      83
                NCREP = CREP                                                       CCRE      84
                IF (NCREP.LT.1) GO TO 190                                          CCRE      85
295         110 CONTINUE                                                           CCRE      86
            C                                                                      CCRE      87
                DO 180 I=1,NCREP                                                   CCRE      88
            C                                                                      CCRE      89
                IF (MECHAN.NE.2) GO TO 130                                         CCRE      90
300         C                                                                      CCRE      91
                    DO 120 IJ=1,NT                                                 CCRE      92
                    IIJ = IJ-1                                                     CCRE      93
                    A(LPAXGP+IIJ) = A(LAXGAP+IIJ)                                  CCRE      94
                    A(LPECRP+IIJ) = A(LECREP+IIJ)                                  CCRE      95
305                 A(LPOAXG+IIJ) = A(LOLAXG+IIJ)                                  CCRE      96
                    A(LPLDTC+IIJ) = A(LOLDTC+IIJ)                                  CCRE      97
                    A(LPLDPG+IIJ) = A(LOLDPG+IIJ)                                  CCRE      98
                    A(LPLDPC+IIJ) = A(LOLDPC+IIJ)                                  CCRE      99
                    A(LPLDUR+IIJ) = A(LOLDUR+IIJ)                                  CCRE     100
310                 A(LPLIGP+IIJ) = A(LOLIGP+IIJ)                                  CCRE     101
                    A(LPOLEP+IIJ) = A(LOLEPS+IIJ)                                  CCRE     102
                    A(LPOFEP+IIJ) = A(LOLFEP+IIJ)                                  CCRE     103
                    A(LPEP+IIJ) = A(LEP+IIJ)                                       CCRE     104
                        DO 120 IK=1,3                                              CCRE     105
315                     IIK = (IK-1)*NA+IIJ                                        CCRE     106
                        A(LEPPP+IIK) = A(LEPP+IIK)                                 CCRE     107
                        A(LREPSP+IIK) = A(LREPS+IIK)                               CCRE     108
                        A(LRFEPP+IIK) = A(LRFEPS+IIK)                              CCRE     109
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      120         CONTINUE                                                      CCRE      110
320   C                                                                         CCRE      111
      C                                                                         CCRE      112
      C                                                                         CCRE      113
            INTGR(1) = NDBG                                                     CCRE      114
            INTGR(2) = IQUIT                                                    CCRE      115
325         INTGR(3) = N2                                                       CCRE      116
            INTGR(4) = MODE                                                     CCRE      117
            INTGR(5) = IT                                                       CCRE      118
            INTGR(6) = NPLAST                                                   CCRE      119
            INTGR(7) = NRELAX                                                   CCRE      120
330   C                                                                         CCRE      121
      C                                                                         CCRE      122
      C   THE FOLLOWING CALL TO FCMI RESULTS IN CLADDING CREEP MECHANICAL      CCRE      123
      C   CALCULATIONS USING THE FRACAS-I SUBCODE                             CCRE      124
      C                                                                         CCRE      125
335   C                                                                         CCRE      126
            CALL FCMI (A(LPG),A(LPC),A(LTCA+1),A(LIGAP),A(LEPS),A(LEPPP),A    CCRE      127
           +(LURF),A(LSIG),A(LRCPSP),A(LRFEPP),A(LFEPS),A(LPEP),A(LDZ),INT    CCRE      128
           +GR,A(LGAP),A(LPINT),RCI,RCO,DLROD,DLREL,RPP,A(LCREP1),A(LEPS1)    CCRE      129
           +,A(LPOLEP),A(LPCFEP),A(LPLDTC),A(LPLDPG),A(LPLDPC),A(LPLDUR),A    CCRE      130
340        +(LPLIGP),A(LEPPSV),A(LEPSAV),A(LSIG1),DTIME,ATIME,A(LPOAXG),A(    CCRE      131
           +LPAXGP),A(LURC),A(LPECRP),A(LREPSV),A(LRFPSV),A(LEP1),A(LEPP1)    CCRE      132
           +,A(LNUDEP),A(LFLAG),A(LDCHEK),NA)                                 CCRE      133
      C                                                                         CCRE      134
      130         CONTINUE                                                      CCRE      135
345   C                                                                         CCRE      136
            IF (MECHAN.NE.3) GO TO 160                                          CCRE      137
            M3 = 13                                                             CCRE      138
      C                                                                         CCRE      139
            DO 140 JJ1=1,NA                                                     CCRE      140
350         REPS2(JJ1,1) = PREPS2(JJ1,1)                                        CCRE      141
            REPS2(JJ1,2) = PREPS2(JJ1,2)                                        CCRE      142
                DO 140 IY=1,M3                                                  CCRE      143
                EP2(JJ1,IY) = PEP2(JJ1,IY)                                      CCRE      144
                    DO 140 II=1,3                                               CCRE      145
355                 EPP2(JJ1,IY,II) = PEPP2(JJ1,IY,II)                          CCRE      146
      140           CONTINUE                                                    CCRE      147
      C                                                                         CCRE      148
            M1 = J-1                                                            CCRE      149
            M2 = 1                                                              CCRE      150
360         M4 = 12                                                             CCRE      151
            M5 = 0                                                              CCRE      152
            M6 = 0                                                              CCRE      153
            KFLAG = 0                                                           CCRE      154
            IF (NNNCRP.EQ.IT) KFLAG = 1                                         CCRE      155
365         N1 = 0                                                              CCRE      156
            N22 = 0                                                             CCRE      157
            N3 = 1                                                              CCRE      158
            N4 = 0                                                              CCRE      159
            NAX = NT                                                            CCRE      160
370         JJJ = 1                                                             CCRE      161
      C                                                                         CCRE      162
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      C   THE FOLLOWING CALL TO FCMI2 COMPUTES THE FUEL AND CLADDING                CCRE  163
      C   MECHANICAL STATE INCLUDUNG CREEP USING FRACAS-2 SUBCODE                    CCRE  164
      C                                                                              CCRE  165
375         CALL FCMI2 (NAX,DLROD2,DLREL2,JJ1,NRELAX,DTIME,ATIME,N1,N22,N3          CCRE  166
           +  ,N4,M1,M2,M3,M4,M5,M6,KFLAG,NELAST,NCRACK,VX,A(LPG),A(LPC),TTT        CCRE  167
           +  ,EPS22,EPP2,SIG2,REPS2,EPS02,ECREP2,EP2,A(LDZ),GAP2,R22,IGAP2,       CCRE  168
           +  OLDT2,OLDPG2,OLDPC2,OLIGP2,FVFRO,DVHPRS,AFCMI2(NEP2),AFCMI2(NE       CCRE  169
           +  PP2),AFCMI2(NECRP2),AFCMI2(NOLDPP),AFCMI2,NT,MNR,MNA)                CCRE  170
380   C                                                                            CCRE  171
            NNNCRP = IT                                                            CCRE  172
      C                                                                            CCRE  173
              DO 150 JJ1=1,NA                                                      CCRE  174
              OLDPG2(JJ1) = A(LPG+JJ1-1)                                           CCRE  175
385           OLDPC2(JJ1) = A(LPC+JJ1-1)                                           CCRE  176
              OLIGP2(JJ1) = IGAP2(JJ1)                                             CCRE  177
              PREPS2(JJ1,1) = REPS2(JJ1,1)                                         CCRE  178
              PREPS2(JJ1,2) = REPS2(JJ1,2)                                         CCRE  179
              A(LPINT+JJ1-1) = -SIG2(JJ1,M4,1)-A(LPG+JJ1-1)                        CCRE  180
390             DO 150 IY=1,M3                                                     CCRE  181
                OLDT2(JJ1,IY) = TTT(JJ1,IY)                                      CCRE  182
                PEP2(JJ1,IY) = EP2(JJ1,IY)                                       CCRE  183
                  DO 150 II=1,3                                                  CCRE  184
                  PEPP2(JJ1,IY,II) = EPP2(JJ1,IY,II)                             CCRE  185
395   150         CONTINUE                                                       CCRE  186
      C                                                                          CCRE  187
      160   CONTINUE                                                           CCRE  188
      C                                                                          CCRE  189
              DO 170 IJ=1,NT                                                   CCRE  190
400           IIJ = IJ-1                                                       CCRE  191
              A(LAXGAP+IIJ) = A(LPAXGP+IIJ)                                    CCRE  192
              A(LECREP+IIJ) = A(LPECRP+IIJ)                                    CCRE  193
              A(LOLAXG+IIJ) = A(LPOAXG+IIJ)                                    CCRE  194
              A(LOLDTC+IIJ) = A(LPLDTC+IIJ)                                    CCRE  195
405           A(LOLDPC+IIJ) = A(LPLDPC+IIJ)                                    CCRE  196
              A(LOLDPG+IIJ) = A(LPLDPG+IIJ)                                    CCRE  197
              A(LOLDUR+IIJ) = A(LPLDUR+IIJ)                                    CCRE  198
              A(LOLIGP+IIJ) = A(LPLIGP+IIJ)                                    CCRE  199
              A(LOLEPS+IIJ) = A(LPOLEP+IIJ)                                    CCRE  200
410           A(LOLFEP+IIJ) = A(LPOFEP+IIJ)                                    CCRE  201
              A(LEP+IIJ) = A(LPEP+IIJ)                                         CCRE  202
                DO 170 IK=1,3                                                  CCRE  203
                IIK = (IK-1)*NA+IIJ                                            CCRE  204
                A(LEPP+IIK) = A(LEPPP+IIK)                                     CCRE  205
415             A(LREPS+IIK) = A(LREPSP+IIK)                                   CCRE  206
                A(LRFEPS+IIK) = A(LRFEPP+IIK)                                  CCRE  207
      170       CONTINUE                                                       CCRE  208
            ATIME = ATIME+DTIME                                              CCRE  209
      180   CONTINUE                                                           CCRE  210
420   190 CONTINUE                                                           CCRE  211
          DTIME = AMOD(X11,X22)                                              CCRE  212
          ATIME = TIME(IT)/3600.E+0-DTIME                                    CCRE  213
      C                                                                      CCRE  214
          IF (DTIME.LE.0.E0) GO TO 200                                       CCRE  215
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425                 IF (IHERE.EQ.1) GO TO 200                                   CCRE   216
                C                                                               CCRE   217
                    IHERE = 1                                                   CCRE   218
                C                                                               CCRE   219
                    NCREP = 1                                                   CCRE   220
430                 GO TO 110                                                   CCRE   221
                C                                                               CCRE   222
                200 CONTINUE                                                    CCRE   223
                C                                                               CCRE   224
                    IF (MECHAN.NE.3) GO TO 220                                  CCRE   225
435                 DLROD = DLROD2                                              CCRE   226
                    DLREL = DLREL2                                              CCRE   227
                        DO 210 I=1,NT                                           CCRE   228
                        A(LGAP+I-1) = GAP2(I)                                   CCRE   229
                        A(LPINT+I-1) = -SIG2(I,M4,1)-A(LPG+I-1)                 CCRE   230
440             210     CONTINUE                                                CCRE   231
                220 CONTINUE                                                    CCRE   232
                C                                                               CCRE   233
                C                                                               CCRE   234
                230 CONTINUE                                                    CCRE   235
445             C                                                               CCRE   236
                    RETURN                                                      CCRE   237
                    END                                                         CCRE   238
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CCREEP 1 446

VARIABLES	SN	TYPE	RELOCATION									
0	A	REAL	ARRAY	FAST	REFS	9	256	257	263	264	265	266
					267	268	269	270	271	272	275	276
					277	303	304	305	306	307	308	309
					310	311	312	313	316	317	318	38*336
					3*375	384	385	389	401	402	403	404
					405	406	407	408	409	410	411	414
					415	416	439	DEFINED	263	264	265	266
					267	268	269	270	271	272	275	276
					277	303	304	305	306	307	308	309
					310	311	312	313	316	317	318	389
					401	402	403	404	405	406	407	408
					409	410	411	414	415	416	438	439
0	AAA	REAL	ARRAY	REALS	REFS	110						
0	AAHA	REAL	ARRAY	MATCNS	REFS	202						
24	AAN	REAL		REALS	REFS	110						
0	ACOR	REAL		INPTR	REFS	156						
1	AFAL	REAL		INPTR	REFS	156						
0	AFCM12	REAL	ARRAY	FAST	REFS	253	257	5*375				
2	AFCR	REAL		INPTR	REFS	156						

VARIABLES	SN	TYPE		RELOCATION								
3	AFDN	REAL		INPTR	REFS	156						
4	AFGR	REAL		INPTR	REFS	156						
5	AFSW	REAL		INPTR	REFS	156						
6	AFTC	REAL		INPTR	REFS	156						
7	AGPC	REAL		INPTR	REFS	156						
25	AIRIN	REAL		REALS	REFS	110						
10	AMFAIR	REAL		INPTR	REFS	156						
11	AMFARG	REAL		INPTR	REFS	156						
12	AMFFG	REAL		INPTR	REFS	156						
13	AMFHE	REAL		INPTR	REFS	156						
14	AMFH2	REAL		INPTR	REFS	156						
15	AMFH20	REAL		INPTR	REFS	156						
16	AMFKRY	REAL		INPTR	REFS	156						
17	AMFN2	REAL		INPTR	REFS	156						
20	AMFXE	REAL		INPTR	REFS	156						
26	AMGP	REAL	ARRAY	REALS	REFS	110						
30	AMGPH	REAL	ARRAY	REALS	REFS	110						
32	AMGR	REAL	ARRAY	REALS	REFS	110						
34	AMGRH	REAL	ARRAY	REALS	REFS	110						
36	AMGRN2	REAL	ARRAY	REALS	REFS	110						
40	AM4DT	REAL		REALS	REFS	110						
41	ANGI	REAL		REALS	REFS	110						
42	ANGT	REAL		REALS	REFS	110						
2555	ANRIN	REAL		INPTR	REFS	156						
43	AN2IN	REAL		REALS	REFS	110						
44	ARGIN	REAL		REALS	REFS	110						
45	ARING	REAL		REALS	REFS	110						
1233	ATIME	REAL			REFS	336	375	418	DEFINED	289	290	418
							422					
46	AVGQI	REAL	ARRAY	REALS	REFS	110						
56	B	REAL	ARRAY	REALS	REFS	110						
64	BP	REAL		REALS	REFS	110						
65	BPP	REAL		REALS	REFS	110						
66	BR	REAL	ARRAY	REALS	REFS	110						
74	BU	REAL		REALS	REFS	110						
21	BUIN	REAL	ARRAY	INPTR	REFS	156						
75	BUOLD	REAL		REALS	REFS	110						
10	BUP	REAL		PHYPRO	REFS	209						
47	CATEXF	REAL		INPTR	REFS	156						
76	CDG	REAL		REALS	REFS	110						
77	CFV	REAL		REALS	REFS	110						
100	CFVA	REAL		REALS	REFS	110						
3	CHEFUS	REAL		PHYPRO	REFS	209						
50	CLDWKD	REAL		INPTR	REFS	156						
2556	CLDWKS	REAL		INPTR	REFS	156						
601	CLOS	REAL		REALS	REFS	134						
101	CMOL	REAL		REALS	REFS	110						
102	CODEID	REAL	ARRAY	REALS	REFS	110						
606	COLDWK	REAL		REALS	REFS	134						
11	COMP	REAL		PHYPRO	REFS	209						
121	CONVC	REAL		REALS	REFS	110						
122	CONVER	REAL	ARRAY	REALS	REFS	110						
2557	CP	REAL		INPTR	REFS	156						

VARIABLES	SN	TYPE		RELOCATION						
51	CPL	REAL		INPTR	REFS	156				
134	CPV	REAL		REALS	REFS	110				
2560	CR	REAL		INPTR	REFS	156				
52	CRDT	REAL		INPTR	REFS	156				
53	CRDTR	REAL		INPTR	REFS	156				
135	CRDTT	REAL		REALS	REFS	110				
1235	CREP	REAL			REFS	293	DEFINED	292		
2554	CREPHR	REAL		INPTR	REFS	156	288			
136	CRN	REAL		REALS	REFS	110				
54	CTMAX	REAL	ARRAY	INPTR	REFS	156				
2	CTMELT	REAL		PHYPRO	REFS	209				
4	CTRANB	REAL		PHYPRO	REFS	209				
5	CTRANE	REAL		PHYPRO	REFS	209				
6	CTRANZ	REAL		PHYPRO	REFS	209				
137	CVV	REAL		REALS	REFS	110				
604	CWKF	REAL		REALS	REFS	134				
605	CWNF	REAL		REALS	REFS	134				
102	DCI	REAL	ARRAY	INPTR	REFS	156				
140	DCIH	REAL		REALS	REFS	110				
141	DCIHP	REAL		REALS	REFS	110				
130	DCO	REAL	ARRAY	INPTR	REFS	156				
156	DE	REAL	ARRAY	INPTR	REFS	156				
142	DELBP	REAL		REALS	REFS	110				
143	DELBU	REAL		REALS	REFS	110				
144	DELH	REAL		REALS	REFS	110	280	287		
12	DELOXY	REAL		PHYPRO	REFS	209				
145	DELT	REAL		REALS	REFS	110				
204	DELTAZ	REAL	ARRAY	INPTR	REFS	156				
146	DELTCR	REAL		REALS	REFS	110				
147	DELTDB	REAL		REALS	REFS	110				
150	DELTFC	REAL		REALS	REFS	110				
151	DELTJL	REAL		REALS	REFS	110				
232	DEN	REAL		INPTR	REFS	156				
233	DENG	REAL		INPTR	REFS	156				
152	DHIC	REAL		REALS	REFS	110				
607	DISH	REAL		REALS	REFS	134				
234	DISHSD	REAL		INPTR	REFS	156				
153	DLREL	REAL		REALS	REFS	110	336	DEFINED	436	
1262	DLREL2	REAL			REFS	375	436			
154	DLROD	REAL		REALS	REFS	110	336	DEFINED	435	
1261	DLROD2	REAL			REFS	375	435			
155	DLTGC	REAL	ARRAY	REALS	REFS	110				
235	DP	REAL	ARRAY	INPTR	REFS	156				
207	DPH	REAL		REALS	REFS	110				
210	DPHF	REAL		REALS	REFS	110				
211	DPHFP	REAL		REALS	REFS	110				
212	DPWP	REAL		REALS	REFS	110				
213	DRS	REAL		REALS	REFS	110				
263	DSPG	REAL		INPTR	REFS	156				
264	DSPGW	REAL		INPTR	REFS	156				
1234	DTIME	REAL			REFS	336	375	418	422	424
					DEFINED	291	421			
0	DVHPRS	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1	

VARIABLES	SN	TYPE	RELOCATION								
0	ECREP2	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1		
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	205					
265	ENRCH	REAL		INPTR	REFS	156					
214	ENRICH	REAL		REALS	REFS	110					
215	EOLSR	REAL		REALS	REFS	110					
0	EPP2	REAL	ARRAY	F.P.	REFS	244	375	394	DEFINED	1	355
0	EPS0	REAL	ARRAY	F.P.	REFS	244	DEFINED	1			
0	EPS02	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1		
0	EPS22	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1		
0	EP2	REAL	ARRAY	F.P.	REFS	244	375	392	DEFINED	1	353
266	EX0	REAL		INPTR	REFS	156					
267	FA	REAL		INPTR	REFS	156					
216	FC	REAL	ARRAY	REALS	REFS	110					
7	FDELTA	REAL		PHYPRO	REFS	209					
217	FGIN	REAL		REALS	REFS	110					
270	FGPAV	REAL		INPTR	REFS	156					
220	FGPAVP	REAL		REALS	REFS	110					
221	FGPAVX	REAL		REALS	REFS	121					
1	FHEFUS	REAL		PHYPRO	REFS	209					
222	FH20	REAL		REALS	REFS	121					
223	FJJ	REAL	ARRAY	REALS	REFS	121					
225	FJJH	REAL	ARRAY	REALS	REFS	121					
271	FLUX	REAL		INPTR	REFS	156					
272	FLXDP	REAL		INPTR	REFS	156					
227	FMGP	REAL	ARRAY	REALS	REFS	121					
602	FNCK	REAL		REALS	REFS	134					
603	FNCN	REAL		REALS	REFS	134					
2552	FOTMTL	REAL		INPTR	REFS	156					
231	FPOR	REAL		REALS	REFS	121					
232	FPORI	REAL		REALS	REFS	121					
273	FQE	REAL		INPTR	REFS	156					
233	FRD	REAL		REALS	REFS	121					
234	FRDH	REAL		REALS	REFS	121					
235	FRDN	REAL		REALS	REFS	121					
0	FTMELT	REAL		PHYPRO	REFS	209					
0	FVFRO	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1		
236	G	REAL		REALS	REFS	121					
0	GAP2	REAL	ARRAY	F.P.	REFS	244	375	438	DEFINED	1	
237	GASES	REAL	ARRAY	REALS	REFS	121					
246	GASIN	REAL		REALS	REFS	121					
247	GDEN	REAL		REALS	REFS	121					
274	GO	REAL	ARRAY	INPTR	REFS	156					
250	GPTH	REAL	ARRAY	REALS	REFS	121					
302	GPTHE	REAL	ARRAY	REALS	REFS	121					
334	GPTHM	REAL		REALS	REFS	121					
335	GPTHP	REAL		REALS	REFS	121					
336	GPTHPG	REAL	ARRAY	REALS	REFS	121					
370	GR	REAL		REALS	REFS	121					
441	GRNSIZ	REAL		INPTR	REFS	156					
371	HCRV	REAL		REALS	REFS	121					
372	HCV	REAL		REALS	REFS	121					
442	HDISH	REAL		INPTR	REFS	156					
373	HDSHV	REAL		REALS	REFS	121					

VARIABLES	SN	TYPE		RELOCATION								
374	HEIN	REAL		REALS	REFS	121						
375	HFLL	REAL		REALS	REFS	121						
376	HFLMDB	REAL		REALS	REFS	121						
377	HFLMP	REAL		REALS	REFS	121						
400	HFPER	REAL		REALS	REFS	121						
401	HFV	REAL		REALS	REFS	121						
410	HGAP	REAL		REALS	REFS	121						
412	HGAPR	REAL		REALS	REFS	121						
402	HGAPT	REAL		REALS	REFS	121						
403	HGV	REAL		REALS	REFS	121						
404	HI	REAL		REALS	REFS	121						
405	HMGP	REAL	ARRAY	REALS	REFS	121						
407	HP	REAL		REALS	REFS	121						
413	HPL	REAL		REALS	REFS	121						
443	HPLT	REAL		INPTR	REFS	156						
414	HPORV	REAL		REALS	REFS	121						
415	HPV	REAL		REALS	REFS	121						
411	HSOLID	REAL		REALS	REFS	121						
416	HUPTAK	REAL		REALS	REFS	121						
417	H2OMI	REAL		REALS	REFS	121						
1223	I	INTEGER			REFS	262	2*438	3*439	DEFINED	261	297	437
275	IAXSYM	INTEGER		INPTI	REFS	175						
270	ICFAC	INTEGER		POINT	REFS	102						
302	ICFCSV	INTEGER		POINT	REFS	102						
24	ICLOSE	INTEGER		INTEG	REFS	148						
0	ICM	INTEGER		INPTI	REFS	175	279					
1	ICOR	INTEGER		INPTI	REFS	175						
2	IDBG	INTEGER		INPTI	REFS	175						
271	IDG	INTEGER		POINT	REFS	102						
272	IDGSAV	INTEGER		POINT	REFS	102						
3	IDXGAS	INTEGER		INPTI	REFS	175						
0	IGAP2	INTEGER	ARRAY	F.P.	REFS	244	375	386	DEFINED	1		
1227	IHERE	INTEGER			REFS	425	DEFINED	285	427			
303	IHLDN	INTEGER		POINT	REFS	102						
1225	II	INTEGER			REFS	274	2*355	2*394	DEFINED	273	354	393
1224	III	INTEGER			REFS	2*263	2*264	2*265	2*266	2*267	2*268	2*269
					2*270	2*271	2*272	274	DEFINED	262		
1226	IIJ	INTEGER			REFS	2*275	2*276	2*277	2*303	2*304	2*305	2*306
					2*307	2*308	2*309	2*310	2*311	2*312	2*313	315
					2*401	2*402	2*403	2*404	2*405	2*406	2*407	2*408
					2*409	2*410	2*411	413	DEFINED	274	302	400
1241	IIK	INTEGER			REFS	2*316	2*317	2*318	2*414	2*415	2*416	
					DEFINED	315	413					
1237	IJ	INTEGER			REFS	302	400	DEFINED	301	399		
1240	IK	INTEGER			REFS	315	413	DEFINED	314	412		
4	IM	INTEGER		INPTI	REFS	175						
4	IMCLAD	INTEGER		EMFLGS	REFS	189						
2	IMDENS	INTEGER		EMFLGS	REFS	189						
23	IMDONE	INTEGER		INTEG	REFS	148						
7	IMENRG	INTEGER		EMFLGS	REFS	189						
10	IMFGAS	INTEGER		EMFLGS	REFS	189						
1	IMFUEL	INTEGER		EMFLGS	REFS	189						
5	IMGAPC	INTEGER		EMFLGS	REFS	189						

VARIABLES	SN	TYPE		RELOCATION								
0	IMPOWR	INTEGER		EMFLGS	REFS	189						
3	IMRELO	INTEGER		EMFLGS	REFS	189						
11	IMSWCH	INTEGER		EMFLGS	REFS	189						
6	IM93WC	INTEGER		EMFLGS	REFS	189						
1263	INTGR	INTEGER	ARRAY		REFS	254	336	DEFINED	323	324	325	326
					327	328	329					
5	IPLANT	INTEGER		INPTI	REFS	175						
304	IPLSTC	INTEGER		POINT	REFS	102						
273	IPRG	INTEGER		POINT	REFS	102						
6	IQ	INTEGER		INPTI	REFS	175						
0	IQUIT	INTEGER		INTEG	REFS	148	324					
264	IRDOT	INTEGER		POINT	REFS	97						
1	IRI	INTEGER		INTEG	REFS	148						
265	ISAVGS	INTEGER		POINT	REFS	97						
305	ISTRNN	INTEGER		POINT	REFS	102						
306	ISTRSS	INTEGER		POINT	REFS	102						
7	ISW	INTEGER		INPTI	REFS	175						
2	IT	INTEGER		INTEG	REFS	148	289	2*290	327	364	381	422
300	ITCL	INTEGER		POINT	REFS	102						
277	ITEMP	INTEGER		POINT	REFS	102						
3	ITER	INTEGER		INTEG	REFS	148						
301	ITFS	INTEGER		POINT	REFS	102						
276	ITRAMP	INTEGER		POINT	REFS	102						
300	ITREST	INTEGER		INPTI	REFS	175						
276	IVARDM	INTEGER		INPTI	REFS	175						
274	IVFC	INTEGER		POINT	REFS	102						
275	IVFF	INTEGER		POINT	REFS	102						
302	IWORDS	INTEGER		INPTI	REFS	175						
267	IX	INTEGER		POINT	REFS	97						
1244	IY	INTEGER			REFS	2*353	2*355	2*391	2*392	2*394		
					DEFINED	352	390					
4	J	INTEGER		INTEG	REFS	148	358					
10	JDLPR	INTEGER		INPTI	REFS	175						
5	JJC	INTEGER		INTEG	REFS	148						
1260	JJJ	INTEGER			REFS	375	DEFINED	370				
1243	JJI	INTEGER			REFS	2*350	2*351	2*353	2*355	2*384	2*385	2*386
					2*387	2*388	3*389	2*391	2*392	2*394		
					DEFINED	349	383					
11	JN	INTEGER	ARRAY	INPTI	REFS	175						
6	JPEAK	INTEGER		INTEG	REFS	148						
21	JST	INTEGER	ARRAY	INPTI	REFS	175						
7	K	INTEGER		INTEG	REFS	148						
1252	KFLAG	INTEGER			REFS	375	DEFINED	363	364			
10	KINDOR	INTEGER		INTEG	REFS	148						
11	KOXI	INTEGER		INTEG	REFS	148						
420	KRYIN	REAL		REALS	REFS	7	121					
216	LACE	INTEGER	ARRAY	INPTI	REFS	175						
215	LACMFG	INTEGER		POINT	REFS	81						
216	LACMHE	INTEGER		POINT	REFS	81						
217	LACMH2	INTEGER		POINT	REFS	81						
220	LACMN2	INTEGER		POINT	REFS	81						
215	LACMOD	INTEGER		INPTI	REFS	175						
152	LAKI	INTEGER		POINT	REFS	52						

VARIABLES	SN	TYPE	RELOCATION						
153	LAK2	INTEGER	POINT	REFS	52				
221	LAMGPT	INTEGER	POINT	REFS	81				
125	LANG	INTEGER	POINT	REFS	38				
120	LANGR	INTEGER	POINT	REFS	38				
253	LANSD	INTEGER	POINT	REFS	91				
256	LANSR	INTEGER	POINT	REFS	91				
14	LARAD	INTEGER	POINT	REFS	19				
10	LAXGAP	INTEGER	POINT	REFS	19	263	303	401	
11	LAXLEN	INTEGER	POINT	REFS	19				
210	LB	INTEGER	POINT	REFS	71				
211	LBR	INTEGER	POINT	REFS	71				
212	LBTOLD	INTEGER	POINT	REFS	71				
12	LBU1	INTEGER	POINT	REFS	19				
13	LBU2	INTEGER	POINT	REFS	19				
172	LCC1	INTEGER	POINT	REFS	64				
173	LCC2	INTEGER	POINT	REFS	64				
213	LCHEM	INTEGER	POINT	REFS	71				
15	LCPDLT	INTEGER	POINT	REFS	19				
2	LCREP1	INTEGER	POINT	REFS	19	336			
154	LCRL	INTEGER	POINT	REFS	52				
111	LDCHEK	INTEGER	POINT	REFS	19	336			
0	LDC1H	INTEGER	POINT	REFS	19				
261	LDECAY	INTEGER	POINT	REFS	91				
16	LDELBP	INTEGER	POINT	REFS	19				
17	LDENMX	INTEGER	POINT	REFS	19				
174	LDENSF	INTEGER	POINT	REFS	64				
175	LDENSP	INTEGER	POINT	REFS	64				
3	LDLH	INTEGER	POINT	REFS	19				
20	LDLPGE	INTEGER	POINT	REFS	19				
155	LDPL	INTEGER	POINT	REFS	52				
156	LDPLH	INTEGER	POINT	REFS	52				
157	LDPN	INTEGER	POINT	REFS	52				
176	LDPW	INTEGER	POINT	REFS	64				
177	LDPWPP	INTEGER	POINT	REFS	64				
260	LDT	INTEGER	POINT	REFS	91				
21	LDZ	INTEGER	POINT	REFS	19	336	375		
22	LDZH	INTEGER	POINT	REFS	19				
23	LDZHP	INTEGER	POINT	REFS	19				
24	LECREP	INTEGER	POINT	REFS	19	304	402		
25	LEP	INTEGER	POINT	REFS	19	272	313	411	
127	LEPP	INTEGER	POINT	REFS	44	275	316	414	
130	LEPPP	INTEGER	POINT	REFS	44	316	336	414	
131	LEPPSV	INTEGER	POINT	REFS	44	275	336		
147	LEPP1	INTEGER	POINT	REFS	44	336			
132	LEPS	INTEGER	POINT	REFS	44	336			
133	LEPSAV	INTEGER	POINT	REFS	44	272	336		
151	LEPS1	INTEGER	POINT	REFS	44	336			
100	LEP1	INTEGER	POINT	REFS	19	336			
167	LF	INTEGER	POINT	REFS	59				
134	LFEPS	INTEGER	POINT	REFS	44	336			
257	LFF	INTEGER	POINT	REFS	91				
121	LFGMGP	INTEGER	POINT	REFS	38				
170	LFH	INTEGER	POINT	REFS	59				

VARIABLES	SN	TYPE	RELOCATION							
110	LFLAG	INTEGER	POINT	REFS	19	336				
254	LFLXFC	INTEGER	POINT	REFS	91					
160	LFMA	INTEGER	POINT	REFS	52					
161	LFMGPR	INTEGER	POINT	REFS	52					
122	LFMGR	INTEGER	POINT	REFS	38					
171	LFN	INTEGER	POINT	REFS	59					
26	LGAP	INTEGER	POINT	REFS	19	336	438			
222	LGASMO	INTEGER	POINT	REFS	81					
200	LGNSIZ	INTEGER	POINT	REFS	64					
27	LGPTP	INTEGER	POINT	REFS	19					
4	LHA	INTEGER	POINT	REFS	19					
262	LHALF	INTEGER	POINT	REFS	91					
30	LHCOEF	INTEGER	POINT	REFS	19					
123	LHEMGP	INTEGER	POINT	REFS	38					
101	LHGAPS	INTEGER	POINT	REFS	19					
114	LHGPC	INTEGER	POINT	REFS	19					
115	LHGPR	INTEGER	POINT	REFS	19					
116	LHGPS	INTEGER	POINT	REFS	19					
5	LHL	INTEGER	POINT	REFS	19					
223	LHMGPT	INTEGER	POINT	REFS	81					
124	LHMGR	INTEGER	POINT	REFS	38					
162	LHRL	INTEGER	POINT	REFS	52					
103	LIGAP	INTEGER	POINT	REFS	19	336				
12	LMN	INTEGER	INTEG	REFS	148					
106	LNFAIL	INTEGER	POINT	REFS	19					
146	LNUDEP	INTEGER	POINT	REFS	44	336				
31	LOLAXG	INTEGER	POINT	REFS	19	264	305	403		
32	LOLDPC	INTEGER	POINT	REFS	19	267	308	405		
33	LOLDPG	INTEGER	POINT	REFS	19	266	307	406		
34	LOLDTC	INTEGER	POINT	REFS	19	265	306	404		
35	LOLDUR	INTEGER	POINT	REFS	19	268	309	407		
36	LOLEPS	INTEGER	POINT	REFS	19	270	311	409		
37	LOLFEP	INTEGER	POINT	REFS	19	271	312	410		
104	LOLIGP	INTEGER	POINT	REFS	19	269	310	408		
40	LPAXGP	INTEGER	POINT	REFS	19	263	303	336	401	
41	LPC	INTEGER	POINT	REFS	19	336	375	385		
42	LPECRP	INTEGER	POINT	REFS	19	304	336	402		
43	LPEP	INTEGER	POINT	REFS	19	313	336	411		
135	LPEPSV	INTEGER	POINT	REFS	44					
255	LPF	INTEGER	POINT	REFS	91					
136	LPFPSV	INTEGER	POINT	REFS	44					
44	LPG	INTEGER	POINT	REFS	19	336	375	384	389	439
45	LPINT	INTEGER	POINT	REFS	19	336	389	439		
224	LPIT	INTEGER	POINT	REFS	81					
46	LPLDPC	INTEGER	POINT	REFS	19	267	308	336	405	
47	LPLDPG	INTEGER	POINT	REFS	19	266	307	336	406	
50	LPLDTC	INTEGER	POINT	REFS	19	265	306	336	404	
51	LPLDUR	INTEGER	POINT	REFS	19	268	309	336	407	
107	LPLIGP	INTEGER	POINT	REFS	19	269	310	336	408	
52	LPOAXG	INTEGER	POINT	REFS	19	264	305	336	403	
53	LPOFEP	INTEGER	POINT	REFS	19	271	312	336	410	
54	LPOLEP	INTEGER	POINT	REFS	19	270	311	336	409	
6	LPOROS	INTEGER	POINT	REFS	19					

VARIABLES	SN	TYPE	RELOCATION					
201	LPORS1	INTEGER	POINT	REFS	64			
202	LPORS2	INTEGER	POINT	REFS	64			
225	LPRT10	INTEGER	POINT	REFS	81			
226	LPRT11	INTEGER	POINT	REFS	81			
227	LPRT12	INTEGER	POINT	REFS	81			
230	LPRT13	INTEGER	POINT	REFS	81			
231	LPRT14	INTEGER	POINT	REFS	81			
232	LPRT15	INTEGER	POINT	REFS	81			
233	LPRT16	INTEGER	POINT	REFS	81			
234	LPRT17	INTEGER	POINT	REFS	81			
235	LPRT18	INTEGER	POINT	REFS	81			
236	LPRT2	INTEGER	POINT	REFS	81			
237	LPRT20	INTEGER	POINT	REFS	81			
240	LPRT3	INTEGER	POINT	REFS	81			
241	LPRT4	INTEGER	POINT	REFS	81			
242	LPRT5	INTEGER	POINT	REFS	81			
243	LPRT6	INTEGER	POINT	REFS	81			
244	LPRT7	INTEGER	POINT	REFS	81			
245	LPRT8	INTEGER	POINT	REFS	81			
246	LPRT9	INTEGER	POINT	REFS	81			
214	LQ	INTEGER	POINT	REFS	76			
105	LQDP	INTEGER	POINT	REFS	19			
206	LR	INTEGER	POINT	REFS	64			
207	LRAD	INTEGER	POINT	REFS	64			
55	LRDCOL	INTEGER	POINT	REFS	19			
137	LREPS	INTEGER	POINT	REFS	44	276	317	415
141	LREPSP	INTEGER	POINT	REFS	44	317	336	415
140	LREPSV	INTEGER	POINT	REFS	44	276	336	
126	LREPS2	INTEGER	POINT	REFS	38			
143	LRFEPP	INTEGER	POINT	REFS	44	318	336	416
142	LRFEPS	INTEGER	POINT	REFS	44	277	318	416
144	LRFPSV	INTEGER	POINT	REFS	44	277	336	
263	LRLEAS	INTEGER	POINT	REFS	91			
113	LRTRNO	INTEGER	POINT	REFS	19			
112	LRTRNP	INTEGER	POINT	REFS	19			
145	LSIG	INTEGER	POINT	REFS	44	336		
150	LSIGI	INTEGER	POINT	REFS	44	336		
266	LSTHIF	INTEGER	POINT	REFS	97			
247	LTAC	INTEGER	POINT	REFS	81			
56	LTAF	INTEGER	POINT	REFS	19			
250	LTAFA	INTEGER	POINT	REFS	81			
57	LTAG	INTEGER	POINT	REFS	19			
251	LTAGA	INTEGER	POINT	REFS	81			
60	LTBAR	INTEGER	POINT	REFS	19			
61	LTBLK	INTEGER	POINT	REFS	19			
62	LTCA	INTEGER	POINT	REFS	19	336		
63	LTCIDI	INTEGER	POINT	REFS	19			
64	LTCODI	INTEGER	POINT	REFS	19			
163	LTFB	INTEGER	POINT	REFS	52			
164	LTFR	INTEGER	POINT	REFS	52			
165	LTFRK	INTEGER	POINT	REFS	52			
203	LTMPDS	INTEGER	POINT	REFS	64			
205	LTMPMX	INTEGER	POINT	REFS	64			

VARIABLES	SN	TYPE	RELOCATION								
117	LTOXO	INTEGER	POINT	REFS	19						
65	LTPS	INTEGER	POINT	REFS	19						
102	LTRTRN	INTEGER	POINT	REFS	19						
252	LTSF	INTEGER	POINT	REFS	81						
7	LUFS	INTEGER	POINT	REFS	19						
204	LUO2LL	INTEGER	POINT	REFS	64						
1	LURC	INTEGER	POINT	REFS	19	336					
66	LURF	INTEGER	POINT	REFS	19	336					
67	LVCH	INTEGER	POINT	REFS	19						
70	LVCHI	INTEGER	POINT	REFS	19						
71	LVCR	INTEGER	POINT	REFS	19						
72	LVDH	INTEGER	POINT	REFS	19						
73	LVFH	INTEGER	POINT	REFS	19						
74	LVGH	INTEGER	POINT	REFS	19						
166	LVPL	INTEGER	POINT	REFS	52						
75	LVPOR	INTEGER	POINT	REFS	19						
76	LZRO2A	INTEGER	POINT	REFS	19						
77	LZRO2B	INTEGER	POINT	REFS	19						
13	M	INTEGER	INTEG	REFS	148						
0	MAXIDX	INTEGER	LACMDL	REFS	205						
166	MDBG	INTEGER	INPTI	REFS	175						
15	MDHPRS	INTEGER	PFRCS2	REFS	195						
271	MECHAN	INTEGER	INPTI	REFS	175	280	299	346	434		
20	MEPP2	INTEGER	PFRCS2	REFS	195						
24	MEPS0	INTEGER	PFRCS2	REFS	195						
22	MEPS02	INTEGER	PFRCS2	REFS	195						
17	MEPS22	INTEGER	PFRCS2	REFS	195						
11	MEP2	INTEGER	PFRCS2	REFS	195						
10	MEREP2	INTEGER	PFRCS2	REFS	195						
14	MFVFR0	INTEGER	PFRCS2	REFS	195						
2	MGAP2	INTEGER	PFRCS2	REFS	195						
3	MIGAP2	INTEGER	PFRCS2	REFS	195						
0	MNA	INTEGER	F.P.	REFS	21*244	375	DEFINED	1			
0	MNR	INTEGER	F.P.	REFS	14*244	375	DEFINED	1			
170	MODE	INTEGER	INPTI	REFS	175	326					
171	MODES	INTEGER	INPTI	REFS	175						
14	MODLOP	INTEGER	INTEG	REFS	148						
1	MODPC2	INTEGER	PFRCS2	REFS	195						
0	MODPG2	INTEGER	PFRCS2	REFS	195						
4	MOIGP2	INTEGER	PFRCS2	REFS	195						
13	MOLDT2	INTEGER	PFRCS2	REFS	195						
23	MPEPP2	INTEGER	PFRCS2	REFS	195						
6	MPEPS2	INTEGER	PFRCS2	REFS	195						
16	MPEP2	INTEGER	PFRCS2	REFS	195						
5	MREPS2	INTEGER	PFRCS2	REFS	195						
12	MR22	INTEGER	PFRCS2	REFS	195						
21	MSIG2	INTEGER	PFRCS2	REFS	195						
172	MTAPE	INTEGER	INPTI	REFS	175						
7	MTTT	INTEGER	PFRCS2	REFS	195						
1245	M1	INTEGER		REFS	375	DEFINED	358				
1246	M2	INTEGER		REFS	375	DEFINED	359				
1242	M3	INTEGER		REFS	352	375	390	DEFINED	347		
1247	M4	INTEGER		REFS	375	389	439	DEFINED	360		

VARIABLES	SN	TYPE	RELOCATION									
1250	M5	INTEGER			REFS	375	DEFINED	361				
1251	M6	INTEGER			REFS	375	DEFINED	362				
266	NA	INTEGER		INPTI	REFS	175	274	315	336	349	383	413
43	NAA	INTEGER		PFCMI2	REFS	227						
15	NAB	INTEGER		INTEG	REFS	148						
233	NAFAIL	INTEGER		INPTI	REFS	175						
25	NALFDT	INTEGER		PFCMI2	REFS	227						
1257	NAX	INTEGER			REFS	375	DEFINED	369				
33	NBB	INTEGER		PFCMI2	REFS	227						
27	NC	INTEGER		INTEG	REFS	148						
45	NCC	INTEGER		PFCMI2	REFS	227						
11	NCOEF	INTEGER		PFCMI2	REFS	227						
272	NCRACK	INTEGER		INPTI	REFS	175	375					
274	NCREEP	INTEGER		INPTI	REFS	175						
1236	NCREP	INTEGER			REFS	294	297	DEFINED	293	429		
173	NDBG	INTEGER		INPTI	REFS	175	323					
5	NDCHCK	INTEGER		PFCMI2	REFS	227						
36	NDD	INTEGER		PFCMI2	REFS	227						
7	NDEP	INTEGER		PFCMI2	REFS	227						
12	NDSIGF	INTEGER		PFCMI2	REFS	227						
21	NE	INTEGER		PFCMI2	REFS	227						
16	NECRP2	INTEGER		PFCMI2	REFS	227	375					
41	NEE	INTEGER		PFCMI2	REFS	227						
44	NEI	INTEGER		PFCMI2	REFS	227						
273	NELAST	INTEGER		INPTI	REFS	175	375					
23	NEPP2	INTEGER		PFCMI2	REFS	227	375					
15	NEP2	INTEGER		PFCMI2	REFS	227	375					
270	NEWPRB	INTEGER		INPTI	REFS	175						
26	NF	INTEGER		INTEG	REFS	148						
174	NFROD	INTEGER		INPTI	REFS	175						
13	NFI	INTEGER		PFCMI2	REFS	227						
14	NF2	INTEGER		PFCMI2	REFS	227						
175	NGAPC	INTEGER		INPTI	REFS	175						
176	NGASR	INTEGER		INPTI	REFS	175						
35	NGG	INTEGER		PFCMI2	REFS	227						
167	NHEAL	INTEGER		INPTI	REFS	175						
30	NHH	INTEGER		PFCMI2	REFS	227						
42	NLL	INTEGER		PFCMI2	REFS	227						
34	NMM	INTEGER		PFCMI2	REFS	227						
32	NMN	INTEGER		PFCMI2	REFS	227						
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	175						
46	NNFF	INTEGER		PFCMI2	REFS	227						
31	NNN	INTEGER		PFCMI2	REFS	227						
25	NNNCRP	INTEGER		PFRCS2	REFS	195	364	DEFINED	381			
40	NNU	INTEGER		PFCMI2	REFS	227						
27	NNUDPP	INTEGER		PFCMI2	REFS	227						
177	NOFAIL	INTEGER		INPTI	REFS	175						
277	NOFRAC	INTEGER		INPTI	REFS	175						
26	NOLDPP	INTEGER		PFCMI2	REFS	227	375					
6	NOLSGF	INTEGER		PFCMI2	REFS	227						
200	NOPT	INTEGER		INPTI	REFS	175						
201	NPCYCL	INTEGER		INPTI	REFS	175						
0	NPIN	INTEGER		PFCMI2	REFS	227						

VARIABLES	SN	TYPE		RELOCATION								
16	NPLAST	INTEGER		INTEG	REFS	148	328					
263	NPLOT	INTEGER		INPTI	REFS	175						
202	NPLTAB	INTEGER		INPTI	REFS	175						
1	NPOUT	INTEGER		PFCMI2	REFS	227						
304	NPRINT	INTEGER		INPTI	REFS	175						
2	NP1	INTEGER		PFCMI2	REFS	227						
3	NP2	INTEGER		PFCMI2	REFS	227						
267	NR	INTEGER		INPTI	REFS	175						
203	NREAD	INTEGER		INPTI	REFS	175						
1230	NRELAX	INTEGER			REFS	329	375	DEFINED	286			
204	NRESTR	INTEGER		INPTI	REFS	175						
17	NRMI	INTEGER		INTEG	REFS	148						
265	NROD	INTEGER		INPTI	REFS	175						
205	NROLL	INTEGER		INPTI	REFS	175						
25	NSH	INTEGER		INTEG	REFS	148						
10	NSLOPE	INTEGER		PFCMI2	REFS	227						
206	NSP	INTEGER		INPTI	REFS	175						
207	NSTART	INTEGER		INPTI	REFS	175						
20	NSTEP	INTEGER		INTEG	REFS	148						
210	NSTOP	INTEGER		INPTI	REFS	175						
24	NSTRTT	INTEGER		PFCMI2	REFS	227						
211	NT	INTEGER		INPTI	REFS	175	261	301	369	375	399	437
212	NTAPE	INTEGER		INPTI	REFS	175						
20	NTN	INTEGER		PFCMI2	REFS	227						
264	NTPLOT	INTEGER		INPTI	REFS	175						
4	NTSAVE	INTEGER		PFCMI2	REFS	227						
17	NT2	INTEGER		PFCMI2	REFS	227						
421	NU	REAL		REALS	REFS	7	121					
213	NUCFC	INTEGER		INPTI	REFS	175						
214	NUNITS	INTEGER		INPTI	REFS	175						
22	NV	INTEGER		PFCMI2	REFS	227						
37	NW	INTEGER		PFCMI2	REFS	227						
301	NWORDS	INTEGER		INPTI	REFS	175						
303	NWRDS	INTEGER		INPTI	REFS	175						
21	NWRITE	INTEGER		INTEG	REFS	148						
262	NXP	INTEGER		INPTI	REFS	175						
1253	N1	INTEGER			REFS	375	DEFINED	365				
22	N2	INTEGER		INTEG	REFS	148	325					
1254	N22	INTEGER			REFS	375	DEFINED	366				
1255	N3	INTEGER			REFS	375	DEFINED	367				
1256	N4	INTEGER			REFS	375	DEFINED	368				
0	OLDPC2	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1	385		
0	OLDPG2	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1	384		
0	OLDT2	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1	391		
0	OLIGP2	INTEGER	ARRAY	F.P.	REFS	242	244	375	DEFINED	1	386	
422	OXDROP	REAL		REALS	REFS	121						
423	OXIDE	REAL		REALS	REFS	121						
424	PECDH	REAL		REALS	REFS	121						
0	PEPP2	REAL	ARRAY	F.P.	REFS	244	355	DEFINED	1	394		
0	PEP2	REAL	ARRAY	F.P.	REFS	244	353	DEFINED	1	392		
425	PI	REAL		REALS	REFS	121						
426	PIN	REAL	ARRAY	REALS	REFS	121						
460	PINP	REAL		REALS	REFS	121						

VARIABLES	SN	TYPE		RELOCATION							
461	PORO	REAL		REALS	REFS	121					
444	PPMH2O	REAL		INPTR	REFS	156					
445	PPMN2	REAL		INPTR	REFS	156					
462	PR	REAL		REALS	REFS	121					
0	PREPS2	REAL	ARRAY	F.P.	REFS	244	350	351	DEFINED	1	387	388
463	PRESS	REAL		REALS	REFS	121					
464	PRTY	REAL		REALS	REFS	121					
465	PRT19	REAL		REALS	REFS	121					
446	P2	REAL	ARRAY	INPTR	REFS	156					
473	QAV	REAL		REALS	REFS	121					
466	QC	REAL		REALS	REFS	121					
613	QEND	REAL	ARRAY	INPTR	REFS	156					
623	QF	REAL	ARRAY	INPTR	REFS	156					
1333	QMPY	REAL	ARRAY	INPTR	REFS	156					
467	QP	REAL		REALS	REFS	121					
474	QPEAK	REAL		REALS	REFS	121					
470	QSP	REAL		REALS	REFS	121					
1500	RAPOW	REAL	ARRAY	INPTR	REFS	156					
1513	RC	REAL		INPTR	REFS	156					
471	RCI	REAL		REALS	REFS	121	336				
472	RCO	REAL		REALS	REFS	121	336				
1514	RDISH	REAL		INPTR	REFS	156					
0	REPS2	REAL	ARRAY	F.P.	REFS	244	375	387	388	DEFINED	1	350
					351							
475	RFNUFF	REAL		REALS	REFS	134					
476	RHO	REAL		REALS	REFS	134					
477	RHOF	REAL		REALS	REFS	134					
500	RHOG	REAL		REALS	REFS	134					
501	RHOUO2	REAL		REALS	REFS	134					
502	RMH	REAL		REALS	REFS	134					
1515	ROUGHC	REAL		INPTR	REFS	156					
1516	ROUGHF	REAL		INPTR	REFS	156					
503	RP	REAL		REALS	REFS	134	260				
1222	RPP	REAL			REFS	336	DEFINED	260			
2551	RSNTR	REAL		INPTR	REFS	156					
504	RSTRAN	REAL		REALS	REFS	134					
505	RSTRES	REAL		REALS	REFS	134					
506	RTRAN	REAL		REALS	REFS	134					
0	R22	REAL	ARRAY	F.P.	REFS	244	375	DEFINED	1		
1517	SGAPF	REAL		INPTR	REFS	156					
0	SIG2	REAL	ARRAY	F.P.	REFS	244	375	389	439	DEFINED	1
507	SKTC	REAL		REALS	REFS	134					
510	SKTS	REAL		REALS	REFS	134					
511	STRN	REAL		REALS	REFS	134					
512	SUMCK	REAL		REALS	REFS	134					
513	SUMDH	REAL		REALS	REFS	134					
514	SUMEXP	REAL		REALS	REFS	134					
515	SUMGP	REAL		REALS	REFS	134					
516	SUMPOR	REAL		REALS	REFS	134					
517	SUMRG	REAL		REALS	REFS	134					
520	SUMTF	REAL		REALS	REFS	134					
521	T	REAL		REALS	REFS	134					
522	TCAC	REAL		REALS	REFS	134					

VARIABLES	SN	TYPE		RELOCATION						
1520	TCC	REAL		INPTR	REFS	156				
523	TCI	REAL		REALS	REFS	134				
524	TCO	REAL		REALS	REFS	134				
525	TFBC	REAL		REALS	REFS	134				
526	TFC	REAL		REALS	REFS	134				
527	TFGFR	REAL		REALS	REFS	134				
530	THEFR	REAL		REALS	REFS	134				
531	TH2OFR	REAL		REALS	REFS	134				
1521	TIME	REAL	ARRAY	INPTR	REFS	156	290	422		
532	TITLE	REAL	ARRAY	REALS	REFS	134				
546	TM	REAL		REALS	REFS	134				
547	TN2FR	REAL		REALS	REFS	134				
1666	TOTL	REAL		INPTR	REFS	156				
550	TOXO	REAL		REALS	REFS	134				
551	TP	REAL		REALS	REFS	134				
552	TPA	REAL		REALS	REFS	134				
553	TPAC	REAL		REALS	REFS	134				
554	TPLEN	REAL		REALS	REFS	134				
555	TRANST	REAL		REALS	REFS	134				
2553	TREF	REAL		INPTR	REFS	156				
556	TSAT	REAL		REALS	REFS	134				
1667	TSINT	REAL		INPTR	REFS	156				
557	TT	REAL		REALS	REFS	134				
0	TTT	REAL	ARRAY	F.P.	REFS	244	375	391	DEFINED	1
1670	TW	REAL	ARRAY	INPTR	REFS	156				
560	TX	REAL		REALS	REFS	134				
561	TXA	REAL		REALS	REFS	134				
562	TXAL	REAL		REALS	REFS	134				
563	TXC	REAL		REALS	REFS	134				
2035	UBFS	REAL		INPTR	REFS	156				
2036	UMELT	REAL		INPTR	REFS	156				
2037	UOFD	REAL		INPTR	REFS	156				
0	VERS	REAL		VER	REFS	207				
564	VISC	REAL		REALS	REFS	134				
565	VPLT	REAL		REALS	REFS	134				
2040	VS	REAL		INPTR	REFS	156				
566	VSS	REAL		REALS	REFS	134				
600	VX	REAL		REALS	REFS	134	375			
567	W	REAL		REALS	REFS	134				
570	WT	REAL		REALS	REFS	134				
571	WTRAN	REAL		REALS	REFS	134				
2041	X	REAL	ARRAY	INPTR	REFS	156				
572	XEIN	REAL		REALS	REFS	134				
573	XK6	REAL		REALS	REFS	134				
574	XK7	REAL		REALS	REFS	134				
1231	X11	REAL			REFS	292	421	DEFINED	287	
1232	X22	REAL			REFS	291	292	421	DEFINED	288
575	YY	REAL		REALS	REFS	134				
576	Z	REAL		REALS	REFS	134				
577	ZRO2WG	REAL		REALS	REFS	134				

EXTERNALS	TYPE	ARGS	REFERENCES
FCHI		47	336
FCHI2		49	375

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
AMOD	REAL	2	INTRIN		421

STATEMENT LABELS		DEF LINE	REFERENCES			
0	100	278	261	273		
166	110	295	430			
0	120	319	301	314		
416	130	344	299			
0	140	356	349	352	354	
0	150	395	383	390	393	
656	160	397	346			
0	170	417	399	412		
0	180	419	297			
776	190	420	294			
1023	200	432	424	425		
0	210	440	437			
1052	220	441	434			
1053	230	444	279	280		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
17	100	I	261 278	103B	NOT INNER
74	100	II	273 278	23B	OPT
170	180	I	297 419	605B	EXT REFS NOT INNER
175	120	IJ	301 319	107B	NOT INNER
256	120	IK	314 319	23B	OPT
425	140	JJI	349 356	40B	NOT INNER
436	140	IY	352 356	24B	NOT INNER
445	140	II	354 356	12B	INSTACK
566	150	JJI	383 395	67B	NOT INNER
621	150	IY	390 395	31B	NOT INNER
635	150	II	393 395	12B	INSTACK
660	170	IJ	399 417	107B	NOT INNER
741	170	IK	412 417	23B	OPT
1034	210	I	437 440	15B	OPT

COMMON BLOCKS	LENGTH
FAST	1
POINT	199
REALS	392
INTEG	24
INPTR	1393
INPTI	197
EMFLGS	10
PFRCS2	22
MATCNS	12
LACMDL	21
VER	1
PHYPRO	11
PFCMI2	39

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STATISTICS
  PROGRAM LENGTH                1352B     746
  SCM LABELED COMMON LENGTH     4422B    2322
        140000B SCM USED
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      SUBROUTINE CCRAK (HSTRES,TCLAD,X,CDAMAG)                                  CCRK       2
C                                                                               CCRK       3
C     IMPLICIT REAL*8 ( A-H, O-Z )                                              CCRK       4
C                                                                               CCRK       5
C     SUBROUTINE CCRAK CALCULATES THE PROBABILITY THAT THE RANDOM               CCRK       6
C     VARIABLE U ( = CRITICAL CRACK LENGTH/CLADDING THICKNESS ) IS              CCRK       7
C     LESS THAN OR EQUAL TO X. THE PROBABILITY DENSITY FUNCTION, F(U),          CCRK       8
C     WAS COMPUTED FROM A KNOWLEDGE OF THE DENSITY FUNCTION OF THE              CCRK       9
C     FAILURE STRESS, SF. THE RANDOM VARIABLES U AND SF ARE RELATED             CCRK      10
C     BY THE FOLLOWING EXPRESSION --  U = 1 - HSTRES/SF . THE FAILURE           CCRK      11
C     STRESS IS ASSUMED TO BE DISTRIBUTED ACCORDING TO THE BETA                 CCRK      12
C     DISTRIBUTION.                                                             CCRK      13
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                                  CCRK      14
C                                                                               CCRK      15
C                                                                               CCRK      16
C     --  INPUT ARGUMENTS --                                                    CCRK      17
C                                                                               CCRK      18
C     HSTRES     CLADDING HOOP STRESS ( N/M2 )                                  CCRK      19
C     TCLAD      TEMPERATURE OF CLADDING ( DEG K )                              CCRK      20
C     X          CRACK LENGTH/ CLADDING THICKNESS ( = INPUT PARAMETER           CCRK      21
C     FOR WHICH THE PROBABILITY OF FAILURE IS CALCULATED)                       CCRK      22
C                                                                               CCRK      23
C                                                                               CCRK      24
C     -- OUTPUT ARGUMENTS --                                                    CCRK      25
C                                                                               CCRK      26
C     CDAMAG     PROBABILITY OF FAILURE, I.E., PROBABILITY THAT THE             CCRK      27
C     CRACK LENGTH HAS EXCEEDED THE CRITICAL CRACK LENGTH                       CCRK      28
C                                                                               CCRK      29
C                                                                               CCRK      30
      CALL FSTRS (TCLAD,DEV,FSTRES)                                             CCRK      31
      T = FSTRES+3.*DEV                                                         CCRK      32
      B = FSTRES-2.*DEV                                                         CCRK      33
      IF (B.LE.0.0) B = 0.                                                      CCRK      34
C                                                                               CCRK      35
C     CHECK WHETHER X IS OUTSIDE THE RANGE OF THE DISTRIBUTION                  CCRK      36
C                                                                               CCRK      37
      AL = 1.-(HSTRES/B)                                                        CCRK      38
      AU = 1.-(HSTRES/T)                                                        CCRK      39
      IF (X.GT.AL) GO TO 100                                                    CCRK      40
      CDAMAG = 0.                                                               CCRK      41
      GO TO 120                                                                 CCRK      42
100   IF (X.LT.AU) GO TO 110                                                    CCRK      43
      CDAMAG = 1.                                                               CCRK      44
      GO TO 120                                                                 CCRK      45
C                                                                               CCRK      46
C     SET UP VARIABLES TO BE USED                                               CCRK      47
C                                                                               CCRK      48
110   T2 = T*T                                                                  CCRK      49
      T3 = T2*T                                                                 CCRK      50
      T4 = T3*T                                                                 CCRK      51
      B2 = B*B                                                                  CCRK      52
      B3 = B2*B                                                                 CCRK      53
      B4 = B3*B                                                                 CCRK      54
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                TB = 1./(T-B)                                                    CCRK       55
55              TB2 = TB*TB                                                      CCRK       56
                TB3 = TB2*TB                                                     CCRK       57
                TB4 = TB3*TB                                                     CCRK       58
                TB5 = TB4*TB                                                     CCRK       59
                H = HSTRES                                                       CCRK       60
60              H2 = H*H                                                         CCRK       61
                H3 = H2*H                                                        CCRK       62
                H4 = H3*H                                                        CCRK       63
                H5 = H4*H                                                        CCRK       64
                X1 = 1./(1.-X)                                                   CCRK       65
65              X2 = X1*X1                                                       CCRK       66
                X3 = X2*X1                                                       CCRK       67
                X4 = X3*X1                                                       CCRK       68
          C                                                                      CCRK       69
          C   CALCULATE NORMALIZING CONSTANT                                     CCRK       70
70        C                                                                      CCRK       71
            CNORM = H*TB5*(T4/12.-B*T3+(-1.+ALOG10(T/B))*3.*B2*T2+(11./3.+2.*A CCRK       72
           +LOG10(T/B))*B3*T+B4/4.)                                              CCRK       73
          C                                                                      CCRK       74
          C   CALCULATE TERMS OF PROBABILITY FUNCTION                            CCRK       75
75        C                                                                      CCRK       76
            TERM1 = (H5*TB5/4.)*(X4-B4/H4)                                       CCRK       77
            TERM2 = (H4*TB5/3.)*(3.*B+2.*T)*(X3-B3/H3)                           CCRK       78
            TERM3 = (H3*TB5/2.)*(3.*B2+6.*B*T+T2)*(X2-B2/H2)                     CCRK       79
            TERM4 = (H2*TB5*B)*(B2+6.*B*T+3.*T2)*(X1-B/H)                        CCRK       80
80          TERM5 = (H*TB5*B2*T)*(2.*B+3.*T)*ALOG10(H*X1/B)                      CCRK       81
            TERM6 = (B3*T2*TB5)*(X-1.+H/B)                                       CCRK       82
          C                                                                      CCRK       83
            CDAMAG = (1./CNORM)*(TERM1-TERM2+TERM3-TERM4+TERM5-TERM6)            CCRK       84
          C                                                                      CCRK       85
85        120 CONTINUE                                                           CCRK       86
          C                                                                      CCRK       87
          C                                                                      CCRK       88
            RETURN                                                               CCRK       89
            END                                                                  CCRK       90
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CCRAK	1	88

VARIABLES

		SN	TYPE	RELOCATION									
321	AL		REAL	REFS	39	DEFINED	37						
322	AU		REAL	REFS	42	DEFINED	38						
320	B		REAL	REFS	33	37	2*51	52	53	54	3*71		
				77	78	3*79	2*80	81	DEFINED	32	33		
326	B2		REAL	REFS	52	71	2*78	79	80				
				DEFINED	51								

VARIABLES	SN	TYPE	RELOCATION									
327	B3	REAL		REFS	53	71	77	81	DEFINED	52		
330	B4	REAL		REFS	71	76	DEFINED	53				
0	CDAMAG	REAL	F.P.	DEFINED	1	40	43	83				
347	CNORM	REAL		REFS	83	DEFINED	71					
315	DEV	REAL		REFS	30	31	32					
316	FSTRES	REAL		REFS	30	31	32					
336	H	REAL		REFS	2*60	61	62	63	71	79	2*80	
				81	DEFINED	59						
0	HSTRES	REAL	F.P.	REFS	37	38	59	DEFINED	1			
337	H2	REAL		REFS	61	78	79	DEFINED	60			
340	H3	REAL		REFS	62	77	78	DEFINED	61			
341	H4	REAL		REFS	63	76	77	DEFINED	62			
342	H5	REAL		REFS	76	DEFINED	63					
317	T	REAL		REFS	38	2*48	49	50	54	3*71	77	
				78	79	2*80	DEFINED	31				
331	TB	REAL		REFS	2*55	56	57	58	DEFINED	54		
332	TB2	REAL		REFS	56	DEFINED	55					
333	TB3	REAL		REFS	57	DEFINED	56					
334	TB4	REAL		REFS	58	DEFINED	57					
335	TB5	REAL		REFS	71	76	77	78	79	80	81	
				DEFINED	58							
0	TCLAD	REAL	F.P.	REFS	30	DEFINED	1					
350	TERM1	REAL		REFS	83	DEFINED	76					
351	TERM2	REAL		REFS	83	DEFINED	77					
352	TERM3	REAL		REFS	83	DEFINED	78					
353	TERM4	REAL		REFS	83	DEFINED	79					
354	TERM5	REAL		REFS	83	DEFINED	80					
355	TERM6	REAL		REFS	83	DEFINED	81					
323	T2	REAL		REFS	49	71	78	79	81			
				DEFINED	48							
324	T3	REAL		REFS	50	71	DEFINED	49				
325	T4	REAL		REFS	71	DEFINED	50					
0	X	REAL	F.P.	REFS	39	42	64	81	DEFINED	1		
343	X1	REAL		REFS	2*65	66	67	79	80			
				DEFINED	64							
344	X2	REAL		REFS	66	78	DEFINED	65				
345	X3	REAL		REFS	67	77	DEFINED	66				
346	X4	REAL		REFS	76	DEFINED	67					

EXTERNALS	TYPE	ARGS		REFERENCES	
ALOG10	REAL	1	LIBRARY	2*71	80
FSTRS		3		30	

STATEMENT LABELS		DEF LINE	REFERENCES	
42	100	42	39	
51	110	48	42	
267	120	85	41	44

STATISTICS

PROGRAM LENGTH 356B 238

140000B SCM USED

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      C                                                                     CDTR       2
      C     .................................................................CDTR       3
      C                                                                     CDTR       4
      C     SUBROUTINE CDTR                                                 CDTR       5
      C                                                                     CDTR       6
      C     PURPOSE                                                         CDTR       7
      C     COMPUTES P(X) = PROBABILITY THAT THE RANDOM VARIABLE U,         CDTR       8
      C     DISTRIBUTED ACCORDING TO THE CHI-SQUARE DISTRIBUTION WITH G     CDTR       9
      C     DEGREES OF FREEDOM, IS LESS THAN OR EQUAL TO X.  F(G,X), THE    CDTR      10
      C     ORDINATE OF THE CHI-SQUARE DENSITY AT X, IS ALSO COMPUTED.      CDTR      11
      C                                                                     CDTR      12
      C     USAGE                                                           CDTR      13
      C     CALL CDTR(X,G,P,D,IER)                                          CDTR      14
      C                                                                     CDTR      15
      C     DESCRIPTION OF PARAMETERS                                       CDTR      16
      C     X   - INPUT SCALAR FOR WHICH P(X) IS COMPUTED.                  CDTR      17
      C     G   - NUMBER OF DEGREES OF FREEDOM OF THE CHI-SQUARE            CDTR      18
      C     DISTRIBUTION.  G IS A CONTINUOUS PARAMETER.                     CDTR      19
      C     P   - OUTPUT PROBABILITY.                                       CDTR      20
      C     D   - OUTPUT DENSITY.                                           CDTR      21
      C     IER - RESULTANT ERROR CODE WHERE                                CDTR      22
      C     IER= 0 --- NO ERROR                                             CDTR      23
      C     IER=-1 --- AN INPUT PARAMETER IS INVALID.  X IS LESS            CDTR      24
      C     THAN 0.0, OR G IS LESS THAN 0.5 OR GREATER                      CDTR      25
      C     THAN 2*10**(+5).  P AND D ARE SET TO -1.E75.                    CDTR      26
      C     IER=+1 --- INVALID OUTPUT.  P IS LESS THAN ZERO OR              CDTR      27
      C     GREATER THAN ONE, OR SERIES FOR TI (SEE                         CDTR      28
      C     MATHEMATICAL DESCRIPTION) HAS FAILED TO                         CDTR      29
      C     CONVERGE.  P IS SET TO 1.E75.                                   CDTR      30
      C                                                                     CDTR      31
      C     REMARKS                                                         CDTR      32
      C     SEE MATHEMATICAL DESCRIPTION.                                   CDTR      33
      C                                                                     CDTR      34
      C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                   CDTR      35
      C     DLGAM                                                           CDTR      36
      C     NDTR                                                            CDTR      37
      C                                                                     CDTR      38
      C     METHOD                                                          CDTR      39
      C     REFER TO R.E. BARGMANN AND S.P. GHOSH, STATISTICAL              CDTR      40
      C     DISTRIBUTION PROGRAMS FOR A COMPUTER LANGUAGE,                  CDTR      41
      C     IBM RESEARCH REPORT RC-1094, 1963.                              CDTR      42
      C                                                                     CDTR      43
      C     .................................................................CDTR      44
      C                                                                     CDTR      45
            SUBROUTINE CDTR (X,G,P,D,IER)                                   CDTR      46
            DOUBLE PRECISION XX,DLXX,X2,DLX2,GG,G2,DLT3,THETA,THPI,         CDTR      47
           +GLG2,DD,TII,SER,CC,XI,FAC,TLOG,TERM,GTH,A2,A,B,C,DT2,DT3,THPI   CDTR      48
      C                                                                     CDTR      49
      C     TEST FOR VALID INPUT DATA                                       CDTR      50
      C                                                                     CDTR      51
            IF (G-(.5-1.E-5)) 680,100,100                                   CDTR      52
      100   IF (G-2.E+5) 110,110,680                                        CDTR      53
      110   IF (X) 680,120,120                                              CDTR      54
```

```
      C
      C   TEST FOR X NEAR 0.0
      C
  120   IF (X-1.E-8) 130,130,170
  130   P = 0.0
        IF (G-2.) 140,150,160
  140   D = 1.E75
        GO TO 700
  150   D = 0.5
        GO TO 700
  160   D = 0.0
        GO TO 700
      C
      C   TEST FOR X GREATER THAN 1.E+6
      C
  170   IF (X-1.E+6) 190,190,180
  180   D = 0.0
        P = 1.0
        GO TO 700
      C
      C   SET PROGRAM PARAMETERS
      C
  190   XX = DBLE(X)
        DLXX = DLOG(XX)
        X2 = XX/2.D0
        DLX2 = DLOG(X2)
        GG = DBLE(G)
        G2 = GG/2.D0
      C
      C   COMPUTE ORDINATE
      C
        CALL DLGAM (G2,GLG2,IOK)
        DD = (G2-1.D0)*DLXX-X2-G2*.6931471805599453-GLG2
        IF (DD-1.68D02) 200,200,210
  200   IF (DD+1.68D02) 220,220,230
  210   D = 1.E75
        GO TO 240
  220   D = 0.0
        GO TO 240
  230   DD = DEXP(DD)
        D = SNGL(DD)
      C
      C   TEST FOR G GREATER THAN 1000.0
      C   TEST FOR X GREATER THAN 2000.0
      C
  240   IF (G-1000.) 250,250,270
  250   IF (X-2000.) 280,280,260
  260   P = 1.0
        GO TO 700
  270   A = DLOG(XX/GG)/3.D0
        A = DEXP(A)
        B = 2.D0/(9.D0*GG)
        C = (A-1.D0+B)/DSQRT(B)
```

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CDTR  55
CDTR  56
CDTR  57
CDTR  58
CDTR  59
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CDTR  61
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CDTR  97
CDTR  98
CDTR  99
CDTR 100
CDTR 101
CDTR 102
CDTR 103
CDTR 104
CDTR 105
CDTR 106
CDTR 107
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                SC = SNGL(C)                                                    CDTR      108
                CALL NDTR (SC,P,DUMMY)                                          CDTR      109
                GO TO 580                                                       CDTR      110
110         C                                                                   CDTR      111
            C   COMPUTE THETA                                                   CDTR      112
            C                                                                   CDTR      113
            280 K = IDINT(G2)                                                   CDTR      114
                THETA = G2-FLOAT(K)                                             CDTR      115
115             IF (THETA-1.D-8) 290,290,300                                    CDTR      116
            290 THETA = 0.D0                                                    CDTR      117
            300 THPI = THETA+1.D0                                               CDTR      118
            C                                                                   CDTR      119
            C   SELECT METHOD OF COMPUTING TI                                   CDTR      120
120         C                                                                   CDTR      121
                IF (THETA) 320,320,310                                          CDTR      122
            310 IF (XX-10.D0) 350,350,410                                       CDTR      123
            C                                                                   CDTR      124
            C   COMPUTE TI FOR THETA EQUALS 0.0                                CDTR      125
125         C                                                                   CDTR      126
            320 IF (X2-1.68D02) 340,330,330                                     CDTR      127
            330 TI = 1.0                                                        CDTR      128
                GO TO 490                                                       CDTR      129
            340 TII = 1.D0-DEXP(-X2)                                            CDTR      130
130             TI = SNGL(TII)                                                  CDTR      131
                GO TO 490                                                       CDTR      132
            C                                                                   CDTR      133
            C   COMPUTE TI FOR THETA GREATER THAN 0.0 AND                       CDTR      134
            C   X LESS THAN OR EQUAL TO 10.0                                    CDTR      135
135         C                                                                   CDTR      136
            350 SER = X2*(1.D0/THPI-X2/(THPI+1.D0))                             CDTR      137
                J = +1                                                          CDTR      138
                CC = FLOAT(J)                                                   CDTR      139
                    DO 360 IT1=3,30                                             CDTR      140
140                 XI = FLOAT(IT1)                                             CDTR      141
                    CALL DLGAM (XI,FAC,IOK)                                     CDTR      142
                    TLOG = XI*DLX2-FAC-DLOG(XI+THETA)                           CDTR      143
                    TERM = DEXP(TLOG)                                           CDTR      144
                    TERM = DSIGN(TERM,CC)                                       CDTR      145
145                 SER = SER+TERM                                              CDTR      146
                    CC = -CC                                                    CDTR      147
                    IF (DABS(TERM)-1.D-9) 370,360,360                           CDTR      148
            360     CONTINUE                                                    CDTR      149
                GO TO 690                                                       CDTR      150
150         370 IF (SER) 690,690,380                                            CDTR      151
            380 CALL DLGAM (THPI,GTH,IOK)                                       CDTR      152
                TLOG = THETA*DLX2+DLOG(SER)-GTH                                 CDTR      153
                IF (TLOG+1.68D02) 390,390,400                                   CDTR      154
            390 TI = 0.0                                                        CDTR      155
155             GO TO 490                                                       CDTR      156
            400 TII = DEXP(TLOG)                                                CDTR      157
                TI = SNGL(TII)                                                  CDTR      158
                GO TO 490                                                       CDTR      159
            C                                                                   CDTR      160
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      C   COMPUTE TI FOR THETA GREATER THAN 0.0 AND                          CDTR  161
      C   X GREATER THAN 10.0 AND LESS THAN 2000.0                           CDTR  162
      C                                                                      CDTR  163
      410   A2 = 0.D0                                                        CDTR  164
            DO 430 I=1,25                                                    CDTR  165
      165   XI = FLOAT(I)                                                    CDTR  166
            CALL DLGAM (THPI,GTH,IOK)                                        CDTR  167
            TII = -(13.D0*XX)/XI+THPI*DLOG(13.D0*XX/XI)-GTH-DLOG(XI)         CDTR  168
            IF (TII+1.68D02) 430,430,420                                     CDTR  169
      420   TII = DEXP(TII)                                                  CDTR  170
      170   A2 = A2+TII                                                      CDTR  171
      430   CONTINUE                                                         CDTR  172
            A = 1.01282051+THETA/156.D0-XX/312.D0                            CDTR  173
            B = DABS(A)                                                      CDTR  174
            C = -X2+THPI*DLX2+DLOG(B)-GTH-3.951243718581427                  CDTR  175
      175   IF (C+1.68D02) 460,460,440                                       CDTR  176
      440   IF (A) 450,460,470                                               CDTR  177
      450   C = -DEXP(C)                                                     CDTR  178
            GO TO 480                                                        CDTR  179
      460   C = 0.D0                                                         CDTR  180
      180   GO TO 480                                                        CDTR  181
      470   C = DEXP(C)                                                      CDTR  182
      480   C = A2+C                                                         CDTR  183
            TII = 1.D0-C                                                     CDTR  184
            TI = SNGL(TII)                                                   CDTR  185
      185   C                                                                CDTR  186
      C   SELECT PROPER EXPRESSION FOR P                                     CDTR  187
      C                                                                      CDTR  188
      490   IF (G-2.) 510,500,500                                            CDTR  189
      500   IF (G-4.) 540,550,550                                            CDTR  190
      190   C                                                                CDTR  191
      C   COMPUTE P FOR G GREATER THAN ZERO AND LESS THAN 2.0                CDTR  192
      C                                                                      CDTR  193
      510   CALL DLGAM (THPI,GTH,IOK)                                        CDTR  194
            DT2 = THETA*DLXX-X2-THPI*.6931471805599453-GTH                   CDTR  195
      195   IF (DT2+1.68D02) 520,520,530                                     CDTR  196
      520   P = TI                                                           CDTR  197
            GO TO 580                                                        CDTR  198
      530   DT2 = DEXP(DT2)                                                  CDTR  199
            T2 = SNGL(DT2)                                                   CDTR  200
      200   P = TI+T2+T2                                                     CDTR  201
            GO TO 580                                                        CDTR  202
      C                                                                      CDTR  203
      C   COMPUTE P FOR G GREATER THAN OR EQUAL TO 2.0                       CDTR  204
      C   AND LESS THAN 4.0                                                 CDTR  205
      205   C                                                                CDTR  206
      540   P = TI                                                           CDTR  207
            GO TO 580                                                        CDTR  208
      C                                                                      CDTR  209
      C   COMPUTE P FOR G GREATER THAN OR EQUAL TO 4.0                       CDTR  210
      210   C   AND LESS THAN OR EQUAL TO 1000.0                             CDTR  211
      C                                                                      CDTR  212
      550   DT3 = 0.D0                                                       CDTR  213
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```
                      DO 570 I3=2,K                                                  CDTR      214
                      THPI = FLOAT(I3)+THETA                                         CDTR      215
215                   CALL DLGAM (THPI,GTH,IOK)                                      CDTR      216
                      DLT3 = THPI*DLX2-DLXX-X2-GTH                                   CDTR      217
                      IF (DLT3+1.68D02) 570,570,560                                  CDTR      218
              560     DT3 = DT3+DEXP(DLT3)                                           CDTR      219
              570     CONTINUE                                                       CDTR      220
220           T3 = SNGL(DT3)                                                         CDTR      221
              P = T1-T3-T3                                                           CDTR      222
              C                                                                      CDTR      223
              C   SET ERROR INDICATOR                                                CDTR      224
              C                                                                      CDTR      225
225           580   IF (P) 590,610,610                                               CDTR      226
              590   IF (ABS(P)-1.E-7) 600,600,690                                    CDTR      227
              600   P = 0.0                                                          CDTR      228
                    GO TO 700                                                      CDTR      229
              610   IF (1.-P) 620,640,640                                           CDTR      230
230           620   IF (ABS(1.-P)-1.E-7) 630,630,690                                 CDTR      231
              630   P = 1.0                                                          CDTR      232
                    GO TO 700                                                      CDTR      233
              640   IF (P-1.E-8) 650,650,660                                         CDTR      234
              650   P = 0.0                                                          CDTR      235
235                 GO TO 700                                                      CDTR      236
              660   IF ((1.0-P)-1.E-8) 670,670,700                                   CDTR      237
              670   P = 1.0                                                          CDTR      238
                    GO TO 700                                                      CDTR      239
              680   IER = -1                                                         CDTR      240
240                 D = -1.E75                                                     CDTR      241
                    P = -1.E75                                                     CDTR      242
                    GO TO 710                                                      CDTR      243
              690   IER = +1                                                         CDTR      244
                    P = 1.E75                                                      CDTR      245
245                 GO TO 710                                                      CDTR      246
              700   IER = 0                                                          CDTR      247
              710   RETURN                                                           CDTR      248
                    END                                                            CDTR      249
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

86	1		CONSTANT TOO LONG. HIGH ORDER DIGITS RETAINED, BUT SOME PRECISION LOST.
174	1		CONSTANT TOO LONG. HIGH ORDER DIGITS RETAINED, BUT SOME PRECISION LOST.
194	1		CONSTANT TOO LONG. HIGH ORDER DIGITS RETAINED, BUT SOME PRECISION LOST.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CDTR 45 247

VARIABLES		SN	TYPE	RELOCATION									
1410	A		DOUBLE		REFS	46	104	106	173	176			
					DEFINED	103	104	172					
1406	A2		DOUBLE		REFS	46	170	182	DEFINED	163	170		
1412	B		DOUBLE		REFS	46	2*106	174	DEFINED	105	173		
1414	C		DOUBLE		REFS	46	107	175	177	181	182	183	
					DEFINED	106	174	177	179	181	182		
1372	CC		DOUBLE		REFS	46	144	146	DEFINED	138	146		
0	D		REAL	F.P.	DEFINED	45	60	62	64	70	89	91	
					94	240							
1364	DD		DOUBLE		REFS	46	87	88	93	94			
					DEFINED	86	93						
1354	DLT3		DOUBLE		REFS	46	217	218	DEFINED	216			
1342	DLXX		DOUBLE		REFS	46	86	194	216	DEFINED	77		
1346	DLX2		DOUBLE		REFS	46	142	152	174	216			
					DEFINED	79							
1416	DT2		DOUBLE		REFS	46	195	198	199	DEFINED	194	198	
1420	DT3		DOUBLE		REFS	46	218	220	DEFINED	212	218		
1426	DUMMY	*	REAL		REFS	108							
1376	FAC		DOUBLE		REFS	46	141	142					
0	G		REAL	F.P.	REFS	51	52	59	80	59	188	189	
					DEFINED	45							
1350	GG		DOUBLE		REFS	46	81	103	105	DEFINED	80		
1362	GLG2		DOUBLE		REFS	46	85	86					
1404	GTH		DOUBLE		REFS	46	151	152	166	167	174	193	
					194	215	216						
1352	G2		DOUBLE		REFS	46	85	2*86	113	114			
					DEFINED	81							
1433	I		INTEGER		REFS	165	DEFINED	164					
0	IER		INTEGER	F.P.	DEFINED	45	239	243	246				
1424	IOK		INTEGER		REFS	85	141	151	166	193	215		
1432	ITI		INTEGER		REFS	140	DEFINED	139					
1435	I3		INTEGER		REFS	214	DEFINED	213					
1431	J		INTEGER		REFS	138	DEFINED	137					
1427	K		INTEGER		REFS	114	213	DEFINED	113				
0	P		REAL	F.P.	REFS	108	225	226	229	230	233	236	
					DEFINED	45	58	71	101	196	200	206	
					221	227	231	234	237	241	244		
1425	SC		REAL		REFS	108	DEFINED	107					
1370	SER		DOUBLE		REFS	46	145	150	152	DEFINED	136	145	
1402	TERM		DOUBLE		REFS	46	144	145	147	DEFINED	143	144	
1356	THETA		DOUBLE		REFS	46	115	117	121	142	152	172	
					194	214	DEFINED	114	116				
1422	THPI		DOUBLE		REFS	46	215	216	DEFINED	214			
1360	THPI		DOUBLE		REFS	46	2*136	151	166	167	174	193	
					194	DEFINED	117						
1400	TLOG		DOUBLE		REFS	46	143	153	156	DEFINED	142	152	
1430	TI		REAL		REFS	196	200	206	221	DEFINED	127	130	
					154	157	184						
1366	TII		DOUBLE		REFS	46	130	157	168	169	170	184	

VARIABLES	SN	TYPE	RELOCATION								
				DEFINED	129	156	167	169	183		
1434	T2	REAL		REFS	2*200	DEFINED	199				
1436	T3	REAL		REFS	2*221	DEFINED	220				
0	X	REAL	F.P.	REFS	53	57	69	76	100		
				DEFINED	45						
1374	XI	DOUBLE		REFS	46	141	2*142	3*167	DEFINED	140	165
1340	XX	DOUBLE		REFS	46	77	78	103	122	2*167	172
				DEFINED	76						
1344	X2	DOUBLE		REFS	46	79	86	126	129	2*136	174
				194	216	DEFINED	78				

EXTERNALS	TYPE	ARGS	REFERENCES							
DEXP	DOUBLE	1	LIBRARY	[illegible]	104	12[illegible]	143	156	169	177	181	198
				218								
DLGAM		3		85	141	151	166	193	215			
DLOG	DOUBLE	1	LIBRARY	77	79	103	142	152	2*167	174		
DSQRT	DOUBLE	1	LIBRARY	106								
NDTR		3		108								

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES						
ABS	REAL	1	INTRIN	226	230						
DABS	DOUBLE	1	INTRIN	147	173						
DBLE	DOUBLE	1	INTRIN	76	80						
DSIGN	DOUBLE	2	INTRIN	144							
FLOAT	REAL	1	INTRIN	114	138	140	165	214			
IDINT	INTEGER	1	INTRIN	113							
SNGL	REAL	1	INTRIN	94	107	130	157	184	199	220	

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100	INACTIVE	52	2*51	
0	110	INACTIVE	53	2*52	
0	120	INACTIVE	57	2*53	
0	130	INACTIVE	58	2*57	
0	140	INACTIVE	60	59	
35	150		62	59	
41	160		64	59	
44	170		69	57	
0	180	INACTIVE	70	69	
55	190		76	2*69	
0	200	INACTIVE	88	2*87	
150	210		89	87	
154	220		91	2*88	
157	230		93	88	
165	240		99	90	92
0	250	INACTIVE	100	2*99	
0	260	INACTIVE	101	100	
200	270		103	99	
262	280		113	2*100	
0	290	INACTIVE	116	2*115	
303	300		117	115	
0	310	INACTIVE	122	121	
321	320		126	2*121	
0	330	INACTIVE	127	2*126	

STATEMENT LABELS			DEF LINE	REFERENCES								
332	340		129	126								
346	350		136	2*122								
0	360		148	139	2*147							
470	370		150	147								
0	380	INACTIVE	151	150								
0	390	INACTIVE	154	2*153								
522	400		156	153								
531	410		163	122								
0	420	INACTIVE	169	168								
630	430		171	164	2*168							
0	440	INACTIVE	176	175								
0	450	INACTIVE	177	176								
722	460		179	2*175	176							
726	470		181	176								
732	480		182	178	180							
750	490		188	128	131	155	158					
0	500	INACTIVE	189	2*188								
760	510		193	188								
0	520	INACTIVE	196	2*195								
1015	530		198	195								
1030	540		206	109								
1034	550		212	2*189								
0	560	INACTIVE	218	217								
1104	570		219	213	2*217							
1116	580		225	109	192	201	207					
0	590	INACTIVE	226	225								
0	600	INACTIVE	227	2*226								
1130	610		229	2*225								
0	620	INACTIVE	230	229								
0	630	INACTIVE	231	2*230								
1144	640		233	2*229								
0	650	INACTIVE	234	2*233								
1153	660		236	233								
0	670	INACTIVE	237	2*236								
1163	680		239	51	52	53						
1172	690		243	149	2*150	226	230					
1200	700		246	61	63	65	72	102	228	232	235	236
				238								
1202	710		247	242	245							

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
403	360	I1	139 148	63B		EXT REFS	EXITS
535	430	I	164 171	76B		EXT REFS	
1040	570	I3	213 219	47B		EXT REFS	

STATISTICS
PROGRAM LENGTH 1437B 799
140000B SCM USED

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      SUBROUTINE CEXPAN (TCA,TXA,TXAL,TXC)                                  CEXP       2
C                                                                           CEXP       3
C     IMPLICIT REAL * 8 (A-H,O-Z)                                           CEXP       4
C                                                                           CEXP       5
C     ***************************************************************       CEXP       6
C                                                                           CEXP       7
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES CLADDING AXIAL       CEXP       8
C     AND RADIAL THERMAL EXPANSION                                          CEXP       9
C     CEXPAN WAS CODED BY G A BERNA IN JANUARY 1978.                        CEXP      10
C                                                                           CEXP      11
C     ***************************************************************       CEXP      12
C     INPUT ARGUMENTS                                                       CEXP      13
C     ***************************************************************       CEXP      14
C                                                                           CEXP      15
C     TCA    - CLADDING AVERAGE TEMPERATURE (F)                             CEXP      16
C                                                                           CEXP      17
C     ***************************************************************       CEXP      18
C     OUTPUT ARGUMENTS                                                      CEXP      19
C     ***************************************************************       CEXP      20
C                                                                           CEXP      21
C     TXA    - CLAD THERMAL EXP COEF IN RADIAL DIRECTION (IN/IN-F)          CEXP      22
C     TXAL   - CLAD THERMAL EXP COEF IN AXIAL DIRECTION (IN/IN-F)           CEXP      23
C     TXC    - CLADDING THERMAL EXPANSION COEFFICIENT (1/F)                 CEXP      24
C                                                                           CEXP      25
C     ***************************************************************       CEXP      26
C                                                                           CEXP      27
      TCAK = (TCA+459.67E0)/1.8E0                                           CEXP      28
      CALL CTHEXP (TCAK,CATHEX,CDTHEX)                                      CEXP      29
      TXA = CDTHEX/(TCA-70.0)                                               CEXP      30
      TXAL = CATHEX/(TCA-70.0)                                              CEXP      31
      TXC = CDTHEX                                                          CEXP      32
C                                                                           CEXP      33
  100 CONTINUE                                                              CEXP      34
      RETURN                                                                CEXP      35
      END                                                                   CEXP      36
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CEXPAN	1	34

VARIABLES		SN	TYPE	RELOCATION							
37	CATHEX		REAL			REFS	28	30			
40	CDTHEX		REAL			REFS	28	29	31		
0	TCA		REAL	F.P.		REFS	27	29	30	DEFINED	1
36	TCAK		REAL			REFS	28	DEFINED	27		
0	TXA		REAL	F.P.	DEFINED	1	29				
0	TXAL		REAL	F.P.	DEFINED	1	30				
0	TXC		REAL	F.P.	DEFINED	1	31				

```
EXTERNALS          TYPE   ARGS       REFERENCES
      CTHEXP                3            28

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100         INACTIVE      33

STATISTICS
  PROGRAM LENGTH                  418      33
        140000B SCM USED
```

```
      SUBROUTINE CHECK (IM,NA,NC,NF,DEN,JN,ENRCH,FA,ICM,NR,NSH,CP,CR,CPL CHECK       2
     +,CRDT,IQ,DISHSD,DSPG,DSPGK,GO,FGPAV,HDISH,HPLT,ICOR,IDXGAS,BUIN,RC CHECK       3
     +,JDLPR,NOPT,NSP,RDISH,TOTL,NUNITS,VS,ROUGHF,ROUGHC,NGASR,DCI,DCO,D CHECK       4
     +E,DP,DELTAZ,QMPY,TIME,TW,P2,JST,X,IQUIT,AMFAIR,AMFARG,AMFFG,AMFHE, CHECK       5
     +AMFH2,QF,AMFH2O,AMFKRY,AMFN2,AMFXE,MECHAN,IVARDM)                  CHECK       6
C                                                                         CHECK       7
      DIMENSION       GO(IM), TIME(IM), QMPY(IM), DCI(NA), DCO(NA),       CHECK       8
     +   DE(NA), DP(NA), TW(IM), P2(IM) , JN(1), JST(1),QF(238),X(238)    CHECK       9
     +   ,DELTAZ(NA) ,BUIN(NA)                                           CHECK      10
C                                                                         CHECK      11
      ISW = 0                                                             CHECK      12
      IMM1 = IM-1                                                         CHECK      13
      JN1 = JN(1)                                                         CHECK      14
      JNM1 = JN1-1                                                        CHECK      15
      NA1 = NA-1                                                          CHECK      16
      NSH = 0                                                             CHECK      17
C                                                                         CHECK      18
      IF (IM.LT.1.OR.IM.GT.1000) WRITE (6,250) IM                         CHECK      19
      IF (IM.LT.1.OR.IM.GT.1000) ISW = ISW+1                              CHECK      20
      IF (NA.LT.1.OR.NA.GT.17) WRITE (6,260) NA                           CHECK      21
      IF (NA.LT.1.OR.NA.GT.17) ISW = ISW+1                                CHECK      22
      IF (NC.LT.0.OR.NC.GE.10) WRITE (6,270) NC                           CHECK      23
      IF (NC.LT.0.OR.NC.GE.10) ISW = ISW+1                                CHECK      24
      IF (NF.LT.0.OR.NF.GE.10) WRITE (6,280) NF                           CHECK      25
      IF (NF.LT.0.OR.NF.GE.10) ISW = ISW+1                                CHECK      26
      IF (DEN.LE.50..OR.DEN.GE.100.) WRITE (6,290) DEN                    CHECK      27
      IF (DEN.LE.50..OR.DEN.GE.100.) ISW = ISW+1                          CHECK      28
      IF (ENRCH.LT.0.E0.OR.ENRCH.GE.100.E0) WRITE (6,300) ENRCH           CHECK      29
      IF (ENRCH.LT.0.E0.OR.ENRCH.GE.100.E0) ISW = ISW+1                   CHECK      30
      IF (FA.LT.0..OR.FA.GT.5.) WRITE (6,310) FA                          CHECK      31
      IF (FA.LT.0..OR.FA.GT.5.) ISW = ISW+1                               CHECK      32
      IF (ICM.EQ.2.OR.ICM.EQ.4) GO TO 100                                 CHECK      33
      WRITE (6,320) ICM                                                   CHECK      34
      ISW = ISW+1                                                         CHECK      35
  100 CONTINUE                                                            CHECK      36
      IF (NR.NE.11) WRITE (6,330) NR                                      CHECK      37
      IF (NR.NE.11) ISW = ISW+1                                           CHECK      38
      IF (NSH.LT.0) WRITE (6,340) NSH                                     CHECK      39
      IF (NSH.LT.0) ISW = ISW+1                                           CHECK      40
      IF (CP.LT.0.) WRITE (6,350) CP                                      CHECK      41
      IF (CP.LT.0.) ISW = ISW+1                                           CHECK      42
      IF (CR.LT.0.) WRITE (6,360) CR                                      CHECK      43
      IF (CR.LT.0.) ISW = ISW+1                                           CHECK      44
      IF (CPL.LT.0.) WRITE (6,370) CPL                                    CHECK      45
      IF (CPL.LT.0.) ISW = ISW+1                                          CHECK      46
      IF (CRDT.LT.0.) WRITE (6,380) CRDT                                  CHECK      47
      IF (CRDT.LT.0.) ISW = ISW+1                                         CHECK      48
      IF (IQ.LT.0) WRITE (6,390) IQ                                       CHECK      49
      IF (IQ.LT.0) ISW = ISW+1                                            CHECK      50
      IF (DISHSD.LT.0.) WRITE (6,400) DISHSD                              CHECK      51
      IF (DISHSD.LT.0.) ISW = ISW+1                                       CHECK      52
      IF (DSPG.LT.0.E0.OR.DSPG.GT.DCI(NA-1)) WRITE (6,410) DSPG           CHECK      53
      IF (DSPG.LT.0.E0.OR.DSPG.GT.DCI(NA-1)) ISW = ISW+1                  CHECK      54
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      IF (DSPGW.LT.0.) WRITE (6,420) DSPGW                                CHECK   55
55    IF (DSPGW.LT.0.) ISW = ISW+1                                        CHECK   56
      IF (FGPAV.LT.0.) WRITE (6,430) FGPAV                                CHECK   57
      IF (FGPAV.LT.0.) ISW = ISW+1                                        CHECK   58
      IF (HDISH.LT.0.) WRITE (6,440) HDISH                                CHECK   59
      IF (HDISH.LT.0.) ISW = ISW+1                                        CHECK   60
60    IF (HPLT.LT.0.) WRITE (6,450) HPLT                                  CHECK   61
      IF (HPLT.LT.0.) ISW = ISW+1                                         CHECK   62
      IF (ICOR.LT.0) WRITE (6,460) ICOR                                   CHECK   63
      IF (ICOR.LT.0) ISW = ISW+1                                          CHECK   64
      IF (IDXGAS.LT.0) WRITE (6,470) IDXGAS                               CHECK   65
65    IF (IDXGAS.LT.0) ISW = ISW+1                                        CHECK   66
      IF (JDLPR.LT.0) WRITE (6,480) JDLPR                                 CHECK   67
      IF (JDLPR.LT.0) ISW = ISW+1                                         CHECK   68
      IF (NOPT.LT.0) WRITE (6,490) NOPT                                   CHECK   69
      IF (NOPT.LT.0) ISW = ISW+1                                          CHECK   70
70    IF (NSP.LT.0) ISW = ISW+1                                           CHECK   71
      IF (NSP.LT.0) WRITE (6,500) NSP                                     CHECK   72
      IF (RC.LT.0.) WRITE (6,510) RC                                      CHECK   73
      IF (RC.LT.0.) ISW = ISW+1                                           CHECK   74
      IF (RDISH.LT.0.) ISW = ISW+1                                        CHECK   75
75    IF (RDISH.LT.0.) WRITE (6,520) RDISH                                CHECK   76
      IF (TOTL.LE.0.) WRITE (6,530) TOTL                                  CHECK   77
      IF (TOTL.LE.0.) ISW = ISW+1                                         CHECK   78
      IF (NUNITS.LT.0) WRITE (6,540) NUNITS                               CHECK   79
      IF (NUNITS.LT.0) ISW = ISW+1                                        CHECK   80
80    IF (VS.LT.0.) WRITE (6,550) VS                                      CHECK   81
      IF (VS.LT.0.) ISW = ISW+1                                           CHECK   82
      IF (X(I).NE.0.) WRITE (6,560) X(I)                                  CHECK   83
      IF (X(I).NE.0.) ISW = ISW+1                                         CHECK   84
      IF (ROUGHF.LT.0.) WRITE (6,570) ROUGHF                              CHECK   85
85    IF (ROUGHF.LT.0.) ISW = ISW+1                                       CHECK   86
      IF (ROUGHC.LT.0.) WRITE (6,580) ROUGHC                              CHECK   87
      IF (ROUGHC.LT.0.) ISW = ISW+1                                       CHECK   88
      IF (NGASR.LT.-2) WRITE (6,590) NGASR                                CHECK   89
      IF (NGASR.LT.-2) ISW = ISW+1                                        CHECK   90
90    IF (JN(I).LT.0) WRITE (6,600) JN(I)                                 CHECK   91
      IF (JN(I).LT.0) ISW = ISW+1                                         CHECK   92
C                                                                         CHECK   93
      DTOT = 0.                                                           CHECK   94
C                                                                         CHECK   95
95    IF (IVARDM.EQ.0) NAI = 1                                            CHECK   96
          DO 110 II=1,NAI                                                 CHECK   97
          IF (DP(II).LE.0.) WRITE (6,610) DP(II)                          CHECK   98
          IF (DP(II).LE.0.) ISW = ISW+1                                   CHECK   99
          IF (DCI(II).LE.DP(II)) WRITE (6,620) DCI(II)                    CHECK  100
100       IF (DCI(II).LE.DP(II)) ISW = ISW+1                              CHECK  101
          IF (DCO(II).LE.DCI(II)) WRITE (6,630) DCO(II)                   CHECK  102
          IF (DCO(II).LE.DCI(II)) ISW = ISW+1                             CHECK  103
          IF (DE(II).LT.0.) WRITE (6,640) DE(II)                          CHECK  104
          IF (DE(II).LT.0.) ISW = ISW+1                                   CHECK  105
105       IF (DELTAZ(II).LT.0.) WRITE (6,650) DELTAZ(II)                  CHECK  106
          IF (DELTAZ(II).LT.0.) ISW = ISW+1                               CHECK  107
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                    DTOT = DTOT+DELTAZ(II)                                          CHECK     108
                    IF (BUIN(II).LT.0) WRITE (6,660) BUIN(II)                       CHECK     109
                    IF (BUIN(II).LT.0) ISW = ISW+1                                  CHECK     110
110         110     CONTINUE                                                        CHECK     111
                C                                                                   CHECK     112
                    IF (IVARDM.EQ.0) GO TO 120                                      CHECK     113
                    IF (DTOT.GT.TOTL+0.01.OR.DTOT.LT.TOTL-0.01) WRITE (6,670) DTOT  CHECK     114
                    IF (DTOT.GT.TOTL+0.01.OR.DTOT.LT.TOTL-0.01) ISW = ISW+1         CHECK     115
115         120     CONTINUE                                                        CHECK     116
                C                                                                   CHECK     117
                    DO 130 II=1,IM                                                  CHECK     118
                    IF (GO(II).LT.0.) WRITE (6,680) GO(II)                          CHECK     119
                    IF (GO(II).LT.0.) ISW = ISW+1                                   CHECK     120
120                 IF (QMPY(II).LT.0.) WRITE (6,690) QMPY(II)                      CHECK     121
                    IF (QMPY(II).LT.0.) ISW = ISW+1                                 CHECK     122
                    IF (TIME(II).LE.0.) WRITE (6,700) TIME(II)                      CHECK     123
                    IF (TIME(II).LE.0.) ISW = ISW+1                                 CHECK     124
                    IF (TW(II).LT.0.) WRITE (6,710) TW(II)                          CHECK     125
125                 IF (TW(II).LT.0.) ISW = ISW+1                                   CHECK     126
                    IF (P2(II).LT.0.) WRITE (6,720) P2(II)                          CHECK     127
                    IF (P2(II).LT.0.) ISW = ISW+1                                   CHECK     128
                    IF (JST(II).LT.0..OR.JST(II).GT.8) WRITE (6,730) JST(II)        CHECK     129
                    IF (JST(II).LT.0..OR.JST(II).GT.8) ISW = ISW+1                  CHECK     130
130         130     CONTINUE                                                        CHECK     131
                    IF (TW(1).LE.0.) WRITE (6,740) TW(1)                            CHECK     132
                    IF (TW(1).LE.0.) ISW = ISW+1                                    CHECK     133
                C                                                                   CHECK     134
                    IF (MECHAN.NE.1) GO TO 150                                      CHECK     135
135                 DO 140 II=1,IMM1                                                CHECK     136
                    IF (NUNITS.EQ.1.AND.ABS(QMPY(II+1)-QMPY(II)).GT.1.0) WRITE (6,  CHECK     137
                +   750)                                                           CHECK     138
                    IF (NUNITS.EQ.0.AND.ABS(QMPY(II+1)-QMPY(II)).GT.3.3) WRITE (6,  CHECK     139
                +   750)                                                           CHECK     140
140         140     CONTINUE                                                        CHECK     141
150         CONTINUE                                                            CHECK     142
                    DO 160 II=1,IMM1                                                CHECK     143
                    IF (TIME(II+1).LT.TIME(II)) WRITE (6,760) II,TIME(II),TIME(II+  CHECK     144
                +   1)                                                            CHECK     145
145                 IF (TIME(II+1).LT.TIME(II)) ISW = ISW+1                         CHECK     146
160                 CONTINUE                                                        CHECK     147
                C                                                                   CHECK     148
                    IF (IDXGAS.NE.6) GO TO 170                                      CHECK     149
                    AADD = AMFFG+AMFARG+AMFH2O+AMFHE+AMFN2+AMFAIR+AMFH2+AMFXE+AMFKRY CHECK     150
150                 IF (AADD.NE.1.0) WRITE (6,770) AADD                             CHECK     151
                    IF (AADD.LT.0.99.OR.AADD.GT.1.01) ISW = ISW+1                   CHECK     152
                C                                                                   CHECK     153
170         CONTINUE                                                            CHECK     154
                    DO 180 II=1,JN1                                                 CHECK     155
155                 IF (QF(II).LT.0.) WRITE (6,780) QF(II)                          CHECK     156
                    IF (QF(II).LT.0) ISW = ISW+1                                    CHECK     157
180                 CONTINUE                                                        CHECK     158
                C                                                                   CHECK     159
                    DO 190 II=1,JNM1                                                CHECK     160
```

```
                      IF (X(II+1).LT.X(II)) WRITE (6,790) X(II+1)                CHECK    161
                      IF (X(II+1).LT.X(II)) ISW = ISW+1                          CHECK    162
              190     CONTINUE                                                   CHECK    163
                    IF (X(JNI).NE.TOTL) WRITE (6,800)                            CHECK    164
                    IF (X(JNI).NE.TOTL) ISW = ISW+1                              CHECK    165
              C                                                                  CHECK    166
                    IF (IQ.EQ.1) GO TO 220                                       CHECK    167
                    QFSAVE = 0.0                                                 CHECK    168
                      DO 200 II=1,JNI                                            CHECK    169
                      IF (QF(II).GT.QFSAVE) QFSAVE = QF(II)                      CHECK    170
              200     CONTINUE                                                   CHECK    171
                    IF (QFSAVE.LT.1.) WRITE (6,810) QFSAVE                       CHECK    172
                    IF (QFSAVE.LT.1.) ISW = ISW+1                                CHECK    173
                    IF (FA.EQ.1.) GO TO 210                                      CHECK    174
                    IF (QFSAVE.GT.1.) WRITE (6,820) QFSAVE                       CHECK    175
                    IF (QFSAVE.GT.1.) ISW = ISW+1                                CHECK    176
                    GO TO 230                                                    CHECK    177
              210   CONTINUE                                                     CHECK    178
                    IF (QFSAVE.EQ.1.) WRITE (6,830)                              CHECK    179
                    GO TO 230                                                    CHECK    180
              220   CONTINUE                                                     CHECK    181
                    IF (FA.LE.1.) WRITE (6,840) FA                               CHECK    182
                    IF (FA.LE.1.) ISW = ISW+1                                    CHECK    183
              230   CONTINUE                                                     CHECK    184
                    C                                                            CHECK    185
                    IF (ISW.EQ.0) GO TO 240                                      CHECK    186
                    WRITE (6,850) ISW                                            CHECK    187
                    IQUIT = 1                                                    CHECK    188
              240   CONTINUE                                                     CHECK    189
                    RETURN                                                       CHECK    190
              C                                                                  CHECK    191
              250   FORMAT (1X,36HIM NOT WITHIN LIMITS (1 TO 1000) IM=,I5)       CHECK    192
              260   FORMAT (1X,34HNA NOT WITHIN LIMITS (1 TO 17) NA=,I5)         CHECK    193
              270   FORMAT (1X,34HNC NOT WITHIN LIMITS (0 TO 10) NC=,I5)         CHECK    194
              280   FORMAT (1X,34HNF NOT WITHIN LIMITS (0 TO 10) NF=,I5)         CHECK    195
              290   FORMAT (1X,38HDEN NOT WITHIN LIMITS (50 TO 100) DEN=,E10.4)  CHECK    196
              300   FORMAT (1X,41HENRCH NOT WITHIN LIMITS (0 TO 100) ENRCH=,E10.4) CHECK   197
              310   FORMAT (1X,33HFA NOT WITHIN LIMITS (0 TO 5) FA=,E10.4)       CHECK    198
              320   FORMAT (2X,35HICM NOT WITHIN LIMITS (2 OR 4) ICM=,I5)        CHECK    199
              330   FORMAT (1X,32HNR NOT WITHIN LIMITS (EQ 11) NR=,I5)           CHECK    200
              340   FORMAT (1X,33HNSH NOT WITHIN LIMITS (GE 0) NSH=,I5)          CHECK    201
              350   FORMAT (1X,31HCP NOT WITHIN LIMITS (GE 0) CP=,E10.4)         CHECK    202
              360   FORMAT (1X,31HCR NOT WITHIN LIMITS (GE 0) CR=,E10.4)         CHECK    203
              370   FORMAT (1X,33HCPL NOT WITHIN LIMITS (GE 0) CPL=,E10.4)       CHECK    204
              380   FORMAT (1X,35HCRDT NOT WITHIN LIMITS (GE 0) CRDT=,E10.4)     CHECK    205
              390   FORMAT (1X,31HIQ NOT WITHIN LIMITS (GE 0) IQ=,I5)            CHECK    206
              400   FORMAT (1X,39HDISHSD NOT WITHIN LIMITS (GE 0) DISHSD=,E10.4) CHECK    207
              410   FORMAT (1X,48HDSPG NOT WITHIN LIMITS (GE 0 AND LE DCI ) DSPG= ,E10 CHECK 208
                   +.4)                                                        CHECK    209
              420   FORMAT (1X,37HDSPGW NOT WITHIN LIMITS (GE 0) DSPGW=,E10.4)    CHECK    210
              430   FORMAT (1X,37HFGPAV NOT WITHIN LIMITS (GE 0) FGPAV=,E10.4)   CHECK    211
              440   FORMAT (1X,37HHDISH NOT WITHIN LIMITS (GE 0) HDISH=,E10.4)   CHECK    212
              450   FORMAT (1X,35HHPLT NOT WITHIN LIMITS (GE 0) HPLT=,E10.4)     CHECK    213
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      460   FORMAT (1X,35HICOR NOT WITHIN LIMITS (GE 0) ICOR=,E10.4)              CHECK     214
      470   FORMAT (1X,39HIDXGAS NOT WITHIN LIMITS (GE 0) IDXGAS=,E10.4)          CHECK     215
215   480   FORMAT (1X,37HJDLPR NOT WITHIN LIMITS (GE 0) JDLPR=,I5)               CHECK     216
      490   FORMAT (1X,35HNOPT NOT WITHIN LIMITS (GE 0) NOPT=,I5)                 CHECK     217
      500   FORMAT (1X,33HNSP NOT WITHIN LIMITS (GE 0) NSP=,I5)                   CHECK     218
      510   FORMAT (1X,31HRC NOT WITHIN LIMITS (GE 0) RC=,I5)                     CHECK     219
      520   FORMAT (1X,37HRDISH NOT WITHIN LIMITS (GE 0) RDISH=,E10.4)            CHECK     220
220   530   FORMAT (1X,35HTOTL NOT WITHIN LIMITS (GT 0) TOTL=,E10.4)              CHECK     221
      540   FORMAT (1X,39HNUNITS NOT WITHIN LIMITS (GE 0) NUNITS=,E10.4)          CHECK     222
      550   FORMAT (1X,31HVS NOT WITHIN LIMITS (GE 0) VS=,E10.4)                  CHECK     223
      560   FORMAT (1X,35HX(I) NOT WITHIN LIMITS (EQ 0) X(I)=,E10.4)              CHECK     224
      570   FORMAT (1X,39HROUGHF NOT WITHIN LIMITS (GE 0) ROUGHF=,E10.4)          CHECK     225
225   580   FORMAT (1X,39HROUGHC NOT WITHIN LIMITS (GE 0) ROUGHC=,E10.4)          CHECK     226
      590   FORMAT (1X,38HNGASR NOT WITHIN LIMITS (GE -2) NGASR=,I5)              CHECK     227
      600   FORMAT (1X,37HJN(I) NOT WITHIN LIMITS (GE 0) JN(I)=,I5)               CHECK     228
      610   FORMAT (1X,31HDP NOT WITHIN LIMITS (GT 0) DP=,E10.4)                  CHECK     229
      620   FORMAT (1X,34HDCI NOT WITHIN LIMITS (GT DP) DCI=,E10.4)               CHECK     230
230   630   FORMAT (1X,35HDCO NOT WITHIN LIMITS (GT DCI) DCO=,E10.4)              CHECK     231
      640   FORMAT (1X,31HDE NOT WITHIN LIMITS (GE 0) DE=,E10.4)                  CHECK     232
      650   FORMAT (1X,39HDELTAZ NOT WITHIN LIMITS (GE 0) DELTAZ=,E10.4)          CHECK     233
      660   FORMAT (1X,36HBUIN NOT WITHIN LIMITS (GE 0) BUIN= ,E10.4)             CHECK     234
      670   FORMAT (1X,45HDELTAZ TOTAL NOT EQUAL TO TOTL, DELTAZ TOTAL=,E10.4)     CHECK     235
235   680   FORMAT (1X,31HGO NOT WITHIN LIMITS (GE 0) GO=,E10.4)                   CHECK     236
      690   FORMAT (1X,35HQMPY NOT WITHIN LIMITS (GE 0) QMPY=,E10.4)               CHECK     237
      700   FORMAT (1X,35HTIME NOT WITHIN LIMITS (GE 0) TIME=,E10.4)               CHECK     238
      710   FORMAT (1X,31HTW NOT WITHIN LIMITS (GE 0) TW=,E10.4)                   CHECK     239
      720   FORMAT (1X,31HP2 NOT WITHIN LIMITS (GE 0) P2=,E10.4)                   CHECK     240
240   730   FORMAT (1X,35HJST NOT WITHIN LIMITS (0 TO 8) JST=,I5)                  CHECK     241
      740   FORMAT (1X,35HTW(I) NOT GREATER THAN 0.0, TW(I) =,E10.4)               CHECK     242
      750   FORMAT (1X,52H WHEN MECHAN = 1, QMPY SHOULD ONLY CLIMB AT 1 KW/FT      CHECK     243
     +,44HPER TIME STEP   OR   3.3 KW/M PER TIME STEP )                          CHECK     244
      760   FORMAT (1X,45HTIME LESS THAN PREVIOUS TIME, PREVIOUS STEP =,I3,3X,     CHECK     245
245  +14HPREVIOUS TIME=,E10.4,3X,5HTIME=,E10.4)                                   CHECK     246
      770   FORMAT (1X,34HGAS TOTAL NOT EQUAL TO 1.0, TOTAL=,E10.4)                CHECK     247
      780   FORMAT (1X,31HQF NOT WITHIN LIMITS (GE 0) QF=,E10.4)                   CHECK     248
      790   FORMAT (1X,38HX VALUE LESS THAN PREVIOUS X VALUE, X=,E10.4)            CHECK     249
      800   FORMAT (1X,24HX(JN1) NOT EQUAL TO TOTL)                                CHECK     250
250   810   FORMAT (1X,53HAT LEAST ONE VALUE OF QF MUST BE 1.0 OR GREATER. QF      CHECK     251
     +=,F6.3)                                                                     CHECK     252
      820   FORMAT (1X,52HFA GREATER THAN 1.0, MAXIMUM QF MUST EQUAL 1.0  QF =     CHECK     253
     +,F6.3)                                                                      CHECK     254
      830   FORMAT (1X,80H*** WARNING *** CHECK QF INPUT - SHOULD BE NORMALIZE     CHECK     255
255  +D TO AVERAGE WHEN FA = 1.0  )                                               CHECK     256
      840   FORMAT (1X,47HWHEN IQ = 1, FA MUST BE GREATER THAN 1.0   FA =,F6.3     CHECK     257
     +)                                                                           CHECK     258
      850   FORMAT (1X,23HTOTAL NUMBER OF ERRORS=,I5)                              CHECK     259
            END                                                                    CHECK     260
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CHECK 1 189

VARIABLES SN TYPE RELOCATION

2465 AAND REAL REFS 2*150 2*151 DEFINED 149
0 AMFAIR REAL F.P. REFS 149 DEFINED 1
0 AMFARG REAL F.P. REFS 149 DEFINED 1
0 AMFFG REAL F.P. REFS 149 DEFINED 1
0 AMFHE REAL F.P. REFS 149 DEFINED 1
0 AMFH2 REAL F.P. REFS 149 DEFINED 1
0 AMFH2O REAL F.P. REFS 149 DEFINED 1
0 AMFKRY REAL F.P. REFS 149 DEFINED 1
0 AMFN2 REAL F.P. REFS 149 DEFINED 1
0 AMFXE REAL F.P. REFS 149 DEFINED 1
0 BUIN REAL ARRAY F.P. REFS 7 2*108 109 DEFINED 1
0 CP REAL F.P. REFS 2*40 41 DEFINED 1
0 CPL REAL F.P. REFS 2*44 45 DEFINED 1
0 CR REAL F.P. REFS 2*42 43 DEFINED 1
0 CRDT REAL F.P. REFS 2*46 47 DEFINED 1
0 DCI REAL ARRAY F.P. REFS 7 52 53 2*99 100 101 102
DEFINED 1
0 DCO REAL ARRAY F.P. REFS 7 2*101 102 DEFINED 1
0 DE REAL ARRAY F.P. REFS 7 2*103 104 DEFINED 1
0 DELTAZ REAL ARRAY F.P. REFS 7 2*105 106 107 DEFINED 1
0 DEN REAL F.P. REFS 3*26 2*27 DEFINED 1
0 DISHSD REAL F.P. REFS 2*50 51 DEFINED 1
0 DP REAL ARRAY F.P. REFS 7 2*97 98 99 100
DEFINED 1
0 DSPG REAL F.P. REFS 3*52 2*53 DEFINED 1
0 DSPGW REAL F.P. REFS 2*54 55 DEFINED 1
2463 DTOT REAL REFS 107 3*113 2*114 DEFINED 93 107
0 ENRCH REAL F.P. REFS 3*28 2*29 DEFINED 1
0 FA REAL F.P. REFS 3*30 2*31 173 2*131 182
DEFINED 1
0 FGPAV REAL F.P. REFS 2*56 57 DEFINED 1
0 GO REAL ARRAY F.P. REFS 7 2*118 119 DEFINED 1
0 HDISH REAL F.P. REFS 2*58 59 DEFINED 1
0 HPLT REAL F.P. REFS 2*60 61 DEFINED 1
0 ICM INTEGER F.P. REFS 2*32 33 DEFINED 1
0 ICOR INTEGER F.P. REFS 2*62 63 DEFINED 1
0 IDXGAS INTEGER F.P. REFS 2*64 65 148 DEFINED 1
2464 II INTEGER REFS 2*97 98 3*99 2*100 3*101 2*102 2*103
104 2*105 106 107 2*108 109 2*118 119
2*120 121 2*122 123 2*124 125 2*126 127
3*128 2*129 2*136 2*138 5*143 2*145 2*155 156
3*160 2*161 2*169 DEFINED 96 117 135 142
154 159 168
0 IH INTEGER F.P. REFS 5*7 12 3*18 2*19 117
DEFINED 1
2457 IMMI INTEGER REFS 135 142 DEFINED 12

VARIABLES	SN	TYPE		RELOCATION								
0	IQ	INTEGER		F.P.	REFS	2*48	49	166	DEFINED	1		
0	IQUIT	INTEGER		F.P.	DEFINED	1	187					
2456	ISW	INTEGER			REFS	19	21	23	25	27	29	31
						34	37	39	41	43	45	47	49
						51	53	55	57	59	61	63	65
						67	69	70	73	74	77	79	81
						83	85	87	89	91	98	100	102
						104	106	109	114	119	121	123	125
						127	129	132	145	151	[illegible]	161	164
						172	175	182	185	186	DEFINED	11	19
						21	23	25	27	29	31	34	37
						39	41	43	45	47	49	51	53
						55	57	59	61	63	65	67	69
						70	73	74	77	79	81	83	85
						87	89	91	98	100	102	104	106
						109	114	119	121	123	125	127	129
						132	145	151	156	161	164	172	175
						182							
0	IVARDM	INTEGER		F.P.	REFS	95	112	DEFINED	1				
0	JDLPR	INTEGER		F.P.	REFS	2*66	67	DEFINED	1				
0	JN	INTEGER	ARRAY	F.P.	REFS	7	13	2*90	91	DEFINED	1		
2461	JNMI	INTEGER			REFS	159	DEFINED	14					
2460	JNI	INTEGER			REFS	14	154	163	164	168			
					DEFINED	13							
0	JST	INTEGER	ARRAY	F.P.	REFS	7	3*128	2*129	DEFINED	1			
0	MECHAN	INTEGER		F.P.	REFS	134	DEFINED	1					
0	NA	INTEGER		F.P.	REFS	6*7	15	3*20	2*21	52	53		
					DEFINED	1							
2462	NAI	INTEGER			REFS	96	DEFINED	15	95				
0	NC	INTEGER		F.P.	REFS	3*22	2*23	DEFINED	1				
0	NF	INTEGER		F.P.	REFS	3*24	2*25	DEFINED	1				
0	NGASR	INTEGER		F.P.	REFS	2*88	89	DEFINED	1				
0	NOPT	INTEGER		F.P.	REFS	2*68	69	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	2*36	37	DEFINED	1				
0	NSH	INTEGER		F.P.	REFS	2*38	39	DEFINED	1	16			
0	NSP	INTEGER		F.P.	REFS	70	2*71	DEFINED	1				
0	NUNITS	INTEGER		F.P.	REFS	2*78	79	136	138	DEFINED	1		
0	P2	REAL	ARRAY	F.P.	REFS	7	2*126	127	DEFINED	1			
0	QF	REAL	ARRAY	F.P.	REFS	7	2*155	156	2*169	DEFINED	1		
2466	QFSAVE	REAL			REFS	169	2*171	172	2*174	175	178		
					DEFINED	167	169						
0	QMPY	REAL	ARRAY	F.P.	REFS	7	2*120	121	2*136	2*138			
					DEFINED	1							
0	RC	REAL		F.P.	REFS	2*72	73	DEFINED	1				
0	RDISH	REAL		F.P.	REFS	74	2*75	DEFINED	1				
0	ROUGHC	REAL		F.P.	REFS	2*86	87	DEFINED	1				
0	ROUGHF	REAL		F.P.	REFS	2*84	85	DEFINED	1				
0	TIME	REAL	ARRAY	F.P.	REFS	7	2*122	123	4*143	2*145			
					DEFINED	1							
0	TOTL	REAL		F.P.	REFS	2*76	77	2*113	2*114	163	164		
					DEFINED	1							
0	TW	REAL	ARRAY	F.P.	REFS	7	2*124	125	2*131	132			
					DEFINED	1							

```
VARIABLES     SN  TYPE          RELOCATION
    0  VS         REAL              F.P.        REFS      2*80      81    DEFINED       1
    0  X          REAL        ARRAY F.P.        REFS         7    2*82         83    3*160    2*161      163      164
                                                DEFINED      1

FILE NAMES      MODE
      TAPE6     FMT                    WRITES      18       20       22       24       26       28       30       33
                                                36       38       40       42       44       46       48       50       52
                                                54       56       58       60       62       64       66       68       71
                                                72       75       76       78       80       82       84       86       88
                                                90       97       99      101      103      105      108      113      118
                                               120      122      124      126      128      131      136      138      143
                                               150      155      160      163      171      174      178      181      186

INLINE FUNCTIONS  TYPE   ARGS        DEF LINE  REFERENCES
      ABS         REAL      1  INTRIN              136      138

STATEMENT LABELS              DEF LINE   REFERENCES
  152  100                        35         32
    0  110                       110         96
  656  120                       115        112
    0  130                       130        117
    0  140                       140        135
 1025  150                       141        134
    0  160                       146        142
 1101  170                       153        148
    0  180                       157        154
    0  190                       162        159
    0  200                       170        168
 1220  210                       177        173
 1226  220                       180        166
 1241  230                       183        176
 1250  240                       188        185
 1637  250      FMT              191         18
 1645  260      FMT              192         20
 1653  270      FMT              193         22
 1661  280      FMT              194         24
 1667  290      FMT              195         26
 1675  300      FMT              196         28
 1704  310      FMT              197         30
 1712  320      FMT              198         33
 1720  330      FMT              199         36
 1726  340      FMT              200         38
 1734  350      FMT              201         40
 1742  360      FMT              202         42
 1750  370      FMT              203         44
 1756  380      FMT              204         46
 1764  390      FMT              205         48
 1771  400      FMT              206         50
 2000  410      FMT              207         52
 2007  420      FMT              209         54
 2015  430      FMT              210         56
 2023  440      FMT              211         58
 2031  450      FMT              212         60
```

STATEMENT LABELS			DEF LINE	REFERENCES
2037	460	FMT	213	62
2045	470	FMT	214	64
2054	480	FMT	215	66
2062	490	FMT	216	68
2070	500	FMT	217	71
2076	510	FMT	218	72
2103	520	FMT	219	75
2111	530	FMT	220	76
2117	540	FMT	221	78
2126	550	FMT	222	80
2134	560	FMT	223	82
2142	570	FMT	224	84
2151	580	FMT	225	86
2160	590	FMT	226	88
2166	600	FMT	227	90
2174	610	FMT	228	97
2202	620	FMT	229	99
2210	630	FMT	230	101
2216	640	FMT	231	103
2224	650	FMT	232	105
2233	660	FMT	233	108
2241	670	FMT	234	113
2250	680	FMT	235	118
2256	690	FMT	236	120
2264	700	FMT	237	122
2272	710	FMT	238	124
2300	720	FMT	239	126
2306	730	FMT	240	128
2314	740	FMT	241	131
2322	750	FMT	242	136 138
2336	760	FMT	244	143
2351	770	FMT	246	150
2357	780	FMT	247	155
2365	790	FMT	248	160
2373	800	FMT	249	163
2400	810	FMT	250	171
2410	820	FMT	252	174
2420	830	FMT	254	178
2432	840	FMT	256	181
2441	850	FMT	258	186

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
527	110	11	96 110	106B	EXT REFS
660	130	11	117 130	103B	EXT REFS
1000	140	11	135 140	24B	EXT REFS
1027	160	11	142 146	20B	EXT REFS
1103	180	11	154 157	15B	EXT REFS
1122	190	11	159 162	17B	EXT REFS
1164	200	11	168 170	7B	INSTACK

STATISTICS

PROGRAM LENGTH	2561B	1393

140000B SCM USED

```
      SUBROUTINE CLADRP (COLDWK,CRN,DCO,FLUX,IT,J,NA,QC,TCA,TCI,TCO,TIME CLAD      2
     +)                                                                  CLAD      3
C                                                                        CLAD      4
C     IMPLICIT  REAL * 8 ( A-H,O-Z )                                     CLAD      5
C                                                                        CLAD      6
C     ******************************************************************* CLAD      7
C                                                                        CLAD      8
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES THE CLADDING      CLAD      9
C     INSIDE SURFACE TEMPERATURE AS WELL AS THE CLADDING AVERAGE TEMP.   CLAD     10
C     CLADRP WAS CODED BY G A BERNA NOVEMBER 1977.                       CLAD     11
C                                                                        CLAD     12
C     ******************************************************************* CLAD     13
C     INPUT  ARGUMENTS                                                   CLAD     14
C     ******************************************************************* CLAD     15
C                                                                        CLAD     16
C     COLDWK - CLADDING COLD WORK                                        CLAD     17
C     CRN    - CLADDING DIAMETER RATIO (DCO/DCI)                         CLAD     18
C     DCO    - CLADDING OUTSIDE DIAMETER (IN)                            CLAD     19
C     FLUX   - FAST NEUTRON FLUX (NEUTRONS/SEC-M**2)                     CLAD     20
C     IT     - POWER-TIME STEP INDEX                                     CLAD     21
C     J      - AXIAL NODE INDEX                                          CLAD     22
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                             CLAD     23
C     QC     - HEAT FLUX AT NODE J (BTU/HR-FT**2)                        CLAD     24
C     TCA    - CLADDING AVERAGE TEMPERATURE (F)                          CLAD     25
C     TCO    - OUTSIDE CLADDING TEMPERATURE (F)                          CLAD     26
C     TIME   - TIME AT FLUX (SEC)                                        CLAD     27
C                                                                        CLAD     28
C     ******************************************************************* CLAD     29
C     OUTPUT ARGUMENTS                                                   CLAD     30
C     ******************************************************************* CLAD     31
C                                                                        CLAD     32
C     TCA    - CLADDING AVERAGE TEMPERATURE (F)                          CLAD     33
C     TCI    - CLADDING INSIDE SURFACE TEMPERATURE (F)                   CLAD     34
C                                                                        CLAD     35
C     ******************************************************************* CLAD     36
C                                                                        CLAD     37
      DIMENSION  TCA(1) , TIME(1)                                        CLAD     38
C                                                                        CLAD     39
  100 TCAK = (TCA(J)+459.67)/1.8                                         CLAD     40
C                                                                        CLAD     41
      CALL CTHCON (TCAK,TIME(IT),FLUX,COLDWK,CCON,CDKDT)                 CLAD     42
C                                                                        CLAD     43
      TCI = TCO+QC*DCO*ALOG(CRN)/(24.*CCON)*1.7296                       CLAD     44
      TCA(J) = 0.5*(TCI+TCO)                                             CLAD     45
C                                                                        CLAD     46
      RETURN                                                             CLAD     47
      END                                                                CLAD     48
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CLADRP 1 46

VARIABLES	SN	TYPE	RELOCATION								
62 CCON		REAL			REFS	41	43				
63 CDKDT	*	REAL			REFS	41					
0 COLDWK		REAL		F.P.	REFS	41	DEFINED	1			
0 CRN		REAL		F.P.	REFS	43	DEFINED	1			
0 DCO		REAL		F.P.	REFS	43	DEFINED	1			
0 FLUX		REAL		F.P.	REFS	41	DEFINED	1			
0 IT		INTEGER		F.P.	REFS	41	DEFINED	1			
0 J		INTEGER		F.P.	REFS	39	44	DEFINED	1		
0 NA		INTEGER	*UNUSED	F.P.	DEFINED	1					
0 QC		REAL		F.P.	REFS	43	DEFINED	1			
0 TCA		REAL	ARRAY	F.P.	REFS	37	39	DEFINED	1	44	
61 TCAK		REAL			REFS	41	DEFINED	39			
0 TCI		REAL		F.P.	REFS	44	DEFINED	1	43		
0 TCO		REAL		F.P.	REFS	43	44	DEFINED	1		
0 TIME		REAL	ARRAY	F.P.	REFS	37	41	DEFINED	1		

EXTERNALS	TYPE	ARGS		REFERENCES
ALOG	REAL	1	LIBRARY	43
CTHCON		6		41

STATEMENT LABELS		DEF LINE	REFERENCES
0 100	INACTIVE	39	

STATISTICS
PROGRAM LENGTH 64B 52
140000B SCM USED

```
      SUBROUTINE CLADF (PG,PC,TC,RCI,RCO,CSIG,CEPS,CEPP,CEP,FS,NRELAX,DT CLDF       2
     +IME,TIME,CREP,NPLAST)                                              CLDF       3
C                                                                        CLDF       4
C     IMPLICIT REAL*8 (A-H,O-Z)                                          CLDF       5
C                                                                        CLDF       6
C     ***************************************************************** CLDF       7
C                                                                        CLDF       8
C     CLADF IS CALLED FROM FCMI AND GAPT AND CALCULATES THE FREE         CLDF       9
C     STANDING CLADDING DEFORMATION                                      CLDF      10
C                                                                        CLDF      11
C     ***************************************************************** CLDF      12
C     INPUT  ARGUMENTS                                                   CLDF      13
C     ***************************************************************** CLDF      14
C                                                                        CLDF      15
C     CSIG   - TEMPORARY HOOP, AXIAL, & RADIAL STRESS (PSI)              CLDF      16
C     DTIME  - TIME INCREMENT (HRS)                                      CLDF      17
C     FS     - THIS IS PRESENTLY EQUAL TO ZERO                           CLDF      18
C     NPLAST - ELASTIC-PLASTIC FLAG                                      CLDF      19
C     NRELAX - CREEP FLAG, = 0 NO CREEP CALCULATED  = 1 CREEP CALCULATED CLDF      20
C     PC     - COOLANT CHANNEL PRESSURE (PSIA)                           CLDF      21
C     PG     - ROD INTERNAL GAS PRESSURE (PSIA)                          CLDF      22
C     RCI    - CLADDING INSIDE RADIUS (IN)                               CLDF      23
C     RCO    - CLADDING OUTSIDE RADIUS (IN)                              CLDF      24
C     TC     - CLADDING AVERAGE TEMPERATURE (F)                          CLDF      25
C     TIME   - END OF STEP TIME (HRS)                                    CLDF      26
C                                                                        CLDF      27
C     ***************************************************************** CLDF      28
C     OUTPUT ARGUMENTS                                                   CLDF      29
C     ***************************************************************** CLDF      30
C                                                                        CLDF      31
C     CEP    - TEMPORARY EFFECTIVE PLASTIC STRAIN (IN/IN)                CLDF      32
C     CEPP   - TEMPORARY HOOP. AXIAL, & RADIAL PLASTIC STRAINS (IN/IN)   CLDF      33
C     CEPS   - TEMPORARY HOOP, AXIAL, & RADIAL STRAINS (IN/IN)           CLDF      34
C     CREP   - CREEP STRAIN (IN/IN)                                      CLDF      35
C                                                                        CLDF      36
C     ***************************************************************** CLDF      37
C                                                                        CLDF      38
C                                                                        MATCNS     2
C     THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES        MATCNS     3
C     USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM                      MATCNS     4
C                                                                        MATCNS     5
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX      MATCNS     6
     +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTMELT ,RSTRAN    MATCNS     7
C                                                                        MATCNS     8
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST      MATCNS     9
C     (HOOP STRAIN)/(RADIAL STRAIN)                                      MATCNS    10
C     COMP   - PUO2 CONTENT (WT%)                                        MATCNS    11
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)  MATCNS    12
C     CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT         MATCNS    13
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED       MATCNS    14
C     CLADDING     (KG OXYGEN/KG ZIRCALOY)                               MATCNS    15
C     FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                           MATCNS    16
C     FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)  MATCNS    17
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      C   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT          MATCNS     18
55    C   FOTMTL - FUEL OXYGEN TO METAL RAITO                                    MATCNS     19
      C   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)              MATCNS     20
      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                    MATCNS     21
      C   RSTRAN - TRUE STRAIN RATE (1/SEC)                                      MATCNS     22
      C                                                                          MATCNS     23
60    C                                                                          MATCNS     24
            REAL   CSIG(3),CEPS(3),CEPP(3),DEPP(3),ALFDT(3)                      CLDF       40
           DATA CNMTPS / 6.894757E3 /,CKTOR / 1.8E0 /, CFTOR / 459.67E0 /        CLDF       41
           DATA PI / 3.14159E0 /, CC /1.E0 /                                     CLDF       42
          CSIG(1) = (RCI*PG-RCO*PC)/(RCO-RCI)                                    CLDF       43
65        CSIG(2) = (PI*(RCI*RCI*PG-RCO*RCO*PC)+FS)/(PI*(RCO**2-RCI**2))         CLDF       44
          IF (NPLAST.EQ.1) GO TO 100                                             CLDF       45
          DEPP(1) = 0.E0                                                         CLDF       46
          DEPP(2) = 0.E0                                                         CLDF       47
          DEPP(3) = 0.E0                                                         CLDF       48
70        DEP = 0.E0                                                             CLDF       49
          GO TO 150                                                              CLDF       50
      100 CONTINUE                                                               CLDF       51
          SIGEFF = SQRT(CSIG(1)**2+CSIG(2)**2-CSIG(1)*CSIG(2))                   CLDF       52
          IF (SIGEFF-0.001) 110,110,120                                          CLDF       53
75    110 DEPP(1) = 0.0                                                          CLDF       54
          DEPP(2) = 0.0                                                          CLDF       55
          DEPP(3) = 0.0                                                          CLDF       56
          DEP = 0.0                                                              CLDF       57
          GO TO 150                                                              CLDF       58
80    120 CONTINUE                                                               CLDF       59
          SM = (CSIG(1)+CSIG(2))/3.0                                             CLDF       60
          S1 = CSIG(1)-SM                                                        CLDF       61
          S2 = CSIG(2)-SM                                                        CLDF       62
          CEP1 = CEP                                                             CLDF       63
85        IF (NRELAX.NE.1) GO TO 130                                             CLDF       64
      C                                                                          CLDF       65
          CALL CREPR (SIGEFF,DEPDOT,TIME,TC,FLUX,CREP)                           CLDF       66
      C                                                                          CLDF       67
          DEP = DEPDOT*DTIME                                                     CLDF       68
90        GO TO 140                                                              CLDF       69
      130 CONTINUE                                                               CLDF       70
      C                                                                          CLDF       71
          CALL STRAIN (SIGEFF,CC,CEP1,TC,RSTRAN,ANRIN,DELOXY,CWKF,CWNF,FNCK,     CLDF       72
         *FNCN)                                                                  CLDF       73
95    C                                                                          CLDF       74
          DEP = CEP1-CEP                                                         CLDF       75
      140 CONTINUE                                                               CLDF       76
          DEPP(1) = 1.5*DEP*S1/SIGEFF                                            CLDF       77
          DEPP(2) = 1.5*DEP*S2/SIGEFF                                            CLDF       78
100       DEPP(3) = -DEPP(1)-DEPP(2)                                             CLDF       79
      150 CONTINUE                                                               CLDF       80
          TC1 = (TC+CFTOR)/CKTOR                                                 CLDF       81
          E = CELMOD(TC1,FNCK,CWKF,DELOXY)/CNMTPS                                CLDF       82
          CR = CSHEAR(TC1,FNCK,CWKF,DELOXY)/CNMTPS                               CLDF       83
105       V = E/(2*CR)-1                                                         CLDF       84
          CALL CTHEXP (TC1,CATHEX,CDTHEX)                                        CLDF       85
```

```
                      ALFDT(1) = CDTHEX                                          CLDF      86
                      ALFDT(2) = CATHEX                                          CLDF      87
                      ALFDT(3) = CDTHEX                                          CLDF      88
  110                 CEPS(1) = (CSIG(1)-V*CSIG(2))/E+CEPP(1)+DEPP(1)            CLDF      89
                      CEPS(2) = (CSIG(2)-V*CSIG(1))/E+CEPP(2)+DEPP(2)            CLDF      90
                      CEPS(3) = -V*(CSIG(1)+CSIG(2))/E+CEPP(3)+DEPP(3)           CLDF      91
                C   ***THESE ARE MECHANICAL STRAINS - NOW ADD THERMAL STRAINS    CLDF      92
                      CEPS(1) = CEPS(1)+ALFDT(1)                                 CLDF      93
  115                 CEPS(2) = CEPS(2)+ALFDT(2)                                 CLDF      94
                      CEPS(3) = CEPS(3)+ALFDT(3)                                 CLDF      95
                      CEPP(1) = CEPP(1)+DEPP(1)                                  CLDF      96
                      CEPP(2) = CEPP(2)+DEPP(2)                                  CLDF      97
                      CEPP(3) = CEPP(3)+DEPP(3)                                  CLDF      98
  120                 IF (NRELAX.NE.1) CEP = CEP+DEP                             CLDF      99
                      IF (NRELAX.EQ.1) CREP = CREP+DEP                           CLDF     100
                      RETURN                                                     CLDF     101
                      END                                                        CLDF     102
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	CLADF	1	122

VARIABLES

352	ALFDT	REAL	ARRAY		REFS	61	114	115	116	DEFINED	107	108
					109							
0	AWRIN	REAL		MATCNS	REFS	42	93					
345	CATHEX	REAL			REFS	106	108					
325	CC	REAL			REFS	93	DEFINED	63				
346	CDTHEX	REAL			REFS	106	107	109				
0	CEP	REAL		F.P.	REFS	84	96	120	DEFINED	1	120	
0	CEPP	REAL	ARRAY	F.P.	REFS	61	110	111	112	117	118	119
					DEFINED	1	117	118	119			
0	CEPS	REAL	ARRAY	F.P.	REFS	61	114	115	116	DEFINED	1	110
					111	112	114	115	116			
337	CEPI	REAL			REFS	93	96	DEFINED	84			
323	CFTOR	REAL			REFS	102	DEFINED	62				
322	CKTOR	REAL			REFS	102	DEFINED	62				
321	CNMTPS	REAL			REFS	103	104	DEFINED	62			
1	COMP	REAL		MATCNS	REFS	42						
343	CR	REAL			REFS	105	DEFINED	104				
0	CREP	REAL		F.P.	REFS	87	121	DEFINED	1	121		
0	CSIG	REAL	ARRAY	F.P.	REFS	61	4*73	2*81	82	83	2*110	2*111
					2*112	DEFINED	1	64	65			
2	CWKF	REAL		MATCNS	REFS	42	93	103	104			
3	CWNF	REAL		MATCNS	REFS	42	93					
4	DELOXY	REAL		MATCNS	REFS	42	93	103	104			
332	DEP	REAL			REFS	98	99	120	121	DEFINED	70	78
					89	96						

```
VARIABLES     SN  TYPE          RELOCATION
  340  DEPDCT     REAL                          REFS        87    89
  347  DEPP       REAL          ARRAY           REFS        61    2*100     110     111     112     117     118
                                                 119  DEFINED    67      68      69      75      76      77
                                                  98          99    100
    0  DTIME      REAL                F.P.      REFS        89  DEFINED       1
  342  E          REAL                          REFS       105    110       111     112     DEFINED     103
    5  FLUX       REAL              MATCNS      REFS        42    87
    6  FNCK       REAL              MATCNS      REFS        42    93      103     104
    7  FNCN       REAL              MATCNS      REFS        42    93
   10  FOTMTL     REAL              MATCNS      REFS        42
   11  FRDEN      REAL              MATCNS      REFS        42
    0  FS         REAL                F.P.      REFS        65  DEFINED       1
   12  FTMELT     REAL              MATCNS      REFS        42
    0  NPLAST     INTEGER             F.P.      REFS        66  DEFINED       1
    0  NRELAX     INTEGER             F.P.      REFS        85    120       121     DEFINED       1
    0  PC         REAL                F.P.      REFS        64     65     DEFINED       1
    0  PG         REAL                F.P.      REFS        64     65     DEFINED       1
  324  PI         REAL                          REFS      2*65  DEFINED      63
    0  RCI        REAL                F.P.      REFS      2*64    3*65     DEFINED       1
    0  RCO        REAL                F.P.      REFS      2*64    3*65     DEFINED       1
   13  RSTRAN     REAL              MATCNS      REFS        42    93
  333  SIGEFF     REAL                          REFS        74    87      93      98      99
                                              DEFINED       73
  334  SM         REAL                          REFS        82    83      DEFINED      81
  335  S1         REAL                          REFS        98  DEFINED      82
  336  S2         REAL                          REFS        99  DEFINED      83
    0  TC         REAL                F.P.      REFS        87    93      102     DEFINED       1
  341  TC1        REAL                          REFS       103    104     106     DEFINED     102
    0  TIME       REAL                F.P.      REFS        87  DEFINED       1
  344  V          REAL                          REFS       110    111     112     DEFINED     105

EXTERNALS          TYPE    ARGS       REFERENCES
     CELMOD     REAL        4            103
     CREPR                  6             87
     CSHEAR     REAL        4            104
     CTHEXP                 3            106
     SQRT       REAL        1 LIBRARY     73
     STRAIN                11             93

STATEMENT LABELS                 DEF LINE    REFERENCES
   43  100                          72          66
    0  110          INACTIVE        75        2*74
   67  120                          80          74
  121  130                          91          85
  131  140                          97          90
  145  150                         101          71

COMMON BLOCKS   LENGTH
     MATCNS        12

STATISTICS
  PROGRAM LENGTH                   355B        237
  SCM LABELED COMMON LENGTH         14B         12
```

STATISTICS
140000B SCM USED

```
      SUBROUTINE CLDGRO (TCA,FLUX,FLXTIM,CATEXF,COLDWK,AXLEN,EPS02,J,EPS CLDG      2
     +0,MNA,MNR,MECHAN)                                                  CLDG      3
C                                                                        CLDG      4
C     IMPLICIT REAL * 8 (A-H,O-Z)                                        CLDG      5
C                                                                        CLDG      6
C     ***************************************************************** CLDG      7
C                                                                        CLDG      8
C     CLDGRO IS CALLED FROM MAIN AND COMPUTES THE CLADDING AXIAL GROWTH  CLDG      9
C                                                                        CLDG     10
C     ***************************************************************** CLDG     11
C     INPUT ARGUMENTS                                                    CLDG     12
C     ***************************************************************** CLDG     13
C                                                                        CLDG     14
C     CATEXF - TEXTURE FACTOR FOR THE AXIAL DIRECTION                    CLDG     15
C     EPS0   - TOTAL FUEL & CLADDING PERMANENT STRAINS(PAST STEP)        CLDG     16
C     COLDWK - CLADDING COLDWORK                                         CLDG     17
C     FLUX   - FAST NEUTRON FLUX (NEUTRONS/SEC-M**2)                     CLDG     18
C     FLXTIM - TIME AT TEMPERATURE (SEC)                                 CLDG     19
C     TCA    - CLADDING AVERAGE TEMPERATURE (F)                          CLDG     20
C                                                                        CLDG     21
C     ***************************************************************** CLDG     22
C     OUTPUT ARGUMENTS                                                   CLDG     23
C     ***************************************************************** CLDG     24
C                                                                        CLDG     25
C     AXLEN  - AXIAL STRAIN DUE TO CLADDING IRRADIATION GROWTH           CLDG     26
C     EPS02  - TOTAL FUEL & CLADDING PERMANENT STRAINS(CURRENT)          CLDG     27
C                                                                        CLDG     28
C     ***************************************************************** CLDG     29
C                                                                        CLDG     30
      DIMENSION EPS02(MNA,MNR,3),EPS0(MNA,MNR,3)                         CLDG     31
      TCAK = (TCA+459.67E0)/1.8E0                                        CLDG     32
      AXLEN = CAGROW(TCAK,FLUX,FLXTIM,CATEXF,COLDWK)                     CLDG     33
      IF (MECHAN.NE.3) GO TO 100                                         CLDG     34
      EPS02(J-1,12,1) = EPS0(J-1,12,1)                                   CLDG     35
      EPS02(J-1,12,2) = EPS0(J-1,12,2)                                   CLDG     36
      EPS02(J-1,12,3) = EPS0(J-1,12,3)+AXLEN                             CLDG     37
      EPS02(J-1,13,1) = EPS0(J-1,13,1)                                   CLDG     38
      EPS02(J-1,13,2) = EPS0(J-1,13,2)                                   CLDG     39
      EPS02(J-1,13,3) = EPS0(J-1,13,3)+AXLEN                             CLDG     40
  100 CONTINUE                                                           CLDG     41
      RETURN                                                             CLDG     42
      END                                                                CLDG     43
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 CLDGRO	1	41

```
VARIABLES     SN  TYPE          RELOCATION
    0  AXLEN     REAL                F.P.      REFS      36      39    DEFINED      1      32
    0  CATEXF    REAL                F.P.      REFS      32  DEFINED       1
    0  COLDWK    REAL                F.P.      REFS      32  DEFINED       1
    0  EPS0      REAL       ARRAY    F.P.      REFS      30      34      35      36      37      38      39
                                                DEFINED    1
    0  EPS02     REAL       ARRAY    F.P.      REFS      30  DEFINED       1      34      35      36      37
                                                  38      39
    0  FLUX      REAL                F.P.      REFS      32  DEFINED       1
    0  FLXTIM    REAL                F.P.      REFS      32  DEFINED       1
    0  J         INTEGER             F.P.      REFS    2*34    2*35    2*36    2*37    2*38    2*39
                                                DEFINED    1
    0  MECHAN    INTEGER             F.P.      REFS      33  DEFINED       1
    0  MNA       INTEGER             F.P.      REFS    2*30  DEFINED       1
    0  MNR       INTEGER             F.P.      REFS    2*30  DEFINED       1
    0  TCA       REAL                F.P.      REFS      31  DEFINED       1
  117  TCAK      REAL                          REFS      32  DEFINED      31

EXTERNALS          TYPE   ARGS       REFERENCES
     CAGROW     REAL       5            32

STATEMENT LABELS              DEF LINE   REFERENCES
  104  100                       40         33

STATISTICS
  PROGRAM LENGTH                 120B       80
        140000B SCM USED
```

```
      SUBROUTINE CLOSE (TC,PG,PC,URF,DELTA,EPP,EP,RCI,RCO,RFO,OLDTC,OLDP
     +G,OLDPC,OLDURF,J,FEPS,RFEPS,REPS,OLEPS,OLFEPS,NRELAX,DTIME,TIME,EC
     +REEP,NA,IQUIT,NPLAST)
C
C     IMPLICIT REAL*8 (A-H,O-Z)
C
C     THIS ROUTINE SEEKS OUT THE POINT OF GAP CLOSURE
C     CLOSE IS CALLED FROM FCMI
C
C
      DIMENSION          TC(1)          ,PG(1)          ,PC(1)
     +                  ,URF(1)         ,CSIG(3)        ,CEPS(3)
     +   ,CEPP(3)       ,EP(1)          ,OLDTC(1)       ,OLDPG(1)
     +   ,OLDPC(1)      ,OLDURF(1)      ,OLFEPS(1)      ,EPP(NA,1)
     +   ,FEPS(NA,1)    ,RFEPS(NA,1)    ,REPS(NA,1)     ,OLEPS(1)
     +   ,ECREEP(1)
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     CSIG   - TEMPORARY HOOP, AXIAL, & RADIAL STRESS (PSI)
C     DELTA  - COLD STATE RADIAL GAP (IN)
C     DTIME  - TIME INCREMENT (HRS)
C     ECREEP - CREEP STRAIN (IN/IN)
C     FEPS   - HOOP, AXIAL, & RADIAL FUEL STRAINS
C     J      - AXIAL NODE INDEX
C     NA     - MAXIMUM NUMBER OF AXIAL NODES
C     NPLAST - ELASTIC-PLASTIC FLAG
C     NRELAX - CREEP FLAG
C     OLDPC  - COOLANT CHANNEL PRESSURE OF PREVIOUS POWER STEP (PSIA)
C     OLDPG  - ROD INTERNAL GAS PRESSURE OF PREVIOUS POWER STEP (PSIA)
C     OLDTC  - CLADDING AVERAGE TEMPERATURE-PREVIOUS POWER STEP (F)
C     OLDURF - FUEL RADIAL DISPLACEMENT OF PREVIOUS POWER STEP (IN)
C     PC     - COOLANT CHANNEL PRESSURE (PSIA)
C     PG     - ROD INTERNAL GAS PRESSURE (PSIA)
C     RFO    - FUEL OUTSIDE RADIUS (IN)
C     TC     - CLADDING AVERAGE TEMPERATURE (F)
C     TIME   - END OF STEP TIME (HRS)
C     URF    - FUEL RADIAL DISPLACEMENT (IN)
C     RCI    - CLADDING  INSIDE RADIUS (IN)
C     RCO    - CLADDING OUTSIDE RADIUS (IN)
C
C     ******************************************************************
C     OUTPUT ARGUMENTS
C     ******************************************************************
C
C     EP     - CLADDING EFFECTIVE PLASTIC STRAIN (IN/IN)
C     EPP    - CLADDING HOOP, AXIAL, & RADIAL STRAINS (IN/IN)
C     IQUIT  - TERMINATION INDEX
C     RFEPS  - RESIDUAL FUEL STRAINS
C     REPS   - RESIDUAL CLADDING STRAINS
C     OLEPS  - OLD CLADDING STRAINS - PREVIOUS POWER STEP
```

```
      C   OLFEPS - OLD FUEL STRAINS - PREVIOUS POWER STEP                      CLOS       55
55    C                                                                        CLOS       56
      C   ************************************************************************ CLOS    57
      C                                                                        CLOS       58
      C   ROOTING FOR ROOTS                                                   CLOS       59
      C                                                                        CLOS       60
60          F(T) = GAPT(T,TC,PG,PC,URF,DELTA,EPP,EP,RCI,RCO,CEPS,CEPP,CEP,CSIG CLOS      61
           +,OLDTC,OLDPG,OLDPC,OLDURF,J,NRELAX,DTIME,TIME,ECREEP,CREP,NA,NPLAS CLOS      62
           +T)                                                                 CLOS       63
      C                                                                        CLOS       64
      C                                                                        CLOS       65
65    C   A MODIFIED FALSE POSITION ROUTINE OPERATING OVER THE INTERVAL ALPHA, CLOS       66
      C   BETA WITH INCREMENT DX  HAS BEEN INSTALLED BY B.W.BURNHAM 1-6-76     CLOS       67
      C                                                                        CLOS       68
          ALPHA = 0.0E0                                                        CLOS       69
          BETA = 1.0E0                                                         CLOS       70
70        DX = .25                                                             CLOS       71
          CUT = 1.0E-10                                                        CLOS       72
          N = 0                                                                CLOS       73
      C                                                                        CLOS       74
      C   A CHECK FOR A LINEAR FUNCTION ON THE ALPHA-BETA INTERVAL            CLOS       75
75        DENOM = F(BETA)-F(ALPHA)                                             CLOS       76
          IF (DENOM.EQ.0.0E0) GO TO 100                                        CLOS       77
          X = (ALPHA*F(BETA)-BETA*F(ALPHA))/DENOM                              CLOS       78
          FOFX = F(X)                                                          CLOS       79
          IF (ABS(FOFX).GT.CUT) GO TO 100                                      CLOS       80
80        VX = X                                                               CLOS       81
          GO TO 220                                                            CLOS       82
      100 CONTINUE                                                             CLOS       83
      C   COMMENCE THE MOVING WINDOW LOOKING FOR ROOT BRACKETS                 CLOS       84
          A = ALPHA                                                            CLOS       85
85        B = A+DX                                                             CLOS       86
          FOFA = F(A)                                                          CLOS       87
      110 FOFB = F(B)                                                          CLOS       88
          IF (FOFA*FOFB) 120,180,200                                           CLOS       89
      120 CONTINUE                                                             CLOS       90
90    C   HAVING BRACKETED A ROOT THE SOLUTION ITERATION COMMENCES             CLOS       91
      C                                                                        CLOS       92
      130 CONTINUE                                                             CLOS       93
          X = (A*FOFB-B*FOFA)/(FOFB-FOFA)                                      CLOS       94
          N = N+1                                                              CLOS       95
95        IF (N.LT.100) GO TO 140                                              CLOS       96
          WRITE (6,250)                                                        CLOS       97
          IQUIT = 1                                                            CLOS       98
          GO TO 240                                                            CLOS       99
      140 FOFX = F(X)                                                          CLOS      100
100   C   TEST THE POSSIBILITY OF THE ITERATION LOOP LANDING ON A ROOT AT X     CLOS      101
      C   OR PASSING BY THE ROOT                                               CLOS      102
          IF (FOFX*FOFA) 160,170,150                                           CLOS      103
      150 CONTINUE                                                             CLOS      104
      C   THE ROOT IS STILL BRACKETED AND THE ITERATION LOOP CONTINUES         CLOS      105
105   C                                                                        CLOS      106
          A = X                                                                CLOS      107
```

```
                FOFA = FOFX                                                    CLOS    108
                FOFB = .5*FOFB                                                 CLOS    109
                IF (ABS(FOFX).GT.CUT) GO TO 130                                CLOS    110
110             VX = X                                                         CLOS    111
                GO TO 220                                                      CLOS    112
            160 CONTINUE                                                       CLOS    113
            C   THE ITERATION SCHEME HAS REBRACKETED THE ROOT-THE BOUNDS ARE   CLOS    114
            C   ADJUSTED AND THE LOOP CONTINUES                                CLOS    115
115         C                                                                  CLOS    116
                B = X                                                          CLOS    117
                FOFB = FOFX                                                    CLOS    118
                FOFA = .5*FOFA                                                 CLOS    119
                IF (ABS(FOFX).GT.CUT) GO TO 130                                CLOS    120
120             VX = X                                                         CLOS    121
                GO TO 220                                                      CLOS    122
            170 CONTINUE                                                       CLOS    123
            C   THE ITERATION SCHEME HAS LANDED ON A ROOT AT (X,FOFX)          CLOS    124
            C                                                                  CLOS    125
125             IF (ABS(FOFA).EQ.0.0E0) GO TO 190                              CLOS    126
                VX = X                                                         CLOS    127
                GO TO 220                                                      CLOS    128
            180 CONTINUE                                                       CLOS    129
            C   THE BRACKETING OPERATION HAS FOUND A ROOT                     CLOS    130
130         C                                                                  CLOS    131
                IF (FOFA.EQ.0.0E0) GO TO 190                                   CLOS    132
            C   THE BRACKETING OPERATION HAS FOUND A ROOT AT (B,FOFB)          CLOS    133
                VX = B                                                         CLOS    134
                GO TO 220                                                      CLOS    135
135         190 CONTINUE                                                       CLOS    136
            C   IF THIS IS THE FIRST BRACKET STEP THEN F(ALPHA)=0. IF OTHERWISE CLOS   137
            C   THE PREVIOUS STEP IS IN ERROR AT FOFB                         CLOS    138
            C   THE INITIAL DATA CONTAINS A ROOT AT ALPHA                     CLOS    139
                VX = A                                                         CLOS    140
140             GO TO 220                                                      CLOS    141
            200 CONTINUE                                                       CLOS    142
            C   THE ROUTINE HAS NOT YET BRACKETED A ROOT-ADJUST THE VARIABLES TO CLOS  143
            C   THE NEXT MESH AND CONTINUE, ALSO TEST TO SEE IF THE INTERVAL HAS CLOS  144
            C   BEEN EXCEEDED                                                  CLOS    145
145             A = B                                                          CLOS    146
                B = B+DX                                                       CLOS    147
                FOFA = FOFB                                                    CLOS    148
                IF (A.GT.BETA) GO TO 210                                       CLOS    149
                GO TO 110                                                      CLOS    150
150         210 CONTINUE                                                       CLOS    151
            C   THE BRACKETING OPERATION HAS OVERRUN THE INTERVAL              CLOS    152
                WRITE (6,260)                                                  CLOS    153
                IQUIT = 1                                                      CLOS    154
                GO TO 240                                                      CLOS    155
155         220 CONTINUE                                                       CLOS    156
            C   ***UPDATE RESIDUAL STRAINS HERE                               CLOS    157
                OLEPS(J) = CEPS(2)                                             CLOS    158
                REPS(J,2) = CEPS(2)                                            CLOS    159
                IF (NRELAX.EQ.1) GO TO 230                                     CLOS    160
```

```
                      OLFEPS(J) = OLFEPS(J)+VX*(FEPS(J,2)-OLFEPS(J))                    CLOS  161
                      RFEPS(J,2) = OLFEPS(J)                                            CLOS  162
                230   CONTINUE                                                          CLOS  163
                C     ***UPDATE PLASTIC STRAINS HERE AFTER                              CLOS  164
                C     GAP ZERO SOLUTION IS FOUND                                        CLOS  165
                      EPP(J,1) = CEPP(1)                                                CLOS  166
                      EPP(J,2) = CEPP(2)                                                CLOS  167
                      EPP(J,3) = CEPP(3)                                                CLOS  168
                      IF (NRELAX.NE.1) EP(J) = CEP                                      CLOS  169
                      IF (NRELAX.EQ.1) ECREEP(J) = CREP                                 CLOS  170
                C     ***CAN PRINT CLAD STRESS AND STRAIN AT ZERO GAP HERE              CLOS  171
                C     WRITE(6,100)                                                      CLOS  172
                C     WRITE(6,101) (CSIG(I),I = 1,3 )                                   CLOS  173
                C     WRITE(6,101) (CEPS(I),I = 1,3 )                                   CLOS  174
                C     WRITE(6,101) (CEPP(I),I = 1,3 )                                   CLOS  175
                C     WRITE(6,101)  REPS(J,2), RFEPS(J,2)                               CLOS  176
                240   CONTINUE                                                          CLOS  177
                      RETURN                                                            CLOS  178
                C                                                                       CLOS  179
                250   FORMAT (65H- THE ITERATION SCHEME HAS PASSED 100 STEPS--EXECUTION CLOS  180
               +TERMINATED)                                                             CLOS  181
                260   FORMAT (48H  THE BRACKET OPERATION HAS OVERRUN THE INTERVAL)      CLOS  182
                      END                                                               CLOS  183
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CLOSE	1	177

VARIABLES

		SN	TYPE		RELOCATION								
1132	A		REAL			REFS	85	86	93	139	148		
						DEFINED	84	106	145				
1117	ALPHA		REAL			REFS	75	2*77	84	DEFINED	68		
1133	B		REAL			REFS	87	95	133	145	146		
						DEFINED	85	116	146				
1120	BETA		REAL			REFS	75	2*77	148	DEFINED	69		
1125	CEP		REAL			REFS	2*75	2*77	78	86	87	99	168
1144	CEPP		REAL	ARRAY		REFS	11	2*75	2*77	78	86	87	99
							165	166	167				
1141	CEPS		REAL	ARRAY		REFS	11	2*75	2*77	78	86	87	99
							157	158					
1126	CREP		REAL			REFS	2*75	2*77	78	86	87	99	169
1136	CSIG		REAL	ARRAY		REFS	11	2*75	2*77	78	86	87	99
1122	CUT		REAL			REFS	79	109	119	DEFINED	71		
0	DELTA		REAL		F.P.	REFS	2*75	2*77	78	86	87	99	
						DEFINED	1						
1124	DENOM		REAL			REFS	76	77	DEFINED	75			
0	DTIME		REAL		F.P.	REFS	2*75	2*77	78	86	87	99	
						DEFINED	1						

VARIABLES	SN	TYPE	RELOCATION									
1121	DX	REAL			REFS	85	146	DEFINED	70			
0	ECREEP	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1	169					
0	EP	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1	168					
0	EPP	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1	165	166	167			
0	FEPS	REAL	ARRAY	F.P.	REFS	11	160	DEFINED	1			
1134	FOFA	REAL			REFS	88	2*93	102	118	125	131	
					DEFINED	86	107	118	147			
1135	FOFB	REAL			REFS	88	2*93	108	147	DEFINED	87	108
					117							
1130	FOFX	REAL			REFS	79	102	107	109	117	119	
					DEFINED	78	99					
0	IQUIT	INTEGER		F.P.	DEFINED	1	97	153				
0	J	INTEGER		F.P.	REFS	2*75	2*77	78	86	87	99	157
					158	4*160	2*161	165	166	167	168	169
					DEFINED	1						
1123	N	INTEGER			REFS	94	95	DEFINED	72	94		
0	NA	INTEGER		F.P.	REFS	4*11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	NPLAST	INTEGER		F.P.	REFS	2*75	2*77	78	86	87	99	
					DEFINED	1						
0	NRELAX	INTEGER		F.P.	REFS	2*75	2*77	78	86	87	99	159
					168	169	DEFINED	1				
0	OLDPC	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	OLDPG	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	OLDTC	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	OLDURF	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	OLEPS	REAL	ARRAY	F.P.	REFS	11	DEFINED	1	157			
0	OLFEPS	REAL	ARRAY	F.P.	REFS	11	2*160	161	DEFINED	1	160	
0	PC	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	PG	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	RCI	REAL		F.P.	REFS	2*75	2*77	78	86	87	99	
					DEFINED	1						
0	RCO	REAL		F.P.	REFS	2*75	2*77	78	86	87	99	
					DEFINED	1						
0	REPS	REAL	ARRAY	F.P.	REFS	11	DEFINED	1	158			
0	RFEPS	REAL	ARRAY	F.P.	REFS	11	DEFINED	1	161			
0	RFO	REAL	*UNUSED	F.P.	DEFINED	1						
0	TC	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
0	TIME	REAL		F.P.	REFS	2*75	2*77	78	86	87	99	
					DEFINED	1						
0	URF	REAL	ARRAY	F.P.	REFS	11	2*75	2*77	78	86	87	99
					DEFINED	1						
1131	VX	REAL			REFS	160	DEFINED	80	110	120	126	133

VARIABLES SN TYPE RELOCATION

				139							
1127	X	REAL	REFS	78	80	99	106	110	116	120	
			126	DEFINED	77	93					

FILE NAMES	MODE				
TAPE6	FMT	WRITES	96	152	

EXTERNALS	TYPE	ARGS	REFERENCES					
GAPT	REAL	26	2*75	2*77	78	86	87	99

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES					
ABS	REAL	1	INTRIN		79	109	119	125		
F	REAL	1	SF	60	2*75	2*77	78	86	87	99

STATEMENT LABELS			DEF LINE	REFERENCES					
276	100		82	76	79				
344	110		87	149					
0	120	INACTIVE	89	88					
410	130		92	109	119				
430	140		99	95					
0	150	INACTIVE	103	102					
511	160		112	102					
527	170		122	102					
536	180		128	88					
544	190		135	125	131				
550	200		141	88					
564	210		150	148					
572	220		155	81	111	121	127	134	140
622	230		162	159					
654	240		176	98	154				
1074	250	FMT	179	96					
1104	260	FMT	181	152					

STATISTICS

PROGRAM LENGTH	1147B	615

140000B SCM USED

```
      SUBROUTINE CONDUC (AGPC,DCO,DLTGC,DPHF,FRDEN,NR,GASES,GPTHE,HGAPT,  COND       2
     +IT,J,K,MECHAN,NDBG,PINE,PRESS,QC,ROUGHC,ROUGHF,TAG,TCI,TFR,NA,HGAP  COND       3
     +,FLUX,TIME,COLDWK,HSOLID,HGAPR,PRG,SIGG,DG,FOTMTL,ZRO,RD,NF,NFFI,N  COND       4
     +CNVG,IM93WC,IMGAPC,FTMELT,FRAC)                                     COND       5
C                                                                         COND       6
C                                                                         COND       7
C     IMPLICIT REAL * 8 (A-H,O-Z)                                         COND       8
C                                                                         COND       9
C     ********************************************************************COND      10
C                                                                         COND      11
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES GAP CONDUCTANCE     COND      12
C     AND GAP TEMPERATURE DROP                                            COND      13
C     CONDUC WAS CODED BY G A BERNA IN JANUARY 1978.                      COND      14
C     CONDUC WAS CHANGED AT PNL IN 1979                                   COND      15
C                                                                         COND      16
C     ********************************************************************COND      17
C     INPUT ARGUMENTS                                                     COND      18
C     ********************************************************************COND      19
C                                                                         COND      20
C     AGPC   - ADDITIONAL GAP CONDUCTANCE FACTOR                          COND      21
C     CFAC   - FUEL THERMAL CONDUCTIVITY FACTOR                           COND      22
C     COLDWK - CLADDING COLD WORK                                         COND      23
C     DCO    - AS FABRICATED CLADDING OUTSIDE DIAMETER (IN)               COND      24
C     DG     - EFFECTIVE GAP (IN) FROM SUBROUTINE RADIAL                  COND      25
C     DPHF   - DIAMETER OF THE PELLET HOT & SWELLED (IN)                  COND      26
C     FLUX   - FAST NEUTRON FLUX (NEUTRONS/SEC-M**2)                      COND      27
C     FTMELT - FUEL MELT TEMPERATURE (K)                                  COND      28
C     FOTMTL - FUEL OXYGEN TO METAL RATIO (ATOMS OXYGEN/ATOMS METAL)      COND      29
C     FRAC   - RATIO OF CONDUCTIVITY OF FILL GAS TO PURE HE               COND      30
C     FRDEN  - FRACTIONAL FUEL DENSITY                                    COND      31
C     GASES  - ARRAY OF MOLE FRACTIONS OF GASES                           COND      32
C     GAS 1 - HELIUM                                                      COND      33
C     GAS 2 - ARGON                                                       COND      34
C     GAS 3 - KRYPTON                                                     COND      35
C     GAS 4 - XENON                                                       COND      36
C     GAS 5 - HYDROGEN                                                    COND      37
C     GAS 6 - AIR                                                         COND      38
C     GAS 7 - WATER VAPOR                                                 COND      39
C     IMGAPC - EM SWITCH FOR GAP CONDUCTANCE                              COND      40
C     IM93WC - EM SWITCH FOR FUEL THERMAL CONDUCTIVITY                    COND      41
C     IT     - POWER-TIME STEP INDEX                                      COND      42
C     J      - AXIAL NODE INDEX                                           COND      43
C     K      - GAP ITERATION INDICATOR                                    COND      44
C     MECHAN - MECHANICAL MODEL INDEX                                     COND      45
C     NDBG   - DEBUG OUTPUT INDEX                                         COND      46
C     NF     - NUMBER OF RADIAL FUEL NODES IN RD ARRAY                    COND      47
C     NFFI   - NUMBER OF RADIAL NODES IN RD ARRAY                         COND      48
C     NR     - NUMBER OF RADIAL NODES                                     COND      49
C     PINE   - INTERFACE PRESSURE ESTIMATE (PSIA)                         COND      50
C     PRESS  - INTERNAL GAS PRESSURE (PSIA)                               COND      51
C     PRG    - INTERFACIAL PRESSURE CALCULATED BY SUBROUTINE RADIAL       COND      52
C     QC     - HEAT FLUX AT NODE J (BTU/HR-FT**2)                         COND      53
C     RCI    - AS-FABRICATED CLAD INSIDE RADIUS                           COND      54
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C   RD     - CURRENT RADIUS ARRAY (PELLET + CLAD)                          COND      55
C   ROUGHC - ARITHMETIC MEAN ROUGHNESS OF THE CLADDING SURFACE (IN)        COND      56
C   ROUGHF - ARITHMETIC MEAN ROUGHNESS OF THE FUEL SURFACE (IN)            COND      57
C   RP     - AS-FABRICATED PELLET RADIUS                                   COND      58
C   SIGG   - EFFECTIVE FUEL-CLADDING GAP ROUGHNESS (IN)                    COND      59
C   TAG    - AVERAGE GAP TEMPERATURE (F)                                   COND      60
C   TCI    - CLADDING INSIDE SURFACE TEMPERATURE (F)                       COND      61
C   TCL    - CENTERLINE TEMPERATURE (F)                                    COND      62
C   TFR    - FUEL RING BOUNDRY TEMPERATURE ARRAY (F)                       COND      63
C   TIME   - TIME TO END OF POWER-TIME STEP (SEC)                          COND      64
C   ZRO    - OXIDE LAYER THICKNESS (M)                                     COND      65
C                                                                          COND      66
C   ********************************************************************** COND      67
C   OUTPUT ARGUMENTS                                                       COND      68
C   ********************************************************************** COND      69
C                                                                          COND      70
C   DLTGC  - TEMPERATURE DROP ACROSS THE GAP (F)                           COND      71
C   HGAP   - GAP CONDUCTANCE DUE TO CONDUCTION (BTU/HR-FT**2-F)            COND      72
C   HGAPR  - GAP CONDUCTANCE DUE TO RADIATIONBTU/HR-FT**2-F)               COND      73
C   HGAPT  - TOTAL GAP CONDUCTANCE (BTU/HR-FT**2-F)                        COND      74
C   HSOLID - GAP CONDUCTANCE DUE TO SOLID CONTACT (BTU/HR-FT**2-F)         COND      75
C                                                                          COND      76
C   ********************************************************************** COND      77
C                                                                          COND      78
      DIMENSION  GASES(7)    ,TFR(NR)        ,TAG(NA)                      COND      79
     +          ,GPTHE(26)   ,DLTGC(26)      ,PINE(26)                     COND      80
      DIMENSION RD(1)                                                      COND      81
C                                                                          COND      82
C                                                                          COND      83
C                                                                          COND      84
C   CALCULATION OF GAP TEMPERATURE DROP AND GAP CONDUCTANCE                COND      85
C                                                                          COND      86
        TAG(J) = TCI+0.5E0*DLTGC(K-1)                                      COND      87
        TPEL = TCI+DLTGC(K-1)                                              COND      88
C                                                                          COND      89
        GAPD = GPTHE(K)/24.E0                                              COND      90
        IF (GPTHE(K).LT.0.E0) GAPD = 0.E0                                  COND      91
C                                                                          COND      92
        RF = DPHF/24.E0                                                    COND      93
C                                                                          COND      94
C                                                                          COND      95
C                                                                          COND      96
C                                                                          COND      97
        CALL GAPRS (GAPD,RF,PINE(K),TAG(J),TPEL,TCI,PRESS,GASES,FLUX,MECHA COND      98
     +N,ROUGHC,ROUGHF,FRDEN,HGAPT,COLDWK,TIME,ZRO,FOTMTL,HSOLID,HGAPR,HG   COND      99
     +AP,PRG,SIGG,DG,IT,NDBG,IM93WC,IMGAPC,FTHELT,FRAC)                    COND     100
C                                                                          COND     101
        IF (MECHAN.NE.1) DLTGC(K) = QC*DCO/(HGAPT*AGPC*(DPHF+GAPD*24.E0))  COND     102
C                                                                          COND     103
C                                                                          COND     104
        IF (MECHAN.EQ.1) DLTGC(K) = QC*DCO/2./(HGAPT*(RD((J-1)*NFF1+NF+1)- COND     105
     +DG/2.))                                                              COND     106
C                                                                          COND     107
```

```
                     IF (MECHAN.EQ.1.AND.K.GT.2.AND.ABS(DLTGC(K)-DLTGC(K-1)).LT.5.) NCN COND      108
                    +VG = 1                                                          COND      109
                C                                                                    COND      110
  110               RETURN                                                           COND      111
                    END                                                              COND      112
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CONDUC 1 110

VARIABLES	SN	TYPE		RELOCATION									
0	AGPC	REAL		F.P.	REFS	101	DEFINED	1					
0	COLDWK	REAL		F.P.	REFS	97	DEFINED	1					
0	DCO	REAL		F.P.	REFS	101	104	DEFINED	1				
0	DG	REAL		F.P.	REFS	97	104	DEFINED	1				
0	DLTGC	REAL	ARRAY	F.P.	REFS	78	86	87	2*107	DEFINED	1	101	
					104								
0	DPHF	REAL		F.P.	REFS	92	101	DEFINED	1				
0	FLUX	REAL		F.P.	REFS	97	DEFINED	1					
0	FOTMTL	REAL		F.P.	REFS	97	DEFINED	1					
0	FRAC	REAL		F.P.	REFS	97	DEFINED	1					
0	FRDEN	REAL		F.P.	REFS	97	DEFINED	1					
0	FTMELT	REAL		F.P.	REFS	97	DEFINED	1					
222	GAPD	REAL			REFS	97	101	DEFINED	89	90			
0	GASES	REAL	ARRAY	F.P.	REFS	78	97	DEFINED	1				
0	GPTHE	REAL	ARRAY	F.P.	REFS	78	89	90	DEFINED	1			
0	HGAP	REAL		F.P.	REFS	97	DEFINED	1					
0	HGAPR	REAL		F.P.	REFS	97	DEFINED	1					
0	HGAPT	REAL		F.P.	REFS	97	101	104	DEFINED	1			
0	HSOLID	REAL		F.P.	REFS	97	DEFINED	1					
0	IMGAPC	INTEGER		F.P.	REFS	97	DEFINED	1					
0	IM93WC	INTEGER		F.P.	REFS	97	DEFINED	1					
0	IT	INTEGER		F.P.	REFS	97	DEFINED	1					
0	J	INTEGER		F.P.	REFS	86	97	104	DEFINED	1			
0	K	INTEGER		F.P.	REFS	86	87	89	90	97	101	104	
					3*107	DEFINED	1						
0	MECHAN	INTEGER		F.P.	REFS	97	101	104	107	DEFINED	1		
0	NA	INTEGER		F.P.	REFS	78	DEFINED	1					
0	NCNVG	INTEGER		F.P.	DEFINED	1	107						
0	NDBG	INTEGER		F.P.	REFS	97	DEFINED	1					
0	NF	INTEGER		F.P.	REFS	104	DEFINED	1					
0	NFFI	INTEGER		F.P.	REFS	104	DEFINED	1					
0	NR	INTEGER		F.P.	REFS	78	DEFINED	1					
0	PINE	REAL	ARRAY	F.P.	REFS	78	97	DEFINED	1				
0	PRESS	REAL		F.P.	REFS	97	DEFINED	1					
0	PRG	REAL		F.P.	REFS	97	DEFINED	1					
0	QC	REAL		F.P.	REFS	101	104	DEFINED	1				
0	RD	REAL	ARRAY	F.P.	REFS	80	104	DEFINED	1				

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VARIABLES     SN  TYPE          RELOCATION
  223  RF         REAL                          REFS    97   DEFINED      92
    0  ROUGHC     REAL                F.P.      REFS    97   DEFINED       1
    0  ROUGHF     REAL                F.P.      REFS    97   DEFINED       1
    0  SIGG       REAL                F.P.      REFS    97   DEFINED       1
    0  TAG        REAL          ARRAY F.P.      REFS    78        97  DEFINED       1        86
    0  TCI        REAL                F.P.      REFS    86        87       97  DEFINED       1
    0  TFR        REAL          ARRAY F.P.      REFS    78   DEFINED       1
    0  TIME       REAL                F.P.      REFS    97   DEFINED       1
  221  TPEL       REAL                          REFS    97   DEFINED      87
    0  ZRO        REAL                F.P.      REFS    97   DEFINED       1

EXTERNALS          TYPE   ARGS       REFERENCES
      GAPRS                 30             97

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE  REFERENCES
      ABS          REAL      1  INTRIN              107

STATISTICS
  PROGRAM LENGTH                224B     148
        140000B SCM USED
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      SUBROUTINE COOLT (DE,DELTAZ,G,IT,J,P2,QC,TBLK,TSAT,TW,WT,NA,RHOF)  COOL      2
C                                                                        COOL      3
C     IMPLICIT REAL * 8 ( A-H,O-Z )                                      COOL      4
C                                                                        COOL      5
C     ***************************************************************** COOL      6
C                                                                        COOL      7
C     THIS SUBROUTINE IS CALLED FROM MAIN AND IS USED TO COMPUTE THE     COOL      8
C     BULK COOLANT TEMPERATURE AS WELL AS THE SATURATION TEMPERATURE.    COOL      9
C     COOLT WAS CODED BY G A BERNA NOVEMBER 1977.                        COOL     10
C                                                                        COOL     11
C     ***************************************************************** COOL     12
C                                                                        COOL     13
C     ***************************************************************** COOL     14
C     INPUT  ARGUMENTS                                                   COOL     15
C     ***************************************************************** COOL     16
C                                                                        COOL     17
C     DE     - CHANNEL EQUIVALENT DIAMETER (FT)                          COOL     18
C     DELTAZ - AXIAL NODE LENGTH (FT)                                    COOL     19
C     G      - AVERAGE MASS FLUX (LBM/HR-FT**2)                          COOL     20
C     IT     - POWER-TIME STEP INDEX                                     COOL     21
C     J      - AXIAL NODE INDEX                                          COOL     22
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                             COOL     23
C     P2     - SYSTEM PRESSURE (PSIA)                                    COOL     24
C     QC     - NODE HEAT FLUX (BTU/HR-FT**2)                             COOL     25
C     TW     - INLET SYSTEM COOLANT TEMPERATURE (F)                      COOL     26
C                                                                        COOL     27
C     ***************************************************************** COOL     28
C     OUTPUT ARGUMENTS                                                   COOL     29
C     ***************************************************************** COOL     30
C                                                                        COOL     31
C     RHOF   - BULK COOLANT DENSITY; UNSATURATED (LBM/FT**3)             COOL     32
C     TBLK   - BULK COOLANT TEMPERATURE AT TOP OF NODE J (F)             COOL     33
C     TSAT   - COOLANT SATURATION TEMPERATURE (F)                        COOL     34
C     WT     - AVERAGE BULK COOLANT TEMPERATURE AT NODE J (F)            COOL     35
C                                                                        COOL     36
C     ***************************************************************** COOL     37
C     SUBROUTINE  PARAMETERS                                             COOL     38
C     ***************************************************************** COOL     39
C                                                                        COOL     40
C     BCHC   - BULK COOLANT HEAT CAPACITY (BTU/LBM-F)                    COOL     41
C     RHO    - BULK COOLANT DENSITY; SATURATED (LBM/FT**3)               COOL     42
C                                                                        COOL     43
C                                                                        COOL     44
      DIMENSION     P2(IT)        ,TBLK(NA)      ,TW(IT)                 COOL     45
C                                                                        COOL     46
      TBLK(1) = TW(IT)                                                   COOL     47
      IF (G.EQ.0.0) GO TO 110                                            COOL     48
      TSAT = (((0.47616716E-8*P2(IT)-0.4424529E-4)*P2(IT))+0.19042968)*P COOL     49
     +2(IT)+394.03519                                                    COOL     50
      IF (TBLK(J-1).GE.TSAT) GO TO 100                                   COOL     51
      RHOF = -810.063+(((-1.06824E-8*TBLK(J-1)+2.29413E-5)*TBLK(J-1)-0.0 COOL     52
     +184872)*TBLK(J-1)+6.56174)*TBLK(J-1)                               COOL     53
      IF (TBLK(J-1).LE.450.E0) RHOF = 65.43E+0-TBLK(J-1)*0.03486E+0      COOL     54
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                      RHO = RHOF*(1.0+0.648E-6*((TSAT-TBLK(J-1))**0.1)*(P2(IT)-800.0))   COOL       55
     55               IF (TBLK(J-1).LT.520.) BCHC = 57.3                                 COOL       56
                      IF (TBLK(J-1).GE.520.0.AND.TBLK(J-1).LT.590.0) BCHC = 57.3*(1.0+7. COOL       57
                     +73E-4*(TBLK(J-1)-520.))                                            COOL       58
                      IF (TBLK(J-1).GE.590.) BCHC = 57.3*(1.+2.95E-3*(TBLK(J-1)-571.6))  COOL       59
                      TBLK(J) = TBLK(J-1)+(QC*RHO)/(DE*G*BCHC/(4.0*DELTAZ))              COOL       60
     60               IF (TBLK(J).LT.TSAT) GO TO 110                                     COOL       61
                 100  TBLK(J) = TSAT                                                     COOL       62
                 110  IF (G.EQ.0.0) TBLK(J) = TW(IT)                                    COOL       63
                      WT = (TBLK(J)+TBLK(J-1))/2.0                                       COOL       64
                 C                                                                       COOL       65
     65               RETURN                                                             COOL       66
                      END                                                                COOL       67
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	COOLT	1	65

VARIABLES

	SN	TYPE		RELOCATION								
214	BCHC	REAL			REFS	59	DEFINED	55	56	58		
0	DE	REAL		F.P.	REFS	59	DEFINED	1				
0	DELTAZ	REAL		F.P.	REFS	59	DEFINED	1				
0	G	REAL		F.P.	REFS	47	59	62	DEFINED	1		
0	IT	INTEGER		F.P.	REFS	2*44	46	3*48	54	62		
					DEFINED	1						
0	J	INTEGER		F.P.	REFS	50	4*51	2*53	54	55	3*56	2*58
					2*59	60	61	62	2*63	DEFINED	1	
0	NA	INTEGER		F.P.	REFS	44	DEFINED	1				
0	P2	REAL	ARRAY	F.P.	REFS	44	3*48	54	DEFINED	1		
0	QC	REAL		F.P.	REFS	59	DEFINED	1				
213	RHO	REAL			REFS	59	DEFINED	54				
0	RHOF	REAL		F.P.	REFS	54	DEFINED	1	51	53		
0	TBLK	REAL	ARRAY	F.P.	REFS	44	50	4*51	2*53	54	55	3*56
					2*58	59	60	2*63	DEFINED	1	46	59
					61	62						
0	TSAT	REAL		F.P.	REFS	50	54	60	61	DEFINED	1	48
0	TW	REAL	ARRAY	F.P.	REFS	44	46	62	DEFINED	1		
0	WT	REAL		F.P.	DEFINED	1	63					

STATEMENT LABELS

		DEF LINE	REFERENCES	
136	100	61	50	
142	110	62	47	60

STATISTICS

PROGRAM LENGTH 215B 141

140000B SCM USED

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      SUBROUTINE COUPLE (PG,PC,TC,RCI,RCO,CSIG,CEPS,CEPP,CEP,URF,DELTA,P
     +INT,NDBG,NRELAX,DTIME,TIME,CREP,IQUIT,NPLAST,IT)
C
CCC   THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES
CCC   USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM
C
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX
     +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTMELT ,RSTRAN
C
CCC   ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST
CCC   (HOOP STRAIN)/(RADIAL STRAIN)
CCC   COMP   - PUO2 CONTENT (WT%)
CCC   CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)
CCC   CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT
CCC   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED
CCC   CLADDING     (KG OXYGEN/KG ZIRCALOY)
CCC   FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)
CCC   FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)
CCC   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT
CCC   FOTMTL - FUEL OXYGEN TO METAL RAITO
CCC   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)
CCC   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)
CCC   RSTRAN - TRUE STRAIN RATE (1/SEC)
CCC
CCC
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION     CSIG(3)      ,CEPS(3)      ,CEPP(3)
     +             ,DEPP(3)      ,OLDEPP(3)    ,ALFDT(3)
C
      REAL     NUDEPP(3)
C
C     THE FOLLOWING DATA STATEMENT CONTAINS VARIOUS CONVERSION FACTORS
      DATA  CNMTPS / 6.894757E3 /, CKTOR / 1.8E0 /, CFTOR / 459.67E0 /
      DATA  ZERO / 0.E0 / , SMALL / 1.E-4 /
C
CCC   ********************************************************************
CCC   INPUT ARGUMENTS
CCC   ********************************************************************
CCC
CCC   CEP    - TEMPORARY EFFECTIVE PLASTIC STRAIN (IN/IN)
CCC   CEPP   - TEMPORARY HOOP, AXIAL, & RADIAL PLASTIC STRAINS (IN/IN)
CCC   CEPS   - TEMPORARY HOOP, AXIAL, & RADIAL STRAINS (IN/IN)
CCC   CREP   - CREEP STRAIN (IN/IN)
CCC   CSIG   - TEMPORARY HOOP, AXIAL, & RADIAL STRESS (PSI)
CCC   DELTA  - COLD STATE RADIAL GAP (IN)
CCC   DTIME  - CREEP STEP TIME INCREMENT (HRS)
CCC   IQUIT  - TERMINATION INDEX
CCC   IT     - POWER-TIME STEP INDEX
CCC   NDBG   - DEBUG OUTPUT INDEX
CCC   NPLAST - ELASTIC-PLASTIC FLAG
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      C   NRELAX - CREEP INDEX                                                    CPLE   33
      C   PC     - COOLANT CHANNEL PRESSURE (PSIA)                               CPLE   34
      C   PG     - ROD INTERNAL GAS PRESSURE (PSIA)                              CPLE   35
      C   TC     - CLADDING AVERAGE TEMPERATURE (F)                              CPLE   36
      C   TIME   - TIME AT THE BEGINNING OF CREEP STEP (HRS)                     CPLE   37
      C   URF    - FUEL RADIAL DISPLACEMENT (IN)                                 CPLE   38
      C   RCI    - CLADDING  INSIDE RADIUS (IN)                                  CPLE   39
      C   RCO    - CLADDING OUTSIDE RADIUS (IN)                                  CPLE   40
      C                                                                          CPLE   41
      C   ************************************************************************ CPLE   42
      C   OUTPUT ARGUMENTS                                                       CPLE   43
      C   ************************************************************************ CPLE   44
      C                                                                          CPLE   45
      C   PINT   - INTERFACIAL PRESSURE (PSI)                                    CPLE   46
      C                                                                          CPLE   47
      C   ************************************************************************ CPLE   48
      C                                                                          CPLE   49
      C   ***CHECK HERE FOR ELASTIC SOLUTION                                     CPLE   50
      C   COMPUTE STRESSES                                                       CPLE   51
            TCI = (TC+CFTOR)/CKTOR                                               CPLE   52
            E = CELMOD(TCI,FNCK,CWKF,DELOXY)/CNMTPS                              CPLE   53
            CR = CSHEAR(TCI,FNCK,CWKF,DELOXY)/CNMTPS                             CPLE   54
            V = E/(2*CR)-1.                                                      CPLE   55
            CALL CTHEXP (TCI,CATHEX,CDTHEX)                                      CPLE   56
            ALFDT(1) = CDTHEX                                                    CPLE   57
            ALFDT(2) = CATHEX                                                    CPLE   58
            ALFDT(3) = CDTHEX                                                    CPLE   59
            AA = 1.E0+V*(RCO-RCI)/(RCO+RCI)                                      CPLE   60
            BB = V*((RCO-RCI)/(RCO+RCI)-1.E0)                                    CPLE   61
            DD = -V                                                              CPLE   62
            EE = 1.E0                                                            CPLE   63
            IF (NRELAX.EQ.1) GO TO 110                                           CPLE   64
            DEPP(1) = 0.E+0                                                      CPLE   65
            DEPP(2) = 0.E+0                                                      CPLE   66
            DEPP(3) = 0.E+0                                                      CPLE   67
            NUDEPP(1) = 0.E+0                                                    CPLE   68
            NUDEPP(2) = 0.E+0                                                    CPLE   69
            NUDEPP(3) = 0.E+0                                                    CPLE   70
            DEP = 0.E0                                                           CPLE   71
            CC = (URF-DELTA)*2.0/(RCO+RCI)                                       CPLE   72
            CC = CC+((RCO-RCI)/(RCO+RCI))*(CEPP(3)+DEPP(3)+ALFDT(3))             CPLE   73
            CC = CC-(CEPP(1)+DEPP(1)+ALFDT(1))                                   CPLE   74
            CC = CC*E                                                            CPLE   75
            FF = CEPS(2)-(CEPP(2)+DEPP(2)+ALFDT(2))                              CPLE   76
            FF = FF*E                                                            CPLE   77
            CSIG(1) = (CC*EE-BB*FF)/(AA*EE-BB*DD)                                CPLE   78
            CSIG(2) = (AA*FF-CC*DD)/(AA*EE-BB*DD)                                CPLE   79
            IF (NPLAST.EQ.0) GO TO 170                                           CPLE   80
            SIGEFI = SQRT(CSIG(1)**2+CSIG(2)**2-CSIG(1)*CSIG(2))                 CPLE   81
            CEPI = CEP                                                           CPLE   82
      C                                                                          CPLE   83
            CALL STRAIN (SIGEFI,CC,CEPI,TC,RSTRAN,ANRIN,DELOXY,CWKF,CWNF,FNCK,   CPLE   84
           +FNCN)                                                                CPLE   85
```

```
      C
            DEP = CEP1-CEP                                                    CPLE      86
            IF (DEP-1.E-10) 170,170,100                                       CPLE      87
110   C   ***START ITERATION SOLUTION HERE                                    CPLE      88
      100   CONTINUE                                                          CPLE      89
            CEP1 = CEP                                                        CPLE      90
      C                                                                       CPLE      91
            CALL STRESS (OLSIGF,ZERO,CEP1,TC,RSTRAN,ANRIN,DELOXY,CWKF,CWNF,FNC CPLE      92
115        +K,FNCN)                                                           CPLE      93
      C                                                                       CPLE      94
            CEP1 = CEP                                                        CPLE      95
      C                                                                       CPLE      96
            CALL STRESS (DSIGF,SMALL,CEP1,TC,RSTRAN,ANRIN,DELOXY,CWKF,CWNF,FNC CPLE      97
120        +K,FNCN)                                                           CPLE      98
      C                                                                       CPLE      99
            SLOPE = (DSIGF-OLSIGF)/SMALL                                      CPLE     100
            COEF = 2.0*(1.0+V)/(3.0*E)                                        CPLE     101
      110   KK = 1                                                            CPLE     102
125         OLDEPP(1) = 1.E-7                                                 CPLE     103
            OLDEPP(2) = 2.E-7                                                 CPLE     104
            OLDEPP(3) = -3.E-7                                                CPLE     105
      120   CONTINUE                                                          CPLE     106
            CC = (URF-DELTA)*2.0/(RCO+RCI)                                    CPLE     107
130         CC = CC+((RCO-RCI)/(RCO+RCI))*(CEPP(3)+OLDEPP(3)+ALFDT(3))        CPLE     108
            CC = CC-(CEPP(1)+OLDEPP(1)+ALFDT(1))                              CPLE     109
            CC = CC*E                                                         CPLE     110
            FF = CEPS(2)-(CEPP(2)+OLDEPP(2)+ALFDT(2))                         CPLE     111
            FF = FF*E                                                         CPLE     112
135         CSIG(1) = (CC*EE-BB*FF)/(AA*EE-BB*DD)                             CPLE     113
            CSIG(2) = (AA*FF-CC*DD)/(AA*EE-BB*DD)                             CPLE     114
            IF (NRELAX.EQ.1) GO TO 130                                        CPLE     115
            EMODH = (CSIG(1)-V*CSIG(2))/E+OLDEPP(1)                           CPLE     116
            EMODX = (CSIG(2)-V*CSIG(1))/E+OLDEPP(2)                           CPLE     117
140         EMODR = -V*(CSIG(1)+CSIG(2))/E-OLDEPP(1)-OLDEPP(2)                CPLE     118
            EET = 0.471405*SQRT((EMODH-EMODR)**2+(EMODR-EMODX)**2+(EMODX-EMODH CPLE     119
           +)**2)                                                             CPLE     120
            DEP = (EET-COEF*OLSIGF)/(1.0+COEF*SLOPE)                          CPLE     121
            EM = (EMODH+EMODR+EMODX)/3.0                                      CPLE     122
145         NUDEPP(1) = (DEP/EET)*(EMODH-EM)                                  CPLE     123
            NUDEPP(2) = (DEP/EET)*(EMODX-EM)                                  CPLE     124
            NUDEPP(3) = -NUDEPP(1)-NUDEPP(2)                                  CPLE     125
            GO TO 140                                                         CPLE     126
      C   ***CALCULATE CREEP STRAINS HERE                                     CPLE     127
150   130   CONTINUE                                                          CPLE     128
            SM = (CSIG(1)+CSIG(2))/3.0                                        CPLE     129
            S1 = CSIG(1)-SM                                                   CPLE     130
            S2 = CSIG(2)-SM                                                   CPLE     131
            DEP = 0.47140452*SQRT((OLDEPP(1)-OLDEPP(2))**2+(OLDEPP(2)-OLDEPP(3 CPLE     132
155        +))**2+(OLDEPP(3)-OLDEPP(1))**2)                                   CPLE     133
            DEPDOT = DEP/DTIME                                                CPLE     134
            CRAP = CREP+DEP                                                   CPLE     135
      C                                                                       CPLE     136
            CALL CREEP (SIGEFF,DEPDOT,TIME,TC,FLUX,CRAP,IQUIT)                CPLE     137
                                                                              CPLE     138
```

```
      C
            NUDEPP(1) = 1.5*DEP*S1/SIGEFF
            NUDEPP(2) = 1.5*DEP*S2/SIGEFF
            NUDEPP(3) = -NUDEPP(1)-NUDEPP(2)
      140   CONTINUE
            RATIO1 = (NUDEPP(1)-OLDEPP(1))/OLDEPP(1)
            RATIO2 = (NUDEPP(2)-OLDEPP(2))/OLDEPP(2)
            RATIO3 = (NUDEPP(3)-OLDEPP(3))/OLDEPP(3)
            RATIO1 = ABS(RATIO1)
            RATIO2 = ABS(RATIO2)
            RATIO3 = ABS(RATIO3)
            RATIO = AMAX1(RATIO1,RATIO2,RATIO3)
            IF (RATIO-0.001) 170,170,150
      150   KK = KK+1
            IF (KK-199) 160,180,180
      160   OLDEPP(1) = NUDEPP(1)
            OLDEPP(2) = NUDEPP(2)
            OLDEPP(3) = NUDEPP(3)
            GO TO 120
      170   CONTINUE
            IF (NRELAX.NE.1) CEP = CEP+DEP
            IF (NRELAX.EQ.1) CREP = CREP+DEP
            CEPP(1) = CEPP(1)+NUDEPP(1)
            CEPP(2) = CEPP(2)+NUDEPP(2)
            CEPP(3) = CEPP(3)+NUDEPP(3)
            GO TO 190
      180   WRITE (6,220) KK
      C     ***EVEN THO ROUTINE DID NOT CONVERGE
      C     ***LAST COMPUTED VALUES ARE RETURNED, AND
      C     ***AN ERROR MESSAGE IS PRINTED
            GO TO 170
      C     ***COMPUTE INTERFACE PRESSURE
      190   PINT = ((RCO-RCI)*CSIG(1)+RCO*PC)/RCI
            IF (PINT.GE.PG) GO TO 200
      C     ***FOR SITUATION WHERE PINT L.T. PG
      C     PINT IS SET EQUAL TO PG AND ELASTIC SOLN IS OBTAINED
      C     SUCH THAT PINT ALWAYS EQUALS PG
            CSIG(1) = (RCI*PG-RCO*PC)/(RCO-RCI)
            RBAR = 0.5*(RCO+RCI)
            T = RCO-RCI
            CSIG(2) = ((RBAR+V*T/2.0)*CSIG(1)+RBAR*E*(CEPP(1)+ALFDT(1))-0.5*T*
           +E*(CEPP(3)+ALFDT(3))-E*(URF-DELTA))/(RCI*V)
            CEPS(1) = (CSIG(1)-V*CSIG(2))/E+CEPP(1)+ALFDT(1)
            CEPS(2) = (CSIG(2)-V*CSIG(1))/E+CEPP(2)+ALFDT(2)
            CEPS(3) = -V*(CSIG(1)+CSIG(2))/E+CEPP(3)+ALFDT(3)
            PINT = PG
            GO TO 210
      200   CONTINUE
      C     ***COMPUTE RADIAL STRAIN
            CEPS(3) = -V*(CSIG(1)+CSIG(2))/E+CEPP(3)+ALFDT(3)
            CEPS(1) = (URF-DELTA+0.5*(RCO-RCI)*CEPS(3))*2.0/(RCO+RCI)
      210   CONTINUE
            RETURN
```

```
                C                                                                    CPLE      192
                220   FORMAT (1H0,20H DID NOT CONVERGE IN,1X,I4,1X,21H ITERATIONS IN COU CPLE      193
      215             +PLE)                                                          CPLE      194
                      END                                                            CPLE      195
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 COUPLE 1 212

VARIABLES	SN	TYPE	RELOCATION									
1033	AA	REAL			REFS	99	2*100	135	2*136	DEFINED	81	
1100	ALFDT	REAL	ARRAY		REFS	29	94	95	97	130	131	133
					2*200	202	203	204	209	DEFINED	78	79
					80							
0	ANRIN	REAL		MATCNS	REFS	7	105	114	119			
1034	BB	REAL			REFS	2*99	100	2*135	136	DEFINED	82	
1031	CATHEX	REAL			REFS	77	79					
1040	CC	REAL			REFS	94	95	96	99	100	105	130
					131	132	135	136	DEFINED	93	94	95
					96	129	130	131	132			
1032	CDTHEX	REAL			REFS	77	78	80				
0	CEP	REAL		F.P.	REFS	103	108	112	117	180		
					DEFINED	1	180					
0	CEPP	REAL	ARRAY	F.P.	REFS	29	94	95	97	130	131	133
					182	183	184	2*200	202	203	204	209
					DEFINED	1	182	183	184			
0	CEPS	REAL	ARRAY	F.P.	REFS	29	97	133	210	DEFINED	1	202
					203	204	209	210				
1043	CEPI	REAL			REFS	105	108	114	119	DEFINED	103	112
					117							
772	CFTOR	REAL			REFS	73	DEFINED	35				
771	CKTOR	REAL			REFS	73	DEFINED	35				
770	CNMTPS	REAL			REFS	74	75	DEFINED	35			
1047	COEF	REAL			REFS	2*143	DEFINED	123				
1	COMP	REAL		MATCNS	REFS	7						
1027	CR	REAL			REFS	76	DEFINED	75				
1062	CRAP	REAL			REFS	159	DEFINED	157				
0	CREP	REAL		F.P.	REFS	157	181	DEFINED	1	181		
0	CSIG	REAL	ARRAY	F.P.	REFS	29	4*102	2*138	2*139	2*140	2*151	152
					153	192	200	2*202	2*203	2*204	2*209	
					DEFINED	1	99	100	135	136	197	200
2	CWKF	REAL		MATCNS	REFS	7	74	75	105	114	119	
3	CWNF	REAL		MATCNS	REFS	7	105	114	119			
1035	DD	REAL			REFS	99	2*100	135	2*136	DEFINED	83	
4	DELOXY	REAL		MATCNS	REFS	7	74	75	105	114	119	
0	DELTA	REAL		F.P.	REFS	93	129	200	210	DEFINED	1	
1037	DEP	REAL			REFS	109	145	146	156	157	161	162
					180	181	DEFINED	92	108	143	154	

VARIABLES	SN	TYPE		RELOCATION								
1061	DEPDOT	REAL			REFS	159	DEFINED	156				
1072	DEPP	REAL	ARRAY		REFS	29	94	95	97	DEFINED	86	87
					88							
1045	DSIGF	REAL			REFS	119	122					
0	DTIME	REAL		F.P.	REFS	156	DEFINED	1				
1026	E	REAL			REFS	76	96	98	123	132	134	138
					139	140	3*200	202	203	204	209	
					DEFINED	74						
1036	EE	REAL			REFS	2*99	100	2*135	136	DEFINED	84	
1054	EET	REAL			REFS	143	145	146	DEFINED	141		
1055	EM	REAL			REFS	145	146	DEFINED	144			
1051	EMODH	REAL			REFS	2*141	144	145	DEFINED	138		
1053	EMODR	REAL			REFS	2*141	144	DEFINED	140			
1052	EMODX	REAL			REFS	2*141	144	146	DEFINED	139		
1041	FF	REAL			REFS	98	99	100	134	135	136	
					DEFINED	97	98	133	134			
5	FLUX	REAL		MATCNS	REFS	7	159					
6	FNCK	REAL		MATCNS	REFS	7	74	75	105	114	119	
7	FNCN	REAL		MATCNS	REFS	7	105	114	119			
10	FOTMTL	REAL		MATCNS	REFS	7						
11	FRDEN	REAL		MATCNS	REFS	7						
12	FTMELT	REAL		MATCNS	REFS	7						
0	IQUIT	INTEGER		F.P.	REFS	159	DEFINED	1				
0	IT	INTEGER	*UNUSED	F.P.	DEFINED	1						
1050	KK	INTEGER			REFS	173	174	186	DEFINED	124	173	
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NPLAST	INTEGER		F.P.	REFS	101	DEFINED	1				
0	NRELAX	INTEGER		F.P.	REFS	85	137	180	181	DEFINED	1	
1103	NUDEPP	REAL	ARRAY		REFS	32	2*147	2*163	165	166	167	175
					176	177	182	183	184	DEFINED	89	90
					91	145	146	147	161	162	163	
1075	OLDEPP	REAL	ARRAY		REFS	29	130	131	133	138	139	2*140
					6*154	2*165	2*166	2*167	DEFINED	125	126	127
					175	176	177					
1044	OLSIGF	REAL			REFS	114	122	143				
0	PC	REAL		F.P.	REFS	192	197	DEFINED	1			
0	PG	REAL		F.P.	REFS	193	197	205	DEFINED	1		
0	PINT	REAL		F.P.	REFS	193	DEFINED	1	192	205		
1067	RATIO	REAL			REFS	172	DEFINED	171				
1064	RATIO1	REAL			REFS	168	171	DEFINED	165	168		
1065	RATIO2	REAL			REFS	169	171	DEFINED	166	169		
1066	RATIO3	REAL			REFS	170	171	DEFINED	167	170		
1070	RBAR	REAL			REFS	2*200	DEFINED	198				
0	RCI	REAL		F.P.	REFS	2*81	2*82	93	2*94	129	2*130	2*192
					2*197	198	199	200	2*210	DEFINED	1	
0	RCO	REAL		F.P.	REFS	2*81	2*82	93	2*94	129	2*130	2*192
					2*197	198	199	2*210	DEFINED	1		
13	RSTRAN	REAL		MATCNS	REFS	7	105	114	119			
1063	SIGEFF	REAL			REFS	159	161	162				
1042	SIGEFI	REAL			REFS	105	DEFINED	102				
1046	SLOPE	REAL			REFS	143	DEFINED	122				
1056	SM	REAL			REFS	152	153	DEFINED	151			
774	SMALL	REAL			REFS	119	122	DEFINED	36			

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VARIABLES     SN  TYPE          RELOCATION
 1057  S1         REAL                        REFS      161   DEFINED     152
 1060  S2         REAL                        REFS      162   DEFINED     153
 1071  T          REAL                        REFS    2*200   DEFINED     199
    0  TC         REAL              F.P.      REFS       73       105     114      119      159
                                              DEFINED     1
 1025  TC1        REAL                        REFS       74        75      77   DEFINED       73
    0  TIME       REAL              F.P.      REFS      159   DEFINED       1
    0  URF        REAL              F.P.      REFS       93       129     200      210   DEFINED        1
 1030  V          REAL                        REFS       81        82      83      123       138      139      140
                                              2*200     202       203     204      209   DEFINED       76
  773  ZERO       REAL                        REFS      114   DEFINED      36

FILE NAMES      MODE
      TAPE6     FMT                 WRITES      186

EXTERNALS         TYPE   ARGS       REFERENCES
      CELMOD      REAL      4            74
      CREEP                 7           159
      CSHEAR      REAL      4            75
      CTHEXP                3            77
      SQRT        REAL      1  LIBRARY   102       141       154
      STRAIN               11           105
      STRESS               11           114       119

INLINE FUNCTIONS  TYPE   ARGS       DEF LINE  REFERENCES
      ABS         REAL      1  INTRIN              168       169       170
      AMAX1       REAL      0  INTRIN              171

STATEMENT LABELS                    DEF LINE  REFERENCES
    0   100          INACTIVE          111       109
  225   110                            124        85
  235   120                            128       178
  400   130                            150       137
  454   140                            164       148
    0   150          INACTIVE          173       172
    0   160          INACTIVE          175       174
  520   170                            179       101      2*109     2*172      190
  545   180                            186      2*174
  551   190                            192       185
  655   200                            207       193
  677   210                            211       206
 1001   220     FMT                    214       186

COMMON BLOCKS   LENGTH
      MATCNS        12

STATISTICS
  PROGRAM LENGTH                     1106B      582
  SCM LABELED COMMON LENGTH            14B       12
        140000B SCM USED
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```
      SUBROUTINE CRAKF (CESIUM,CESUMO,CRAKI,CTHICK,DELTAT,HSTRES,HSTRSO,  CRAK      2
     +IODINE,IODINO,TCLAD,TCLADO,CDAMAG,A)                                CRAK      3
C                                                                         CRAK      4
C     IMPLICIT REAL*8( A-H, O-Z )                                         CRAK      5
C                                                                         CRAK      6
C     SUBROUTINE CRAKF DETERMINES THE PROBABILITY OF CLADDING FAILURE     CRAK      7
C     FROM A FRACTURE MECHANICS TYPE OF APPROACH.  THIS ROUTINE           CRAK      8
C     ACCOUNTS FOR CUMULATIVE DAMAGE. SUBROUTINES PREDICTING STRESS       CRAK      9
C     CORROSION CRACKING ARE CALLED FROM CRAKF.                           CRAK     10
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                            CRAK     11
C                                                                         CRAK     12
C                                                                         CRAK     13
C     --  INPUT ARGUMENTS --                                              CRAK     14
C                                                                         CRAK     15
C     CESIUM     CLADDING CESIUM CONTENT ( KG/M2 )                        CRAK     16
C     COLDWK     DEGREE OF INITIAL CLADDING COLD WORK                     CRAK     17
C     CRAKI      INITIAL CRACK LENGTH THROUGH CLADDING ( M )              CRAK     18
C     CTHICK     CLADDING THICKNESS ( M )                                 CRAK     19
C     DELTAT     TIMESTEP LENGTH ( SEC )                                  CRAK     20
C     HSTRES     CLADDING HOOP STRESS ( N/M2 )                            CRAK     21
C     IODINE     CLADDING IODINE CONTENT ( KG/M2 )                        CRAK     22
C     TCLAD      CLADDING TEMPERATURE ( DEG K )                           CRAK     23
C                                                                         CRAK     24
C                                                                         CRAK     25
C     -- OUTPUT ARGUMENTS --                                             CRAK     26
C                                                                         CRAK     27
C     A          CRACK LENGTH THROUGH CLADDING THICKNESS ( M )            CRAK     28
C     CDAMAG     PROBABILITY OF FAILURE, I.E., PROBABILITY THAT THE       CRAK     29
C     EXISTING CRACK LENGTH HAS EXCEEDED THE CRITICAL                     CRAK     30
C     CRACK LENGTH.                                                       CRAK     31
C                                                                         CRAK     32
C                                                                         CRAK     33
      REAL IODINE, IODINO                                                 CRAK     34
C                                                                         CRAK     35
      DATA C1, C2, C3 /7.990132996E5, 1.055187397E3, -1.875E-1 /          CRAK     36
C     DATA C1, C2, C3 /7.990132996D5, 1.055187397D3, -1.875D-1 /          CRAK     37
      DATA Y/1.29/                                                        CRAK     38
      DATA  SHIGH / 1.E20 /                                               CRAK     39
      DATA CDAMGO / 0.0 /                                                 CRAK     40
C                                                                         CRAK     41
C                                                                         CRAK     42
      SQRTA = SQRT(A)                                                     CRAK     43
C     SQRTA = DSQRT( A )                                                  CRAK     44
C                                                                         CRAK     45
C     CHECK WHETHER THRESHOLD STRESS FOR SCC HAS BEEN EXCEEDED            CRAK     46
C                                                                         CRAK     47
      IF (IODINE.GT.0.E0) GO TO 100                                       CRAK     48
      THSTRS = SHIGH                                                      CRAK     49
      GO TO 120                                                           CRAK     50
100   THSTRS = (C1-C2*TCLAD)*(IODINE**C3)/(Y*SQRTA)                       CRAK     51
      IF (HSTRES.GT.THSTRS) GO TO 110                                     CRAK     52
      GO TO 120                                                           CRAK     53
110   CALL SCC (CESIUM,CESUMO,CRAKI,CTHICK,DELTAT,HSTRES,HSTRSO,IODINE,I  CRAK     54
```

```
                +ODINO,TCLAD,TCLADO,A)                                                  CRAK      55
55          C                                                                           CRAK      56
            C   CALCULATE NEW CRACK LENGTH                                             CRAK      57
            C                                                                           CRAK      58
            C                                                                           CRAK      59
            C   CALCULATE THE PROBABILITY THAT THE CRACK HAS EXCEEDED A CRITICAL       CRAK      60
60          C   LENGTH.                                                                CRAK      61
            C                                                                           CRAK      62
            120   X = A/CTHICK                                                          CRAK      63
                  CALL CCRAK (HSTRES,TCLAD,X,CDAMAG)                                    CRAK      64
            C                                                                           CRAK      65
65          C                                                                           CRAK      66
                  RETURN                                                                CRAK      67
                  END                                                                   CRAK      68
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CRAKF	1	66

VARIABLES	SN	TYPE	RELOCATION							
0	A	REAL	F.P.	REFS	42	53	62	DEFINED	1	
0	CDAMAG	REAL	F.P.	REFS	63	DEFINED	1			
125	CDAMGO *	REAL		DEFINED	39					
0	CESIUM	REAL	F.P.	REFS	53	DEFINED	1			
0	CESUMO	REAL	F.P.	REFS	53	DEFINED	1			
0	CRAKI	REAL	F.P.	REFS	53	DEFINED	1			
0	CTHICK	REAL	F.P.	REFS	53	62	DEFINED	1		
120	C1	REAL		REFS	50	DEFINED	35			
121	C2	REAL		REFS	50	DEFINED	35			
122	C3	REAL		REFS	50	DEFINED	35			
0	DELTAT	REAL	F.P.	REFS	53	DEFINED	1			
0	HSTRES	REAL	F.P.	REFS	51	53	63	DEFINED	1	
0	HSTRSO	REAL	F.P.	REFS	53	DEFINED	1			
0	IODINE	REAL	F.P.	REFS	33	47	50	53	DEFINED	1
0	IODINO	REAL	F.P.	REFS	33	53	DEFINED	1		
124	SHIGH	REAL		REFS	48	DEFINED	38			
126	SQRTA	REAL		REFS	50	DEFINED	42			
0	TCLAD	REAL	F.P.	REFS	50	53	63	DEFINED	1	
0	TCLADO	REAL	F.P.	REFS	53	DEFINED	1			
127	THSTRS	REAL		REFS	51	DEFINED	48	50		
130	X	REAL		REFS	63	DEFINED	62			
123	Y	REAL		REFS	50	DEFINED	37			

EXTERNALS	TYPE	ARGS		REFERENCES
CCRAK		4		63
SCC		12		53
SQRT	REAL	1	LIBRARY	42

STATEMENT LABELS

		DEF LINE	REFERENCES	
21	100	50	47	
36	110	53	51	
61	120	62	49	52

STATISTICS

PROGRAM LENGTH 1318 89

140000B SCM USED

```
      FUNCTION CRAP (SAG,EDOT,T,TC,PHI,ECREEP)                                  CRAP       2
C                                                                               CRAP       3
C     IMPLICIT REAL*8 (A-H,O-Z)                                                 CRAP       4
C                                                                               CRAP       5
C     ***************************************************************           CRAP       6
C                                                                               CRAP       7
C     CRAP IS CALLED FROM CREEP.                                                CRAP       8
C     CRAP  COMPUTES EFFECTIVE STRESS AS A FUNCTION OF                          CRAP       9
C     THE CREEP STRAIN RATE, TEMPERATURE, FAST                                  CRAP      10
C     NEUTRON FLUX AND ACCUMULATED TOTAL CREEP STRAIN                           CRAP      11
C                                                                               CRAP      12
C     ***************************************************************           CRAP      13
C     INPUT  ARGUMENTS                                                          CRAP      14
C     ***************************************************************           CRAP      15
C                                                                               CRAP      16
C     EDOT = CREEP STRAIN RATE (1/HR)                                           CRAP      17
C     TC = CLADDING TEMPERATURE (F)                                             CRAP      18
C     T = TIME (HR) NOT USED IN THIS VERSION                                    CRAP      19
C     PHI = FLUX (NEUTRONS/M**2/SEC)                                            CRAP      20
C     ECREEP = TOTAL ACCUMULATED CREEP STRAIN (DIMENSIONLESS)                   CRAP      21
C                                                                               CRAP      22
C     ***************************************************************           CRAP      23
C     OUTPUT ARGUMENTS                                                          CRAP      24
C     ***************************************************************           CRAP      25
C                                                                               CRAP      26
C     CRAP= EFFECTIVE STRESS (PSI)                                              CRAP      27
C                                                                               CRAP      28
C     ***************************************************************           CRAP      29
C                                                                               CRAP      30
C     THE CREEP RATE EQUATION USED IN THIS SUBROUTINE WAS BASED ON :            CRAP      31
C     THE TIME AND STRESS DEPENDENCE TAKEN FROM "INREACTOR TUBULAR              CRAP      32
C     CREEP OF ZIRCALOY-2 AT 260 TO 300C, E.F. IBRHAIM, J. NUCL. MATER          CRAP      33
C     VOL 46 (1973) PP 169-182                                                  CRAP      34
C     THE FLUX DEPENDENCE WAS BASED ON ROSS-ROSS AND HUNT, J. NUCL.             CRAP      35
C     MATER. VOL 26 (1968) PP 2 - 17                                            CRAP      36
C     THE TEMPERATURE DEPENDENCE, DEPX(-Q/RT), WAS BASED ON A VALUE             CRAP      37
C     OF Q = 10000 CAL/MOLE NEAR 573K FROM FIDLERIS, AECL-4766                  CRAP      38
C                                                                               CRAP      39
C     CODED BY M.P.BOHN, DEC.28,1975 BASED ON THE MATPRO                        CRAP      40
C     FUNCTION "CCRPR"                                                          CRAP      41
C                                                                               CRAP      42
C     DPDT AND SIG ARE TRANSVERSE QUANTITIES                                    CRAP      43
C                                                                               CRAP      44
C     WRITE(6,2) SIG,EDOT,TC,PHI,ECREEP                                         CRAP      45
        SIG = SAG*6894.7573*1.1547                                              CRAP      46
        DPDT = (EDOT/3600.0)/1.1547                                             CRAP      47
        TC1 = (TC+459.67)/1.8                                                   CRAP      48
        B = 725.2                                                               CRAP      49
        C = 4.967E-08                                                           CRAP      50
        AK = 5.129E-29                                                          CRAP      51
        R = 1.987                                                               CRAP      52
        E = ECREEP/1.1547                                                       CRAP      53
        A1 = SQRT(E*DPDT/2.0)/(AK*PHI)                                          CRAP      54
```

```
                A2 = EXP(10000.0/(R*TC1))                                  CRAP       55
 55             A3 = A1*A2                                                 CRAP       56
                CRAP = A3-B*EXP(C*SIG)-SIG                                 CRAP       57
          100   CONTINUE                                                   CRAP       58
                RETURN                                                     CRAP       59
          C                                                                CRAP       60
 60             END                                                        CRAP       61
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	CRAP	1	58

VARIABLES	SN	TYPE	RELOCATION					
115	AK	REAL		REFS	53	DEFINED	50	
120	A1	REAL		REFS	55	DEFINED	53	
121	A2	REAL		REFS	55	DEFINED	54	
122	A3	REAL		REFS	56	DEFINED	55	
113	B	REAL		REFS	56	DEFINED	48	
114	C	REAL		REFS	56	DEFINED	49	
107	CRAP	REAL		DEFINED	56			
111	DPDT	REAL		REFS	53	DEFINED	46	
117	E	REAL		REFS	53	DEFINED	52	
0	ECREEP	REAL	F.P.	REFS	52	DEFINED	1	
0	EDOT	REAL	F.P.	REFS	46	DEFINED	1	
0	PHI	REAL	F.P.	REFS	53	DEFINED	1	
116	R	REAL		REFS	54	DEFINED	51	
0	SAG	REAL	F.P.	REFS	45	DEFINED	1	
110	SIG	REAL		REFS	2*56	DEFINED	45	
0	T	REAL	*UNUSED	F.P. DEFINED	1			
0	TC	REAL	F.P.	REFS	47	DEFINED	1	
112	TC1	REAL		REFS	54	DEFINED	47	

EXTERNALS	TYPE	ARGS	REFERENCES	
EXP	REAL	1 LIBRARY	54	56
SQRT	REAL	1 LIBRARY	53	

STATEMENT LABELS		DEF LINE	REFERENCES
0	100 INACTIVE	57	

STATISTICS

PROGRAM LENGTH 123B 83

140000B SCM USED

```
      SUBROUTINE CREEP (SIG,EDOT,Z,TC,PHI,ECREEP,IQUIT)                 CREP      2
C                                                                       CREP      3
C     IMPLICIT REAL*8 (A-H,O-Z)                                         CREP      4
C                                                                       CREP      5
C     ****************************************************************  CREP      6
C                                                                       CREP      7
C     CREEP IS CALLED FROM COUPLE AND STACK AND SEARCHES FOR THE CORRECT CREP      8
C     VALUE OF STRESS                                                   CREP      9
C                                                                       CREP     10
C     ****************************************************************  CREP     11
C     INPUT  ARGUMENTS                                                  CREP     12
C     ****************************************************************  CREP     13
C                                                                       CREP     14
C     ECREEP - TOTAL ACCUMULATED CREEP STRAIN                           CREP     15
C     EDOT   - CREEP STRAIN RATE (1/HR)                                 CREP     16
C     PHI    - FLUX (NEUTRONS/M**2/SEC)                                 CREP     17
C     TC     - CLADDING AVERAGE TEMPERATURE (F)                         CREP     18
C     Z      - TIME (HR) - NOT USED PRESENTLY                           CREP     19
C                                                                       CREP     20
C     ****************************************************************  CREP     21
C     OUTPUT ARGUMENTS                                                  CREP     22
C     ****************************************************************  CREP     23
C                                                                       CREP     24
C     SIG    - CLADDING HOOP STRESS (PSIA)                              CREP     25
C     IQUIT  - TERMINATION INDEX                                        CREP     26
C                                                                       CREP     27
C     ****************************************************************  CREP     28
C                                                                       CREP     29
C     ROOTING FOR ROOTS                                                 CREP     30
        F(T) = CRAP(T,EDOT,Z,TC,PHI,ECREEP)                             CREP     31
C                                                                       CREP     32
C                                                                       CREP     33
C     A MODIFIED FALSE POSITION ROUTINE GPERATING OVER THE INTERVAL ALPH CREP     34
C     BETA WITH INCREMENT DX                                            CREP     35
C                                                                       CREP     36
        ALPHA = 0.0E0                                                   CREP     37
        BETA = 900000.                                                  CREP     38
        DX = 10000.                                                     CREP     39
        CUT = 5.0                                                       CREP     40
        CUTI = CUT                                                      CREP     41
        N = 0                                                           CREP     42
C                                                                       CREP     43
        A = ALPHA                                                       CREP     44
        B = A+DX                                                        CREP     45
        FOFA = F(A)                                                     CREP     46
100     FOFB = F(B)                                                     CREP     47
        IF (A.EQ.0.E+0.AND.FOFA.LT.0.E+0) GO TO 110                     CREP     48
        GO TO 120                                                       CREP     49
110     WRITE (6,250)                                                   CREP     50
        IQUIT = 1                                                       CREP     51
        GO TO 240                                                       CREP     52
120     CONTINUE                                                        CREP     53
C     WRITE(6,81) A,FOFA,B,FOFB                                         CREP     54
```

```
                IF (FOFA*FOFB) 130,190,210                                      CREP       55
55          130 CONTINUE                                                        CREP       56
            C   HAVING BRACKETED A ROOT THE SOLUTION ITERATION COMMENCES         CREP       57
            C                                                                   CREP       58
            140   X = (A*FOFB-B*FOFA)/(FOFB-FOFA)                               CREP       59
                  N = N+1                                                       CREP       60
60                IF (N.LT.100) GO TO 150                                       CREP       61
                  WRITE (6,260)                                                 CREP       62
                  IQUIT = 1                                                     CREP       63
                  GO TO 240                                                     CREP       64
            150   FOFX = F(X)                                                   CREP       65
65          C   WRITE(6,80) X,FOFX                                             CREP       66
            C   TEST THE POSSIBILITY OF THE ITERATION LOOP LANDING ON A ROOT AT X CREP       67
            C   OR PASSING BY THE ROOT                                         CREP       68
                IF (FOFX*FOFA) 170,180,160                                      CREP       69
            160 CONTINUE                                                        CREP       70
70          C   THE ROOT IS STILL BRACKETED AND THE ITERATION LOOP CONTINUES    CREP       71
            C                                                                   CREP       72
                  A = X                                                         CREP       73
                  FOFA = FOFX                                                   CREP       74
                  FOFB = .5*FOFB                                                CREP       75
75                IF ((ABS(B-A).GT.CUT).AND.(ABS(FOFX).GT.CUT1)) GO TO 140      CREP       76
                  VX = X                                                        CREP       77
                  GO TO 230                                                     CREP       78
            170 CONTINUE                                                        CREP       79
            C   THE ITERATION SCHEME HAS REBRACKETED THE ROOT-THE BOUNDS ARE    CREP       80
80          C   ADJUSTED AND THE LOOP CONTINUES                                 CREP       81
            C                                                                   CREP       82
                  B = X                                                         CREP       83
                  FOFB = FOFX                                                   CREP       84
                  FOFA = .5*FOFA                                                CREP       85
35                IF ((ABS(B-A).GT.CUT).AND.(ABS(FOFX).GT.CUT1)) GO TO 140      CREP       86
                  VX = X                                                        CREP       87
                  GO TO 230                                                     CREP       88
            180 CONTINUE                                                        CREP       89
            C   THE ITERATION SCHEME HAS LANDED ON A ROOT AT (X,FOFX)           CREP       90
90          C                                                                   CREP       91
                IF (ABS(FOFA).EQ.0.0E0) GO TO 200                               CREP       92
                VX = X                                                          CREP       93
                GO TO 230                                                       CREP       94
            190 CONTINUE                                                        CREP       95
95          C   THE BRACKETING OPERATION HAS FOUND A ROOT                      CREP       96
            C                                                                   CREP       97
                IF (FOFA.EQ.0.0E0) GO TO 200                                    CREP       98
            C   THE BRACKETING OPERATION HAS FOUND A ROOT AT (B,FOFB)           CREP       99
                VX = B                                                          CREP      100
100             GO TO 230                                                       CREP      101
            200 CONTINUE                                                        CREP      102
            C   IF THIS IS THE FIRST BRACKET STEP THEN F(ALPHA)=0. IF OTHERWISE CREP      103
            C   THE PREVIOUS STEP IS IN ERROR AT FOFB                          CREP      104
                WRITE (6,270) A                                                 CREP      105
105             GO TO 230                                                       CREP      106
            210 CONTINUE                                                        CREP      107
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C   BEEN EXCEEDED                                                          CREP  108
C   THE ROUTINE HAS NOT YET BRACKETED A ROOT-ADJUST THE VARIABLES TO       CREP  109
C   THE NEXT MESH AND CONTINUE, ALSO TEST TO SEE IF THE INTERVAL HAS       CREP  110
110   A = B                                                                CREP  111
      B = B+DX                                                             CREP  112
      FOFA = FOFB                                                          CREP  113
      IF (A.GT.BETA) GO TO 220                                             CREP  114
      GO TO 100                                                            CREP  115
115 220  CONTINUE                                                         CREP  116
C   THE BRACKETING OPERATION HAS OVERRUN THE INTERVAL                      CREP  117
      WRITE (6,280)                                                        CREP  118
      IQUIT = 1                                                            CREP  119
      GO TO 240                                                            CREP  120
120 230  CONTINUE                                                         CREP  121
C   WRITE(6,74) VX,N                                                       CREP  122
      SIG = VX                                                             CREP  123
240   CONTINUE                                                           CREP  124
      RETURN                                                               CREP  125
125 C                                                                      CREP  126
250   FORMAT (//,5X,29H***** NEGATIVE FOFA AT A = 0 ,21H IN SUBROUTINE C  CREP  127
     +REEP )                                                               CREP  128
260   FORMAT (65H- THE ITERATION SCHEME HAS PASSED 100 STEPS--EXECUTION    CREP  129
     +TERMINATED,21H IN SUBROUTINE CREEP )                                 CREP  130
130 270  FORMAT (41H,  INITIAL DATA CONTAINS A ROOT AT ALPHA=,E15.6)       CREP  131
280   FORMAT (48H  THE BRACKET OPERATION HAS OVERRUN THE INTERVAL,21H IN   CREP  132
     + SUBROUTINE CREEP )                                                  CREP  133
      END                                                                  CREP  134
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CREEP	1	124

VARIABLES	SN	TYPE	RELOCATION								
357	A	REAL		REFS	44	45	47	58	75	85	104
				113	DEFINED	43	72	110			
351	ALPHA	REAL		REFS	43	DEFINED	36				
360	B	REAL		REFS	46	58	75	85	99	110	111
				DEFINED	44	82	111				
352	BETA	REAL		REFS	113	DEFINED	37				
354	CUT	REAL		REFS	40	75	85	DEFINED	39		
355	CUT1	REAL		REFS	75	85	DEFINED	40			
353	DX	REAL		REFS	44	111	DEFINED	38			
0	ECREEP	REAL	F.P.	REFS	45	46	64	DEFINED	1		
0	EDOT	REAL	F.P.	REFS	45	46	64	DEFINED	1		
361	FOFA	REAL		REFS	47	54	2*58	68	84	91	97
				DEFINED	45	73	84	112			
362	FOFB	REAL		REFS	54	2*58	74	112	DEFINED	46	74
				83							

VARIABLES	SN	TYPE	RELOCATION							
364	FOFX	REAL			REFS	68	73	75	83	85
					DEFINED	64				
0	IQUIT	INTEGER		F.P.	DEFINED	1	50	62	118	
356	N	INTEGER			REFS	59	60	DEFINED	41	59
0	PHI	REAL		F.P.	REFS	45	46	64	DEFINED	1
0	SIG	REAL		F.P.	DEFINED	1	122			
0	TC	REAL		F.P.	REFS	45	46	64	DEFINED	1
365	VX	REAL			REFS	122	DEFINED	76	86	92	99
363	X	REAL			REFS	64	72	76	82	86	92
					DEFINED	58				
0	Z	REAL		F.P.	REFS	45	46	64	DEFINED	1

FILE NAMES	MODE					
TAPE6	FMT	WRITES	49	61	104	117

EXTERNALS	TYPE	ARGS	REFERENCES		
CRAP	REAL	6	45	46	64

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES		
ABS	REAL	1	INTRIN		2*75	2*85	91
F	REAL	1	SF	30	45	46	64

STATEMENT LABELS			DEF LINE	REFERENCES				
42	100		46	114				
61	110		49	47				
67	120		52	48				
0	130	INACTIVE	55	54				
73	140		58	75	85			
113	150		64	60				
0	160	INACTIVE	69	68				
150	170		78	68				
171	180		88	68				
200	190		94	54				
206	200		101	91	97			
212	210		106	54				
226	220		115	113				
234	230		120	77	87	93	100	105
237	240		123	51	63	119		
302	250	FMT	126	49				
312	260	FMT	128	61				
325	270	FMT	130	104				
334	280	FMT	131	117				

STATISTICS

PROGRAM LENGTH 366B 246

140000B SCM USED

```
      SUBROUTINE CRERUP (DOXIDE,HYDRO,IODINE,STRESS,TCLAD,TIMES,RUPTIM)  CRER     2
C                                                                        CRER     3
C     IMPLICIT REAL*8(A-H,O-Z)                                           CRER     4
C                                                                        CRER     5
C     SUBROUTINE CRERUP PREDICTS THE TIME TO RUPTURE AS A FUNCTION OF    CRER     6
C     THE IMPOSED STRESS LEVEL                                           CRER     7
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                           CRER     8
C                                                                        CRER     9
C                                                                        CRER    10
C     --  INPUT ARGUMENTS  --                                            CRER    11
C                                                                        CRER    12
C     DOXIDE     DEPTH OF OXIDE LAYER ( PER CENT OF CLAD THICKNESS )     CRER    13
C     HYDRO      CLADDING HYDROGEN CONTENT ( PPM )                       CRER    14
C     IODINE     CLADDING IODINE CONTENT ( KG/ M3 )                      CRER    15
C     STRESS     EFFECTIVE STRESS ( N/M2 )                               CRER    16
C     TCLAD      CLADDING TEMPERATURE ( DEG K )                          CRER    17
C     TIMES      TIME AT STRESS LEVEL ( SEC )                            CRER    18
C                                                                        CRER    19
C                                                                        CRER    20
C     -- OUTPUT ARGURMENTS  --                                           CRER    21
C                                                                        CRER    22
C     RUPTIM     TIME TO RUPTURE AT GIVEN STRESS LEVEL ( SEC )           CRER    23
C                                                                        CRER    24
      REAL IODINE                                                        CRER    25
C                                                                        CRER    26
C     SET RUPTURE TIME TO VERY HIGH LEVEL UNTIL CORRECT RUPTURE TIME     CRER    27
C     IS PUT IN                                                          CRER    28
C                                                                        CRER    29
C     RUPTIM = 1.0D+15                                                   CRER    30
      RUPTIM = 1.0E+15                                                   CRER    31
C                                                                        CRER    32
      RETURN                                                             CRER    33
      END                                                                CRER    34
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CRERUP	1	32

VARIABLES	SN	TYPE	RELOCATION						
0	DOXIDE	REAL	*UNUSED	F.P.	DEFINED	1			
0	HYDRO	REAL	*UNUSED	F.P.	DEFINED	1			
0	IODINE	REAL	*UNUSED	F.P.	REFS	24	DEFINED	1	
0	RUPTIM	REAL		F.P.	DEFINED	1		30	
0	STRESS	REAL	*UNUSED	F.P.	DEFINED	1			
0	TCLAD	REAL	*UNUSED	F.P.	DEFINED	1			
0	TIMES	REAL	*UNUSED	F.P.	DEFINED	1			

STATISTICS
PROGRAM LENGTH 128 10
140000B SCM USED

```
      SUBROUTINE CREPR (SIG,EDOT,T,TC,PHI,ECREEP)                       CRPR       2
C                                                                       CRPR       3
C     IMPLICIT REAL*8 (A-H,O-Z)                                         CRPR       4
C                                                                       CRPR       5
C     ******************************************************************CRPR       6
C                                                                       CRPR       7
C     CREPR IS CALLED FROM CLADF.                                       CRPR       8
C     CREPR COMPUTES (TRANSVERSE) CLADDING CREEP STRAIN RATE            CRPR       9
C     AS A FUNCTION OF EFFECTIVE STRESS,TEMPERATURE, FAST               CRPR      10
C     NEUTRON FLUX AND ACCUMULATED TOTAL CREEP STRAIN                   CRPR      11
C                                                                       CRPR      12
C     ******************************************************************CRPR      13
C     INPUT ARGUMENTS                                                   CRPR      14
C     ******************************************************************CRPR      15
C                                                                       CRPR      16
C     ECREEP - TOTAL ACCUMULATED CREED STRAIN (DIMENSIONLESS)           CRPR      17
C     PHI    - FLUX (NEUTRONS/M**2/SEC)                                 CRPR      18
C     T      - TIME TO END OF POWER STEP (HR)                           CRPR      19
C     TC     - CLADDING AVERAGE TEMPERATURE (F)                         CRPR      20
C     SIG    - CLADDING HOOP, AXIAL, & RADIAL STRESS PER NODE (PSI)     CRPR      21
C                                                                       CRPR      22
C     ******************************************************************CRPR      23
C     OUTPUT ARGUMENTS                                                  CRPR      24
C     ******************************************************************CRPR      25
C                                                                       CRPR      26
C     EDOT   - CREEP STRAIN RATE (1/HR)                                 CRPR      27
C                                                                       CRPR      28
C     ******************************************************************CRPR      29
C                                                                       CRPR      30
C     THE CREEP RATE EQUATION USED IN THIS SUBROUTINE WAS BASED ON :    CRPR      31
C     THE TIME AND STRESS DEPENDENCE TAKEN FROM ¢INREACTOR TUBULAR      CRPR      32
C     CREEP OF ZIRCALOY-2 AT 260 TO 3000¢, E.F. IBRHAIM, J. NUCL. MATER CRPR      33
C     VOL 46 (1973) PP 169-182                                          CRPR      34
C     THE FLUX DEPENDENCE WAS BASED ON ROSS-ROSS AND HUNT, J. NUCL.     CRPR      35
C     MATER. VOL 26 (1968) PP 2 - 17                                    CRPR      36
C     THE TEMPERATURE DEPENDENCE, DEPX(-Q/RT), WAS BASED ON A VALUE     CRPR      37
C     OF Q = 10000 CAL/MOLE NEAR 573K FROM FIDLERIS, AECL-4766          CRPR      38
C                                                                       CRPR      39
C     CODED BY M.P.BOHN, DEC.28,1975 BASED ON THE MATPRO                CRPR      40
C     FUNCTION "CCRPR"                                                  CRPR      41
C                                                                       CRPR      42
C     SAG IS TRANSVERSE STRESS                                          CRPR      43
C                                                                       CRPR      44
      SAG = SIG*6894.7573*1.1547                                        CRPR      45
      TC1 = (TC+459.67)/1.8                                             CRPR      46
      B = 725.2                                                         CRPR      47
      C = 4.987E-08                                                     CRPR      48
      AK = 5.129E-29                                                    CRPR      49
      R = 1.987                                                         CRPR      50
      E = ECREEP                                                        CRPR      51
      IF (E.LE.0.0001) E = 0.0001                                       CRPR      52
      A1 = AK*PHI                                                       CRPR      53
      A2 = EXP(-10000.0/(R*TC1))                                        CRPR      54
```

```
                    A3 = SAG+B*EXP(C*SAG)                                  CRPR       55
55                  EDOT = (2.0*(A1*A2*A3)**2)/E                           CRPR       56
                    EDOT = EDOT*3600.0*1.1547                              CRPR       57
                C   WRITE(6,20) EDOT                                       CRPR       58
                100 CONTINUE                                               CRPR       59
                    RETURN                                                 CRPR       60
60              C                                                          CRPR       61
                    END                                                    CRPR       62
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CREPR	1	59

VARIABLES	SN	TYPE	RELOCATION								
107	AK	REAL			REFS	52	DEFINED	48			
112	A1	REAL			REFS	55	DEFINED	52			
113	A2	REAL			REFS	55	DEFINED	53			
114	A3	REAL			REFS	55	DEFINED	54			
105	B	REAL			REFS	54	DEFINED	46			
106	C	REAL			REFS	54	DEFINED	47			
111	E	REAL			REFS	51	55	DEFINED	50	51	
0	ECREEP	REAL		F.P.	REFS	50	DEFINED	1			
0	EDOT	REAL		F.P.	REFS	56	DEFINED	1	55	56	
0	PHI	REAL		F.P.	REFS	52	DEFINED	1			
110	R	REAL			REFS	53	DEFINED	49			
103	SAG	REAL			REFS	2*54	DEFINED	44			
0	SIG	REAL		F.P.	REFS	44	DEFINED	1			
0	T	REAL	*UNUSED	F.P.	DEFINED	1					
0	TC	REAL		F.P.	REFS	45	DEFINED	1			
104	TC1	REAL			REFS	53	DEFINED	45			

EXTERNALS	TYPE	ARGS		REFERENCES	
EXP	REAL	1	LIBRARY	53	54

STATEMENT LABELS		DEF LINE	REFERENCES
0 100	INACTIVE	58	

STATISTICS

PROGRAM LENGTH 115B 77

140000B SCM USED

```
      SUBROUTINE DDLF (TFS,RII,RD,POW,Z,YY,W,B,IPOW,DENSF,BTOLD,ITER,NA,  DDLF       2
     +GAPC,GAPH,GAPT,RFSH,GASES,TRANST,ITERR,IQUIT,RTRAN,BR,RTRANO,FOTMT DDLF       3
     +L,MECHAN,CFAC,VOLSTR,IM93WC,FTMELT)                                DDLF       4
C                                                                        DDLF       5
C                                                                        DDLF       6
C*****************************************************************     DDLF       7
C                                                                        DDLF       8
C  DDLF IS CALLED FROM SUBROUTINE TMPSUB                                 DDLF       9
C  THIS SUBROUTINE CALCULATES THE COEFFICIENTS FOR A POWER               DDLF      10
C  SERIES EXPANSION OF THE STEADY STATE FUEL TEMPERATURES                DDLF      11
C  AS A FUNCTION OF RADIAL POSITION.  THE FORMATION OF A ZONE OF         DDLF      12
C  RESTRUCTURED FUEL IS ACCOUNTED FOR IN THIS VERSION.                   DDLF      13
C  THE SERIES EXPANSION IS IN POWERS OF RADIAL POSITION,                 DDLF      14
C  NORMALIZED TO THE CURRENT FUEL OUTER RADIUS, RD.                      DDLF      15
C  DDLF WAS CODED BY D. B. LANNING IN APRIL 1978                         DDLF      16
C  DDLF WAS MODIFIED BY G A BERNA IN JUNE 1978 FOR CRACKING EFFECTS      DDLF      17
C                                                                        DDLF      18
C*****************************************************************     DDLF      19
C  INPUT  ARGUMENTS                                                      DDLF      20
C*****************************************************************     DDLF      21
C                                                                        DDLF      22
C  COMP   - PUO2 COMPOSITION (WEIGHT PERCENT)                            DDLF      23
C  CFAC   - CONDUCTIVITY MULTIPLIER FROM RADIAL AND CONDUC               DDLF      24
C  DENSF  - FRACTION OF FUEL THEORETICAL DENSITY                         DDLF      25
C  FOTMTL - FUEL OXYGEN TO METAL RATIO (ATOMS OXYGEN/ATOMS METAL)        DDLF      26
C  FTMELT - FUEL MELT TEMPERATURE (K)                                    DDLF      27
C  GAPC   - AS FABRICATED RADIAL GAP (M)                                 DDLF      28
C  GAPH   - UNRELOCATED RADIAL GAP (M)                                   DDLF      29
C  GAPT   - RELOCATED   RADIAL GAP (M)                                   DDLF      30
C  GASES  - ARRAY OF THE SEVEN GAS MOLE FRACTIONS                        DDLF      31
C  (1) = HELIUM                                                          DDLF      32
C  (2) = ARGON                                                           DDLF      33
C  (3) = KRYPTON                                                         DDLF      34
C  (4) = XENON                                                           DDLF      35
C  (5) = HYDROGEN                                                        DDLF      36
C  (6) = AIR                                                             DDLF      37
C  (7) = WATER VAPOR                                                     DDLF      38
C  IM93WC - EM SWITCH FOR FUEL THERMAL CONDUCTIVITY                      DDLF      39
C  IPOW   - AXIAL NODE INDEX                                             DDLF      40
C  ITERR  - GAS LOOP ITERATION INDEX                                     DDLF      41
C  MECHAN - FLAG FOR MECHANICAL MODEL CHOICE                             DDLF      42
C  NA     - NUMBER OF AXIAL NODES PLUS ONE                               DDLF      43
C  POW    - LINEAR HEAT GENERATION RATE (W/M)                            DDLF      44
C  RD     - FUEL OUTSIDE RADIUS (M)                                      DDLF      45
C  RFSH   - AS FABRICATED PELLET RADIUS (M)                              DDLF      46
C  RII    - FUEL CORE RADIUS (M)                                         DDLF      47
C  RTRANO - MAXIMUM RTRAN PREVIOUSLY ATTAINED (M)                        DDLF      48
C  TFS    - FUEL SURFACE TEMPERATUR (DEGREES C)                          DDLF      49
C  TRANST - TEMPERATURE ABOVE WHICH NO CRACKING IS ASSUMED (K)           DDLF      50
C  VOLSTR - VOLUME STRAIN DUE TO RELOCATION (DELTA-V/VOLUME)             DDLF      51
C  W      - COEFFICIENT DESCRIBING FLUX DEPRESSION                       DDLF      52
C  YY     - COEFFICIENT DESCRIBING FLUX DEPRESSION                       DDLF      53
C  Z      - COEFFICIENT DESCRIBING FLUX DEPRESSION                       DDLF      54
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      C                                                                                DDLF       55
55    C   ***************************************************************************  DDLF       56
      C   OUTPUT ARGUMENTS                                                             DDLF       57
      C   ***************************************************************************  DDLF       58
      C                                                                                DDLF       59
      C   B      - SET OF COEFFICIENTS FOR CALCULATING FUEL TEMPERATURES               DDLF       60
60    C   BELOW THE TRANSITION TEMPERATURE                                            DDLF       61
      C   BR     - SET OF COEFFICIENTS FOR CALCULATING FUEL TEMPERATURES               DDLF       62
      C   ABOVE THE TRANSITION TEMPERATURE                                            DDLF       63
      C   RTRAN  - RADIUS OUT TO THE REGION WHERE CRACKS BEGIN (M)                     DDLF       64
      C   BTOLD  - PREVIOUS B-VALUES                                                   DDLF       65
65    C   IQUIT  - CODE STOP INDEX                                                     DDLF       66
      C                                                                                DDLF       67
      C   ***************************************************************************  DDLF       68
      C                                                                                DDLF       69
        DIMENSION  RTRANO(NA)                                                          DDLF       70
70      DIMENSION RC(6,6),A(6,6),AS(6,6),BTOLD(NA,6)                                   DDLF       71
        DIMENSION  BR(6) , AR(6,6)                                                     DDLF       72
        DIMENSION  RT(6) , TTRM(6) , Q(6) , T(6) , B(6)                                DDLF       73
        DIMENSION  GASES(7)                                                            DDLF       74
      C                                                                                DDLF       75
75    C   DEFINE CONSTANTS.                                                           DDLF       76
      C                                                                                DDLF       77
        DATA (RT(I),I=1,6)/0.0,0.0694318,0.33000948,0.66999052,0.9305682,1             DDLF       78
       +.0/                                                                            DDLF       79
        DATA  N6 / 6 /                                                                 DDLF       80
80    C                                                                                DDLF       81
        IF (RII.LT.1.E-5) RII = 1.E-5                                                  DDLF       82
        TTRAN = TRANST-273.15E0                                                        DDLF       83
        RDD2 = RD**2                                                                   DDLF       84
        RDD4 = RD**4                                                                   DDLF       85
85      DENOM = (Z/2.)*(RDD2-RII**2)+(YY/4.)*(RDD4-RII**4)+(W/6.)*(RD**6-R             DDLF       86
       +II**6)                                                                         DDLF       87
        CON = 2.*3.141592                                                              DDLF       88
        RN = POW*RDD2/(DENOM*CON)                                                      DDLF       89
      C   THIS LOOP DEFINES THE INITIAL TEMPERATURE AND THE                           DDLF       90
90    C   VOLUMETRIC HEAT GENERATION AT EACH COLLOCATION PT.(RC(I))                    DDLF       91
      C                                                                                DDLF       92
        FAC = POW/37.7                                                                 DDLF       93
            DO 100 K=2,5                                                               DDLF       94
            RC(K,1) = ((RD-RII)*RT(K)+RII)/RD                                          DDLF       95
95          T(K) = FAC*(1.-RC(K,1)*RC(K,1))+TFS                                        DDLF       96
            IF (ITER.GT.1) T(K) = BTOLD(IPOW,K)                                        DDLF       97
            RM = RC(K,1)*RD                                                            DDLF       98
            Q(K) = RN*(Z+YY*RM**2+W*RM**4)                                             DDLF       99
      100   CONTINUE                                                                   DDLF      100
100     T(1) = TFS+FAC                                                                 DDLF      101
        T(6) = TFS                                                                     DDLF      102
        RC(1,1) = RII/RD                                                               DDLF      103
        RC(6,1) = 1.0                                                                  DDLF      104
      C                                                                                DDLF      105
105   C   THIS LOOP DEFINES POWERS OF RC FOR LATER USE.                               DDLF      106
      C                                                                                DDLF      107
```

```
                      DO 110 I=1,6                                                      DDLF      108
                         DO 110 J=2,6                                                   DDLF      109
                         RC(I,J) = RC(I,1)*RC(I,J-1)                                    DDLF      110
110          110         CONTINUE                                                       DDLF      111
             C                                                                          DDLF      112
             C   BEGIN  UNRESTRUCTURED STEADY STATE CALCULATION                         DDLF      113
             C   THE FOLLOWING 4 LOOPS SET UP THE B.C. AND COLLOCATION                 DDLF      114
             C   EQUATIONS FOR THE FUEL. THE PERMANENT AS(I,J) MATRIX NEED              DDLF      115
115          C   NOT BE CALCULATED FOR ITER.GT.1                                        DDLF      116
             C   FIRST THE BOUNDARY CONDITIONS FOR FUEL                                 DDLF      117
             C                                                                          DDLF      118
               AS(1,1) = 0.0                                                            DDLF      119
               AS(6,1) = 1.0                                                            DDLF      120
120            AS(1,2) = 1.0                                                            DDLF      121
               AS(6,2) = RC(6,1)                                                        DDLF      122
                  DO 120 J=3,6                                                          DDLF      123
                  AS(1,J) = RC(1,J-2)*(J-1)                                             DDLF      124
                  AS(6,J) = RC(6,J-1)                                                   DDLF      125
125          120     CONTINUE                                                          DDLF      126
             C                                                                          DDLF      127
             C   COLLOCATION EQUATIONS FOR FUEL                                       DDLF      128
             C                                                                          DDLF      129
                  DO 130 I=2,5                                                          DDLF      130
130               AS(I,1) = 0.0                                                        DDLF      131
                  AS(I,2) = 1.0/RC(I,1)                                                 DDLF      132
                  AS(I,3) = 4.0                                                         DDLF      133
                  AS(I,4) = 9.0*RC(I,1)                                                 DDLF      134
                  AS(I,5) = 16.0*RC(I,2)                                                DDLF      135
135               AS(I,6) = 25.0*RC(I,3)                                                DDLF      136
             130  CONTINUE                                                           DDLF      137
             C                                                                          DDLF      138
             C   DEFINE SURFACE HEAT FLUX AT COLL PTS.                                DDLF      139
             C                                                                          DDLF      140
140               DO 140 I=2,5                                                          DDLF      141
                  TTRM(I) = (Z/2.)*(RC(I,2)-RC(I,2))+(YY/4.)*(RC(I,4)-RC(I,4))*R     DDLF      142
              +     DD2+(W/6.)*(RC(I,6)-RC(I,6))*RDD4                                 DDLF      143
             140  CONTINUE                                                           DDLF      144
               TK = T(4)+273.15                                                         DDLF      145
145          C                                                                          DDLF      146
               CALL FTHCON (TK,DENSF,FOTMTL,RKLAB,DKDT)                                 DDLF      147
             C                                                                          DDLF      148
               IF (IM93WC.EQ.1) RKLAB = EMFTC(RKLAB,FTMELT)                             DDLF      149
             C                                                                          DDLF      150
150            IF (MECHAN.EQ.1) GO TO 150                                               DDLF      151
             C                                                                          DDLF      152
               CALL EFFCON (RLKF,DRDT,RKLAB,TK,GAPC,GAPH,GAPT,GASES,DKDT,RFSH,VOL     DDLF      153
              +STR,MECHAN)                                                              DDLF      154
             C                                                                          DDLF      155
155          150  CONTINUE                                                           DDLF      156
             C   IF THE EM CONDUCTIVITY MODEL IS SPECIFIED, NO CRACKING EFFECTS       DDLF      157
             C   ARE CONSIDERED                                                       DDLF      158
             C                                                                          DDLF      159
               IF (IM93WC.EQ.1) RLKF = 1.E0                                             DDLF      160
```

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      IF (IM93WC.EQ.1) DRDT = 0.E0                                      DDLF   161
C                                                                       DDLF   162
C   ITERATION BEGINS HERE                                               DDLF   163
      DO 220 N=1,20                                                     DDLF   164
C   SET EXPENDABLE A(I,J) EQUAL TO PERMANENT AS(I,J)                    DDLF   165
      DO 170 I=1,6                                                      DDLF   166
        DO 160 J=1,6                                                    DDLF   167
        A(I,J) = AS(I,J)                                                DDLF   168
160     CONTINUE                                                        DDLF   169
170   CONTINUE                                                          DDLF   170
      DO 200 K=2,5                                                      DDLF   171
      TK = T(K)+273.15                                                  DDLF   172
C                                                                       DDLF   173
      CALL FTHCON (TK,DENSF,FOTMTL,RKLAB,DKDT)                          DDLF   174
C                                                                       DDLF   175
      IF (IM93WC.EQ.1) RKLAB = EMFTC(RKLAB,FTMELT)                      DDLF   176
C                                                                       DDLF   177
      IF (MECHAN.EQ.1) GO TO 180                                        DDLF   178
C                                                                       DDLF   179
      RK = RKLAB*RLKF                                                   DDLF   180
      DKDT = RKLAB*DRDT+RLKF*DKDT                                       DDLF   181
      GO TO 190                                                         DDLF   182
C                                                                       DDLF   183
180   CONTINUE                                                          DDLF   184
      RK = RKLAB*CFAC                                                   DDLF   185
      DKDT = DKDT*CFAC                                                  DDLF   186
190   CONTINUE                                                          DDLF   187
C                                                                       DDLF   188
      FAC = RN/(RC(K,1)*RK)                                             DDLF   189
      TFAC = FAC*TTRM(K)                                                DDLF   190
      TFACT = TFAC**2                                                   DDLF   191
      B(K) = -(Q(K)+DKDT*TFACT)/RK                                      DDLF   192
200   CONTINUE                                                          DDLF   193
      B(1) = 0.0                                                        DDLF   194
      B(6) = TFS                                                        DDLF   195
C                                                                       DDLF   196
      CALL SIMQ (A,B,N6,KS)                                             DDLF   197
C                                                                       DDLF   198
      SUM = 0.0                                                         DDLF   199
      DO 210 I=1,6                                                      DDLF   200
      TT = B(1)+B(2)*RC(I,1)+B(3)*RC(I,2)+B(4)*RC(I,3)+B(5)*RC(I        DDLF   201
     +,4)+B(6)*RC(I,5)                                                  DDLF   202
      ADEL = 100.E0*ABS(T(I)-TT)/T(I)                                   DDLF   203
      SUM = SUM+ADEL                                                    DDLF   204
      T(I) = TT                                                         DDLF   205
      BTOLD(IPOW,I) = T(I)                                              DDLF   206
210   CONTINUE                                                          DDLF   207
      IF (SUM.LT.4.E0) GO TO 230                                        DDLF   208
      IF (N.GT.20) WRITE (6,*) "T(I)",T(I)                              DDLF   209
220   CONTINUE                                                          DDLF   210
230 CONTINUE                                                            DDLF   211
      IF (N.GE.20) WRITE (6,520)                                        DDLF   212
      IF (N.GE.40.AND.ITERR.GT.1) IQUIT = 1                             DDLF   213
```

```
                TEST = TTRAN+50.E0                                                DDLF   214
              C                                                                   DDLF   215
  215           IF (MECHAN.EQ.1) GO TO 500                                        DDLF   216
              C                                                                   DDLF   217
                TEST = TTRAN+50.E0                                                DDLF   218
                IF (RTRANO(IPOW).GT.0.E0) GO TO 240                               DDLF   219
                IF (T(I).LE.TEST) GO TO 500                                       DDLF   220
  220         C                                                                   DDLF   221
              C   LOCATE THE TRANSITION TEMPERATURE BOUNDARY.(RTRAN)              DDLF   222
              C   NOTE RTRAN IS IN METERS                                        DDLF   223
              C                                                                   DDLF   224
              240 CONTINUE                                                        DDLF   225
  225           IF (T(I).LE.TEST) RTRAN = 0.E0                                    DDLF   226
                IF (T(I).LE.TEST) GO TO 340                                       DDLF   227
                REST = RII/RD                                                     DDLF   228
                    DO 260 I=1,5                                                  DDLF   229
                    TT = 0.0                                                      DDLF   230
  230               RST = 1.0                                                     DDLF   231
                        DO 250 J=1,5                                              DDLF   232
                        RST = RST*REST                                            DDLF   233
                        TT = B(J+1)*RST+TT                                        DDLF   234
              250       CONTINUE                                                  DDLF   235
  235               TT = TT+B(1)                                                  DDLF   236
                    IF (TT.LT.TTRAN) GO TO 270                                    DDLF   237
                    REST = REST+0.2                                               DDLF   238
              260   CONTINUE                                                      DDLF   239
              270 REST = REST-0.2                                                 DDLF   240
  240             DO 290 I=1,10                                                   DDLF   241
                  TT = 0.0                                                        DDLF   242
                  RST = 1.0                                                       DDLF   243
                      DO 280 J=1,5                                                DDLF   244
                      RST = RST*REST                                              DDLF   245
  245                 TT = B(J+1)*RST+TT                                          DDLF   246
              280     CONTINUE                                                    DDLF   247
                  TT = TT+B(1)                                                    DDLF   248
                  IF (TT.LT.TTRAN) GO TO 300                                      DDLF   249
                  REST = REST+0.02                                                DDLF   250
  250         290 CONTINUE                                                        DDLF   251
              300 REST = REST-0.02                                                DDLF   252
                  DO 320 I=1,10                                                   DDLF   253
                  TT = 0.0                                                        DDLF   254
                  RST = 1.0                                                       DDLF   255
  255               DO 310 J=1,5                                                DDLF   256
                    RST = RST*REST                                                DDLF   257
                    TT = B(J+1)*RST+TT                                            DDLF   258
              310   CONTINUE                                                      DDLF   259
                  TT = TT+B(1)                                                    DDLF   260
  260             IF (TT.LT.TTRAN) GO TO 330                                      DDLF   261
                  REST = REST+0.002                                               DDLF   262
              320 CONTINUE                                                        DDLF   263
              330 RTRAN = (REST-.001)*RD                                          DDLF   264
              340 CONTINUE                                                        DDLF   265
  265           IF (RTRANO(IPOW).GT.RTRAN) GO TO 350                              DDLF   266
```

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                C                                                                       DDLF      267
                C   THE FOLLOWING CODING PROVIDES FOR PERMANENET CRACK HEALING         DDLF      268
                C                                                                       DDLF      269
                C   ****                                                                DDLF      270
270             C                                                                       DDLF      271
                      GO TO 360                                                         DDLF      272
                350   CONTINUE                                                          DDLF      273
                      RTI = RTRANO(IPOW)/RD                                             DDLF      274
                      TTRANT = B(1)+B(2)*RTI+B(3)*RTI**2+B(4)*RTI**3+B(5)*RTI**4+B(6)*RT DDLF      275
275                  +I**5                                                              DDLF      276
                      IF (TTRANT.LT.TTRAN) TTRAN = TTRANT                               DDLF      277
                      RTRAN = RTRANO(IPOW)                                              DDLF      278
                C   ****                                                                DDLF      279
                360   CONTINUE                                                          DDLF      280
280             C                                                                       DDLF      281
                C   SET UP COLLOCATION POINTS,POWERS,AND TEMPERATURES,FOR THE INNER REGI DDLF      282
                C                                                                       DDLF      283
                          DO 380 K=2,5                                                  DDLF      284
                          RM = RII+RT(K)*(RTRAN-RII)                                    DDLF      285
285                       RC(K,1) = RM/RD                                               DDLF      286
                          Q(K) = RN*(Z+YY*RM*RM+W*RM**4)                                DDLF      287
                          SUM = 0.0                                                     DDLF      288
                              DO 370 IJ=2,6                                             DDLF      289
                              SUM = SUM+B(IJ)*RC(K,1)**(IJ-1)                           DDLF      290
290             370           CONTINUE                                                  DDLF      291
                          T(K) = SUM+B(1)                                               DDLF      292
                380       CONTINUE                                                      DDLF      293
                      RC(1,1) = RII/RD                                                  DDLF      294
                      RC(6,1) = RTRAN/RD                                                DDLF      295
295                       DO 400 I=1,6                                                  DDLF      296
                              DO 390 J=2,6                                              DDLF      297
                              RC(I,J) = RC(I,1)*RC(I,J-1)                               DDLF      298
                390           CONTINUE                                                  DDLF      299
                400       CONTINUE                                                      DDLF      300
300             C                                                                       DDLF      301
                C   SET UP COLLOCATION EQUATIONS FOR THE INNER REGION                    DDLF      302
                C                                                                       DDLF      303
                          DO 410 J=1,6                                                  DDLF      304
                          AR(1,J) = RC(1,1)**(J-2)*(J-1)                                DDLF      305
305                       AR(6,J) = RC(6,1)**(J-1)                                      DDLF      306
                410       CONTINUE                                                      DDLF      307
                          DO 420 I=2,5                                                  DDLF      308
                          AR(I,1) = 0.0                                                 DDLF      309
                          AR(I,2) = 1.0/RC(I,1)                                         DDLF      310
310                       AR(I,3) = 4.0                                                 DDLF      311
                          AR(I,4) = 9.0*RC(I,1)                                         DDLF      312
                          AR(I,5) = 16.0*RC(I,2)                                        DDLF      313
                          AR(I,6) = 25.0*RC(I,3)                                        DDLF      314
                420       CONTINUE                                                      DDLF      315
315                       DO 430 I=2,5                                                  DDLF      316
                          TTRM(I) = (Z/2.)*(RC(I,2)-RC(I,2))+(YY/4.)*(RC(I,4)-RC(I,4))*R DDLF      317
                     +    DD2+(W/6.)*(RC(I,6)-RC(I,6))*RDD4                             DDLF      318
                430       CONTINUE                                                      DDLF      319
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                C
320             C   INNER REGION ITERATION BEGINS HERE.
                C
                      DO 480 N=1,20
                          DO 450 JJ=1,6
                              DO 440 KK=1,6
325                           A(KK,JJ) = AR(KK,JJ)
                440           CONTINUE
                450       CONTINUE
                          DO 460 K=2,5
                          TK = T(K)+273.15
330             C
                          CALL FTHCON (TK,DENSF,FOTMTL,RK,DKDT)
                C
                          IF (IM93WC.EQ.1) RK = EMFTC(RK,FTMELT)
                C
335                       FAC = RN/(RC(K,1)*RK)
                          TFAC = FAC*TTRM(K)
                          TFACT = TFAC**2
                          BR(K) = -(Q(K)+DKDT*TFACT)/RK
                460       CONTINUE
340                   BR(1) = 0.0
                      BR(6) = TTRAN
                C
                      CALL SIMQ (A,BR,N6,KS)
                C
345                   SUM = 0.0
                      DO 470 I=1,6
                      TT = BR(1)+BR(2)*RC(I,1)+BR(3)*RC(I,2)+BR(4)*RC(I,3)+BR(5)
                     +*RC(I,4)+BR(6)*RC(I,5)
                      ADEL = ABS(T(I)-TT)
350                   SUM = SUM+ADEL
                      T(I) = TT
                470   CONTINUE
                  IF (SUM.LT.1.00) GO TO 490
                480   CONTINUE
355             490 CONTINUE
                    IF (N.GE.20) WRITE (6,510)
                    IF (N.GE.20.AND.ITERR.GT.1) IQUIT = 1
                500 CONTINUE
                    RETURN
360             C
                510 FORMAT (5X,36HNONCONVERGENCE IN DDLF--INNER REGION)
                520 FORMAT (5X,22HNONCONVERGENCE IN DDLF)
                    END
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 DDLF 1 359

VARIABLES	SN	TYPE	RELOCATION									
1550	A	REAL	ARRAY		REFS	70	196	343	DEFINED	167	325	
1473	ADEL	REAL			REFS	203	350	DEFINED	202	349		
1660	AR	REAL	ARRAY		REFS	71	325	DEFINED	304	305	308	309
						310	311	312	313			
1614	AS	REAL	ARRAY		REFS	70	167	DEFINED	118	119	120	121
						123	124	130	131	132	133	134	135
0	B	REAL	ARRAY	F.P.	REFS	72	196	6*200	233	235	245	247
						257	259	6*274	289	291	DEFINED	1	191
						193	194					
0	BR	REAL	ARRAY	F.P.	REFS	71	343	6*347	DEFINED	1	338	340
						341						
0	BTOLD	REAL	ARRAY	F.P.	REFS	70	96	DEFINED	1	205		
0	CFAC	REAL		F.P.	REFS	184	185	DEFINED	1			
1450	CON	REAL			REFS	88	DEFINED	87				
1447	DENOM	REAL			REFS	88	DEFINED	85				
0	DENSF	REAL		F.P.	REFS	146	173	331	DEFINED	1		
1461	DKDT	REAL			REFS	146	152	173	180	185	191	331
						338	DEFINED	180	185			
1463	DRDT	REAL			REFS	152	180	DEFINED	160			
1452	FAC	REAL			REFS	95	100	189	336	DEFINED	92	188
						335						
0	FOTMTL	REAL		F.P.	REFS	146	173	331	DEFINED	1		
0	FTMELT	REAL		F.P.	REFS	148	175	333	DEFINED	1		
0	GAPC	REAL		F.P.	REFS	152	DEFINED	1				
0	GAPH	REAL		F.P.	REFS	152	DEFINED	1				
0	GAPT	REAL		F.P.	REFS	152	DEFINED	1				
0	GASES	REAL	ARRAY	F.P.	REFS	73	152	DEFINED	1			
1455	I	INTEGER			REFS	3*109	130	2*131	132	2*133	2*134	2*135
						4*141	2*167	5*200	2*202	204	2*205	3*297	308
						2*309	310	2*311	2*312	2*313	4*316	5*347	349
						351	DEFINED	107	129	140	165	199	228
						240	252	295	307	315	346		
1501	IJ	INTEGER			REFS	2*289	DEFINED	288				
0	IM93WC	INTEGER		F.P.	REFS	148	159	160	175	333		
					DEFINED	1						
0	IPOW	INTEGER		F.P.	REFS	96	205	218	265	273	277	
					DEFINED	1						
0	IQUIT	INTEGER		F.P.	DEFINED	1	212	357				
0	ITER	INTEGER		F.P.	REFS	96	DEFINED	1				
0	ITERR	INTEGER		F.P.	REFS	212	357	DEFINED	1			
1456	J	INTEGER			REFS	2*109	3*123	2*124	2*167	233	245	257
						2*297	3*304	2*305	DEFINED	108	122	166	231
						243	255	296	303			
1502	JJ	INTEGER			REFS	2*325	DEFINED	323				
1453	K	INTEGER			REFS	2*94	3*95	2*96	97	98	171	188
						189	2*191	284	285	286	289	291	329
						335	336	2*338	DEFINED	93	170	283	328
1503	KK	INTEGER			REFS	2*325	DEFINED	324				
1470	KS	INTEGER			REFS	196	343					

VARIABLES	SN	TYPE		RELOCATION									
0	MECHAN	INTEGER		F.P.	REFS	150	152	177	215	DEFINED	1		
1464	N	INTEGER			REFS	208	211	212	356	357			
					DEFINED	163	322						
0	NA	INTEGER		F.P.	REFS	69	70	DEFINED	1				
1373	N6	INTEGER			REFS	196	343	DEFINED	79				
0	POW	REAL		F.P.	REFS	88	92	DEFINED	1				
1740	Q	REAL	ARRAY		REFS	72	191	338	DEFINED	98	286		
1504	RC	REAL	ARRAY		REFS	70	2*95	97	2*109	121	123	124	
					131	133	134	135	6*141	188	5*200	289	
					2*297	304	305	309	311	312	313	6*316	
					335	5*347	DEFINED	94	102	103	109	285	
					293	294	297						
0	RD	REAL		F.P.	REFS	83	84	85	2*94	97	102	227	
					263	273	285	293	294	DEFINED	1		
1445	RDD2	REAL			REFS	85	88	141	316	DEFINED	83		
1446	RDD4	REAL			REFS	85	141	316	DEFINED	84			
1475	REST	REAL			REFS	232	237	239	244	249	251	256	
					261	263	DEFINED	227	237	239	249	251	
					261								
0	RFSH	REAL		F.P.	REFS	152	DEFINED	1					
0	RII	REAL		F.P.	REFS	81	3*85	2*94	102	227	2*284	293	
					DEFINED	1	81						
1465	RK	REAL			REFS	188	191	331	333	335	338		
					DEFINED	179	184	333					
1460	RKLAB	REAL			REFS	146	148	152	173	175	179	180	
					184	DEFINED	148	175					
1462	RLKF	REAL			REFS	152	179	180	DEFINED	159			
1454	RM	REAL			REFS	2*98	285	3*286	DEFINED	97	284		
1451	RN	REAL			REFS	98	188	286	335	DEFINED	88		
1476	RST	REAL			REFS	232	233	244	245	256	257		
					DEFINED	230	232	242	244	254	256		
1724	RT	REAL	ARRAY		REFS	72	94	284	DEFINED	77			
1477	RTI	REAL			REFS	5*274	DEFINED	273					
0	RTRAN	REAL		F.P.	REFS	265	284	294	DEFINED	1	225	263	
					277								
0	RTRANO	REAL	ARRAY	F.P.	REFS	69	218	265	273	277			
					DEFINED	1							
1471	SUM	REAL			REFS	203	207	289	291	350	353		
					DEFINED	198	203	287	289	345	350		
1746	T	REAL	ARRAY		REFS	72	144	171	2*202	205	208	219	
					225	226	329	349	DEFINED	95	96	100	
					101	204	291	351					
1474	TEST	REAL			REFS	219	225	226	DEFINED	213	217		
1466	TFAC	REAL			REFS	190	337	DEFINED	189	336			
1467	TFACT	REAL			REFS	191	338	DEFINED	190	337			
0	TFS	REAL		F.P.	REFS	95	100	101	194	DEFINED	1		
1457	TK	REAL			REFS	146	152	173	331	DEFINED	144	171	
					329								
0	TRANST	REAL		F.P.	REFS	82	DEFINED	1					
1472	TT	REAL			REFS	202	204	233	235	236	245	247	
					248	257	259	260	349	351			
					DEFINED	200	229	233	235	241	245	247	
					253	257	259	347					

VARIABLES	SN	TYPE	RELOCATION								
1444	TTRAN	REAL			REFS	213	217	236	248	260	276	341
					DEFINED	82	276					
1500	TTRANT	REAL			REFS	2*276	DEFINED	274				
1732	TTRM	REAL	ARRAY		REFS	72	189	336	DEFINED	141	316	
0	VOLSTR	REAL		F.P.	REFS	152	DEFINED	1				
0	W	REAL		F.P.	REFS	85	98	141	286	316		
					DEFINED	1						
0	YY	REAL		F.P.	REFS	85	98	141	286	316		
					DEFINED	1						
0	Z	REAL		F.P.	REFS	85	98	141	286	316		
					DEFINED	1						

FILE NAMES	MODE			
TAPE6	MIXED	WRITES	208	211	356

EXTERNALS	TYPE	ARGS	REFERENCES		
EFFCON		12	152		
EMFTC	REAL	2	148	175	333
FTHCON		5	146	173	331
SIMQ		4	196	343	

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
ABS	REAL	1	INTRIN		202	349

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	99	93	
0	110	110	107	108
0	120	125	122	
0	130	136	129	
0	140	143	140	
301	150	155	150	
0	160	168	166	
0	170	169	165	
365	180	183	177	
373	190	186	181	
0	200	192	170	
0	210	206	199	
0	220	209	163	
501	230	210	207	
534	240	224	218	
0	250	234	231	
0	260	238	228	
604	270	239	236	
0	280	246	243	
0	290	250	240	
644	300	251	248	
0	310	258	255	
0	320	262	252	
704	330	263	260	
711	340	264	226	
720	350	272	265	
747	360	279	271	
0	370	290	288	

STATEMENT LABELS			DEF LINE	REFERENCES	
0	380		292	283	
0	390		298	296	
0	400		299	295	
0	410		306	303	
0	420		314	307	
0	430		318	315	
0	440		326	324	
0	450		327	323	
0	460		339	329	
0	470		352	346	
0	480		354	322	
1273	490		355	353	
1306	500		358	215	219
1406	510	FMT	361	356	
1414	520	FMT	362	211	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
55	100	K	93 99	36B	OPT			
127	110	I	107 110	15B		NOT INNER		
131	110	J	108 110	10B	INSTACK			
156	120	J	122 125	14B	OPT			
174	130	I	129 136	24B	OPT			
222	140	I	140 143	21B	OPT			
313	220	N	163 209	165B		EXT REFS	EXITS	NOT INNER
315	170	I	165 169	15B		NOT INNER		
317	160	J	166 168	10B	INSTACK			
334	200	K	170 192	60B		EXT REFS		
427	210	I	199 206	36B	OPT			
550	260	I	228 238	33B		EXITS	NOT INNER	
556	250	J	231 234	11B	INSTACK			
610	290	I	240 250	33B		EXITS	NOT INNER	
616	280	J	243 246	11B	INSTACK			
650	320	I	252 262	33B		EXITS	NOT INNER	
656	310	J	255 258	11B	INSTACK			
751	380	K	283 292	45B		EXT REFS	NOT INNER	
774	370	IJ	288 290	14B		EXT REFS		
1026	400	I	295 299	15B		NOT INNER		
1030	390	J	296 298	10B	INSTACK			
1045	410	J	303 306	21B		EXT REFS		
1070	420	I	307 314	24B	OPT			
1116	430	I	315 318	21B	OPT			
1141	480	N	322 354	1318		EXT REFS	EXITS	NOT INNER
1143	450	JJ	323 327	15B		NOT INNER		
1145	440	KK	324 326	10B	INSTACK			
1162	460	K	328 339	36B		EXT REFS		
1233	470	I	346 352	31B	OPT			

STATISTICS
PROGRAM LENGTH 2045B 1061
140000B SCM USED

```
      SUBROUTINE DFRAC (CTMAX,HSTRAN,TCLAD,TIMEF,PFR)                    DFRC       2
C                                                                        DFRC       3
C     IMPLICIT REAL*8(A-H,O-Z)                                           DFRC       4
C                                                                        DFRC       5
C     SUBROUTINE DFRAC PREDICTS THE PERCENTAGE OF FUEL RODS IN A SYSTEM  DFRC       6
C     THAT WILL FAIL DUE TO AN OVERSTRAIN CONDITION                      DFRC       7
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                           DFRC       8
C                                                                        DFRC       9
C     --  INPUT ARGUMENTS  --                                            DFRC      10
C                                                                        DFRC      11
C     CTMAX      PREVIOUS MAXIMUM CLAD TEMPERATURE ( DEG K )           DFRC      12
C     HSTRAN     ENGINEERING HOOP STRAIN                               DFRC      13
C     TCLAD      CLADDING TEMPERATURE ( DEG K )                        DFRC      14
C     TIMEF      TIME AT FLUX ( SEC )                                  DFRC      15
C                                                                        DFRC      16
C                                                                        DFRC      17
C     --  OUTPUT ARGUMENTS  --                                           DFRC      18
C                                                                        DFRC      19
C     PFR        FRACTION OF RODS THAT FAIL DUE TO OVERSTRAINING       DFRC      20
C                                                                        DFRC      21
C                                                                        DFRC      22
      CALL FSTEMP (CTMAX,HSTRAN,TCLAD,PFR)                               DFRC      23
C                                                                        DFRC      24
      RETURN                                                             DFRC      25
      END                                                                DFRC      26
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	DFRAC	1	24

VARIABLES	SN	TYPE		RELOCATION				
0	CTMAX	REAL		F.P.	REFS	22	DEFINED	1
0	HSTRAN	REAL		F.P.	REFS	22	DEFINED	1
0	PFR	REAL		F.P.	REFS	22	DEFINED	1
0	TCLAD	REAL		F.P.	REFS	22	DEFINED	1
0	TIMEF	REAL	*UNUSED	F.P.	DEFINED	1		

EXTERNALS	TYPE	ARGS	REFERENCES
FSTEMP		4	22

STATISTICS

PROGRAM LENGTH 238 19

140000B SCM USED

```
      C                                                                     DLGA       2
      C     .................................................................DLGA       3
      C                                                                     DLGA       4
      C     SUBROUTINE DLGAM                                                DLGA       5
      C                                                                     DLGA       6
      C     PURPOSE                                                         DLGA       7
      C     COMPUTES THE DOUBLE PRECISION NATURAL LOGARITHM OF THE          DLGA       8
      C     GAMMA FUNCTION OF A GIVEN DOUBLE PRECISION ARGUMENT.            DLGA       9
      C                                                                     DLGA      10
      C     USAGE                                                           DLGA      11
      C     CALL DLGAM(XX,DLNG,IER)                                         DLGA      12
      C                                                                     DLGA      13
      C     DESCRIPTION OF PARAMETERS                                       DLGA      14
      C     XX   - THE DOUBLE PRECISION ARGUMENT FOR THE LOG GAMMA          DLGA      15
      C     FUNCTION.                                                       DLGA      16
      C     DLNG - THE RESULTANT DOUBLE PRECISION LOG GAMMA FUNCTION        DLGA      17
      C     VALUE.                                                          DLGA      18
      C     IER  - RESULTANT ERROR CODE WHERE                               DLGA      19
      C     IER= 0----NO ERROR.                                             DLGA      20
      C     IER=-1----XX IS WITHIN 10**(-9) OF BEING ZERO OR XX             DLGA      21
      C     IS NEGATIVE.  DLNG IS SET TO -1.0D75.                           DLGA      22
      C     IER=+1----XX IS GREATER THAN 10**70. DLNG IS SET TO             DLGA      23
      C     +1.0D75.                                                        DLGA      24
      C                                                                     DLGA      25
      C     REMARKS                                                         DLGA      26
      C     NONE                                                            DLGA      27
      C                                                                     DLGA      28
      C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                   DLGA      29
      C     NONE                                                            DLGA      30
      C                                                                     DLGA      31
      C     METHOD                                                          DLGA      32
      C     THE EULER-MCLAURIN EXPANSION TO THE SEVENTH DERIVATIVE TERM     DLGA      33
      C     IS USED, AS GIVEN BY M. ABRAMOWITZ AND I.A. STEGUN,             DLGA      34
      C     'HANDBOOK OF MATHEMATICAL FUNCTIONS', U. S. DEPARTMENT OF       DLGA      35
      C     COMMERCE, NATIONAL BUREAU OF STANDARDS APPLIED MATHEMATICS      DLGA      36
      C     SERIES, 1966, EQUATION 6.1.41.                                  DLGA      37
      C                                                                     DLGA      38
      C     .................................................................DLGA      39
      C                                                                     DLGA      40
            SUBROUTINE DLGAM (XX,DLNG,IER)                                  DLGA      41
            DOUBLE PRECISION XX,ZZ,TERM,RZ2,DLNG                            DLGA      42
            IER = 0                                                         DLGA      43
            ZZ = XX                                                         DLGA      44
            IF (XX-1.D10) 110,110,100                                       DLGA      45
      100   IF (XX-1.D70) 170,180,180                                       DLGA      46
      C                                                                     DLGA      47
      C     SEE IF XX IS NEAR ZERO OR NEGATIVE                              DLGA      48
      C                                                                     DLGA      49
      110   IF (XX-1.D-9) 120,120,130                                       DLGA      50
      120   IER = -1                                                        DLGA      51
            DLNG = -1.D75                                                   DLGA      52
            GO TO 190                                                       DLGA      53
      C                                                                     DLGA      54
```

```
                C   XX GREATER THAN ZERO AND LESS THAN OR EQUAL TO 1.D+10                  DLGA       55
55              C                                                                        DLGA       56
                130   TERM = 1.D0                                                        DLGA       57
                140   IF (ZZ-18.D0) 150,150,160                                          DLGA       58
                150   TERM = TERM*ZZ                                                     DLGA       59
                      ZZ = ZZ+1.D0                                                       DLGA       60
60                    GO TO 140                                                          DLGA       61
                160   RZ2 = 1.D0/ZZ**2                                                   DLGA       62
                      DLNG = (ZZ-0.5D0)*DLOG(ZZ)-ZZ+0.9189385332046727-DLOG(TERM)+(1.D0/ DLGA       63
                     +ZZ)*(.83333333333333333D-1-(RZ2*(.27777777777777777D-2+(RZ2*(.793650 DLGA       64
                     +7936507936D-3-(RZ2*(.595238095238095 2D-3)))))))                   DLGA       65
65                    GO TO 190                                                          DLGA       66
                C                                                                        DLGA       67
                C   XX GREATER THAN 1.D+10 AND LESS THAN 1.D+70                           DLGA       68
                C                                                                        DLGA       69
                170   DLNG = ZZ*(DLOG(ZZ)-1.D0)                                          DLGA       70
70                    GO TO 190                                                          DLGA       71
                C                                                                        DLGA       72
                C   XX GREATER THAN OR EQUAL TO 1.D+70                                  DLGA       73
                C                                                                        DLGA       74
                180   IER = +1                                                           DLGA       75
75                    DLNG = 1.D75                                                       DLGA       76
                190   RETURN                                                             DLGA       77
                      END                                                                DLGA       78
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

62 1 CONSTANT TOO LONG. HIGH ORDER DIGITS RETAINED, BUT SOME PRECISION LOST.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	DLGAM	40	76

VARIABLES		SN	TYPE	RELOCATION								
0	DLNG		DOUBLE	F.P.	REFS	41	DEFINED	40	51	62	69	75
0	IER		INTEGER	F.P.	DEFINED	40	42	50	74			
277	RZ2		DOUBLE		REFS	41	3*62	DEFINED	61			
275	TERM		DOUBLE		REFS	41	58	62	DEFINED	56	58	
0	XX		DOUBLE	F.P.	REFS	41	43	44	45	49		
					DEFINED	40						
273	ZZ		DOUBLE		REFS	41	57	58	59	61	4*62	2*69
					DEFINED	43	59					

```
EXTERNALS          TYPE    ARGS       REFERENCES
      DLOG       DOUBLE     1 LIBRARY    2*62        69

STATEMENT LABELS                DEF LINE    REFERENCES
    0  100          INACTIVE        45          44
   31  110                          49          2*44
    0  120          INACTIVE        50          2*49
   47  130                          56          49
   53  140                          57          60
    0  150          INACTIVE        58          2*57
   74  160                          61          57
  205  170                          69          45
  220  180                          74          2*45
  227  190                          76          52          65          70

STATISTICS
  PROGRAM LENGTH                    301B        193
        140000B SCM USED
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```
      SUBROUTINE EFFCON (RLKF,DRDT,CON,FTEMP,GAPC,GAPH,GAPT,GASES,DKDT,R EFFCON     2
     +FSH,VOLSTR,MECHAN)                                                 EFFCON     3
C                                                                        EFFCON     4
C     IMPLICIT REAL*8(A-H,O-Z)                                           EFFCON     5
C                                                                        EFFCON     6
C     ******************************************************************* EFFCON     7
C                                                                        EFFCON     8
C     THIS SUBROUTINE IS CALLED FROM DDLF AND COMPUTES THE FACTOR TO BE  EFFCON     9
C     APPLIED TO THE FUEL CONDUCTIVITY TO ACCOUNT FOR THE EFFECTS OF     EFFCON    10
C     CRACKING                                                           EFFCON    11
C                                                                        EFFCON    12
C     ******************************************************************* EFFCON    13
C     INPUT ARGUMENTS                                                    EFFCON    14
C     ******************************************************************* EFFCON    15
C                                                                        EFFCON    16
C     CON    - FUEL THERMAL CONDUCTIVITY (W/M**2-K)                      EFFCON    17
C     DKDT   - THE DERIVITAVE OF THE FUEL CONDUCTIVITY WRT TEMPERATURE   EFFCON    18
C     FTEMP  - FUEL TEMPERATURE(K).                                      EFFCON    19
C     GAPC   - COLD STATE RADIAL GAP (M)                                 EFFCON    20
C     GAPH   - HOT STATE UNRELOCATED RADIAL GAP (M)                      EFFCON    21
C     GAPT   - HOT STATE RELOCATED RADIAL GAP (M)                        EFFCON    22
C     GASES  - ARRAY OF GAS MOLE FRACTIONS                               EFFCON    23
C     GAS 1 - HELIUM                                                     EFFCON    24
C     GAS 2 - ARGON                                                      EFFCON    25
C     GAS 3 - KRYPTON                                                    EFFCON    26
C     GAS 4 - XENON                                                      EFFCON    27
C     GAS 5 - HYDROGEN                                                   EFFCON    28
C     GAS 6 - AIR                                                        EFFCON    29
C     GAS 7 - WATER VAPOR                                                EFFCON    30
C     MECHAN - MECHANICAL SUBCODE INDEX ,=2 FRACAS-I ,=3 FRACAS-II       EFFCON    31
C     RFSH   - COLD STATE FUEL PELLET RADIUS (M)                         EFFCON    32
C     VOLSTR - VOLUME STRAIN DUE TO RELOCATION (DELTA-V/VOLUME)          EFFCON    33
C                                                                        EFFCON    34
C     ******************************************************************* EFFCON    35
C     OUTPUT ARGUMENTS                                                   EFFCON    36
C     ******************************************************************* EFFCON    37
C                                                                        EFFCON    38
C     RLKF   - CONDUCTIVITY MULTIPLIER TO ACCOUNT FOR CRACKING           EFFCON    39
C     DRDT   - THE DERIVITAVE OF RLKF WRT TEMPERATURE                    EFFCON    40
C                                                                        EFFCON    41
C                                                                        EFFCON    42
      DIMENSION GASES(7)                                                 EFFCON    43
      DATA  TGUESS / 4.E-6 / , PGUESS / 7.E6 /                           EFFCON    44
      DATA  CONST / 0.30E0 /                                             EFFCON    45
C                                                                        EFFCON    46
      TGUESS = (GAPH-GAPT)/2.E0                                          EFFCON    47
      GPCON = GTHCON(GASES,FTEMP,PGUESS,TGUESS)                          EFFCON    48
      IF (VOLSTR.EQ.0.E0) GO TO 100                                      EFFCON    49
      CREL = (GAPH-GAPT)/(RFSH*(VOLSTR/3.E0))                            EFFCON    50
      IF (MECHAN.EQ.3) CREL = VOLSTR/(4.E0*GAPC/RFSH)                    EFFCON    51
      CREL = CREL*(GAPC/0.8E-4)                                          EFFCON    52
      IF (MECHAN.EQ.3) CREL = CREL*1.6E0                                 EFFCON    53
      IF (CREL.LE.0.125E0) CREL = 0.125E0                                EFFCON    54
```

```
                      GO TO 110                                                          EFFCON     55
55              100   CREL = 0.125E0                                                     EFFCON     56
                110   CONTINUE                                                           EFFCON     57
                      C                                                                  EFFCON     58
                      RLKF = 1.E0-CONST*CREL*(1.E0-GPCON/CON)                            EFFCON     59
                      IF (RLKF.LT.0.4E0) RLKF = 0.4E0                                    EFFCON     60
60                    DRDT = -CONST*CREL*DKDT*GPCON/CON**2                               EFFCON     61
                      IF (RLKF.EQ.0.4E0) DRDT = 0.E0                                     EFFCON     62
                      RETURN                                                             EFFCON     63
                      END                                                                EFFCON     64
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	EFFCON	1	62

VARIABLES

		SN	TYPE		RELOCATION								
0	CON		REAL		F.P.	REFS	58	60	DEFINED	1			
112	CONST		REAL			REFS	52	60	DEFINED	44			
125	CREL		REAL			REFS	51	52	53	58	60		
						DEFINED	49	50	51	52	53	55	
0	DKDT		REAL		F.P.	REFS	60	DEFINED	1				
0	DRDT		REAL		F.P.	DEFINED	1	60	61				
0	FTEMP		REAL		F.P.	REFS	47	DEFINED	1				
0	GAPC		REAL		F.P.	REFS	50	51	DEFINED	1			
0	GAPH		REAL		F.P.	REFS	46	49	DEFINED	1			
0	GAPT		REAL		F.P.	REFS	46	49	DEFINED	1			
0	GASES		REAL	ARRAY	F.P.	REFS	42	47	DEFINED	1			
124	GPCON		REAL			REFS	58	60	DEFINED	47			
0	MECHAN		INTEGER		F.P.	REFS	50	52	DEFINED	1			
111	PGUESS		REAL			REFS	47	DEFINED	43				
0	RFSH		REAL		F.P.	REFS	49	50	DEFINED	1			
0	RLKF		REAL		F.P.	REFS	59	61	DEFINED	1	58	59	
110	TGUESS		REAL			REFS	47	DEFINED	43	46			
0	VOLSTR		REAL		F.P.	REFS	48	49	50	DEFINED	1		

EXTERNALS

	TYPE	ARGS	REFERENCES
GTHCON	REAL	4	47

STATEMENT LABELS

		DEF LINE	REFERENCES
53	100	55	48
56	110	56	54

STATISTICS

PROGRAM LENGTH 126B 86

140000B SCM USED

```
      FUNCTION EMDNSF (BN,DFS,ROW,ROWS)                                 EMDNSF     2
C                                                                       EMDNSF     3
C     EMDNSF IS CALLED FROM SUBROUTINE SWELL                            EMDNSF     4
C     FUNCTION EMDNSF IS USED TO CALCULATE THE DENSIFICATION OF THE FUEL EMDNSF     5
C     USING R O MEYER"S MODEL DESCRIBED IN NUREG 0085                   EMDNSF     6
C                                                                       EMDNSF     7
C     ************************************************************      EMDNSF     8
C     INPUT ARGUMENTS                                                   EMDNSF     9
C     ************************************************************      EMDNSF    10
C                                                                       EMDNSF    11
C     BN      - BURNUP (MWD/MTU)                                        EMDNSF    12
C     DFS     - FUEL PELLET DIAMETER (IN                                EMDNSF    13
C     ROW     - FUEL DENSITY (GM/CC)                                    EMDNSF    14
C     ROWS    - RESINTERED DENSITY (GM/CC)                              EMDNSF    15
C                                                                       EMDNSF    16
C     ************************************************************      EMDNSF    17
C     OUTPUT ARGUMENT                                                   EMDNSF    18
C     ************************************************************      EMDNSF    19
C                                                                       EMDNSF    20
C     EMDNSF - FUEL DENSIFICATION STRAIN (UNITLESS)                     EMDNSF    21
C                                                                       EMDNSF    22
C     ************************************************************      EMDNSF    23
C                                                                       EMDNSF    24
      BU = BN                                                           EMDNSF    25
      DELPI = 0.                                                        EMDNSF    26
      DR = ROWS-ROW                                                     EMDNSF    27
      IF (ROWS.LE.ROW) GO TO 120                                        EMDNSF    28
      IF (DR.LE..4384) GO TO 100                                        EMDNSF    29
      IF (BU.LE.5.) GO TO 120                                           EMDNSF    30
      IF (BU.GT.500.) BU = 500.                                         EMDNSF    31
      DELR = .5*DR*ALOG10(BU/5.)                                        EMDNSF    32
      GO TO 110                                                         EMDNSF    33
  100 IF (BU.LE.20.) GO TO 120                                          EMDNSF    34
      IF (BU.GT.2000.) BU = 2000.                                       EMDNSF    35
      DELR = .5*DR*ALOG10(BU/20.)                                       EMDNSF    36
  110 DELPI = -DELR*DFS/3./ROW                                          EMDNSF    37
  120 CONTINUE                                                          EMDNSF    38
      EMDNSF = DELPI/DFS                                                EMDNSF    39
      RETURN                                                            EMDNSF    40
      END                                                               EMDNSF    41
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	EMDNSF	1	39

VARIABLES	SN	TYPE	RELOCATION									
0	BN	REAL	F.P.	REFS	24	DEFINED	1					
102	BU	REAL		REFS	29		30	31	33	34	35	

```
VARIABLES     SN  TYPE          RELOCATION
                                          DEFINED   24      30        34
  103  DELPI      REAL                      REFS      38  DEFINED       25        36
  105  DELR       REAL                      REFS      36  DEFINED       31        35
    0  DFS        REAL                F.P.  REFS      36      38    DEFINED         1
  104  DR         REAL                      REFS      28      31        35  DEFINED       26
  101  EMDNSF     REAL                      DEFINED   38
    0  ROW        REAL                F.P.  REFS      26      27        36  DEFINED        1
    0  ROWS       REAL                F.P.  REFS      26      27    DEFINED         1

EXTERNALS          TYPE   ARGS      REFERENCES
       ALOG10      REAL     1 LIBRARY     31        35

STATEMENT LABELS              DEF LINE   REFERENCES
   42  100                       33         28
   56  110                       36         32
   63  120                       37         27        29        33

STATISTICS
  PROGRAM LENGTH                 106B       70
        140000B SCM USED
```

```
      FUNCTION EMFTC (CONBE,FTMELT)                                          EMFTC      2
C                                                                            EMFTC      3
C     EMFTC IS THE UO2 THERMAL CONDUCTIVITY EVALUATION MODEL.                EMFTC      4
C                                                                            EMFTC      5
C     EMFTC = OUTPUT CONSERVATIVE FUEL THERMAL CONDUCTIVITY   (W/M-K)       EMFTC      6
C     CONBE = INPUT BEST ESTIMATE FUEL THERMAL CONDUCTIVITY   (W/M-K)       EMFTC      7
C     FTMELT= INPUT FUEL MELT TEMPERATURE (K)                                EMFTC      8
C                                                                            EMFTC      9
C     THIS EVALUATION MODEL DECREASES THE FUEL THERMAL CONDUCTIVITY           EMFTC     10
C     TO ONE BASED ON 93 W/CM AT BOL BY SHIFTING THE CONDUCTIVITY CURVE       EMFTC     11
C     DOWN FROM ONE BASED ON 97 W/CM.                                        EMFTC     12
C                                                                            EMFTC     13
C     CODED BY G.A. BERNA, JANUARY 1980                                      EMFTC     14
C                                                                            EMFTC     15
      EMFTC = CONBE-400.E0/(FTMELT-273.15E0)                                 EMFTC     16
C                                                                            EMFTC     17
      RETURN                                                                 EMFTC     18
      END                                                                    EMFTC     19
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    5  EMFTC          1         17

VARIABLES     SN  TYPE          RELOCATION
    0  CONBE      REAL               F.P.      REFS      15    DEFINED      1
   17  EMFTC      REAL                         DEFINED   15
    0  FTMELT     REAL               F.P.      REFS      15    DEFINED      1

STATISTICS
  PROGRAM LENGTH                   20B      16
        140000B SCM USED
```

```
      FUNCTION EMRLOC (RP,GAP,BURNUP,P)                                 EMRLOC     2
C                                                                       EMRLOC     3
C   EMRLOC IS CALLED FROM SUBROUTINE MAIN AND COMPUTES THE RELOCATION   EMRLOC     4
C   AS SPECIFIED IN BNWL-1898.                                          EMRLOC     5
C                                                                       EMRLOC     6
C   ********************************************************************EMRLOC     7
C   INPUT ARGUMENTS                                                     EMRLOC     8
C   ********************************************************************EMRLOC     9
C                                                                       EMRLOC    10
C   BURNUP - BURNUP (MWD/MTU)                                           EMRLOC    11
C   GAP    - COLD STATE RADIAL GAP SIZE (IN)                            EMRLOC    12
C   P      - LOCAL POWER (KW/FT)                                        EMRLOC    13
C   RP     - FUEL PELLET COLD STATE RADIUS (IN)                         EMRLOC    14
C                                                                       EMRLOC    15
C   ********************************************************************EMRLOC    16
C   OUTPUT ARGUMENT                                                     EMRLOC    17
C   ********************************************************************EMRLOC    18
C                                                                       EMRLOC    19
C   EMRLOC - RELOCATION STRAIN (UNITLESS)                               EMRLOC    20
C                                                                       EMRLOC    21
C   ********************************************************************EMRLOC    22
C                                                                       EMRLOC    23
      IF (BURNUP.LE.0.E0) GO TO 100                                     EMRLOC    24
      B = EXP(-4.+BURNUP**.25)                                          EMRLOC    25
      GO TO 110                                                         EMRLOC    26
  100 CONTINUE                                                          EMRLOC    27
      B = 0.0183156E0                                                   EMRLOC    28
  110 CONTINUE                                                          EMRLOC    29
      DELGD = (40.*(B/(1.+B))+0.8*P+1.)*GAP/100.                        EMRLOC    30
      DELGD = DELGD-.28*GAP                                             EMRLOC    31
      IF (DELGD.LT.0) DELGD = 0.0                                       EMRLOC    32
      EMRLOC = DELGD/RP                                                 EMRLOC    33
      RETURN                                                            EMRLOC    34
      END                                                               EMRLOC    35
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	EMRLOC	1	33

VARIABLES	SN	TYPE	RELOCATION									
70	B	REAL		REFS	2*29	DEFINED	24	27				
0	BURNUP	REAL	F.P.	REFS	23	24	DEFINED	1				
71	DELGD	REAL		REFS	30	31	32	DEFINED	29	30	31	
67	EMRLOC	REAL		DEFINED	32							
0	GAP	REAL	F.P.	REFS	29	30	DEFINED	1				
0	P	REAL	F.P.	REFS	29	DEFINED	1					
0	RP	REAL	F.P.	REFS	32	DEFINED	1					

```
EXTERNALS          TYPE   ARGS       REFERENCES
       EXP       REAL      1 LIBRARY     24

STATEMENT LABELS              DEF LINE   REFERENCES
   23  100                       26         23
   26  1.0                       28         25

STATISTICS
  PROGRAM LENGTH                 72B       58
        140000B SCM USED
```

```
      SUBROUTINE EMSSF2 (TF,TC,RF,GPTHK,ZRO,FE)                          EMS2       2
C                                                                        EMS2       3
C  SUBROUTINE COMPUTES EMISSIVITY FACTOR FOR FUEL-CLADDING GAP           EMS2       4
C  RADIATION HEAT TRANSFER CALCULATIONS                                  EMS2       5
C  THIS SUBROUTINE IS CALLED FROM GAPRS                                  EMS2       6
C  EMSSF2 IS CALLED FROM GAPCRS                                          EMS2       7
C                                                                        EMS2       8
C  INPUT ARGUMENTS                                                       EMS2       9
C                                                                        EMS2      10
C  TF     : TEMPERATURE OF OUTSIDE SURFACE OF FUEL (F)                   EMS2      11
C  TC     : TEMPERATURE OF INSIDE SURFACE OF CLADDING (F)                EMS2      12
C  RF     : RADIUS OF OUTSIDE SURFACE OF FUEL (FT)                       EMS2      13
C  GPTHK  : THICKNESS OF FUEL-CLADDING GAP (FT)                          EMS2      14
C  ZRO    - ZIRCALOY-OXIDE THICKNESS (M)                                 EMS2      15
C                                                                        EMS2      16
C  OUTPUT ARGUMENT                                                       EMS2      17
C                                                                        EMS2      18
C  FE     : TO BE COMPUTED EMISSIVITY FACTOR                             EMS2      19
C                                                                        EMS2      20
C  IMPLICIT REAL*8(A-H,O-Z)                                              EMS2      21
C                                                                        EMS2      22
C  COMPUTE FUEL EMISSIVITY                                               EMS2      23
C                                                                        EMS2      24
      TK = (TF+459.67E0)/1.8E0                                           EMS2      25
C                                                                        EMS2      26
      EF = FEMISS(TK)                                                    EMS2      27
C                                                                        EMS2      28
C  COMPUTE CLADDING EMISSIVITY                                           EMS2      29
C                                                                        EMS2      30
C                                                                        EMS2      31
C  * CONVERT CLADDING TEMPERATURE FROM F TO K                            EMS2      32
C                                                                        EMS2      33
      TCK = (TC+459.67E0)/1.8E0                                          EMS2      34
C                                                                        EMS2      35
      CALL ZOEMIS (TCK,ZRO,EC)                                           EMS2      36
      RC = RF+GPTHK                                                      EMS2      37
      FE = 1./(1./EF+(RF/RC)*(1./EC-1.))                                 EMS2      38
      RETURN                                                             EMS2      39
      END                                                                EMS2      40
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	EMSSF2	1	38

VARIABLES	SN	TYPE	RELOCATION					
54	EC	REAL		REFS	35		37	
52	EF	REAL		REFS	37	DEFINED	26	
0	FE	REAL	F.P.	DEFINED	1		37	

```
VARIABLES     SN  TYPE          RELOCATION
    0  GPTHK      REAL               F.P.      REFS      36    DEFINED       1
   55  RC         REAL                         REFS      37    DEFINED      36
    0  RF         REAL               F.P.      REFS      36       37     DEFINED       1
    0  TC         REAL               F.P.      REFS      33    DEFINED       1
   53  TCK        REAL                         REFS      35    DEFINED      33
    0  TF         REAL               F.P.      REFS      24    DEFINED       1
   51  TK         REAL                         REFS      26    DEFINED      24
    0  ZRO        REAL               F.P.      REFS      35    DEFINED       1

EXTERNALS          TYPE   ARGS       REFERENCES
       FEMISS      REAL      1            26
       ZOEMIS                3            35

STATISTICS
  PROGRAM LENGTH                  56B      46
        140000B SCM USED
```

```
      SUBROUTINE ENERGY (CPDELT,J,RAD,TBAR,TFB,IT,NDBG,NR,COMP,FOTMTL,FT ENRG       2
     +MELT,NA,TREF,FHEFUS)                                               ENRG       3
C                                                                        ENRG       4
      IMPLICIT REAL * 8 (A-H,O-Z)                                        ENRG       5
C                                                                        ENRG       6
C     THIS SUBROUTINE IS CALLED FROM MAIN AND WAS CODED BY G A BERNA     ENRG       7
C     THIS ROUTINE COMPUTES THE STORED ENERGY AT THE VOLUMETRIC AVERAGE   ENRG       8
C     TEMPERATURE -TBAR BY SUMMING THE CONTRIBUTIONS OF EACH RADIAL      ENRG       9
C     RING IN A GIVEN AXIAL INCREMENT                                    ENRG      10
C                                                                        ENRG      11
C     ********************************************************************* ENRG   12
C     INPUT ARGUMENTS                                                    ENRG      13
C     ********************************************************************* ENRG   14
C                                                                        ENRG      15
C     COMP   - PUO2 PERCENT OF THE FUEL (W/:)                            ENRG      16
C     FHEFUS - HEAT OF FUSSION OF THE FUEL (J/KG)                        ENRG      17
C     FOTMTL - FUEL OXYGEN TO METAL RATIO                                ENRG      18
C     FTMELT - FUEL MELT TEMPERATURE (DEG K)                             ENRG      19
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                             ENRG      20
C     NR     - NUMBER OF RADIAL NODES                                    ENRG      21
C     NDBG   - DEBUG OUTPUT INDEX                                        ENRG      22
C     NMAX   - MAXIMUM NUMBER OF RADIAL NODES                            ENRG      23
C     RAD    - HOT FUEL RING RADIUS (METERS)                             ENRG      24
C     TFB    - FUEL RING TEMPERATURE (F)                                 ENRG      25
C     TREF   - REFERENCE TEMPERATURE UPON WHICH THE STORED ENERGY IS     ENRG      26
C     BASED (K)                                                          ENRG      27
C     IT     - POWER STEP INDEX                                          ENRG      28
C     J      - AXIAL NODE INDEX                                          ENRG      29
C                                                                        ENRG      30
C     ********************************************************************* ENRG   31
C     OUTPUT ARGUMENTS                                                   ENRG      32
C     ********************************************************************* ENRG   33
C                                                                        ENRG      34
C     CPDELT - STORED ENERGY AT TBAR FOR AXIAL INCREMENT J (JOULES/KG)   ENRG      35
C     TBAR   - VOLUMETRIC FUEL AVERAGE TEMPERATURE AT NODE J (F)         ENRG      36
C                                                                        ENRG      37
C     ********************************************************************* ENRG   38
C                                                                        ENRG      39
      DIMENSION  CPDELT(NA) , TBAR(NA)                                   ENRG      40
      DIMENSION  RAD(NR) ,TFB(NR)                                        ENRG      41
C                                                                        ENRG      42
C                                                                        ENRG      43
      TBAR1 = 0.E0                                                       ENRG      44
      FCOMP = COMP/100.E0                                                ENRG      45
      SUMENR = 0.E0                                                      ENRG      46
C                                                                        ENRG      47
          DO 100 L=2,NR                                                  ENRG      48
C                                                                        ENRG      49
C     CONVERT TO DEGREES K FROM F                                        ENRG      50
C                                                                        ENRG      51
          TBAR2 = (TFB(L-1)+459.67E0)/1.8E0                              ENRG      52
          VOL = (RAD(L-1)**2-RAD(L)**2)/RAD(1)**2                        ENRG      53
          FACMOT = 0.E0                                                  ENRG      54
```

```
                    IF (TBAR2.GT.FTMELT) FACMOT = 1.E0                                    ENRG      55
55                  SUMCPT = FENTHL(TBAR2,FCOMP,FOTMTL,FTMELT,FACMOT,FHEFUS)-FENTH        ENRG      56
                +   L(TREF,FCOMP,FOTMTL,FTMELT,FACMOT,FHEFUS)                            ENRG      57
                    SUMENR = SUMENR+SUMCPT*VOL                                            ENRG      58
                    TBAR1 = TBAR1+TBAR2*VOL                                               ENRG      59
              100   CONTINUE                                                              ENRG      60
60            C                                                                           ENRG      61
            CPDELT(J) = SUMENR                                                            ENRG      62
            TBAR(J) = (TBAR1*1.8E0)-459.67E0                                              ENRG      63
            RETURN                                                                        ENRG      64
            END                                                                           ENRG      65
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	ENERGY	1	63

VARIABLES

	SN	TYPE		RELOCATION						
0	COMP	REAL		F.P.	REFS	44	DEFINED	1		
0	CPDELT	REAL	ARRAY	F.P.	REFS	39	DEFINED	1	61	
127	FACMOT	REAL			REFS	2*55	DEFINED	53	54	
122	FCOMP	REAL			REFS	2*55	DEFINED	44		
0	FHEFUS	REAL		F.P.	REFS	2*55	DEFINED	1		
0	FOTMTL	REAL		F.P.	REFS	2*55	DEFINED	1		
0	FTMELT	REAL		F.P.	REFS	54	2*55	DEFINED	1	
0	IT	INTEGER	*UNUSED	F.P.	DEFINED	1				
0	J	INTEGER		F.P.	REFS	61	62	DEFINED	1	
124	L	INTEGER			REFS	51	2*52	DEFINED	47	
0	NA	INTEGER		F.P.	REFS	2*39	DEFINED	1		
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	2*40	47	DEFINED	1	
0	RAD	REAL	ARRAY	F.P.	REFS	40	3*52	DEFINED	1	
130	SUMCPT	REAL			REFS	57	DEFINED	55		
123	SUMENR	REAL			REFS	57	61	DEFINED	45	57
0	TBAR	REAL	ARRAY	F.P.	REFS	39	DEFINED	1	62	
121	TBAR1	REAL			REFS	58	62	DEFINED	43	58
125	TBAR2	REAL			REFS	54	55	58	DEFINED	51
0	TFB	REAL	ARRAY	F.P.	REFS	40	51	DEFINED	1	
0	TREF	REAL		F.P.	REFS	55	DEFINED	1		
126	VOL	REAL			REFS	57	58	DEFINED	52	

EXTERNALS

	TYPE	ARGS	REFERENCES
FENTHL	REAL	6	2*55

STATEMENT LABELS

		DEF LINE	REFERENCES
0	100	59	47

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
20	100	L	47 59	45B	EXT REFS

STATISTICS
PROGRAM LENGTH 146B 102
140000B SCM USED

```
      SUBROUTINE EUMELT (DOXIDE,TCLAD,TCOOL,ZRNI,IMELT)                  EUMT        2
C                                                                        EUMT        3
C     IMPLICIT REAL*8(A-H,O-Z)                                           EUMT        4
C                                                                        EUMT        5
C     SUBROUTINE EUMELT CALCULATES WHETHER THE TEMPERATURE OF THE        EUMT        6
C     CLADDING AT THE SPACER GRID LOCATION EXCEEDS THE TEMPERATURE AT    EUMT        7
C     WHICH A EUTECTIC WOULD FORM AND MELT -- AN OXIDE LAYER WOULD       EUMT        8
C     INHIBIT THE FORMATION OF THE EUTECTIC                              EUMT        9
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                           EUMT       10
C                                                                        EUMT       11
C     --  INPUT ARGUMENTS  --                                            EUMT       12
C                                                                        EUMT       13
C     DOXIDE     DEPTH OF OXIDE LAYER ( M )                            EUMT       14
C     TCLAD      TEMPERATURE OF CLADDING ( DEG K )                     EUMT       15
C     TCOOL      TEMPERATURE OF COOLANT ( DEG K )                      EUMT       16
C     ZRNI       ZIRC-NICKEL EUTECTIC MELT TEMPERATURE ( DEG K )       EUMT       17
C                                                                        EUMT       18
C                                                                        EUMT       19
C     -- OUTPUT ARGUMENTS  --                                           EUMT       20
C                                                                        EUMT       21
C     IMELT      MELT INDICATOR                                        EUMT       22
C     = 0, NO EUTECTIC MELT                                            EUMT       23
C     = 1, EUTECTIC MELT                                               EUMT       24
C                                                                        EUMT       25
C     ESTIMATE THE TEMPERATURE OF THE CLADDING AT A SPACER GRID          EUMT       26
C                                                                        EUMT       27
      TGRID = (TCLAD+.5*TCOOL)/1.5                                       EUMT       28
C                                                                        EUMT       29
      IMELT = 0                                                          EUMT       30
      IF (TGRID.GE.ZRNI) IMELT = 1                                       EUMT       31
C                                                                        EUMT       32
C                                                                        EUMT       33
      RETURN                                                             EUMT       34
      END                                                                EUMT       35
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	EUMELT	DEF LINE 1, REFERENCES 33

VARIABLES

0	DOXIDE	REAL	*UNUSED	F.P.	DEFINED	1			
0	IMELT	INTEGER		F.P.	DEFINED	1	29	30	
0	TCLAD	REAL		F.P.	REFS	27	DEFINED	1	
0	TCOOL	REAL		F.P.	REFS	27	DEFINED	1	
25	TGRID	REAL			REFS	30	DEFINED	27	
0	ZRNI	REAL		F.P.	REFS	30	DEFINED	1	

STATISTICS
PROGRAM LENGTH 26B 22
140000B SCM USED

```
      SUBROUTINE FAILUR (DELH,CRAKI,CRAKL,CTMAX,ESR,FB,FFR,FREQ,HUPTAK,I
     +CDOFF,IFBSW,ISTOFF,MODFAL,NOPT,NUCFC,PCYCL,PFB,PSR,RSTRAN,TCC,TFLI
     +F,TIMEF,TIMES,EPS,NA,CHEM,OLIGAP,SIG,TC,TW,ZRO2B,IT,BU2,CDAMAG,CES
     +IUM,NR,FDAMAG,FRDEN,ODINE,NAFAIL,UMELT,NNFAIL,ZRNI,TMPDIS,TMPMAX,D
     +ELBPP,TIELAP,UBFS,UOFD,NFROD)
C
C     IMPLICIT  REAL * 8 (A-H,O-Z)
C
      INTEGER  OLIGAP
C
C     ******************************************************************
C
C     FAILUR IS CALLED FROM MAIN AND COMPUTES FAILURE INFORMATION
C     ***  PART OF FRAIL FAILURE PACKAGE   ***
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     BU2    - BURNUP (MWD/MTU)
C     CESIUM - CLAD CESIUM CONTENT (KG/M**2)
C     CHEM(I,3)-CLAD CESIUM CONTENT IN PREVIOUS TIMESTEP (KG/M**2)
C     CHEM   - CLADDING CONTENT OF HYDROGEN, IODINE, & CESIUM
C     CRAKI  - INITIAL CRACK LENGTH THROUGH CLADDING (M)
C     CTMAX  - PREVIOUS MASIMUM CLAD TEMPERATURE (K)
C     DELBPP - BURNUP DURING POWER TIME STEP FOR NODE J (MWD/MTU)
C     DELH   - TIME STEP SIZE (HRS)
C     EPS    - CLADDING STRAIN IN THE HOOP, AXIAL, & RADIAL
C     ESR    - ELASTIC STRAIN RANGE
C     FRDEN  - FRACTIONAL FUEL DENSITY
C     FREQ   - FREQUENCY OF POWER CYCLE (SEC-1)
C     CHEM(I,4)-HOOP STRESS IN THE PREVIOUS TIMESTEP (N/M**2)
C     HUPTAK - HYDROGEN UPTAKE (PPM)
C     ICDOFF - SWITCH CONTROLLING CUMULATIVE DAMAGE ROUTINE
C     = 0, TURN ON ROUTINE
C     = 1, TURN OFF ROUTINE
C     IFBSW  - FLOW BLOCKAGE SWITCH
C     = 0, FLOW BLOCKAGE ROUTINE NOT USED
C     = 1, FLOW BLOCKAGE ROUTINE ONLY (NO OTHER FAILURE
C     MODES ARE CONSIDERED)
C     ISTOFF - SWITCH CONTROLLING OVERSTRAIN FAILURE
C     = 0, STRAIN FAILURE ROUTINE USED
C     = 1, STRAIN FAILURE ROUTINE SKIPPED
C     IT     - POWER-TIME STEP INDEX
C     NA     - MAXIMUM NUMBER OF AXIAL NODES
C     NAFAIL - QUANTITY OF AXIAL NODES WHERE FAILURE IS CONSIDERED
C     NFROD  - NUMBER OF LIKE FUEL RODS BEING ANALYZED
C     NNFAIL - ARRAY OF NODE NUMBERS WHERE FAILURE IS CONSIDERED
C     NOPT   - TYPE OF OUTPUT INDEX
C     NR     - NUMBER OF RADIAL NODES
C     NUCFC  - USRE COLLAPSE FAILURE CRITERIA
C     ODINE  - CLADDING IODINE CONTENT ( KG/M**2 )
C     CHEM(I,2)-CLAD IODINE CONTENT IN PREVIOUS TIMESTEP (KG/M**2)
```

```
      C   OLIGAP - OLD VALUES OF IGAP (THE GAP CLOSURE INDEX )                    FALU       55
55    C   PCYCL  - NUMBER OF POWER CYCLES                                          FALU       56
      C   PSR    - PLASTIC STRAIN RANGE                                           FALU       57
      C   SIG    - CLADDING STRESS IN THE HOOP, AXIAL, & RADIAL (PSIA)            FALU       58
      C   RSTRAN - STRAIN RATE (SEC-1)                                            FALU       59
      C   TC     - CLADDING AVERAGE TEMPERATURE (F)                               FALU       60
60    C   TCC    - COLD STATE CLADDING THICKNESS (IN)                             FALU       61
      C   CHEM(I,5)-CLAD TEMPERATURE IN PREVIOUS TIMESTEP (K)                     FALU       62
      C   TFLIF  - TRANSITION FATIGUE LIFE (CYCLES)                               FALU       63
      C   TIELAP - ELAPSED TIME  (SEC)                                            FALU       64
      C   TIMEF  - TIME AT FLUX (SEC)                                             FALU       65
65    C   TIMES  - TIME AT STRESS LEVEL (SEC)                                     FALU       66
      C   TMPDIS - AXIAL AND RADIAL TEMPERATURE DISTRIBUTION (F)                  FALU       67
      C   TMPMAX - MAXIMUM TEMPDIS (K)                                            FALU       68
      C   TW     - INLET WATER TEMPERATURE (F)                                    FALU       69
      C   UBFS   - USER BALLOON FAILURE STRAIN                                    FALU       70
70    C   UMELT  - USER MELT TEMPERATURE (K)                                      FALU       71
      C   UOFD   - USER OXIDE FAILURE DEPTH ( PERCENT OF CLADDING THICKNESS)      FALU       72
      C   ZRNI   - ZIRC-NICKEL EUTECTIC MELT TEMPERATURE (K)                      FALU       73
      C   ZRO2B  - ZIRCALOY OXIDE THICKNESS (FT)                                  FALU       74
      C                                                                           FALU       75
75    C   ************************************************************          FALU       76
      C   OUTPUT ARGUMENTS                                                        FALU       77
      C   ************************************************************          FALU       78
      C                                                                           FALU       79
      C   CDAMAG - STRESS RUPTURE DAMAGE                                         FALU       80
80    C   CRAKL  - CRACK LENGTH THROUGH CLAD THICKNESS (M)                       FALU       81
      C   FB     - ARRAY OF FLOW BLOCKAGE PREDICATIONS (FRACTIONAL VALUES)        FALU       82
      C   FDAMAG - FATIGUE DAMAGE                                                FALU       83
      C   FFR    - FRACTION OF FAILED RODS                                        FALU       84
      C   MODFAL - FAILURE MODE                                                   FALU       85
85    C   PFB    - ARRAY CONTAINING THE PROBABILITIES OF EXCEEDING THE            FALU       86
      C   FLOW BLOCKAGES CONTAINED IN FB (FRACTIONAL VALUES)                      FALU       87
      C                                                                           FALU       88
      C   ************************************************************          FALU       89
      C                                                                           FALU       90
90          DIMENSION  CS(5) ,MODFAL(1)    ,BU2(NA)       ,CHEM(NA,6)           FALU       91
     +                      ,EPS(NA,3)    ,SIG(NA,3)     ,ZRO2B(NA)            FALU       92
     +     ,TC(NA)          ,OLIGAP(NA)   ,FFR(1)                               FALU       93
     +     ,FB(23)          ,PFB(20)      ,DELBPP(NA)    ,ROID(8)              FALU       94
     +     ,NNFAIL(NA)      ,TMPDIS(NR,NA),TMPMAX(NR,NA)                        FALU       95
95    C                                                                           FALU       96
          DATA  CFTOR / 459.67E0 / , CHRTOS / 3600.E0 / , CKTOR / 1.8E0 /       FALU       97
     +     , CINTOM / 0.0254E0/ , CPSTNM / 6894.757E0 /                         FALU       98
      C                                                                           FALU       99
          TCONV(T) = (T+CFTOR)/CKTOR                                            FALU      100
100       IF (NOPT.NE.0) GO TO 120                                              FALU      101
          IF (IT.EQ.1) GO TO 120                                                FALU      102
      C   LOOP ON AXIAL LOCATIONS CONSIDERED FOR FAILURE                        FALU      103
            DO 110 I=1,NAFAIL                                                   FALU      104
            II = NNFAIL(I)                                                      FALU      105
105         DELB = DELBPP(II)*86.4                                              FALU      106
            DELT = DELH*3600.                                                   FALU      107
```

```
                      CESIUM = 0.                                                                FALU      108
                      ODINE = 0.                                                                 FALU      109
                C                                                                                FALU      110
110                       DO 100 NRI=1,NR                                                        FALU      111
                          FTEMP = TMPDIS(NRI,II)*5./9.+255.42                                    FALU      112
                          CALL CESIOD (TIELAP,TMPMAX(NRI,II),DELB,DELT,FTEMP,FRDEN,C             FALU      113
                    +     S,ROID)                                                                FALU      114
                          CESIUM = CESIUM+CS(I)                                                  FALU      115
115                       ODINE = ODINE+ROID(I)                                                  FALU      116
                100       CONTINUE                                                               FALU      117
                      ASTRAN = EPS(II,2)                                                         FALU      118
                      ASTRES = SIG(II,2)*CPSTNM                                                  FALU      119
                      CTHICK = TCC*CINTOM                                                        FALU      120
120                   DELTAT = DELH*CHRTOS                                                       FALU      121
                      DOXIDE = ZRO2B(II+1)*100.E0/(TCC/12.E0)                                    FALU      122
                      TCLAD = TCONV(TC(II))                                                      FALU      123
                      HSTRAN = EPS(II,1)                                                         FALU      124
                      HSTRES = SIG(II,1)*CPSTNM                                                  FALU      125
125                   ICLAPS = OLIGAP(II)                                                        FALU      126
                      STRANR = EPS(II,3)                                                         FALU      127
                      TCOOL = TCONV(TW)                                                          FALU      128
                      TGRID = TCOOL                                                              FALU      129
                C                                                                                FALU      130
130                   CALL FRAIL (ASTRAN,ASTRES,CESIUM,CHEM(II,3),CRAKI,CTHICK,CTMAX             FALU      131
                    +,DELTAT,DOXIDE,ESR,FREQ,HSTRAN,HSTRES,CHEM(II,4),HUPTAK,ICDOFF            FALU      132
                    +,ICLAPS,IFBSW,ODINE,CHEM(II,2),ISTOFF,NFROD,PCYCL,PSR,STRANR,R            FALU      133
                    +STRAN,TCLAD,CHEM(II,5),TCOOL,TFLIF,TGRID,TIMEF,TIMES,UBFS,NUCF            FALU      134
                    +C,UMELT,UOFD,ZRNI,CDAMAG,CRAKL,FB,FDAMAG,MODES,NFAIL,PFB,PFR)             FALU      135
135             C                                                                                FALU      136
                      CHEM(II,1) = HUPTAK                                                        FALU      137
                      CHEM(II,2) = ODINE                                                         FALU      138
                      CHEM(II,3) = CESIUM                                                        FALU      139
                      CHEM(II,4) = HSTRES                                                        FALU      140
140                   CHEM(II,5) = TCLAD                                                         FALU      141
                C     !!!!--FFR AND MODFAL ARRAYS MUST BE EXPANDED IF MULTIPLE AXIAL             FALU      142
                C     !!!!--LOCATIONS ARE CONSIDERED                                             FALU      143
                      FFR(I) = PFR                                                               FALU      144
                      MODFAL(I) = MODES                                                          FALU      145
145             C                                                                                FALU      146
                      IF (MODES.EQ.0) GO TO 110                                                  FALU      147
                C                                                                                FALU      148
                      IIT = IT-1                                                                 FALU      149
                      UMELTB = UMELT/CKTOR-CFTOR                                                 FALU      150
150                   ZRNIBR = ZRNI/CKTOR-CFTOR                                                  FALU      151
                C                                                                                FALU      152
                      IF (MODES.GT.0) WRITE (6,130)                                              FALU      153
                C                                                                                FALU      154
                      IF (MODES.EQ.1) WRITE (6,140) IIT,II,TC(II),TCLAD,UMELTB,UMELT             FALU      155
155             C                                                                                FALU      156
                      IF (MODES.EQ.2) WRITE (6,150) IIT,II,TC(II),TCLAD,TW,TCOOL,ZRN             FALU      157
                    + IBR,ZRNI                                                                   FALU      158
                C                                                                                FALU      159
                      IF (MODES.EQ.3) WRITE (6,160) IIT,II,DOXIDE,UOFD                           FALU      160
```

```
      C                                                                      FALU  161
            IF (MODES.EQ.4) WRITE (6,170) IIT,II,EPS(II,1),UBFS              FALU  162
      C                                                                      FALU  163
            PFRPCT = PFR*100.E0                                              FALU  164
            IF (MODES.EQ.5) WRITE (6,180) IIT,II                             FALU  165
      C                                                                      FALU  166
            IF (MODES.GE.6) WRITE (6,190) IIT,II,CDAMAG,FDAMAG,NFAIL,NFROD   FALU  167
     +    ,PFRPCT                                                           FALU  168
      C                                                                      FALU  169
            IF (MODES.GT.0) WRITE (6,200)                                    FALU  170
      C                                                                      FALU  171
      110   CONTINUE                                                         FALU  172
      120   CONTINUE                                                         FALU  173
            RETURN                                                           FALU  174
      C                                                                      FALU  175
      130   FORMAT (//,1H ,132HXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  FALU  176
     +XXX    FAILURE SUBCODE RESULTS    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  FALU  177
     +XXXXXXXXXXXXXXXXXX/)                                                   FALU  178
      140   FORMAT (5X,15H AT POWER STEP ,I2,24H AND AT AXIAL INCREMENT ,I2,51  FALU  179
     +H THIS ROD HAS FAILED BY EXCEEDING THE CLADDING MELT13H TEMPERATUR     FALU  180
     +E.,//,5X,29H THE CLADDING TEMPERATURE IS ,F7.1,5H (F) ,2X,F7.1,5H      FALU  181
     +(K) ,21H MELT TEMPERATURE IS ,F7.1,5H (F) ,2X,F7.1,5H (K) )            FALU  182
      150   FORMAT (5X,15H AT POWER STEP ,I2,24H AND AT AXIAL INCREMENT ,I2,51  FALU  183
     +H THIS ROD HAS FAILED BY EXCEEDING THE EUTECTIC MELT,13H TEMPERATU     FALU  184
     +RE.,//,5X,29H THE CLADDING TEMPERATURE IS ,,F7.1,5H (F) ,2X,F7.1,5     FALU  185
     +H (K) ,22H THE COOLANT TEMP. IS ,F7.1,5H (F) ,2X,F7.1,5H (K) ,/,23     FALU  186
     +H EUTECTIC MELT TEMP. IS,F7.1,5H (F) ,2X,F7.1,5H (K) )                 FALU  187
      160   FORMAT (5X,15H AT POWER STEP ,I2,24H AND AT AXIAL INCREMENT ,I2,50  FALU  188
     +H THIS ROD HAS FAILED BY LOSS OF NECESSARY CLADDING,28H THICKNESS      FALU  189
     +DUE TO OXIDATION ,//,5X,15H THE PERCENT OF,35H THE CLADDING WHICH      FALU  190
     +IS OXIDIZED IS ,F7.4,5H (%) ,,25H THE FAILURE CRITERION IS,F7.4)       FALU  191
      170   FORMAT (5X,15H AT POWER STEP ,I2,24H AND AT AXIAL INCREMENT ,I2,45  FALU  192
     +H THIS ROD HAS FAILED BY EXCESSIVE HOOP STRAIN,//,34H FRAP-S HAS P     FALU  193
     +REDICTED A STRAIN OF ,E12.5,4H THE,22H FAILURE CRITERION IS ,E12.5     FALU  194
     +)                                                                      FALU  195
      180   FORMAT (5X,15H AT POWER STEP ,I2,24H AND AT AXIAL INCREMENT ,I2,33  FALU  196
     +H THIS ROD HAS FAILED BY COLLAPSE )                                    FALU  197
      190   FORMAT (5X,15H AT POWER STEP ,I2,24H AND AT AXIAL INCREMENT ,I2,5X  FALU  199
     +,20H THE CREEP DAMAGE IS,E12.5,19H THE FATIGUE DAMAGE,4H IS ,E12.5     FALU  199
     +,/,5X,34H DAMAGE IS DEFINED AS THE FRACTION,49H OF RODS WHICH WOUL     FALU  200
     +D FAIL DUE TO CREEP OR FATIGUE,/,5X,13H A PREDICTED ,I7,,25H RODS      FALU  201
     +HAVE FAILED OUT OF ,I7,10X,F7.2,,8H PERCENT,40H HAVE FAILED BY OVE     FALU  202
     +RSTRESS OR OVERSTRAIN)                                                 FALU  203
      200   FORMAT (/1H ,48HXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX,6  FALU  204
     +1HXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX,23  FALU  205
     +HXXXXXXXXXXXXXXXXXXXX)                                                 FALU  206
            END                                                              FALU  207
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FAILUR 1 173

VARIABLES	SN	TYPE	RELOCATION											
1023	ASTRAN	REAL			REFS	130	DEFINED	117						
1024	ASTRES	REAL			REFS	130	DEFINED	118						
0	BU2	REAL	ARRAY	F.P.	REFS	90	DEFINED	1						
0	CDAMAG	REAL		F.P.	REFS	130	166	DEFINED	1					
0	CESIUM	REAL		F.P.	REFS	114	130	138	DEFINED	1	107	114		
426	CFTOR	REAL			REFS	122	127	149	150	DEFINED	96			
0	CHEM	REAL	ARRAY	F.P.	REFS	90	4*130	DEFINED	1	136	137	138		
					139	140								
427	CHRTOS	REAL			REFS	120	DEFINED	96						
431	CINTOM	REAL			REFS	119	DEFINED	96						
430	CKTOR	REAL			REFS	122	127	149	150	DEFINED	96			
432	CPSTNM	REAL			REFS	118	124	DEFINED	96					
0	CRAKI	REAL		F.P.	REFS	130	DEFINED	1						
0	CRAKL	REAL		F.P.	REFS	130	DEFINED	1						
1046	CS	REAL	ARRAY		REFS	90	112	114						
1025	CTHICK	REAL			REFS	130	DEFINED	119						
0	CTMAX	REAL		F.P.	REFS	130	DEFINED	1						
1017	DELB	REAL			REFS	112	DEFINED	105						
0	DELBPP	REAL	ARRAY	F.P.	REFS	90	105	DEFINED	1					
0	DELH	REAL		F.P.	REFS	106	120	DEFINED	1					
1020	DELT	REAL			REFS	112	DEFINED	106						
1026	DELTAT	REAL			REFS	130	DEFINED	120						
1027	DOXIDE	REAL			REFS	130	159	DEFINED	121					
0	EPS	REAL	ARRAY	F.P.	REFS	90	117	123	126	161				
					DEFINED	1								
0	ESR	REAL		F.P.	REFS	130	DEFINED	1						
0	FB	REAL	ARRAY	F.P.	REFS	90	130	DEFINED	1					
0	FDAMAG	REAL		F.P.	REFS	130	166	DEFINED	1					
0	FFR	REAL	ARRAY	F.P.	REFS	90	DEFINED	1	143					
0	FRDEN	REAL		F.P.	REFS	112	DEFINED	1						
0	FREQ	REAL		F.P.	REFS	130	DEFINED	1						
1022	FTEMP	REAL			REFS	112	DEFINED	111						
1031	HSTRAN	REAL			REFS	130	DEFINED	123						
1032	HSTRES	REAL			REFS	130	139	DEFINED	124					
0	HUPTAK	REAL		F.P.	REFS	130	136	DEFINED	1					
1015	I	INTEGER			REFS	104	DEFINED	103						
0	ICDOFF	INTEGER		F.P.	REFS	130	DEFINED	1						
1033	ICLAPS	INTEGER			REFS	130	DEFINED	125						
0	IFBSW	INTEGER		F.P.	REFS	130	DEFINED	1						
1016	II	INTEGER			REFS	105	111	112	117	118	121	122		
					123	124	125	126	4*130	136	137	138		
					139	140	2*154	2*156	159	2*161	164	166		
					DEFINED	104								
1042	IIT	INTEGER			REFS	154	156	159	161	164	166			
					DEFINED	148								
0	ISTOFF	INTEGER		F.P.	REFS	130	DEFINED	1						

VARIABLES	SN	TYPE		RELOCATION									
0	IT	INTEGER		F.P.	REFS	101	148	DEFINED	1				
1037	MODES	INTEGER			REFS	130	144	146	152	154	156	159	
						161	164	166	169				
0	MODFAL	INTEGER	ARRAY	F.P.	REFS	90	DEFINED	1	144				
0	NA	INTEGER		F.P.	REFS	11*90	DEFINED	1					
0	NAFAIL	INTEGER		F.P.	REFS	103	DEFINED	1					
1040	NFAIL	INTEGER			REFS	130	166						
0	NFROD	INTEGER		F.P.	REFS	130	166	DEFINED	1				
0	NNFAIL	INTEGER	ARRAY	F.P.	REFS	90	104	DEFINED	1				
0	NOPT	INTEGER		F.P.	REFS	100	DEFINED	1					
0	NR	INTEGER		F.P.	REFS	2*90	110	DEFINED	1				
1021	NRI	INTEGER			REFS	111	112	DEFINED	110				
0	NUCFC	INTEGER		F.P.	REFS	130	DEFINED	1					
0	ODINE	REAL		F.P.	REFS	115	130	137	DEFINED	1	108	115	
0	OLIGAP	INTEGER	ARRAY	F.P.	REFS	9	90	125	DEFINED	1			
0	PCYCL	REAL		F.P.	REFS	130	DEFINED	1					
0	PFB	REAL	ARRAY	F.P.	REFS	90	130	DEFINED	1				
1041	PFR	REAL			REFS	130	143	163					
1045	PFRPCT	REAL			REFS	166	DEFINED	163					
0	PSR	REAL		F.P.	REFS	130	DEFINED	1					
1053	ROID	REAL	ARRAY		REFS	90	112	115					
0	RSTRAN	REAL		F.P.	REFS	130	DEFINED	1					
0	SIG	REAL	ARRAY	F.P.	REFS	90	118	124	DEFINED	1			
1034	STRANR	REAL			REFS	130	DEFINED	126					
0	TC	REAL	ARRAY	F.P.	REFS	90	122	154	156	DEFINED	1		
0	TCC	REAL		F.P.	REFS	119	121	DEFINED	1				
1030	TCLAD	REAL			REFS	130	140	154	156	DEFINED	122		
1035	TCOOL	REAL			REFS	128	130	156	DEFINED	127			
0	TFLIF	REAL		F.P.	REFS	130	DEFINED	1					
1036	TGRID	REAL			REFS	130	DEFINED	128					
0	TIELAP	REAL		F.P.	REFS	112	DEFINED	1					
0	TIMEF	REAL		F.P.	REFS	130	DEFINED	1					
0	TIMES	REAL		F.P.	REFS	130	DEFINED	1					
0	TMPDIS	REAL	ARRAY	F.P.	REFS	90	111	DEFINED	1				
0	TMPMAX	REAL	ARRAY	F.P.	REFS	90	112	DEFINED	1				
0	TW	REAL		F.P.	REFS	127	156	DEFINED	1				
0	UBFS	REAL		F.P.	REFS	130	161	DEFINED	1				
0	UMELT	REAL		F.P.	REFS	130	149	154	DEFINED	1			
1043	UMELTB	REAL			REFS	154	DEFINED	149					
0	UOFD	REAL		F.P.	REFS	130	159	DEFINED	1				
0	ZRNI	REAL		F.P.	REFS	130	150	156	DEFINED	1			
1044	ZRNIBR	REAL			REFS	156	DEFINED	150					
0	ZRO2B	REAL	ARRAY	F.P.	REFS	90	121	DEFINED	1				

FILE NAMES	MODE							
TAPE6	FMT	WRITES	152	154	156	159	161	164	166	169

EXTERNALS	TYPE	ARGS	REFERENCES
CESIOD		8	112
FRAIL		46	130

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
TCONV	REAL	1 SF	99	122 127

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100		116	110	
327	110		171	103	146
333	120		172	100	101
522	130	FMT	175	152	
542	140	FMT	178	154	
573	150	FMT	182	156	
632	160	FMT	187	159	
664	170	FMT	191	161	
710	180	FMT	195	164	
723	190	FMT	197	166	
765	200	FMT	203	169	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
22	110	I	103 171	310B	EXT REFS	NOT INNER
41	100	NRI	110 116	27B	EXT REFS	

STATISTICS
PROGRAM LENGTH 1174B 636
140000B SCM USED

```
      SUBROUTINE FBLOK (STRESS,DFB,FBAVG)                                FBLK    2
C                                                                        FBLK    3
C     SUBROUTINE FBLOK PREDICTS THE AVERAGE FLOW BLOCKAGE FRACTION AS    FBLK    4
C     A FUNCTION OF STRESS. A THIRD-ORDER POLYNOMIAL WAS FIT TO THE      FBLK    5
C     MULTIROD BURST TEST DATA OF ORNL (ORNL 4752). THE STANDARD         FBLK    6
C     DEVIATION IS ALSO RETURNED.                                        FBLK    7
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                           FBLK    8
C                                                                        FBLK    9
C                                                                        FBLK   10
C     -- INPUT ARGUMENTS --                                             FBLK   11
C                                                                        FBLK   12
C     STRESS     ENGINEERING HOOP STRESS ( N/M2 )                      FBLK   13
C                                                                        FBLK   14
C                                                                        FBLK   15
C     --OUTPUT ARGUMENTS --                                             FBLK   16
C                                                                        FBLK   17
C     DFB        STANDARD DEVIATION OF FLOW BLOCKAGE FRACTION           FBLK   18
C     FBAVG      MEAN FLOW BLOCKAGE FRACTION AT INPUT STRESS LEVEL      FBLK   19
C                                                                        FBLK   20
C                                                                        FBLK   21
      DATA FMAX / .705E0 /                                               FBLK   22
      DATA A1, A2, A3, A4 / 1.4352308ZE0, -.697394374E-3,                FBLK   23
     +                      .124995314E-6, -.628029591E-11 /             FBLK   24
      DATA CONV / 6.8947572E3 /                                          FBLK   25
C                                                                        FBLK   26
C                                                                        FBLK   27
      DFB = .12231E0                                                     FBLK   28
      STRES = STRESS/CONV                                                FBLK   29
      FBAVG = A1+STRES*(A2+STRES*(A3+A4*STRES))                          FBLK   30
      IF (STRES.GT.9000.) FBAVG = FMAX                                   FBLK   31
C                                                                        FBLK   32
      RETURN                                                             FBLK   33
      END                                                                FBLK   34
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	FBLOK	1	32

VARIABLES	SN	TYPE	RELOCATION						
27	A1	REAL		REFS	29	DEFINED	22		
30	A2	REAL		REFS	29	DEFINED	22		
31	A3	REAL		REFS	29	DEFINED	22		
32	A4	REAL		REFS	29	DEFINED	22		
33	CONV	REAL		REFS	28	DEFINED	24		
0	DFB	REAL	F.P.	DEFINED	1	27			
0	FBAVG	REAL	F.P.	DEFINED	1	29	30		
26	FMAX	REAL		REFS	30	DEFINED	21		
36	STRES	REAL		REFS	3*29	30	DEFINED	28	

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VARIABLES     SN  TYPE          RELOCATION
    0  STRESS     REAL               F.P.       REF5       28    DEFINED       1

STATISTICS
  PROGRAM LENGTH                  37B      31
        140000B SCM USED
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```
      SUBROUTINE FCMI (PG,PC,TC,IGAP,EPS,EPP,URF,SIG,REPS,RFEPS,FEPS,EP,  FCMI     2
     +DZ,INTGR,GAP,PINT,RCI,RCO,DLROD,DLREL,RFO,CREPI,EPSI,OLEPS,OLFEPS,  FCMI     3
     +OLDTC,OLDPG,OLDPC,OLDURF,OLIGAP,EPPSAV,EPSAV,SIGI,DTIME,TIME,OLAXG  FCMI     4
     +P,AXGAP,URC,ECREEP,REPSAV,RFPSAV,EPI,EPPI,NUDEPP,FLAG,DCHECK,NA)    FCMI     5
C                                                                          FCMI     6
C***THIS PACKAGE OF SUBROUTINES PERFORMS AN ELASTO-PLASTIC                 FCMI     7
C   ANALYSIS OF A TYPICAL PWR FUEL ROD. FUEL RADIAL DISPLACEMENTS          FCMI     8
C   AND AXIAL STRAINS AT EACH AXIAL NODE ARE INPUT.                        FCMI     9
C   FCMI IS CALLED FROM FRACAS.                                            FCMI    10
C                                                                          FCMI    11
C**********************************************************************  FCMI    12
C   INPUT ARGUMENTS                                                        FCMI    13
C**********************************************************************  FCMI    14
C                                                                          FCMI    15
C   DTIME  - TIME INCREMENT (HRS)                                          FCMI    16
C   DZ     - AXIAL NODE LENGTH (IN)                                        FCMI    17
C   FEPS   - HOOP, AXIAL, & RADIAL FUEL STRAINS                            FCMI    18
C   IT     - POWER-TIME STEP NUMBER                                        FCMI    19
C   JJJ    - AXIAL NODE INDEX                                              FCMI    20
C   MODE   - SIMPLIFIED STACK SWITCH                                       FCMI    21
C   NA     - MAXIMUM NUMBER OF AXIAL NODES                                 FCMI    22
C   NDBG   - DEBUG OUTPUT INDEX                                            FCMI    23
C   NRELAX - CREEP FLAG                                                    FCMI    24
C   NPLAST - ELASTIC-PLASTIC FLAG                                          FCMI    25
C   OLAXGP - OLD VALUES OF AXIAL GAP (IN)                                  FCMI    26
C   OLDPC  - COOLANT CHANNEL PRESSURE OF PREVIOUS POWER STEP (PSIA)        FCMI    27
C   OLDPG  - ROD INTERNAL GAS PRESSURE OF PREVIOUS POWER STEP (PSIA)       FCMI    28
C   OLDTC  - CLADDING AVERAGE TEMPERATURE OF PREVIOUS POWER STEP (F)       FCMI    29
C   OLDURF - FUEL RADIAL DISPLACEMENT OF PREVIOUS POWER STEP (IN)          FCMI    30
C   OLEPS  - OLD CLADDING STRAINS - PREVIOUS POWER STEP                    FCMI    31
C   OLFEPS - OLD FUEL STRAINS OF PREVIOUS POWER STEP                       FCMI    32
C   OLIGAP - OLD VALUES OF GAP CLOSURE INDEX                               FCMI    33
C   PC     - COOLANT CHANNEL PRESSURE (PSIA)                               FCMI    34
C   PG     - ROD INTERNAL GAS PRESSURE (PSIA)                              FCMI    35
C   RCI    - CLADDING INSIDE RADIUS (IN)                                   FCMI    36
C   RCO    - CLADDING OUTSIDE RADIUS (IN)                                  FCMI    37
C   REPSAV - RESIDUAL CLADDING STRAIN                                      FCMI    38
C   RFO    - PELLET RADIUS (IN)                                            FCMI    39
C   RFPSAV - RESIDUAL FUEL STRAIN                                          FCMI    40
C   TC     - CLADDING AVERAGE TEMPERATURE (F)                              FCMI    41
C   TIME   - END OF STEP TIME (HRS)                                        FCMI    42
C   URF    - FUEL RADIAL DISPLACEMENT (IN)                                 FCMI    43
C                                                                          FCMI    44
C**********************************************************************  FCMI    45
C   OUTPUT ARGUMENTS                                                       FCMI    46
C**********************************************************************  FCMI    47
C                                                                          FCMI    48
C   AXGAP  - AXIAL GAP (IN)                                                FCMI    49
C   DLREL  - RELATIVE CHANGE IN LENGTH WRT THE FUEL LENGTH CHANGE (IN)     FCMI    50
C   DLROD  - CHANGE IN LENGTH OF THE ACTIVE CLADDING LENGTH (IN)           FCMI    51
C   ECREEP - TOTAL ACCUMULATED CREEP STRAIN (DIMENSIONLESS)                FCMI    52
C   GAP    - RADIAL GAP THICKNESS (IN)                                     FCMI    53
C   IGAP   - GAP CLOSURE INDEX                                             FCMI    54
```

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      C   EP     - CLADDING EFFECTIVE PLASTIC STRAIN (IN/IN)                          FCMI       55
   55 C   EPP    - CLADDING HOOP, AXIAL, & RADIAL STRAIN (IN/IN)                      FCMI       56
      C   EPS    - CLADDING HOOP, AXIAL, & RADIAL STRAIN PER NODE                     FCMI       57
      C   EPPSAV - PLASTIC CLADDING STRAIN                                           FCMI       58
      C   EPSAV  - CLADDING STRAIN                                                   FCMI       59
      C   PINT   - INTERFACIAL PRESSURE (PSIA)                                       FCMI       60
   60 C   REPS   - RESIDUAL CLADDING STRAINS                                         FCMI       61
      C   RFEPS  - RESIDUAL FUEL STRAINS                                            FCMI       62
      C   SIG    - CLADDING HOOP, AXIAL, & RADIAL STRESS PER NODE (PSI)              FCMI       63
      C                                                                             FCMI       64
      C   ********************************************************************      FCMI       65
   65 C                                                                             FCMI       66
      C   IMPLICIT REAL*8 (A-H,O-Z)                                                 FCMI       67
      C                                                                             FCMI       68
            REAL  NUDEPP                                                            FCMI       69
            INTEGER  OLIGAP  ,DCHECK ,FLAG                                          FCMI       70
   70 C                                                                             FCMI       71
            DIMENSION       TC(NA)          ,EPS(NA,3)      ,EPP(NA,3)            FCMI       72
           +               ,EPPI(NA,3)      ,DZ(NA)         ,EP(NA)               FCMI       73
           + ,SIG(NA,3)    ,REPS(NA,3)      ,URF(NA)        ,EPI(NA)              FCMI       74
           + ,URC(NA)      ,PINT(NA)        ,GAP(NA)        ,RFEPS(NA,3)          FCMI       75
   75      + ,FEPS(NA,3)   ,CSIG(3)         ,CEPS(3)        ,CEPP(3)              FCMI       76
           + ,PG(NA)       ,PC(NA)          ,SIGI(NA,3)     ,EPSI(NA,3)           FCMI       77
           + ,OLEPS(NA)    ,OLFEPS(NA)      ,EPPSAV(NA,3)   ,EPSAV(NA)            FCMI       78
           + ,OLDTC(NA)    ,OLDPG(NA)       ,OLDPC(NA)      ,OLDURF(NA)           FCMI       79
           + ,REPSAV(NA,3) ,RFPSAV(NA,3)    ,IGAP(NA)       ,OLIGAP(NA)           FCMI       80
   80      + ,AXGAP(NA)    ,OLAXGP(NA)      ,ECREEP(NA)     ,CREPI(NA)            FCMI       81
           + ,NUDEPP(NA,3) ,FLAG(NA)        ,DCHECK(NA)     ,INTGR(10)            FCMI       82
      C                                                                             FCMI       83
      C   **FIND FREE CLAD DISPLACEMENT DUE TO INTERNAL AND                         FCMI       84
      C   EXTERNAL PRESSURES. COMPUTE A GAP WIDTH.                                  FCMI       85
   85 C                                                                             FCMI       86
            NDBG = INTGR(1)                                                         FCMI       87
            IQUIT = INTGR(2)                                                        FCMI       88
            JJJ = INTGR(3)                                                          FCMI       89
            MODE = INTGR(4)                                                         FCMI       90
   90       IT = INTGR(5)                                                          FCMI       91
            NPLAST = INTGR(6)                                                       FCMI       92
            NRELAX = INTGR(7)                                                       FCMI       93
            NN = NA-1                                                               FCMI       94
      C                                                                             FCMI       95
   95       MODE = 1                                                               FCMI       96
            DELTA = RCI-RFO                                                         FCMI       97
                DO 120 J=1,NN                                                       FCMI       98
                CEPP(1) = EPP(J,1)                                                  FCMI       99
                CEPP(2) = EPP(J,2)                                                  FCMI      100
  100           CEPP(3) = EPP(J,3)                                                  FCMI      101
                CEP = EP(J)                                                         FCMI      102
                CREP = ECREEP(J)                                                    FCMI      103
                FS = 0.0                                                            FCMI      104
      C                                                                             FCMI      105
  105           CALL CLADF (PG(J),PC(J),TC(J),RCI,RCO,CSIG,CEPS,CEPP,CEP,FS,NR    FCMI      106
           +    ELAX,DTIME,TIME,CREP,NPLAST)                                       FCMI      107
```

```
      C
            SIGI(J,1) = CSIG(1)                                                  FCMI      108
            SIGI(J,2) = CSIG(2)                                                  FCMI      109
            SIGI(J,3) = 0.E0                                                     FCMI      110
            EPSI(J,1) = CEPS(1)                                                  FCMI      111
            EPSI(J,2) = CEPS(2)                                                  FCMI      112
            EPSI(J,3) = CEPS(3)                                                  FCMI      113
            EPPI(J,1) = CEPP(1)                                                  FCMI      114
            EPPI(J,2) = CEPP(2)                                                  FCMI      115
            EPPI(J,3) = CEPP(3)                                                  FCMI      116
            EPI(J) = CEP                                                         FCMI      117
            CREPI(J) = CREP                                                      FCMI      118
            URCI = 0.5*((RCO+RCI)*EPSI(J,1)-(RCO-RCI)*EPSI(J,3))                 FCMI      119
      C   ***NOW CHECK FOR INTERFERENCE                                          FCMI      120
            GAPI = URCI+DELTA-URF(J)                                             FCMI      121
            IF (GAPI) 100,100,110                                                FCMI      122
      100   IGAP(J) = 1                                                          FCMI      123
            GO TO 120                                                            FCMI      124
      110   IGAP(J) = 0                                                          FCMI      125
      120   CONTINUE                                                             FCMI      126
      C                                                                          FCMI      127
            DO 190 J=1,NN                                                        FCMI      128
            IF (IGAP(J)) 170,170,130                                             FCMI      129
      C   NODE J IS IN CONTACT                                                  FCMI      130
      C   COMPUTE PRESCRIBED AXIAL STRAIN IN CLAD                              FCMI      131
      C   BASED ON LAST VALUES OF AXIAL STRAIN                                 FCMI      132
      C   PRIOR TO CONTACT. LOCAL FUEL RADIAL                                  FCMI      133
      C   DISPLACEMENT IS PASSED TO *COUPLE* .                                 FCMI      134
      130   CONTINUE                                                           FCMI      135
      C                                                                          FCMI      136
      C   ************************************************************************FCMI      137
            IF (NRELAX.EQ.1) GO TO 140                                           FCMI      138
            IF (IGAP(J).EQ.1.AND.J.NE.JJJ) GO TO 190                             FCMI      139
      140   CONTINUE                                                           FCMI      140
      C   ************************************************************************FCMI      141
      C                                                                          FCMI      142
            IF (OLIGAP(J).NE.0) GO TO 150                                        FCMI      143
      C                                                                          FCMI      144
            CALL CLOSE (TC,PG,PC,URF,DELTA,EPP,EP,RCI,RCO,RFO,OLDTC,OLDPG,     FCMI      145
           +    OLDPC,OLDURF,J,FEPS,RFEPS,REPS,OLEPS,OLFEPS,NRELAX,DTIME,TIME, FCMI      146
           +    ECREEP,NA,IQUIT,NPLAST)                                         FCMI      147
      C                                                                          FCMI      148
      150   EPS(J,2) = REPS(J,2)+(FEPS(J,2)-RFEPS(J,2))                          FCMI      149
            CEPS(2) = EPS(J,2)                                                   FCMI      150
            CEPP(1) = EPP(J,1)                                                   FCMI      151
            CEPP(2) = EPP(J,2)                                                   FCMI      152
            CEPP(3) = EPP(J,3)                                                   FCMI      153
            CEP = EP(J)                                                          FCMI      154
            CREP = ECREEP(J)                                                     FCMI      155
      C   NO SLIP ASSUMED IN AXIAL DIRECTION AS LONG                           FCMI      156
      C   AS INTERFACE PRESSURE IS ABOVE LOCAL GAS PRESSURE                    FCMI      157
      C                                                                          FCMI      158
            CALL COUPLE (PG(J),PC(J),TC(J),RCI,RCO,CSIG,CEPS,CEPP,CEP,URF(     FCMI      159
                                                                               FCMI      160
```

```
     +    J),DELTA,PINT(J),NDBG,NRELAX,DTIME,TIME,CREP,IQUIT,NPLAST,IT)                FCMI      161
C                                                                                      FCMI      162
      SIG(J,1) = CSIG(1)                                                               FCMI      163
      SIG(J,2) = CSIG(2)                                                               FCMI      164
      SIG(J,3) = 0.0                                                                   FCMI      165
      EPS(J,1) = CEPS(1)                                                               FCMI      166
      EPS(J,2) = CEPS(2)                                                               FCMI      167
      EPS(J,3) = CEPS(3)                                                               FCMI      168
      EPP(J,1) = CEPP(1)                                                               FCMI      169
      EPP(J,2) = CEPP(2)                                                               FCMI      170
      EPP(J,3) = CEPP(3)                                                               FCMI      171
      EP(J) = CEP                                                                      FCMI      172
      ECREEP(J) = CREP                                                                 FCMI      173
C     ***************************************************************************    FCMI      174
      IF (NRELAX.EQ.1) GO TO 160                                                       FCMI      175
      EPPSAV(J,1) = CEPP(1)                                                            FCMI      176
      EPPSAV(J,2) = CEPP(2)                                                            FCMI      177
      EPPSAV(J,3) = CEPP(3)                                                            FCMI      178
      EPSAV(J) = CEP                                                                   FCMI      179
      REPSAV(J,1) = REPS(J,1)                                                          FCMI      180
      REPSAV(J,2) = REPS(J,2)                                                          FCMI      181
      REPSAV(J,3) = REPS(J,3)                                                          FCMI      182
      RFPSAV(J,1) = RFEPS(J,1)                                                         FCMI      183
      RFPSAV(J,2) = RFEPS(J,2)                                                         FCMI      184
      RFPSAV(J,3) = RFEPS(J,3)                                                         FCMI      185
160   CONTINUE                                                                         FCMI      186
C     ***************************************************************************    FCMI      187
      GAP(J) = 0.0                                                                     FCMI      188
      GO TO 190                                                                        FCMI      189
C                                                                                      FCMI      190
170   CONTINUE                                                                         FCMI      191
      K = J                                                                            FCMI      192
      SIG(K,1) = SIGI(K,1)                                                             FCMI      193
      SIG(K,2) = SIGI(K,2)                                                             FCMI      194
      SIG(K,3) = SIGI(K,3)                                                             FCMI      195
      EPS(K,1) = EPSI(K,1)                                                             FCMI      196
      EPS(K,2) = EPSI(K,2)                                                             FCMI      197
      EPS(K,3) = EPSI(K,3)                                                             FCMI      198
      REPS(K,2) = EPS(K,2)                                                             FCMI      199
      RFEPS(K,2) = FEPS(K,2)                                                           FCMI      200
      URC(K) = 0.5*(RCO+RCI)*EPS(K,1)-0.5*(RCO-RCI)*EPS(K,3)                           FCMI      201
      GAP(K) = URC(K)+DELTA-URF(K)                                                     FCMI      202
      PINT(K) = 0.0                                                                    FCMI      203
      EPP(K,1) = EPPI(K,1)                                                             FCMI      204
      EPP(K,2) = EPPI(K,2)                                                             FCMI      205
      EPP(K,3) = EPPI(K,3)                                                             FCMI      206
      EP(K) = EPI(K)                                                                   FCMI      207
      ECREEP(K) = CREPI(K)                                                             FCMI      208
C     ***************************************************************************    FCMI      209
      IF (NRELAX.EQ.1) GO TO 180                                                       FCMI      210
      IF (J.NE.JJJ) GO TO 190                                                          FCMI      211
      EPPSAV(K,1) = EPPI(K,1)                                                          FCMI      212
      EPPSAV(K,2) = EPPI(K,2)                                                          FCMI      213
```

```
                EPPSAV(K,3) = EPPI(K,3)                                          FCMI      214
                EPSAV(K) = EPI(K)                                                FCMI      215
215             REPSAV(K,1) = REPS(K,1)                                          FCMI      216
                REPSAV(K,2) = REPS(K,2)                                          FCMI      217
                REPSAV(K,3) = REPS(K,3)                                          FCMI      218
                RFPSAV(K,1) = RFEPS(K,1)                                         FCMI      219
                RFPSAV(K,2) = RFEPS(K,2)                                         FCMI      220
220             RFPSAV(K,3) = RFEPS(K,3)                                         FCMI      221
          180   CONTINUE                                                         FCMI      222
          C     ***************************************************************  FCMI      223
                GO TO 190                                                        FCMI      224
          190   CONTINUE                                                         FCMI      225
225       C     ***COMPUTE ROD LENGTH AND DISPLACEMENT BETWEEN FUEL STACK + CLAD  FCMI      226
            DLROD = 0.0                                                          FCMI      227
            DLREL = 0.0                                                          FCMI      228
                DO 200 N=1,NN                                                    FCMI      229
                DLROD = DLROD+(EPS(N,2))*DZ(N)                                   FCMI      230
230         200 DLREL = DLREL+(EPS(N,2)-FEPS(N,2))*DZ(N)                         FCMI      231
                DO 210 K=1,NN                                                    FCMI      232
                OLEPS(K) = EPS(K,2)                                              FCMI      233
                OLFEPS(K) = FEPS(K,2)                                            FCMI      234
                OLIGAP(K) = IGAP(K)                                              FCMI      235
235             OLDTC(K) = TC(K)                                                 FCMI      236
                OLDPG(K) = PG(K)                                                 FCMI      237
                OLDPC(K) = PC(K)                                                 FCMI      238
                OLDURF(K) = URF(K)                                               FCMI      239
                OLAXGP(K) = AXGAP(K)                                             FCMI      240
240         210 CONTINUE                                                         FCMI      241
            RETURN                                                               FCMI      242
            END                                                                  FCMI      243
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	FCMI	1	241

VARIABLES

0	AXGAP	REAL	ARRAY	F.P.	REFS	71	239	DEFINED	1					
1013	CEP	REAL			REFS	105	117	159	171	178				
					DEFINED	101	154							
1030	CEPP	REAL	ARRAY		REFS	71	105	114	115	116	159	168		
					169	170	175	176	177	DEFINED	98	99		
					100	151	152	153						
1025	CEPS	REAL	ARRAY		REFS	71	105	111	112	113	159	165		
					166	167	DEFINED	150						
1014	CREP	REAL			REFS	105	118	159	172	DEFINED	102	155		
0	CREPI	REAL	ARRAY	F.P.	REFS	71	207	DEFINED	1	118				
1022	CSIG	REAL	ARRAY		REFS	71	105	108	109	159	162	163		
0	DCHECK	INTEGER	ARRAY	F.P.	REFS	69	71	DEFINED	1					

VARIABLES	SN	TYPE		RELOCATION									
1011	DELTA	REAL			REFS	121	145	159	201	DEFINED	96		
0	DLREL	REAL		F.P.	REFS	230	DEFINED	1	227	230			
0	DLROD	REAL		F.P.	REFS	229	DEFINED	1	226	229			
0	DTIME	REAL		F.P.	REFS	105	145	159	DEFINED	1			
0	DZ	REAL	ARRAY	F.P.	REFS	71	229	230	DEFINED	1			
0	ECREEP	REAL	ARRAY	F.P.	REFS	71	102	145	155	DEFINED	1	172	
					207								
0	EP	REAL	ARRAY	F.P.	REFS	71	101	145	154	DEFINED	1	171	
					206								
0	EPP	REAL	ARRAY	F.P.	REFS	71	98	99	100	145	151	152	
					153	DEFINED	1	168	169	170	203	204	
					205								
0	EPPSAV	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	175	176	177	211	
					212	213							
0	EPPI	REAL	ARRAY	F.P.	REFS	71	203	204	205	211	212	213	
					DEFINED	1	114	115	116				
0	EPS	REAL	ARRAY	F.P.	REFS	71	150	198	2*200	229	230	232	
					DEFINED	1	149	165	166	167	195	196	
					197								
0	EPSAV	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	178	214			
0	EPSI	REAL	ARRAY	F.P.	REFS	71	2*119	195	196	197			
					DEFINED	1	111	112	113				
0	EPI	REAL	ARRAY	F.P.	REFS	71	206	214	DEFINED	1	117		
0	FEPS	REAL	ARRAY	F.P.	REFS	71	145	149	199	230	233		
					DEFINED	1							
0	FLAG	INTEGER	ARRAY	F.P.	REFS	69	71	DEFINED	1				
1015	FS	REAL			REFS	105	DEFINED	103					
0	GAP	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	187	201			
1017	GAPI	REAL			REFS	122	DEFINED	121					
0	IGAP	INTEGER	ARRAY	F.P.	REFS	71	129	139	234	DEFINED	1	123	
					125								
0	INTGR	INTEGER	ARRAY	F.P.	REFS	71	86	87	88	89	90	91	
					92	DEFINED	1						
1002	IQUIT	INTEGER			REFS	145	159	DEFINED	87				
1005	IT	INTEGER			REFS	159	DEFINED	90					
1012	J	INTEGER			REFS	98	99	100	101	102	3*105	108	
					109	110	111	112	113	114	115	116	
					117	118	2*119	121	123	125	129	2*139	
					143	145	4*149	150	151	152	153	154	
					155	5*159	162	163	164	165	166	167	
					168	169	170	171	172	175	176	177	
					178	2*179	2*180	2*181	2*182	2*183	2*184	187	
					191	210	DEFINED	97	128				
1003	JJJ	INTEGER			REFS	139	210	DEFINED	88				
1020	K	INTEGER			REFS	2*192	2*193	2*194	2*195	2*196	2*197	2*198	
					2*199	3*200	3*201	202	2*203	2*204	2*205	2*206	
					2*207	2*211	2*212	2*213	2*214	2*215	2*216	2*217	
					2*218	2*219	2*220	2*232	2*233	2*234	2*235	2*236	
					2*237	2*238	2*239	DEFINED	191	231			
1004	MODE	INTEGER			DEFINED	89	95						
1021	N	INTEGER			REFS	2*229	3*230	DEFINED	228				
0	NA	INTEGER		F.P.	REFS	38*71	93	145	DEFINED	1			
1001	NDBG	INTEGER			REFS	159	DEFINED	86					

VARIABLES	SN	TYPE	RELOCATION										
1010	NN	INTEGER			REFS	97	128	228	231	DEFINED	93		
1006	NPLAST	INTEGER			REFS	105	145	159	DEFINED	91			
1007	NRELAX	INTEGER			REFS	105	138	145	159	174	209		
					DEFINED	92							
0	NUDEPP	REAL	ARRAY	F.P.	REFS	68	71	DEFINED	1				
0	OLAXGP	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	239				
0	OLDPC	REAL	ARRAY	F.P.	REFS	71	145	DEFINED	1	237			
0	OLDPG	REAL	ARRAY	F.P.	REFS	71	145	DEFINED	1	236			
0	OLDTC	REAL	ARRAY	F.P.	REFS	71	145	DEFINED	1	235			
0	OLDURF	REAL	ARRAY	F.P.	REFS	71	145	DEFINED	1	238			
0	OLEPS	REAL	ARRAY	F.P.	REFS	71	145	DEFINED	1	232			
0	OLFEPS	REAL	ARRAY	F.P.	REFS	71	145	DEFINED	1	233			
0	OLIGAP	INTEGER	ARRAY	F.P.	REFS	69	71	143	DEFINED	1	234		
0	PC	REAL	ARRAY	F.P.	REFS	71	105	145	159	237			
					DEFINED	1							
0	PG	REAL	ARRAY	F.P.	REFS	71	105	145	159	236			
					DEFINED	1							
0	PINT	REAL	ARRAY	F.P.	REFS	71	159	DEFINED	1	202			
0	RC1	REAL		F.P.	REFS	96	105	2*119	145	159	2*200		
					DEFINED	1							
0	RC0	REAL		F.P.	REFS	105	2*119	145	159	2*200			
					DEFINED	1							
0	REPS	REAL	ARRAY	F.P.	REFS	71	145	149	179	180	181	215	
					216	217	DEFINED	1	198				
0	REPSAV	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	179	180	181	215	
					216	217							
0	RFEPS	REAL	ARRAY	F.P.	REFS	71	145	149	182	183	184	218	
					219	220	DEFINED	1	199				
0	RFO	REAL		F.P.	REFS	96	145	DEFINED	1				
0	RFPSAV	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	182	183	184	218	
					219	220							
0	SIG	REAL	ARRAY	F.P.	REFS	71	DEFINED	1	162	163	164	192	
					193	194							
0	SIGI	REAL	ARRAY	F.P.	REFS	71	192	193	194	DEFINED	1	108	
					109	110							
0	TC	REAL	ARRAY	F.P.	REFS	71	105	145	159	235			
					DEFINED	1							
0	TIME	REAL		F.P.	REFS	105	145	159	DEFINED	1			
0	URC	REAL	ARRAY	F.P.	REFS	71	201	DEFINED	1	200			
1016	URC1	REAL			REFS	121	DEFINED	119					
0	URF	REAL	ARRAY	F.P.	REFS	71	121	145	159	201	238		
					DEFINED	1							

EXTERNALS	TYPE	ARGS	REFERENCES
CLADF		15	105
CLOSE		27	145
COUPLE		20	159

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100	INACTIVE	123	2*122	
171	110		125	122	
174	120		126	97	124
0	130	INACTIVE	135	129	

STATEMENT LABELS		DEF LINE	REFERENCES				
216	140	140	138				
251	150	149	143				
431	160	185	174				
435	170	190	2*129				
607	180	221	209				
610	190	224	128	139	188	210	223
0	200	230	228				
0	210	240	231				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
47	120	J	97 126	130B	EXT REFS
201	190	J	128 224	412B	EXT REFS
621	200	N	228 230	15B	OPT
640	210	K	231 240	35B	OPT

STATISTICS
PROGRAM LENGTH 1320B 720
140000B SCM USED

```
      FUNCTION FENTHL (TEMP,FCOMP,FOTMTL,FTMELT,FACMOT,FHEFUS)
C
C     IMPLICIT  REAL * 8 (A-H,O-Z)
C
C     ******************************************************************
C
C     THIS FUNCTION IS CALLED BY SUBROUTINE ENERGY AND COMPUTES THE
C     ENTHALPY OF FUEL AT A POINT RELATIVE TO ZERO DEGREES ABSOLUTE
C     TEMPERATURE
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     FACMOT - FRACTION OF MOLTEN FUEL
C     FCOMP  - PUO2 FRACTION OF THE FUEL
C     FHEFUS - HEAT OF FUSSION OF THE FUEL (J/KG)
C     FOTMTL - FUEL OXYGEN TO METAL RATIO
C     FTMELT - FUEL MELTING TEMPERATURE (K)
C     TEMP   - LOCAL TEMPERATURE (K)
C
C     ******************************************************************
C     OUTPUT
C     ******************************************************************
C
C     FENTHL - LOCAL FUEL ENTHALPY RELATIVE TO ZERO DEGREES-K (J/KG)
C
C     ******************************************************************
C
C     FCPMOL = SPECIFIC HEAT CAPACITY OF MOLTEN FUEL ( J/(KG*K) )
C
      DATA  FCPMOL / 503.E0 /
C
C     THE FOLLOWING DATA STATEMENTS CONTAIN CONSTANTS FROM MATPRO-11 FCP
C
      DATA  C1U, C2U, C3U, THU, EDU  / 296.7   , 2.43E-02, 8.745E07,
     +                                 535.285, 1.577E05 /
      DATA  C1PU,C2PU,C3PU,THPU,EDPU / 347.4   , 3.95E-04, 3.860E07,
     +                                 571.0   , 1.967E05 /
C
C     THE FOLLOWING EQUATION IS THE INTEGRAL OF THE FUEL SPECIFIC HEAT
C     WITH RESPECT TO TEMPERATURE
C
      CPDT(C1,TH,C2,OTM,ED,T,C3) = C1*TH*(1./(EXP(TH/T)-1.))+C2*T*T/2.E0
     ++C3*OTM*EXP(-ED/(T*8.314E0))/2.E0
C
      TX = TEMP
      IF (TX.GT.FTMELT) TX = FTMELT
C
      FENTHL = CPDT(C1U,THU,C2U,FOTMTL,EDU,TX,C3U)*(1.E0-FCOMP)
C
      IF (FCOMP.GT.0.E0) FENTHL = FENTHL+CPDT(C1PU,THPU,C2PU,FOTMTL,EDPU
     +,TX,C3PU)*FCOMP
```

```
                C
     55         C     IF (TEMP.LE.FTMELT-2.E0) GO TO 100
                C
                C
                C
                      FENTHL = FENTHL+FHEFUS*FACMOT
     60         C
                C     IF (TEMP.LE.(FTMELT+2.)) GO TO 100
                C
                C
                      FENTHL = FENTHL+(TEMP-FTMELT)*FCPMOL
     65         100   CONTINUE
                C
                      RETURN
                      END
```

```
FENTHL     55
FENTHL     56
FENTHL     57
FENTHL     58
FENTHL     59
FENTHL     60
FENTHL     61
FENTHL     62
FENTHL     63
FENTHL     64
FENTHL     65
FENTHL     66
FENTHL     67
FENTHL     68
FENTHL     69
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	FENTHL	1	67

VARIABLES	SN	TYPE	RELOCATION									
127	C1PU	REAL		REFS	52	DEFINED	38					
122	C1U	REAL		REFS	50	DEFINED	36					
130	C2PU	REAL		REFS	52	DEFINED	38					
123	C2U	REAL		REFS	50	DEFINED	36					
131	C3PU	REAL		REFS	52	DEFINED	38					
124	C3U	REAL		REFS	50	DEFINED	36					
133	EDPU	REAL		REFS	52	DEFINED	38					
126	EDU	REAL		REFS	50	DEFINED	36					
0	FACMOT	REAL	F.P.	REFS	59	DEFINED	1					
0	FCOMP	REAL	F.P.	REFS	50	2*52	DEFINED	1				
121	FCPMOL	REAL		REFS	64	DEFINED	32					
140	FENTHL	REAL		REFS	52	59	64	DEFINED	50	52	59	64
0	FHEFUS	REAL	F.P.	REFS	59	DEFINED	1					
0	FOTHTL	REAL	F.P.	REFS	50	52	DEFINED	1				
0	FTMELT	REAL	F.P.	REFS	2*48	55	61	64	DEFINED	1		
0	TEMP	REAL	F.P.	REFS	47	55	61	64	DEFINED	1		
132	THPU	REAL		REFS	2*52	DEFINED	38					
125	THU	REAL		REFS	2*50	DEFINED	36					
141	TX	REAL		REFS	48	4*50	4*52	DEFINED	47	48		

EXTERNALS	TYPE	ARGS		REFERENCES	
EXP	REAL	1	LIBRARY	2*50	2*52

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
CPDT	REAL	7	SF	44	50	52

STATEMENT LABELS

	DEF LINE	REFERENCES
111 100	65	55 61

STATISTICS

PROGRAM LENGTH	142B	98
140000B SCM USED		

```
      SUBROUTINE FEXPAN (FTMELT,SUMTF,SUMEXP,NR,NRM1,TFR,TFB,UO2LL,AFAL,  FEXP      2
     +R,J,NA,DPH)                                                         FEXP      3
C                                                                         FEXP      4
C   IMPLICIT REAL * 8 (A-H,O-Z)                                           FEXP      5
C                                                                         FEXP      6
C   ********************************************************************* FEXP      7
C                                                                         FEXP      8
C   FEXPAN IS CALLED FROM MAIN AND COMPUTES THE THERMAL EXPANSION OF      FEXP      9
C   THE FUEL.                                                             FEXP     10
C   THIS SUBROUTINE WAS CODED BY G A BERNA IN MARCH 1978.                 FEXP     11
C                                                                         FEXP     12
C   ********************************************************************* FEXP     13
C   INPUT ARGUMENTS                                                       FEXP     14
C   ********************************************************************* FEXP     15
C                                                                         FEXP     16
C   AFAL   - ADDITIONAL THERMAL EXPANSION FACTOR                          FEXP     17
C   FTMELT - FUEL MELT TEMPERATURE (K)                                    FEXP     18
C   J      - AXIAL NODE INDEX                                             FEXP     19
C   NR     - MAXIMUM NUMBER OF RADIAL NODES                               FEXP     20
C   NA     - NUMBER OF AXIAL NODES PLUS ONE                               FEXP     21
C   NRM1   - NR - 1                                                       FEXP     22
C   R      - COLD STATE RADII OF FUEL RADIAL NODES (IN)                   FEXP     23
C   TFB    - FUEL RING TEMPERATURES (F)                                   FEXP     24
C   TFR    - RADIAL NODE TEMPERATURES (F)                                 FEXP     25
C                                                                         FEXP     26
C   ********************************************************************* FEXP     27
C   OUTPUT ARGUMENTS                                                      FEXP     28
C   ********************************************************************* FEXP     29
C                                                                         FEXP     30
C   DPH    - THERMALLY EXPANDED PELLET DIAMETER (IN)                      FEXP     31
C   SUMTF  - SUMMATION OF FUEL RING TEMPERATURES (F)                      FEXP     32
C   SUMEXP - TOTAL FUEL SURFACE DISPLACEMENT DUE TO THERMAL EXPAN.(IN)    FEXP     33
C   UO2LL  - THERMAL EXPANSION (STRAIN)                                   FEXP     34
C                                                                         FEXP     35
C   ********************************************************************* FEXP     36
C                                                                         FEXP     37
      DIMENSION     TFR(NR)  ,TFB(NR)  ,R(NR)     ,UO2LL(NR,NA)         FEXP     38
C                                                                         FEXP     39
      SUMTF = 0.E0                                                        FEXP     40
      SUMEXP = 0.E0                                                       FEXP     41
          DO 100 L=1,NRM1                                                 FEXP     42
          TFB(L) = 0.5*(TFR(L)+TFR(L+1))                                  FEXP     43
          TFBK = (TFB(L)+459.67)/1.8                                      FEXP     44
          FACMOT = 0.0                                                    FEXP     45
          IF (TFBK.GT.FTMELT) FACMOT = 1.0                                FEXP     46
          UO2LL(L,J) = FTHEXP(TFBK,FACMOT)*AFAL                           FEXP     47
          SUMEXP = SUMEXP+(R(L)-R(L+1))*(1.E0+UO2LL(L,J))                 FEXP     48
  100     CONTINUE                                                        FEXP     49
      SUMEXP = SUMEXP+R(NR)*(1.E0+UO2LL(NRM1,J))                          FEXP     50
      DPH = SUMEXP*2.E0                                                   FEXP     51
C                                                                         FEXP     52
      RETURN                                                              FEXP     53
      END                                                                 FEXP     54
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FEXPAN 1 52

VARIABLES SN TYPE RELOCATION

0	AFAL	REAL		F.P.	REFS	46	DEFINED	1				
0	DPH	REAL		F.P.	DEFINED	1	50					
107	FACMOT	REAL			REFS	46	DEFINED	44	45			
[illegible]	FTMELT	REAL		F.P.	REFS	45	DEFINED	1				
[illegible]	J	INTEGER		F.P.	REFS	46	47	49	DEFINED	1		
[illegible]5	L	INTEGER			REFS	3*42	43	46	3*47	DEFINED	41	
0	NA	INTEGER		F.P.	REFS	37	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	4*37	49	DEFINED	1			
0	NRM1	INTEGER		F.P.	REFS	41	49	DEFINED	1			
0	R	REAL	ARRAY	F.P.	REFS	37	2*47	49	DEFINED	1		
0	SUMEXP	REAL		F.P.	REFS 49	47	49	50	DEFINED	1	40	47
0	SUMTF	REAL		F.P.	DEFINED	1	39					
0	TFB	REAL	ARRAY	F.P.	REFS	37	43	DEFINED	1	42		
106	TFBK	REAL			REFS	45	46	DEFINED	43			
0	TFR	REAL	ARRAY	F.P.	REFS	37	2*42	DEFINED	1			
0	UO2LL	REAL	ARRAY	F.P.	REFS	37	47	49	DEFINED	1	46	

EXTERNALS TYPE ARGS REFERENCES
FTHEXP REAL 2 46

STATEMENT LABELS DEF LINE REFERENCES
0 100 48 41

LOOPS LABEL INDEX FROM-TO LENGTH PROPERTIES
17 100 L 41 48 37B EXT REFS

STATISTICS
PROGRAM LENGTH 125B 85
140000B SCM USED

```
      SUBROUTINE FGASRE (AFGR,ANG,ANGI,ANGR,CC1,CC2,TOTL,DELH,DELTAZ,DEN FGRL       2
     +,FMGR,HMGR,PFAVE,TNOW,TLAST,TFR,IT,J,IGPNOD,NGASR,HMGP,FMGP,RNODLS FGRL       3
     +,NVOID,NR,NA,AK1,AK2,FMA,DPN,DPL,F,FMGPR,DPLH,FH,FN,DP,B,IM,BU,DEL FGRL       4
     +BP,RC,POWPRO,TIMX,Q,JST,QMPY,RELEAS,DCO,ANSD,FLXFAC,PF,ANSR,FF,DT, FGRL       5
     +DECAY,HALF,BP,BPP,IMFGAS,NOTONE)                                   FGRL       6
C                                                                        FGRL       7
C     IMPLICIT REAL*8 (A-H,O-Z)                                          FGRL       8
C                                                                        FGRL       9
C     ******************************************************************* FGRL      10
C                                                                        FGRL      11
C     SUBROUTINE FGASRE COMPUTES THE FISSION GAS PRODUCTION AND RELEASE, FGRL      12
C     THE HELIUM PRODUCTION AND RELEASE , AND THE NITROGEN RELEASE  FOR  FGRL      13
C     A GIVEN AXIAL NODE. FGASRE IS CALLED BY THE MAIN SUBROUTINE.       FGRL      14
C     THIS SUBROUTINE WAS MODIFIED FOR USE IN FRAP-T AND FRAPCON BY      FGRL      15
C     G A BERNA FROM THE SUBROUTINE OF THE SAME NAME IN FRAP-S IN OCT 77 FGRL      16
C                                                                        FGRL      17
C     ******************************************************************* FGRL      18
C                                                                        FGRL      19
      DIMENSION AK1(1)     ,AK2(1)     ,ANG(NA,1)  ,ANGR(NA,1) ,DPL(1)   FGRL      20
     +,DPLH(1) ,CC1(NR,1)  ,CC2(NR,1)  ,DPN(1)     ,FMA(1)               FGRL      21
     +,FH(NR,1),FN(NR,1)   ,HMGR(NA,1) ,FMGR(NA,1) ,FMGPR(1)             FGRL      22
     +,F(NR,1) ,HMGP(NA,1) ,RNODLS(1)  ,TIME(2)    ,FMGP(NA,1) ,TFR(1)   FGRL      23
C                                                                        FGRL      24
      DIMENSION  POWPRO(3)                                               FGRL      25
      DIMENSION  TIMX(IM) ,B(6) ,QMPY(IM) ,JST(IM) ,Q(NA,8)              FGRL      26
      DIMENSION  DV(20) ,RV(20)                                          FGRL      27
      DIMENSION RELEAS(1), ANSD(1), FLXFAC(1), PF(1), ANSR(1), DT(1),    FGRL      28
     +   DECAY(1), HALF(1), FF(1)                                        FGRL      29
C                                                                        FGRL      30
C     ******************************************************************* FGRL      31
C     INPUT ARGUMENTS                                                    FGRL      32
C     ******************************************************************* FGRL      33
C                                                                        FGRL      34
C     AFGR    - ADDITIONAL FRACTIONAL GAS RELEASE FACTOR                 FGRL      35
C     ANG     - CUMULATIVE N2 CONSENTRATION IN FUEL PER POWER STEP(MOLES) FGRL      36
C     ANGI    - INITIAL NITROGEN CONSENTRATION IN FUEL (MOLES)           FGRL      37
C     BP      -  BURNUP TO EOS FOR AXIAL NODE J (MWD/MTU)                FGRL      38
C     BPP     -  BURNUP TO BOS FOR AXIAL NODE J (MWD/MTU)                FGRL      39
C     B       - COEFFICIENT ARRAY FOR FUEL TEMP PROFILE FROM DDLF        FGRL      40
C     BU      - TOTAL BURNUP THIS AXIAL NODE                             FGRL      41
C     CC1     - CONSENTRATION OF FISSION GAS PER RING & NODE BOS (MOLES) FGRL      42
C     DELBP   - INCREMENTAL BURNUP THIS TIME STEP, THIS AXIAL NODE       FGRL      43
C     DCO     - AS FABRICATED CLAD O.D.                                  FGRL      44
C     DELH    - POWER-TIME STEP TIME (HOURS)                             FGRL      45
C     DELTAZ  - LENGTH OF THE AXIAL NODE  (FT)                           FGRL      46
C     DEN     - PERCENT OF THEORETICAL DENSITY OF THE FUEL               FGRL      47
C     DP      - PELLET DIAMETER                                          FGRL      48
C     FMGP    - CUMULATIVE FISSION GAS PRODUCTION PER TIME STEP & NODE   FGRL      49
C     HMGP    - CUMULATIVE HELIUM  GAS PRODUCTION PER TIME STEP & NODE   FGRL      50
C     IGPNOD  - FUEL SURFACE NODE INDEX                                  FGRL      51
C     IMFGAS  -  EVALUATION MODEL SWITCH FOR FISSION BAS RELEASE         FGRL      52
C     = 0 , NO EM ENHANCEMENT USED                                       FGRL      53
C     = 1 , EM ENHANCEMENT USED BEYOND 20000 MWD/MTU                     FGRL      54
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```
      C   IM     - TOTAL NUMBER OF TIME STEPS                                    FGRL       55
      C   IT     - POWER-TIME STEP INDEX                                         FGRL       56
      C   ITER   - GAS LOOP ITERATION INDEX                                     FGRL       57
      C   J      - AXIAL NODE INDEX                                              FGRL       58
      C   JST    - POINTER ARRAY FOR TIME DEPENDENT AXIAL POWER PROFILE          FGRL       59
      C   NA     - NUMBER OF AXIAL NODES PLUS ONE                                FGRL       60
      C   NGASR  - FISSION GAS RELEASE MODEL INDEX                               FGRL       61
      C   =-1,  BOOTH DIFFUSION                                                  FGRL       62
      C   = 0 , MACDONALD-WEISMAN                                               FGRL       63
      C   GE 1 AND LE 5, BEYER-HANN                                             FGRL       64
      C   GE 6, ANS-5.4                                                         FGRL       65
      C   NMESH  - CLADDING OUTSIDE SURFACE NODE INDEX                          FGRL       66
      C   NOTONE - EM FLAG USED TO ENFORCE ONE PCT RELEASE AT 20000MWD/MTU       FGRL       67
      C   NR     - MAXIMUM NUMBER OF RADIAL NODES                                FGRL       68
      C   NVOID  - CENTRAL VOID INDEX                                            FGRL       69
      C   = 0 , NO CENTRAL VOID                                                  FGRL       70
      C   = 1 , CENTRAL VOID EXISTS                                             FGRL       71
      C   POWPRO - COEFFICIENTS FOR FLUX DEPRESSION CALCULATIONS (W,YY,Z)       FGRL       72
      C   Q      - AXIAL POWER PROFILE ARRAY                                     FGRL       73
      C   QMPY   - TIME DEPENDENT POWER ARRAY                                    FGRL       74
      C   RC     - RADIUS OF PELLET ANNULUS                                      FGRL       75
      C   RNODLS - COLD STATE RADIAL NODE LOCATIONS FROM CL (IN)                 FGRL       76
      C   TFGFR  - ROD FRACTIONAL FISSION GAS RELEASE                            FGRL       77
      C   TFR    - FUEL RING BOUNDARY TEMPERATURE ARRAY (F)                      FGRL       78
      C   TIMX   - TIME STEP ARRAY                                              FGRL       79
      C   TLAST  - TIME TO BEGINNING OF POWER-TIME STEP (SEC)                    FGRL       80
      C   TNOW   - TIME TO END OF POWER-TIME STEP (SEC)                          FGRL       81
      C   TOTL   - TOTAL ACTIVE FUEL LENGTH (FT)                                FGRL       82
      C                                                                          FGRL       83
      C   ************************************************************************ FGRL       84
      C   OUTPUT ARGUMENTS                                                       FGRL       85
      C   ************************************************************************ FGRL       86
      C                                                                          FGRL       87
      C   AK1    - PORTION OF GAS RELEASED WITHOUT TRAPPING                      FGRL       88
      C   AK2    - PORTION OF GAS TAHAT IS TRAPPED                               FGRL       89
      C   ANGR   - NITROGEN RELEASE PER NODE & POWER STEP (MOLES)               FGRL       90
      C   ANSD   - ARRAY USED IN ANS54 SUBROUTINE                               FGRL       91
      C   CC2    - CONSENTRATION OF FISSION GAS PER RING & NODE EOS (MOLES)      FGRL       92
      C   DPLH   - HELIUM DIFFUSION CONSTANT (1/SEC)                            FGRL       93
      C   DPN    - NITROGEN DIFFUSION CONSTANT (1/SEC)                           FGRL       94
      C   F      - FRACTION OF FISSION GAS RELEASE PER RING                      FGRL       95
      C   FH     - HELIUM FRACTION RELEAS PER RING                               FGRL       96
      C   FMA    - FISSION GAS RELEASED PER RING ( GM-MOLES )                    FGRL       97
      C   FMGR   - CUMULATIVE FISSION GAS RELEASE PER NODE & TIME (MOLES)        FGRL       98
      C   FMGPR  - FISSION GAS PRODUCTION PER RING ( GM-MOLES )                  FGRL       99
      C   FN     - NITROGEN FRACTION RELEASE PER RING                            FGRL      100
      C   HMGR   - HELIUM RELEASE PER NODE & POWER STEP (MOLES)                  FGRL      101
      C   RELEAS - FRACTION SHORT-LIVED RADIOACTIVE GASES RELEASED               FGRL      102
      C                                                                          FGRL      103
      C   ************************************************************************ FGRL      104
      C                                                                          FGRL      105
      C                                                                          FGRL      106
      C                                                                          FGRL      107
```

```
      Y(A,B) = (1.E0-EXP(-0.436E-4*(B-2.E4)))/(1.E0+(0.665E0/A)*EXP(-0.1  FGRL  108
     +107E-3*(B-2.E4)))                                                   FGRL  109
C                                                                         FGRL  110
110   PI = 3.141592654                                                    FGRL  111
      W = POWPRO(1)                                                       FGRL  112
      YY = POWPRO(2)                                                      FGRL  113
      Z = POWPRO(3)                                                       FGRL  114
      TIME(1) = TLAST                                                     FGRL  115
115   TIME(2) = TNOW                                                      FGRL  116
      NT = NA-1                                                           FGRL  117
      DELHS = DELH*3600.E0                                                FGRL  118
      RDOT = 0.0                                                          FGRL  119
C                                                                         FGRL  120
120       DO 240 I=1,2                                                    FGRL  121
          LT = I                                                          FGRL  122
C                                                                         FGRL  123
          N = 1                                                           FGRL  124
          IF (NVOID.EQ.1) N = 2                                           FGRL  125
125           DO 200 L=N,NR                                               FGRL  126
C                                                                         FGRL  127
C   CALCULATION OF HELIUM FRACTION RELEASE  ( BOOTH DIFFUSION MODEL)      FGRL  128
C                                                                         FGRL  129
C   IF(TFR(L) .LE. 1112.0) DPLH(L) = 0.28E-5 * EXP( (4.E+04/1.986) * (    FGRL  130
130 C   1.E+0/ 1673. -1.E+0/873.))                                        FGRL  131
C   THE ABOVE  COMMENTED OUT EQUATION IS REPLACED WITH THE ONE BELOW      FGRL  132
              IF (TFR(L).LE.1112.E0) DPLH(L) = 0.452847E-10               FGRL  133
C                                                                         FGRL  134
              IF (TFR(L).GT.1112.0) DPLH(L) = .28E-5*EXP((4.E+04/1.986)*  FGRL  135
135       +   (1.E+0/1673.0-1.8E+0/(TFR(L)+459.4)))                       FGRL  136
C                                                                         FGRL  137
              IF (TIME(LT).GT.(1./(PI*PI*DPLH(L)))) GO TO 100             FGRL  138
C                                                                         FGRL  139
              FH(L,I) = 4.*SQRT(DPLH(L)*TIME(LT)/PI)-3.*DPLH(L)*TIME(LT)  FGRL  140
140       +   /2.                                                         FGRL  141
C                                                                         FGRL  142
C                                                                         FGRL  143
              IF (FH(L,I).LE.0.57) GO TO 110                              FGRL  144
C                                                                         FGRL  145
145   100     COEFF = PI*PI*DPLH(L)*TIME(LT)                              FGRL  146
              COEFI = COEFF                                               FGRL  147
              IF (COEFI.GT.200.E0) COEFI = 200.E0                         FGRL  148
              FH(L,I) = 1.E0+(0.607927E0*EXP(-COEFI)-0.653644)/COEFF      FGRL  149
C                                                                         FGRL  150
150   C                                                                   FGRL  151
              IF (FH(L,I).GT.1.0) FH(L,I) = 1.0                           FGRL  152
C                                                                         FGRL  153
C   CALCULATION OF NITROGEN FRACTION RELEASE (BOOTH DIFFUSION MODEL)      FGRL  154
C                                                                         FGRL  155
155   110     DPN(L) = 0.173*EXP(-33400./(1.9969*(TFR(L)+459.4)/1.8))     FGRL  156
C                                                                         FGRL  157
              COEFF = PI*PI*DPN(L)*TIME(LT)                               FGRL  158
              COEFI = COEFF                                               FGRL  159
              IF (COEFI.GT.200.E0) COEFI = 200.E0                         FGRL  160
```

```
                      IF (COEFF.GT.1.E0) FN(L,I) = 1.E0-6.E0*EXP(-COEFI)/PI**2
      C
                      IF (COEFF.LE.1.E0) FN(L,I) = 6.0*SQRT(DPN(L)*TIME(LT)/PI)-
     +                3.0*DPN(L)*TIME(LT)
      C
                      IF (FN(L,I).GT.1.0) FN(L,I) = 1.0
      C
      C   NGASR = +,0,-1 FOR ANS-5.4,MACDONALD-WEISMAN,BOOTH FISSION GAS RELEA
      C
                      IF (NGASR.GT.0) GO TO 200
      C
      C   CALCULATION OF FISSION GAS FRACTION RELEASE ( BOOTH DIFFUSION )
      C
      C
                      IF (NGASR.NE.-1) GO TO 130
                      IF (TFR(L).LE.1292.) DPL(L) = .95E-9*EXP((3.E+04/1.986)*(1
     +                .E+0/1673.0-1.E+0/973.))
      C
                      IF (TFR(L).GT.1292.) DPL(L) = .95E-9*EXP((30000./1.986)*(1
     +                .0/1673.0-1.8/(TFR(L)+459.4)))
      C
                      IF (TIME(LT).GT.(1.0/(PI*PI*DPL(L)))) GO TO 120
                      F(L,I) = 4.0*SQRT(DPL(L)*TIME(LT)/PI)-3.0*DPL(L)*TIME(LT)/
     +                2.0
      C
                      IF (F(L,I).LE.0.57) GO TO 130
      120             COEFF = PI*PI*DPL(L)*TIME(LT)
                      COEFI = COEFF
                      IF (COEFI.GT.200.E0) COEFI = 200.E0
                      F(L,I) = 1.E0+(0.607927E0*EXP(-COEFI)-0.653644E0)/COEFF
      C
                      IF (F(L,I).GT.1.0) F(L,I) = 1.0
      C
      C   CALCULATIAN OF FISSION GAS FRACTION RELEASE
      C   (MACDONALD-WEISMAN MODEL)
      C
      130             IF (NGASR.NE.0.OR.I.EQ.1) GO TO 190
      C
                      IF (TFR(L).LE.400.0) GO TO 140
      C
      200             AK1(L) = EXP(-12450./(TFR(L)+460.)+33.95-.338*DEN)
                      AK2(L) = .25*EXP(-21410./(TFR(L)+460.))
                      GO TO 150
      140             AK1(L) = EXP(-12450./860.+33.95-.338*DEN)
      C   AK2(L) = .25 * EXP(-2.141E+04/860.)
      C   THE ABOVE COMMENTED OUT EQN. IS REPLACED BY THE ONE BELOW
                      AK2(L) = 3.855E-12
      150             F(L,I) = (1.0-(1.0-AK1(L))*((1.0-EXP(-AK2(L)*DELH))/(AK2(L
     +                )*DELH)))*AFGR
      C
                      IF (F(L,I).GT.1.0) F(L,I) = 1.0
                      IF (F(L,I).LT.0.E0) F(L,I) = 0.E0
                      IF (LT.LE.1) CC1(L,J) = 0.0
```

```
                      IF (L.EQ.1) GO TO 180                                      FGRL      214
                      IF (NVOID.EQ.1.AND.L.EQ.2) GO TO 180                       FGRL      215
215             C                                                                FGRL      216
                C     RR HAS A MINUS SIGN BECAUSE FRAPCON NODES ARE FROM SURF TO CENT  FGRL 217
                C                                                                FGRL      218
                      RR = -(RNODLS(L)**2-RNODLS(L-1)**2)/RNODLS(IGPNOD)**2      FGRL      219
                      IF (IT.GT.1) FMGPR(L) = RR*FMGP(J,2)*DELHS/TNOW            FGRL      220
220                   FMA(L) = 0.5*(F(L,I)+F(L-1,I))*FMGPR(L)+CC1(L,J)*((1.0-EXP FGRL      221
                     +      (-AK2(L)*DELH))+(1.0-EXP(-AK2(L-1)*DELH)))*0.5*AFGR FGRL      222
                C                                                                FGRL      223
                      CC2(L,J) = CC1(L,J)+FMGPR(L)-FMA(L)                        FGRL      224
                C                                                                FGRL      225
225             C                                                                FGRL      226
                C     IF IMFGAS IS ONE THE FISSION GAS RELEASE ENHANCEMENT AT BURNUPS  FGRL 227
                C     GREATER THAN 20000 MWD/MTU AS DESCRIBED IN NUREG-0418 IS USED  FGRL 228
                C                                                                FGRL      229
                      IF (IMFGAS.EQ.0) GO TO 170                                 FGRL      230
230                   IF (BP.LE.20000.E0) GO TO 170                              FGRL      231
                      AVAIL = CC1(L,J)+FMGPR(L)                                  FGRL      232
                      FOFT = FMA(L)/AVAIL                                        FGRL      233
                      IF (NOTONE.EQ.1.AND.FOFT.LT.0.01E0) FOFT = 0.01E0          FGRL      234
                      FPOFT = FOFT+(1.E0-FOFT)*Y(FOFT,BP)                        FGRL      235
235             C                                                                FGRL      236
                      IF (BPP.GT.20000.E0) GO TO 160                             FGRL      237
                      DTI = TNOW-TLAST                                           FGRL      238
                      TM = (20000.E0-BPP)*DTI/(BP-BPP)                           FGRL      239
                      FPOFT = FOFT*TM/DTI+(DTI-TM)*FPOFT/DTI                     FGRL      240
240             C                                                                FGRL      241
                160   CONTINUE                                                   FGRL      242
                C                                                                FGRL      243
                      FMA(L) = AVAIL*FPOFT                                       FGRL      244
                      CC2(L,J) = AVAIL-FMA(L)                                    FGRL      245
245             170   CONTINUE                                                   FGRL      246
                C                                                                FGRL      247
                C                                                                FGRL      248
                      FMGR(J,I) = FMGR(J,I)+FMA(L)                               FGRL      249
                180   IF (L.EQ.1) FMGR(J,I) = 0.0                                FGRL      250
250             C                                                                FGRL      251
                190   CONTINUE                                                   FGRL      252
                C                                                                FGRL      253
                200   CONTINUE                                                   FGRL      254
                C                                                                FGRL      255
255             C     NGASR GT 0 AND LT 6, BEYER-HANN                            FGRL      256
                C     NGASR GT 5, ANS54                                          FGRL      257
                      IF (NGASR.LT.6.OR.I.EQ.1) GO TO 220                        FGRL      258
                C                                                                FGRL      259
                C     CALCULATION OF FISSION GAS RELEASE                         FGRL      260
260             C     (ANS-5.4 MODEL)                                            FGRL      261
                C                                                                FGRL      262
                      BRNUP = BU-DELBP/2.                                        FGRL      263
                      JPOW = J-1                                                 FGRL      264
                      IF (DELBP.GT.2500.) WRITE (6,250) IT,JPOW,DELBP            FGRL      265
265                   NFN = 11                                                   FGRL      266
```

```
                C                                                                    FGRL   267
                C   CONVERSION FACTOR - INCHES * .0254 = METERS                      FGRL   268
                      RDEL = DP*0.0254/2./(NFN-1)                                    FGRL   269
                C                                                                    FGRL   270
270             C   CALCULATE FLUX DEPRESSION ARRAY                                  FGRL   271
                          DO 210 IRV=1,NFN                                           FGRL   272
                          DV(IRV) = (IRV-1)*RDEL                                     FGRL   273
                C                                                                    FGRL   274
                C   RV IS FUNCTION OF RADIUS                                        FGRL   275
275                       RV(IRV) = Z+DV(IRV)**2*YY+DV(IRV)**4*W                     FGRL   276
                C                                                                    FGRL   277
                C   CONVERT DV TO DIAMETER FOR USE IN ANS54                         FGRL   278
                          DV(IRV) = DV(IRV)*2./.0254                                 FGRL   279
                210       CONTINUE                                                   FGRL   280
280             C                                                                    FGRL   281
                     CALL ANS54 (IT,BRNUP,DP,JPOW,NT,IM,RV,DV,NFN,TIMX,B,Q,RC,RDOT,  FGRL   282
                    +    NA,QMPY,JST,RELEAS,DEN,DCO,NGASR,ANSD,FLXFAC,PF,ANSR,FF,DT,DEC FGRL   283
                    +    AY,HALF,PFAVE)                                             FGRL   284
                C                                                                    FGRL   285
285             220       CONTINUE                                                   FGRL   286
                C                                                                    FGRL   287
                C   CALCULATION OF THE INCREMENT AVERAGE GAS FRACTION RELEASE OF     FGRL   288
                C   FISSION GAS , HELIUM , AND NITROGEN                             FGRL   289
                C                                                                    FGRL   290
290                   FL = 0.E0                                                      FGRL   291
                      FLH = 0.E0                                                     FGRL   292
                      FNN = 0.E0                                                     FGRL   293
                      M = 2                                                          FGRL   294
                      IF (NVOID.EQ.1) M = 3                                          FGRL   295
295                       DO 230 IL=M,NR                                             FGRL   296
                          RR = -(RNODLS(IL)**2-RNODLS(IL-1)**2)/2.E0                 FGRL   297
                          IF (NGASR.LE.0) FL = FL+(F(IL,I)+F(IL-1,I))*RR             FGRL   298
                          FLH = FLH+(FH(IL,I)+FH(IL-1,I))*RR                         FGRL   299
                          FNN = FNN+(FN(IL,I)+FN(IL-1,I))*RR                         FGRL   300
300             230       CONTINUE                                                   FGRL   301
                      NRINGS = NR-1                                                  FGRL   302
                      IF (NVOID.EQ.1) NRINGS = NRINGS-1                              FGRL   303
                      RPSTN = RNODLS(ICPNOD)**2*NRINGS                               FGRL   304
                      FRD = FL/RPSTN                                                 FGRL   305
305                   IF (NGASR.GT.0) FRD = RDOT                                     FGRL   306
                      FRDH = FLH/RPSTN                                               FGRL   307
                      FRDN = FNN/RPSTN                                               FGRL   308
                C                                                                    FGRL   309
                C   CALCULATION OF FISSION GAS, HELIUM AND NITROGEN RELEASE IN MOLES  FGRL   310
310             C                                                                    FGRL   311
                      IF (NGASR.NE.0) FMGR(J,I) = FRD*FMGP(J,I)                      FGRL   312
                      HMGR(J,I) = FRDH*HMGP(J,I)                                     FGRL   313
                      ANGR(J,I) = FRDN*ANGI/(TOTL/DELTAZ)                            FGRL   314
                C                                                                    FGRL   315
315             240       CONTINUE                                                   FGRL   316
                C                                                                    FGRL   317
                     ANG(J,2) = AMAX1((ANG(J,1)-ANGR(J,2)+ANGR(J,1)),0.E+0)          FGRL   318
                C                                                                    FGRL   319
```

```
                RETURN                                                                  FGRL      320
320             C                                                                       FGRL      321
                250   FORMAT (" TIME STEP, AXIAL NODE, INCREMENTAL BURNUP"/1X,I6,5X,I6,E FGRL      322
               +11.2/" INCREMENTAL BURNUP GREATER THAN 2500 MWD/MTM - SEE ANS54")       FGRL      323
                END                                                                     FGRL      324
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FGASRE	1	319

VARIABLES

		SN	TYPE		RELOCATION									
0	AFGR		REAL		F.P.	REFS	207	220	DEFINED	1				
0	AKI		REAL	ARRAY	F.P.	REFS	19	207	DEFINED	1	200	203		
0	AK2		REAL	ARRAY	F.P.	REFS	19	2*207	2*220	DEFINED	1	201	206	
0	ANG		REAL	ARRAY	F.P.	REFS	19	317	DEFINED	1	317			
0	ANGI		REAL		F.P.	REFS	313	DEFINED	1					
0	ANGR		REAL	ARRAY	F.P.	REFS	19	2*317	DEFINED	1	313			
0	ANSD		REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1				
0	ANSR		REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1				
1327	AVAIL		REAL			REFS	232	243	244	DEFINED	231			
0	B		REAL	ARRAY	F.P.	REFS	25	281	DEFINED	1				
0	BP		REAL		F.P.	REFS	230	2*234	238	DEFINED	1			
0	BPP		REAL		F.P.	REFS	236	2*238	DEFINED	1				
1334	BRNUP		REAL			REFS	281	DEFINED	262					
0	BU		REAL		F.P.	REFS	262	DEFINED	1					
0	CC1		REAL	ARRAY	F.P.	REFS	19	220	223	231	DEFINED	1	212	
0	CC2		REAL	ARRAY	F.P.	REFS	19	DEFINED	1	223	244			
1324	COEFF		REAL			REFS	146	148	158	160	162	187	189	
						DEFINED	145	157	186					
1325	COEFI		REAL			REFS	147	148	159	160	188	189		
						DEFINED	146	147	158	159	187	188		
0	DCO		REAL		F.P.	REFS	281	DEFINED	1					
0	DECAY		REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1				
0	DELBP		REAL		F.P.	REFS	262	2*264	DEFINED	1				
0	DELH		REAL		F.P.	REFS	117	2*207	2*220	DEFINED	1			
1316	DELHS		REAL			REFS	219	DEFINED	117					
0	DELTAZ		REAL		F.P.	REFS	313	DEFINED	1					
0	DEN		REAL		F.P.	REFS	200	203	281	DEFINED	1			
0	DP		REAL		F.P.	REFS	268	281	DEFINED	1				
0	DPL		REAL	ARRAY	F.P.	REFS	19	181	2*182	186	DEFINED	1	175	
						178								
0	DPLH		REAL	ARRAY	F.P.	REFS	19	137	2*139	145	DEFINED	1	132	
						134								
0	DPN		REAL	ARRAY	F.P.	REFS	19	157	2*162	DEFINED	1	155		
0	DT		REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1				
1332	DTI		REAL			REFS	238	3*239	DEFINED	237				
1355	DV		REAL	ARRAY		REFS	26	2*275	278	281	DEFINED	272	278	
0	F		REAL	ARRAY	F.P.	REFS	19	185	191	210	211	2*220	2*297	

VARIABLES	SN	TYPE	RELOCATION									
					DEFINED	1	182	189	191	207	210	211
0	FF	REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1			
0	FH	REAL	ARRAY	F.P.	REFS	19	143	151	2*298	DEFINED	1	139
					148	151						
1341	FL	REAL			REFS	297	304	DEFINED	290	297		
1342	FLH	REAL			REFS	298	306	DEFINED	291	298		
0	FLXFAC	REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1			
0	FMA	REAL	ARRAY	F.P.	REFS	19	223	232	244	248		
					DEFINED	1	220	243				
0	FMGP	REAL	ARRAY	F.P.	REFS	19	219	311	DEFINED	1		
0	FMGPR	REAL	ARRAY	F.P.	REFS	19	220	223	231	DEFINED	1	219
0	FMGR	REAL	ARRAY	F.P.	REFS	19	248	DEFINED	1	248	249	311
0	FN	REAL	ARRAY	F.P.	REFS	19	165	2*299	DEFINED	1	160	162
					165							
1343	FNN	REAL			REFS	299	307	DEFINED	292	299		
1330	FOFT	REAL			REFS	233	3*234	239	DEFINED	232	233	
1331	FPOFT	REAL			REFS	239	243	DEFINED	234	239		
1350	FRD	REAL			REFS	311	DEFINED	304	305			
1351	FRDH	REAL			REFS	312	DEFINED	306				
1352	FRDN	REAL			REFS	313	DEFINED	307				
0	HALF	REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1			
0	HMGP	REAL	ARRAY	F.P.	REFS	19	312	DEFINED	1			
0	HMGR	REAL	ARRAY	F.P.	REFS	19	DEFINED	1	312			
1320	I	INTEGER			REFS	121	139	143	148	2*151	160	162
					2*165	182	185	189	2*191	196	207	2*210
					2*211	2*220	2*248	249	257	2*297	2*298	2*299
					2*311	2*312	313	DEFINED	120			
0	IGPNOD	INTEGER		F.P.	REFS	218	303	DEFINED	1			
1345	IL	INTEGER			REFS	2*296	2*297	2*298	2*299	DEFINED	295	
0	IM	INTEGER		F.P.	REFS	3*25	281	DEFINED	1			
0	IMFGAS	INTEGER		F.P.	REFS	229	DEFINED	1				
1340	IRV	INTEGER			REFS	2*272	3*275	2*278	DEFINED	271		
0	IT	INTEGER		F.P.	REFS	219	264	281	DEFINED	1		
0	J	INTEGER		F.P.	REFS	212	219	220	2*223	231	244	2*248
					249	263	2*311	2*312	313	4*317		
					DEFINED	1						
1335	JPOW	INTEGER			REFS	264	281	DEFINED	263			
0	JST	INTEGER	ARRAY	F.P.	REFS	25	281	DEFINED	1			
1323	L	INTEGER			REFS	2*132	3*134	137	3*139	143	145	148
					2*151	2*155	157	160	3*162	2*165	2*175	3*178
					181	3*182	185	186	189	2*191	198	2*200
					2*201	203	206	4*207	2*210	2*211	212	213
					214	2*218	219	7*220	4*223	2*231	232	243
					2*244	248	249	DEFINED	125			
1321	LT	INTEGER			REFS	137	2*139	145	157	2*162	181	2*182
					186	212	DEFINED	121				
1344	M	INTEGER			REFS	295	DEFINED	293	294			
1322	N	INTEGER			REFS	125	DEFINED	123	124			
0	NA	INTEGER		F.P.	REFS	6*19	25	116	281	DEFINED	1	
1336	NFN	INTEGER			REFS	268	271	281	DEFINED	265		
0	NGASR	INTEGER		F.P.	REFS	169	174	196	257	281	297	305
					311	DEFINED	1					
0	NOTONE	INTEGER		F.P.	REFS	233	DEFINED	1				

VARIABLES	SN	TYPE		RELOCATION								
0	NR	INTEGER		F.P.	REFS	5*19	125	295	301	DEFINED	1	
1346	NRINGS	INTEGER			REFS	302	303	DEFINED	301	302		
1315	NT	INTEGER			REFS	281	DEFINED	116				
0	NVOID	INTEGER		F.P.	REFS	124	214	294	302	DEFINED	1	
0	PF	REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1			
0	PFAVE	REAL		F.P.	REFS	281	DEFINED	1				
1311	PI	REAL			REFS	2*137	139	2*145	2*157	160	162	2*181
					182	2*186	DEFINED	110				
0	POWPRO	REAL	ARRAY	F.P.	REFS	24	111	112	113	DEFINED	1	
0	Q	REAL	ARRAY	F.P.	REFS	25	281	DEFINED	1			
0	QMPY	REAL	ARRAY	F.P.	REFS	25	281	DEFINED	1			
0	RC	REAL		F.P.	REFS	281	DEFINED	1				
1337	RDEL	REAL			REFS	272	DEFINED	268				
1317	RDOT	REAL			REFS	281	305	DEFINED	118			
0	RELEAS	REAL	ARRAY	F.P.	REFS	27	281	DEFINED	1			
0	RNODLS	REAL	ARRAY	F.P.	REFS	19	3*218	2*296	303	DEFINED	1	
1347	RPSTN	REAL			REFS	304	306	307	DEFINED	303		
1326	RR	REAL			REFS	219	297	298	299	DEFINED	218	296
1401	RV	REAL	ARRAY		REFS	26	281	DEFINED	275			
0	TFR	REAL	ARRAY	F.P.	REFS	19	132	2*134	155	175	2*178	198
					200	201	DEFINED	1				
1353	TIME	REAL	ARRAY		REFS	19	137	2*139	145	157	2*162	181
					2*182	186	DEFINED	114	115			
0	TIMX	REAL	ARRAY	F.P.	REFS	25	281	DEFINED	1			
0	TLAST	REAL		F.P.	REFS	114	237	DEFINED	1			
1333	TM	REAL			REFS	2*239	DEFINED	238				
0	TNOW	REAL		F.P.	REFS	115	219	237	DEFINED	1		
0	TOTL	REAL		F.P.	REFS	313	DEFINED	1				
1312	W	REAL			REFS	275	DEFINED	111				
1313	YY	REAL			REFS	275	DEFINED	112				
1314	Z	REAL			REFS	275	DEFINED	113				

FILE NAMES	MODE			
TAPE6	FMT	WRITES	264	

EXTERNALS	TYPE	ARGS		REFERENCES								
ANS54		30		281								
EXP	REAL	1	LIBRARY	134	148	155	160	175	178	189	200	201
				203	207	2*220	2*234					
SQRT	REAL	1	LIBRARY	139	162	162						

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
AMAX1	REAL	0	INTRIN		317
Y	REAL	2	SF	107	234

STATEMENT LABELS		DEF LINE	REFERENCES	
127	100	145	137	
162	110	155	143	
325	120	186	181	
360	130	196	174	185
413	140	203	198	
426	150	207	202	
630	160	241	236	

STATEMENT LABELS			DEF LINE	REFERENCES	
641	170		245	229	230
650	180		249	213	214
656	190		251	196	
657	200		253	125	169
0	210		279	271	
765	220		285	257	
0	230		300	295	
0	240		315	120	
1207	250	FMT	321	264	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
43	240	I	120 315	1053B	EXT REFS	NOT INNER
55	200	L	125 253	605B	EXT REFS	
713	210	IRV	271 279	20B	OPT	
1003	230	IL	295 300	36B	OPT	

STATISTICS

PROGRAM LENGTH 1663B 947

1400000B SCM USED

```
      SUBROUTINE FLMDRP (CRDTR,CRDTT,DE,G,HCOEF,ICOR,IT,J,NA,P2,QC,TCO,T FLMD
     +IME,TSAT,WT,DELTCR,DELTDB,DELTFC,DELTJL)                           FLMD
C                                                                        FLMD
C     IMPLICIT  REAL * 8 ( A-H,O-Z )                                     FLMD
C                                                                        FLMD
C     ***************************************************************** FLMD
C                                                                        FLMD
C     THIS SUBROUTINE IS CALLED FROM MAIN AND CALCULATES THE TEMPERATURE FLMD
C     DROP ACROSS THE FILM AND CRUD                                      FLMD
C     FLMDRP WAS CODED BY G A BERNA NOVEMBER 1977.                       FLMD
C                                                                        FLMD
C     ***************************************************************** FLMD
C     INPUT ARGUMENTS                                                    FLMD
C     ***************************************************************** FLMD
C                                                                        FLMD
C     CRDTR  - CRUD DEPOSITION RATE (MILS/HR)                            FLMD
C     DE     - EQUIVALENT HYDRAULIC DIAMETER (FT)                        FLMD
C     G      - MASS FLUX OF COOLANT (LBM/HR-FT**2)                       FLMD
C     ICOR   - CRUD DEPOSITION INDEX                                     FLMD
C     IT     - POWER-TIME STEP INDEX                                     FLMD
C     J      - AXIAL NODE INDEX                                          FLMD
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                             FLMD
C     P2     - COOLANT PRESSURE DURING POWER-TIME STEP (PSIA)            FLMD
C     QC     - HEAT FLUX AT NODE J (BTU/HR-FT**2)                        FLMD
C     TIME   - END OF STEP TIME (SEC)                                    FLMD
C     TSAT   - SATURATION TEMPERATURE (F)                                FLMD
C     WT     - AVERAGE BULK WATER TEMPERATURE (F)                        FLMD
C                                                                        FLMD
C     ***************************************************************** FLMD
C     OUTPUT ARGUMENTS                                                   FLMD
C     ***************************************************************** FLMD
C                                                                        FLMD
C     CRDTT  - CRUD THICKNESS (MILS)                                     FLMD
C     DELTCR - TEMPERATURE DROP ACROSS THE CRUD (F)                      FLMD
C     DELTDB - TEMPERATURE DROP ACROSS THE FILM USING DITTUS-BOELTER (F) FLMD
C     DELTFC - TEMPERATURE DROP ACROSS THE FILM TOTAL FORCED CONVEC. (F) FLMD
C     DELTJL - TEMPERATURE DROP ACROSS THE FILM USING JENS-LOTTES (F)    FLMD
C     HCOEF  - SURFACE HEAT TRANSFER COEFFICIENT (BTU/HR-FT**2-F)        FLMD
C     TCO    - ROD SURFACE TEMPERATURE (F)                               FLMD
C                                                                        FLMD
C     ***************************************************************** FLMD
C                                                                        FLMD
      DIMENSION     HCOEF(1)      ,P2(1)         ,TIME(1)              FLMD
C                                                                        FLMD
      IF (G.EQ.0.0) GO TO 100                                            FLMD
C                                                                        FLMD
      IF (ICOR.EQ.2) CRDTT = CRDTR*(TIME(IT)/3600.E0)                    FLMD
C                                                                        FLMD
C     CALCULATION OF FILM TEMPERATURE DROP                               FLMD
C     HFLMDB IS THE DITTUS-BOELTER FILM    COEFF.                        FLMD
C     DELTCR IS THE CRUD TEMPERATURE DROP                                FLMD
C     DELTJL IS THE JENS-LOTTES FILM DROP  ****WCAP 2059,PP 21-22        FLMD
C                                                                        FLMD
```

```
                HFLMDB = ((-5.1889E-5+6.5044E-8*WT)*WT+(3.5796E-7-1.0337E-9*WT)*P2 FLMD      55
55             +(IT)+3.2377E-2)*G*(G*DE)**(-0.2)                                   FLMD      56
                DELTDB = QC/HFLMDB                                                 FLMD      57
                DELTCR = QC*CRDTT/6000.0                                           FLMD      58
                DELTFC = DELTDB+DELTCR                                             FLMD      59
                DELTJL = 1.9*QC**0.25*EXP(-1.111E-3*P2(IT))                        FLMD      60
60              TCO = AMIN1(WT+DELTDB,TSAT+DELTJL)+DELTCR                          FLMD      61
                IF (ICOR.EQ.0) TCO = AMIN1(WT+DELTFC,TSAT+DELTJL)                  FLMD      62
                HCOEF(J) = HFLMDB                                                  FLMD      63
                DLTSAT = TCO-TSAT                                                  FLMD      64
                IF (WT+DELTFC.GT.TSAT+DELTJL) HCOEF(J) = QC/(DLTSAT+DELTCR)        FLMD      65
65          C                                                                      FLMD      66
            C                                                                      FLMD      67
            C                                                                      FLMD      68
            100 IF (G.EQ.0.0) TCO = WT                                             FLMD      69
                RETURN                                                             FLMD      70
70              END                                                                FLMD      71
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

SN	ENTRY POINTS	DEF LINE	REFERENCES
4	FLMDRP	1	69

VARIABLES

SN	VARIABLES	TYPE		RELOCATION									
0	CRDTR	REAL		F.P.	REFS	47	DEFINED	1					
0	CRDTT	REAL		F.P.	REFS	57	DEFINED	1	47				
0	DE	REAL		F.P.	REFS	54	DEFINED	1					
0	DELTCR	REAL		F.P.	REFS	58	60	64	DEFINED	1	57		
0	DELTDB	REAL		F.P.	REFS	58	60	DEFINED	1	56			
0	DELTFC	REAL		F.P.	REFS	61	64	DEFINED	1	58			
0	DELTJL	REAL		F.P.	REFS	60	61	64	DEFINED	1	59		
165	DLTSAT	REAL			REFS	64	DEFINED	63					
0	G	REAL		F.P.	REFS	45	2*54	68	DEFINED	1			
0	HCOEF	REAL	ARRAY	F.P.	REFS	43	DEFINED	1	62	64			
164	HFLMDB	REAL			REFS	56	62	DEFINED	54				
0	ICOR	INTEGER		F.P.	REFS	47	61	DEFINED	1				
0	IT	INTEGER		F.P.	REFS	47	54	59	DEFINED	1			
0	J	INTEGER		F.P.	REFS	62	64	DEFINED	1				
0	NA	INTEGER	*UNUSED	F.P.	DEFINED	1							
0	P2	REAL	ARRAY	F.P.	REFS	43	54	59	DEFINED	1			
0	QC	REAL		F.P.	REFS	56	57	59	64	DEFINED	1		
0	TCO	REAL		F.P.	REFS	63	DEFINED	1	60	61	68		
0	TIME	REAL	ARRAY	F.P.	REFS	43	47	DEFINED	1				
0	TSAT	REAL		F.P.	REFS	60	61	63	64	DEFINED	1		
0	WT	REAL		F.P.	REFS	3*54	60	61	64	68			
					DEFINED	1							

```
EXTERNALS          TYPE   ARGS       REFERENCES
      EXP          REAL      1 LIBRARY     59

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE  REFERENCES
      AMINI        REAL      0  INTRIN                60        61

STATEMENT LABELS              DEF LINE   REFERENCES
  131  100                        68         45

STATISTICS
  PROGRAM LENGTH                 166B      118
        140000B SCM USED
```

```
      SUBROUTINE FLOBLK (CTEMP,STRESS,FB,PFB,PFR)                       FLOB      2
                                                                        FLOB      3
C     SUBROUTINE FLOBLK PREDICTS THE NUMBER OF FAILED FUEL RODS AS A    FLOB      4
C     FUNCTION OF NORMALIZED PRESSURE AND CLADDING TEMPERATURE.  THIS   FLOB      5
C     ROUTINE IS SPECIFIC TO A TRANSIENT HIGH TEMPERATURE CALLING       FLOB      6
C     SUBCODE.  FLOBLK ALSO RETURNS FLOW BLOCKAGE PREDICTIONS AS A      FLOB      7
C     FUNCTION OF NORMALIZED PRESSURE.  THE FLOW BLOCKAGE IS CURRENTLY  FLOB      8
C     RETURNED AS AN ARRAY WITH CORRESPONDING VALUES OF PROBABILITIES   FLOB      9
C     OF EXCEEDING EACH FLOW BLOCKAGE PREDICTION.                       FLOB     10
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                          FLOB     11
C                                                                       FLOB     12
C                                                                       FLOB     13
C     -- INPUT ARGUMENTS --                                             FLOB     14
C                                                                       FLOB     15
C     CTEMP      CLADDING TEMPERATURE ( DEG K )                         FLOB     16
C     STRESS     ENGINEERING HOOP STRESS ( N/M2 )                       FLOB     17
C                                                                       FLOB     18
C                                                                       FLOB     19
C     -- OUTPUT ARGUMENTS --                                            FLOB     20
C                                                                       FLOB     21
C     FB         ARRAY OF FLOW BLOCKAGE PREDICTIONS ( FRACTIONAL VALUE) FLOB     22
C     PFB        ARRAY CONTAINING THE PROBABILITIES OF EXCEEDING THE    FLOB     23
C     FLOW BLOCKAGES CONTAINED IN FB ( FRACTIONAL VALUE )               FLOB     24
C     PFR        PROBABILITY OF ROD FAILURE ( FRACTIONAL VALUE )        FLOB     25
C                                                                       FLOB     26
      DIMENSION FB( 23 ),  PFB( 20 )                                    FLOB     27
      DATA GAMF, ENETAF / 5.4E0, 9.2E0 /                                FLOB     28
      DATA GAMS, ENETAS /1.047E0, 3.090E0/                              FLOB     29
      DATA GAMT, ENETAT/4.61E0, 3.93E0/                                 FLOB     30
      DATA ST, SB, TTB / 8.5E2, 3.2E3, 2.5E2 /                          FLOB     31
      DATA CONVS, CONVT1, CONVT2 / 6.8947572E3, 4.5967E2, 1.8E0 /       FLOB     32
      DATA A1, A2, A3, A4, A5 / 5.018866387E4, -3.714887I3E0,           FLOB     33
     +          7.0817526E-1, -2.580377E-2, -6.9187468755E4 /          FLOB     34
      DATA BSTRES, BTEMP /2 (0.E0)/                                     FLOB     35
      DATA DEVS, DEVT / 2.816508E6, 3.9E1 /                             FLOB     36
      DATA A, BI, CI / -1.827359E-2, 1.19190606E3, 2.5633I7625E5 /      FLOB     37
C                                                                       FLOB     38
C                                                                       FLOB     39
C                                                                       FLOB     40
      CALL BURST (CTEMP,STRESS,BSTRES,BTEMP,DEVS,DEVT)                  FLOB     41
      STRS = STRESS/CONVS                                               FLOB     42
      TEMP = CONVT2*CTEMP-CONVT1                                        FLOB     43
      S = BSTRES/CONVS                                                  FLOB     44
      T = BTEMP*CONVT2-CONVT1                                           FLOB     45
      IF (STRS.LT.2000.) GO TO 100                                      FLOB     46
      TLS = STRS-ST                                                     FLOB     47
      BLS = STRS+SB                                                     FLOB     48
      TLIMIT = (A1*TLS)/(A2+A3*TLS)+A4*TLS+A5+TTB                       FLOB     49
      BLIMIT = (A1*BLS)/(A2+A3*BLS)+A4*BLS+A5-TTB                       FLOB     50
      IF (BLIMIT.LT.0.E0) BLIMIT = 0.E0                                 FLOB     51
      X = (TEMP-BLIMIT)/(TLIMIT-BLIMIT)                                 FLOB     52
      EGAMMA = GAMT                                                     FLOB     53
      ENETA = ENETAT                                                    FLOB     54
```

```
                GO TO 110                                                       FLOB       55
55          100 TLT = TEMP-TTB                                                  FLOB       56
                B = BI-A3*TLT                                                   FLOB       57
                C = CI-A2*TLT                                                   FLOB       58
                TLIMIT = ST+(-B-SQRT(B*B-4.0*A*C))/(2.0*A)                      FLOB       59
                BLIMIT = 0.E0                                                   FLOB       60
60              X = STRS/TLIMIT                                                 FLOB       61
                X = (X-.5897E-1)/.9763E0                                        FLOB       62
                EGAMMA = GAMS                                                   FLOB       63
                ENETA = ENETAS                                                  FLOB       64
            110 CALL BDTR (X,EGAMMA,ENETA,P,D,IER)                              FLOB       65
65              DELPFR = P-PFR                                                  FLOB       66
                IF (DELPFR.LT.0.) DELPFR = 0.E0                                 FLOB       67
                IF (PFR.GT.P) P = PFR                                           FLOB       68
                PFR = P                                                         FLOB       69
            C                                                                   FLOB       70
7           C   CALCULATE FLOW BLOCKAGE                                         FLOB       71
70          C                                                                   FLOB       72
                CALL FBLOK (STRESS,DFB,FBAVG)                                   FLOB       73
                TL = FBAVG+1.7*DFB                                              FLOB       74
                BL = FBAVG-DFB                                                  FLOB       75
75              IF (BL.LT.0.) BL = 0.E0                                         FLOB       76
                    DO 120 I=1,20                                               FLOB       77
                    XF = (FB(I)-BL)/(TL-BL)                                     FLOB       78
                    CALL BDTR (XF,GAMF,ENETAF,PROB,D,IER)                       FLOB       79
                    PFB(I) = PFB(I)+(1.0-PROB)*DELPFR                           FLOB       80
80          120     CONTINUE                                                    FLOB       81
                FB(21) = FB(21)+FBAVG*DELPFR                                    FLOB       82
                FB(22) = FB(22)+TL*DELPFR                                       FLOB       83
                IF (FB(22).GT.1.0) FB(22) = 1.0                                 FLOB       84
                FB(23) = FB(23)+BL*DELPFR                                       FLOB       85
85              RETURN                                                          FLOB       86
                END                                                             FLOB       87
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	FLOBLK	1	85

VARIABLES	SN	TYPE	RELOCATION									
317	A	REAL		REFS	2*58	DEFINED	36					
306	AI	REAL		REFS	48	49	DEFINED	32				
307	A2	REAL		REFS	48	49	57	DEFINED	32			
310	A3	REAL		REFS	48	49	56	DEFINED	32			
311	A4	REAL		REFS	48	49	DEFINED	32				
312	A5	REAL		REFS	48	49	DEFINED	32				
345	B	REAL		REFS	3*58	DEFINED	56					
320	BI	REAL		REFS	56	DEFINED	36					
356	BL	REAL		REFS	75	2*77	84	DEFINED	74	75		

VARIABLES	SN	TYPE	RELOCATION									
340	BLIMIT	REAL			REFS	50	2*51	DEFINED	49	50	59	
336	BLS	REAL			REFS	3*49	DEFINED	47				
313	BSTRES	REAL			REFS	40	43	DEFINED	34			
314	BTEMP	REAL			REFS	40	44	DEFINED	34			
346	C	REAL			REFS	58	DEFINED	57				
321	CI	REAL			REFS	57	DEFINED	36				
303	CONVS	REAL			REFS	41	43	DEFINED	31			
304	CONVT1	REAL			REFS	42	44	DEFINED	31			
305	CONVT2	REAL			REFS	42	44	DEFINED	31			
0	CTEMP	REAL		F.P.	REFS	40	42	DEFINED	1			
350	D	REAL			REFS	64	78					
352	DELPFR	REAL			REFS	66	79	81	82	84		
					DEFINED	65	66					
315	DEVS	REAL			REFS	40	DEFINED	35				
316	DEVT	REAL			REFS	40	DEFINED	35				
353	DFB	REAL			REFS	72	73	74				
342	EGAMMA	REAL			REFS	64	DEFINED	52	62			
343	ENETA	REAL			REFS	64	DEFINED	53	63			
273	ENETAF	REAL			REFS	78	DEFINED	27				
275	ENETAS	REAL			REFS	63	DEFINED	28				
277	ENETAT	REAL			REFS	53	DEFINED	29				
0	FB	REAL	ARRAY	F.P.	REFS	26	77	81	82	83	84	
					DEFINED	1	81	82	83	84		
354	FBAVG	REAL			REFS	72	73	74	81			
272	GAMF	REAL			REFS	78	DEFINED	27				
274	GAMS	REAL			REFS	62	DEFINED	28				
276	GAMT	REAL			REFS	52	DEFINED	29				
357	I	INTEGER			REFS	77	2*79	DEFINED	76			
351	IER	INTEGER			REFS	64	78					
347	P	REAL			REFS	64	65	67	68	DEFINED	67	
0	PFB	REAL	ARRAY	F.P.	REFS	26	79	DEFINED	1	79		
0	PFR	REAL		F.P.	REFS	65	2*67	DEFINED	1	68		
361	PROB	REAL			REFS	78	79					
333	S	* REAL			DEFINED	43						
301	SB	REAL			REFS	47	DEFINED	30				
300	ST	REAL			REFS	46	58	DEFINED	30			
0	STRESS	REAL		F.P.	REFS	40	41	72	DEFINED	1		
331	STRS	REAL			REFS	45	46	47	60	DEFINED	41	
334	T	* REAL			DEFINED	44						
332	TEMP	REAL			REFS	51	55	DEFINED	42			
355	TL	REAL			REFS	77	82	DEFINED	73			
337	TLIMIT	REAL			REFS	51	60	DEFINED	48	58		
335	TLS	REAL			REFS	3*48	DEFINED	46				
344	TLT	REAL			REFS	56	57	DEFINED	55			
302	TTB	REAL			REFS	48	49	55	DEFINED	30		
341	X	REAL			REFS	61	64	DEFINED	51	60	61	
360	XF	REAL			REFS	78	DEFINED	77				

EXTERNALS	TYPE	ARGS		REFERENCES	
BDTR		6		64	78
BURST		6		40	
FBLOK		3		72	
SQRT	REAL	1	LIBRARY	58	

```
STATEMENT LABELS                DEF LINE   REFERENCES
  100  100                          55         45
  141  110                          64         54
    0  120                          80         76

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  176  120      I           76 80       17B                EXT REFS

STATISTICS
  PROGRAM LENGTH                    365B     245
        140000B SCM USED
```

```
      SUBROUTINE FLUXD (ENRCH,DEN,TINLET,Z,YY,W,R,RAPOW,IPLANT,IT,NDBG,T
     +,NR)
C
C     IMPLICIT  REAL * 8 ( A-H,O-Z )
C
C     ******************************************************************
C
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES FLUX DEPRESSION
C     COEFFICIENTS Z, YY, AND W FOR USE IN THE DDLF FUEL TEMPERATURE
C     DISTRIBUTION
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     ENRCH  - FUEL ENRICHMENT (PERCENT)
C     DEN    - PERCENT OF THEORETICAL DENSITY
C     IPLANT - RADIAL PROFILE INDEX
C     IT     - POWER-TIME STEP INDEX
C     NDBG   - DEBUG OUTPUT INDEX
C     NR     - NUMBER OF RADIAL NODES
C     R      - FUEL RING RADII (IN)
C     RAPOW  - NORMALIZED RADIAL POWER PROFILE
C     T      - TIME TO THE END OF STEP (HRS)
C     TINLET - COOLANT INLET TEMPERATURE (F)
C
C     ******************************************************************
C     OUTPUT ARGUMENTS
C     ******************************************************************
C
C     W,YY,&Z- FLUX DEPRESSION COEFFICIENTS
C
C     ******************************************************************
C
      DIMENSION  A(3,3) , B(3) , R(NR) , RAPOW(NR)
C
      DATA N3 / 3 / , CINTMS / 6.4516E-4 /
      DATA SIGA5,SIGA8,SIGAO,SIGT5,SIGT8,SIGTO/578.,2.33,0.,586.5,10.8,4
     +.2/
C
      IF (IPLANT.NE.0) GO TO 100
C
      FR35 = ENRCH/100.E0
      RHO = 10.97*DEN/100.E0
      FR38 = 1.-FR35
      EN5 = RHO*FR35*.00225927
      EN8 = RHO*FR38*.00223079
      ENO = (EN5+EN8)*2.
      SGA = (EN5*SIGA5+EN8*SIGA8+ENO*SIGAO)
      SGT = (EN5*SIGT5+EN8*SIGT8+ENO*SIGTO)
      CAPSQ = 3.*SGA*SGT*(1.-.8*SGA/SGT)
      CORR = .6*((TINLET-70.)/(394.))+1.0
      CAPPA = SQRT(CAPSQ)*CORR
```

```
                CAPSQ = CAPPA**2                                                  FLUXD      55
55              Z = 1.                                                            FLUXD      56
                YY = CAPSQ/4.*1.E4                                                FLUXD      57
                W = YY**2/4.                                                      FLUXD      58
                GO TO 110                                                         FLUXD      59
            100 CONTINUE                                                          FLUXD      60
60          C   THE FOLLOWING CALL TO PWRDEP COMPUTES THE RADIAL POWER            FLUXD      61
            C   DISTRIBUTION AS A FUNCTION OF TIME AND ENRICHMENT USING A FIT     FLUXD      62
            C   TO "LASER" PREDICTIONS                                            FLUXD      63
            C                                                                     FLUXD      64
                IF (IPLANT.GE.1) CALL PWRDEP (ENRCH,T,IPLANT,IT,NDBG,P1,P2,P3)    FLUXD      65
65          C                                                                     FLUXD      66
            C                                                                     FLUXD      67
            C   THE FOLLOWING CODING CREATES THE THREE COEFFICIENTS               FLUXD      68
            C   FOR DDLF WHEN THE USER SPECIFIES RADIAL POWER INPUT               FLUXD      69
            C                                                                     FLUXD      70
70              B(1) = 1.E0                                                       FLUXD      71
                B(2) = RAPOW(1)/RAPOW(NR)                                         FLUXD      72
                B(3) = RAPOW(9)/RAPOW(NR)                                         FLUXD      73
                IF (IPLANT.GE.1) PCENT = P3                                       FLUXD      74
                IF (IPLANT.GE.1.AND.R(NR).GT.0.E0) PCENT = P1*(R(NR)/R(1))**P2+P3 FLUXD      75
75              IF (IPLANT.GE.1) B(2) = (P1+P3)/PCENT                             FLUXD      76
                IF (IPLANT.GE.1) B(3) = (P1*0.3E0**P2+P3)/PCENT                   FLUXD      77
                A(1,1) = 1.E0                                                     FLUXD      78
                A(1,2) = R(11)*R(11)*CINTMS                                       FLUXD      79
                A(1,3) = A(1,2)*A(1,2)                                            FLUXD      80
80              A(2,1) = 1.E0                                                     FLUXD      81
                A(2,2) = R(1)*R(1)*CINTMS                                         FLUXD      82
                A(2,3) = A(2,2)*A(2,2)                                            FLUXD      83
                A(3,1) = 1.E0                                                     FLUXD      84
                A(3,2) = R(9)*R(9)*CINTMS                                         FLUXD      85
85              IF (IPLANT.GE.1) A(3,2) = (R(1)*0.3E0)**2*CINTMS                  FLUXD      86
                A(3,3) = A(3,2)*A(3,2)                                            FLUXD      87
            C                                                                     FLUXD      88
                CALL SIMQ (A,B,N3,KS)                                             FLUXD      89
            C                                                                     FLUXD      90
90              W = B(3)                                                          FLUXD      91
                YY = B(2)                                                         FLUXD      92
                Z = B(1)                                                          FLUXD      93
            110 CONTINUE                                                          FLUXD      94
                RETURN                                                            FLUXD      95
95              END                                                               FLUXD      96
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 FLUXD	1	94

VARIABLES	SN	TYPE	RELOCATION									
332	A	REAL	ARRAY		REFS	35	2*79	2*82	2*86	88		
					DEFINED	77	78	79	80	81	82	83
						84	85	86				
343	B	REAL	ARRAY		REFS	35	88	90	91	92		
					DEFINED	70	71	72	75	76		
324	CAPPA	REAL			REFS	54	DEFINED	53				
322	CAPSQ	REAL			REFS	53	56	DEFINED	51	54		
264	CINTMS	REAL			REFS	78	81	84	85	DEFINED	37	
323	CORR	REAL			REFS	53	DEFINED	52				
0	DEN	REAL		F.P.	REFS	44	DEFINED	1				
317	ENQ	REAL			REFS	49	50	DEFINED	48			
0	ENRCH	REAL		F.P.	REFS	43	64	DEFINED	1			
315	EN5	REAL			REFS	48	49	50	DEFINED	46		
316	EN8	REAL			REFS	48	49	50	DEFINED	47		
312	FR35	REAL			REFS	45	46	DEFINED	43			
314	FR38	REAL			REFS	47	DEFINED	45				
0	IPLANT	INTEGER		F.P.	REFS	41	2*64	73	74	75	76	85
					DEFINED	1						
0	IT	INTEGER		F.P.	REFS	64	DEFINED	1				
331	KS	* INTEGER			REFS	88						
0	NDBG	INTEGER		F.P.	REFS	64	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	2*35	71	72	2*74	DEFINED	1	
263	N3	INTEGER			REFS	88	DEFINED	37				
330	PCENT	REAL			REFS	75	76	DEFINED	73	74		
325	P1	REAL			REFS	64	74	75	76			
326	P2	REAL			REFS	64	74	76				
327	P3	REAL			REFS	64	73	74	75	76		
0	R	REAL	ARRAY	F.P.	REFS	35	3*74	2*78	2*81	2*84	85	
					DEFINED	1						
0	RAPOW	REAL	ARRAY	F.P.	REFS	35	2*71	2*72	DEFINED	1		
313	RHO	REAL			REFS	46	47	DEFINED	44			
320	SGA	REAL			REFS	2*51	DEFINED	49				
321	SGT	REAL			REFS	2*51	DEFINED	50				
267	SIGA0	REAL			REFS	49	DEFINED	38				
265	SIGA5	REAL			REFS	49	DEFINED	38				
266	SIGA8	REAL			REFS	49	DEFINED	38				
272	SIGT0	REAL			REFS	50	DEFINED	38				
270	SIGT5	REAL			REFS	50	DEFINED	38				
271	SIGT8	REAL			REFS	50	DEFINED	38				
0	T	REAL		F.P.	REFS	64	DEFINED	1				
0	TINLET	REAL		F.P.	REFS	52	DEFINED	1				
0	W	REAL		F.P.	DEFINED	1	57	90				
0	YY	REAL		F.P.	REFS	57	DEFINED	1	56	91		
0	Z	REAL		F.P.	DEFINED	1	55	92				

EXTERNALS	TYPE	ARGS		REFERENCES
PWRDEP		8		64
SIMQ		4		88
SQRT	REAL	1	LIBRARY	53

```
STATEMENT LABELS                DEF LINE    REFERENCES
  104  100                          59          41
  233  110                          93          58

STATISTICS
  PROGRAM LENGTH                   346B       230
        140000B SCM USED
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```
      SUBROUTINE FRACAS (DVHPRS,TTT,EPS22,EPP2,FVFRO,SIG2,REPS2,EPS02,EP
     +2,GAP2,R22,ECREP2,PREPS2,PEPP2,OLDT2,PEP2,OLDPG2,OLDPC2,OLIGP2,IGA
     +P2,EPS0,MNR,MNA)
C
C     IMPLICIT REAL * 8 (A-H,O-Z)
C
      REAL  NU , KRYIN
C
C
C
C     THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY
C     DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL
C
C
C     ( NA )      -  ARRAYS
C
      COMMON  / POINT /
     +       LDCIH    ,LURC     ,LCREPI   ,LDLH     ,LHA      ,LHL
     +      ,LPOROS   ,LUFS     ,LAXGAP   ,LAXLEN   ,LBU1     ,LBU2
     +      ,LARAD    ,LCPDLT   ,LDELBP   ,LDENMX   ,LDLPGE
     +      ,LDZ      ,LDZH     ,LDZHP    ,LECREP   ,LEP
     +      ,LGAP     ,LGPTP    ,LHCOEF   ,LOLAXG   ,LOLDPC
     +      ,LOLDPG   ,LOLDTC   ,LOLDUR   ,LOLEPS   ,LOLFEP
     +      ,LPAXGP   ,LPC      ,LPECRP   ,LPEP     ,LPG
     +      ,LPINT    ,LPLDPC   ,LPLDPG   ,LPLDTC   ,LPLDUR   ,LPOAXG
     +      ,LPOFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR
     +      ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF
     +      ,LVCH     ,LVCH1    ,LVCR     ,LVDH     ,LVFH     ,LVGH
     +      ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEP1
     +      ,LHGAPS   ,LTRTRN   ,LIGAP    ,LOLIGP   ,LQDP
     +      ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO
     +      ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO
C
C     ( NA X 2 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG
     +      ,LREPS2
C
C     ( NA X 3 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS
     +      ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS
     +      ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPP1
     +      ,LSIG1    ,LEPS1
C
C     ( NR )      -  ARRAYS
C
      COMMON  / POINT /
     +       LAK1     ,LAK2     ,LCRL     ,LDPL     ,LDPLH    ,LDPN
     +      ,LFMA     ,LFMGPR   ,LHRL     ,LTFB     ,LTFR     ,LTFRK
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      +       ,LVPL                                                                    REALCM     46
55          C                                                                          REALCM     47
            C   ( NR X 2 )  -  ARRAYS                                                  REALCM     48
            C                                                                          REALCM     49
              COMMON  / POINT /                                                        REALCM     50
            +          LF       ,LFH      ,LFN                                       REALCM     51
60          C                                                                          REALCM     52
            C   ( NR X NA ) -  ARRAYS                                                  REALCM     53
            C                                                                          REALCM     54
              COMMON  / POINT /                                                        REALCM     55
            +          LCC1     ,LCC2     ,LDENSF   ,LDENSP   ,LDPW     ,LDPWPP    REALCM     56
65          +         ,LGNSIZ   ,LPORS1   ,LPORS2   ,LTMPDS   ,LUO2LL   ,LTMPMX    REALCM     57
            +         ,LR       ,LRAD                                              REALCM     58
            C                                                                          REALCM     59
            C   ( NA X 6 )  -  ARRAYS                                                  REALCM     60
            C                                                                          REALCM     61
70            COMMON  / POINT /                                                        REALCM     62
            +          LB       ,LBR      ,LBTOLD   ,LCHEM                           REALCM     63
            C                                                                          REALCM     64
            C   ( NA X 8 )  -  ARRAYS                                                  REALCM     65
            C                                                                          REALCM     66
75            COMMON  / POINT /                                                        REALCM     67
            +          LQ                                                            REALCM     68
            C                                                                          REALCM     69
            C   ( IT )      -  ARRAYS                                                  REALCM     70
            C                                                                          REALCM     71
80            COMMON  / POINT /          LACMFG   ,LACMHE   ,LACMH2   ,LACMN2       REALCM     72
            +                 ,LAMGPT   ,LGASMO   ,LHMGPT   ,LPIT     ,LPRT10      REALCM     73
            +         ,LPRT11   ,LPRT12   ,LPRT13   ,LPRT14   ,LPRT15   ,LPRT16    REALCM     74
            +         ,LPRT17   ,LPRT18   ,LPRT2    ,LPRT20   ,LPRT3    ,LPRT4     REALCM     75
            +         ,LPRT5    ,LPRT6    ,LPRT7    ,LPRT8    ,LPRT9    ,LTAC      REALCM     76
85          +         ,LTAFA    ,LTAGA    ,LTSF                                      REALCM     77
            C                                                                          REALCM     78
            C                                                                          REALCM     79
            C   ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME                    REALCM     80
            C                                                                          REALCM     81
90            COMMON / POINT /                                                         REALCM     82
            +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,               REALCM     83
            +   LDECAY,   LHALF,    LRLEAS                                           REALCM     84
            C                                                                          REALCM     85
            C   BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME                          REALCM     86
95          C                                                                          REALCM     87
              COMMON / POINT /                                                         REALCM     88
            +   IRDOT,    ISAVGS,   LSTHIF,   IX                                     REALCM     89
            C                                                                          REALCM     90
            C   RADIAL MODEL ARRAYS                                                   REALCM     91
100         C                                                                          REALCM     92
              COMMON / POINT /                                                         REALCM     93
            +   ICFAC     ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF            REALCM     94
            +  ,ITRAMP    ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV                    REALCM     95
            +  ,IHLDN     ,IPLSTC   ,ISTRNN   ,ISTRSS                              REALCM     96
105         C                                                                          REALCM     97
            C                                                                          REALCM     98
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      C                                                                      REALCM     99
      C                                                                      REALCM    100
            COMMON / REALS /   AAA(20)  ,AAN       ,AIRIN    ,AMGP(2) ,AMGPH(2) REALCM    101
     110   +                  ,AMGR(2)  ,AMGRH(2)  ,AMGRN2(2),AMWDT    ,ANGI    REALCM    102
           +          ,ANGT   ,AN2IN    ,ARGIN    ,ARING    ,AVGQI(8) ,B(6)    REALCM    103
           +          ,BP     ,BPP      ,BR(6)    ,BU       ,BUOLD    ,CDG     REALCM    104
           +          ,CFV    ,CFVA     ,CMOL     ,CODEID(15),CONVC,CONVER(10) REALCM    105
           +          ,CPV    ,CRDTT    ,CRN      ,CVV      ,DCIH              REALCM    106
     115   +          ,DCIHP  ,DELBP    ,DELBU    ,DELH     ,DELT              REALCM    107
           +          ,DELTCR ,DELTDB   ,DELTFC   ,DELTJL   ,DHIC     ,DLREL   REALCM    108
           +          ,DLROD  ,DLTGC(26),DPH      ,DPHF     ,DPHFP    ,DPWP    REALCM    109
           +          ,DRS    ,ENRICH   ,EOLSR    ,FC(1)    ,FGIN     ,FGPAVP  REALCM    110
      C                                                                      REALCM    111
     120    COMMON / REALS /   FGPAVX   ,FH2O     ,FJJ(2)   ,FJJH(2)  ,FMGP(2) REALCM    112
           +                  ,FPOR     ,FPORI    ,FRD      ,FRDH     ,FRDN    REALCM    113
           +          ,G      ,GASES(7) ,GASIN    ,GDEN   ,GPTH(26) ,GPTHE(26) REALCM    114
           +          ,GPTHM  ,GPTHP    ,GPTHPG(26) ,GR     ,HCRU     ,HCV     REALCM    115
           +          ,HDSHV  ,HEIN     ,HFLL     ,HFLMDB   ,HFLMP    ,HFPER   REALCM    116
     125   +          ,HFV    ,HGAPT    ,HGV      ,HI       ,HMGP(2)  ,HP      REALCM    117
           +          ,HGAP   ,HSOLID   ,HGAPR                                 REALCM    118
           +          ,HPL    ,HPORV    ,HPV      ,HUPTAK   ,H2OMI    ,KRYIN   REALCM    119
           +          ,NU     ,OXDROP   ,OXIDE    ,PECDH    ,PI       ,PIN(26) REALCM    120
           +          ,PINP   ,PORO     ,PR       ,PRESS    ,PRTY     ,PRT19   REALCM    121
     130   +          ,QC     ,QP       ,QSP      ,RCI      ,RCO               REALCM    122
           +          ,QAV    ,QPEAK                                           REALCM    123
      C                                                                      REALCM    124
            COMMON / REALS /   RFNUFF   ,RHO      ,RHOF     ,RHOG     ,RHOUO2  REALCM    125
           +                  ,RMH      ,RP       ,RSTRAN   ,RSTRES   ,RTRAN   REALCM    126
     135   +          ,SKTC   ,SKTS     ,STRN     ,SUMCK    ,SUMDH    ,SUMEXP  REALCM    127
           +          ,SUMGP  ,SUMPOR   ,SUMRG    ,SUMTF    ,T        ,TCAC    REALCM    128
           +          ,TCI    ,TCO      ,TFBC     ,TFC      ,TFGFR    ,THEFR   REALCM    129
           +          ,TH2OFR ,TITLE(12),TM       ,TN2FR    ,TOXO     ,TP      REALCM    130
           +          ,TPA    ,TPAC     ,TPLEN    ,TRANST   ,TSAT     ,TT      REALCM    131
     140   +          ,TX     ,TXA      ,TXAL     ,TXC      ,VISC     ,VPLT    REALCM    132
           +          ,VSS    ,W        ,WT       ,WTRAN    ,XEIN     ,XK6     REALCM    133
           +          ,XK7    ,YY       ,Z        ,ZRO2WG   ,VX       ,CLOS    REALCM    134
           +          ,FNCK   ,FNCN     ,CWKF     ,CWNF     ,COLDWK            REALCM    135
           +          ,DISH                                                    REALCM    136
     145   C                                                                    REALCM    137
      C                                                                      INTGCM      2
            COMMON / INTEG /                                                 INTGCM      3
           +    IQUIT       ,IRI       ,IT       ,ITER       ,J             INTGCM      4
           +   ,JJC         ,JPEAK     ,K        ,KINDOR     ,KOXI          INTGCM      5
     150   +   ,LMN         ,M         ,MODLOP   ,NAB        ,NPLAST        INTGCM      6
           +   ,NRMI        ,NSTEP     ,NWRITE   ,N2         ,IMDONE        INTGCM      7
           +   ,ICLOSE      ,NSH       ,NF       ,NC                        INTGCM      8
      C                                                                      INTGCM      9
      C                                                                      INPRCM      2
     155    COMMON / INPTR /ACOR       ,AFAL     ,AFCR       ,AFDN          INPRCM      3
           +                  ,AFGR     ,AFSW     ,AFTC       ,AGPC          INPRCM      4
           +   ,AMFAIR      ,AMFARG    ,AMFFG    ,AMFHE      ,AMFH2         INPRCM      5
           +   ,AMFH2O      ,AMFKRY    ,AMFN2    ,AMFXE                     INPRCM      6
           +   ,BUIN(22)    ,CATEXF                                          INPRCM      7
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      +    ,CLDWKD    ,CPL       ,CRDT      ,CRDTR     ,CTMAX(22)     INPRCM     8
      +    ,DCI(22)   ,DCO(22)   ,DE(22)    ,DELTAZ(22),DEN           INPRCM     9
      +    ,DENG      ,DISHSD    ,DP(22)    ,DSPG      ,DSPGW         INPRCM    10
      +    ,ENRCH     ,EXO       ,FA        ,FGPAV     ,FLUX          INPRCM    11
      +    ,FLXDP     ,FQE       ,GO(101)   ,GRNSIZ    ,HDISH         INPRCM    12
      +    ,HPLT      ,PPMH2O    ,PPMN2     ,P2(101)   ,QEND(8)       INPRCM    13
      +    ,QF(328)   ,QMPY(101) ,RAPOW(11) ,RC        ,RDISH         INPRCM    14
      +    ,ROUGHC    ,ROUGHF    ,SGAPF                               INPRCM    15
      +    ,TCC       ,TIME(101) ,TOTL      ,TSINT     ,TW(101)       INPRCM    16
      +    ,UBFS      ,UMELT     ,UQFD      ,VS        ,X(328)        INPRCM    17
      +    ,RSNTR     ,FOTHTL    ,TREF      ,CREPHR    ,ANRIN         INPRCM    18
      +    ,CLDWKS                                                    INPRCM    19
      +    ,CP        ,CR                                             INPRCM    20
      C                                                               INPICM     2
            COMMON / INPTI /ICM    ,ICOR      ,IDBG      ,IDXGAS      INPICM     3
      +                   ,IM      ,IPLANT    ,IQ        ,ISW         INPICM     4
      +    ,JDLPR     ,JN(8)     ,JST(101)  ,MDBG      ,NHEAL         INPICM     5
      +    ,MODE      ,MODES     ,MTAPE     ,NDBG      ,NFROD         INPICM     6
      +    ,NGAPC     ,NGASR     ,NOFAIL    ,NOPT      ,NPCYCL        INPICM     7
      +    ,NPLTAB    ,NREAD     ,NRESTR    ,NROLL     ,NSP           INPICM     8
      +    ,NSTART    ,NSTOP     ,NT        ,NTAPE     ,NUCFC         INPICM     9
      +    ,NUNITS    ,LACMOD    ,LACE(13)  ,NAFAIL    ,NNFAIL(22)    INPICM    10
      +    ,NXP       ,NPLOT     ,NTPLOT    ,NROD      ,NA            INPICM    11
      +    ,NR        ,NEWPRB    ,MECHAN    ,NCRACK    ,NELAST        INPICM    12
      +    ,NCREEP    ,IAXSYM    ,IVARDM    ,NOFRAC    ,ITREST        INPICM    13
      +    ,NWORDS    ,IWORDS    ,NWRDS     ,NPRINT                   INPICM    14
      C                                                               INPICM    15
      C                                                               INPICM    16
            COMMON  /EMFLGS/   IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO  INPICM    17
           +                  ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG   INPICM    18
           +          ,IMFGAS   ,IMSWCH                               INPICM    19
      C                                                               INPICM    20
      C                                                               INPICM    21
      C                                                               INPICM    22
            COMMON/PFRCS2/     MODPG2        ,MODPC2        ,MGAP2    INPICM    23
           +   ,MIGAP2         ,MOIGP2        ,MREPS2        ,MPEPS2  INPICM    24
           +   ,MTTT           ,MEREP2        ,MEP2          ,MR22    INPICM    25
           +   ,MOLDT2         ,MFUFRO        ,MDHPRS        ,MPEP2   INPICM    26
           +   ,MEPS22         ,MEPP2         ,MSIG2         ,MEPS02  INPICM    27
           +   ,MPEPP2         ,MEPS0         ,NNNCRP                 INPICM    28
      C                                                               INPICM    29
            COMMON /MATCNS/ AAHA(12)                                  INPICM    30
      C                                                               INPICM    31
      C                                                               INPICM    32
            COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                     INPICM    33
      C                                                               INPICM    34
            COMMON /VER/ VERS                                         INPICM    35
      C                                                               PHYPRO     2
            COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB  PHYPRO     3
           +             ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP   PHYPRO     4
           +             ,DELOXY                                        PHYPRO     5
      C                                                               PHYPRO     6
      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)         PHYPRO     7
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      C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)                PHYPRO      8
      C   CTMELT - ZR CLAD MELTING POINT (K)                                     PHYPRO      9
      C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                               PHYPRO     10
      C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)             PHYPRO     11
      C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)               PHYPRO     12
      C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)             PHYPRO     13
      C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)               PHYPRO     14
      C   BU     - BURNUP (MW-S/KG-U)                                           PHYPRO     15
      C   COMP   - PUO2 CONTENT (WT-PERCENT)                                    PHYPRO     16
      C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED          PHYPRO     17
      C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                  PHYPRO     18
      C                                                                         PHYPRO     19
      C                                                                         FRAC       16
      C                                                                         FRAC       17
            INTEGER  OLIGP2                                                     FRAC       18
            DIMENSION TTT(MNA,MNR),EPS22(MNA,MNR,3),EPP2(MNA,MNR,3)             FRAC       19
           + ,SIG2(MNA,MNR,3),REPS2(MNA,2),EPS02(MNA,MNR,3)                     FRAC       20
           + ,EP2(MNA,MNR),GAP2(MNA),R22(MNA,MNR),ECREP2(MNA,MNR)               FRAC       21
           + ,OLDT2(MNA,MNR)                                                    FRAC       22
           + ,OLDPG2(MNA),OLDPC2(MNA),OLIGP2(MNA),IGAP2(MNA)                    FRAC       23
           + ,EPS0(MNA,MNR,3)                                                   FRAC       24
           + ,PEP2(MNA,MNR),PEPP2(MNA,MNR,3),PREPS2(MNA,2)                      FRAC       25
           + ,FVFRO(MNA,MNR) ,DVHPRS(MNA,MNR)                                   FRAC       26
      C                                                                         FRAC       27
            DIMENSION AFCMI2(1)                                                 FRAC       28
            DIMENSION  INTGR(10)                                                FRAC       29
      C                                                                         FRAC       30
            COMMON / FAST / A(1)                                                FRAC       31
      C                                                                         FRAC       32
            COMMON/PFCMI2/          NPIN                                        FRAC       33
           +                       ,NPOUT      ,NPI         ,NP2               FRAC       34
           +                       ,NTSAVE     ,NDCHCK      ,NOLSGF            FRAC       35
           +                       ,NDEP       ,NSLOPE      ,NCOEF             FRAC       36
           +                       ,NDSIGF     ,NFI         ,NF2               FRAC       37
           +                       ,NEP2       ,NECRP2      ,NT2               FRAC       38
           +                       ,NTN        ,NE          ,NV                FRAC       39
           +                       ,NEPP2      ,NSTRTT      ,NALFDT            FRAC       40
           +                       ,NOLDPP     ,NNUDPP      ,NHH               FRAC       41
           +                       ,NNN        ,NMN         ,NBB               FRAC       42
           +                       ,NMM        ,NGG         ,NDD               FRAC       43
           +                       ,NW         ,NNU         ,NEE               FRAC       44
           +                       ,NLL        ,NAA         ,NEI               FRAC       45
           +                       ,NCC        ,NNFF                           FRAC       46
            EQUIVALENCE (A(1),AFCMI2(1))                                        FRAC       47
      C                                                                         FRAC       48
      C                                                                         FRAC       49
            DATA  BB / 0.5E0 /                                                  FRAC       50
      C                                                                         FRAC       51
      C   SETTING UP DATA FOR FRACAS (FUEL ROD AND CLADDING ANALYSIS            FRAC       52
      C   SUBCODE)                                                             FRAC       53
            RPP = RP                                                            FRAC       54
            NRELAX = 0                                                          FRAC       55
      C                                                                         FRAC       56
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                DTIME = DELH                                                                                    FRAC       57
                ATIME = TIME(IT-1)/3600.E0                                                                      FRAC       58
                ZZ = DELTAZ(J)*12.E0                                                                            FRAC       59
                IF (NAB.NE.1) GO TO 110                                                                         FRAC       60
270             NAB = 2                                                                                         FRAC       61
                GP = CDG/2000.                                                                                  FRAC       62
                GPTHE(1) = CDG/1000.                                                                            FRAC       63
                    DO 100 I=1,NT                                                                               FRAC       64
                    A(LDZ+I-1) = ZZ                                                                             FRAC       65
275         100     CONTINUE                                                                                    FRAC       66
                CALL MEMSET (ZZ,A(LDZH),NA)                                                                     FRAC       67
                CALL MEMSET (0.E0,A(LAXLEN),NA)                                                                 FRAC       68
                CALL MEMSET (GP,A(LGAP),NA)                                                                     FRAC       69
            110 CONTINUE                                                                                        FRAC       70
280         C                                                                                                   FRAC       71
                NELAST = 1-NPLAST                                                                               FRAC       72
                IF (MECHAN.EQ.3) GO TO 140                                                                      FRAC       73
            C                                                                                                   FRAC       74
                    DO 120 I=1,NT                                                                               FRAC       75
285                 IJ = I-1                                                                                    FRAC       76
                    A(LPEP+IJ) = A(LEP+IJ)                                                                      FRAC       77
                    A(LPG+IJ) = PRESS                                                                           FRAC       78
                    A(LPC+IJ) = P2(IT)                                                                          FRAC       79
                    A(LPOLEP+IJ) = A(LOLEPS+IJ)                                                                 FRAC       80
290                 A(LPOFEP+IJ) = A(LOLFEP+IJ)                                                                 FRAC       81
                    A(LPLDTC+IJ) = A(LOLDTC+IJ)                                                                 FRAC       82
                    A(LPLDPC+IJ) = A(LOLDPC+IJ)                                                                 FRAC       83
                    A(LPLDPG+IJ) = A(LOLDPG+IJ)                                                                 FRAC       84
                    A(LPLDUR+IJ) = A(LOLDUR+IJ)                                                                 FRAC       85
295                 A(LPLIGP+IJ) = A(LOLIGP+IJ)                                                                 FRAC       86
                    A(LPOAXG+IJ) = A(LOLAXG+IJ)                                                                 FRAC       87
                    A(LPAXGP+IJ) = A(LAXGAP+IJ)                                                                 FRAC       88
                        DO 120 II=1,3                                                                           FRAC       89
                        IK = (II-1)*NA+IJ                                                                       FRAC       90
300                     A(LEPPP+IK) = A(LEPP+IK)                                                                FRAC       91
                        A(LRFEPP+IK) = A(LRFEPS+IK)                                                             FRAC       92
                        A(LREPSP+IK) = A(LREPS+IK)                                                              FRAC       93
            120         CONTINUE                                                                                FRAC       94
                URFOLD = A(LURF+J-2)                                                                            FRAC       95
305             A(LURF+J-2) = A(LRAD)-RPP                                                                       FRAC       96
                A(LURF+J-2) = BB*A(LURF+J-2)+(1.E0-BB)*URFOLD                                                   FRAC       97
                A(LDZH+J-1) = 0.E0                                                                              FRAC       98
                A(LFEPS+J-2) = A(LURF+J-2)/RPP                                                                  FRAC       99
                    DO 130 L=1,NRM1                                                                             FRAC      100
310                 IJ = NR*(J-1)+L-1                                                                           FRAC      101
                    A(LHRL+L-1) = A(LCRL+L-1)*(1.E0+A(LUO2LL+IJ)+A(LDPW+IJ)+A(LDEN                              FRAC      102
                +       SF+IJ))                                                                                 FRAC      103
                    A(LDZH+J-1) = AMAX1(A(LDZH+J-1),A(LHRL+L-1))                                                FRAC      104
            130     CONTINUE                                                                                    FRAC      105
315             A(LFEPS+J-2+NA) = (A(LDZH+J-1)-ZZ)/ZZ                                                           FRAC      106
                A(LDZ+J-2) = ZZ*(1.E0+A(LAXLEN+J-1))                                                            FRAC      107
            C                                                                                                   FRAC      108
                NPLAST = 1                                                                                      FRAC      109
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      C                                                                      FRAC      110
320         INTGR(1) = NDBG                                                  FRAC      111
            INTGR(2) = IQUIT                                                 FRAC      112
            INTGR(3) = N2                                                    FRAC      113
            INTGR(4) = MODE                                                  FRAC      114
            INTGR(5) = IT                                                    FRAC      115
325         INTGR(6) = NPLAST                                                FRAC      116
            INTGR(7) = NRELAX                                                FRAC      117
      C                                                                      FRAC      118
      C     THE FOLLOWING CALL TO FCMI RESULTS IN CLADDING MECHANICAL        FRAC      119
      C     CALCULATIONS USING THE FRACAS-1 SUBCODE                          FRAC      120
330   C                                                                      FRAC      121
            CALL FCMI (A(LPG),A(LPC),A(LTCA+1),A(LIGAP),A(LEPS),A(LEPPP),A(LUR FRAC      122
           +F),A(LSIG),A(LREPSP),A(LRFEPP),A(LFEPS),A(LPEP),A(LDZ),INTGR,A(LGA FRAC      123
           +P),A(LPINT),RCI,RCO,DLROD,DLREL,RPP,A(LCREP1),A(LEPS1),A(LPOLEP),A FRAC      124
           +(LPOFEP),A(LPLDTC),A(LPLDPG),A(LPLDPC),A(LPLDUR),A(LPLIGP),A(LEPPS FRAC      125
335        +V),A(LEPSAV),A(LSIG1),DTIME,ATIME,A(LPOAXG),A(LPAXGP),A(LURC),A(LP FRAC      126
           +ECRP),A(LREPSV),A(LRFPSV),A(LEP1),A(LEPP1),A(LNUDEP),A(LFLAG),A(LD FRAC      127
           +CHEK),NA)                                                        FRAC      128
      C                                                                      FRAC      129
            GO TO 160                                                        FRAC      130
340   C                                                                      FRAC      131
      C                                                                      FRAC      132
      C     THE FOLLOWING CALL TO FCMI2 COMPUTES THE FUEL AND CLADDING       FRAC      133
      C     MECHANICAL STATE USING FRACAS-2 SUBCODE                          FRAC      134
      C                                                                      FRAC      135
345   140   CONTINUE                                                         FRAC      136
      C                                                                      FRAC      137
            M1 = J-1                                                         FRAC      138
            M2 = 1                                                           FRAC      139
            M3 = 13                                                          FRAC      140
350         M4 = 12                                                          FRAC      141
            M5 = 0                                                           FRAC      142
            M6 = 0                                                           FRAC      143
            KFLAG = 0                                                        FRAC      144
            N1 = 0                                                           FRAC      145
355         N22 = 0                                                          FRAC      146
            N3 = 1                                                           FRAC      147
            N4 = 0                                                           FRAC      148
      C                                                                      FRAC      149
            REPS2(J-1,1) = PREPS2(J-1,1)                                     FRAC      150
360         REPS2(J-1,2) = PREPS2(J-1,2)                                     FRAC      151
                DO 150 I=1,M3                                                FRAC      152
                EP2(J-1,I) = PEP2(J-1,I)                                     FRAC      153
                    DO 150 II=1,3                                            FRAC      154
                    EPP2(J-1,I,II) = PEPP2(J-1,I,II)                         FRAC      155
365   150           CONTINUE                                                 FRAC      156
      C                                                                      FRAC      157
            NAX = M1                                                         FRAC      158
            JJJ = M1                                                         FRAC      159
      C                                                                      FRAC      160
370         CALL FCMI2 (NAX,DLROD2,DLREL2,JJJ,NRELAX,DTIME,ATIME,N1,N22,N3,N4, FRAC      161
           +M1,M2,M3,M4,M5,M6,KFLAG,NELAST,NCRACK,VX,A(LPG),A(LPC),TTT,EPS22,E FRAC      162
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     +PP2,SIG2,REPS2,EPSO2,ECREP2,EP2,A(LDZ),GAP2,R22,IGAP2,OLDT2,OLDPG2 FRAC      163
     +,OLDPC2,OLIGP2,FVFRO,DVHPRS,AFCMI2(NEP2),AFCMI2(NEPP2),AFCMI2(NECR FRAC      164
     +P2),AFCMI2(NOLDPP),AFCMI2,NT,MNR,MNA)                              FRAC      165
375  C                                                                   FRAC      166
     C                                                                   FRAC      167
          DLROD = DLROD2                                                 FRAC      168
          DLREL = DLREL2                                                 FRAC      169
          A(LGAP+J-2) = GAP2(J-1)                                        FRAC      170
380       A(LPINT+J-2) = -SIG2(J-1,M4,1)-A(LPG+J-2)                      FRAC      171
     160  CONTINUE                                                       FRAC      172
     C                                                                   FRAC      173
          RETURN                                                         FRAC      174
          END                                                            FRAC      175
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FRACAS	1	383

VARIABLES

		SN	TYPE		RELOCATION								
0	A		REAL	ARRAY	FAST	REFS	240	256	276	277	278	286	289
							290	291	292	293	294	295	296	297
							300	301	302	304	305	306	308	4*311
							2*313	315	316	38*331	3*370	380		
						DEFINED	274	286	287	288	289	290	291	
							292	293	294	295	296	297	300	301
							302	305	306	307	308	311	313	315
							316	379	380					
0	AAA		REAL	ARRAY	REALS	REFS	109							
0	AAHA		REAL	ARRAY	MATCNS	REFS	201							
24	AAN		REAL		REALS	REFS	109							
0	ACOR		REAL		INPTR	REFS	155							
1	AFAL		REAL		INPTR	REFS	155							
0	AFCMi2		REAL	ARRAY	FAST	REFS	237	256	5*370					
2	AFCR		REAL		INPTR	REFS	155							
3	AFDN		REAL		INPTR	REFS	155							
4	AFGR		REAL		INPTR	REFS	155							
5	AFSW		REAL		INPTR	REFS	155							
6	AFTC		REAL		INPTR	REFS	155							
7	AGPC		REAL		INPTR	REFS	155							
25	AIRIN		REAL		REALS	REFS	109							
10	AMFAIR		REAL		INPTR	REFS	155							
11	AMFARG		REAL		INPTR	REFS	155							
12	AMFFG		REAL		INPTR	REFS	155							
13	AMFHE		REAL		INPTR	REFS	155							
14	AMFH2		REAL		INPTR	REFS	155							
15	AMFH20		REAL		INPTR	REFS	155							
16	AMFKRY		REAL		INPTR	REFS	155							
17	AMFN2		REAL		INPTR	REFS	155							

VARIABLES	SN	TYPE	RELOCATION							
20	AMFXE	REAL		INPTR	REFS	155				
26	AMGP	REAL	ARRAY	REALS	REFS	109				
30	AMGPH	REAL	ARRAY	REALS	REFS	109				
32	AMGR	REAL	ARRAY	REALS	REFS	109				
34	AMGRH	REAL	ARRAY	REALS	REFS	109				
36	AMGRN2	REAL	ARRAY	REALS	REFS	109				
40	AMWDT	REAL		REALS	REFS	109				
41	ANGI	REAL		REALS	REFS	109				
42	ANGT	REAL		REALS	REFS	109				
2555	ANRIN	REAL		INPTR	REFS	155				
43	AN2IN	REAL		REALS	REFS	109				
44	ARGIN	REAL		REALS	REFS	109				
45	ARING	REAL		REALS	REFS	109				
1002	ATIME	REAL			REFS	331	370	DEFINED	267	
46	AVGQI	REAL	ARRAY	REALS	REFS	109				
56	B	REAL	ARRAY	REALS	REFS	109				
770	BB	REAL			REFS	2*306	DEFINED	259		
64	BP	REAL		REALS	REFS	109				
65	BPP	REAL		REALS	REFS	109				
66	BR	REAL	ARRAY	REALS	REFS	109				
74	BU	REAL		REALS	REFS	109				
21	BUIN	REAL	ARRAY	INPTR	REFS	155				
75	BUOLD	REAL		REALS	REFS	109				
10	BUP	REAL		PHYPRO	REFS	208				
47	CATEXF	REAL		INPTR	REFS	155				
76	CDG	REAL		REALS	REFS	109	271	272		
77	CFV	REAL		REALS	REFS	109				
100	CFVA	REAL		REALS	REFS	109				
3	CHEFUS	REAL		PHYPRO	REFS	208				
50	CLDWKD	REAL		INPTR	REFS	155				
2556	CLDWKS	REAL		INPTR	REFS	155				
601	CLOS	REAL		REALS	REFS	133				
101	CMOL	REAL		REALS	REFS	109				
102	CODEID	REAL	ARRAY	REALS	REFS	109				
606	COLDWK	REAL		REALS	REFS	133				
11	COMP	REAL		PHYPRO	REFS	208				
121	CONVC	REAL		REALS	REFS	109				
122	CONVER	REAL	ARRAY	REALS	REFS	109				
2557	CP	REAL		INPTR	REFS	155				
51	CPL	REAL		INPTR	REFS	155				
134	CPV	REAL		REALS	REFS	109				
2560	CR	REAL		INPTR	REFS	155				
52	CRDT	REAL		INPTR	REFS	155				
53	CRDTR	REAL		INPTR	REFS	155				
135	CRDTT	REAL		REALS	REFS	109				
2554	CREPHR	REAL		INPTR	REFS	155				
136	CRN	REAL		REALS	REFS	109				
54	CTMAX	REAL	ARRAY	INPTR	REFS	155				
2	CTMELT	REAL		PHYPRO	REFS	208				
4	CTRANB	REAL		PHYPRO	REFS	208				
5	CTRANE	REAL		PHYPRO	REFS	208				
6	CTRANZ	REAL		PHYPRO	REFS	208				
137	CVV	REAL		REALS	REFS	109				

VARIABLES	SN	TYPE		RELOCATION						
604	CWKF	REAL		REALS	REFS	133				
605	CWNF	REAL		REALS	REFS	133				
102	DCI	REAL	ARRAY	INPTR	REFS	155				
140	DCIH	REAL		REALS	REFS	109				
141	DCIHP	REAL		REALS	REFS	109				
130	DCO	REAL	ARRAY	INPTR	REFS	155				
156	DE	REAL	ARRAY	INPTR	REFS	155				
142	DELBP	REAL		REALS	REFS	109				
143	DELBU	REAL		REALS	REFS	109				
144	DELH	REAL		REALS	REFS	109	266			
12	DELOXY	REAL		PHYPRO	REFS	208				
145	DELT	REAL		REALS	REFS	109				
204	DELTAZ	REAL	ARRAY	INPTR	REFS	155	268			
146	DELTCR	REAL		REALS	REFS	109				
147	DELTDB	REAL		REALS	REFS	109				
150	DELTFC	REAL		REALS	REFS	109				
151	DELTJL	REAL		REALS	REFS	109				
232	DEN	REAL		INPTR	REFS	155				
233	DENG	REAL		INPTR	REFS	155				
152	DHIC	REAL		REALS	REFS	109				
607	DISH	REAL		REALS	REFS	133				
234	DISHSD	REAL		INPTR	REFS	155				
153	DLREL	REAL		REALS	REFS	109	331	DEFINED	378	
1031	DLREL2	REAL			REFS	370	378			
154	DLROD	REAL		REALS	REFS	109	331	DEFINED	377	
1030	DLROD2	REAL			REFS	370	377			
155	DLTGC	REAL	ARRAY	REALS	REFS	109				
235	DP	REAL	ARRAY	INPTR	REFS	155				
207	DPH	REAL		REALS	REFS	109				
210	DPHF	REAL		REALS	REFS	109				
211	DPHFP	REAL		REALS	REFS	109				
212	DPWP	REAL		REALS	REFS	109				
213	DRS	REAL		REALS	REFS	109				
263	DSPG	REAL		INPTR	REFS	155				
264	DSPGW	REAL		INPTR	REFS	155				
1001	DTIME	REAL			REFS	331	370	DEFINED	266	
0	DVHPRS	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
0	ECREP2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	204				
265	ENRCH	REAL		INPTR	REFS	155				
214	ENRICH	REAL		REALS	REFS	109				
215	EOLSR	REAL		REALS	REFS	109				
0	EPP2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	364
0	EPS0	REAL	ARRAY	F.P.	REFS	228	DEFINED	1		
0	EPS02	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
0	EPS22	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
0	EP2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	362
266	EXO	REAL		INPTR	REFS	155				
267	FA	REAL		INPTR	REFS	155				
216	FC	REAL	ARRAY	REALS	REFS	109				
7	FDELTA	REAL		PHYPRO	REFS	208				
217	FGIN	REAL		REALS	REFS	109				
270	FGPAV	REAL		INPTR	REFS	155				

VARIABLES	SN	TYPE		RELOCATION						
220	FGPAVP	REAL		REALS	REFS	109				
221	FGPAVX	REAL		REALS	REFS	120				
1	FHEFUS	REAL		PHYPRO	REFS	208				
222	FH2O	REAL		REALS	REFS	120				
223	FJJ	REAL	ARRAY	REALS	REFS	120				
225	FJJH	REAL	ARRAY	REALS	REFS	120				
271	FLUX	REAL		INPTR	REFS	155				
272	FLXDP	REAL		INPTR	REFS	155				
227	FMGP	REAL	ARRAY	REALS	REFS	120				
602	FNCK	REAL		REALS	REFS	133				
603	FNCN	REAL		REALS	REFS	133				
2552	FOTMTL	REAL		INPTR	REFS	155				
231	FPOR	REAL		REALS	REFS	120				
232	FPORI	REAL		REALS	REFS	120				
273	FQE	REAL		INPTR	REFS	155				
233	FRD	REAL		REALS	REFS	120				
234	FRDH	REAL		REALS	REFS	120				
235	FRDN	REAL		REALS	REFS	120				
0	FTMELT	REAL		PHYPRO	REFS	208				
0	FUFRO	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
236	G	REAL		REALS	REFS	120				
0	GAP2	REAL	ARRAY	F.P.	REFS	228	370	379	DEFINED	1
237	GASES	REAL	ARRAY	REALS	REFS	120				
246	GASIN	REAL		REALS	REFS	120				
247	GDEN	REAL		REALS	REFS	120				
274	GO	REAL	ARRAY	INPTR	REFS	155				
1004	GP	REAL			REFS	278	DEFINED	271		
250	GPTH	REAL	ARRAY	REALS	REFS	120				
302	GPTHE	REAL	ARRAY	REALS	REFS	120	DEFINED	272		
334	GPTHM	REAL		REALS	REFS	120				
335	GPTHP	REAL		REALS	REFS	120				
336	GPTHPG	REAL	ARRAY	REALS	REFS	120				
370	GR	REAL		REALS	REFS	120				
441	GRNSIZ	REAL		INPTR	REFS	155				
371	HCRV	REAL		REALS	REFS	120				
372	HCV	REAL		REALS	REFS	120				
442	HDISH	REAL		INPTR	REFS	155				
373	HDSHV	REAL		REALS	REFS	120				
374	HEIN	REAL		REALS	REFS	120				
375	HFLL	REAL		REALS	REFS	120				
376	HFLMDB	REAL		REALS	REFS	120				
377	HFLMP	REAL		REALS	REFS	120				
400	HFPER	REAL		REALS	REFS	120				
401	HFV	REAL		REALS	REFS	120				
410	HGAP	REAL		REALS	REFS	120				
412	HGAPR	REAL		REALS	REFS	120				
402	HGAPT	REAL		REALS	REFS	120				
403	HGV	REAL		REALS	REFS	120				
404	HI	REAL		REALS	REFS	120				
405	HMGP	REAL	ARRAY	REALS	REFS	120				
407	HP	REAL		REALS	REFS	120				
413	HPL	REAL		REALS	REFS	120				
443	HPLT	REAL		INPTR	REFS	155				

VARIABLES	SN	TYPE		RELOCATION								
414	HPORV	REAL		REALS	REFS	120						
415	HPV	REAL		REALS	REFS	120						
411	HSOLID	REAL		REALS	REFS	120						
416	HUPTAK	REAL		REALS	REFS	120						
417	H2OMI	REAL		REALS	REFS	120						
1005	I	INTEGER			REFS	274	285	2*362	2*364	DEFINED	273	284
						361						
275	IAXSYM	INTEGER		INPTI	REFS	174						
270	ICFAC	INTEGER		POINT	REFS	101						
302	ICFCSV	INTEGER		POINT	REFS	101						
24	ICLOSE	INTEGER		INTEG	REFS	147						
0	ICM	INTEGER		INPTI	REFS	174						
1	ICOR	INTEGER		INPTI	REFS	174						
2	IDBG	INTEGER		INPTI	REFS	174						
271	IDG	INTEGER		POINT	REFS	101						
272	IDGSAV	INTEGER		POINT	REFS	101						
3	IDXGAS	INTEGER		INPTI	REFS	174						
0	GAP2	INTEGER	ARRAY	F.P.	REFS	228	370	DEFINED	1			
303	IHLDN	INTEGER		POINT	REFS	101						
1007	II	INTEGER			REFS	299	2*364	DEFINED	298	363		
1006	IJ	INTEGER			REFS	2*286	287	288	2*289	2*290	2*291	2*292
					2*293	2*294	2*295	2*296	2*297	299	3*311	
					DEFINED	285	310					
1010	IK	INTEGER			REFS	2*300	2*301	2*302	DEFINED	299		
4	IM	INTEGER		INPTI	REFS	174						
4	IMCLAD	INTEGER		EMFLGS	REFS	188						
2	IMDENS	INTEGER		EMFLGS	REFS	188						
23	IMDONE	INTEGER		INTEG	REFS	147						
7	IMENRG	INTEGER		EMFLGS	REFS	188						
10	IMFGAS	INTEGER		EMFLGS	REFS	188						
1	IMFUEL	INTEGER		EMFLGS	REFS	188						
5	IMGAPC	INTEGER		EMFLGS	REFS	188						
0	IMPOWR	INTEGER		EMFLGS	REFS	108						
3	IMRELO	INTEGER		EMFLGS	REFS	188						
11	IMSWCH	INTEGER		EMFLGS	REFS	188						
6	IM93HC	INTEGER		EMFLGS	REFS	188						
1032	INTGR	INTEGER	ARRAY		REFS	238	331	DEFINED	320	321	322	323
					324	325	326					
5	IPLANT	INTEGER		INPTI	REFS	174						
304	IPLSTC	INTEGER		POINT	REFS	101						
273	IPRG	INTEGER		POINT	REFS	101						
6	IQ	INTEGER		INPTI	REFS	174						
0	IQUIT	INTEGER		INTEG	REFS	147	321					
264	IRDOT	INTEGER		POINT	REFS	96						
1	IRI	INTEGER		INTEG	REFS	147						
265	ISAVGS	INTEGER		POINT	REFS	96						
305	ISTRNN	INTEGER		POINT	REFS	101						
306	ISTRSS	INTEGER		POINT	REFS	101						
7	ISW	INTEGER		INPTI	REFS	174						
2	IT	INTEGER		INTEG	REFS	147	267	286	324			
300	ITCL	INTEGER		POINT	REFS	101						
277	ITEMP	INTEGER		POINT	REFS	101						
3	ITER	INTEGER		INTEG	REFS	147						

VARIABLES	SN	TYPE		RELOCATION								
301	ITFS	INTEGER		POINT	REFS	101						
276	ITRAMP	INTEGER		POINT	REFS	101						
300	ITREST	INTEGER		INPTI	REFS	174						
276	IVARDM	INTEGER		INPTI	REFS	174						
274	IVFC	INTEGER		POINT	REFS	101						
275	IVFF	INTEGER		POINT	REFS	101						
302	IWORDS	INTEGER		INPTI	REFS	174						
267	IX	INTEGER		POINT	REFS	96						
4	J	INTEGER		INTEG	REFS	147	268	304	305	2*306	307	2*308
						310	2*313	2*315	2*316	347	2*359	2*360	2*362
						2*364	2*379	3*380				
10	JDLPR	INTEGER		INPTI	REFS	174						
5	JJC	INTEGER		INTEG	REFS	147						
1027	JJJ	INTEGER			REFS	370	DEFINED	368				
11	JN	INTEGER	ARRAY	INPTI	REFS	174						
6	JPEAK	INTEGER		INTEG	REFS	147						
21	JST	INTEGER	ARRAY	INPTI	REFS	174						
7	K	INTEGER		INTEG	REFS	147						
1021	KFLAG	INTEGER			REFS	370	DEFINED	353				
10	KINDOR	INTEGER		INTEG	REFS	147						
11	KOXI	INTEGER		INTEG	REFS	147						
420	KRYIN	REAL		REALS	REFS	7	120					
1012	L	INTEGER			REFS	310	2*311	313	DEFINED	309		
216	LACE	INTEGER	ARRAY	INPTI	REFS	174						
215	LACMFG	INTEGER		POINT	REFS	80						
216	LACMHE	INTEGER		POINT	REFS	80						
217	LACMH2	INTEGER		POINT	REFS	80						
220	LACMN2	INTEGER		POINT	REFS	80						
215	LACMOD	INTEGER		INPTI	REFS	174						
152	LAK1	INTEGER		POINT	REFS	51						
153	LAK2	INTEGER		POINT	REFS	51						
221	LAMGPT	INTEGER		POINT	REFS	80						
125	LANG	INTEGER		POINT	REFS	37						
120	LANGR	INTEGER		POINT	REFS	37						
253	LANSD	INTEGER		POINT	REFS	90						
256	LANSR	INTEGER		POINT	REFS	90						
14	LARAD	INTEGER		POINT	REFS	18						
10	LAXGAP	INTEGER		POINT	REFS	18	297					
11	LAXLEN	INTEGER		POINT	REFS	18	277	316				
210	LB	INTEGER		POINT	REFS	70						
211	LBR	INTEGER		POINT	REFS	70						
212	LBTOLD	INTEGER		POINT	REFS	70						
12	LBU1	INTEGER		POINT	REFS	18						
13	LBU2	INTEGER		POINT	REFS	18						
172	LCC1	INTEGER		POINT	REFS	63						
173	LCC2	INTEGER		POINT	REFS	63						
213	LCHEM	INTEGER		POINT	REFS	70						
15	LCPDLT	INTEGER		POINT	REFS	18						
2	LCREPI	INTEGER		POINT	REFS	18	331					
154	LCRL	INTEGER		POINT	REFS	51	311					
111	LDCHEK	INTEGER		POINT	REFS	18	331					
0	LDCIH	INTEGER		POINT	REFS	18						
261	LDECAY	INTEGER		POINT	REFS	90						

VARIABLES	SN	TYPE	RELOCATION						
16	LDELBP	INTEGER	POINT	REFS	18				
17	LDENMX	INTEGER	POINT	REFS	18				
174	LDENSF	INTEGER	POINT	REFS	63	311			
175	LDENSP	INTEGER	POINT	REFS	63				
3	LDLH	INTEGER	POINT	REFS	18				
20	LDLPGE	INTEGER	POINT	REFS	18				
155	LDPL	INTEGER	POINT	REFS	51				
156	LDPLH	INTEGER	POINT	REFS	51				
157	LDPN	INTEGER	POINT	REFS	51				
176	LDPW	INTEGER	POINT	REFS	63	311			
177	LDPWPP	INTEGER	POINT	REFS	63				
260	LDT	INTEGER	POINT	REFS	90				
21	LDZ	INTEGER	POINT	REFS	18	274	316	331	370
22	LDZH	INTEGER	POINT	REFS	18	276	307	2*313	315
23	LDZHP	INTEGER	POINT	REFS	18				
24	LECREP	INTEGER	POINT	REFS	18				
25	LEP	INTEGER	POINT	REFS	18	286			
127	LEPP	INTEGER	POINT	REFS	43	300			
130	LEPPP	INTEGER	POINT	REFS	43	300	331		
131	LEPPSV	INTEGER	POINT	REFS	43	331			
147	LEPPI	INTEGER	POINT	REFS	43	331			
132	LEPS	INTEGER	POINT	REFS	43	331			
133	LEPSAV	INTEGER	POINT	REFS	43	331			
151	LEPSI	INTEGER	POINT	REFS	43	331			
100	LEPI	INTEGER	POINT	REFS	18	331			
167	LF	INTEGER	POINT	REFS	58				
134	LFEPS	INTEGER	POINT	REFS	43	308	315	331	
257	LFF	INTEGER	POINT	REFS	90				
121	LFGMGP	INTEGER	POINT	REFS	37				
170	LFH	INTEGER	POINT	REFS	58				
110	LFLAG	INTEGER	POINT	REFS	18	331			
254	LFLXFC	INTEGER	POINT	REFS	90				
160	LFMA	INTEGER	POINT	REFS	51				
161	LFMGPR	INTEGER	POINT	REFS	51				
122	LFMGR	INTEGER	POINT	REFS	37				
171	LFN	INTEGER	POINT	REFS	58				
26	LGAP	INTEGER	POINT	REFS	18	278	331	379	
222	LGASMO	INTEGER	POINT	REFS	80				
200	LGNSIZ	INTEGER	POINT	REFS	63				
27	LGPTP	INTEGER	POINT	REFS	18				
4	LHA	INTEGER	POINT	REFS	18				
262	LHALF	INTEGER	POINT	REFS	90				
30	LHCOEF	INTEGER	POINT	REFS	18				
123	LHEMGP	INTEGER	POINT	REFS	37				
101	LHGAPS	INTEGER	POINT	REFS	18				
114	LHGPC	INTEGER	POINT	REFS	18				
115	LHGPR	INTEGER	POINT	REFS	18				
116	LHGPS	INTEGER	POINT	REFS	18				
5	LHL	INTEGER	POINT	REFS	18				
223	LHMGPT	INTEGER	POINT	REFS	80				
124	LHMGR	INTEGER	POINT	REFS	37				
162	LHRL	INTEGER	POINT	REFS	51	311	313		
103	LIGAP	INTEGER	POINT	REFS	18	331			

VARIABLES	SN	TYPE	RELOCATION							
12	LMN	INTEGER	INTEG	REFS	147					
106	LNFAIL	INTEGER	POINT	REFS	18					
146	LNUDEP	INTEGER	POINT	REFS	43	331				
31	LOLAXG	INTEGER	POINT	REFS	18	296				
32	LOLDPC	INTEGER	POINT	REFS	18	292				
33	LOLDPG	INTEGER	POINT	REFS	18	293				
34	LOLDTC	INTEGER	POINT	REFS	18	291				
35	LOLDUR	INTEGER	POINT	REFS	18	294				
36	LOLEPS	INTEGER	POINT	REFS	18	289				
37	LOLFEP	INTEGER	POINT	REFS	18	290				
104	LOLIGP	INTEGER	POINT	REFS	18	295				
40	LPAXGP	INTEGER	POINT	REFS	18	297	331			
41	LPC	INTEGER	POINT	REFS	18	288	331	370		
42	LPECRP	INTEGER	POINT	REFS	18	331				
43	LPEP	INTEGER	POINT	REFS	18	286	331			
135	LPEPSV	INTEGER	POINT	REFS	43					
255	LPF	INTEGER	POINT	REFS	90					
136	LPFPSV	INTEGER	POINT	REFS	43					
44	LPG	INTEGER	POINT	REFS	18	287	331	370	380	
45	LPINT	INTEGER	POINT	REFS	18	331	380			
224	LPIT	INTEGER	POINT	REFS	80					
46	LPLDPC	INTEGER	POINT	REFS	18	292	331			
47	LPLDPG	INTEGER	POINT	REFS	18	293	331			
50	LPLDTC	INTEGER	POINT	REFS	18	291	331			
51	LPLDUR	INTEGER	POINT	REFS	18	294	331			
107	LPLIGP	INTEGER	POINT	REFS	18	295	331			
52	LPOAXG	INTEGER	POINT	REFS	18	296	331			
53	LPOFEP	INTEGER	POINT	REFS	18	290	331			
54	LPOLEP	INTEGER	POINT	REFS	18	289	331			
6	LPOROS	INTEGER	POINT	REFS	18					
201	LPORS1	INTEGER	POINT	REFS	63					
202	LPORS2	INTEGER	POINT	REFS	63					
225	LPRT10	INTEGER	POINT	REFS	80					
226	LPRT11	INTEGER	POINT	REFS	80					
227	LPRT12	INTEGER	POINT	REFS	80					
230	LPRT13	INTEGER	POINT	REFS	80					
231	LPRT14	INTEGER	POINT	REFS	80					
232	LPRT15	INTEGER	POINT	REFS	80					
233	LPRT16	INTEGER	POINT	REFS	80					
234	LPRT17	INTEGER	POINT	REFS	80					
235	LPRT18	INTEGER	POINT	REFS	80					
236	LPRT2	INTEGER	POINT	REFS	80					
237	LPRT20	INTEGER	POINT	REFS	80					
240	LPRT3	INTEGER	POINT	REFS	80					
241	LPRT4	INTEGER	POINT	REFS	80					
242	LPRT5	INTEGER	POINT	REFS	80					
243	LPRT6	INTEGER	POINT	REFS	80					
244	LPRT7	INTEGER	POINT	REFS	80					
245	LPRT8	INTEGER	POINT	REFS	80					
246	LPRT9	INTEGER	POINT	REFS	80					
214	LQ	INTEGER	POINT	REFS	75					
105	LQDP	INTEGER	POINT	REFS	18					
206	LR	INTEGER	POINT	REFS	63					

VARIABLES	SN	TYPE	RELOCATION							
207	LRAD	INTEGER	POINT	REFS	63	305				
55	LRDCOL	INTEGER	POINT	REFS	18					
137	LREPS	INTEGER	POINT	REFS	43	302				
141	LREPSP	INTEGER	POINT	REFS	43	302	331			
140	LREPSV	INTEGER	POINT	REFS	43	331				
126	LREPS2	INTEGER	POINT	REFS	37					
143	LRFEPP	INTEGER	POINT	REFS	43	301	331			
142	LRFEPS	INTEGER	POINT	REFS	43	301				
144	LRFPSV	INTEGER	POINT	REFS	43	331				
263	LRLEAS	INTEGER	POINT	REFS	90					
113	LRTRNO	INTEGER	POINT	REFS	18					
112	LRTRNP	INTEGER	POINT	REFS	18					
145	LSIG	INTEGER	POINT	REFS	43	331				
150	LSIGI	INTEGER	POINT	REFS	43	331				
266	LSTHIF	INTEGER	POINT	REFS	96					
247	LTAC	INTEGER	POINT	REFS	80					
56	LTAF	INTEGER	POINT	REFS	18					
250	LTAFA	INTEGER	POINT	REFS	80					
57	LTAG	INTEGER	POINT	REFS	18					
251	LTAGA	INTEGER	POINT	REFS	80					
60	LTBAR	INTEGER	POINT	REFS	18					
61	LTBLK	INTEGER	POINT	REFS	18					
62	LTCA	INTEGER	POINT	REFS	18	331				
63	LTCIDI	INTEGER	POINT	REFS	18					
64	LTCODI	INTEGER	POINT	REFS	18					
163	LTFB	INTEGER	POINT	REFS	51					
164	LTFR	INTEGER	POINT	REFS	51					
165	LTFRK	INTEGER	POINT	REFS	51					
203	LTMPDS	INTEGER	POINT	REFS	63					
205	LTMPMX	INTEGER	POINT	REFS	63					
117	LTOXO	INTEGER	POINT	REFS	18					
65	LTPS	INTEGER	POINT	REFS	18					
102	LTRTRN	INTEGER	POINT	REFS	18					
252	LTSF	INTEGER	POINT	REFS	80					
7	LUFS	INTEGER	POINT	REFS	18					
204	LUO2LL	INTEGER	POINT	REFS	63	311				
1	LURC	INTEGER	POINT	REFS	18	331				
66	LURF	INTEGER	POINT	REFS	18	304	305	2*306	308	331
67	LVCH	INTEGER	POINT	REFS	18					
70	LVCHI	INTEGER	POINT	REFS	18					
71	LVCR	INTEGER	POINT	REFS	18					
72	LVDH	INTEGER	POINT	REFS	18					
73	LVFH	INTEGER	POINT	REFS	18					
74	LVGH	INTEGER	POINT	REFS	18					
166	LVPL	INTEGER	POINT	REFS	51					
75	LVPOR	INTEGER	POINT	REFS	18					
76	LZRO2A	INTEGER	POINT	REFS	18					
77	LZRO2B	INTEGER	POINT	REFS	18					
13	M	INTEGER	INTEG	REFS	147					
0	MAXIDX	INTEGER	LACMDL	REFS	204					
166	MDBG	INTEGER	INPTI	REFS	174					
15	MDHPRS	INTEGER	PFRCS2	REFS	194					
271	MECHAN	INTEGER	INPTI	REFS	174	282				

VARIABLES	SN	TYPE	RELOCATION								
20	MEPP2	INTEGER	PFRCS2	REFS	194						
24	MEPS0	INTEGER	PFRCS2	REFS	194						
22	MEPS02	INTEGER	PFRCS2	REFS	194						
17	MEPS22	INTEGER	PFRCS2	REFS	194						
11	MEP2	INTEGER	PFRCS2	REFS	194						
10	MEREP2	INTEGER	PFRCS2	REFS	194						
14	MFVFR0	INTEGER	PFRCS2	REFS	194						
2	MGAP2	INTEGER	PFRCS2	REFS	194						
3	MIGAP2	INTEGER	PFRCS2	REFS	194						
0	MNA	INTEGER	F.P.	REFS	21*228	370	DEFINED	1			
0	MNR	INTEGER	F.P.	REFS	14*228	370	DEFINED	1			
170	MODE	INTEGER	INPTI	REFS	174	323					
171	MODES	INTEGER	INPTI	REFS	174						
14	MODLOP	INTEGER	INTEG	REFS	147						
1	MODPC2	INTEGER	PFRCS2	REFS	194						
0	MODPG2	INTEGER	PFRCS2	REFS	194						
4	MOIGP2	INTEGER	PFRCS2	REFS	194						
13	MOLDT2	INTEGER	PFRCS2	REFS	194						
23	MPEPP2	INTEGER	PFRCS2	REFS	194						
6	MPEPS2	INTEGER	PFRCS2	REFS	194						
16	MPEP2	INTEGER	PFRCS2	REFS	194						
5	MREPS2	INTEGER	PFRCS2	REFS	194						
12	MR22	INTEGER	PFRCS2	REFS	194						
21	MSIG2	INTEGER	PFRCS2	REFS	194						
172	MTAPE	INTEGER	INPTI	REFS	174						
7	MTTT	INTEGER	PFRCS2	REFS	194						
1013	M1	INTEGER		REFS	367	368	370	DEFINED	347		
1014	M2	INTEGER		REFS	370	DEFINED	348				
1015	M3	INTEGER		REFS	361	370	DEFINED	349			
1016	M4	INTEGER		REFS	370	380	DEFINED	350			
1017	M5	INTEGER		REFS	370	DEFINED	351				
1020	M6	INTEGER		REFS	370	DEFINED	352				
266	NA	INTEGER	INPTI	REFS	174	276	277	278	299	315	331
43	NAA	INTEGER	PFCMI2	REFS	242						
15	NAB	INTEGER	INTEG	REFS	147	269	DEFINED	270			
233	NAFAIL	INTEGER	INPTI	REFS	174						
25	NALFDT	INTEGER	PFCMI2	REFS	242						
1026	NAX	INTEGER		REFS	370	DEFINED	367				
33	NBB	INTEGER	PFCMI2	REFS	242						
27	NC	INTEGER	INTEG	REFS	147						
45	NCC	INTEGER	PFCMI2	REFS	242						
11	NCOEF	INTEGER	PFCMI2	REFS	242						
272	NCRACK	INTEGER	INPTI	REFS	174	370					
274	NCREEP	INTEGER	INPTI	REFS	174						
173	NDBG	INTEGER	INPTI	REFS	174	320					
5	NDCHCK	INTEGER	PFCMI2	REFS	242						
36	NDD	INTEGER	PFCMI2	REFS	242						
7	NDEP	INTEGER	PFCMI2	REFS	242						
12	NDSIGF	INTEGER	PFCMI2	REFS	242						
21	NE	INTEGER	PFCMI2	REFS	242						
16	NECRP2	INTEGER	PFCMI2	REFS	242	379					
41	NEE	INTEGER	PFCMI2	REFS	242						
44	NEI	INTEGER	PFCMI2	REFS	242						

VARIABLES	SN	TYPE		RELOCATION						
273	NELAST	INTEGER		INPTI	REFS	174	370	DEFINED	281	
23	NEPP2	INTEGER		PFCMI2	REFS	242	370			
15	NEP2	INTEGER		PFCMI2	REFS	242	370			
270	NEWPRB	INTEGER		INPTI	REFS	174				
26	NF	INTEGER		INTEG	REFS	147				
174	NFROD	INTEGER		INPTI	REFS	174				
13	NFI	INTEGER		PFCMI2	REFS	242				
14	NF2	INTEGER		PFCMI2	REFS	242				
175	NGRPC	INTEGER		INPTI	REFS	174				
176	NGASK	INTEGER		INPTI	REFS	174				
35	NGG	INTEGER		PFCMI2	REFS	242				
167	NHEAL	INTEGER		INPTI	REFS	174				
30	NHH	INTEGER		PFCMI2	REFS	242				
42	NLL	INTEGER		PFCMI2	REFS	242				
34	NMM	INTEGER		PFCMI2	REFS	242				
32	NMN	INTEGER		PFCMI2	REFS	242				
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	174				
46	NNFF	INTEGER		PFCMI2	REFS	242				
31	NNN	INTEGER		PFCMI2	REFS	242				
25	NNNCRP	INTEGER		PFRCS2	REFS	194				
40	NNU	INTEGER		PFCMI2	REFS	242				
27	NNUDPP	INTEGER		PFCMI2	REFS	242				
177	NOFAIL	INTEGER		INPTI	REFS	174				
277	NOFRAC	INTEGER		INPTI	REFS	174				
26	NOLDPP	INTEGER		PFCMI2	REFS	242	370			
6	NOLSGF	INTEGER		PFCMI2	REFS	242				
200	NOPT	INTEGER		INPTI	REFS	174				
201	NPCYCL	INTEGER		INPTI	REFS	174				
0	NPIN	INTEGER		PFCMI2	REFS	242				
16	NPLAST	INTEGER		INTEG	REFS	147	281	325	DEFINED	318
263	NPLOT	INTEGER		INPTI	REFS	174				
202	NPLTAB	INTEGER		INPTI	REFS	174				
1	NPOUT	INTEGER		PFCMI2	REFS	242				
304	NPRINT	INTEGER		INPTI	REFS	174				
2	NPI	INTEGER		PFCMI2	REFS	242				
3	NP2	INTEGER		PFCMI2	REFS	242				
267	NR	INTEGER		INPTI	REFS	174	310			
203	NREAD	INTEGER		INPTI	REFS	174				
1000	NRELAX	INTEGER			REFS	326	370	DEFINED	264	
204	NRESTR	INTEGER		INPTI	REFS	174				
17	NRMI	INTEGER		INTEG	REFS	147	309			
265	NROD	INTEGER		INPTI	REFS	174				
205	NROLL	INTEGER		INPTI	REFS	174				
25	NSH	INTEGER		INTEG	REFS	147				
10	NSLOPE	INTEGER		PFCMI2	REFS	242				
206	NSP	INTEGER		INPTI	REFS	174				
207	NSTART	INTEGER		INPTI	REFS	174				
20	NSTEP	INTEGER		INTEG	REFS	147				
210	NSTOP	INTEGER		INPTI	REFS	174				
24	NSTRTT	INTEGER		PFCMI2	REFS	242				
211	NT	INTEGER		INPTI	REFS	174	273	284	370	
212	NTAPE	INTEGER		INPTI	REFS	174				
20	NTN	INTEGER		PFCMI2	REFS	242				

VARIABLES	SN	TYPE		RELOCATION								
264	NTPLOT	INTEGER		INPTI	REFS	174						
4	NTSAVE	INTEGER		PFCMI2	REFS	242						
17	NT2	INTEGER		PFCMI2	REFS	242						
421	NU	REAL		REALS	REFS	7	120					
213	NUCFC	INTEGER		INPTI	REFS	174						
214	NUNITS	INTEGER		INPTI	REFS	174						
22	NV	INTEGER		PFCMI2	REFS	242						
37	NW	INTEGER		PFCMI2	REFS	242						
301	NWORDS	INTEGER		INPTI	REFS	174						
303	NWRDS	INTEGER		INPTI	REFS	174						
21	NWRITE	INTEGER		INTEG	REFS	147						
262	NXP	INTEGER		INPTI	REFS	174						
1022	N1	INTEGER			REFS	370	DEFINED	354				
22	N2	INTEGER		INTEG	REFS	147	322					
1023	N22	INTEGER			REFS	370	DEFINED	355				
1024	N3	INTEGER			REFS	370	DEFINED	356				
1025	N4	INTEGER			REFS	370	DEFINED	357				
0	OLDPC2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1			
0	OLDPG2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1			
0	OLDT2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1			
0	OLIGP2	INTEGER	ARRAY	F.P.	REFS	227	228	370	DEFINED	1		
422	OXDROP	REAL		REALS	REFS	120						
423	OXIDE	REAL		REALS	REFS	120						
424	PECDH	REAL		REALS	REFS	120						
0	PEPP2	REAL	ARRAY	F.P.	REFS	228	364	DEFINED	1			
0	PEP2	REAL	ARRAY	F.P.	REFS	228	362	DEFINED	1			
425	PI	REAL		REALS	REFS	120						
426	PIN	REAL	ARRAY	REALS	REFS	120						
460	PINP	REAL		REALS	REFS	120						
461	PORO	REAL		REALS	REFS	120						
444	PPMH2O	REAL		INPTR	REFS	155						
445	PPMN2	REAL		INPTR	REFS	155						
462	PR	REAL		REALS	REFS	120						
0	PREPS2	REAL	ARRAY	F.P.	REFS	228	359	360	DEFINED	1		
463	PRESS	REAL		REALS	REFS	120	287					
464	PRTY	REAL		REALS	REFS	120						
465	PRT19	REAL		REALS	REFS	120						
446	P2	REAL	ARRAY	INPTR	REFS	155	288					
473	QAV	REAL		REALS	REFS	120						
466	QC	REAL		REALS	REFS	120						
613	QEND	REAL	ARRAY	INPTR	REFS	155						
623	QF	REAL	ARRAY	INPTR	REFS	155						
1333	QMPY	REAL	ARRAY	INPTR	REFS	155						
467	QP	REAL		REALS	REFS	120						
474	QPEAK	REAL		REALS	REFS	120						
470	QSP	REAL		REALS	REFS	120						
1500	RAPOW	REAL	ARRAY	INPTR	REFS	155						
1513	RC	REAL		INPTR	REFS	155						
471	RCI	REAL		REALS	REFS	120	331					
472	RCO	REAL		REALS	REFS	120	331					
1514	RDISH	REAL		INPTR	REFS	155						
0	REPS2	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	359	360	
475	RFNVFF	REAL		REALS	REFS	133						

VARIABLES	SN	TYPE		RELOCATION						
476	RHO	REAL		REALS	REFS	133				
477	RHOF	REAL		REALS	REFS	133				
500	RHOG	REAL		REALS	REFS	133				
501	RHOUO2	REAL		REALS	REFS	133				
502	RMH	REAL		REALS	REFS	133				
1515	ROUGHC	REAL		INPTR	REFS	155				
1516	ROUGHF	REAL		INPTR	REFS	155				
503	RP	REAL		REALS	REFS	133	263			
777	RPP	REAL			REFS	305	308	331	DEFINED	263
2551	RSNTR	REAL		INPTR	REFS	155				
504	RSTRAN	REAL		REALS	REFS	133				
505	RSTRES	REAL		REALS	REFS	133				
506	RTRAN	REAL		REALS	REFS	133				
0	R22	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
1517	SGAPF	REAL		INPTR	REFS	155				
0	SIG2	REAL	ARRAY	F.P.	REFS	226	370	360	DEFINED	1
507	SKTC	REAL		REALS	REFS	133				
510	SKTS	REAL		REALS	REFS	133				
511	STRN	REAL		REALS	REFS	133				
512	SUMCK	REAL		REALS	REFS	133				
513	SUMDH	REAL		REALS	REFS	133				
514	SUMEXP	REAL		REALS	REFS	133				
515	SUMGP	REAL		REALS	REFS	133				
516	SUMPOR	REAL		REALS	REFS	133				
517	SUMRG	REAL		REALS	REFS	133				
520	SUMTF	REAL		REALS	REFS	133				
521	T	REAL		REALS	REFS	133				
522	TCAC	REAL		REALS	REFS	133				
1520	TCC	REAL		INPTR	REFS	155				
523	TCI	REAL		REALS	REFS	133				
524	TCO	REAL		REALS	REFS	133				
525	TFBC	REAL		REALS	REFS	133				
526	TFC	REAL		REALS	REFS	133				
527	TFGFR	REAL		REALS	REFS	133				
530	THEFR	REAL		REALS	REFS	133				
531	TH2OFR	REAL		REALS	REFS	133				
1521	TIME	REAL	ARRAY	INPTR	REFS	155	267			
532	TITLE	REAL	ARRAY	REALS	REFS	133				
546	TM	REAL		REALS	REFS	133				
547	TN2FR	REAL		REALS	REFS	133				
1666	TOTL	REAL		INPTR	REFS	155				
550	TQXO	REAL		REALS	REFS	133				
551	TP	REAL		REALS	REFS	133				
552	TPA	REAL		REALS	REFS	133				
553	TPAC	REAL		REALS	REFS	133				
554	TPLEN	REAL		REALS	REFS	133				
555	TRANST	REAL		REALS	REFS	133				
2553	TREF	REAL		INPTR	REFS	155				
556	TSAT	REAL		REALS	REFS	133				
1667	TSINT	REAL		INPTR	REFS	155				
557	TT	REAL		REALS	REFS	133				
0	TTT	REAL	ARRAY	F.P.	REFS	228	370	DEFINED	1	
1670	TW	REAL	ARRAY	INPTR	REFS	155				

VARIABLES	SN	TYPE		RELOCATION							
560	TX	REAL		REALS	REFS	133					
561	TXA	REAL		REALS	REFS	133					
562	TXAL	REAL		REALS	REFS	133					
563	TXC	REAL		REALS	REFS	133					
2035	UBFS	REAL		INPTR	REFS	155					
2036	UMELT	REAL		INPTR	REFS	155					
2037	UOFD	REAL		INPTR	REFS	155					
1011	URFOLD	REAL			REFS	306	DEFINED	304			
0	VERS	REAL		VER	REFS	206					
564	VISC	REAL		REALS	REFS	133					
565	VPLT	REAL		REALS	REFS	133					
2040	VS	REAL		INPTR	REFS	155					
566	VSS	REAL		REALS	REFS	133					
600	VX	REAL		REALS	REFS	133	370				
567	W	REAL		REALS	REFS	133					
570	WT	REAL		REALS	REFS	133					
571	WTRAN	REAL		REALS	REFS	133					
2041	X	REAL	ARRAY	INPTR	REFS	155					
572	XEIN	REAL		REALS	REFS	133					
573	XK6	REAL		REALS	REFS	133					
574	XK7	REAL		REALS	REFS	133					
575	YY	REAL		REALS	REFS	133					
576	Z	REAL		REALS	REFS	133					
577	ZRO2WG	REAL		REALS	REFS	133					
1003	ZZ	REAL			REFS	274	276	2*315	316	DEFINED	268

EXTERNALS	TYPE	ARGS	REFERENCES		
FCMI		47	331		
FCMI2		49	370		
MEMSET		3	276	277	278

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
AMAXI	REAL	0	INTRIN	313

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	275	273	
67	110	279	269	
0	120	303	284	298
0	130	314	309	
424	140	345	282	
0	150	365	361	363
607	160	381	339	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
44	100	I	273 275	68	INSTACK	
77	120	I	284 303	1128		NOT INNER
163	120	II	298 303	238	OPT	
242	130	L	309 314	308	OPT	
466	150	I	361 365	248		NOT INNER
475	150	II	363 365	128	INSTACK	

COMMON BLOCKS	LENGTH
POINT	199
REALS	392
INTEG	24
INPTR	1393
INPTI	197
EMFLGS	10
PFRCS2	22
MATCNS	12
LACMDL	21
VER	1
PHYPRO	11
FAST	1
PFCM12	39

STATISTICS

PROGRAM LENGTH	10518	553
SCM LABELED COMMON LENGTH	4422B	2322

140000B SCM USED

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      SUBROUTINE FRPCON (IAXSM)                                                 FRPCON     2
C                                                                               FRPCON     3
C*****************************************************************************  FRPCON     4
C                                                                               FRPCON     5
C  FRPCON IS CALLED FROM DRIVER AND CALLS ALL OF THE MAJOR SUBCODES             FRPCON     6
C                                                                               FRPCON     7
C*****************************************************************************  FRPCON     8
C                                                                               FRPCON     9
C  IAXSM  - INDEX FOR AXISYM ANALYSIS                                           FRPCON    10
C  = 0, NO AXISYM ANALYSIS                                                      FRPCON    11
C  = 1, FRAPCON ANALYSIS FOLLOWED BY AN AXISYM ANALYSIS                         FRPCON    12
C                                                                               FRPCON    13
C                                                                               FRPCON    14
C  IMPLICIT REAL*8 (A-H,O-Z)                                                    FRPCON    15
C                                                                               FRPCON    16
C    LOGICAL UNIT                                                               FRPCON    17
C                                                                               FRPCON    18
C    REAL  NU , KRYIN                                                           FRPCON    19
C                                                                               FRPCON    20
C                                                                               FRPCON    21
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),               FRPCON    22
     +  NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),DI(40,40),NRUN,NFAC,           FRPCON    23
     +   ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES           FRPCON    24
     +     ,IUNCRT                                                              FRPCON    25
      LEVEL 2,FACTOR                                                            FRPCON    26
C                                                                               FRPCON    27
C                                                                               PELPT     2
      COMMON / PNTPNL / IFIRST, IAELM, IAK, IARAA, IARE, ISB, IBA,              PELPT     3
     + IBASAV, IBASE, ISBB, IBBA, IBBSV, ICA, ICC, ICRATE, ICRPG, IDISP,        PELPT     4
     + IDISPC, IDSPSV, IEFSTR, IELM, IELSTN, ILSTNA, ILSTRA, IELSTR,            PELPT     5
     + IPSLA, IEPSLM, IESTNV, IESTSV, JIIJ, IIPOS, IKSAVE, IMADET, INDC,        PELPT     6
     + INDF, INDT, INODET, IOLDSE, IPSSRT, IPSSV, IPSTS, IR, IRA, IRBR,         PELPT     7
     + IRBRA, IRD, ISTRES, ISTRSA, ITCB, ITCRP, ITEC, ITEF, ITELM, ITFB,        PELPT     8
     + ITHET, ITHTAX, ITHSAV, ITHXSV, ITME, ITSTNR, ITSTSR, ITV, ITW,           PELPT     9
     + IXKT, IXLOAD, IXLODA, IXRD, IY, IYACF, IZ, ILAST                         PELPT    10
C                                                                               PELPT    11
C                                                                               REALCM    2
C                                                                               REALCM    3
C  THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY                 REALCM    4
C  DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL                    REALCM    5
C                                                                               REALCM    6
C                                                                               REALCM    7
C  ( NA )      -  ARRAYS                                                        REALCM    8
C                                                                               REALCM    9
      COMMON  / POINT /                                                         REALCM   10
     +         LDCIH    ,LURC    ,LCREPI   ,LDLH    ,LHA     ,LHL            REALCM   11
     +        ,LPOROS   ,LUFS    ,LAXGAP   ,LAXLEN  ,LBU1    ,LBU2           REALCM   12
     +        ,LARAD    ,LCPDLT  ,LDELBP   ,LDENMX  ,LDLPGE                   REALCM   13
     +        ,LDZ      ,LDZH    ,LDZHP    ,LECREP  ,LEP                      REALCM   14
     +        ,LGAP     ,LGPTP   ,LHCOEF   ,LOLAXG  ,LOLDPC                   REALCM   15
     +        ,LOLDPG   ,LOLDTC  ,LOLDUR   ,LOLEPS  ,LOLFEP                   REALCM   16
     +        ,LPAXGP   ,LPC     ,LPECRP   ,LPEP    ,LPG                     REALCM   17
     +        ,LPINT    ,LPLDPC  ,LPLDPG   ,LPLDTC  ,LPLDUR   ,LPOAXG         REALCM   18
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     +       ,LPQFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR    REALCM     19
55   +       ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF     REALCM     20
     +       ,LVCH     ,LVCHI    ,LVCR     ,LVDH     ,LVFH     ,LVGH     REALCM     21
     +       ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEPI                          REALCM     22
     +       ,LHGAPS   ,LTRTRN   ,LIGAP    ,LQLIGP   ,LQDP               REALCM     23
     +       ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO   REALCM     24
60   +       ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO                         REALCM     25
C                                                                          REALCM     26
CC   ( NA X 2 )  -  ARRAYS                                                 REALCM     27
C                                                                          REALCM     28
      COMMON  / POINT /                                                    REALCM     29
65   +         LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG     REALCM     30
     +       ,LREPS2                                                       REALCM     31
C                                                                          REALCM     32
CC   ( NA X 3 )  -  ARRAYS                                                 REALCM     33
C                                                                          REALCM     34
70    COMMON  / POINT /                                                    REALCM     35
     +         LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS    REALCM     36
     +       ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS   REALCM     37
     +       ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPPI              REALCM     38
     +       ,LSIGI    ,LEPSI                                              REALCM     39
75   C                                                                     REALCM     40
CC   ( NR )      -  ARRAYS                                                 REALCM     41
C                                                                          REALCM     42
      COMMON  / POINT /                                                    REALCM     43
     +         LAK1     ,LAK2     ,LCRL     ,LDPL     ,LDPLH    ,LDPN     REALCM     44
80   +       ,LFMA     ,LFMGPR   ,LHRL     ,LTFB     ,LTFR     ,LTFRK    REALCM     45
     +       ,LVPL                                                         REALCM     46
C                                                                          REALCM     47
CC   ( NR X 2 )  -  ARRAYS                                                 REALCM     48
C                                                                          REALCM     49
85    COMMON  / POINT /                                                    REALCM     50
     +         LF       ,LFH      ,LFN                                    REALCM     51
C                                                                          REALCM     52
CC   ( NR X NA ) -  ARRAYS                                                 REALCM     53
C                                                                          REALCM     54
90    COMMON  / POINT /                                                    REALCM     55
     +         LCC1     ,LCC2     ,LDENSF   ,LDENSP   ,LDPW     ,LDPWPP   REALCM     56
     +       ,LGNSIZ   ,LPORS1   ,LPORS2   ,LTMPDS   ,LUO2LL   ,LTMPMX   REALCM     57
     +       ,LR       ,LRAD                                               REALCM     58
C                                                                          REALCM     59
95   CC   ( NA X 6 )  -  ARRAYS                                            REALCM     60
C                                                                          REALCM     61
      COMMON  / POINT /                                                    REALCM     62
     +         LB       ,LBR      ,LBTOLD   ,LCHEM                        REALCM     63
C                                                                          REALCM     64
100  CC   ( NA X 8 )  -  ARRAYS                                            REALCM     65
C                                                                          REALCM     66
      COMMON  / POINT /                                                    REALCM     67
     +         LQ                                                          REALCM     68
C                                                                          REALCM     69
105  CC   ( IT )      -  ARRAYS                                            REALCM     70
C                                                                          REALCM     71
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      COMMON / POINT /          LACMFG   ,LACMHE   ,LACMH2   ,LACMN2  REALCM     72
     +                ,LAMGPT   ,LGASMO  ,LHMGPT   ,LPIT     ,LPRT10  REALCM     73
     +         ,LPRT11  ,LPRT12  ,LPRT13  ,LPRT14  ,LPRT15  ,LPRT16  REALCM     74
     +         ,LPRT17  ,LPRT18  ,LPRT2   ,LPRT20  ,LPRT3   ,LPRT4   REALCM     75
     +         ,LPRT5   ,LPRT6   ,LPRT7   ,LPRT8   ,LPRT9   ,LTAC    REALCM     76
     +         ,LTAFA   ,LTAGA   ,LTSF                               REALCM     77
C                                                                      REALCM     78
C                                                                      REALCM     79
C   ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME                REALCM     80
C                                                                      REALCM     81
      COMMON / POINT /                                                 REALCM     82
     +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,       REALCM     83
     +   LDECAY,   LHALF,    LRLEAS                                   REALCM     84
C                                                                      REALCM     85
C   BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME                       REALCM     86
C                                                                      REALCM     87
      COMMON / POINT /                                                 REALCM     88
     +   IRDOT,    ISAVGS,   LSTHIF,   IX                             REALCM     89
C                                                                      REALCM     90
C   RADIAL MODEL ARRAYS                                                REALCM     91
C                                                                      REALCM     92
      COMMON / POINT /                                                 REALCM     93
     +   ICFAC    ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF      REALCM     94
     +  ,ITRAMP   ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV                REALCM     95
     +  ,IHLDN    ,IPLSTC   ,ISTRNN   ,ISTRSS                          REALCM     96
C                                                                      REALCM     97
C                                                                      REALCM     98
C                                                                      REALCM     99
C                                                                      REALCM    100
      COMMON / REALS /   AAA(20)  ,AAN      ,AIRIN    ,AMGP(2) ,AMGPH(2) REALCM    101
     +                  ,AMGR(2)  ,AMGRH(2) ,AMGRN2(2),AMWDT    ,ANGI    REALCM    102
     +         ,ANGT     ,AN2IN    ,ARGIN    ,ARING    ,AVSQI(8) ,B(6)    REALCM    103
     +         ,BP       ,BPP      ,BR(6)    ,BU       ,BUULD    ,CDG     REALCM    104
     +         ,CFV      ,CFVA     ,CMOL     ,CODEID(15),CONVC,CONVER(10) REALCM    105
     +         ,CPV      ,CRDTT    ,CRN      ,CVV      ,DCIH              REALCM    106
     +         ,DCIHP    ,DELBP    ,DELBU    ,DELH     ,DELT              REALCM    107
     +         ,DELTCR   ,DELTDB   ,DELTFC   ,DELTJL   ,DHIC     ,DLREL   REALCM    108
     +         ,DLROD    ,DLTGC(26),DPH      ,DPHF     ,DPHFP    ,DPWP    REALCM    109
     +         ,DRS      ,ENRICH   ,EOLSR    ,FC(1)    ,FGIN     ,FGPAVP  REALCM    110
C                                                                      REALCM    111
      COMMON / REALS /   FGPAVX   ,FH2O     ,FJJ(2)   ,FJJH(2)  ,FMGP(2)  REALCM    112
     +                  ,FPOR     ,FPORI    ,FRD      ,FRDH     ,FRDN    REALCM    113
     +         ,G        ,GASES(7) ,GASIN    ,GDEN   ,GPTH(26) ,GPTHE(26) REALCM    114
     +         ,GPTHM    ,GPTHP    ,GPTHPG(26) ,GR     ,HCRV     ,HCV     REALCM    115
     +         ,HDSHV    ,HEIN     ,HFLL     ,HFLMDB   ,HFLMP    ,HFPER   REALCM    116
     +         ,HFV      ,HGAPT    ,HGV      ,HI       ,HMGP(2)  ,HP      REALCM    117
     +         ,HGAP     ,HSOLID   ,HGAPR                                 REALCM    118
     +         ,HPL      ,HPORV    ,HPV      ,HUPTAK   ,H2OMI    ,KRYIN   REALCM    119
     +         ,NU       ,OXDROP   ,OXIDE    ,PECDH    ,PI       ,PIN(26) REALCM    120
     +         ,PINP     ,PORO     ,PR       ,PRESS    ,PRTY     ,PRT19   REALCM    121
     +         ,QC       ,QP       ,QSP      ,RCI      ,RCO               REALCM    122
     +         ,QAV      ,QPEAK                                           REALCM    123
C                                                                      REALCM    124
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      COMMON / REALS /  RFHUFF   ,RHO      ,RHOF     ,RHOG     ,RHOUO2  REALCM   125
     +                 ,RMH      ,RP       ,RSTRAN   ,RSTRES   ,RTRAN   REALCM   126
     +          ,SKTC  ,SKTS     ,STRN     ,SUMCK    ,SUMDH    ,SUMEXP  REALCM   127
     +          ,SUMGP ,SUMPOR   ,SUMRG    ,SUMTF    ,T        ,TCAC    REALCM   128
     +          ,TCI   ,TCO      ,TFBC     ,TFC      ,TFGFR    ,THEFR   REALCM   129
     +          ,TH2OFR,TITLE(12),TM       ,TN2FR    ,TOXO     ,TP      REALCM   130
     +          ,TPA   ,TPAC     ,TPLEN    ,TRANST   ,TSAT     ,TT      REALCM   131
     +          ,TX    ,TXA      ,TXAL     ,TXC      ,VISC     ,VPLT    REALCM   132
     +          ,VSS   ,W        ,WT       ,WTRAN    ,XEIN     ,XK6     REALCM   133
     +          ,XK7   ,YY       ,Z        ,ZRO2WG   ,VX       ,CLOS    REALCM   134
     +          ,FNCK  ,FNCN     ,CHKF     ,CHNF     ,COLDWK             REALCM   135
     +          ,DISH                                                     REALCM   136
C                                                                          REALCM   137
C
      COMMON / INTEG /                                                     INTGCM     2
     +    IQUIT      ,IR1       ,IT       ,ITER     ,J                   INTGCM     3
     +   ,JJC        ,JPEAK     ,K        ,KINDOR   ,KOXI                INTGCM     4
     +   ,LMN        ,M         ,MODLOP   ,NAB      ,NPLAST              INTGCM     5
     +   ,NRM1       ,NSTEP     ,NWRITE   ,N2       ,IMDONE              INTGCM     6
     +   ,ICLOSE     ,N5H       ,NF       ,NC                            INTGCM     7
C                                                                          INTGCM     8
C                                                                          INTGCM     9
      COMMON / INPTR /ACOR       ,AFAL     ,AFCR     ,AFDN                INPRCM     2
     +               ,AFGR       ,AFSW     ,AFTC     ,AGPC                INPRCM     3
     +   ,AMFAIR     ,AMFARG    ,AMFFG    ,AMFHE    ,AMFH2               INPRCM     4
     +   ,AMFH2O     ,AMFKRY    ,AMFN2    ,AMFXE                         INPRCM     5
     +   ,BUIN(22)   ,CATEXF                                             INPRCM     6
     +   ,CLDWKD     ,CPL       ,CRDT     ,CRDTR    ,CTMAX(22)           INPRCM     7
     +   ,DCI(22)    ,DCO(22)   ,DE(22)   ,DELTAZ(22),DEN                INPRCM     8
     +   ,DENG       ,DISHSD    ,DP(22)   ,DSPG     ,DSPGW               INPRCM     9
     +   ,ENRCH      ,EXO       ,FA       ,FGPAV    ,FLUX                INPRCM    10
     +   ,FLXDP      ,FQE       ,GO(101)  ,GRNSIZ   ,HDISH               INPRCM    11
     +   ,HPLT       ,PPMH2O    ,PPMN2    ,P2(101)  ,QFND(8)             INPRCM    12
     +   ,QF(328)    ,QMPY(10)  ,RAPOW(11),RC       ,RDISH               INPRCM    13
     +   ,ROUGHC     ,ROUGHF    ,SGAPF                                    INPRCM    14
     +   ,TCC        ,TIME(101) ,TOTL     ,TSINT    ,TW(101)             INPRCM    15
     +   ,UBFS       ,UMELT     ,UOFD     ,V5       ,X(328)              INPRCM    16
     +   ,RSNTR      ,FOTMTL    ,TREF     ,CREPHR   ,ANRIN               INPRCM    17
     +   ,CLDWKS                                                         INPRCM    18
     +   ,CP         ,CR                                                 INPRCM    19
C                                                                          INPRCM    20
C                                                                          INPICM     2
      COMMON / INPTI /ICM        ,ICOR     ,IDBG     ,IDXGAS              INPICM     3
     +               ,IM         ,IPLANT   ,IQ       ,ISW                 INPICM     4
     +   ,JDLPR      ,JN(8)     ,JST(101) ,MDBG     ,NHEAL               INPICM     5
     +   ,MODE       ,MODES     ,MTAPE    ,NDBG     ,NFROD               INPICM     6
     +   ,NGAPC      ,NGASR     ,NOFAIL   ,NOPT     ,NPCYCL              INPICM     7
     +   ,NPLTAB     ,NREAD     ,NRESTR   ,NROLL    ,NSP                 INPICM     8
     +   ,NSTART     ,NSTOP     ,NT       ,NTAPE    ,NUCFC               INPICM     9
     +   ,NUNITS     ,LACMOD    ,LACE(13) ,NAFAIL   ,NNFAIL(22)          INPICM    10
     +   ,NXP        ,NPLOT     ,NTPLOT   ,NROD     ,NA                  INPICM    11
     +   ,NR         ,NEWPRB    ,MECHAN   ,NCRACK   ,NELAST              INPICM    12
     +   ,NCREEP     ,IAXSYM    ,IVARDM   ,NOFRAC   ,ITREST              INPICM    13
     +   ,NWORDS     ,IWORDS    ,NWRDS    ,NPRINT                        INPICM    14
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      C                                                                      INPICM     15
      C                                                                      INPICM     16
      215       COMMON  /EMFLGS/   IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO     INPICM     17
               +                  ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG     INPICM     18
               +         ,IMFGAS   ,IMSWCH                                    INPICM     19
      C                                                                      INPICM     20
      CC                                                                     INPICM     21
      220   C                                                                INPICM     22
               COMMON/PFRCS2/     MODPG2         ,MODPC2         ,MGAP2      INPICM     23
               +  ,MIGAP2         ,MOIGP2         ,MREPS2         ,MPEPS2    INPICM     24
               +  ,MTTT           ,MEREP2         ,MEP2           ,MR22      INPICM     25
               +  ,MOLDT2         ,MFVFRO         ,MDHPRS         ,MPEP2     INPICM     26
      225      +  ,MEPS22         ,MEPP2          ,MSIG2          ,MEPS02    INPICM     27
               +  ,MPEPP2         ,MEPS0          ,NNNCRP                    INPICM     28
      C                                                                      INPICM     29
               COMMON /MATCNS/ AAHA(12)                                      INPICM     30
      C                                                                      INPICM     31
      230   C                                                                INPICM     32
               COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                         INPICM     33
      C                                                                      INPICM     34
               COMMON /VER/ VERS                                             INPICM     35
      C                                                                      PHYPRO      4
      235      COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB PHYPRO      5
               +             ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP     ,COMP   PHYPRO      6
               +             ,DELOXY                                         PHYPRO      7
      C                                                                      PHYPRO      8
      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                PHYPRO      9
      240 C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)         PHYPRO     10
      C   CTMELT - ZR CLAD MELTING POINT (K)                                 PHYPRO     11
      C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                           PHYPRO     12
      C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)          PHYPRO     13
      C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)            PHYPRO     14
      245 C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)      PHYPRO     15
      C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)           PHYPRO     16
      C   BU     - BURNUP (MW-S/KG-U)                                       PHYPRO     17
      C   COMP   - PUO2 CONTENT (WT-PERCENT)                                PHYPRO     18
      C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED      PHYPRO     19
      250 C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                           PHYPRO     20
      C                                                                      FRPCON     34
               DIMENSION       FFR(1)      ,MODFAL(1)  ,PFB(20)    ,FB(23)  FRPCON     35
               +              ,GASFRC(9)   ,PINE(26)                         FRPCON     36
               +              ,DMWI(20)                                      FRPCON     37
      255      +   ,PSP(20)   ,AGRASS(1)   ,AFCMI2(1)                       FRPCON     38
      C                                                                      FRPCON     39
               COMMON/PFCMI2/          NPIN                                  FRPCON     40
               +                      ,NPOUT       ,NPI         ,NP2        FRPCON     41
               +                      ,NTSAVE      ,NDCHCK      ,NOLSGF     FRPCON     42
      260      +                      ,NLEF        ,NSLOPE      ,NCOEF      FRPCON     43
               +                      ,NDSIGF      ,NFI         ,NF2        FRPCON     44
               +                      ,NEP2        ,NECRP2      ,NT2        FRPCON     45
               +                      ,NTN         ,NE          ,NV         FRPCON     46
               +                      ,NEPP2       ,NSTRTT      ,NALFDT     FRPCON     47
      265      +                      ,NOLDPP      ,NNUDPP      ,NHH        FRPCON     48
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                     +                    ,NNN          ,NMN          ,NBB          FRPCON     48
                     +                    ,NMM          ,NGG          ,NDD          FRPCON     49
                     +                    ,NW           ,NNU          ,NEE          FRPCON     50
                     +                    ,NLL          ,NAA          ,NEI          FRPCON     51
270                  +                    ,NCC          ,NNFF                       FRPCON     52
                C                                                                   FRPCON     53
                C                                                                   FRPCON     54
                      COMMON / GRSPTR /   NVAR1    ,NVAR2    ,NVAR3    ,NVAR4      FRPCON     55
                     +          ,NVAR5    ,NVAR6    ,NVAR7    ,NVAR8    ,NVAR9      FRPCON     56
275                  +          ,NVAR10   ,NVAR11   ,NVAR12   ,NVAR13   ,NVAR14     FRPCON     57
                     +          ,NVAR15   ,NVAR16   ,NVAR17   ,NVAR18   ,NVAR19     FRPCON     58
                     +          ,NVAR20   ,NVAR21   ,NVAR22   ,NVAR23   ,NVAR24     FRPCON     59
                     +          ,NVAR25   ,NVAR26   ,NVAR27   ,NVAR28   ,NVAR29     FRPCON     60
                     +          ,NVAR30   ,NVAR31   ,NVAR32   ,NVAR33   ,NVAR34     FRPCON     61
280                  +          ,NVAR35   ,NVAR36   ,NVAR37   ,LGRASS               FRPCON     62
                C                                                                   FRPCON     63
                      COMMON / AXL / SUMM, SUMFF, SUMSAV, GROW                      FRPCON     64
                      COMMON /LIMITS/ M1, M2, NOEL, NOELF, NOELC, IDF, NFF, NETOT, NEWF, FRPCON     65
                     +NEWT, KA, NARF, NARC, NART, NABF, NABC, NABT, NAEC, NAEF, NTAE,   FRPCON     66
285                  +JAM, NAXBT, NAXB2, NAXB4, NFF1, NABF2, NABT2, XP, XR, XFRDEN, KZ1, FRPCON     67
                     +ISSTOP, IPLAS, NKN, ICRPP, MAXT. KRNCHF, KRNCHC, KRNCHT, NFF2,    FRPCON     68
                     +NC4, NF4, MAXA, NEW, NMX, KRNCH, MCUD, IADJ, ICUT, TIMEC, XTIMEF, FRPCON     69
                     +IT1, STEP, NOLD, KPLAS, ICNT, RRAKR, IRAK, RAKSUM, IPLEND, ISP,IRZ FRPCON     70
                C                                                                   FRPCON     71
290             C                                                                   FRPCON     72
                      COMMON /BA/ DELZA(40), NN, NCONN, NCNN, ISTRT, ITERD, FLXRD,  FRPCON     73
                     +ERAD(20), EAX(20)                                             FRPCON     74
                      INTEGER GASFLG                                                FRPCON     75
                      COMMON / FAST / A(1)                                          FRPCON     76
295                   EQUIVALENCE ( A(1) , IA(1)  , D(1)  ,AGRASS(1) , AFCM12(1)  ) FRPCON     77
                      EQUIVALENCE ( A(1)  , AFRCS2(1) )                             FRPCON     78
                      DIMENSION  IA(1) , D(1)                                       FRPCON     79
                      DIMENSION  POWPRO(3)                                          FRPCON     80
                      DIMENSION AFRCS2(1)                                           FRPCON     81
300             C                                                                   FRPCON     82
                      TCONV(TTTT) = (TTTT+459.67E0)/1.8E0                           FRPCON     83
                C                                                                   FRPCON     84
                      PFAVE = 0.0                                                   FRPCON     85
                      UNIT = .TRUE.                                                 FRPCON     86
305                   CDAMAG = 0.E0                                                 FRPCON     87
                      FDAMAG = 0.E0                                                 FRPCON     88
                      CRAKL = 1.27E-5                                               FRPCON     89
                      FDELTA = 0.E0                                                 FRPCON     90
                      CTMELT = 1.E0                                                 FRPCON     91
310                   CTRANB = 1.E0                                                 FRPCON     92
                      CTRANE = 1.E0                                                 FRPCON     93
                      CTRANZ = 1.E0                                                 FRPCON     94
                      CHEFUS = 1.E0                                                 FRPCON     95
                      NOTONE = 0                                                    FRPCON     96
315                   FHEFUS = 1.E0                                                 FRPCON     97
                      FRAC = 0.90                                                   FRPCON     98
                      GAPH = 1.E-2                                                  FRPCON     99
                      GAPT = 1.E-2                                                  FRPCON    100
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                GRT = 0.0                                                       FRPCON  101
320             FFR(I) = 0.E0                                                   FRPCON  102
                MODFAI(I) = 0                                                   FRPCON  103
                ISTOFF = 1                                                      FRPCON  104
                CESIUM = 0.E0                                                   FRPCON  105
                ZRNI = 1233.E0                                                  FRPCON  106
325             FREQ = 0.E0                                                     FRPCON  107
                ODINE = 0.E0                                                    FRPCON  108
                TFLIF = 1.E4                                                    FRPCON  109
                ESR = 0.E0                                                      FRPCON  110
                PSR = 0.E0                                                      FRPCON  111
330             CRAKI = 1.27E-5                                                 FRPCON  112
                ICDOFF = 0                                                      FRPCON  113
                TIMEF = 0.E0                                                    FRPCON  114
                TIMES = 0.E0                                                    FRPCON  115
                IFBSW = 0                                                       FRPCON  116
335             CINTOM = 0.0254E0                                               FRPCON  117
                CFTTOM = 0.3048E0                                               FRPCON  118
                CBHTWM = 3.1525E0                                               FRPCON  119
                ZRO2BI = 0.0                                                    FRPCON  120
                ZRO2AI = 0.0                                                    FRPCON  121
340             CHYDAI = 0.0                                                    FRPCON  122
                CHYDBI = 0.0                                                    FRPCON  123
                CALL MEMSET (0.E0,PINE,26)                                      FRPCON  124
                CALL MEMSET (0.E0,PFB,20)                                       FRPCON  125
                CALL MEMSET (0.E0,FB,23)                                        FRPCON  126
345             CALL MEMSET (0.E0,PSP,20)                                       FRPCON  127
                CALL MEMSET (0.E0,SUMM,4)                                       FRPCON  128
                CALL MEMSET (0,MI,62)                                           FRPCON  129
                NTIME = 1                                                       FRPCON  130
C                                                                               FRPCON  131
350         100 CONTINUE                                                        FRPCON  132
C                                                                               FRPCON  133
C   THE FOLLOWING CALL TO SETUP READS AND PROCESSES INPUT AND SETS UP           FRPCON  134
C   THE DYNAMIC DIMENSIONING POINTERS                                           FRPCON  135
C                                                                               FRPCON  136
355             CALL SETUP (MNA,MNR)                                            FRPCON  137
C                                                                               FRPCON  138
                IF (IQUIT.EQ.1) GO TO 790                                       FRPCON  139
C                                                                               FRPCON  140
                N7 = 7                                                          FRPCON  141
360             N3 = 3                                                          FRPCON  142
                N6 = 6                                                          FRPCON  143
                NA1 = NA+1                                                      FRPCON  144
                IAXSM = IAXSYM                                                  FRPCON  145
                GASFRC(8) = 0.E0                                                FRPCON  146
365             GASFRC(9) = 0.E0                                                FRPCON  147
C                                                                               FRPCON  148
                IF (NREAD.EQ.0) GO TO 110                                       FRPCON  149
C                                                                               FRPCON  150
C   THE FOLLOWING CALL TO TAPEGN READS THE RESTART INFORMATION FOR A            FRPCON  151
370 C   FRAPCON RESTART                                                         FRPCON  152
C                                                                               FRPCON  153
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      CALL TAPEGN (A(LBU2),A(LZRO2B),ANG,A(LRTRNO),A(LCC2),A(LPORS2),A(L FRPCON  154
     +DENSF),A(LDPW),A(LOLDPG),A(LOLEPS),A(LOLFEP),A(LOLDTC),A(LOLDPC),A FRPCON  155
     +(LOLDUR),A(LOLIGP),A(LREPS),A(LRFEPS),A(LEPP),A(LEP),A(LSIG),A(LEP FRPCON  156
375  +S),CTMAX,A(LCHEM),NA,NR,IRI,N7,IT,NREAD,NRESTR,NROLL,GASES,N3,N6,M FRPCON  157
     +ECHAN,IQUIT,TIME(1),A(L3TOLD),ITREST,NWORDS,LENGTH,NGASR,AGRASS,LG FRPCON  158
     +RASS)                                                             FRPCON  159
C                                                                       FRPCON  160
      IF (IQUIT.EQ.1) GO TO 790                                         FRPCON  161
380 C                                                                   FRPCON  162
110   CONTINUE                                                          FRPCON  163
      ITT = 1                                                           FRPCON  164
      NRM1 = NR-1                                                       FRPCON  165
      TRANST = 0.8E0*TSINT                                              FRPCON  166
385   FRDEN = DEN/100.E0                                                FRPCON  167
C                                                                       FRPCON  168
C                                                                       FRPCON  169
      IF (MECHAN.NE.1) GO TO 200                                        FRPCON  170
C                                                                       FRPCON  171
390   XP = CP                                                           FRPCON  172
      XR = CR                                                           FRPCON  173
      RCI = DCI(NA/2)/2.E0                                              FRPCON  174
      RP = DP(NA/2)/2.E0                                                FRPCON  175
C                                                                       FRPCON  176
395 C   VFCC FOR USE IN SUBROUTINE RADIAL                               FRPCON  177
        VFCC = (RCI*RCI-RP*RP)/(RCI*RCI)*100.                           FRPCON  178
C   INITIALIZE TPLEN                                                    FRPCON  179
      TPLEN = TW(1)                                                     FRPCON  180
      FLXRD = FLUX                                                      FRPCON  181
400 C   SIGG IS GAP ROUGHNESS, SIGC IS CRACK ROUGHNESS                  FRPCON  182
      SIGG = (RCI-RP)/8.                                                FRPCON  183
      SIGC = (RCI-RP)/5.                                                FRPCON  184
C                                                                       FRPCON  185
C   LOAD THE RD ARRAY FOR USE BY PELET (SAVES RADII OF ALL NODES)       FRPCON  186
405 C                                                                   FRPCON  187
      RCD = 0.0005                                                      FRPCON  188
      IF (RC.GT.RCD) RCD = RC                                           FRPCON  189
          DO 170 I=1,NABT                                               FRPCON  190
          IF (I.NE.1) GO TO 120                                         FRPCON  191
410       RCO = DCO(1)/2.                                               FRPCON  192
          RCI = DCI(1)/2.                                               FRPCON  193
          RP = DP(1)/2.                                                 FRPCON  194
          GO TO 140                                                     FRPCON  195
120       CONTINUE                                                      FRPCON  196
415       IF (I.GE.NA) GO TO 130                                        FRPCON  197
          RCO = DCO(I-1)/2.                                             FRPCON  198
          RCI = DCI(I-1)/2.                                             FRPCON  199
          RP = DP(I-1)/2.                                               FRPCON  200
          GO TO 140                                                     FRPCON  201
420       CONTINUE                                                      FRPCON  202
          RCO = DCO(NA-1)/2.                                            FRPCON  203
          RCI = DCI(NA-1)/2.                                            FRPCON  204
          RP = DP(NA-1)/2.                                              FRPCON  205
140       CONTINUE                                                      FRPCON  206
```

```
      C
      C   DRC IS DELTA CLAD RADIUS    DRF IS DELTA FUEL RADIUS
            DRC = (RCO-RCI)/FLOAT(NC-1)
            DRF = ((RCI-0.001)-RCD)/FLOAT(NF-1)
                DO 160 JX=1,NFF1
                IF (JX.LE.NF) GO TO 150
                D(IRD+(I-1)*NFF1+JX-1) = FLOAT(JX-NF-1)*DRC+RCI
                GO TO 160
      150       CONTINUE
                D(IRD+(I-1)*NFF1+JX-1) = FLOAT(JX-1)*DRF+RCD
      160       CONTINUE
      170   CONTINUE
      C
      C   LOAD THE DELTA ARRAY,AXIAL SEGMENT LENGTHS FOR USE IN PELET
      C
            DELZA(1) = 0.5
                DO 180 I=2,NA
                DELZA(I) = DELTAZ(I-1)*12.E0
      180       CONTINUE
            DELZA(NA+1) = CPL
            NA2 = NA+2
                DO 190 I=NA2,40
                DELZA(I) = 0.0
      190       CONTINUE
      200   CONTINUE
      C
            DELOXY = 0.0
            FNCK = 0.0
            FNCN = 0.0
            CWKF = CLDWKS
            CWNF = CLDWKD
            COLDWK = CLDWKS
            RSTRAN = 1.E-05
      C
            PCYCL = NPCYCL
            IF (NREAD.EQ.0) NAB = 1
            IF (NDBG.GT.0) NDBG = NDBG+1
      C
            IF (NREAD.EQ.1) IT = 2
            GASIN = HEIN+ARGIN+AIRIN+AN2IN+FGIN
            IF (NREAD.EQ.1) GO TO 220
                DO 210 IJ=2,IR1
                A(LBU1+IJ-1) = BUIN(IJ-1)*A(LQ+(M-1)*NA+IJ-2)*FA
      210       CONTINUE
            IT = 0
            NEW = 2
      C
      C   **********************************************************************
      C   START OF TIME STEP LOOP, IT=1,IM
      C
      220   ITER = 1
            IT = IT+1
      C
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                IF (MECHAN.NE.1) GO TO 230                                                FRPCON   260
              C                                                                           FRPCON   261
480           C   NOLD, NEW ARE USED  BY PELET IN THE INCREMENTAL SOLUTION TECHNIQUE      FRPCON   262
              C                                                                           FRPCON   263
                NOLD = 2                                                                  FRPCON   264
                IF (NEW.EQ.1) NOLD = 1                                                    FRPCON   265
                NEW = 1                                                                   FRPCON   266
485             IF (NOLD.EQ.1) NEW = 2                                                    FRPCON   267
                IRZ = IT                                                                  FRPCON   268
              C                                                                           FRPCON   269
              C   D(ITME, ETC) ARE USED AS PAST, PRESENT AND FUTURE TIME BY PELET        FRPCON   270
              C                                                                           FRPCON   271
490             D(ITME) = D(ITME+1)                                                       FRPCON   272
                D(ITME+1) = D(ITME+2)                                                     FRPCON   273
                D(ITME+2) = TIME(IT)/24./3600.                                            FRPCON   274
                IF (IT.EQ.IM) D(ITME+2) = D(ITME+1)+1.                                    FRPCON   275
              C                                                                           FRPCON   276
495           C                                                                           FRPCON   277
              230   CONTINUE                                                            FRPCON   278
                IF (IT.GE.NSTART.AND.IT.LE.NSTOP) NDBG = IT                               FRPCON   279
                IF (NWRITE.EQ.1) NDBG = IT                                                FRPCON   280
              C                                                                           FRPCON   281
500             GASFLG = 0                                                                FRPCON   282
                ZRO2AI = ZRO2BI                                                           FRPCON   283
                CHYDAI = CHYDBI                                                           FRPCON   284
                M = JST(IT)                                                               FRPCON   285
                G = GO(IT)                                                                FRPCON   286
505             T = TIME(IT)/3600.0                                                       FRPCON   287
                QAV = QMPY(IT)*(DCO(1)*PI/12.)/3413./FA                                   FRPCON   288
                QPEAK = A(LQ+JPEAK-2+(M-1)*NA)*QAV*FA                                     FRPCON   289
                IF (IT.EQ.1) DELH = T                                                     FRPCON   290
                IF (IT.GT.1) DELH = (TIME(IT)-TIME(IT-1))/3600.0                          FRPCON   291
510             DELHS = DELH*3600.                                                        FRPCON   292
                TP = T-DELH                                                               FRPCON   293
                IF (IT.EQ.1.AND.NREAD.EQ.0) GO TO 240                                     FRPCON   294
              C                                                                           FRPCON   295
              C   THE FOLLOWING CALL TO CANEAL COMPUTES EFFECTIVE FLUENCES AND           FRPCON   296
515           C   EFFECTIVE COLDWORKS                                                     FRPCON   297
              C                                                                           FRPCON   298
                IF (IT.GE.2) CTEMP = TCONV(A(LTAC+IT-2))                                  FRPCON   299
                RTEMP = 0.0                                                               FRPCON   300
                IF (IT.GE.3) RTEMP = (CTEMP-(A(LTAC+IT-3)+459.76)/1.8)/DELHS              FRPCON   301
520             CALL CANEAL (FLUX,DELHS,CTEMP,RTEMP,FNCK,FNCN,CWKF,CWNF)                  FRPCON   302
              C                                                                           FRPCON   303
              C   THE FOLLOWING CALL TO STORE RETAINS CONVERGED INFORMATION NEEDED       FRPCON   304
              C   FOR THE NEXT POWER-TIME STEP                                           FRPCON   305
              C                                                                           FRPCON   306
525             CALL STORE (A(LBU1),A(LBU2),A(LCC1),A(LCC2),A(LDENSP),A(LDENSF),A(      FRPCON   307
                +LDPWPP),A(LDPW),A(LPORS1),A(LPORS2),A(LZRO2A),A(LZRO2B),IR1,NA,NR,      FRPCON   308
                +NHEAL,A(LANG),A(LRTRNP),A(LRTRNO),BU,BUOLD,A(LTMPDS),A(LTMPMX))         FRPCON   309
              C                                                                           FRPCON   310
              240   J = 2                                                               FRPCON   311
530           C                                                                           FRPCON   312
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                GASLAS = A(LPIT+IT-1)                                                    FRPCON    313
C                                                                                        FRPCON    314
C   ***********************************************************************              FRPCON    315
C   START OF GAS RELEASE LOOP, ITER = 1, CONVERGENCE                                     FRPCON    316
C                                                                                        FRPCON    317
C                                                                                        FRPCON    318
                IF (MECHAN.NE.1) GO TO 270                                               FRPCON    319
C                                                                                        FRPCON    320
                CALL RADIAL (D(ICFAC),DEN,D(IDG),D(IDGSAV),EAX,ERAD,FRAC,ITER,NA,N       FRPCON    321
               +F,NFFI,D(IPRG),D(IRD),RP,SIGC,SIGG,D(ITCL),D(ITEMP),D(ITFS),D(ITRA       FRPCON    322
               +MP),D(IVFC),D(IVFF),VFCC,A(LDENSF),A(LDPW),A(LR),RCI,NR,D(IPLSTC),       FRPCON    323
               +D(ICFCSV))                                                               FRPCON    324
C                                                                                        FRPCON    325
                    DO 260 JRAD=2,NA                                                     FRPCON    326
                    D(ICFCSV+(ITER-1)*NA+JRAD-1) = D(ICFAC+JRAD-1)                       FRPCON    327
                    CSUM = 0.0                                                           FRPCON    328
                    SUMI = 0.0                                                           FRPCON    329
                        DO 250 IRR=1,ITER                                                FRPCON    330
                        IR = IRR                                                         FRPCON    331
                        IRAD = ITER-IR+1                                                 FRPCON    332
                        CSUM = CSUM+D(ICFCSV+(IR-1)*NA+JRAD-1)/FLOAT(IRAD)               FRPCON    333
                        SUMI = SUMI+1./FLOAT(IRAD)                                       FRPCON    334
            250         CONTINUE                                                         FRPCON    335
                    D(ICFAC+JRAD-1) = CSUM/SUMI                                          FRPCON    336
            260     CONTINUE                                                             FRPCON    337
C                                                                                        FRPCON    338
C                                                                                        FRPCON    339
            270 CONTINUE                                                                 FRPCON    340
C                                                                                        FRPCON    341
C   ***********************************************************************              FRPCON    342
C   START OF AXIAL NODE LOOP,  J=2,NA                                                    FRPCON    343
C                                                                                        FRPCON    344
            280   QC = QMPY(IT)*A(LQ+J-2+(M-1)*NA)                                       FRPCON    345
                  N2 = J-1                                                               FRPCON    346
                  CRN = DCO(J-1)/DCI(J-1)                                                FRPCON    347
                  DRS = CRN*CRN                                                          FRPCON    348
                  RCI = DCI(J-1)/2.E0                                                    FRPCON    349
                  RCO = DCO(J-1)/2.E0                                                    FRPCON    350
                  RP = DP(J-1)/2.E0                                                      FRPCON    351
                  TCC = RCO-RCI                                                          FRPCON    352
                  DEH = DE(J-1)/12.E0                                                    FRPCON    353
                  CDG = 2.E3*(RCI-RP)                                                    FRPCON    354
                  RFSH = RP*CINTOM                                                       FRPCON    355
                  GAPC = (RCI-RP)*CINTOM                                                 FRPCON    356
                  GRATIO = (RCI-RP)/RP                                                   FRPCON    357
                  NRMESH = 2                                                             FRPCON    358
C                                                                                        FRPCON    359
C   THE FOLLING CALL TO RMESH COMPUTES THE RADIAL NODALIZATION                           FRPCON    360
C   IF NODE POINTS ARE NOT INPUT                                                         FRPCON    361
C                                                                                        FRPCON    362
                  IF (NRMESH.EQ.2) GO TO 290                                             FRPCON    363
C                                                                                        FRPCON    364
                  CALL RMESH (NRMESH,NR,A(LR),RC,NRMI,PI,RP,NA)                          FRPCON    365
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C                                                                               FRPCON   366
585         290   CONTINUE                                                      FRPCON   367
C                                                                               FRPCON   368
C     THE FOLLOWING CALL TO BURNUP COMPUTES THE FUEL BURNUP                     FRPCON   369
C                                                                               FRPCON   370
        CALL BURNUP (BU,A(LBU1),A(LBU2),CFV,DCO(J-1),FA,J,M,NA,NXP,A(LQ),Q      FRPCON   371
590    +MPY,RHOUO2,TOTL,IT,IM,BUIN(J-1),DELH,TIME,BUP,DELBU,DELBP,BUOLD,PI      FRPCON   372
       +,ITT)                                                                   FRPCON   373
C                                                                               FRPCON   374
        IF (BU.GE.20000.E0.AND.NOTONE.EQ.0) NOTONE = 1                          FRPCON   375
C                                                                               FRPCON   376
595   C     THE FOLLOWING CALL TO PHYPRP COMPUTES THE PHYSICAL PROPERTIES       FRPCON   377
      C     OF THE FUEL AND THE CLADDING BASED ON THE PRESENT BURNUP            FRPCON   378
      C                                                                         FRPCON   379
        CALL PHYPRP                                                             FRPCON   380
      C                                                                         FRPCON   381
600   C     THE FOLLOWING LOADS THE MATPRO COMMON BLOCK                         FRPCON   382
      C                                                                         FRPCON   383
        AAHA(1) = ANRIN                                                         FRPCON   384
        AAHA(2) = COMP                                                          FRPCON   385
        AAHA(3) = CWKF                                                          FRPCON   386
605     AAHA(4) = CWNF                                                          FRPCON   387
        AAHA(5) = DELOXY                                                        FRPCON   388
        AAHA(6) = FLUX                                                          FRPCON   389
        AAHA(7) = FNCK                                                          FRPCON   390
        AAHA(8) = FNCN                                                          FRPCON   391
610     AAHA(9) = FOTMTL                                                        FRPCON   392
        AAHA(10) = FRDEN                                                        FRPCON   393
        AAHA(11) = FTMELT                                                       FRPCON   394
        AAHA(12) = R5TRAN                                                       FRPCON   395
C                                                                               FRPCON   396
615   C     THE FOLLOWING CALL TO GASPRO COMPUTES THE GAS PRODUCTION            FRPCON   397
      C                                                                         FRPCON   398
        CALL GASPRO (DCO(J-1),DELTAZ(J-1),A(LFGMGP),A(LHEMGP),QC,SGAPF,TIM      FRPCON   399
       +E,NA,IT,J)                                                              FRPCON   400
C                                                                               FRPCON   401
620   C     THE FOLLOWING CALL TO COOLT RETURNS BULK COOLANT TEMPERATURES  AS    FRPCON   402
      C     WELL AS THE SATURATION TEMPERATURE FOR AXIAL NODE J.                FRPCON   403
      C                                                                         FRPCON   404
        CALL COOLT (DEH,DELTAZ(J-1),G,IT,J,P2,QC,A(LTBLK),TSAT,TW,WT,NA,RH      FRPCON   405
       +OF)                                                                     FRPCON   406
625   C                                                                         FRPCON   407
      C     THE FOLLOWING CALL TO FLMDRP COMPUTES THE TEMPERATURE DROP ACROSS   FRPCON   408
      C     THE FILM AND CRUD                                                   FRPCON   409
      C                                                                         FRPCON   410
        CALL FLMDRP (CRDTR,CRDTT,DEH,G,A(LHCOEF),ICOR,IT,J,NA,P2,QC,TCO,TI      FRPCON   411
630    +ME,TSAT,WT,DELTCR,DELTDB,DELTFC,DELTJL)                                 FRPCON   412
C                                                                               FRPCON   413
        TCOK = (TCO+459.67)/1.8                                                 FRPCON   414
C                                                                               FRPCON   415
C     THE FOLLOWING CALL TO ZOTCON COMPUTES THE ZIRCALOY-OXIDE THERMAL          FRPCON   416
635   C     CONDUCTIVITY                                                        FRPCON   417
      C                                                                         FRPCON   418
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                ZOXKI = ZOTCON(TCOK)                                                    FRPCON    419
                ZOXK = ZOXKI/1.7296                                                     FRPCON    420
              C                                                                         FRPCON    421
640           C     QCIM = QC*CBHTWM                                                    FRPCON    422
                ZRO2I = A(LZRO2A+J-1)*0.3048E0                                          FRPCON    423
              C                                                                         FRPCON    424
                MMM = 3                                                                 FRPCON    425
                IF (WT.GE.TSAT) MMM = 1                                                 FRPCON    426
645           C                                                                         FRPCON    427
              C   THE FOLLOWING CALL TO CORROS COMPUTES THE CORROSION THICKNESS        FRPCON    428
              C                                                                         FRPCON    429
                CALL CORROS (TCOK,QCIM,ZRO2I,ZRO2O,ZOXKI,MMM,DELHS)                     FRPCON    430
              C                                                                         FRPCON    431
650           C     A(LZRO2B+J-1) = ZRO2O/0.3048E0                                      FRPCON    432
              C                                                                         FRPCON    433
                TCO = TCO+QC*A(LZRO2B+J-1)/ZOXK                                         FRPCON    434
              C                                                                         FRPCON    435
              C   THE FOLLOWING CALL TO CLADRP COMPUTES THE CLADDING INSIDE SURFACE     FRPCON    436
655           C   AND AVERAGE TEMPERATURES.                                            FRPCON    437
              C                                                                         FRPCON    438
                    DO 300 II=1,2                                                       FRPCON    439
              C                                                                         FRPCON    440
                    CALL CLADRP (COLDWK,CRN,DCO(J-1),FLUX,IT,J,NA,QC,A(LTCA),TCI,T      FRPCON    441
660            +    CO,TIME)                                                            FRPCON    442
              300   CONTINUE                                                            FRPCON    443
                IF (MECHAN.EQ.3) AFRCS2(MTTT+MNA*NR+J-2) = TCI                          FRPCON    444
                IF (MECHAN.EQ.3) AFRCS2(MTTT+MNA*(NR+1)+J-2) = TCO                      FRPCON    445
              C                                                                         FRPCON    446
665           C   THE FOLLOWING CALL TO FLUXDP COMPUTES THE FLUX DEPRESSION FACTOR     FRPCON    447
              C                                                                         FRPCON    448
                  CALL FLUXD (ENRCH,DEN,TW(IT),Z,YY,W,A(LR),RAPOW,IPLANT,IT,NDBG,T,N    FRPCON    449
                 +R)                                                                    FRPCON    450
              C                                                                         FRPCON    451
670           C   THE FOLLOWING CALL TO CEXPAN COMPUTES THE RADIAL AND AXIAL           FRPCON    452
              C   THERMAL EXPANSION OF THE CLADDING                                    FRPCON    453
              C                                                                         FRPCON    454
                IF (MECHAN.NE.1) CALL CEXPAN (A(LTCA+J-1),TXA,TXAL,TXC)                 FRPCON    455
              C                                                                         FRPCON    456
675             PINS = A(LPINT+J-2)                                                     FRPCON    457
              C                                                                         FRPCON    458
              C   THE FOLLOWING CALL TO REPACK COMPUTES THE FUEL SURFACE RELOCATION     FRPCON    459
              C                                                                         FRPCON    460
                IF (MECHAN.NE.1) CALL REPACK (FC,GRATIO,PINS)                           FRPCON    461
680           C                                                                         FRPCON    462
                VOLSTR = 3.E0*FC(1)                                                     FRPCON    463
              C   WHEN IM93WC = 1, NO CRACKING EFFECTS ARE ALLOWED                      FRPCON    464
              C                                                                         FRPCON    465
                IF (IM93WC.EQ.1) VOLSTR = 0.E0                                          FRPCON    466
685             IF (MECHAN.EQ.3) VOLSTR = AFRCS2(MFVFRO+MNA*(NR-1)+J-2)+AFRCS2(MDH      FRPCON    467
                +PRS+MNA*(NR-1)+J-2)                                                    FRPCON    468
              C                                                                         FRPCON    469
              C   THE FOLLOWING CALL TO CLDGRO COMPUTES THE CLADDING IRRADIATION       FRPCON    470
              C   GROWTH                                                              FRPCON    471
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690         C                                                                       FRPCON    472
                CALL CLDGRO (A(LTCA+J-1),FLUX,TIME(IT),CATEXF,COLDWK,A(LAXLEN+J-1) FRPCON    473
               +,AFRCS2(MEPS02),J,AFRCS2(MEPS0),MNA,MNR,MECHAN)                     FRPCON    474
            C                                                                       FRPCON    475
                A(LQDP+J-2) = 7.6726E-5*QC*DCO(J-1)                                 FRPCON    476
695             IF (ITER.NE.1) GO TO 320                                            FRPCON    477
                IF (IT.GT.1) GO TO 310                                              FRPCON    478
                GPTHP = 0.0                                                         FRPCON    479
                DCIHP = 0.0                                                         FRPCON    480
                DPHFP = 0.0                                                         FRPCON    481
700             A(LDELBP+J-1) = 0.E0                                                FRPCON    482
            310 CONTINUE                                                            FRPCON    483
                A(LGPTP+J-1) = GPTH(K)                                              FRPCON    484
                A(LDELBP+J-1) = DELBP                                               FRPCON    485
            320 LMN = 0                                                             FRPCON    486
705             IF (ITER.EQ.1.AND.IT.EQ.1) LMN = 1                                  FRPCON    487
                TM = T                                                              FRPCON    488
                BPP = A(LBU1+J-1)                                                   FRPCON    489
                BP = A(LBU2+J-1)                                                    FRPCON    490
            C                                                                       FRPCON    491
710             IF (IT.EQ.1) FGPAVP = FGPAV                                         FRPCON    492
                IF (IT.GT.1) FGPAVP = A(LPIT+IT-2)                                  FRPCON    493
            C                                                                       FRPCON    494
                IIT = IT-1                                                          FRPCON    495
            C                                                                       FRPCON    496
715         C   THE FOLLOWING CALL TO EMRLOC COMPUTES THE EM RELOCATION FACTOR      FRPCON    497
            C                                                                       FRPCON    498
                CGAP = CDG/2000.E0                                                  FRPCON    499
            C                                                                       FRPCON    500
                IF (IMRELO.EQ.1) FC(1) = EMRLOC(RP,CGAP,BP,A(LQDP+J-2))             FRPCON    501
720         C                                                                       FRPCON    502
                A(LTCODI+J-1) = TCO                                                 FRPCON    503
                A(LTCIDI+J-1) = TCI                                                 FRPCON    504
                CALL MEMSET (PRESS,A(LPG),NA)                                       FRPCON    505
                CALL MEMSET (P2(IT),A(LPC),NA)                                      FRPCON    506
725         C                                                                       FRPCON    507
                K = 1                                                               FRPCON    508
                NCONVG = 0                                                          FRPCON    509
                NCONT = 0                                                           FRPCON    510
                IF (IT.EQ.1.AND.LMN.EQ.1) DLTGC(1) = QC/1000.0                      FRPCON    511
730             IF (IT.GT.1.OR.LMN.EQ.0) DLTGC(1) = A(LDLPGE+J-1)                   FRPCON    512
                IF (IT.GT.1.OR.LMN.EQ.0) GPTHE(1) = GPTHPG(J)                       FRPCON    513
                IF (IT.GT.1.OR.LMN.EQ.0) PINE(1) = 0.E0                             FRPCON    514
            C                                                                       FRPCON    515
                NCNT = 5                                                            FRPCON    516
735             NCNVG = 0                                                           FRPCON    517
            C                                                                       FRPCON    518
            C   ********************************************************************FRPCON    519
            C   ITERATION ON GAP AND PELLET TEMPERATURE DISTRIBUTION BEGINS HERE    FRPCON    520
            C                                                                       FRPCON    521
740         330 CONTINUE                                                            FRPCON    522
            C                                                                       FRPCON    523
                A(LTPS+J-1) = TCI+DLTGC(K)                                          FRPCON    524
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                  VLSTRN = VOLSTR                                                    FRPCON    525
                  GAP = AMAX1(A(LGAP+J-2),0.E0)                                      FRPCON    526
745               IF (MECHAN.EQ.3) VLSTRN = VOLSTR+4.E0*GAP*DCI(J-1)/DP(J-1)**2      FRPCON    527
                  IF (MECHAN.EQ.3) GAPH = (A(LGAP+J-2)+VOLSTR/3.E0)*CINTOM           FRPCON    528
            C                                                                        FRPCON    529
            C   THE FOLLOWING CALL TO TMPSUB CALCULATES THE FUEL TEMPERATURE         FRPCON    530
            C   DISTRIBUTION                                                        FRPCON    531
750         C                                                                        FRPCON    532
                  CALL TMPSUB (Z,YY,W,NR,A(LTPS+J-1),RP,A(LTFR),A(LQDP+J-2),NDBG,RC, FRPCON    533
                 +A(LBTOLD),B,A(LR),J,IT,NA,GAPC,GAPH,GAPT,RFSH,GASES,TRANST,ITER,IQ FRPCON    534
                 +UIT,RTRAN,BR,A(LRTRNO),A(LRTRNP),FQTMTL,AFRCS2(MTTT),A(LPORS2),A(L FRPCON    535
                 +TRTRN),VLSTRN,MECHAN,D(ICFAC+J-1),IM93WC,FTMELT,MNA,MNR)           FRPCON    536
755         C                                                                        FRPCON    537
            C                                                                        FRPCON    538
                    DO 340 ISIX=1,6                                                  FRPCON    539
                    A(LB+(J-2)*6+ISIX-1) = B(ISIX)                                   FRPCON    540
                    A(LBR+(J-2)*6+ISIX-1) = BR(ISIX)                                 FRPCON    541
760         340     CONTINUE                                                         FRPCON    542
            C                                                                        FRPCON    543
                  IF (MECHAN.NE.1) GO TO 350                                         FRPCON    544
            C                                                                        FRPCON    545
            C   LOAD FUEL TEMPERATURES FOR USE IN RADIAL                            FRPCON    546
765               D(ITEMP+(J-1)*2) = A(LTFR+NR-1)                                    FRPCON    547
                  D(ITEMP+(J-1)*2+1) = A(LTFR)                                       FRPCON    548
            350   CONTINUE                                                         FRPCON    549
            C                                                                        FRPCON    550
            C   THE FOLLOWING CALL TO FEXPAN COMPUTES THE FUEL THERMAL EXPANSION     FRPCON    551
770         C                                                                        FRPCON    552
                  CALL FEXPAN (FTMELT,SUMTF,SUMEXP,NR,NRM1,A(LTFR),A(LTFB),A(LUO2LL) FRPCON    553
                 +,AFAL,A(LR),J,NA,DPH)                                              FRPCON    554
            C                                                                        FRPCON    555
            C   THE FOLLOWING CALL TO SWELL COMPUTES SWELLING AND DENSIFICATION     FRPCON    556
775         C                                                                        FRPCON    557
                  CALL SWELL (BP,DEN,A(LDENSF),A(LDENSP),DPHF,A(LDPW),A(LDPWPP),IT,J FRPCON    558
                 +,NDBG,A(LPORS1),A(LPORS2),BPP,A(LR),A(LRAD),AFDN,A(LTFR),TSINT,A(L FRPCON    559
                 +UO2LL),NRM1,NR,RSNTR,NA,COMP,AFRCS2(MEPS02),IMDENS,DP(J-1),MNA,MNR FRPCON    560
                 +,MECHAN)                                                           FRPCON    561
780         C                                                                        FRPCON    562
                  NPLAST = 0                                                         FRPCON    563
            C                                                                        FRPCON    564
                  IF (MECHAN.EQ.3) GO TO 360                                         FRPCON    565
            C                                                                        FRPCON    566
785         C   THE FOLLOWING CALL TO FRACAS CALCULATES THE CLADDING ELASTIC         FRPCON    567
            C   DEFORMATION                                                        FRPCON    568
            C                                                                        FRPCON    569
                  CALL FRACAS (AFRCS2(MDHPRS),AFRCS2(MTTT),AFRCS2(MEPS22),AFRCS2(MEP FRPCON    570
                 +P2),AFRCS2(MFVFRO),AFRCS2(MSIG2),AFRCS2(MREPS2),AFRCS2(MEPS02),AFR FRPCON    571
790              +CS2(MEP2),AFRCS2(MGAP2),AFRCS2(MR22),AFRCS2(MEREP2),AFRCS2(MPEPS2) FRPCON    572
                 +,AFRCS2(MPEPP2),AFRCS2(MOLDT2),AFRCS2(MPEP2),AFRCS2(MODPG2),AFRCS2 FRPCON    573
                 +(MODPC2),AFRCS2(MOIGP2),AFRCS2(MIGAP2),AFRCS2(MEPS0),MNR,MNA)      FRPCON    574
            C                                                                        FRPCON    575
            C                                                                        FRPCON    576
795               IF (MECHAN.EQ.2) GPTH(K) = (A(LGAP+J-2)-RP*FC(1))*2.E0             FRPCON    577
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      C   THE FOLLOWING CALL TO NEWGAP CALCULATES THE NEW THERMAL GAP          FRPCON   578
      C                                                                        FRPCON   579
            CALL NEWGAP (DLTGC,FC,A(LGAP),GPTH,GPTHE,J,K,NCONVG,NCONT,PIN,PINE FRPCON   580
           +,A(LPINT),MECHAN)                                                  FRPCON   581
800   C                                                                        FRPCON   582
            GAPT = GPTHE(K)*CINTOM/2.E0                                        FRPCON   583
            GAPH = A(LGAP+J-2)*CINTOM                                          FRPCON   584
            IF (MECHAN.EQ.3) GAPH = (A(LGAP+J-2)+VOLSTR/3.E0)*CINTOM           FRPCON   585
      C                                                                        FRPCON   586
805   360   CONTINUE                                                           FRPCON   587
      C                                                                        FRPCON   588
            IF (NCNVG.EQ.1) GO TO 380                                          FRPCON   589
            IF (NCNT.EQ.1) GO TO 370                                           FRPCON   590
            IF (MECHAN.EQ.1) NCNT = NCNT-1                                     FRPCON   591
810         IF (MECHAN.EQ.1) K = K+1                                           FRPCON   592
      C                                                                        FRPCON   593
      C   THE FOLLOWING CALL TO CONDUC CALCULATES THE GAP CONDUCTANCE AND      FRPCON   594
      C   THE GAP TEMPERATURE DROP                                            FRPCON   595
      C                                                                        FRPCON   596
815         CALL CONDUC (AGPC,DCO(J-1),DLTGC,DPHF,FRDEN,NR,GASES,GPTHE,HGAPT,I FRPCON   597
           +T,J,K,MECHAN,NDBG,PINE,PRESS,QC,ROUGHC,ROUGHF,A(LTAG),TCI,A(LTFR), FRPCON   598
           +NA,HGAP,FLUX,TIME(IT),COLDWK,HSOLID,HGAPR,D(IPRG+J-1),SIGG,D(IDG+J FRPCON   599
           +-1),FOTHTL,ZRO20,D(IRD),NF,NFFI,NCNVG,IM93WC,IMGAPC,FTHELT,FRAC)   FRPCON   600
      C                                                                        FRPCON   601
820   C                                                                        FRPCON   602
            IF (NCONVG.EQ.1) GO TO 380                                         FRPCON   603
            IF (NCONT.EQ.1) GO TO 370                                          FRPCON   604
      C                                                                        FRPCON   605
      C   END OF TEMPERATURE ITERATION                                        FRPCON   606
825   C   ************************************************************************ FRPCON   607
      C                                                                        FRPCON   608
            GO TO 330                                                          FRPCON   609
      C                                                                        FRPCON   610
      370   CONTINUE                                                           FRPCON   611
830         IIT = IT-1                                                         FRPCON   612
            TD1 = DLTGC(K)*0.5555                                              FRPCON   613
            TD2 = DLTGC(K-1)*0.5555                                            FRPCON   614
            WRITE (6,800) J,IIT,TD1,TD2                                        FRPCON   615
            IF (MECHAN.NE.1) WRITE (6,810) A(LGAP+J-2),A(LPINT+J-2)            FRPCON   616
835   C                                                                        FRPCON   617
      380   CONTINUE                                                           FRPCON   618
            A(LDLPGE+J-1) = DLTGC(K)                                           FRPCON   619
            GPTHPG(J) = GPTH(K)                                                FRPCON   620
            A(LGPTP+J-1) = GPTH(K)                                             FRPCON   621
840   C                                                                        FRPCON   622
            A(LTAG+J-1) = TCI+0.5E0*DLTGC(K)                                   FRPCON   623
            IF (MECHAN.EQ.2) DCIH = DCI(J-1)*(1.E0+A(LEPS+J-2))                FRPCON   624
            IF (MECHAN.EQ.3) DCIH = DCI(J-1)*(1.E0+AFRCS2(MEPS22+MNA*MNR+MNA*N FRPCON   625
           +R+J-2))                                                            FRPCON   626
845   C                                                                        FRPCON   627
            IF (MECHAN.EQ.2) A(LARAD+N2) = DPHF/2.E0                           FRPCON   628
            IF (MECHAN.EQ.3) A(LARAD+N2) = DPHF/2.E0                           FRPCON   629
            IF (MECHAN.NE.1) A(LDCIH+N2) = DCIH                                FRPCON   630
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                OXIDE = A(LZRO2B+J-1)*12.E0                                      FRPCON    631
850             CHORG = 10.E0                                                    FRPCON    632
                DCOM = DCO(J-1)*CINTOM                                           FRPCON    633
                DCIM = DCI(J-1)*CINTOM                                           FRPCON    634
                DPM = DP(J-1)*CINTOM                                             FRPCON    635
                ZRO2BI = A(LZRO2B+J-1)*CFTTOM                                    FRPCON    636
855             QCIM = QC*CBHTWM                                                 FRPCON    637
                ZRO2WG = A(LZRO2B+J-1)/0.225E-5                                  FRPCON    638
                AVTEMP = (A(LTCODI+J-1)+459.67E0)/1.8E0                          FRPCON    639
                ICHEM = 3                                                        FRPCON    640
                IF (IPLANT.EQ.2.OR.IPLANT.EQ.4) ICHEM = 2                        FRPCON    641
860             ZOXKI = ZOTCON(AVTEMP)                                           FRPCON    642
              C                                                                  FRPCON    643
              C   THE FOLLOWING CALL TO CHUPTK COMPUTES THE HYDROGEN UPTAKE ON THE FRPCON    644
              C   SURFACE OF THE ROD                                             FRPCON    645
              C                                                                  FRPCON    646
865             CALL CHUPTK (CHORG,PPMH2O,DPM,ICM,DCOM,DCIM,ICHEM,ZRO2AI,ZRO2BI,AV FRPCON    647
               +TEMP,QCIM,ZOXKI,CHYDAI,CHYDBI,HUPTAK)                            FRPCON    648
              C                                                                  FRPCON    649
                TCOK = (TCO+459.67)/1.8                                          FRPCON    650
                ZOXK = ZOTCON(TCOK)/1.7296                                       FRPCON    651
870             TOXO = TCO-QC*A(LZRO2B+J-1)/ZOXK                                 FRPCON    652
                A(LTOXO+J-1) = TOXO                                              FRPCON    653
                OXDROP = TCO-TOXO                                                FRPCON    654
                    DO 390 L=1,NR                                                FRPCON    655
                    IJ = NR*(J-1)+L-1                                            FRPCON    656
875                 A(LTMPDS+IJ) = A(LTFR+L-1)                                   FRPCON    657
              390   CONTINUE                                                     FRPCON    658
                GPTHM = GPTH(K)*1000.                                            FRPCON    659
                IF (J.NE.JPEAK) GO TO 400                                        FRPCON    660
              C                                                                  FRPCON    661
880             A(LPRT2+IT-1) = BP                                               FRPCON    662
                A(LPRT3+IT-1) = A(LQDP+J-2)                                      FRPCON    663
                A(LPRT4+IT-1) = TCO                                              FRPCON    664
                A(LPRT6+IT-1) = TCI                                              FRPCON    665
                A(LPRT7+IT-1) = GPTHM                                            FRPCON    666
885             IF (MECHAN.EQ.1) A(LPRT7+IT-1) = A(IDG+JPEAK-1)*1000.            FRPCON    667
                A(LPRT11+IT-1) = A(LTFR+NR-1)                                    FRPCON    668
                A(LPRT12+IT-1) = PIN(K)                                          FRPCON    669
                IF (MECHAN.EQ.1) A(LPRT12+IT-1) = A(IPRG+JPEAK-1)                FRPCON    670
                A(LPRT16+IT-1) = DPHF                                            FRPCON    671
890             A(LPRT17+IT-1) = HGAPT                                           FRPCON    672
                A(LPRT18+IT-1) = OXIDE*1000.E0                                   FRPCON    673
                PRT19 = ZRO2WG                                                   FRPCON    674
                A(LPRT20+IT-1) = HUPTAK                                          FRPCON    675
              C                                                                  FRPCON    676
895           400   CONTINUE                                                     FRPCON    677
              C                                                                  FRPCON    678
                IF (MECHAN.EQ.1) GO TO 410                                       FRPCON    679
              C                                                                  FRPCON    680
              C   THE FOLLOWING CALL TO VOLUME COMPUTES THE VOID VOLUMES        FRPCON    681
900           C                                                                  FRPCON    682
                CALL VOLUME (A(LCRL),DCIH,DEN,DPHF,A(LDPW),A(LDENSF),A(LDZH),FPORI FRPCON    683
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     +,A(LHRL),A(LRAD),A(LTFR),A(LUO2LL),A(LVCH),A(LVCR),A(LVDH),A(LVFH)  FRPCON    684
     +,A(LVGH),A(LVPL),A(LVPOR),IT,J,L,NDBG,FTMELT,TCC,A(LVCHI),NR,A(LDZ  FRPCON    685
     +HP),NRMI,PI,A(LGPTP),A(LGAP))                                       FRPCON    686
905  C                                                                    FRPCON    687
410   CONTINUE                                                            FRPCON    688
     C                                                                    FRPCON    689
      NVOID = 0                                                           FRPCON    690
      IGPNOD = 1                                                          FRPCON    691
910   TNOW = TIME(IT)                                                     FRPCON    692
      TLAST = 0.E0                                                        FRPCON    693
      POWPRO(1) = W                                                       FRPCON    694
      POWPRO(2) = YY                                                      FRPCON    695
      POWPRO(3) = Z                                                       FRPCON    696
915   IF (IT.GT.1) TLAST = TIME(IT-1)                                     FRPCON    697
      IF (NGASR.EQ.-2) GO TO 420                                          FRPCON    698
     C                                                                    FRPCON    699
     C   THE FOLLOWING CALL TO FGASRE COMPUTES GAS RELEASE                FRPCON    700
     C                                                                    FRPCON    701
920   CALL FGASRE (AFGR,A(LANG),ANSI,A(LANGR),A(LCC1),A(LCC2),TOTL,DELH,  FRPCON    702
     +DELTAZ(J-1),DEN,A(LFMGR),A(LHMGR),PFAVE,TNOW,TLAST,A(LTFR),IT,J,IG  FRPCON    703
     +PNOD,NGASR,A(LHEMGP),A(LFGMGP),A(LR),NVOID,NR,NA,A(LAK1),A(LAK2),A  FRPCON    704
     +(LFMA),A(LDPN),A(LDPL),A(LF),A(LFMGPR),A(LDPLH),A(LFH),A(LFN),DP(J  FRPCON    705
     +-1),A(LB+(J-2)*6),IM,A(LBU2+J-1),DELBP,RC,POWPRO,TIME,A(LQ),JST,GM  FRPCON    706
925   +PY,A(LRLEAS),DCO(J-1),A(LANSD),A(LFLXFC),A(LPF),A(LANSR),A(LFF),A(  FRPCON    707
     +LDT),A(LDECAY),A(LHALF),BP,BPP,IMFGAS,NOTONE)                       FRPCON    708
     C                                                                    FRPCON    709
     C                                                                    FRPCON    710
     C   GASREL IS BEYER - HANN FISSION GAS RELEASE MODEL FROM GAPCON -    FRPCON    711
930  C   THERMAL - 2 AND 3                                                FRPCON    712
     C                                                                    FRPCON    713
     C   NGASR EQUAL 1 OR 2, BEYER-HANN                                   FRPCON    714
     C   NGASR GT 5, ANS54                                                FRPCON    715
     C                                                                    FRPCON    716
935   IF (NGASR.NE.1.AND.NGASR.NE.2) GO TO 420                            FRPCON    717
     C                                                                    FRPCON    718
      CALL GASREL (A(IRDOT),A(LFMGR),A(LFGMGP),A(LTFR),IT,J,NA,NR,DP(J-1  FRPCON    719
     +),IM,RC,A(ISAVGS),A(IX),A(LBU2+J-1),A(LSTHIF),W,YY,Z,NGASR)         FRPCON    720
     C                                                                    FRPCON    721
940  420   CONTINUE                                                        FRPCON    722
      TREFK = TCONV(TREF)                                                 FRPCON    723
     C                                                                    FRPCON    724
     C   THE FOLLOWING CALL TO ENERGY COMPUTES THE FUEL STORED ENERGY      FRPCON    725
     C                                                                    FRPCON    726
945   CALL ENERGY (A(LCPDLT),J,A(LRAD),A(LTBAR),A(LTFB),IT,NDBG,NR,COMP,  FRPCON    727
     +FOTMTL,FTMELT,NA,TREFK,FHEFUS)                                      FRPCON    728
     C                                                                    FRPCON    729
     C   CONVERT TO BRITISH UNITS                                         FRPCON    730
      A(LCPDLT+J-1) = A(LCPDLT+J-1)*0.4299E-3                             FRPCON    731
950   A(LHGAPS+J-1) = HGAPT                                               FRPCON    732
      A(LHGPS+J-1) = HSOLID                                               FRPCON    733
      A(LHGPC+J-1) = HGAP                                                 FRPCON    734
      A(LHGPR+J-1) = HGAPR                                                FRPCON    735
     C                                                                    FRPCON    736
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      IF (IQUIT.EQ.1) GO TO 790                                                 FRPCON   737
C                                                                               FRPCON   738
C                                                                               FRPCON   739
      TCAK = (A(LTCA+J-1)+459.67E0)/1.8E0                                       FRPCON   740
      CTMAX(J) = AMAX1(CTMAX(J),TCAK)                                           FRPCON   741
C                                                                               FRPCON   742
      IF (J.EQ.IRI) GO TO 430                                                   FRPCON   743
      J = J+1                                                                   FRPCON   744
C                                                                               FRPCON   745
C   END OF AXIAL NODE LOOP                                                      FRPCON   746
C   ***************************************************************************FRPCON   747
C                                                                               FRPCON   748
      GO TO 280                                                                 FRPCON   749
C                                                                               FRPCON   750
430   CONTINUE                                                                  FRPCON   751
C                                                                               FRPCON   752
C   THE FOLLOWING CALL TO TOTGAS COMPUTES THE TOTAL GAS IN THE ROD              FRPCON   753
C                                                                               FRPCON   754
      CALL TOTGAS (GASES,AAN,AIRIN,ANGI,AN2IN,ARGIN,FGIN,HEIN,H2OMI,KRYI        FRPCON   755
     +N,NDBG,IT,NGASR,XEIN,TFGFR,THEFR,TN2FR,TH2OFR,IRI,A(LFMGR),A(LHMGR        FRPCON   756
     +),A(LFGMGP),A(LHEMGP),AMFHE,A(LACMFG),A(LACMN2),A(LACMHE),A(LACMH2        FRPCON   757
     +),A(LGASMO+IT-1),AMFH2,A(LANG),A(LANGR),A(LANGPT),A(LHMGPT),ANGT,A        FRPCON   758
     +MFFG,NA,AMFKRY,AMFXE,AMFN2,NREAD)                                         FRPCON   759
C                                                                               FRPCON   760
      NPLAST = I                                                                FRPCON   761
C                                                                               FRPCON   762
C   ******                                                                      FRPCON   763
C                                                                               FRPCON   764
C   MECHAN IS FLAG FOR PNL OR INEL MECHANICAL+RELOCATION PACKAGE                FRPCON   765
C                                                                               FRPCON   766
      IF (MECHAN.EQ.1) GO TO 460                                                FRPCON   767
C                                                                               FRPCON   768
C   THE FOLLOWING STATEMENT ELIMINATES CLADDING PLASTIC DEFORMATION             FRPCON   769
C   WHEN THE CLADDING DIMENSIONAL CHANGE SWITCH IS SPECIFIED                    FRPCON   770
C                                                                               FRPCON   771
      IF (IMCLAD.EQ.1) GO TO 450                                                FRPCON   772
C                                                                               FRPCON   773
      IF (MECHAN.EQ.2) GO TO 450                                                FRPCON   774
C   INEL PACKAGE - FRACAS                                                       FRPCON   775
C                                                                               FRPCON   776
C   THE FOLLOWING CALL TO FRACAS COMPUTES THE TIME INDEPENDENT                  FRPCON   777
C   PLASTIC CLADDING DEFORMATION                                                FRPCON   778
C                                                                               FRPCON   779
      DO 440 JI=2,IRI                                                           FRPCON   780
      J = JI                                                                    FRPCON   781
      CALL FRACAS (AFRCS2(MDHPRS),AFRCS2(MTTT),AFRCS2(MEPS22),AFRCS2            FRPCON   782
     +    (MEPP2),AFRCS2(MFVFRO),AFRCS2(MSIG2),AFRCS2(MREPS2),AFRCS2(MEP        FRPCON   783
     +    S02),AFRCS2(MEP2),AFRCS2(MGAP2),AFRCS2(MR22),AFRCS2(MEREP2),AF        FRPCON   784
     +    RCS2(MPEPS2),AFRCS2(MPEPP2),AFRCS2(MOLDT2),AFRCS2(MPEP2),AFRCS        FRPCON   785
     +    2(MODPG2),AFRCS2(MODPC2),AFRCS2(MOIGP2),AFRCS2(MIGAP2),AFRCS2(        FRPCON   786
     +    MEPS0),NNR,MN9)                                                       FRPCON   787
C                                                                               FRPCON   788
450   CONTINUE                                                                  FRPCON   789
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      C                                                                                 FRPCON    790
            GO TO 470                                                                   FRPCON    791
1010  C                                                                                 FRPCON    792
      460   CONTINUE                                                                    FRPCON    793
      C                                                                                 FRPCON    794
      C     PNL PACKAGE - PELET                                                         FRPCON    795
      C                                                                                 FRPCON    796
1015  C     THE FOLLOWING CALL TO PELET COMPUTES THE ELASTIC-PLASTIC CLADDING            FRPCON    797
      C     DEFORMATION                                                                 FRPCON    798
      C                                                                                 FRPCON    799
            ISTOP = ITER                                                                FRPCON    800
      C                                                                                 FRPCON    801
1020        IF (GASFLG.EQ.1) CALL PELET (D(ITME),D(IRD),D(IDISPC),D(IEFSTR),D(        FRPCON    802
           +IDSPSV),A(LB),A(LTCIDI),A(LTCODI),NA,D(ITELM),D(ITW),A(LTBLK+NT).T       FRPCON    803
           +PLEN,TW(IT),RP,P2(IT),COMP,TREF,ITER,A(LPIT+IT-1),FRDEN,RCI,RCO,IS       FRPCON    804
           +TOP,RCD,NOEL,NABF,NTAE,NARC,NFFI,NF,NC,NSH,NABT2,D(ITCB),D(ITFB),D       FRPCON    805
           +(ITEC),D(ITEF),D(ITV),D(IXRD),D(IPRG),A(LAXLEN),D(IHLDN),D(IPLSTC)       FRPCON    806
1025       +,D(ISTRNN),D(ISTRSS))                                                       FRPCON    807
      C                                                                                 FRPCON    808
      C                                                                                 FRPCON    809
      470   CONTINUE                                                                    FRPCON    810
      C                                                                                 FRPCON    811
1030  C     THE FOLLOWING CALL TO PLNT COMPUTES THE PLENUM TEMPERATURE AND              FRPCON    812
      C     HOT STATE PLENUM VOLUME                                                     FRPCON    813
      C                                                                                 FRPCON    814
            KK = NT-1+(M-1)*NA                                                          FRPCON    815
      C                                                                                 FRPCON    816
1035        CALL PLNT (AMFAIR,AMFARG,AMFFG,AMFHE,AMFH2O,AMFN2,COLDWK,CPL,CRDTT        FRPCON    817
           +,DCI(NT),HPV,DCO(NT),DEH,DHIC,FA,FLUX,G,HPL,GASES,GR,HFLL,HFLMDB,H       FRPCON    818
           +FLMP,A(LTBAR+NT),QSP,IT,UP,NU,PRESS,RHOG,TOTL,TPLEN,VSS,WMPY(IT),A       FRPCON    819
           +(LQ+KK),QEND(M),A(LTCA+NT),P2(IT),A(LTBLK+NT),TIME(IT),PI,A(LAXLEN       FRPCON    820
           +),NA,A(LEPS),DELTAZ,AMFKRY,AMFXE,AMFH2,DELOXY,CWKF,FNCK)                  FRPCON    821
1040  C                                                                                 FRPCON    822
      C     THE FOLLOWING CALL TO GSPRES COMPUTES THE ROD INTERNAL PRESSURE           FRPCON    823
      C                                                                                 FRPCON    824
            CALL GSPRES (A(LAXLEN),A(LDZH),HCRV,HCV,HDSHV,HFLL,HFPER,HFV,HGV,H        FRPCON    825
           +PORV,IRI,IT,J,N2,NT,HPV,A(LPIT),PRESS,RFNVFF,SUMCK,SUMDH,SUMGP,SUM       FRPCON    826
1045       +POR,SUMRG,A(LTAC),A(LTBAR),A(LTAFA),A(LTAG),A(LTAGA),A(LTPS),TOTL,       FRPCON    827
           +A(LTSF),A(LVCHI),A(LVCR),A(LVDH),A(LVFH),A(LVGH),A(LVPOR),A(LGASMO       FRPCON    828
           ++IT-1),TPLEN,A(LTCA),D(IVFF),D(IVFC),D(IDG),D(IRD),DELZA,NF,NFFI,P       FRPCON    829
           +I,MECHAN,A(LTRTRN),NA,NDBG,DISH)                                          FRPCON    830
      C                                                                                 FRPCON    831
1050        A(LPRT5+IT-1) = A(LTCA+JPEAK-1)                                           FRPCON    832
            A(LPRT8+IT-1) = A(LTAG+JPEAK-1)                                           FRPCON    833
            A(LPRT9+IT-1) = A(LTPS+JPEAK-1)                                           FRPCON    834
            A(LPRT10+IT-1) = A(LTBAR+JPEAK-1)                                         FRPCON    835
            IF (MECHAN.EQ.1) GO TO 480                                                FRPCON    836
1055        IF (MECHAN.EQ.3) GO TO 490                                                FRPCON    837
            A(LPRT13+IT-1) = A(LSIG+JPEAK-2)                                          FRPCON    838
            A(LPRT14+IT-1) = A(LSIG+JPEAK-2+NA)                                       FRPCON    839
            A(LPRT15+IT-1) = A(LEPS+JPEAK-2)                                          FRPCON    840
            GO TO 500                                                                 FRPCON    841
1060  480   CONTINUE                                                                  FRPCON    842
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                  JP1 = JPEAK-1                                                          FRPCON    843
                  A(LPRT13+IT-1) = A(ISTRSS+JP1*4+2)                                     FRPCON    844
                  A(LPRT14+IT-1) = A(ISTRSS+JP1*4+3)                                     FRPCON    845
                  A(LPRT15+IT-1) = A(ISTRNN+JP1*4+2)                                     FRPCON    846
1065              GO TO 500                                                              FRPCON    847
            490   CONTINUE                                                               FRPCON    848
                  A(LPRT13+IT-1) = AFRCS2(MSIG2+MNA*MNR+MNA*NR+JPEAK-2)                  FRPCON    849
                  A(LPRT14+IT-1) = AFRCS2(MSIG2+2*MNA*MNR+MNA*NR+JPEAK-2)                FRPCON    850
                  A(LPRT15+IT-1) = AFRCS2(MEPS22+MNA*MNR+MNA*NR+JPEAK-2)                 FRPCON    851
1070        500   CONTINUE                                                               FRPCON    852
            C                                                                            FRPCON    853
            C                                                                            FRPCON    854
                  IF (ITER.EQ.1) GO TO 510                                               FRPCON    855
            C                                                                            FRPCON    856
1075        C     *                                                                      FRPCON    857
            C     *     *                                                                FRPCON    858
            C     *    GAS     *                                                         FRPCON    859
            C     *   CONVERGENCE    *                                                   FRPCON    860
            C     *     ?      *                                                        FRPCON    861
1080        C     *     *                                                               FRPCON    862
            C     *                                                                     FRPCON    863
            C                                                                           FRPCON    864
                  IF (GASFLG.EQ.1) GO TO 520                                            FRPCON    865
                  IF (((ABS(A(LPIT+IT-1)-GASLAS))/GASLAS).LE.1.E-2) GASFLG = 1          FRPCON    866
1085              IF (ITER.GT.10.AND.ABS(A(LPIT+IT-1)-GASLAS)/GASLAS.LE.5.E-2) GASFL   FRPCON    867
                 +G = 1                                                                 FRPCON    868
                  IF (ITER.EQ.20) GASFLG = 1                                            FRPCON    869
                  IF (ITER.GT.6) WRITE (6,820) ITER,GASLAS,A(LPIT+IT-1)                 FRPCON    870
            510   ITER = ITER+1                                                         FRPCON    871
1090        C                                                                           FRPCON    872
                  GO TO 240                                                             FRPCON    873
            C                                                                           FRPCON    874
            C   END OF GAS RELEASE LOOP                                                FRPCON    875
            C   ************************************************************           FRPCON    876
1095        C                                                                           FRPCON    877
            520   CONTINUE                                                              FRPCON    878
            C                                                                           FRPCON    879
            C   GASPLT OUTPUTS A PLOT AND TABLE DESCRIBING THE RELEASE OF SHORT-LIVE    FRPCON    880
            C   RADIOACTIVE GASES.  THE INFORMATION IS CALCULATED BY AN554.            FRPCON    881
1100        C                                                                           FRPCON    882
                  IT1 = IT-1                                                            FRPCON    883
                  IF (NGASR.GE.6.AND.TIME(IT).GT.86400.) CALL GASPLT (A(LRLEAS),IT1,    FRPCON    884
                 +TIME(IT))                                                             FRPCON    885
            C                                                                           FRPCON    886
1105              IF (NGASR.LT.1.OR.NGASR.GT.5.OR.IT.EQ.1) GO TO 540                    FRPCON    887
            C                                                                           FRPCON    888
            C   BEYER-HANN GAS RELEASE MODEL - LAST HIGHEST RELEASE                     FRPCON    889
                  DO 530 I=1,NA                                                         FRPCON    890
                  K9 = A(LSTHIF+I-1)                                                    FRPCON    891
1110        C                                                                           FRPCON    892
            C   DID THIS TIME STEP RELEASE A HIGHER FRACTION THAN THE LAST             FRPCON    893
            C   HIGHEST FRACTION.  IF IT DID, SAVE THIS TIME STEP NUMBER               FRPCON    894
                  IF (A(IRDOT+(I-1)*IM+IT-1).GE.A(IRDOT+(I-1)*IM+K9-1)) A(LSTHIF      FRPCON    895
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     +     ) = IT                                                                    FRPCON    896
1115      530      CONTINUE                                                          FRPCON    897
          540  CONTINUE                                                              FRPCON    898
          C                                                                          FRPCON    899
               IF (MECHAN.NE.3) GO TO 580                                            FRPCON    900
               M3 = NR+2                                                             FRPCON    901
1120               DO 550 JJ=2,IRI                                                   FRPCON    902
                   AFRCS2(MPEPS2+JJ-2) = AFRCS2(MREPS2+JJ-2)                         FRPCON    903
                   AFRCS2(MPEPS2+JJ-2+MNA) = AFRCS2(MREPS2+JJ-2+MNA)                 FRPCON    904
                   AFRCS2(MODPG2+JJ-2) = A(LPG+JJ-2)                                 FRPCON    905
                   AFRCS2(MODPC2+JJ-2) = A(LPC+JJ-2)                                 FRPCON    906
1125      550      AFRCS2(MOIGP2+JJ-2) = AFRCS2(MIGAP2+JJ-2)                         FRPCON    907
               IRIM3 = IRI*M3                                                        FRPCON    908
                   DO 560 JJ=1,IRIM3                                                 FRPCON    909
                   AFRCS2(MOLDT2+JJ-1) = AFRCS2(MTTT+JJ-1)                           FRPCON    910
          560      AFRCS2(MPEP2+JJ-1) = AFRCS2(MEP2+JJ-1)                            FRPCON    911
1130           IRIM33 = IRIM3*3                                                      FRPCON    912
                   DO 570 JJ=1,IRIM33                                                FRPCON    913
          570      AFRCS2(MPEPP2+JJ-1) = AFRCS2(MEPP2+JJ-1)                          FRPCON    914
          C                                                                          FRPCON    915
          C                                                                          FRPCON    916
1135      580  CONTINUE                                                              FRPCON    917
               CTMAXK = CTMAX(JPEAK)                                                 FRPCON    918
          C                                                                          FRPCON    919
               IF (NOFAIL.EQ.1) GO TO 590                                            FRPCON    920
          C                                                                          FRPCON    921
1140      C    THE FOLLOWING CALL TO FAILUR CALCULATES FAILURE INFORMATION AFTER     FRPCON    922
          C    THE POWER-TIME STEP                                                   FRPCON    923
          C                                                                          FRPCON    924
               CALL FAILUR (DELH,CRAKI,CRAKL,CTMAXK,ESR,FB,FFR,FREQ,HUPTAK,ICDOFF    FRPCON    925
              +,IFBSW,ISTOFF,MODFAL,NOPT,NUCFC,PCYCL,PFB,PSR,RSTRAN,TCC,TFLIF,TIM    FRPCON    926
1145          +EF,TIMES,A(LEPS),NA,A(LCHEM),A(LOLIGP),A(LSIG),A(LTCA+1),TW(IT),A(    FRPCON    927
              +LZRO2B),IT,A(LBU2),CDAMAG,CESIUM,NR,FDAMAG,FRDEN,ODINE,NAFAIL,UMEL    FRPCON    928
              +T,NNFAIL,ZRNI,A(LTMPDS),A(LTMPMX),A(LDELBP),TIME(IT),UBFS,UOFD,NFR    FRPCON    929
              +OD)                                                                  FRPCON    930
          C                                                                          FRPCON    931
1150      590  CONTINUE                                                              FRPCON    932
          C                                                                          FRPCON    933
          C    THE FOLLOWING STATEMENT ELIMINATES CLADDING PLASTIC DEFORMATION       FRPCON    934
          C    WHEN THE CLADDING DIMENSIONAL CHANGE SWITCH IS SPECIFIED              FRPCON    935
          C                                                                          FRPCON    936
1155           IF (IMCLAD.EQ.1) GO TO 600                                            FRPCON    937
          C                                                                          FRPCON    938
          C    THE FOLLOWING CALL TO CCREEP COMPUTES THE CLADDING CREEP              FRPCON    939
          C                                                                          FRPCON    940
               IF (MECHAN.NE.1) CALL CCREEP (AFRCS2(MDHPRS),AFRCS2(MTTT),AFRCS2(M    FRPCON    941
1160          +EPS22),AFRCS2(MEPP2),AFRCS2(MFVFRO),AFRCS2(MSIG2),AFRCS2(MREPS2),A    FRPCON    942
              +FRCS2(MEPS02),AFRCS2(MEP2),AFRCS2(MGAP2),AFRCS2(MR22),AFRCS2(MEREP    FRPCON    943
              +2),AFRCS2(MPEPS2),AFRCS2(MPEPP2),AFRCS2(MOLDT2),AFRCS2(MPEP2),AFRC    FRPCON    944
              +S2(MODPG2),AFRCS2(MODPC2),AFRCS2(MOIGP2),AFRCS2(MIGAP2),AFRCS2(MEP    FRPCON    945
              +S0),MNR,MNA)                                                         FRPCON    946
1165      C                                                                          FRPCON    947
          600  CONTINUE                                                              FRPCON    948
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      IF (NGASR.NE.-2) GO TO 690                                          FRPCON   949
C                                                                         FRPCON   950
C   FRAPCON DYNAMICALLY DIMENSIONED GRASS LINKAGE ***                     FRPCON   951
C                                                                         FRPCON   952
C   GRASS-SST IS A MECHANISTIC COMPUTER CODE FOR PREDICTING FISSION-      FRPCON   953
C   GAS BEHAVIOR IN NUCLEAR FUELS. GRASS TREATS FISSION-GAS RELEASE       FRPCON   954
C   AND FUEL SWELLING ON AN EQUAL BASIS AND SIMULTANEOUSLY TREATS ALL     FRPCON   955
C   MAJOR MECHANISMS THAT INFLUENCE FISSION GAS BEHAVIOR.                 FRPCON   956
C                                                                         FRPCON   957
C   THE SUBROUTINE CALLGR CALLS THE GRASS ROUTINES. NODALLY DEPENDENT     FRPCON   958
C   VARIABLES ARE STORED IN THE AGRASS ARRAY. SEE GRASS9 FOR THEIR        FRPCON   959
C   LOCATION IN THE AGRASS ARRAY.                                         FRPCON   960
C                                                                         FRPCON   961
C   INPUT QUANTITIES ARE:                                                 FRPCON   962
C   DEL        : TIME STEP (S)                                            FRPCON   963
C   NF         : TOTAL NUMBER OF AXIAL FUEL SECTIONS                      FRPCON   964
C   KF         : TOTAL NUMBER OF RADIAL RINGS                             FRPCON   965
C   FL         : LENGTH OF FUEL ROD (CM)                                  FRPCON   966
C   RH(J,K)    : FUEL DENSITYIN ZONE (J,K) (GM/CC)                        FRPCON   967
C   TK(J,K)    : AVERAGE TEMPERATURE IN ZONE (J,K) (K)                    FRPCON   968
C   PRSO(J,K)  : HYDROSTATIC PRESSURE IN ZONE (J,K) (PSI)                 FRPCON   969
C   POW(J)     : LINEAR POWER IN AXIAL SECTION J (KW/FT)                  FRPCON   970
C   RS(J,K)    : INNER RADIUS OF ZONE (J,K) (CM)                          FRPCON   971
C   TS(J,K)    : TEMPERATURE AT RS(J,K) (C)                               FRPCON   972
C   GRSIZ(J,K): GRAIN DIAMETER IN REGION (J,K) (CM)                       FRPCON   973
C   POROS(J,K): FRACTIONAL POROSITY IN REGION (J,K)                       FRPCON   974
C   FDP(K)     : RADIAL FLUX DEPRESSION FACTOR IN REGION K                FRPCON   975
C   TIT        : IRRADIATION TIME (S)                                     FRPCON   976
C   PLENP      : PLENUM PRESSURE (PSI)                                    FRPCON   977
C   IRSTAR     : RESTART INDICATOR                                        FRPCON   978
C   1 : RESTART                                                           FRPCON   979
C   12 : DUMP                                                             FRPCON   980
C   13 : TRANSIENT                                                        FRPCON   981
C   0 : STEADY POWER                                                      FRPCON   982
C   NPRINT     : LEVEL OF PRINTOUT                                        FRPCON   983
C   1 : NO PRINTOUT                                                       FRPCON   984
C   2-3 : INTERMEDIATE LEVEL OF PRINTOUT                                  FRPCON   985
C   4 : FULL PRINTOUT                                                     FRPCON   986
C   DEFAULT IS 4                                                          FRPCON   987
C   GRT        : INITIAL AMOUT IN PLENUM--TOTAL FISSION GAS               FRPCON   988
C   RELEASED (MOLES)                                                      FRPCON   989
C                                                                         FRPCON   990
C   OUTPUT QUANTITIES ARE:                                                FRPCON   991
C   GS(J,K)    : AMOUNT OF RETAINED GAS IN REGION (J,K) (MOLES)           FRPCON   992
C   GR(J)      : AMOUNT OF GAS RELEASED FROM AXIAL SECTION (J)            FRPCON   993
C   (MOLES) DURING DEL (S)                                                FRPCON   994
C   GRT        : TOTAL FISSION GAS RELEASED (MOLES)                       FRPCON   995
C   BV(J,K)    : FISSION-GAS SWELLING/VOLUME IN REGION (J,K)              FRPCON   996
C   BVS(J)     : FISSION-GAS SWELLING/VOLUME IN AXIAL SECTION (J)         FRPCON   997
C   BVST       : TOTAL FISSION-GAS SWELLING/VOLUME                        FRPCON   998
C                                                                         FRPCON   999
C   FRAPCON NODALIZATION IS INCONSISTENT WITH GRASS NODALIZATION.         FRPCON  1000
C   FRAPCON PROVIDES MESH POINT DATA AT THE CENTER OF AXIAL NODES AND     FRPCON  1001
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1220          C   AT THE BOUNDARIES OF THE RADIAL NODES. THE FOLLOWING WILL MAKE THE    FRPCON   1002
              C   SHIFT IN NODALIZATION, MAKE UNIT CONVERSIONS WHERE NEEDED, AND       FRPCON   1003
              C   DEFINE INPUT VARIABLES IN AGRASS ARRAY.                              FRPCON   1004
              C                                                                        FRPCON   1005
              C   THE NUMBER OF AXIAL FUEL SECTIONS -- NF = NT                        FRPCON   1006
1225          C   THE NUMBER OF RADIAL RINGS -- KF = NR - 1                            FRPCON   1007
              C                                                                        FRPCON   1008
              C   TIME STEP (S)                                                        FRPCON   1009
              C   C                                                                    FRPCON   1010
              C                                                                        FRPCON   1011
1230                DEL = DELH*0.36E4                                                  FRPCON   1012
              C                                                                        FRPCON   1013
              C   LENGTH OF FUEL ROD (CM)                                            FRPCON   1014
                  FL = TOTL*30.48                                                    FRPCON   1015
              C                                                                        FRPCON   1016
1235          C   IRRADIATION TIME (S) -- TIT = TIME(IT)                             FRPCON   1017
              C   PLENUM PRESSURE (PSI) -- PLENP = PRESS                            FRPCON   1018
              C   INITIAL AMOUNT OF FISSION GAS IN PLENUM -- GRT = 0.0               FRPCON   1019
              C                                                                        FRPCON   1020
              C   RESTART INDICATOR                                                  FRPCON   1021
1240          C                                                                      FRPCON   1022
                  IF (NRESTR.EQ.0) IRSTAR = 0                                        FRPCON   1023
                                                                                     FRPCON   1024
                  KF = NR-1                                                          FRPCON   1025
                  NTKF = NT*KF                                                       FRPCON   1026
1245                DO 610 I=1,NTKF                                                  FRPCON   1027
              C                                                                      FRPCON   1028
              C   FUEL DENSITY IN ZONE(J,K) (GM/CC) -- RH(J,K)                      FRPCON   1029
              C                                                                      FRPCON   1030
                    IF (COMP.EQ.0.0) AGRASS(NVAR26+I-1) = DEN*.1097                  FRPCON   1031
1250                IF (COMP.GT.0.0) AGRASS(NVAR26+I-1) = DEN*(.1097-COMP*.001097+   FRPCON   1032
                +   COMP*.001146)                                                    FRPCON   1033
              C                                                                      FRPCON   1034
              C   GRAIN DIAMETER IN REGION (J,K) (CM) -- GRSIZ(J,K)                 FRPCON   1035
              C                                                                      FRPCON   1036
1255                AGRASS(NVAR18+I-1) = .0005                                       FRPCON   1037
              C                                                                      FRPCON   1038
              C   HYDROSTATIC PRESSURE IN ZONE(J,K) (PSI) -- PRSO(J,K)             FRPCON   1039
              C                                                                      FRPCON   1040
                    AGRASS(NVAR25+I-1) = PRESS                                       FRPCON   1041
1260          C                                                                      FRPCON   1042
              C   FRACTIONAL POROSITY IN REGION (J,K) -- POROS(J,K)                 FRPCON   1043
              C                                                                      FRPCON   1044
                    AGRASS(NVAR23+I-1) = 1.0-DEN*.01                                 FRPCON   1045
              610   CONTINUE                                                         FRPCON   1046
1265          C                                                                      FRPCON   1047
              C                                                                      FRPCON   1048
                    DO 620 I=1,KF                                                    FRPCON   1049
              C                                                                      FRPCON   1050
              C   RADIAL FLUX DEPRESSION FACTOR IN REGION K -- FDP(K)              FRPCON   1051
1270          C                                                                      FRPCON   1052
                    AGRASS(NVAR5+I-1) = 1.0                                          FRPCON   1053
              620   CONTINUE                                                         FRPCON   1054
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      C                                                                      FRPCON   1055
      C   THE AXIAL INDEX IS J; THE RADIAL INDEX IS K.                       FRPCON   1056
      C                                                                      FRPCON   1057
      C   THE OUTER LOOP IS THE RADIAL LOOP.                                 FRPCON   1058
      C                                                                      FRPCON   1059
            I = 1                                                            FRPCON   1060
                DO 640 IK=1,NR                                               FRPCON   1061
                K = IK                                                       FRPCON   1062
      C                                                                      FRPCON   1063
      C   THE INNER LOOP IS THE AXIAL LOOP.                                 FRPCON   1064
      C                                                                      FRPCON   1065
                    DO 630 JJ=1,NT                                           FRPCON   1066
      C                                                                      FRPCON   1067
      C   INNER RADIUS OF ZONE(J,K) (CM) -- RS(J,K)                          FRPCON   1068
      C                                                                      FRPCON   1069
                    AGRASS(NVAR28+I-1) = A(LRAD-K+NR)                        FRPCON   1070
      C                                                                      FRPCON   1071
      C   TEMPERATURE AT RS(J,K) (C) -- TS(J,K)                             FRPCON   1072
      C                                                                      FRPCON   1073
                    AGRASS(NVAR32+I-1) = (A(LTMPDS+NR*(JJ+1)-K)-32.)/1.8     FRPCON   1074
                    I = I+1                                                  FRPCON   1075
            630     CONTINUE                                                 FRPCON   1076
            640   CONTINUE                                                   FRPCON   1077
      C                                                                      FRPCON   1078
      C                                                                      FRPCON   1079
      C   LINEAR POWER IN AXIAL SECTION J (KW/FT) -- POW(J)                  FRPCON   1080
      C                                                                      FRPCON   1081
            DO 650 JJ=1,NT                                                   FRPCON   1082
            AGRASS(NVAR3+JJ-1) = A(LQDP+JJ-1)                                FRPCON   1083
      650   CONTINUE                                                         FRPCON   1084
      C                                                                      FRPCON   1085
      C   AVERAGE TEMPERATURE IN ZONE(J,K) (K) -- TK(J,K)                    FRPCON   1086
      C                                                                      FRPCON   1087
        I = 1                                                                FRPCON   1088
            DO 670 IK=1,KF                                                   FRPCON   1089
            K = IK                                                           FRPCON   1090
                DO 660 JJ=1,NT                                               FRPCON   1091
                AGRASS(NVAR30+I-1) = ((AGRASS(NVAR32+I-1)+AGRASS(NVAR32+I-   FRPCON   1092
     +          1+NT))*.5)+273.15                                           FRPCON   1093
                I = I+1                                                      FRPCON   1094
            660 CONTINUE                                                     FRPCON   1095
            670   CONTINUE                                                   FRPCON   1096
      C                                                                      FRPCON   1097
      C                                                                      FRPCON   1098
       CALL CALLGR (DEL,NT,KF,FL,PRESS,TIME(IT),GRT,IRSTAR,NPRINT,AGRASS(    FRPCON   1099
     +1),NWORDS)                                                             FRPCON   1100
      C                                                                      FRPCON   1101
      C                                                                      FRPCON   1102
      C   AMOUNT OF GAS RELEASED FROM AXIAL SECTION (J) (MOLES) DURING DEL   FRPCON   1103
      C   COPY GR(J) FROM AGRASS ARRAY                                       FRPCON   1104
      C                                                                      FRPCON   1105
            DO 680 JJ=1,NA                                                   FRPCON   1106
            A(LFMGR+2*(JJ-1)) = AGRASS(NVAR2+JJ-2)                           FRPCON   1107
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      680       CONTINUE                                                          FRPCON   1108
C                                                                                 FRPCON   1109
C                                                                                 FRPCON   1110
      690   CONTINUE                                                              FRPCON   1111
1330  C                                                                           FRPCON   1112
CCC   THE FOLLOWING CALL TO PRINT2 PROVIDES THE AXIAL NODE OUTPUT                 FRPCON   1113
C                                                                                 FRPCON   1114
C                                                                                 FRPCON   1115
        IF (NOPT.NE.0.OR.GASFLG.NE.1) GO TO 710                                   FRPCON   1116
1335  C                                                                           FRPCON   1117
            DO 700 IJ=2,NAI                                                       FRPCON   1118
            J = IJ                                                                FRPCON   1119
            N2 = J-1                                                              FRPCON   1120
      C                                                                           FRPCON   1121
1340        CALL PRINT2 (AFRCS2(MDHPRS),AFRCS2(MTTT),AFRCS2(MEPS22),AFRCS2        FRPCON   1122
     +      (MEPP2),AFRCS2(MFVFRO),AFRCS2(MSIG2),AFRCS2(MREPS2),AFRCS2(MEP        FRPCON   1123
     +      S02),AFRCS2(MEP2),AFRCS2(MGAP2),AFRCS2(MR22),AFRCS2(MEREP2),AF        FRPCON   1124
     +      RCS2(MPEPS2),AFRCS2(MPEPP2),AFRCS2(MOLDT2),AFRCS2(MPEP2),AFRCS        FRPCON   1125
     +      2(MODPG2),AFRCS2(MODPC2),AFRCS2(MOIGP2),AFRCS2(MIGAP2),AFRCS2(        FRPCON   1126
1345  +      MEPSO),MNR,MNA)                                                       FRPCON   1127
      C                                                                           FRPCON   1128
      700       CONTINUE                                                          FRPCON   1129
      C                                                                           FRPCON   1130
      710   CONTINUE                                                              FRPCON   1131
1350  C                                                                           FRPCON   1132
CCC   THE FOLLOWING CALL TO PLTOUT STORES THE PLOT INFORMATION                    FRPCON   1133
C                                                                                 FRPCON   1134
        CALL PLTOUT (AMFHE,DCO,DLROD,GASIN,A(LGASMO+IT-1),HFLL,IRI,NR,NA,N        FRPCON   1135
     +PLOT,NPLTAB,NTPLOT,IT,NUNITS,PI,A(LTCODI),TOTL,TPLEN,UNIT,A(LCPDLT        FRPCON   1136
1355 +),A(LEPS),A(LGAP),GO,A(LHCOEF),A(LHGAPS),A(LPIT),P2,A(LQ),QMPY,A(L        FRPCON   1137
     +TBLK),A(LTCA),TIME,A(LTMPDS),A(LTPS),A(LZRO2B),M,A(LBU2),A(LPINT),        FRPCON   1138
     +AFRCS2(MFVFRO+MNA*(NR-2)),AFRCS2(MDHPRS+MNA*(NR-2)),MECHAN,A(ISTRN        FRPCON   1139
     +N),SUMM,A(IDG),DLREL)                                                       FRPCON   1140
      C                                                                           FRPCON   1141
1360    IF (IAXSYM.EQ.0) GO TO 720                                                FRPCON   1142
        IF (MECHAN.EQ.1) GO TO 720                                                FRPCON   1143
      C                                                                           FRPCON   1144
CCC   THE FOLLOWING CALL TO AXIWRT STORES THE INFORMATION NECESSARY FOR           FRPCON   1145
CC    AN AXISYM ANALYSIS AT THE HOT AXIAL NODE                                    FRPCON   1146
1365  C                                                                           FRPCON   1147
        NCRAX = 0                                                                 FRPCON   1148
        DELHCR = DELH                                                             FRPCON   1149
        CGAPR = GAPC/CINTOM                                                       FRPCON   1150
        NAXSYM = 46                                                               FRPCON   1151
1370    TCI = A(LTCIDI+JPEAK-1)                                                   FRPCON   1152
        TCO = A(LTCODI+JPEAK-1)                                                   FRPCON   1153
        RCO = DCO(JPEAK)/2.E0                                                     FRPCON   1154
        TCC = (DCO(JPEAK)-DCI(JPEAK))/2.E0                                        FRPCON   1155
      C                                                                           FRPCON   1156
1375    CALL AXIWRT (NUNITS,HPLT,A(LTMPDS),TCI,TCO,DELHCR,NCRAX,PRESS,P2(I        FRPCON   1157
     +T),NAXSYM,NA,NR,JPEAK,IT,CGAPR,IM,NR,A(LR),DISHSD,HDISH,RCO,TCC,CL        FRPCON   1158
     +OS,ICLOSE)                                                                  FRPCON   1159
      C                                                                           FRPCON   1160
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      720   CONTINUE                                                                  FRPCON  1161
1380        C                                                                         FRPCON  1162
            C   THE FOLLOWING CALL TO WRITER PUTS THE UNCRETAINTY ANALYSIS           FRPCON  1163
            C   INFORMATION ON TAPE45.                                               FRPCON  1164
            C                                                                         FRPCON  1165
              IF (IUNCRT.EQ.0) GO TO 730                                              FRPCON  1166
1385        C                                                                         FRPCON  1167
              CALL WRITER (NA,NR,A(LZRO2B),A(LUFS),A(LEPP),A(LEP),CTMAX,A(LPOROS      FRPCON  1168
             +),A(LBU2),A(LTMPDS),A(LTCIDI),A(LTCODI),PRESS,A(LGPTP),A(LGASMO+IT      FRPCON  1169
             +-1),GASES,A(LREPS),A(LRFEPS),A(LPINT))                                  FRPCON  1170
            C                                                                         FRPCON  1171
1390          NTIME = NTIME+1                                                         FRPCON  1172
            C                                                                         FRPCON  1173
      730   CONTINUE                                                                  FRPCON  1174
            C                                                                         FRPCON  1175
              IF (NTAPE.LE.0) GO TO 760                                               FRPCON  1176
1395        C                                                                         FRPCON  1177
                DO 750 IJ=1,NT                                                        FRPCON  1178
                U = 0.E0                                                              FRPCON  1179
                  DO 740 I=2,NR                                                       FRPCON  1180
                  II = NR-I+2                                                         FRPCON  1181
1400              IJJ = NR*IJ+II-2                                                    FRPCON  1182
                  U = U+(A(LDPW+IJJ)+A(LDENSF+IJJ))*(A(LR+II-2)-A(LR+II-1))/          FRPCON  1183
                +   12.E0                                                           FRPCON  1184
      740         CONTINUE                                                          FRPCON  1185
                A(LPOROS+IJ-1) = A(LVPOR+IJ)/A(LVFH+IJ)                               FRPCON  1186
1405            A(LUFS+IJ-1) = U                                                      FRPCON  1187
      750       CONTINUE                                                            FRPCON  1188
            C                                                                         FRPCON  1189
            C   THE FOLLOWING CALL TO RESTFS WRITES THE FRAP-T RESTART INFORMATION   FRPCON  1190
              IF (MECHAN.EQ.1) GO TO 760                                              FRPCON  1191
1410        C                                                                         FRPCON  1192
              CALL RESTFS (NA,NR,A(LEPP),A(LEP),A(LZRO2B),NT,A(LUFS),CTMAX,A(LPO      FRPCON  1193
             +ROS),A(LBU2),A(LTCODI),A(LGPTP),A(LR),RCI,RCO,TIME(IT),A(LTCIDI),G      FRPCON  1194
             +ASES,PRESS,A(LTMPDS),DMWI,A(LREPS),A(LRFEPS),A(LOLEPS),A(LOLFEP),A      FRPCON  1195
             +(LOLDTC),A(LOLDPG),A(LOLDPC),A(LOLDUR),A(LPINT),A(LOLIGP),A(LGASMO      FRPCON  1196
1415         ++IT-1))                                                                 FRPCON  1197
            C                                                                         FRPCON  1198
      760   CONTINUE                                                                  FRPCON  1199
            C                                                                         FRPCON  1200
              IF (NRESTR.EQ.0) GO TO 770                                              FRPCON  1201
1420        C                                                                         FRPCON  1202
            C   THE FOLLOWING CALL TO TAPEGN WRITES RESTART INFORMATION FOR A        FRPCON  1203
            C   FRAPCON RESTART                                                      FRPCON  1204
            C                                                                         FRPCON  1205
              CALL TAPEGN (A(LBU2),A(LZRO2B),ANG,A(LRTRNP),A(LCC2),A(LPORS2),A(L      FRPCON  1206
1425         +DENSF),A(LDPW),A(LOLDPG),A(LOLEPS),A(LOLFEP),A(LOLDTC),A(LOLDPC),A      FRPCON  1207
             +(LOLDUR),A(LOLIGP),A(LREPS),A(LRFEPS),A(LEPP),A(LEP),A(LSIG),A(LEP      FRPCON  1208
             +S),CTMAX,A(LCHEM),NA,NR,IR1,N7,IT,NREAD,NRESTR,NROLL,GASES,N3,N6,M      FRPCON  1209
             +ECHAN,IQUIT,TIME(IT),A(LBTOLD),ITREST,NWORDS,LENGTH,NGASR,AGRASS,L      FRPCON  1210
             +GRASS)                                                                  FRPCON  1211
1430        C                                                                         FRPCON  1212
      770   CONTINUE                                                                  FRPCON  1213
```

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C                                                                                FRPCON  1214
C                                                                                FRPCON  1215
      IF (NDBG.EQ.0) GO TO 780                                                   FRPCON  1216
      IF (MECHAN.NE.3) GO TO 780                                                 FRPCON  1217
C                                                                                FRPCON  1218
C   THE FOLLOWING CALL TO PRINTM WRITES FRACAS-2 STRESSES, STRAINS,              FRPCON  1219
C   YOUNGS MODULUS, POISSONS'S RATION, AND ALPHA-DELTA-T                         FRPCON  1220
C                                                                                FRPCON  1221
      M1 = NT                                                                    FRPCON  1222
      M2 = NR+2                                                                  FRPCON  1223
      CALL PRINTM (AFRCS2(MSIG2),AFRCS2(MEPS22),AFRCS2(MEPP2),AFRCS2(MEP         FRPCON  1224
     +2),AFRCS2(MEREP2),M1,M2,M3,AFRCS2(MR22),AFRCS2(MTTT),A(LPG),A(LPC)         FRPCON  1225
     +,AFRCS2(MFVFRO),AFRCS2(MDHPRS),MNR,MNA,AFCM12(NALFDT),AFRCS2(MEPS0         FRPCON  1226
     +2),AFRCS2(MEPS0))                                                          FRPCON  1227
C                                                                                FRPCON  1228
C                                                                                FRPCON  1229
780   CONTINUE                                                                   FRPCON  1230
C                                                                                FRPCON  1231
      IF (IT.NE.IM) GO TO 220                                                    FRPCON  1232
C                                                                                FRPCON  1233
C   END OF TIME STEP LOOP                                                        FRPCON  1234
C   ********************************************************************         FRPCON  1235
C                                                                                FRPCON  1236
      IMDONE = 1                                                                 FRPCON  1237
C                                                                                FRPCON  1238
C   THE FOLLOWING CALL TO PRINT2 RESULTS IN PRINTOUT OT THE SUMMARY              FRPCON  1239
C   PAGE AS WELL AS EOL STRAIN RANGE, CUMULATIVE FISSION GAS RELEASE,            FRPCON  1240
C   AND THE ZIRCALOY-OXIDE WEIGHT GAIN.                                          FRPCON  1241
C                                                                                FRPCON  1242
      CALL PRINT2 (AFRCS2(MDHPRS),AFRCS2(MTTT),AFRCS2(MEPS22),AFRCS2(MEP         FRPCON  1243
     +P2),AFRCS2(MFVFRO),AFRCS2(MSIG2),AFRCS2(MREPS2),AFRCS2(MEPS02),AFR         FRPCON  1244
     +CS2(MEP2),AFRCS2(MGAP2),AFRCS2(MR22),AFRCS2(MEREP2),AFRCS2(MPEPS2)         FRPCON  1245
     +,AFRCS2(MPEPP2),AFRCS2(MOLDT2),AFRCS2(MPEP2),AFRCS2(MODPG2),AFRCS2         FRPCON  1246
     +(MODPC2),AFRCS2(MOIGP2),AFRCS2(MIGAP2),AFRCS2(MEPS0),MNR,MNA)              FRPCON  1247
C                                                                                FRPCON  1248
      NTPLOT = 17                                                                FRPCON  1249
C                                                                                FRPCON  1250
      GO TO 100                                                                  FRPCON  1251
790   CONTINUE                                                                   FRPCON  1252
      RETURN                                                                     FRPCON  1253
C                                                                                FRPCON  1254
800   FORMAT (1H0,10X,53HNO CONVERGENCE ON GAP TEMPERATURE DROP FOR AXIA         FRPCON  1255
     +L NODE,I3,11H, TIME STEP,I3/10X,49HTHE TEMPERATURE DROP THE LAST T         FRPCON  1256
     +WO ITERATIONS WERE,F6.2,4H AND,F6.2,11H DEGREES K.)                        FRPCON  1257
810   FORMAT (1H ,7H GAP = ,E12.5,5X,22H INTERFACE PRESSURE = ,E12.5)            FRPCON  1258
820   FORMAT (/" GAS LOOP  ITER = ",I2,10X,"PRESSURE LAST TWO LOOPS",2F1         FRPCON  1259
     +0.2)                                                                       FRPCON  1260
      END                                                                        FRPCON  1261
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

301 I DESNBL NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FRPCON 1 1471

VARIABLES SN TYPE RELOCATION
0 A REAL ARRAY FAST

REFS 294 295 296 22*372 467 507 517
519 17*525 531 3*539 563 583 3*589 2*617
623 629 641 652 659 667 673 675
2*691 707 708 711 719 723 724 730
744 746 9*751 765 766 4*771 10*776 795
2*798 802 803 2*815 2*834 842 849 854
856 857 870 875 881 885 886 888
19*901 32*920 8*937 4*945 949 958 13*973 6*1020
6*1035 19*1043 1050 1051 1052 1053 1056 1057
1058 1062 1063 1064 1084 1085 1088 1102
1109 2*1113 1123 1124 10*1143 1288 1292 1301
18*1353 1370 1371 2*1375 14*1386 4*1401 2*1404 22*1411
22*1424 2*1442 DEFINED 467 650 694 700 702
703 721 722 742 758 759 837 839
841 846 847 848 871 875 880 881
882 883 884 885 886 887 888 889
890 891 893 949 950 951 952 953
1050 1051 1052 1053 1056 1057 1058 1062
1063 1064 1067 1068 1069 1113 1325 1405
1405

0 AAA REAL ARRAY REALS REFS 136
0 AAHA REAL ARRAY MATCNS REFS 228 DEFINED 602 603 604 605 606
607 608 609 610 611 612 613
24 AAN REAL REALS REFS 136 973
0 ACOR REAL INPTR REFS 182
1 AFAL REAL INPTR REFS 182 771
0 AFCM12 REAL ARRAY FAST REFS 252 295 1442
2 AFCR REAL INPTR REFS 182
3 AFDN REAL INPTR REFS 182 776
4 AFGR REAL INPTR REFS 182 920
0 AFRCS2 REAL ARRAY FAST REFS 296 299 2*685 2*691 751 776 21*788
843 21*1000 1067 1068 1069 1121 1122 1125
1128 1129 1132 21*1159 21*1340 2*1353 11*1442 21*1461
DEFINED 662 663 1121 1122 1123 1124 1125
1128 1129 1132
5 AFSW REAL INPTR REFS 182
6 AFTC REAL INPTR REFS 182
7 AGPC REAL INPTR REFS 182 815
0 AGRASS REAL ARRAY FAST REFS 252 295 372 2*1310 1317 1325 1424

VARIABLES	SN	TYPE	RELOCATION								
					DEFINED	1249	1250	1255	1259	1263	1271	1288
						1292	1301	1310				
25	AIRIN	REAL		REALS	REFS	136	464	973				
10464	ALPHA	REAL	ARRAY	DESNBL	REFS	21						
10	AMFAIR	REAL		INPTR	REFS	182	1035					
11	AMFARG	REAL		INPTR	REFS	182	1035					
12	AMFFG	REAL		INPTR	REFS	182	973	1035				
13	AMFHE	REAL		INPTR	REFS	182	973	1035	1353			
14	AMFH2	REAL		INPTR	REFS	182	973	1035				
15	AMFH2O	REAL		INPTR	REFS	182	1035					
16	AMFKRY	REAL		INPTR	REFS	182	973	1035				
17	AMFN2	REAL		INPTR	REFS	182	973	1035				
20	AMFXE	REAL		INPTR	REFS	182	973	1035				
26	AMGP	REAL	ARRAY	REALS	REFS	136						
30	AMGPH	REAL	ARRAY	REALS	REFS	136						
32	AMGR	REAL	ARRAY	REALS	REFS	136						
34	AMGRH	REAL	ARRAY	REALS	REFS	136						
36	AMGRN2	REAL	ARRAY	REALS	REFS	136						
4542	AMU	REAL	ARRAY	DESNBL	REFS	21						
40	AMWDT	REAL		REALS	REFS	136						
7136	ANG	REAL			REFS	372	1424					
41	ANGI	REAL		REALS	REFS	136	920	973				
42	ANGT	REAL		REALS	REFS	136	973					
2555	ANRIN	REAL		INPTR	REFS	182	602					
43	AN2IN	REAL		REALS	REFS	136	464	973				
44	ARGIN	REAL		REALS	REFS	136	464	973				
45	ARING	REAL		REALS	REFS	136						
46	AVGQI	REAL	ARRAY	REALS	REFS	136						
7224	AVTEMP	REAL			REFS	860	865	DEFINED	857			
56	B	REAL	ARRAY	REALS	REFS	136	751	758				
64	BP	REAL		REALS	REFS	136	719	776	880	920		
					DEFINED	708						
65	BPP	REAL		REALS	REFS	136	776	920	DEFINED	707		
66	BR	REAL	ARRAY	REALS	REFS	136	751	759				
74	BU	REAL		REALS	REFS	136	525	589	593			
21	BUIN	REAL	ARRAY	INPTR	REFS	182	467	589				
75	BUOLD	REAL		REALS	REFS	136	525	589				
10	BUP	REAL		PHYPRO	REFS	235	589					
144	C	REAL	ARRAY	DESNBL	REFS	21						
47	CATEXF	REAL		INPTR	REFS	182	691					
7123	CBHTWM	REAL			REFS	640	855	DEFINED	337			
7074	CDAMAG	REAL			REFS	1143	DEFINED	305				
76	CDG	REAL		REALS	REFS	136	717	DEFINED	572			
7105	CESIUM	REAL			REFS	1143	DEFINED	323				
7122	CFTTOM	REAL			REFS	854	DEFINED	336				
77	CFV	REAL		REALS	REFS	136	589					
100	CFVA	REAL		REALS	REFS	136						
7206	CGAP	REAL			REFS	719	DEFINED	717				
7257	CGAPR	REAL			REFS	1375	DEFINED	1368				
3	CHEFUS	REAL		PHYPRO	REFS	235	DEFINED	313				
7220	CHORG	REAL			REFS	865	DEFINED	850				
7126	CHYDAI	REAL			REFS	865	DEFINED	340	502			
7127	CHYDBI	REAL			REFS	502	865	DEFINED	341			

VARIABLES	SN	TYPE		RELOCATION								
7121	CINTOM	REAL			REFS	573	574	746	801	802	803	851
						852	853	1368	DEFINED	335		
50	CLDWKD	REAL		INPTR	REFS	182	455					
2556	CLDWKS	REAL		INPTR	REFS	182	454	456				
601	CLOS	REAL		REALS	REFS	160	1375					
101	CMOL	REAL		REALS	REFS	136						
102	CODEID	REAL	ARRAY	REALS	REFS	136						
603	COLDWK	REAL		REALS	REFS	160	659	691	815	1035		
					DEFINED	456						
11	COMP	REAL		PHYPRO	REFS	235	603	776	945	1020	1249	3*1250
121	CONVC	REAL		REALS	REFS	136						
122	CONVER	REAL	ARRAY	REALS	REFS	136						
2557	CP	REAL		INPTR	REFS	182	390					
51	CPL	REAL		INPTR	REFS	182	444	1035				
134	CPV	REAL		REALS	REFS	136						
2560	CR	REAL		INPTR	REFS	182	391					
7114	CRAKI	REAL			REFS	1143	DEFINED	330				
7076	CRAKL	REAL			REFS	1143	DEFINED	307				
52	CRDT	REAL		INPTR	REFS	182						
53	CRDTR	REAL		INPTR	REFS	182	629					
135	CRDTT	REAL		REALS	REFS	136	629	1035				
2554	CREPHR	REAL		INPTR	REFS	182						
136	CRN	REAL		REALS	REFS	136	2*566	659	DEFINED	565		
7162	CSUM	REAL			REFS	551	554	DEFINED	546	551		
7156	CTEMP	REAL			REFS	519	520	DEFINED	517			
54	CTMAX	REAL	ARRAY	INPTR	REFS	182	372	959	1136	1386	1411	1424
					DEFINED	959						
7246	CTMAXK	REAL			REFS	1143	DEFINED	1136				
2	CTMELT	REAL		PHYPRO	REFS	235	DEFINED	309				
4	CTRANB	REAL		PHYPRO	REFS	235	DEFINED	310				
5	CTRANE	REAL		PHYPRO	REFS	235	DEFINED	311				
6	CTRANZ	REAL		PHYPRO	REFS	235	DEFINED	312				
137	CUV	REAL		REALS	REFS	136						
604	CWKF	REAL		REALS	REFS	160	520	604	1035	DEFINED	454	
605	CWNF	REAL		REALS	REFS	160	520	605	DEFINED	455		
0	D	REAL	ARRAY	FAST	REFS	295	297	490	491	493	13*539	545
						551	751	3*815	18*1020	4*1043	DEFINED	431	434
						490	491	492	493	545	554	765	766
102	DCI	REAL	ARRAY	INPTR	REFS	182	392	411	417	422	565	567
						745	842	843	852	1035	1373	
140	DCIH	REAL		REALS	REFS	136	848	901	DEFINED	842	843	
141	DCIHP	REAL		REALS	REFS	136	DEFINED	698				
7222	DCIM	REAL			REFS	865	DEFINED	852				
130	DCO	REAL	ARRAY	INPTR	REFS	182	410	416	421	506	565	568
						589	617	659	694	815	851	920	1035
						1353	1372	1373				
7221	DCOM	REAL			REFS	865	DEFINED	851				
156	DE	REAL	ARRAY	INPTR	REFS	182	571					
7166	DEH	REAL			REFS	623	629	1035	DEFINED	571		
7247	DEL	REAL			REFS	1317	DEFINED	1230				
142	DELBP	REAL		REALS	REFS	136	589	703	920			
143	DELBU	REAL		REALS	REFS	136	589					
144	DELH	REAL		REALS	REFS	136	510	511	589	920	1143	1230

VARIABLES SN TYPE RELOCATION

7256	DELHCR	REAL			1367	DEFINED	508	509				
7155	DELHS	REAL			REFS	1375	DEFINED	1367				
12	DELQXY	REAL		PHYPRO	REFS	519	520	648	DEFINED	510		
145	DELT	REAL		REALS	REFS	235	606	1035	DEFINED	451		
204	DELTAZ	REAL	ARRAY	INPTR	REFS	136						
146	DELTCR	REAL		REALS	REFS	182	442	617	623	920	1035	
147	DELTDB	REAL		REALS	REFS	136	629					
150	DELTFC	REAL		REALS	REFS	136	629					
151	DELTJL	REAL		REALS	REFS	136	629					
0	DELZA	REAL	ARRAY	BA	REFS	291	1043	DEFINED	440	442	444	447
232	DEN	REAL		INPTR	REFS	182	385	539	667	776	901	926
					1249	1250	1263					
233	DENG	REAL		INPTR	REFS	182						
152	DHIC	REAL		REALS	REFS	136	1035					
607	DISH	REAL		REALS	REFS	160	1043					
234	DISHSD	REAL		INPTR	REFS	182	1375					
153	DLREL	REAL		REALS	REFS	136	1353					
154	DLROD	REAL		REALS	REFS	136	1353					
155	DLTGC	REAL	ARRAY	REALS	REFS	136	742	798	815	831	832	837
					841	DEFINED	729	730				
7403	DMWI	REAL	ARRAY		REFS	252	1411					
235	DP	REAL	ARRAY	INPTR	REFS	182	393	412	418	423	569	745
					776	853	920	937				
207	DPH	REAL		REALS	REFS	136	771					
210	DPHF	REAL		REALS	REFS	136	776	815	846	847	889	901
211	DPHFP	REAL		REALS	REFS	136	DEFINED	699				
7223	DPM	REAL			REFS	865	DEFINED	853				
212	DPWP	REAL		REALS	REFS	136						
7147	DRC	REAL			REFS	431	DEFINED	427				
7150	DRF	REAL			REFS	434	DEFINED	428				
213	DRS	REAL		REALS	REFS	136	DEFINED	566				
263	DSPG	REAL		INPTR	REFS	182						
264	DSPGW	REAL		INPTR	REFS	182						
5362	DI	REAL	ARRAY	DESNBL	REFS	21						
102	EAX	REAL	ARRAY	BA	REFS	291	539					
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	231						
265	ENRCH	REAL		INPTR	REFS	182	667					
214	ENRICH	REAL		REALS	REFS	136						
215	EOLSR	REAL		REALS	REFS	136						
56	ERAD	REAL	ARRAY	BA	REFS	291	539					
7112	ESR	REAL			REFS	1143	DEFINED	328				
266	EXO	REAL		INPTR	REFS	182						
267	FA	REAL		INPTR	REFS	182	467	506	507	589	1035	
0	FACTOR	REAL	ARRAY	DESNBL	REFS	21	25					
7311	FB	REAL	ARRAY		REFS	252	344	1143				
216	FC	REAL	ARRAY	REALS	REFS	136	679	681	795	798		
					DEFINED	719						
7075	FDAMAG	REAL			REFS	1143	DEFINED	306				
7	FDELTA	REAL		PHYPRO	REFS	235	DEFINED	308				
7263	FFR	REAL	ARRAY		REFS	252	1143	DEFINED	320			
217	FGIN	REAL		REALS	REFS	136	464	973				
270	FGPAV	REAL		INPTR	REFS	182	710					

VARIABLES	SN	TYPE		RELOCATION								
220	FGPAVP	REAL		REALS	REFS	136	DEFINED	710	711			
221	FGPAVX	REAL		REALS	REFS	147						
1	FHEFUS	REAL		PHYPRO	REFS	235	945	DEFINED	315			
222	FH2O	REAL		REALS	REFS	147						
223	FJJ	REAL	ARRAY	REALS	REFS	147						
225	FJJH	REAL	ARRAY	REALS	REFS	147						
7250	FL	REAL			REFS	1317	DEFINED	1233				
271	FLUX	REAL		INPTR	REFS	182	399	520	607	659	691	815
					1035							
272	FLXDP	REAL		INPTR	REFS	182						
55	FLXRD	REAL		BA	REFS	291	DEFINED	399				
227	FMGP	REAL	ARRAY	REALS	REFS	147						
602	FNCK	REAL		REALS	REFS	160	520	608	1035	DEFINED	452	
603	FNCN	REAL		REALS	REFS	160	520	609	DEFINED	453		
2552	FOTHTL	REAL		INPTR	REFS	182	610	751	815	945		
231	FPOR	REAL		REALS	REFS	147						
232	FPORI	REAL		REALS	REFS	147	901					
273	FQE	REAL		INPTR	REFS	182						
7100	FRAC	REAL			REFS	539	815	DEFINED	316			
233	FRD	REAL		REALS	REFS	147						
7141	FRDEN	REAL			REFS	611	815	1020	1143	DEFINED	385	
234	FRDH	REAL		REALS	REFS	147						
235	FRDN	REAL		REALS	REFS	147						
7107	FREQ	REAL			REFS	1143	DEFINED	325				
0	FTHELT	REAL		PHYPRO	REFS	235	612	751	771	815	901	945
236	G	REAL		REALS	REFS	147	623	629	1035	DEFINED	504	
7214	GAP	REAL			REFS	745	DEFINED	744				
7170	GAPC	REAL			REFS	751	1368	DEFINED	574			
7101	GAPH	REAL			REFS	751	DEFINED	317	746	802	803	
7102	GAPT	REAL			REFS	751	DEFINED	318	801			
237	GASES	REAL	ARRAY	REALS	REFS	147	372	751	815	973	1035	1386
					1411	1424						
7072	GASFLG	INTEGER			REFS	293	1020	1083	1334	DEFINED	500	1084
					1085	1087						
7340	GASFRC	REAL	ARRAY		REFS	252	DEFINED	364	365			
246	GASIN	REAL		REALS	REFS	147	1353	DEFINED	464			
7160	GASLAS	REAL			REFS	2*1084	2*1085	1088	DEFINED	531		
247	GDEN	REAL		REALS	REFS	147						
274	GO	REAL	ARRAY	INPTR	REFS	182	504	1353				
250	GPTH	REAL	ARRAY	REALS	REFS	147	702	798	838	839	977	
					DEFINED	795						
302	GPTHE	REAL	ARRAY	REALS	REFS	147	798	801	815	DEFINED	731	
334	GPTHM	REAL		REALS	REFS	147	884	DEFINED	877			
335	GPTHP	REAL		REALS	REFS	147	DEFINED	697				
336	GPTHPG	REAL	ARRAY	REALS	REFS	147	731	DEFINED	838			
370	GR	REAL		REALS	REFS	147	1035					
7171	GRATIO	REAL			REFS	679	DEFINED	575				
441	GRNSIZ	REAL		INPTR	REFS	182						
3	GROW	REAL		AXL	REFS	282						
7103	GRT	REAL			REFS	1317	DEFINED	319				
371	HCRV	REAL		REALS	REFS	147	1043					
372	HCV	REAL		REALS	REFS	147	1043					
442	HDISH	REAL		INPTR	REFS	182	1375					

VARIABLES	SN	TYPE		RELOCATION								
373	HDSHV	REAL		REALS	REFS	147	1043					
374	HEIN	REAL		REALS	REFS	147	464	973				
375	HFLL	REAL		REALS	REFS	147	1035	1043	1353			
376	HFLMDB	REAL		REALS	REFS	147	1035					
377	HFLMP	REAL		REALS	REFS	147	1035					
400	HFPER	REAL		REALS	REFS	147	1043					
401	HFV	REAL		REALS	REFS	147	1043					
410	HGAP	REAL		REALS	REFS	147	815	952				
412	HGAPR	REAL		REALS	REFS	147	815	953				
402	HGAPT	REAL		REALS	REFS	147	815	890	950			
403	HGV	REAL		REALS	REFS	147	1043					
404	HI	REAL		REALS	REFS	147						
405	HMGP	REAL	ARRAY	REALS	REFS	147						
407	HP	REAL		REALS	REFS	147						
413	HPL	REAL		REALS	REFS	147	1035					
443	HPLT	REAL		INPTR	REFS	182	1375					
414	HPORV	REAL		REALS	REFS	147	1043					
415	HPV	REAL		REALS	REFS	147	1035	1043				
411	HSOLID	REAL		REALS	REFS	147		951				
416	HUPTAK	REAL		REALS	REFS	147		893	1143			
417	H2OMI	REAL		REALS	REFS	147						
7146	I	INTEGER			REFS	409	4[illegible]	416	417	418	431	434
					2*442	447	1109	2*1113	1249	1250	1255	1259
					1263	1271	1288	1292	1293	3*1310	1312	1399
					DEFINED	408	441	446	1108	1245	1267	1278
					1293	1306	1312	1398				
0	IA	INTEGER	ARRAY	FAST	REFS	295	297					
57	IADJ	INTEGER		LIMITS	REFS	283						
1	IAELM	INTEGER		PNTPNL	REFS	28						
2	IAK	INTEGER		PNTPNL	REFS	28						
3	IARAA	INTEGER		PNTPNL	REFS	28						
4	IARE	INTEGER		PNTPNL	REFS	28						
0	IAXSM	INTEGER		F.P.	DEFINED	1	363					
275	IAXSYM	INTEGER		INPTI	REFS	201	363	1360				
6	IBA	INTEGER		PNTPNL	REFS	28						
7	IBASAV	INTEGER		PNTPNL	REFS	28						
10	IBASE	INTEGER		PNTPNL	REFS	28						
12	IBBA	INTEGER		PNTPNL	REFS	28						
13	IBBSV	INTEGER		PNTPNL	REFS	28						
14	ICA	INTEGER		PNTPNL	REFS	28						
15	ICC	INTEGER		PNTPNL	REFS	28						
7115	ICDOFF	INTEGER			REFS	1143	DEFINED	331				
270	ICFAC	INTEGER		POINT	REFS	128	539	545	554	751		
302	ICFCSV	INTEGER		POINT	REFS	128	539	545	551			
7225	ICHEM	INTEGER			REFS	865	DEFINED	858	859			
24	ICLOSE	INTEGER		INTEG	REFS	174	1375					
0	ICM	INTEGER		INPTI	REFS	201	865					
67	ICNT	INTEGER		LIMITS	REFS	283						
10631	ICOM	INTEGER	ARRAY	DESNBL	REFS	21						
1	ICOR	INTEGER		INPTI	REFS	201	629					
11173	ICOUNT	INTEGER		DESNBL	REFS	21						
16	ICRATE	INTEGER		PNTPNL	REFS	28						
17	ICRPG	INTEGER		PNTPNL	REFS	28						

VARIABLES	SN	TYPE	RELOCATION								
42	ICRPP	INTEGER	LIMITS	REFS	283						
60	ICUT	INTEGER	LIMITS	REFS	283						
2	IDBG	INTEGER	INPTI	REFS	201						
5	IDF	INTEGER	LIMITS	REFS	283						
271	IDG	INTEGER	POINT	REFS	128	539	815	885	1043	1353	
272	IDGSAV	INTEGER	POINT	REFS	128	539					
20	IDISP	INTEGER	PNTPNL	REFS	28						
21	IDISPC	INTEGER	PNTPNL	REFS	28	1020					
22	IDSPSV	INTEGER	PNTPNL	REFS	28	1020					
3	IDXGAS	INTEGER	INPTI	REFS	201						
23	IEFSTR	INTEGER	PNTPNL	REFS	28	1020					
24	IELM	INTEGER	PNTPNL	REFS	28						
25	IELSTN	INTEGER	PNTPNL	REFS	28						
30	IELSTR	INTEGER	PNTPNL	REFS	28						
32	IEPSLM	INTEGER	PNTPNL	REFS	28						
33	IESTNV	INTEGER	PNTPNL	REFS	28						
34	IESTSV	INTEGER	PNTPNL	REFS	28						
7120	IFBSW	INTEGER		REFS	1143	DEFINED	334				
0	IFIRST	INTEGER	PNTPNL	REFS	28						
11172	IFLAG	INTEGER	DESNBL	REFS	21						
7230	IGPNOD	INTEGER		REFS	920	DEFINED	909				
303	IHLDN	INTEGER	POINT	REFS	128	1020					
7202	II	INTEGER		REFS	1400	2*1401	DEFINED	657	1399		
36	IIPOS	INTEGER	PNTPNL	REFS	28						
7205	IIT	INTEGER		REFS	833	DEFINED	713	830			
7154	IJ	INTEGER		REFS	3*467	875	1337	1400	3*1404	1405	
				DEFINED	466	874	1336	1396			
7262	IJJ	INTEGER		REFS	2*1401	DEFINED	1400				
7254	IK	INTEGER		REFS	1280	1308	DEFINED	1279	1307		
37	IKSAVE	INTEGER	PNTPNL	REFS	28						
106	ILAST	INTEGER	PNTPNL	REFS	28						
26	ILSTNA	INTEGER	PNTPNL	REFS	28						
27	ILSTRA	INTEGER	PNTPNL	REFS	28						
4	IM	INTEGER	INPTI	REFS	201	493	589	920	937	2*1113	1375
					1450						
4	IMCLAD	INTEGER	EMFLGS	REFS	215	990	1155				
2	IMDENS	INTEGER	EMFLGS	REFS	215	776					
23	IMDONE	INTEGER	INTEG	REFS	174	DEFINED	1455				
7	IMENRG	INTEGER	EMFLGS	REFS	215						
10	IMFGAS	INTEGER	EMFLGS	REFS	215	920					
1	IMFUEL	INTEGER	EMFLGS	REFS	215						
5	IMGAPC	INTEGER	EMFLGS	REFS	215	815					
0	IMPOWR	INTEGER	EMFLGS	REFS	215						
3	IMRELO	INTEGER	EMFLGS	REFS	215	719					
11	IMSWCH	INTEGER	EMFLGS	REFS	215						
6	IM93WC	INTEGER	EMFLGS	REFS	215	684	751	815			
40	INADET	INTEGER	PNTPNL	REFS	28						
41	INDC	INTEGER	PNTPNL	REFS	28						
42	INDF	INTEGER	PNTPNL	REFS	28						
43	INDT	INTEGER	PNTPNL	REFS	28						
44	INODET	INTEGER	PNTPNL	REFS	28						
45	IOLDSE	INTEGER	PNTPNL	REFS	28						
5	IPLANT	INTEGER	INPTI	REFS	201	667	2*859				

VARIABLES	SN	TYPE	RELOCATION							
40	IPLAS	INTEGER	LIMITS	REFS	283					
73	IPLEND	INTEGER	LIMITS	REFS	283					
304	IPLSTC	INTEGER	POINT	REFS	128	539	1020			
273	IPRG	INTEGER	POINT	REFS	128	539	815	888	1020	
10630	IPRINT	INTEGER	DESNBL	REFS	21					
31	IPSLA	INTEGER	PNTPNL	REFS	28					
46	IPSSRT	INTEGER	PNTPNL	REFS	28					
47	IPSSV	INTEGER	PNTPNL	REFS	28					
50	IPSTS	INTEGER	PNTPNL	REFS	28					
6	IQ	INTEGER	INPTI	REFS	201					
0	IQUIT	INTEGER	INTEG	REFS	174	357	372	379	751	955 1424
51	IR	INTEGER	PNTPNL	REFS	28	550	551	DEFINED	549	
52	IRA	INTEGER	PNTPNL	REFS	28					
7165	IRAD	INTEGER		REFS	551	552	DEFINED	550		
71	IRAK	INTEGER	LIMITS	REFS	283					
53	IRBR	INTEGER	PNTPNL	REFS	28					
54	IRBRA	INTEGER	PNTPNL	REFS	28					
55	IRD	INTEGER	PNTPNL	REFS	28	431	434	539	815	1020 1043
264	IRDOT	INTEGER	POINT	REFS	123	937	2*1113			
7164	IRR	INTEGER		REFS	549	DEFINED	548			
7251	IRSTAR	INTEGER		REFS	1317	DEFINED	1241			
75	IRZ	INTEGER	LIMITS	REFS	283	DEFINED	486			
1	IRI	INTEGER	INTEG	REFS	174	372	466	525	961	973 998
				1043	1120	1126	1353	1424		
7244	IRIM3	INTEGER		REFS	1127	1130	DEFINED	1126		
7245	IRIM33	INTEGER		REFS	1131	DEFINED	1130			
265	ISAVGS	INTEGER	POINT	REFS	123	937				
5	ISB	INTEGER	PNTPNL	REFS	28					
11	ISBB	INTEGER	PNTPNL	REFS	28					
7215	ISIX	INTEGER		REFS	2*758	2*759	DEFINED	757		
74	ISP	INTEGER	LIMITS	REFS	283					
37	ISSTOP	INTEGER	LIMITS	REFS	283					
1175	ISTART	INTEGER	DESNBL	REFS	21					
7104	ISTOFF	INTEGER		REFS	1143	DEFINED	322			
7236	ISTOP	INTEGER		REFS	1020	DEFINED	1018			
56	ISTRES	INTEGER	PNTPNL	REFS	29					
305	ISTRNN	INTEGER	POINT	REFS	128	1020	1064	1353		
57	ISTRSA	INTEGER	PNTPNL	REFS	28					
306	ISTRSS	INTEGER	POINT	REFS	128	1020	1062	1063		
53	ISTRT	INTEGER	BA	REFS	291					
7	ISW	INTEGER	INPTI	REFS	201					
2	IT	INTEGER	INTEG	REFS	174	372	476	486	492	493 3*497
				498	503	504	505	506	508	3*509 512
				2*517	2*519	531	563	589	617	623 629
				659	2*667	691	696	705	710	2*711 713
				724	729	730	731	732	751	776 2*815
				830	880	881	882	883	884	885 886
				887	888	889	890	891	893	901 910
				2*915	920	937	945	2*973	3*1020	4*1035 2*1043
				1050	1051	1052	1053	1056	1057	1058 1062
				1063	1064	1067	1068	1069	1084	1085 1088
				1101	2*1102	1105	2*1113	3*1143	1317	2*1353 2*1375
				1386	2*1411	2*1424	1450	DEFINED	463	469 476

VARIABLES	SN	TYPE	RELOCATION								
60	ITCB	INTEGER	PNTPNL	REFS	28	1020					
300	ITCL	INTEGER	POINT	REFS	128	539					
61	ITCRP	INTEGER	PNTPNL	REFS	28						
62	ITEC	INTEGER	PNTPNL	REFS	28	1020					
63	ITEF	INTEGER	PNTPNL	REFS	28	1020					
64	ITELM	INTEGER	PNTPNL	REFS	28	1020					
277	ITEMP	INTEGER	POINT	REFS	128	539	765	766			
3	ITER	INTEGER	INTEG	REFS	174	539	545	548	550	695	705
				751	1018	1020	1073	1085	1087	2*1088	1089
				DEFINED	475	1089					
54	ITERD	INTEGER	BA	REFS	291						
65	ITFB	INTEGER	PNTPNL	REFS	28	1020					
301	ITFS	INTEGER	POINT	REFS	128	539					
66	ITHET	INTEGER	PNTPNL	REFS	28						
70	ITHSAV	INTEGER	PNTPNL	REFS	28						
67	ITHTAX	INTEGER	PNTPNL	REFS	28						
71	ITHXSV	INTEGER	PNTPNL	REFS	28						
72	ITME	INTEGER	PNTPNL	REFS	28	2*490	2*491	492	2*493	1020	
276	ITRAMP	INTEGER	POINT	REFS	128	539					
300	ITREST	INTEGER	INPTI	REFS	201	372	1424				
73	ITSTNR	INTEGER	PNTPNL	REFS	28						
74	ITSTSR	INTEGER	PNTPNL	REFS	28						
7140	ITT	INTEGER		REFS	589	DEFINED	382				
75	ITV	INTEGER	PNTPNL	REFS	28	1020					
76	ITW	INTEGER	PNTPNL	REFS	28	1020					
63	ITI	INTEGER	LIMITS	REFS	283	1102	DEFINED	1101			
11177	IUNCRT	INTEGER	DESNBL	REFS	21	1384					
276	IVARDM	INTEGER	INPTI	REFS	201						
274	IVFC	INTEGER	POINT	REFS	128	539	1043				
275	IVFF	INTEGER	POINT	REFS	128	539	1043				
302	IWORDS	INTEGER	INPTI	REFS	201						
267	IX	INTEGER	POINT	REFS	123	937					
77	IXKT	INTEGER	PNTPNL	REFS	28						
100	IXLOAD	INTEGER	PNTPNL	REFS	28						
101	IXLODA	INTEGER	PNTPNL	REFS	28						
102	IXRD	INTEGER	PNTPNL	REFS	28	1020					
103	IY	INTEGER	PNTPNL	REFS	28						
104	IYACF	INTEGER	PNTPNL	REFS	28						
105	IZ	INTEGER	PNTPNL	REFS	28						
4	J	INTEGER	INTEG	REFS	174	563	564	2*565	567	568	569
				571	3*589	3*617	2*623	629	641	650	652
				2*659	662	663	673	675	2*685	3*691	2*694
				700	702	703	707	708	719	721	722
				730	731	742	744	2*745	746	4*751	758
				759	765	766	771	2*776	795	798	802
				803	4*815	833	2*834	837	838	839	841
				2*842	2*843	849	851	852	853	854	856
				857	870	871	874	878	881	901	6*920
				3*937	945	2*949	950	951	952	953	958
				2*959	961	962	1043	1338	DEFINED	529	962
				999	1337						
24	JAM	INTEGER	LIMITS	REFS	283						
10	JDLPR	INTEGER	INPTI	REFS	201						

VARIABLES SN TYPE RELOCATION

7235	JI	INTEGER			REFS	999	DEFINED	998				
35	JIIJ	INTEGER		PNTPNL	REFS	28						
7243	JJ	INTEGER			REFS	2*1121	2*1122	2*1123	2*1124	2*1125	2*1128	2*1129
					2*1132	1292	2*1301	2*1325	DEFINED	1120	1127	1131
						1284	1300	1309	1324			
5	JJC	INTEGER		INTEG	REFS	174						
11	JN	INTEGER	ARRAY	INPTI	REFS	201						
6	JPEAK	INTEGER		INTEG	REFS	174	507	878	885	888	1050	1051
					1052	1053	1056	1057	1058	1061	1067	1068
					1069	1136	1370	1371	1372	2*1373	1375	
7240	JPI	INTEGER			REFS	1062	1063	1064	DEFINED	1061		
7161	JRAD	INTEGER			REFS	2*545	551	554	DEFINED	544		
21	JST	INTEGER	ARRAY	INPTI	REFS	201	503	920				
7151	JX	INTEGER			REFS	430	2*431	2*434	DEFINED	429		
7	K	INTEGER		INTEG	REFS	174	702	742	795	798	801	810
					815	831	832	837	838	839	841	877
					887	1288	1292	DEFINED	726	810	1280	1338
12	KA	INTEGER		LIMITS	REFS	283						
7252	KF	INTEGER			REFS	1244	1267	1307	1317	DEFINED	1243	
10	KINDOR	INTEGER		INTEG	REFS	174						
7237	KK	INTEGER			REFS	1035	DEFINED	1033				
11	KOXI	INTEGER		INTEG	REFS	174						
66	KPLAS	INTEGER		LIMITS	REFS	283						
55	KRNCH	INTEGER		LIMITS	REFS	203						
45	KRNCHC	INTEGER		LIMITS	REFS	283						
44	KRNCHF	INTEGER		LIMITS	REFS	283						
46	KRNCHT	INTEGER		LIMITS	REFS	283						
420	KRYIN	REAL		REALS	REFS	18	147	973				
36	KZI	INTEGER		LIMITS	REFS	283						
7241	K9	INTEGER			REFS	1113	DEFINED	1109				
7226	L	INTEGER			REFS	874	875	901	DEFINED	873		
216	LACE	INTEGER	ARRAY	INPTI	REFS	201						
215	LACMFG	INTEGER		POINT	REFS	107	973					
216	LACMHE	INTEGER		POINT	REFS	107	973					
217	LACMH2	INTEGER		POINT	REFS	107	973					
220	LACMN2	INTEGER		POINT	REFS	107	973					
215	LACMOD	INTEGER		INPTI	REFS	201						
152	LAK1	INTEGER		POINT	REFS	78	920					
153	LAK2	INTEGER		POINT	REFS	78	920					
221	LAMGPT	INTEGER		POINT	REFS	107	973					
125	LANG	INTEGER		POINT	REFS	64	525	920	973			
120	LANGR	INTEGER		POINT	REFS	64	920	973				
253	LANSD	INTEGER		POINT	REFS	117	920					
256	LANSR	INTEGER		POINT	REFS	117	920					
14	LARAD	INTEGER		POINT	REFS	45	846	847				
10	LAXGAP	INTEGER		POINT	REFS	45						
11	LAXLEN	INTEGER		POINT	REFS	45	691	1020	1035	1043		
210	LB	INTEGER		POINT	REFS	97	758	920	1020			
211	LBR	INTEGER		POINT	REFS	97	759					
212	LBTOLD	INTEGER		POINT	REFS	97	372	751	1424			
12	LBU1	INTEGER		POINT	REFS	45	467	525	589	707		
13	LBU2	INTEGER		POINT	REFS	45	372	525	589	708	920	937
					1143	1353	1386	1411	1424			

VARIABLES	SN	TYPE	RELOCATION								
172	LCC1	INTEGER	POINT	REFS	90	525	920				
173	LCC2	INTEGER	POINT	REFS	90	372	525	920	1424		
213	LCHEM	INTEGER	POINT	REFS	97	372	1143	1424			
15	LCPDLT	INTEGER	POINT	REFS	45	945	2*949	1353			
2	LCREPI	INTEGER	POINT	REFS	45						
154	LCRL	INTEGER	POINT	REFS	78	901					
111	LDCHEK	INTEGER	POINT	REFS	45						
0	LDCIH	INTEGER	POINT	REFS	45	848					
261	LDECAY	INTEGER	POINT	REFS	117	920					
16	LDELBP	INTEGER	POINT	REFS	45	700	703	1143			
17	LDENMX	INTEGER	POINT	REFS	45						
174	LDENSF	INTEGER	POINT	REFS	90	372	525	539	776	901	1401
				1424							
175	LDENSP	INTEGER	POINT	REFS	90	525	776				
3	LDLH	INTEGER	POINT	REFS	45						
20	LDLPGE	INTEGER	POINT	REFS	45	730	837				
155	LDPL	INTEGER	POINT	REFS	78	920					
156	LDPLH	INTEGER	POINT	REFS	78	920					
157	LDPN	INTEGER	POINT	REFS	78	920					
176	LDPW	INTEGER	POINT	REFS	90	372	525	539	776	901	1401
				1424							
177	LDPWPP	INTEGER	POINT	REFS	90	525	776				
260	LDT	INTEGER	POINT	REFS	117	920					
21	LDZ	INTEGER	POINT	REFS	45						
22	LDZH	INTEGER	POINT	REFS	45	90:	1043				
23	LDZHP	INTEGER	POINT	REFS	45	901					
24	LECREP	INTEGER	POINT	REFS	45						
7137	LENGTH	INTEGER		REFS	372	1424					
25	LEP	INTEGER	POINT	REFS	45	372	1386	1411	1424		
127	LEPP	INTEGER	POINT	REFS	70	372	1386	1411	1424		
130	LEPPP	INTEGER	POINT	REFS	70						
131	LEPPSV	INTEGER	POINT	REFS	70						
147	LEPPI	INTEGER	POINT	REFS	70						
132	LEPS	INTEGER	POINT	REFS	70	372	842	1035	1058	1143	1353
				1424							
133	LEPSAV	INTEGER	POINT	REFS	70						
151	LEPSI	INTEGER	POINT	REFS	70						
100	LEPI	INTEGER	POINT	REFS	45						
167	LF	INTEGER	POINT	REFS	85	920					
4374	LFAC	INTEGER	ARRAY DESNBL	REFS	21						
134	LFEPS	INTEGER	POINT	REFS	70						
257	LFF	INTEGER	POINT	REFS	117	920					
121	LFGMGP	INTEGER	POINT	REFS	64	617	920	937	973		
170	LFH	INTEGER	POINT	REFS	85	920					
110	LFLAG	INTEGER	POINT	REFS	45						
254	LFLXFC	INTEGER	POINT	REFS	117	920					
160	LFMA	INTEGER	POINT	REFS	78	920					
161	LFMGPR	INTEGER	POINT	REFS	78	920					
122	LFMGR	INTEGER	POINT	REFS	64	920	937	973	1325		
171	LFN	INTEGER	POINT	REFS	85	920					
26	LGAP	INTEGER	POINT	REFS	45	744	746	795	798	802	803
				834	901	1353					
222	LGASMO	INTEGER	POINT	REFS	107	973	1043	1353	1386	1411	

VARIABLES	SN	TYPE	RELOCATION							
200	LGNSIZ	INTEGER	POINT	REFS	90					
27	LGPTP	INTEGER	POINT	REFS	45	702	839	901	1386	1411
45	LGRASS	INTEGER	GRSPTR	REFS	273	372	1424			
4	LHA	INTEGER	POINT	REFS	45					
262	LHALF	INTEGER	POINT	REFS	117	920				
30	LHCOEF	INTEGER	POINT	REFS	45	629	1353			
123	LHEMGP	INTEGER	POINT	REFS	64	617	920	973		
101	LHGAPS	INTEGER	POINT	REFS	45	950	1353			
114	LHGPC	INTEGER	POINT	REFS	45	952				
115	LHGPR	INTEGER	POINT	REFS	45	953				
116	LHGPS	INTEGER	POINT	REFS	45	951				
5	LHL	INTEGER	POINT	REFS	45					
223	LHMGPT	INTEGER	POINT	REFS	107	973				
124	LHMGR	INTEGER	POINT	REFS	64	920	973			
162	LHRL	INTEGER	POINT	REFS	78	901				
103	LIGAP	INTEGER	POINT	REFS	45					
12	LMN	INTEGER	INTEG	REFS	174	729	730	731	732	
				DEFINED	704	705				
106	LNFAIL	INTEGER	POINT	REFS	45					
146	LNUDEP	INTEGER	POINT	REFS	70					
31	LOLAXG	INTEGER	POINT	REFS	45					
32	LOLDPC	INTEGER	POINT	REFS	45	372	1411	1424		
33	LOLDPG	INTEGER	POINT	REFS	45	372	1411	1424		
34	LOLDTC	INTEGER	POINT	REFS	45	372	1411	1424		
35	LOLDUR	INTEGER	POINT	REFS	45	372	1411	1424		
36	LOLEPS	INTEGER	POINT	REFS	45	372	1411	1424		
37	LOLFEP	INTEGER	POINT	REFS	45	372	1411	1424		
104	LOLIGP	INTEGER	POINT	REFS	45	372	1143	1411	1424	
40	LPAXGP	INTEGER	POINT	REFS	45					
4541	LPB	INTEGER	DESNBL	REFS	21					
41	LPC	INTEGER	POINT	REFS	45	724	1124	1442		
42	LPECRP	INTEGER	POINT	REFS	45					
43	LPEP	INTEGER	POINT	REFS	45					
135	LPEPSV	INTEGER	POINT	REFS	70					
255	LPF	INTEGER	POINT	REFS	117	920				
136	LPFPSV	INTEGER	POINT	REFS	70					
44	LPG	INTEGER	POINT	REFS	45	723	1123	1442		
45	LPINT	INTEGER	POINT	REFS	45	675	798	834	1353	1386 1411
224	LPIT	INTEGER	POINT	REFS	107	531	711	1020	1043	1084 1085
				1088	1353					
46	LPLDPC	INTEGER	POINT	REFS	45					
47	LPLDPG	INTEGER	POINT	REFS	45					
50	LPLDTC	INTEGER	POINT	REFS	45					
51	LPLDUR	INTEGER	POINT	REFS	45					
107	LPLIGP	INTEGER	POINT	REFS	45					
52	LPOAXG	INTEGER	POINT	REFS	45					
53	LPOFEP	INTEGER	POINT	REFS	45					
54	LPOLEP	INTEGER	POINT	REFS	45					
6	LPOROS	INTEGER	POINT	REFS	45	1386	1404	1411		
201	LPORS1	INTEGER	POINT	REFS	90	525	776			
202	LPORS2	INTEGER	POINT	REFS	90	372	525	751	776	1424
225	LPRT10	INTEGER	POINT	REFS	107	1053				
226	LPRT11	INTEGER	POINT	REFS	107	886				

VARIABLES	SN	TYPE		RELOCATION								
227	LPRT12	INTEGER		POINT	REFS	107	887	888				
230	LPRT13	INTEGER		POINT	REFS	107	1056	1062	1067			
231	LPRT14	INTEGER		POINT	REFS	107	1057	1063	1068			
232	LPRT15	INTEGER		POINT	REFS	107	1058	1064	1069			
233	LPRT16	INTEGER		POINT	REFS	107	889					
234	LPRT17	INTEGER		POINT	REFS	107	890					
235	LPRT18	INTEGER		POINT	REFS	107	891					
236	LPRT2	INTEGER		POINT	REFS	107	880					
237	LPRT20	INTEGER		POINT	REFS	107	893					
240	LPRT3	INTEGER		POINT	REFS	107	881					
241	LPRT4	INTEGER		POINT	REFS	107	882					
242	LPRT5	INTEGER		POINT	REFS	107	1050					
243	LPRT6	INTEGER		POINT	REFS	107	883					
244	LPRT7	INTEGER		POINT	REFS	107	884	885				
245	LPRT8	INTEGER		POINT	REFS	107	1051					
246	LPRT9	INTEGER		POINT	REFS	107	1052					
214	LQ	INTEGER		POINT	REFS	102	467	507	563	589	920	1035
					1353							
105	LQDP	INTEGER		POINT	REFS	45	694	719	751	881	1301	
206	LR	INTEGER		POINT	REFS	90	539	583	667	751	771	776
					920	1375	2*1401	1411				
207	LRAD	INTEGER		POINT	REFS	90	776	901	945	1288		
55	LRDCOL	INTEGER		POINT	REFS	45						
137	LREPS	INTEGER		POINT	REFS	70	372	1386	1411	1424		
141	LREPSP	INTEGER		POINT	REFS	70						
140	LREPSV	INTEGER		POINT	REFS	70						
126	LREPS2	INTEGER		POINT	REFS	64						
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	21						
143	LRFEPP	INTEGER		POINT	REFS	70						
142	LRFEPS	INTEGER		POINT	REFS	70	372	1386	1411	1424		
144	LRFPSV	INTEGER		POINT	REFS	70						
263	LRLEAS	INTEGER		POINT	REFS	117	920	1102				
113	LRTRNC	INTEGER		POINT	REFS	45	372	525	751			
112	LRTRNP	INTEGER		POINT	REFS	45	525	751	1424			
145	LSIG	INTEGER		POINT	REFS	70	372	1056	1057	1143	1424	
150	LSIGI	INTEGER		POINT	REFS	70						
266	LSTHIF	INTEGER		POINT	REFS	123	937	1109	1113			
247	LTAC	INTEGER		POINT	REFS	107	517	519	1043			
56	LTAF	INTEGER		POINT	REFS	45						
250	LTAFA	INTEGER		POINT	REFS	107	1043					
57	LTAG	INTEGER		POINT	REFS	45	815	841	1043	1051		
251	LTAGA	INTEGER		POINT	REFS	107	1043					
60	LTBAR	INTEGER		POINT	REFS	45	945	1035	1043	1053		
61	LTBLK	INTEGER		POINT	REFS	45	623	1020	1035	1353		
62	LTCA	INTEGER		POINT	REFS	45	659	673	691	958	1035	1043
					1050	1143	1353					
63	LTCIDI	INTEGER		POINT	REFS	45	722	1020	1370	1386	1411	
64	LTCODI	INTEGER		POINT	REFS	45	721	857	1020	1353	1371	1386
					1411							
163	LTFB	INTEGER		POINT	REFS	78	771	945				
164	LTFR	INTEGER		POINT	REFS	78	751	765	766	771	776	815
					875	886	901	920	937			
165	LTFRK	INTEGER		POINT	REFS	78						

VARIABLES	SN	TYPE	RELOCATION								
203	LTMPDS	INTEGER	POINT	REFS	90	525	875	1143	1292	1353	1375
				1386	1411						
205	LTMPMX	INTEGER	POINT	REFS	90	525	1143				
117	LTOXO	INTEGER	POINT	REFS	45	871					
65	LTPS	INTEGER	POINT	REFS	45	742	751	1043	1052	1353	
102	LTRTRN	INTEGER	POINT	REFS	45	751	1043				
252	LTSF	INTEGER	POINT	REFS	107	1043					
4540	LTYPE	INTEGER	DESNBL	REFS	21						
7	LUFS	INTEGER	POINT	REFS	45	1386	1405	1411			
204	LUO2LL	INTEGER	POINT	REFS	90	771	776	901			
1	LURC	INTEGER	POINT	REFS	45						
66	LURF	INTEGER	POINT	REFS	45						
67	LVCH	INTEGER	POINT	REFS	45	901					
70	LVCHI	INTEGER	POINT	REFS	45	901	1043				
71	LVCR	INTEGER	POINT	REFS	45	901	1043				
72	LVDH	INTEGER	POINT	REFS	45	901	1043				
73	LVFH	INTEGER	POINT	REFS	45	901	1043	1404			
74	LVGH	INTEGER	POINT	REFS	45	901	1043				
166	LVPL	INTEGER	POINT	REFS	78	901					
75	LVPOR	INTEGER	POINT	REFS	45	901	1043	1404			
76	LZRO2A	INTEGER	POINT	REFS	45	525	641				
77	LZRO2B	INTEGER	POINT	REFS	45	372	525	650	652	849	854
				856	870	1143	1353	1386	1411	1424	
13	M	INTEGER	INTEG	REFS	174	467	507	563	589	1033	1035
				1353	DEFINED	503					
52	MAXA	INTEGER	LIMITS	REFS	283						
0	MAXIDX	INTEGER	LACMDL	REFS	231						
43	MAXT	INTEGER	LIMITS	REFS	283						
56	MCUD	INTEGER	LIMITS	REFS	283						
166	MDBG	INTEGER	INPTI	REFS	201						
15	MDHPRS	INTEGER	PFRCS2	REFS	221	685	788	1000	1159	1340	1353
				1442	1461						
271	MECHAN	INTEGER	INPTI	REFS	201	372	388	478	537	662	663
				673	679	685	691	745	746	751	762
				776	783	795	798	803	809	810	815
				834	842	843	846	847	848	885	888
				897	985	992	1043	1054	1055	1118	1159
				1353	1361	1409	1424	1435			
20	MEPP2	INTEGER	PFRCS2	REFS	221	788	1000	1132	1159	1340	1442
				1461							
24	MEPS0	INTEGER	PFRCS2	REFS	221	691	788	1000	1159	1340	1442
				1461							
22	MEPS02	INTEGER	PFRCS2	REFS	221	691	776	788	1000	1159	1340
				1442	1461						
17	MEPS22	INTEGER	PFRCS2	REFS	221	788	843	1000	1069	1159	1340
				1442	1461						
11	MEP2	INTEGER	PFRCS2	REFS	221	788	1000	1129	1159	1340	1442
				1461							
10	MEREP2	INTEGER	PFRCS2	REFS	221	788	1000	1159	1340	1442	1461
14	MFVFR0	INTEGER	PFRCS2	REFS	221	685	788	1000	1159	1340	1353
				1442	1461						
2	MGAP2	INTEGER	PFRCS2	REFS	221	788	1000	1159	1340	1461	
3	MIGAP2	INTEGER	PFRCS2	REFS	221	788	1000	1125	1159	1340	1461

VARIABLES	SN	TYPE	RELOCATION								
7200	MMM	INTEGER			REFS	648	DEFINED	643	644		
7130	MNA	INTEGER			REFS	355	662	663	2*685	691	751	776
						788	2*843	1000	2*1067	2*1068	2*1069	2*1122	1159
						1340	2*1353	1442	1461				
7131	MNR	INTEGER			REFS	355	691	751	776	788	843	1000
						1067	1068	1069	1159	1340	1442	1461	
170	MODE	INTEGER		INPTI	REFS	201						
171	MODES	INTEGER		INPTI	REFS	201						
7264	MODFAL	INTEGER	ARRAY		REFS	252	1143	DEFINED	321			
14	MODLOP	INTEGER		INTEG	REFS	174						
1	MODPC2	INTEGER		PFRCS2	REFS	221	788	1000	1124	1159	1340	1461
0	MODPG2	INTEGER		PFRCS2	REFS	221	788	1000	1123	1159	1340	1461
4	MOIGP2	INTEGER		PFRCS2	REFS	221	788	1000	1125	1159	1340	1461
13	MOLDT2	INTEGER		PFRCS2	REFS	221	788	1000	1128	1159	1340	1461
23	MPEPP2	INTEGER		PFRCS2	REFS	221	788	1000	1132	1159	1340	1461
6	MPEPS2	INTEGER		PFRCS2	REFS	221	788	1000	1121	1122	1159	1340
					1461							
16	MPEP2	INTEGER		PFRCS2	REFS	221	788	1000	1129	1159	1340	1461
5	MREPS2	INTEGER		PFRCS2	REFS	221	788	1000	1121	1122	1159	1340
					1461							
12	MR22	INTEGER		PFRCS2	REFS	221	788	1000	1159	1340	1442	1461
21	MSIG2	INTEGER		PFRCS2	REFS	221	788	1000	1067	1068	1159	1340
					1442	1461						
172	MTAPE	INTEGER		INPTI	REFS	201						
7	MTTT	INTEGER		PFRCS2	REFS	221	662	663	751	788	1000	1128
					1159	1340	1442	1461				
0	M1	INTEGER		LIMITS	REFS	283	347	1442	DEFINED	1440		
1	M2	INTEGER		LIMITS	REFS	283	1442	DEFINED	1441			
7242	M3	INTEGER			REFS	1126	1442	DEFINED	1119			
266	NA	INTEGER		INPTI	REFS	201	362	372	392	393	415	421
					422	423	441	444	445	467	507	525
					539	544	545	551	563	583	589	617
					623	629	659	723	724	751	771	776
					815	920	937	945	973	1020	1033	1035
					1043	1057	1108	1143	1324	1353	1375	1386
					1411	1424						
43	NAA	INTEGER		PFCMI2	REFS	257						
15	NAB	INTEGER		INTEG	REFS	174	DEFINED	460				
17	NABC	INTEGER		LIMITS	REFS	283						
16	NABF	INTEGER		LIMITS	REFS	283	1020					
31	NABF2	INTEGER		LIMITS	REFS	283						
20	NABT	INTEGER		LIMITS	REFS	283	408					
32	NABT2	INTEGER		LIMITS	REFS	283	1020					
21	NAEC	INTEGER		LIMITS	REFS	283						
22	NAEF	INTEGER		LIMITS	REFS	283						
233	NAFAIL	INTEGER		INPTI	REFS	201	1143					
25	NALFDT	INTEGER		PFCMI2	REFS	257	1442					
14	NARC	INTEGER		LIMITS	REFS	283	1020					
13	NARF	INTEGER		LIMITS	REFS	283						
15	NART	INTEGER		LIMITS	REFS	283						
25	NAXBT	INTEGER		LIMITS	REFS	283						
26	NAXB2	INTEGER		LIMITS	REFS	283						
27	NAXB4	INTEGER		LIMITS	REFS	283						

VARIABLES	SN	TYPE	RELOCATION								
7260	NAXSYM	INTEGER		REFS	1375	DEFINED	1363				
7135	NA1	INTEGER		REFS	1336	DEFINED	362				
7152	NA2	INTEGER		REFS	446	DEFINED	445				
33	NBB	INTEGER	PFCM12	REFS	257						
27	NC	INTEGER	INTEG	REFS	174	427	1020				
45	NCC	INTEGER	PFCM12	REFS	257						
52	NCNN	INTEGER	BA	REFS	291						
7211	NCNT	INTEGER		REFS	808	809	DEFINED	734	809		
7212	NCNVG	INTEGER		REFS	807	815	DEFINED	735			
11	NCOEF	INTEGER	PFCM12	REFS	257						
51	NCONN	INTEGER	BA	REFS	291						
7210	NCONT	INTEGER		REFS	798	822	DEFINED	728			
7207	NCONVG	INTEGER		REFS	798	821	DEFINED	727			
272	NCRACK	INTEGER	INPTI	REFS	201						
7255	NCRAX	INTEGER		REFS	1375	DEFINED	1366				
274	NCREEP	INTEGER	INPTI	REFS	201						
50	NC4	INTEGER	LIMITS	REFS	283						
173	NDBG	INTEGER	INPTI	REFS	201	2*461	667	751	776	815	901
				945	973	1043	1434	DEFINED	461	497	498
5	NDCHCK	INTEGER	PFCM12	REFS	257						
36	NDD	INTEGER	PFCM12	REFS	257						
7	NDEP	INTEGER	PFCM12	REFS	257						
12	NDSIGF	INTEGER	PFCM12	REFS	257						
21	NE	INTEGER	PFCM12	REFS	257						
16	NECRP2	INTEGER	PFCM12	REFS	257						
41	NEE	INTEGER	PFCM12	REFS	257						
44	NEI	INTEGER	PFCM12	REFS	257						
273	NELAST	INTEGER	INPTI	REFS	201						
23	NEPP2	INTEGER	PFCM12	REFS	257						
15	NEP2	INTEGER	PFCM12	REFS	257						
7	NETOT	INTEGER	LIMITS	REFS	283						
53	NEW	INTEGER	LIMITS	REFS	283	483	DEFINED	470	484	485	
10	NEWF	INTEGER	LIMITS	REFS	283						
270	NEWPRB	INTEGER	INPTI	REFS	201						
11	NEWT	INTEGER	LIMITS	REFS	283						
26	NF	INTEGER	INTEG	REFS	174	428	430	431	539	815	1020
				1043							
10463	NFAC	INTEGER	DESNBL	REFS	21						
6	NFF	INTEGER	LIMITS	REFS	283						
30	NFF1	INTEGER	LIMITS	REFS	283	429	431	434	539	815	1020
				1043							
47	NFF2	INTEGER	LIMITS	REFS	283						
174	NFROD	INTEGER	INPTI	REFS	201	1143					
13	NF1	INTEGER	PFCM12	REFS	257						
14	NF2	INTEGER	PFCM12	REFS	257						
51	NF4	INTEGER	LIMITS	REFS	283						
175	NGAPC	INTEGER	INPTI	REFS	201						
176	NGASR	INTEGER	INPTI	REFS	201	372	916	920	2*935	937	973
				1102	2*1105	1167	1424				
35	NGG	INTEGER	PFCM12	REFS	257						
167	NHEAL	INTEGER	INPTI	REFS	201	525					
30	NHH	INTEGER	PFCM12	REFS	257						
41	NKN	INTEGER	LIMITS	REFS	283						

VARIABLES	SN	TYPE		RELOCATION							
42	NLL	INTEGER		PFCMI2	REFS	257					
34	NMM	INTEGER		PFCMI2	REFS	257					
32	NMN	INTEGER		PFCMI2	REFS	257					
54	NMX	INTEGER		LIMITS	REFS	283					
50	NN	INTEGER		BA	REFS	291					
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	201	1143				
46	NNFF	INTEGER		PFCMI2	REFS	257					
31	NNN	INTEGER		PFCMI2	REFS	257					
25	NNNCRP	INTEGER		PFRCS2	REFS	221					
40	NNU	INTEGER		PFCMI2	REFS	257					
27	NNUDPP	INTEGER		PFCMI2	REFS	257					
4230	NODE	INTEGER	ARRAY	DESNBL	REFS	21					
2	NOEL	INTEGER		LIMITS	REFS	283	1020				
4	NOELC	INTEGER		LIMITS	REFS	283					
3	NOELF	INTEGER		LIMITS	REFS	283					
177	NOFAIL	INTEGER		INPTI	REFS	201	1138				
277	NOFRAC	INTEGER		INPTI	REFS	201					
65	NOLD	INTEGER		LIMITS	REFS	283	485	DEFINED	482	483	
26	NOLDPP	INTEGER		PFCMI2	REFS	257					
6	NOLSGF	INTEGER		PFCMI2	REFS	257					
200	NOPT	INTEGER		INPTI	REFS	201	1143	1334			
7077	NOTONE	INTEGER			REFS	593	920	DEFINED	314	593	
201	NPCYCL	INTEGER		INPTI	REFS	201	459				
0	NPIN	INTEGER		PFCMI2	REFS	257					
16	NPLAST	INTEGER		INTEG	REFS	174	DEFINED	781	979		
263	NPLOT	INTEGER		INPTI	REFS	201	1353				
202	NPLTAB	INTEGER		INPTI	REFS	201	1353				
1	NPOUT	INTEGER		PFCMI2	REFS	257					
304	NPRINT	INTEGER		INPTI	REFS	201	1317				
2	NP1	INTEGER		PFCMI2	REFS	257					
3	NP2	INTEGER		PFCMI2	REFS	257					
267	NR	INTEGER		INPTI	REFS	201	372	383	525	539	583	662
						663	667	2*685	751	765	771	776	815
						843	873	874	886	901	920	937	945
						1067	1068	1069	1119	1143	1243	1279	1288
						1292	3*1353	2*1375	1386	1398	1399	1400	1411
						1424	1441						
203	NREAD	INTEGER		INPTI	REFS	201	367	372	460	463	465	512	
						973	1424						
11176	NRES	INTEGER		DESNBL	REFS	21							
204	NRESTR	INTEGER		INPTI	REFS	201	372	1241	1419	1424			
7172	NRMESH	INTEGER			REFS	581	583	DEFINED	576				
17	NRMI	INTEGER		INTEG	REFS	174	583	771	776	901			
					DEFINED	383							
265	NROD	INTEGER		INPTI	REFS	201							
205	NROLL	INTEGER		INPTI	REFS	201	372	1424					
10462	NRUN	INTEGER		DESNBL	REFS	21							
25	NSH	INTEGER		INTEG	REFS	174	1020						
10	NSLOPE	INTEGER		PFCMI2	REFS	257							
206	NSP	INTEGER		INPTI	REFS	201							
207	NSTART	INTEGER		INPTI	REFS	201	497						
20	NSTEP	INTEGER		INTEG	REFS	174							
210	NSTOP	INTEGER		INPTI	REFS	201	497						

VARIABLES	SN	TYPE	RELOCATION								
24	NSTRTT	INTEGER	PFCMI2	REFS	257						
211	NT	INTEGER	INPTI	REFS	201	1020	1033	5*1035	1043	1244	1284
				1300	1309	1310	1317	1396	1411	1440	
23	NTAE	INTEGER	LIMITS	REFS	283	1020					
212	NTAPE	INTEGER	INPTI	REFS	201	1394					
11174	NTIME	INTEGER	DESNBL	REFS	21	1390	DEFINED	348	1390		
7253	NTKF	INTEGER		REFS	1245	DEFINED	1244				
20	NTN	INTEGER	PFCMI2	REFS	257						
264	NTPLOT	INTEGER	INPTI	REFS	201	1353	DEFINED	1467			
4	NTSAVE	INTEGER	PFCMI2	REFS	257						
17	NT2	INTEGER	PFCMI2	REFS	257						
421	NU	REAL	REALS	REFS	18	147	1035				
213	NUCFC	INTEGER	INPTI	REFS	201	1143					
214	NUNITS	INTEGER	INPTI	REFS	201	1353	1375				
22	NV	INTEGER	PFCMI2	REFS	257						
0	NVAR1	INTEGER	GRSPTR	REFS	273						
11	NVAR10	INTEGER	GRSPTR	REFS	273						
12	NVAR11	INTEGER	GRSPTR	REFS	273						
13	NVAR12	INTEGER	GRSPTR	REFS	273						
14	NVAR13	INTEGER	GRSPTR	REFS	273						
15	NVAR14	INTEGER	GRSPTR	REFS	273						
16	NVAR15	INTEGER	GRSPTR	REFS	273						
17	NVAR16	INTEGER	GRSPTR	REFS	273						
20	NVAR17	INTEGER	GRSPTR	REFS	273						
21	NVAR18	INTEGER	GRSPTR	REFS	273	1255					
22	NVAR19	INTEGER	GRSPTR	REFS	273						
1	NVAR2	INTEGER	GRSPTR	REFS	273	1325					
23	NVAR20	INTEGER	GRSPTR	REFS	273						
24	NVAR21	INTEGER	GRSPTR	REFS	273						
25	NVAR22	INTEGER	GRSPTR	REFS	273						
26	NVAR23	INTEGER	GRSPTR	REFS	273	1263					
27	NVAR24	INTEGER	GRSPTR	REFS	273						
30	NVAR25	INTEGER	GRSPTR	REFS	273	1259					
31	NVAR26	INTEGER	GRSPTR	REFS	273	1249	1250				
32	NVAR27	INTEGER	GRSPTR	REFS	273						
33	NVAR28	INTEGER	GRSPTR	REFS	273	1288					
34	NVAR29	INTEGER	GRSPTR	REFS	273						
2	NVAR3	INTEGER	GRSPTR	REFS	273	1301					
35	NVAR30	INTEGER	GRSPTR	REFS	273	1310					
36	NVAR3	INTEGER	GRSPTR	REFS	273						
37	NVAR32	INTEGER	GRSPTR	REFS	273	1292	2*1310				
40	NVAR33	INTEGER	GRSPTR	REFS	273						
41	NVAR34	INTEGER	GRSPTR	REFS	273						
42	NVAR35	INTEGER	GRSPTR	REFS	273						
43	NVAR36	INTEGER	GRSPTR	REFS	273						
44	NVAR37	INTEGER	GRSPTR	REFS	273						
3	NVAR4	INTEGER	GRSPTR	REFS	273						
4	NVAR5	INTEGER	GRSPTR	REFS	273	1271					
5	NVAR6	INTEGER	GRSPTR	REFS	273						
6	NVAR7	INTEGER	GRSPTR	REFS	273						
7	NVAR8	INTEGER	GRSPTR	REFS	273						
10	NVAR9	INTEGER	GRSPTR	REFS	273						
7227	NVOID	INTEGER		REFS	920	DEFINED	908				

VARIABLES	SN	TYPE		RELOCATION								
37	NW	INTEGER		PFCMI2	REFS	257						
301	NWORDS	INTEGER		INPTI	REFS	201	372	1317	1424			
303	NWRDS	INTEGER		INPTI	REFS	201						
21	NWRITE	INTEGER		INTEG	REFS	174	498					
262	NXP	INTEGER		INPTI	REFS	201	589					
22	N2	INTEGER		INTEG	REFS	174	846	847	848	1043		
					DEFINED	564	1338					
7133	N3	INTEGER			REFS	372	1424	DEFINED	360			
7134	N6	INTEGER			REFS	372	1424	DEFINED	361			
7132	N7	INTEGER			REFS	372	1424	DEFINED	359			
7110	ODINE	REAL			REFS	1143	DEFINED	326				
422	OXDROP	REAL		REALS	REFS	147	DEFINED	872				
423	OXIDE	REAL		REALS	REFS	147	891	DEFINED	849			
7153	PCYCL	REAL			REFS	1143	DEFINED	459				
424	PECDH	REAL		REALS	REFS	147						
7073	PFAVE	REAL			REFS	920	DEFINED	303				
7265	PFB	REAL	ARRAY		REFS	252	343	1143				
425	PI	REAL		REALS	REFS	147	506	583	589	901	1035	1043
					1353							
426	PIN	REAL	ARRAY	REALS	REFS	147	798	887				
7351	PINE	REAL	ARRAY		REFS	252	342	798	815	DEFINED	732	
460	PINP	REAL		REALS	REFS	147						
7203	PINS	REAL			REFS	679	DEFINED	675				
461	PORO	REAL		REALS	REFS	147						
7453	POWPRO	REAL	ARRAY		REFS	298	920	DEFINED	912	913	914	
444	PPMH2O	REAL		INPTR	REFS	182	865					
445	PPMN2	REAL		INPTR	REFS	182						
462	PR	REAL		REALS	REFS	147						
463	PRESS	REAL		REALS	REFS	147	723	815	1035	1043	1259	1317
					1375	1386	1411					
464	PRTY	REAL		REALS	REFS	147						
465	PRT19	REAL		REALS	REFS	147	DEFINED	892				
7427	PSP	REAL	ARRAY		REFS	252	345					
7113	PSR	REAL			REFS	1143	DEFINED	329				
446	P2	REAL	ARRAY	INPTR	REFS	182	623	629	724	1020	1035	1353
					1375							
473	QAV	REAL		REALS	REFS	147	507	DEFINED	506			
466	QC	REAL		REALS	REFS	147	617	623	629	640	652	659
					694	729	815	855	870	DEFINED	563	
7176	QCIM	REAL			REFS	648	865	DEFINED	640	855		
613	QEND	REAL	ARRAY	INPTR	REFS	182	1035					
623	QF	REAL	ARRAY	INPTR	REFS	182						
1333	QMPY	REAL	ARRAY	INPTR	REFS	182	506	563	589	920	1035	1353
467	QP	REAL		REALS	REFS	147	1035					
474	QPEAK	REAL		REALS	REFS	147	DEFINED	507				
470	QSP	REAL		REALS	REFS	147	1035					
72	RAKSUM	REAL		LIMITS	REFS	283						
1500	RAPOW	REAL	ARRAY	INPTR	REFS	182	667					
1513	RC	REAL		INPTR	REFS	182	2*407	583	751	920	937	
7145	RCD	REAL			REFS	407	428	434	1020	DEFINED	406	407
471	RCI	REAL		REALS	REFS	147	4*396	401	402	427	428	431
					539	570	572	574	575	1020	1411	
					DEFINED	392	411	417	422	567		

	VARIABLES	SN	TYPE	RELOCATION								
	472	RCO	REAL	REALS	REFS	147	427	570	1020	1375	1411	
					DEFINED	410	416	421	568	1372		
	1514	RDISH	REAL	INPTR	REFS	182						
	475	RFNUFF	REAL	REALS	REFS	160	1043					
	7167	RFSH	REAL		REFS	751	DEFINED	573				
	476	RHO	REAL	REALS	REFS	160						
815	477	RHOF	REAL	REALS	REFS	160	623					
	500	RHOG	REAL	REALS	REFS	160	1035					
	501	RHOUO2	REAL	REALS	REFS	160	589					
	502	RMH	REAL	REALS	REFS	160						
	1515	ROUGHC	REAL	INPTR	REFS	182	815					
	1516	ROUGHF	REAL	INPTR	REFS	182	815					
	503	RP	REAL	REALS	REFS	160	2*396	401	402	539	572	573
					574	2*575	583	719	751	795	1020	
					DEFINED	393	412	418	423	569		
	70	RRAKR	REAL	LIMITS	REFS	283						
	2551	RSNTR	REAL	INPTR	REFS	182	776					
	504	RSTRAN	REAL	REALS	REFS	160	613	1143	DEFINED	457		
	505	RSTRES	REAL	REALS	REFS	160						
	7157	RTEMP	REAL		REFS	520	DEFINED	518	519			
	506	RTRAN	REAL	REALS	REFS	160	751					
	1517	SGAPF	REAL	INPTR	REFS	182	617					
	7144	SIGC	REAL		REFS	539	DEFINED	402				
945	7143	SIGG	REAL		REFS	539	615	DEFINED	401			
	507	SKTC	REAL	REALS	REFS	160						
	510	SKTS	REAL	REALS	REFS	160						
	64	STEP	REAL	LIMITS	REFS	283						
	511	STRN	REAL	REALS	REFS	160						
	512	SUMCK	REAL	REALS	REFS	160	1043					
386	513	SUMDH	REAL	REALS	REFS	160	1043					
	514	SUMEXP	REAL	REALS	REFS	160	771					
084	1	SUMFF	REAL	AXL	REFS	282						
	515	SUMGP	REAL	REALS	REFS	160	1043					
	7163	SUMI	REAL		REFS	552	554	DEFINED	547	552		
	0	SUMM	REAL	AXL	REFS	282	346	1353				
	516	SUMPOR	REAL	REALS	REFS	160	1043					
	517	SUMRG	REAL	REALS	REFS	160	1043					
	2	SUMSAV	REAL	AXL	REFS	282						
	520	SUMTF	REAL	REALS	REFS	160	771					
	521	T	REAL	REALS	REFS	160	508	511	667	706		
					DEFINED	505						
	522	TCAC	REAL	REALS	REFS	160						
	7234	TCAK	REAL		REFS	959	DEFINED	958				
	1520	TCC	REAL	INPTR	REFS	182	901	1143	1375	DEFINED	570	1373
	523	TCI	REAL	REALS	REFS	160	659	662	722	742	815	841
					883	1375	DEFINED	1370				
	524	TCO	REAL	REALS	REFS	160	629	632	652	659	663	721
					868	870	872	882	1375	DEFINED	652	1371
	7173	TCOK	REAL		REFS	637	648	869	DEFINED	632	868	
	7216	TDI	REAL		REFS	833	DEFINED	831				
	7217	TDZ	REAL		REFS	833	DEFINED	832				
	525	TFBC	REAL	REALS	REFS	160						
	526	TFC	REAL	REALS	REFS	160						

VARIABLES	SN	TYPE	RELOCATION									
527	TFGFR	REAL		REALS	REFS	160	973					
7111	TFLIF	REAL			REFS	1143	DEFINED	327				
530	THEFR	REAL		REALS	REFS	160	973					
531	TH2OFR	REAL		REALS	REFS	160	973					
1521	TIME	REAL	ARRAY	INPTR	REFS	182	372	492	505	2*509	589	617
					629	659	691	815	910	915	920	1035
					2*1102	1143	1317	1353	1411	1424		
61	TIMEC	REAL		LIMITS	REFS	283						
7116	TIMEF	REAL			REFS	1143	DEFINED	332				
7117	TIMES	REAL			REFS	1143	DEFINED	333				
532	TITLE	REAL	ARRAY	REALS	REFS	160						
3244	TL	REAL	ARRAY	DESNBL	REFS	21						
7232	TLAST	REAL			REFS	920	DEFINED	911	915			
546	TM	REAL		REALS	REFS	160	DEFINED	706				
7231	TNOW	REAL			REFS	920	DEFINED	910				
547	TN2FR	REAL		REALS	REFS	160	973					
1666	TOTL	REAL		INPTR	REFS	182	589	920	1035	1043	1233	1353
550	TOXO	REAL		REALS	REFS	160	871	872	DEFINED	870		
551	TP	REAL		REALS	REFS	160	DEFINED	511				
552	TPA	REAL		REALS	REFS	160						
553	TPAC	REAL		REALS	REFS	160						
554	TPLEN	REAL		REALS	REFS	160	1020	1035	1043	1353		
					DEFINED	398						
555	TRANST	REAL		REALS	REFS	160	751	DEFINED	384			
2553	TREF	REAL		INPTR	REFS	182	941	1020				
7233	TREFK	REAL			REFS	945	DEFINED	941				
556	TSAT	REAL		REALS	REFS	160	623	629	644			
1667	TSINT	REAL		INPTR	REFS	182	304	776				
557	TT	REAL		REALS	REFS	160						
1670	TW	REAL	ARRAY	INPTR	REFS	182	398	623	667	1020	1143	
560	TX	REAL		REALS	REFS	160						
561	TXA	REAL		REALS	REFS	160	673					
562	TXAL	REAL		REALS	REFS	160	673					
563	TXC	REAL		REALS	REFS	160	673					
7261	U	REAL			REFS	1401	1405	DEFINED	1397	1401		
2035	UBFS	REAL		INPTR	REFS	182	1143					
2036	UMELT	REAL		INPTR	REFS	182	1143					
7071	UNIT	LOGICAL			REFS	16	1353	DEFINED	304			
2037	UOFD	REAL		INPTR	REFS	182	1143					
0	VERS	REAL		VER	REFS	233						
7142	VFCC	REAL			REFS	539	DEFINED	396				
564	VISC	REAL		REALS	REFS	160						
7213	VLSTRN	REAL			REFS	751	DEFINED	743	745			
7204	VOLSTR	REAL			REFS	743	745	746	803	DEFINED	681	684
					685							
565	VPLT	REAL		REALS	REFS	160						
2040	VS	REAL		INPTR	REFS	182						
566	VSS	REAL		REALS	REFS	160	1035					
600	VX	REAL		REALS	REFS	160						
567	W	REAL		REALS	REFS	160	667	751	912	937		
570	WT	REAL		REALS	REFS	160	623	629	644			
571	WTRAN	REAL		REALS	REFS	160						
2041	X	REAL	ARRAY	INPTR	REFS	182						

VARIABLES	SN	TYPE	RELOCATION								
572	XEIN	REAL	REALS	REFS	160	373					
35	XFRDEN	REAL	LIMITS	REFS	283						
573	XK6	REAL	REALS	REFS	160						
574	XK7	REAL	REALS	REFS	160						
33	XP	REAL	LIMITS	REFS	283	DEFINED	390				
34	XR	REAL	LIMITS	REFS	283	DEFINED	391				
62	XTIMEF	REAL	LIMITS	REFS	283						
575	YY	REAL	REALS	REFS	160	667	751	913	937		
576	Z	REAL	REALS	REFS	160	667	751	914	937		
7175	ZOXK	REAL		REFS	652	870	DEFINED	638	869		
7174	ZOXKI	REAL		REFS	638	648	865	DEFINED	637	860	
7106	ZRNI	REAL		REFS	1143	DEFINED	324				
7125	ZRO2AI	REAL		REFS	865	DEFINED	339	501			
7124	ZRO2BI	REAL		REFS	501	865	DEFINED	338	854		
7177	ZRO2I	REAL		REFS	646	DEFINED	641				
7201	ZRO2O	REAL		REFS	648	650	815				
577	ZRO2WG	REAL	REALS	REFS	160	892	DEFINED	856			

FILE NAMES	MODE				
TAPE6	FMT	WRITES	833	834	1088

EXTERNALS	TYPE	ARGS	REFERENCES						
AXIWRT		24	1375						
BURNUP		25	589						
CALLGR		11	1317						
CANEAL		8	520						
CCREEP		23	1159						
CEXPAN		4	673						
CHUPTK		15	865						
CLADRP		12	659						
CLDGRO		12	691						
CONDUC		42	815						
COOLT		13	623						
CORROS		7	648						
EMRLOC	REAL	4	719						
ENERGY		14	945						
FAILUR		50	1143						
FEXPAN		13	771						
FGASRE		61	920						
FLMDRP		19	629						
FLUXD		13	667						
FRACAS		23	788	1000					
GASPLT		3	1102						
GASPRO		10	617						
GASREL		19	937						
GSPRES		54	1043						
MEMSET		3	342	343	344	345	346	723	724
NEMSET		3	347						
NEWGAP		13	798						
PELET		46	1020						
PHYPRP		0	598						
PLNT		51	1035						
PLTOUT		45	1353						

EXTERNALS	TYPE	ARGS	REFERENCES		
PRINTM		19	1442		
PRINT2		23	1340	1461	
RADIAL		30	539		
REPACK		3	679		
RESTFS		32	1411		
RMESH		8	583		
SETUP		2	355		
STORE		23	525		
SWELL		30	776		
TAPEGN		44	372	1424	
TMPSUB		39	751		
TOTGAS		41	973		
VOLUME		32	901		
WRITER		19	1386		
ZOTCON	REAL	1	637	860	869

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES					
ABS	REAL	1	INTRIN		1084	1085				
AMAX1	REAL	0	INTRIN		744	959				
FLOAT	REAL	1	INTRIN		427	428	431	434	551	552
TCONV	REAL	1	SF	301	517	941				

STATEMENT LABELS		DEF LINE	REFERENCES	
143	100	350	1469	
240	110	381	367	
337	120	414	409	
355	130	420	415	
367	140	424	413	419
421	150	433	430	
431	160	435	429	432
0	170	436	408	
0	180	443	441	
0	190	448	446	
467	200	449	388	
0	210	468	466	
554	220	475	465	1450
617	230	496	478	
772	240	529	512	1091
0	250	553	548	
0	260	555	544	
1105	270	558	537	
1106	280	563	967	
1174	290	585	581	
0	300	661	657	
1465	310	701	696	
1475	320	704	695	
1632	330	740	827	
0	340	760	757	
1751	350	767	762	
2112	360	805	783	
2156	370	829	808	822
2204	380	836	807	821
0	390	876	873	

STATEMENT LABELS			DEF LINE	REFERENCES		
2500	400		895	878		
2543	410		906	897		
2710	420		940	916	935	
2767	430		969	961		
0	440		1000	998		
3103	450		1007	990	992	
3105	460		1011	985		
3164	470		1028	1009		
3337	480		1060	1054		
3363	490		1066	1055		
3412	500		1070	1059	1065	
3455	510		1089	1073		
3461	520		1096	1083		
0	530		1115	1102		
3526	540		1116	1105		
0	550		1125	1120		
0	560		1129	1127		
0	570		1132	1131		
3621	580		1135	1118		
3654	590		1150	1138		
3724	600		1166	1155		
0	610		1264	1245		
0	620		1272	1267		
0	630		1294	1284		
0	640		1295	1279		
0	650		1302	1300		
0	660		1313	1309		
0	670		1314	1307		
0	680		1326	1324		
4132	690		1329	1167		
0	700		1347	1336		
4214	710		1349	1334		
4325	720		1379	1360	1361	
4363	730		1392	1384		
0	740		1403	1398		
0	750		1406	1396		
4502	760		1417	1394	1409	
4552	770		1431	1419		
4614	780		1448	1434	1435	
4667	790		1470	357	379	955
6745	800	FMT	1473	833		
6767	810	FMT	1476	834		
6776	820	FMT	1477	1088		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
321	170	I	408 436	116B	NOT INNER
404	160	JX	429 435	30B	OPT
443	180	I	441 443	6B	INSTACK
461	190	I	446 448	5B	INSTACK
534	210	IJ	466 468	13B	OPT
1036	260	JRAD	544 555	46B	NOT INNER
1052	250	IRR	548 553	23B	OPT
1332	300	II	657 661	10B	EXT REFS

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
1713	340	ISIX	757 760	17B	OPT
2366	390	L	873 876	14B	OPT
3033	440	JI	998 1000	47B	EXT REFS
3505	530	I	1108 1115	20B	OPT
3536	550	JJ	1120 1125	30B	OPT
3573	560	JJ	1127 1129	12B	INSTACK
3612	570	JJ	1131 1132	6B	INSTACK
3750	610	I	1245 1264	33B	OPT
4005	620	I	1267 1272	6B	INSTACK
4017	640	IK	1279 1295	32B	NOT INNER
4023	630	JJ	1284 1294	23B	OPT
4053	650	JJ	1300 1302	7B	INSTACK
4066	670	IK	1307 1314	25B	NOT INNER
4072	660	JJ	1309 1313	16B	OPT
4121	680	JJ	1324 1326	10B	INSTACK
4141	700	IJ	1336 1347	52B	EXT REFS
4367	750	IJ	1396 1406	42B	NOT INNER
4373	740	I	1398 1403	23B	OPT

COMMON BLOCKS	LENGTH	
DESNBL	4736	LCM
PNTPNL	71	
POINT	199	
REALS	392	
INTEG	24	
INPTR	1393	
INPTI	197	
EMFLGS	10	
PFRCS2	22	
MATCNS	12	
LACMDL	21	
VER	1	
PHYPRO	11	
PFCMI2	39	
GRSPTR	38	
AXL	4	
LIMITS	62	
BA	86	
FAST	1	

STATISTICS

PROGRAM LENGTH	7456B	3886
SCM LABELED COMMON LENGTH	5027B	2563
LCM LABELED COMMON LENGTH	11200B	4736

140000B SCM USED

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      SUBROUTINE FRAIL (ASTRAN,ASTRES,CESIUM,CESUMO,CRAKI,CTHICK,CTMAX,D  FRAL     2
     +ELTAT,DOXIDE,ESR,FREQ,HSTRAN,HSTRES,HSTRSO,HYDRO,ICDOFF,ICLAPS,IFB  FRAL     3
     +SN,IODINE,IODINO,ISTOFF,NFROD,NPCYCL,PSR,STRANR,RSTRAN,TCLAD,TCLAD  FRAL     4
     +O,TCOOL,TFLIF,TGRID,TIMEF,TIMES,UBFS,UCFC,UMELT,UOFD,ZRNI,CDAMAG,C  FRAL     5
     +RAKL,FB,FDAMAG,MODE,NFAIL,PFB,PFR)                                  FRAL     6
C                                                                         FRAL     7
C     IMPLICIT REAL*8(A-H,O-Z)                                            FRAL     8
C                                                                         FRAL     9
C     SUBROUTINE FRAIL PREDICTS THE NUMBER OF FUEL RODS THAT WILL FAIL    FRAL    10
C     BECAUSE OF MELTING, WALL THINNING DUE TO GROWTH OF OXIDE LAYER,     FRAL    11
C     BALLOONING, COLLAPSING, BRITTLE FRACTURE, DUCTILE FRACTURE,         FRAL    12
C     FATIGUE FAILURE AND STRESS-RUPTURE FAILURE                          FRAL    13
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                            FRAL    14
C                                                                         FRAL    15
C                                                                         FRAL    16
C     --  INPUT ARGUMENTS  --                                             FRAL    17
C                                                                         FRAL    18
C     ASTRAN     ENGINEERING CLADDING AXIAL STRAIN                      FRAL    19
C     ASTRES     ENGINEERING CLADDING AXIAL STRESS ( N/M2 )             FRAL    20
C     CESIUM     CLAD CESIUM CONTENT ( KG/M2 )                          FRAL    21
C     CESUMO     CLAD CESIUM CONTENT IN PREVIOUS TIMESTEP ( KG/M2 )     FRAL    22
C     CRAKI      INITIAL CRACK LENGTH THROUGH CLADDING ( M )            FRAL    23
C     CTHICK     CURRENT CLADDING THICKNESS                             FRAL    24
C     CTMAX      PREVIOUS MAXIMUM CLAD TEMPERATURE ( DEG K )            FRAL    25
C     DELTAT     TIMESTEP LENGTH ( SEC )                                FRAL    26
C     DOXIDE     DEPTH OF OXIDE LAYER ( PER CENT OF CLAD THICKNESS )    FRAL    27
C     ESR        ELASTIC STRAIN RANGE                                   FRAL    28
C     FREQ       FREQUENCY OF POWER CYCLE ( SEC-1 )                     FRAL    29
C     HSTRAN     ENGINEERING HOOP STRAIN                                FRAL    30
C     HSTRES     ENGINEERING HOOP STRESS ( N/M2 )                       FRAL    31
C     HSTRSO     HOOP STRESS IN THE PREVIOUS TIMESTEP ( N/M2 )          FRAL    32
C     HYDRO      CLADDING HYDROGEN CONTENT ( PPM )                      FRAL    33
C     ICDOFF     SWITCH CONTROLLING CUMULATIVE DAMAGE ROUTINE           FRAL    34
C     = 0, TURN ON ROUTINE                                              FRAL    35
C     = 1, TURN OFF ROUTINE                                             FRAL    36
C     ICLAPS     COLLAPSE INDICATOR                                     FRAL    37
C     = 0, NO COLLAPSE                                                  FRAL    38
C     = 1, COLLAPSE                                                     FRAL    39
C     IFBSW      FLOW BLOCKAGE SWITCH                                   FRAL    40
C     = 0, FLOW BLOCKAGE ROUTINE NOT USED                               FRAL    41
C     = 1, FLOW BLOCKAGE ROUTINE ONLY (NO OTHER FAILURE                 FRAL    42
C     MODES ARE CONSIDERED)                                             FRAL    43
C     = 2, FLOW BLOCKAGE ROUTINE NOT USED, BFRAC2 USED                  FRAL    44
C     IODINE     CLAD IODINE CONTENT ( KG/M2 )                          FRAL    45
C     IODINO     CLAD IODINE CONTENT IN PREVIOUS TIMESTEP ( KG/M2 )     FRAL    46
C     ISTOFF     SWITCH CONTROLLING OVERSTRAIN FAILURE                  FRAL    47
C     = 0, STRAIN FAILURE ROUTINE SKIPPED                               FRAL    48
C     = 1, STRAIN FAILURE ROUTINE USED                                  FRAL    49
C     NFROD      NUMBER OF FUEL RODS IN SYSTEM                          FRAL    50
C     NPCYCL     NUMBER OF PREVIOUS POWER CYCLES                        FRAL    51
C     PSR        PLASTIC STRAIN RANGE                                   FRAL    52
C     RSTRAN     STRAIN RATE  (SEC-1)                                   FRAL    53
C     STRANR     ENGINEERING RADIAL STRAIN                              FRAL    54
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      C   TCLAD       CLADDING TEMPERATURE ( DEG K )                                    FRAL       55
      C     TCLADO      CLAD TEMPERATURE IN PREVIOUS TIMESTEP ( DEG K )                 FRAL       56
      C   TCOOL       COOLANT TEMPERATURE ( DEG K )                                     FRAL       57
      C   TFLIF       TRANSITION FATIGUE LIFE ( CYCLES )                                FRAL       58
      C   TGRID       TEMPERATURE OF CLADDING AT SPACER GRID ( DEG K )                  FRAL       59
      C   TIMEF       TIME AT FLUX ( SEC )                                              FRAL       60
      C   TIMES       TIME AT STRESS LEVEL ( SEC )                                      FRAL       61
      C   UBFS        USER BALLOON FAILURE STRAIN                                       FRAL       62
      C   UCFC        USER COLLAPSE FAILURE CRITERIA                                    FRAL       63
      C   = 0,  COLLAPSE NOT CONSIDERED FAILURE                                         FRAL       64
      C   = 1,  COLLAPSE IS CONSIDERED FAILURE                                         FRAL       65
      C   UMELT       USER MELT TEMPERATURE ( DEG K )                                   FRAL       66
      C   UOFD        USER OXIDE FAILURE DEPTH ( PER CENT OF CLAD THICKNESS)            FRAL       67
      C   ZRNI        ZIRC-NICKEL EUTECTIC MELT TEMPERATURE ( DEG K )                   FRAL       68
      C                                                                                 FRAL       69
      C                                                                                 FRAL       70
      C   --  OUTPUT ARGUMENTS  --                                                      FRAL       71
      C                                                                                 FRAL       72
      C                                                                                 FRAL       73
      C   CDAMAG      STRESS-RUPTURE DAMAGE                                             FRAL       74
      C   CRAKL       CRACK LENGTH THROUGH CLAD THICKNESS ( M )                         FRAL       75
      C   FB          ARRAY OF FLOW BLOCKAGE PREDICTIONS(FRACTIONAL VALUES)             FRAL       76
      C   FDAMAG      FATIGUE DAMAGE                                                    FRAL       77
      C   MODE        MODE OF FAILURE                                                   FRAL       78
      C   = 1, CLADDING MELT                                                           FRAL       79
      C   = 2, EUTECTIC MELT                                                          FRAL       80
      C   = 3, OXIDE LAYER WALL THINNING                                              FRAL       81
      C   = 4, BALLOONING                                                            FRAL       82
      C   = 5, COLLAPSE                                                             FRAL       83
      C   = 6, BRITTLE FRACTURE, FATIGUE AND STRESS-RUPTURE                         FRAL       84
      C   = 7, DUCTILE FRACTURE, FATIGUE AND STRESS-RUPTURE                         FRAL       85
      C   = 8, CUMULATIVE DAMAGE, FATIGUE AND STRESS RUPTURE                        FRAL       86
      C   = 9, BFRAC2 FAILURE MODE                                                  FRAL       87
      C   NFAIL       NUMBER OF FAILED RODS                                         FRAL       88
      C   PFB         ARRAY CONTAINING THE PROBABILITIES OF EXCEEDING THE           FRAL       89
      C   FLOW BLOCKAGES CONTAINED IN FB (FRACTIONAL VALUES)                        FRAL       90
      C   PFR         PERCENTAGE OF RODS THAT FAIL THRU DUCTILE OR BRITTLE           FRAL       91
      C   FRACTURE                                                                  FRAL       92
      C                                                                             FRAL       93
      C                                                                             FRAL       94
      C   REAL*8 IODINE, NPCYCL, NCF                                                FRAL       95
            INTEGER UCFC                                                            FRAL       96
            REAL IODINE, IODINO, NPCYCL, NCF                                        FRAL       97
            DIMENSION FB(23), PFB(20)                                               FRAL       98
      C                                                                             FRAL       99
      C   DATA PFRO / 0.D0/, BPFR /0.D0/                                            FRAL      100
            DATA PFRO / 0.E0/, BPFR /0.E0/                                          FRAL      101
      C                                                                             FRAL      102
      C   STRESS = .707107 * DSQRT(( HSTRES - ASTRES )**2 + ASTRES**2 +             FRAL      103
      C  1          HSTRES**2 )                                                     FRAL      104
      C                                                                             FRAL      105
      C                                                                             FRAL      106
        HSTSTE = HSTRES*(1.+HSTRAN)/(1.+STRANR)                                     FRAL      107
```

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      C   HSTSTE IS EFFECTIVE TRUE HOOP STRESS                                  FRAL      108
            IF (IFBSW.EQ.1) GO TO 210                                            FRAL      109
            STRESS = .707107*SQRT((HSTRES-ASTRES)**2+ASTRES**2+HSTRES**2)        FRAL      110
110         PFR = 0.                                                             FRAL      111
      C   50  PFR = 0.D0                                                         FRAL      112
      C                                                                          FRAL      113
      C   CLADDING MELT                                                         FRAL      114
      C                                                                          FRAL      115
115         CALL MELT (TCLAD,NFROD,UMELT,MODE,NFAIL)                             FRAL      116
            IF (NFAIL.EQ.NFROD) GO TO 220                                        FRAL      117
      C                                                                          FRAL      118
      C   EUTECTIC MELT                                                         FRAL      119
      C                                                                          FRAL      120
120         IF (TCLAD.LT.ZRNI) GO TO 100                                         FRAL      121
            CALL EUMELT (DOXIDE,TCLAD,TCOOL,ZRNI,IMELT)                          FRAL      122
            IF (IMELT.EQ.0) GO TO 100                                            FRAL      123
            NFAIL = NFROD                                                        FRAL      124
            MODE = 2                                                             FRAL      125
125         GO TO 220                                                            FRAL      126
      C                                                                          FRAL      127
      C   OXIDE LAYER WALL THINNING                                             FRAL      128
      C                                                                          FRAL      129
      100   IF (DOXIDE.LT.UOFD) GO TO 110                                        FRAL      130
130         NFAIL = NFROD                                                        FRAL      131
            MODE = 3                                                             FRAL      132
            GO TO 220                                                            FRAL      133
      C                                                                          FRAL      134
      C   BALLOONING                                                            FRAL      135
135   C                                                                          FRAL      136
      110   IF (HSTRAN.LT.UBFS) GO TO 120                                        FRAL      137
            NFAIL = NFROD                                                        FRAL      138
            MODE = 4                                                             FRAL      139
            GO TO 220                                                            FRAL      140
140   C                                                                          FRAL      141
      C   COLLAPSE                                                             FRAL      142
      C                                                                          FRAL      143
      120   IF (UCFC.EQ.0) GO TO 130                                             FRAL      144
            IF (UCFC.NE.ICLAPS) GO TO 130                                        FRAL      145
145         NFAIL = NFROD                                                        FRAL      146
            MODE = 5                                                             FRAL      147
            GO TO 220                                                            FRAL      148
      C                                                                          FRAL      149
      C   OVERSTRESS FAILURE                                                    FRAL      150
150   C                                                                          FRAL      151
      130   IF (HSTRES.LT.0.E0) GO TO 140                                        FRAL      152
      C   500  IF ( HSTRES .LT. 0.D0 )  GO TO 510                               FRAL      153
            CALL BFRAC (CTMAX,DOXIDE,HSTRES,HYDRO,IODINE,STRESS,TCLAD,TIMEF,BP   FRAL      154
           +FR,HSTRAN,STRANR,HSTSTE,IFBSW)                                       FRAL      155
155         MODE = 6                                                             FRAL      156
            IF (IFBSW.EQ.2) MODE = 9                                             FRAL      157
      C                                                                          FRAL      158
      C   CUMULATIVE DAMAGE ( STRESSED CRACK )                                  FRAL      159
      C                                                                          FRAL      160
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160                 IF (ICDOFF.EQ.1) GO TO 140                                        FRAL      161
                    CALL CRAKF (CESIUM,CESUMO,CRAKI,CTHICK,DELTAT,HSTRES,HSTRSO,IODINE FRAL      162
                   +,IODINO,TCLAD,TCLADO,CUMDAM,CRAKL)                                FRAL      163
                    IF (BPFR.GT.CUMDAM) GO TO 140                                     FRAL      164
                    BPFR = CUMDAM                                                     FRAL      165
165                 MODE = 8                                                          FRAL      166
              140   CONTINUE                                                          FRAL      167
                    IF (IFBSW.EQ.2) GO TO 160                                         FRAL      168
              C                                                                       FRAL      169
              C     OVERSTRAIN FAILURE                                                FRAL      170
170           C                                                                       FRAL      171
                    IF (ISTOFF.EQ.0) GO TO 150                                        FRAL      172
                    IF (HSTRAN.LT.0.E0) GO TO 150                                     FRAL      173
              C     IF ( HSTRAN .LT. 0.D0 ) GO TO 520                                 FRAL      174
                    CALL DFRAC (CTMAX,HSTRAN,TCLAD,TIMEF,PFR)                         FRAL      175
175           150   CONTINUE                                                          FRAL      176
                    IF (PFR.GE.BPFR) GO TO 170                                        FRAL      177
              160   PFR = BPFR                                                        FRAL      178
                    GO TO 180                                                         FRAL      179
              170   MODE = 7                                                          FRAL      180
180           180   CONTINUE                                                          FRAL      181
              C                                                                       FRAL      182
              C     FATIGUE DAMAGE                                                    FRAL      183
              C                                                                       FRAL      184
              C     TFLIF = (( C1/EM ) * FREQ ** C2 ) ** C3                           FRAL      185
185                 IF (NPCYCL.GT.TFLIF) GO TO 190                                    FRAL      186
                    CALL LCFF (DOXIDE,FREQ,HYDRO,IODINE,NPCYCL,PSR,TCLAD,NCF)         FRAL      187
                    GO TO 200                                                         FRAL      188
              190   CALL HCFF (DOXIDE,ESR,FREQ,HYDRO,IODINE,NPCYCL,TCLAD,NCF)         FRAL      189
              C                                                                       FRAL      190
190           C     STRESS-RUPTURE                                                    FRAL      191
              C                                                                       FRAL      192
              200   CALL CRERUP (DOXIDE,HYDRO,IODINE,STRESS,TCLAD,TIMES,RUPTIM)       FRAL      193
              C                                                                       FRAL      194
              C                                                                       FRAL      195
195                 CDAMAG = CDAMAG+DELTAT/RUPTIM                                     FRAL      196
                    FDAMAG = FDAMAG+NPCYCL/NCF                                        FRAL      197
              C                                                                       FRAL      198
                    IF (PFRO.GT.PFR) PFR = PFRO                                       FRAL      199
                    PFRO = PFR                                                        FRAL      200
200                 NFAIL = NFROD*(PFR+CDAMAG+FDAMAG-PFR*CDAMAG-PFR*FDAMAG-CDAMAG*FDAM FRAL      201
                   +AG+PFR*CDAMAG*FDAMAG)                                             FRAL      202
                    GO TO 220                                                         FRAL      203
              C                                                                       FRAL      204
              C     CALCULATE FLOW BLOCKAGE                                           FRAL      205
205           C                                                                       FRAL      206
              210   CALL FLOBLK (TCLAD,HSTRES,FB,PFB,PFR)                             FRAL      207
                    NFAIL = NFROD*PFR                                                 FRAL      208
              C                                                                       FRAL      209
              C                                                                       FRAL      210
210           220   RETURN                                                            FRAL      211
                    END                                                               FRAL      212
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FRAIL 1 210

VARIABLES	SN	TYPE		RELOCATION									
0	ASTRAN	REAL	*UNUSED	F.P.	DEFINED	1							
0	ASTRES	REAL		F.P.	REFS	2*109	DEFINED	1					
510	BPFR	REAL			REFS	153	163	176	177	DEFINED	100	164	
0	CDAMAG	REAL		F.P.	REFS	195	4*200	DEFINED	1	195			
0	CESIUM	REAL		F.P.	REFS	161	DEFINED	1					
0	CESUMO	REAL		F.P.	REFS	161	DEFINED	1					
0	CRAKI	REAL		F.P.	REFS	161	DEFINED	1					
0	CRAKL	REAL		F.P.	REFS	161	DEFINED	1					
0	CTHICK	REAL		F.P.	REFS	161	DEFINED	1					
0	CTMAX	REAL		F.P.	REFS	153	174	DEFINED	1				
517	CUMDAM	REAL			REFS	161	163	164					
0	DELTAT	REAL		F.P.	REFS	161	195	DEFINED	1				
0	DOXIDE	REAL		F.P.	REFS	121	129	153	186	188	192		
					DEFINED	1							
0	ESR	REAL		F.P.	REFS	188	DEFINED	1					
0	FB	REAL	ARRAY	F.P.	REFS	97	206	DEFINED	1				
0	FDAMAG	REAL		F.P.	REFS	196	4*200	DEFINED	1	196			
0	FREQ	REAL		F.P.	REFS	186	188	DEFINED	1				
0	HSTRAN	REAL		F.P.	REFS	106	136	153	172	174			
					DEFINED	1							
0	HSTRES	REAL		F.P.	REFS	106	2*109	151	153	161	206		
					DEFINED	1							
0	HSTRSO	REAL		F.P.	REFS	161	DEFINED	1					
514	HSTSTE	REAL			REFS	153	DEFINED	106					
0	HYDRO	REAL		F.P.	REFS	153	186	188	192	DEFINED	1		
0	ICDOFF	INTEGER		F.P.	REFS	160	DEFINED	1					
0	ICLAPS	INTEGER		F.P.	REFS	144	DEFINED	1					
0	IFBSW	INTEGER		F.P.	REFS	108	153	156	167	DEFINED	1		
516	IMELT	INTEGER			REFS	121	122						
0	IODINE	REAL		F.P.	REFS	96	153	161	186	188	192		
					DEFINED	1							
0	IODINO	REAL		F.P.	REFS	96	161	DEFINED	1				
0	ISTOFF	INTEGER		F.P.	REFS	171	DEFINED	1					
0	MODE	INTEGER		F.P.	REFS	115	DEFINED	1	124	131	138	146	
					155	156	165	179					
513	NCF	REAL			REFS	96	186	188	196				
0	NFAIL	INTEGER		F.P.	REFS	115	116	DEFINED	1	123	130	137	
					145	200	207						
0	NFROD	INTEGER		F.P.	REFS	115	116	123	130	137	145	200	
					207	DEFINED	1						
0	NPCYCL	REAL		F.P.	REFS	96	185	186	188	196			
					DEFINED	1							
0	PFB	REAL	ARRAY	F.P.	REFS	97	206	DEFINED	1				
0	PFR	REAL		F.P.	REFS	174	176	198	199	4*200	206	207	
					DEFINED	1	110	177	198				
507	PFRO	REAL			REFS	2*198	DEFINED	100	199				

VARIABLES	SN	TYPE	RELOCATION									
0	PSR	REAL		F.P.	REFS	186	DEFINED	1				
0	RSTRAN	REAL	*UNUSED	F.P.	DEFINED	1						
520	RUPTIM	REAL			REFS	192	195					
0	STRANR	REAL		F.P.	REFS	106	153	DEFINED	1			
515	STRESS	REAL			REFS	153	192	DEFINED	109			
0	TCLAD	REAL		F.P.	REFS	115	120	121	153	161	174	186
					188	192	206	DEFINED	1			
0	TCLALO	REAL		F.P.	REFS	161	DEFINED	1				
0	TCOOL	REAL		F.P.	REFS	121	DEFINED	1				
0	TFLIF	REAL		F.P.	REFS	185	DEFINED	1				
0	TGRID	REAL	*UNUSED	F.P.	DEFINED	1						
0	TIMEF	REAL		F.P.	REFS	153	174	DEFINED	1			
0	TIMES	REAL		F.P.	REFS	192	DEFINED	1				
0	UBFS	REAL		F.P.	REFS	136	DEFINED	1				
0	UCFC	INTEGER		F.P.	REFS	95	143	144	DEFINED	1		
0	UMELT	REAL		F.P.	REFS	115	DEFINED	1				
0	UOFD	REAL		F.P.	REFS	129	DEFINED	1				
0	ZRNI	REAL		F.P.	REFS	120	121	DEFINED	1			

EXTERNALS	TYPE	ARGS	REFERENCES
BFRAC		13	153
CRAKF		13	161
CRERUP		7	192
DFRAC		5	174
EUMELT		5	121
FLOBLK		5	206
HCFF		8	188
LCFF		8	186
MELT		5	115
SQRT	REAL	1 LIBRARY	109

STATEMENT LABELS		DEF LINE	REFERENCES					
71	100	129	120	122				
103	110	136	129					
115	120	143	136					
131	130	151	143	144				
216	140	166	151	160	163			
237	150	175	171	172				
243	160	177	167					
247	170	179	176					
252	180	180	178					
272	190	188	185					
306	200	192	187					
350	210	206	108					
365	220	210	116	125	132	139	147	202

STATISTICS
PROGRAM LENGTH 521B 337
140000B SCM USED

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      SUBROUTINE FSIGT (CTMAX,HSTRES,TCLAD,TIMEF,BPFR,HSTRAN,STRANR,HSTS  FSIG     2
     +TE,IFBSW)                                                           FSIG     3
C                                                                         FSIG     4
C     IMPLICIT REAL*8(A-H,O-Z)                                            FSIG     5
C     REAL*4   X, EGAMMA, ENETA, P, D                                     FSIG     6
C                                                                         FSIG     7
C     SUBROUTINE FSIGT DETERMINES THE PROBABILITY OF FAILURE DUE TO       FSIG     8
C     OVERSTRESS AS A FUNCTION OF TEMPERATURE.  THE STRESS AT FAILURE     FSIG     9
C     IS ASSUMED TO BE DISTRIBUTED ACCORDING TO THE BETA DISTRIBUTION.    FSIG    10
C     THE UPPER AND LOWER LIMITS ARE SET AT +3 STANDARD DEVIATIONS AND    FSIG    11
C     -2 STANDARD DEVIATIONS, RESPECTIVELY, FROM THE MEAN FAILURE         FSIG    12
C     STRESS( LOG SCALE ).                                                FSIG    13
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                            FSIG    14
C                                                                         FSIG    15
C                                                                         FSIG    16
C     --  INPUT ARGUMENTS  --                                             FSIG    17
C                                                                         FSIG    18
C     CTMAX      PREVIOUS MAXIMUM CLAD TEMPERATURE ( DEG K )              FSIG    19
C     HSTRES     ENGINEERING HOOP STRESS ( N/M2 )                         FSIG    20
C     TCLAD      CLADDING TEMPERATURE ( DEG K )                           FSIG    21
C     TIMEF      TIME AT FLUX ( SEC )                                     FSIG    22
C                                                                         FSIG    23
C                                                                         FSIG    24
C     -- OUTPUT ARGUMENTS  --                                            FSIG    25
C                                                                         FSIG    26
C     BPFR       PERCENTAGE OF FUEL RODS THAT FAIL BY OVERSTRESS          FSIG    27
C                                                                         FSIG    28
C                                                                         FSIG    29
C                                                                         MATCNS   2
C     THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES         MATCNS   3
C     USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM                       MATCNS   4
C                                                                         MATCNS   5
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX       MATCNS   6
     +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTMELT ,RSTRAN     MATCNS   7
C                                                                         MATCNS   8
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST       MATCNS   9
C     (HOOP STRAIN)/(RADIAL STRAIN)                                       MATCNS  10
C     COMP   - PUO2 CONTENT (WT%)                                         MATCNS  11
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)   MATCNS  12
C     CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT          MATCNS  13
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED        MATCNS  14
C     CLADDING     (KG OXYGEN/KG ZIRCALOY)                                MATCNS  15
C     FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                            MATCNS  16
C     FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)   MATCNS  17
C     FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT       MATCNS  18
C     FOTMTL - FUEL OXYGEN TO METAL RAITO                                 MATCNS  19
C     FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)           MATCNS  20
C     FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                 MATCNS  21
C     RSTRAN - TRUE STRAIN RATE (1/SEC)                                   MATCNS  22
C                                                                         MATCNS  23
C                                                                         MATCNS  24
C                                                                         FSIG    31
      DATA ENETA, EGAMMA / 3.0E0, 2.0E0 /                                 FSIG    32
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```
                DELTMP = 50.0                                                    FSIG      33
55          C                                                                    FSIG      34
                CINWID = 6.34E-04                                                FSIG      35
                CINRAD = 5.143E-03                                               FSIG      36
                CDPRES = HSTRES*CINWID/CINRAD                                    FSIG      37
                CAXRAD = 1.0E+03                                                 FSIG      38
60              CAXSTR = 1.0E+10                                                 FSIG      39
            C   CINWID AND CINRAD VALUES ARE NOT RELEVENT WHEN CAXRAD             FSIG      40
            C   IS GREATER THAN 10.   SEE CMLIMT LISTING                        FSIG      41
                CALL CMLIMT (TCLAD,DELOXY,FNCK,FNCN,CWKF,CWNF,CINWID,CINRAD,CDPRES FSIG      42
               +,CAXRAD,CAXSTR,RSTRAN,DELTMP,STRNYT,STRNYE,STRNJE,STRNIE,STSRPT,ST FSIG      43
65             +RRPE,CYLDST,CYLDSE,CULTSE,CBRSTE,CBRSST,CTSTRT)                  FSIG      44
                FSTRES = CBRSST                                                  FSIG      45
                DEV = 0.2*FSTRES                                                 FSIG      46
                TLIMIT = FSTRES+3.*DEV                                           FSIG      47
                BLIMIT = FSTRES-2.*DEV                                           FSIG      48
70              IF (BLIMIT.LT.0.) BLIMIT = 0.E0                                  FSIG      49
            C   IF ( BLIMIT .LT. 0.D0 ) BLIMIT = 0.D0                            FSIG      50
                X = (HSTSTE-BLIMIT)/(TLIMIT-BLIMIT)                              FSIG      51
                CALL BDTR (X,EGAMMA,ENETA,P,D,IER)                               FSIG      52
                BPFR = P                                                         FSIG      53
75              RETURN                                                           FSIG      54
                END                                                              FSIG      55
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FSIGT	1	75

VARIABLES

		SN	TYPE		RELOCATION							
0	ANRIN		REAL		MATCNS	REFS	33					
157	BLIMIT		REAL			REFS	70	2*72	DEFINED	69	70	
0	BPFR		REAL		F.P.	DEFINED	1	74				
136	CAXRAD		REAL			REFS	63	DEFINED	59			
137	CAXSTR		REAL			REFS	63	DEFINED	60			
152	CBRSST		REAL			REFS	63	66				
151	CBRSTE	*	REAL			REFS	63					
135	CDPRES		REAL			REFS	63	DEFINED	58			
134	CINRAD		REAL			REFS	58	63	DEFINED	57		
133	CINWID		REAL			REFS	58	63	DEFINED	56		
1	COMP		REAL		MATCNS	REFS	33					
0	CTMAX		REAL	*UNUSED	F.P.	DEFINED	1					
153	CTSTRT	*	REAL			REFS	63					
150	CULTSE	*	REAL			REFS	63					
2	CWKF		REAL		MATCNS	REFS	33	63				
3	CWNF		REAL		MATCNS	REFS	33	63				
147	CYLDSE	*	REAL			REFS	63					
146	CYLDST	*	REAL			REFS	63					
162	D	*	REAL			REFS	73					

VARIABLES	SN	TYPE	RELOCATION							
4	DELOXY	REAL		MATCNS	REFS	33	63			
132	DELTMP	REAL			REFS	63	DEFINED	54		
155	DEV	REAL			REFS	68	69	DEFINED	67	
121	EGAMMA	REAL			REFS	73	DEFINED	53		
120	ENETA	REAL			REFS	73	DEFINED	53		
5	FLUX	REAL		MATCNS	REFS	33				
6	FNCK	REAL		MATCNS	REFS	33	63			
7	FNCN	REAL		MATCNS	REFS	33	63			
10	FOTMTL	REAL		MATCNS	REFS	33				
11	FRDEN	REAL		MATCNS	REFS	33				
154	FSTRES	REAL			REFS	67	68	69	DEFINED	66
12	FTMELT	REAL		MATCNS	REFS	33				
0	HSTRAN	REAL	*UNUSED	F.P.	DEFINED	1				
0	HSTRES	REAL		F.P.	REFS	58	DEFINED	1		
0	HSTSTE	REAL		F.P.	REFS	72	DEFINED	1		
163	IER	* INTEGER			REFS	73				
0	IFBSW	INTEGER	*UNUSED	F.P.	DEFINED	1				
161	P	REAL			REFS	73	74			
13	RSTRAN	REAL		MATCNS	REFS	33	63			
0	STRANR	REAL	*UNUSED	F.P.	DEFINED	1				
143	STRNIE	* REAL			REFS	63				
142	STRNUE	* REAL			REFS	63				
141	STRNYE	* REAL			REFS	63				
140	STRNYT	* REAL			REFS	63				
145	STRRPE	* REAL			REFS	63				
144	STSRPT	* REAL			REFS	63				
0	TCLAD	REAL		F.P.	REFS	63	DEFINED	1		
0	TIMEF	REAL	*UNUSED	F.P.	DEFINED	1				
156	TLIMIT	REAL			REFS	72	DEFINED	68		
160	X	REAL			REFS	73	DEFINED	72		

EXTERNALS	TYPE	ARGS	REFERENCES
BDTR		6	73
CMLIMT		25	63

COMMON BLOCKS	LENGTH
MATCNS	12

STATISTICS

PROGRAM LENGTH	164B	116
SCM LABELED COMMON LENGTH	14B	12

140000B SCM USED

```
      SUBROUTINE FSTEMP (CTMAX,HSTRAN,TCLAD,PFR)                        FSTP       2
C                                                                       MATCNS     2
C     THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES       MATCNS     3
C     USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM                     MATCNS     4
C                                                                       MATCNS     5
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX     MATCNS     6
     +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTMELT ,RSTRAN   MATCNS     7
C                                                                       MATCNS     8
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST     MATCNS     9
C     (HOOP STRAIN)/(RADIAL STRAIN)                                     MATCNS    10
C     COMP   - PUO2 CONTENT (WT%)                                       MATCNS    11
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2) MATCNS    12
C     CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT        MATCNS    13
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED      MATCNS    14
C              CLADDING     (KG OXYGEN/KG ZIRCALOY)                     MATCNS    15
C     FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                          MATCNS    16
C     FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2) MATCNS    17
C     FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT     MATCNS    18
C     FOTMTL - FUEL OXYGEN TO METAL RAITO                               MATCNS    19
C     FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)         MATCNS    20
C     FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)               MATCNS    21
C     RSTRAN - TRUE STRAIN RATE (1/SEC)                                 MATCNS    22
C                                                                       MATCNS    23
C                                                                       MATCNS    24
C                                                                       FSTP       4
C     SUBROUTINE FSTEMP DETERMINES THE PROBABILITY OF FAILURE FOR AN    FSTP       5
C     OVERSTRAINED FUEL ROD.  THE STRAIN AT FAILURE IS CALCULATED IN    FSTP       6
C     A MATPRO SUBROUTINE (CSRUPT) AS A FUNCTION OF TEMPERATURE,        FSTP       7
C     FLUENCE AND COLDWORK.  THE FAILURE STRAIN IS ASSUMED TO BE        FSTP       8
C     DISTRIBUTED ACCORDING TO THE BETA DISTRIBUTION.  THE UPPER AND    FSTP       9
C     LOWER LIMITS OF THE DISTRIBUTION ARE FUNCTIONS OF TEMPERATURE     FSTP      10
C     AND ARE CHOSEN TO INCLUDE ALL THE DATA.  THESE LIMITS ARE         FSTP      11
C     MODIFIED TO ACCOUNT FOR FLUENCE AND COLDWORK BY USING THE P AND   FSTP      12
C     Q VALUES CALCULATED IN CSRUPT.                                    FSTP      13
C                                                                       FSTP      14
      DATA EGAMMA, ENETA /2.026E0, 2.252E0 /                            FSTP      15
C                                                                       FSTP      16
C                                                                       FSTP      17
C     OBTAIN STRAIN AT FAILURE                                          FSTP      18
C                                                                       FSTP      19
      DELTMP = 50.0                                                     FSTP      20
      CALL CSRUPT (TCLAD,FNCN,CWNF,DELTMP,STRRPE,USTRPE,STRRPT,USTRTP,US FSTP      21
     +TRTN)                                                             FSTP      22
      STRNOR = HSTRAN/STRRPE                                            FSTP      23
      IF (TCLAD.GT.1090.) GO TO 120                                     FSTP      24
      BL = 6.33E-5*TCLAD+.201                                           FSTP      25
      TL = 1.530E-3*TCLAD+2.2E-3                                        FSTP      26
      IF (TCLAD.LE.260.) TL = .40                                       FSTP      27
      IF (CTMAX.GT.850.) GO TO 150                                      FSTP      28
      P = (EXP(-2.1E1*CWNF)+3.3E-1)/1.33                                FSTP      29
      Q = (1.00+2.00*EXP(-FNCN/1.00E+23))/3.00                          FSTP      30
      IF (CTMAX.LT.620.) GO TO 110                                      FSTP      31
      IF (CTMAX.GT.700.) GO TO 100                                      FSTP      32
```

```
                Q = Q*((700.-CTMAX)/8.00E1)+CTMAX/8.00E1-7.75                    FSTP      33
55              GO TO 110                                                        FSTP      34
          100   Q = 1.00                                                         FSTP      35
                IF (CTMAX.LT.775.) GO TO 110                                     FSTP      36
                P = P*((8.50E2-CTMAX)/7.5E1)+(CTMAX-7.75E2)/7.5E1                FSTP      37
          110   BL = BL*P*Q                                                      FSTP      38
60              TL = TL*P*Q                                                      FSTP      39
                GO TO 150                                                        FSTP      40
          120   IF (TCLAD.GT.1170.) GO TO 130                                    FSTP      41
                TL = -1.40E-2*TCLAD+16.93                                        FSTP      42
                BL = -2.875E-3*TCLAD+3.404                                       FSTP      43
65              GO TO 150                                                        FSTP      44
          130   IF (TCLAD.GT.1600.) GO TO 140                                    FSTP      45
                TL = 6.92[illegible]E-4*TCLAD-[illegible]866[illegible]-1        FSTP      46
                BL = 3.344E-4*TCLAD-3.5[illegible]F-1                            FSTP      47
                GO TO 150                                                        FSTP      48
70        140   TL = .82                                                         FSTP      49
                BL = .1[illegible]4                                              FSTP      50
          150   IF (BL.LT.0.E0) BL = 0.E0                                        FSTP      51
          C                                                                      FSTP      52
          C   NORMALIZE STRAIN TO UPPER AND LOWER LIMITS ( TL, BL )              FSTP      53
75        C   AND CALCULATE FAILURE PROBABILITY                                 FSTP      54
          C                                                                      FSTP      55
                X = (HSTRAN-BL)/(TL-BL)                                          FSTP      56
                CALL BDT[illegible] (X,EGAMMA,ENETA,P,D,IER)                     FSTP      57
                PFR = P                                                          FSTP      58
80        C                                                                      FSTP      59
          C                                                                      FSTP      60
                RETURN                                                           FSTP      61
                END                                                              FSTP      62
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FSTEMP	1	82

VARIABLES

		SN	TYPE	RELOCATION								
0	ANRIN		REAL	MATCNS	REFS	6						
272	BL		REAL		REFS	59	72	2*77	DEFINED	46	59	64
						68	71	72				
1	COMP		REAL	MATCNS	REFS	6						
0	CTMAX		REAL	F.P.	REFS	49	52	53	2*54	57	2*58	
					DEFINED	1						
2	CWKF		REAL	MATCNS	REFS	6						
3	CWNF		REAL	MATCNS	REFS	6	42	50				
277	D	*	REAL		REFS	78						
4	DELOXY		REAL	MATCNS	REFS	6						
263	DELTMP		REAL		REFS	42	DEFINED	41				
217	EGAMMA		REAL		REFS	78	DEFINED	36				

VARIABLES	SN	TYPE	RELOCATION							
220 ENETA		REAL		REFS	78	DEFINED	36			
5 FLUX		REAL	MATCNS	REFS	6					
6 FNCK		REAL	MATCNS	REFS	6					
7 FNCN		REAL	MATCNS	REFS	6	42	51			
10 FOTMTL		REAL	MATCNS	REFS	6					
11 FRDEN		REAL	MATCNS	REFS	6					
12 FTMELT		REAL	MATCNS	REFS	6					
0 HSTRAN		REAL	F.P.	REFS	44	77	DEFINED	1		
300 IER	*	INTEGER		REFS	78					
274 P		REAL		REFS	58	59	60	78	79	
				DEFINED	50	58				
0 PFR		REAL	F.P.	DEFINED	1	79				
275 Q		REAL		REFS	54	59	60	DEFINED	51	54 56
13 RSTRAN		REAL	MATCNS	REFS	6					
271 STRNOR	*	REAL		DEFINED	44					
264 STRRPE		REAL		REFS	42	44				
266 STRRPT	*	REAL		REFS	42					
0 TCLAD		REAL	F.P.	REFS	42	45	46	47	48	62 63
				64	66	67	68	DEFINED	1	
273 TL		REAL		REFS	60	77	DEFINED	47	48	60 63
				67	70					
265 USTRPE	*	REAL		REFS	42					
270 USTRTN	*	REAL		REFS	42					
267 USTRTP	*	REAL		REFS	42					
276 X		REAL		REFS	78	DEFINED	77			

EXTERNALS	TYPE	ARGS		REFERENCES		
BDTR		6		78		
CSRUPT		2		42		
EXP	REAL	1	LIBRARY	50	51	

STATEMENT LABELS		DEF LINE	REFERENCES			
75	100	56	53			
111	110	59	52	55	57	
121	120	62	45			
136	130	66	62			
153	140	70	66			
160	150	72	49	61	65	69

COMMON BLOCKS	LENGTH
MATCNS	12

STATISTICS

PROGRAM LENGTH	301B	193
SCM LABELED COMMON LENGTH	14B	12

140000B SCM USED

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      SUBROUTINE FSTRS (TCLAD,DEV,FSTRES)                                FSTR      2
C                                                                        FSTR      3
C     IMPLICIT REAL*8                                                    FSTR      4
C                                                                        FSTR      5
C     SUBROUTINE FSTRS CALCULATES THE FAILURE STRESS AND STANDARD        FSTR      6
C     DEVIATION AS A FUNCTION OF TEMPERATURE                             FSTR      7
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                           FSTR      8
C                                                                        FSTR      9
C                                                                        FSTR     10
C     --  INPUT ARGUMENTS  --                                            FSTR     11
C                                                                        FSTR     12
C     TCLAD      CLADDING TEMPERATURE ( DEG K )                        FSTR     13
C                                                                        FSTR     14
C                                                                        FSTR     15
C     -- OUTPUT ARGUMENTS  --                                           FSTR     16
C                                                                        FSTR     17
C     DEV        STANDARD DEVIATION ( N/M2 )                           FSTR     18
C     FSTRES     MEAN FAILURE STRESS ( N/M2 )                          FSTR     19
C                                                                        FSTR     20
C                                                                        FSTR     21
C     THE FAILURE STRESS IS FOUND FROM A POLYNOMIAL LEAST-SQUARES        FSTR     22
C     FIT OF DATA FROM THE FOLLOWING REFERENCES                          FSTR     23
C                                                                        FSTR     24
C     (1) CC BUSBY AND KB MARSH, WAPD-TM-900, HIGH TEMPERATURE           FSTR     25
C     DEFORMATION AND BURST CHARACTERISTICS OF RECRYSTALLIZED            FSTR     26
C     ZIRCALOY-4 TUBING, JANUARY 1970.                                   FSTR     27
C                                                                        FSTR     28
C     (2) DO HOBSON AND PL RITTENHOUSE, ORNL-4727, DEFORMATION AND       FSTR     29
C     RUPTURE BEHAVIOR OF LIGHT WATER REACTOR FUEL CLADDING,             FSTR     30
C     OCTOBER 1971.                                                      FSTR     31
C                                                                        FSTR     32
C     (3) MF OSBORNE AND GW PARKER, ORNL-3626, THE EFFECT OF             FSTR     33
C     IRRADIATION ON THE FAILURE OF ZIRCALOY-CLAD FUEL RODS,             FSTR     34
C     JANUARY 1972.                                                      FSTR     35
C                                                                        FSTR     36
C     (4) DO HOBSON, MF OSBORNE, AND GW PARKER, COMPARISON OF RUPTURE    FSTR     37
C     DATA FROM IRRADIATED FUEL RODS AND UNIRRADIATED CLADDING,          FSTR     38
C     NUCLEAR TECHNOLOGY, 11, AUGUST 1971.                               FSTR     39
C                                                                        FSTR     40
C     (5) DG HARDY, ASTM-STP 484, THE EFFECT OF NEUTRON IRRADIATION      FSTR     41
C     ON THE MECHANICAL PROPERTIES OF ZIRCONIUM ALLOY FUEL               FSTR     42
C     CLADDING IN UNIAXIAL AND BIAXIAL TESTS, PP 215-218.                FSTR     43
C                                                                        FSTR     44
C     (6) WJ LANGFORD, ASTM-STP 484, METALLURGICAL PROPERTIES OF         FSTR     45
C     COLD-WORKED ZIRCALOY-2 PRESSURE TUBES IRRADIATED UNDER             FSTR     46
C     CANDU-PHW POWER REACTOR CONDITIONS, PP 259-286.                    FSTR     47
C                                                                        FSTR     48
C     (7) SAXTON CORE RESULTS, WCAP-3385-56, PP 4-84, 4-85,              FSTR     49
C     WCAP-3385-57, PP 3-69, 3-132, 3-134.                               FSTR     50
C                                                                        FSTR     51
C     (8) ASTM-STP 529, BURST TESTING OF ZIRCALOY CLADDING FROM          FSTR     52
C     IRRADIATED PICKERING-TYPE FUEL BUNDLES, PP 415-434.                FSTR     53
C                                                                        FSTR     54
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                C                                                                       FSTR       55
55              C   FSTRS WAS CODED BY J.D. KERRIGAN, APRIL 1976.                       FSTR       56
                C                                                                       FSTR       57
                      DIMENSION A(4)                                                    FSTR       58
                C                                                                       FSTR       59
                C   DATA A /5.0014769D0, .326968085D-3, -.1151662D-5, .256025754D-9/    FSTR       60
60              C   DATA STD, CONV / .132665D0, 2.302585093D0 /                         FSTR       61
                C   DATA TMIN, TMAX / .3387056D3, .16442611D4/                          FSTR       62
                C   DATA SMAX, SMIN / .7311269482D9, .2883573619D7 /                    FSTR       63
                C   DATA CONV5/ 6.8947572D3 /                                          FSTR       64
                C   DATA CONVT1, CONVT2/ .18D1, .45967D3 /                            FSTR       65
65              C                                                                       FSTR       66
                      DATA A /5.0014769E0, .326968085E-3, -.1151662E-5, .256025754E-9/  FSTR       67
                      DATA STD, CONV / .132665E0, 2.302585093E0 /                       FSTR       68
                      DATA TMIN, TMAX / .3387056E3, .16442611E4 /                       FSTR       69
                      DATA SMAX, SMIN / .7311269482E9, .2883573619E7 /                  FSTR       70
70                    DATA CONV5/ 6.8947572E3 /                                         FSTR       71
                      DATA CONVT1, CONVT2 /.18E1, .45967E3 /                            FSTR       72
                C                                                                       FSTR       73
                      IF (TCLAD.GE.TMAX) GO TO 110                                      FSTR       74
                      IF (TCLAD.LE.TMIN) GO TO 100                                      FSTR       75
75                    T = CONVT1*TCLAD-CONVT2                                           FSTR       76
                      FLOGS = A(1)+T*(A(2)+T*(A(3)+T*A(4)))                             FSTR       77
                      FSTRES = CONV5*(10.E0**FLOGS)                                     FSTR       78
                C   FSTRES = CONV5*( 10.D0 ** FLOGS )                                  FSTR       79
                      GO TO 120                                                         FSTR       80
80              100   FSTRES = SMAX                                                    FSTR       81
                      GO TO 120                                                         FSTR       82
                110   FSTRES = SMIN                                                     FSTR       83
                120   CONTINUE                                                          FSTR       84
                      DEV = STD*CONV*FSTRES                                             FSTR       85
85              C                                                                       FSTR       86
                C                                                                       FSTR       87
                      RETURN                                                            FSTR       88
                      END                                                               FSTR       89
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

SN	ENTRY POINTS	DEF LINE	REFERENCES
4	FSTRS	1	87

VARIABLES

SN	VARIABLES	TYPE	RELOCATION						
67	A	REAL	ARRAY	REFS	57	4*76	DEFINED	66	
54	CONV	REAL		REFS	84	DEFINED	67		
61	CONV5	REAL		REFS	77	DEFINED	70		
62	CONVT1	REAL		REFS	75	DEFINED	71		
63	CONVT2	REAL		REFS	75	DEFINED	71		
0	DEV	REAL	F.P.	DEFINED	1	84			
66	FLOGS	REAL		REFS	77	DEFINED	76		

VARIABLES	SN	TYPE	RELOCATION								
0	FSTRES	REAL	F.P.	REFS	84	DEFINED	1	77	80	82	
57	SMAX	REAL		REFS	80	DEFINED	69				
60	SMIN	REAL		REFS	82	DEFINED	69				
53	STD	REAL		REFS	84	DEFINED	67				
65	T	REAL		REFS	3*76	DEFINED	75				
0	TCLAD	REAL	F.P.	REFS	73	74	75	DEFINED	1		
56	TMAX	REAL		REFS	73	DEFINED	68				
55	TMIN	REAL		REFS	74	DEFINED	68				

STATEMENT LABELS		DEF LINE	REFERENCES	
34	100	80	74	
40	110	82	73	
43	120	83	79	81

STATISTICS
PROGRAM LENGTH 738 59
140000B SCM USED

```
      1                SUBROUTINE FTBNUL                                  FTBNUL      2
                      C                                                   FTBNUL      3
                      C                                                   FTBNUL      4
                       COMMON  / FAST    /  A(1)                          FTBNUL      5
      5                RETURN                                             FTBNUL      6
                       END                                                FTBNUL      7
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
2	FTBNUL	1	5

VARIABLES	SN	TYPE		RELOCATION			
0	A	REAL	ARRAY	FAST	REFS	4	

COMMON BLOCKS	LENGTH
FAST	1

STATISTICS

PROGRAM LENGTH	4B	4
SCM LABELED COMMON LENGTH	1B	1

140000B SCM USED

```
      SUBROUTINE FLUXDP (AMI,AMO,BP,BUCRIT,DELBP,DELBPP,FLXDPP,J,NA,IT,N +DBG)
C     IMPLICIT  REAL * 8 (A-H,/-Z)
C
C     ***************************************************************
C
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES THE FLUX
C     DEPRESSION.
C     FLUXDP WAS CODED BY G A BERNA IN DECEMBER 1977.
C
C     ***************************************************************
C     INPUT  ARGUMENTS
C     ***************************************************************
C
C     AMI    - SLOPE OF FLUX DEPRES VS. BURNUP AFTER BUCRIT (MWD/MTU/HR)
C     AMO    - INITIAL SLOPE OF FLUX DEPRES VS. BURNUP (MWD/MTU/HR)
C     BP     - BURNUP TO THE END OF POWER-TIME STEP (MWD/MTU)
C     BUCRIT - BURNUP AT WHICH FLUX DEPRESSION CHANGES (MWD/MTU)
C     DELBP  - CHANGE IN BURNUP (MWD/MTU)
C     DELBPP - PREVIOUS POWER-TIME STEP CHANGE IN BURNUP (MWD/MTU)
C     IT     - POWER-TIME STEP INDEX
C     J      - AXIAL NODE INDEX
C     NA     - MAXIMUM NUMBER OF AXIAL NODES
C     NDBG   - DEBUG OUTPUT INDEX
C
C     ***************************************************************
C     OUTPUT ARGUMENTS
C     ***************************************************************
C
C     FLXDPP - FLUX DEPRESSION FACTOR AT NODE J
C
C     ***************************************************************
C
      DIMENSION  FLXDPP(NA)  ,DELBPP(NA)
C
C
C     CALCULATION OF FLUX DEPRESSION FACTOR
C
      IF (BP.LE.BUCRIT) FLXDPP(J) = FLXDPP(J)+AMO*(DELBP/2.+DELBPP(J)/2. +0)
      IF (BP.GT.BUCRIT) FLXDPP(J) = FLXDPP(J)+AMI*(DELBP/2.+DELBPP(J)/2. +0)
      IF (FLXDPP(J).GT.0.9999) FLXDPP(J) = 0.9999
      IF (NDBG.EQ.IT) WRITE (6,100) AMO,AMI,DELBP,DELBPP(J),FLXDPP(J)
      DELBPP(J) = DELBP
C
      RETURN
C
100   FORMAT (//2X,4HAMO=,E11.4,2X,4HAMI=,E11.4,2X,6HDELBP=,E11.4,2X,7HD +ELBPP=,E11.4,2X,7HFLXDPP=,E11.4)
      END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FLUXDP 1 47

VARIABLES	SN	TYPE		RELOCATION								
0 AMI		REAL		F.P.	REFS	41	44	DEFINED	1			
0 AMO		REAL		F.P.	REFS	39	44	DEFINED	1			
0 BP		REAL		F.P.	REFS	39	41	DEFINED	1			
0 BUCRIT		REAL		F.P.	REFS	39	41	DEFINED	1			
0 DELBP		REAL		F.P.	REFS	39	41	44	45	DEFINED	1	
0 DELBPP		REAL	ARRAY	F.P.	REFS	34	39	41	44	DEFINED	1	45
0 FLXDPP		REAL	ARRAY	F.P.	REFS	34	39	41	43	44		
					DEFINED	1	39	41	43			
0 IT		INTEGER		F.P.	REFS	44	DEFINED	1				
0 J		INTEGER		F.P.	REFS	3*39	3*41	2*43	2*44	45		
					DEFINED	1						
0 NA		INTEGER		F.P.	REFS	2*34	DEFINED	1				
0 NDBG		INTEGER		F.P.	REFS	44	DEFINED	1				

FILE NAMES MODE
TAPE6 FMT WRITES 44

STATEMENT LABELS DEF LINE REFERENCES
70 100 FMT 49 44

STATISTICS
PROGRAM LENGTH 105B 69
140000B SCM USED

```
      SUBROUTINE GSPRES (AXLEN,DZH,HCRV,HCV,HDSHV,HFLL,HFPER,HFV,HGV,HPO GAPP      2
     +RV,IRI,IT,J,N2,NT,HPV,PIT,PRESS,RFNVFF,SUMCK,SUMDH,SUMGP,SUMPOR,SU GAPP      3
     +MRG,TAC,TAF,TAFA,TAG,TAGA,TPS,TOTL,TSF,VCHI,VCR,VDH,VFH,VGH,VPOR,G GAPP      4
     +ASMOL,TPLEN,TCA,VFF,VFC,DG,RD,DELZA,NF,NFFI,PI,MECHAN,TRTRAN,NA,ND GAPP      5
     +BG,DISH)                                                          GAPP      6
C                                                                       GAPP      7
C    IMPLICIT REAL * 8 (A-H,O-Z)                                        GAPP      8
C                                                                       GAPP      9
C    ********************************************************************** GAPP     10
C                                                                       GAPP     11
C    THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES THE ROD INTERNAL  GAPP     12
C    GAS PRESSURE                                                       GAPP     13
C    GSPRES WAS CODED BY G A BERNA IN JANUARY 1978.                     GAPP     14
C                                                                       GAPP     15
C    ********************************************************************** GAPP     16
C    INPUT ARGUMENTS                                                    GAPP     17
C    ********************************************************************** GAPP     18
C                                                                       GAPP     19
C    AXLEN  - AXIAL STRAIN DUE TO CLADDING IRRADIATION GROWTH           GAPP     20
C    DELZA  - AXIAL REGION LENGTHS                                      GAPP     21
C    DZH    - HOT NODE LENGTH (IN)                                      GAPP     22
C    HPV    - HOT PLENUM VOLUME (IN**3)                                 GAPP     23
C    IRI    - NUMBER OF AXIAL NODES PLUS ONE                            GAPP     24
C    IT     - POWER-TIME STEP INDEX                                     GAPP     25
C    J      - AXIAL NODE INDEX                                          GAPP     26
C    NA     - NUMBER OF AXIAL NODES PLUS ONE                            GAPP     27
C    N2     - AXIAL INCREMENT NUMBER                                    GAPP     28
C    NT     - NUMBER OF AXIAL INCREMENTS                                GAPP     29
C    RFNVFF - FUEL ROUGHNESS VOLUME (%)                                 GAPP     30
C    TAF    - AVERAGE PELLET TEMPERATURE (F)                            GAPP     31
C    TAG    - AVERAGE GAP TEMPERATURE (F)                               GAPP     32
C    TCA    - CLADDING AVERAGE TEMPERATURE (F)                          GAPP     33
C    TPLEN  - PLENUM TEMPERATURE (F)                                    GAPP     34
C    TOTL   - FUEL STACK HEIGHT (FT)                                    GAPP     35
C    TPS    - TEMPERATURE OF PELLET SURFACE (F)                         GAPP     36
C    TRTRAN - TEMPERATURE AT THE RESTRUCTURED RADIUS, RTRAN (F)         GAPP     37
C    VCHI   - HOT CLADDING VOLUME PER NODE (CU IN)                      GAPP     38
C    VCR    - CRACK VOLUME AT EACH AXIAL NODE (CU IN)                   GAPP     39
C    VDH    - HOT DISH VOLUME PER NODE (CU IN)                          GAPP     40
C    VFH    - HOT FUEL VOLUME PER NODE  (CU IN)                         GAPP     41
C    VGH    - HOT GAP VOLUME PER NODE (CU IN)                           GAPP     42
C    VPOR   - HOT OPEN POROSITY VOLUME (CU IN)                          GAPP     43
C                                                                       GAPP     44
C    VFC    - VOID FRACTION WITHIN CLAD - SEE RADIAL                    GAPP     45
C    VFF    - VOID FRACTION WITHIN FUEL                                 GAPP     46
C    DELZA  - AXIAL REGION LENGTHS                                      GAPP     47
C    DG     - GAP SIZE                                                  GAPP     48
C    RD     - RADII ARRAY FROM PELET                                    GAPP     49
C                                                                       GAPP     50
C    ********************************************************************** GAPP     51
C    OUTPUT ARGUMENTS                                                   GAPP     52
C    ********************************************************************** GAPP     53
C                                                                       GAPP     54
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C   GASMOL - MOLES OF GAS IN THE ROD (MOLES)                                  GAPP   55
C   HCRV   - TOTAL HOT CRACK VOLUME (IN**3)                                   GAPP   56
C   HCV    - TOTAL HOT CLAD VOLUME (IN**3)                                    GAPP   57
C   HDSHV  - TOTAL HOT DISH VOLUME (IN**3)                                    GAPP   58
C   HFLL   - MAXIMUM HOT FUEL STACK HEIGHT (IN)                               GAPP   59
C   HFPER  - INCREASE OF FUEL STACK HEIGHT (%)                                GAPP   60
C   HFV    - TOTAL HOT FUEL VOLUME (IN**3)                                    GAPP   61
C   HGV    - TOTAL HOT GAP VOLUME (IN**3)                                     GAPP   62
C   HPORV  - TOTAL HOT POROSITY VOLUME (IN**3)                                GAPP   63
C   PIT    - ROD PRESSURE (PSI)                                               GAPP   64
C   PRESS  - ROD INTERNAL GAS PRESSURE (PSIA)                                 GAPP   65
C   SUMCK  - SUM OF AXIAL CRACK VOLUMES / CRACK TEMPERATURES (IN**3/F)        GAPP   66
C   SUMDH  - SUM OF AXIAL DISH VOLUMES / DISH TEMPERATURES (IN**3/F)          GAPP   67
C   SUMGP  - SUM OF AXIAL GAP VOLUMES / GAP TEMPERATURES (IN**3/F)            GAPP   68
C   SUMPOR - SUM OF AXIAL POROSITY VOLUMES / POROSITY TEMPS (IN**3/F)         GAPP   69
C   SUMRG  - SUM OF AXIAL ROUGHNESS VOLUMES / ROUGHNESS TEMPERATURE           GAPP   70
C   TAC    - AVERAGE CLADDING TEMPERATURE AT LEVEL J (F)                      GAPP   71
C   TAFA   - RADIAL AND AXIAL FUEL AVERAGE TEMPERATURE (F,                    GAPP   72
C   TAGA   - RADIAL AND AXIAL GAP AVERAGE TEMPERATURE (F)                     GAPP   73
C   TSF    - AVERAGE FUEL SURFACE TEMPERATURE                                 GAPP   74
C                                                                             GAPP   75
C   ************************************************************************ GAPP   76
C                                                                             GAPP   77
      DIMENSION              PIT(1)   ,VPOR(1)  ,VFH(1)   ,TAG(1)            GAPP   78
     +          ,TAGA(1)  ,TAF(1)   ,VCR(1)   ,TPS(1)   ,VGH(1)            GAPP   79
     +   ,VDH(1)   ,DZH(1)   ,TAFA(1)  ,TSF(1)   ,TCA(1)   ,TAC(1)          GAPP   80
     +   ,VCHI(1)  ,AXLEN(1)                                                 GAPP   81
      DIMENSION VFF(1), VFC(1), DG(1), RD(1), DELZA(1)                        GAPP   82
      DIMENSION  TRTRAN(NA)                                                   GAPP   83
C                                                                             GAPP   84
C   CALCULATION OF CLAD , FUEL , DISH , GAP , CRACK , POROSITY VOLUMES        GAPP   85
C                                                                             GAPP   86
      HFV = 0.0                                                               GAPP   87
      HCV = 0.0                                                               GAPP   88
      HGV = 0.0                                                               GAPP   89
      HDSHV = 0.0                                                             GAPP   90
      HCRV = 0.0                                                              GAPP   91
      HPORV = 0.0                                                             GAPP   92
      HFLL = 0.0                                                              GAPP   93
      TAC(IT) = 0.0                                                           GAPP   94
      TSF(IT) = 0.0                                                           GAPP   95
      TAFA(IT) = 0.0                                                          GAPP   96
      TAGA(IT) = 0.0                                                          GAPP   97
      SUMDH = 0.0                                                             GAPP   98
      SUMGP = 0.0                                                             GAPP   99
      SUMCK = 0.0                                                             GAPP  100
      SUMRG = 0.0                                                             GAPP  101
      SUMPOR = 0.0                                                            GAPP  102
          DO 110 I=2,IRI                                                      GAPP  103
          IF (MECHAN.EQ.1) GO TO 100                                          GAPP  104
          HFV = HFV+VFH(I)                                                    GAPP  105
          HCV = HCV+VCHI(I)*(1.E0+AXLEN(I))                                   GAPP  106
          HGV = HGV+VGH(I)                                                    GAPP  107
```

```
                      HDSHV = HDSHV+VDH(I)                                          GAPP      108
                      HCRV = HCRV+VCR(I)                                            GAPP      109
                      HPORV = HPORV+VPOR(I)                                         GAPP      110
  110                 HFLL = HFLL+DZH(I)                                            GAPP      111
                      TAC(IT) = TAC(IT)+TCA(I)/(NT)                                 GAPP      112
                      TSF(IT) = TSF(IT)+TPS(I)/(NT)                                 GAPP      113
                      TAFA(IT) = TAFA(IT)+TAF(I)/(NT)                               GAPP      114
                      TAGA(IT) = TAGA(IT)+TAG(I)/(NT)                               GAPP      115
  115                 SUMDH = SUMDH+VDH(I)/(TAF(I)+460.)                            GAPP      116
                      SUMGP = SUMGP+VGH(I)/(TAG(I)+460.)                            GAPP      117
                      SUMCK = SUMCK+VCR(I)/(((TPS(I)+TRTRAN(I))/2.E0)+460.E0)       GAPP      118
                      SUMRG = SUMRG+RFNVFF*VFH(I)/(TAG(I)+460.)                     GAPP      119
                      SUMPOR = SUMPOR+VPOR(I)/(TAF(I)+460.)                         GAPP      120
  120           C                                                                   GAPP      121
                      GO TO 110                                                     GAPP      122
                100   CONTINUE                                                      GAPP      123
                C                                                                   GAPP      124
                      VRCI = RD((I-1)*NFFI+NF+1)**2*PI*DELZA(I)                     GAPP      125
  125                 VRCO = RD(I*NFFI)**2*PI*DELZA(I)                              GAPP      126
                      VRFS = (RD((I-1)*NFFI+NF+1)-DG(I))**2*PI*DELZA(I)             GAPP      127
                C                                                                   GAPP      128
                      VCHI(I) = VRCO-VRCI                                           GAPP      129
                      VFH(I) = VRFS*(1.-VFF(I)/100.)                                GAPP      130
  130                 VCR(I) = VRFS*VFF(I)/100.                                     GAPP      131
                      VC = VRCI*VFC(I)/100.                                         GAPP      132
                      VGH(I) = VC-VCR(I)                                            GAPP      133
                C                                                                   GAPP      134
                      HFV = HFV+VFH(I)                                              GAPP      135
  135                 HGV = HGV+VGH(I)                                              GAPP      136
                      HCV = HCV+VCHI(I)                                             GAPP      137
                      HDSHV = HDSHV+VDH(I)                                          GAPP      138
                      HCRV = HCRV+VCR(I)                                            GAPP      139
                      HPORV = 1.E-12                                                GAPP      140
  140                 RFNVFF = 1.E-12                                               GAPP      141
                      HFLL = HFLL+DELZA(I)                                          GAPP      142
                C                                                                   GAPP      143
                      TAC(IT) = TAC(IT)+TCA(I)/FLOAT(NT)                            GAPP      144
                      TSF(IT) = TSF(IT)+TPS(I)/FLOAT(NT)                            GAPP      145
  145                 TAFA(IT) = TAFA(IT)+TAF(I)/FLOAT(NT)                          GAPP      146
                      TAGA(IT) = TAGA(IT)+TAG(I)/FLOAT(NT)                          GAPP      147
                      SUMGP = SUMGP+VGH(I)/(TAG(I)+460.)                            GAPP      148
                      SUMCK = SUMCK+VCR(I)/(TAF(I)+460.)                            GAPP      149
                      SUMPOR = 1.E-15                                               GAPP      150
  150                 SUMRG = 1.E-15                                                GAPP      151
                110   CONTINUE                                                      GAPP      152
                C                                                                   GAPP      153
                    IF (MECHAN.EQ.1) SUMDH = DISH/(TAFA(I)+460.)                    GAPP      154
                    HFPER = (HFLL/(TOTL*12.)-1.0)*100.                              GAPP      155
  155           C                                                                   GAPP      156
                C   CALCULATION OF ROD INTERNAL PRESSURE                           GAPP      157
                C                                                                   GAPP      158
                    SUMPLN = HPV/(TPLEN+460.)                                       GAPP      159
                    PIT(IT) = (GASMOL*40.8)/(SUMPLN+SUMGP+SUMDH+SUMCK+SUMPOR+SUMRG) GAPP      160
```

```
160          C
                       PRESS = PIT(IT)
             C
             C
                       IF (N2.EQ.NT) J = IRI+1
165          C
                       RETURN
                       END
```

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GAPP  161
GAPP  162
GAPP  163
GAPP  164
GAPP  165
GAPP  166
GAPP  167
GAPP  168
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GSPRES 1 166

VARIABLES	SN	TYPE		RELOCATION								
0	AXLEN	REAL	ARRAY	F.P.	REFS	77	105	DEFINED	1			
0	DELZA	REAL	ARRAY	F.P.	REFS	81	124	125	126	141		
					DEFINED	1						
0	DG	REAL	ARRAY	F.P.	REFS	81	126	DEFINED	1			
0	DISH	REAL		F.P.	REFS	153	DEFINED	1				
0	DZH	REAL	ARRAY	F.P.	REFS	77	110	DEFINED	1			
0	GASMOL	REAL		F.P.	REFS	159	DEFINED	1				
0	HCRV	REAL		F.P.	REFS	108	138	DEFINED	1	90	108	138
0	HCV	REAL		F.P.	REFS	105	136	DEFINED	1	87	105	136
0	HDSHV	REAL		F.P.	REFS	107	137	DEFINED	1	89	107	137
0	HFLL	REAL		F.P.	REFS	110	141	154	DEFINED	1	92	110
					141							
0	HFPER	REAL		F.P.	DEFINED	1	154					
0	HFV	REAL		F.P.	REFS	104	134	DEFINED	1	86	104	134
0	HGV	REAL		F.P.	REFS	106	135	DEFINED	1	88	106	135
0	HPORV	REAL		F.P.	REFS	109	DEFINED	1	91	109	139	
0	HPV	REAL		F.P.	REFS	158	DEFINED	1				
414	I	INTEGER			REFS	104	2*105	106	107	108	109	110
					111	112	113	114	2*115	2*116	3*117	2*118
					2*119	2*124	2*125	3*126	128	2*129	2*130	131
					2*132	134	135	136	137	138	141	143
					144	145	146	2*147	2*148	153		
					DEFINED	102						
0	IRI	INTEGER		F.P.	REFS	102	164	DEFINED	1			
0	IT	INTEGER		F.P.	REFS	93	94	95	96	2*111	2*112	2*113
					2*114	2*143	2*144	2*145	2*146	159	161	
					DEFINED	1						
0	J	INTEGER		F.P.	DEFINED	1	164					
0	MECHAN	INTEGER		F.P.	REFS	103	153	DEFINED	1			
0	NA	INTEGER		F.P.	REFS	82	DEFINED	1				
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NF	INTEGER		F.P.	REFS	124	126	DEFINED	1			
0	NFFI	INTEGER		F.P.	REFS	124	125	126	DEFINED	1		
0	NT	INTEGER		F.P.	REFS	111	112	113	114	143	144	145

VARIABLES	SN	TYPE		RELOCATION									
						146	164	DEFINED	1				
0	N2	INTEGER		F.P.	REFS	164	DEFINED	1					
0	PI	REAL		F.P.	REFS	124	125	126	DEFINED	1			
0	PIT	REAL	ARRAY	F.P.	REFS	77	161	DEFINED	1	159			
0	PRESS	REAL		F.P.	DEFINED	1	161						
0	RD	REAL	ARRAY	F.P.	REFS	81	124	125	126	DEFINED	1		
0	RFNVFF	REAL		F.P.	REFS	118	DEFINED	1	140				
0	SUMCK	REAL		F.P.	REFS	117	148	159	DEFINED	1	99	117	
					148								
0	SUMDH	REAL		F.P.	REFS	115	159	DEFINED	1	97	115	153	
0	SUMGP	REAL		F.P.	REFS	116	147	159	DEFINED	1	98	116	
					147								
421	SUMPLN	REAL			REFS	159	DEFINED	158					
0	SUMPOR	REAL		F.P.	REFS	119	159	DEFINED	1	101	119	149	
0	SUMRG	REAL		F.P.	REFS	118	159	DEFINED	1	100	118	150	
0	TAC	REAL	ARRAY	F.P.	REFS	77	111	143	DEFINED	1	93	111	
					143								
0	TAF	REAL	ARRAY	F.P.	REFS	77	113	115	119	145	148		
					DEFINED	1							
0	TAFA	REAL	ARRAY	F.P.	REFS	77	113	145	153	DEFINED	1	95	
					113	145							
0	TAG	REAL	ARRAY	F.P.	REFS	77	114	116	118	146	147		
					DEFINED	1							
0	TAGA	REAL	ARRAY	F.P.	REFS	77	114	146	DEFINED	1	96	114	
					146								
0	TCA	REAL	ARRAY	F.P.	REFS	77	111	143	DEFINED	1			
0	TOTL	REAL		F.P.	REFS	154	DEFINED	1					
0	TPLEN	REAL		F.P.	REFS	158	DEFINED	1					
0	TPS	REAL	ARRAY	F.P.	REFS	77	112	117	144	DEFINED	1		
0	TRTRAN	REAL	ARRAY	F.P.	REFS	82	117	DEFINED	1				
0	TSF	REAL	ARRAY	F.P.	REFS	77	112	144	DEFINED	1	94	112	
					144								
420	VC	REAL			REFS	132	DEFINED	131					
0	VCH1	REAL	ARRAY	F.P.	REFS	77	105	136	DEFINED	1	128		
0	VCR	REAL	ARRAY	F.P.	REFS	77	108	117	132	138	148		
					DEFINED	1	130						
0	VDH	REAL	ARRAY	F.P.	REFS	77	107	115	137	DEFINED	1		
0	VFC	REAL	ARRAY	F.P.	REFS	81	131	DEFINED	1				
0	VFF	REAL	ARRAY	F.P.	REFS	81	129	130	DEFINED	1			
0	VFH	REAL	ARRAY	F.P.	REFS	77	104	118	134	DEFINED	1	129	
0	VGH	REAL	ARRAY	F.P.	REFS	77	106	116	135	147			
					DEFINED	1	132						
0	VPOR	REAL	ARRAY	F.P.	REFS	77	109	119	DEFINED	1			
415	VRCI	REAL			REFS	128	131	DEFINED	124				
416	VRCO	REAL			REFS	128	DEFINED	125					
417	VRFS	REAL			REFS	129	130	DEFINED	126				

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES			
FLOAT	REAL	1	INTRIN		143	144	145	146

STATEMENT LABELS		DEF LINE	REFERENCES	
171	100	122	103	
330	110	151	102	121

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
55	110	I	102 151	256B	OPT

STATISTICS
PROGRAM LENGTH 602B 386
140000B SCM USED

```
      SUBROUTINE GAPRS (GPTHK,RF,PFC,TG,TF,TC,PG,GASES,FLUX,MECHAN,RUFC,  GAPRS      2
     +RUFF,FRDEN,HGAPT,COLDWK,TFLUX,ZRO,FOTMTL,HSOLID,HGAPR,HGAP,PRG,SIG GAPRS      3
     +G,DG,IT,NDBG,IM93WC,IMGAPC,FTMELT,FRAC)                            GAPRS      4
C                                                                        GAPRS      5
C  THIS SUBROUTINE COMPUTES GAP CONDUCTANCE ACCOUNTING FOR RADIATION     GAPRS      6
C  HEAT TRANSFER ACROSS GAS GAP AND GAP THICKNESS CHANGE. IF MESH        GAPRS      7
C  SPACING USED IN TEMPERATURE DISTRIBUTION CALCULATIONS IS ADJUSTED     GAPRS      8
C  TO CONFORM WITH DEFORMATION CALCULATIONS, INPU  GPTHK0 = GPTHK .      GAPRS      9
C                                                                        GAPRS     10
C  *** INPUT VARIABLES ***                                               GAPRS     11
C                                                                        GAPRS     12
C  COLDWK= CLADDING COLD WORK                                            GAPRS     13
C  COMP  = PUO2 CONTENT (WEIGHT PERCENT)                                 GAPRS     14
C  DG     - EFFECTIVE GAP (IN) FROM SUBROUTINE RADIAL                    GAPRS     15
C  FOTMTL= FUEL OXYGEN TO METAL RATIO                                    GAPRS     16
C  FRDEN = RATIO OF FUEL DENSITY TO THEORETICAL DENSITY                  GAPRS     17
C  FTMELT - FUEL MELT TEMPERATURE (K)                                    GAPRS     18
C  GASES(I)  ABSOLUTE MOLE FRACTIONS                                     GAPRS     19
C                                                                        GAPRS     20
C  GAS INDEX NUMBER KEY                                                  GAPRS     21
C  1=HELIUM                                                              GAPRS     22
C  2=ARGON                                                               GAPRS     23
C  3=KRYPTON                                                             GAPRS     24
C  4=XENON                                                               GAPRS     25
C  5=HYDROGEN                                                            GAPRS     26
C  6=AIR                                                                 GAPRS     27
C  7=WATER VAPOR                                                         GAPRS     28
C                                                                        GAPRS     29
C  GPTHK = GAS GAP THICKNESS (RADIAL FT)                                 GAPRS     30
C  IMGAPC - EM SWITCH FOR GAP CONDUCTANCE                                GAPRS     31
C  IM93WC - EM SWITCH FOR FUEL THERMAL CONDUCTIVITY                      GAPRS     32
C  IT     - POWER-TIME STEP INDEX                                        GAPRS     33
C  NDBG   - DEBUG OUTPUT INDEX                                          GAPRS     34
C  MECHAN - MECHANICAL MODEL INDEX                                       GAPRS     35
C  : 1, PELET MECHANICS SUBCODE                                          GAPRS     36
C  : 2, FRACAS-I MECHANICS SUBCODE                                       GAPRS     37
C  : 3, FRACAS-II MECHANICS SUBCODE                                      GAPRS     38
C  PFC    : PELLET - CLADDING INTERFACIAL PRESSURE (PSIA)                GAPRS     39
C  PG     : PRESSURE OF GAS IN GAS GAP (PSIA)                           GAPRS     40
C  PRG     - INTERFACIAL PRESSURE CALCULATED BY SUBROUTINE RADIAL       GAPRS     41
C  RF     : RADIUS TO OUTSIDE SURFACE OF FUEL (FT)                       GAPRS     42
C  RUFC   : ARITHMETIC MEAN ROUGHNESS HEIGHT OF CLADDING (IN)           GAPRS     43
C  RUFF   : ARITHMETIC MEAN ROUGHNESS HEIGHT OF FUEL (IN)               GAPRS     44
C  SIGG    - GAP MACRO-ROUGHNESS USED IN RADIAL                         GAPRS     45
C  TC     : TEMPERATURE OF INSIDE SURFACE OF CLADDING (F)                GAPRS     46
C  TF     : TEMPERATURE OF OUTSIDE SURFACE OF FUEL (F)                   GAPRS     47
C  TG     : TEMPERATURE OF GAS IN GAP (F)                               GAPRS     48
C  ZRO     - ZIRCALOY-OXIDE THICKNESS (M)                               GAPRS     49
C                                                                        GAPRS     50
C  *** OUTPUT VARIABLES ***                                              GAPRS     51
C                                                                        GAPRS     52
C  HGAP   - CONDUCTION CONTRIBUTION TO CONDUCTANCE (BTU/HR-FT**2-F)      GAPRS     53
C  HGAPR  - RADIATION CONTRIBUTION TO CONDUCTANCE (BTU/HR-FT**2-F)       GAPRS     54
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      C   HGAPT = GAP CONDUCTANCE (BTU/HR-FT**2-F)                                    GAPRS      55
55    C   HSOLID - CONTACT   CONTRIBUTION TO CONDUCTANCE (BTU/HR-FT**2-F)             GAPRS      56
      C                                                                               GAPRS      57
      C   IMPLICIT REAL*8(A-H,O-Z)                                                    GAPRS      58
      C                                                                               GAPRS      59
            DIMENSION GMWT(7)                                                         GAPRS      60
60          DIMENSION GASES(7)                                                        GAPRS      61
            DIMENSION HEGAS(7)                                                        GAPRS      62
            DATA HEGAS / 1., 6*0. /                                                   GAPRS      63
            DATA (GMWT(I),I=1,7)/4.,39.,84.,131.3,2.,28.,18./                         GAPRS      64
            DATA SBC , CONVP ,THKMIN          / .4806E-12 ,1.4505E-4,1.E-10 /         GAPRS      65
65          DATA CONVK ,SECHR  , CONVL    / 1.7300E0 , 3600.E0      , .03281/         GAPRS      66
            DATA  CONVP2   / 14.2234E0 /                                              GAPRS      67
            DATA  GPSI , GPTHKN / 0.E0 , 0.E0 /                                       GAPRS      68
      C                                                                               GAPRS      69
      C                                                                               GAPRS      70
70          TCONV(T) = (T+459.67E0)/1.8E0                                             GAPRS      71
      C                                                                               GAPRS      72
      C   * CONVERT GAS GAP TEMPERATURE FROM F TO K                                   GAPRS      73
      C                                                                               GAPRS      74
            TGK = TCONV(TG)                                                           GAPRS      75
75    C                                                                               GAPRS      76
      C   COMPUTE CONDUCTIVITY OF GAS IN GAS GAP                                     GAPRS      77
      C                                                                               GAPRS      78
            GPCON = GTHCON(GASES,TGK,GPSI,GPTHKN)                                     GAPRS      79
      C                                                                               GAPRS      80
80    C   * CONVERT GPCON FROM W/M-C  TO BTU/FT-F-SEC                                 GAPRS      81
      C                                                                               GAPRS      82
            GPCON = GPCON/(CONVK*SECHR)                                               GAPRS      83
      C                                                                               GAPRS      84
      C                                                                               GAPRS      85
85          IF (MECHAN.NE.1) GO TO 100                                                GAPRS      86
            HECON = GTHCON(HEGAS,TGK,GPSI,GPTHKN)                                     GAPRS      87
            HECON = HECON/(CONVK*SECHR)                                               GAPRS      88
            FRAC = GPCON/HECON                                                        GAPRS      89
      C                                                                               GAPRS      90
90    100   CONTINUE                                                                  GAPRS      91
      C                                                                               GAPRS      92
      C   COMPUTE RADIATION HEAT TRANSFER ACROSS GAS GAP. TRANSFORM TO AN             GAPRS      93
      C   EFFECTIVE CONDUCTIVITY                                                      GAPRS      94
      C                                                                               GAPRS      95
95    C   ASSUME CONFIGURATION FACTOR EQUALS 1                                        GAPRS      96
      C                                                                               GAPRS      97
            FA = 1.E0                                                                 GAPRS      98
      C                                                                               GAPRS      99
            GPTHM = GPTHK                                                             GAPRS     100
100         IF (GPTHM.LT.THKMIN) GPTHM = THKMIN                                       GAPRS     101
      C                                                                               GAPRS     102
      C   COMPUTE EMISSIVITY FACTOR FE                                               GAPRS     103
      C                                                                               GAPRS     104
            CALL EMSSF2 (TF,TC,RF,GPTHM,ZRO,FE)                                       GAPRS     105
105   C                                                                               GAPRS     106
      C   CONVERT TEMPERATURE TO RANKINE                                             GAPRS     107
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                  TFR = TF+459.67E0                                                  GAPRS   108
                  TCR = TC+459.67E0                                                  GAPRS   109
                  HGAPR = SBC*FA*FE*(TFR*TFR+TCR*TCR)*(TFR+TCR)                      GAPRS   110
110               HGAPR = HGAPR*SECHR                                                GAPRS   111
                C                                                                    GAPRS   112
                C   COMPUTE TEMPERATURE JUMP DISTANCE,USING RECOMMENDED FORM       GAPRS   113
                C   IN  REPORT BNWL 1984                                            GAPRS   114
                C                                                                    GAPRS   115
115               AHE = .425-2.3E-4*TGK                                              GAPRS   116
                  AXE = .749-2.5E-4*TGK                                              GAPRS   117
                  SLOP = (AXE-AHE)/127.                                              GAPRS   118
                  RINT = AHE-4.*SLOP                                                 GAPRS   119
                  SUM = 0.0                                                          GAPRS   120
120                   DO 110 IJJ=1,7                                                 GAPRS   121
                      ADR = (GMWT(IJJ))**0.5                                         GAPRS   122
                      AGS = SLOP*GMWT(IJJ)+RINT                                      GAPRS   123
                      SUM = SUM+AGS*GASES(IJJ)/ADR                                   GAPRS   124
              110     CONTINUE                                                       GAPRS   125
125               DJUMP = 2.23*(GPCON*SQRT(TGK)/PG)/SUM                              GAPRS   126
                C   * CONVERT DJUMP FROM CM TO FT                                   GAPRS   127
                C                                                                    GAPRS   128
                  DJMPFT = CONVL*DJUMP                                               GAPRS   129
                C                                                                    GAPRS   130
130             C   CHECK FOR GAP CLOSURE                                           GAPRS   131
                  IF (GPTHK.EQ.0.0.OR.MECHAN.EQ.1) GO TO 120                         GAPRS   132
                C                                                                    GAPRS   133
                C   CONDUCTIVITY FOR OPEN GAP                                      GAPRS   134
                C                                                                    GAPRS   135
135             C   * INCLUDE ROUGHNESS FACTOR TO HAVE CONTINUOUS TRANSITION GOING FROM GAPRS   136
                C   * CALCULATION FOR OPEN GAP TO CLOSED GAP                        GAPRS   137
                C                                                                    GAPRS   138
                  DROUGH = CONVL*3.6*(RUFF+RUFC)*2.54E0                              GAPRS   139
                  HGAP = GPCON/(GPTHK+DJMPFT+DROUGH)                                 GAPRS   140
140               HGAP = HGAP*SECHR                                                  GAPRS   141
                  HGAPT = HGAP+HGAPR                                                 GAPRS   142
                C                                                                    GAPRS   143
                  GO TO 200                                                          GAPRS   144
                C   CONDUCTIVITY FOR CLOSED GAP                                    GAPRS   145
145             C                                                                    GAPRS   146
                C   CONDUCTIVITY COMPUTED BY FORMULA SHOWN ON PAGE A-10 OF BNWL-1778 GAPRS   147
                C                                                                    GAPRS   148
                C                                                                    GAPRS   149
                C   * CONVERT FUEL AND CLADDING SURFACE TEMPERATURES FROM F TO K     GAPRS   150
150             C                                                                    GAPRS   151
                120   TFSI = TCONV(TF)                                             GAPRS   152
                      TCSI = TCONV(TC)                                             GAPRS   153
                C                                                                    GAPRS   154
                C                                                                    GAPRS   155
155               CALL FTHCON (TFSI,FRDEN,FOTMTL,CONU,DKDT)                          GAPRS   156
                C                                                                    GAPRS   157
                  IF (IM93WC.EQ.1) CONU = EMFTC(CONU,FTMELT)                         GAPRS   158
                C                                                                    GAPRS   159
                  CONF = CONU*57.803/100./SECHR                                      GAPRS   160
```

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      C                                                                      GAPRS   161
      C   EQUATION A-10 IN REPORT BNWL-1894                                  GAPRS   162
      C   FORMULA IN REPORT  BNWL-1984                                       GAPRS   163
      C                                                                      GAPRS   164
            CALL CTHCON (TCSI,TFLUX,FLUX,COLDWK,CCON,CDKDT)                  GAPRS   165
      C                                                                      GAPRS   166
            CONC = CCON*57.803/100./SECHR                                    GAPRS   167
            FKM = 2.E0*CONF*CONC/(CONF+CONC)                                 GAPRS   168
            HMEYER = CMHARD(TCSI)*CONVP                                      GAPRS   169
            IF (MECHAN.EQ.1) GO TO 130                                       GAPRS   170
      C                                                                      GAPRS   171
      C   * CONVERT PFC FROM PSI TO KG/CM**2                                 GAPRS   172
            PFCI = PFC/CONVP2                                                GAPRS   173
      C                                                                      GAPRS   174
      C   THE FOLLOWING STATEMENT ELIMINATES CREDIT FOR INTERFACE PRESSURE   GAPRS   175
      C   IN THE GAP CONDUCTANCE WHEN THE EM GAP CONDUCTANCE IS SPECIFIED     GAPRS   176
      C                                                                      GAPRS   177
            IF (IMGAPC.EQ.1) PFCI = 0.E0                                     GAPRS   178
      C                                                                      GAPRS   179
            CEE = 3.6*EXP(-.00125*PFCI)                                      GAPRS   180
            THC = CEE*(RUFF+RUFC)+DJUMP/2.54-5.5E-5                          GAPRS   181
            IF (THC.LT.2.5E-5) THC = 2.5E-5                                  GAPRS   182
            PREL = AMAX1(PFC/HMEYER,0.E0)                                    GAPRS   183
            GO TO 140                                                        GAPRS   184
      130   CONTINUE                                                         GAPRS   185
            THC = DG+DJMPFT*12.                                              GAPRS   186
            PREL = PRG/HMEYER                                                GAPRS   187
      140   CONTINUE                                                         GAPRS   188
            RI = RUFF*1.E6                                                   GAPRS   189
            R = (RUFC**2+RUFF**2)**0.5                                       GAPRS   190
      C                                                                      GAPRS   191
            IF (MECHAN.EQ.1) GO TO 180                                       GAPRS   192
            IF (PREL.GT..01) GO TO 160                                       GAPRS   193
            IF (PREL.LT..0001) GO TO 150                                     GAPRS   194
            HSOLID = 5.*FKM/(R*EXP(5.738-.528*ALOG(RI)))*.01                 GAPRS   195
            GO TO 170                                                        GAPRS   196
      150   HSOLID = 5.*FKM*PREL**0.5/(R*EXP(5.738-.528*ALOG(RI)))           GAPRS   197
            GO TO 170                                                        GAPRS   198
      160   HSOLID = 5.*FKM*PREL/(R*EXP(5.738-.528*ALOG(RI)))                GAPRS   199
      170   CONTINUE                                                         GAPRS   200
            HSOLID = HSOLID*SECHR                                            GAPRS   201
            GO TO 190                                                        GAPRS   202
      180   CONTINUE                                                         GAPRS   203
            RR = SIGG*2.54*1.E-4/1.11                                        GAPRS   204
            PP = PRG*6895.E-6                                                GAPRS   205
            HSOLID = 0.038-RR*0.002+(.017-RR*.0003)*PP                       GAPRS   206
      C   CONVERT FROM W/CM**2-C TO BTU/SEC-FT**2-F                         GAPRS   207
            HSOLID = HSOLID*SECHR/2.04                                       GAPRS   208
      190   CONTINUE                                                         GAPRS   209
            HGAP = GPCON/(THC/12.)                                           GAPRS   210
            HGAP = HGAP*SECHR                                                GAPRS   211
      C                                                                      GAPRS   212
            HGAPT = HGAP+HSOLID+HGAPR                                        GAPRS   213
```

```
                C                                                                  GAPRS    214
                200   CONTINUE                                                     GAPRS    215
    215               CALL DIALOT (TG,28,FDIALA,FDIALM)                            GAPRS    216
                      HGAPT = (HGAPT+FDIALA)*FDIALM                                GAPRS    217
                      RETURN                                                       GAPRS    218
                      END                                                          GAPRS    219
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GAPRS 217

VARIABLES	SN	TYPE	RELOCATION								
655 ADR		REAL			REFS	123	DEFINED	121			
656 AGS		REAL			REFS	123	DEFINED	122			
647 AHE		REAL			REFS	117	118	DEFINED	115		
650 AXE		REAL			REFS	117	DEFINED	116			
667 CCON		REAL			REFS	164	166				
670 CDKDT	*	REAL			REFS	164					
675 CEE		REAL			REFS	180	DEFINED	179			
0 COLDWK		REAL		F.P.	REFS	164	DEFINED	1			
671 CONC		REAL			REFS	2*167	DEFINED	166			
666 CONF		REAL			REFS	2*167	DEFINED	159			
664 CONU		REAL			REFS	155	157	159	DEFINED	157	
565 CONVK		REAL			REFS	82	87	DEFINED	65		
567 CONVL		REAL			REFS	128	138	DEFINED	65		
563 CONVP		REAL			REFS	168	DEFINED	64			
570 CONVP2		REAL			REFS	172	DEFINED	66			
0 DG		REAL		F.P.	REFS	185	DEFINED	1			
660 DJMPFT		REAL			REFS	139	185	DEFINED	128		
657 DJUMP		REAL			REFS	128	180	DEFINED	125		
665 DKDT	*	REAL			REFS	155					
661 DROUGH		REAL			REFS	139	DEFINED	138			
642 FA		REAL			REFS	109	DEFINED	97			
704 FDIALA		REAL			REFS	215	216				
705 FDIALM		REAL			REFS	215	216				
644 FE		REAL			REFS	104	109				
672 FKM		REAL			REFS	194	196	198	DEFINED	167	
0 FLUX		REAL		F.P.	REFS	164	DEFINED	1			
0 FOTMTL		REAL		F.P.	REFS	155	DEFINED	1			
0 FRAC		REAL		F.P.	DEFINED	1	88				
0 FRDEN		REAL		F.P.	REFS	155	DEFINED	1			
0 FTMELT		REAL		F.P.	REFS	157	DEFINED	1			
0 GASES		REAL	ARRAY	F.P.	REFS	60	78	123	DEFINED	1	
706 GMWT		REAL	ARRAY		REFS	59	121	122	DEFINED	63	
640 GPCON		REAL			REFS	82	88	125	139	209	
					DEFINED	78	82				
571 GPSI		REAL			REFS	78	86	DEFINED	67		
0 GPTHK		REAL		F.P.	REFS	99	131	139	DEFINED	1	

VARIABLES	SN	TYPE		RELOCATION								
572	GPTHKN	REAL			REFS	78	86	DEFINED	67			
643	GPTHM	REAL			REFS	100	104	DEFINED	99	100		
641	HECON	REAL			REFS	87	88	DEFINED	86	87		
715	HEGAS	REAL	ARRAY		REFS	61	86	DEFINED	62			
0	HGAP	REAL		F.P.	REFS	140	141	210	212	DEFINED	1	139
					140	209	210					
0	HGAPR	REAL		F.P.	REFS	110	141	212	DEFINED	1	109	110
0	HGAPT	REAL		F.P.	REFS	216	DEFINED	1	141	212	216	
673	HMEYER	REAL			REFS	182	186	DEFINED	168			
0	HSOLID	REAL		F.P.	REFS	200	207	212	DEFINED	1	194	196
					198	200	205	207				
654	IJJ	INTEGER			REFS	121	122	123	DEFINED	120		
0	IMGAPC	INTEGER		F.P.	REFS	177	DEFINED	1				
0	IM93WC	INTEGER		F.P.	REFS	157	DEFINED	1				
0	IT	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	MECHAN	INTEGER		F.P.	REFS	85	131	169	191	DEFINED	1	
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	PFC	REAL		F.P.	REFS	172	182	DEFINED	1			
674	PFC1	REAL			REFS	179	DEFINED	172	177			
0	PG	REAL		F.P.	REFS	125	DEFINED	1				
703	PP	REAL			REFS	205	DEFINED	204				
677	PREL	REAL			REFS	192	193	196	198	DEFINED	182	186
0	PRG	REAL		F.P.	REFS	186	204	DEFINED	1			
701	R	REAL			REFS	194	196	198	DEFINED	189		
0	RF	REAL		F.P.	REFS	104	DEFINED	1				
652	RINT	REAL			REFS	122	DEFINED	118				
702	RR	REAL			REFS	2*205	DEFINED	203				
0	RUFC	REAL		F.P.	REFS	138	180	189	DEFINED	1		
0	RUFF	REAL		F.P.	REFS	138	180	188	189	DEFINED	1	
700	RI	REAL			REFS	194	196	198	DEFINED	188		
562	SBC	REAL			REFS	109	DEFINED	64				
566	SECHR	REAL			REFS	82	87	110	140	159	166	200
					207	210	DEFINED	65				
0	SIGG	REAL		F.P.	REFS	203	DEFINED	1				
651	SLOP	REAL			REFS	118	122	DEFINED	117			
653	SUM	REAL			REFS	123	125	DEFINED	119	123		
0	TC	REAL		F.P.	REFS	104	108	152	DEFINED	1		
646	TCR	REAL			REFS	3*109	DEFINED	108				
663	TCS1	REAL			REFS	164	168	DEFINED	152			
0	TF	REAL		F.P.	REFS	104	107	151	DEFINED	1		
0	TFLUX	REAL		F.P.	REFS	164	DEFINED	1				
645	TFR	REAL			REFS	3*109	DEFINED	107				
662	TFS1	REAL			REFS	155	DEFINED	151				
0	TG	REAL		F.P.	REFS	74	215	DEFINED	1			
637	TGK	REAL			REFS	78	86	115	116	125		
					DEFINED	74						
676	THC	REAL			REFS	181	209	DEFINED	180	181	185	
564	THKMIN	REAL			REFS	2*100	DEFINED	64				
0	ZRO	REAL		F.P.	REFS	104	DEFINED	1				

EXTERNALS	TYPE	ARGS		REFERENCES		
ALOG	REAL	1	LIBRARY	194	196	198
CMHARD	REAL	1		168		

EXTERNALS	TYPE	ARGS		REFERENCES			
CTHCON		6		164			
DIALOT		4		215			
EMFTC	REAL	2		157			
EMSSF2		6		104			
EXP	REAL	1	LIBRARY	179	194	196	198
FTHCON		5		155			
GTHCON	REAL	4		78	86		
SQRT	REAL	1	LIBRARY	125			

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES		
AMAX1	REAL	0	INTRIN		132		
TCONV	REAL	1	SF	70	74	151	152

STATEMENT LABELS		DEF LINE	REFERENCES	
37	100	90	85	
0	110	124	120	
204	120	151	131	
315	130	184	169	
325	140	187	183	
362	150	196	193	
400	160	198	192	
413	170	199	195	197
420	180	202	191	
442	190	208	201	
457	200	214	143	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
121	110	IJJ	120 124	21B	EXT REFS

STATISTICS
PROGRAM LENGTH 726B 470
140000B SCM USED

```
      FUNCTION GAPT (F,TC,PG,PC,URF,DELTA,EPP,EP,RCI,RCO,CEPS,CEPP,CEP,C
     +SIG,OLDTC,OLDPG,OLDPC,OLDURF,J,NRELAX,DTIME,TIME,ECREEP,CREP,NA,NP
     +LAST)
C
C     IMPLICIT REAL * 8 (A-H,O-Z)
C
C     THIS ROUTINE CALCULATES GAP THICKNESS
C     GAPT IS CALLED FROM CLOSE
C
      REAL          TC(1)    ,PG(1)    ,PC(1)    ,URF(1)   ,CSIG(3)
     +             ,CEPS(3)  ,CEPP(3)  ,EP(1)    ,OLDTC(1) ,OLDPG(1)
     +   ,OLDPC(1) ,OLDURF(1),EPP(NA,1),ECREEP(1)
C
C     ***************************************************************
C     INPUT ARGUMENTS
C     ***************************************************************
C
C     CEP    - TEMPORARY EFFECTIVE PLASTIC STRAIN (IN/IN)
C     CEPP   - TEMPORARY HOOP, AXIAL, & RADIAL PLASTIC STRAINS (IN/IN)
C     CEPS   - TEMPORARY HOOP, AXIAL, & RADIAL STRAINS (IN/IN)
C     CSIG   - TEMPORARY HOOP, AXIAL, & RADIAL STRESS (PSI)
C     DTIME  - TIME INCREMENT (HRS)
C     DELTA  - COLD STATE RADIAL GAP (IN)
C     EP     - CLADDING EFFECTIVE PLASTIC STRAIN (IN/IN)
C     EPP    - CLADDING HOOP, AXIAL, & RADIAL STRAINS (IN/IN)
C     F      - INTERPOLATION FACTOR
C     J      - AXIAL NODE INDEX
C     NA     - MAXIMUM NUMBER OF AXIAL NODES
C     NPLAST - ELASTIC-PLASTIC FLAG
C     NRELAX - CREEP FLAG
C     OLDPC  - COOLANT CHANNEL PRESSURE OF PREVIOUS POWER STEP (PSIA)
C     OLDPG  - ROD INTERNAL GAS PRESSURE OF PREVIOUS POWER STEP (PSIA)
C     OLDTC  - CLADDING AVERAGE TEMPERATURE-PREVIOUS POWER STEP (F)
C     OLDURF - FUEL RADIAL DISPLACEMENT OF PREVIOUS POWER STEP (IN)
C     PC     - COOLANT CHANNEL PRESSURE (PSIA)
C     PG     - ROD INTERNAL GAS PRESSURE (PSIA)
C     TC     - CLADDING AVERAGE TEMPERATURE (F)
C     TIME   - END OF STEP TIME (HRS)
C     URF    - FUEL RADIAL DISPLACEMEN (IN)
C     RCI    - CLADDING  INSIDE RADIUS (IN)
C     RCO    - CLADDING OUTSIDE RADIUS (IN)
C
C     ***************************************************************
C     OUTPUT ARGUMENTS
C     ***************************************************************
C
C     GAPT   - GAP THICKNESS (IN)
C
C     ***************************************************************
C
        CEPP(1) = EPP(J,1)
        CEPP(2) = EPP(J,2)
        CEPP(3) = EPP(J,3)
```

```
                CEP = EP(J)                                                          GAPT       55
55              CREP = ECREEP(J)                                                     GAPT       56
                FS = 0.0E0                                                           GAPT       57
                IF (NRELAX.NE.1) GO TO 100                                           GAPT       58
                DT = F*DTIME                                                         GAPT       59
                T = TC(J)                                                            GAPT       60
60              PI = PG(J)                                                           GAPT       61
                PO = PC(J)                                                           GAPT       62
                UR = URF(J)                                                          GAPT       63
          C   NOTE....FOR DEFORMABLE PELLET, URF IS A FUNCTION                       GAPT       64
          C   OF TIME DURING CREEP                                                  GAPT       65
65              GO TO 110                                                            GAPT       66
          100   CONTINUE                                                           GAPT       67
                T = OLDTC(J)+F*(TC(J)-OLDTC(J))                                      GAPT       68
                PI = OLDPG(J)+F*(PG(J)-OLDPG(J))                                     GAPT       69
                PO = OLDPC(J)+F*(PC(J)-OLDPC(J))                                     GAPT       70
70              UR = OLDURF(J)+F*(URF(J)-OLDURF(J))                                  GAPT       71
          110   CONTINUE                                                           GAPT       72
          C                                                                        GAPT       73
                CALL CLADF (PI,PO,T,RCI,RCO,CSIG,CEPS,CEPP,CEP,FS,NRELAX,DT,TIME,C GAPT       74
               +REP,NPLAST)                                                        GAPT       75
75        C                                                                        GAPT       76
                UCLAD = ((RCO+RCI)*CEPS(1)-(RCO-RCI)*CEPS(3))*0.5E0                  GAPT       77
                GAPT = UCLAD-UR+DELTA                                                GAPT       78
                RETURN                                                               GAPT       79
                END                                                                  GAPT       80
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	GAPT	1	78

VARIABLES

		SN	TYPE		RELOCATION								
0	CEP		REAL		F.P.	REFS	73	DEFINED	1	54			
0	CEPP		REAL	ARRAY	F.P.	REFS	10	73	DEFINED	1	51	52	53
0	CEPS		REAL	ARRAY	F.P.	REFS	10	73	2*76	DEFINED	1		
0	CREP		REAL		F.P.	REFS	73	DEFINED	1	55			
0	CSIG		REAL	ARRAY	F.P.	REFS	10	73	DEFINED	1			
0	DELTA		REAL		F.P.	REFS	77	DEFINED	1				
206	DT		REAL			REFS	73	DEFINED	58				
0	DTIME		REAL		F.P.	REFS	58	DEFINED	1				
0	ECREEP		REAL	ARRAY	F.P.	REFS	10	55	DEFINED	1			
0	EP		REAL	ARRAY	F.P.	REFS	10	54	DEFINED	1			
0	EPP		REAL	ARRAY	F.P.	REFS	10	51	52	53	DEFINED	1	
0	F		REAL		F.P.	REFS	58	67	68	69	70		
						DEFINED	1						
205	FS		REAL			REFS	73	DEFINED	56				
204	GAPT		REAL			DEFINED	77						
0	J		INTEGER		F.P.	REFS	51	52	53	54	55	59	60

VARIABLES	SN	TYPE		RELOCATION		61	62	3*67	3*68	3*69	3*70
						DEFINED	1				
0	NA	INTEGER		F.P.	REFS	10	DEFINED	1			
0	NPLAST	INTEGER		F.P.	REFS	73	DEFINED	1			
0	NRELAX	INTEGER		F.P.	REFS	57	73	DEFINED	1		
0	OLDPC	REAL	ARRAY	F.P.	REFS	10	2*69	DEFINED	1		
0	OLDPG	REAL	ARRAY	F.P.	REFS	10	2*68	DEFINED	1		
0	OLDTC	REAL	ARRAY	F.P.	REFS	10	2*67	DEFINED	1		
0	OLDURF	REAL	ARRAY	F.P.	REFS	10	2*70	DEFINED	1		
0	PC	REAL	ARRAY	F.P.	REFS	10	61	69	DEFINED	1	
0	PG	REAL	ARRAY	F.P.	REFS	10	60	68	DEFINED	1	
210	PI	REAL			REFS	73	DEFINED	60	68		
211	PO	REAL			REFS	73	DEFINED	61	69		
0	RCI	REAL		F.P.	REFS	73	2*76	DEFINED	1		
0	RCO	REAL		F.P.	REFS	73	2*76	DEFINED	1		
207	T	REAL			REFS	73	DEFINED	59	67		
0	TC	REAL	ARRAY	F.P.	REFS	10	59	67	DEFINED	1	
0	TIME	REAL		F.P.	REFS	73	DEFINED	1			
213	UCLAD	REAL			REFS	77	DEFINED	76			
212	UR	REAL			REFS	77	DEFINED	62	70		
0	URF	REAL	ARRAY	F.P.	REFS	10	62	70	DEFINED	1	

EXTERNALS	TYPE	ARGS	REFERENCES
CLADF		15	73

STATEMENT LABELS		DEF LINE	REFERENCES
71	100	66	57
126	110	71	65

STATISTICS

PROGRAM LENGTH 214B 140

140000B SCM USED

```
      SUBROUTINE GASPLT (Y,N,T)                                          GASPLT      2
C                                                                        GASPLT      3
C   GASPLT SHOULD BE USED TO OUTPUT THE FRACTION OF SHORTLIVED           GASPLT      4
C   RADIOACTIVE GASES RELEASED AS PREDICTED BY THE ANS54 GAS RELEASE     GASPLT      5
C   MODEL                                                                GASPLT      6
C                                                                        GASPLT      7
C   CODED BY W N RAUSCH OF BATTELLE-NORTHWEST                            GASPLT      8
C                                                                        GASPLT      9
C   OUTPUT BOTH TABLE AND PLOT                                           GASPLT     10
C                                                                        GASPLT     11
C   H : HALF-LIFE ARRAY                                                  GASPLT     12
C   Y : RELEASE ARRAY                                                    GASPLT     13
C   N : CURRENT TIME STEP NUMBER                                         GASPLT     14
C   T : CURRENT TIME IN SECONDS                                          GASPLT     15
C   TD: CURRENT TIME IN DAYS                                             GASPLT     16
C                                                                        GASPLT     17
      DIMENSION Y(11),H(11),S(11),R(11)                                  GASPLT     18
      DELTIM = 0.5                                                       GASPLT     19
          DO 100 I=1,11                                                  GASPLT     20
          RTIME = 1.+(I-1)*DELTIM                                        GASPLT     21
          H(I) = 10.**RTIME                                              GASPLT     22
  100     CONTINUE                                                       GASPLT     23
      TD = T/86400.0                                                     GASPLT     24
      WRITE (6,180) N,TD                                                 GASPLT     25
      WRITE (6,260)                                                      GASPLT     26
C   OUTPUT TABLE OF HALF-LIVES VS FRACTION RELEASED                      GASPLT     27
      WRITE (6,190) (H(I),I=1,11),(Y(I),I=1,11)                          GASPLT     28
      WRITE (6,200)                                                      GASPLT     29
C   INITIALIZE PLOT TO BLANKS                                            GASPLT     30
C   R WILL BE USED TO SAVE VALUES OF S(SYMBOL)                           GASPLT     31
      DIF = 1./40.                                                       GASPLT     32
          DO 110 I=2,10                                                  GASPLT     33
          S(I) = 5H                                                      GASPLT     34
          R(I) = S(I)                                                    GASPLT     35
  110     CONTINUE                                                       GASPLT     36
      S(1) = 5H.                                                         GASPLT     37
      S(11) = 5H.                                                        GASPLT     38
      R(1) = S(1)                                                        GASPLT     39
      R(11) = S(11)                                                      GASPLT     40
C                                                                        GASPLT     41
C   BEGIN PLOT CALCULATIONS ONE LINE AT A TIME                           GASPLT     42
          DO 160 I=1,39                                                  GASPLT     43
          P = 1.-I*DIF                                                   GASPLT     44
              DO 120 J=1,11                                              GASPLT     45
              IF (Y(J).GE.P) S(J) = 5H*                                  GASPLT     46
  120         CONTINUE                                                   GASPLT     47
          IF (I.NE.20) GO TO 130                                         GASPLT     48
C                                                                        GASPLT     49
C   PRINT LABEL FOR VERTICAL AXIS                                        GASPLT     50
          WRITE (6,220) (S(K),K=1,11)                                    GASPLT     51
          GO TO 140                                                      GASPLT     52
  130     CONTINUE                                                       GASPLT     53
          WRITE (6,210) (S(K),K=1,11)                                    GASPLT     54
```

```
                140       CONTINUE                                                        GASPLT     55
55                            DO 150 J=1,11                                               GASPLT     56
                              S(J) = R(J)                                                 GASPLT     57
                150           CONTINUE                                                    GASPLT     58
                160       CONTINUE                                                        GASPLT     59
                          DO 170 J=1,10                                                   GASPLT     60
60              C   PRINT BOTTOM AXIS OF PLOT                                             GASPLT     61
                          S(J) = 5H*....                                                  GASPLT     62
                170       CONTINUE                                                        GASPLT     63
                      S(11) = 5H*                                                         GASPLT     64
                      WRITE (6,230) (S(J),J=1,11)                                         GASPLT     65
65              C   PRINT LABEL FOR HORIZONTAL AXIS                                      GASPLT     66
                      WRITE (6,240) (H(J),J=1,11,2)                                       GASPLT     67
                      WRITE (6,250)                                                       GASPLT     68
                      RETURN                                                              GASPLT     69
                C                                                                         GASPLT     70
70              180   FORMAT (1H1,/50X,"FRACTION RADIOACTIVE GASES RELEASED"//55X,"TIME   GASPLT     71
                     +STEP = ",I3/55X,"TIME AT END OF STEP =",F6.1," DAYS"/)              GASPLT     72
                190   FORMAT (/5X,"HALF-LIFE(SEC)",5X,11(1PE10.1),/5X,"FRACTION"/5X,"REL GASPLT     73
                     +EASED",11X,11(1PE10.2))                                             GASPLT     74
                200   FORMAT (/135(1H*)//40X,"1.0.",51(1H.))                            GASPLT     75
75              210   FORMAT (44X,11A5)                                                 GASPLT     76
                220   FORMAT (16X,"FRACTION RELEASED",7X,"0.5.",11A5)                   GASPLT     77
                230   FORMAT (40X,"0.0.",11A5)                                          GASPLT     78
                240   FORMAT (44X,6(1H.,9X),37X,3F10.0,2X,3F10.0)                       GASPLT     79
                250   FORMAT (/62X,"HALF-LIFE(SEC)"////)                                GASPLT     80
60              260   FORMAT (29X,"RELEASE FRACTION - FRACTION OF NON-DECAYED INVENTORY GASPLT     81
                     +THAT RESIDES IN THE GAP"//135(1H*))                                 GASPLT     82
                      END                                                               GASPLT     83
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	GASPLT	1	68

VARIABLES

		SN	TYPE		RELOCATION									
341	DELTIM		REAL			REFS	20	DEFINED	18					
345	DIF		REAL			REFS	43	DEFINED	31					
351	H		REAL	ARRAY		REFS	17	27	66	DEFINED	21			
342	I		INTEGER			REFS	20	21	2*27	33	2*34	43	47	
						DEFINED	19	2*27	32	42				
347	J		INTEGER			REFS	2*45	2*56	61	64	66			
						DEFINED	44	55	59	64	66			
350	K		INTEGER			REFS	50	53	DEFINED	50	53			
0	N		INTEGER		F.P.	REFS	24	DEFINED	1					
346	P		REAL			REFS	45	DEFINED	43					
377	R		REAL	ARRAY		REFS	17	56	DEFINED	34	38	39		
343	RTIME		REAL			REFS	21	DEFINED	20					
364	S		REAL	ARRAY		REFS	17	34	38	39	50	53	64	

VARIABLES	SN	TYPE	RELOCATION									
					DEFINED	33	36	37	45	56	61	63
0	T	REAL		F.P.	REFS	23	DEFINED	1				
344	TD	REAL			REFS	24	DEFINED	23				
0	Y	REAL	ARRAY	F.P.	REFS	17	27	45	DEFINED	1		

FILE NAMES	MODE										
TAPE6	FMT	WRITES	24	25	27	28	50	53	64	66	
		67									

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		22	19
0	110		35	32
0	120		46	44
115	130		52	47
120	140		54	51
0	150		57	55
0	160		58	42
0	170		62	59
236	180	FMT	70	24
253	190	FMT	72	27
264	200	FMT	74	28
271	210	FMT	75	53
273	220	FMT	76	50
300	230	FMT	77	64
303	240	FMT	78	66
310	250	FMT	79	67
314	260	FMT	80	25

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
13	100	I	19 22	13B		EXT REFS	
45	110	I	32 35	11B	INSTACK		
70	160	I	42 58	43B		EXT REFS	NOT INNER
76	120	J	44 46	10B	INSTACK		
122	150	J	55 57	6B	INSTACK		
135	170	J	59 62	6B	INSTACK		
152		J	66 66	7B		EXT REFS	

STATISTICS
PROGRAM LENGTH 414B 268
140000B SCM USED

```
      SUBROUTINE GASPRO (DCO,DELTAZ,FMGP,HMGP,QC,SGAPF,TIME,NA,IT,J)     GASP       2
C                                                                        GASP       3
C     IMPLICIT  REAL * 8 (A-H,O-Z)                                       GASP       4
C                                                                        GASP       5
C     ***********************************************************        GASP       6
C                                                                        GASP       7
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES THE FISSION GAS   GASP       8
C     AND HELIUM PRODUCTION.                                             GASP       9
C     THIS ROUTINE WAS CODED BY G A BERNA IN DECEMBER 1977.              GASP      10
C                                                                        GASP      11
C     ***********************************************************        GASP      12
C     INPUT  ARGUMENTS                                                   GASP      13
C     ***********************************************************        GASP      14
C                                                                        GASP      15
C     DCO    - CLADDING OUTSIDE DIAMETER (IN)                            GASP      16
C     DELTAZ - NODE LENGTH (FT)                                          GASP      17
C     IT     - POWER-TIME STEP INDEX                                     GASP      18
C     J      - AXIAL NODE INDEX                                          GASP      19
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                             GASP      20
C     QC     - HEAT FLUX AT NODE J (BTU/HR-FT**2)                        GASP      21
C     SGAPF  - NUMBER OF FISSION GAS ATOMS PRODUCED PER 100 FISSIONS     GASP      22
C     TIME   - TIME (SEC)                                                GASP      23
C                                                                        GASP      24
C     ***********************************************************        GASP      25
C     OUTPUT ARGUMENTS                                                   GASP      26
C     ***********************************************************        GASP      27
C                                                                        GASP      28
C     FMGP   - CUMULATIVE FISSION GAS PRODUCTION (GM-MOLES)              GASP      29
C     HMGP   - CUMULATIVE HELIUM GAS PRODUCTION (GM-MOLES)               GASP      30
C                                                                        GASP      31
C     ***********************************************************        GASP      32
C                                                                        GASP      33
      DIMENSION     FMGP(NA,1)                                           GASP      34
     +             ,HMGP(NA,1)    ,TIME(1)                             GASP      35
C                                                                        GASP      36
      IL = IT-1                                                          GASP      37
      IF (IT.EQ.1) IL = IT                                               GASP      38
          DO 100 LT=IL,IT                                                GASP      39
          I = 2+LT-IT                                                    GASP      40
C                                                                        GASP      41
          FMGP(J,I) = QC*TIME(LT)*DCO*DELTAZ*SGAPF*9.95E-18              GASP      42
          FMGP(J,I) = FMGP(J,I)*4.0                                      GASP      43
C                                                                        GASP      44
          HMGP(J,I) = QC*TIME(LT)*DCO*DELTAZ*2.98E-18                    GASP      45
C                                                                        GASP      46
  100     CONTINUE                                                       GASP      47
C                                                                        GASP      48
      RETURN                                                             GASP      49
      END                                                                GASP      50
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GASPRO 1 48

VARIABLES	SN	TYPE		RELOCATION								
0	DCO	REAL		F.P.	REFS	41	44	DEFINED	1			
0	DELTAZ	REAL		F.P.	REFS	41	44	DEFINED	1			
0	FMGP	REAL	ARRAY	F.P.	REFS	33	42	DEFINED	1	41	42	
0	HMGP	REAL	ARRAY	F.P.	REFS	33	DEFINED	1	44			
65	I	INTEGER			REFS	41	2*42	44	DEFINED	39		
63	IL	INTEGER			REFS	38	DEFINED	36	37			
0	IT	INTEGER		F.P.	REFS	36	2*37	38	39	DEFINED	1	
0	J	INTEGER		F.P.	REFS	41	2*42	44	DEFINED	1		
64	LT	INTEGER			REFS	39	41	44	DEFINED	38		
0	NA	INTEGER		F.P.	REFS	2*33	DEFINED	1				
0	QC	REAL		F.P.	REFS	41	44	DEFINED	1			
0	SGAPF	REAL		F.P.	REFS	41	DEFINED	1				
0	TIME	REAL	ARRAY	F.P.	REFS	33	41	44	DEFINED	1		

STATEMENT LABELS	DEF LINE	REFERENCES
0 100	46	38

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
22	100	LT	38 46	34B	OPT

STATISTICS
PROGRAM LENGTH 110B 72
140000B SCM USED

```
      SUBROUTINE GASREL (RDOT,FMGR,FMGP,TFR,NT,IPOW,NA,NR,DFS,IM,RVOID,S
     +AVGAS,X,BURNUP,STHIF,W,YY,Z,NGASR)
C
      REAL LGSR
      DIMENSION RDOT(IM,1),      STHIF(NA)    ,      FMGR(NA,1) ,
     +  FMGP(NA,1), TFR(NR), SAVGAS(IM,1), X(NR)
C
C
C     BEYER-HANN GAS RELEASE MODEL DESCRIBED IN REPORT BNWL-1875.
C
C
C     FMGP   - FISSION GAS MOLES PRODUCED TO BEGIN AND END OF TIME STEP
C     FMGR   - FISSION GAS MOLES RELEASED THIS TIME STEP
C     LGSR   - LOW TEMPERATURE MODEL GAS RELEASE FRACTION
C     NGASR  - FLAG FOR NRC HIGH BURNUP FACTOR
C     = 1, USE HIGH BURNUP FACTOR
C     = 2, DO NOT USE HIGH BURNUP FACTOR
C     RDOT   - FRACTION FISSION GAS RELEASED
C     SAVGAS - TOTAL GAS AVAILABLE FOR RELEASE
C     STHIF  - TIME STEP INDEX OF HGIHEST FRACTION RELEASE TO DATE
C
      FLUX(X,Y,Z,D) = Z+Y*(D/2.*0.0254)**2+X*(D/2.*0.0254)**4
C
      SAVGAS(NT,IPOW) = FMGP(IPOW,2)
      IF (NT.GT.1) SAVGAS(NT,IPOW) = SAVGAS(NT-1,IPOW)+FMGP(IPOW,2)-FMGP
     +(IPOW,1)
      RATTM = 0.0
      IF (RVOID.LT..001) RVOID = .001
      IF (NT.NE.1) GO TO 110
      DVOID = RVOID*2.E0
      DX = (DFS-DVOID)/FLOAT(NR-1)
          DO 100 I=1,NR
          X(I) = DFS-DX*(I-1)
  100     CONTINUE
  110 CONTINUE
      LGSR = 0.
C   FIND RADIUS AT EACH TEMPERATURE IN METERS.
      R1200 = TERP(2192.,TFR,X,NR)*.0127
      R1400 = TERP(2552.,TFR,X,NR)*.0127
      R1700 = TERP(3092.,TFR,X,NR)*.0127
      RTM = TERP(5072.,TFR,X,NR)*.0127
      RFS = DFS/2.
      RFSM = RFS*.0254
      RVOIDM = RVOID*.0254
      DENOM = (W/2.)*(RFSM**2-RVOIDM**2)+(YY/4.)*(RFSM**4-RVOIDM**4)+(Z/
     +6.)*(RFSM**6-RVOIDM**6)
C   USE CORRECT FUEL INNER RADIUS WHEN (RTM=0) IS USED TO CALCULATE X17
      IF (RTM.LE.RVOID) GO TO 120
      RATTM = (W/2.)*(RTM**2-RVOIDM**2)+(YY/4.)*(RTM**4-RVOIDM**4)+(Z/6.
     +)*(RTM**6-RVOIDM**6)
      RATTM = RATTM/DENOM
  120 CONTINUE
      RTEST = RVOIDM+.0002
```

```
                IF (R1200.LT.RTEST) GO TO 130                                   GASREL     55
55              RAT12 = (W/2.)*(R1200**2-R1400**2)+(YY/4.)*(R1200**4-R1400**4)+(Z/ GASREL     56
               +6.)*(R1200**6-R1400**6)                                         GASREL     57
                RAT12 = RAT12/DENOM                                             GASREL     58
                RAT14 = (W/2.)*(R1400**2-R1700**2)+(YY/4.)*(R1400**4-R1700**4)+(Z/ GASREL     59
               +6.)*(R1400**6-R1700**6)                                         GASREL     60
60              RAT14 = RAT14/DENOM                                             GASREL     61
                RAT17 = (W/2.)*(R1700**2-RTM**2)+(YY/4.)*(R1700**4-RTM**4)+(Z/6.)* GASREL     62
               +(R1700**6-RTM**6)                                               GASREL     63
                RAT17 = RAT17/DENOM                                             GASREL     64
                GO TO 140                                                       GASREL     65
65          130 CONTINUE                                                        GASREL     66
                RAT17 = 0.0                                                     GASREL     67
                RAT14 = 0.0                                                     GASREL     68
                RAT12 = 0.0                                                     GASREL     69
            140 CONTINUE                                                        GASREL     70
70              RATLG = (W/2.)*(RFSM**2-R1200**2)+(YY/4.)*(RFSM**4-R1200**4)+(Z/6. GASREL     71
               +)*(RFSM**6-R1200**6)                                            GASREL     72
                RATLG = RATLG/DENOM                                             GASREL     73
            C   THE LOW TEMP.(-1200 C) GAS RELEASE FRACTION DEPENDS ONLY ON BURNUP GASREL     74
                LGSR = 0.01/20000.*BURNUP                                       GASREL     75
75              IF (LGSR.GT.0.01) LGSR = 0.01                                   GASREL     76
                RDOT(NT,IPOW) = .05*RAT12+.141*RAT14+.807*RAT17+RATTM           GASREL     77
                IF (RDOT(NT,IPOW).LT.LGSR) RDOT(NT,IPOW) = LGSR                 GASREL     78
                IF (BURNUP.LE.20000.) GO TO 150                                 GASREL     79
                IF (NGASR.EQ.2) GO TO 150                                       GASREL     80
80              DELB = BURNUP-20000.                                            GASREL     81
                FRETN = 1.-RDOT(NT,IPOW)                                        GASREL     82
                BRNEF = (1.-EXP(-.436E-4*DELB))/(1.+.665/RDOT(NT,IPOW)*EXP(-1.167E GASREL     83
               +-4*DELB))                                                       GASREL     84
                RDOT(NT,IPOW) = RDOT(NT,IPOW)+BRNEF*FRETN                       GASREL     85
85          150 CONTINUE                                                        GASREL     86
                SUM6 = 0.0                                                      GASREL     87
                NX = NT-1                                                       GASREL     88
                IF (NT.EQ.1) GO TO 180                                          GASREL     89
                IF (RDOT(NT,IPOW).LE.RDOT(NX,IPOW)) GO TO 170                   GASREL     90
90          C   LSTHIF=LAST HIGHEST RELEASED FRACTION                           GASREL     91
                LSL = IFIX(STHIF(IPOW))                                         GASREL     92
                NIX = NX                                                        GASREL     93
                L = 0                                                           GASREL     94
                    DO 160 NLL=LSL,NIX                                          GASREL     95
95                  L = L+1                                                     GASREL     96
            C   ELIMINATE THE POSSIBILITY OF NL=0 AND RDOT(NL,IPOW) BEING USED  GASREL     97
                    NL = NT-L                                                   GASREL     98
                    IF (RDOT(NT,IPOW).GE.RDOT(NL,IPOW)) GO TO 160               GASREL     99
                    NX = NL                                                     GASREL    100
100                 GO TO 170                                                   GASREL    101
            160     CONTINUE                                                    GASREL    102
                NX = 1                                                          GASREL    103
            C                                                                   GASREL    104
            170 CONTINUE                                                        GASREL    105
105             SUM6 = SAVGAS(NX,IPOW)                                          GASREL    106
            C                                                                   GASREL    107
```

```
                180   CONTINUE                                                          GASREL   108
                      FMGR(IPOW,2) = RDOT(NT,IPOW)*(SAVGAS(NT,IPOW)-SUM6)               GASREL   109
                      SAVGAS(NT,IPOW) = SAVGAS(NT,IPOW)-FMGR(IPOW,2)                    GASREL   110
    110               RETURN                                                            GASREL   111
                      END                                                               GASREL   112
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	GASREL	1	110

VARIABLES

		SN	TYPE		RELOCATION								
626	BRNEF		REAL			REFS	84	DEFINED	82				
0	BURNUP		REAL		F.P.	REFS	74	78	80	DEFINED	1		
624	DELB		REAL			REFS	2*82	DEFINED	80				
616	DENOM		REAL			REFS	51	57	60	63	72		
						DEFINED	45						
0	DFS		REAL		F.P.	REFS	31	33	42	DEFINED	1		
604	DVOID		REAL			REFS	31	DEFINED	30				
605	DX		REAL			REFS	33	DEFINED	31				
0	FMGP		REAL	ARRAY	F.P.	REFS	5	24	2*25	DEFINED	1		
0	FMGR		REAL	ARRAY	F.P.	REFS	5	109	DEFINED	1	108		
625	FRETN		REAL			REFS	84	DEFINED	81				
606	I		INTEGER			REFS	2*33	DEFINED	32				
0	IM		INTEGER		F.P.	REFS	2*5	DEFINED	1				
0	IPOW		INTEGER		F.P.	REFS	2*24	4*25	76	2*77	81	82	2*84
							2*89	91	2*98	105	3*108	3*109	
						DEFINED	1						
633	L		INTEGER			REFS	95	97	DEFINED	93	95		
602	LGSR		REAL			REFS	4	75	2*77	DEFINED	36	74	75
631	LSL		INTEGER			REFS	94	DEFINED	91				
0	NA		INTEGER		F.P.	REFS	3*5	DEFINED	1				
0	NGASR		INTEGER		F.P.	REFS	79	DEFINED	1				
635	NL		INTEGER			REFS	98	99	DEFINED	97			
634	NLL	*	INTEGER			DEFINED	94						
0	NR		INTEGER		F.P.	REFS	2*5	31	32	38	39	40	41
						DEFINED	1						
0	NT		INTEGER		F.P.	REFS	24	3*25	29	76	2*77	81	82
							2*84	87	88	89	97	98	2*108	2*109
						DEFINED	1						
630	NX		INTEGER			REFS	89	92	105	DEFINED	87	99	102
632	NIX		INTEGER			REFS	94	DEFINED	92				
623	RATLG		REAL			REFS	72	DEFINED	70	72			
603	RATTM		REAL			REFS	51	76	DEFINED	27	49	51	
620	RAT12		REAL			REFS	57	76	DEFINED	55	57	68	
621	RAT14		REAL			REFS	60	76	DEFINED	58	60	67	
622	RAT17		REAL			REFS	63	76	DEFINED	61	63	66	
0	RDOT		REAL	ARRAY	F.P.	REFS	5	77	81	82	84	2*89	2*98
							108	DEFINED	1	76	77	84	

VARIABLES	SN	TYPE	RELOCATION									
613	RFS	REAL			REFS	43	DEFINED	42				
614	RFSM	REAL			REFS	3*45	3*70	DEFINED	43			
617	RTEST	REAL			REFS	54	DEFINED	53				
612	RTM	REAL			REFS	48	3*49	3*61	DEFINED	41		
0	RVOID	REAL		F.P.	REFS	28	30	44	48	DEFINED	1	28
615	RVOIDM	REAL			REFS	3*45	3*49	53	DEFINED	44		
607	R1200	REAL			REFS	54	3*55	3*70	DEFINED	38		
610	R1400	REAL			REFS	3*55	3*58	DEFINED	39			
611	R1700	REAL			REFS	3*58	3*61	DEFINED	40			
0	SAVGAS	REAL	ARRAY	F.P.	REFS	5	25	105	108	109		
					DEFINED	1	24	25	109			
0	STHIF	REAL	ARRAY	F.P.	REFS	5	91	DEFINED	1			
627	SUM6	REAL			REFS	108	DEFINED	86	105			
0	TFR	REAL	ARRAY	F.P.	REFS	5	38	39	40	41		
					DEFINED	1						
0	W	REAL		F.P.	REFS	45	49	55	58	61	70	
					DEFINED	1						
0	X	REAL	ARRAY	F.P.	REFS	5	38	39	40	41		
					DEFINED	1	33					
0	YY	REAL		F.P.	REFS	45	49	55	58	61	70	
					DEFINED	1						
0	Z	REAL		F.P.	REFS	45	49	55	58	61	70	
					DEFINED	1						

EXTERNALS	TYPE	ARGS		REFERENCES				
EXP	REAL	1	LIBRARY	2*82				
TERP	REAL	4		38	39	40	41	

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
FLOAT	REAL	1	INTRIN		31
FLUX	REAL	4	SF	22	
IFIX	INTEGER	1	INTRIN		91

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	34	32	
70	110	35	29	
201	120	52	48	
263	130	65	54	
272	140	69	64	
407	150	85	78	79
457	160	101	94	98
465	170	104	89	100
474	180	107	88	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
57	100	I	32 34	10B	INSTACK	
440	160	NLL	94 101	22B	OPT	EXITS

STATISTICS
PROGRAM LENGTH 647B 423
140000B SCM USED

```
      SUBROUTINE HCFF (DOXIDE,ESR,FREQ,HYDRO,IODINE,NPCYCL,TCLAD,NCF)
C
C     IMPLICIT REAL*8(A-H,O-Z)
C
C     SUBROUTINE HCFF PREDICTS THE NUMBER OF POWER CYCLES TO FAILURE
C     FOR A ROD SUBJECTED TO HIGH CYCLE FATIGUE
C     ***  PART OF FRAIL FAILURE PACKAGE   ***
C
C
C     --  INPUT ARGUMENTS  --
C
C     DOXIDE     DEPTH OF OXIDE LAYER ( PER CENT OF CLAD THICKNESS )
C     ESR        ELASTIC STRAIN RANGE
C     FREQ       FREQUENCY OF POWER CYCLE ( SEC-1 )
C     HYDRO      CLADDING HYDROGEN CONTENT ( PPM )
C     IODINE     CLADDING IODINE CONTENT ( KG/ M3 )
C     NPCYCL     NUMBER OF PREVIOUS POWER CYCLES
C     TCLAD      CLADDING TEMPERATURE ( DEG K )
C
C     -- OUTPUT ARGUMENTS  --
C
C     NCF        NUMBER OF POWER CYCLES TO FAILURE
C
      REAL*8 IODINE, NPCYCL, NCF
C        REAL IODINE, NPCYCL, NCF
C     SET THE NUMBER OF CYCLES TO FAILURE TO A LARGE NUMBER UNTIL THE
C     CORRECT NUMBER OF CYCLES IS KNOWN
C     NCF = 1.0D+9
        NCF = 1.0E+9
C
        RETURN
        END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	HCFF	1	32

VARIABLES

		SN	TYPE	RELOCATION							
0	DOXIDE		REAL	*UNUSED	F.P.	DEFINED	1				
0	ESR		REAL	*UNUSED	F.P.	DEFINED	1				
0	FREQ		REAL	*UNUSED	F.P.	DEFINED	1				
0	HYDRO		REAL	*UNUSED	F.P.	DEFINED	1				
0	IODINE		REAL	*UNUSED	F.P.	REFS	26	DEFINED	1		
0	NCF		REAL		F.P.	REFS	26	DEFINED	1	30	
0	NPCYCL		REAL	*UNUSED	F.P.	REFS	26	DEFINED	1		
0	TCLAD		REAL	*UNUSED	F.P.	DEFINED	1				

```
STATISTICS
  PROGRAM LENGTH                 12B      10
        140000B SCM USED
```

```
      SUBROUTINE INITAL (DVHPRS,TTT,EPS22,EPP2,FVFRO,SIG2,REPS2,EPS02,EP
     +2,GAP2,R22,ECREP2,PREPS2,PEPP2,OLDT2,PEP2,OLDPG2,OLDPC2,OLIGP2,IGA
     +P2,EPS0,MNR,MNA)
C
C     IMPLICIT REAL*8 (A-H,O-Z)
C
      REAL  NU , KRYIN
C
      COMMON  / FAST / A
C
      DIMENSION  A(1)
C
C
C     THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY
C     DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL
C
C
C     ( NA )      -  ARRAYS
C
      COMMON  / POINT /
     +       LDC1H    ,LURC     ,LCREP1   ,LDLH     ,LHA      ,LHL
     +      ,LPOROS   ,LUFS     ,LAXGAP   ,LAXLEN   ,LBU1     ,LBU2
     +      ,LARAD    ,LCPDLT   ,LDELBP   ,LDENMX   ,LDLPGE
     +      ,LDZ      ,LDZH     ,LDZHP    ,LECREP   ,LEP
     +      ,LGAP     ,LGPTP    ,LHCOEF   ,LOLAXG   ,LOLDPC
     +      ,LOLDPG   ,LOLDTC   ,LOLDUR   ,LOLEPS   ,LOLFEP
     +      ,LPAXGP   ,LPC      ,LPECRP   ,LPEP     ,LPG
     +      ,LPINT    ,LPLDPC   ,LPLDPG   ,LPLDTC   ,LPLDUR   ,LPOAXG
     +      ,LPOFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR
     +      ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF
     +      ,LVCH     ,LVCH1    ,LVCR     ,LVDH     ,LVFH     ,LVGH
     +      ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEP1
     +      ,LHGAPS   ,LTRTRN   ,LIGAP    ,LOLIGP   ,LQDP
     +      ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO
     +      ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO
C
C     ( NA X 2 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG
     +      ,LREPS2
C
C     ( NA X 3 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS
     +      ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS
     +      ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPPI
     +      ,LSIGI    ,LEPSI
C
C     ( NR )      -  ARRAYS
C
      COMMON  / POINT /
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      +       LAK1    ,LAK2    ,LCRL    ,LDPL    ,LDPLH   ,LDPN    REALCM  44
55    +      ,LFMA    ,LFMGPR  ,LHRL    ,LTFB    ,LTFR    ,LTFRK   REALCM  45
      +      ,LVPL                                                  REALCM  46
      C                                                             REALCM  47
      CC  ( NR X 2 )  -  ARRAYS                                     REALCM  48
      C                                                             REALCM  49
60      COMMON  / POINT /                                           REALCM  50
      +       LF      ,LFH     ,LFN                                 REALCM  51
      C                                                             REALCM  52
      CC  ( NR X NA ) -  ARRAYS                                     REALCM  53
      C                                                             REALCM  54
65      COMMON  / POINT /                                           REALCM  55
      +       LCC1    ,LCC2    ,LDENSF  ,LDENSP  ,LDPW    ,LDPWPP  REALCM  56
      +      ,LGNSIZ  ,LPORS1  ,LPORS2  ,LTMPDS  ,LU02LL  ,LTMPMX  REALCM  57
      +      ,LR      ,LRAD                                         REALCM  58
      C                                                             REALCM  59
70    CC  ( NA X 6 )  -  ARRAYS                                     REALCM  60
      C                                                             REALCM  61
      COMMON  / POINT /                                             REALCM  62
      +       LB      ,LBR     ,LBTOLD  ,LCHEM                      REALCM  63
      C                                                             REALCM  64
75    CC  ( NA X 8 )  -  ARRAYS                                     REALCM  65
      C                                                             REALCM  66
      COMMON  / POINT /                                             REALCM  67
      +       LQ                                                    REALCM  68
      C                                                             REALCM  69
80    C   ( IT )      -  ARRAYS                                     REALCM  70
      C                                                             REALCM  71
      COMMON  / POINT /          LACMFG   ,LACMHE  ,LACMH2  ,LACMN2 REALCM  72
      +                 ,LAMGPT  ,LGASMO  ,LHMGPT  ,LPIT    ,LPRT10  REALCM  73
      +      ,LPRT11  ,LPRT12  ,LPRT13  ,LPRT14  ,LPRT15  ,LPRT16  REALCM  74
85    +      ,LPRT17  ,LPRT18  ,LPRT2   ,LPRT20  ,LPRT3   ,LPRT4   REALCM  75
      +      ,LPRT5   ,LPRT6   ,LPRT7   ,LPRT8   ,LPRT9   ,LTAC    REALCM  76
      +      ,LTAFA   ,LTAGA   ,LTSF                                REALCM  77
      C                                                             REALCM  78
      CC                                                            REALCM  79
90    CC  ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME       REALCM  80
      C                                                             REALCM  81
      COMMON / POINT /                                              REALCM  82
      +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,    REALCM  83
      +   LDECAY,   LHALF,    LRLEAS                                REALCM  84
95    C                                                             REALCM  85
      CC  BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME              REALCM  86
      C                                                             REALCM  87
      COMMON / POINT /                                              REALCM  88
      +   IRDOT,    ISAVGS,   LSTHIF,   IX                        REALCM  89
100   C                                                             REALCM  90
      CC  RADIAL MODEL ARRAYS                                       REALCM  91
      C                                                             REALCM  92
      COMMON / POINT /                                              REALCM  93
      +   ICFAC    ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF   REALCM  94
105   +  ,ITRAMP   ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV             REALCM  95
      +  ,IHLDN    ,IPLSTC   ,ISTRNN   ,ISTRSS                       REALCM  96
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      C                                                                                                  REALCM     97
      C                                                                                                  REALCM     98
      C                                                                                                  REALCM     99
110   C                                                                                                  REALCM    100
       COMMON / REALS /   AAA(20)  ,AAN       ,AIRIN    ,AMGP(2) ,AMGPH(2)                              REALCM    101
      +                  ,AMGR(2)  ,AMGRH(2) ,AMGRN2(2),AMWDT    ,ANGI                                  REALCM    102
      +          ,ANGT   ,AN2IN    ,ARGIN    ,ARING    ,AVGQI(8) ,B(6)                                  REALCM    103
      +          ,BP     ,BPP      ,BR(6)    ,BU       ,BUOLD    ,CDG                                   REALCM    104
115   +          ,CFV    ,CFVA     ,CHOL     ,CODEID(15),CONVC,CONVER(10)                             REALCM    105
      +          ,CPV    ,CRDTT    ,CRN      ,CVV      ,DCIH                                          REALCM    106
      +          ,DCIHP  ,DELBP    ,DELBU    ,DELH     ,DELT                                          REALCM    107
      +          ,DELTCR ,DELTDB   ,DELTFC   ,DELTJL   ,DHIC     ,DLREL                               REALCM    108
      +          ,DLROD  ,DLTGC(26),DPH      ,DPHF     ,DPHFP    ,DPWP                                REALCM    109
120   +          ,DRS    ,ENRICH   ,EOLSR    ,FC(1)    ,FGIN     ,FGPAVP                              REALCM    110
      C                                                                                                  REALCM    111
       COMMON / REALS /   FGPAVX   ,FH2O     ,FJJ(2)   ,FJJH(2)  ,FMGP(2)                             REALCM    112
      +                  ,FPOR     ,FPORI    ,FRD      ,FRDH     ,FRDN                                REALCM    113
      +          ,G      ,GASES(7) ,GASIN    ,GDEN   ,GPTH(26) ,GPTHE(26)                           REALCM    114
125   +          ,GPTHM  ,GPTHP    ,GPTHPG(26) ,GR     ,HCRV     ,HCV                                 REALCM    115
      +          ,HDSHV  ,HEIN     ,HFLL     ,HFLMDB   ,HFLMP    ,HFPER                               REALCM    116
      +          ,HFV    ,HGAPT    ,HGV      ,HI       ,HMGF(2)  ,HP                                  REALCM    117
      +          ,HGAP   ,HSOLID   ,HGAPR                                                              REALCM    118
      +          ,HPL    ,HPORV    ,HPV      ,HUPTAK   ,H2OMI    ,KRYIN                               REALCM    119
130   +          ,NU     ,OXDROP   ,OXIDE    ,PECDH    ,PI       ,PIN(26)                             REALCM    120
      +          ,PINP   ,PORO     ,PR       ,PRESS    ,PRTY     ,PRT19                               REALCM    121
      +          ,QC     ,QP       ,QSP      ,RCI      ,RCO                                           REALCM    122
      +          ,QAV    ,QPEAK                                                                        REALCM    123
      C                                                                                                  REALCM    124
135    COMMON / REALS /   RFNVFF   ,RHO      ,RHOF     ,RHOG     ,RHOU02   REALCM    125
      +                  ,RMH      ,RP       ,RSTRAN   ,RSTRES   ,RTRAN    REALCM    126
      +          ,SKTC   ,SKTS     ,STRN     ,SUMCK    ,SUMDH    ,SUMEXP   REALCM    127
      +          ,SUMGP  ,SUMPOR   ,SUMRG    ,SUMTF    ,T        ,TCAC     REALCM    128
      +          ,TCI    ,TCO      ,TFBC     ,TFC      ,TFGFR    ,THEFR    REALCM    129
140   +          ,TH2OFR ,TITLE(12),TM       ,TN2FR    ,TOXO     ,TP       REALCM    130
      +          ,TPA    ,TPAC     ,TPLEN    ,TRANST   ,TSAT     ,TT       REALCM    131
      +          ,TX     ,TXA      ,TXAL     ,TXC      ,VISC     ,VPLT     REALCM    132
      +          ,V55    ,W        ,WT       ,WTRAN    ,XEIN     ,XK6      REALCM    133
      +          ,XK7    ,YY       ,Z        ,ZRO2WG   ,VX       ,CLOS     REALCM    134
145   +          ,FNCK   ,FNCN     ,CWKF     ,CWNF     ,COLDWK             REALCM    135
      +          ,DISH                                                     REALCM    136
      C                                                                    REALCM    137
      C                                                                    INTGCM      2
       COMMON / INTEG /                                                    INTGCM      3
150   +    IQUIT      ,IRI      ,IT       ,ITER     ,J                    INTGCM      4
      +   ,JJC        ,JPEAK    ,K        ,KINDOR   ,KOXI                 INTGCM      5
      +   ,LMN        ,M        ,MODLOP   ,NAB      ,NPLAST               INTGCM      6
      +   ,NRMI       ,NSTEP    ,NWRITE   ,N2       ,IMDONE               INTGCM      7
      +   ,ICLOSE     ,NSH      ,NF       ,NC                             INTGCM      8
155   C                                                                    INTGCM      9
      C                                                                    INPRCM      2
       COMMON / INPTR /ACOR      ,AFAL     ,AFCR     ,AFDN                 INPRCM      3
      +                ,AFGR     ,AFSW     ,AFTC     ,AGPC                 INPRCM      4
      +   ,AMFAIR      ,AMFARG   ,AMFFG    ,AMFHE    ,AMFH2                INPRCM      5
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      +    ,AMFH2O    ,AMFKRY    ,AMFN2     ,AMFXE                          INPRCM     6
      +    ,BUIN(22)  ,CATEXF                                               INPRCM     7
      +    ,CLDWKD    ,CPL       ,CRDT      ,CRDTR     ,CTMAX(22)           INPRCM     8
      +    ,DCI(22)   ,DCO(22)   ,DE(22)    ,DELTAZ(22),DEN                 INPRCM     9
      +    ,DENG      ,DISHSD    ,DP(22)    ,DSPG      ,DSPGW               INPRCM    10
      +    ,ENRCH     ,EXO       ,FA        ,FGPAV     ,FLUX                INPRCM    11
      +    ,FLXDP     ,FQE       ,GO(101)   ,GRNSIZ    ,HDISH               INPRCM    12
      +    ,HPLT      ,PPMH2O    ,PPMN2     ,P2(101)   ,QEND(8)             INPRCM    13
      +    ,QF(328)   ,QMPY(101) ,RAPOW(11) ,RC        ,RDISH               INPRCM    14
      +    ,ROUGHC    ,ROUGHF    ,SGAPF                                       INPRCM    15
      +    ,TCC       ,TIME(101) ,TOTL      ,TSINT     ,TW(101)             INPRCM    16
      +    ,UBFS      ,UMELT     ,UOFD      ,VS        ,X(328)              INPRCM    17
      +    ,RSNTR     ,FOTMTL    ,TREF      ,CREPHR    ,ANRIN               INPRCM    18
      +    ,CLDWKS                                                          INPRCM    19
      +    ,CP        ,CR                                                   INPRCM    20
      C                                                                     INPICM     2
       COMMON / INPTI /ICM       ,ICOR      ,IDBG      ,IDXGAS              INPICM     3
      +               ,IM        ,IPLANT    ,IQ        ,ISW                 INPICM     4
      +    ,JDLPR     ,JN(8)     ,JST(101)  ,MDBG      ,NHEAL               INPICM     5
      +    ,MODE      ,MODES     ,MTAPE     ,NDBG      ,NFROD               INPICM     6
      +    ,NGAPC     ,NGASR     ,NOFAIL    ,NOPT      ,NPCYCL              INPICM     7
      +    ,NPLTAB    ,NREAD     ,NRESTR    ,NROLL     ,NSP                 INPICM     8
      +    ,NSTART    ,NSTOP     ,NT        ,NTAPE     ,NUCFC               INPICM     9
      +    ,NUNITS    ,LACMOD    ,LACE(13)  ,NAFAIL    ,NNFAIL(22)          INPICM    10
      +    ,NXP       ,NPLOT     ,NTPLOT    ,NROD      ,NA                  INPICM    11
      +    ,NR        ,NEWPRB    ,MECHAN    ,NCRACK    ,NELAST              INPICM    12
      +    ,NCREEP    ,IAXSYM    ,IVARDM    ,NOFRAC    ,ITREST              INPICM    13
      +    ,NWORDS    ,IWORDS    ,NWRDS     ,NPRINT                         INPICM    14
      C                                                                     INPICM    15
      C                                                                     INPICM    16
       COMMON  /EMFLGS/   IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO             INPICM    17
      +                 ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG             INPICM    18
      +         ,IMFGAS   ,IMSWCH                                          INPICM    19
      C                                                                     INPICM    20
      C                                                                     INPICM    21
      C                                                                     INPICM    22
       COMMON/PFRCS2/     MODPG2          ,MODPC2          ,MGAP2          INPICM    23
      +  ,MIGAP2          ,MOIGP2          ,MREPS2          ,MFEPS2         INPICM    24
      +  ,MTTT            ,MEREP2          ,MEP2            ,MR22           INPICM    25
      +  ,MOLDT2          ,MFVFRO          ,MDHPRS          ,MPEP2          INPICM    26
      +  ,MEPS22          ,MEPP2           ,MSIG2           ,MEPS02         INPICM    27
      +  ,MPEPP2          ,MEPS0           ,NNNCRP                          INPICM    28
      C                                                                     INPICM    29
       COMMON /MATCNS/ AAHA(12)                                             INPICM    30
      C                                                                     INPICM    31
      C                                                                     INPICM    32
       COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                                INPICM    33
      C                                                                     INPICM    34
       COMMON /VER/ VERS                                                    INPICM    35
      C                                                                     PHYPRO     2
       COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB        PHYPRO     3
      +             ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP          PHYPRO     4
      +             ,DELOXY                                                PHYPRO     5
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      C                                                                      PHYPRO     6
      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)               PHYPRO     7
215   C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)             PHYPRO     8
      C   CTMELT - ZR CLAD MELTING POINT (K)                                 PHYPRO     9
      C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                           PHYPRO    10
      C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)         PHYPRO    11
      C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)           PHYPRO    12
220   C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)         PHYPRO    13
      C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)           PHYPRO    14
      C   BU     - BURNUP (MW-S/KG-U)                                       PHYPRO    15
      C   COMP   - PUO2 CONTENT (WT-PERCENT)                               PHYPRO    16
      C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED      PHYPRO    17
225   C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                              PHYPRO    18
      C                                                                      PHYPRO    19
            COMMON / AXL /  SUMM , SUMFF , SUMSAV , GROW                     INIT      18
            DIMENSION AGRASS(1)                                              INIT      19
            EQUIVALENCE (AGRASS(1),A(1))                                     INIT      20
230         EQUIVALENCE (A(1),AFCMI2(1))                                     INIT      21
            DIMENSION AFCMI2(1)                                              INIT      22
      C                                                                      INIT      23
      C                                                                      INIT      24
      C                                                                      INIT      25
235         INTEGER  OLIGP2                                                  INIT      26
            DIMENSION TTT(MNA,MNR),EPS22(MNA,MNR,3),EPP2(MNA,MNR,3)          INIT      27
           + ,SIG2(MNA,MNR,3),REPS2(MNA,2),EPS02(MNA,MNR,3)                  INIT      28
           + ,EP2(MNA,MNR),GAP2(MNA),R22(MNA,MNR),ECREP2(MNA,MNR)            INIT      29
           + ,OLDT2(MNA,MNR)                                                 INIT      30
240        + ,OLDPG2(MNA),OLDPC2(MNA),OLIGP2(MNA),IGAP2(MNA)                 INIT      31
           + ,EPS0(MNA,MNR,3)                                                INIT      32
           + ,PEP2(MNA,MNR),PEPP2(MNA,MNR,3),PREPS2(MNA,2)                   INIT      33
           + ,FVFRO(MNA,MNR) ,DVHPRS(MNA,MNR)                                INIT      34
      C                                                                      INIT      35
245         COMMON / GRSPTR /   NVAR1    ,NVAR2    ,NVAR3    ,NVAR4        INIT      36
           +          ,NVAR5    ,NVAR6    ,NVAR7    ,NVAR8    ,NVAR9       INIT      37
           +          ,NVAR10   ,NVAR11   ,NVAR12   ,NVAR13   ,NVAR14      INIT      38
           +          ,NVAR15   ,NVAR16   ,NVAR17   ,NVAR18   ,NVAR19      INIT      39
           +          ,NVAR20   ,NVAR21   ,NVAR22   ,NVAR23   ,NVAR24      INIT      40
250        +          ,NVAR25   ,NVAR26   ,NVAR27   ,NVAR28   ,NVAR29      INIT      41
           +          ,NVAR30   ,NVAR31   ,NVAR32   ,NVAR33   ,NVAR34      INIT      42
           +          ,NVAR35   ,NVAR36   ,NVAR37   ,LGRASS                INIT      43
      C                                                                      INIT      44
      C   THE FOLLOWING DATA STATEMENTS CONTAIN VARIOUS CONVERSION FACTORS    INIT      45
255   C                                                                      INIT      46
      C                                                                      INIT      47
            DATA      CMTOIN  , CMTOML  , CMTOFT  , CNMTPS  , CSTOHR         INIT      48
           +         /39.37 E+0,3.9370E04,3.28084E0,1.4504E-4,2.77778E-4/    INIT      49
            DATA      CKSTPH  , CMSTMD  , CWCTKF  , CKTOR   , CFTOR          INIT      50
260        +         /737.338E0,1.1574E-2,3.048E-02, 1.8E0   ,459.67E+00/    INIT      51
      C                                                                      INIT      52
            NAMELIST / FRPCON /    COMP     ,CPL      ,DCI      ,DCO        INIT      53
           +  ,DE       ,DELTAZ   ,DEN      ,DISHSD   ,DP       ,DSPG       INIT      54
           +  ,DSPGW    ,ENRCH    ,FA       ,FGPAV    ,FLUX     ,LINKT      INIT      55
265        +  ,GO       ,HDISH    ,HPLT     ,ICM      ,IDXGAS   ,IPLANT     INIT      56
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     +  ,IQ       ,IVARDM   ,JDLPR    ,JN       ,JST      ,NOPT      INIT       57
     +  ,NSP      ,NUNITS   ,P2       ,QF       ,QMPY     ,RC        INIT       58
     +  ,ROUGHC   ,ROUGHF   ,TIME     ,TOTL     ,TW       ,VS        INIT       59
     +  ,X        ,AMFAIR   ,AMFARG   ,AMFFG    ,AMFHE               INIT       60
270  +  ,AMFH2    ,AMFH2O   ,AMFKRY   ,AMFN2    ,AMFXE    ,BETA      INIT       61
     +  ,BUIN     ,CATEXF   ,CLDWKD   ,CP       ,CR       ,CRDT      INIT       62
     +  ,CRDTR    ,CTMAX    ,DENG     ,GRNSIZ   ,ICOR     ,IMSWCH    INIT       63
     +  ,NOFAIL   ,NFROD    ,FOTMTL   ,NPCYCL   ,NPLTAB   ,NREAD     INIT       64
     +  ,NRESTR   ,CLDWKS   ,ITREST   ,NTAPE    ,NUCFC    ,PPMH2O    INIT       65
275  +  ,PPMN2    ,QEND     ,RAPOW    ,RSNTR    ,SGAPF    ,TSINT     INIT       66
     +  ,UBFS     ,UMELT    ,UOFD     ,CREPHR   ,NPRINT              INIT       67
     C                                                                INIT       68
     C                                                                INIT       69
      NAMELIST  / EMFPCN /    IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO   INIT       70
280  +                       ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG   INIT       71
     +                       ,IMFGAS                                 INIT       72
     C                                                                INIT       73
      IF (NEWPRB.EQ.1) GO TO 130                                      INIT       74
     C                                                                INIT       75
285   ACOR = 1.E0                                                     INIT       76
      AFCR = 1.E0                                                     INIT       77
      AFDN = 1.E0                                                     INIT       78
      AFGR = 1.E0                                                     INIT       79
      AFSW = 1.E0                                                     INIT       80
290   AFTC = 1.E0                                                     INIT       81
      AFAL = 1.E0                                                     INIT       82
      AGPC = 1.E0                                                     INIT       83
      ANRIN = 0.0                                                     INIT       84
      BETA = 1.E0                                                     INIT       85
295   CATEXF = 0.05E0                                                 INIT       86
      CNOB = 2.E0                                                     INIT       87
      CLDWKD = 0.E0                                                   INIT       88
      CLDWKS = 0.2E0                                                  INIT       89
      COLDWK = 0.1                                                    INIT       90
300   COMP = 0.E0                                                     INIT       91
      CP = 1.0                                                        INIT       92
      CR = 1.0                                                        INIT       93
      CRDT = 1.E0                                                     INIT       94
      CRDTR = 1.1415525E-4                                            INIT       95
305   CREPHR = 10.E0                                                  INIT       96
      DENG = 0.75E0                                                   INIT       97
      EXO = 1.E0                                                      INIT       98
      FA = 1.E0                                                       INIT       99
      FLXDP = 0.9999E0                                                INIT      100
310   FLUX = 6.E17                                                    INIT      101
      FOTMTL = 2.E0                                                   INIT      102
      FQE = 1.E0                                                      INIT      103
      GRNSIZ = 5.0E+0                                                 INIT      104
      IDBG = 0                                                        INIT      105
315   IMSWCH = 0                                                      INIT      106
      ISW = 0                                                         INIT      107
      ITREST = 0                                                      INIT      108
      IVARDM = 0                                                      INIT      109
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                KINDOR = 1                                                  INIT  110
320             LACMOD = 0                                                  INIT  111
                LINKT = 5                                                   INIT  112
                MAXIDX = 19                                                 INIT  113
                MDBG = 0                                                    INIT  114
                MODE = 0                                                    INIT  115
325             MODES = 0                                                   INIT  116
                MTAPE = 1                                                   INIT  117
                NAFAIL = 1                                                  INIT  118
                NCRACK = 1                                                  INIT  119
                NCREEP = 0                                                  INIT  120
330             NSH = 0                                                     INIT  121
                NELAST = 0                                                  INIT  122
                NFROD = 1                                                   INIT  123
                NGAPC = 1                                                   INIT  124
                NHEAL = 1                                                   INIT  125
335             NOFAIL = 1                                                  INIT  126
                NOFRAC = 0                                                  INIT  127
                NOPT = 0                                                    INIT  128
                NPCYCL = 0                                                  INIT  129
                NPLTAB = 0                                                  INIT  130
340             NPRINT = 1                                                  INIT  131
                NREAD = 0                                                   INIT  132
                NRESTR = 0                                                  INIT  133
                NROLL = 0                                                   INIT  134
                NSTART = 0                                                  INIT  135
345             NSTOP = 0                                                   INIT  136
                NTAPE = 0                                                   INIT  137
                NUCFC = 0                                                   INIT  138
                NUNITS = 0                                                  INIT  139
                PPMN2 = 0.E0                                                INIT  140
350             RC = 0.E0                                                   INIT  141
                ROUGHC = 4.5E-5                                             INIT  142
                ROUGHF = 8.5E-5                                             INIT  143
                RSNTR = 0.E0                                                INIT  144
                SGAPF = 30.E0                                               INIT  145
355             TCC = 0.E0                                                  INIT  146
                TREF = 77.E0                                                INIT  147
                TSINT = 2912.E0                                             INIT  148
                UBFS = 1.E9                                                 INIT  149
                UMELT = 0.E0                                                INIT  150
360             UOFD = 17.E0                                                INIT  151
          C                                                                 INIT  152
                DO 100 II=1,NR                                              INIT  153
          100   RAPOW(II) = 1.E0                                            INIT  154
                NAP1 = NA+1                                                 INIT  155
365             DO 110 II=1,NAP1                                            INIT  156
          110   CTMAX(II) = 386.33E0                                        INIT  157
                DO 120 I=1,8                                                INIT  158
          120   QEND(I) = 0.3                                               INIT  159
          C                                                                 INIT  160
370       130 CONTINUE                                                      INIT  161
                IF (MECHAN.NE.2) NOFAIL = 1                                 INIT  162
```

```
      C
            READ (5,FRPCON)                                                    INIT      163
      C                                                                         INIT      164
            WRITE (6,FRPCON)                                                    INIT      165
      C                                                                         INIT      166
      C                                                                         INIT      167
      C     THE FOLLOWING CALL TO NEMSET SETS ALL EM MODELS ON OR OFF           INIT      168
      C                                                                         INIT      169
            CALL NEMSET (IMSWCH,IMPOWR,9)                                       INIT      170
      C                                                                         INIT      171
            IF (IMSWCH.EQ.-1) CALL NEMSET (0,IMPOWR,9)                          INIT      172
            IF (IMSWCH.EQ.-1) READ (5,EMFPCN)                                   INIT      173
      C                                                                         INIT      174
            IF (IMENRG.EQ.1) TREF = 32.E0                                       INIT      175
      C                                                                         INIT      176
            IF (IMSWCH.NE.0) MECHAN = 2                                         INIT      177
            IF (IVARDM.EQ.2) GO TO 150                                          INIT      178
            IF (IVARDM.NE.1) DELTAZ(1) = TOTL/NT                                INIT      179
            CDG = (DCI(1)-DP(1))*1.E3                                           INIT      180
                DO 140 II=2,NA                                                  INIT      181
                BUIN(II) = BUIN(1)                                              INIT      182
                DCO(II) = DCO(1)                                                INIT      183
                DCI(II) = DCI(1)                                                INIT      184
                DP(II) = DP(1)                                                  INIT      185
                DE(II) = DE(1)                                                  INIT      186
                IF (IVARDM.NE.1) DELTAZ(II) = DELTAZ(1)                         INIT      187
      140       CONTINUE                                                        INIT      188
      150   CONTINUE                                                            INIT      189
            DUMMY = 0.0                                                         INIT      190
            CALL DIALOT (DUMMY,61,FDIALA,FDIALM)                                INIT      191
            CPL = (CPL+FDIALA)*FDIALM                                           INIT      192
            CALL DIALOT (DUMMY,38,FDIALA,FDIALM)                                INIT      193
            DCI(1) = (DCI(1)+FDIALA)*FDIALM                                     INIT      194
            CALL DIALOT (DUMMY,39,FDIALA,FDIALM)                                INIT      195
            DCO(1) = (DCO(1)+FDIALA)*FDIALM                                     INIT      196
            CALL DIALOT (DUMMY,62,FDIALA,FDIALM)                                INIT      197
            DE(1) = (DE(1)+FDIALA)*FDIALM                                       INIT      198
            CALL DIALOT (DUMMY,32,FDIALA,FDIALM)                                INIT      199
            DEN = (DEN+FDIALA)*FDIALM                                           INIT      200
            CALL DIALOT (DUMMY,33,FDIALA,FDIALM)                                INIT      201
            DISHSD = (DISHSD+FDIALA)*FDIALM                                     INIT      202
            CALL DIALOT (DUMMY,37,FDIALA,FDIALM)                                INIT      203
            DP(1) = (DP(1)+FDIALA)*FDIALM                                       INIT      204
            CALL DIALOT (DUMMY,63,FDIALA,FDIALM)                                INIT      205
            DSPG = (DSPG+FDIALA)*FDIALM                                         INIT      206
            CALL DIALOT (DUMMY,64,FDIALA,FDIALM)                                INIT      207
            DSPGW = (DSPGW+FDIALA)*FDIALM                                       INIT      208
            CALL DIALOT (DUMMY,65,FDIALA,FDIALM)                                INIT      209
            ENRCH = (ENRCH+FDIALA)*FDIALM                                       INIT      210
            CALL DIALOT (DUMMY,44,FDIALA,FDIALM)                                INIT      211
            FGPAV = (FGPAV+FDIALA)*FDIALM                                       INIT      212
            CALL DIALOT (DUMMY,66,FDIALA,FDIALM)                                INIT      213
                DO 160 L=1,IM                                                   INIT      214
                                                                                INIT      215
```

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                      GO(L) = (GO(L)+FDIALA)*FDIALM                                  INIT      216
                CALL DIALOT (DUMMY,34,FDIALA,FDIALM)                                 INIT      217
                HDISH = (HDISH+FDIALA)*FDIALM                                        INIT      218
                CALL DIALOT (DUMMY,35,FDIALA,FDIALM)                                 INIT      219
                HPLT = (HPLT+FDIALA)*FDIALM                                          INIT      220
                CALL DIALOT (DUMMY,67,FDIALA,FDIALM)                                 INIT      221
                      DO 170 L=1,IM                                                  INIT      222
          170         P2(L) = (P2(L)+FDIALA)*FDIALM                                  INIT      223
                CALL DIALOT (DUMMY,68,FDIALA,FDIALM)                                 INIT      224
                ISUM = 0                                                             INIT      225
                      DO 180 L=1,8                                                   INIT      226
          180         ISUM = ISUM+JN(L)                                              INIT      227
                      DO 190 L=1,ISUM                                                INIT      228
          190         QF(L) = (QF(L)+FDIALA)*FDIALM                                  INIT      229
                CALL DIALOT (DUMMY,48,FDIALA,FDIALM)                                 INIT      230
                      DO 200 L=1,IM                                                  INIT      231
          200         QMPY(L) = (QMPY(L)+FDIALA)*FDIALM                              INIT      232
                CALL DIALOT (DUMMY,69,FDIALA,FDIALM)                                 INIT      233
                TOTL = (TOTL+FDIALA)*FDIALM                                          INIT      234
                CALL DIALOT (DUMMY,70,FDIALA,FDIALM)                                 INIT      235
                      DO 210 L=1,IM                                                  INIT      236
          210         TW(L) = (TW(L)+FDIALA)*FDIALM                                  INIT      237
                CALL DIALOT (DUMMY,71,FDIALA,FDIALM)                                 INIT      238
                VS = (VS+FDIALA)*FDIALM                                              INIT      239
                CALL DIALOT (DUMMY,72,FDIALA,FDIALM)                                 INIT      240
                BUIN(1) = (BUIN(1)+FDIALA)*FDIALM                                    INIT      241
                CALL DIALOT (DUMMY,73,FDIALA,FDIALM)                                 INIT      242
                CATEXF = (CATEXF+FDIALA)*FDIALM                                      INIT      243
                CALL DIALOT (DUMMY,74,FDIALA,FDIALM)                                 INIT      244
                CLDWKD = (CLDWKD+FDIALA)*FDIALM                                      INIT      245
                CLDWKS = (CLDWKS+FDIALA)*FDIALM                                      INIT      246
                CALL DIALOT (DUMMY,75,FDIALA,FDIALM)                                 INIT      247
                COMP = (COMP+FDIALA)*FDIALM                                          INIT      248
                CALL DIALOT (DUMMY,76,FDIALA,FDIALM)                                 INIT      249
                CRDT = (CRDT+FDIALA)*FDIALM                                          INIT      250
                CALL DIALOT (DUMMY,77,FDIALA,FDIALM)                                 INIT      251
                CRDTR = (CRDTR+FDIALA)*FDIALM                                        INIT      252
                CALL DIALOT (DUMMY,78,FDIALA,FDIALM)                                 INIT      253
                DENG = (DENG+FDIALA)*FDIALM                                          INIT      254
                CALL DIALOT (DUMMY,79,FDIALA,FDIALM)                                 INIT      255
                FLUX = (FLUX+FDIALA)*FDIALM                                          INIT      256
                CALL DIALOT (DUMMY,80,FDIALA,FDIALM)                                 INIT      257
                GRNSIZ = (GRNSIZ+FDIALA)*FDIALM                                      INIT      258
                CALL DIALOT (DUMMY,81,FDIALA,FDIALM)                                 INIT      259
                PPMH2O = (PPMH2O+FDIALA)*FDIALM                                      INIT      260
                CALL DIALOT (DUMMY,82,FDIALA,FDIALM)                                 INIT      261
                PPMN2 = (PPMN2+FDIALA)*FDIALM                                        INIT      262
                CALL DIALOT (DUMMY,83,FDIALA,FDIALM)                                 INIT      263
                      DO 220 L=1,8                                                   INIT      264
          220         QEND(L) = (QEND(L)+FDIALA)*FDIALM                              INIT      265
                CALL DIALOT (DUMMY,84,FDIALA,FDIALM)                                 INIT      266
                RC = (RC+FDIALA)*FDIALM                                              INIT      267
                CALL DIALOT (DUMMY,40,FDIALA,FDIALM)                                 INIT      268
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                ROUGHC = (ROUGHC+FDIALA)*FDIALM                                  INIT   269
                CALL DIALOT (DUMMY,41,FDIALA,FDIALM)                             INIT   270
480             ROUGHF = (ROUGHF+FDIALA)*FDIALM                                  INIT   271
                CALL DIALOT (DUMMY,85,FDIALA,FDIALM)                             INIT   272
                SGAPF = (SGAPF+FDIALA)*FDIALM                                    INIT   273
                CALL DIALOT (DUMMY,86,FDIALA,FDIALM)                             INIT   274
                TSINT = (TSINT+FDIALA)*FDIALM                                    INIT   275
485             CALL DIALOT (DUMMY,87,FDIALA,FDIALM)                             INIT   276
                UOFD = (UOFD+FDIALA)*FDIALM                                      INIT   277
                IF (NUNITS.EQ.1) GO TO 230                                       INIT   278
              C                                                                  INIT   279
                CONVER(1) = 1.E+3                                                INIT   280
490             CONVER(2) = 86.4E0                                               INIT   281
                CONVER(3) = CMTOFT                                               INIT   282
                CONVER(4) = CFTOR                                                INIT   283
                CONVER(5) = CKTOR                                                INIT   284
                CONVER(6) = 0.0254E0                                             INIT   285
495             CONVER(6) = 0.0254E0                                             INIT   286
                CONVER(7) = 1.E-6/CNMTPS                                         INIT   287
                CONVER(8) = 5.6745E0                                             INIT   288
                CONVER(9) = 0.0254E0                                             INIT   289
                GO TO 240                                                        INIT   290
500         230 CONTINUE                                                         INIT   291
                CONVER(1) = 3600.E0                                              INIT   292
                CONVER(2) = 1.E0                                                 INIT   293
                CONVER(3) = 1.E0                                                 INIT   294
                CONVER(4) = 0.E0                                                 INIT   295
505             CONVER(5) = 1.E0                                                 INIT   296
                CONVER(6) = 1.E0                                                 INIT   297
                CONVER(7) = 1.E0                                                 INIT   298
                CONVER(8) = 1.E0                                                 INIT   299
                CONVER(9) = 1.E0                                                 INIT   300
510         240 CONTINUE                                                         INIT   301
              C                                                                  INIT   302
              C                                                                  INIT   303
              C THE FOLLOWING CALL TO LACINP SETS THE LACE FLAGS                 INIT   304
              C                                                                  INIT   305
515           C                                                                  INIT   306
                CALL LACINP (LACMOD,LACE,EMFLAG,MAXIDX)                          INIT   307
              C                                                                  INIT   308
              C THE FOLLOWING CODING SPECIFIES THE MODEL OPTIONS                 INIT   309
              C                                                                  INIT   310
520             IF (NGASR.EQ.-2) MODLOP = 5000000                                INIT   311
                IF (NGASR.EQ.-1) MODLOP = 4000000                                INIT   312
                IF (NGASR.EQ.0) MODLOP = 3000000                                 INIT   313
                IF (NGASR.EQ.1) MODLOP = 1000000                                 INIT   314
                IF (NGASR.EQ.2) MODLOP = 2000000                                 INIT   315
525             IF (NGASR.GE.6) MODLOP = 3000000                                 INIT   316
                IF (IPLANT.EQ.1) MODLOP = MODLOP+10000000                        INIT   317
                IF (IPLANT.EQ.2) MODLOP = MODLOP+20000000                        INIT   318
                IF (IPLANT.EQ.3) MODLOP = MODLOP+30000000                        INIT   319
                IF (IPLANT.EQ.4) MODLOP = MODLOP+40000000                        INIT   320
530             IF (IPLANT.EQ.-1) MODLOP = MODLOP+50000000                       INIT   321
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                IF (IPLANT.EQ.0.AND.ENRCH.EQ.0.E0) MODLOP = MODLOP+60000000          INIT      322
                IF (IPLANT.EQ.0.AND.ENRCH.GT.0.E0) MODLOP = MODLOP+70000000          INIT      323
                MODLOP = MODLOP+MECHAN*100000                                        INIT      324
          C                                                                          INIT      325
535       C   THE FOLLOWING CALL TO CHECK EDITS THE INPUT INFORMATION FOR            INIT      326
          C   OBVIOUS ERRORS                                                        INIT      327
          C                                                                          INIT      328
                CALL CHECK (IM,NA,NC,NF,DEN,JN,ENRCH,FA,ICM,NR,NSH,CP,CR,CPL,CRDT, INIT      329
               +IQ,DISHSD,DSPG,DSPGW,GO,FGPAV,HDISH,HPLT,ICOR,IDXGAS,BUIN,RC,JDLPR INIT      330
540            +,NOPT,NSP,RDISH,TOTL,NUNITS,VS,ROUGHF,ROUGHC,NGASR,DCI,DCO,DE,DP,D INIT      331
               +ELTAZ,QMPY,TIME,TW,P2,JST,X,IQUIT,AMFAIR,AMFARG,AMFFG,AMFHE,AMFH2, INIT      332
               +QF,AMFH2O,AMFKRY,AMFN2,AMFXE,MECHAN,IVARDM)                         INIT      333
          C                                                                          INIT      334
                IF (IQUIT.EQ.1) GO TO 540                                            INIT      335
545       C                                                                          INIT      336
                    DO 250 II=1,NT                                                   INIT      337
                    IJ = NT-II+1                                                     INIT      338
          250       CTMAX(IJ+1) = CTMAX(IJ)                                          INIT      339
          C                                                                          INIT      340
550             IF (NSTART.GT.0) NSTART = NSTART+1                                   INIT      341
                IF (NSTOP.GT.0) NSTOP = NSTOP+1                                      INIT      342
                IF (UMELT.NE.0.E+0) UMELT = (UMELT+CFTOR)/CKTOR                      INIT      343
                IF (NUNITS.NE.0) GO TO 290                                           INIT      344
                IF (TREF.EQ.77.E0) TREF = 298.15E0                                   INIT      345
555             IF (CRDT.EQ.1.E0) CRDT = 2.54E-5                                     INIT      346
                IF (CRDTR.EQ.1.1415525E-4) CRDTR = 8.05E-13                          INIT      347
                IF (ROUGHC.EQ.4.5E-5) ROUGHC = 1.143E-6                              INIT      348
                IF (ROUGHF.EQ.8.5E-5) ROUGHF = 2.159E-6                              INIT      349
                IF (TSINT.EQ.2912.E0) TSINT = 1873.15                                INIT      350
560             CPL = CPL*CMTOIN                                                     INIT      351
                CDG = CDG*CMTOIN                                                     INIT      352
                CRDT = CRDT*CMTOML                                                   INIT      353
                CRDTR = CRDTR*CMTOML/CSTOHR                                          INIT      354
                DISHSD = DISHSD*CMTOIN                                               INIT      355
565             DSPG = DSPG*CMTOIN                                                   INIT      356
                DSPGW = DSPGW*CMTOIN                                                 INIT      357
                FGPAV = FGPAV*CNMTPS                                                 INIT      358
                HDISH = HDISH*CMTOIN                                                 INIT      359
                HPLT = HPLT*CMTOIN                                                   INIT      360
570             RC = RC*CMTOIN                                                       INIT      361
                TCC = TCC*CMTOIN                                                     INIT      362
                TOTL = TOTL*CMTOFT                                                   INIT      363
                ROUGHF = ROUGHF*CMTOIN                                               INIT      364
                ROUGHC = ROUGHC*CMTOIN                                               INIT      365
575             TREF = TREF*CKTOR-CFTOR                                              INIT      366
                TSINT = TSINT*CKTOR-CFTOR                                            INIT      367
                NTP1 = NT+1                                                          INIT      368
                    DO 260 II=1,NTP1                                                 INIT      369
                    BUIN(II) = BUIN(II)*CMSTMD                                       INIT      370
580                 DCO(II) = DCO(II)*CMTOIN                                         INIT      371
                    DCI(II) = DCI(II)*CMTOIN                                         INIT      372
                    DP(II) = DP(II)*CMTOIN                                           INIT      373
                    DE(II) = DE(II)*CMTOIN                                           INIT      374
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                DELTAZ(II) = DELTAZ(II)*CMTOFT                                    INIT     375
585       260   CTMAX(II) = CTMAX(II)*CKTOR-CFTOR                                 INIT     376
                DO 270 II=1,IM                                                    INIT     377
                GO(II) = GO(II)*CKSTPH                                            INIT     378
                P2(II) = P2(II)*CNMTPS                                            INIT     379
                QMPY(II) = QMPY(II)*0.3048E0                                      INIT     380
590             TW(II) = TW(II)*CKTOR-CFTOR                                       INIT     381
          270   CONTINUE                                                          INIT     382
                DO 280 II=1,328                                                   INIT     383
          280   X(II) = X(II)*CMTOFT                                              INIT     384
          290 CONTINUE                                                          INIT     385
595             IF (ACOR.NE.1.E0.OR.AFCR.NE.1.E0.OR.AFGR.NE.1.E0) CNOB = 1.       INIT     386
                IF (AFSW.NE.1.E0.OR.AFTC.NE.1.E0.OR.AFAL.NE.1.E0) CNOB = 1.       INIT     387
                IF (BETA.NE.1.E0.OR.EXO.NE.1.E0) CNOB = 1.                        INIT     388
                IF (AFDN.NE.1.E0.OR.AGPC.NE.1.E0) CNOB = 1.                       INIT     389
                CODEID(15) = CNOB                                                 INIT     390
600             ENRICH = ENRCH                                                    INIT     391
                PRESS = FGPAV                                                     INIT     392
                CRDTT = CRDT                                                      INIT     393
                IF (NDBG.EQ.-1) NWRITE = 1                                        INIT     394
          C                                                                       INIT     395
605             IRI = NT+1                                                        INIT     396
                JJC = 0                                                           INIT     397
                    DO 300 II=1,IM                                                INIT     398
                    IF (JST(II).EQ.0) JST(II) = 1                                 INIT     399
          300       JJC = AMAX0(JJC,JST(II))                                      INIT     400
610       C                                                                       INIT     401
                FGPAVP = FGPAV                                                    INIT     402
                    DO 310 II=1,IM                                                INIT     403
                    IF (QMPY(II).EQ.0.E0) QMPY(II) = 1.E-6                        INIT     404
          310       QMPY(II) = QMPY(II)*FQE                                       INIT     405
615             PI = 3.14159265                                                   INIT     406
                RHOUO2 = (DEN-DENG)*10.97E0*0.01E0*2.54E0**3                      INIT     407
                IF (COMP.GT.0.E0) RHOUO2 = (1.E0-COMP)*RHOUO2+COMP*RHOUO2*11.46/10 INIT     408
               +.97                                                               INIT     409
                VSS = VS*(PI*(DSPGW*DSPGW)/4.0)*PI*(DSPG-DSPGW)                   INIT     410
620             CPV = PI*DCI(NA)*DCI(NA)*CPL/4.E0-VSS                             INIT     411
          C                                                                       INIT     412
          C   CALCULATION OF INITIAL FUEL POROSITY                                INIT     413
          C                                                                       INIT     414
                PRTY = (100.-DEN)/100.                                            INIT     415
625       C                                                                       INIT     416
                NRMI = NR-1                                                       INIT     417
                    DO 320 JJ=2,IRI                                               INIT     418
                        DO 320 I=1,NRMI                                           INIT     419
                        IJ = NR*(JJ-1)+I-1                                        INIT     420
630                     A(LPORSI+IJ) = PRTY/3.E0                                  INIT     421
          320           CONTINUE                                                  INIT     422
          C                                                                       INIT     423
          C   CALCULATION OF INITIAL PELLET RADII                                 INIT     424
          C                                                                       INIT     425
635             A(LR+NR-1) = RC                                                   INIT     426
                A(LR+NRMI-1) = SQRT(DP(1)*DP(1)/40.E0+0.9E0*RC*RC)                INIT     427
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```
                ARING = PI*(A(LR+NRM1-1)**2-RC*RC)                                  INIT     428
                NRM2 = NR-2                                                         INIT     429
                    DO 330 I=1,NRM2                                                 INIT     430
640                 L = NRM1-I                                                      INIT     431
                    A(LR+L-1) = SQRT(A(LR+L)*A(LR+L)+ARING/PI)                      INIT     432
          330       CONTINUE                                                        INIT     433
          C                                                                         INIT     434
          C   CALCULATION OF HEIGHT OF EACH FUEL RING                              INIT     435
645       C                                                                         INIT     436
                CFVA = PI*DP(1)*DP(1)*TOTL*3.E0                                     INIT     437
                IF (HDISH.LE.0.0) GO TO 370                                         INIT     438
                DISHSG = DP(1)/2.E0-DISHSD                                          INIT     439
                RDISH = (HDISH*HDISH+DISHSG*DISHSG)/(2*HDISH)                       INIT     440
650             RMH = RDISH-HDISH                                                   INIT     441
                VPLT = 0.0                                                          INIT     442
          C                                                                         INIT     443
          C                                                                         INIT     444
                    DO 360 I=1,NR                                                   INIT     445
655                 L = 12-I                                                        INIT     446
                    IF (RDISH.LT.A(LR+L-1)) GO TO 340                               INIT     447
                    HI = RDISH-AMAX1(SQRT(RDISH*RDISH-A(LR+L-1)**2),RMH)            INIT     448
                    GO TO 350                                                       INIT     449
          340       CONTINUE                                                        INIT     450
660                 HI = RDISH-RMH                                                  INIT     451
          350       CONTINUE                                                        INIT     452
                    A(LVPL+L-1) = (DELTAZ(I)/HPLT)*PI*(A(LR+L-1)**2*(HPLT+2.E0*(HI  INIT     453
                +     -HDISH))-2.E0*HI*HI*(RDISH-HI/3.E0))*12.E0-VPLT               INIT     454
                    A(LCRL+L-1) = A(LVPL+L-1)/ARING                                 INIT     455
665                 VPLT = VPLT+A(LVPL+L-1)                                         INIT     456
          C                                                                         INIT     457
          C                                                                         INIT     458
          360       CONTINUE                                                        INIT     459
                CFV = (VPLT-PI*RC*RC*A(LCRL+NR-1))*NT                               INIT     460
670             IF (RC.GT.0.E0) A(LCRL+NR-1) = A(LVPL+NR-1)/(PI*RC*RC)              INIT     461
                GO TO 390                                                           INIT     462
          370       DO 380 L=1,NRM1                                                 INIT     463
                    A(LVPL+L-1) = (DP(I)*DP(I)-4.0*RC*RC)*PI*DELTAZ(I)*3./10.       INIT     464
                    A(LCRL+L-1) = DELTAZ(I)*12.E0                                   INIT     465
675       380       CONTINUE                                                        INIT     466
                CFV = CFVA-PI*RC*RC*TOTL*12.0                                       INIT     467
          390   CONTINUE                                                            INIT     468
                PECDH = (CFVA-CFV)/CFVA                                             INIT     469
                DISH = CFVA-CFV                                                     INIT     470
680       C                                                                         INIT     471
          C   CALCULATION OF PELLET OPEN POROSITY                                  INIT     472
          C                                                                         INIT     473
                GDEN = DEN-1.25                                                     INIT     474
                IF (GDEN.GE.94.0) FPORI = 0.0                                       INIT     475
685             IF (GDEN.GT.91.25.AND.GDEN.LT.94.) FPORI = 0.0012019636*(94.-GDEN)  INIT     476
                IF (GDEN.LE.91.25) FPORI = 16.929682-0.23285470*GDEN-8.7183686E-4*  INIT     477
               +GDEN**2+1.5242216E-5*GDEN**3                                        INIT     478
          C                                                                         INIT     479
                IF (MECHAN.NE.3) GO TO 420                                          INIT     480
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      C
      C   CALCULATE FRACAS II ROD DIMENSIONS AND
      C   INITIAL FUEL VOID FRACTION FROM RELOCATION
      C
        IF (MECHAN.NE.3) GO TO 410
      C
            DO 400 JJ=1,NA
            U = 0.79E0*(DCI(JJ)-DP(JJ))/2.E0-0.00131378E0
            IF (U.LT.0.0) U = 0.0
      C   CRACK DEPTH SET TO 1/2 THE RADIUS
            RCRACK = DP(JJ)/4.
      C   SET UP RADIA FOR 2 FIXED CLADDING RADIAL NODES
            R22(JJ,NR+2) = DCO(JJ)/2.0
            R22(JJ,NR+1) = DCI(JJ)/2.0
                DO 400 II=1,NR
                R22(JJ,II) = A(LR+NR-II)*(DP(JJ)+2.*U)/DP(JJ)
                DVHPRS(JJ,II) = 0.0
                FVFRO(JJ,II) = 0.0
                IF (R22(JJ,II).GE.RCRACK) FVFRO(JJ,II) = DP(JJ)*U/((DP(JJ)
             +  /2.)**2-RCRACK**2)
      400       CONTINUE
      C
      410   CONTINUE
      C
      420   CONTINUE
      C
      C   CALCULATION OF ROUGHNESS VOLUME
      C
        RFNUFF = 14.4E-6*PI*DP(1)*TOTL*144.E0/CFV
      C
      C   CALCULATION OF INITIAL GAS MOLES
      C
        CVV = CPV+RFNUFF*CFV+FPORI*CFV+(DCI(1)**2-(1.0-PECDH)*DP(1)**2)*PI
       +*TOTL*3.E0
        CMOL = FGPAV*CVV/(40.8*532.0)
      C
        IF (IDXGAS.EQ.6) GO TO 430
        IF (IDXGAS.EQ.1) AMFHE = 1.0
        IF (IDXGAS.EQ.2) AMFAIR = 1.0
        IF (IDXGAS.EQ.3) AMFN2 = 1.0
        IF (IDXGAS.EQ.4) AMFFG = 1.0
        IF (IDXGAS.EQ.5) AMFARG = 1.0
        AMFKRY = 0.15*AMFFG
        AMFXE = 0.85*AMFFG
      430   CONTINUE
        AAN = AMFAIR+AMFN2
        HEIN = CMOL*AMFHE
        AIRIN = CMOL*AMFAIR
        AN2IN = CMOL*AMFN2
        IF (IDXGAS.EQ.6.AND.AMFFG.GT.0.E0) AMFXE = 0.85*AMFFG
        IF (IDXGAS.EQ.6.AND.AMFFG.GT.0.E0) AMFKRY = 0.15*AMFFG
        FGIN = CMOL*AMFFG
        IF (IDXGAS.EQ.6.AND.AMFFG.EQ.0.E0) FGIN = (AMFXE+AMFKRY)*CMOL
```

```
                ARGIN = CMOL*AMFARG                                              INIT      534
                XEIN = AMFXE*CMOL                                                INIT      535
745             KRYIN = AMFKRY*CMOL                                              INIT      536
                A(LACMH2) = AMFH2O*CMOL                                          INIT      537
                GASES(1) = AMFHE                                                 INIT      538
                GASES(2) = AMFARG                                                INIT      539
                GASES(3) = AMFKRY                                                INIT      540
750             GASES(4) = AMFXE                                                 INIT      541
                GASES(5) = AMFH2                                                 INIT      542
                GASES(6) = AAN                                                   INIT      543
                GASES(7) = AMFH2O                                                INIT      544
          C                                                                      INIT      545
755       C   CALCULATION OF INITIAL CONCENTRATION OF WATER AND NITROGEN          INIT      546
          C                                                                      INIT      547
                ANGI = PPMN2*CFV*RHOUO2/(28.E+6)                                 INIT      548
                    DO 440 I=2,IRI                                               INIT      549
          440       A(LANG+I-1) = ANGI/(TOTL/DELTAZ(I))                          INIT      550
760       C                                                                      INIT      551
          C   INITIALIZATION OF SOME NODALLY DEPENDENT VARIABLES IN AGRASS       INIT      552
          C                                                                      INIT      553
          C   INITIALIZATION IS DEPENDENT UPON THE GRASS VERSION; IF             INIT      554
          C                                                                      INIT      555
765       C   VERS = 4HFAST    ;    FAST GRASS                                   INIT      556
          C   VERS = 4HGRAS    ;    GRASS-SST                                    INIT      557
          C                                                                      INIT      558
                IF (NGASR.NE.-2) GO TO 490                                       INIT      559
                NRI = NR-I                                                       INIT      560
770             NFKF = NRI*NT                                                    INIT      561
                    DO 450 I=1,NRI                                               INIT      562
                    IF (VERS.EQ.4HGRAS) AGRASS(NVAR9+I-1) = 1.0E9                INIT      563
                    IF (VERS.EQ.4HGRAS) AGRASS(NVAR6+I-1) = 0.31831              INIT      564
                    AGRASS(NVAR7+I-1) = .63662                                   INIT      565
775       450       CONTINUE                                                     INIT      566
                    DO 460 I=1,NFKF                                              INIT      567
                    AGRASS(NVAR20+I-1) = 3.E31                                   INIT      568
          460       CONTINUE                                                     INIT      569
                IF (VERS.EQ.4HGRAS) GO TO 490                                    INIT      570
780       C                                                                      INIT      571
          C   FAST GRASS INITIALIZATION ONLY                                     INIT      572
          C   SAVG ARRAY                                                        INIT      573
          C                                                                      INIT      574
                    DO 470 I=1,NFKF                                              INIT      575
785       470       AGRASS(NVAR37+I-1) = 1.0                                     INIT      576
                K = NFKF                                                         INIT      577
                    DO 480 JJ=1,3                                                INIT      578
                        DO 480 I=1,NFKF                                          INIT      579
                        K = K+1                                                  INIT      580
790       480           AGRASS(NVAR37+K-1) = 100.0                               INIT      581
          490   CONTINUE                                                         INIT      582
          C                                                                      INIT      583
                IF (NSP.EQ.1) GO TO 510                                          INIT      584
                    DO 500 II=1,IM                                               INIT      585
795                 GO(II) = GO(1)                                               INIT      586
```

```
                    P2(II) = P2(1)                                                  INIT      587
              500   TW(II) = TW(1)                                                  INIT      588
              C                                                                     INIT      589
              510   CALL PRINT1 (DVHPRS,TTT,EPS22,EPP2,FVFR0,SIG2,REPS2,EPS02,EP2,GAP2 INIT   590
800                +,R22,ECREP2,PREPS2,PEPP2,OLDT2,PEP2,OLDPG2,OLDPC2,OLIGP2,IGAP2,EPS INIT   591
                   +0,MNR,MNA)                                                      INIT      592
              C                                                                     INIT      593
                   TSINT = (TSINT+CFTOR)/CKTOR                                      INIT      594
                       DO 520 II=1,IM                                               INIT      595
805                    QMPY(II) = QMPY(II)*3413.E0/(DCO(1)*PI/12.E0)                INIT      596
                       TIME(II) = TIME(II)*86400.                                   INIT      597
              520      CONTINUE                                                     INIT      598
              C                                                                     INIT      599
              C                                                                     INIT      600
810           C   THE FOLLOWING CODING CREATES AN INITAL TIME STEP WITH SMALL       INIT      601
              C   VALUES OF TIME AND POWER TO AVOID INSTABILITIES                   INIT      602
              C                                                                     INIT      603
                   DO 530 IJ=1,IM                                                   INIT      604
                   II = IM-IJ+1                                                     INIT      605
815                P2(II+1) = P2(II)                                                INIT      606
                   GO(II+1) = GO(II)                                                INIT      607
                   TW(II+1) = TW(II)                                                INIT      608
                   QMPY(II+1) = QMPY(II)                                            INIT      609
                   TIME(II+1) = TIME(II)                                            INIT      610
820                JST(II+1) = JST(II)                                              INIT      611
              530  CONTINUE                                                         INIT      612
                   IM = IM+1                                                        INIT      613
                   TIME(1) = 0.01E0                                                 INIT      614
                   QMPY(1) = 300.E0                                                 INIT      615
825           C                                                                     INIT      616
              540  CONTINUE                                                         INIT      617
                   RETURN                                                           INIT      618
                   END                                                              INIT      619
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	INITAL	1	827

VARIABLES

	SN	TYPE		RELOCATION								
0	A	REAL	ARRAY	FAST	REFS	9	11	229	230	637	2*641	656
						657	662	664	665	669	670	705
					DEFINED	630	635	636	641	662	664	670
						673	674	746	759			
0	AAA	REAL	ARRAY	REALS	REFS	111						
0	AAHA	REAL	ARRAY	MATCNS	REFS	203						
24	AAN	REAL		REALS	REFS	111	752	DEFINED	735			
0	ACOR	REAL		INPTR	REFS	157	595	DEFINED	285			
1	AFAL	REAL		INPTR	REFS	157	596	DEFINED	291			

VARIABLES	SN	TYPE	RELOCATION									
0	AFCMI2	REAL	ARRAY	FAST	REFS	230	231					
2	AFCR	REAL		INPTR	REFS	157	595	DEFINED	286			
3	AFDN	REAL		INPTR	REFS	157	598	DEFINED	287			
4	AFGR	REAL		INPTR	REFS	157	595	DEFINED	288			
5	AFSW	REAL		INPTR	REFS	157	596	DEFINED	289			
6	AFTC	REAL		INPTR	REFS	157	596	DEFINED	290			
7	AGPC	REAL		INPTR	REFS	157	598	DEFINED	292			
0	AGRASS	REAL	ARRAY	FAST	REFS	228	229	DEFINED	772	773	774	777
					785	790						
25	AIRIN	REAL		REALS	REFS	111	DEFINED	737				
10	AMFAIR	REAL		INPTR	REFS	157	262	538	735	737		
					DEFINED	728						
11	AMFARG	REAL		INPTR	REFS	157	262	538	743	748		
					DEFINED	731						
12	AMFFG	REAL		INPTR	REFS	157	262	538	732	733	2*739	2*740
					741	742	DEFINED	730				
13	AMFHE	REAL		INPTR	REFS	157	262	538	736	747		
					DEFINED	727						
14	AMFH2	REAL		INPTR	REFS	157	262	538	751			
15	AMFH20	REAL		INPTR	REFS	157	262	538	746	753		
16	AMFKRY	REAL		INPTR	REFS	157	262	538	742	745	749	
					DEFINED	732	740					
17	AMFN2	REAL		INPTR	REFS	157	262	538	735	738		
					DEFINED	729						
20	AMFXE	REAL		INPTR	REFS	157	262	538	742	744	750	
					DEFINED	733	739					
26	AMGP	REAL	ARRAY	REALS	REFS	111						
30	AMGPH	REAL	ARRAY	REALS	REFS	111						
32	AMGR	REAL	ARRAY	REALS	REFS	111						
34	AMGRH	REAL	ARRAY	REALS	REFS	111						
36	AMGRN2	REAL	ARRAY	REALS	REFS	111						
40	AMWDT	REAL		REALS	REFS	111						
41	ANGI	REAL		REALS	REFS	111	759	DEFINED	757			
42	ANGT	REAL		REALS	REFS	111						
2555	ANRIN	REAL		INPTR	REFS	157	DEFINED	293				
43	AN2IN	REAL		REALS	REFS	111	DEFINED	738				
44	ARGIN	REAL		REALS	REFS	111	DEFINED	743				
45	ARING	REAL		REALS	REFS	111	641	664	DEFINED	637		
46	AVGQI	REAL	ARRAY	REALS	REFS	111						
56	B	REAL	ARRAY	REALS	REFS	111						
3735	BETA	REAL			REFS	262	597	DEFINED	294			
64	BP	REAL		REALS	REFS	111						
65	BPP	REAL		REALS	REFS	111						
66	BR	REAL	ARRAY	REALS	REFS	111						
74	BU	REAL		REALS	REFS	111						
21	BUIN	REAL	ARRAY	INPTR	REFS	157	262	392	450	538	579	
					DEFINED	392	450	579				
75	BUOLD	REAL		REALS	REFS	111						
10	BUP	REAL		PHYPRO	REFS	210						
47	CATEXF	REAL		INPTR	REFS	157	262	452	DEFINED	295	452	
76	CDG	REAL		REALS	REFS	111	561	DEFINED	390	561		
3217	CFTOR	REAL			REFS	492	552	575	576	585	590	803
					DEFINED	259						

VARIABLES	SN	TYPE		RELOCATION								
77	CFV	REAL		REALS	REFS	111	678	679	718	2*722	757	
					DEFINED	669	676					
100	CFVA	REAL		REALS	REFS	111	676	2*678	679	DEFINED	646	
3	CHEFUS	REAL		PHYPRO	REFS	210						
3213	CKSTPH	REAL			REFS	587	DEFINED	259				
3216	CKTOR	REAL			REFS	493	552	575	576	585	590	803
					DEFINED	259						
50	CLDWKD	REAL		INPTR	REFS	157	262	454	DEFINED	297	454	
2556	CLDWKS	REAL		INPTR	REFS	157	262	455	DEFINED	298	455	
601	CLOS	REAL		REALS	REFS	135						
101	CMOL	REAL		REALS	REFS	111	736	737	738	741	742	743
					744	745	746	DEFINED	724			
3214	CMSTMD	REAL			REFS	579	DEFINED	259				
3210	CMTOFT	REAL			REFS	491	572	584	593	DEFINED	257	
3206	CMTOIN	REAL			REFS	560	561	564	565	566	568	569
					570	571	573	574	580	581	582	583
					DEFINED	257						
3207	CMTOML	REAL			REFS	562	563	DEFINED	257			
3211	CNMTPS	REAL			REFS	496	567	588	DEFINED	257		
3736	CNOB	REAL			REFS	599	DEFINED	296	595	596	597	598
102	CODEID	REAL	ARRAY	REALS	REFS	111	DEFINED	599				
606	COLDWK	REAL		REALS	REFS	135	DEFINED	299				
11	COMP	REAL		PHYPRO	REFS	210	262	457	3*617	DEFINED	300	457
121	CONVC	REAL		REALS	REFS	111						
122	CONVER	REAL	ARRAY	REALS	REFS	111	DEFINED	489	490	491	492	493
					494	495	496	497	498	501	502	503
					504	505	506	507	508	509		
2557	CP	REAL		INPTR	REFS	157	262	538	DEFINED	301		
51	CPL	REAL		INPTR	REFS	157	262	402	538	560	620	
					DEFINED	402	560					
134	CPV	REAL		REALS	REFS	111	722	DEFINED	620			
2560	CR	REAL		INPTR	REFS	157	262	538	DEFINED	302		
52	CRDT	REAL		INPTR	REFS	157	262	459	538	555	562	602
					DEFINED	303	459	555	562			
53	CRDTR	REAL		INPTR	REFS	157	262	461	556	563		
					DEFINED	304	461	556	563			
135	CRDTT	REAL		REALS	REFS	111	DEFINED	602				
2554	CREPHR	REAL		INPTR	REFS	157	262	DEFINED	305			
136	CRN	REAL		REALS	REFS	111						
3212	CSTOHR	REAL			REFS	563	DEFINED	257				
54	CTMAX	REAL	ARRAY	INPTR	REFS	157	262	548	585	DEFINED	366	548
					585							
2	CTMELT	REAL		PHYPRO	REFS	210						
4	CTRANB	REAL		PHYPRO	REFS	210						
5	CTRANE	REAL		PHYPRO	REFS	210						
6	CTRANZ	REAL		PHYPRO	REFS	210						
137	CVV	REAL		REALS	REFS	111	724	DEFINED	722			
3215	CWCTKF	* REAL			DEFINED	259						
604	CWKF	REAL		REALS	REFS	135						
605	CWNF	REAL		REALS	REFS	135						
102	DC1	REAL	ARRAY	INPTR	REFS	157	262	390	394	404	538	581
					2*620	697	703	722	DEFINED	394	404	581
140	DCIH	REAL		REALS	REFS	111						

VARIABLES	SN	TYPE		RELOCATION								
141	DCIHP	REAL		REALS	REFS	111						
130	DCO	REAL	ARRAY	INPTR	REFS	157	262	393	406	538	580	702
					805	DEFINED	393	406	580			
156	DE	REAL	ARRAY	INPTR	REFS	157	262	396	408	538	583	
					DEFINED	396	408	583				
142	DELBP	REAL		REALS	REFS	111						
143	DELBU	REAL		REALS	REFS	111						
144	DELH	REAL		REALS	REFS	111						
12	DELOXY	REAL		PHYPRO	REFS	210						
145	DELT	REAL		REALS	REFS	111						
204	DELTAZ	REAL	ARRAY	INPTR	REFS	157	262	397	538	584	662	673
					674	759	DEFINED	389	397	584		
146	DELTCR	REAL		REALS	REFS	111						
147	DELTDB	REAL		REALS	REFS	111						
150	DELTFC	REAL		REALS	REFS	111						
151	DELTJL	REAL		REALS	REFS	111						
232	DEN	REAL		INPTR	REFS	157	262	410	538	616	624	683
					DEFINED	410						
233	DENG	REAL		INPTR	REFS	157	262	463	616	DEFINED	306	463
152	DHIC	REAL		REALS	REFS	111						
607	DISH	REAL		REALS	REFS	135	DEFINED	679				
234	DISHSD	REAL		INPTR	REFS	157	262	412	538	564	648	
					DEFINED	412	564					
3753	DISHSG	REAL			REFS	2*649	DEFINED	648				
153	DLREL	REAL		REALS	REFS	111						
154	DLROD	REAL		REALS	REFS	111						
155	DLTGC	REAL	ARRAY	REALS	REFS	111						
235	DP	REAL	ARRAY	INPTR	REFS	157	262	390	395	414	538	582
					2*636	2*646	648	2*673	697	700	2*705	2*708
					718	722	DEFINED	395	414	582		
207	DPH	REAL		REALS	REFS	111						
210	DPHF	REAL		REALS	REFS	111						
211	DPHFP	REAL		REALS	REFS	111						
212	DPWP	REAL		REALS	REFS	111						
213	DRS	REAL		REALS	REFS	111						
263	DSPG	REAL		INPTR	REFS	157	262	416	538	565	619	
					DEFINED	416	565					
264	DSPGW	REAL		INPTR	REFS	157	262	418	538	566	3*619	
					DEFINED	418	566					
3742	DUMMY	REAL			REFS	401	403	405	407	409	411	413
					415	417	419	421	423	426	428	430
					433	439	442	444	447	449	451	453
					456	458	460	462	464	466	468	470
					472	475	477	479	481	483	485	
					DEFINED	400						
0	DVHPRS	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1	706		
0	ECREP2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	206	516					
265	ENRCH	REAL		INPTR	REFS	157	262	420	531	532	538	600
					DEFINED	420						
214	ENRICH	REAL		REALS	REFS	111	DEFINED	600				
215	EOLSR	REAL		REALS	REFS	111						
0	EPP2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			

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VARIABLES     SN  TYPE          RELOCATION
    0   EPS0       REAL    ARRAY     F.P.     REFS     236     799    DEFINED       1
    0   EPS02      REAL    ARRAY     F.P.     REFS     236     799    DEFINED       1
    0   EPS22      REAL    ARRAY     F.P.     REFS     236     799    DEFINED       1
    0   EP2        REAL    ARRAY     F.P.     REFS     236     799    DEFINED       1
  266   EXO        REAL              INPTR    REFS     157     597    DEFINED     307
  267   FA         REAL              INPTR    REFS     157     262        538 DEFINED     308
  216   FC         REAL    ARRAY     REALS    REFS     111
    7   FDELTA     REAL              PHYPRO   REFS     210
 3743   FDIALA     REAL                       REFS     401     402     403     404     405     406     407
                                               408     409     410     411     412     413     414     415
                                               416     417     418     419     420     421     422     423
                                               425     426     427     428     429     430     432     433
                                               439     439     441     442     443     444     446     447
                                               448     449     450     451     452     453     454     455
                                               456     457     458     459     460     461     462     463
                                               464     465     466     467     468     469     470     471
                                               472     474     475     476     477     478     479     480
                                               481     482     483     484     485     486
 3744   FDIALM     REAL                       REFS     401     402     403     404     405     406     407
                                               408     409     410     411     412     413     414     415
                                               416     417     418     419     420     421     422     423
                                               425     426     427     428     429     430     432     433
                                               438     439     441     442     443     444     446     447
                                               448     449     450     451     452     453     454     455
                                               456     457     458     459     460     461     462     463
                                               464     465     466     467     468     469     470     471
                                               472     474     475     476     477     478     479     480
                                               481     482     483     484     485     486
  217   FGIN       REAL              REALS    REFS     111 DEFINED     741     742
  270   FGPAV      REAL              INPTR    REFS     157     262     422     538     567     601     611
                                               724 DEFINED     422     567
  220   FGPAVP     REAL              REALS    REFS     111 DEFINED     611
  221   FGPAVX     REAL              REALS    REFS     122
    1   FHEFUS     REAL              PHYPRO   REFS     210
  222   FH2O       REAL              REALS    REFS     122
  223   FJJ        REAL    ARRAY     REALS    REFS     122
  225   FJJH       REAL    ARRAY     REALS    REFS     122
  271   FLUX       REAL              INPTR    REFS     157     262     465 DEFINED     310     465
  272   FLXDP      REAL              INPTR    REFS     157 DEFINED     309
  227   FMGP       REAL    ARRAY     REALS    REFS     122
  602   FNCK       REAL              REALS    REFS     135
  603   FNCN       REAL              REALS    REFS     135
 2552   FOTMTL     REAL              INPTR    REFS     157     262 DEFINED     311
  231   FPOR       REAL              REALS    REFS     122
  232   FPOR1      REAL              REALS    REFS     122     722 DEFINED     684     685     686
  273   FQE        REAL              INPTR    REFS     157     614 DEFINED     312
  233   FRD        REAL              REALS    REFS     122
  234   FRDH       REAL              REALS    REFS     122
  235   FRDN       REAL              REALS    REFS     122
    0   FTMELT     REAL              PHYPRO   REFS     210
    0   FVFRO      REAL    ARRAY     F.P.     REFS     236     799    DEFINED       1     707     708
  236   G          REAL              REALS    REFS     122
    0   GAP2       REAL    ARRAY     F.P.     REFS     236     799    DEFINED       1
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VARIABLES	SN	TYPE	RELOCATION									
237	GASES	REAL	ARRAY	REALS	REFS	122	DEFINED	747	748	749	750	751
					752	753						
246	GASIN	REAL		REALS	REFS	122						
247	GDEN	REAL		REALS	REFS	122	684	3*685	4*686	DEFINED	683	
274	GO	REAL	ARRAY	INPTR	REFS	157	262	425	538	587	795	816
					DEFINED	425	587	795	816			
250	GPTH	REAL	ARRAY	REALS	REFS	122						
302	GPTHE	REAL	ARRAY	REALS	REFS	122						
334	GPTHM	REAL		REALS	REFS	122						
335	GPTHP	REAL		REALS	REFS	122						
336	GPTHPG	REAL	ARRAY	REALS	REFS	122						
370	GR	REAL		REALS	REFS	122						
441	GRNSIZ	REAL		INPTR	REFS	157	262	467	DEFINED	313	467	
3	GROW	REAL		AXL	REFS	227						
371	HCRV	REAL		REALS	REFS	122						
372	HCV	REAL		REALS	REFS	122						
442	HDISH	REAL		INPTR	REFS	157	262	427	538	568	647	3*649
					650	662	DEFINED	427	568			
373	HDSHV	REAL		REALS	REFS	122						
374	HEIN	REAL		REALS	REFS	122	DEFINED	736				
375	HFLL	REAL		REALS	REFS	122						
376	HFLMDB	REAL		REALS	REFS	122						
377	HFLMP	REAL		REALS	REFS	122						
400	HFPER	REAL		REALS	REFS	122						
401	HFV	REAL		REALS	REFS	122						
410	HGAP	REAL		REALS	REFS	122						
412	HGAPR	REAL		REALS	REFS	122						
402	HGAPT	REAL		REALS	REFS	122						
403	HGV	REAL		REALS	REFS	122						
404	HI	REAL		REALS	REFS	122	4*662	DEFINED	657	660		
405	HMGP	REAL	ARRAY	REALS	REFS	122						
407	HP	REAL		REALS	REFS	122						
413	HPL	REAL		REALS	REFS	122						
443	HPLT	REAL		INPTR	REFS	157	262	429	538	569	2*662	
					DEFINED	429	569					
414	HPORV	REAL		REALS	REFS	122						
415	HPV	REAL		REALS	REFS	122						
411	HSOL!D	REAL		REALS	REFS	122						
416	HUPTAK	REAL		REALS	REFS	122						
417	H2OMI	REAL		REALS	REFS	122						
3741	I	INTEGER			REFS	368	629	640	655	759	772	773
					774	777	785	DEFINED	367	628	639	654
					758	771	776	784	786			
275	IAXSYM	INTEGER		INPTI	REFS	176						
270	ICFAC	INTEGER		POINT	REFS	103						
302	ICFCSV	INTEGER		POINT	REFS	103						
24	ICLOSE	INTEGER		INTEG	REFS	149						
0	ICM	INTEGER		INPTI	REFS	176	262	538				
1	ICOR	INTEGER		INPTI	REFS	176	262	538				
2	IDBG	INTEGER		INPTI	REFS	176	DEFINED	314				
271	IDG	INTEGER		POINT	REFS	103						
272	IDGSAV	INTEGER		POINT	REFS	103						
3	IDXGAS	INTEGER		INPTI	REFS	176	262	538	726	727	728	729

VARIABLES	SN	TYPE	RELOCATION									
						730	731	739	740	742		
0	IGAP2	INTEGER	ARRAY	F.P.	REFS	236	799	DEFINED	1			
303	IHLDN	INTEGER		POINT	REFS	103						
3737	II	INTEGER			REFS	363	366	392	393	394	395	396
						397	547	2*579	2*580	2*581	2*582	2*583	2*584
						2*585	2*587	2*588	2*589	2*590	2*593	2*608	609
						2*613	2*614	2*705	706	707	2*708	795	796
						797	2*805	2*806	2*815	2*816	2*817	2*818	2*819
						2*820	DEFINED	362	365	391	546	578	586
						592	607	612	704	794	804	814	
3747	IJ	INTEGER			REFS	2*548	630	814	DEFINED	547	629	813	
4	IM	INTEGER		INPTI	REFS	176	424	431	440	445	538	586	
						607	612	794	804	813	814	822	
					DEFINED	822							
4	IMCLAD	INTEGER		EMFLGS	REFS	190	279						
2	IMDENS	INTEGER		EMFLGS	REFS	190	279						
23	IMDONE	INTEGER		INTEG	REFS	149							
7	IMENRG	INTEGER		EMFLGS	REFS	190	279	385					
10	IMFGAS	INTEGER		EMFLGS	REFS	190	279						
1	IMFUEL	INTEGER		EMFLGS	REFS	190	279						
5	IMGAPC	INTEGER		EMFLGS	REFS	190	279						
0	IMPOWR	INTEGER		EMFLGS	REFS	190	279	380	382				
3	IMRELO	INTEGER		EMFLGS	REFS	190	279						
11	IMSWCH	INTEGER		EMFLGS	REFS	190	262	380	382	383	387		
					DEFINED	315							
6	IM93WC	INTEGER		EMFLGS	REFS	190	279						
5	IPLANT	INTEGER		INPTI	REFS	176	262	526	527	528	529	530	
						531	532						
304	IPLSTC	INTEGER		POINT	REFS	103							
273	IPRG	INTEGER		POINT	REFS	103							
6	IQ	INTEGER		INPTI	REFS	176	262	538					
0	IQUIT	INTEGER		INTEG	REFS	149	538	544					
264	IRDOT	INTEGER		POINT	REFS	98							
1	IRI	INTEGER		INTEG	REFS	149	627	758	DEFINED	605			
265	ISAVGS	INTEGER		POINT	REFS	98							
305	ISTRNN	INTEGER		POINT	REFS	103							
306	ISTRSS	INTEGER		POINT	REFS	103							
3746	ISUM	INTEGER			REFS	436	437	DEFINED	434	436			
7	ISW	INTEGER		INPTI	REFS	176	DEFINED	316					
2	IT	INTEGER		INTEG	REFS	149							
300	ITCL	INTEGER		POINT	REFS	103							
277	ITEMP	INTEGER		POINT	REFS	103							
3	ITER	INTEGER		INTEG	REFS	149							
301	ITFS	INTEGER		POINT	REFS	103							
276	ITRAMP	INTEGER		POINT	REFS	103							
300	ITREST	INTEGER		INPTI	REFS	176	262	DEFINED	317				
276	IWARDM	INTEGER		INPTI	REFS	176	262	388	389	397	538		
					DEFINED	318							
274	IVFC	INTEGER		POINT	REFS	103							
275	IVFF	INTEGER		POINT	REFS	103							
302	IWORDS	INTEGER		INPTI	REFS	176							
267	IX	INTEGER		POINT	REFS	98							
4	J	INTEGER		INTEG	REFS	149							

VARIABLES	SN	TYPE		RELOCATION								
10	JDLPR	INTEGER		INPTI	REFS	176	262	538				
3751	JJ	INTEGER			REFS	629	2*697	700	2*702	2*703	3*705	706
					707	4*708	DEFINED	627	696	787		
5	JJC	INTEGER		INTEG	REFS	149	609	DEFINED	606	609		
11	JN	INTEGER	ARRAY	INPTI	REFS	176	262	436	538			
6	JPEAK	INTEGER		INTEG	REFS	149						
21	JST	INTEGER	ARRAY	INPTI	REFS	176	262	538	608	609	820	
					DEFINED	608	820					
7	K	INTEGER		INTEG	REFS	149	789	790	DEFINED	786	789	
10	KINDOR	INTEGER		INTEG	REFS	149	DEFINED	319				
11	KOXI	INTEGER		INTEG	REFS	149						
420	KRYIN	REAL		REALS	REFS	7	122	DEFINED	745			
3745	L	INTEGER			REFS	2*425	2*432	436	2*438	2*441	2*446	2*474
					3*641	656	657	2*662	2*664	665	673	674
					DEFINED	424	431	435	437	440	445	473
					640	655	672					
216	LACE	INTEGER	ARRAY	INPTI	REFS	176	516					
215	LACMFG	INTEGER		POINT	REFS	82						
216	LACMHE	INTEGER		POINT	REFS	82						
217	LACMH2	INTEGER		POINT	REFS	82	746					
220	LACMN2	INTEGER		POINT	REFS	82						
215	LACMOD	INTEGER		INPTI	REFS	176	516	DEFINED	320			
152	LAK1	INTEGER		POINT	REFS	53						
153	LAK2	INTEGER		POINT	REFS	53						
221	LAMGPT	INTEGER		POINT	REFS	82						
125	LANG	INTEGER		POINT	REFS	39	759					
120	LANGR	INTEGER		POINT	REFS	39						
253	LANSD	INTEGER		POINT	REFS	92						
256	LANSR	INTEGER		POINT	REFS	92						
14	LARAD	INTEGER		POINT	REFS	20						
10	LAXGAP	INTEGER		POINT	REFS	20						
11	LAXLEN	INTEGER		POINT	REFS	20						
210	LB	INTEGER		POINT	REFS	72						
211	LBR	INTEGER		POINT	REFS	72						
212	LBTOLD	INTEGER		POINT	REFS	72						
12	LBU1	INTEGER		POINT	REFS	20						
13	LBU2	INTEGER		POINT	REFS	20						
172	LCC1	INTEGER		POINT	REFS	65						
173	LCC2	INTEGER		POINT	REFS	65						
213	LCHEM	INTEGER		POINT	REFS	72						
15	LCPDLT	INTEGER		POINT	REFS	20						
2	LCREPi	INTEGER		POINT	REFS	20						
154	LCRL	INTEGER		POINT	REFS	53	664	669	670	674		
111	LDCHEK	INTEGER		POINT	REFS	20						
0	LDCIH	INTEGER		POINT	REFS	20						
261	LDECAY	INTEGER		POINT	REFS	92						
16	LDELBP	INTEGER		POINT	REFS	20						
17	LDENMX	INTEGER		POINT	REFS	20						
174	LDENSF	INTEGER		POINT	REFS	65						
175	LDENSP	INTEGER		POINT	REFS	65						
3	LDLH	INTEGER		POINT	REFS	20						
20	LDLPGE	INTEGER		POINT	REFS	20						
155	LDPL	INTEGER		POINT	REFS	53						

VARIABLES	SN	TYPE	RELOCATION				
156	LDPLH	INTEGER	POINT	REFS	53		
157	LDPN	INTEGER	POINT	REFS	53		
176	LDPW	INTEGER	POINT	REFS	65		
177	LDPWPP	INTEGER	POINT	REFS	65		
260	LDT	INTEGER	POINT	REFS	92		
21	LDZ	INTEGER	POINT	REFS	20		
22	LDZH	INTEGER	POINT	REFS	20		
23	LDZHP	INTEGER	POINT	REFS	20		
24	LECREP	INTEGER	POINT	REFS	20		
25	LEP	INTEGER	POINT	REFS	20		
127	LEPP	INTEGER	POINT	REFS	45		
130	LEPPP	INTEGER	POINT	REFS	45		
131	LEPPSV	INTEGER	POINT	REFS	45		
147	LEPPI	INTEGER	POINT	REFS	45		
132	LEPS	INTEGER	POINT	REFS	45		
133	LEPSAV	INTEGER	POINT	REFS	45		
151	LEPSI	INTEGER	POINT	REFS	45		
100	LEPI	INTEGER	POINT	REFS	20		
167	LF	INTEGER	POINT	REFS	60		
134	LFEPS	INTEGER	POINT	REFS	45		
257	LFF	INTEGER	POINT	REFS	92		
121	LFGMGP	INTEGER	POINT	REFS	39		
170	LFH	INTEGER	POINT	REFS	60		
110	LFLAG	INTEGER	POINT	REFS	20		
254	LFLXFC	INTEGER	POINT	REFS	92		
160	LFMA	INTEGER	POINT	REFS	53		
161	LFMGPR	INTEGER	POINT	REFS	53		
122	LFMGR	INTEGER	POINT	REFS	39		
171	LFN	INTEGER	POINT	REFS	60		
26	LGAP	INTEGER	POINT	REFS	20		
222	LGASMO	INTEGER	POINT	REFS	82		
200	LGNSIZ	INTEGER	POINT	REFS	65		
27	LGPTP	INTEGER	POINT	REFS	20		
45	LGRASS	INTEGER	GRSPTR	REFS	245		
4	LHA	INTEGER	POINT	REFS	20		
262	LHALF	INTEGER	POINT	REFS	92		
30	LHCOEF	INTEGER	POINT	REFS	20		
123	LHEMGP	INTEGER	POINT	REFS	39		
101	LHGAPS	INTEGER	POINT	REFS	20		
114	LHGPC	INTEGER	POINT	REFS	20		
115	LHGPR	INTEGER	POINT	REFS	20		
116	LHGPS	INTEGER	POINT	REFS	20		
5	LHL	INTEGER	POINT	REFS	20		
223	LHMGPT	INTEGER	POINT	REFS	82		
124	LHMGR	INTEGER	POINT	REFS	39		
162	LHRL	INTEGER	POINT	REFS	53		
103	LIGAP	INTEGER	POINT	REFS	20		
3734	LINKT	INTEGER		REFS	262	DEFINED	321
12	LMN	INTEGER	INTEG	REFS	149		
106	LNFAIL	INTEGER	POINT	REFS	20		
146	LNUDEP	INTEGER	POINT	REFS	45		
31	LOLAXG	INTEGER	POINT	REFS	20		
32	LOLDPC	INTEGER	POINT	REFS	20		

VARIABLES	SN	TYPE	RELOCATION							
33	LOLDPG	INTEGER	POINT	REFS	20					
34	LOLDTC	INTEGER	POINT	REFS	20					
35	LOLDUR	INTEGER	POINT	REFS	20					
36	LOLEPS	INTEGER	POINT	REFS	20					
37	LOLFEP	INTEGER	POINT	REFS	20					
104	LOLIGP	INTEGER	POINT	REFS	20					
40	LPAXGP	INTEGER	POINT	REFS	20					
41	LPC	INTEGER	POINT	REFS	20					
42	LPECRP	INTEGER	POINT	REFS	20					
43	LPEP	INTEGER	POINT	REFS	20					
135	LPEPSV	INTEGER	POINT	REFS	45					
255	LPF	INTEGER	POINT	REFS	92					
136	LPFPSV	INTEGER	POINT	REFS	45					
44	LPG	INTEGER	POINT	REFS	20					
45	LPINT	INTEGER	POINT	REFS	20					
224	LPIT	INTEGER	POINT	REFS	82					
46	LPLDPC	INTEGER	POINT	REFS	20					
47	LPLDPG	INTEGER	POINT	REFS	20					
50	LPLDTC	INTEGER	POINT	REFS	20					
51	LPLDUR	INTEGER	POINT	REFS	20					
107	LPLIGP	INTEGER	POINT	REFS	20					
52	LPOAXG	INTEGER	POINT	REFS	20					
53	LPOFEP	INTEGER	POINT	REFS	20					
54	LPOLEP	INTEGER	POINT	REFS	20					
6	LPOROS	INTEGER	POINT	REFS	20					
201	LPOR51	INTEGER	POINT	REFS	65	630				
202	LPOR52	INTEGER	POINT	REFS	65					
225	LPRT10	INTEGER	POINT	REFS	82					
226	LPRT11	INTEGER	POINT	REFS	82					
227	LPRT12	INTEGER	POINT	REFS	82					
230	LPRT13	INTEGER	POINT	REFS	82					
231	LPRT14	INTEGER	POINT	REFS	82					
232	LPRT15	INTEGER	POINT	REFS	82					
233	LPRT16	INTEGER	POINT	REFS	82					
234	LPRT17	INTEGER	POINT	REFS	82					
235	LPRT18	INTEGER	POINT	REFS	82					
236	LPRT2	INTEGER	POINT	REFS	82					
237	LPRT20	INTEGER	POINT	REFS	82					
240	LPRT3	INTEGER	POINT	REFS	82					
241	LPRT4	INTEGER	POINT	REFS	82					
242	LPRT5	INTEGER	POINT	REFS	82					
243	LPRT6	INTEGER	POINT	REFS	82					
244	LPRT7	INTEGER	POINT	REFS	82					
245	LPRT8	INTEGER	POINT	REFS	82					
246	LPRT9	INTEGER	POINT	REFS	82					
214	LQ	INTEGER	POINT	REFS	77					
105	LQDF	INTEGER	POINT	REFS	20					
206	LR	INTEGER	POINT	REFS	65	635	636	637	3*641	656	657
					662	705					
207	LRAD	INTEGER	POINT	REFS	65					
55	LRDCOL	INTEGER	POINT	REFS	20					
137	LREPS	INTEGER	POINT	REFS	45					
141	LREPSP	INTEGER	POINT	REFS	45					

VARIABLES	SN	TYPE	RELOCATION							
140	LREPSV	INTEGER	POINT	REFS	45					
126	LREPS2	INTEGER	POINT	REFS	39					
143	LRFEPP	INTEGER	POINT	REFS	45					
142	LRFEPS	INTEGER	POINT	REFS	45					
144	LRFPSV	INTEGER	POINT	REFS	45					
263	LRLEAS	INTEGER	POINT	REFS	92					
113	LRTRNO	INTEGER	POINT	REFS	20					
112	LRTRNP	INTEGER	POINT	REFS	20					
145	LSIG	INTEGER	POINT	REFS	45					
150	LSIGI	INTEGER	POINT	REFS	45					
266	LSTHIF	INTEGER	POINT	REFS	98					
247	LTAC	INTEGER	POINT	REFS	82					
56	LTAF	INTEGER	POINT	REFS	20					
250	LTAFA	INTEGER	POINT	REFS	82					
57	LTAG	INTEGER	POINT	REFS	20					
251	LTAGA	INTEGER	POINT	REFS	82					
60	LTBAR	INTEGER	POINT	REFS	20					
61	LTBLK	INTEGER	POINT	REFS	20					
62	LTCA	INTEGER	POINT	REFS	20					
63	LTCIDI	INTEGER	POINT	REFS	20					
64	LTCODI	INTEGER	POINT	REFS	20					
163	LTFB	INTEGER	POINT	REFS	53					
164	LTFR	INTEGER	POINT	REFS	53					
165	LTFRK	INTEGER	POINT	REFS	53					
203	LTMPDS	INTEGER	POINT	REFS	65					
205	LTMPMX	INTEGER	POINT	REFS	65					
117	LTQXO	INTEGER	POINT	REFS	20					
65	LTPS	INTEGER	POINT	REFS	20					
102	LTPTRN	INTEGER	POINT	REFS	20					
252	LTSF	INTEGER	POINT	REFS	82					
7	LUFS	INTEGER	POINT	REFS	20					
204	LUO2LL	INTEGER	POINT	REFS	65					
1	LURC	INTEGER	POINT	REFS	20					
66	LUPF	INTEGER	POINT	REFS	20					
67	LUVH	INTEGER	POINT	REFS	20					
70	LUVHI	INTEGER	POINT	REFS	20					
71	LUVR	INTEGER	POINT	REFS	20					
72	LUWH	INTEGER	POINT	REFS	20					
73	LUFH	INTEGER	POINT	REFS	20					
74	LUGH	INTEGER	POINT	REFS	20					
166	LUPL	INTEGER	POINT	REFS	53	662	664	665	670	673
75	LUPUR	INTEGER	POINT	REFS	20					
76	LZRO2A	INTEGER	POINT	REFS	20					
77	LZRO2B	INTEGER	POINT	REFS	20					
13	M	INTEGER	INTEG	REFS	149					
0	MAXIDX	INTEGER	LACMDL	REFS	206	516	DEFINED	322		
166	MDBG	INTEGER	INPTI	REFS	176	DEFINED	323			
15	MDHPRS	INTEGER	PFRCS2	REFS	196					
271	MECHAN	INTEGER	INPTI	REFS	176	371	533	538	689	694
				DEFINED	387					
20	MEPP2	INTEGER	PFRCS2	REFS	196					
24	MEPS0	INTEGER	PFRCS2	REFS	196					
22	MEPS02	INTEGER	PFRCS2	REFS	196					

VARIABLES	SN	TYPE		RELOCATION								
17	MEPS22	INTEGER		PFRCS2	REFS	196						
11	MEP2	INTEGER		PFRCS2	REFS	196						
10	MEREP2	INTEGER		PFRCS2	REFS	196						
14	MFVFRO	INTEGER		PFRCS2	REFS	196						
2	MGAP2	INTEGER		PFRCS2	REFS	196						
3	MIGAP2	INTEGER		PFRCS2	REFS	196						
[illegible]	MNA	INTEGER		F.P.	REFS	21*236	799	DEFINED	1			
[illegible]	MNR	INTEGER		F.P.	REFS	14*236	799	DEFINED	1			
170	MODE	INTEGER		INPTI	REFS	176	DEFINED	324				
171	MODES	INTEGER		INPTI	REFS	176	DEFINED	325				
14	MODLOP	INTEGER		INTEG	REFS	149	526	527	528	529	530	531
						532	533	DEFINED	520	521	522	523	524
						525	526	527	528	529	530	531	532
						533							
1	MODPC2	INTEGER		PFRCS2	REFS	196						
0	MODPG2	INTEGER		PFRCS2	REFS	196						
4	MOIGP2	INTEGER		PFRCS2	REFS	196						
13	MOLDT2	INTEGER		PFRCS2	REFS	196						
23	MPEPP2	INTEGER		PFRCS2	REFS	196						
6	MPEPS2	INTEGER		PFRCS2	REFS	196						
16	MFEP2	INTEGER		PFRCS2	REFS	196						
5	MREPS2	INTEGER		PFRCS2	REFS	196						
12	MR22	INTEGER		PFRCS2	REFS	196						
21	MSIG2	INTEGER		PFRCS2	REFS	196						
172	MTAPE	INTEGER		INPTI	REFS	176	DEFINED	326				
7	MTTT	INTEGER		PFRCS2	REFS	196						
266	NA	INTEGER		INPTI	REFS	176	364	391	538	2*620	696	
15	NAB	INTEGER		INTEG	REFS	149						
233	NAFAIL	INTEGER		INPTI	REFS	176	DEFINED	327				
3740	NAPI	INTEGER			REFS	365	DEFINED	364				
27	NC	INTEGER		INTEG	REFS	149	538					
272	NCRACK	INTEGER		INPTI	REFS	176	DEFINED	328				
274	NCREEP	INTEGER		INPTI	REFS	176	DEFINED	329				
173	NDBG	INTEGER		INPTI	REFS	176	603					
273	NELAST	INTEGER		INPTI	REFS	176	DEFINED	331				
270	NEWPRB	INTEGER		INPTI	REFS	176	283					
26	NF	INTEGER		INTEG	REFS	149	538					
3757	NFKF	INTEGER			REFS	776	784	786	788	DEFINED	770	
174	NFROD	INTEGER		INPTI	REFS	176	262	DEFINED	332			
175	NGAPC	INTEGER		INPTI	REFS	176	DEFINED	333				
176	NGASR	INTEGER		INPTI	REFS	176	520	521	522	523	524	525
						538	768					
167	NHEAL	INTEGER		INPTI	REFS	176	DEFINED	334				
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	176						
25	NNNCRP	INTEGER		PFRCS2	REFS	196						
177	NOFAIL	INTEGER		INPTI	REFS	176	262	DEFINED	335	371		
277	NOFRAC	INTEGER		INPTI	REFS	176	DEFINED	336				
200	NOPT	INTEGER		INPTI	REFS	176	262	538	DEFINED	337		
201	NPCYCL	INTEGER		INPTI	REFS	176	262	DEFINED	338			
16	NPLAST	INTEGER		INTEG	REFS	149						
263	NPLOT	INTEGER		INPTI	REFS	176						
202	NPLTAB	INTEGER		INPTI	REFS	176	262	DEFINED	339			
304	NPRINT	INTEGER		INPTI	REFS	176	262	DEFINED	340			

VARIABLES	SN	TYPE	RELOCATION								
267	NR	INTEGER	INPTI	REFS	176	362	538	626	629	635	638
				654	669	2*670	702	703	704	705	769
203	NREAD	INTEGER	INPTI	REFS	176	262	DEFINED	341			
204	NRESTR	INTEGER	INPTI	REFS	176	262	DEFINED	342			
17	NRM1	INTEGER	INTEG	REFS	149	628	636	637	640	672	
				DEFINED	626						
3752	NRM2	INTEGER		REFS	639	DEFINED	638				
265	NROD	INTEGER	INPTI	REFS	176						
205	NROLL	INTEGER	INPTI	REFS	176	DEFINED	343				
3756	NR1	INTEGER		REFS	770	771	DEFINED	769			
25	NSH	INTEGER	INTEG	REFS	149	538	DEFINED	330			
206	NSP	INTEGER	INPTI	REFS	176	262	538	793			
207	NSTART	INTEGER	INPTI	REFS	176	2*550	DEFINED	344	550		
20	NSTEP	INTEGER	INTEG	REFS	149						
210	NSTOP	INTEGER	INPTI	REFS	176	2*551	DEFINED	345	551		
211	NT	INTEGER	INPTI	REFS	176	389	546	547	577	605	669
				770							
212	NTAPE	INTEGER	INPTI	REFS	176	262	DEFINED	346			
264	NTPLOT	INTEGER	INPTI	REFS	176						
3750	NTP1	INTEGER		REFS	578	DEFINED	577				
421	NU	REAL	REALS	REFS	7	122					
213	NUCFC	INTEGER	INPTI	REFS	176	262	DEFINED	347			
214	NUNITS	INTEGER	INPTI	REFS	176	262	487	538	553		
				DEFINED	348						
0	NVAR1	INTEGER	GRSPTR	REFS	245						
11	NVAR10	INTEGER	GRSPTR	REFS	245						
12	NVAR11	INTEGER	GRSPTR	REFS	245						
13	NVAR12	INTEGER	GRSPTR	REFS	245						
14	NVAR13	INTEGER	GRSPTR	REFS	245						
15	NVAR14	INTEGER	GRSPTR	REFS	245						
16	NVAR15	INTEGER	GRSPTR	REFS	245						
17	NVAR16	INTEGER	GRSPTR	REFS	245						
20	NVAR17	INTEGER	GRSPTR	REFS	245						
21	NVAR18	INTEGER	GRSPTR	REFS	245						
22	NVAR19	INTEGER	GRSPTR	REFS	245						
1	NVAR2	INTEGER	GRSPTR	REFS	245						
23	NVAR20	INTEGER	GRSPTR	REFS	245	777					
24	NVAR21	INTEGER	GRSPTR	REFS	245						
25	NVAR22	INTEGER	GRSPTR	REFS	245						
26	NVAR23	INTEGER	GRSPTR	REFS	245						
27	NVAR24	INTEGER	GRSPTR	REFS	245						
30	NVAR25	INTEGER	GRSPTR	REFS	245						
31	NVAR26	INTEGER	GRSPTR	REFS	245						
32	NVAR27	INTEGER	GRSPTR	REFS	245						
33	NVAR28	INTEGER	GRSPTR	REFS	245						
34	NVAR29	INTEGER	GRSPTR	REFS	245						
2	NVAR3	INTEGER	GRSPTR	REFS	245						
35	NVAR30	INTEGER	GRSPTR	REFS	245						
36	NVAR31	INTEGER	GRSPTR	REFS	245						
37	NVAR32	INTEGER	GRSPTR	REFS	245						
40	NVAR33	INTEGER	GRSPTR	REFS	245						
41	NVAR34	INTEGER	GRSPTR	REFS	245						
42	NVAR35	INTEGER	GRSPTR	REFS	245						

VARIABLES	SN	TYPE		RELOCATION								
43	NVAR36	INTEGER		GRSPTR	REFS	245						
44	NVAR37	INTEGER		GRSPTR	REFS	245	785	790				
3	NVAR4	INTEGER		GRSPTR	REFS	245						
4	NVAR5	INTEGER		GRSPTR	REFS	245						
5	NVAR6	INTEGER		GRSPTR	REFS	245	773					
6	NVAR7	INTEGER		GRSPTR	REFS	245	774					
7	NVAR8	INTEGER		GRSPTR	REFS	245						
10	NVAR9	INTEGER		GRSPTR	REFS	245	772					
301	NWORDS	INTEGER		INPTI	REFS	176						
303	NWRDS	INTEGER		INPTI	REFS	176						
21	NWRITE	INTEGER		INTEG	REFS	149	DEFINED	603				
262	NXP	INTEGER		INPTI	REFS	176						
22	N2	INTEGER		INTEG	REFS	149						
0	OLDPC2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
0	OLDPG2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
0	OLDT2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
0	OLIGP2	INTEGER	ARRAY	F.P	REFS	235	236	799	DEFINED	1		
422	OXDROP	REAL		REAL5	REFS	122						
423	OXIDE	REAL		REAL5	REFS	122						
424	PECDH	REAL		REAL5	REFS	122	722	DEFINED	678			
0	PEPP2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
0	PEP2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
425	PI	REAL		REAL5	REFS	122	2*619	620	637	641	646	662
					669	670	673	676	718	722	805	
					DEFINED	615						
426	PIN	REAL	ARRAY	REAL5	REFS	122						
460	PINP	REAL		REAL5	REFS	122						
461	PORO	REAL		REAL5	REFS	122						
444	PPMH2O	REAL		INPTR	REFS	157	262	469	DEFINED	469		
445	PPMN2	REAL		INPTR	REFS	157	262	471	757	DEFINED	349	471
462	PR	REAL		REAL5	REFS	122						
0	PREPS2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
463	PRESS	REAL		REAL5	REFS	122	DEFINED	601				
464	PRTY	REAL		REAL5	REFS	122	630	DEFINED	624			
465	PRT19	REAL		REAL5	REFS	122						
446	P2	REAL	ARRAY	INPTR	REFS	157	262	432	538	588	796	815
					DEFINED	432	588	796	815			
473	QAV	REAL		REAL5	REFS	122						
466	QC	REAL		REAL5	REFS	122						
613	QEND	REAL	ARRAY	INPTR	REFS	157	262	474	DEFINED	368	474	
623	QF	REAL	ARRAY	INPTR	REFS	157	262	438	538	DEFINED	438	
1333	QMPY	REAL	ARRAY	INPTR	REFS	157	262	441	538	589	613	614
					805	818	DEFINED	441	589	613	614	805
					818	824						
467	QP	REAL		REAL5	REFS	122						
474	QPEAK	REAL		REAL5	REFS	122						
470	QSP	REAL		REAL5	REFS	122						
1500	RAPOW	REAL	ARRAY	INPTR	REFS	157	262	DEFINED	363			
1513	RC	REAL		INPTR	REFS	157	262	476	538	570	635	2*636
					2*637	2*669	3*670	2*673	2*676	DEFINED	350	476
					570							
471	RCI	REAL		REAL5	REFS	122						
472	RCO	REAL		REAL5	REFS	122						

VARIABLES SN TYPE RELOCATION

3755	RCRACK	REAL			REFS	2*708	DEFINED	700				
1514	RDISH	REAL		INPTR	REFS	157	538	650	656	3*657	660	662
					DEFINED	649						
0	REPS2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
475	RFNVFF	REAL		REALS	REFS	135	722	DEFINED	718			
476	RHO	REAL		REALS	REFS	135						
477	RHOF	REAL		REALS	REFS	135						
500	RHOG	REAL		REALS	REFS	135						
501	RHOU02	REAL		REALS	REFS	135	2*617	757	DEFINED	616	617	
502	RMH	REAL		REALS	REFS	135	657	660	DEFINED	650		
1515	ROUGHC	REAL		INPTR	REFS	157	262	478	538	557	574	
					DEFINED	351	478	557	574			
1516	ROUGHF	REAL		INPTR	REFS	157	262	480	538	558	573	
					DEFINED	352	480	558	573			
503	RP	REAL		REALS	REFS	135						
2551	RSNTR	REAL		INPTR	REFS	157	262	DEFINED	353			
504	RSTRAN	REAL		REALS	REFS	135						
505	RSTRES	REAL		REALS	REFS	135						
506	RTRAN	REAL		REALS	REFS	135						
0	R22	REAL	ARRAY	F.P.	REFS	236	708	799	DEFINED	1	702	703
					705							
1517	SGAPF	REAL		INPTR	REFS	157	262	482	DEFINED	354	482	
0	SIG2	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
507	SKTC	REAL		REALS	REFS	135						
510	SKTS	REAL		REALS	REFS	135						
511	STRN	REAL		REALS	REFS	135						
512	SUMCK	REAL		REALS	REFS	135						
513	SUMDH	REAL		REALS	REFS	135						
514	SUMEXP	REAL		REALS	REFS	135						
1	SUMFF	REAL		AXL	REFS	227						
515	SUMGP	REAL		REALS	REFS	135						
0	SUMM	REAL		AXL	REFS	227						
516	SUMPOR	REAL		REALS	REFS	135						
517	SUMRG	REAL		REALS	REFS	135						
2	SUMSAV	REAL		AXL	REFS	227						
520	SUMTF	REAL		REALS	REFS	135						
521	T	REAL		REALS	REFS	135						
522	TCAC	REAL		REALS	REFS	135						
1520	TCC	REAL		INPTR	REFS	157	571	DEFINED	355	571		
523	TCI	REAL		REALS	REFS	135						
524	TCO	REAL		REALS	REFS	135						
525	TFBC	REAL		REALS	REFS	135						
526	TFC	REAL		REALS	REFS	135						
527	TFGFR	REAL		REALS	REFS	135						
530	THEFR	REAL		REALS	REFS	135						
531	TH2OFR	REAL		REALS	REFS	135						
1521	TIME	REAL	ARRAY	INPTR	REFS	157	262	538	806	819		
					DEFINED	806	819	823				
532	TITLE	REAL	ARRAY	REALS	REFS	135						
546	TM	REAL		REALS	REFS	135						
547	TN2FR	REAL		REALS	REFS	135						
1666	TOTL	REAL		INPTR	REFS	157	262	389	443	538	572	646
					676	718	722	759	DEFINED	443	572	

VARIABLES	SN	TYPE		RELOCATION								
550	TOXO	REAL		REALS	REFS	135						
551	TP	REAL		REALS	REFS	135						
552	TPA	REAL		REALS	REFS	135						
553	TPAC	REAL		REALS	REFS	135						
554	TPLEN	REAL		REALS	REFS	135						
555	TRANST	REAL		REALS	REFS	135						
2553	TREF	REAL		INPTR	REFS	157	554	575	DEFINED	356	385	554
					575							
556	TSAT	REAL		REALS	REFS	135						
1667	TSINT	REAL		INPTR	REFS	157	262	484	559	576	803	
					DEFINED	357	484	559	576	803		
557	TT	REAL		REALS	REFS	135						
0	TTT	REAL	ARRAY	F.P.	REFS	236	799	DEFINED	1			
1670	TW	REAL	ARRAY	INPTR	REFS	157	262	446	538	590	797	817
					DEFINED	446	590	797	817			
560	TX	REAL		REALS	REFS	135						
561	TXA	REAL		REALS	REFS	135						
562	TXAL	REAL		REALS	REFS	135						
563	TXC	REAL		REALS	REFS	135						
3754	U	REAL			REFS	698	705	708	DEFINED	697	698	
2035	UBFS	REAL		INPTR	REFS	157	262	DEFINED	358			
2036	UMELT	REAL		INPTR	REFS	157	262	2*552	DEFINED	359	552	
2037	UOFD	REAL		INPTR	REFS	157	262	486	DEFINED	360	486	
0	VERS	REAL		VER	REFS	208	772	773	779			
564	VISC	REAL		REALS	REFS	135						
565	VPLT	REAL		REALS	REFS	135	662	665	669	DEFINED	651	665
2040	VS	REAL		INPTR	REFS	157	262	448	538	619		
					DEFINED	448						
566	VSS	REAL		REALS	REFS	135	620	DEFINED	619			
600	VX	REAL		REALS	REFS	135						
567	W	REAL		REALS	REFS	135						
570	WT	REAL		REALS	REFS	135						
571	WTRAN	REAL		REALS	REFS	135						
2041	X	REAL	ARRAY	INPTR	REFS	157	262	538	593	DEFINED	593	
572	XEIN	REAL		REALS	REFS	135	DEFINED	744				
573	XK6	REAL		REALS	REFS	135						
574	XK7	REAL		REALS	REFS	135						
575	YY	REAL		REALS	REFS	135						
576	Z	REAL		REALS	REFS	135						
577	ZRO2WG	REAL		REALS	REFS	135						

FILE NAMES	MODE			
TAPE5	NAME	READS	373	383
TAPE6	NAME	WRITES	375	

EXTERNALS	TYPE	ARGS	REFERENCES								
CHECK		61	538								
DIALOT		4	401	403	405	407	409	411	413	415	417
			419	421	423	426	428	430	433	439	442
			444	447	449	451	453	456	458	460	462
			464	466	468	470	472	475	477	479	481
			483	485							
LACINP		4	516								

EXTERNALS	TYPE	ARGS		REFERENCES		
NEMSET		3		380	382	
PRINTI		23		799		
SQRT	REAL	1	LIBRARY	636	641	657

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
AMAX0	REAL	0	INTRIN		609
AMAX1	REAL	0	INTRIN		657

NAMELISTS	DEF LINE	REFERENCES	
EMFPCN	279	383	
FRPCON	262	373	375

	STATEMENT LABELS	DEF LINE	REFERENCES	
0	100	363	362	
0	110	366	365	
0	120	368	367	
274	130	370	283	
0	140	398	391	
373	150	399	388	
0	160	425	424	
0	170	432	431	
0	180	436	435	
0	190	438	437	
0	200	441	440	
0	210	446	445	
0	220	474	473	
777	230	500	487	
1022	240	510	499	
0	250	548	546	
0	260	585	578	
0	270	591	586	
0	280	593	592	
1335	290	594	553	
0	300	609	607	
0	310	614	612	
0	320	631	627	628
0	330	642	639	
1640	340	659	656	
1644	350	661	658	
0	360	668	654	
1716	370	672	647	
0	380	675	672	
1744	390	677	671	
0	400	710	696	704
2077	410	712	694	
2100	420	714	689	
2163	430	734	726	
0	440	759	758	
0	450	775	771	
0	460	778	776	
0	470	785	784	
0	480	790	787	788
2374	490	791	768	779

STATEMENT LABELS		DEF LINE	REFERENCES
0	500	797	794
2415	510	799	793
0	520	807	804
0	530	821	813
2540	540	826	544

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
246	100	II	362 363	5B	INSTACK	
260	110	II	365 366	5B	INSTACK	
267	120	I	367 368	4B	INSTACK	
343	140	II	391 398	27B	OPT	
470	160	L	424 425	6B	INSTACK	
514	170	L	431 432	6B	INSTACK	
530	180	L	435 436	5B	INSTACK	
537	190	L	437 438	6B	INSTACK	
551	200	L	440 441	6B	INSTACK	
570	210	L	445 446	6B	INSTACK	
701	220	L	473 474	6B	INSTACK	
1125	250	II	546 548	10B	INSTACK	
1253	260	II	578 585	30B	OPT	
1305	270	II	586 591	20B	OPT	
1327	280	II	592 593	5B	INSTACK	
1413	300	II	607 609	12B	INSTACK	
1431	310	II	612 614	11B	INSTACK	
1504	320	JJ	627 631	20B		NOT INNER
1506	320	I	628 631	13B	OPT	
1551	330	I	639 642	17B		EXT REFS
1615	360	I	654 668	61B		EXT REFS
1717	380	L	672 675	17B	OPT	
2010	400	JJ	696 710	66B		NOT INNER
2037	400	II	704 710	34B	OPT	
2266	440	I	758 759	7B	INSTACK	
2310	450	I	771 775	20B	OPT	
2332	460	I	776 778	6B	INSTACK	
2345	470	I	784 785	5B	INSTACK	
2356	480	JJ	787 790	15B		NOT INNER
2360	480	I	788 790	10B	INSTACK	
2401	500	II	794 797	13B	OPT	
2464	520	II	804 807	13B	OPT	
2501	530	JJ	813 821	30B	OPT	

COMMON BLOCKS	LENGTH
FAST	1
POINT	199
REALS	392
INTEG	24
INPTR	1393
INPTI	197
EMFLGS	10
PFRCS2	22
MATCNS	12
LACMDL	21
VER	1

```
COMMON BLOCKS   LENGTH
       PHYPRO       11
       AXL           4
       GRSPTR       38

STATISTICS
  PROGRAM LENGTH                  3770B    2040
  SCM LABELED COMMON LENGTH       4425B    2325
        140000B SCM USED
```

```
      SUBROUTINE LACINP (LACMOD,LACE,EMFLAG,MAXIDX)                          LACE
C     ***********************************************************************LACE
C     LACINP IS CALLED FROM INITAL AND CONVERTS LACE OPTION INPUT            LACE
C     FOR MATPRO COMPATIBILITY                                               LACE
C     ***********************************************************************LACE
C                                                                            LACE
      DIMENSION ITRANS(13),EMFLAG(1),LACE(1)                                 LACE
      DATA    ON/2HON/,                                                      LACE
     +       OFF/3HOFF/,                                                     LACE
     +       ITRANS/3,5,6,7,8,9,10,11,12,13,16,18,19/,                       LACE
     +   B/1/                                                                LACE
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                                    LACE
C     LACMOD=  1 ALL LACE OPTIONS ON                                         LACE
C     LACMOD=  0 ALL LACE OPTIONS OFF                                        LACE
C     LACMOD= -1 USER SELECTS LACE OPTIONS                                   LACE
C     LACE(I)=1 OPTION I ON                                                  LACE
C     LACE(I)=0 OPTION I OFF                                                 LACE
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                                    LACE
      IF (LACMOD) 100,120,100                                                LACE
  100     DO 110 I=1,MAXIDX                                                  LACE
          EMFLAG(I) = ON                                                     LACE
  110     CONTINUE                                                           LACE
      IF (LACMOD.LT.1) GO TO 140                                             LACE
      RETURN                                                                 LACE
  120     DO 130 I=1,MAXIDX                                                  LACE
          EMFLAG(I) = OFF                                                    LACE
  130     CONTINUE                                                           LACE
      RETURN                                                                 LACE
  140     DO 150 I=1,13                                                      LACE
          J = ITRANS(I)                                                      LACE
          IF (LACE(I).EQ.1) GO TO 150                                        LACE
          EMFLAG(J) = OFF                                                    LACE
  150     CONTINUE                                                           LACE
      RETURN                                                                 LACE
      END                                                                    LACE
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES		
4	LACINP	1	24	28	34

VARIABLES

		SN	TYPE			RELOCATION									
60	B	*	REAL			DEFINED	8								
0	EMFLAG		REAL	ARRAY	F.P.	REFS	7	DEFINED	1	21	26	32			
61	I		INTEGER			REFS	21	26	30	31	DEFINED	20	25		
						29									
63	ITRANS		INTEGER	ARRAY		REFS	7	30	DEFINED	8					
62	J		INTEGER			REFS	32	DEFINED	30						
0	LACE		INTEGER	ARRAY	F.P.	REFS	7	31	DEFINED	1					

VARIABLES	SN	TYPE	RELOCATION						
0	LACMOD	INTEGER	F.P.	REFS	19	23	DEFINED	1	
0	MAXIDX	INTEGER	F.P.	REFS	20	25	DEFINED	1	
57	OFF	REAL		REFS	26	32	DEFINED	8	
56	ON	REAL		REFS	21	DEFINED	8		

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100	INACTIVE	20	2*19	
0	110		22	20	
26	120		25	19	
0	130		27	25	
37	140		29	23	
52	150		33	29	31

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
13	110	I	20 22	6B	INSTACK
27	130	I	25 27	6B	INSTACK
40	150	I	29 33	15B	OPT

STATISTICS
PROGRAM LENGTH 107B 71
140000B SCM USED

```
      SUBROUTINE LCFF (DOXIDE,FREQ,HYDRO,IODINE,NPCYCL,PSR,TCLAD,NCF)
C
C     IMPLICIT REAL*8(A-H,O-Z)
C
C     SUBROUTINE LCFF PREDICTS THE NUMBER OF POWER CYCLES TO FAILURE
C     FOR A ROD SUBJECTED TO LOW CYCLE FATIGUE
C     ***  PART OF FRAIL FAILURE PACKAGE   ***
C
C
C     --  INPUT ARGUMENTS  --
C
C     DOXIDE     DEPTH OF OXIDE LAYER ( PER CENT OF CLAD THICKNESS )
C     FREQ       FREQUENCY OF POWER CYCLE ( SEC-1 )
C     HYDRO      CLADDING HYDROGEN CONTENT ( PPM )
C     IODINE     CLADDING IODINE CONTENT ( KG/ M3 )
C     NPCYCL     NUMBER OF PREVIOUS POWER CYCLES
C     PSR        PLASTIC STRAIN RANGE
C     TCLAD      CLADDING TEMPERATURE ( DEG K )
C
C
C     -- OUTPUT ARGUMENTS  --
C
C     NCF        NUMBER OF POWER CYCLES TO FAILURE
C
      REAL*8 IODINE, NPCYCL, NCF
C        REAL IODINE, NPCYCL, NCF
C
C     SET THE NUMBER OF CYCLES TO FAILURE TO A LARGE NUMBER UNTIL THE
C     CORRECT NUMBER OF CYCLES IS KNOWN
C
C     NCF = 1.0D+9
        NCF = 1.0E+9
C
        RETURN
        END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	LCFF	1

DEF LINE: 1

REFERENCES: 34

VARIABLES

	SN	TYPE	RELOCATION						
0	DOXIDE	REAL	*UNUSED	F.P.	DEFINED	1			
0	FREQ	REAL	*UNUSED	F.P.	DEFINED	1			
0	HYDRO	REAL	*UNUSED	F.P.	DEFINED	1			
0	IODINE	REAL	*UNUSED	F.P.	REFS	26	DEFINED	1	
0	NCF	REAL		F.P.	REFS	26	DEFINED	1	32
0	NPCYCL	REAL	*UNUSED	F.P.	REFS	26	DEFINED	1	
0	PSR	REAL	*UNUSED	F.P.	DEFINED	1			

```
VARIABLES     SN  TYPE          RELOCATION
    0  TCLAD      REAL       *UNUSED    F.P.      DEFINED        1

STATISTICS
  PROGRAM LENGTH                  12B       10
        140000B SCM USED
```

```
      SUBROUTINE MELT (TCLAD,NFROD,UMELT,MODE,NFAIL)                    MELT       2
C                                                                       MELT       3
C     IMPLICIT REAL*8(A-H,O-Z)                                          MELT       4
C                                                                       MELT       5
C     SUBROUTINE MELT DETERMINES IF A ROD HAS FAILED BY MELTING         MELT       6
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                          MELT       7
C                                                                       MELT       8
C     --  INPUT ARGUMENTS --                                            MELT       9
C     NFROD       NUMBER OF FUEL RODS IN SYSTEM                       MELT      10
C     TCLAD       TEMPERATURE OF CLADDING ( DEG K )                   MELT      11
C     UMELT       USER-SELECTED MELT TEMPERATURE ( DEG K )            MELT      12
C                                                                       MELT      13
C     -- OUTPUT ARGUMENTS --                                           MELT      14
C                                                                       MELT      15
C     MODE        MODE OF FAILURE ( = 1  IF CLADDING MELTED )         MELT      16
C     NFAIL       NUMBER OF FAILED FUEL RODS                          MELT      17
C                                                                       MELT      18
C                                                                       PHYPRO     2
      COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB     PHYPRO     3
     +             ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP       PHYPRO     4
     +             ,DELOXY                                              PHYPRO     5
C                                                                       PHYPRO     6
C     FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)               PHYPRO     7
C     FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)            PHYPRO     8
C     CTMELT - ZR CLAD MELTING POINT (K)                                PHYPRO     9
C     CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                           PHYPRO    10
C     CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)         PHYPRO    11
C     CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)           PHYPRO    12
C     CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)         PHYPRO    13
C     FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)           PHYPRO    14
C     BU     - BURNUP (MW-S/KG-U)                                       PHYPRO    15
C     COMP   - PUO2 CONTENT (WT-PERCENT)                                PHYPRO    16
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED      PHYPRO    17
C     CLADDING     (KG OXYGEN/KG ZIRCALOY)                              PHYPRO    18
C                                                                       PHYPRO    19
C                                                                       MELT      20
      IF (UMELT.NE.0.) GO TO 100                                        MELT      21
      UMELT = CTMELT                                                    MELT      22
  100 IF (UMELT.GE.TCLAD) GO TO 110                                     MELT      23
      NFAIL = NFROD                                                     MELT      24
      MODE = 1                                                          MELT      25
      GO TO 120                                                         MELT      26
  110 NFAIL = 0                                                         MELT      27
  120 CONTINUE                                                          MELT      28
C                                                                       MELT      29
      RETURN                                                            MELT      30
      END                                                               MELT      31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	MELT	1	46

VARIABLES	SN	TYPE	RELOCATION						
10	BUP	REAL	PHYPRO	REFS	19				
3	CHEFUS	REAL	PHYPRO	REFS	19				
11	COMP	REAL	PHYPRO	REFS	19				
2	CTMELT	REAL	PHYPRO	REFS	19	38			
4	CTRANB	REAL	PHYPRO	REFS	19				
5	CTRANE	REAL	PHYPRO	REFS	19				
6	CTRANZ	REAL	PHYPRO	REFS	19				
12	DELOXY	REAL	PHYPRO	REFS	19				
7	FDELTA	REAL	PHYPRO	REFS	19				
1	FHEFUS	REAL	PHYPRO	REFS	19				
0	FTMELT	REAL	PHYPRO	REFS	19				
0	MODE	INTEGER	F.P.	DEFINED	1	41			
0	NFAIL	INTEGER	F.P.	DEFINED	1	40	43		
0	NFROD	INTEGER	F.P.	REFS	40	DEFINED	1		
0	TCLAD	REAL	F.P.	REFS	39	DEFINED	1		
0	UMELT	REAL	F.P.	REFS	37	39	DEFINED	1	38

STATEMENT LABELS		DEF LINE	REFERENCES
13	100	39	37
25	110	43	39
27	120	44	42

COMMON BLOCKS	LENGTH
PHYPRO	11

STATISTICS

PROGRAM LENGTH	30B	24
SCM LABELED COMMON LENGTH	13B	11

140000B SCM USED

```
1                SUBROUTINE MEMSET (FILL,A,N)                                  MSET        2
                 IMPLICIT REAL*8 (A-H,O-Z)                                     MSET        3
                 DIMENSION A(1)                                                MSET        4
                     DO 100 J=1,N                                              MSET        5
5                    A(J) = FILL                                               MSET        6
100              CONTINUE                                                      MSET        7
                 RETURN                                                        MSET        8
                 END                                                           MSET        9
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	MEMSET	1	7

VARIABLES	SN	TYPE		RELOCATION					
0	A	REAL	ARRAY	F.P.	REFS	3	DEFINED	1	5
0	FILL	REAL		F.P.	REFS	5	DEFINED	1	
20	J	INTEGER			REFS	5	DEFINED	4	
0	N	INTEGER		F.P.	REFS	4	DEFINED	1	

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	6	4

JOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
11	100	J	4 6	6B	INSTACK

STATISTICS

PROGRAM LENGTH	25B	21
140000B SCM USED		

```
      SUBROUTINE NDTR (X,P,D)                                                   NDTR       2
C                                                                               NDTR       3
C                                                                               NDTR       4
C     SUBROUTINE NDTR COMPUTES  Y = P(X) = PROBABILITY THAT THE RANDOM          NDTR       5
C     VARIABLE U, DISTRIBUTED NORMALLY (0,1), IS LESS THAN OR EQUAL TO          NDTR       6
C     X.  F(X), THE ORDINATE OF THE NORMAL DENSITY AT X, IS ALSO                NDTR       7
C     COMPUTED.                                                                 NDTR       8
C                                                                               NDTR       9
C     NDTR IS A SUBROUTINE OF THE SYSTEM/360 SCIENTIFIC SUBROUTINE              NDTR      10
C     PACKAGE.                                                                  NDTR      11
C     ***  PART OF FRAIL FAILURE PACKAGE   ***                                  NDTR      12
C                                                                               NDTR      13
C                                                                               NDTR      14
C     --  INPUT ARGUMENTS --                                                    NDTR      15
C                                                                               NDTR      16
C     X          INPUT SCALAR FOR WHICH P(X) IS COMPUTED                        NDTR      17
C     = ( VALUE - AVERAGE ) / STANDARD DEVIATION                                NDTR      18
C                                                                               NDTR      19
C                                                                               NDTR      20
C     -- OUTPUT ARGUMENTS --                                                    NDTR      21
C                                                                               NDTR      22
C     P          PROBABILITY                                                    NDTR      23
C     D          DENSITY                                                        NDTR      24
C                                                                               NDTR      25
C                                                                               NDTR      26
C     IMPLICIT REAL*8(A-H,O-Z)                                                  NDTR      27
C                                                                               NDTR      28
      AX = ABS(X)                                                               NDTR      29
      T = 1.0/(1.0+.2316419*AX)                                                 NDTR      30
      D = 0.3989423*EXP(-X*X/2.0)                                               NDTR      31
      P = 1.0-D*T*((((1.330274*T-1.821256)*T+1.781478)*T-0.3565638)*T+0.        NDTR      32
     +3193815)                                                                  NDTR      33
      IF (X) 100,110,110                                                        NDTR      34
  100 P = 1.0-P                                                                 NDTR      35
  110 CONTINUE                                                                  NDTR      36
      RETURN                                                                    NDTR      37
      END                                                                       NDTR      38
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	NDTR	1	36

VARIABLES	SN	TYPE	RELOCATION								
62	AX	REAL		REFS	29	DEFINED	28				
0	D	REAL	F.P.	REFS	31	DEFINED	1	30			
0	P	REAL	F.P.	REFS	34	DEFINED	1	31	34		
63	T	REAL		REFS	5*31	DEFINED	29				
0	X	REAL	F.P.	REFS	28	2*30	33	DEFINED	1		

```
EXTERNALS          TYPE    ARGS       REFERENCES
      EXP        REAL       1 LIBRARY     30

INLINE FUNCTIONS   TYPE    ARGS         DEF LINE  REFERENCES
      ABS        REAL       1  INTRIN                  28

STATEMENT LABELS                 DEF LINE   REFERENCES
    0  100          INACTIVE        34          33
   44  110                          35        2*33

STATISTICS
  PROGRAM LENGTH                    64B       52
        140000B SCM USED
```

```
      SUBROUTINE NEWGAP (DLTGC,FC,GAP,GPTH,GPTHE,J,K,NCONVG,NCOUNT,PIN,P NEWG     2
     +INE,PINT,MECHAN)                                                  NEWG     3
C                                                                       NEWG     4
C     IMPLICIT REAL * 8 (A-H,O-Z)                                       NEWG     5
C                                                                       NEWG     6
C     ********************************************************************NEWG     7
C                                                                       NEWG     8
C     NEWGAP IS CALLED FROM MAIN AND COMPUTES THE NEW ESTIMATE OF GAP   NEWG     9
C     AND INTERFACIAL PRESSURE. IT ALSO CHECKS ON CONVERGENCE OF THE    NEWG    10
C     INNER LOOP BASED ON GAP TEMPERATURE DROP.                         NEWG    11
C                                                                       NEWG    12
C     ********************************************************************NEWG    13
C     INPUT ARGUMENTS                                                   NEWG    14
C     ********************************************************************NEWG    15
C                                                                       NEWG    16
C     DLTGC  - GAP TEMPERATURE DROP (F)                                 NEWG    17
C     FC     - RELOCATION FACTOR                                        NEWG    18
C     GAP    - PELLET CLADDING GAP AT EACH AXIAL NODE (IN)              NEWG    19
C     J      - AXIAL NODE INDEX                                         NEWG    20
C     K      - GAP ITERATION INDICATOR                                  NEWG    21
C     MECHAN - MECHANICAL MODEL INDEX                                   NEWG    22
C     = 1, PELET SUBCODE                                                NEWG    23
C     = 2, FRACAS-I SUBCODE                                             NEWG    24
C     = 3, FRACAS-II SUBCODE                                            NEWG    25
C     PINT   - INTERFACE PRESSURE (PSIA)                                NEWG    26
C                                                                       NEWG    27
C     ********************************************************************NEWG    28
C     OUTPUT ARGUMENTS                                                  NEWG    29
C     ********************************************************************NEWG    30
C                                                                       NEWG    31
C     GPTH   - THERMAL GAP THICKNESS (IN)                               NEWG    32
C     GPTHE  - ESTIMATED GAP THICKNESS (IN)                             NEWG    33
C     NCONVG - CONVERGENCE INDEX                                        NEWG    34
C     NCOUNT - NON-CONVERGENCE INDEX ( 26 ITERATIONS )                  NEWG    35
C     PIN    - INTERFACE PRESSURE (PSIA)                                NEWG    36
C     PINE   - INTERFACE PRESSURE ESTIMATE (PSIA)                       NEWG    37
C                                                                       NEWG    38
C     ********************************************************************NEWG    39
C                                                                       NEWG    40
      DIMENSION     FC(1)    ,PIN(1)   ,PINT(1)  ,GAP(1)   ,GPTH(1)    NEWG    41
     +             ,PINE(1)  ,DLTGC(1) ,GPTHE(1)                        NEWG    42
C                                                                       NEWG    43
      IF (PINT(J-1).LT.0.E0) PINT(J-1) = 0.E0                           NEWG    44
      PIN(K) = PINT(J-1)                                                NEWG    45
      IF (GAP(J-1).LT.0.E0) GAP(J-1) = 0.E0                             NEWG    46
      IF (MECHAN.EQ.3) GPTH(K) = 0.E0                                   NEWG    47
      IF (GPTH(K).LT.0.E0) GPTH(K) = 0.E0                               NEWG    48
C                                                                       NEWG    49
      IF (K.LE.2) GO TO 100                                             NEWG    50
C                                                                       NEWG    51
C     CHECK FOR CONVERGENCE ON THE GAP TEMPERATURE DROP, DLTGC          NEWG    52
C                                                                       NEWG    53
      CONVC = AMAX1(0.01E0*DLTGC(K),0.5E0)                              NEWG    54
```

```
                IF (ABS(DLTGC(K)-DLTGC(K-1)).LE.CONVC) NCONVG = 1                  NEWG      55
55          C                                                                      NEWG      56
            100 CONTINUE                                                           NEWG      57
                IF (NCONVG.EQ.1) GO TO 160                                         NEWG      58
            C                                                                      NEWG      59
            C   CALCULATION OF ESTIMATED GAP                                       NEWG      60
60          C                                                                      NEWG      61
                K = K+1                                                            NEWG      62
                IF (K.GT.25) NCOUNT = 1                                            NEWG      63
                IF (K.GT.25) GO TO 160                                             NEWG      64
                IF (K.LE.3) GO TO 110                                              NEWG      65
65              IF (GPTH(K-1).EQ.GPTH(K-2)) GO TO 120                              NEWG      66
                COS = 1.-(GPTHE(K-1)-GPTHE(K-2))/(GPTH(K-1)-GPTH(K-2))             NEWG      67
                IF (ABS(COS).LE.0.1) GO TO 120                                     NEWG      68
                GPTHE(K) = (GPTHE(K-2)*GPTH(K-1)-GPTHE(K-1)*GPTH(K-2))/(GPTHE(K-2) NEWG      69
               ++GPTH(K-1)-GPTHE(K-1)-GPTH(K-2))                                   NEWG      70
70              IF (GPTHE(K).LT.0.E0) GO TO 120                                    NEWG      71
                GO TO 130                                                          NEWG      72
            110 CONTINUE                                                           NEWG      73
            120 GPTHE(K) = 0.5*(GPTHE(K-1)+GPTH(K-1))                              NEWG      74
                IF (K.LE.3) GO TO 140                                              NEWG      75
75          130 IF (PIN(K-1).EQ.PIN(K-2)) GO TO 140                                NEWG      76
                IF (PINE(K-1).EQ.0.E0.AND.PINE(K-2).EQ.0.E0) GO TO 140             NEWG      77
                COSP = 1.-(PINE(K-1)-PINE(K-2))/(PIN(K-1)-PIN(K-2))                NEWG      78
                IF (ABS(COSP).LE.0.1) GO TO 140                                    NEWG      79
                PINE(K) = (PINE(K-2)*PIN(K-1)-PINE(K-1)*PIN(K-2))/(PINE(K-2)+PIN(K NEWG      80
80             +-1)-PINE(K-1)-PIN(K-2))                                            NEWG      81
                GO TO 150                                                          NEWG      82
            140 PINE(K) = .5*(PINE(K-1)+PIN(K-1))                                  NEWG      83
            150 CONTINUE                                                           NEWG      84
            C                                                                      NEWG      85
85          160 CONTINUE                                                           NEWG      86
                RETURN                                                             NEWG      87
                END                                                                NEWG      88
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	NEWGAP	DEF LINE 1 — REFERENCES 86

VARIABLES

		SN	TYPE			RELOCATION							
227	CONVC		REAL				REFS	54	DEFINED	53			
230	COS		REAL				REFS	67	DEFINED	66			
231	COSP		REAL				REFS	78	DEFINED	77			
0	DLTGC		REAL	ARRAY	F.P.		REFS	40	53.	2*54	DEFINED	1	
0	FC		REAL	ARRAY	F.P.		REFS	40	DEFINED	1			
0	GAP		REAL	ARRAY	F.P.		REFS	40	45	DEFINED	1	45	
0	GPTH		REAL	ARRAY	F.P.		REFS	40	47	2*65	2*66	4*68	73
							DEFINED	1	46	47			

```
VARIABLES     SN  TYPE          RELOCATION
    0  GPTHE      REAL      ARRAY     F.P.      REFS      40      2*66      4*68      70      73
                                                DEFINED    1        68        73
    0  J          INTEGER             F.P.      REFS    2*43       44      2*45  DEFINED      1
    0  K          INTEGER             F.P.      REFS      44       46      2*47      49      53      2*54      61
                                                          62       63        64      2*65      4*66      9*68      70      3*73
                                                          74    2*75     2*76      4*77      9*79      3*82
                                                DEFINED    1        61
    0  MECHAN     INTEGER             F.P.      REFS      46  DEFINED        1
    0  NCONVG     INTEGER             F.P.      REFS      57  DEFINED        1      54
    0  NCOUNT     INTEGER             F.P.      DEFINED    1        62
    0  PIN        REAL      ARRAY     F.P.      REFS      40     2*75      2*77      4*79      82
                                                DEFINED    1        44
    0  PINE       REAL      ARRAY     F.P.      REFS      40     2*76      2*77      4*79      82
                                                DEFINED    1        79        82
    0  PINT       REAL      ARRAY     F.P.      REFS      40        43        44  DEFINED      1      43

INLINE FUNCTIONS   TYPE    ARGS        DEF LINE  REFERENCES
       ABS         REAL       1  INTRIN            54      67        78
       AMAX1       REAL       0  INTRIN            53

STATEMENT LABELS              DEF LINE   REFERENCES
   56  100                        56         49
  136  110                        72         64
  137  120                        73         65        67      70
  151  130                        75         71
  212  140                        82         74        75      76        78
  221  150                        83         81
  222  160                        85         57        63

STATISTICS
  PROGRAM LENGTH                  232B       154
        140000B SCM USED
```

```
 SUBROUTINE NEMSET     76/176  OPT=0 TRACE STATIC              FTN 4.8+508        10/21/80  14.29.35       PAGE     1

 1                SUBROUTINE NEMSET (FILL,IN,N)                                    NSET        2
                  DIMENSION IN(1)                                                  NSET        3
                  INTEGER  FILL                                                    NSET        4
                      DO 100 I=1,N                                                 NSET        5
 5          10C         IN(I) = FILL                                              NSET        6
                  RETURN                                                           NSET        7
                  END                                                              NSET        8


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
     NEMSET           1          6

VARIABLES     SN  TYPE              RELOCATION
     0  FILL       INTEGER                F.P.        REFS        3        5    DEFINED        1
    17  I          INTEGER                            REFS        5   DEFINED          4
     0  IN         INTEGER    ARRAY       F.P.        REFS        2   DEFINED          1        5
     0  N          INTEGER                F.P.        REFS        4   DEFINED          1

STATEMENT LABELS              DEF LINE   REFERENCES
     0  100                       5          4

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   11  100       I            4 5          5B      INSTACK

STATISTICS
  PROGRAM LENGTH                    24B       20
          140000B SCM USED
```

```
      SUBROUTINE PGHEAD (CODID,MODLOP,TITLE)                                  PGHD        2
C                                                                             PGHD        3
C   THIS SUBROUTINE PRINTS OUT THE PROGRAM VERSION IDENTIFICATION AT          PGHD        4
C   THE TOP OF EACH OUTPUT PAGE                                               PGHD        5
C                                                                             PGHD        6
C   IMPLICIT REAL*8 (A-H,O-Z)                                                 PGHD        7
C                                                                             PGHD        8
      DIMENSION TITLE(12)                                                     PGHD        9
      DIMENSION   A(3), CODEID(13) ,CODID(15)                                 PGHD       10
C   REAL   DAY(2)                                                             PGHD       11
      DATA      NPAGE,CNOB /     0, 8HKNOBS    /                            PGHD       12
C                                                                             PGHD       13
C   THE CODE IDENTIFICATION SHOULD BE CHANGED EACH TIME CHANGES ARE           PGHD       14
C   MADE IN THE CODE                                                          PGHD       15
C                                                                             PGHD       16
      DATA CODEID /                                                           PGHD       17
     +  8HFRAPCON ,8HMOD 002                                                  PGHD       18
     + ,8HVER5001                                                             PGHD       19
     + ,8H  STEADY,8H-STATE F,8HUEL ROD                                       PGHD       20
     + ,8HANALYSIS,8H CODE                                                    PGHD       21
     + ,5*8H        /                                                        PGHD       22
C                                                                             PGHD       23
      CALL PROPID (A)                                                         PGHD       24
      IF (NPAGE.GT.0) GO TO 110                                               PGHD       25
      CNOB3 = CODEID(3)                                                       PGHD       26
          DO 100 I=1,3                                                        PGHD       27
          CODID(I+3) = A(I)                                                   PGHD       28
  100     CODID(I) = CODEID(I)                                                PGHD       29
  110 CONTINUE                                                                PGHD       30
      CODEID(3) = CNOB3                                                       PGHD       31
      IF (CODID(15).NE.2.E0) CODEID(3) = CNOB                                 PGHD       32
      CODID(3) = CODEID(3)                                                    PGHD       33
C                                                                             PGHD       34
      NPAGE = NPAGE+1                                                         PGHD       35
      CALL DATE (DAY)                                                         PGHD       36
      WRITE (6,120)                                                           PGHD       37
      WRITE (6,130)                                                           PGHD       38
      WRITE (6,160) CODEID(1)                                                 PGHD       39
      WRITE (6,140) (CODEID(I),I=4,8)                                         PGHD       40
      WRITE (6,150) (CODEID(I),I=2,3),(A(I),I=1,3)                            PGHD       41
      WRITE (6,180) DAY,MODLOP,NPAGE                                          PGHD       42
      WRITE (6,190) (TITLE(I),I=1,12)                                         PGHD       43
      WRITE (6,170)                                                           PGHD       44
      RETURN                                                                  PGHD       45
C                                                                             PGHD       46
  120 FORMAT (1H1)                                                            PGHD       47
  130 FORMAT (1H+,40X,53(1HX))                                                PGHD       48
  140 FORMAT (1H ,40X,1HX,6X,5A8,5X,1HX)                                      PGHD       49
  150 FORMAT (1H ,40X,1HX,5X,2A8,2X,3A8,4X,1HX)                               PGHD       50
  160 FORMAT (1H ,40X,1HX,17X,5H**** ,A8,4H****,17X,1HX)                      PGHD       51
  170 FORMAT (1H ,40X,53(1HX))                                                PGHD       52
  180 FORMAT (1H ,40X,1HX,1X,12H RUN DATE = ,A10,9H OPTIONS ,I8,1X,5HPAG      PGHD       53
     +E ,I4,1X,1HX)                                                           PGHD       54
```

```
                190   FORMAT (1H.,40X,1HX,2X,12A4,1X,1HX)                    PGHD      55
     55                 END                                                  PGHD      56
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 PGHEAD 1 44

VARIABLES	SN	TYPE	RELOCATION									
200 A		REAL	ARRAY		REFS	9	23	27	40			
72 CNOB		REAL			REFS	31	DEFINED	11				
175 CNOB3		REAL			REFS	30	DEFINED	25				
203 CODEID		REAL	ARRAY		REFS	9	25	28	32	38	39	40
					DEFINED	16	30	31				
0 CODID		REAL	ARRAY	F.P.	REFS	9	31	DEFINED	1	27	28	32
177 DAY		REAL			REFS	35	41					
176 I		INTEGER			REFS	2*27	2*28	39	2*40	42		
					DEFINED	26	39	2*40	42			
0 MODLOP		INTEGER		F.P.	REFS	41	DEFINED	1				
71 NPAGE		INTEGER			REFS	24	34	41	DEFINED	11	34	
0 TITLE		REAL	ARRAY	F.P.	REFS	8	42	DEFINED	1			

FILE NAMES	MODE									
TAPE6	FMT	WRITES	36	37	38	39	40	41	42	43

EXTERNALS	TYPE	ARGS	REFERENCES
DATE		1	35
PROPID		1	23

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		28	26
27	110		29	24
133	120	FMT	46	36
135	130	FMT	47	37
140	140	FMT	48	39
144	150	FMT	49	40
150	160	FMT	50	38
155	170	FMT	51	43
160	180	FMT	52	41
170	190	FMT	54	42

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
17	100	I	26 28	7B	INSTACK

STATISTICS
PROGRAM LENGTH 223B 147
140000B SCM USED

```
      SUBROUTINE PLNT (AMFAIR,AMFARG,AMFFG,AMFHE,AMFH2O,AMFN2,COLDWK,CPL
     +,CRDTT,DCI,HPV,DCO,DE,DHIC,FA,FLUX,G,HPL,GASES,GR,HFLL,HFLMDB,HFLM
     +P,TPAA,QSP,IT,QP,NU,PRESS,RHOG,TOTL,TPLEN,VSS,QMPY,Q,QEND,TAC,P2,T
     +BLK,TIME,PI,AXLEN,NA,EPS,DELTAZ,AMFKRY,AMFXE,AMFH2,DELOXY,CWKF,FNC
     +K)
C
C     IMPLICIT REAL*8 (A-H,O-Z)
C
      REAL  NU , MOLN
C
C     ******************************************************************
C
C     SUBROUTINE PLNT IS CALLED FROM MAIN AND COMPUTES THE PLENUM
C     TEMPERATURE AND HOT STATE PLENUM VOLUME
C     PLNT WAS CODED BY G A BERNA IN JANUARY 1978.
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     AMFAIR - ABSOLUTE MOLE FRACTION OF AIR
C     AMFARG - ABSOLUTE MOLE FRACTION OF ARGON
C     AMFFG  - ABSOLUTE MOLE FRACTION OF FISSION GASES
C     AMFHE  - ABSOLUTE MOLE FRACTION OF HELIUM
C     AMFH2  - ABSOLUTE MOLE FRACTION OF HYDROGEN
C     AMFH2O - ABSOLUTE MOLE FRACTION OF WATER
C     AMFKRY - ABSOLUTE MOLE FRACTION OF KRYPTON
C     AMFN2  - ABSOLUTE MOLE FRACTION OF NITROGEN
C     AMFXE  - ABSOLUTE MOLE FRACTION OF XENON
C     AXLEN  - AXIAL STRAIN DUE TO CLADDING IRRADIATION GROWTH (M/M)
C     COLDWK - CLADDING COLD WORK
C     CPL    - COLD PLENUM LENGTH (IN)
C     CRDTT  - CRUD THICKNESS (MILS)
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED
C     CLADDING (KG OXYGEN/KG ZIRCALOY)
C     DELTAZ - AXIAL NODE LENGTHS (FT)
C     DCI    - COLD STATE CLADDING INSIDE DIAMETER (IN)
C     EPS    - CLADDING STRAINS (M/M)
C     FNCK   - EFFECTIVE FAST FLUENCD FOR STRAIN HARDENING EXPONENT
C     GASES  - ARRAY OF MOLE FRACTIONS OF GASES
C     GAS 1 - HELIUM
C     GAS 2 - ARGON
C     GAS 3 - KRYPTON
C     GAS 4 - XENON
C     GAS 5 - HYDROGEN
C     GAS 6 - AIR
C     GAS 7 - WATER VAPOR
C     HFLL   - MAXIMUM HOT FUEL STACK HEIGHT (IN)
C     IT     - POWER TIME STEP INDEX
C     PRESS  - ROD INTERNAL GAS PRESSURE (PSIA)
C     PI     - THE CONSTANT 3.1415926
C     P2     - SYSTEM PRESSURE (PSIA)
```

```
      C   Q      - NORMALIZED AXIAL NODE POWER                                  PLNT       55
55    C   QEND   - NORMALIZED HEAT FLUX AT TOP OF FUEL STACK                    PLNT       56
      C   QMPY   - ROD AVERAGE HEAT FLUX FOR POWER-TIME STEP (BTU/HR-FT**2)     PLNT       57
      C   TAC    - AVERAGE CLADDING TEMPERATURE OF TOP AXIAL NODE (F)           PLNT       58
      C   TBLK   - BULK COOLANT TEMPERATURE AT THE TOP OF FUEL STACK (F)       PLNT       59
      C   TIME   - TIME STEP ARRAY (SEC)                                       PLNT       60
60    C   TOTL   - FUEL STACK HEIGHT (FT)                                      PLNT       61
      C   TPAA   - AVERAGE TEMPERATURE OF THE TOP PELLET (F)                   PLNT       62
      C   VSS    - HOT VOLUME OF SPRING ''N**3)                                PLNT       63
      C                                                                        PLNT       64
      C                                                                        PLNT       65
65    C   ************************************************************************ PLNT    66
      C   OUTPUT ARGUMENTS                                                     PLNT       67
      C   ************************************************************************ PLNT    68
      C                                                                        PLNT       69
      C   GR     - GRASHOFF NUMBER OF PLENUM GAS MIXTURE                       PLNT       70
70    C   HFLMDB - DITTUS-BOELTER FILM COEFFICIENT (BTU/HR-FT**2-F)           PLNT       71
      C   HFLMP  - FORCED CONVECTION FILM COEFFICIENT (BTU/HR-FT**2-F)         PLNT       72
      C   HPL    - HOT PLENUM LENGTH (IN)                                      PLNT       73
      C   HPV    - HOT PLENUM VOLUME (CU.IN.)                                  PLNT       74
      C   NU     - NUSSELT NUMBER OF PLENUM GAS MIXTURE                        PLNT       75
75    C   QP     - HEAT FLOW FROM TOP OF FUEL STACK (BTU/HR)                   PLNT       76
      C   QSP    - HEAT GENERATED IN SPRING (BTU/HR)                           PLNT       77
      C   RHOG   - DENSITY OF PLENUM GAS MIXTURE (LB/FT**3)                    PLNT       78
      C   TPLEN  - PLENUM TEMPERATURE (F)                                      PLNT       79
      C                                                                        PLNT       80
80    C   ************************************************************************ PLNT    81
      C                                                                        PLNT       82
      C                                                                        PLNT       83
            DIMENSION  GASES(7) ,EPS(NA,3) ,DELTAZ(22) ,AXLEN(NA)              PLNT       84
      C                                                                        PLNT       85
85    C                                                                        PLNT       86
            IF (IT.EQ.1) TPLEN = TBLK                                          PLNT       87
            TPA = TPAA                                                         PLNT       88
            TPA = QEND*FA/Q*(TPA-TBLK)+TBLK                                    PLNT       89
      C                                                                        PLNT       90
90    C   CALCULATION OF HOT PLENUM LENGTH                                     PLNT       91
            TACK = (TAC+459.67)/1.8                                            PLNT       92
            CALL CTHEXP (TACK,CATHEX,CDTHEX)                                   PLNT       93
            TXC = CDTHEX                                                       PLNT       94
            TXCL = CATHEX                                                      PLNT       95
95    C                                                                        PLNT       96
      C   COMPUTE  HOT CLADDING LENGTH                                        PLNT       97
      C                                                                        PLNT       98
            CLDLEN = CPL*(1.E0+TXCL+AXLEN(NA))                                 PLNT       99
                DO 100 I=2,NA                                                  PLNT      100
100                 IM1 = I-1                                                  PLNT      101
                    CLDLEN = CLDLEN+DELTAZ(I)*(1.E0+EPS(IM1,2)+AXLEN(I))*12.   PLNT      102
      100       CONTINUE                                                       PLNT      103
      C                                                                        PLNT      104
            HPL = CLDLEN-HFLL                                                  PLNT      105
105   C                                                                        PLNT      106
            ELASTS = 0.E0                                                      PLNT      107
```

```
                E = CELMOD(TACK,FNCK,CWKF,DELOXY)/6.8947572E3                          PLNT      108
                IF (HPL.GT.2.E0*DCI) ELASTS = ((PRESS*DCI-P2*DCO)/(DCO-DCI))/E         PLNT      109
                DHIC = DCI*(1.E0+TXC+ELASTS)/12.E0                                     PLNT      110
110         C                                                                          PLNT      111
            C                                                                          PLNT      112
            C   CALCULATION OF HOT PLENUM VOLUME                                       PLNT      113
            C                                                                          PLNT      114
                HPV = HPL*PI*DHIC*DHIC*144./4.-VSS*(1.+3.*1.39E-5*(TPLEN-70.)/1.8)     PLNT      115
115         C                                                                          PLNT      116
            C   CALCULATION OF NATURAL CONVEVTION HEAT TRANSFER COEFFICIENT (HP)       PLNT      117
            C   AT THE TOP OF THE FUEL STACK, USING EQUATIONS FROM MCADAMS ,           PLNT      118
            C   PAGE 180 (    (RHOG = DENSITY , VISC = VISCOSITY , GR = GRASHOF        PLNT      119
            C   NUMBER , PR = PRANDTL NUMBER , AND NU = NUSSELT NUMBER )               PLNT      120
120         C                                                                          PLNT      121
                IF (HPV.LE.0.0) GO TO 130                                              PLNT      122
                IF (TPA.LE.TPLEN) GO TO 110                                            PLNT      123
                MOLN = AMFFG*124.17+AMFAIR*28.96+AMFN2*28.0+AMFHE*4.0+AMFARG*39.94     PLNT      124
               ++AMFH2O*18.015                                                         PLNT      125
125             RHOG = (MOLN*492.*PRESS)/(359.*(TPLEN+460.)*15.)                       PLNT      126
                TPLENK = (TPLEN+459.67)/1.8                                            PLNT      127
                VISC = GVISCO(GASES,TPLENK)                                            PLNT      128
                GR = (0.9*DHIC)**3*RHOG*RHOG*32.2*0.000828*(TPA-TPLEN)/(VISC*VISC)     PLNT      129
                GASCP = AMFHE*1.240+AMFAIR*0.241+AMFARG*0.125+AMFH2*3.43+AMFKRY*0.     PLNT      130
130            +059+AMFN2*0.249+AMFH2O*1.000+AMFXE*0.115                               PLNT      131
            C                                                                          PLNT      132
                GPRES = PRESS*6894.76E0                                                PLNT      133
                GPTHK = 0.E0                                                           PLNT      134
                CGAS = GTHCON(GASES,TPLENK,GPRES,GPTHK)/1.7296E0                       PLNT      135
135             PR = GASCP*VISC*2414.E0/CGAS                                           PLNT      136
                IF (GR*PR.GT.2.E7) NU = 0.14E0*((GR*PR)**0.3333E0)                     PLNT      137
                IF (GR*PR.LE.2.E7) NU = 0.54E0*((GR*PR)**0.2500E0)                     PLNT      138
                IF (NU.LE.0.4) NU = 0.4                                                PLNT      139
                HP = NU*CGAS/DHIC                                                      PLNT      140
140         110 IF (TPA.LE.TPLEN) HP = 0.0                                             PLNT      141
            C                                                                          PLNT      142
            C   CALCULATION OF PLENUM HEAT                                           PLNT      143
            C   QF IS THE HEAT FLOW INTO THE PLENUM FROM THE FUEL STACK               PLNT      144
            C   QSP IS THE HEAT GENERATED IN THE SPRING BY GAMMA RADIATION            PLNT      145
145         C                                                                          PLNT      146
                QSP = (3.05E+5*QMPY/(2.662E+5*FA))*VSS/1728.                           PLNT      147
                IF (G.LE.0.0) GO TO 120                                                PLNT      148
                HFLMDB = ((-5.1889E-5+6.5044E-8*TBLK)*TBLK+(3.5796E-7-1.0337E-9*TB     PLNT      149
               +LK)*P2+3.2377E-2)*G*(G*DE)**(-0.2)                                     PLNT      150
150             HFLMP = 1.0/(1.0/HFLMDB+CRDTT/6000.)                                   PLNT      151
            120 IF (G.LE.0.0) HFLMP = 50000.0                                          PLNT      152
                TBLKK = (TBLK+459.67)/1.8                                              PLNT      153
            C                                                                          PLNT      154
                CALL CTHCON (TBLKK,TIME,FLUX,COLDWK,CCON,CDKDT)                        PLNT      155
155         C                                                                          PLNT      156
                CCLAD = CCON/1.7296                                                    PLNT      157
                UI = (1.0/(1.0/(DHIC*15.0/2.0)+ALOG(DCO/DCI)/CCLAD+1.0/(DCO*(1.E0+     PLNT      158
               +TXC+ELASTS)*HFLMP/24.E0)))*8.E0*HPV/(DHIC*DHIC*1728.E0)                 PLNT      159
            C                                                                          PLNT      160
```

```
160                TPLEN = (QSP+UI*TBLK+TPA*HP*PI*DHIC*DHIC/4.0)/(UI+(HP*PI*DHIC*DHIC PLNT      161
                  +/4.0))                                                            PLNT      162
                C                                                                    PLNT      163
                   QP = HP*0.785*DHIC*DHIC*(TPA-TPLEN)                               PLNT      164
                130 IF (HPV.LE.0.0) TPLEN = TPA                                      PLNT      165
165                IF (HPV.LT.0.E0) HPV = 0.E0                                       PLNT      166
                C                                                                    PLNT      167
                   RETURN                                                            PLNT      168
                   END                                                               PLNT      169
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	PLNT	1

DEF LINE: 167

VARIABLES

		SN	TYPE	RELOCATION							
0	AMFAIR		REAL	F.P.	REFS	123	129	DEFINED	1		
0	AMFARG		REAL	F.P.	REFS	123	129	DEFINED	1		
0	AMFFG		REAL	F.P.	REFS	123	DEFINED	1			
0	AMFHE		REAL	F.P.	REFS	123	129	DEFINED	1		
0	AMFH2		REAL	F.P.	REFS	129	DEFINED	1			
0	AMFH2O		REAL	F.P.	REFS	123	129	DEFINED	1		
0	AMFKRY		REAL	F.P.	REFS	129	DEFINED	1			
0	AMFN2		REAL	F.P.	REFS	123	129	DEFINED	1		
0	AMFXE		REAL	F.P.	REFS	129	DEFINED	1			
0	AXLEN		REAL ARRAY	F.P.	REFS	83	98	101	DEFINED	1	
605	CATHEX		REAL		REFS	92	94				
631	CCLAD		REAL		REFS	157	DEFINED	156			
627	CCON		REAL		REFS	154	156				
630	CDKDT	*	REAL		REFS	154					
606	CDTHEX		REAL		REFS	92	93				
623	CGAS		REAL		REFS	135	139	DEFINED	134		
611	CLDLEN		REAL		REFS	101	104	DEFINED	98	101	
0	COLDWK		REAL	F.P.	REFS	154	DEFINED	1			
0	CPL		REAL	F.P.	REFS	98	DEFINED	1			
0	CRDTT		REAL	F.P.	REFS	150	DEFINED	1			
0	CWKF		REAL	F.P.	REFS	107	DEFINED	1			
0	DCI		REAL	F.P.	REFS	3*108	109	157	DEFINED	1	
0	DCO		REAL	F.P.	REFS	2*108	2*157	DEFINED	1		
0	DE		REAL	F.P.	REFS	148	DEFINED	1			
0	DELOXY		REAL	F.P.	REFS	107	DEFINED	1			
0	DELTAZ		REAL ARRAY	F.P.	REFS	83	101	DEFINED	1		
0	DHIC		REAL	F.P.	REFS	2*114	128	139	3*157	4*160	2*163
					DEFINED	1	109				
615	E		REAL		REFS	108	DEFINED	107			
614	ELASTS		REAL		REFS	109	157	DEFINED	106	108	
0	EPS		REAL ARRAY	F.P.	REFS	83	101	DEFINED	1		
0	FA		REAL	F.P.	REFS	88	146	DEFINED	1		
0	FLUX		REAL	F.P.	REFS	154	DEFINED	1			

VARIABLES	SN	TYPE	RELOCATION										
0	FNCK	REAL		F.P.	REFS	107	DEFINED	1					
0	G	REAL		F.P.	REFS	147	2*148	151	DEFINED	1			
620	GASCP	REAL			REFS	135	DEFINED	129					
0	GASES	REAL	ARRAY	F.P.	REFS	83	127	134	DEFINED	1			
621	GPRES	REAL			REFS	134	DEFINED	132					
622	GPTHK	REAL			REFS	134	DEFINED	133					
0	GR	REAL		F.P.	REFS	2*136	2*137	DEFINED	1	128			
0	HFLL	REAL		F.P.	REFS	104	DEFINED	1					
0	HFLMDB	REAL		F.P.	REFS	150	DEFINED	1	148				
0	HFLMP	REAL		F.P.	REFS	157	DEFINED	1	150	151			
625	HP	REAL			REFS	2*160	163	DEFINED	139	140			
0	HPL	REAL		F.P.	REFS	108	114	DEFINED	1	104			
0	HPV	REAL		F.P.	REFS	121	157	164	165	DEFINED	1	114	
					165								
612	I	INTEGER			REFS	100	2*101	DEFINED	99				
613	IMI	INTEGER			REFS	101	DEFINED	100					
0	IT	INTEGER		F.P.	REFS	86	DEFINED	1					
602	MOLN	REAL			REFS	9	125	DEFINED	123				
0	NA	INTEGER		F.P.	REFS	2*83	98	99	DEFINED	1			
0	NU	REAL		F.P.	REFS	9	138	139	DEFINED	1	136	137	
					138								
0	PI	REAL		F.P.	REFS	114	2*160	DEFINED	1				
624	PR	REAL			REFS	2*136	2*137	DEFINED	135				
0	PRESS	REAL		F.P.	REFS	108	125	132	DEFINED	1			
0	P2	REAL		F.P.	REFS	108	148	DEFINED	1				
0	Q	REAL		F.P.	REFS	88	DEFINED	1					
0	QEND	REAL		F.P.	REFS	88	DEFINED	1					
0	QMPY	REAL		F.P.	REFS	146	DEFINED	1					
0	QP	REAL		F.P.	DEFINED	1	163						
0	QSP	REAL		F.P.	REFS	160	DEFINED	1	146				
0	RHOG	REAL		F.P.	REFS	2*128	DEFINED	1	125				
0	TAC	REAL		F.P.	REFS	91	DEFINED	1					
604	TACK	REAL			REFS	92	107	DEFINED	91				
0	TBLK	REAL		F.P.	REFS	86	2*88	3*148	152	160			
					DEFINED	1							
626	TBLKK	REAL			REFS	154	DEFINED	152					
0	TIME	REAL		F.P.	REFS	154	DEFINED	1					
0	TOTL	REAL	*UNUSED	F.P.	DEFINED	1							
603	TPA	REAL			REFS	88	122	128	140	160	163	164	
					DEFINED	87	88						
0	TPAA	REAL		F.P.	REFS	87	DEFINED	1					
0	TPLEN	REAL		F.P.	REFS	114	122	125	126	128	140	163	
					DEFINED	1	86	160	164				
616	TPLENK	REAL			REFS	127	134	DEFINED	126				
607	TXC	REAL			REFS	109	157	DEFINED	93				
610	TXCL	REAL			REFS	98	DEFINED	94					
632	UI	REAL			REFS	2*160	DEFINED	157					
617	VISC	REAL			REFS	2*128	135	DEFINED	127				
0	VSS	REAL		F.P.	REFS	114	146	DEFINED	1				

EXTERNALS	TYPE	ARGS	REFERENCES
ALOG	REAL	1 LIBRARY	157
CELMOD	REAL	4	107

EXTERNALS	TYPE	ARGS	REFERENCES
CTHCON		6	154
CTHEXP		3	92
GTHCON	REAL	4	134
GVISCO	REAL	2	127

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	102	99
301	110	140	122
343	120	151	147
431	130	164	121

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
50	100	I	99 102	16B	OPT

STATISTICS
PROGRAM LENGTH 640B 416
140000B SCM USED

```
      SUBROUTINE PLTINP (NTAPE,NPLOT,CODEID,TMAX,NAXN,NROD,IAPLT,MODLOP,  PLTI        2
     +TITLE)                                                              PLTI        3
C                                                                         PLTI        4
C   SUBROUTINE READS IN INFORMATION REQUIRED FOR PLOTTING                 PLTI        5
C   AND WRITES INITIAL INFO TO PLOT DATA SET                              PLTI        6
C   NTAPE = FORTRAN LOGICAL UNIT FOR PLOT DATA                            PLTI        7
C   IS RESET TO ZERO IF NO PLOTS                                          PLTI        8
C   NPLOT = NUMBER OF VARIABLES TO BE PLOTTED,  PLUS 1                    PLTI        9
C   CODEID= IDENTIFIER ARRAY OF FRAP VERSION                              PLTI       10
C   TITLE  - INPUT RUN TITLE                                              PLTI       11
C   TMAX   = END-TIME FOR FRAP RUN                                        PLTI       12
C   NAXN   = NUMBER OF AXIAL NODES                                        PLTI       13
C   NROD   = NUMBER OF FUEL RODS                                          PLTI       14
C                                                                         PLTI       15
C   IMPLICIT REAL*8(A-H,O-Z)                                              PLTI       16
C                                                                         PLTI       17
C   IAPLT = WORK ARRAY FOR NODE NUMBERS FOR PLOTS                         PLTI       18
C                                                                         PLTI       19
      DIMENSION CODEID(15), IAPLT(1), CARD(8)                             PLTI       20
      DIMENSION TITLE(12)                                                 PLTI       21
      DATA NCHAR / 5 /                                                    PLTI       22
C                                                                         PLTI       23
      READ (5,150) NPLTNO,NOGRID                                          PLTI       24
      IF (EOF(5)) 120,100                                                 PLTI       25
  100 CONTINUE                                                            PLTI       26
      IF (NPLTNO.EQ.0) GO TO 120                                          PLTI       27
      IF (NPLTNO.LT.0) GO TO 130                                          PLTI       28
C                                                                         PLTI       29
C   WRITE FRAP VERSION ID, RUN INFO.                                      PLTI       30
      WRITE (NTAPE) (CODEID(J),J=1,3),(CODEID(J),J=4,6),NOGRID            PLTI       31
      IPLOT = NPLOT-1                                                     PLTI       32
      WRITE (NTAPE) IPLOT,NCHAR,NPLTNO,TMAX,NAXN,NROD,MODLOP              PLTI       33
C                                                                         PLTI       34
C   READ IN NODE NUMBERS((J-1)*NAXN+K) TO BE PLOTTED                      PLTI       35
C                                                                         PLTI       36
      READ (5,150) (IAPLT(J),J=1,NPLTNO)                                  PLTI       37
      WRITE (NTAPE) (IAPLT(J),J=1,NPLTNO)                                 PLTI       38
C                                                                         PLTI       39
      CALL PGHEAD (CODEID,MODLOP,TITLE)                                   PLTI       40
C                                                                         PLTI       41
      WRITE (6,170) NPLTNO,(IAPLT(J),J=1,NPLTNO)                          PLTI       42
      WRITE (6,180)                                                       PLTI       43
C                                                                         PLTI       44
C   READ IN MINIMUM AND MAXIMUM VALUES TO BE PLOTTED, AXIS LENGTH         PLTI       45
C   AND AXIS LABEL                                                        PLTI       46
C                                                                         PLTI       47
      DO 110 J=1,NPLOT                                                    PLTI       48
      READ (5,160) CARD                                                   PLTI       49
C   READ(5,15)SCALI(1,J),SCALI(2,J),SCALI(3,J),(CHAR(L,J),L=1,NCHAR)      PLTI       50
      WRITE (NTAPE) CARD                                                  PLTI       51
      WRITE (6,190) CARD                                                  PLTI       52
  110 CONTINUE                                                            PLTI       53
      GO TO 140                                                           PLTI       54
```

```
                120   NTAPE = 0                                                          PLTI       55
55                    WRITE (6,200)                                                      PLTI       56
                      GO TO 140                                                          PLTI       57
                130   WRITE (6,210) NTAPE                                                PLTI       58
                C                                                                        PLTI       59
                C                                                                        PLTI       60
60              140   CONTINUE                                                           PLTI       61
                      RETURN                                                             PLTI       62
                C                                                                        PLTI       63
                150   FORMAT (1615)                                                      PLTI       64
                160   FORMAT (3F10.0,5A8)                                                PLTI       65
65              170   FORMAT (20HOPLOTS REQUESTED FOR,I3,6H MODES/(1615))                PLTI       66
                180   FORMAT (90HO     MINIMUM         MAXIMUM        AXIS LENGTH     ----- PLTI       67
                     +--LABEL----------------------------)                               PLTI       68
                190   FORMAT (3E15.4,5X,5A8)                                             PLTI       69
                200   FORMAT (20HOPLOTS NOT REQUESTED)                                   PLTI       70
70              210   FORMAT (45HOCONTINUATION OF PREVIOUS PLOT TAPE REQUESTED/34H  (DIS PLTI       71
                     +P=MOD SHOULD BE ON JCL, UNIT,I3,1H))                               PLTI       72
                      END                                                                PLTI       73
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 PLTINP 1 61

VARIABLES	SN	TYPE	RELOCATION									
262	CARD	REAL	ARRAY		REFS	19	50	51	DEFINED	48		
0	CODEID	REAL	ARRAY	F.P.	REFS	19	2*30	39	DEFINED	1		
0	IAPLT	INTEGER	ARRAY	F.P.	REFS	19	37	41	DEFINED	1	36	
261	IPLOT	INTEGER			REFS	32	DEFINED	31				
260	J	INTEGER			REFS	2*30	36	37	41	DEFINED	2*30	36
					37	41	47					
0	MODLOP	INTEGER		F.P.	REFS	32	39	DEFINED	1			
0	NAXN	INTEGER		F.P.	REFS	32	DEFINED	1				
115	NCHAR	INTEGER			REFS	32	DEFINED	21				
257	NOGRID	INTEGER			REFS	30	DEFINED	23				
0	NPLOT	INTEGER		F.P.	REFS	31	47	DEFINED	1			
256	NPLTNO	INTEGER			REFS	26	27	32	36	37	2*41	
					DEFINED	23						
0	NROD	INTEGER		F.P.	REFS	32	DEFINED	1				
0	NTAPE	INTEGER		F.P.	REFS	57	DEFINED	1	54	I/O REFS	30	32
					37	50						
0	TITLE	REAL	ARRAY	F.P.	REFS	20	39	DEFINED	1			
0	TMAX	REAL		F.P.	REFS	32	DEFINED	1				

FILE NAMES	MODE						
TAPE5	FMT	READS	23	36	48		
TAPE6	FMT	WRITES	41	42	51	55	57

VARIABLES USED AS FILE NAMES, SEE ABOVE

```
EXTERNALS          TYPE   ARGS      REFERENCES
      EOF          REAL      1           24
      PGHEAD                 3           39

STATEMENT LABELS              DEF LINE   REFERENCES
    0   100          INACTIVE     25         24
    0   110                       52         47
   76   120                       54         24        26
  103   130                       57         27
  1[illegible]   140                       60         53        56
  205   150     FMT               63         23        36
  207   160     FMT               64         48
  212   170     FMT               65         41
  220   180     FMT               66         42
  233   190     FMT               68         51
  236   200     FMT               69         55
  242   210     FMT               70         57

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   63  110      J           47 52      11B                 EXT REFS

STATISTICS
  PROGRAM LENGTH                 274B     188
        140000B SCM USED
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      SUBROUTINE PLTOUT (AMFHE,DCO,DLROD,GASIN,GASMOL,HFLL,IRI,NR,NA,NPL PLTO      2
     +OT,NPLTAB,NTPLOT,IT,NUNITS,PI,TCODIS,TOTL,TPLEN,UNIT,CPDELT,EPS,GA PLTO      3
     +P,GO,HCOEF,HGAPS,PIT,P2,Q,QMPY,TBLK,TCA,TIME,TMPDIS,TPS,ZRO2B,M,BU PLTO      4
     +2,PINT,FVFRO,DVHPRS,MECHAN,STRN,DELROD,DG,DLREL)                   PLTO      5
C                                                                        PLTO      6
C     IMPLICIT REAL * 8 (A-H,O-Z)                                        PLTO      7
C                                                                        PLTO      8
C     ******************************************************************* PLTO      9
C                                                                        PLTO     10
C     THIS SUBROUTINE IS CALLED FROM MAIN AND STORES PLOT DATA           PLTO     11
C     PLTOUT WAS CODED BY G A BERNA IN DECEMBER 1977.                    PLTO     12
C                                                                        PLTO     13
C     ******************************************************************* PLTO     14
C     INPUT ARGUMENTS                                                    PLTO     15
C     ******************************************************************* PLTO     16
C                                                                        PLTO     17
C     AMFHE  - ABSOLUTE MOLE FRACTION OF HELIUM (GRAM-MOLES)             PLTO     18
C     BU2    - BURNUP OF EACH AXIAL NODE (MWD/MTU)                       PLTO     19
C     CPDELT - STORED ENERGY (BTU/LBM)                                   PLTO     20
C     DCO    - AS FABRICATED CLADDING OUTSIDE DIAMETER (IN)              PLTO     21
C     DELROD - CLAD AXIAL EXPANSION FOR MECHAN = 1 (IN)                  PLTO     22
C     DLREL  - CHANGE IN CLADDING LENGTH WITH RESPECT TO THE FUEL (IN)   PLTO     23
C     DG     - PELLET CLAD GAP SIZE FOR MECHAN = 1 (IN)                  PLTO     24
C     DLROD  - CHANGE IN LENGTH OF THE ACTIVE CLADDING LENGTH            PLTO     25
C     EPS    - CLADDING STRAIN                                           PLTO     26
C     GAP    - PELLET-CLADDING GAP AT EACH AXIAL INCREMENT (IN)          PLTO     27
C     GASIN  - TOTAL INITIAL MOLES OF GAS IN THE ROD (GRAM-MOLES)        PLTO     28
C     GASMOL - MOLES OF GAS IN THE ROD (MOLES)                           PLTO     29
C     GO     - AVERAGE MASS FLOW VELOCITY (POUNDS/HOUR-FOOT**2)          PLTO     30
C     HCOEF  - FILM HEAT TRANSFER COEFFICIENT (BTU/HR-FT**2-F)           PLTO     31
C     HFLL   - MAXIMUM HOT FUEL STACK HEIGHT (IN)                        PLTO     32
C     HGAPS  - GAP CONDUCTANCE                                           PLTO     33
C     IRI    - NUMBER OF AXIAL NODES PLUS ONE                            PLTO     34
C     IT     - POWER-TIME STEP INDEX                                     PLTO     35
C     ITER   - GAS ITERATION LOOP INDEX                                  PLTO     36
C     M      - AXIAL POWER SHAPE INDEX                                   PLTO     37
C     MECHAN - MECHANICAL MODEL INDICATOR                                PLTO     38
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                             PLTO     39
C     NPLOT  - NUMBER OF DIFFERENT PLOT QUANTITIES                       PLTO     40
C     NPLTAB - INDEX TO SPECIFY PLOT ABCISSA                             PLTO     41
C     NTPLOT - PLOT OUTPUT UNIT                                          PLTO     42
C     NUNITS - UNITS INDEX  = 0, SI UNITS USED, = 1, BRITISH UNITS USED  PLTO     43
C     PI     - 3.14159265                                                PLTO     44
C     PIT    - ROD INTERNAL PRESSURE (PSIA)                              PLTO     45
C     P2     - SYSTEM PRESSURE (PSIA)                                    PLTO     46
C     Q      - NORMALIZED AXIAL NODE POWER                               PLTO     47
C     QMPY   - ROD AVERAGE HEAT FLUX FOR POWER-TIME STEP(BTU/HR-FT**2)   PLTO     48
C     TBLK   - BULK COOLANT TEMPERATURE AT TOP OF NODE J (F)             PLTO     49
C     TCA    - CLADDING AVERAGE TEMPERATURE (F)                          PLTO     50
C     TCODIS - OUTSIDE CLADDING TEMPERATURE OF EACH AXIAL NODE (F)       PLTO     51
C     TIME   - TIME TO THE END OF THE POWER-TIME STEP (SEC)              PLTO     52
C     TMPDIS - FUEL TEMPERATURE DISTRIBUTION - AXIAL & RADIAL (F)        PLTO     53
C     TOTL   - FUEL STACK HEIGHT (FT)                                    PLTO     54
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C   TPLEN  - PLENUM TEMPERATURE (F)                                                  PLTO       55
C   TPS    - TEMPERATURE OF PELLET SURFACE (F)                                      PLTO       56
C   UNIT   - PLOT UNITS                                                             PLTO       57
C   ZRO2B  - ZIRCALOY OXIDE THICKNESS (FT)                                          PLTO       58
C                                                                                   PLTO       59
C   ********************************************************************************PLTO       60
C                                                                                   PLTO       61
      LOGICAL  UNIT                                                                 PLTO       62
C                                                                                   PLTO       63
      DIMENSION          FVFRO(NA)    ,DVHPRS(NA)    ,PINT(NA)                    PLTO       64
     +                  ,PLTV(21)     ,TCODIS(NA)    ,TMPDIS(NR,NA)               PLTO       65
     +                  ,P2(IT)       ,DCO(NA)       ,EPS(NA,3)                   PLTO       66
     +   ,QMPY(IT)      ,Q(NA,8)      ,TIME(IT)      ,GO(IT)                      PLTO       67
     +   ,GAP(NA)       ,TBLK(NA)     ,ZRO2B(NA)     ,HGAPS(NA)                   PLTO       68
     +   ,HCOEF(NA)     ,PIT(IT)      ,TCA(NA)       ,TPS(NA)                     PLTO       69
     +   ,CPDELT(NA)    ,BU2(NA)                                                   PLTO       70
     +   ,STRN(4,NA)      , DG(NA)                                                 PLTO       71
C                                                                                   PLTO       72
      IF (IT.EQ.1) GO TO 110                                                        PLTO       73
      IF (NTPLOT.EQ.0) GO TO 110                                                    PLTO       74
      IF (NUNITS.EQ.0) UNIT = .FALSE.                                               PLTO       75
      LOOP = 2                                                                      PLTO       76
      IF (NPLTAB.GT.0) LOOP = 1                                                     PLTO       77
          DO 100 II=1,LOOP                                                          PLTO       78
          ITP = IT-2+II                                                             PLTO       79
C                                                                                   PLTO       80
C   PLOTTING-IF DESIRED NTPLOT .GT. ZERO                                            PLTO       81
C                                                                                   PLTO       82
          SISEC = 86400.E0                                                          PLTO       83
          IF (NPLTAB.EQ.0) PLTV(1) = TIME(ITP)/SISEC                                PLTO       84
          PLTV(6) = (DLROD-DLREL)*12.E0                                             PLTO       85
          IF (MECHAN.NE.1) PLTV(7) = DLROD/12.0                                     PLTO       86
          IF (MECHAN.EQ.1) PLTV(7) = DELROD/12.0                                    PLTO       87
          PLTV(14) = AMFHE                                                          PLTO       88
          PLTV(15) = TPLEN                                                          PLTO       89
          PLTV(16) = (GASMOL/GASIN-1.E+0)*100.E+0                                   PLTO       90
              DO 100 I=2,IRI                                                        PLTO       91
              IF (NPLTAB.EQ.1) PLTV(1) = QMPY(IT)*DCO(I)*PI/40956.E0                PLTO       92
              IF (NPLTAB.EQ.2) PLTV(1) = BU2(I)                                     PLTO       93
              PLTV(2) = TCODIS(I)                                                   PLTO       94
              PLTV(3) = TMPDIS(NR,I)                                                PLTO       95
              PLTV(4) = PIT(IT)                                                     PLTO       96
              IF (MECHAN.NE.1) PLTV(5) = EPS(I-1,1)                                 PLTO       97
              IF (MECHAN.EQ.1) PLTV(5) = STRN(3,I)                                  PLTO       98
              PLTV(8) = (QMPY(IT)*(DCO(I)*PI/12.E0)/3413.E0)*Q(I-1,M)               PLTO       99
              PLTV(9) = TPS(I)                                                      PLTO      100
              PLTV(10) = HGAPS(I)                                                   PLTO      101
              PLTV(11) = HCOEF(I)                                                   PLTO      102
              PLTV(12) = TCA(I)                                                     PLTO      103
              PLTV(13) = ZRO2B(I)*12.E0                                             PLTO      104
              PLTV(17) = GO(IT)                                                     PLTO      105
              PLTV(18) = CPDELT(I)                                                  PLTO      106
              PLTV(19) = P2(IT)                                                     PLTO      107
```

```
                      IF (MECHAN.NE.1) PLTV(20) = GAP(I-1)*1000.                PLTO      108
                      IF (MECHAN.EQ.1) PLTV(20) = DG(I)*1000.                   PLTO      109
                      PLTV(21) = TBLK(I)                                        PLTO      110
110                   CALL PLOTW (PLTV,NTPLOT,NPLOT,UNIT,NPLTAB)                PLTO      111
                C                                                               PLTO      112
                100   CONTINUE                                                  PLTO      113
                110 CONTINUE                                                    PLTO      114
                    RETURN                                                      PLTO      115
115                 END                                                         PLTO      116
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	PLTOUT	1	114

VARIABLES

		SN	TYPE		RELOCATION								
0	AMFHE		REAL		F.P.	REFS	87	DEFINED	1				
0	BU2		REAL	ARRAY	F.P.	REFS	63	92	DEFINED	1			
0	CPDELT		REAL	ARRAY	F.P.	REFS	63	105	DEFINED	1			
0	DCO		REAL	ARRAY	F.P.	REFS	63	91	98	DEFINED	1		
0	DELROD		REAL		F.P.	REFS	86	DEFINED	1				
0	DG		REAL	ARRAY	F.P.	REFS	63	108	DEFINED	1			
0	DLREL		REAL		F.P.	REFS	84	DEFINED	1				
0	DLROD		REAL		F.P.	REFS	84	85	DEFINED	1			
0	DVHPRS		REAL	ARRAY	F.P.	REFS	63	DEFINED	1				
0	EPS		REAL	ARRAY	F.P.	REFS	63	96	DEFINED	1			
0	FVFRO		REAL	ARRAY	F.P.	REFS	63	DEFINED	1				
0	GAP		REAL	ARRAY	F.P.	REFS	63	107	DEFINED	1			
0	GASIN		REAL		F.P.	REFS	89	DEFINED	1				
0	GASMOL		REAL		F.P.	REFS	89	DEFINED	1				
0	GO		REAL	ARRAY	F.P.	REFS	63	104	DEFINED	1			
0	HCOEF		REAL	ARRAY	F.P.	REFS	63	101	DEFINED	1			
0	HFLL		REAL	*UNUSED	F.P.	DEFINED	1						
0	HGAPS		REAL	ARRAY	F.P.	REFS	63	100	DEFINED	1			
254	I		INTEGER			REFS	91	92	93	94	96	97	2*98
						99	100	101	102	103	105	107	108
						109	DEFINED	90					
251	II		INTEGER			REFS	78	DEFINED	77				
0	IR1		INTEGER		F.P.	REFS	90	DEFINED	1				
0	IT		INTEGER		F.P.	REFS	5*63	72	78	91	95	98	104
						106	DEFINED	1					
252	ITP		INTEGER			REFS	83	DEFINED	78				
250	LOOP		INTEGER			REFS	77	DEFINED	75	76			
0	M		INTEGER		F.P.	REFS	98	DEFINED	1				
0	MECHAN		INTEGER		F.P.	REFS	85	86	96	97	107	108	
						DEFINED	1						
0	NA		INTEGER		F.P.	REFS	19*63	DEFINED	1				
0	NPLOT		INTEGER		F.P.	REFS	110	DEFINED	1				
0	NPLTAB		INTEGER		F.P.	REFS	76	83	91	92	110		

```
VARIABLES     SN  TYPE          RELOCATION
                                          DEFINED      1
    0  NR          INTEGER                F.P.    REFS  63      94    DEFINED      1
    0  NTPLOT      INTEGER                F.P.    REFS  73     110    DEFINED      1
    0  NUNITS      INTEGER                F.P.    REFS  74 DEFINED        1
    0  PI          REAL                   F.P.    REFS  91      98    DEFINED      1
    0  PINT        REAL          ARRAY    F.P.    REFS  63 DEFINED        1
    0  PIT         REAL          ARRAY    F.P.    REFS  63      95    DEFINED      1
  255  PLTV        REAL          ARRAY            REFS  63     110    DEFINED     83       64       85       86
                                                     87    88      89       91     92       93       94       95
                                                     96    97      98       99    100      101      102      103
                                                    104   105     106      107    108      109
    0  P2          REAL          ARRAY    F.P.    REFS  63     106    DEFINED      1
    0  Q           REAL          ARRAY    F.P.    REFS  63      98    DEFINED      1
    0  QMPY        REAL          ARRAY    F.P.    REFS  63      91       98 DEFINED        1
  253  SISEC       REAL                           REFS  83 DEFINED       82
    0  STRN        REAL          ARRAY    F.P.    REFS  63      97    DEFINED      1
    0  TBLK        REAL          ARRAY    F.P.    REFS  63     109    DEFINED      1
    0  TCA         REAL          ARRAY    F.P.    REFS  63     102    DEFINED      1
    0  TCODIS      REAL          ARRAY    F.P.    REFS  63      93    DEFINED      1
    0  TIME        REAL          ARRAY    F.P.    REFS  63      83    DEFINED      1
    0  TMPDIS      REAL          ARRAY    F.P.    REFS  63      94    DEFINED      1
    0  TOTL        REAL          *UNUSED  F.P. DEFINED      1
    0  TPLEN       REAL                   F.P.    REFS  88 DEFINED        1
    0  TPS         REAL          ARRAY    F.P.    REFS  63      99    DEFINED      1
    0  UNIT        LOGICAL                F.P.    REFS  61     110    DEFINED      1       74
    0  ZRO2B       REAL          ARRAY    F.P.    REFS  63     103    DEFINED      1

EXTERNALS           TYPE   ARGS      REFERENCES
      PLOTW                  5           110

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                      112        77       90
  230  110                      113        72       73

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   33  100      II          77 112     174B              EXT REFS  NOT INNER
   74  100      I           90 112     130B              EXT REFS

STATISTICS
  PROGRAM LENGTH                372B     250
        140000B SCM USED
```

```
      C                                                                      PLTW       2
        SUBROUTINE PLOTW (PLTV,NTAPE,NPLOT,UNIT,NPLTAB)                      PLTW       3
      C                                                                      PLTW       4
      C   IMPLICIT REAL*8 (A-H,O-Z)                                         PLTW       5
      C                                                                      PLTW       6
      C   SUBROUTINE PLOTW  WRITES PLOT DATA TO TAPE,                       PLTW       7
      C   AFTER CONVERTING UNITS IF NECESSARY.                              PLTW       8
      C                                                                      PLTW       9
      C   THIS ROUTINE MUST BE CLOSELY CORRELATED WITH MAIN, IN NUMBER AND   PLTW      10
      C   DIMENSIONS OF VARIABLES IN ARRAY PLTV.                             PLTW      11
      C                                                                      PLTW      12
      C   NTAPE = FORTRAN LOGICAL UNIT FOR PLOT DATA                         PLTW      13
      C   NPLOT = NUMBER OF VALUES IN PLTV                                   PLTW      14
      C   NPLTAB= PLOT ABCISSA  0=TIME, 1=ROD AVE POWER, 2=BURNUP            PLTW      15
      C   UNIT  = .TRUE. IF INTERNAL AND EXTERNAL UNITS ARE SAME            PLTW      16
      C                                                                      PLTW      17
      C   * * CONTENTS OF PLTV * *                                          PLTW      18
      C   1  TIME,POWER,OR BURNUP  (HR),(KW/FT),OR (MWD/MTU)                PLTW      19
      C   2  CLAD SURFACE TEMPERATURE   (F)                                 PLTW      20
      C   3  FUEL CENTER LINE TEMP.     (F)                                 PLTW      21
      C   4  ROD GAS PRESSURE          (PSI)                                PLTW      22
      C   5  CLADDING HOOP STRAIN       ---                                 PLTW      23
      C   6  FUEL AXIAL DISPLACEMENT   (FT)                                 PLTW      24
      C   7  CLADDING AXIAL DISPL.     (FT)                                 PLTW      25
      C   8  ROD LINEAR POWER         (KW/FT)                               PLTW      26
      C   9  FUEL SURFACE TEMPERATURE   (F)                                 PLTW      27
      C   10  GAP HEAT TRANSFER COEF.  (BTU/HR.FT2.F)                       PLTW      28
      C   11  SURFACE HEAT TRANS. COEF (BTU/HR.FT2.F)                       PLTW      29
      C   12  CLAD AVERAGE TEMPERATURE   (F)                               PLTW      30
      C   13  ZIRCALOY OXIDE THICKNESS (IN)                                 PLTW      31
      C   14  MOLE FRACTION OF HELIUM                                        PLTW      32
      C   15  PLENUM TEMPERATURE (F)                                        PLTW      33
      C   16  INCREASE IN ROD GAS CONTENT (% OF INITIAL)                     PLTW      34
      C   17  COOLANT CHANNEL MASS FLUX (LBM/HR-FT**2)                       PLTW      35
      C   18  STORED ENERGY (BTU/LBM)                                        PLTW      36
      C   19  COOLANT CHANNEL PRESSURE (PSIA)                               PLTW      37
      C   20  GAP THICKNESS (RADIAL) (IN)                                   PLTW      38
      C   21  COOLANT CHANNEL BULK TEMPERATURE (F)                          PLTW      39
      C                                                                      PLTW      40
        DIMENSION PLTV(NPLOT)                                                PLTW      41
        LOGICAL UNIT                                                         PLTW      42
        DATA  FT,     HTCO          ,     PSI           ,   RANF  , RANK /   PLTW      43
       + .3048E0, 5.67826334111131E0, 6.89475729316B1E3, 459.67E0, 1.8E0/    PLTW      44
        TK(TF) = (TF+RANF)/RANK                                              PLTW      45
      C                                                                      PLTW      46
        IF (UNIT) GO TO 100                                                  PLTW      47
      C CHANGE DIMENSIONS TO S.I.                                            PLTW      48
      C PLTV(1) = PLTV(1)                                                    PLTW      49
        IF (NPLTAB.EQ.1) PLTV(1) = PLTV(1)/FT                                PLTW      50
        IF (NPLTAB.EQ.2) PLTV(1) = PLTV(1)*86.4                              PLTW      51
        PLTV(2) = TK(PLTV(2))                                                PLTW      52
        PLTV(3) = TK(PLTV(3))                                                PLTW      53
        PLTV(4) = PLTV(4)*PSI                                                PLTW      54
```

```
      C   PLTV(5) = PLTV(5)
55          PLTV(6) = PLTV(6)*FT
            PLTV(7) = PLTV(7)*FT
            PLTV(8) = PLTV(8)/FT
            PLTV(9) = TK(PLTV(9))
            PLTV(10) = PLTV(10)*5.675
60          PLTV(11) = PLTV(11)*HTCO
            PLTV(12) = TK(PLTV(12))
      C
            PLTV(13) = PLTV(13)*(FT/1.2E+4)
      C   PLTV(14) = PLTV(14)
            PLTV(15) = TK(PLTV(15))
65    C   PLTV(16) = PLTV(16)
            PLTV(17) = PLTV(17)/737.338E+0
            PLTV(18) = PLTV(18)*5555.555E+0
            PLTV(19) = PLTV(19)*PSI
70          PLTV(20) = PLTV(20)*FT/1.2E+4
            PLTV(21) = TK(PLTV(21))
      100   WRITE (NTAPE) PLTV
            RETURN
            END
```

```
PLTH    55
PLTH    56
PLTH    57
PLTH    58
PLTH    59
PLTH    60
PLTH    61
PLTH    62
PLTH    63
PLTH    64
PLTH    65
PLTH    66
PLTH    67
PLTH    68
PLTH    69
PLTH    70
PLTH    71
PLTH    72
PLTH    73
PLTH    74
PLTH    75
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 PLOTH 2 73

VARIABLES	SN	TYPE		RELOCATION								
124 FT		REAL			REFS	49	55	56	57	63	70	
					DEFINED	42						
125 HTCO		REAL			REFS	60	DEFINED	42				
0 NPLOT		INTEGER		F.P.	REFS	40	DEFINED	2				
0 NPLTAB		INTEGER		F.P.	REFS	49	50	DEFINED	2			
0 NTAPE		INTEGER		F.P.	DEFINED	2	I/O REFS	72				
0 PLTV		REAL	ARRAY	F.P.	REFS	40	49	50	51	52	53	55
						56	57	58	59	60	61	63	65
						67	68	69	70	71	72	
					DEFINED	2	49	50	51	52	53	55
						56	57	58	59	60	61	63	65
						67	68	69	70	71		
126 PSI		REAL			REFS	53	69	DEFINED	42			
127 RANF		REAL			REFS	51	52	58	61	65	71	
					DEFINED	42						
130 RANK		REAL			REFS	51	52	58	61	65	71	
					DEFINED	42						
0 UNIT		LOGICAL		F.P.	REFS	41	46	DEFINED	2			

VARIABLES USED AS FILE NAMES, SEE ABOVE

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES					
TK	REAL	1	SF	44	51	52	58	61	65	71

STATEMENT LABELS	DEF LINE	REFERENCES
116 100	72	46

STATISTICS

PROGRAM LENGTH	141B	97

140000B SCM USED

```
      SUBROUTINE POINTR (NTMSTP,NAXNS,NRANS,LENGTH,MECHAN,IQUIT,NC,NF,NG POINTR      2
     +ASR,NWORDS,IWORDS,NWRDS,MNA,MNR)                                    POINTR      3
C                                                                         POINTR      4
C     POINTR IS CALLED FROM SETUP                                         POINTR      5
C     SUBROUTINE POINTER SETS UP THE INDEX POINTERS TO THE STARTING       POINTR      6
C     INDICES FOR THE DYNAMICALLY DIMENSIONED ARRAYS                      POINTR      7
C                                                                         POINTR      8
C     ********************************************************************POINTR      9
C     INPUT ARGUMENTS                                                     POINTR     10
C     ********************************************************************POINTR     11
C                                                                         POINTR     12
C     IAXSYM - INDEX FOR AXISYM ANALYSIS                                  POINTR     13
C     = 0, NO AXISYM ANALYSIS                                             POINTR     14
C     = 1, FRAPCON ANALYSIS FOLLOWED BY AN AXISYM ANALYSIS                POINTR     15
C     MECHAN - MECHANICAL SUBCODE INDEX                                   POINTR     16
C     = 0, USER IS REQUESTED TO MAKE A CHOICE OF MODEL                    POINTR     17
C     = 1, PELET IS USED (PNL)                                            POINTR     18
C     = 2, FRACAS-1 IS USED (INEL)                                        POINTR     19
C     = 3, FRACAS-2 IS USED (INEL)                                        POINTR     20
C     NTMSTP - NUMBER OF POWER-TIME STEPS                                 POINTR     21
C     NAXNS  - NUMBER OF AXIAL NODES                                      POINTR     22
C     NRANS  - NUMBER OF RADIAL NODES                                     POINTR     23
C     NC     - NUMBER OF RADIAL NODES IN CLAD                             POINTR     24
C     NF     - NUMBER OF RADIAL NODES IN FUEL                             POINTR     25
C     NGASR  - INDEX FOR GAS RELEASE MODEL                                POINTR     26
C     = -1   BOOTH DIFFUSION                                              POINTR     27
C     =  0  MACDONALD - WEISMAN                                           POINTR     28
C     =  +  ANS-5.4 MODEL                                                 POINTR     29
C     = -2  GRASS MODEL                                                   POINTR     30
C     NWORDS - NUMBER OF WORDS NEEDED FOR GRASS MODEL                     POINTR     31
C     IWORDS - NUMBER OF WORDS NEEDED FOR AFRCS2 ARRAY (FRACAS-2)         POINTR     32
C     NWRDS  - NUMBER OF WORDS NEEDED FOR AFCM12 ARRAY (FRACAS-2)         POINTR     33
C                                                                         POINTR     34
C     ********************************************************************POINTR     35
C     OUTPUT ARGUMENTS                                                    POINTR     36
C     ********************************************************************POINTR     37
C                                                                         POINTR     38
C     IQUIT  - JOB TERMINATOR INDEX                                       POINTR     39
C     LENGTH - THE LENGTH OF THE A-ARRAY FOR THIS PROBLEM                 POINTR     40
C                                                                         POINTR     41
C     ********************************************************************POINTR     42
C                                                                         POINTR     43
C                                                                         POINTR     44
C                                                                         POINTR     45
      COMMON  /FAST     /   A                                           POINTR     46
C                                                                         POINTR     47
      DIMENSION             A(1)  ,     IA  (1)                         POINTR     48
C                                                                         POINTR     49
      EQUIVALENCE       (   A(1)  ,     IA  (1)  )                      POINTR     50
C                                                                         POINTR     51
C                                                                         POINTR     52
      COMMON / PNTPNL / IFIRST, IAELM, IAK, IARAA, IARE, ISB, IBA,        PELPT      2
                                                                          PELPT      3
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      + IBASAV, IBASE, ISBB, IBBA, IBBSV, ICA, ICC, ICRATE, ICRPG, IDISP,  PELPT      4
55    + IDISPC, IDSPSV, IEFSTR, IELM, IELSTN, ILSTNA, ILSTRA, IELSTR,      PELPT      5
      + IPSLA, IEPSLM, IESTNV, IESTSV, JIIJ, IIPOS, IKSAVE, INADET, INDC,  PELPT      6
      + INDF, INDT, INODET, IOLDSE, IPSSRT, IPSSV, IPSTS, IR, IRA, IRBR,   PELPT      7
      + IRBRA, IRD, ISTRES, ISTRSA, ITCB, ITCRP, ITEC, ITEF, ITELM, ITFB,  PELPT      8
      + ITHET, ITHTAX, ITHSAV, ITHXSV, ITME, ITSTNR, ITSTSR, ITV, ITW,     PELPT      9
60    + IXKT, IXLOAD, IXLODA, IXRD, IY, IYACF, IZ, ILAST                   PELPT     10
      C                                                                    PELPT     11
      C                                                                    POINTR    54
       COMMON /LIMITS/ M1, M2, NOEL, NOELF, NOELC, IDF, NFF, NETOT, NEWF,  POINTR    55
      +NEWT, KA, NARF, NARC, NART, NABF, NABC, NABT, NAEC, NAEF, NTAE,     POINTR    56
65    +JAM, NAXBT, NAXB2, NAXB4, NFF1, NABF2, NABT2, XP, XR, XFRDEN, KZ1,  POINTR    57
      +ISSTOP, IPLAS, NKN, ICRPP, MAXT, KRNCHF, KRNCHC, KRNCHT, NFF2,      POINTR    58
      +NC4, NF4, MAXA, NEW, NMX, KRNCH, MCUD, IADJ, ICUT, TIMEC, XTIMEF,   POINTR    59
      +IT1, STEP, NOLD, KPLAS, ICNT, RRAKR, IRAK, RAKSUM, IPLEND, ISP,IRZ  POINTR    60
       COMMON/PFRCS2/    MODPG2          ,MODPC2          ,MGAP2           POINTR    61
70    +   ,MIGAP2         ,MOIGP2         ,MREPS2          ,MPRES2          POINTR    62
      +   ,MTTT           ,MEREP2         ,MEP2            ,MR22            POINTR    63
      +   ,MOLDT2         ,MFVFR0         ,MDHPRS          ,MPEP2           POINTR    64
      +   ,MEPS22         ,MEPP2          ,MSIG2           ,MEPS02          POINTR    65
      +   ,MPEPP2         ,MEPS0          ,NNNCRP                           POINTR    66
75    C                                                                    POINTR    67
       COMMON/PFCM12/          NPIN                                        POINTR    68
      +                       ,NPOUT          ,NP1             ,NP2        POINTR    69
      +                       ,NTSAVE         ,NDCHCK          ,NOLSGF     POINTR    70
      +                       ,NDEP           ,NSLOPE          ,NCOEF      POINTR    71
80    +                       ,NDSIGF         ,NF1             ,NF2        POINTR    72
      +                       ,NEP2           ,NECRP2          ,NT2        POINTR    73
      +                       ,NTN            ,NE              ,NV         POINTR    74
      +                       ,NEPP2          ,NSTRTT          ,NALFDT     POINTR    75
      +                       ,NOLDPP         ,NNUDPP          ,NHH        POINTR    76
85    +                       ,NNN            ,NMN             ,NBB        POINTR    77
      +                       ,NMM            ,NGG             ,NDD        POINTR    78
      +                       ,NW             ,NNU             ,NEE        POINTR    79
      +                       ,NLL            ,NAA             ,NEI        POINTR    80
      +                       ,NCC            ,NNFF                        POINTR    81
90    C                                                                    POINTR    82
       COMMON / GRSPTR /   NVAR1    ,NVAR2    ,NVAR3    ,NVAR4            POINTR    83
      +          ,NVAR5    ,NVAR6    ,NVAR7    ,NVAR8    ,NVAR9           POINTR    84
      +          ,NVAR10   ,NVAR11   ,NVAR12   ,NVAR13   ,NVAR14          POINTR    85
      +          ,NVAR15   ,NVAR16   ,NVAR17   ,NVAR18   ,NVAR19          POINTR    86
95    +          ,NVAR20   ,NVAR21   ,NVAR22   ,NVAR23   ,NVAR24          POINTR    87
      +          ,NVAR25   ,NVAR26   ,NVAR27   ,NVAR28   ,NVAR29          POINTR    88
      +          ,NVAR30   ,NVAR31   ,NVAR32   ,NVAR33   ,NVAR34          POINTR    89
      +          ,NVAR35   ,NVAR36   ,NVAR37   ,LGRASS                    POINTR    90
      C                                                                    POINTR    91
100   C                                                                    POINTR    92
      C   SET UP THE LOOP INDICES.                                         POINTR    93
      C                                                                    POINTR    94
      C   DIMENSIONED ARRAYS - IT = POWER-TIME STEP, NA = AXIAL, NR = RADIAL  POINTR  95
      C                                                                    POINTR    96
105   C   NBRTMV IS THE NUMBER OF  ( IT )        ARRAYS                    POINTR    97
      C   NBRAXV IS THE NUMBER OF  ( NA )        ARRAYS                    POINTR    98
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      C   NBRFIV IS THE NUMBER OF  ( NA X 2 )     ARRAYS                    POINTR     99
      C   NBRTHN IS THE NUMBER OF  ( NA X 3 )     ARRAYS                    POINTR    100
      C   NBRARV IS THE NUMBER OF  ( NR )         ARRAYS                    POINTR    101
110   C   NBRTWO IS THE NUMBER OF  ( NR X 2)      ARRAYS                    POINTR    102
      C   NBRTLV IS THE NUMBER OF  ( NR X NA )    ARRAYS                    POINTR    103
      C   NBRSIX IS THE NUMBER OF  ( NA X 6 )     ARRAYS                    POINTR    104
      C   NBRATE IS THE NUMBER OF  ( NA X 8 )     ARRAYS                    POINTR    105
      C                                                                     POINTR    106
115         DATA NBRTMV /30/,                                               POINTR    107
     +       NBRAXV /80/,                                                   POINTR    108
     +       NBRFIV / 7/,                                                   POINTR    109
     +       NBRTHN /19/,                                                   POINTR    110
     +       NBRARV /13/,                                                   POINTR    111
120  +       NBRTWO / 3/,                                                   POINTR    112
     +       NBRTLV /14/,                                                   POINTR    113
     +       NBRSIX / 4/,                                                   POINTR    114
     +       NBRATE / 1/,                                                   POINTR    115
     +       LOCMEC / 0/,                                                   POINTR    116
125  +       LOCIDX / 0/                                                    POINTR    117
      C                                                                     POINTR    118
      C   SET STARTING LOAD INDEX                                           POINTR    119
      C                                                                     POINTR    120
      C   THE FIRST 300 WORDS IN THE A-VECTOR ARE RESERVED FOR THE VARIOUS  POINTR    121
130   C   INDEX POINTERS.  THE FIRST LOADABLE WORD IS A(301).               POINTR    122
      C                                                                     POINTR    123
        DATA NLSTRT / 301 / , NPSTRT / 4 /                                  POINTR    124
      C                                                                     POINTR    125
      C                                                                     POINTR    126
135   C   ALL THE POINTERS ARE INDICES OF THE STARTING LOCATIONS FOR THE     POINTR    127
      C   VARIABLY DIMENSIONED ARRAYS                                       POINTR    128
      C                                                                     POINTR    129
      C                                                                     POINTR    130
      C                                                                     POINTR    131
140     NTMSP = NTMSTP+1                                                    POINTR    132
        NAXN = NAXNS+1                                                      POINTR    133
        NRAN = NRANS                                                        POINTR    134
      C   DEFINE DIMENSIONS FOR FRACAS-2                                   POINTR    135
        MNA = NAXNS+1                                                       POINTR    136
145     MNR = NRANS+2                                                       POINTR    137
      C                                                                     POINTR    138
        IA(1) = NTMSP                                                       POINTR    139
        IA(2) = NAXN                                                        POINTR    140
        IA(3) = NRAN                                                        POINTR    141
150     IA(4) = NLSTRT                                                      POINTR    142
        LENGTH = NLSTRT                                                     POINTR    143
      C                                                                     POINTR    144
      C   SET THE FIRST LOAD INDEX                                         POINTR    145
      C                                                                     POINTR    146
155     LOCIDX = NPSTRT                                                     POINTR    147
      C                                                                     POINTR    148
      C                                                                     POINTR    149
        CALL NEMSET (0,NPIN,39)                                             POINTR    150
        CALL NEMSET (0,MODPG2,22)                                           POINTR    151
```

```
      C
            IF (MECHAN.EQ.0) GO TO 340
      C
      C
      C     SET UP AXIAL NODE DEPENDENT POINTERS
      C
            MBRAXV = NBRAXV+1
                DO 100 K=1,MBRAXV
                IA(LOCIDX+K) = IA(LOCIDX)+(K-1)*NAXN
        100     CONTINUE
      C
      C
            LOCIDX = LOCIDX+NBRAXV
      C
      C
      C
      C     SET THE SPACE FACTOR FOR THE TWO - DIMENSIONAL AXIAL ARRAYS
      C
            NSPACE = 2*NAXN
      C
            MBRFIV = NBRFIV+1
                DO 110 K=2,MBRFIV
                IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE
        110     CONTINUE
      C
      C
            LOCIDX = LOCIDX+NBRFIV
      C
      C     SET THE SPACE FACTOR FOR THE THREE - DIMENSIONAL AXIAL ARRAYS
      C
            NSPACE = 3*NAXN
      C
      C
            MBRTHN = NBRTHN+1
                DO 120 K=2,MBRTHN
                IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE
        120     CONTINUE
      C
      C
            LOCIDX = LOCIDX+NBRTHN
      C
      C
      C     UPDATE LENGTH
      C
            LENGTH = LENGTH+NAXN*(NBRAXV+2*NBRFIV+3*NBRTHN)
      C
      C
      C     SET UP THE RADIAL ARRAYS
      C
      C
            MBRARV = NBRARV+1
                DO 130 K=2,MBRARV
```

POINTR 152 … POINTR 204

```
                IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NRAN                          POINTR   205
          130   CONTINUE                                                        POINTR   206
215             C                                                               POINTR   207
                C                                                               POINTR   208
                LOCIDX = LOCIDX+NBRARV                                          POINTR   209
                C                                                               POINTR   210
                CCCC                                                            POINTR   211
220             CCCC  RESET THE SPACE FACTOR FOR THE TWO - DIMENSIONAL ARRAYS   POINTR   212
                C                                                               POINTR   213
                NSPACE = 2*NRAN                                                 POINTR   214
                C                                                               POINTR   215
                C                                                               POINTR   216
225             MBRTWO = NBRTWO+1                                               POINTR   217
                DO 140 K=2,MBRTWO                                               POINTR   218
                IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE                        POINTR   219
          140   CONTINUE                                                        POINTR   220
                C                                                               POINTR   221
230             C                                                               POINTR   222
                LOCIDX = LOCIDX+NBRTWO                                          POINTR   223
                C                                                               POINTR   224
                CCCC                                                            POINTR   225
                CCCC  RESET THE SPACE FACTOR FOR THE  NAXN * NRAN ARRAYS        POINTR   226
235             C                                                               POINTR   227
                NSPACE = NRAN*NAXN                                              POINTR   228
                C                                                               POINTR   229
                C                                                               POINTR   230
                MBRTLV = NBRTLV+1                                               POINTR   231
240             DO 150 K=2,MBRTLV                                               POINTR   232
                IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE                        POINTR   233
          150   CONTINUE                                                        POINTR   234
                C                                                               POINTR   235
                C                                                               POINTR   236
245             LOCIDX = LOCIDX+NBRTLV                                          POINTR   237
                C                                                               POINTR   238
                CCCC                                                            POINTR   239
                CCCC  UPDATE LENGTH                                             POINTR   240
                C                                                               POINTR   241
250             LENGTH = LENGTH+NRAN*(NAXN*NBRTLV+2*NBRTWO+NBRARV)              POINTR   242
                C                                                               POINTR   243
                CCCC  SET UP THE AXIAL BY 6 ARRAYS                              POINTR   244
                C                                                               POINTR   245
                NSPACE = 6*NAXN                                                 POINTR   246
255             C                                                               POINTR   247
                MBRSIX = NBRSIX+1                                               POINTR   248
                DO 160 K=2,MBRSIX                                               POINTR   249
                IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE                        POINTR   250
          160   CONTINUE                                                        POINTR   251
260             C                                                               POINTR   252
                LOCIDX = LOCIDX+NBRSIX                                          POINTR   253
                C                                                               POINTR   254
                CCCC  UPDATE LENGTH                                             POINTR   255
                C                                                               POINTR   256
265             LENGTH = LENGTH+NAXN*6*NBRSIX                                   POINTR   257
```

```
      C                                                                  POINTR   258
      C                                                                  POINTR   259
      C   SET  UP THE AXIAL BY 8 ARRAYS                                  POINTR   260
      C                                                                  POINTR   261
270         NSPACE = 8*NAXN                                              POINTR   262
      C                                                                  POINTR   263
            MBRATE = NBRATE+1                                            POINTR   264
                DO 170 K=2,MBRATE                                        POINTR   265
      C                                                                  POINTR   266
275           IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE                   POINTR   267
      C                                                                  POINTR   268
      170       CONTINUE                                                 POINTR   269
      C                                                                  POINTR   270
      C                                                                  POINTR   271
280         LOCIDX = LOCIDX+NBRATE                                       POINTR   272
      C                                                                  POINTR   273
      C   UPDATE LENGTH                                                  POINTR   274
      C                                                                  POINTR   275
            LENGTH = LENGTH+NAXN*8*NBRATE                                POINTR   276
285   C                                                                  POINTR   277
      C   SET UP THE TIME STEP DEPENDENT VARIABLE POINTERS                POINTR   278
      C                                                                  POINTR   279
            MBRTMV = NBRTMV+1                                            POINTR   280
                DO 180 K=2,MBRTMV                                        POINTR   281
290           IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NTMSP                    POINTR   282
      C                                                                  POINTR   283
      180       CONTINUE                                                 POINTR   284
      C                                                                  POINTR   285
      C   UPDATE LENGTH                                                  POINTR   286
295   C                                                                  POINTR   287
            LENGTH = LENGTH+NBRTMV*NTMSP                                 POINTR   288
      C                                                                  POINTR   289
      C                                                                  POINTR   290
      C                                                                  POINTR   291
300         LOCIDX = LOCIDX+NBRTMV                                       POINTR   292
      C                                                                  POINTR   293
      C                                                                  POINTR   294
      C   A( LENGTH+1)  IS THE NEXT AVAILABLE STORAGE LOCATION            POINTR   295
      C                                                                  POINTR   296
305         IF (NGASR.LE.0) GO TO 240                                    POINTR   297
      C   NGASR GT 0 AND LT 6, BEYER-HANN                                POINTR   298
      C   NGASR GT 5, ANS54                                              POINTR   299
            IF (NGASR.LT.6) GO TO 210                                    POINTR   300
      C                                                                  POINTR   301
310   C   SET UP ANSD ARRAY                                              POINTR   302
      C                                                                  POINTR   303
            NSPACE = NGASR*NAXN*NTMSP                                    POINTR   304
      C                                                                  POINTR   305
            IA(LOCIDX+2) = IA(LOCIDX+1)+NSPACE                           POINTR   306
315   C                                                                  POINTR   307
            LOCIDX = LOCIDX+1                                            POINTR   308
      C                                                                  POINTR   309
      C   UPDATE LENGTH                                                  POINTR   310
```

```
      C
320         LENGTH = LENGTH+NSPACE
      C
            IA(LOCIDX+2) = IA(LOCIDX+1)+NGASR
            LOCIDX = LOCIDX+1
            LENGTH = LENGTH+NGASR
325   C
            IA(LOCIDX+2) = IA(LOCIDX+1)+NGASR*NAXN
            LOCIDX = LOCIDX+1
            LENGTH = LENGTH+NGASR*NAXN
      C
330         IA(LOCIDX+2) = IA(LOCIDX+1)+NGASR
            IA(LOCIDX+3) = IA(LOCIDX+2)+NGASR
            LOCIDX = LOCIDX+2
            LENGTH = LENGTH+NGASR*2
      C
335         IA(LOCIDX+2) = IA(LOCIDX+1)+NTMSP
            LOCIDX = LOCIDX+1
            LENGTH = LENGTH+NTMSP
      C
                DO 190 K=2,4
340             IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*11
      190       CONTINUE
            LOCIDX = LOCIDX+3
            LENGTH = LENGTH+3*11
      C
345   C
      C   ZERO OUT BEYER-HANN ARRAYS
      C
                DO 200 K=1,4
                IA(LOCIDX+2) = IA(LOCIDX+1)+1
350             LOCIDX = LOCIDX+1
                LENGTH = LENGTH+1
      200       CONTINUE
      C
            GO TO 260
      C
355   210   CONTINUE
      C
      C
      C   ZERO OUT AN554 ARRAYS
360         DO 220 K=1,9
            IA(LOCIDX+2) = IA(LOCIDX+1)+1
            LOCIDX = LOCIDX+1
            LENGTH = LENGTH+1
      220   CONTINUE
      C
365   C
      C   SET UP BEYER-HANN ARRAYS
      C
            DO 230 K=2,3
            IA(LOCIDX+2) = IA(LOCIDX+1)+NTMSP*NAXN
370         LOCIDX = LOCIDX+1
            LENGTH = LENGTH+NTMSP*NAXN
```

```
      230       CONTINUE                                                  POINTR    364
C                                                                       POINTR    365
            IA(LOCIDX+2) = IA(LOCIDX+1)+NAXN                            POINTR    366
375         LOCIDX = LOCIDX+1                                           POINTR    367
            LENGTH = LENGTH+NAXN                                        POINTR    368
C                                                                       POINTR    369
            IA(LOCIDX+2) = IA(LOCIDX+1)+NRAN                            POINTR    370
            LOCIDX = LOCIDX+1                                           POINTR    371
380         LENGTH = LENGTH+NRAN                                        POINTR    372
C                                                                       POINTR    373
            GO TO 260                                                   POINTR    374
C                                                                       POINTR    375
      240   CONTINUE                                                    POINTR    376
385   C                                                                 POINTR    377
C                                                                       POINTR    378
C     ZERO AN554 AND BEYER-HANN ARRAYS                                  POINTR    379
C                                                                       POINTR    380
            DO 250 K=1,13                                               POINTR    381
390         IA(LOCIDX+2) = IA(LOCIDX+1)+1                               POINTR    382
            LOCIDX = LOCIDX+1                                           POINTR    383
            LENGTH = LENGTH+1                                           POINTR    384
      250   CONTINUE                                                    POINTR    385
C                                                                       POINTR    386
395   260   CONTINUE                                                    POINTR    387
C                                                                       POINTR    388
C                                                                       POINTR    389
            IF (MECHAN.EQ.1) GO TO 280                                  POINTR    390
            IF (MECHAN.EQ.2) GO TO 320                                  POINTR    391
400   C                                                                 POINTR    392
C     ZERO OUT RADIAL ARRAY IN COMMON POINT IF PELET NOT USED           POINTR    393
C                                                                       POINTR    394
C                                                                       POINTR    395
            DO 270 K=1,15                                               POINTR    396
405         IA(LOCIDX+2) = IA(LOCIDX+1)+1                               POINTR    397
            LOCIDX = LOCIDX+1                                           POINTR    398
            LENGTH = LENGTH+1                                           POINTR    399
      270   CONTINUE                                                    POINTR    400
C                                                                       POINTR    401
410   C                                                                 POINTR    402
C     SUBROUTINE FRC2PTR COMPUTES POINTERS FOR THE VARIABLE DIMENSIONED POINTR    403
C     ARRAYS PASSED TO FRACAS-2 FROM FRAPCON                            POINTR    404
        CALL FR2PTR (MNA,MNR,IWORDS,LENGTH)                             POINTR    405
C                                                                       POINTR    406
415   C     UPDATE LENGTH                                               POINTR    407
C                                                                       POINTR    408
        LENGTH = LENGTH+IWORDS                                          POINTR    409
C     SUBROUTINE FC2PTR COMPUTES POINTERS FOR THE VARIABLE DIMENSIONED  POINTR    410
C     ARRAYS USED IN FRACAS-2.  SEE SUBROUTINE FOR ARRAY LISTING.       POINTR    411
420   C                                                                 POINTR    412
        CALL FC2PTR (MNA,MNR,NWRDS,LENGTH)                              POINTR    413
C                                                                       POINTR    414
C     UPDATE LENGTH                                                     POINTR    415
C                                                                       POINTR    416
```

```
      LENGTH = LENGTH+NWRDS                                                  POINTR   417
C                                                                            POINTR   418
CC                                                                           POINTR   419
C                                                                            POINTR   420
      GO TO 320                                                              POINTR   421
280   CONTINUE                                                               POINTR   422
C     ***************************************************************        POINTR   423
C     THE FOLLOWING POINTERS WILL BE USED BY                                 POINTR   424
C     THE PELET MECHANICAL PACKAGE                                           POINTR   425
C                                                                            POINTR   426
C                                                                            POINTR   427
C     SET UP ARRAYS FOR RADIAL (AXIAL, 2 * AXIAL, 8 * AXIAL)                 POINTR   428
C                                                                            POINTR   429
          DO 290 K=2,8                                                       POINTR   430
          IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NAXN                             POINTR   431
290       CONTINUE                                                           POINTR   432
      LOCIDX = LOCIDX+7                                                      POINTR   433
      LENGTH = LENGTH+7*NAXN                                                 POINTR   434
C                                                                            POINTR   435
      NSPACE = 2*NAXN                                                        POINTR   436
C                                                                            POINTR   437
          DO 300 K=2,4                                                       POINTR   438
          IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE                           POINTR   439
300       CONTINUE                                                           POINTR   440
C                                                                            POINTR   441
      LOCIDX = LOCIDX+3                                                      POINTR   442
      LENGTH = LENGTH+3*NSPACE                                               POINTR   443
C                                                                            POINTR   444
      IA(LOCIDX+2) = IA(LOCIDX+1)+8*NAXN                                     POINTR   445
      LOCIDX = LOCIDX+1                                                      POINTR   446
      LENGTH = LENGTH+20*NAXN                                                POINTR   447
C                                                                            POINTR   448
C                                                                            POINTR   449
      NSPACE = 4*(NAXN+1)                                                    POINTR   450
C                                                                            POINTR   451
          DO 310 K=2,5                                                       POINTR   452
          IA(LOCIDX+K) = IA(LOCIDX+1)+(K-1)*NSPACE                           POINTR   453
310       CONTINUE                                                           POINTR   454
C                                                                            POINTR   455
      LOCIDX = LOCIDX+4                                                      POINTR   456
      LENGTH = LENGTH+4*NSPACE                                               POINTR   457
C                                                                            POINTR   458
C                                                                            POINTR   459
C     LIMITS FOR POINTERS                                                    POINTR   460
C                                                                            POINTR   461
C     DATA INPUT NOW COMPLETE, NOW COMPUTE GEOMETRY AND ELEMENT              POINTR   462
C     SIZE INCRIMENTS.                                                       POINTR   463
C                                                                            POINTR   464
C     RADIAL CALCULATION PARAMETERS                                          POINTR   465
C                                                                            POINTR   466
C     NFF=TOTAL NODES IN RADIAL MECHANICAL MODEL                             POINTR   467
C     NF4=TOTAL D.O.F. IN RADIAL MODEL OF FUEL                               POINTR   468
C     NC4=TOTAL D.O.F. IN RADIAL MODEL OF CLAD                               POINTR   469
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      C   NFF2=NUMBER OF D.O.F. IN COMBINED FUEL-CLAD MODEL                  POINTR   470
      C   PLUS 4.                                                            POINTR   471
480   C   NOELC=NUMBER OF RADIAL CLAD ELEMENTS                               POINTR   472
      C   NOELF=NUMBER OF RADIAL FUEL ELEMENTS                               POINTR   473
      C   NOELC=TOTAL NUMBER OF RADIAL ELEMENTS                              POINTR   474
      C   NFF1=TOTAL NUMBER OF RADIAL BOUNDARIES                             POINTR   475
      C                                                                      POINTR   476
485         NA = NAXN                                                        POINTR   477
            NABF = NA+1                                                      POINTR   478
            NABT = NA+2                                                      POINTR   479
            NABF2 = NABF*2                                                   POINTR   480
            NABT2 = NABT*2                                                   POINTR   481
490         NFF = (NF+NC)*2                                                  POINTR   482
            NF4 = 4*NF                                                       POINTR   483
            NC4 = 4*NC                                                       POINTR   484
            NFF1 = NF+NC                                                     POINTR   485
            NFF2 = 2*NFF                                                     POINTR   486
495         NOELC = (NC-1)*2                                                 POINTR   487
            NOELF = (NF-1)*2                                                 POINTR   488
            NOEL = NOELC+NOELF                                               POINTR   489
      C                                                                      POINTR   490
      C   AXIAL CALCULATION PARAMETERS                                       POINTR   491
500   C                                                                      POINTR   492
      C   NARF=NUMBER OF AXIAL REGIONS IN THE FUEL                           POINTR   493
      C   NART=NARC=TOTAL NUMBER OF AXIAL REAGIONS                           POINTR   494
      C   NABT,NABF=NUMBER OF AZIAL BOUNDARIES IN CLAD AND FUEL,RESPECTIVELY POINTR   495
      C   NAXBT=TOTAL NUMBER OF AXIAL BOUNDARIES                             POINTR   496
505   C   NAXB2=TOTAL NUMBER OF NODES IN AXIAL MODEL                         POINTR   497
      C   NAXB4=TOTAL NUMBER OF D.O.F. IN AXIAL MODEL                        POINTR   498
      C   NAEF=NUMBER OF ELEMENTS IN AXIAL FUEL MODEL                        POINTR   499
      C   NAEC=NUMBER OF ELEMENTS IN AXIAL CLAD MODEL                        POINTR   500
      C   NTAE=TOTAL NUMBER OF ELEMENTS IN THE AXIAL MODEL                   POINTR   501
510   C                                                                      POINTR   502
            NARF = NABF-1                                                    POINTR   503
            NART = NABT-1                                                    POINTR   504
            NAXBT = NABT+NABF                                                POINTR   505
            NAXB4 = 4*NAXBT+(NARF+NART)*2                                    POINTR   506
515         NAEF = NARF*4                                                    POINTR   507
            NAEC = NART*4                                                    POINTR   508
            NTAE = NAEF+NAEC                                                 POINTR   509
            NARC = NART                                                      POINTR   510
      C   PARAMETERS FOR CHOLESKY (MINIMUM-SPACE) STORAGE OF STIFFNESS       POINTR   511
520   C   MATRICES                                                           POINTR   512
      C                                                                      POINTR   513
      C   MAXF=TOTAL NUMBER OF STORAGE LOCATIONS REQUIRED FOR THE FUEL       POINTR   514
      C   RADIAL STIFFNESS MATRIX                                            POINTR   515
      C   MAXC=STORAGE REQUIRED FOR RADIAL CLAD MATRIX                       POINTR   516
525   C   MAXT=STORAGE FOR COMBINED FUEL-CLAD RADIAL MATRIX                  POINTR   517
      C   MAXA=STORAGE FOR THE AXIAL MODEL MATRIX                            POINTR   518
      C                                                                      POINTR   519
            NMX = NFF2-4                                                     POINTR   520
            MAXT = NMX+7*(NMX-4)                                             POINTR   521
530         MAXA = (NAXB4+25*(NAXB4-13))*2                                   POINTR   522
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      C                                                                      POINTR    523
      C                                                                      POINTR    524
      C     CALCULATION OF POINTERS BEGINS HERE.  A LISTING OF VARIABLY      POINTR    525
      C     DIMENSIONED VARIABLES AND THEIR ASSOCIATED POINTERS IS GIVEN BELOW POINTR   526
  535 C                                                                      POINTR    527
      C     VARIABLE   POINTER   MEANING                          UNITS    POINTR    528
      C                                                                      POINTR    529
      C     AELM       IAELM     AXIAL MODEL EL. NODE NO"S          ---     POINTR    530
      C     AK         IAK       AXIAL STIFFNESS MATRIX          POUNDS/IN  POINTR    531
  540 C     ARAA       IARAA     AXIAL EL. AREA                  IN**2      POINTR    532
      C     AREA       IARE      RADIAL EL. AREA                 IN**2      POINTR    533
      C     B          ISB       COMB. RADIAL MODEL DISP.        IN         POINTR    534
      C     BA         IBS       IBAAL MODEL DISP.               IN         POINTR    535
      C     BASAVE     IBASAV    SAVE AXIAL MOD. LOAD            POUNDS     POINTR    536
  545 C     BASE       IBASE     SAVE INCR. EL. EFFECT, ST9522     -X+9     POINTR    537
      C     FOR PLASTIC CALC.                                              POINTR    538
      C     BB         ISBB      COMB. RAD. MODEL LOADS          POUNDS     POINTR    539
      C     BBA        IBBA      AXIAL MODEL LOADS               POUNDS     POINTR    540
      C     BBSAV      IBBSV     SAVE COMB. RAD. MOD. LOADS      POUNDS     POINTR    541
  550 C     CA         ICA       AXIAL STRAIN-TO-STRESS CONV.    PSI        POINTR    542
      C     CC         ICC       RADIAL STRAIN-TO-STRESS CONV.   PSI        POINTR    543
      C     CRATE      ICRATE    GEN. STRAIN EL. INCR.           IN/IN      POINTR    544
      C     CRPG       ICRPG     GEN. EL. STRAIN                 IN/IN      POINTR    545
      C     DISPA      IDISP     AXIAL MOD. DISPLACEMENTS        IN         POINTR    546
  555 C     DISPC      IDISPC    CLAD OR COMB. RAD. MOD. DISP.   IN         POINTR    547
      C     DSPSV      IDSPSV    SAVE INNER CLAD RAD. DISP.      IN         POINTR    548
      C     EFSTR      IEFSTR    EFFECTIVE STRESS-RAD. MOD.      PSI        POINTR    549
      C     ELM        IELM      RADIAL MOD. EL. NODE. NO"S         ---     POINTR    550
      C     ELSTN      IELSTN    INCR. EL. STRAIN-RAD. MOD.      IN/IN      POINTR    551
  560 C     ELSTNA     ILSTNA    INCR. EL. STRAIN. AXIAL MOD.    IN/IN      POINTR    552
      C     ELSTRA     ILSTRA    INCR EL. STRESS-AXIAL MOD.      PSI        POINTR    553
      C     ELSTRS     IELSTR    INCR. EL. STRESS-RAD. MOD.      PSI        POINTR    554
      C     EPSLA      IPSLA     DISP.-TO-STRAIN CONV.-AX. MOD.  IN*-1      POINTR    555
      C     EPSLM      IEPSLM    DIS.-TO-STRAIN CONV.-RAD. MOD.  IN*-1      POINTR    556
  565 C     ESTNV      IESTNV    SAVED VALUES RAD. MOD. INCR. STN. IN/IN    POINTR    557
      C     ESTSV      IESTSV    SAVED VALUES RAD. MOD. INCR.    PSI        POINTR    558
      C     STRS.                                                          POINTR    559
      C     IJ         JIIJ      POSITION VECTOR, PLASTIC CALC.     ---     POINTR    560
      C     IPOS       IIPOS     POSITION VECTOR, PLASTIC CALC.     ---     POINTR    561
  570 C     NADET      INADET    D.O.F. ARRAY FOR RAD. MOD.         ---     POINTR    562
      C     NDC        INDC      AIDS TO D.O.F. ARRAY-RAD. MOD.     ---     POINTR    563
      C     NDF        INDF      AIDS TO D.O.F. ARRAY-RAD. MOD.     ---     POINTR    564
      C     NDT        INDT      AIDS TO D.O.F. ARRAY-RAD. MOD.     ---     POINTR    565
      C     NODET      INODET    D.O.F. ARRAY-RAD. COMB. MOD.       ---     POINTR    566
  575 C     OLDSE      IOLDSE    PREV. EL. EFFECT. STRESS        PSI        POINTR    567
      C     PRESS      IPRESS    INTERFACIAL PRESSURE            PSI        POINTR    568
      C     PSSRT      IPSSRT    SORTED ARRAY OF PSSV            PSI        POINTR    569
      C     PSSV       IPSSV     SAVED VALUES OF PLASTICITY      PSI        POINTR    570
      C     PSTS       IPSTS     CLAD. EL. YIELD STRESS, RAD. MOD. PSI      POINTR    571
  580 C     R          IR        ARRAY OF RAD. NODE LOCATIONS-   IN         POINTR    572
      C     RAD. MOD.                                                      POINTR    573
      C     RA         IRA       ARRAY OF RAD. NODE LOCATIONS-   IN         POINTR    574
      C     AX. MOD.                                                       POINTR    575
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      C   RBR       IRBR      EL. CENTROID RAD. LOCATION-          IN          POINTR  576
      C   RAD. MODEL                                                           POINTR  577
      C   RBRA      IRBRA     EL. CENTROID RAD. LOCATION-          IN          POINTR  578
      C   AX. MODEL                                                           POINTR  579
      C   RD        IRD       GEN. ARRAY OF RAD. BOUNDARY          IN          POINTR  580
      C   LOCATIONS, RAD. MODEL                                               POINTR  581
      C   STRESS    ISTRES    DISP.-TO-STRESS CONV.-RAD. MOD.      PSI/IN      POINTR  582
      C   STRSA     ISTRSA    DISP.-TO-STRESS CONV.-AX. MOD.       PSI/IN      POINTR  583
      C   TCB       ITCB      CLAD RAD. BOUND. TEMP.-RAD. MOD.     F           POINTR  584
      C   TCRP      ITCRP     INCR. EL. CREEP-PLAS. STRAIN-        IN/IN       POINTR  585
      C   RAD. MOD.                                                           POINTR  586
      C   TDELE     ITDELE    INCR. CHANGE IN TELM                 F           POINTR  587
      C   TELM      ITELM     EL. TEMP.-RAD. MOD.                  F           POINTR  588
      C   TFB       ITFB      FUEL RAD. BOUND. TEM.-TAD. MOD.      F           POINTR  589
      C   THET      ITHET     INCR. EL. TH. STRAIN-RAD. MOD.       IN/IN       POINTR  590
      C   THETAX    ITHTAX    INCR. EL. TH. STRAIN-AX. MOD.        IN/IN       POINTR  591
      C   THSAV     ITHSAV    SAVED VALUES OF THET                 IN/IN       POINTR  592
      C   THXSV     ITHXSV    SAVED VALUES OF THETAX               IN/IN       POINTR  593
      C   TME       ITME      PAST, PRESENT, FUTURE TIME           DAYS        POINTR  594
      C   TSTNR     ITSTNR    TOTAL EL. STRAIN-RAD. MOD.           PSI         POINTR  595
      C   TSTSR     ITSTSR    TOTAL EL. STRESS-RAD. MOD.           PSI         POINTR  596
      C   TW        ITW       EL. TEMP.-AX. MOD.                   F           POINTR  597
      C   TWDEL     ITWDEL    INCR. CHANGE IN TW                   F           POINTR  598
      C   Y         IY        AXIAL BOUND. LOCATIONS-AX. MOD.      IN          POINTR  599
      C   YACF      IYACF     Y IN 1-D ARRAY                       IN          POINTR  600
      C   YM        IYM       INTERPOLATION WORK SPACE               ---       POINTR  601
      C   XKT       IXKT      COMB. RAD. MOD. STIFFNESS            POUNDS/-N   POINTR  602
      C   XKTT      IXKTT     SAVED VALUES OF XKT                  POUNDS/IN   POINTR  603
      C   XLOAD     IXLOAD    STRAIN-TO-LOAD CONV.-RAD. MOD.       POUNDS      POINTR  604
      C   XLOADA    IXLODA    STRAIN-TO-LOAD CONV.-AX. MOD.        POUNDS      POINTR  605
      C                                                                        POINTR  606
            IFIRST = LENGTH+1                                                  POINTR  607
            IAELM = IFIRST+20                                                  POINTR  608
            IAK = IAELM+3*NTAE                                                 POINTR  609
            IARAA = IAK+MAXA                                                   POINTR  610
            IARE = IARAA+NTAE                                                  POINTR  611
            ISB = IARE+NOEL                                                    POINTR  612
            IBA = ISB+NFF2                                                     POINTR  613
            IBASAV = IBA+NAXB4                                                 POINTR  614
            IBASE = IBASAV+NAXB4                                               POINTR  615
            ISBB = IBASE+NOEL*NARF                                             POINTR  616
            IBBA = ISBB+NFF2                                                   POINTR  617
            IBBSV = IBBA+NAXB4                                                 POINTR  618
            ICA = IBBSV+NFF2*NARC                                              POINTR  619
            ICC = ICA+4*4*NTAE                                                 POINTR  620
            ICRATE = ICC+4*4*NOEL                                              POINTR  621
            ICRPG = ICRATE+NOEL*NARC                                           POINTR  622
            IDISP = ICRPG+NOEL*NARC                                            POINTR  623
            IDISPC = IDISP+NAXB4                                               POINTR  624
            IDSPSV = IDISPC+NFF1*NABT                                          POINTR  625
            IEFSTR = IDSPSV+NOEL*NARF                                          POINTR  626
            IELM = IEFSTR+NOEL*NARC                                            POINTR  627
            IELSTN = IELM+3*NFF                                                POINTR  628
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      ILSTNA = IELSTN+4*NOEL                                            POINTR   629
      ILSTRA = ILSTNA+4*NTAE                                            POINTR   630
      IELSTR = ILSTRA+4*NTAE                                            POINTR   631
640   IPSLA = IELSTR+4*NOEL                                             POINTR   632
      IEPSLM = IPSLA+36*NTAE                                            POINTR   633
      IESTNV = IEPSLM+36*NOEL                                           POINTR   634
      IESTSV = IESTNV+NOEL*NARC*4                                       POINTR   635
      JIIJ = IESTSV+NOEL*NARC*4                                         POINTR   636
645   IIPOS = JIIJ+NOEL*NARF                                            POINTR   637
      IKSAVE = IIPOS+NOEL*NARF                                          POINTR   638
      INADET = IKSAVE+36                                                POINTR   639
      INDC = INADET+NAXB4                                               POINTR   640
      INDF = INDC+NC4                                                   POINTR   641
650   INDT = INDF+NF4                                                   POINTR   642
      INODET = INDT+NFF2                                                POINTR   643
      IOLDSE = INODET+NFF                                               POINTR   644
      IPSSRT = IOLDSE+NOEL*NARF                                         POINTR   645
      IPSSV = IPSSRT+NOEL*NARF                                          POINTR   646
655   IPSTS = IPSSV+NOEL*NARF                                           POINTR   647
      IR = IPSTS+NOEL*NARF                                              POINTR   648
      IRA = IR+NFF                                                      POINTR   649
      IRBR = IRA+4*NABT                                                 POINTR   650
      IRBRA = IRBR+NOEL                                                 POINTR   651
660   IRD = IRBRA+NTAE                                                  POINTR   652
      ISTRES = IRD+NFF1*NABT                                            POINTR   653
      ISTRSA = ISTRES+36*NOEL                                           POINTR   654
      ITCB = ISTRSA+36*NTAE                                             POINTR   655
      ITCRP = ITCB+2*NABT                                               POINTR   656
665   ITEC = ITCRP+4*NOEL*NARC                                          POINTR   657
      ITEF = ITEC+NC*NABT                                               POINTR   658
      ITELM = ITEF+NF*NABT                                              POINTR   659
      ITFB = ITELM+NOEL*NABT*2                                          POINTR   660
      ITHET = ITFB+2*NABT                                               POINTR   661
670   ITHTAX = ITHET+4*NOEL                                             POINTR   662
      ITHSAV = ITHTAX+4*NTAE                                            POINTR   663
      ITHXSV = ITHSAV+NOEL*NARC*4                                       POINTR   664
      ITME = ITHXSV+NTAE*4                                              POINTR   665
      ITSTNR = ITME+20                                                  POINTR   666
675   ITSTSR = ITSTNR+4*NOEL*NARC                                       POINTR   667
      ITV = ITSTSR+4*NOEL*NARC                                          POINTR   668
      ITW = ITV+NABT                                                    POINTR   669
      IXKT = ITW+NTAE*2                                                 POINTR   670
      IXLOAD = IXKT+MAXT                                                POINTR   671
680   IXLODA = IXLOAD+6*4*NOEL                                          POINTR   672
      IXRD = IXLODA+6*4*NTAE                                            POINTR   673
      IY = IXRD+NFF1                                                    POINTR   674
      IYACF = IY+4*NABT                                                 POINTR   675
      IZ = IYACF+4*NABT                                                 POINTR   676
685   ILAST = IZ+NFF                                                    POINTR   677
C                                                                       POINTR   678
C                                                                       POINTR   679
      LENGTH = ILAST                                                    POINTR   680
      WRITE (6,*) "IFIRST",IFIRST,"ILAST",ILAST                         POINTR   681
```

```
      LOCMEC = 73                                                        POINTR   682
      LOCIDX = LOCIDX+73                                                 POINTR   683
320   CONTINUE                                                           POINTR   684
C                                                                        POINTR   685
      CALL ASSIGN (LOCIDX,NPSTRT,MECHAN,LOCMEC)                          POINTR   686
C                                                                        POINTR   687
C                                                                        POINTR   688
C   IF GRASS OPTION IS USED, GRASS9 COMPUTES POINTERS FOR THE NODALLY    POINTR   689
C   DEPENDENT VARIABLES CONTAINED IN THE AGRASS ARRAY AND COMPUTES       POINTR   690
C   NWORDS, THE NUMBER OF WORDS NEEDED FOR AGRASS.                       POINTR   691
C                                                                        POINTR   692
      IF (NGASR.EQ.-2) CALL GRASS9 (NAXNS,NRANS-1,NWORDS,LENGTH)         POINTR   693
C                                                                        POINTR   694
C   IF GRASS MODEL IS USED, ADD THE SEPARATELY COMPUTED LENGTH OF AGRASS POINTR   695
C   TO THE LENGTH                                                        POINTR   696
      LGRASS = LENGTH+1                                                  POINTR   697
      IF (NGASR.EQ.-2) LENGTH = LENGTH+NWORDS                            POINTR   698
C                                                                        POINTR   699
C   ZERO THE A - ARRAY                                                   POINTR   700
C                                                                        POINTR   701
      DO 330 K=NLSTRT,LENGTH                                             POINTR   702
C                                                                        POINTR   703
      A(K) = 0.E0                                                        POINTR   704
330   CONTINUE                                                           POINTR   705
C                                                                        POINTR   706
C                                                                        POINTR   707
C   ALL OF THE POINTERS ARE SET.  AT THIS POINT A CORE - MACRO COULD     POINTR   708
C   BE CALLED AND RETURN ALL THE SURPLUS CORE                            POINTR   709
C                                                                        POINTR   710
C                                                                        POINTR   711
      LOCID = LOCIDX-NPSTRT                                              POINTR   712
      WRITE (6,360) LOCID                                                POINTR   713
C                                                                        POINTR   714
      WRITE (6,370) LENGTH                                               POINTR   715
C                                                                        POINTR   716
      WRITE (6,380) ((K,IA(K)),K=1,300)                                  POINTR   717
C                                                                        POINTR   718
      GO TO 350                                                          POINTR   719
340   CONTINUE                                                           POINTR   720
C                                                                        POINTR   721
      WRITE (6,390)                                                      POINTR   722
C                                                                        POINTR   723
      IQUIT = 1                                                          POINTR   724
C                                                                        POINTR   725
C                                                                        POINTR   726
350   CONTINUE                                                           POINTR   727
C                                                                        POINTR   728
      RETURN                                                             POINTR   729
C                                                                        POINTR   730
360   FORMAT (///,1H ,26H THE NUMBER OF ARRAYS IS  ,I5)                  POINTR   731
370   FORMAT (///,1H ,30H THE LENGTH OF THE A-ARRAY IS ,I10,///)         POINTR   732
380   FORMAT (2(I5,2X,I5))                                               POINTR   733
390   FORMAT (1H1,//,20X,38H THE USER NEEDS TO SPECIFY A MECHANICS,39H P POINTR   734
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     +ACKAGE BEFORE EXECUTION CAN CONTINUE )                    POINTR   735
      END                                                       POINTR   736
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CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     148    I      IA         ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     149    I      IA         ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     150    I      IA         ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

SN	ENTRY POINTS	DEF LINE	REFERENCES
4	POINTR	1	737

VARIABLES

SN	VARIABLES	TYPE	RELOCATION									
0	A	REAL	ARRAY	FAST	REFS	45	47	49	DEFINED	712		
0	IA	INTEGER	ARRAY	FAST	REFS	47	49	168	182	196	213	227
						241	258	275	290	314	322	326	330
						331	335	340	349	361	369	374	378
						390	405	439	447	453	461	725	
					DEFINED	147	148	149	150	168	182	196	
						213	227	241	258	275	290	314	322
						326	330	331	335	340	349	361	369
						374	378	390	405	439	447	453	461
57	IADJ	INTEGER		LIMITS	REFS	63							
1	IAELM	INTEGER		PNTPNL	REFS	53	617	DEFINED	616				
2	IAK	INTEGER		PNTPNL	REFS	53	618	DEFINED	617				
3	IARAA	INTEGER		PNTPNL	REFS	53	619	DEFINED	618				
4	IARE	INTEGER		PNTPNL	REFS	53	620	DEFINED	619				
6	IBA	INTEGER		PNTPNL	REFS	53	622	DEFINED	621				
7	IBASAV	INTEGER		PNTPNL	REFS	53	623	DEFINED	622				
10	IBASE	INTEGER		PNTPNL	REFS	53	624	DEFINED	623				
12	IBBA	INTEGER		PNTPNL	REFS	53	626	DEFINED	625				
13	IBBSV	INTEGER		PNTPNL	REFS	53	627	DEFINED	626				
14	ICA	INTEGER		PNTPNL	REFS	53	628	DEFINED	627				
15	ICC	INTEGER		PNTPNL	REFS	53	629	DEFINED	628				
67	ICNT	INTEGER		LIMITS	REFS	63							
16	ICRATE	INTEGER		PNTPNL	REFS	53	630	DEFINED	629				
17	ICRPG	INTEGER		PNTPNL	REFS	53	631	DEFINED	630				
42	ICRPP	INTEGER		LIMITS	REFS	63							
60	ICUT	INTEGER		LIMITS	REFS	63							
5	IDF	INTEGER		LIMITS	REFS	63							
20	IDISP	INTEGER		PNTPNL	REFS	53	632	DEFINED	631				
21	IDISPC	INTEGER		PNTPNL	REFS	53	633	DEFINED	632				
22	IDSPSV	INTEGER		PNTPNL	REFS	53	634	DEFINED	633				
23	IEFSTR	INTEGER		PNTPNL	REFS	53	635	DEFINED	634				

VARIABLES	SN	TYPE	RELOCATION						
24	IELM	INTEGER	PNTPNL	REFS	53	636	DEFINED	635	
25	IELSTN	INTEGER	PNTPNL	REFS	53	637	DEFINED	636	
30	IELSTR	INTEGER	PNTPNL	REFS	53	640	DEFINED	639	
32	IEPSLM	INTEGER	PNTPNL	REFS	53	642	DEFINED	641	
33	IESTNV	INTEGER	PNTPNL	REFS	53	643	DEFINED	642	
34	IESTSV	INTEGER	PNTPNL	REFS	53	644	DEFINED	643	
0	IFIRST	INTEGER	PNTPNL	REFS	53	616	689	DEFINED	615
36	IIPOS	INTEGER	PNTPNL	REFS	53	646	DEFINED	645	
37	IKSAVE	INTEGER	PNTPNL	REFS	53	647	DEFINED	646	
106	ILAST	INTEGER	PNTPNL	REFS	53	688	689	DEFINED	685
26	ILSTNA	INTEGER	PNTPNL	REFS	53	638	DEFINED	637	
27	ILSTRA	INTEGER	PNTPNL	REFS	53	639	DEFINED	638	
40	INADET	INTEGER	PNTPNL	REFS	53	648	DEFINED	647	
41	INDC	INTEGER	PNTPNL	REFS	53	649	DEFINED	648	
42	INDF	INTEGER	PNTPNL	REFS	53	650	DEFINED	649	
43	INDT	INTEGER	PNTPNL	REFS	53	651	DEFINED	650	
44	INODET	INTEGER	PNTPNL	REFS	53	652	DEFINED	651	
45	IOLDSE	INTEGER	PNTPNL	REFS	53	653	DEFINED	652	
40	IPLAS	INTEGER	LIMITS	REFS	63				
73	IPLEND	INTEGER	LIMITS	REFS	63				
31	IPSLA	INTEGER	PNTPNL	REFS	53	641	DEFINED	640	
46	IPSSRT	INTEGER	PNTPNL	REFS	53	654	DEFINED	653	
47	IPSSV	INTEGER	PNTPNL	REFS	53	655	DEFINED	654	
50	IPSTS	INTEGER	PNTPNL	REFS	53	656	DEFINED	655	
0	IQUIT	INTEGER	F.P.	DEFINED	1	732			
51	IR	INTEGER	PNTPNL	REFS	53	657	DEFINED	656	
52	IRA	INTEGER	PNTPNL	REFS	53	658	DEFINED	657	
71	IRAK	INTEGER	LIMITS	REFS	63				
53	IRBR	INTEGER	PNTPNL	REFS	53	659	DEFINED	658	
54	IRBRA	INTEGER	PNTPNL	REFS	53	660	DEFINED	659	
55	IRD	INTEGER	PNTPNL	REFS	53	661	DEFINED	660	
75	IRZ	INTEGER	LIMITS	REFS	63				
5	ISB	INTEGER	PNTPNL	REFS	53	621	DEFINED	620	
11	ISBB	INTEGER	PNTPNL	REFS	53	625	DEFINED	624	
74	ISP	INTEGER	LIMITS	REFS	63				
37	ISSTOP	INTEGER	LIMITS	REFS	63				
56	ISTRES	INTEGER	PNTPNL	REFS	53	662	DEFINED	661	
57	ISTRSA	INTEGER	PNTPNL	REFS	53	663	DEFINED	662	
60	ITCB	INTEGER	PNTPNL	REFS	53	664	DEFINED	663	
61	ITCRP	INTEGER	PNTPNL	REFS	53	665	DEFINED	664	
62	ITEC	INTEGER	PNTPNL	REFS	53	666	DEFINED	665	
63	ITEF	INTEGER	PNTPNL	REFS	53	667	DEFINED	666	
64	ITELM	INTEGER	PNTPNL	REFS	53	668	DEFINED	667	
65	ITFB	INTEGER	PNTPNL	REFS	53	669	DEFINED	668	
66	ITHET	INTEGER	PNTPNL	REFS	53	670	DEFINED	669	
70	ITHSAV	INTEGER	PNTPNL	REFS	53	672	DEFINED	671	
67	ITHTAX	INTEGER	PNTPNL	REFS	53	671	DEFINED	670	
71	ITHXSV	INTEGER	PNTPNL	REFS	53	673	DEFINED	672	
72	ITME	INTEGER	PNTPNL	REFS	53	674	DEFINED	673	
73	ITSTNR	INTEGER	PNTPNL	REFS	53	675	DEFINED	674	
74	ITSTSR	INTEGER	PNTPNL	REFS	53	676	DEFINED	675	
75	ITV	INTEGER	PNTPNL	REFS	53	677	DEFINED	676	
76	ITW	INTEGER	PNTPNL	REFS	53	678	DEFINED	677	

VARIABLES	SN	TYPE	RELOCATION									
63	ITI	INTEGER	LIMITS	REFS	63							
0	IWORDS	INTEGER	F.P.	REFS	413	417	DEFINED	1				
77	IXKT	INTEGER	PNTPNL	REFS	53	679	DEFINED	678				
100	IXLOAD	INTEGER	PNTPNL	REFS	53	680	DEFINED	679				
101	IXLODA	INTEGER	PNTPNL	REFS	53	681	DEFINED	680				
102	IXRD	INTEGER	PNTPNL	REFS	53	682	DEFINED	681				
103	IY	INTEGER	PNTPNL	REFS	53	683	DEFINED	682				
104	IYACF	INTEGER	PNTPNL	REFS	53	684	DEFINED	683				
105	IZ	INTEGER	PNTPNL	REFS	53	685	DEFINED	684				
24	JAM	INTEGER	LIMITS	REFS	63							
35	JIIJ	INTEGER	PNTPNL	REFS	53	645	DEFINED	644				
1610	K	INTEGER		REFS	2*168	2*182	2*196	2*213	2*227	2*241	2*258	
				2*275	2*290	2*340	2*439	2*447	2*461	712	2*725	
				DEFINED	167	181	195	212	226	240	257	
				273	289	339	348	360	368	389	404	
				438	446	460	710	725				
12	KA	INTEGER	LIMITS	REFS	63							
66	KPLAS	INTEGER	LIMITS	REFS	63							
55	KRNCH	INTEGER	LIMITS	REFS	63							
45	KRNCHC	INTEGER	LIMITS	REFS	63							
44	KRNCHF	INTEGER	LIMITS	REFS	63							
46	KRNCHT	INTEGER	LIMITS	REFS	63							
36	KZI	INTEGER	LIMITS	REFS	63							
0	LENGTH	INTEGER	F.P.	REFS	205	250	265	284	296	320	324	
				328	333	337	343	351	363	371	376	
				380	392	407	413	417	421	425	442	
				451	455	465	615	701	705	706	710	
				723	DEFINED	1	151	205	250	265	284	
				296	320	324	328	333	337	343	351	
				363	371	376	380	392	407	417	425	
				442	451	455	465	688	706			
45	LGRASS	INTEGER	GRSPTR	REFS	91	DEFINED	705					
1623	LOCID	INTEGER		REFS	721	DEFINED	720					
1515	LOCIDX	INTEGER		REFS	2*168	172	2*182	186	2*196	200	2*213	
				217	2*227	231	2*241	245	2*258	261	2*275	
				280	2*290	300	2*314	316	2*322	323	2*326	
				327	2*330	2*331	332	2*335	336	2*340	342	
				2*349	350	2*361	362	2*369	370	2*374	375	
				2*378	379	2*390	391	2*405	406	2*439	441	
				2*447	450	2*453	454	2*461	464	691	694	
				720	DEFINED	115	155	172	186	200	217	
				231	245	261	280	300	316	323	327	
				332	336	342	350	362	370	375	379	
				391	406	441	450	454	464	691		
1514	LOCMEC	INTEGER		REFS	694	DEFINED	115	690				
52	MAXA	INTEGER	LIMITS	REFS	63	618	DEFINED	530				
43	MAXT	INTEGER	LIMITS	REFS	63	679	DEFINED	529				
1614	MBRARV	INTEGER		REFS	212	DEFINED	211					
1620	MBRATE	INTEGER		REFS	273	DEFINED	272					
1607	MBRAXV	INTEGER		REFS	167	DEFINED	166					
1612	MBRFIV	INTEGER		REFS	181	DEFINED	180					
1617	MBRSIX	INTEGER		REFS	257	DEFINED	256					
1613	MBRTHN	INTEGER		REFS	195	DEFINED	194					

VARIABLES SN TYPE RELOCATION

1616	MBRTLV	INTEGER		REFS	240	DEFINED	239					
1621	MBRTHV	INTEGER		REFS	289	DEFINED	288					
1615	MBRTWO	INTEGER		REFS	226	DEFINED	225					
56	MCUD	INTEGER	LIMITS	REFS	63							
15	MDHPRS	INTEGER	PFRCS2	REFS	69							
0	MECHAN	INTEGER	F.P.	REFS	161	398	399	694	DEFINED	1		
20	MEPP2	INTEGER	PFRCS2	REFS	69							
24	MEPS0	INTEGER	PFRCS2	REFS	69							
22	MEPS02	INTEGER	PFRCS2	REFS	69							
17	MEPS22	INTEGER	PFRCS2	REFS	69							
11	MEP2	INTEGER	PFRCS2	REFS	69							
10	MEREP2	INTEGER	PFRCS2	REFS	69							
14	MFVFR0	INTEGER	PFRCS2	REFS	69							
2	MGAP2	INTEGER	PFRCS2	REFS	69							
3	MIGAP2	INTEGER	PFRCS2	REFS	69							
0	MNA	INTEGER	F.P.	REFS	413	421	DEFINED	1	144			
0	MNR	INTEGER	F.P.	REFS	413	421	DEFINED	1	145			
1	MODPC2	INTEGER	PFRCS2	REFS	69							
0	MODPG2	INTEGER	PFRCS2	REFS	69	159						
4	MOIGP2	INTEGER	PFRCS2	REFS	69							
13	MOLDT2	INTEGER	PFRCS2	REFS	69							
23	MPEPP2	INTEGER	PFRCS2	REFS	69							
16	MPEP2	INTEGER	PFRCS2	REFS	69							
6	MPRES2	INTEGER	PFRCS2	REFS	69							
5	MREPS2	INTEGER	PFRCS2	REFS	69							
12	MR22	INTEGER	PFRCS2	REFS	69							
21	MSIG2	INTEGER	PFRCS2	REFS	69							
7	MTTT	INTEGER	PFRCS2	REFS	69							
0	M1	INTEGER	LIMITS	REFS	63							
1	M2	INTEGER	LIMITS	REFS	63							
1622	NA	INTEGER		REFS	486	487	DEFINED	485				
43	NAA	INTEGER	PFCM12	REFS	76							
17	NABC	INTEGER	LIMITS	REFS	63							
16	NABF	INTEGER	LIMITS	REFS	63	488	511	513	DEFINED	486		
31	NABF2	INTEGER	LIMITS	REFS	63	DEFINED	488					
20	NABT	INTEGER	LIMITS	REFS	63	489	512	513	633	658	661	
				664	666	667	668	669	677	683	684	
				DEFINED	487							
32	NABT2	INTEGER	LIMITS	REFS	63	DEFINED	489					
21	NAEC	INTEGER	LIMITS	REFS	63	517	DEFINED	516				
22	NAEF	INTEGER	LIMITS	REFS	63	517	DEFINED	515				
25	NALFDT	INTEGER	PFCM12	REFS	76							
14	NARC	INTEGER	LIMITS	REFS	63	627	630	631	635	643	644	
				665	672	675	676	DEFINED	518			
13	NARF	INTEGER	LIMITS	REFS	63	514	515	624	634	645	646	
				653	654	655	656	DEFINED	511			
15	NART	INTEGER	LIMITS	REFS	63	514	516	518	DEFINED	512		
25	NAXBT	INTEGER	LIMITS	REFS	63	514	DEFINED	513				
26	NAXB2	INTEGER	LIMITS	REFS	63							
27	NAXB4	INTEGER	LIMITS	REFS	63	2*530	622	623	626	632	648	
				DEFINED	514							
1605	NAXN	INTEGER		REFS	148	168	178	191	205	236	250	
				254	265	270	284	312	326	328	369	

VARIABLES	SN	TYPE	RELOCATION									
					371	374	376	439	442	444	453	455
					458	485	DEFINED	141				
0	NAXNS	INTEGER	F.P.	REFS	141		144	701	DEFINED	1		
33	NBB	INTEGER	PFCM12	REFS	76							
1507	NBRAR'	INTEGER		REFS	211		217	250	DEFINED	115		
1513	NBRAT:	INTEGER		REFS	272		280	284	DEFINED	115		
1504	NBRAXV	INTEGER		REFS	166		172	205	DEFINED	115		
1505	NBRFIV	INTEGER		REFS	180		186	205	DEFINED	115		
1512	NBRSIX	INTEGER		REFS	256		261	265	DEFINED	115		
1506	NBRTHN	INTEGER		REFS	194		200	205	DEFINED	115		
1511	NBRTLV	INTEGER		REFS	239		245	250	DEFINED	115		
1503	NBRTMV	INTEGER		REFS	288		296	300	DEFINED	115		
1510	NBRTWO	INTEGER		REFS	225		231	250	DEFINED	115		
0	NC	INTEGER	F.P.	REFS	490		492	493	495	666		
				DEFINED	1							
45	NCC	INTEGER	PFCM12	REFS	76							
11	NCOEF	INTEGER	PFCM12	REFS	76							
50	NC4	INTEGER	LIMITS	REFS	63		649	DEFINED	492			
5	NDCHCK	INTEGER	PFCM12	REFS	76							
36	NDD	INTEGER	PFCM12	REFS	76							
7	NDEP	INTEGER	PFCM12	REFS	76							
12	NDSIGF	INTEGER	PFCM12	REFS	76							
21	NE	INTEGER	PFCM12	REFS	76							
16	NECRP2	INTEGER	PFCM12	REFS	76							
41	NEE	INTEGER	PFCM12	REFS	76							
44	NEI	INTEGER	PFCM12	REFS	76							
23	NEPP2	INTEGER	PFCM12	REFS	76							
15	NEP2	INTEGER	PFCM12	REFS	76							
7	NETOT	INTEGER	LIMITS	REFS	63							
53	NEW	INTEGER	LIMITS	REFS	63							
10	NEWF	INTEGER	LIMITS	REFS	63							
11	NEWT	INTEGER	LIMITS	REFS	63							
0	NF	INTEGER	F.P.	REFS	490		491	493	496	667		
				DEFINED	1							
6	NFF	INTEGER	LIMITS	REFS	63		494	636	652	657	685	
				DEFINED	490							
30	NFF1	INTEGER	LIMITS	REFS	63		633	661	682	DEFINED	493	
47	NFF2	INTEGER	LIMITS	REFS	63		528	621	625	627	651	
				DEFINED	494							
13	NF1	INTEGER	PFCM12	REFS	76							
14	NF2	INTEGER	PFCM12	REFS	76							
51	NF4	INTEGER	LIMITS	REFS	63		650	DEFINED	491			
0	NGASR	INTEGER	F.P.	REFS	305		308	312	322	324	326	328
				330	331		333	701	706	DEFINED	1	
35	NGG	INTEGER	PFCM12	REFS	76							
30	NHH	INTEGER	PFCM12	REFS	76							
41	NKN	INTEGER	LIMITS	REFS	63							
42	NLL	INTEGER	PFCM12	REFS	76							
1516	NLSTRT	INTEGER		REFS	150		151	710	DEFINED	132		
34	NMM	INTEGER	PFCM12	REFS	76							
32	NMN	INTEGER	PFCM12	REFS	76							
54	NMX	INTEGER	LIMITS	REFS	63		2*529	DEFINED	528			
46	NNFF	INTEGER	PFCM12	REFS	76							

VARIABLES	SN	TYPE	RELOCATION									
31	NNN	INTEGER	PFCMI2	REFS	76							
25	NNNCRP	INTEGER	PFRCS2	REFS	69							
40	NNU	INTEGER	PFCMI2	REFS	76							
27	NNUDPP	INTEGER	PFCMI2	REFS	76							
2	NOEL	INTEGER	LIMITS	REFS	63	620	624	629	630	631	634	
					635	637	640	642	643	644	645	646
					653	654	655	656	659	662	665	668
					670	672	675	676	680	DEFINED	497	
4	NOELC	INTEGER	LIMITS	REFS	63	497	DEFINED	495				
3	NOELF	INTEGER	LIMITS	REFS	63	497	DEFINED	496				
65	NOLD	INTEGER	LIMITS	REFS	63							
26	NOLDPP	INTEGER	PFCMI2	REFS	76							
6	NOLSGF	INTEGER	PFCMI2	REFS	76							
0	NPIN	INTEGER	PFCMI2	REFS	76	158						
1	NPOUT	INTEGER	PFCMI2	REFS	76							
1517	NPSTRT	INTEGER		REFS	155	694	720	DEFINED	132			
2	NP1	INTEGER	PFCMI2	REFS	76							
3	NP2	INTEGER	PFCMI2	REFS	76							
1606	NRAN	INTEGER		REFS	149	213	222	236	250	378	380	
				DEFINED	142							
0	NRANS	INTEGER	F.P.	REFS	142	145	701	DEFINED	1			
10	NSLOPE	INTEGER	PFCMI2	REFS	76							
1611	NSPACE	INTEGER		REFS	182	196	227	241	258	275	314	
					320	447	451	461	465	DEFINED	178	191
					222	236	254	270	312	444	458	
24	NSTRTT	INTEGER	PFCMI2	REFS	76							
23	NTAE	INTEGER	LIMITS	REFS	63	617	619	628	638	639	641	
					660	663	671	673	678	681		
				DEFINED	517							
1604	NTMSP	INTEGER		REFS	147	290	296	312	335	337	369	
					371	DEFINED	140					
0	NTMSTP	INTEGER	F.P.	REFS	140	DEFINED	1					
20	NTN	INTEGER	PFCMI2	REFS	76							
4	NTSAVE	INTEGER	PFCMI2	REFS	76							
17	NT2	INTEGER	PFCMI2	REFS	76							
22	NU	INTEGER	PFCMI2	REFS	76							
0	NUAR1	INTEGER	GRSPTR	REFS	91							
11	NUAR10	INTEGER	GRSPTR	REFS	91							
12	NUAR11	INTEGER	GRSPTR	REFS	91							
13	NUAR12	INTEGER	GRSPTR	REFS	91							
14	NUAR13	INTEGER	GRSPTR	REFS	91							
15	NUAR14	INTEGER	GRSPTR	REFS	91							
16	NUAR15	INTEGER	GRSPTR	REFS	91							
17	NUAR16	INTEGER	GRSPTR	REFS	91							
20	NUAR17	INTEGER	GRSPTR	REFS	91							
21	NUAR18	INTEGER	GRSPTR	REFS	91							
22	NUAR19	INTEGER	GRSPTR	REFS	91							
1	NUAR2	INTEGER	GRSPTR	REFS	91							
23	NUAR20	INTEGER	GRSPTR	REFS	91							
24	NUAR21	INTEGER	GRSPTR	REFS	91							
25	NUAR22	INTEGER	GRSPTR	REFS	91							
26	NUAR23	INTEGER	GRSPTR	REFS	91							
27	NUAR24	INTEGER	GRSPTR	REFS	91							

VARIABLES	SN	TYPE	RELOCATION					
30	NVAR25	INTEGER	GRSPTR	REFS	91			
31	NVAR26	INTEGER	GRSPTR	REFS	91			
32	NVAR27	INTEGER	GRSPTR	REFS	91			
33	NVAR28	INTEGER	GRSPTR	REFS	91			
34	NVAR29	INTEGER	GRSPTR	REFS	91			
2	NVAR3	INTEGER	GRSPTR	REFS	91			
35	NVAR30	INTEGER	GRSPTR	REFS	91			
36	NVAR31	INTEGER	GRSPTR	REFS	91			
37	NVAR32	INTEGER	GRSPTR	REFS	91			
40	NVAR33	INTEGER	GRSPTR	REFS	91			
41	NVAR34	INTEGER	GRSPTR	REFS	91			
42	NVAR35	INTEGER	GRSPTR	REFS	91			
43	NVAR36	INTEGER	GRSPTR	REFS	91			
44	NVAR37	INTEGER	GRSPTR	REFS	91			
3	NVAR4	INTEGER	GRSPTR	REFS	91			
4	NVAR5	INTEGER	GRSPTR	REFS	91			
5	NVAR6	INTEGER	GRSPTR	REFS	91			
6	NVAR7	INTEGER	GRSPTR	REFS	91			
7	NVAR8	INTEGER	GRSPTR	REFS	91			
10	NVAR9	INTEGER	GRSPTR	REFS	91			
37	NW	INTEGER	PFCM12	REFS	76			
0	NWORDS	INTEGER	F.P.	REFS	701	706	DEFINED	1
0	NWRDS	INTEGER	F.P.	REFS	421	425	DEFINED	1
72	RAKSUM	REAL	LIMITS	REFS	63			
70	RRAKR	REAL	LIMITS	REFS	63			
64	STEP	REAL	LIMITS	REFS	63			
61	TIMEC	REAL	LIMITS	REFS	63			
35	XFRDEN	REAL	LIMITS	REFS	63			
33	XP	REAL	LIMITS	REFS	63			
34	XR	REAL	LIMITS	REFS	63			
62	XTIMEF	REAL	LIMITS	REFS	63			

FILE NAMES	MODE					
TAPE6	MIXED	WRITES	689	721	723	725	730

EXTERNALS	TYPE	ARGS	REFERENCES	
ASSIGN		4	694	
FC2PTR		4	421	
FR2PTR		4	413	
GRASS9		4	701	
NEMSET		3	158	159

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	169	167
0	110	183	181
0	120	197	195
0	130	214	212
0	140	228	226
0	150	242	240
0	160	259	257
0	170	277	273
0	180	292	289
0	190	341	339

STATEMENT LABELS			DEF LINE	REFERENCES	
0	200		352	348	
450	210		356	308	
0	220		364	360	
0	230		372	368	
524	240		384	305	
0	250		393	389	
541	260		395	354	382
0	270		408	404	
611	280		430	398	
0	290		440	438	
0	300		448	446	
0	310		462	460	
1356	320		692	399	429
0	330		713	710	
1440	340		728	161	
1445	350		735	727	
1550	360	FMT	739	721	
1555	370	FMT	740	723	
1563	380	FMT	741	725	
1566	390	FMT	742	730	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
54	100	K	167 169	10B	INSTACK
75	110	K	181 183	10B	INSTACK
117	120	K	195 197	10B	INSTACK
144	130	K	212 214	10B	INSTACK
165	140	K	226 228	10B	INSTACK
207	150	K	240 242	10B	INSTACK
237	160	K	257 259	10B	INSTACK
264	170	K	273 277	10B	INSTACK
307	180	K	289 292	10B	INSTACK
415	190	K	339 341	10B	INSTACK
434	200	K	348 352	12B	INSTACK
452	220	K	360 364	12B	INSTACK
466	230	K	368 372	14B	OPT
526	250	K	389 393	12B	INSTACK
551	270	K	404 408	12B	INSTACK
613	290	K	438 440	10B	INSTACK
634	300	K	446 448	10B	INSTACK
666	310	K	460 462	10B	INSTACK
1406	330	K	710 713	5B	INSTACK
1425		K	725 725	7B	EXT REFS

COMMON BLOCKS	LENGTH
FAST	1
PNTPNL	71
LIMITS	62
PFRCS2	22
PFCMI2	39
GRSPTR	38

```
STATISTICS
  PROGRAM LENGTH                 1637B     927
  SCM LABELED COMMON LENGTH       351B     233
        140000B SCM USED
```

```
      FUNCTION POLATE (XY,XX,NN,KK)                                     POLA      2
C     IMPLICIT REAL*8 (A-H,O-Z)                                         POLA      3
C                                                                       POLA      4
      DIMENSION XY(2)                                                   POLA      5
C                                                                       POLA      6
C     XY IS A TABLE OF Y(1), X(1), Y(2), X(2), ... Y(NN), X(NN)         POLA      7
C     XX IS THE GIVEN VALUE FOR X                                       POLA      8
C     NN IS THE NUMBER OF PAIRS OF ENTRIES IN XY                        POLA      9
C     KK IS BOTH THE POSITION GUESS AND THE FINAL VALUE                 POLA     10
C                                                                       POLA     11
      DATA NERR, NPRMAX / 1, 20 /                                       POLA     12
      DATA ZERO , DM10 / 0.  ,  1.E-10 /                                POLA     13
C                                                                       POLA     14
      X = XX                                                            POLA     15
      N = NN                                                            POLA     16
      M = IABS(N)                                                       POLA     17
      K = KK                                                            POLA     18
      IF (K.LT.1) K = 1                                                 POLA     19
      IF (K.GE.M) K = M-1                                               POLA     20
C                                                                       POLA     21
C     IS CONSTANT WANTED                                                POLA     22
      IF (M-1) 100,110,120                                              POLA     23
100   POLATE = ZERO                                                     POLA     24
      RETURN                                                            POLA     25
110   POLATE = XY(1)                                                    POLA     26
      RETURN                                                            POLA     27
C                                                                       POLA     28
C     LOOP TO DECREASE INDEX                                            POLA     29
120   IF (XY(2*K)-X) 140,140,130                                        POLA     30
130   K = K-1                                                           POLA     31
      IF (K) 160,160,120                                                POLA     32
C                                                                       POLA     33
C     LOOP TO INCREASE INDEX                                            POLA     34
140   IF (X-XY(2*K+2)-DM10) 200,200,150                                 POLA     35
150   K = K+1                                                           POLA     36
      IF (K-M) 140,180,180                                              POLA     37
C                                                                       POLA     38
C     TEST FOR EXTRAPOLATION                                            POLA     39
160   IF (N) 170,100,210                                                POLA     40
170   K = 1                                                             POLA     41
      GO TO 200                                                         POLA     42
180   IF (N) 190,100,220                                                POLA     43
190   K = M-1                                                           POLA     44
C                                                                       POLA     45
C     EVERYTHING OK, GET ANSWER                                         POLA     46
200   KK = K                                                            POLA     47
      POLATE = XY(2*K-1)+(X-XY(2*K))*(XY(2*K+1)-XY(2*K-1))/(XY(2*K+2)-XY POLA     48
     +(2*K))                                                            POLA     49
      RETURN                                                            POLA     50
C                                                                       POLA     51
C     POLATE FAILURE, SEARCH OUT OF BOUNDS                              POLA     52
210   POLATE = XY(1)                                                    POLA     53
      GO TO 230                                                         POLA     54
```

```
                220   POLATE = XY(2*M-1)                                                    POLA      55
55              230   IF (NERR.GT.NPRMAX) GO TO 240                                         POLA      56
                      WRITE (6,250) KK,K,N,X,(XY(2*I),I=1,N)                                POLA      57
                C   CALL ERRTRA                                                             POLA      58
                      IF (NERR.EQ.NPRMAX) WRITE (6,260)                                     POLA      59
                      NERR = NERR+1                                                         POLA      60
60              240   RETURN                                                                POLA      61
                C                                                                           POLA      62
                C                                                                           POLA      63
                250   FORMAT (16H ERROR IN POLATE/16H0INITIAL INDEX =,I6,10X,13HFINAL IN    POLA      64
                     +DEX =,I6,10X,14HARRAY LENGTH =,I6,10X,10HARGUMENT =,E14.6/20H0TABL   POLA      65
65                   +E OF X VALUES =/(8E15.6))                                            POLA      66
                260   FORMAT (34H0***** FURTHER MESSAGES SUPPRESSED)                        POLA      67
                      END                                                                   POLA      68
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    5  POLATE          1        24        26        49        60

VARIABLES     SN  TYPE           RELOCATION
  163  DM10       REAL                    REFS        34    DEFINED        12
  233  I          INTEGER                 REFS        56    DEFINED        56
  232  K          INTEGER                 REFS        18         19        29        30        31        34        35
                                          36        46       6*47        56    DEFINED        17        18        19
                                          30        35         40        43
    0  KK         INTEGER          F.P.   REFS        17         56    DEFINED         1        46
  231  M          INTEGER                 REFS      2*19         22        36        43        54
                                      DEFINED        16
  230  N          INTEGER                 REFS        16         39        42      2*56    DEFINED        15
  160  NERR       INTEGER                 REFS        55         58        59    DEFINED        11        59
    0  NN         INTEGER          F.P.   REFS        15    DEFINED         1
  161  NPRMAX     INTEGER                 REFS        55         58    DEFINED        11
  226  POLATE     REAL                DEFINED        23         25        47        52        54
  227  X          REAL                    REFS        29         34        47        56    DEFINED        14
    0  XX         REAL             F.P.   REFS        14    DEFINED         1
    0  XY         REAL       ARRAY F.P.   REFS         4         25        29        34      6*47        52        54
                                          56    DEFINED         1
  162  ZERO       REAL                    REFS        23    DEFINED        12

FILE NAMES       MODE
     TAPE6       FMT                WRITES        56        58

INLINE FUNCTIONS   TYPE     ARGS          DEF LINE   REFERENCES
     IABS          INTEGER     1  INTRIN                  16

STATEMENT LABELS                DEF LINE   REFERENCES
   33  100                          23        22        39        42
   37  110                          25        22
```

```
STATEMENT LABELS                DEF LINE   REFERENCES
    43   120                        29         22          31
     0   130          INACTIVE      30         29
    55   140                        34       2*29          36
     0   150          INACTIVE      35         34
    71   160                        39       2*31
     0   170          INACTIVE      40         39
    77   180                        42       2*36
     0   190          INACTIVE      43         42
   105   200                        46       2*34          41
   120   210                        52         39
   124   220                        54         42
   130   230                        55         53
   157   240                        60         55
   201   250     FMT                63         56
   221   260     FMT                66         58

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  136           I           56 56       10B                EXT REFS

STATISTICS
  PROGRAM LENGTH                 234B     156
        140000B SCM USED
```

```
      SUBROUTINE PRINTI (DVHPRS,TTT,EPS22,EPP2,FVFRO,SIG2,REPS2,EPS02,EP
     +2,GAP2,R22,ECREP2,PREPS2,PEPP2,OLDT2,PEP2,OLDPG2,OLDPC2,OLIGP2,IGA
     +P2,EPS0,MNR,MNA)
C
C   IMPLICIT REAL*8 (A-H,O-Z)
C
      REAL  NU , KRYIN
C
      COMMON  / FAST / A
C
C
C
C   THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY
C   DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL
C
C
C   ( NA )      -  ARRAYS
C
      COMMON  / POINT /
     +       LDCIH    ,LURC     ,LCREPI   ,LDLH     ,LHA      ,LHL
     +      ,LPOROS   ,LUFS     ,LAXGAP   ,LAXLEN   ,LBUI     ,LBU2
     +      ,LARAD    ,LCPDLT   ,LDELBP   ,LDENMX   ,LDLPGE
     +      ,LDZ      ,LDZH     ,LDZHP    ,LECREP   ,LEP
     +      ,LGAP     ,LGPTP    ,LHCOEF   ,LOLAXG   ,LOLDPC
     +      ,LOLDPG   ,LOLDTC   ,LOLDUR   ,LOLEPS   ,LOLFEP
     +      ,LPAXGP   ,LPC      ,LPECRP   ,LPEP     ,LPG
     +      ,LPINT    ,LPLDPC   ,LPLDPG   ,LPLDTC   ,LPLDUR   ,LPOAXG
     +      ,LPOFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR
     +      ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF
     +      ,LVCH     ,LVCHI    ,LVCR     ,LVDH     ,LVFH     ,LVGH
     +      ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEPI
     +      ,LHGAPS   ,LTRTRN   ,LIGAP    ,LOLIGP   ,LQDP
     +      ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO
     +      ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO
C
C   ( NA X 2 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG
     +      ,LREPS2
C
C   ( NA X 3 )  -  ARRAYS
C
      COMMON  / POINT /
     +       LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS
     +      ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS
     +      ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPPI
     +      ,LSIGI    ,LEPSI
C
C   ( NR )      -  ARRAYS
C
      COMMON  / POINT /
     +       LAK1     ,LAK2     ,LCRL     ,LDPL     ,LDPLH    ,LDPN
```

```
     +       ,LFMA     ,LFMGPR   ,LHRL     ,LTFB     ,LTFR     ,LTFRK    REALCM     45
     +       ,LVPL                                                       REALCM     46
C                                                                        REALCM     47
CC   ( NR X 2 )  -  ARRAYS                                               REALCM     48
C                                                                        REALCM     49
      COMMON  / POINT /                                                  REALCM     50
     +         LF       ,LFH      ,LFN                                  REALCM     51
C                                                                        REALCM     52
CC   ( NR X NA ) -  ARRAYS                                               REALCM     53
C                                                                        REALCM     54
      COMMON  / POINT /                                                  REALCM     55
     +         LCC1     ,LCC2     ,LDENSF   ,LDENSP   ,LDPW     ,LDPWPP  REALCM     56
     +       ,LGNSIZ   ,LPORS1   ,LPORS2   ,LTMPDS   ,LUO2LL   ,LTMPMX  REALCM     57
     +       ,LR       ,LRAD                                             REALCM     58
C                                                                        REALCM     59
CC   ( NA X 6 )  -  ARRAYS                                               REALCM     60
C                                                                        REALCM     61
      COMMON  / POINT /                                                  REALCM     62
     +         LB       ,LBR      ,LBTOLD   ,LCHEM                      REALCM     63
C                                                                        REALCM     64
CC   ( NA X 8 )  -  ARRAYS                                               REALCM     65
C                                                                        REALCM     66
      COMMON  / POINT /                                                  REALCM     67
     +         LQ                                                        REALCM     68
C                                                                        REALCM     69
CC   ( IT )      -  ARRAYS                                               REALCM     70
C                                                                        REALCM     71
      COMMON  / POINT /          LACMFG   ,LACMHE   ,LACMH2   ,LACMN2  REALCM     72
     +                 ,LAMGPT   ,LGASMO   ,LHMGPT   ,LPIT     ,LPRT10   REALCM     73
     +       ,LPRT11   ,LPRT12   ,LPRT13   ,LPRT14   ,LPRT15   ,LPRT16  REALCM     74
     +       ,LPRT17   ,LPRT18   ,LPRT2    ,LPRT20   ,LPRT3    ,LPRT4   REALCM     75
     +       ,LPRT5    ,LPRT6    ,LPRT7    ,LPRT8    ,LPRT9    ,LTAC    REALCM     76
     +       ,LTAFA    ,LTAGA    ,LTSF                                   REALCM     77
C                                                                        REALCM     78
CC                                                                       REALCM     79
C    ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME                 REALCM     80
C                                                                        REALCM     81
      COMMON / POINT /                                                   REALCM     82
     +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,         REALCM     83
     +   LDECAY,   LHALF,    LRLEAS                                       REALCM     84
C                                                                        REALCM     85
C    BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME                        REALCM     86
C                                                                        REALCM     87
      COMMON / POINT /                                                   REALCM     88
     +   IRDOT,    ISAVGS,   LSTHIF,   IX                               REALCM     89
C                                                                        REALCM     90
C    RADIAL MODEL ARRAYS                                                 REALCM     91
C                                                                        REALCM     92
      COMMON / POINT /                                                   REALCM     93
     +   ICFAC     ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF      REALCM     94
     +  ,ITRAMP    ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV                REALCM     95
     +  ,IHLDN     ,IPLSTC   ,ISTRNN   ,ISTRSS                          REALCM     96
C                                                                        REALCM     97
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      C                                                                                                  REALCM     98
      C                                                                                                  REALCM     99
      C                                                                                                  REALCM    100
110         COMMON / REALS /   AAA(20)  ,AAN       ,AIRIN    ,AMGP(2) ,AMGPH(2)                       REALCM    101
           +                  ,AMGR(2)  ,AMGRH(2)  ,AMGRN2(2),AMWDT    ,ANGI                        REALCM    102
           +          ,ANGT   ,AN2IN    ,ARGIN    ,ARING    ,AVGGI(8) ,B(6)                        REALCM    103
           +          ,BP     ,BPP      ,BR(6)    ,BU       ,BUOLD    ,CDG                         REALCM    104
           +          ,CFV    ,CFVA     ,CHOL     ,CODEID(15),CONVC,CONVER(10)                     REALCM    105
115        +          ,CPV    ,CRDTT    ,CRN      ,CVV      ,DCIH                                  REALCM    106
           +          ,DCIHP  ,DELBP    ,DELBU    ,DELH     ,DELT                                  REALCM    107
           +          ,DELTCR ,DELTDB   ,DELTFC   ,DELTJL   ,DHIC     ,DLREL                       REALCM    108
           +          ,DLROD  ,DLTGC(26),DPH      ,DPHF     ,DPHFP    ,DPWP                        REALCM    109
           +          ,DRS    ,ENRICH   ,EOLSR    ,FC(1)    ,FGIN     ,FGPAVP                      REALCM    110
120        C                                                                                               REALCM    111
         COMMON / REALS /   FGPAVX   ,FH2O     ,FJJ(2)   ,FJJH(2)  ,FMGP(2)                        REALCM    112
           +                ,FPOR     ,FPORI    ,FRD      ,FRDH     ,FRDN                          REALCM    113
           +          ,G      ,GASES(7) ,GASIN    ,GDEN   ,GPTH(26) ,GPTHE(26)                     REALCM    114
           +          ,GPTHM  ,GPTHP    ,GPTHPG(26) ,GR     ,HCRV     ,HCV                       REALCM    115
125        +          ,HDSHV  ,HEIN     ,HFLL     ,HFLMDB   ,HFLMP    ,HFPER                     REALCM    116
           +          ,HFV    ,HGAPT    ,HGV      ,HI       ,HMGP(2)  ,HP                        REALCM    117
           +          ,HGAP   ,HSOLID   ,HGAPR                                                      REALCM    118
           +          ,HPL    ,HPORV    ,HPV      ,HUPTAK   ,H2OMI    ,KRYIN                     REALCM    119
           +          ,NU     ,OXDROP   ,OXIDE    ,PECDH    ,PI       ,PIN(26)                   REALCM    120
130        +          ,PINP   ,PORO     ,PR       ,PRESS    ,PRTY     ,PRT19                     REALCM    121
           +          ,QC     ,QP       ,QSP      ,RCI      ,RCO                                   REALCM    122
           +          ,QAV    ,QPEAK                                                                 REALCM    123
      C                                                                                               REALCM    124
         COMMON / REALS /   RFNVFF   ,RHO      ,RHOF     ,RHOG     ,RHOUO2                        REALCM    125
135        +                ,RMH      ,RP       ,RSTRAN   ,RSTRES   ,RTRAN                         REALCM    126
           +          ,SKTC   ,SKTS     ,STRN     ,SUMCK    ,SUMDH    ,SUMEXP                      REALCM    127
           +          ,SUMGP  ,SUMPOR   ,SUMRG    ,SUMTF    ,T        ,TCAC                        REALCM    128
           +          ,TCI    ,TCO      ,TFBC     ,TFC      ,TFGFR    ,THEFR                       REALCM    129
           +          ,TH2OFR ,TITLE(12),TM       ,TN2FR    ,TOXO     ,TP                          REALCM    130
140        +          ,TPA    ,TPAC     ,TPLEN    ,TRANST   ,TSAT     ,TT                          REALCM    131
           +          ,TX     ,TXA      ,TXAL     ,TXC      ,VISC     ,VPLT                        REALCM    132
           +          ,VSS    ,W        ,WT       ,WTRAN    ,XEIN     ,XK6                         REALCM    133
           +          ,XK7    ,YY       ,Z        ,ZRO2WG   ,VX       ,CLOS                        REALCM    134
           +          ,FNCK   ,FNCN     ,CWKF     ,CWNF     ,COLDWK                                REALCM    135
145        +          ,DISH                                                                          REALCM    136
      C                                                                                               REALCM    137
      C                                                                                               INTGCM      2
         COMMON / INTEG /                                                                             INTGCM      3
           +    IQUIT       ,IRI      ,IT       ,ITER     ,J                                       INTGCM      4
150        +   ,JJC         ,JPEAK    ,K        ,KINDOR   ,KOXI                                      INTGCM      5
           +   ,LMN         ,M        ,MODLOP   ,NAB      ,NPLAST                                  INTGCM      6
           +   ,NRMI        ,NSTEP    ,NWRITE   ,N2       ,IMDONE                                  INTGCM      7
           +   ,ICLOSE      ,NSH      ,NF       ,NC                                                INTGCM      8
      C                                                                                               INTGCM      9
155   C                                                                                               INPRCM      2
         COMMON / INPTR /ACOR       ,AFAL     ,AFCR     ,AFDN                                        INPRCM      3
           +                ,AFGR     ,AFSW     ,AFTC     ,AGPC                                    INPRCM      4
           +   ,AMFAIR      ,AMFARG   ,AMFFG    ,AMFHE    ,AMFH2                                   INPRCM      5
           +   ,AMFH2O      ,AMFKRY   ,AMFN2    ,AMFXE                                             INPRCM      6
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      +    ,BUIN(22)    ,CATEXF                                                    !NPRCM      7
      +    ,CLDWKD      ,CPL         ,CRDT       ,CRDTR       ,CTMAX(22)        INPRCM      8
      +    ,DCI(22)     ,DCO(22)     ,DE(22)     ,DELTAZ(22)  ,DEN              INPRCM      9
      +    ,DENG        ,DISHSD      ,DP(22)     ,DSPG        ,DSPGW            INPRCM     10
      +    ,ENRCH       ,EXO         ,FA         ,FGPAV       ,FLUX             INPRCM     11
      +    ,FLXDP       ,FQE         ,GO(101)    ,GRNSIZ      ,HDISH            INPRCM     12
      +    ,HPLT        ,PPMH2O      ,PPMN2      ,P2(101)     ,QEND(8)          INPRCM     13
      +    ,QF(328)     ,QMPY(101)   ,RAPOW(11)  ,RC          ,RDISH            INPRCM     14
      +    ,ROUGHC      ,ROUGHF      ,SGAPF                                       INPRCM     15
      +    ,TCC         ,TIME(101)   ,TOTL       ,TSINT       ,TW(101)          INPRCM     16
      +    ,UBFS        ,UMELT       ,UOFD       ,VS          ,X(328)           INPRCM     17
      +    ,RSNTR       ,FOTMTL      ,TREF       ,CREPHR      ,ANRIN            INPRCM     18
      +    ,CLDWKS                                                                INPRCM     19
      +    ,CP          ,CR                                                       INPRCM     20
      C                                                                           INPICM      2
            COMMON / INPTI /ICM       ,ICOR       ,IDBG       ,IDXGAS           INPICM      3
      +                    ,IM        ,IPLANT     ,IQ         ,ISW              INPICM      4
      +    ,JDLPR       ,JN(8)       ,JST(101)   ,MDBG       ,NHEAL            INPICM      5
      +    ,MODE        ,MODES       ,MTAPE      ,NDBG       ,NFROD            INPICM      6
      +    ,NGAPC       ,NGASR       ,NOFAIL     ,NOPT       ,NPCYCL           INPICM      7
      +    ,NPLTAB      ,NREAD       ,NRESTR     ,NROLL      ,NSP              INPICM      8
      +    ,NSTART      ,NSTOP       ,NT         ,NTAPE      ,NUCFC            INPICM      9
      +    ,NUNITS      ,LACMOD      ,LACE(13)   ,NAFAIL     ,NNFAIL(22)       INPICM     10
      +    ,NXP         ,NPLOT       ,NTPLOT     ,NROD       ,NA               INPICM     11
      +    ,NR          ,NEWPRB      ,MECHAN     ,NCRACK     ,NELAST           INPICM     12
      +    ,NCREEP      ,IAXSYM      ,IVARDM     ,NOFRAC     ,ITREST           INPICM     13
      +    ,NWORDS      ,IWORDS      ,NWRDS      ,NPRINT                       INPICM     14
      C                                                                           INPICM     15
      C                                                                           INPICM     16
            COMMON  /EMFLGS/   IMPOWR    ,IMFUEL    ,IMDENS    ,IMRELO         INPICM     17
      +                        ,IMCLAD    ,IMGAPC    ,IM93WC    ,IMENRG         INPICM     18
      +          ,IMFGAS    ,IMSWCH                                             INPICM     19
      C                                                                           INPICM     20
      C                                                                           INPICM     21
      C                                                                           INPICM     22
            COMMON/PFRCS2/      MODPG2          ,MODPC2          ,MGAP2         INPICM     23
      +   ,MIGAP2           ,MOIGP2          ,MREPS2          ,MPEPS2          INPICM     24
      +   ,MTTT             ,MEREP2          ,MEP2            ,MR22            INPICM     25
      +   ,MOLDT2           ,MFVFRO          ,MDHPRS          ,MPEP2           INPICM     26
      +   ,MEPS22           ,MEPP2           ,MSIG2           ,MEPS02          INPICM     27
      +   ,MPEPP2           ,MEPS0           ,NNNCRP                           INPICM     28
      C                                                                           INPICM     29
            COMMON /MATCNS/ AAHA(12)                                              INPICM     30
      C                                                                           INPICM     31
      C                                                                           INPICM     32
            COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                                 INPICM     33
      C                                                                           INPICM     34
            COMMON /VER/ VERS                                                     INPICM     35
      C                                                                           PHYPRO      2
            COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB        PHYPRO      3
      +                  ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP          PHYPRO      4
      +                  ,DELOXY                                                 PHYPRO      5
      C                                                                           PHYPRO      6
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      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                    PHYPRO      7
      C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)                 PHYPRO      8
215   C   CTMELT - ZR CLAD MELTING POINT (K)                                      PHYPRO      9
      C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                                PHYPRO     10
      C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)              PHYPRO     11
      C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)                PHYPRO     12
      C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)              PHYPRO     13
220   C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)                PHYPRO     14
      C   BU     - BURNUP (MW-S/KG-U)                                            PHYPRO     15
      C   COMP   - PUO2 CONTENT (WT-PERCEN )                                     PHYPRO     16
      C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED           PHYPRO     17
      C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                   PHYPRO     18
225   C                                                                          PHYPRO     19
        DIMENSION  A(1)                                                        PRTI       17
      C                                                                        PRTI       18
      CC                                                                       PRTI       19
      C                                                                        PRTI       20
230     INTEGER  OLIGP2                                                        PRTI       21
        DIMENSION TTT(MNA,MNR),EPS22(MNA,MNR,3),EPP2(MNA,MNR,3)                PRTI       22
       + ,SIG2(MNA,MNR,3),REPS2(MNA,2),EPS02(MNA,MNR,3)                        PRTI       23
       + ,EP2(MNA,MNR),GAP2(MNA),R22(MNA,MNR),ECREP2(MNA,MNR)                  PRTI       24
       + ,OLDT2(MNA,MNR)                                                       PRTI       25
235    + ,OLDPG2(MNA),OLDPC2(MNA),OLIGP2(MNA),IGAP2(MNA)                       PRTI       26
       + ,EPS0(MNA,MNR,3)                                                      PRTI       27
       + ,PEP2(MNA,MNR),PEPP2(MNA,MNR,3),PREPS2(MNA,2)                         PRTI       28
       + ,FVFRO(MNA,MNR) ,DVHPRS(MNA,MNR)                                      PRTI       29
      C                                                                        PRTI       30
240   C   THE FOLLOWING DATA STATEMENTS CONTAIN VARIOUS CONVERSION FACTORS      PRTI       31
      C                                                                        PRTI       32
        DATA  CINTMM / 25.4E0 / , CHRTDA / 24.E0 / , CINTCM / 2.54E0 /         PRTI       33
        DATA  CMDTMS / 86.4E0 / , CPSTMP / 6894.7572E-6 /                      PRTI       34
        DATA  CINTOM / 2.54E-2 / , CFTTOM / 0.3048E0 / , CKSTPH / 737.34 /     PRTI       35
245   C                                                                        PRTI       36
        TK(TTT) = (TTT+459.67E0)/1.8E0                                         PRTI       37
        CALL PGHEAD (CODEID,MODLOP,TITLE)                                      PRTI       38
      C                                                                        PRTI       39
      C                                                                        PRTI       40
250     RATE = 0.E+0                                                           PRTI       41
        IF (ICOR.EQ.2) RATE = CRDTR*8760.E0                                    PRTI       42
        WRITE (6,190)                                                          PRTI       43
        IF (IPLANT.LE.0) GO TO 140                                             PRTI       44
        GO TO (100,110,120,130), IPLANT                                        PRTI       45
255   100   WRITE (6,200)                                                      PRTI       46
        GO TO 140                                                              PRTI       47
      110   WRITE (6,210)                                                      PRTI       48
        GO TO 140                                                              PRTI       49
      120   WRITE (6,220) COMP                                                 PRTI       50
260     GO TO 140                                                              PRTI       51
      130   WRITE (6,230) COMP                                                 PRTI       52
      140   CONTINUE                                                           PRTI       53
        CI3TM3 = CINTOM**3                                                     PRTI       54
        RUFFML = ROUGHF*1.E3                                                   PRTI       55
265     RUFCML = ROUGHC*1.E3                                                   PRTI       56
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                SIRUFC = ROUGHC*CINTMM                                          PRTI       57
                SIRUFF = ROUGHF*CINTMM                                          PRTI       58
                SHDSI = DISHSD*CINTMM                                           PRTI       59
                BUINSI = BUIN(I)*CMDTMS                                         PRTI       60
270             DCOSI = DCO(I)*CINTCM                                           PRTI       61
                DCISI = DCI(I)*CINTCM                                           PRTI       62
                DPSI = DP(I)*CINTCM                                             PRTI       63
                DESI = DE(I)*CINTCM                                             PRTI       64
                FGPAVS = FGPAV*CPSTMP                                           PRTI       65
275             HPLTSI = HPLT*CINTCM                                            PRTI       66
                TOTLSI = TOTL*CFTTOM                                            PRTI       67
                RDISHS = RDISH*CINTCM                                           PRTI       68
                HDISHS = HDISH*CINTMM                                           PRTI       69
                RCSI = RC*CINTMM                                                PRTI       70
280             CFVSI = CFV*CI3TM3                                              PRTI       71
                VSSSI = VSS*CI3TM3                                              PRTI       72
                CPLSI = CPL*CINTCM                                              PRTI       73
                DSPGSI = DSPG*CINTCM                                            PRTI       74
                CPVSI = CPV*CI3TM3                                              PRTI       75
285             CVVSI = CVV*CI3TM3                                              PRTI       76
                DSPGWS = DSPGW*CINTMM                                           PRTI       77
                TCC = (DCO(I)-DCI(I))/2.E0                                      PRTI       78
                TCCSI = TCC*CINTMM                                              PRTI       79
                CDGSI = CDG*CINTMM/1.E3                                         PRTI       80
290             CRDTSI = CRDT*CINTMM/1.E3                                       PRTI       81
                TSINTK = TK(TSINT)                                              PRTI       82
          C                                                                     PRTI       83
                IF (ICM.EQ.2) WRITE (6,240)                                     PRTI       84
                IF (ICM.EQ.4) WRITE (6,250)                                     PRTI       85
295             IF (IVARDM.EQ.0) WRITE (6,260) DCOSI,DCO(I)                     PRTI       86
                IF (IVARDM.EQ.0) WRITE (6,270) DCISI,DCI(I)                     PRTI       87
                IF (IVARDM.EQ.0) WRITE (6,280) TCCSI,TCC                        PRTI       88
                WRITE (6,400) SIRUFC,RUFCML                                     PRTI       89
                IF (IVARDM.EQ.0) WRITE (6,290) CDGSI,CDG                        PRTI       90
300             IF (IVARDM.EQ.0) WRITE (6,300) DPSI,DP(I)                       PRTI       91
                WRITE (6,310) HPLTSI,HPLT                                       PRTI       92
                WRITE (6,350) HDISHS,HDISH                                      PRTI       93
                WRITE (6,360) SHDSI,DISHSD                                      PRTI       94
                WRITE (6,370) RDISHS,RDISH                                      PRTI       95
305             WRITE (6,380) RCSI,RC                                           PRTI       96
                WRITE (6,410) TSINTK,TSINT                                      PRTI       97
                WRITE (6,340) DEN                                               PRTI       98
                WRITE (6,420) CFVSI,CFV                                         PRTI       99
                WRITE (6,390) SIRUFF,RUFFML                                     PRTI      100
310             WRITE (6,320) TOTLSI,TOTL                                       PRTI      101
                WRITE (6,430) PECDH                                             PRTI      102
                WRITE (6,330) ENRCH                                             PRTI      103
                WRITE (6,500) SGAPF                                             PRTI      104
                WRITE (6,510) PPMH2O                                            PRTI      105
315             WRITE (6,520) PPMN2                                             PRTI      106
                WRITE (6,440) CPLSI,CPL                                         PRTI      107
                WRITE (6,450) DSPGSI,DSPG                                       PRTI      108
                WRITE (6,460) DSPGWS,DSPGW                                      PRTI      109
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                WRITE (6,470) VSSSI,VSS                                                  PRTI      110
320             WRITE (6,480) CPVSI,CPV                                                  PRTI      111
                WRITE (6,490) VS                                                         PRTI      112
                WRITE (6,550) CVVSI,CVV                                                  PRTI      113
                WRITE (6,560) FGPAVS,FGPAV                                               PRTI      114
                IF (IDXGAS.EQ.1) WRITE (6,570)                                           PRTI      115
325             IF (IDXGAS.EQ.2) WRITE (6,580)                                           PRTI      116
                IF (IDXGAS.EQ.3) WRITE (6,590)                                           PRTI      117
                IF (IDXGAS.EQ.4) WRITE (6,600)                                           PRTI      118
                IF (IDXGAS.EQ.5) WRITE (6,610)                                           PRTI      119
                IF (IDXGAS.EQ.6) WRITE (6,620)                                           PRTI      120
330             IF (CRDT.GT.0.E0) WRITE (6,630) CRDTSI,CRDT                              PRTI      121
                IF (BUIN(1).GT.0.E0.AND.IVARDM.EQ.0) WRITE (6,540) BUINSI,BUIN(1)        PRTI      122
                IF (IVARDM.EQ.0) WRITE (6,530) DESI,DE(1)                                PRTI      123
            C                                                                            PRTI      124
            C                                                                            PRTI      125
335             IF (IVARDM.EQ.0) GO TO 160                                               PRTI      126
            C                                                                            PRTI      127
                WRITE (6,640)                                                            PRTI      128
            C                                                                            PRTI      129
                DO 150 I=2,NA                                                            PRTI      130
340             II = I-1                                                                 PRTI      131
            C                                                                            PRTI      132
                BUINSI = BUIN(I)*CMDTMS                                                  PRTI      133
                DESI = DE(I)*CINTMM                                                      PRTI      134
                DCOSI = DCO(I)*CINTMM                                                    PRTI      135
345             DCISI = DCI(I)*CINTMM                                                    PRTI      136
                DPSI = DP(I)*CINTMM                                                      PRTI      137
                GP = DCI(I)-DP(I)                                                        PRTI      138
                GPSI = GP*CINTMM                                                         PRTI      139
                GPMIL = GP*1.E3                                                          PRTI      140
350             WRITE (6,650) II,DESI,DE(I),DCOSI,DCO(I),DCISI,DCI(I),GPSI,GPM           PRTI      141
           +    IL,DPSI,DP(I),BUINSI,BUIN(I)                                             PRTI      142
            150 CONTINUE                                                                 PRTI      143
            160 CONTINUE                                                                 PRTI      144
            C                                                                            PRTI      145
355             CALL PGHEAD (CODEID,MODLOP,TITLE)                                        PRTI      146
            C                                                                            PRTI      147
                WRITE (6,660)                                                            PRTI      148
            C                                                                            PRTI      149
            C                                                                            PRTI      150
360             IMPI = IM+1                                                              PRTI      151
                DO 170 I=2,IMPI                                                          PRTI      152
                II = I-1                                                                 PRTI      153
            C                                                                            PRTI      154
                IF (I.EQ.52) CALL PGHEAD (CODEID,MODLOP,TITLE)                           PRTI      155
365             IF (I.EQ.52) WRITE (6,660)                                               PRTI      156
            C                                                                            PRTI      157
            C                                                                            PRTI      158
                GOSI = GO(II)/CKSTPH                                                     PRTI      159
                TWSI = TK(TW(II))                                                        PRTI      160
370             POWSI = QMPY(II)/CFTTOM                                                  PRTI      161
                P2SI = P2(II)*CPSTMP                                                     PRTI      162
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                  TIMEHR = TIME(II)*CHRTDA                                          PRTI      163
                C                                                                   PRTI      164
                  WRITE (6,670) II,TIMEHR,TIME(II),POWSI,QMPY(II),P2SI,P2(II),TW    PRTI      165
375             +   SI,TW(II),GOSI,GO(II)                                           PRTI      166
                C                                                                   PRTI      167
                C                                                                   PRTI      168
                170   CONTINUE                                                      PRTI      169
                C                                                                   PRTI      170
380               IF (IMSWCH.EQ.0) GO TO 180                                        PRTI      171
                C                                                                   PRTI      172
                  CALL PGHEAD (CODEID,MODLOP,TITLE)                                 PRTI      173
                C                                                                   PRTI      174
                  WRITE (6,680)                                                     PRTI      175
385               WRITE (6,690) IMPOWR,IMFUEL,IMDENS,IMRELO,IMCLAD,IMGAPC,IM93WC,IME PRTI      176
                +NRG,IMFGAS                                                         PRTI      177
                C                                                                   PRTI      178
                180   CONTINUE                                                      PRTI      179
                C                                                                   PRTI      180
390               IF (IMPOWR.EQ.1) WRITE (6,700)                                    PRTI      181
                C                                                                   PRTI      182
                  IF (IMFUEL.EQ.1) WRITE (6,710)                                    PRTI      183
                C                                                                   PRTI      184
                  IF (IMDENS.EQ.1) WRITE (6,720)                                    PRTI      185
395             C                                                                   PRTI      186
                  IF (IMRELO.EQ.1) WRITE (6,730)                                    PRTI      187
                C                                                                   PRTI      188
                  IF (IMCLAD.EQ.1) WRITE (6,740)                                    PRTI      189
                C                                                                   PRTI      190
400               IF (IMGAPC.EQ.1) WRITE (6,750)                                    PRTI      191
                C                                                                   PRTI      192
                  IF (IM93WC.EQ.1) WRITE (6,760)                                    PRTI      193
                C                                                                   PRTI      194
                  WRITE (6,770) TREF                                                PRTI      195
405             C                                                                   PRTI      196
                  IF (IMFGAS.EQ.1) WRITE (6,780)                                    PRTI      197
                C                                                                   PRTI      198
                C                                                                   PRTI      199
                  RETURN                                                            PRTI      200
410             C                                                                   PRTI      201
                190   FORMAT (10X,121HXXX
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      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      216
  290  FORMAT (1H ,3X,47H DIAMETRAL GAP THICKNESS,          MM(MILS)    , PRTI      217
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      218
  300  FORMAT (1H ,3X,47H FUEL PELLET DIAMETER,             CM(IN.)     , PRTI      219
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      220
  310  FORMAT (1H ,3X,47H FUEL PELLET LENGTH,               CM(IN.)     , PRTI      221
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      222
  320  FORMAT (1H ,3X,47H FUEL STACK HEIGHT,                M(FT.)      , PRTI      223
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      224
  330  FORMAT (1H ,3X,49H FUEL ENRICHMENT,                  WEIGHT PCT    PRTI      225
     + ,1PE8.2)                                                                 PRTI      226
  340  FORMAT (1H ,3X,47H FUEL PELLET TRUE DENSITY,         PERCENT     , PRTI      227
      +2X,1PE8.2)                                                               PRTI      228
  350  FORMAT (1H ,3X,47H FUEL PELLET DISH DEPTH,           MM(IN.)     , PRTI      229
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      230
  360  FORMAT (1H ,3X,47H FUEL PELLET DISH SHOULDER WIDTH,  MM(IN.)     , PRTI      231
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      232
  370  FORMAT (1H ,3X,47H FUEL PELLET DISH SPERICAL RADIUS, CM(IN.)     , PRTI      233
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      234
  380  FORMAT (1H ,3X,47H FUEL PELLET CORE RADIUS,          MM(IN.)     , PRTI      235
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      236
  390  FORMAT (1H ,3X,47H FUEL ARITHMETIC MEAN ROUGHNESS,   MM(MILS)    , PRTI      237
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      238
  400  FORMAT (1H ,3X,47H CLAD ARITHMETIC MEAN ROUGHNESS,   MM(MILS)    , PRTI      239
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      240
  410  FORMAT (1H ,3X,47H FUEL PELLET SINTERING TEMPERATURE,K(F)        , PRTI      241
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      242
  420  FORMAT (1H ,3X,47H FUEL VOLUME,                      CU.M(CU.IN.), PRTI      243
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      244
  430  FORMAT (1H ,3X,47H FUEL DISH VOLUME FRACTION,                , PRTI      245
      +2X,1PE8.2)                                                               PRTI      246
  440  FORMAT (1H ,3X,47H PLENUM LENGTH,                    CM(IN.)     , PRTI      247
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      248
  450  FORMAT (1H ,3X,47H PLENUM SPRING DIAMETER,           CM(IN.)     , PRTI      249
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      250
  460  FORMAT (1H ,3X,47H PLENUM SPRING WIRE DIAMETER,      MM(IN.)     , PRTI      251
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      252
  470  FORMAT (1H ,3X,47H PLENUM SPRING VOLUME,             CU.M(CU.IN.), PRTI      253
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      254
  480  FORMAT (1H ,3X,47H PLENUM VOLUME,                    CU.M(CU.IN.), PRTI      255
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      256
  490  FORMAT (1H ,3X,47H PLENUM SPRING TURNS,                      , PRTI      257
      +2X,1PE8.2)                                                               PRTI      258
  500  FORMAT (1H ,3X,47H FUEL FISSION ATOMS/100 FISSIONS,          , PRTI      259
      +2X,1PE8.2)                                                               PRTI      260
  510  FORMAT (1H ,3X,47H FUEL WATER CONCENTRATION,         PPM         , PRTI      261
      +2X,1PE8.2)                                                               PRTI      262
  520  FORMAT (1H ,3X,47H FUEL NITROGEN CONCENTRATION,      PPM         , PRTI      263
      +2X,1PE8.2)                                                               PRTI      264
  530  FORMAT (1H ,3X,47H CHANNEL EQUIVALENT DIAMETER,      CM(IN.)     , PRTI      265
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      266
  540  FORMAT (1H ,3X,47H INITIAL BURNUP, MWS/KGU(MWD/MTU)          , PRTI      267
      +2X,1PE8.2,1H(,1PE8.2,1H))                                                PRTI      268
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      550   FORMAT (1H ,3X,47H ROD TOTAL VOID VOLUME,          CU.M(CU.IN.), PRTI      269
     +2X,1PE8.2,1H(,1PE8.2,1H))                                              PRTI      270
480   560   FORMAT (1H ,3X,47H ROD INTERNAL          PRESSURE,MPA(PSIA)   , PRTI      271
     +2X,1PE8.2,1H(,1PE8.2,1H))                                              PRTI      272
      570   FORMAT (1H+,16X,12H   HELIUM   )                                  PRTI      273
      580   FORMAT (1H+,16X,12H     AIR    )                                  PRTI      274
      590   FORMAT (1H+,16X,12H  NITROGEN  )                                  PRTI      275
485   600   FORMAT (1H+,16X,12H FISSION GAS)                                  PRTI      276
      610   FORMAT (1H+,16X,12H    ARGON   )                                  PRTI      277
      620   FORMAT (1H+,16X,12H  MIXED GAS )                                  PRTI      278
      630   FORMAT (1H ,3X,47H ROD CRUD THICKNESS,              MM(MILS)    , PRTI      279
     +2X,1PE8.2,1H(,1PE8.2,1H))                                              PRTI      280
490   640   FORMAT (/,8X,6H AXIAL,3X,13H EQUIV. DIAM.,7X,10H CLAD O.D.,9X,10H PRTI      281
     +CLAD I.D.,8X,10H GAP(DIAM),8X,10H FUEL O.D.,5X,15H INITIAL BURNUP,     PRTI      282
     +/,8X,5H NODE,4X,5H (MM),3X,5H (IN),5X,5H (MM),3X,5H (IN),6X,5H (MM PRTI      283
     +),3X,5H (IN),5X,5H (MM),3X,6H(MILS),4X,5H (MM),3X,5H (IN),3X,7H MW PRTI      284
     +S/KG,3X,8H MWD/MTU,/)                                                  PRTI      285
495   650   FORMAT (10X,I2,5X,3(F6.2,2X,F6.4,4X)F6.3,2X,F6.2,4X,F6.2,2X,F6.4,3 PRTI      286
     +X,1PE9.3,2X,1PE9.3)                                                    PRTI      287
      660   FORMAT (/,4X,11H POWER-TIME,7X,5H TIME,16X,6H POWER,10X,17H COOLAN PRTI      288
     +T PRESSURE,3X,20H COOLANT INLET TEMP.,6X,18H COOLANT MASS FLUX,/,7     PRTI      289
     +X,5H STEP,4X,6H (HRS),4X,7H (DAYS),5X,7H (KW/M),2X,8H (KW/FT),5X,6    PRTI      290
500  +H (MPA),2X,7H (PSIA),7X,4H (K),5X,4H (F),5X,12H (KG/S-M**2),2X,13H PRTI      291
     + (LBM/HR-FT2),/)                                                       PRTI      292
      670   FORMAT (1H ,6X,I3,5X,F8.1,3X,F7.2,5X,F7.2,3X,F6.2,6X,F6.2,3X,F6.0, PRTI      293
     +6X,F6.0,3X,F6.0,7X,F7.0,5X,F9.0)                                       PRTI      294
      680   FORMAT (//,30X,46H THE USER HAS SPECIFIED THAT THE FOLLOWING SET,/ PRTI      295
505  +,30X,41H OF EVALUATION MODELS WILL BE USED IN THE,/,30X,45H ANALYS PRTI      296
     +IS OF THIS FUEL ROD , = 0 IS OFF , = 1,8H IS ON. ,//)                  PRTI      297
      690   FORMAT (1H ,54X,10H IMPOWR = ,I1,/,,55X,10H IMFUEL = ,I1,/,,55X,10 PRTI      298
     +H IMDENS = ,I1,/,,55X,10H IMRELO = ,I1,/,,55X,10H IMCLAD = ,I1,/,,    PRTI      299
     +55X,10H IMGAPC = ,I1,/,,55X,10H IM93WC = ,I1,/,,55X,10H IMENRG = ,    PRTI      300
510  +I1,/,,55X,10H IMFGAS = ,I1)                                            PRTI      301
      700   FORMAT (1H ,/,11X,42H THE INPUT POWER IS ASSUMED TO BE BASED ON,37 PRTI      302
     +H CONTINUOUS OPERATION AT MAXIMUM CORE,38H POWER WITH MAXIMUM PEAK    PRTI      303
     +ING FACTOR AND,/,11X,42H APPROPRIATE UNCERTAINTIES CONSIDERED.  NO    PRTI      304
     +,40H CREDIT IS ASSUMED FOR GAMMA HEATING AND,16H GAMMA SMEARING./)    PRTI      305
515   710   FORMAT (1H ,10X,39H FUEL DEMENSIONAL CHANGES CONSIDER FUEL,44H SWE PRTI      306
     +LLING, DENSIFICATION, THERMAL EXPANSION,,35H AND RELOCATION. FUEL     PRTI      307
     +IS CONSIDERED,/,11X,39H INCOMPRESSIBLE FOR MECHANICAL RESPONSE,14H    PRTI      308
     + CALCULATIONS./)                                                       PRTI      309
      720   FORMAT (1H ,10X,40H THE FUEL DENSIFICATION IS CALCULATED AS,37H SP PRTI      310
520  +ECIFIED IN REGULATORY GUIDE 1.126./)                                   PRTI      311
      730   FORMAT (1H ,10X,37H THE FUEL RELOCATION IS CALCULATED AS,25H SPECI PRTI      312
     +FIED IN BNWL-1898. /)                                                  PRTI      313
      740   FORMAT (1H ,10X,43H CLADDING DIMENSIONAL CHANGES CONSIDER ONLY,43H PRTI      314
     + THERMAL EXPANSION AND ELASTIC DEFORMATION.,/)                         PRTI      315
525   750   FORMAT (1H ,10X,44H GAP CONDUCTANCE IS BASED ON UNIFORM ANNULAR,35 PRTI      316
     +H GAP MODEL WITH NO CREDIT GIVEN FOR,22H INTERFACIAL PRESSURE./)       PRTI      317
      760   FORMAT (1H ,10X,37H THE THERMAL CONDUCTIVITY OF THE FUEL,38H IS BA PRTI      318
     +SED ON TEMPERATURE AND UNCRACKED,15H LOCAL DENSITY./)                  PRTI      319
      770   FORMAT (1H ,10X,35H THE STORED ENERGY IS NORMALIZED TO,F7.2,10H DE PRTI      320
530  +GREES F,/)                                                             PRTI      321
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      780   FORMAT (1H ,10X,38H THE FISSION GAS RELEASE CONFORMS WITH,12H NURE PRTI      322
     +G-0418.)                                                                PRTI      323
            END                                                               PRTI      324
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	PRINTI	1	409

VARIABLES	SN	TYPE		RELOCATION			
0	A	REAL	ARRAY	FAST	REFS	9	226
0	AAA	REAL	ARRAY	REALS	REFS	110	
0	AAHA	REAL	ARRAY	MATCNS	REFS	202	
24	AAN	REAL		REALS	REFS	110	
0	ACOR	REAL		INPTR	REFS	156	
1	AFAL	REAL		INPTR	REFS	156	
2	AFCR	REAL		INPTR	REFS	156	
3	AFDN	REAL		INPTR	REFS	156	
4	AFGR	REAL		INPTR	REFS	156	
5	AFSW	REAL		INPTR	REFS	156	
6	AFTC	REAL		INPTR	REFS	156	
7	AGPC	REAL		INPTR	REFS	156	
25	AIRIN	REAL		REALS	REFS	110	
10	AMFAIR	REAL		INPTR	REFS	156	
11	AMFARG	REAL		INPTR	REFS	156	
12	AMFFG	REAL		INPTR	REFS	156	
13	AMFHE	REAL		INPTR	REFS	156	
14	AMFH2	REAL		INPTR	REFS	156	
15	AMFH2O	REAL		INPTR	REFS	156	
16	AMFKRY	REAL		INPTR	REFS	156	
17	AMFN2	REAL		INPTR	REFS	156	
20	AMFXE	REAL		INPTR	REFS	156	
26	AMGP	REAL	ARRAY	REALS	REFS	110	
30	AMGPH	REAL	ARRAY	REALS	REFS	110	
32	AMGR	REAL	ARRAY	REALS	REFS	110	
34	AMGRH	REAL	ARRAY	REALS	REFS	110	
36	AMGRN2	REAL	ARRAY	REALS	REFS	110	
40	AMWDT	REAL		REALS	REFS	110	
41	ANGI	REAL		REALS	REFS	110	
42	ANGT	REAL		REALS	REFS	110	
2555	ANRIN	REAL		INPTR	REFS	156	
43	AN2IN	REAL		REALS	REFS	110	
44	ARGIN	REAL		REALS	REFS	110	
45	ARING	REAL		REALS	REFS	110	
46	AVGQI	REAL	ARRAY	REALS	REFS	110	
56	B	REAL	ARRAY	REALS	REFS	110	
64	BP	REAL		REALS	REFS	110	
65	BPP	REAL		REALS	REFS	110	
66	BR	REAL	ARRAY	REALS	REFS	110	

VARIABLES	SN	TYPE		RELOCATION								
74	BU	REAL		REALS	REFS	110						
21	BUIN	REAL	ARRAY	INPTR	REFS	156	269	2*331	342	350		
2353	BUINSI	REAL			REFS	331	350	DEFINED	269	342		
75	BUOLD	REAL		REALS	REFS	110						
10	BUP	REAL		PHYPRO	REFS	209						
47	CATEXF	REAL		INPTR	REFS	156						
76	CDG	REAL		REALS	REFS	110	289	299				
2376	CDGSI	REAL			REFS	299	DEFINED	289				
606	CFTTOM	REAL			REFS	276	370	DEFINED	244			
77	CFV	REAL		REALS	REFS	110	280	308				
100	CFVA	REAL		REALS	REFS	110						
2366	CFVSI	REAL			REFS	308	DEFINED	280				
3	CHEFUS	REAL		PHYPRO	REFS	209						
601	CHRTDA	REAL			REFS	372	DEFINED	242				
602	CINTCM	REAL			REFS	270	271	272	273	275	277	282
					283	DEFINED	242					
600	CINTMM	REAL			REFS	266	267	268	278	279	286	288
					289	290	343	344	345	346	348	
					DEFINED	242						
605	CINTOM	REAL			REFS	263	DEFINED	244				
2345	CI3TM3	REAL			REFS	280	281	284	285	DEFINED	263	
607	CKSTPH	REAL			REFS	368	DEFINED	244				
50	CLDWKD	REAL		INPTR	REFS	156						
2556	CLDWKS	REAL		INPTR	REFS	156						
601	CLOS	REAL		REALS	REFS	134						
603	CMDTMS	REAL			REFS	269	342	DEFINED	243			
101	CMOL	REAL		REALS	REFS	110						
102	CODEID	REAL	ARRAY	REALS	REFS	110	247	355	364	382		
606	COLDWK	REAL		REALS	REFS	134						
11	COMP	REAL		PHYPRO	REFS	209	259	261				
121	CONVC	REAL		REALS	REFS	110						
122	CONVER	REAL	ARRAY	REALS	REFS	110						
2557	CP	REAL		INPTR	REFS	156						
51	CPL	REAL		INPTR	REFS	156	282	316				
2370	CPLSI	REAL			REFS	316	DEFINED	282				
604	CPSTMP	REAL			REFS	274	371	DEFINED	243			
134	CPV	REAL		REALS	REFS	110	284	320				
2372	CPVSI	REAL			REFS	320	DEFINED	284				
2560	CR	REAL		INPTR	REFS	156						
52	CRDT	REAL		INPTR	REFS	156	290	2*330				
53	CRDTR	REAL		INPTR	REFS	156	251					
2377	CRDTSI	REAL			REFS	330	DEFINED	290				
135	CRDTT	REAL		REALS	REFS	110						
2554	CREPHR	REAL		INPTR	REFS	156						
136	CRN	REAL		REALS	REFS	110						
54	CTMAX	REAL	ARRAY	INPTR	REFS	156						
2	CTMELT	REAL		PHYPRO	REFS	209						
4	CTRANB	REAL		PHYPRO	REFS	209						
5	CTRANE	REAL		PHYPRO	REFS	209						
6	CTRANZ	REAL		PHYPRO	REFS	209						
137	CVV	REAL		REALS	REFS	110	285	322				
2373	CVVSI	REAL			REFS	322	DEFINED	285				
604	CWKF	REAL		REALS	REFS	134						

VARIABLES	SN	TYPE		RELOCATION								
605	CWNF	REAL		REALS	REFS	134						
102	DCI	REAL	ARRAY	INPTR	REFS	156	271	287	296	345	347	350
140	DCIH	REAL		REALS	REFS	110						
141	DCIHP	REAL		REALS	REFS	110						
2355	DCISI	REAL			REFS	296	350	DEFINED	271	345		
130	DCO	REAL	ARRAY	INPTR	REFS	156	270	287	295	344	350	
2354	DCOSI	REAL			REFS	295	350	DEFINED	270	344		
156	DE	REAL	ARRAY	INPTR	REFS	156	273	332	343	350		
142	DELBP	REAL		REALS	REFS	110						
143	DELBU	REAL		REALS	REFS	110						
144	DELH	REAL		REALS	REFS	110						
12	DELOXY	REAL		PHYPRO	REFS	209						
145	DELT	REAL		REALS	REFS	110						
204	DELTAZ	REAL	ARRAY	INPTR	REFS	156						
146	DELTCR	REAL		REALS	REFS	110						
147	DELTDB	REAL		REALS	REFS	110						
150	DELTFC	REAL		REALS	REFS	110						
151	DELTJL	REAL		REALS	REFS	110						
232	DEN	REAL		INPTR	REFS	156	307					
233	DENG	REAL		INPTR	REFS	156						
2357	DESI	REAL			REFS	332	350	DEFINED	273	343		
152	DHIC	REAL		REALS	REFS	110						
607	DISH	REAL		REALS	REFS	134						
234	DISHSD	REAL		INPTR	REFS	156	268	303				
153	DLREL	REAL		REALS	REFS	110						
154	DLRJD	REAL		REALS	REFS	110						
155	DLRGC	REAL	ARRAY	REALS	REFS	110						
235	DP	REAL	ARRAY	INPTR	REFS	156	272	300	346	347	350	
207	DPH	REAL		REALS	REFS	110						
210	DPHF	REAL		REALS	REFS	110						
211	DPHFP	REAL		REALS	REFS	110						
2356	DPSI	REAL			REFS	300	350	DEFINED	272	346		
212	DPWP	REAL		REALS	REFS	110						
213	DRS	REAL		REALS	REFS	110						
263	DSPG	REAL		INPTR	REFS	156	283	317				
2371	DSPGSI	REAL			REFS	317	DEFINED	283				
264	DSPGW	REAL		INPTR	REFS	156	286	318				
2374	DSPGWS	REAL			REFS	318	DEFINED	286				
0	DVHPRS	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
0	ECREP2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	205						
265	ENRCH	REAL		INPTR	REFS	156	312					
214	ENRICH	REAL		REALS	REFS	110						
215	EOLSR	REAL		REALS	REFS	110						
0	EPP2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
0	EPS0	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
0	EPS02	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
0	EPS22	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
0	EP2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1				
266	EXO	REAL		INPTR	REFS	156						
267	FA	REAL		INPTR	REFS	156						
216	FC	REAL	ARRAY	REALS	REFS	110						
7	FDELTA	REAL		PHYPRO	REFS	209						

VARIABLES	SN	TYPE		RELOCATION						
217	FGIN	REAL		REALS	REFS	110				
270	FGPAV	REAL		INPTR	REFS	156	274	323		
220	FGPAVP	REAL		REALS	REFS	110				
2360	FGPAVS	REAL			REFS	323	DEFINED	274		
221	FGPAVX	REAL		REALS	REFS	121				
1	FHEFUS	REAL		PHYPRO	REFS	209				
222	FH2O	REAL		REALS	REFS	121				
223	FJJ	REAL	ARRAY	REALS	REFS	121				
225	FJJH	REAL	ARRAY	REALS	REFS	121				
271	FLUX	REAL		INPTR	REFS	156				
272	FLXDP	REAL		INPTR	REFS	156				
227	FMGP	REAL	ARRAY	REALS	REFS	121				
602	FNCK	REAL		REALS	REFS	134				
603	FNCN	REAL		REALS	REFS	134				
2552	FOTMTL	REAL		INPTR	REFS	156				
231	FPOR	REAL		REALS	REFS	121				
232	FPORI	REAL		REALS	REFS	121				
273	FQE	REAL		INPTR	REFS	156				
233	FRD	REAL		REALS	REFS	121				
234	FRDH	REAL		REALS	REFS	121				
235	FRDN	REAL		REALS	REFS	121				
0	FTMELT	REAL		PHYPRO	REFS	209				
0	FVFRO	REAL	ARRAY	F.P.	REFS	231	DEFINED	1		
236	G	REAL		REALS	REFS	121				
0	GAP2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1		
237	GASES	REAL	ARRAY	REALS	REFS	121				
246	GASIN	REAL		REALS	REFS	121				
247	GDEN	REAL		REALS	REFS	121				
274	GO	REAL	ARRAY	INPTR	REFS	156	368	374		
2407	GOSI	REAL			REFS	374	DEFINED	368		
2403	GP	REAL			REFS	348	349	DEFINED	347	
2405	GPMIL	REAL			REFS	350	DEFINED	349		
2404	GPSI	REAL			REFS	350	DEFINED	348		
250	GPTH	REAL	ARRAY	REALS	REFS	121				
302	GPTHE	REAL	ARRAY	REALS	REFS	121				
334	GPTHM	REAL		REALS	REFS	121				
335	GPTHP	REAL		REALS	REFS	121				
336	GPTHPG	REAL	ARRAY	REALS	REFS	121				
370	GR	REAL		REALS	REFS	121				
441	GRNSIZ	REAL		INPTR	REFS	156				
371	HCRV	REAL		REALS	REFS	121				
372	HCV	REAL		REALS	REFS	121				
442	HDISH	REAL		INPTR	REFS	156	278	302		
2364	HDISHS	REAL			REFS	302	DEFINED	278		
373	HDSHV	REAL		REALS	REFS	121				
374	HEIN	REAL		REALS	REFS	121				
375	HFLL	REAL		REALS	REFS	121				
376	HFLMDB	REAL		REALS	REFS	121				
377	HFLMP	REAL		REALS	REFS	121				
400	HFPER	REAL		REALS	REFS	121				
401	HFV	REAL		REALS	REFS	121				
410	HGAP	REAL		REALS	REFS	121				
412	HGAPR	REAL		REALS	REFS	121				

VARIABLES	SN	TYPE		RELOCATION								
402	HGAPT	REAL		REALS	REFS	121						
403	HGV	REAL		REALS	REFS	121						
404	HI	REAL		REALS	REFS	121						
405	HMGP	REAL	ARRAY	REALS	REFS	121						
407	HP	REAL		REALS	REFS	121						
413	HPL	REAL		REALS	REFS	121						
443	HPLT	REAL		INPTR	REFS	156	275	301				
2361	HPLTSI	REAL			REFS	301	DEFINED	275				
414	HPORV	REAL		REALS	REFS	121						
415	HPV	REAL		REALS	REFS	121						
411	HSOLID	REAL		REALS	REFS	121						
416	HUPTAK	REAL		REALS	REFS	121						
417	H2OMI	REAL		REALS	REFS	121						
2401	I	INTEGER			REFS	340	342	343	344	345	346	2*347
					5*350	362	364	365	DEFINED	339	361	
275	IAXSYM	INTEGER		INPTI	REFS	175						
270	ICFAC	INTEGER		POINT	REFS	102						
302	ICFCSV	INTEGER		POINT	REFS	102						
24	ICLOSE	INTEGER		INTEG	REFS	148						
0	ICM	INTEGER		INPTI	REFS	175	293	294				
1	ICOR	INTEGER		INPTI	REFS	175	251					
2	IDBG	INTEGER		INPTI	REFS	175						
271	IDG	INTEGER		POINT	REFS	102						
272	IDGSAV	INTEGER		POINT	REFS	102						
3	IDXGAS	INTEGER		INPTI	REFS	175	324	325	326	327	328	329
0	IGAP2	INTEGER	ARRAY	F.P.	REFS	231	DEFINED	1				
303	IHLDN	INTEGER		POINT	REFS	102						
2402	II	INTEGER			REFS	350	368	369	370	371	372	6*374
					DEFINED	340	362					
4	IM	INTEGER		INPTI	REFS	175	360					
4	IMCLAD	INTEGER		EMFLGS	REFS	189	385	398				
2	IMDENS	INTEGER		EMFLGS	REFS	189	385	394				
23	IMDONE	INTEGER		INTEG	REFS	148						
7	IMENRG	INTEGER		EMFLGS	REFS	189	385					
10	IMFGAS	INTEGER		EMFLGS	REFS	189	385	406				
1	IMFUEL	INTEGER		EMFLGS	REFS	189	385	392				
5	IMGAPC	INTEGER		EMFLGS	REFS	189	385	400				
0	IMPOWR	INTEGER		EMFLGS	REFS	189	385	390				
2406	IMPI	INTEGER			REFS	361	DEFINED	360				
3	IMRELO	INTEGER		EMFLGS	REFS	189	385	396				
11	IMSWCH	INTEGER		EMFLGS	REFS	189	380					
6	IM93WC	INTEGER		EMFLGS	REFS	189	385	402				
5	IPLANT	INTEGER		INPTI	REFS	175	253	254				
304	IPLSTC	INTEGER		POINT	REFS	102						
273	IPRG	INTEGER		POINT	REFS	102						
6	IQ	INTEGER		INPTI	REFS	175						
0	IQUIT	INTEGER		INTEG	REFS	148						
264	IRDOT	INTEGER		POINT	REFS	97						
1	IRI	INTEGER		INTEG	REFS	148						
265	ISAVGS	INTEGER		POINT	REFS	97						
305	ISTRNN	INTEGER		POINT	REFS	102						
306	ISTRSS	INTEGER		POINT	REFS	102						
7	ISW	INTEGER		INPTI	REFS	175						

VARIABLES	SN	TYPE		RELOCATION								
2	IT	INTEGER		INTEG	REFS	148						
300	ITCL	INTEGER		POINT	REFS	102						
277	ITEMP	INTEGER		POINT	REFS	102						
3	ITER	INTEGER		INTEG	REFS	148						
301	ITFS	INTEGER		POINT	REFS	102						
276	ITRAMP	INTEGER		POINT	REFS	102						
300	ITREST	INTEGER		INPTI	REFS	175						
276	IVARDM	INTEGER		INPTI	REFS	175	295	296	297	299	300	331
						332	335					
274	IVFC	INTEGER		POINT	REFS	102						
275	IVFF	INTEGER		POINT	REFS	102						
302	IWORDS	INTEGER		INPTI	REFS	175						
267	IX	INTEGER		POINT	REFS	97						
4	J	INTEGER		INTEG	REFS	148						
10	JDLPR	INTEGER		INPTI	REFS	175						
5	JJC	INTEGER		INTEG	REFS	148						
11	JN	INTEGER	ARRAY	INPTI	REFS	175						
6	JPEAK	INTEGER		INTEG	REFS	148						
21	JST	INTEGER	ARRAY	INPTI	REFS	175						
7	K	INTEGER		INTEG	REFS	148						
10	KINDOR	INTEGER		INTEG	REFS	148						
11	KOXI	INTEGER		INTEG	REFS	148						
420	KRYIN	REAL		REALS	REFS	7	121					
216	LACE	INTEGER	ARRAY	INPTI	REFS	175						
215	LACMFG	INTEGER		POINT	REFS	81						
216	LACMHE	INTEGER		POINT	REFS	81						
217	LACMH2	INTEGER		POINT	REFS	81						
220	LACMN2	INTEGER		POINT	REFS	81						
215	LACMOD	INTEGER		INPTI	REFS	175						
152	LAK1	INTEGER		POINT	REFS	52						
153	LAK2	INTEGER		POINT	REFS	52						
221	LAMGPT	INTEGER		POINT	REFS	81						
125	LANG	INTEGER		POINT	REFS	38						
120	LANGR	INTEGER		POINT	REFS	38						
253	LANSD	INTEGER		POINT	REFS	91						
256	LANSR	INTEGER		POINT	REFS	91						
14	LARAD	INTEGER		POINT	REFS	19						
10	LAXGAP	INTEGER		POINT	REFS	19						
11	LAXLEN	INTEGER		POINT	REFS	19						
210	LB	INTEGER		POINT	REFS	71						
211	LBR	INTEGER		POINT	REFS	71						
212	LBTOLD	INTEGER		POINT	REFS	71						
12	LBU1	INTEGER		POINT	REFS	19						
13	LBU2	INTEGER		POINT	REFS	19						
172	LCC1	INTEGER		POINT	REFS	64						
173	LCC2	INTEGER		POINT	REFS	64						
213	LCHEM	INTEGER		POINT	REFS	71						
15	LCPDLT	INTEGER		POINT	REFS	19						
2	LCREP1	INTEGER		POINT	REFS	19						
154	LCRL	INTEGER		POINT	REFS	52						
111	LDCHCK	INTEGER		POINT	REFS	19						
0	LDCIH	INTEGER		POINT	REFS	19						
261	LDECAY	INTEGER		POINT	REFS	91						

VARIABLES	SN	TYPE	RELOCATION		
16	LDELBP	INTEGER	POINT	REFS	19
17	LDENMX	INTEGER	POINT	REFS	19
174	LDENSF	INTEGER	POINT	REFS	64
175	LDENSP	INTEGER	POINT	REFS	64
3	LDLH	INTEGER	POINT	REFS	19
20	LDLPGE	INTEGER	POINT	REFS	19
155	LDPL	INTEGER	POINT	REFS	52
156	LDPLH	INTEGER	POINT	REFS	52
157	LDPN	INTEGER	POINT	REFS	52
176	LDPW	INTEGER	POINT	REFS	64
177	LDPWPP	INTEGER	POINT	REFS	64
260	LDT	INTEGER	POINT	REFS	91
21	LDZ	INTEGER	POINT	REFS	19
22	LDZH	INTEGER	POINT	REFS	19
23	LDZHP	INTEGER	POINT	REFS	19
24	LECREP	INTEGER	POINT	REFS	19
25	LEP	INTEGER	POINT	REFS	19
127	LEPP	INTEGER	POINT	REFS	44
130	LEPPP	INTEGER	POINT	REFS	44
131	LEPPSV	INTEGER	POINT	REFS	44
147	LEPPI	INTEGER	POINT	REFS	44
132	LEPS	INTEGER	POINT	REFS	44
133	LEPSAV	INTEGER	POINT	REFS	44
151	LEPSI	INTEGER	POINT	REFS	44
100	LEPI	INTEGER	POINT	REFS	19
167	LF	INTEGER	POINT	REFS	59
134	LFEPS	INTEGER	POINT	REFS	44
257	LFF	INTEGER	POINT	REFS	91
121	LFGMGP	INTEGER	POINT	REFS	38
170	LFH	INTEGER	POINT	REFS	59
110	LFLAG	INTEGER	POINT	REFS	19
254	LFLXFC	INTEGER	POINT	REFS	91
160	LFMA	INTEGER	POINT	REFS	52
161	LFMGPR	INTEGER	POINT	REFS	52
122	LFMGR	INTEGER	POINT	REFS	38
171	LFN	INTEGER	POINT	REFS	59
26	LGAP	INTEGER	POINT	REFS	19
222	LGASMO	INTEGER	POINT	REFS	81
200	LGNSIZ	INTEGER	POINT	REFS	64
27	LGPTP	INTEGER	POINT	REFS	19
4	LHA	INTEGER	POINT	REFS	19
262	LHALF	INTEGER	POINT	REFS	91
30	LHCOEF	INTEGER	POINT	REFS	19
123	LHEMGP	INTEGER	POINT	REFS	38
101	LHGAPS	INTEGER	POINT	REFS	19
114	LHGPC	INTEGER	POINT	REFS	19
115	LHGPR	INTEGER	POINT	REFS	19
116	LHGPS	INTEGER	POINT	REFS	19
5	LHL	INTEGER	POINT	REFS	19
223	LHMGPT	INTEGER	POINT	REFS	81
124	LHMGR	INTEGER	POINT	REFS	38
162	LHRL	INTEGER	POINT	REFS	52
103	LIGAP	INTEGER	POINT	REFS	19

VARIABLES	SN	TYPE	RELOCATION		
12	LMN	INTEGER	INTEG	REFS	148
106	LNFAIL	INTEGER	POINT	REFS	19
146	LNUDEP	INTEGER	POINT	REFS	44
31	LOLAXG	INTEGER	POINT	REFS	19
32	LOLDPC	INTEGER	POINT	REFS	19
33	LOLDPG	INTEGER	POINT	REFS	19
34	LOLDTC	INTEGER	POINT	REFS	19
35	LOLDUR	INTEGER	POINT	REFS	19
36	LOLEPS	INTEGER	POINT	REFS	19
37	LOLFEP	INTEGER	POINT	REFS	19
104	LOLIGP	INTEGER	POINT	REFS	19
40	LPAXGP	INTEGER	POINT	REFS	19
41	LPC	INTEGER	POINT	REFS	19
42	LPECRP	INTEGER	POINT	REFS	19
43	LPEP	INTEGER	POINT	REFS	19
135	LPEPSV	INTEGER	POINT	REFS	44
255	LPF	INTEGER	POINT	REFS	91
136	LPFPSV	INTEGER	POINT	REFS	44
44	LPG	INTEGER	POINT	REFS	19
45	LPINT	INTEGER	POINT	REFS	19
224	LPIT	INTEGER	POINT	REFS	81
46	LPLDPC	INTEGER	POINT	REFS	19
47	LPLDPG	INTEGER	POINT	REFS	19
50	LPLDTC	INTEGER	POINT	REFS	19
51	LPLDUR	INTEGER	POINT	REFS	19
107	LPLIGP	INTEGER	POINT	REFS	19
52	LPOAXG	INTEGER	POINT	REFS	19
53	LPOFEP	INTEGER	POINT	REFS	19
54	LPOLEP	INTEGER	POINT	REFS	19
6	LPOROS	INTEGER	POINT	REFS	19
201	LPORS1	INTEGER	POINT	REFS	64
202	LPORS2	INTEGER	POINT	REFS	64
225	LPRT10	INTEGER	POINT	REFS	81
226	LPRT11	INTEGER	POINT	REFS	81
227	LPRT12	INTEGER	POINT	REFS	81
230	LPRT13	INTEGER	POINT	REFS	81
231	LPRT14	INTEGER	POINT	REFS	81
232	LPRT15	INTEGER	POINT	REFS	81
233	LPRT16	INTEGER	POINT	REFS	81
234	LPRT17	INTEGER	POINT	REFS	81
235	LPRT18	INTEGER	POINT	REFS	81
236	LPRT2	INTEGER	POINT	REFS	81
237	LPRT20	INTEGER	POINT	REFS	81
240	LPRT3	INTEGER	POINT	REFS	81
241	LPRT4	INTEGER	POINT	REFS	81
242	LPRT5	INTEGER	POINT	REFS	81
243	LPRT6	INTEGER	POINT	REFS	81
244	LPRT7	INTEGER	POINT	REFS	81
245	LPRT8	INTEGER	POINT	REFS	81
246	LPRT9	INTEGER	POINT	REFS	81
214	LQ	INTEGER	POINT	REFS	76
105	LQDP	INTEGER	POINT	REFS	19
206	LR	INTEGER	POINT	REFS	64

VARIABLES	SN	TYPE	RELOCATION		
207	LRAD	INTEGER	POINT	REFS	64
55	LRDCOL	INTEGER	POINT	REFS	19
137	LREPS	INTEGER	POINT	REFS	44
141	LREPSP	INTEGER	POINT	REFS	44
140	LREPSV	INTEGER	POINT	REFS	44
126	LREPS2	INTEGER	POINT	REFS	38
143	LRFEPP	INTEGER	POINT	REFS	44
142	LRFEPS	INTEGER	POINT	REFS	44
144	LRFPSV	INTEGER	POINT	REFS	44
263	LRLEAS	INTEGER	POINT	REFS	91
113	LRTRNO	INTEGER	POINT	REFS	19
112	LRTRNP	INTEGER	POINT	REFS	19
145	LSIG	INTEGER	POINT	REFS	44
150	LSIGI	INTEGER	POINT	REFS	44
266	LSTHIF	INTEGER	POINT	REFS	97
247	LTAC	INTEGER	POINT	REFS	81
56	LTAF	INTEGER	POINT	REFS	19
250	LTAFA	INTEGER	POINT	REFS	81
57	LTAG	INTEGER	POINT	REFS	19
251	LTAGA	INTEGER	POINT	REFS	81
60	LTBAR	INTEGER	POINT	REFS	19
61	LTBLK	INTEGER	POINT	REFS	19
62	LTCA	INTEGER	POINT	REFS	19
63	LTCIDI	INTEGER	POINT	REFS	19
64	LTCODI	INTEGER	POINT	REFS	19
163	LTFB	INTEGER	POINT	REFS	52
164	LTFR	INTEGER	POINT	REFS	52
165	LTFRK	INTEGER	POINT	REFS	52
203	LTMPDS	INTEGER	POINT	REFS	64
205	LTMPMX	INTEGER	POINT	REFS	64
117	LTOXO	INTEGER	POINT	REFS	19
65	LTPS	INTEGER	POINT	REFS	19
102	LTRTRN	INTEGER	POINT	REFS	19
252	LTSF	INTEGER	POINT	REFS	81
7	LUFS	INTEGER	POINT	REFS	19
204	LUO2LL	INTEGER	POINT	REFS	64
1	LURC	INTEGER	POINT	REFS	19
66	LURF	INTEGER	POINT	REFS	19
67	LVCH	INTEGER	POINT	REFS	19
70	LVCHI	INTEGER	POINT	REFS	19
71	LVCR	INTEGER	POINT	REFS	19
72	LVDH	INTEGER	POINT	REFS	19
73	LVFH	INTEGER	POINT	REFS	19
74	LVGH	INTEGER	POINT	REFS	19
166	LVPL	INTEGER	POINT	REFS	52
75	LVPOR	INTEGER	POINT	REFS	19
76	LZRO2A	INTEGER	POINT	REFS	19
77	LZRO2B	INTEGER	POINT	REFS	19
13	M	INTEGER	INTEG	REFS	148
0	MAXIDX	INTEGER	LACMDL	REFS	205
166	MDBG	INTEGER	INPTI	REFS	175
15	MDHPRS	INTEGER	PFRC52	REFS	195
271	MECHAN	INTEGER	INPTI	REFS	175

VARIABLES	SN	TYPE		RELOCATION							
20	MEPP2	INTEGER		PFRCS2	REFS	195					
24	MEPS0	INTEGER		PFRCS2	REFS	195					
22	MEPS02	INTEGER		PFRCS2	REFS	195					
17	MEPS22	INTEGER		PFRCS2	REFS	195					
11	MEP2	INTEGER		PFRCS2	REFS	195					
10	MEREP2	INTEGER		PFRCS2	REFS	195					
14	MFVFR0	INTEGER		PFRCS2	REFS	195					
2	MGAP2	INTEGER		PFRCS2	REFS	195					
3	MIGAP2	INTEGER		PFRCS2	REFS	195					
0	MNA	INTEGER		F.P.	REFS	21*231	DEFINED	1			
0	MNR	INTEGER		F.P.	REFS	14*231	DEFINED	1			
170	MODE	INTEGER		INPTI	REFS	175					
171	MODES	INTEGER		INPTI	REFS	175					
14	MODLOP	INTEGER		INTEG	REFS	148	247	355	364	382	
1	MODPC2	INTEGER		PFRCS2	REFS	195					
0	MODPG2	INTEGER		PFRCS2	REFS	195					
4	MOIGP2	INTEGER		PFRCS2	REFS	195					
13	MOLDT2	INTEGER		PFRCS2	REFS	195					
23	MPEPP2	INTEGER		PFRCS2	REFS	195					
6	MPEPS2	INTEGER		PFRCS2	REFS	195					
16	MPEP2	INTEGER		PFRCS2	REFS	195					
5	MREPS2	INTEGER		PFRCS2	REFS	195					
12	MR22	INTEGER		PFRCS2	REFS	195					
21	MSIG2	INTEGER		PFRCS2	REFS	195					
172	MTAPE	INTEGER		INPTI	REFS	175					
7	MTTT	INTEGER		PFRCS2	REFS	195					
266	NA	INTEGER		INPTI	REFS	175	339				
15	NAB	INTEGER		INTEG	REFS	148					
233	NAFAIL	INTEGER		INPTI	REFS	175					
27	NC	INTEGER		INTEG	REFS	148					
272	NCRACK	INTEGER		INPTI	REFS	175					
274	NCREEP	INTEGER		INPTI	REFS	175					
173	NDBG	INTEGER		INPTI	REFS	175					
273	NELAST	INTEGER		INPTI	REFS	175					
270	NEWPRB	INTEGER		INPTI	REFS	175					
26	NF	INTEGER		INTEG	REFS	148					
174	NFROD	INTEGER		INPTI	REFS	175					
175	NGAPC	INTEGER		INPTI	REFS	175					
176	NGASR	INTEGER		INPTI	REFS	175					
167	NHEAL	INTEGER		INPTI	REFS	175					
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	175					
25	NNNCRP	INTEGER		PFRCS2	REFS	195					
177	NOFAIL	INTEGER		INPTI	REFS	175					
277	NOFRAC	INTEGER		INPTI	REFS	175					
200	NOPT	INTEGER		INPTI	REFS	175					
201	NPCYCL	INTEGER		INPTI	REFS	175					
16	NPLAST	INTEGER		INTEG	REFS	148					
263	NPLOT	INTEGER		INPTI	REFS	175					
202	NPLTAB	INTEGER		INPTI	REFS	175					
304	NPRINT	INTEGER		INPTI	REFS	175					
267	NR	INTEGER		INPTI	REFS	175					
203	NREAD	INTEGER		INPTI	REFS	175					
204	NRESTR	INTEGER		INPTI	REFS	175					

VARIABLES SN TYPE RELOCATION

17	NRMI	INTEGER		INTEG	REFS	148			
265	NROD	INTEGER		INPTI	REFS	175			
205	NROLL	INTEGER		INPTI	REFS	175			
25	NSH	INTEGER		INTEG	REFS	148			
206	NSP	INTEGER		INPTI	REFS	175			
207	NSTART	INTEGER		INPTI	REFS	175			
20	NSTEP	INTEGER		INTEG	REFS	148			
210	NSTOP	INTEGER		INPTI	REFS	175			
211	NT	INTEGER		INPTI	REFS	175			
212	NTAPE	INTEGER		INPTI	REFS	175			
264	NTPLOT	INTEGER		INPTI	REFS	175			
421	NU	REAL		REALS	REFS	7	121		
213	NUCFC	INTEGER		INPTI	REFS	175			
214	NUNITS	INTEGER		INPTI	REFS	175			
301	NWORDS	INTEGER		INPTI	REFS	175			
303	NWRDS	INTEGER		INPTI	REFS	175			
21	NWRITE	INTEGER		INTEG	REFS	148			
262	NXP	INTEGER		INPTI	REFS	175			
22	N2	INTEGER		INTEG	REFS	148			
0	OLDPC2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
0	OLDPG2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
0	OLDT2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
0	OLIGP2	INTEGER	ARRAY	F.P.	REFS	230	231	DEFINED	1
422	OXDROP	REAL		REALS	REFS	121			
423	OXIDE	REAL		REALS	REFS	121			
424	PECDH	REAL		REALS	REFS	121	311		
0	PEPP2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
0	PEP2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
425	PI	REAL		REALS	REFS	121			
426	PIN	REAL	ARRAY	REALS	REFS	121			
460	PINP	REAL		REALS	REFS	121			
461	PORO	REAL		REALS	REFS	121			
2411	POWSI	REAL			REFS	374	DEFINED	370	
444	PPMH20	REAL		INPTR	REFS	156	314		
445	PPMN2	REAL		INPTR	REFS	156	315		
462	PR	REAL		REALS	REFS	121			
0	PREPS2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
463	PRESS	REAL		REALS	REFS	121			
464	PRTY	REAL		REALS	REFS	121			
465	PRT19	REAL		REALS	REFS	121			
446	P2	REAL	ARRAY	INPTR	REFS	156	371	374	
2412	P2SI	REAL			REFS	374	DEFINED	371	
473	QAV	REAL		REALS	REFS	121			
466	QC	REAL		REALS	REFS	121			
613	QEND	REAL	ARRAY	INPTR	REFS	156			
623	QF	REAL	ARRAY	INPTR	REFS	156			
1333	QMPY	REAL	ARRAY	INPTR	REFS	156	370	374	
467	QP	REAL		REALS	REFS	121			
474	QPEAK	REAL		REALS	REFS	121			
470	QSP	REAL		REALS	REFS	121			
1500	RAPOW	REAL	ARRAY	INPTR	REFS	156			
2344	RATE	REAL			DEFINED	250	251		
513	RC	REAL		INPTR	REFS	156	279	305	

VARIABLES	SN	TYPE	RELOCATION							
471	RCI	REAL		REALS	REFS	121				
472	RCO	REAL		REALS	REFS	121				
2365	RCSI	REAL			REFS	305	DEFINED	279		
1514	RDISH	REAL		INPTR	REFS	156	277	304		
2363	RDISHS	REAL			REFS	304	DEFINED	277		
0	REPS2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1		
475	RFNVFF	REAL		REALS	REFS	134				
476	RHO	REAL		REALS	REFS	134				
477	RHOF	REAL		REALS	REFS	134				
500	RHOG	REAL		REALS	REFS	134				
501	RHOUO2	REAL		REALS	REFS	134				
502	RMH	REAL		REALS	REFS	134				
1515	ROUGHC	REAL		INPTR	REFS	156	265	266		
1516	ROUGHF	REAL		INPTR	REFS	156	264	267		
503	RP	REAL		REALS	REFS	134				
2551	RSNTR	REAL		INPTR	REFS	156				
504	RSTRAN	REAL		REALS	REFS	134				
505	RSTRES	REAL		REALS	REFS	134				
506	RTRAN	REAL		REALS	REFS	134				
2347	RUFCML	REAL			REFS	298	DEFINED	265		
2346	RUFFML	REAL			REFS	309	DEFINED	264		
0	R22	REAL	ARRAY	F.P.	REFS	231	DEFINED	1		
1517	SGAPF	REAL		INPTR	REFS	156	313			
2352	SHDSI	REAL			REFS	303	DEFINED	268		
0	SIG2	REAL	ARRAY	F.P.	REFS	231	DEFINED	1		
2350	SIRUFC	REAL			REFS	298	DEFINED	266		
2351	SIRUFF	REAL			REFS	309	DEFINED	267		
507	SKTC	REAL		REALS	REFS	134				
510	SKTS	REAL		REALS	REFS	134				
511	STRN	REAL		REALS	REFS	134				
512	SUMCK	REAL		REALS	REFS	134				
513	SUMDH	REAL		REALS	REFS	134				
514	SUMEXP	REAL		REALS	REFS	134				
515	SUMGP	REAL		REALS	REFS	134				
516	SUMPOR	REAL		REALS	REFS	134				
517	SUMRG	REAL		REALS	REFS	134				
520	SUMTF	REAL		REALS	REFS	134				
521	T	REAL		REALS	REFS	134				
522	TCAC	REAL		REALS	REFS	134				
1520	TCC	REAL		INPTR	REFS	156	288	297	DEFINED	287
2375	TCCSI	REAL			REFS	297	DEFINED	288		
523	TCI	REAL		REALS	REFS	134				
524	TCO	REAL		REALS	REFS	134				
525	TFBC	REAL		REALS	REFS	134				
526	TFC	REAL		REALS	REFS	134				
527	TFGFR	REAL		REALS	REFS	134				
530	THEFR	REAL		REALS	REFS	134				
531	TH2OFR	REAL		REALS	REFS	134				
1521	TIME	REAL	ARRAY	INPTR	REFS	156	372	374		
2413	TIMEHR	REAL			REFS	374	DEFINED	372		
532	TITLE	REAL	ARRAY	REALS	REFS	134	247	355	364	382
546	TM	REAL		REALS	REFS	134				
547	TN2FR	REAL		REALS	REFS	134				

VARIABLES	SN	TYPE		RELOCATION					
1666	TOTL	REAL		INPTR	REFS	156	276	310	
2362	TOTLSI	REAL			REFS	310	DEFINED	276	
550	TOXO	REAL		REALS	REFS	134			
551	TP	REAL		REALS	REFS	134			
552	TPA	REAL		REALS	REFS	134			
553	TPAC	REAL		REALS	REFS	134			
554	TPLEN	REAL		REALS	REFS	134			
555	TRANST	REAL		REALS	REFS	134			
2553	TREF	REAL		INPTR	REFS	156	404		
556	TSAT	REAL		REALS	REFS	134			
1667	TSINT	REAL		INPTR	REFS	156	291	306	
2400	TSINTK	REAL			REFS	306	DEFINED	291	
557	TT	REAL		REALS	REFS	134			
0	TTT	REAL	ARRAY	F.P.	REFS	231	DEFINED	1	
1670	TW	REAL	ARRAY	INPTR	REFS	156	369	374	
2410	TWSI	REAL			REFS	374	DEFINED	369	
560	TX	REAL		REALS	REFS	134			
561	TXA	REAL		REALS	REFS	134			
562	TXAL	REAL		REALS	REFS	134			
563	TXC	REAL		REALS	REFS	134			
2035	UBFS	REAL		INPTR	REFS	156			
2036	UMELT	REAL		INPTR	REFS	156			
2037	UOFD	REAL		INPTR	REFS	156			
0	VERS	REAL		VER	REFS	207			
564	VISC	REAL		REALS	REFS	134			
565	VPLT	REAL		REALS	REFS	134			
2040	VS	REAL		INPTR	REFS	156	321		
566	VSS	REAL		REALS	REFS	134	281	319	
2367	VSSSI	REAL			REFS	319	DEFINED	281	
600	VX	REAL		REALS	REFS	134			
567	W	REAL		REALS	REFS	134			
570	WT	REAL		REALS	REFS	134			
571	WTRAN	REAL		REALS	REFS	134			
2041	X	REAL	ARRAY	INPTR	REFS	156			
572	XEIN	REAL		REALS	REFS	134			
573	XK6	REAL		REALS	REFS	134			
574	XK7	REAL		REALS	REFS	134			
575	YY	REAL		REALS	REFS	134			
576	Z	REAL		REALS	REFS	134			
577	ZRO2WG	REAL		REALS	REFS	134			

FILE NAMES	MODE								
TAPE6	FMT	WRITES	252	255	257	259	261	293	294	295
		296	297	298	299	300	301	302	303	304
		305	306	307	308	309	310	311	312	313
		314	315	316	317	318	319	320	321	322
		323	324	325	326	327	328	329	330	331
		332	337	350	357	365	374	384	385	390
		392	394	396	398	400	402	404	406	

EXTERNALS	TYPE	ARGS	REFERENCES				
PGHEAD		3	247	355	364	382	

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
TK	REAL	1 SF	246	291 369

STATEMENT LABELS			DEF LINE	REFERENCES
35	100		255	254
41	110		257	254
45	120		259	254
51	130		261	254
54	140		262	253 256 258 260
0	150		352	339
437	160		353	335
0	170		378	361
531	180		388	380
1234	190	FMT	411	252
1252	200	FMT	414	255
1257	210	FMT	415	257
1264	220	FMT	416	259
1272	230	FMT	417	261
1300	240	FMT	418	293
1306	250	FMT	419	294
1314	260	FMT	420	295
1325	270	FMT	422	296
1336	280	FMT	424	297
1347	290	FMT	426	299
1360	300	FMT	428	300
1371	310	FMT	430	301
1402	320	FMT	432	310
1413	330	FMT	434	312
1423	340	FMT	436	307
1433	350	FMT	438	302
1444	360	FMT	440	303
1455	370	FMT	442	304
1466	380	FMT	444	305
1477	390	FMT	446	309
1510	400	FMT	448	298
1521	410	FMT	450	306
1532	420	FMT	452	308
1543	430	FMT	454	311
1553	440	FMT	456	316
1564	450	FMT	458	317
1575	460	FMT	460	318
1606	470	FMT	462	319
1617	480	FMT	464	320
1630	490	FMT	466	321
1640	500	FMT	468	313
1650	510	FMT	470	314
1660	520	FMT	472	315
1670	530	FMT	474	332
1701	540	FMT	476	331
1712	550	FMT	478	322
1723	560	FMT	480	323
1734	570	FMT	482	324
1740	580	FMT	483	325

STATEMENT LABELS			DEF LINE	REFERENCES	
1744	590	FMT	484	326	
1750	600	FMT	485	327	
1754	610	FMT	486	328	
1760	620	FMT	487	329	
1764	630	FMT	488	330	
1775	640	FMT	490	337	
2026	650	FMT	495	350	
2036	660	FMT	497	357	365
2067	670	FMT	502	374	
2100	680	FMT	504	384	
2122	690	FMT	507	385	
2146	700	FMT	511	390	
2200	710	FMT	515	392	
2225	720	FMT	519	394	
2240	730	FMT	521	396	
2251	740	FMT	523	398	
2265	750	FMT	525	400	
2302	760	FMT	527	402	
2316	770	FMT	529	404	
2326	780	FMT	531	406	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
366	150	I	339 352	50B	EXT REFS
450	170	I	361 378	50B	EXT REFS

COMMON BLOCKS	LENGTH
FAST	1
POINT	199
REALS	392
INTEG	24
INPTR	1393
INPTI	197
EMFLGS	10
PFRCS2	22
MATCNS	12
LACMDL	21
VER	1
PHYPRO	11

STATISTICS

PROGRAM LENGTH	2414B	1292
SCM LABELED COMMON LENGTH	4353B	2283

140000B SCM USED

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      SUBROUTINE PRINT2 (DUMPRS,TTT,EPS22,EPP2,FVFRO,SIG2,REPS2,EPS02,EP  PRT2      2
     +2,GAP2,R22,ECREP2,PREPS2,PEPP2,OLDT2,PEP2,OLDPG2,OLDPC2,OLIGP2,IGA  PRT2      3
     +P2,EPS0,MNR,MNA)                                                    PRT2      4
C                                                                         PRT2      5
C     IMPLICIT REAL*8 (A-H,O-Z)                                           PRT2      6
C                                                                         PRT2      7
      REAL  NU , KRYIN                                                    PRT2      8
C                                                                         PRT2      9
      COMMON  / FAST / A                                                  PRT2     10
C                                                                         PRT2     11
C                                                                         REALCM    2
C                                                                         REALCM    3
C     THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY        REALCM    4
C     DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL           REALCM    5
C                                                                         REALCM    6
C                                                                         REALCM    7
C     ( NA )      -  ARRAYS                                               REALCM    8
C                                                                         REALCM    9
      COMMON  / POINT /                                                   REALCM   10
     +         LDCTH    ,LURC     ,LCREPI   ,LDLH     ,LHA      ,LHL     REALCM   11
     +        ,LPOROS   ,LUFS     ,LAXGAP   ,LAXLEN   ,LBU1     ,LBU2    REALCM   12
     +        ,LARAD    ,LCPDLT   ,LDELBP   ,LDENMX   ,LDLPGE             REALCM   13
     +        ,LDZ      ,LDZH     ,LDZHP    ,LECREP   ,LEP               REALCM   14
     +        ,LGAP     ,LGPTP    ,LHCOEF   ,LOLAXG   ,LOLDPC            REALCM   15
     +        ,LOLDPG   ,LOLDTC   ,LOLDUR   ,LOLEPS   ,LOLFEP            REALCM   16
     +        ,LPAXGP   ,LPC      ,LPECRP   ,LPEP     ,LPG               REALCM   17
     +        ,LPINT    ,LPLDPC   ,LPLDPG   ,LPLDTC   ,LPLDUR   ,LPOAXG  REALCM   18
     +        ,LPOFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR   REALCM   19
     +        ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF    REALCM   20
     +        ,LVCH     ,LVCHI    ,LVCR     ,LVDH     ,LVFH     ,LVGH    REALCM   21
     +        ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEPI                          REALCM   22
     +        ,LHGAPS   ,LTRTRN   ,LIGAP    ,LOLIGP   ,LQDP               REALCM   23
     +        ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO  REALCM   24
     +        ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO                        REALCM   25
C                                                                         REALCM   26
C     ( NA X 2 )  -  ARRAYS                                               REALCM   27
C                                                                         REALCM   28
      COMMON  / POINT /                                                   REALCM   29
     +         LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG    REALCM   30
     +        ,LREPS2                                                     REALCM   31
C                                                                         REALCM   32
C     ( NA X 3 )  -  ARRAYS                                               REALCM   33
C                                                                         REALCM   34
      COMMON  / POINT /                                                   REALCM   35
     +         LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS   REALCM   36
     +        ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS  REALCM   37
     +        ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPPI              REALCM   38
     +        ,LSIGI    ,LEPSI                                            REALCM   39
C                                                                         REALCM   40
C     ( NR )      -  ARRAYS                                               REALCM   41
C                                                                         REALCM   42
      COMMON  / POINT /                                                   REALCM   43
     +         LAK1     ,LAK2     ,LCRL     ,LDPL     ,LDPLH    ,LDPN    REALCM   44
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      +       ,LFMA     ,LFMGPR   ,LHRL     ,LTFB     ,LTFR     ,LTFRK    REALCM     45
55    +       ,LVPL                                                       REALCM     46
C                                                                         REALCM     47
C     ( NR X 2 )  -  ARRAYS                                               REALCM     48
C                                                                         REALCM     49
      COMMON  / POINT /                                                   REALCM     50
60    +         LF        ,LFH      ,LFN                                  REALCM     51
C                                                                         REALCM     52
C     ( NR X NA ) -  ARRAYS                                               REALCM     53
C                                                                         REALCM     54
      COMMON  / POINT /                                                   REALCM     55
65    +         LCC1      ,LCC2     ,LDENSF   ,LDENSP   ,LDPW     ,LDPWPP REALCM     56
      +       ,LGNS12     ,LPORS1   ,LPORS2   ,LTMPDS   ,LUO2LL   ,LTMPMX REALCM     57
      +       ,LR         ,LRAD                                           REALCM     58
C                                                                         REALCM     59
C     ( NA X 6 )  -  ARRAYS                                               REALCM     60
70    C                                                                   REALCM     61
      COMMON  / POINT /                                                   REALCM     62
      +         LB        ,LBR      ,LBTOLD   ,LCHEM                      REALCM     63
C                                                                         REALCM     64
C     ( NA X 8 )  -  ARRAYS                                               REALCM     65
75    C                                                                   REALCM     66
      COMMON  / POINT /                                                   REALCM     67
      +         LQ                                                        REALCM     68
C                                                                         REALCM     69
C     ( IT )      -  ARRAYS                                               REALCM     70
80    C                                                                   REALCM     71
      COMMON  / POINT /           LACMFG    ,LACMHE   ,LACMH2   ,LACMN2 REALCM     72
      +                 ,LAMGPT   ,LGASMO   ,LHMGPT   ,LPIT     ,LPRT10   REALCM     73
      +       ,LPRT11   ,LPRT12   ,LPRT13   ,LPRT14   ,LPRT15   ,LPRT16   REALCM     74
      +       ,LPRT17   ,LPRT18   ,LPRT2    ,LPRT20   ,LPRT3    ,LPRT4    REALCM     75
85    +       ,LPRT5    ,LPRT6    ,LPRT7    ,LPRT8    ,LPRT9    ,LTAC     REALCM     76
      +       ,LTAFA    ,LTAGA    ,LTSF                                   REALCM     77
C                                                                         REALCM     78
C                                                                         REALCM     79
C     ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME                 REALCM     80
90    C                                                                   REALCM     81
      COMMON / POINT /                                                    REALCM     82
      +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,        REALCM     83
      +   LDECAY,   LHALF,    LRLEAS                                      REALCM     84
C                                                                         REALCM     85
95    C     BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME                  REALCM     86
C                                                                         REALCM     87
      COMMON / POINT /                                                    REALCM     88
      +   IRDOT,    ISAVGS,   LSTHIF,   IX                              REALCM     89
C                                                                         REALCM     90
100   C     RADIAL MODEL ARRAYS                                           REALCM     91
C                                                                         REALCM     92
      COMMON / POINT /                                                    REALCM     93
      +   ICFAC     ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF       REALCM     94
      +  ,ITRAMP    ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV                 REALCM     95
105   +  ,IHLDN     ,IPLSTC   ,ISTRNN   ,ISTRSS                           REALCM     96
C                                                                         REALCM     97
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      C                                                                      REALCM     98
      C                                                                      REALCM     99
      C                                                                      REALCM    100
      COMMON / REALS /  AAA(20)  ,AAN       ,AIRIN    ,AMGP(2) ,AMGPH(2)   REALCM    101
     +                 ,AMGR(2)  ,AMGRH(2)  ,AMGRN2(2),AMWDT    ,ANGI      REALCM    102
     +          ,ANGT   ,AN2IN    ,ARGIN    ,ARING    ,AVGQI(8) ,B(6)      REALCM    103
     +          ,BP     ,BPP      ,BR(6)    ,BU       ,BUOLD    ,CDG       REALCM    104
     +          ,CFV    ,CFVA     ,CHOL     ,CODEID(15),CONVC,CONVER(10)   REALCM    105
     +          ,CPV    ,CRDTT    ,CRN      ,CVV      ,DCIH               REALCM    106
     +          ,DCIHP  ,DELBP    ,DELBU    ,DELH     ,DELT               REALCM    107
     +          ,DELTCR ,DELTDB   ,DELTFC   ,DELTJL   ,DHIC     ,DLREL     REALCM    108
     +          ,DLROD  ,DLTGC(26),DPH      ,DPHF     ,DPHFP    ,DPWP      REALCM    109
     +          ,DRS    ,ENRICH   ,EOLSR    ,FC(1)    ,FGIN     ,FGPAVP    REALCM    110
      C                                                                      REALCM    111
      COMMON / REALS /  FGPAVX  ,FH2O     ,FJJ(2)   ,FJJH(2)  ,FMGP(2)    REALCM    112
     +                 ,FPOR    ,FPORI    ,FRD      ,FRDH     ,FRDN      REALCM    113
     +          ,G      ,GASES(7),GASIN    ,GDEN   ,GPTH(26) ,GPTHE(26)   REALCM    114
     +          ,GPTHM  ,GPTHP    ,GPTHPG(26),GR      ,HCRV     ,HCV       REALCM    115
     +          ,HDSHV  ,HEIN     ,HFLL     ,HFLMDB   ,HFLMP    ,HFPER     REALCM    116
     +          ,HFV    ,HGAPT    ,HGV      ,HI       ,HMGP(2)  ,HP        REALCM    117
     +          ,HGAP   ,HSOLID   ,HGAPR                                     REALCM    118
     +          ,HPL    ,HPORV    ,HPV      ,HUPTAK   ,H2OMI    ,KRYIN     REALCM    119
     +          ,NU     ,OXDROP   ,OXIDE    ,PECDH    ,PI       ,PIN(26)   REALCM    120
     +          ,PINP   ,PORO     ,PR       ,PRESS    ,PRTY     ,PRT19     REALCM    121
     +          ,QC     ,QP       ,QSP      ,RCI      ,RCO                 REALCM    122
     +          ,QAV    ,QPEAK                                               REALCM    123
      C                                                                      REALCM    124
      COMMON / REALS /  RFNVFF  ,RHO      ,RHOF     ,RHOG     ,RHOUO2      REALCM    125
     +                 ,RMH     ,RP       ,RSTRAN   ,RSTRES   ,RTRAN       REALCM    126
     +          ,SKTC   ,SKTS     ,STRN     ,SUMCK    ,SUMDH    ,SUMEXP    REALCM    127
     +          ,SUMGP  ,SUMPOR   ,SUMRG    ,SUMTF    ,T        ,TCAC      REALCM    128
     +          ,TCI    ,TCO      ,TFBC     ,TFC      ,TFGFR    ,THEFR     REALCM    129
     +          ,TH2OFR ,TITLE(12),TM       ,TN2FR    ,TOXO     ,TP        REALCM    130
     +          ,TPA    ,TPAC     ,TPLEN    ,TRANST   ,TSAT     ,TT        REALCM    131
     +          ,TX     ,TXA      ,TXAL     ,TXC      ,VISC     ,VPLT      REALCM    132
     +          ,VSS    ,W        ,WT       ,WTRAN    ,XEIN     ,XK6       REALCM    133
     +          ,XK7    ,YY       ,Z        ,ZRO2WG   ,VX       ,CLOS      REALCM    134
     +          ,FNCK   ,FNCN     ,CHKF     ,CHNF     ,COLDWK              REALCM    135
     +          ,DISH                                                        REALCM    136
      C                                                                      REALCM    137
      C                                                                      INTGCM      2
      COMMON / INTEG /                                                       INTGCM      3
     +    IQUIT     ,IRI      ,IT       ,ITER     ,J                       INTGCM      4
     +   ,JJC       ,JPEAK    ,K        ,KINDOR   ,KOXI                    INTGCM      5
     +   ,LMN       ,M        ,MODLOP   ,NAB      ,NPLAST                  INTGCM      6
     +   ,NRMI      ,NSTEP    ,NWRITE   ,N2       ,IMDONE                  INTGCM      7
     +   ,ICLOSE    ,NSH      ,NF       ,NC                                INTGCM      8
      C                                                                      INTGCM      9
      C                                                                      INPRCM      2
      COMMON / INPTR /ACOR     ,AFAL     ,AFCR     ,AFDN                    INPRCM      3
     +               ,AFGR     ,AFSW     ,AFTC     ,AGPC                    INPRCM      4
     +   ,AMFAIR    ,AMFARG   ,AMFFG    ,AMFHE    ,AMFH2                   INPRCM      5
     +   ,AMFH2O    ,AMFKRY   ,AMFN2    ,AMFXE                             INPRCM      6
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      +    ,BUIN(22)    ,CATEXF                                                    INPRCM      7
      +    ,CLDWKD      ,CPL          ,CRDT         ,CRDTR        ,CTMAX(22)     INPRCM      8
      +    ,DCI(22)     ,DCO(22)      ,DE(22)       ,DELTAZ(22)   ,DEN           INPRCM      9
      +    ,DENG        ,DISHSD       ,DP(22)       ,DSPG         ,DSPGW         INPRCM     10
      +    ,ENRCH       ,EXO          ,FA           ,FGPAV        ,FLUX          INPRCM     11
      +    ,FLXDP       ,FQE          ,GO(101)      ,GRNSIZ       ,HDISH         INPRCM     12
      +    ,HPLT        ,PPMH2O       ,PPMN2        ,P2(101)      ,QEND(8)       INPRCM     13
      +    ,QF(328)     ,QMPY(101)    ,RAPOW(11)    ,RC           ,RDISH         INPRCM     14
      +    ,ROUGHC      ,ROUGHF       ,SGAPF                                     INPRCM     15
      +    ,TCC         ,TIME(101)    ,TOTL         ,TSINT        ,TW(101)       INPRCM     16
      +    ,UBFS        ,UMELT        ,UOFD         ,VS           ,X(328.        INPRCM     17
      +    ,RSNTR       ,FOTHTL       ,TREF         ,CREPHR       ,ANRIN         INPRCM     18
      +    ,CLDWKS                                                                INPRCM     19
      +    ,CP          ,CR                                                       INPRCM     20
      C                                                                           INPICM      2
       COMMON / INPTI /ICM          ,ICOR         ,IDBG         ,IDXGAS          INPICM      3
      +               ,IM           ,IPLANT       ,IQ           ,ISW             INPICM      4
      +    ,JDLPR     ,JN(8)        ,JST(101)     ,MDBG         ,NHEAL           INPICM      5
      +    ,MODE      ,MODES        ,MTAPE        ,NDBG         ,NFROD           INPICM      6
      +    ,NGAPC     ,NGASR        ,NOFAIL       ,NOPT         ,NPCYCL          INPICM      7
      +    ,NPLTAB    ,NREAD        ,NRESTR       ,NROLL        ,NSP             INPICM      8
      +    ,NSTART    ,NSTOP        ,NT           ,NTAPE        ,NUCFC           INPICM      9
      +    ,NUNITS    ,LACMOD       ,LACE(13)     ,NAFAIL       ,NNFAIL(22)      INPICM     10
      +    ,NXP       ,NPLOT        ,NTPLOT       ,NROD         ,NA              INPICM     11
      +    ,NR        ,NEWPRB       ,MECHAN       ,NCRACK       ,NELAST          INPICM     12
      +    ,NCREEP    ,IAXSYM       ,IVARDM       ,NOFRAC       ,ITREST          INPICM     13
      +    ,NWORDS    ,IWORDS       ,NWRDS        ,NPRINT                        INPICM     14
      C                                                                           INPICM     15
      C                                                                           INPICM     16
       COMMON  /EMFLGS/   IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO                   INPICM     17
      +                 ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG                    INPICM     18
      +         ,IMFGAS   ,IMSWCH                                                 INPICM     19
      C                                                                           INPICM     20
      C                                                                           INPICM     21
      C                                                                           INPICM     22
       COMMON/PFRCS2/     MODPG2          ,MODPC2          ,MGAP2                 INPICM     23
      +  ,MIGAP2          ,MOIGP2          ,MREPS2          ,MPEPS2               INPICM     24
      +  ,MTTT            ,MEREP2          ,MEP2            ,MR22                 INPICM     25
      +  ,MOLDT2          ,MFVFRO          ,MDHPRS          ,MPEP2                INPICM     26
      +  ,MEPS22          ,MEPP2           ,MSIG2           ,MEPS02               INPICM     27
      +  ,MPEPP2          ,MEPS0           ,NNNCRP                                INPICM     28
      C                                                                           INPICM     29
       COMMON /MATCNS/ AAHA(12)                                                   INPICM     30
      C                                                                           INPICM     31
      C                                                                           INPICM     32
       COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                                      INPICM     33
      C                                                                           INPICM     34
       COMMON /VER/ VERS                                                          INPICM     35
      C                                                                           PHYPRO      2
       COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB              PHYPRO      3
      +             ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP               PHYPRO      4
      +             ,DELOXY                                                       PHYPRO      5
      C                                                                           PHYPRO      6
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      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                  PHYPRO      7
      C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)               PHYPRO      8
215   C   CTMELT - ZR CLAD MELTING POINT (K)                                    PHYPRO      9
      C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                              PHYPRO     10
      C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)            PHYPRO     11
      C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)              PHYPRO     12
      C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)            PHYPRO     13
220   C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)              PHYPRO     14
      C   BU     - BURNUP (MW-S/KG-U)                                          PHYPRO     15
      C   COMP   - PUO2 CONTENT (WT-PERCENT)                                   PHYPRO     16
      C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED         PHYPRO     17
      C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                 PHYPRO     18
225   C                                                                        PHYPRO     19
      C                                                                        PELPT       2
       COMMON / PNTPNL / IFIRST, IAELM, IAK, IARAA, IARE, ISB, IBA,            PELPT       3
      + IBASAV, IBASE, ISBB, IBBA, IBBSV, ICA, ICC, ICRATE, ICRPG, IDISP,      PELPT       4
      + IDISPC, IDSPSV, IEFSTR, IELM, IELSTN, ILSTNA, ILSTRA, IELSTR,          PELPT       5
230   + IPSLA, IEPSLM, IESTNV, IESTSV, JTTJ, IIPOS, IKSAVE, INADET, INDC,      PELPT       6
      + INDF, INDT, INODET, IOLDSE, IPSORT, IPSSV, IPSTS, IR, IRA, IRBR,       PELPT       7
      + IRBRA, IRD, ISTRES, ISTRSA, ITCB, ITCRP, ITEC, ITEF, ITELM, ITFB,      PELPT       8
      + ITHET, ITHTAX, ITHSAV, ITHYSV, ITME, ITSTNR, ITSTSR, ITV, ITW,         PELPT       9
      + IXKT, IXLOAD, IXLODA, IXRD, IY, IYACF, IZ, ILAST                       PELPT      10
235   C                                                                        PELPT      11
      C                                                                        PRT2       18
       COMMON / LIMITS / M1, M2, NOEL, NOELF, NOELC, IDF, NFF, NETOT,          PRT2       19
      +  NEWF, NEWT, KA, NARF, NARC, NART, NABF, NABC, NABT, NAEC, NAEF,       PRT2       20
      +  NTAE, JAM, NAXBT, NAXB2, NAXB4, NFF1, NABF2, NABT2, XP, XR,           PRT2       21
240   +  FRDEN, KZI, ISSTOP, IPLAS, NKN, ICRPP, MAXT, KRNCHF, KRNCHC,          PRT2       22
      +  KRNCHT, NFF2, NC4, NF4, MAXA, NEW, NMX, KRNCH, MCUD, IADJ, ICUT,     PRT2       23
      +  TIMEC, TIMEF, ITI, STEP, NOLD, KPLAS, ICNT, RRAKR, IRAK, RAKSUM,     PRT2       24
      +  IPLEND, ISP, IRZ                                                      PRT2       25
       COMMON / AXL / SUMM, SUMFF, SUMSAV, GROW                                PRT2       26
245   C                                                                        PRT2       27
       COMMON / BA / DELZA(40), NN, NCONN, NCNN, ITERD, FLXRD, ERAD(20),       PRT2       28
      +   EAX(20)                                                             PRT2       29
      C                                                                        PRT2       30
       DIMENSION  A(1)                                                         PRT2       31
250   C                                                                        PRT2       32
      C                                                                        PRT2       33
      C                                                                        PRT2       34
       INTEGER  OLIGP2                                                         PRT2       35
       DIMENSION TTT(MNA,MNR),EPS22(MNA,MNR,3),EPP2(MNA,MNR,3)                 PRT2       36
255   + ,SIG2(MNA,MNR,3),REPS2(MNA,2),EPS02(MNA,MNR,3)                        PRT2       37
      + ,EP2(MNA,MNR),GAP2(MNA),R22(MNA,MNR),ECREP2(MNA,MNR)                  PRT2       38
      + ,OLDT2(MNA,MNR)                                                       PRT2       39
      + ,OLDPG2(MNA),OLDPC2(MNA),OLIGP2(MNA),IGAP2(MNA)                       PRT2       40
      + ,EPS0(MNA,MNR,3)                                                      PRT2       41
260   + ,PEP2(MNA,MNR),PEPP2(MNA,MNR,3),PREPS2(MNA,2)                         PRT2       42
      + ,FVFRO(MNA,MNR) ,DVHPRS(MNA,MNR)                                      PRT2       43
      C                                                                        PRT2       44
      C                                                                        PRT2       45
      C                                                                        PRT2       46
265   C   THE FOLLOWING DATA STATEMENTS CONTAIN VARIOUS CONVERSION FACTORS     PRT2       47
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                DATA  CHRTOS / 3600.E0 / , CBHTW2 / 3.15284E0 /                    PRT2       48
                DATA  CMDTMS / 86.4E0 /                                           PRT2       49
                DATA  CBHTWM / 5.6745E0 / , CPSTNM / 6894.757E0 /                 PRT2       50
                DATA  CMLTOM  , CFTTM                                             PRT2       51
270           +   / 0.0254E-3, 0.3048E0/                                          PRT2       52
          C                                                                       PRT2       53
                DATA  CFTTOM / 0.3048E0 / , CDATOS / 8.64E4 / , CINCM3 /1.6387E1/ PRT2       54
                DATA  CPSTMP / 6.894757E-3 / , CINTCM / 2.54E0 /                  PRT2       55
          C                                                                       PRT2       56
275       C                                                                       PRT2       57
                TCONV(TTT) = (TTT+459.67E0)/1.8E0                                 PRT2       58
          C                                                                       PRT2       59
                IF (IMDONE.EQ.1) GO TO 360                                        PRT2       60
                NRP1 = NR+1                                                       PRT2       61
280             NRP2 = NR+2                                                       PRT2       62
                ITM1 = IT-1                                                       PRT2       63
          C                                                                       PRT2       64
                IF (IT.NE.1.OR.J.NE.JPEAK) GO TO 100                              PRT2       65
                IF (MECHAN.EQ.1) DLROD = SUMM                                     PRT2       66
285             DLRDSI = 25.4*DLROD                                               PRT2       67
                WRITE (6,400) DLRDSI,DLROD                                        PRT2       68
          100   CONTINUE                                                          PRT2       69
                IF (IT.EQ.1) GO TO 390                                            PRT2       70
                IF (J.EQ.IR1+1) GO TO 220                                         PRT2       71
290             IF (J.NE.JPEAK.AND.JDLPR.EQ.1) GO TO 390                          PRT2       72
          C                                                                       PRT2       73
          C                                                                       PRT2       74
                CALL PGHEAD (CODEID,MODLOP,TITLE)                                 PRT2       75
          C                                                                       PRT2       76
295             FULDEN = DEN/100.E+0                                              PRT2       77
                A(LDENMX+J-1) = FULDEN                                            PRT2       78
                TPSEC = TP*CHRTOS                                                 PRT2       79
                TSECON = T*CHRTOS                                                 PRT2       80
                QC = QMPY(IT)*A(LQ+J-2+(M-1)*NA)                                  PRT2       81
300             QCM = QC*CBHTW2                                                   PRT2       82
                BPP = A(LBU1+J-1)                                                 PRT2       83
                BP = A(LBU2+J-1)                                                  PRT2       84
                DELBP = A(LDELBP+J-1)                                             PRT2       85
                BPM = BP*CMDTMS                                                   PRT2       86
305             BPPM = BPP*CMDTMS                                                 PRT2       87
                DELBPM = DELBP*CMDTMS                                             PRT2       88
          C                                                                       PRT2       89
                WT = A(LTBLK+J-1)                                                 PRT2       90
                WTK = TCONV(WT)                                                   PRT2       91
310       C                                                                       PRT2       92
                OXIDE = A(LZRO2B+J-1)*12.                                         PRT2       93
          C                                                                       PRT2       94
                SIFLMP = HFLMP*CBHTWM                                             PRT2       95
          C                                                                       PRT2       96
315             TOXO = A(LTOXO+J-1)                                               PRT2       97
                TOXOK = TCONV(TOXO)                                               PRT2       98
          C                                                                       PRT2       99
                TCI = A(LTCIDI+J-1)                                               PRT2      100
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                TCO = A(LTCODI+J-1)                                                  PRT2      101
320             TCOM = TCONV(TCO)                                                    PRT2      102
                TCIM = TCONV(TCI)                                                    PRT2      103
          C                                                                          PRT2      104
                SIGAP = GPTHM*CMLTOM                                                 PRT2      105
                HGAPT = A(LHGAPS+J-1)                                                PRT2      106
325             HSOLID = A(LHGFS+J-1)                                                PRT2      107
                HGAP = A(LHGPC+J-1)                                                  PRT2      108
                HGAPR = A(LHGPR+J-1)                                                 PRT2      109
                HGAPSI = HGAPT*CBHTHM                                                PRT2      110
                IF (MECHAN.NE.1) PINBR = AMAX1(A(LPINT+J-2),0.E0)                    PRT2      111
330             IF (MECHAN.EQ.1) PINBR = A(IPRG+J-1)                                 PRT2      112
                PINSI = PINBR*CPSTNM/1.E6                                            PRT2      113
                TAGK = TCONV(A(LTAG+J-1))                                            PRT2      114
                PRESG = PRESS*CPSTNM                                                 PRT2      115
                CGAPSI = GTHCON(GASES,TAGK,PRESG,SIGAP)                              PRT2      116
335             CONGAP = CGAPSI/(CBHTHM*CFTTM)                                       PRT2      117
          C                                                                          PRT2      118
                CPDLTX = A(LCPDLT+J-1)*2.32444                                       PRT2      119
                TBARK = TCONV(A(LTBAR+J-1))                                          PRT2      120
          C                                                                          PRT2      121
340             QDPM = A(LQDP+J-2)/CFTTOM                                            PRT2      122
                TDAYS = TIME(ITM1)/CDATOS                                            PRT2      123
                QPEAKM = QPEAK/CFTTOM                                                PRT2      124
                QAVM = QAV/CFTTOM                                                    PRT2      125
                UO2LLX = 0.E0                                                        PRT2      126
345             DPWX = 0.E0                                                          PRT2      127
                DENSIX = 0.E0                                                        PRT2      128
                GASCND = HGAP/HGAPT                                                  PRT2      129
                CONCND = HSOLID/HGAPT                                                PRT2      130
                RADCND = HGAPR/HGAPT                                                 PRT2      131
350             RESI = 1.E0/HGAPSI                                                   PRT2      132
                RESIS = 1.E0/HGAPT                                                   PRT2      133
                TIMDAY = TSECON/CDATOS                                               PRT2      134
                TDAYS = TPSEC/CDATOS                                                 PRT2      135
                DELTP = TSECON-TPSEC                                                 PRT2      136
355             DELDAY = DELTP/CDATOS                                                PRT2      137
                TSR = A(LTMPDS+NR*(J-1))                                             PRT2      138
                TCL = A(LTMPDS+NR*(J)-1)                                             PRT2      139
                TCLK = TCONV(TCL)                                                    PRT2      140
                TSRK = TCONV(TSR)                                                    PRT2      141
360       C                                                                          PRT2      142
          C                                                                          PRT2      143
                IF (MECHAN-2) 110,120,130                                            PRT2      144
          110   CONTINUE                                                           PRT2      145
                ERADSI = ERAD(J)*CPSTNM                                              PRT2      146
365             EAXSI = EAX(J)*CPSTNM                                                PRT2      147
                EPSI1 = A(ISTRNN+(J-1)*4+2)*100.                                     PRT2      148
                EPS2 = A(ISTRNN+(J-1)*4+3)*100.                                      PRT2      149
                EPS3 = A(ISTRNN+(J-1)*4)*100.                                        PRT2      150
                ARAD = A(IRD+NFF1*(J-1)+NF)-A(IDG+J-1)                               PRT2      151
370             TOTCR = EPSI1                                                        PRT2      152
                CREAP = A(IPLSTC+(J-1)*4+2)*100.                                     PRT2      153
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                EXPNR = A(IHLDN+(J-1)*4+2)*100.                                  PRT2   154
                SIGM1B = A(ISTRSS+(J-1)*4+2)/1.E3                                PRT2   155
                SIGM2B = A(ISTRSS+(J-1)*4+3)/1.E3                                PRT2   156
375             SIGM3B = A(ISTRSS+(J-1)*4)/1.E3                                  PRT2   157
                SIGM1 = SIGM1B*CPSTMP*1.E3                                       PRT2   158
                SIGM2 = SIGM2B*CPSTMP*1.E3                                       PRT2   159
                SIGM3 = SIGM3B*CPSTMP*1.E3                                       PRT2   160
                GO TO 140                                                        PRT2   161
380         120 CONTINUE                                                         PRT2   162
                EPS11 = A(LEPS+N2-1)*100.                                        PRT2   163
                EPS2 = A(LEPS+N2-1+NA)*100.                                      PRT2   164
                EPS3 = A(LEPS+N2-1+NA*2)*100.                                    PRT2   165
                ARAD = A(LARAD+N2)                                               PRT2   166
385             TOTCR = EPS11                                                    PRT2   167
                CREAP = A(LEPPSV+N2-1)*100.E0                                    PRT2   168
                EXPNR = TOTCR-CREAP                                              PRT2   169
                SIGM1B = A(LSIG+N2-1)/1.E3                                       PRT2   170
                SIGM2B = A(LSIG+N2-1+NA)/1.E3                                    PRT2   171
390             SIGM3B = A(LSIG+N2-1+NA*2)/1.E3                                  PRT2   172
                SIGM1 = SIGM1B*CPSTMP*1.E3                                       PRT2   173
                SIGM2 = SIGM2B*CPSTMP*1.E3                                       PRT2   174
                SIGM3 = SIGM3B*CPSTMP*1.E3                                       PRT2   175
                GO TO 140                                                        PRT2   176
395         130 CONTINUE                                                         PRT2   177
                ARAD = A(LARAD+N2)                                               PRT2   178
                TOTCR = EPS22(N2,NRP1,2)*1.E2                                    PRT2   179
                CREAP = EPP2(N2,NRP1,2)*1.E2                                     PRT2   180
                EXPNR = TOTCR-CREAP                                              PRT2   181
400             EPS3 = EPS22(N2,NRP1,1)*1.E2                                     PRT2   182
                EPS11 = EPS22(N2,NRP1,2)*1.E2                                    PRT2   183
                EPS2 = EPS22(N2,NRP1,3)*1.E2                                     PRT2   184
                SIGM3B = SIG2(N2,NRP1,1)/1.E3                                    PRT2   185
                SIGM1B = SIG2(N2,NRP1,2)/1.E3                                    PRT2   186
405             SIGM2B = SIG2(N2,NRP1,3)/1.E3                                    PRT2   187
                SIGM1 = SIGM1B*CPSTMP*1.E3                                       PRT2   188
                SIGM2 = SIGM2B*CPSTMP*1.E3                                       PRT2   189
                SIGM3 = SIGM3B*CPSTMP*1.E3                                       PRT2   190
            140 CONTINUE                                                         PRT2   191
410             RADP2 = ARAD*0.2E0                                               PRT2   192
                RADP4 = ARAD*0.4E0                                               PRT2   193
                RADP6 = ARAD*0.6E0                                               PRT2   194
                RADP8 = ARAD*0.8E0                                               PRT2   195
                RADSR = ARAD                                                     PRT2   196
415             RADCL = RC                                                       PRT2   197
                RADCLM = RADCL*CINTCM                                            PRT2   198
                RADP2M = RADP2*CINTCM                                            PRT2   199
                RADP4M = RADP4*CINTCM                                            PRT2   200
                RADP6M = RADP6*CINTCM                                            PRT2   201
420             RADP8M = RADP8*CINTCM                                            PRT2   202
                RADSRM = RADSR*CINTCM                                            PRT2   203
                IF (MECHAN.NE.1) RCIH = A(LDCIH+N2)/2.E0                         PRT2   204
                IF (MECHAN.NE.1) RCOH = RCIH+TCC*(1.0+A(LEPS+N2-1+2*NA))         PRT2   205
                IF (MECHAN.EQ.1) RCIH = A(IRD+NFF1*(J-1)+NF)                     PRT2   206
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      IF (MECHAN.EQ.1) RCOH = A(IRD+NFFI*J-1)                                PRT2  207
      ROX = RCOH+OXIDE                                                       PRT2  208
      RCIHM = RCIH*CINTCM                                                    PRT2  209
      RCOHM = RCOH*CINTCM                                                    PRT2  210
      ROXM = ROX*CINTCM                                                      PRT2  211
          DO 150 I=1,NR                                                      PRT2  212
          L = NR+1-I                                                         PRT2  213
          IJ = NR*(J-1)+L-1                                                  PRT2  214
          DELRNG = -(A(LR+L)-A(LR+L-1))                                      PRT2  215
          UO2LLX = UO2LLX+DELRNG*A(LUO2LL+IJ)                                PRT2  216
          DPWX = DPWX+DELRNG*A(LDPW+IJ)                                      PRT2  217
          DENSIX = DENSIX+DELRNG*A(LDENSF+IJ)                                PRT2  218
  150     CONTINUE                                                           PRT2  219
      DENR = DENSIX*100.E0/RP                                                PRT2  220
      SWLR = DPWX*100.E0/RP                                                  PRT2  221
      EXPR = UO2LLX*100.E0/RP                                                PRT2  222
      TOTFR = DENR+SWLR+EXPR                                                 PRT2  223
C                                                                            PRT2  224
          DO 170 IK=1,4                                                      PRT2  225
          I = 5-IK                                                           PRT2  226
          IF (I*0.00508E0*RP.LT.A(LRTRNP+J-1)) GO TO 180                     PRT2  227
          TFRC = 0.E0                                                        PRT2  228
              DO 160 IJ=1,6                                                  PRT2  229
              B(IJ) = A(LB+(J-2)*6+IJ-1)                                     PRT2  230
  160         TFRC = B(IJ)*(I*0.2)**(IJ-1)+TFRC                              PRT2  231
          IF (I.EQ.1) TP2 = TFRC*1.9E0+32.E0                                 PRT2  232
          IF (I.EQ.2) TP4 = TFRC*1.8E0+32.E0                                 PRT2  233
          IF (I.EQ.3) TP6 = TFRC*1.8E0+32.E0                                 PRT2  234
          IF (I.EQ.4) TP8 = TFRC*1.8E0+32.E0                                 PRT2  235
  170     CONTINUE                                                           PRT2  236
      GO TO 210                                                              PRT2  237
  180 CONTINUE                                                               PRT2  238
          DO 200 IL=IK,4                                                     PRT2  239
          II = 5-IL                                                          PRT2  240
          TFRC = 0.E0                                                        PRT2  241
              DO 190 IJ=1,6                                                  PRT2  242
              BR(IJ) = A(LBR+(J-2)*6+IJ-1)                                   PRT2  243
  190         TFRC = BR(IJ)*(II*0.2)**(IJ-1)+TFRC                            PRT2  244
          IF (II.EQ.1) TP2 = TFRC*1.8E0+32.E0                                PRT2  245
          IF (II.EQ.2) TP4 = TFRC*1.8E0+32.E0                                PRT2  246
          IF (II.EQ.3) TP6 = TFRC*1.8E0+32.E0                                PRT2  247
          IF (II.EQ.4) TP8 = TFRC*1.8E0+32.E0                                PRT2  248
  200     CONTINUE                                                           PRT2  249
  210 CONTINUE                                                               PRT2  250
      TP2K = TCONV(TP2)                                                      PRT2  251
      TP4K = TCONV(TP4)                                                      PRT2  252
      TP6K = TCONV(TP6)                                                      PRT2  253
      TP8K = TCONV(TP8)                                                      PRT2  254
C                                                                            PRT2  255
      WRITE (6,410) N2,ITMI                                                  PRT2  256
      WRITE (6,420) QAVM,QAV                                                 PRT2  257
      WRITE (6,430) QDPM,A(LQDP+J-2),QCM,QC                                  PRT2  258
      WRITE (6,440) QPEAKM,QPEAK                                             PRT2  259
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                WRITE (6,450) TDAYS,TPSEC,BPPM,BPP                                PRT2      260
                WRITE (6,460) DELDAY,DELTP,DELBPM,DELBP                           PRT2      261
480             WRITE (6,470) TIMDAY,TSECON,BPM,BP                                PRT2      262
                WRITE (6,480)                                                     PRT2      263
                WRITE (6,490) RADCLM,RADCL,TCLK,TCL                               PRT2      264
                WRITE (6,500) RADP2M,RADP2,TP2K,TP2                               PRT2      265
                WRITE (6,510) RADP4M,RADP4,TP4K,TP4                               PRT2      266
485             WRITE (6,520) RADP6M,RADP6,TP6K,TP6                               PRT2      267
                WRITE (6,530) RADP8M,RADP8,TP8K,TP8                               PRT2      268
                WRITE (6,540) RADSRM,RADSR,TSRK,TSR                               PRT2      269
                WRITE (6,550) RCIHM,RCIH,TCIM,TCI                                 PRT2      270
                WRITE (6,560) RCOHM,RCOH,TCOM,TCO                                 PRT2      271
490             WRITE (6,570) ROXM,ROX,TOXOK,TOXO                                 PRT2      272
                WRITE (6,580) WTK,WT                                              PRT2      273
                WRITE (6,590)                                                     PRT2      274
                WRITE (6,600) CGAPSI,SIGM3,SIGM3B,EPS3,CONGAP,SIGM2,SIGM2B,EPS2   PRT2      275
                WRITE (6,610) SIGM1,SIGM1B,EPS11                                  PRT2      276
495             WRITE (6,620) DENR,HGAPSI                                         PRT2      277
                WRITE (6,630) SWLR,HGAPT                                          PRT2      278
                WRITE (6,640) EXPR                                                PRT2      279
                WRITE (6,650) RESI,TOTFR,RESIS,SIFLMP,HFLMP                       PRT2      280
                IF (MECHAN.NE.1) WRITE (6,660)                                    PRT2      281
500             IF (MECHAN.EQ.1) WRITE (6,670)                                    PRT2      282
                IF (MECHAN.NE.1) WRITE (6,680) GASCND                             PRT2      283
                IF (MECHAN.EQ.1) WRITE (6,690) GASCND,ERADS1,ERAD(J)              PRT2      284
                IF (MECHAN.NE.1) WRITE (6,700) CREAP,CONCND                       PRT2      285
                IF (MECHAN.EQ.1) WRITE (6,710) CREAP,CONCND,EAXSI,EAX(J)          PRT2      286
505             WRITE (6,720) EXPNR,RADCND                                        PRT2      287
                IF (MECHAN.NE.1) WRITE (6,730) TOTCR,PINSI,PINBR                  PRT2      288
                IF (MECHAN.EQ.1) WRITE (6,740) TOTCR,PINSI,PINBR,A(ICFAC+J-1)     PRT2      289
            C                                                                     PRT2      290
            C                                                                     PRT2      291
510             GO TO 390                                                         PRT2      292
            220 CONTINUE                                                          PRT2      293
            C                                                                     PRT2      294
                IF (IT.EQ.1) GO TO 390                                            PRT2      295
                CALL PGHEAD (CODEID,MODLOP,TITLE)                                 PRT2      296
515         C                                                                     PRT2      297
                BUSI = BU*CMDTMS                                                  PRT2      298
            C                                                                     PRT2      299
                RFNCI = RFNUFF*CFV                                                PRT2      300
                TAGAK = TCONV(A(LTAGA+IT-1))                                      PRT2      301
520             TAFAK = TCONV(A(LTAFA+IT-1))                                      PRT2      302
                TSFK = TCONV(A(LTSF+IT-1))                                        PRT2      303
                THVV = HPV+HGV+HDSHV+HCRV+RFNCI+HPORV                             PRT2      304
                THVVSI = THVV*CINCM3                                              PRT2      305
                TPLENS = TCONV(TPLEN)                                             PRT2      306
525             TCRKF = 0.E0                                                      PRT2      307
                    DO 230 I=1,NT                                                 PRT2      308
                    TCRKF = TCRKF+(A(LTRTRN+I)+A(LTPS+I))/2.E0                    PRT2      309
            230     CONTINUE                                                      PRT2      310
                TCRKF = TCRKF/NT                                                  PRT2      311
530             IF (MECHAN.EQ.1) TCRKF = A(LTAFA+ITM1)                            PRT2      312
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                TCRKK = TCONV(TCRKF)                                                    PRT2      313
                VFRCPL = HPV/THVV                                                       PRT2      314
                VFRCCR = HCRV/THVV                                                      PRT2      315
                VFRCDS = HDSHV/THVV                                                     PRT2      316
535             VFRCPR = HPORV/THVV                                                     PRT2      317
                VFRCRF = RFNCI/THVV                                                     PRT2      318
                VFRCGP = HGV/THVV                                                       PRT2      319
          C                                                                             PRT2      320
                TKRFR = 0.15E0*TFGFR                                                    PRT2      321
540             TXEFR = 0.85E0*TFGFR                                                    PRT2      322
                TARFR = 0.E0                                                            PRT2      323
                TH2FR = 0.E0                                                            PRT2      324
                TFGPCT = TFGFR*100.E0                                                   PRT2      325
                PRSMPA = PRESS*CPSTMP                                                   PRT2      326
545       C                                                                             PRT2      327
                WRITE (6,780) ITMI                                                      PRT2      328
                WRITE (6,790) BUSI,BU,THEFR,AMFHE,TH2FR,AMFH2                           PRT2      329
                WRITE (6,810) TPLENS,TPLEN,VFRCPL,TN2FR,AMFN2                           PRT2      330
                WRITE (6,620) TAGAK,A(LTAGA+ITMI),VFRCGP,TARFR,AMFARG                   PRT2      331
550             WRITE (6,830) TSFK,A(LTSF+ITMI),VFRCRF,TKRFR,AMFKRY                     PRT2      332
                WRITE (6,840) TAFAK,A(LTAFA+ITMI),VFRCDS,TXEFR,AMFXE                    PRT2      333
                WRITE (6,850) TAFAK,A(LTAFA+ITMI),VFRCPR,TH2OFR,AMFH2O                  PRT2      334
                WRITE (6,900) TCRKK,TCRKF,VFRCCR                                        PRT2      335
                WRITE (6,800) THVVSI,THVV,A(LGASMO+ITMI),PRSMPA,PRESS,TFGPCT            PRT2      336
555             WRITE (6,940)                                                           PRT2      337
                IF (MECHAN.EQ.2) WRITE (6,910)                                          PRT2      338
                IF (MECHAN.EQ.3) WRITE (6,920)                                          PRT2      339
                IF (MECHAN.EQ.1) WRITE (6,930)                                          PRT2      340
                WRITE (6,860)                                                           PRT2      341
560       C                                                                             PRT2      342
                DO 280 I=1,NT                                                           PRT2      343
                IMI = I-1                                                               PRT2      344
                IF (MECHAN-2) 240,250,260                                               PRT2      345
          240   CONTINUE                                                                PRT2      346
565             EPSAX = A(ISTRNN+I*4+3)*100.                                            PRT2      347
                EPSHPO = A(ISTRNN+I*4+2)*100.                                           PRT2      348
                EPSHPI = A(ISTRNN+I*4+1)*100.                                           PRT2      349
                EPSRA = A(ISTRNN+I*4)*100.                                              PRT2      350
                SIGAXB = A(ISTRSS+I*4+3)                                                PRT2      351
570             SGHPOB = A(ISTRSS+I*4+2)                                                PRT2      352
                SGHPIB = A(ISTRSS+I*4+1)                                                PRT2      353
                SIGRAB = A(ISTRSS+I*4)                                                  PRT2      354
                SIGRA = SIGRAB*CPSTMP                                                   PRT2      355
                SIGAX = SIGAXB*CPSTMP                                                   PRT2      356
575             SIGHPI = SGHPIB*CPSTMP                                                  PRT2      357
                SIGHPO = SGHPOB*CPSTMP                                                  PRT2      358
                GO TO 270                                                               PRT2      359
          250   CONTINUE                                                                PRT2      360
                IMINA = IMI+NA                                                          PRT2      361
580             IMINA2 = IMINA+NA                                                       PRT2      362
                SIGRA = A(LSIG+IMINA2)*CPSTMP                                           PRT2      363
                SIGRAB = A(LSIG+IMINA2)                                                 PRT2      364
                SIGAX = A(LSIG+IMINA)*CPSTMP                                            PRT2      365
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                      SIGAXB = A(LSIG+IMINA)                                          PRT2      366
585                   SIGHPO = A(LSIG+IMI)*CPSTMP                                     PRT2      367
                      SIGHPI = SIGHPO                                                 PRT2      368
                      SGHPOB = A(LSIG+IMI)                                            PRT2      369
                      SGHPIB = SGHPOB                                                 PRT2      370
                      EPSHPO = A(LEPS+IMI)*1.E2                                       PRT2      371
590                   EPSHPI = EPSHPO                                                 PRT2      372
                      EPSRA = A(LEPS+IMINA2)*1.E2                                     PRT2      373
                      EPSAX = A(LEPS+IMINA)*1.E2                                      PRT2      374
                      GO TO 270                                                       PRT2      375
               260    CONTINUE                                                        PRT2      376
595                   IMI = I                                                         PRT2      377
                      SIGRAB = SIG2(IMI,NRP1,1)                                       PRT2      378
                      SIGRA = SIGRAB*CPSTMP                                           PRT2      379
                      SIGAXB = (SIG2(IMI,NRP1,3)+SIG2(IMI,NRP2,3))/2.E0               PRT2      380
                      SIGAX = SIGAXB*CPSTMP                                           PRT2      381
600                   SGHPOB = SIG2(IMI,NRP2,2)                                       PRT2      382
                      SGHPIB = SIG2(IMI,NRP1,2)                                       PRT2      383
                      SIGHPO = SGHPOB*CPSTMP                                          PRT2      384
                      SIGHPI = SGHPIB*CPSTMP                                          PRT2      385
                      EPSHPO = EPS22(IMI,NRP2,2)*1.E2                                 PRT2      386
605                   EPSHPI = EPS22(IMI,NRP1,2)*1.E2                                 PRT2      387
                      EPSRA = EPS22(IMI,NRP1,1)*1.E2                                  PRT2      388
                      EPSAX = EPS22(IMI,NRP1,3)*1.E2                                  PRT2      389
               270    CONTINUE                                                        PRT2      390
                      WRITE (6,870) I,SIGRA,SIGRAB,SIGHPI,SGHPIB,SIGHPO,SGHPOB,SIGAX  PRT2      391
610             +     ,SIGAXB,EPSRA,EPSHPI,EPSHPO,EPSAX                               PRT2      392
               280    CONTINUE                                                        PRT2      393
               C                                                                      PRT2      394
                     IF (MECHAN.NE.1) GO TO 290                                       PRT2      395
               C                                                                      PRT2      396
615            C    OUTPUT PLENUM CLADDING STRESSES AND STRAINS                       PRT2      397
               C                                                                      PRT2      398
                     EPSRA = A(ISTRNN+4*NA)*100.                                      PRT2      399
                     EPSHPI = A(ISTRNN+4*NA+1)*100.                                   PRT2      400
                     EPSHPO = A(ISTRNN+4*NA+2)*100.                                   PRT2      401
620                  EPSAX = A(ISTRNN+4*NA+3)*100.                                    PRT2      402
                     SIGRAB = A(ISTRSS+4*NA)                                          PRT2      403
                     SGHPIB = A(ISTRSS+4*NA+1)                                        PRT2      404
                     SGHPOB = A(ISTRSS+4*NA+2)                                        PRT2      405
                     SIGAXB = A(ISTRSS+4*NA+3)                                        PRT2      406
625                  SIGRA = SIGRAB*CPSTMP                                            PRT2      407
                     SIGHPI = SGHPIB*CPSTMP                                           PRT2      408
                     SIGHPO = SGHPOB*CPSTMP                                           PRT2      409
                     SIGAX = SIGAXB*CPSTMP                                            PRT2      410
                     WRITE (6,770) SIGRA,SIGRAB,SIGHPI,SGHPIB,SIGHPO,SGHPOB,SIGAX,SIGAX PRT2    411
630                 +B,EPSRA,EPSHPI,EPSHPO,EPSAX                                     PRT2      412
               C                                                                      PRT2      413
               290   CONTINUE                                                         PRT2      414
               C                                                                      PRT2      415
               C                                                                      PRT2      416
635                  WRITE (6,880)                                                    PRT2      417
               C                                                                      PRT2      418
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                      DO 340 I=2,NA                                                                  PRT2      419
                      IM1 = I-1                                                                      PRT2      420
                      IF (MECHAN-2) 300,310,320                                                      PRT2      421
640         300       CONTINUE                                                                       PRT2      422
                      EPPRA = A(IPLSTC+(I-1)*4)*100.                                                 PRT2      423
                      EPPAX = A(IPLSTC+(I-1)*4+3)*100.                                               PRT2      424
                      EPPHPO = A(IPLSTC+(I-1)*4+2)*100.                                              PRT2      425
                      EPPHPI = A(IPLSTC+(I-1)*4+1)*100.                                              PRT2      426
645                   GO TO 330                                                                      PRT2      427
            310       CONTINUE                                                                       PRT2      428
                      IM2 = I-2                                                                      PRT2      429
                      IM2NA = IM2+NA                                                                 PRT2      430
                      IM2NA2 = IM2NA+NA                                                              PRT2      431
650                   EPPRA = A(LEPP+IM2NA2)*1.E2                                                    PRT2      432
                      EPPAX = A(LEPP+IM2NA)*1.E2                                                     PRT2      433
                      EPPHPI = A(LEPP+IM2)*1.E2                                                      PRT2      434
                      EPPHPO = EPPHPI                                                                PRT2      435
                      GO TO 330                                                                      PRT2      436
655         320       CONTINUE                                                                       PRT2      437
                      EPPRA = EPP2(IM1,NRP1,1)*1.E2                                                  PRT2      438
                      EPPAX = EPP2(IM1,NRP1,3)*1.E2                                                  PRT2      439
                      EPPHPI = EPP2(IM1,NRP1,2)*1.E2                                                 PRT2      440
                      EPPHPO = EPP2(IM1,NRP2,2)*1.E2                                                 PRT2      441
660         330       CONTINUE                                                                       PRT2      442
                      IJ = NR*I-1                                                                    PRT2      443
                      CPDLTX = A(LCPDLT+IM1)*2.32444E3                                               PRT2      444
                      TCAK = TCONV(A(LTCA+IM1))                                                      PRT2      445
                      TBARK = TCONV(A(LTBAR+IM1))                                                    PRT2      446
665                   TFRK = TCONV(A(LTMPDS+IJ))                                                     PRT2      447
                      TBLKK = TCONV(A(LTBLK+IM1))                                                    PRT2      448
                C                                                                                    PRT2      449
                      WRITE (6,890) IM1,TFRK,A(LTMPDS+IJ),TBARK,A(LTBAR+IM1),TCAK,A(                 PRT2      450
                     +    LTCA+IM1),TBLKK,A(LTBLK+IM1),CPDLTX,EPPRA,EPPHPI,EPPHPO,EPPAX              PRT2      451
670         340       CONTINUE                                                                       PRT2      452
                C                                                                                    PRT2      453
                      IF (MECHAN.NE.1) GO TO 350                                                     PRT2      454
                C                                                                                    PRT2      455
                C   OUTPUT PLENUM CLAD STRAINS                                                       PRT2      456
675             C                                                                                    PRT2      457
                      EPPRA = A(IPLSTC+4*NA)*100.                                                    PRT2      458
                      EPPHPI = A(IPLSTC+4*NA+1)*100.                                                 PRT2      459
                      EPPHPO = A(IPLSTC+4*NA+2)*100.                                                 PRT2      460
                      EPPAX = A(IPLSTC+4*NA+3)*100.                                                  PRT2      461
680                   WRITE (6,760) EPPRA,EPPHPI,EPPHPO,EPPAX                                        PRT2      462
                C                                                                                    PRT2      463
                350   CONTINUE                                                                       PRT2      464
                C                                                                                    PRT2      465
                      IF (MECHAN.EQ.1) DLROD = SUMM                                                  PRT2      466
685                   DLRDSI = DLROD*25.4                                                            PRT2      467
                      WRITE (6,750) DLRDSI,DLROD                                                     PRT2      468
                C                                                                                    PRT2      469
                C                                                                                    PRT2      470
                      GO TO 390                                                                      PRT2      471
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      360   CONTINUE                                                          PRT2      472
C                                                                             PRT2      473
      CALL PGHEAD (CODEID,MODLOP,TITLE)                                       PRT2      474
C                                                                             PRT2      475
      WRITE (6,950)                                                           PRT2      476
      WRITE (6,960)                                                           PRT2      477
      IF (NUNITS.EQ.1) WRITE (6,970)                                          PRT2      478
      IF (NUNITS.EQ.0) WRITE (6,980)                                          PRT2      479
C                                                                             PRT2      480
          DO 370 II=2,IM                                                      PRT2      481
          IIT = II-1                                                          PRT2      482
          AAA(1) = TIME(II)/CONVER(1)                                         PRT2      483
          AAA(2) = A(LPRT2+IIT)*CONVER(2)                                     PRT2      484
          AAA(3) = A(LPRT3+IIT)*CONVER(3)                                     PRT2      485
          AAA(4) = (A(LPRT4+IIT)+CONVER(4))/CONVER(5)                         PRT2      486
          AAA(5) = (A(LPRT5+IIT)+CONVER(4))/CONVER(5)                         PRT2      487
          AAA(6) = (A(LPRT6+IIT)+CONVER(4))/CONVER(5)                         PRT2      488
          AAA(7) = A(LPRT7+IIT)*CONVER(6)                                     PRT2      489
          AAA(8) = (A(LPRT8+IIT)+CONVER(4))/CONVER(5)                         PRT2      490
          AAA(9) = (A(LPRT9+IIT)+CONVER(4))/CONVER(5)                         PRT2      491
          AAA(10) = (A(LPRT10+IIT)+CONVER(4))/CONVER(5)                       PRT2      492
          AAA(11) = (A(LPRT11+IIT)+CONVER(4))/CONVER(5)                       PRT2      493
          AAA(12) = A(LPRT12+IIT)*CONVER(7)                                   PRT2      494
          AAA(13) = A(LPRT13+IIT)*CONVER(7)                                   PRT2      495
          AAA(14) = A(LPRT14+IIT)*CONVER(7)                                   PRT2      496
          AAA(15) = A(LPRT15+IIT)*100.E0                                      PRT2      497
          AAA(16) = A(LPRT16+IIT)*CONVER(9)                                   PRT2      498
          AAA(17) = A(LPRT17+IIT)*CONVER(8)                                   PRT2      499
          AAA(18) = A(LPIT+IIT)*CONVER(7)                                     PRT2      500
          AAA(19) = A(LPRT18+IIT)*CONVER(6)                                   PRT2      501
          AAA(20) = A(LPRT20+IIT)                                             PRT2      502
C                                                                             PRT2      503
          IF (NUNITS.EQ.1) WRITE (6,990) IIT,(AAA(I),I=1,20)                  PRT2      504
          IF (NUNITS.EQ.0) WRITE (6,1000) IIT,(AAA(I),I=1,20)                 PRT2      505
C                                                                             PRT2      506
      370     CONTINUE                                                        PRT2      507
      SRM = 100.E0                                                            PRT2      508
          DO 380 I=1,IM                                                       PRT2      509
      380     SRM = AMIN1(A(LPRT15+I-1),SRM)                                  PRT2      510
      EOLSR = ABS(A(LPRT15+IM-1)-SRM)                                         PRT2      511
C                                                                             PRT2      512
      CALL PGHEAD (CODEID,MODLOP,TITLE)                                       PRT2      513
C                                                                             PRT2      514
      WRITE (6,1010) EOLSR                                                    PRT2      515
C                                                                             PRT2      516
      WRITE (6,1020) TFGFR                                                    PRT2      517
C                                                                             PRT2      518
      WRITE (6,1030) PRT19                                                    PRT2      519
C                                                                             PRT2      520
      390   CONTINUE                                                          PRT2      521
      RETURN                                                                  PRT2      522
C                                                                             PRT2      523
      400   FORMAT (1H0,10X,"ZERO POWER CLADDING AXIAL EXPANSION"," (ROOM TEMP PRT2      524
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      +ERATURE REFERENCE), MM(IN)",F10.2,3X,"(",F6.4,")"/)                    PRT2      525
  410  FORMAT (/,1H ,40X,21H AXIAL REGION NUMBER ,I2,10X,,16H POWER-TIME      PRT2      526
745   +STEP,I3,/)                                                             PRT2      527
  420  FORMAT (3X,"AVG.  LINEAR HEAT RATING, KW/M(KW/FT)",3X,F6.2,"(",F6.     PRT2      528
      +2,")")                                                                 PRT2      529
  430  FORMAT (3X,"LOCAL LINEAR HEAT RATING, KW/M(KW/FT)",3X,F6.2,"(",F6.     PRT2      530
      +2,")",10X,44H ROD SURFACE HEAT FLUX, W/M**2(BTU/HR-FT**2),2X,1PE8.     PRT2      531
750   +2,1H(,1PE8.2,1H))                                                      PRT2      532
  440  FORMAT (3X,"PEAK  LINEAR HEAT RATING, KW/M(KW/FT)",3X,F6.2,"(",F6.     PRT2      533
      +2,")"/)                                                                PRT2      534
  450  FORMAT (3X,"STEP STARTS AT TIME, DAYS(SEC)  ",F7.2,"(",1PE9.2,")",     PRT2      535
      +15X,37HSTARTING BURNUP,  MWS/KGU(MWD/MTU)   ,0PE11.4,1H(,F7.0,1H))     PRT2      536
755  460  FORMAT (3X,"TIME INCREMENT,      DAYS(SEC)  ",F7.2,"(",1PE9.2,")",     PRT2      537
      +15X,37HBURNUP INCREMENT, MWS/KGU(MWD/MTU)   ,0PE11.4,1H(,F7.0,1H))     PRT2      538
  470  FORMAT (3X,"END STEP,            DAYS(SEC)  ",F7.2,"(",1PE9.2,")",     PRT2      539
      +15X,37HEND STEP BURNUP,  MWS/KGU(MWD/MTU)   ,0PE11.4,1H(,F7.0,1H))     PRT2      540
  480  FORMAT (/52X,"RADIAL TEMPERATURE DISTRIBUTION"//29X,27X,"RADIUS, C      PRT2      541
760   +M(IN)",17X,"TEMP, K(F)"/)                                              PRT2      542
  490  FORMAT (27X,"FUEL--CENTER          ",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      543
      +,"(",F5.0,")")                                                         PRT2      544
  500  FORMAT (27X,"FUEL--.2*RADIUS       ",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      545
      +,"(",F5.0,")")                                                         PRT2      546
765   510  FORMAT (27X,"FUEL--.4*RADIUS       ",5X,F6.4,"(",F7.4,")",17X,F5.0  PRT2      547
      +,"(",F5.0,")")                                                         PRT2      548
  520  FORMAT (27X,"FUEL--.6*RADIUS       ",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      549
      +,"(",F5.0,")")                                                         PRT2      550
  530  FORMAT (27X,"FUEL--.8*RADIUS       ",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      551
770   +,"(",F5.0,")")                                                         PRT2      552
  540  FORMAT (27X,"FUEL--OUTER SURFACE   ",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      553
      +,"(",F5.0,")"/)                                                        PRT2      554
  550  FORMAT (27X,"CLADDING INNER SURFACE",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      555
      +,"(",F5.0,")")                                                         PRT2      556
775   560  FORMAT (27X,"CLADDING OUTER SURFACE",5X,F6.4,"(",F7.4,")",17X,F5.0  PRT2      557
      +,"(",F5.0,")"/)                                                        PRT2      558
  570  FORMAT (27X,"OXIDE SURFACE          ",5X,F6.4,"(",F7.4,")",17X,F5.0      PRT2      559
      +,"(",F5.0,")"/)                                                        PRT2      560
  580  FORMAT (27X,"COOLANT TEMPERATURE    ",37X,F5.0,"(",F5.0,")"//)          PRT2      561
780   590  FORMAT (3X,"    RADIAL GEOMETRY CHANGES    ",5X,"          INTERFAC  PRT2      562
      +E CONDITIONS          ",6X," STRESSES, MPA(KSI)  ",6X,"STRAINS, PC      PRT2      563
      +T "/)                                                                  PRT2      564
  600  FORMAT (3X,"PERCENT CHANGE IN",18X,"GAS CONDUCTIVITY, W/M-K",8X,1P      PRT2      565
      +E9.2,5X,"RADIAL  ",0PF6.1,"(",F6.2,")",9X,F5.2/3X,"FUEL RADIUS DUE     PRT2      566
785   + TO",30X,"(BTU/HR-FT-F)",4X,"(",1PE9.2,")",4X,"AXIAL",3X,0PF6.1,"(     PRT2      567
      +",F6.2,")",9X,F5.2)                                                    PRT2      568
  610  FORMAT (83X,"HOOP",4X,F6.1,"("F6.2,")",9X,F5.2)                         PRT2      569
  620  FORMAT (9X,"DENSIFICATION",6X,F6.3,4X,"GAP CONDUCTANCE, W/M2-K",8X      PRT2      570
      +,1PE9.2)                                                               PRT2      571
790   630  FORMAT (9X,"SWELLING     ",6X,F6.3,17X,"(BTU/HR-FT2-F)",3X,"(",1PE  PRT2      572
      +9.2,")")                                                               PRT2      573
  640  FORMAT (9X,"THERMAL EXPANSION",2X,F6.3)                                 PRT2      574
  650  FORMAT (27X,"--------",3X,"INTERFACE RESISTANCE, M2-K/W",3X,1PE9.2       PRT2      575
      +/10X," TOTAL  ",10X,0PF6.3,19X,"(HR-FT2-F/BTU) (",1PE9.2,")",4X,"C      PRT2      576
795   +LAD-COOLANT FILM COEFFICIENT, W/M2-K",2X,E10.2/107X,"(BTU/HR-FT2-F      PRT2      577
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     +) (",E9.2,")"/)                                                                  PRT2      578
660   FORMAT (3X,"PCT CHANGE IN CLADDING ",12X,"FRACTION CONDUCTANCE DUE                PRT2      579
     + TO "/6X,"RADIUS DUE TO")                                                        PRT2      580
670   FORMAT (3X,"PCT CHANGE IN CLADDING ",12X,"FRACTION CONDUCTANCE DUE                PRT2      581
800       + TO ",17X,"EFFECTIVE FUEL ELASTIC MODULI, PA(PSI)"/6X,"RADIUS DUE           PRT2      582
     +TO")                                                                             PRT2      583
680   FORMAT (44X,"GAS CONDUCTANCE",10X,F5.3)                                           PRT2      584
690   FORMAT (44X,"GAS CONDUCTANCE",10X,F5.3,32X,"RADIAL",1X,1PE9.2,"(",                PRT2      585
     +E9.2,")")                                                                        PRT2      586
805   700   FORMAT (9X,"PERMANENT  ",8X,F6.3,10X,"CONTACT    ",14X,F5.3)              PRT2      587
710   FORMAT (9X,"PERMANENT  ",8X,F6.3,10X,"CONTACT    ",14X,F5.3,32X,"A                PRT2      588
     +XIAL ",1X,1PE9.2,"(",E9.2,")")                                                   PRT2      589
720   FORMAT (9X,"RECOVERABLE",8X,F6.3,10X,"RADIATION  ",14X,F5.3/27X,"-                PRT2      590
     +-------")                                                                        PRT2      591
810   730   FORMAT (9X,"  TOTAL  ",10X,F6.3,4X,"INTERFACE PRESSURE, MPA",6X,F6        PRT2      592
     +.1/57X,"(PSI)    (",F6.1,")"/)                                                   PRT2      593
740   FORMAT (9X,"  TOTAL  ",10X,F6.3,4X,"INTERFACE PRESSURE, MPA",6X,F6              PRT2      594
     +.1,10X,"FUEL THERMAL CONDUCTIVITY"/57X,"(PSI)",4X,"(",F6.1,")",13X             PRT2      595
     +,"DEGRADATION FACTOR",F7.3/)                                                     PRT2      596
815   750   FORMAT (/10X,"CLADDING AXIAL EXPANSION (ROOM TEMPERATURE REFERENCE        PRT2      597
     +), MM(IN)",F10.2,3X,"(",F6.4,")"/)                                               PRT2      598
760   FORMAT (3X,"PLENUM",79X,F5.2,6X,F5.2,3X,F5.2,5X,F5.2)                             PRT2      599
770   FORMAT (3X,"PLENUM",3X,F6.1,"(",F7.0,")",4X,F6.1,"(",F7.0,")",1X,F                PRT2      600
     +6.1,"(",F7.0,")",4X,F6.1,"(",F7.0,")",7X,F5.2,6X,F5.2,3X,F5.2,5X,F               PRT2      601
820  +5.2)                                                                             PRT2      602
780   FORMAT (/,1H ,56X,16H POWER-TIME STEP,I3)                                         PRT2      603
790   FORMAT (/10X,"BURNUP TO END OF TIME STEP,MWS/KGU(MWD/MTU)",F9.0,"(                PRT2      604
     +",F7.0,")",24X,"GAS COMPOSITION"//18X,"COMPONENTS OF INTERNAL VOID               PRT2      605
     + AND TEMPERATURES",20X,"GAS",8X,"CUMULATIVE FRACTION",5X,"CURRENT                PRT2      606
825  +MOLE"/79X,"COMPONENT",10X,"RELEASED,",12X,"FRACTION"/36X,"ASSOCIAT               PRT2      607
     +ED",12X,"FRACTION"/17X,"ITEM",12X,"TEMPERATURE, K(F)",6X,"TOTAL VO               PRT2      608
     +LUME",13X,"HE",16X,F5.3,16X,F5.3/81X,"H",17X,F5.3,16X,F5.3)                      PRT2      609
800   FORMAT (/12X,33H TOTAL VOID VOLUME, CU.CM(CU.IN.),7X,F7.2,1H(,F6.3                PRT2      610
     +,1H),7X,"CUMULATIVE QUANTITY OF FREE GAS IN THE ROD, MOLES",1X,1PE               PRT2      611
830  +7.1/12X,37H ROD INTERNAL GAS PRESSURE, MPA(PSIA),4X,0PF6.3,1H(,F6.               PRT2      612
     +0,1H),7X,"CUMULATIVE FISSION GAS RELEASE, PERCENT",11X,F5.2//)                   PRT2      613
810   FORMAT (13X,"PLENUM              ",5X,F5.0,"(",F5.0,")",12X,F5.3,17X,             PRT2      614
     +"N  ",15X,F5.3,16X,F5.3)                                                         PRT2      615
820   FORMAT (13X,"GAP                 ",5X,F5.0,"(",F5.0,")",12X,F5.3,17X,             PRT2      616
835  +"AR ",15X,F5.3,16X,F5.3)                                                         PRT2      617
830   FORMAT (13X,"ROUGHNESS           ",5X,F5.0,"(",F5.0,")",12X,F5.3,17X,             PRT2      618
     +"KR ",15X,F5.3,16X,F5.3)                                                         PRT2      619
840   FORMAT (13X,"DISHES              ",5X,F5.0,"(",F5.0,")",12X,F5.3,17X,             PRT2      620
     +"XE ",15X,F5.3,16X,F5.3)                                                         PRT2      621
840   850   FORMAT (13X,"POROSITY            ",5X,F5.0,"(",F5.0,")",12X,F5.3,17X,     PRT2      622
     +"H2O",15X,F5.3,16X,F5.3)                                                         PRT2      623
860   FORMAT (13X,"-------------------CLADDING STRESSES, MPA(PSI)------               PRT2      624
     +-------------",9X,"-----CLADDING STRAINS,PERCENT-----"/3X,"AXIAL"                PRT2      625
     +,9X,"RADIAL",22X,"HOOP",22X,"AXIAL",13X,"RADIAL",10X,"HOOP",9X,"AX              PRT2      626
845  +IAL"/3X,"REGION",10X,"ID",17X,"ID",14X,"OD",35X,"ID",9X,"ID",6X,"O               PRT2      627
     +D"/)                                                                             PRT2      628
870   FORMAT (5X,I2,5X,F6.1,"(",F7.0,")",4X,F6.1,"(",F7.0,")",1X,F6.1,"(               PRT2      629
     +",F7.0,")",4X,F6.1,"(",F7.0,")",7X,F5.2,6X,F5.2,3X,F5.2,5X,F5.2)                 PRT2      630
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                880   FORMAT (/3X,"AXIAL",3X,"CENTERLINE",3X,"FUEL AVERAGE",2X,"CLADDING PRT2      631
850                   + AVERAGE",4X,7HCOOLANT,9X,6HSTORED,3X,6(1H-),34HCLADDING PERMANENT PRT2      632
                      + STRAINS,PERCENT,6(1H-)/3X,"REGION",2X,"TEMPERATURE",2X,"TEMPERATU PRT2      633
                      +RE",6X,"TEMPERATURE",4X,11HTEMPERATURE,7X,6HENERGY,9X,6HRADIAL,10X PRT2      634
                      +,4HHOOP,9X,5HAXIAL,/14X,4HK(F),10X,"K(F)",12X,"K(F)",11X,4HK(F),12 PRT2      635
                      +X,4HJ/KG,12X,2HID,9X,2HID,6X,2HOD,/)                               PRT2      636
855             890   FORMAT (5X,I2,3X,2(F5.0,"(",F5.0,")",2X),2X,F5.0,"(",F5.0,")",3X,F PRT2      637
                      +5.0,1H(,F5.0,1H),6X,1PE8.2,7X,0PF5.2,6X,F5.2,3X,F5.2,5X,F5.2)      PRT2      638
                900   FORMAT (13X,"CRACK                ",5X,F5.0,"(",F5.0,")",12X,F5.3)  PRT2      639
                910   FORMAT (1H+,79X,18H FRACAS-I SUBCODE ,/)                            PRT2      640
                920   FORMAT (1H+,79X,18H FRACAS-II SUBCODE,/)                            PRT2      641
860             930   FORMAT (1H+,79X,18H PELET SUBCODE    ,/)                            PRT2      642
                940   FORMAT (1H ,35X,44H MECHANICAL PARAMETERS AND RESULTS USING THE)    PRT2      643
                950   FORMAT (//)                                                         PRT2      644
                960   FORMAT (42X,10H**********,2X,30H PEAK POWER AXIAL NODE OUTPUT ,10H PRT2      645
                      +**********,/)                                                      PRT2      646
865             970   FORMAT (3X,53H TIME   BURNUP POWER  CLAD TEMP (F)   GAP   GAP  FUE PRT2      647
                      +L,49H TEMP (F)  CONT.   CLAD STRESS  STRAIN FUEL OD   ,23H GAP   F PRT2      648
                      +GAS  ZRO2    H2,/,2X,15H HOURS   MWD/TU,50H KW/FT  OD.  AVG  ID.  PRT2      649
                      +MILS   (F)  OD.  AVG CENT  ,50H PSI    HOOP  AXIAL   PCT    INCH  PRT2      650
                      +  CONDCT   PSI ,12H MIL     PPM,/,1X,29HXXXXXXXX XXXXXXX XXXXX XXX PRT2      651
870                   +XXX,52HXXXXXXXX XXXXXX XXXX XXXXXXXXXXXXX  XXXXX XXXXXXXXX,49HXXX PRT2      652
                      +XXXXXXXXX XXXXXXX  XXXXXX XXXXX XXXXX  XXXXXX )                    PRT2      653
                980   FORMAT (3X,53H TIME   BURNUP POWER  CLAD TEMP (K)   GAP   GAP  FUE PRT2      654
                      +L,49H TEMP (K)  CONT.   CLAD STRESS  STRAIN FUEL OD   ,23H GAP   F PRT2      655
                      +GAS  ZRO2    H2,/,1H ,16H SEC*E-3  MWS/KG,50H KW/M   OD.  AVG  ID. PRT2      656
875                   +   MM    (K)  OD.  AVG CENT  ,50H MPA    HOOP  AXIAL   PCT     M  PRT2      657
                      +    CONDCT  MPA  ,12H  MM     PPM,/,1X,29HXXXXXXX XXXXXXX XXXXX X PRT2      658
                      +XXXXX,52HXXXXXXXX XXXXXX XXXX XXXXXXXXXXXXX  XXXXX XXXXXXXXX,49HX PRT2      659
                      +XXXXXXXXXX XXXXXXX  XXXXXX XXXXX XXXXX  XXXXXX )                   PRT2      660
                990   FORMAT (1H ,I2,F6.0,F8.0,F6.2,3(F5.0),1X,F6.2,4(F5.0),1X,F6.0,1X,F PRT2      661
880                   +7.0,F7.0,F7.4,F8.5,1X,F7.0,1X,F5.0,F6.2,1X,F7.1)                   PRT2      662
                1000  FORMAT (1H ,I2,F6.0,F8.0,F6.2,3(F5.0),1X,F6.2,4(F5.0),1X,F6.3,1X,F PRT2      663
                      +7.3,F7.3,F7.4,F8.6,1X,F7.0,F6.3,F6.2,1X,F7.1)                      PRT2      664
                1010  FORMAT (//,40X,38H END OF LIFE STRAIN RANGE (PERCENT) = ,F9.4)      PRT2      665
                1020  FORMAT (//,40X,43H FISSION GAS CUMULATIVE FRACTION RELEASE = ,F8.6 PRT2      666
885                   +,/)                                                                PRT2      667
                1030  FORMAT (//,40X,30H ZRO2 WEIGHT GAIN ,(GM/M**2) =,F8.2,/)           PRT2      668
                      END                                                                 PRT2      669
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES						
4	PRINT2	1	740						
VARIABLES	**SN**	**TYPE**	**RELOCATION**						
0	A	REAL	ARRAY FAST	REFS	9	245	299	301	302	303	308
				311	315	318	319	324	325	326	327
				329	330	332	337	338	340	356	357

VARIABLES	SN	TYPE			RELOCATION								
						366	367	368	2*369	371	372	373	374
						375	381	382	383	384	386	388	389
						390	396	422	423	424	425	2*433	434
						435	436	445	448	461	476	507	519
						520	521	2*527	530	549	550	551	552
						554	565	566	567	568	569	570	571
						572	581	582	583	584	585	587	589
						591	592	617	618	619	620	621	622
						623	624	641	642	643	644	650	651
						652	662	663	664	665	666	4*668	676
						677	678	679	702	703	704	705	706
						707	708	709	710	711	712	713	714
						715	716	717	718	719	720	728	729
					DEFINED	296							
0	AAA	REAL	ARRAY	REALS	REFS	110	722	723	DEFINED	701	702	703	
						704	705	706	707	708	709	710	711
						712	713	714	715	716	717	718	719
						720							
0	AAHA	REAL	ARRAY	MATCNS	REFS	202							
24	AAN	REAL		REALS	REFS	110							
0	ACOR	REAL		INPTR	REFS	156							
1	AFAL	REAL		INPTR	REFS	156							
2	AFCR	REAL		INPTR	REFS	156							
3	AFDN	REAL		INPTR	REFS	156							
4	AFGR	REAL		INPTR	REFS	156							
5	AFSW	REAL		INPTR	REFS	156							
6	AFTC	REAL		INPTR	REFS	156							
7	AGPC	REAL		INPTR	REFS	156							
25	AIRIN	REAL		REALS	REFS	110							
10	AMFAIR	REAL		INPTR	REFS	156							
11	AMFARG	REAL		INPTR	REFS	156		549					
12	AMFFG	REAL		INPTR	REFS	156							
13	AMFHE	REAL		INPTR	REFS	156		547					
14	AMFH2	REAL		INPTR	REFS	156		547					
15	AMFH2O	REAL		INPTR	REFS	156		552					
16	AMFKRY	REAL		INPTR	REFS	156		550					
17	AMFN2	REAL		INPTR	REFS	156		548					
20	AMFXE	REAL		INPTR	REFS	156		551					
26	AMGP	REAL	ARRAY	REALS	REFS	110							
30	AMGPH	REAL	ARRAY	REALS	REFS	110							
32	AMGR	REAL	ARRAY	REALS	REFS	110							
34	AMGRH	REAL	ARRAY	REALS	REFS	110							
36	AMGRN2	REAL	ARRAY	REALS	REFS	110							
40	AMWDT	REAL		REALS	REFS	110							
41	ANGI	REAL		REALS	REFS	110							
42	ANGT	REAL		REALS	REFS	110							
2555	ANRIN	REAL		INPTR	REFS	156							
43	AN2IN	REAL		REALS	REFS	110							
5257	ARAD	REAL			REFS	410		411	412	413	414		
					DEFINED	369		384	396				
44	ARGIN	REAL		REALS	REFS	110							
45	ARING	REAL		REALS	REFS	110							
46	AVGQI	REAL	ARRAY	REALS	REFS	110							

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VARIABLES     SN  TYPE          RELOCATION
    56  B          REAL      ARRAY    REALS      REFS      110      449    DEFINED      448
    64  BP         REAL               REALS      REFS      110      304      480    DEFINED      302
  5205  BPM        REAL                          REFS      480    DEFINED      304
    65  BPP        REAL               REALS      REFS      110      305      478    DEFINED      301
  5206  BPPM       REAL                          REFS      478    DEFINED      305
    66  BR         REAL      ARRAY    REALS      REFS      110      462    DEFINED      461
    74  BU         REAL               REALS      REFS      110      516      547
    21  BUIN       REAL      ARRAY    INPTR      REFS      156
    75  BUOLD      REAL               REALS      REFS      110
    10  BUP        REAL               PHYPRO     REFS      209
  5337  BUSI       REAL                          REFS      547    DEFINED      516
    47  CATEXF     REAL               INPTR      REFS      156
  2726  CBHTW1     REAL                          REFS      313      328      335    DEFINED      268
  2724  CBHTW2     REAL                          REFS      300    DEFINED      266
  2733  CDATOS     REAL                          REFS      341      352      353      355    DEFINED      272
    76  CDG        REAL               REALS      REFS      110
  2731  CFTTM      REAL                          REFS      335    DEFINED      269
  2732  CFTTOM     REAL                          REFS      340      342      343    DEFINED      272
    77  CFV        REAL               REALS      REFS      110      518
   100  CFVA       REAL               REALS      REFS      110
  5223  CGAPSI     REAL                          REFS      335      493    DEFINED      334
     3  CHEFUS     REAL               PHYPRO     REFS      209
  2723  CHRTOS     REAL                          REFS      297      298    DEFINED      266
  2734  CINCM3     REAL                          REFS      523    DEFINED      272
  2736  CINTCM     REAL                          REFS      416      417      418      419      420      421      427
                                                   428      429    DEFINED      273
    50  CLDWKD     REAL               INPTR      REFS      156
  2556  CLDWKS     REAL               INPTR      REFS      156
   601  CLOS       REAL               REALS      REFS      134
  2725  CMDTMS     REAL                          REFS      304      305      306      516    DEFINED      267
  2730  CMLTOM     REAL                          REFS      323    DEFINED      269
   101  CMOL       REAL               REALS      REFS      110
   102  CODEID     REAL      ARRAY    REALS      REFS      110      293      514      692      731
   606  COLDWK     REAL               REALS      REFS      134
    11  COMP       REAL               PHYPRO     REFS      209
  5237  CONCND     REAL                          REFS      503      504    DEFINED      348
  5224  CONGAP     REAL                          REFS      493    DEFINED      335
   121  CONVC      REAL               REALS      REFS      110
   122  CONVER     REAL      ARRAY    REALS      REFS      110      701      702      703    2*704    2*705    2*706
                                                   707    2*708    2*709    2*710    2*711      712      713      714
                                                   716      717      718      719
  2557  CP         REAL               INPTR      REFS      156
  5225  CPDLTX     REAL                          REFS      668    DEFINED      337      662
    51  CPL        REAL               INPTR      REFS      156
  2735  CPSTMP     REAL                          REFS      376      377      378      391      392      393      406
                                                   407      408      544      573      574      575      576      581
                                                   583      585      597      599      602      603      625      626
                                                   627      628    DEFINED      273
  2727  CPSTNM     REAL                          REFS      331      333      364      365    DEFINED      268
   134  CPV        REAL               REALS      REFS      110
  2560  CR         REAL               INPTR      REFS      156
    52  CRDT       REAL               INPTR      REFS      156
    53  CRDTR      REAL               INPTR      REFS      156
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VARIABLES	SN	TYPE		RELOCATION							
135	CRDTT	REAL		REALS	REFS	110					
5261	CREAP	REAL			REFS	387	399	503	504	DEFINED	371	386
					398							
2554	CREPHR	REAL		INPTR	REFS	156					
136	CRN	REAL		REALS	REFS	110					
54	CTMAX	REAL	ARRAY	INPTR	REFS	156					
2	CTMELT	REAL		PHYPRO	REFS	209					
4	CTRANB	REAL		PHYPRO	REFS	209					
5	CTRANE	REAL		PHYPRO	REFS	209					
6	CTRANZ	REAL		PHYPRO	REFS	209					
137	CVV	REAL		REALS	REFS	110					
604	CWKF	REAL		REALS	REFS	134					
605	CWNF	REAL		REALS	REFS	134					
102	DCI	REAL	ARRAY	INPTR	REFS	156					
140	DCIH	REAL		REALS	REFS	110					
141	DCIHP	REAL		REALS	REFS	110					
130	DCO	REAL	ARRAY	INPTR	REFS	156					
156	DE	REAL	ARRAY	INPTR	REFS	156					
142	DELBP	REAL		REALS	REFS	110	306	479	DEFINED	303	
5207	DELBPM	REAL			REFS	479	DEFINED	306			
143	DELBU	REAL		REALS	REFS	110					
5245	DELDAY	REAL			REFS	479	DEFINED	355			
144	DELH	REAL		REALS	REFS	110					
12	DELOXY	REAL		PHYPRO	REFS	209					
5316	DELRNG	REAL			REFS	434	435	436	DEFINED	433	
145	DELT	REAL		REALS	REFS	110					
204	DELTAZ	REAL	ARRAY	INPTR	REFS	156					
146	DELTCR	REAL		REALS	REFS	110					
147	DELTDB	REAL		REALS	REFS	110					
150	DELTFC	REAL		REALS	REFS	110					
151	DELTJL	REAL		REALS	REFS	110					
5244	DELTP	REAL			REFS	355	479	DEFINED	354		
0	DELZA	REAL	ARRAY	BA	REFS	246					
232	DEN	REAL		INPTR	REFS	156	295				
233	DENG	REAL		INPTR	REFS	156					
5317	DENR	REAL			REFS	441	495	DEFINED	438		
5235	DENSIX	REAL			REFS	436	438	DEFINED	346	436	
152	DHIC	REAL		REALS	REFS	110					
607	DISH	REAL		REALS	REFS	134					
234	DISHSD	REAL		INPTR	REFS	156					
5200	DLRDSI	REAL			REFS	286	686	DEFINED	285	685	
153	DLREL	REAL		REALS	REFS	110					
154	DLROD	REAL		REALS	REFS	110	285	286	685	686	
					DEFINED	284	684				
155	DLTGC	REAL	ARRAY	REALS	REFS	110					
235	DP	REAL	ARRAY	INPTR	REFS	156					
207	DPH	REAL		REALS	REFS	110					
210	DPHF	REAL		REALS	REFS	110					
211	DPHFP	REAL		REALS	REFS	110					
212	DPWP	REAL		REALS	REFS	110					
5234	DPWX	REAL			REFS	435	439	DEFINED	345	435	
213	DRS	REAL		REALS	REFS	110					
263	DSPG	REAL		INPTR	REFS	156					

VARIABLES	SN	TYPE	RELOCATION									
264	DSPGW	REAL		INPTR	REFS	156						
0	DVHPRS	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
101	EAX	REAL	ARRAY	BA	REFS	246	365	504				
5253	EAXSI	REAL			REFS	504	DEFINED	365				
0	ECREP2	REAL	ARRAY	F.P	REFS	254	DEFINED	1				
1	EMFLAG	REAL	ARRAY	LACHBL	REFS	205						
265	ENRCH	REAL		INPTR	REFS	156						
214	ENRICH	REAL		REALS	REFS	110						
215	EOLSR	REAL		REALS	REFS	110	733	DEFINED	729			
5405	EPPAX	REAL			REFS	668	680	DEFINED	642	651	657	679
5407	EPPHPI	REAL			REFS	653	668	680	DEFINED	644	652	658
					677							
5406	EPPHPO	REAL			REFS	668	680	DEFINED	643	653	659	678
5404	EPPRA	REAL			REFS	668	680	DEFINED	641	650	656	676
0	EPP2	REAL	ARRAY	F.P.	REFS	254	396	656	657	658	659	
					DEFINED	1						
5366	EPSAX	REAL			REFS	609	629	DEFINED	565	592	607	620
5370	EPSHPI	REAL			REFS	609	629	DEFINED	567	590	605	618
5367	EPSHPO	REAL			REFS	590	609	629	DEFINED	566	589	604
					619							
5371	EPSRA	REAL			REFS	609	629	DEFINED	568	591	606	617
0	EPS0	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
0	EPS02	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
5254	EPS11	REAL			REFS	370	385	494	DEFINED	366	381	401
5255	EPS2	REAL			REFS	493	DEFINED	367	382	402		
0	EPS22	REAL	ARRAY	F.P.	REFS	254	397	400	401	402	604	605
					606	607	DEFINED	1				
5256	EPS3	REAL			REFS	493	DEFINED	368	383	400		
0	EP2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
55	ERAD	REAL	ARRAY	BA	REFS	246	364	502				
5252	ERADSI	REAL			REFS	502	DEFINED	364				
266	EXO	REAL		INPTR	REFS	156						
5262	EXPNR	REAL			REFS	505	DEFINED	372	387	399		
5321	EXPR	REAL			REFS	441	497	DEFINED	440			
267	FA	REAL		INPTR	REFS	156						
216	FC	REAL	ARRAY	REALS	REFS	110						
7	FDELTA	REAL		PHYPRO	REFS	209						
217	FGIN	REAL		REALS	REFS	110						
270	FGPAV	REAL		INPTR	REFS	156						
220	FGPAVP	REAL		REALS	REFS	110						
221	FGPAVX	REAL		REALS	REFS	121						
1	FHEFUS	REAL		PHYPRO	REFS	209						
222	FH2O	REAL		REALS	REFS	121						
223	FJJ	REAL	ARRAY	REALS	REFS	121						
225	FJJH	REAL	ARRAY	REALS	REFS	121						
271	FLUX	REAL		INPTR	REFS	156						
272	FLXDP	REAL		INPTR	REFS	156						
54	FLXRD	REAL		BA	REFS	246						
227	FMGP	REAL	ARRAY	REALS	REFS	121						
602	FNCK	REAL		REALS	REFS	134						
603	FNCN	REAL		REALS	REFS	134						
2552	FOTMTL	REAL		INPTR	REFS	156						
231	FPOR	REAL		REALS	REFS	121						

VARIABLES	SN	TYPE		RELOCATION								
232	FPORI	REAL		REALS	REFS	121						
273	FQE	REAL		INPTR	REFS	156						
233	FRD	REAL		REALS	REFS	121						
35	FRDEN	REAL		LIMITS	REFS	237						
234	FRDH	REAL		REALS	REFS	121						
235	FRDN	REAL		REALS	REFS	121						
0	FTMELT	REAL		PHYPRO	REFS	209						
5201	FULDEN	REAL			REFS	296	DEFINED	295				
0	FVFRO	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
236	G	REAL		REALS	REFS	121						
0	GAP2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
5236	GASCND	REAL			REFS	501	502	DEFINED	347			
237	GASES	REAL	ARRAY	REALS	REFS	121	334					
246	GASIN	REAL		REALS	REFS	121						
247	GDEN	REAL		REALS	REFS	121						
274	GO	REAL	ARRAY	INPTR	REFS	156						
250	GPTH	REAL	ARRAY	REALS	REFS	121						
302	GPTHE	REAL	ARRAY	REALS	REFS	121						
334	GPTHM	REAL		REALS	REFS	121	323					
335	GPTHP	REAL		REALS	REFS	121						
336	GPTHPS	REAL	ARRAY	REALS	REFS	121						
370	GR	REAL		REALS	REFS	121						
441	GRNSIZ	REAL		INPTR	REFS	156						
3	GROW	REAL		AXL	REFS	244						
371	HCRV	REAL		REALS	REFS	121	522	533				
372	HCV	REAL		REALS	REFS	121						
442	HDISH	REAL		INPTR	REFS	156						
373	HDSHV	REAL		REALS	REFS	121	522	534				
374	HEIN	REAL		REALS	REFS	121						
375	HFLL	REAL		REALS	REFS	121						
376	HFLMDB	REAL		REALS	REFS	121						
377	HFLMP	REAL		REALS	REFS	121	313	498				
400	HFPER	REAL		REALS	REFS	121						
401	HFV	REAL		REALS	REFS	121						
410	HGAP	REAL		REALS	REFS	121	347	DEFINED	326			
412	HGAPR	REAL		REALS	REFS	121	349	DEFINED	327			
5216	HGAPSI	REAL			REFS	350	495	DEFINED	328			
402	HGAPT	REAL		REALS	REFS	121	328	347	348	349	351	496
					DEFINED	324						
403	HGV	REAL		REALS	REFS	121	522	537				
404	HI	REAL		REALS	REFS	121						
405	HMGP	REAL	ARRAY	REALS	REFS	121						
407	HP	REAL		REALS	REFS	121						
413	HPL	REAL		REALS	REFS	121						
443	HPLT	REAL		INPTR	REFS	156						
414	HPORV	REAL		REALS	REFS	121	522	535				
415	HPV	REAL		REALS	REFS	121	522	532				
411	HSOLID	REAL		REALS	REFS	121	348	DEFINED	325			
416	HUPTAK	REAL		REALS	REFS	121						
417	H2OMI	REAL		REALS	REFS	121						
5313	I	INTEGER			REFS	431	445	449	450	451	452	453
					2*527	562	565	566	567	568	569	570
					571	572	595	609	638	641	642	643

VARIABLES	SN	TYPE		RELOCATION								
						644	647	661	722	723	728	
					DEFINED	430	444	526	561	637	722	723
						727						
57	IADJ	INTEGER		LIMITS	REFS	237						
1	IAELM	INTEGER		PNTPNL	REFS	227						
2	IAK	INTEGER		PNTPNL	REFS	227						
3	IARAA	INTEGER		PNTPNL	REFS	227						
4	IARE	INTEGER		PNTPNL	REFS	227						
275	IAXSYM	INTEGER		INPTI	REFS	175						
6	IBA	INTEGER		PNTPNL	REFS	227						
7	IBASAV	INTEGER		PNTPNL	REFS	227						
10	IBASE	INTEGER		PNTPNL	REFS	227						
12	IBBA	INTEGER		PNTPNL	REFS	227						
13	IBBSV	INTEGER		PNTPNL	REFS	227						
14	ICA	INTEGER		PNTPNL	REFS	227						
15	ICC	INTEGER		PNTPNL	REFS	227						
270	ICFAC	INTEGER		POINT	REFS	102	507					
302	ICFCSV	INTEGER		POINT	REFS	102						
24	ICLOSE	INTEGER		INTEG	REFS	148						
0	ICM	INTEGER		INPTI	REFS	175						
67	ICNT	INTEGER		LIMITS	REFS	237						
1	ICOR	INTEGER		INPTI	REFS	175						
16	ICRATE	INTEGER		PNTPNL	REFS	227						
17	ICRPG	INTEGER		PNTPNL	REFS	227						
42	ICRP	INTEGER		LIMITS	REFS	237						
60	ICUT	INTEGER		LIMITS	REFS	237						
2	IDBG	INTEGER		INPTI	REFS	175						
5	IDF	INTEGER		LIMITS	REFS	237						
271	IDG	INTEGER		POINT	REFS	102	369					
272	IDGSAV	INTEGER		POINT	REFS	102						
20	IDISP	INTEGER		PNTPNL	REFS	227						
21	IDISPC	INTEGER		PNTPNL	REFS	227						
22	IDSPSV	INTEGER		PNTPNL	REFS	227						
3	IDXGAS	INTEGER		INPTI	REFS	175						
23	IEFSTR	INTEGER		PNTPNL	REFS	227						
24	IELM	INTEGER		PNTPNL	REFS	227						
25	IELSAV	INTEGER		PNTPNL	REFS	227						
30	IELSTR	INTEGER		PNTPNL	REFS	227						
32	IEPSLM	INTEGER		PNTPNL	REFS	227						
33	IESTNV	INTEGER		PNTPNL	REFS	227						
34	IESTSV	INTEGER		PNTPNL	REFS	227						
0	IFIRST	INTEGER		PNTPNL	REFS	227						
0	IGAP2	INTEGER	ARRAY	F.P.	REFS	254	DEFINED	1				
303	IHLDN	INTEGER		POINT	REFS	102	372					
5332	II	INTEGER			REFS	462	463	464	465	466	700	701
					DEFINED	458	699					
36	IIPOS	INTEGER		PNTPNL	REFS	227						
5416	IIT	INTEGER			REFS	702	703	704	705	706	707	708
						709	710	711	712	713	714	715	716
						717	718	719	720	722	723	
					DEFINED	700						
5315	IJ	INTEGER			REFS	434	435	436	2*448	2*449	2*461	2*462
						665	668	DEFINED	432	447	460	661

VARIABLES	SN	TYPE	RELOCATION									
5323	IK	INTEGER		REFS	444	457	DEFINED	443				
37	IKSAVE	INTEGER	PNTPNL	REFS	227							
5331	IL	INTEGER		REFS	458	DEFINED	457					
106	ILAST	INTEGER	PNTPNL	REFS	227							
26	ILSTNA	INTEGER	PNTPNL	REFS	227							
27	ILSTRA	INTEGER	PNTPNL	REFS	227							
4	IM	INTEGER	INPTI	REFS	175	699	727	729				
4	IMCLAD	INTEGER	EMFLGS	REFS	189							
2	IMDENS	INTEGER	EMFLGS	REFS	189							
23	IMDONE	INTEGER	INTEG	REFS	148	278						
7	IMENRG	INTEGER	EMFLGS	REFS	189							
10	IMFGAS	INTEGER	EMFLGS	REFS	189							
1	IMFUEL	INTEGER	EMFLGS	REFS	189							
5	IMGAPC	INTEGER	EMFLGS	REFS	189							
0	IMPOWR	INTEGER	EMFLGS	REFS	189							
3	IMRELO	INTEGER	EMFLGS	REFS	189							
11	IMSWCH	INTEGER	EMFLGS	REFS	189							
5365	IMI	INTEGER		REFS	579	585	587	589	596	2*598	600	
				601	604	605	606	607	656	657	658	
				659	662	663	664	666	4*668			
				DEFINED	562	595	638					
5402	IMINA	INTEGER		REFS	580	583	584	592	DEFINED	579		
5403	IMINA2	INTEGER		REFS	581	582	591	DEFINED	580			
5410	IM2	INTEGER		REFS	648	652	DEFINED	647				
5411	IM2NA	INTEGER		REFS	649	651	DEFINED	648				
5412	IM2NA2	INTEGER		REFS	650	DEFINED	649					
6	IM93WC	INTEGER	EMFLGS	REFS	189							
40	INADET	INTEGER	PNTPNL	REFS	227							
41	INDC	INTEGER	PNTPNL	REFS	227							
42	INDF	INTEGER	PNTPNL	REFS	227							
43	INDT	INTEGER	PNTPNL	REFS	227							
44	INODET	INTEGER	PNTPNL	REFS	227							
45	IOLDSE	INTEGER	PNTPNL	REFS	227							
5	IPLANT	INTEGER	INPTI	REFS	175							
40	IPLAS	INTEGER	LIMITS	REFS	237							
73	IPLEND	INTEGER	LIMITS	REFS	237							
304	IPLSTC	INTEGER	POINT	REFS	102	371	641	642	643	644	676	
				677	678	679						
273	IPRG	INTEGER	POINT	REFS	102	330						
31	IPSLA	INTEGER	PNTPNL	REFS	227							
46	IPSSRT	INTEGER	PNTPNL	REFS	227							
47	IPSSV	INTEGER	PNTPNL	REFS	227							
50	IPSTS	INTEGER	PNTPNL	REFS	227							
6	IQ	INTEGER	INPTI	REFS	175							
0	IQUIT	INTEGER	INTEG	REFS	148							
51	IR	INTEGER	PNTPNL	REFS	227							
52	IRA	INTEGER	PNTPNL	REFS	227							
71	IRAK	INTEGER	LIMITS	REFS	237							
53	IRBR	INTEGER	PNTPNL	REFS	227							
54	IRBRA	INTEGER	PNTPNL	REFS	227							
55	IRD	INTEGER	PNTPNL	REFS	227	369	424	425				
264	IRDOT	INTEGER	POINT	REFS	97							
75	IRZ	INTEGER	LIMITS	REFS	237							

VARIABLES	SN	TYPE	RELOCATION									
1	IRI	INTEGER	INTEG	REFS	148	289						
265	ISAVGS	INTEGER	POINT	REFS	97							
5	ISB	INTEGER	PNTPNL	REFS	227							
11	ISBB	INTEGER	PNTPNL	REFS	227							
74	ISP	INTEGER	LIMITS	REFS	237							
37	ISSTOP	INTEGER	LIMITS	REFS	237							
56	ISTRES	INTEGER	PNTPNL	REFS	227							
305	ISTRNN	INTEGER	POINT	REFS	102	366	367	368	565	566	567	
				568	617	618	619	620				
57	ISTRSA	INTEGER	PNTPNL	REFS	227							
306	ISTRSS	INTEGER	POINT	REFS	102	373	374	375	569	570	571	
				572	621	622	623	624				
7	ISW	INTEGER	INPTI	REFS	175							
2	IT	INTEGER	INTEG	REFS	148	281	283	288	299	513	519	
				520	521							
60	ITCB	INTEGER	PNTPNL	REFS	227							
300	ITCL	INTEGER	POINT	REFS	102							
61	ITCRP	INTEGER	PNTPNL	REFS	227							
62	ITEC	INTEGER	PNTPNL	REFS	227							
63	ITEF	INTEGER	PNTPNL	REFS	227							
64	ITELM	INTEGER	PNTPNL	REFS	227							
277	ITEMP	INTEGER	POINT	REFS	102							
3	ITER	INTEGER	INTEG	REFS	148							
53	ITERD	INTEGER	BA	REFS	246							
65	ITFB	INTEGER	PNTPNL	REFS	227							
301	ITFS	INTEGER	POINT	REFS	102							
66	ITHET	INTEGER	PNTPNL	REFS	227							
70	ITHSAV	INTEGER	PNTPNL	REFS	227							
67	ITHTAX	INTEGER	PNTPNL	REFS	227							
71	ITHXSV	INTEGER	PNTPNL	REFS	227							
72	ITME	INTEGER	PNTPNL	REFS	227							
5177	ITMI	INTEGER		REFS	341	474	530	546	549	550	551	
				552	554	DEFINED	281					
276	ITRAMP	INTEGER	POINT	REFS	102							
300	ITREST	INTEGER	INPTI	REFS	175							
73	ITSTNR	INTEGER	PNTPNL	REFS	227							
74	ITSTSR	INTEGER	PNTPNL	REFS	227							
75	ITV	INTEGER	PNTPNL	REFS	227							
76	ITW	INTEGER	PNTPNL	REFS	227							
63	ITI	INTEGER	LIMITS	REFS	237							
276	IVARDM	INTEGER	INPTI	REFS	175							
274	IVFC	INTEGER	POINT	REFS	102							
275	IVFF	INTEGER	POINT	REFS	102							
302	IWORDS	INTEGER	INPTI	REFS	175							
267	IX	INTEGER	POINT	REFS	97							
77	IXKT	INTEGER	PNTPNL	REFS	227							
100	IXLOAD	INTEGER	PNTPNL	REFS	227							
101	IXLODA	INTEGER	PNTPNL	REFS	227							
102	IXRD	INTEGER	PNTPNL	REFS	227							
103	IY	INTEGER	PNTPNL	REFS	227							
104	IYACF	INTEGER	PNTPNL	REFS	227							
105	IZ	INTEGER	PNTPNL	REFS	227							
4	J	INTEGER	INTEG	REFS	148	283	289	290	296	299	301	

VARIABLES	SN	TYPE		RELOCATION									
						302	303	308	311	315	318	319	324
						325	326	327	329	330	332	337	338
						340	356	357	364	365	366	367	368
						2*369	371	372	373	374	375	424	425
						432	445	448	461	476	502	504	507
24	JAM	INTEGER		LIMITS	REFS		237						
10	JDLPR	INTEGER		INPTI	REFS		175	290					
35	JIIJ	INTEGER		PNTPNL	REFS		227						
5	JJC	INTEGER		INTEG	REFS		148						
11	JN	INTEGER	ARRAY	INPTI	REFS		175						
6	JPEAK	INTEGER		INTEG	REFS		148	283	290				
21	JST	INTEGER	ARRAY	INPTI	REFS		175						
7	K	INTEGER		INTEG	REFS		148						
12	KA	INTEGER		LIMITS	REFS		237						
10	KINDOR	INTEGER		INTEG	REFS		148						
11	KOXI	INTEGER		INTEG	REFS		148						
66	KPLAS	INTEGER		LIMITS	REFS		237						
55	KRNCH	INTEGER		LIMITS	REFS		237						
45	KRNCHC	INTEGER		LIMITS	REFS		237						
44	KRNCHF	INTEGER		LIMITS	REFS		237						
46	KRNCHT	INTEGER		LIMITS	REFS		237						
420	KRYIN	REAL		REALS	REFS		7	121					
36	KZI	INTEGER		LIMITS	REFS		237						
5314	L	INTEGER			REFS		432	2*433	DEFINED	431			
216	LACE	INTEGER	ARRAY	INPTI	REFS		175						
215	LACMFG	INTEGER		POINT	REFS		81						
216	LACMHE	INTEGER		POINT	REFS		81						
217	LACMH2	INTEGER		POINT	REFS		81						
220	LACMN2	INTEGER		POINT	REFS		81						
215	LACMOD	INTEGER		INPTI	REFS		175						
152	LAK1	INTEGER		POINT	REFS		52						
153	LAK2	INTEGER		POINT	REFS		52						
221	LAMGPT	INTEGER		POINT	REFS		81						
125	LANG	INTEGER		POINT	REFS		38						
120	LANGR	INTEGER		POINT	REFS		38						
253	LANSD	INTEGER		POINT	REFS		91						
256	LANSR	INTEGER		POINT	REFS		91						
14	LARAD	INTEGER		POINT	REFS		19	384	396				
10	LAXGAP	INTEGER		POINT	REFS		19						
11	LAXLEN	INTEGER		POINT	REFS		19						
210	LB	INTEGER		POINT	REFS		71	448					
211	LBR	INTEGER		POINT	REFS		71	461					
212	LBTOLD	INTEGER		POINT	REFS		71						
12	LBU1	INTEGER		POINT	REFS		19	301					
13	LBU2	INTEGER		POINT	REFS		19	302					
172	LCC1	INTEGER		POINT	REFS		64						
173	LCC2	INTEGER		POINT	REFS		64						
213	LCHEM	INTEGER		POINT	REFS		71						
15	LCPDLT	INTEGER		POINT	REFS		19	337	662				
2	LCREP1	INTEGER		POINT	REFS		19						
154	LCRL	INTEGER		POINT	REFS		52						
111	LDCHEK	INTEGER		POINT	REFS		19						
0	LDC1H	INTEGER		POINT	REFS		19	422					

VARIABLES	SN	TYPE	RELOCATION								
261	LDECAY	INTEGER	POINT	REFS	91						
16	LDELBP	INTEGER	POINT	REFS	19	303					
17	LDENMX	INTEGER	POINT	REFS	19	296					
174	LDENSF	INTEGER	POINT	REFS	64	436					
175	LDENSP	INTEGER	POINT	REFS	64						
3	LDLH	INTEGER	POINT	REFS	19						
20	LDLPGE	INTEGER	POINT	REFS	19						
155	LDPL	INTEGER	POINT	REFS	52						
156	LDPLH	INTEGER	POINT	REFS	52						
157	LDPN	INTEGER	POINT	REFS	52						
176	LDPW	INTEGER	POINT	REFS	64	435					
177	LDPWPP	INTEGER	POINT	REFS	64						
260	LDT	INTEGER	POINT	REFS	91						
21	LDZ	INTEGER	POINT	REFS	19						
22	LDZH	INTEGER	POINT	REFS	19						
23	LDZHP	INTEGER	POINT	REFS	19						
24	LECREP	INTEGER	POINT	REFS	19						
25	LEP	INTEGER	POINT	REFS	19						
127	LEPP	INTEGER	POINT	REFS	44	650	651	652			
130	LEPPP	INTEGER	POINT	REFS	44						
131	LEPPSV	INTEGER	POINT	REFS	44	386					
147	LEPPI	INTEGER	POINT	REFS	44						
132	LEPS	INTEGER	POINT	REFS	44	381	382	383	423	589	591
				592							
133	LEPSAV	INTEGER	POINT	REFS	44						
151	LEPSI	INTEGER	POINT	REFS	44						
100	LEPI	INTEGER	POINT	REFS	19						
167	LF	INTEGER	POINT	REFS	59						
134	LFEPS	INTEGER	POINT	REFS	44						
257	LFF	INTEGER	POINT	REFS	91						
121	LFGMGP	INTEGER	POINT	REFS	38						
170	LFH	INTEGER	POINT	REFS	59						
110	LFLAG	INTEGER	POINT	REFS	19						
254	LFLXFC	INTEGER	POINT	REFS	91						
160	LFMA	INTEGER	POINT	REFS	52						
161	LFMGPR	INTEGER	POINT	REFS	52						
122	LFMGR	INTEGER	POINT	REFS	38						
171	LFN	INTEGER	POINT	REFS	59						
26	LGAP	INTEGER	POINT	REFS	19						
222	LGASMQ	INTEGER	POINT	REFS	81	554					
200	LGNSIZ	INTEGER	POINT	REFS	64						
27	LGPTP	INTEGER	POINT	REFS	19						
4	LHA	INTEGER	POINT	REFS	19						
262	LHALF	INTEGER	POINT	REFS	91						
30	LHCOEF	INTEGER	POINT	REFS	19						
123	LHEMGP	INTEGER	POINT	REFS	38						
101	LHGAPS	INTEGER	POINT	REFS	19	324					
114	LHGPC	INTEGER	POINT	REFS	19	326					
115	LHGPR	INTEGER	POINT	REFS	19	327					
116	LHGPS	INTEGER	POINT	REFS	19	325					
5	LHL	INTEGER	POINT	REFS	19						
223	LHMGPT	INTEGER	POINT	REFS	81						
124	LHMGR	INTEGER	POINT	REFS	38						

VARIABLES	SN	TYPE	RELOCATION						
162	LHRL	INTEGER	POINT	REFS	52				
103	LIGAP	INTEGER	POINT	REFS	19				
12	LMN	INTEGER	INTEG	REFS	148				
106	LNFAIL	INTEGER	POINT	REFS	19				
146	LNUDEP	INTEGER	POINT	REFS	44				
31	LOLAXG	INTEGER	POINT	REFS	19				
32	LOLDPC	INTEGER	POINT	REFS	19				
33	LOLDPG	INTEGER	POINT	REFS	19				
34	LOLDTC	INTEGER	POINT	REFS	19				
35	LOLDUR	INTEGER	POINT	REFS	19				
36	LOLEPS	INTEGER	POINT	REFS	19				
37	LOLFEP	INTEGER	POINT	REFS	19				
104	LOLIGP	INTEGER	POINT	REFS	19				
40	LPAXGP	INTEGER	POINT	REFS	19				
41	LPC	INTEGER	POINT	REFS	19				
42	LPECRP	INTEGER	POINT	REFS	19				
43	LPEP	INTEGER	POINT	REFS	19				
135	LPEPSV	INTEGER	POINT	REFS	44				
255	LPF	INTEGER	POINT	REFS	91				
136	LPFPSV	INTEGER	POINT	REFS	44				
44	LPG	INTEGER	POINT	REFS	19				
45	LPINT	INTEGER	POINT	REFS	19	329			
224	LPIT	INTEGER	POINT	REFS	81	718			
46	LPLDPC	INTEGER	POINT	REFS	19				
47	LPLDPG	INTEGER	POINT	REFS	19				
50	LPLDTC	INTEGER	POINT	REFS	19				
51	LPLDUR	INTEGER	POINT	REFS	19				
107	LPLIGP	INTEGER	POINT	REFS	19				
52	LPOAXG	INTEGER	POINT	REFS	19				
53	LPOFEP	INTEGER	POINT	REFS	19				
54	LPOLEP	INTEGER	POINT	REFS	19				
6	LPOROS	INTEGER	POINT	REFS	19				
201	LPORS1	INTEGER	POINT	REFS	64				
202	LPORS2	INTEGER	POINT	REFS	64				
225	LPRT10	INTEGER	POINT	REFS	81	710			
226	LPRT11	INTEGER	POINT	REFS	81	711			
227	LPRT12	INTEGER	POINT	REFS	81	712			
230	LPRT13	INTEGER	POINT	REFS	81	713			
231	LPRT14	INTEGER	POINT	REFS	81	714			
232	LPRT15	INTEGER	POINT	REFS	81	715	728	729	
233	LPRT16	INTEGER	POINT	REFS	81	716			
234	LPRT17	INTEGER	POINT	REFS	81	717			
235	LPRT18	INTEGER	POINT	REFS	81	719			
236	LPRT2	INTEGER	POINT	REFS	81	702			
237	LPRT20	INTEGER	POINT	REFS	81	720			
240	LPRT3	INTEGER	POINT	REFS	81	703			
241	LPRT4	INTEGER	POINT	REFS	81	704			
242	LPRT5	INTEGER	POINT	REFS	81	705			
243	LPRT6	INTEGER	POINT	REFS	81	706			
244	LPRT7	INTEGER	POINT	REFS	81	707			
245	LPRT8	INTEGER	POINT	REFS	81	708			
246	LPRT9	INTEGER	POINT	REFS	81	709			
214	LQ	INTEGER	POINT	REFS	76	299			

VARIABLES	SN	TYPE	RELOCATION							
105	LQDP	INTEGER	POINT	REFS	19	340	476			
206	LR	INTEGER	POINT	REFS	64	2*433				
207	LRAD	INTEGER	POINT	REFS	64					
55	LRDCOL	INTEGER	POINT	REFS	19					
137	LREPS	INTEGER	POINT	REFS	44					
141	LREPSP	INTEGER	POINT	REFS	44					
140	LREPSV	INTEGER	POINT	REFS	44					
126	LREPS2	INTEGER	POINT	REFS	38					
143	LRFEPP	INTEGER	POINT	REFS	44					
142	LRFEPS	INTEGER	POINT	REFS	44					
144	LRFPSV	INTEGER	POINT	REFS	44					
263	LRLEAS	INTEGER	POINT	REFS	91					
113	LRTRNO	INTEGER	POINT	REFS	19					
112	LRTRNP	INTEGER	POINT	REFS	19	445				
145	LSIG	INTEGER	POINT	REFS	44	388	389	390	581	582 583
				584	585	587				
150	LSIGI	INTEGER	POINT	REFS	44					
266	LSTHIF	INTEGER	POINT	REFS	97					
247	LTAC	INTEGER	POINT	REFS	81					
56	LTAF	INTEGER	POINT	REFS	19					
250	LTAFA	INTEGER	POINT	REFS	81	520	530	551	552	
57	LTAG	INTEGER	POINT	REFS	19	332				
251	LTAGA	INTEGER	POINT	REFS	81	519	549			
60	LTBAR	INTEGER	POINT	REFS	19	338	664	668		
61	LTBLK	INTEGER	POINT	REFS	19	308	666	668		
62	LTCA	INTEGER	POINT	REFS	19	663	668			
63	LTCIDI	INTEGER	POINT	REFS	19	318				
64	LTCODI	INTEGER	POINT	REFS	19	319				
163	LTFB	INTEGER	POINT	REFS	52					
164	LTFR	INTEGER	POINT	REFS	52					
165	LTFRK	INTEGER	POINT	REFS	52					
203	LTMPDS	INTEGER	POINT	REFS	64	356	357	665	668	
205	LTMPMX	INTEGER	POINT	REFS	64					
117	LTOXO	INTEGER	POINT	REFS	19	315				
65	LTPS	INTEGER	POINT	REFS	19	527				
102	LTRTRN	INTEGER	POINT	REFS	19	527				
252	LTSF	INTEGER	POINT	REFS	81	521	550			
7	LUFS	INTEGER	POINT	REFS	19					
204	LUO2LL	INTEGER	POINT	REFS	64	434				
1	LURC	INTEGER	POINT	REFS	19					
66	LURF	INTEGER	POINT	REFS	19					
67	LVCH	INTEGER	POINT	REFS	19					
70	LVCHI	INTEGER	POINT	REFS	19					
71	LVCR	INTEGER	POINT	REFS	19					
72	LVDH	INTEGER	POINT	REFS	19					
73	LVFH	INTEGER	POINT	REFS	19					
74	LVGH	INTEGER	POINT	REFS	19					
166	LVPL	INTEGER	POINT	REFS	52					
75	LVPOR	INTEGER	POINT	REFS	19					
76	LZRO2A	INTEGER	POINT	REFS	19					
77	LZRO2B	INTEGER	POINT	REFS	19	311				
13	M	INTEGER	INTEG	REFS	148	299				
52	MAXA	INTEGER	LIMITS	REFS	237					

VARIABLES	SN	TYPE	RELOCATION								
0	MAXIDX	INTEGER	LACMDL	REFS	205						
43	MAXT	INTEGER	LIMITS	REFS	237						
56	MCUD	INTEGER	LIMITS	REFS	237						
166	MDBG	INTEGER	INPTI	REFS	175						
15	MDHPRS	INTEGER	PFRCS2	REFS	195						
271	MECHAN	INTEGER	INPTI	REFS	175	284	329	330	362	422	423
				424	425	499	500	501	502	503	504
				506	507	530	556	557	558	563	613
				639	672	684					
20	MEPP2	INTEGER	PFRCS2	REFS	195						
24	MEPS0	INTEGER	PFRCS2	REFS	195						
22	MEPS02	INTEGER	PFRCS2	REFS	195						
17	MEPS22	INTEGER	PFRCS2	REFS	195						
11	MEP2	INTEGER	PFRCS2	REFS	195						
10	MEREP2	INTEGER	PFRCS2	REFS	195						
14	MFVFR0	INTEGER	PFRCS2	REFS	195						
2	MGAP2	INTEGER	PFRCS2	REFS	195						
3	MIGAP2	INTEGER	PFRCS2	REFS	195						
0	MNA	INTEGER	F.P.	REFS	21*254	DEFINED	1				
0	MNR	INTEGER	F.P.	REFS	14*254	DEFINED	1				
170	MODE	INTEGER	INPTI	REFS	175						
171	MODES	INTEGER	INPTI	REFS	175						
14	MODLOP	INTEGER	INTEG	REFS	148	293	514	692	731		
1	MODPC2	INTEGER	PFRCS2	REFS	195						
0	MODPG2	INTEGER	PFRCS2	REFS	195						
4	MOIGP2	INTEGER	PFRCS2	REFS	195						
13	MOLDT2	INTEGER	PFRCS2	REFS	195						
23	MPEPP2	INTEGER	PFRCS2	REFS	195						
6	MPEPS2	INTEGER	PFRCS2	REFS	195						
16	MPEP2	INTEGER	PFRCS2	REFS	195						
5	MREPS2	INTEGER	PFRCS2	REFS	195						
12	MR22	INTEGER	PFRCS2	REFS	195						
21	MSIG2	INTEGER	PFRCS2	REFS	195						
172	MTAPE	INTEGER	INPTI	REFS	175						
7	MTTT	INTEGER	PFRCS2	REFS	195						
0	MI	INTEGER	LIMITS	REFS	237						
1	M2	INTEGER	LIMITS	REFS	237						
266	NA	INTEGER	INPTI	REFS	175	299	382	383	389	390	423
				579	580	617	618	619	620	621	622
				623	624	637	648	649	676	677	678
				679							
15	NAB	INTEGER	INTEG	REFS	148						
17	NABC	INTEGER	LIMITS	REFS	237						
16	NABF	INTEGER	LIMITS	REFS	237						
31	NABF2	INTEGER	LIMITS	REFS	237						
20	NABT	INTEGER	LIMITS	REFS	237						
32	NABT2	INTEGER	LIMITS	REFS	237						
21	NAEC	INTEGER	LIMITS	REFS	237						
22	NAEF	INTEGER	LIMITS	REFS	237						
233	NAFAIL	INTEGER	INPTI	REFS	175						
14	NARC	INTEGER	LIMITS	REFS	237						
13	NARF	INTEGER	LIMITS	REFS	237						
15	NART	INTEGER	LIMITS	REFS	237						

VARIABLES	SN	TYPE		RELOCATION								
25	NAXBT	INTEGER		LIMITS	REFS	237						
26	NAXB2	INTEGER		LIMITS	REFS	237						
27	NAXB4	INTEGER		LIMITS	REFS	237						
27	NC	INTEGER		INTEG	REFS	148						
52	NCNN	INTEGER		BA	REFS	246						
51	NCONN	INTEGER		BA	REFS	246						
272	NCRACK	INTEGER		INPTI	REFS	175						
274	NCREEP	INTEGER		INPTI	REFS	175						
50	NC4	INTEGER		LIMITS	REFS	237						
173	NDBG	INTEGER		INPTI	REFS	175						
273	NELAST	INTEGER		INPTI	REFS	175						
7	NETOT	INTEGER		LIMITS	REFS	237						
53	NEW	INTEGER		LIMITS	REFS	237						
10	NEWF	INTEGER		LIMITS	REFS	237						
270	NEWPRB	INTEGER		INPTI	REFS	175						
11	NEWT	INTEGER		LIMITS	REFS	237						
26	NF	INTEGER		INTEG	REFS	148	369	424				
6	NFF	INTEGER		LIMITS	REFS	237						
30	NFF1	INTEGER		LIMITS	REFS	237	369	424	425			
47	NFF2	INTEGER		LIMITS	REFS	237						
174	NFROD	INTEGER		INPTI	REFS	175						
51	NF4	INTEGER		LIMITS	REFS	237						
175	NGAPC	INTEGER		INPTI	REFS	175						
176	NGASR	INTEGER		INPTI	REFS	175						
167	NHEAL	INTEGER		INPTI	REFS	175						
41	NKN	INTEGER		LIMITS	REFS	237						
54	NMX	INTEGER		LIMITS	REFS	237						
50	NN	INTEGER		BA	REFS	246						
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	175						
25	NNNCRP	INTEGER		PFRCS2	REFS	195						
2	NOEL	INTEGER		LIMITS	REFS	237						
4	NOELC	INTEGER		LIMITS	REFS	237						
3	NOELF	INTEGER		LIMITS	REFS	237						
177	NOFAIL	INTEGER		INPTI	REFS	175						
277	NOFRAC	INTEGER		INPTI	REFS	175						
65	NOLD	INTEGER		LIMITS	REFS	237						
200	NOPT	INTEGER		INPTI	REFS	175						
201	NPCYCL	INTEGER		INPTI	REFS	175						
16	NPLAST	INTEGER		INTEG	REFS	148						
263	NPLOT	INTEGER		INPTI	REFS	175						
202	NPLTAB	INTEGER		INPTI	REFS	175						
304	NPRINT	INTEGER		INPTI	REFS	175						
267	NR	INTEGER		INPTI	REFS	175	279	280	356	357	430	431
						432	661					
203	NREAD	INTEGER		INPTI	REFS	175						
204	NRESTR	INTEGER		INPTI	REFS	175						
17	NRMI	INTEGER		INTEG	REFS	148						
265	NROD	INTEGER		INPTI	REFS	175						
205	NROLL	INTEGER		INPTI	REFS	175						
5175	NRP1	INTEGER			REFS	397	398	400	401	402	403	404
						405	596	598	601	605	606	607	656
						657	658	DEFINED	279			
5176	NRP2	INTEGER			REFS	598	600	604	659	DEFINED	280	

VARIABLES	SN	TYPE		RELOCATION									
25	NSH	INTEGER		INTEG	REFS	148							
206	NSP	INTEGER		INPTI	REFS	175							
207	NSTART	INTEGER		INPTI	REFS	175							
20	NSTEP	INTEGER		INTEG	REFS	148							
210	NSTOP	INTEGER		INPTI	REFS	175							
211	NT	INTEGER		INPTI	REFS	175	526	529	561				
23	NTAE	INTEGER		LIMITS	REFS	237							
212	NTAPE	INTEGER		INPTI	REFS	175							
264	NTPLOT	INTEGER		INPTI	REFS	175							
421	NU	REAL		REALS	REFS	7	121						
213	NUCFC	INTEGER		INPTI	REFS	175							
214	NUNITS	INTEGER		INPTI	REFS	175	696	697	722	723			
301	NWORDS	INTEGER		INPTI	REFS	175							
303	NWRDS	INTEGER		INPTI	REFS	175							
21	NWRITE	INTEGER		INTEG	REFS	148							
262	NXP	INTEGER		INPTI	REFS	175							
22	N2	INTEGER		INTEG	REFS	148	381	382	383	384	396	398	
						389	390	396	397	398	400	401	402
						403	404	405	422	423	474		
0	OLDPC2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1					
0	OLDPG2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1					
0	OLDT2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1					
0	OLIGP2	INTEGER	ARRAY	F.P.	REFS	253	254	DEFINED	1				
422	OXDROP	REAL		REALS	REFS	121							
423	OXIDE	REAL		REALS	REFS	121	426	DEFINED	311				
424	PECDH	REAL		REALS	REFS	121							
0	PEPP2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1					
0	PEP2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1					
425	PI	REAL		REALS	REFS	121							
426	PIN	REAL	ARRAY	REALS	REFS	121							
5217	PINBR	REAL			REFS	331	506	507	DEFINED	329	330		
460	PINP	REAL		REALS	REFS	121							
5220	PINSI	REAL			REFS	506	507	DEFINED	331				
461	PORO	REAL		REALS	REFS	121							
444	PPMH2O	REAL		INPTR	REFS	156							
445	PPMN2	REAL		INPTR	REFS	156							
462	PR	REAL		REALS	REFS	121							
0	PREPS2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1					
5222	PRESG	REAL			REFS	334	DEFINED	333					
463	PRESS	REAL		REALS	REFS	121	333	544	554				
5364	PRSMPA	REAL			REFS	554	DEFINED	544					
464	PRTY	REAL		REALS	REFS	121							
465	PRT19	REAL		REALS	REFS	121	737						
446	P2	REAL	ARRAY	INPTR	REFS	156							
473	QAV	REAL		REALS	REFS	121	343	475					
5232	QAVM	REAL			REFS	475	DEFINED	343					
466	QC	REAL		REALS	REFS	121	300	476	DEFINED	299			
5204	QCM	REAL			REFS	476	DEFINED	300					
5227	QDPM	REAL			REFS	476	DEFINED	340					
613	QEND	REAL	ARRAY	INPTR	REFS	156							
623	QF	REAL	ARRAY	INPTR	REFS	156							
1333	QMPY	REAL	ARRAY	INPTR	REFS	156	299						
467	QP	REAL		REALS	REFS	121							

VARIABLES	SN	TYPE		RELOCATION								
474	QPEAK	REAL		REALS	REFS	121	342	477				
5231	QPEAKM	REAL			REFS	477	DEFINED	342				
470	QSP	REAL		REALS	REFS	121						
5276	RADCL	REAL			REFS	416	482	DEFINED	415			
5277	RADCLM	REAL			REFS	482	DEFINED	416				
5240	RADCND	REAL			REFS	505	DEFINED	349				
5271	RADP2	REAL			REFS	417	483	DEFINED	410			
5300	RADP2M	REAL			REFS	483	DEFINED	417				
5272	RADP4	REAL			REFS	418	484	DEFINED	411			
5301	RADP4M	REAL			REFS	484	DEFINED	418				
5273	RADP6	REAL			REFS	419	485	DEFINED	412			
5302	RADP6M	REAL			REFS	485	DEFINED	419				
5274	RADP8	REAL			REFS	420	486	DEFINED	413			
5303	RADP8M	REAL			REFS	486	DEFINED	420				
5275	RADSR	REAL			REFS	421	487	DEFINED	414			
5304	RADSRM	REAL			REFS	487	DEFINED	421				
72	RAKSUM	REAL		LIMITS	REFS	237						
1500	RAPOW	REAL	ARRAY	INPTR	REFS	156						
1513	RC	REAL		INPTR	REFS	156	415					
471	RCI	REAL		REALS	REFS	121						
5305	RCIH	REAL			REFS	423	427	488	DEFINED	422	424	
5310	RCIHM	REAL			REFS	488	DEFINED	427				
472	RCO	REAL		REALS	REFS	121						
5306	RCOH	REAL			REFS	426	428	489	DEFINED	423	425	
5311	RCOHM	REAL			REFS	489	DEFINED	428				
1514	RDISH	REAL		INPTR	REFS	156						
0	REPS2	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
5241	RESI	REAL			REFS	498	DEFINED	350				
5242	RESIS	REAL			REFS	498	DEFINED	351				
5340	RFNCI	REAL			REFS	522	536	DEFINED	518			
475	RFNVFF	REAL		REALS	REFS	134	518					
476	RHO	REAL		REALS	REFS	134						
477	RHOF	REAL		REALS	REFS	134						
500	RHOG	REAL		REALS	REFS	134						
501	RHOUO2	REAL		REALS	REFS	134						
502	RMH	REAL		REALS	REFS	134						
1515	ROUGHC	REAL		INPTR	REFS	156						
1516	ROUGHF	REAL		INPTR	REFS	156						
5307	ROX	REAL			REFS	429	490	DEFINED	426			
5312	ROXM	REAL			REFS	490	DEFINED	429				
503	RP	REAL		REALS	REFS	134	438	439	440	445		
70	RRAKR	REAL		LIMITS	REFS	237						
2551	RSNTR	REAL		INPTR	REFS	156						
504	RSTRAN	REAL		REALS	REFS	134						
505	RSTRES	REAL		REALS	REFS	134						
506	RTRAN	REAL		REALS	REFS	134						
0	R22	REAL	ARRAY	F.P.	REFS	254	DEFINED	1				
1517	SGAPF	REAL		INPTR	REFS	156						
5374	SGHPIB	REAL			REFS	575	603	609	626	629		
					DEFINED	571	588	601	622			
5373	SGHPOB	REAL			REFS	576	588	602	609	627	629	
					DEFINED	570	587	600	623			
5211	SIFLMP	REAL			REFS	498	DEFINED	313				

VARIABLES	SN	TYPE	RELOCATION									
5215	SIGAP	REAL			REFS	334	DEFINED	323				
5377	SIGAX	REAL			REFS	609	629	DEFINED	574	583	599	628
5372	SIGAXB	REAL			REFS	574	599	609	628	629		
					DEFINED	569	584	598	624			
5400	SIGHPI	REAL			REFS	609	629	DEFINED	575	586	603	626
5401	SIGHPO	REAL			REFS	586	609	629	DEFINED	576	585	602
					627							
5266	SIGM1	REAL			REFS	494	DEFINED	376	391	406		
5263	SIGM1B	REAL			REFS	376	391	406	494	DEFINED	373	388
					404							
5267	SIGM2	REAL			REFS	493	DEFINED	377	392	407		
5264	SIGM2B	REAL			REFS	377	392	407	493	DEFINED	374	389
					405							
5270	SIGM3	REAL			REFS	493	DEFINED	378	393	408		
5265	SIGM3B	REAL			REFS	378	393	408	493	DEFINED	375	390
					403							
5376	SIGRA	REAL			REFS	609	629	DEFINED	573	581	597	625
5375	SIGRAB	REAL			REFS	573	597	609	625	629		
					DEFINED	572	582	596	621			
0	SIG2	REAL	ARRAY	F.P.	REFS	254	403	404	405	596	2*598	600
					601	DEFINED	1					
507	SKTC	REAL		REALS	REFS	134						
510	SKTS	REAL		REALS	REFS	134						
5417	SRM	REAL			REFS	728	729	DEFINED	726	728		
64	STEP	REAL		LIMITS	REFS	237						
511	STRN	REAL		REALS	REFS	134						
512	SUMCK	REAL		REALS	REFS	134						
513	SUMDH	REAL		REALS	REFS	134						
514	SUMEXP	REAL		REALS	REFS	134						
1	SUMFF	REAL		AXL	REFS	244						
515	SUMGP	REAL		REALS	REFS	134						
0	SUMM	REAL		AXL	REFS	244	284	684				
516	SUMPOR	REAL		REALS	REFS	134						
517	SUMRG	REAL		REALS	REFS	134						
2	SUMSAV	REAL		AXL	REFS	244						
520	SUMTF	REAL		REALS	REFS	134						
5320	SWLR	REAL			REFS	441	496	DEFINED	439			
521	T	REAL		REALS	REFS	134	298					
5342	TAFAK	REAL			REFS	551	552	DEFINED	520			
5341	TAGAK	REAL			REFS	549	DEFINED	519				
5221	TAGK	REAL			REFS	334	DEFINED	332				
5361	TARFR	REAL			REFS	549	DEFINED	541				
5226	TBARK	REAL			REFS	668	DEFINED	338	664			
5415	TBLKK	REAL			REFS	668	DEFINED	666				
522	TCAC	REAL		REALS	REFS	134						
5413	TCAK	REAL			REFS	668	DEFINED	663				
1520	TCC	REAL		INPTR	REFS	156	423					
523	TCI	REAL		REALS	REFS	134	321	488	DEFINED	318		
5214	TCIM	REAL			REFS	488	DEFINED	321				
5247	TCL	REAL			REFS	358	482	DEFINED	357			
5250	TCLK	REAL			REFS	482	DEFINED	358				
524	TCO	REAL		REALS	REFS	134	320	489	DEFINED	319		
5213	TCOM	REAL			REFS	489	DEFINED	320				

VARIABLES SN TYPE RELOCATION

5347	TCRKF	REAL			REFS	527	529	531	553	DEFINED	525	527
						529	530					
5350	TCRKK	REAL			REFS	553	DEFINED	531				
5230	TDAYS	REAL			REFS	478	DEFINED	341	353			
525	TFBC	REAL		REALS	REFS	134						
526	TFC	REAL		REALS	REFS	134						
527	TFGFR	REAL		REALS	REFS	134	539	540	543	735		
5363	THGPCT	REAL			REFS	554	DEFINED	543				
5324	TFRC	REAL			REFS	449	450	451	452	453	462	463
						464	465	466	DEFINED	446	449	459	462
5414	TFRK	REAL			REFS	668	DEFINED	665				
530	THEFR	REAL		REALS	REFS	134	547					
5344	THVV	REAL			REFS	523	532	533	534	535	536	537
						554	DEFINED	522				
5345	THVVSI	REAL			REFS	554	DEFINED	523				
5362	TH2FR	REAL			REFS	547	DEFINED	542				
531	TH2OFR	REAL		REALS	REFS	134	552					
5243	TIMDAY	REAL			REFS	480	DEFINED	352				
1521	TIME	REAL	ARRAY	INPTR	REFS	156	341	701				
61	TIMEC	REAL		LIMITS	REFS	237						
62	TIMEF	REAL		LIMITS	REFS	237						
532	TITLE	REAL	ARRAY	REALS	REFS	134	293	514	692	731		
5357	TKRFR	REAL			REFS	550	DEFINED	539				
546	TM	REAL		REALS	REFS	134						
547	TN2FR	REAL		REALS	REFS	134	548					
5260	TOTCR	REAL			REFS	387	399	506	507	DEFINED	370	385
						397						
5322	TOTFR	REAL			REFS	498	DEFINED	441				
1666	TOTL	REAL		INPTR	REFS	156						
550	TOXD	REAL		REALS	REFS	134	316	490	DEFINED	315		
5212	TOXOK	REAL			REFS	490	DEFINED	316				
551	TP	REAL		REALS	REFS	134	297					
552	TPA	REAL		REALS	REFS	134						
553	TPAC	REAL		REALS	REFS	134						
554	TPLEN	REAL		REALS	REFS	134	524	548				
5346	TPLENS	REAL			REFS	548	DEFINED	524				
5202	TPSEC	REAL			REFS	353	354	478	DEFINED	297		
5325	TP2	REAL			REFS	469	483	DEFINED	450	463		
5333	TP2K	REAL			REFS	483	DEFINED	469				
5326	TP4	REAL			REFS	470	484	DEFINED	451	464		
5334	TP4K	REAL			REFS	484	DEFINED	470				
5327	TP6	REAL			REFS	471	485	DEFINED	452	465		
5335	TP6K	REAL			REFS	485	DEFINED	471				
5330	TP8	REAL			REFS	472	486	DEFINED	453	466		
5336	TP8K	REAL			REFS	486	DEFINED	472				
555	TRANST	REAL		REALS	REFS	134						
2553	TREF	REAL		INPTR	REFS	156						
556	TSAT	REAL		REALS	REFS	134						
5203	TSECON	REAL			REFS	352	354	480	DEFINED	298		
5343	TSFK	REAL			REFS	550	DEFINED	521				
1667	TSINT	REAL		INPTR	REFS	156						
5246	TSR	REAL			REFS	359	487	DEFINED	356			
5251	TSRK	REAL			REFS	487	DEFINED	359				

VARIABLES	SN	TYPE		RELOCATION							
557	TT	REAL		REALS	REFS	134					
0	TTT	REAL	ARRAY	F.P.	REFS	254	DEFINED	1			
1670	TW	REAL	ARRAY	INPTR	REFS	156					
560	TX	REAL		REALS	REFS	134					
561	TXA	REAL		REALS	REFS	134					
562	TXAL	REAL		REALS	REFS	134					
563	TXC	REAL		REALS	REFS	134					
5360	TXEFR	REAL			REFS	551	DEFINED	540			
2035	UBFS	REAL		INPTR	REFS	156					
2036	UMELT	REAL		INPTR	REFS	156					
2037	UOFD	REAL		INPTR	REFS	156					
5233	UO2LLX	REAL			REFS	434	440	DEFINED	344	434	
0	VERS	REAL		VER	REFS	207					
5352	VFRCCR	REAL			REFS	553	DEFINED	533			
5353	VFRCDS	REAL			REFS	551	DEFINED	534			
5356	VFRCGP	REAL			REFS	549	DEFINED	537			
5351	VFRCPL	REAL			REFS	548	DEFINED	532			
5354	VFRCPR	REAL			REFS	552	DEFINED	535			
5355	VFRCRF	REAL			REFS	550	DEFINED	536			
564	VISC	REAL		REALS	REFS	134					
565	VPLT	REAL		REALS	REFS	134					
2040	VS	REAL		INPTR	REFS	156					
566	VSS	REAL		REALS	REFS	134					
600	VX	REAL		REALS	REFS	134					
567	W	REAL		REALS	REFS	134					
570	WT	REAL		REALS	REFS	134	309	491	DEFINED	308	
5210	WTK	REAL			REFS	491	DEFINED	309			
571	WTRAN	REAL		REALS	REFS	134					
2041	X	REAL	ARRAY	INPTR	REFS	156					
572	XEIN	REAL		REALS	REFS	134					
573	XK6	REAL		REALS	REFS	134					
574	XK7	REAL		REALS	REFS	134					
33	XP	REAL		LIMITS	REFS	237					
34	XR	REAL		LIMITS	REFS	237					
575	YY	REAL		REALS	REFS	134					
576	Z	REAL		REALS	REFS	134					
577	ZRO2WG	REAL		REALS	REFS	134					

FILE NAMES	MODE								
TAPE6	FMT	WRITES	286	474	475	476	477	478	479	480
		481	482	483	484	485	486	487	488	489
		490	491	492	493	494	495	496	497	498
		499	500	501	502	503	504	505	506	507
		546	547	548	549	550	551	552	553	554
		555	556	557	558	559	609	629	635	668
		680	686	694	695	696	697	722	723	733
		735	737							

EXTERNALS	TYPE	ARGS	REFERENCES				
GTHCON	REAL	4	334				
PGHEAD		3	293	514	692	731	

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES							
ABS	REAL	1	INTRIN		729							
AMAX1	REAL	0	INTRIN		329							
AMIN1	REAL	0	INTRIN		728							
TCONV	REAL	1	SF	276	309	316	320	321	332	338	358	359
					469	470	471	472	519	520	521	524
					531	663	664	665	666			

STATEMENT LABELS			DEF LINE	REFERENCES				
47	100		287	283				
0	110	INACTIVE	363	362				
510	120		380	362				
600	130		395	362				
707	140		409	379	394			
0	150		437	430				
0	160		449	447				
0	170		454	443				
1173	180		456	445				
0	190		462	460				
0	200		467	457				
1261	210		468	455				
1445	220		511	289				
0	230		528	526				
0	240	INACTIVE	564	563				
1765	250		578	563				
2047	260		594	563				
2144	270		608	577	593			
0	280		611	561				
2233	290		632	613				
0	300	INACTIVE	640	639				
2273	310		646	639				
2324	320		655	639				
2354	330		660	645	654			
0	340		670	637				
2454	350		682	672				
2467	360		690	278				
0	370		725	699				
0	380		728	727				
2702	390		739	288	290	510	513	689
3542	400	FMT	742	286				
3557	410	FMT	744	474				
3567	420	FMT	746	475				
3577	430	FMT	748	476				
3616	440	FMT	751	477				
3626	450	FMT	753	478				
3644	460	FMT	755	479				
3662	470	FMT	757	480				
3700	480	FMT	759	481				
3712	490	FMT	761	482				
3723	500	FMT	763	483				
3734	510	FMT	765	484				
3745	520	FMT	767	485				
3756	530	FMT	769	486				

STATEMENT LABELS			DEF LINE	REFERENCES
3767	540	FMT	771	487
4000	550	FMT	773	488
4011	560	FMT	775	489
4022	570	FMT	777	490
4033	580	FMT	779	491
4042	590	FMT	780	492
4061	600	FMT	783	493
4110	610	FMT	787	494
4116	620	FMT	788	495
4126	630	FMT	790	496
4136	640	FMT	792	497
4143	650	FMT	793	498
4171	660	FMT	797	499
4203	670	FMT	799	500
4222	680	FMT	802	501
4227	690	FMT	803	502
4237	700	FMT	805	503
4246	710	FMT	806	504
4260	720	FMT	808	505
4270	730	FMT	810	506
4302	740	FMT	812	507
4323	750	FMT	815	686
4336	760	FMT	817	680
4344	770	FMT	818	629
4362	780	FMT	821	546
4366	790	FMT	822	547
4436	800	FMT	828	554
4470	810	FMT	832	548
4502	820	FMT	834	549
4514	830	FMT	836	550
4526	840	FMT	838	551
4540	850	FMT	840	552
4552	860	FMT	842	559
4606	870	FMT	847	609
4624	880	FMT	849	635
4666	890	FMT	855	668
4703	900	FMT	857	553
4712	910	FMT	858	556
4716	920	FMT	859	557
4722	930	FMT	860	558
4726	940	FMT	861	555
4735	950	FMT	862	694
4737	960	FMT	863	695
4747	970	FMT	865	696
5023	980	FMT	872	697
5077	990	FMT	879	722
5112	1000	FMT	881	723
5125	1010	FMT	883	733
5134	1020	FMT	884	735
5143	1030	FMT	886	737

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
1023	150	I	430 437	36B	OPT			
1100	170	IK	443 454	71B		EXT REFS	EXITS	NOT INNER
1115	160	IJ	447 449	21B		EXT REFS		
1175	200	IL	457 467	63B		EXT REFS	NOT INNER	
1204	190	IJ	460 462	21B		EXT REFS		
1521	230	I	526 528	11B	INSTACK			
1701	280	I	561 611	250B		EXT REFS		
2237	340	I	637 670	167B		EXT REFS		
2506	370	II	699 725	143B		EXT REFS		
2655	380	I	727 728	7B	INSTACK			

COMMON BLOCKS	LENGTH
FAST	1
POINT	199
REALS	392
INTEG	24
INPTR	1393
INPTI	197
EMFLGS	10
PFRC52	22
MATCNS	12
LACMDL	21
VER	1
PHYPRO	11
PNTPNL	71
LIMITS	62
AXL	4
BA	85

STATISTICS

PROGRAM LENGTH	5436B	2846
SCM LABELED COMMON LENGTH	4711B	2505

140000B SCM USED

```
      SUBROUTINE PWRDEP (ENRICH,TM,IPLANT,IT,NDBG,P1,P2,P3)                  PWRD       2
C                                                                            PWRD       3
C     IMPLICIT REAL*8 (A-H,O-Z)                                              PWRD       4
C                                                                            PWRD       5
C     ***************************************************************        PWRD       6
C                                                                            PWRD       7
C     THIS SUBROUTINE IS CALLED FROM FLUXD AND COMPUTES THE "LASER"          PWRD       8
C     POWER FACTORS                                                          PWRD       9
C                                                                            PWRD      10
C     ***************************************************************        PWRD      11
C     INPUT ARGUMENTS                                                        PWRD      12
C     ***************************************************************        PWRD      13
C                                                                            PWRD      14
C     ENRICH - FUEL ENRICHMENT (% U235)                                      PWRD      15
C     IPLANT - POWER PLANT TYPE INDEX                                        PWRD      16
C     IT     - POWER-TIME STEP INDEX                                         PWRD      17
C     NDBG   - DEBUG OUTPUT INDEX                                            PWRD      18
C     TM     - TIME TO END OF STEP (HR)                                      PWRD      19
C                                                                            PWRD      20
C     ***************************************************************        PWRD      21
C     OUTPUT ARGUMENTS                                                       PWRD      22
C     ***************************************************************        PWRD      23
C                                                                            PWRD      24
C     FF     - LASER TABEL FACTOR                                            PWRD      25
C     P1     - LASER TABLE FACTOR                                            PWRD      26
C     P2     - LASER TABLE FACTOR                                            PWRD      27
C     P3     - LASER TABLE FACTOR                                            PWRD      28
C                                                                            PWRD      29
C     ***************************************************************        PWRD      30
C                                                                            PWRD      31
      GO TO (100,110,120,130), IPLANT                                        PWRD      32
C     PWR U235 LAZER POWER DISTRIBUTION DATA                                 PWRD      33
100   E = ENRICH/3.0                                                         PWRD      34
      IF (TM.GT.22100.) TM = 22100.                                          PWRD      35
      IF (E.GT.2.0) E = 2.0                                                  PWRD      36
      IF (E.LT.0.6667) E = 0.6667                                            PWRD      37
      P1 = 6.75298E-2+7.18469E-1*E-7.91543E-2*E*E+(1.82027E-3-1.56930E-3     PWRD      38
     +*E+3.79892E-4*E*E)*TM+(-1.49195E-7+1.47074E-7*E-3.78156E-8*E*E)*TM     PWRD      39
     +*TM+(3.76922E-12-3.89070E-12*E+1.03291E-12*E*E)*TM*TM*TM               PWRD      40
      P2 = 2.79418-5.95252E-01*E+2.48612E-01*E*E+(1.99999E-03-1.71031E-0     PWRD      41
     +3*E+4.17523E-04*E*E)*TM+(-2.69231E-07+2.52819E-07*E-6.45166E-08*E*     PWRD      42
     +E)*TM*TM+(1.20611E-11-1.16197E-11*E+3.03672E-12*E*E)*TM*TM*TM+(-1.     PWRD      43
     +71170E-16+1.64471E-16*E-4.33757E-17*E*E)*TM*TM*TM*TM                   PWRD      44
      P3 = 6.69661-.579519*E+EXP(.2669*E)-.598866*ALOG(1.0-1.14923E-4*TM     PWRD      45
     ++4.2213E-4*TM/E)                                                       PWRD      46
      GO TO 140                                                              PWRD      47
C                                                                            PWRD      48
C                                                                            PWRD      49
C     BWR U235 LAZER POWER DISTRIBUTION DATA                                 PWRD      50
C                                                                            PWRD      51
110   E = ENRICH/2.1                                                         PWRD      52
      IF (TM.GT.29300.) TM = 29300.                                          PWRD      53
      IF (E.GT.1.6667) E = 1.6667                                            PWRD      54
```

```
      IF (E.LT.0.7143) E = 0.7143                                                PWRD       55
55    P1 = 57.9736E-02-19.7357E-02*E+14.5904E-02*E*E+(31.5340E-05-19.648         PWRD       56
     +6E-05*E+42.0033E-06*E*E)*TM+(-79.4302E-10+68.4852E-10*E-17.8214E-1         PWRD       57
     +0*E*E)*TM*TM                                                              PWRD       58
      P2 = 29.7849E-01-17.4154E-02*E+(14.9830E-05+20.0363E-06*E)*TM+(-40         PWRD       59
     +.4864E-10-14.4630E-10*E)*TM*TM+(25.5171E-16+50.5413E-15*E)*TM*TM*T         PWRD       60
60   +M                                                                         PWRD       61
      P3 = 3.39082-.370756*E+EXP(.203946*E)-.316945*ALOG(1.0-88.641E-06*         PWRD       62
     +TM+40.5904E-05*TM/E)                                                      PWRD       63
      GO TO 140                                                                 PWRD       64
C                                                                               PWRD       65
65    C                                                                         PWRD       66
C     PWR PU LAZER POWER DISTRIBUTION DATA                                      PWRD       67
C                                                                               PWRD       68
120   E = ENRICH/3.0                                                            PWRD       69
      IF (TM.GT.22100.) TM = 22100.                                             PWRD       70
70    IF (E.GT.3.3333) E = 3.3333                                               PWRD       71
      IF (E.LT.0.6667) E = 0.6667                                               PWRD       72
      P1 = 31.5018E-02+18.0792E-01*E-23.4942E-02*E*E+(74.3288E-05-54.201        PWRD       73
     +0E-05*E+96.8590E-06*E*E)*TM+(-20.7791E-09+17.0359E-09*E-33.1132E-1         PWRD       74
     +0*E*E)*TM*TM                                                              PWRD       75
75    P2 = 28.6931E-01-13.6593E-02*E+79.1636E-03*E*E+(27.9790E-05-83.073         PWRD       76
     +6E-06*E)*TM+(-89.6565E-10+31.5117E-10*E)*TM*TM                            PWRD       77
      P3 = 75.9989E-01-75.1603E-02*E+11.7085E-02*E*E+(-19.9554E-05+16.61         PWRD       78
     +59E-05*E-31.8240E-06*E*E)*TM+(52.5990E-10-48.1300E-10*E+99.8960E-1         PWRD       79
     +1*E*E)*TM*TM                                                              PWRD       80
80    GO TO 140                                                                 PWRD       81
C                                                                               PWRD       82
C                                                                               PWRD       83
C     BWR PU LAZER POWER DISTRIBUTION DATA                                      PWRD       84
C                                                                               PWRD       85
85    130   E = ENRICH/3.0                                                      PWRD       86
      IF (TM.GT.29300.) TM = 29300.                                             PWRD       87
      IF (E.GT.2.) E = 2.                                                       PWRD       88
      IF (E.LT.0.5) E = 0.5                                                     PWRD       89
      P1 = 27.2686E-02+13.3875E-01*E-26.3031E-02*E*E+(35.4470E-05-36.552        PWRD       90
90   +2E-05*E+96.4620E-06*E*E)*TM+(-62.7614E-10+78.1725E-10*E-23.4029E-1         PWRD       91
     +0*E*E)*TM*TM                                                              PWRD       92
      P2 = 25.2374E-01+16.3499E-02*E+(27.7826E-05-12.2622E-05*E)*TM+(-47         PWRD       93
     +.8085E-10+23.3993E-10*E)*TM*TM                                            PWRD       94
      P3 = 42.8215E-01-50.5500E-02*E+10.300E-02*E*E+(-86.5370E-06+10.432        PWRD       95
95   +0E-05*E-29.973E-06*E*E)*TM+(18.4450E-10-25.8100E-10*E+82.220E-11*E         PWRD       96
     +*E)*TM*TM                                                                 PWRD       97
140   CONTINUE                                                                  PWRD       98
C                                                                               PWRD       99
C     SIMPSONS RULE INTERGRATION OF POWER OVER PELLET RADIUS                    PWRD      100
100   C                                                                         PWRD      101
      QR = P1+2.0*P3                                                            PWRD      102
          DO 150 L=1,5                                                          PWRD      103
          R = SQRT((11.E+0-2.E+0*L)/10.E+0)                                     PWRD      104
150       QR = QR+(P1*R**P2+P3)*4.0                                             PWRD      105
105       DO 160 L=1,4                                                          PWRD      106
          R = SQRT((10.E+0-2.E+0*L)/10.E+0)                                     PWRD      107
```

```
                160       QR = QR+(P1*R**P2+P3)*2.0                                  PWRD      108
                      QR = QR*0.0333333                                              PWRD      109
                C                                                                    PWRD      110
110                   IF (IPLANT.EQ.2.OR.IPLANT.EQ.4) GO TO 170                      PWRD      111
                      FF = QR/7.7316069                                              PWRD      112
                      P1 = P1/7.7316069                                              PWRD      113
                      P3 = P3/7.7316069                                              PWRD      114
                      GO TO 180                                                      PWRD      115
115             170   P1 = P1/4.4353724                                              PWRD      116
                      P3 = P3/4.4353724                                              PWRD      117
                      FF = QR/4.4353724                                              PWRD      118
                180   CONTINUE                                                       PWRD      119
                C                                                                    PWRD      120
120                   RETURN                                                         PWRD      121
                      END                                                            PWRD      122
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	PWRDEP	1

DEF LINE: 120

VARIABLES

SN		TYPE			RELOCATION							
716	E	REAL			REFS	35	36	12*37	15*40	3*44	53	54
					9*55	4*58	3*61	70	71	9*72	5*75	9*77
					87	88	9*89	3*92	9*94	DEFINED	33	35
					36	51	53	54	68	70	71	85
					87	88						
0	ENRICH	REA.		F.P.	REFS	33	51	68	85	DEFINED	1	
722	FF	REAL			DEFINED	111	117					
0	IPLANT	INTEGER		F.P.	REFS	31	2*110	DEFINED	1			
0	IT	INTEGER	*UNUSED	F.P.	DEFINED	1						
720	L	INTEGER			REFS	103	106	DEFINED	102	105		
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	P1	REAL		F.P.	REFS	101	104	107	112	115		
					DEFINED	1	37	55	72	89	112	115
0	P2	REAL		F.P.	REFS	104	107	DEFINED	1	40	58	75
					92							
0	P3	REAL		F.P.	REFS	101	104	107	113	116		
					DEFINED	1	44	61	77	94	113	116
717	QR	REAL			REFS	104	107	108	111	117		
					DEFINED	101	104	107	108			
721	R	REAL			REFS	104	107	DEFINED	103	106		
0	TM	REAL		F.P.	REFS	34	6*37	10*40	2*44	52	3*55	6*58
					2*61	69	3*72	3*75	3*77	86	3*89	3*92
					3*94	DEFINED	1	34	52	69	86	

EXTERNALS

	TYPE	ARGS		REFERENCES	
ALOG	REAL	1	LIBRARY	44	61
EXP	REAL	1	LIBRARY	44	61

```
EXTERNALS          TYPE   ARGS      REFERENCES
      SQRT       REAL      1 LIBRARY    103       106

STATEMENT LABELS              DEF LINE   REFERENCES
   21  100                       33         31
  134  110                       51         31
  230  120                       68         31
  317  130                       85         31
  404  140                       97         46        63        80
    0  150                      104        102
    0  160                      107        105
  477  170                      115        110
  510  180                      118        114

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  412  150        L        102 104      21B              EXT REFS
  435  160        L        105 107      20B              EXT REFS

STATISTICS
  PROGRAM LENGTH                732B     474
        140000B SCM USED
```

```
      SUBROUTINE REPACK (FC,GRATIO,PINS)                                    REPK       2
C                                                                           REPK       3
C     IMPLICIT REAL*8 (A-H,O-Z)                                             REPK       4
C                                                                           REPK       5
C     ***************************************************************       REPK       6
C                                                                           REPK       7
C     THIS SUBROUTINE IS CALLED FROM MAIN AND COMPUTES THE FUEL SURFACE     REPK       8
C     RELOCATION FACTOR                                                     REPK       9
C     REPACK WAS CODED BY G A BERNA NOVEMBER 1977.                          REPK      10
C                                                                           REPK      11
C     ***************************************************************       REPK      12
C     INPUT ARGUMENTS                                                       REPK      13
C     ***************************************************************       REPK      14
C                                                                           REPK      15
C     GRATIO - RATIO OF COLD RADIAL GAP TO THE COLD PELLET RADIUS           REPK      16
C     PINS   - STRUCTURAL INTERFACIAL PRESSURE    (PSIA)                    REPK      17
C                                                                           REPK      18
C     ***************************************************************       REPK      19
C     OUTPUT ARGUMENTS                                                      REPK      20
C     ***************************************************************       REPK      21
C                                                                           REPK      22
C     FC     - RELOCATION FACTOR                                            REPK      23
C                                                                           REPK      24
C     ***************************************************************       REPK      25
C                                                                           REPK      26
      DIMENSION FC(1)                                                       REPK      27
      DATA  SLOPE / 1.00E0 / , SLOP2 / 0.10E0 / , CLDRAT / 0.005E0 /        REPK      28
      DATA  STAR / 500.E0 /                                                 REPK      29
C                                                                           REPK      30
      PRATIO = PINS/STAR                                                    REPK      31
      FC(1) = SLOPE*(GRATIO-CLDRAT)*(1.E0-PRATIO)                           REPK      32
      IF (PRATIO.LT.0.E0.OR.PRATIO.GE.1.E0) FC(1) = 0.E0                    REPK      33
      IF (GRATIO.LT.CLDRAT) FC(1) = 0.E0                                    REPK      34
      PIN = PINS                                                            REPK      35
      IF (PINS.GT.STAR) PIN = STAR                                          REPK      36
      B = ((PIN/STAR)*(GRATIO-CLDRAT))*SLOP2                                REPK      37
      FC(1) = AMAX1(FC(1),B)                                                REPK      38
  100 CONTINUE                                                              REPK      39
      RETURN                                                                REPK      40
      END                                                                   REPK      41
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	REPACK	1	39

VARIABLES	SN	TYPE	RELOCATION							
56	B	REAL		REFS	37	DEFINED	36			
51	CLDRAT	REAL		REFS	31	33	36	DEFINED	27	

```
VARIABLES     SN  TYPE          RELOCATION
    0  FC         REAL      ARRAY     F.P.       REFS       26       37    DEFINED       1        31       32       33
                                                   37
    0  GRATIO     REAL                F.P.       REFS       31       33       36    DEFINED       1
   55  PIN        REAL                           REFS       36    DEFINED       34       35
    0  PINS       REAL                F.P.       REFS       30       34       35    DEFINED       1
   54  PRATIO     REAL                           REFS       31     2*32    DEFINED       30
   47  SLOPE      REAL                           REFS       31    DEFINED       27
   50  SLOP2      REAL                           REFS       36    DEFINED       27
   52  STAR       REAL                           REFS       30     2*35       36    DEFINED       28

INLINE FUNCTIONS   TYPE    ARGS        DEF LINE  REFERENCES
       AMAX1      REAL       0  INTRIN                37

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100          INACTIVE     38

STATISTICS
  PROGRAM LENGTH                  578      47
        140000B SCM USED
```

```
      SUBROUTINE RESTFS (NA,NR,EPP,EP,ZRO2B,NT,UFS,CTMAX,POROSA,BU2,TCOD RESTFS      2
     +IS,GPTP,R,RCI,RCO,TIME,TCIDIS,GASES,PRESS,TMPDIS,DMWI,REPS,RFEPS,O RESTFS      3
     +LEPS,OLFEPS,OLDTC,OLDPG,OLDPC,OLDURF,PINT,NOIGAP,GASMOL)          RESTFS      4
C                                                                       RESTFS      5
C     IMPLICIT  REAL * 8 ( A-H,O-Z )                                    RESTFS      6
C                                                                       RESTFS      7
C     ************************************************************      RESTFS      8
C     INPUT  ARGUMENTS                                                  RESTFS      9
C     ************************************************************      RESTFS     10
C                                                                       RESTFS     11
C     BU2    - BURNUP ( MWD/MTU)                                        RESTFS     12
C     CTMAX  - MAXIMUM CLADDING TEMPERATURE REACHED DURING ROD LIFE (F) RESTFS     13
C     DMWI   - WORK ARRAY                                               RESTFS     14
C     EP     - EFFECTIVE PERMANENT STRAIN                               RESTFS     15
C     EPP    - HOOP, AXIAL, & RADIAL PLASTIC STRAINS                    RESTFS     16
C     GASES  - MOLE FRACTION OF ROD GASES                               RESTFS     17
C     GASMOL - GM-MOLES OF GAS IN THE ROD                               RESTFS     18
C     GPTP   - GAP THICKNESS (IN) DIAMETRAL THERMAL                     RESTFS     19
C     NA     - NUMBER OF AXIAL NODES                                    RESTFS     20
C     NOIGAP - OLD VALUES OF GAP CLOSURE INDICIES                       RESTFS     21
C     NR     - NUMBER OF RADIAL NODES                                   RESTFS     22
C     OLDPC  - OLD VALUES OF COOLANT PRESSURE (PSI)                     RESTFS     23
C     OLDPG  - OLD VALUES OF GAP PRESSURE (PSI)                         RESTFS     24
C     OLDTC  - OLD VALUES OF CLADDING AVERAGE TEMPERATURE (F)           RESTFS     25
C     OLDURF - OLD VALUES OF FUEL OUTSIDE SURFACE DISPLACEMENT (IN)     RESTFS     26
C     OLEPS  - OLD VALUES OF CLADDING STRAIN                            RESTFS     27
C     OLFEPS - OLD VALUES OF FUEL STRAIN                                RESTFS     28
C     POROSA - VOLUME FRACTION OF FUEL POROSITY                         RESTFS     29
C     PINT   - INTERFACIAL PRESSURE (PSI)                               RESTFS     30
C     PRESS  - ROD GAS GAP PRESSURE (PSIA)                              RESTFS     31
C     R      - RADIUS TO EACH RADIAL NODE (IN)                          RESTFS     32
C     RCI    - RADIUS OF THE CLADDING  INSIDE SURFACE (IN)              RESTFS     33
C     RCO    - RADIUS OF THE CLADDING OUTSIDE SURFACE (IN)              RESTFS     34
C     REPS   - RESIDUAL CLADDING STRAINS                                RESTFS     35
C     RFEPS  - RESIDUAL FUEL STRAINS                                    RESTFS     36
C     TCIDIS - CLADDING  INSIDE SURFACE TEMPERATURE (F)                 RESTFS     37
C     TCODIS - CLADDING OUTSIDE SURFACE TEMPERATURE (F)                 RESTFS     38
C     TIME   - TIME TO END OF STEP (SEC)                                RESTFS     39
C     TMPDIS - FUEL TEMPERATURE DISTRIBUTION (F)                        RESTFS     40
C     UFS    - PERMANENT FUEL DISPLACEMENT (FT)                         RESTFS     41
C     ZRO2B  - ZIRCALOY-OXIDE THICKNESS (FT)                            RESTFS     42
C                                                                       RESTFS     43
C     ************************************************************      RESTFS     44
C                                                                       RESTFS     45
      DIMENSION    ZRO2B(NA) ,UFS(NA)       ,EPP(NA,3)     ,EP(NA)      RESTFS     46
     +        ,CTMAX(NA)     ,POROSA(NA)    ,TCIDIS(NA)    ,TCODIS(NA)  RESTFS     47
     +        ,GPTP(NA)      ,BU2(NA)       ,GASES(1)      ,R(NR)       RESTFS     48
     +        ,TMPDIS(NR,1)  ,DMWI(1)       ,REPS(NA,1)    ,RFEPS(NA,1) RESTFS     49
     +        ,OLEPS(1)      ,OLFEPS(1)     ,OLDTC(1)      ,OLDPG(1)    RESTFS     50
     +        ,OLDPC(1)      ,OLDURF(1)     ,PINT(1)       ,NOIGAP(1)   RESTFS     51
C                                                                       RESTFS     52
      DATA  NTL / 1 / , TWELVE / 12.E0 /                                RESTFS     53
      DATA NDEBUG / 0 /                                                 RESTFS     54
```

```
      C                                                                 RESTFS     55
55          NAP1 = NT+1                                                 RESTFS     56
            NRP1 = NR+1                                                 RESTFS     57
            NRP2 = NR+2                                                 RESTFS     58
            RCIF = RCI/TWELVE                                           RESTFS     59
            RCOF = RCO/TWELVE                                           RESTFS     60
60    C                                                                 RESTFS     61
      C     WRITE THE END OF STEP TIME (SEC)                            RESTFS     62
      C                                                                 RESTFS     63
            WRITE (NTL) TIME                                            RESTFS     64
      C                                                                 RESTFS     65
65    C     WRITE THE NUMBER OF FRAPCON AXIAL NODES                     RESTFS     66
      C                                                                 RESTFS     67
            WRITE (NTL) NT                                              RESTFS     68
            IF (NDEBUG.EQ.1) WRITE (6,210) NT                           RESTFS     69
      C                                                                 RESTFS     70
70    C     WRITE THE ZIRCALOY-OXIDE THICKNESS OF THE CLADDING OUTSIDE SURFACE  RESTFS  71
      C     IN INCHES                                                   RESTFS     72
      C                                                                 RESTFS     73
                  DO 100 K=2,NAP1                                       RESTFS     74
      100         DMWI(K) = ZRO2B(K)*TWELVE                             RESTFS     75
75          WRITE (NTL) (DMWI(K),K=2,NAP1)                              RESTFS     76
            IF (NDEBUG.EQ.1) WRITE (6,220) (DMWI(K),K=2,NAP1)           RESTFS     77
      C                                                                 RESTFS     78
      C     WRITE THE NET PERMANENT FUEL DEFORMATION DUE TO SWELLING AND  RESTFS    79
      C     DENSIFICATION (FT)                                          RESTFS     80
80    C                                                                 RESTFS     81
            WRITE (NTL) (UFS(K),K=1,NT)                                 RESTFS     82
            IF (NDEBUG.EQ.1) WRITE (6,230) (UFS(K),K=1,NT)              RESTFS     83
      C                                                                 RESTFS     84
      C     WRITE THE CLADDING PLASTIC STRAINS INCLUDING CREEP          RESTFS     85
85    C     L = 1  HOOP                                                 RESTFS     86
      C     L = 2  AXIAL                                                RESTFS     87
      C     L = 3  RADIAL                                               RESTFS     88
      C                                                                 RESTFS     89
                  DO 110 L=1,3                                          RESTFS     90
90                IF (NDEBUG.EQ.1) WRITE (6,240) (EPP(KK),KK=1,NT)      RESTFS     91
      110         WRITE (NTL) (EPP(K,L),K=1,NT)                         RESTFS     92
      C                                                                 RESTFS     93
      C     WRITE THE CLADDING EFFECTIVE PLASTIC STRAINS                RESTFS     94
      C                                                                 RESTFS     95
95          WRITE (NTL) (EP(K),K=1,NT)                                  RESTFS     96
            IF (NDEBUG.EQ.1) WRITE (6,250) (EP(K),K=1,NT)               RESTFS     97
      C                                                                 RESTFS     98
      C     WRITE THE CLADDING PEAK TEMPERATURE DURING OPERATION LIFE (F)  RESTFS   99
      C                                                                 RESTFS    100
100         WRITE (NTL) (CTMAX(K),K=2,NAP1)                             RESTFS    101
            IF (NDEBUG.EQ.1) WRITE (6,260) (CTMAX(K),K=2,NAP1)          RESTFS    102
      C                                                                 RESTFS    103
      C     WRITE THE OPEN POROSITY OF EACH AXIAL NODE ( FRACTION OF PELLET )  RESTFS  104
      C                                                                 RESTFS    105
105         WRITE (NTL) (POROSA(K),K=1,NT)                              RESTFS    106
            IF (NDEBUG.EQ.1) WRITE (6,280) (POROSA(K),K=1,NT)           RESTFS    107
```

```
      C                                                                      RESTFS   108
      C   WRITE THE FUEL BURNUP ( MW-SEC/KG )                               RESTFS   109
      C                                                                      RESTFS   110
110         DO 120 K=2,NAP1                                                  RESTFS   111
      120   DMWI(K) = BU2(K)*86.4E0                                          RESTFS   112
          WRITE (NTL) (DMWI(K),K=2,NAP1)                                     RESTFS   113
          IF (NDEBUG.EQ.1) WRITE (6,270) (DMWI(K),K=2,NAP1)                  RESTFS   114
      C                                                                      RESTFS   115
115   C   WRITE RADIAL NODES AT FUEL SURFACE , CLADDING  INSIDE SURFACE ,    RESTFS   116
      C   CLADDING OUTSIDE SURFACE                                          RESTFS   117
      C                                                                      RESTFS   118
          WRITE (NTL) NR,NRP1,NRP2                                           RESTFS   119
          IF (NDEBUG.EQ.1) WRITE (6,290) NR,NRP1,NRP2                        RESTFS   120
120   C                                                                      RESTFS   121
      C   WRITE THE RADIUS TO EACH RADIAL NODE (FT)                         RESTFS   122
      C                                                                      RESTFS   123
          DO 130 L=1,NR                                                      RESTFS   124
          II = NR-L+1                                                        RESTFS   125
125   130   DMWI(L) = R(II)/TWELVE                                           RESTFS   126
          DMWI(NRP1) = RCIF                                                  RESTFS   127
          DMWI(NRP2) = RCOF                                                  RESTFS   128
          WRITE (NTL) (DMWI(L),L=1,NRP2)                                     RESTFS   129
          IF (NDEBUG.EQ.1) WRITE (6,300) (DMWI(L),L=1,NRP2)                  RESTFS   130
130   C                                                                      RESTFS   131
      C   WRITE THE RADIAL TEMPERATURE DISTRIBUTION (F)                     RESTFS   132
      C                                                                      RESTFS   133
          DO 150 K=1,NT                                                      RESTFS   134
              DO 140 I=1,NR                                                  RESTFS   135
135           II = NR-I+1                                                    RESTFS   136
      140     DMWI(I) = TMPDIS(II,K+1)                                       RESTFS   137
          DMWI(NRP1) = TCIDIS(K+1)                                           RESTFS   138
          DMWI(NRP2) = TCODIS(K+1)                                           RESTFS   139
          IF (NDEBUG.EQ.1) WRITE (6,310) (DMWI(LL),LL=1,NRP2)                RESTFS   140
140   150   WRITE (NTL) (DMWI(L),L=1,NRP2)                                   RESTFS   141
      C                                                                      RESTFS   142
      C   WRITE THE INTERNAL GAS PRESSURE (PSIA)                            RESTFS   143
      C                                                                      RESTFS   144
          DO 160 K=1,NT                                                      RESTFS   145
145   160   DMWI(K) = PRESS                                                  RESTFS   146
        WRITE (NTL) (DMWI(K),K=1,NT)                                         RESTFS   147
        IF (NDEBUG.EQ.1) WRITE (6,320) (DMWI(K),K=1,NT)                      RESTFS   148
      C                                                                      RESTFS   149
      C   WRITE THE RADIAL GAS GAP (FT)                                     RESTFS   150
150   C                                                                      RESTFS   151
          DO 170 K=2,NAP1                                                    RESTFS   152
      170 DMWI(K) = GPTP(K)/24.E0                                            RESTFS   153
        WRITE (NTL) (DMWI(K),K=2,NAP1)                                       RESTFS   154
        IF (NDEBUG.EQ.1) WRITE (6,330) (DMWI(K),K=2,NAP1)                    RESTFS   155
155   C                                                                      RESTFS   156
      C   WRITE THE GM-MOLES OF GAS IN THE ROD                              RESTFS   157
      C                                                                      RESTFS   158
        WRITE (NTL) GASMOL                                                   RESTFS   159
        IF (NDEBUG.EQ.1) WRITE (6,340) GASMOL                                RESTFS   160
```

```
      C
      C   WRITE THE MOLE FRACTION OF ROD GASES(I)                          RESTFS  161
      C   I = 1  HELIUM                                                    RESTFS  162
      C   I = 2  ARGON                                                     RESTFS  163
      C   I = 3  KRYPTON                                                   RESTFS  164
      C   I = 4  XENON                                                     RESTFS  165
      C   I = 5  HYDROGEN                                                  RESTFS  166
      C   I = 6  AIR                                                       RESTFS  167
      C   I = 7  WATER VAPOR                                               RESTFS  168
      C                                                                    RESTFS  169
      C                                                                    RESTFS  170
        WRITE (NTL) (GASES(I),I=1,7)                                       RESTFS  171
        IF (NDEBUG.EQ.1) WRITE (6,350) (GASES(I),I=1,7)                    RESTFS  172
      C                                                                    RESTFS  173
      C   WRITE THE RESIDUAL CLADDING STRAINS                             RESTFS  174
      C                                                                    RESTFS  175
            DO 180 L=1,3                                                   RESTFS  176
            IF (NDEBUG.EQ.1) WRITE (6,360) (REPS(KK,L),KK=1,NT)            RESTFS  177
  180       WRITE (NTL) (REPS(K,L),K=1,NT)                                 RESTFS  178
      C                                                                    RESTFS  179
      C   WRITE THE RESIDUAL FUEL STRAINS                                 RESTFS  180
      C                                                                    RESTFS  181
            DO 190 L=1,3                                                   RESTFS  182
            IF (NDEBUG.EQ.1) WRITE (6,370) (RFEPS(KK,L),KK=1,NT)           RESTFS  183
  190       WRITE (NTL) (RFEPS(K,L),K=1,NT)                                RESTFS  184
      C                                                                    RESTFS  185
      C   WRITE THE OLD VALUES OF CLADDING STRAIN                          RESTFS  186
      C                                                                    RESTFS  187
        WRITE (NTL) (OLEPS(K),K=1,NT)                                      RESTFS  188
        IF (NDEBUG.EQ.1) WRITE (6,380) (OLEPS(K),K=1,NT)                   RESTFS  189
      C                                                                    RESTFS  190
      C   WRITE THE OLD VALUES OF FUEL STRAIN                             RESTFS  191
      C                                                                    RESTFS  192
        WRITE (NTL) (OLFEPS(K),K=1,NT)                                     RESTFS  193
        IF (NDEBUG.EQ.1) WRITE (6,390) (OLFEPS(K),K=1,NT)                  RESTFS  194
      C                                                                    RESTFS  195
      C   WRITE THE OLD CLADDING AVERAGE TEMPERATURES                      RESTFS  196
      C                                                                    RESTFS  197
        WRITE (NTL) (OLDTC(K),K=1,NT)                                      RESTFS  198
        IF (NDEBUG.EQ.1) WRITE (6,400) (OLDTC(K),K=1,NT)                   RESTFS  199
      C                                                                    RESTFS  200
      C   WRITE THE OLD GAP PRESSURES                                      RESTFS  201
      C                                                                    RESTFS  202
        WRITE (NTL) (OLDPG(K),K=1,NT)                                      RESTFS  203
        IF (NDEBUG.EQ.1) WRITE (6,410) (OLDPG(K),K=1,NT)                   RESTFS  204
      C                                                                    RESTFS  205
      C   WRITE THE OLD COOLANT PRESSURES                                  RESTFS  206
      C                                                                    RESTFS  207
        WRITE (NTL) (OLDPC(K),K=1,NT)                                      RESTFS  208
        IF (NDEBUG.EQ.1) WRITE (6,420) (OLDPC(K),K=1,NT)                   RESTFS  209
      C                                                                    RESTFS  210
      C   WRITE THE OLD FUEL RADIAL DISPLACEMENTS                          RESTFS  211
      C                                                                    RESTFS  212
        WRITE (NTL) (OLDURF(K),K=1,NT)                                     RESTFS  213
```

```
      IF (NDEBUG.EQ.1) WRITE (6,430) (OLDURF(K),K=1,NT)                  RESTFS   214
C                                                                        RESTFS   215
C     WRITE THE INTERFACIAL PRESSURE                                     RESTFS   216
C                                                                        RESTFS   217
      WRITE (NTL) (PINT(K),K=1,NT)                                       RESTFS   218
      IF (NDEBUG.EQ.1) WRITE (6,440) (PINT(K),K=1,NT)                    RESTFS   219
C                                                                        RESTFS   220
C     WRITE THE GAP CLOSURE INDICIES                                     RESTFS   221
C                                                                        RESTFS   222
      WRITE (NTL) (NOIGAP(K),K=1,NT)                                     RESTFS   223
      IF (NDEBUG.EQ.1) WRITE (6,450) (NOIGAP(K),K=1,NT)                  RESTFS   224
C                                                                        RESTFS   225
C                                                                        RESTFS   226
      WRITE (6,200) TIME                                                 RESTFS   227
C                                                                        RESTFS   228
CCC                                                                      RESTFS   229
C                                                                        RESTFS   230
      RETURN                                                             RESTFS   231
C                                                                        RESTFS   232
200   FORMAT (//,5X,46H A FRAP-T RESTART HAS BEEN WRITTEN AT TIME =  ,E1 RESTFS   233
     +2.5,6H (SEC),//)                                                   RESTFS   234
210   FORMAT (1H ,35H NUMBER OF AXIAL NODES IS          ,I3)             RESTFS   235
220   FORMAT (1H ,35H  ZIRCALOY-OXIDE THICKNESS (IN)    ,/,11(1X,E11.4)) RESTFS   236
230   FORMAT (1H ,35H FUEL PERMANENT SURFACE DISP (FT)  ,/,11(1X,E11.4)) RESTFS   237
240   FORMAT (1H ,35H CLADDING EPP'S                    ,/,11(1X,E11.4)) RESTFS   238
250   FORMAT (1H ,35H CLADDING EP'S                     ,/,11(1X,E11.4)) RESTFS   239
260   FORMAT (1H ,35H MAXIMUM CLADDING AVERAGE TEMP (K) ,/,11(1X,E11.4)) RESTFS   240
270   FORMAT (1H ,35H BURNUP (MWS/KG)                   ,/,11(1X,E11.4)) RESTFS   241
280   FORMAT (1H ,35H OPEN POROSITY FRACTION            ,/,11(1X,E11.4)) RESTFS   242
290   FORMAT (1H ,35H  NR , NR+1 , NR+2                 ,/,3I5)          RESTFS   243
300   FORMAT (1H ,35H  RADIUS TO EACH NODE (FT)         ,/,11(1X,E11.4)) RESTFS   244
310   FORMAT (1H ,35H  RADIAL TEMP. DIST (F)            ,/,11(1X,E11.4)) RESTFS   245
320   FORMAT (1H ,35H  INTERNAL GAS PRESSURE (PSIA)     ,/,11(1X,E11.4)) RESTFS   246
330   FORMAT (1H ,35H  RADIAL GAP THICKNESS (FT)        ,/,11(1X,E11.4)) RESTFS   247
340   FORMAT (1H ,35H  GM-MOLES OF GAS                  ,/,11(1X,E11.4)) RESTFS   248
350   FORMAT (1H ,35H  MOLE FRACTIONS OF GAS            ,/,11(1X,E11.4)) RESTFS   249
360   FORMAT (1H ,35H  RESIDUAL CLADDING STRAINS        ,/,11(1X,E11.4)) RESTFS   250
370   FORMAT (1H ,35H  RESIDUAL FUEL STRAINS            ,/,11(1X,E11.4)) RESTFS   251
380   FORMAT (1H ,35H  OLD CLADDING STRAINS             ,/,11(1X,E11.4)) RESTFS   252
390   FORMAT (1H ,35H  OLD FUEL STRAINS                 ,/,11(1X,E11.4)) RESTFS   253
400   FORMAT (1H ,35H  OLD CLADDING AVE. TEMPS. (F)     ,/,11(1X,E11.4)) RESTFS   254
410   FORMAT (1H ,35H  OLD GAP PRESSURE (PSI)           ,/,11(1X,E11.4)) RESTFS   255
420   FORMAT (1H ,35H  OLD COOLANT PRESSURE (PSI)       ,/,11(1X,E11.4)) RESTFS   256
430   FORMAT (1H ,35H  OLD FUEL SURFACE DISP. (IN)      ,/,11(1X,E11.4)) RESTFS   257
440   FORMAT (1H ,35H  INTERFACIAL PRESSURE (PSI)       ,/,11(1X,E11.4)) RESTFS   258
450   FORMAT (1H ,35H  OLD IGAP'S                       ,/,11(1X,I5))    RESTFS   259
      END                                                                RESTFS   260
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
75	1	DMWI	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
76	1	DMWI	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
112	1	DMWI	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
113	1	DMWI	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
153	1	DMWI	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
154	1	DMWI	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
170	1		ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
171	1		ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	RESTFS	1	230

VARIABLES	SN	TYPE	RELOCATION										
0	BU2	REAL	ARRAY	F.P.	REFS	45	111	DEFINED	1				
0	CTMAX	REAL	ARRAY	F.P.	REFS	45	100	101	DEFINED	1			
0	DMWI	REAL	ARRAY	F.P.	REFS	45	75	76	112	113	128	129	
					139	140	146	147	153	154			
					DEFINED	1	74	111	125	126	127	136	
					137	138	145	152					
0	EP	REAL	ARRAY	F.P.	REFS	45	95	96	DEFINED	1			
0	EPP	REAL	ARRAY	F.P.	REFS	45	90	91	DEFINED	1			
0	GASES	REAL	ARRAY	F.P.	REFS	45	170	171	DEFINED	1			
0	GASMOL	REAL		F.P.	REFS	158	159	DEFINED	1				
0	GPTP	REAL	ARRAY	F.P.	REFS	45	152	DEFINED	1				
1510	I	INTEGER			REFS	135	136	170	171	DEFINED	134	170	
					171								
1507	II	INTEGER			REFS	125	136	DEFINED	124	135			
1504	K	INTEGER			REFS	2*74	75	76	81	82	91	95	
					96	100	101	105	106	2*111	112	113	
					136	137	138	145	146	147	2*152	153	
					154	177	183	187	188	192	193	197	
					198	202	203	207	208	212	213	217	
					218	222	223	DEFINED	73	75	76	81	
					82	91	95	96	100	101	105	106	
					110	112	113	133	144	146	147	151	
					153	154	177	183	187	188	192	193	
					197	198	202	203	207	208	212	213	
					217	218	222	223					
1506	KK	INTEGER			REFS	90	176	182	DEFINED	90	176	182	
1505	L	INTEGER			REFS	91	124	125	128	129	140	176	
					177	182	183	DEFINED	89	123	128	129	
					140	175	181						
1511	LL	INTEGER			REFS	139	DEFINED	139					
0	NA	INTEGER		F.P.	REFS	12*45	DEFINED	1					
1477	NAPI	INTEGER			REFS	73	75	76	100	101	110	112	

VARIABLES	SN	TYPE			RELOCATION								
						113	151	153	154	DEFINED	55		
714	NDEBUG	INTEGER			REFS	68	76	82	90	96	101	106	
						113	119	129	139	147	154	159	171
						176	182	188	193	198	203	208	213
						218	223	DEFINED	53				
0	NOIGAP	INTEGER	ARRAY	F.P.	REFS	45		222	223	DEFINED	1		
0	NR	INTEGER		F.P.	REFS	2*45		56	57	118	119	123	124
						134	135	DEFINED	1				
1500	NRP1	INTEGER			REFS	118		119	126	137	DEFINED	56	
1501	NRP2	INTEGER			REFS	118		119	127	128	129	138	139
						140	DEFINED	57					
0	NT	INTEGER		F.P.	REFS	55		67	68	81	82	90	91
						95	96	105	106	133	144	146	147
						176	177	182	183	187	188	192	193
						197	198	202	203	207	208	212	213
						217	218	222	223	DEFINED	1		
712	NTL	INTEGER			DEFINED	52		I/O REFS	63	67	75	81	91
						95	100	105	112	118	128	140	146
						153	158	170	177	183	187	192	197
						202	207	212	217	222			
0	OLDPC	REAL	ARRAY	F.P.	REFS	45		207	208	DEFINED	1		
0	OLDPG	REAL	ARRAY	F.P.	REFS	45		202	203	DEFINED	1		
0	OLDTC	REAL	ARRAY	F.P.	REFS	45		197	198	DEFINED	1		
0	OLDURF	REAL	ARRAY	F.P.	REFS	45		212	213	DEFINED	1		
0	OLEPS	REAL	ARRAY	F.P.	REFS	45		187	188	DEFINED	1		
0	OLFEPS	REAL	ARRAY	F.P.	REFS	45		192	193	DEFINED	1		
0	PINT	REAL	ARRAY	F.P.	REFS	45		217	218	DEFINED	1		
0	POROSA	REAL	ARRAY	F.P.	REFS	45		105	106	DEFINED	1		
0	PRESS	REAL		F.P.	REFS	145	DEFINED	1					
0	R	REAL	ARRAY	F.P.	REFS	45		125	DEFINED	1			
0	RCI	REAL		F.P.	REFS	58	DEFINED	1					
1502	RCIF	REAL			REFS	126	DEFINED	58					
0	RCO	REAL		F.P.	REFS	59	DEFINED	1					
1503	RCOF	REAL			REFS	127	DEFINED	59					
0	REPS	REAL	ARRAY	F.P.	REFS	45		176	177	DEFINED	1		
0	RFEPS	REAL	ARRAY	F.P.	REFS	45		182	183	DEFINED	1		
0	TCIDIS	REAL	ARRAY	F.P.	REFS	45		137	DEFINED	1			
0	TCODIS	REAL	ARRAY	F.P.	REFS	45		138	DEFINED	1			
0	TIME	REAL		F.P.	REFS	63		226	DEFINED	1			
0	TMPDIS	REAL	ARRAY	F.P.	REFS	45		136	DEFINED	1			
713	TWELVE	REAL			REFS	58		59	74	125	DEFINED	52	
0	UFS	REAL	ARRAY	F.P.	REFS	45		81	82	DEFINED	1		
0	ZRO2B	REAL	ARRAY	F.P.	REFS	45		74	DEFINED	1			

FILE NAMES	MODE							
TAPE6	FMT	WRITES	68	76	82	90	96	101	106	113
			119	129	139	147	154	159	171	176	182
			188	193	198	203	208	213	218	223	226

VARIABLES USED AS FILE NAMES, SEE ABOVE

STATEMENT LABELS	DEF LINE	REFERENCES
0 100	74	73
0 110	91	89

STATEMENT LABELS			DEF LINE	REFERENCES
0	120		111	110
0	130		125	123
0	140		136	134
0	150		140	133
0	160		145	144
0	170		152	151
0	180		177	175
0	190		183	181
1207	200	FMT	232	226
1220	210	FMT	234	68
1226	220	FMT	235	76
1235	230	FMT	236	82
1244	240	FMT	237	90
1253	250	FMT	238	96
1262	260	FMT	239	101
1271	270	FMT	240	113
1300	280	FMT	241	106
1307	290	FMT	242	119
1315	300	FMT	243	129
1324	310	FMT	244	139
1333	320	FMT	245	147
1342	330	FMT	246	154
1351	340	FMT	247	159
1360	350	FMT	248	171
1367	360	FMT	249	176
1376	370	FMT	250	182
1405	380	FMT	251	188
1414	390	FMT	252	193
1423	400	FMT	253	198
1432	410	FMT	254	203
1441	420	FMT	255	208
1450	430	FMT	256	213
1457	440	FMT	257	218
1466	450	FMT	258	223

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
44	100	K	73 74	5B	INSTACK		
111	110	L	89 91	25B		EXT REFS	
214	120	K	110 111	5B	INSTACK		
251	130	L	123 125	11B	INSTACK		
310	150	K	133 140	43B		EXT REFS	NOT INNER
312	140	I	134 136	12B	INSTACK		
355	160	K	144 145	5B	INSTACK		
402	170	K	151 152	5B	INSTACK		
445	180	L	175 177	27B		EXT REFS	
476	190	L	181 183	27B		EXT REFS	

STATISTICS

PROGRAM LENGTH	1565B	885

140000B SCM USED

```
      SUBROUTINE RMESH (NRMESH,NR,R,RC,NRM1,PI,RP,NA)                    RMESH      2
C                                                                        RMESH      3
C*************************************************************************RMESH      4
C                                                                        RMESH      5
C  THIS SUBROUTINE IS CALLED FROM FRPCON AND COMPUTES THE RADIAL         RMESH      6
C  NODES TO BE USED FOR COMPUTATION AND OUTPUT. THIS WAS CODED BY        RMESH      7
C  G.A.BERNA IN JANUARY 1979.                                            RMESH      8
C                                                                        RMESH      9
C*************************************************************************RMESH     10
C  INPUT  ARGUMENTS                                                      RMESH     11
C*************************************************************************RMESH     12
C                                                                        RMESH     13
C  NA     - NUMBER OF AXIAL NODES PLUS ONE                               RMESH     14
C  NR     - NUMBER OF RADIAL NODES                                       RMESH     15
C  NRMESH - NODALIZATION INDEX                                           RMESH     16
C  : 0, EQUAL AREA MESH                                                  RMESH     17
C  : 1, EQUAL SPACING MESH                                               RMESH     18
C  : 2, USER INPUT MESH                                                  RMESH     19
C  NRM1   - NUMBER OF RADIAL NODES MINUS ONE                             RMESH     20
C  PI     - CONSTANT 3.1415926                                           RMESH     21
C  RC     - RADIUS OF THE THERMOCOUPLE HOLE (IN)                         RMESH     22
C  RP     - RADIUS OF THE FUEL PELLET (IN)                               RMESH     23
C                                                                        RMESH     24
C*************************************************************************RMESH     25
C  OUTPUT ARGUMENTS                                                      RMESH     26
C*************************************************************************RMESH     27
C                                                                        RMESH     28
C  R      - RADII OF THE SPECIFIED NODALIZATION                          RMESH     29
C                                                                        RMESH     30
C*************************************************************************RMESH     31
C                                                                        RMESH     32
      DIMENSION  R(NR)                                                   RMESH     33
C                                                                        RMESH     34
      R(1) = RC                                                          RMESH     35
      R(NR) = RP                                                         RMESH     36
C                                                                        RMESH     37
      IF (NRMESH.EQ.1) GO TO 110                                         RMESH     38
C                                                                        RMESH     39
C  THE FOLLOWING CODING COMPUTES NODALIZATION BASED ON EQUAL AREAS       RMESH     40
C  BETWEEN NODES                                                         RMESH     41
C                                                                        RMESH     42
      ARING = (RP*RP-RC*RC)/NRM1                                         RMESH     43
          DO 100 I=2,NRM1                                                RMESH     44
          R(I) = SQRT(R(I-1)**2+ARING)                                   RMESH     45
  100     CONTINUE                                                       RMESH     46
C                                                                        RMESH     47
  110 CONTINUE                                                           RMESH     48
C                                                                        RMESH     49
C  THE FOLLOWING CODING COMPUTES NODALIZATION BASED ON EQUAL SPACING     RMESH     50
C  BETWEEN NODES                                                         RMESH     51
C                                                                        RMESH     52
      SPACE = (RP-RC)/NRM1                                               RMESH     53
          DO 120 I=2,NRM1                                                RMESH     54
```

```
                     R(I) = R(I-1)+SPACE                                    RMESH      55
55          120      CONTINUE                                               RMESH      56
            C                                                               RMESH      57
            C                                                               RMESH      58
                 RETURN                                                     RMESH      59
                 END                                                        RMESH      60
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	RMESH	1	58

VARIABLES	SN	TYPE	RELOCATION									
63	ARING	REAL			REFS	44	DEFINED	42				
64	I	INTEGER			REFS	2*44	2*54	DEFINED	43	53		
0	NA	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NR	INTEGER		F.P.	REFS	32	35	DEFINED	1			
0	NRMESH	INTEGER		F.P.	REFS	37	DEFINED	1				
0	NRM1	INTEGER		F.P.	REFS	42	43	52	53	DEFINED	1	
0	PI	REAL	*UNUSED	F.P.	DEFINED	1						
0	R	REAL	ARRAY	F.P.	REFS	32	44	54	DEFINED	1	34	35
0	RC	REAL		F.P.	REFS	34	2*42	52	DEFINED	1		
0	RP	REAL		F.P.	REFS	35	2*42	52	DEFINED	1		
65	SPACE	REAL			REFS	54	DEFINED	52				

EXTERNALS	TYPE	ARGS		REFERENCES
SQRT	REAL	1	LIBRARY	44

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	45	43
42	110	47	37
0	120	55	53

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
30	100	I	43 45	11B	EXT REFS
51	120	I	53 55	6B	INSTACK

STATISTICS

PROGRAM LENGTH 74B 60

140000B SCM USED

```
      SUBROUTINE SCC (CESIUM,CESUMO,CRAKI,CTHICK,DELTAT,HSTRES,HSTRSO,IO
     +DINE,IODINO,TCLAD,TCLADO,CRAKL)
C
C   IMPLICIT REAL*8 ( A-H, O-Z )
C
C   SUBROUTINE SCC CALCULATES CRACK LENGTH AS A FUNCTION OF STRESS,
C   TEMPERATURE AND CORROSION PRODUCT CONTENT.
C   ***  PART OF FRAIL FAILURE PACKAGE   ***
C
C   --  INPUT ARGUMENTS --
C
C   CESIUM     CLADDING CESIUM CONTENT ( KG/M2 )
C   CESUMO     CLADDING CESIUM CONTENT DURING PREVIOUS TIMESTEP
C   CRAKI      INITIAL CRACK LENGTH THROUGH CLADDING ( M )
C   DELTAT     TIMESTEP LENGTH ( SEC )
C   HSTRES     CLADDING HOOP STRESS ( N/M2 )
C   HSTRSO     CLADDING HOOP STRESS DURING PREVIOUS TIMESTEP
C   IODINE     CLADDING IODINE CONTENT ( KG/M2 )
C   IODINO     CLADDING IODINE CONTENT DURING PREVIOUS TIMESTEP
C   TCLAD      CLADDING TEMPERATURE ( DEG K )
C   TCLADO     CLADDING TEMPERATURE DURING PREVIOUS TIMESTEP
C
C   -- OUTPUT ARGUMENTS --
C   CRAKL      CRACK LENGTH ( M )
C
C
      REAL IODINE, IODINO
      DATA Y, Y4, FTO / 1.29E0, 2.76923E0, 0.E0 /
      DATA A1, A2, A3 / 3.832779896E-23, .75E0, 1.806744E4 /
C     DATA Y, Y4, FTO / 1.29D0, 2.76923D0, 0.D0 /
C     DATA A1, A2, A3 / 3.832779896D-23, .75D0, 1.806744D4 /
      DATA N / 11 /
      DATA CDAM / .0 /
C
C
        COMPAR = 1./CTHICK
        FSUM1 = 0.
        FSUM2 = 0.
C
C   CALCULATE F(T) = CRACK VELOCITY/(CRACK LENGTH)**2
C
        FT = A1*Y4*(IODINE**A2)*(HSTRES**4)*EXP(-A3/TCLAD)
        FTO = A1*Y4*(IODINO**A2)*(HSTRSO**4)*EXP(-A3/TCLADO)
        IF (N.GT.0) GO TO 100
C
C   INTEGRATE F(T) USING TRAPEZOIDAL RULE
C
        CDAM = CDAM+.5*DELTAT*(FT+FTO)
C
C   CALCULATE NEW CRACK LENGTH
```

```
      C                                                                 SCC        55
55          STOR = 1./CRAKI-CDAM                                        SCC        56
            IF (STOR.LE.COMPAR) GO TO 140                               SCC        57
            CRAKL = 1./STOR                                             SCC        58
            GO TO 150                                                   SCC        59
      100   CONTINUE                                                    SCC        60
60          C                                                           SCC        61
      C     INTEGRATE F(T) USING SIMPSON'S RULE                         SCC        62
      C                                                                 SCC        63
            L = 2*N-1                                                   SCC        64
                DO 110 I=1,L,2                                          SCC        65
65              H = HSTRSO+(HSTRES-HSTRSO)*I/(2.*N)                     SCC        66
                CORR = IODINO+(IODINE-IODINO)*I/(2.*N)                  SCC        67
                TC = TCLADO+(TCLAD-TCLADO)*I/(2.*N)                     SCC        68
                FSUM1 = FSUM1+A1*Y4*(CORR**A2)*(H**4)*EXP(-A3/TC)       SCC        69
      110       CONTINUE                                                SCC        70
70          IF (N.LT.2) GO TO 130                                       SCC        71
            L = N-1                                                     SCC        72
                DO 120 I=1,L                                            SCC        73
                H = HSTRSO+(HSTRES-HSTRSO)*I/N                          SCC        74
                CORR = IODINO+(IODINE-IODINO)*I/N                       SCC        75
75              TC = TCLADO+(TCLAD-TCLADO)*I/N                          SCC        76
                FSUM2 = FSUM2+A1*Y4*(CORR**A2)*(H**4)*EXP(-A3/TC)       SCC        77
      120       CONTINUE                                                SCC        78
      130   CONTINUE                                                    SCC        79
            CDAM = DELTAT*(FT+FTO+2.*FSUM2+4.*FSUM1)/(6.*N)+CDAM        SCC        80
80          C                                                           SCC        81
      C     CALCULATE NEW CRACK LENGTH                                  SCC        82
      C                                                                 SCC        83
            STOR = 1./CRAKI-CDAM                                        SCC        84
            IF (STOR.LE.COMPAR) GO TO 140                               SCC        85
85          CRAKL = 1./STOR                                             SCC        86
            GO TO 150                                                   SCC        87
      140   CRAKL = CTHICK                                              SCC        88
      150   CONTINUE                                                    SCC        89
      C                                                                 SCC        90
90          C                                                           SCC        91
            RETURN                                                      SCC        92
            END                                                         SCC        93
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	SCC	1	91

VARIABLES	SN	TYPE	RELOCATION							
266	A1	REAL		REFS	45	46	68	76	DEFINED	32
267	A2	REAL		REFS	45	46	68	76	DEFINED	32
270	A3	REAL		REFS	45	46	68	76	DEFINED	32

```
VARIABLES     SN  TYPE          RELOCATION
  272  CDAM       REAL                                  REFS      51     55      79      83   DEFINED      36      51
                                                          79
    0  CESIUM     REAL       *UNUSED     F.P.        DEFINED       1
    0  CESUMO     REAL       *UNUSED     F.P.        DEFINED       1
  300  COMPAR     REAL                                  REFS      56     84   DEFINED      39
  310  CORR       REAL                                  REFS      68     76   DEFINED      66      74
    0  CRAKI      REAL                   F.P.           REFS      55     83   DEFINED       1
    0  CRAKL      REAL                   F.P.        DEFINED       1     57        85      87
    0  CTHICK     REAL                   F.P.           REFS      39     87   DEFINED       1
    0  DELTAT     REAL                   F.P.           REFS      51     79   DEFINED       1
  301  FSUM1      REAL                                  REFS      68     79   DEFINED      40      68
  302  FSUM2      REAL                                  REFS      76     79   DEFINED      41      76
  303  FT         REAL                                  REFS      51     79   DEFINED      45
  265  FTO        REAL                                  REFS      51     79   DEFINED      31      46
  307  H          REAL                                  REFS      68     76   DEFINED      65      73
    0  HSTRES     REAL                   F.P.           REFS      45     65        73  DEFINED       1
    0  HSTRSO     REAL                   F.P.           REFS      46   2*65      2*73  DEFINED       1
  306  I          INTEGER                               REFS      65     66        67      73      74      75
                                                     DEFINED      64     72
    0  IODINE     REAL                   F.P.           REFS      30     45        66      74   DEFINED       1
    0  IODINO     REAL                   F.P.           REFS      30     46      2*66    2*74   DEFINED       1
  305  L          INTEGER                               REFS      64     72   DEFINED      63      71
  271  N          INTEGER                               REFS      47     63        65      66      67      70      71
                                                          73      74     75        79   DEFINED      35
  304  STOR       REAL                                  REFS      56     57        84      85   DEFINED      55      83
  311  TC         REAL                                  REFS      68     76   DEFINED      67      75
    0  TCLAD      REAL                   F.P.           REFS      45     67        75  DEFINED       1
    0  TCLADO     REAL                   F.P.           REFS      46   2*67      2*75  DEFINED       1
  263  Y        * REAL                                DEFINED      31
  264  Y4         REAL                                  REFS      45     46        68      76   DEFINED      31

EXTERNALS          TYPE   ARGS       REFERENCES
       EXP         REAL      1 LIBRARY      45      46      68      76

STATEMENT LABELS              DEF LINE   REFERENCES
   73  100                       59         47
    0  110                       69         64
    0  120                       77         72
  214  130                       78         70
  242  140                       87         56      84
  245  150                       88         58      86

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  100  110      I           64 69       43B             EXT REFS
  153  120      I           72 77       40B             EXT REFS

STATISTICS
  PROGRAM LENGTH                 327B     215
        140000B SCM USED
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      SUBROUTINE SETUP (MNA,MNR)                                                SETUP     2
C                                                                               SETUP     3
C     SETUP IS CALLED FROM MAIN AND IS USED TO READ AND PROCESS INPUT           SETUP     4
C     AND TO SET UP THE POINTERS FOR DYNAMICALLY DIMENSIONED ARRAYS             SETUP     5
C                                                                               SETUP     6
C     IMPLICIT  REAL * 8 ( A-H,O-Z )                                            SETUP     7
C                                                                               SETUP     8
      REAL  NU , KRYIN                                                          SETUP     9
C                                                                               SETUP    10
      COMMON  / FAST    /   A                                                   SETUP    11
C                                                                               SETUP    12
C                                                                               REALCM    2
C                                                                               REALCM    3
C     THE COMMON /POINT/ CONTAINS THE POINTERS FOR THE DYNAMICALLY              REALCM    4
C     DIMENSIONED ARRAYS - IT = TIME , NA = AXIAL , NR = RADIAL                 REALCM    5
C                                                                               REALCM    6
C                                                                               REALCM    7
C     ( NA )      -  ARRAYS                                                     REALCM    8
C                                                                               REALCM    9
      COMMON  / POINT /                                                         REALCM   10
     +         LDCIM    ,LURC     ,LCREPI   ,LDLH     ,LHA      ,LHL         REALCM   11
     +        ,LPOROS   ,LUFS     ,LAXGAP   ,LAXLEN   ,LBU1     ,LBU2        REALCM   12
     +        ,LARAD    ,LCPDLT   ,LDELBP   ,LDENMX   ,LDLPGE                 REALCM   13
     +        ,LDZ      ,LDZH     ,LDZHP    ,LECREP   ,LEP                    REALCM   14
     +        ,LGAP     ,LGPTP    ,LHCOEF   ,LOLAXG   ,LOLDPC                 REALCM   15
     +        ,LOLDPG   ,LOLDTC   ,LOLDUR   ,LOLEPS   ,LOLFEP                 REALCM   16
     +        ,LPAXGP   ,LPC      ,LPECRP   ,LPEP     ,LPG                    REALCM   17
     +        ,LPINT    ,LPLDPC   ,LPLDPG   ,LPLDTC   ,LPLDUR   ,LPOAXG       REALCM   18
     +        ,LPOFEP   ,LPOLEP   ,LRDCOL   ,LTAF     ,LTAG     ,LTBAR       REALCM   19
     +        ,LTBLK    ,LTCA     ,LTCIDI   ,LTCODI   ,LTPS     ,LURF        REALCM   20
     +        ,LVCH     ,LVCH1    ,LVCR     ,LVDH     ,LVFH     ,LVGH        REALCM   21
     +        ,LVPOR    ,LZRO2A   ,LZRO2B   ,LEP1                              REALCM   22
     +        ,LHGAPS   ,LTRTRN   ,LIGAP    ,LOLIGP   ,LQDP                   REALCM   23
     +        ,LNFAIL   ,LPLIGP   ,LFLAG    ,LDCHEK   ,LRTRNP   ,LRTRNO       REALCM   24
     +        ,LHGPC    ,LHGPR    ,LHGPS    ,LTOXO                            REALCM   25
C                                                                               REALCM   26
C     ( NA X 2 )  -  ARRAYS                                                     REALCM   27
C                                                                               REALCM   28
      COMMON  / POINT /                                                         REALCM   29
     +         LANGR    ,LFGMGP   ,LFMGR    ,LHEMGP   ,LHMGR    ,LANG        REALCM   30
     +        ,LREPS2                                                          REALCM   31
C                                                                               REALCM   32
C     ( NA X 3 )  -  ARRAYS                                                     REALCM   33
C                                                                               REALCM   34
      COMMON  / POINT /                                                         REALCM   35
     +         LEPP     ,LEPPP    ,LEPPSV   ,LEPS     ,LEPSAV   ,LFEPS       REALCM   36
     +        ,LPEPSV   ,LPFPSV   ,LREPS    ,LREPSV   ,LREPSP   ,LRFEPS      REALCM   37
     +        ,LRFEPP   ,LRFPSV   ,LSIG     ,LNUDEP   ,LEPPI                  REALCM   38
     +        ,LSIGI    ,LEPSI                                                 REALCM   39
C                                                                               REALCM   40
C     ( NR )      -  ARRAYS                                                     REALCM   41
C                                                                               REALCM   42
      COMMON  / POINT /                                                         REALCM   43
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     +       LAK1     ,LAK2     ,LCRL     ,LDPL     ,LDPLH    ,LDPN     REALCM  44
55   +      ,LFMA     ,LFMGPR   ,LHRL     ,LTFB     ,LTFR     ,LTFRK    REALCM  45
     +      ,LVPL                                                        REALCM  46
C                                                                         REALCM  47
C    ( NR X 2 )  -  ARRAYS                                                REALCM  48
C                                                                         REALCM  49
60     COMMON  / POINT /                                                  REALCM  50
     +       LF       ,LFH      ,LFN                                     REALCM  51
C                                                                         REALCM  52
C    ( NR X NA ) -  ARRAYS                                                REALCM  53
C                                                                         REALCM  54
65     COMMON  / POINT /                                                  REALCM  55
     +       LCC1     ,LCC2     ,LDENSF   ,LDENSP   ,LDPW     ,LDPWPP   REALCM  56
     +      ,LGNSIZ   ,LPORS1   ,LPORS2   ,LTMPDS   ,LUO2LL   ,LTMPMX   REALCM  57
     +      ,LR       ,LRAD                                              REALCM  58
C                                                                         REALCM  59
70   C    ( NA X 6 )  -  ARRAYS                                           REALCM  60
C                                                                         REALCM  61
     COMMON  / POINT /                                                    REALCM  62
     +       LB       ,LBR      ,LBTOLD   ,LCHEM                         REALCM  63
C                                                                         REALCM  64
75   C    ( NA X 8 )  -  ARRAYS                                           REALCM  65
C                                                                         REALCM  66
     COMMON  / POINT /                                                    REALCM  67
     +       LQ                                                           REALCM  68
C                                                                         REALCM  69
80   C    ( IT )      -  ARRAYS                                           REALCM  70
C                                                                         REALCM  71
     COMMON  / POINT /          LACMFG   ,LACMHE   ,LACMH2   ,LACMN2     REALCM  72
     +                 ,LAMGPT  ,LGASMO  ,LLAMGPT  ,LPIT     ,LPRT10    REALCM  73
     +       ,LPRT11   ,LPRT12  ,LPRT13  ,LPRT14   ,LPRT15   ,LPRT16    REALCM  74
85   +       ,LPRT17   ,LPRT18  ,LPRT2   ,LPRT20   ,LPRT3    ,LPRT4     REALCM  75
     +       ,LPRT5    ,LPRT6   ,LPRT7   ,LPRT8    ,LPRT9    ,LTAC      REALCM  76
     +       ,LTAFA    ,LTAGA   ,LTSF                                     REALCM  77
C                                                                         REALCM  78
CCC                                                                       REALCM  79
90   CCC  ANS GAS RELEASE MODEL ARRAY - RADIAL * AXIAL * TIME             REALCM  80
C                                                                         REALCM  81
     COMMON / POINT /                                                     REALCM  82
     +   LANSD,    LFLXFC,   LPF,      LANSR,    LFF,      LDT,         REALCM  83
     +   LDECAY,   LHALF,    LRLEAS                                       REALCM  84
95   C                                                                    REALCM  85
CCC  BEYER-HANN GAS RELEASE ARRAYS - AXIAL * TIME                         REALCM  86
C                                                                         REALCM  87
     COMMON / POINT /                                                     REALCM  88
     +   IRDOT,    ISAVGS,   LSTHIF,   IX                                 REALCM  89
100  C                                                                    REALCM  90
CCC  RADIAL MODEL ARRAYS                                                  REALCM  91
C                                                                         REALCM  92
     COMMON / POINT /                                                     REALCM  93
     +   ICFAC    ,IDG      ,IDGSAV   ,IPRG     ,IVFC     ,IVFF         REALCM  94
105  +  ,ITRAMP   ,ITEMP    ,ITCL     ,ITFS     ,ICFCSV                   REALCM  95
     +  ,IHLDN    ,IPLSTC   ,ISTRNN   ,ISTRSS                             REALCM  96
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      C                                                                                 REALCM     97
      C                                                                                 REALCM     98
      C                                                                                 REALCM     99
110   C                                                                                 REALCM    100
       COMMON / REALS /   AAA(20)  ,AAN       ,AIRIN    ,AMGP(2) ,AMGPH(2)           REALCM    101
     +                   ,AMGR(2)  ,AMGRH(2)  ,AMGRN2(2),AMWDT    ,ANGI              REALCM    102
     +         ,ANGT     ,AN2IN    ,ARGIN     ,ARING    ,AVGQI(8) ,B(6)              REALCM    103
     +         ,BP       ,BPP      ,BR(6)     ,BU       ,BUOLD    ,CDG               REALCM    104
115  +         ,CFV      ,CFVA     ,CMOL      ,CODEID(15),CONVC,CONVER(10)           REALCM    105
     +         ,CPV      ,CRDTT    ,CRN       ,CVV      ,DCIH                        REALCM    106
     +         ,DCIHP    ,DELBP    ,DELBU     ,DELH     ,DELT                        REALCM    107
     +         ,DELTCR   ,DELTDB   ,DELTFC    ,DELTJL   ,DHIC     ,DLREL             REALCM    108
     +         ,DLROD    ,DLTGC(26),DPH       ,DPHF     ,DPHFP    ,DPHP              REALCM    109
120  +         ,DRS      ,ENRICH   ,EOLSR     ,FC(1)    ,FGIN     ,FGPAVP            REALCM    110
      C                                                                                 REALCM    111
       COMMON / REALS /   FGPAVX   ,FH2O      ,FJJ(2)   ,FJJH(2)  ,FMGP(2)           REALCM    112
     +                   ,FPOR     ,FPORI     ,FRD      ,FRDH     ,FRDN              REALCM    113
     +         ,G        ,GASES(7) ,GASIN     ,GDEN   ,GPTH(26) ,GPTHE(26)          REALCM    114
125  +         ,GPTHM    ,GPTHP    ,GPTHPG(26) ,GR      ,HCRV     ,HCV               REALCM    115
     +         ,HDSHV    ,HEIN     ,HFLL      ,HFLMDB   ,HFLMP    ,HFPER             REALCM    116
     +         ,HFV      ,HGAPT    ,HGV       ,HI       ,HMGP(2)  ,HP                REALCM    117
     +         ,HGAP     ,HSOLID   ,HGAPR                                             REALCM    118
     +         ,HPL      ,HPORV    ,HPV       ,HUPTAK   ,H2OMI    ,KRYIN             REALCM    119
130  +         ,NU       ,OXDROP   ,OXIDE     ,PECDH    ,PI       ,PIN(26)           REALCM    120
     +         ,PINP     ,PORO     ,PR        ,PRESS    ,PRTY     ,PRT19             REALCM    121
     +         ,QC       ,QP       ,QSP       ,RCI      ,RCO                         REALCM    122
     +         ,QAV      ,QPEAK                                                       REALCM    123
      C                                                                                 REALCM    124
135    COMMON / REALS /   RFNUFF   ,RHO       ,RHOF     ,RHOG     ,RHOUO2            REALCM    125
     +                   ,RMH      ,RP        ,RSTRAN   ,RSTRES   ,RTRAN             REALCM    126
     +         ,SKTC     ,SKTS     ,STRN      ,SUMCK    ,SUMDH    ,SUMEXP            REALCM    127
     +         ,SUMGP    ,SUMPOR   ,SUMRG     ,SUMTF    ,T        ,TCAC              REALCM    128
     +         ,TCI      ,TCO      ,TFBC      ,TFC      ,TFGFR    ,THEFR             REALCM    129
140  +         ,TH2OFR   ,TITLE(12),TM        ,TN2FR    ,TQXO     ,TP                REALCM    130
     +         ,TPA      ,TPAC     ,TPLEN     ,TRANST   ,TSAT     ,TT                REALCM    131
     +         ,TX       ,TXA      ,TXAL      ,TXC      ,VISC     ,VPLT              REALCM    132
     +         ,VSS      ,W        ,WT        ,WTRAN    ,XEIN     ,XK6               REALCM    133
     +         ,XK7      ,YY       ,Z         ,ZRO2WG   ,VX       ,CLOS              REALCM    134
145  +         ,FNCK     ,FNCN     ,CWKF      ,CWNF     ,COLDWK                      REALCM    135
     +         ,DISH                                                                  REALCM    136
      C                                                                                 REALCM    137
      C                                                                                 INTGCM      2
       COMMON / INTEG /                                                                 INTGCM      3
150  +    IQUIT       ,IRI        ,IT        ,ITER       ,J                          INTGCM      4
     +   ,JJC         ,JPEAK      ,K         ,KINDOR     ,KOXI                       INTGCM      5
     +   ,LMN         ,M          ,MODLOP    ,NAB        ,NPLAST                     INTGCM      6
     +   ,NRMI        ,NSTEP      ,NWRITE    ,N2         ,IMDONE                     INTGCM      7
     +   ,ICLOSE      ,NSH        ,NF        ,NC                                     INTGCM      8
155   C                                                                               INTGCM      9
      C                                                                               INPRCM      2
       COMMON / INPTR /ACOR       ,AFAL      ,AFCR       ,AFDN                       INPRCM      3
     +                ,AFGR       ,AFSW      ,AFTC       ,AGPC                       INPRCM      4
     +   ,AMFAIR      ,AMFARG     ,AMFFG     ,AMFHE      ,AMFH2                      INPRCM      5
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      +   ,AMFH2O     ,AMFKRY     ,AMFN2      ,AMFXE                          INPRCM      6
      +   ,BUIN(22)   ,CATEXF                                                INPRCM      7
      +   ,CLDWKD     ,CPL        ,CRDT       ,CRDTR      ,CTMAX(22)          INPRCM      8
      +   ,DCI(22)    ,DCO(22)    ,DE(22)     ,DELTAZ(22) ,DEN                INPRCM      9
      +   ,DENG       ,DISHSD     ,DP(22)     ,DSPG       ,DSPGW              INPRCM     10
      +   ,ENRCH      ,EXO        ,FA         ,FGPAV      ,FLUX               INPRCM     11
      +   ,FLXDP      ,FQE        ,GO(101)    ,GRNSIZ     ,HDISH              INPRCM     12
      +   ,HPLT       ,PPMH2O     ,PPMN2      ,P2(101)    ,QEND(8)            INPRCM     13
      +   ,QF(328)    ,QMPY(101)  ,RAPOW(11)  ,RC         ,RDISH              INPRCM     14
      +   ,ROUGHC     ,ROUGHF     ,SGAPF                                      INPRCM     15
      +   ,TCC        ,TIME(101)  ,TOTL       ,TSINT      ,TW(101)            INPRCM     16
      +   ,UBFS       ,UMELT      ,UOFD       ,VS         ,X(328)             INPRCM     17
      +   ,RSNTR      ,FOTMTL     ,TREF       ,CREPHR     ,ANRIN              INPRCM     18
      +   ,CLDWKS                                                             INPRCM     19
      +   ,CP         ,CR                                                     INPRCM     20
      C                                                                       INPICM      2
       COMMON / INPTI /ICM        ,ICOR       ,IDBG       ,IDXGAS             INPICM      3
      +               ,IM         ,IPLANT     ,IQ         ,ISW                INPICM      4
      +   ,JDLPR      ,JN(8)      ,JST(101)   ,MDBG       ,NHEAL              INPICM      5
      +   ,MODE       ,MODES      ,MTAPE      ,NDBG       ,NFROD              INPICM      6
      +   ,NGAPC      ,NGASR      ,NOFAIL     ,NOPT       ,NPCYCL             INPICM      7
      +   ,NPLTAB     ,NREAD      ,NRESTR     ,NROLL      ,NSP                INPICM      8
      +   ,NSTART     ,NSTOP      ,NT         ,NTAPE      ,NUCFC              INPICM      9
      +   ,NUNITS     ,LACMOD     ,LACE(13)   ,NAFAIL     ,NNFAIL(22)         INPICM     10
      +   ,NXP        ,NPLOT      ,NTPLOT     ,NROD       ,NA                 INPICM     11
      +   ,NR         ,NEWPRB     ,MECHAN     ,NCRACK     ,NELAST             INPICM     12
      +   ,NCREEP     ,IAXSYM     ,IVARDM     ,NOFRAC     ,ITREST             INPICM     13
      +   ,NWORDS     ,IWORDS     ,NWRDS      ,NPRINT                         INPICM     14
      C                                                                       INPICM     15
      C                                                                       INPICM     16
       COMMON  /EMFLGS/   IMPOWR   ,IMFUEL   ,IMDENS   ,IMRELO              INPICM     17
      +                  ,IMCLAD   ,IMGAPC   ,IM93WC   ,IMENRG               INPICM     18
      +         ,IMFGAS   ,IMSWCH                                           INPICM     19
      C                                                                       INPICM     20
      C                                                                       INPICM     21
      C                                                                       INPICM     22
       COMMON/PFRCS2/     MODPG2          ,MODPC2          ,MGAP2             INPICM     23
      +  ,MIGAP2          ,MOIGP2          ,MREPS2          ,MPEPS2            INPICM     24
      +  ,MTTT            ,MEREP2          ,MEP2            ,MR22              INPICM     25
      +  ,MOLDT2          ,MFVFRO          ,MDHPRS          ,MPEP2             INPICM     26
      +  ,MEPS22          ,MEPP2           ,MSIG2           ,MEPS02            INPICM     27
      +  ,MPEPP2          ,MEPS0           ,NNNCRP                             INPICM     28
      C                                                                       INPICM     29
       COMMON /MATCNS/ AAHA(12)                                               INPICM     30
      C                                                                       INPICM     31
      C                                                                       INPICM     32
       COMMON  /LACMDL/  MAXIDX , EMFLAG(20)                                  INPICM     33
      C                                                                       INPICM     34
       COMMON /VER/ VERS                                                      INPICM     35
      C                                                                       PHYPRO      2
       COMMON/PHYPRO/FTMELT   ,FHEFUS   ,CTMELT   ,CHEFUS   ,CTRANB          PHYPRO      3
      +             ,CTRANE   ,CTRANZ   ,FDELTA   ,BUP      ,COMP            PHYPRO      4
      +             ,DELOXY                                                   PHYPRO      5
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      C                                                                      PHYPRO      6
      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)              PHYPRO      7
215   C   FHEFUS - UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)           PHYPRO      8
      C   CTMELT - ZR CLAD MELTING POINT (K)                               PHYPRO      9
      C   CHEFUS - ZR CLAD HEAT OF FUSION (J/KG).                          PHYPRO     10
      C   CTRANB - START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)        PHYPRO     11
      C   CTRANE - END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)          PHYPRO     12
220   C   CTRANZ - ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)        PHYPRO     13
      C   FDELTA - LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)          PHYPRO     14
      C   BU     - BURNUP (MW-S/KG-U)                                      PHYPRO     15
      C   COMP   - PUO2 CONTENT (WT-PERCENT)                              PHYPRO     16
      C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED     PHYPRO     17
225   C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                             PHYPRO     18
      C                                                                      PHYPRO     19
            DIMENSION  IRAW1(20)                                           SETUP      18
      C                                                                    SETUP      19
            COMMON / GRSPTR /   NVAR1    ,NVAR2    ,NVAR3    ,NVAR4      SETUP      20
230         +          ,NVAR5    ,NVAR6    ,NVAR7    ,NVAR8    ,NVAR9    SETUP      21
            +          ,NVAR10   ,NVAR11   ,NVAR12   ,NVAR13   ,NVAR14   SETUP      22
            +          ,NVAR15   ,NVAR16   ,NVAR17   ,NVAR18   ,NVAR19   SETUP      23
            +          ,NVAR20   ,NVAR21   ,NVAR22   ,NVAR23   ,NVAR24   SETUP      24
            +          ,NVAR25   ,NVAR26   ,NVAR27   ,NVAR28   ,NVAR29   SETUP      25
235         +          ,NVAR30   ,NVAR31   ,NVAR32   ,NVAR33   ,NVAR34   SETUP      26
            +          ,NVAR35   ,NVAR36   ,NVAR37   ,LGRASS             SETUP      27
      C                                                                    SETUP      28
      C                                                                    SETUP      29
            COMMON/PFCM12/          NPIN                                 SETUP      30
240         +                      ,NPOUT      ,NP1        ,NP2          SETUP      31
            +                      ,NTSAVE     ,NDCHCK     ,NOLSGF       SETUP      32
            +                      ,NDEP       ,NSLOPE     ,NCOEF        SETUP      33
            +                      ,NDSIGF     ,NF1        ,NF2          SETUP      34
            +                      ,NEP2       ,NECRP2     ,NT2          SETUP      35
245         +                      ,NTN        ,NE         ,NV           SETUP      36
            +                      ,NEPP2      ,NSTRTT     ,NALFDT       SETUP      37
            +                      ,NOLDPP     ,NNUDPP     ,NHH          SETUP      38
            +                      ,NNN        ,NMN        ,NBB          SETUP      39
            +                      ,NMM        ,NGG        ,NDD          SETUP      40
250         +                      ,NW         ,NNU        ,NEE          SETUP      41
            +                      ,NLL        ,NAA        ,NEI          SETUP      42
            +                      ,NCC        ,NNFF                     SETUP      43
      C                                                                    SETUP      44
            DIMENSION   IA(1) , A(1)                                       SETUP      45
255         DIMENSION AFRCS2(1)                                            SETUP      46
      C                                                                    SETUP      47
            EQUIVALENCE  ( A(1) , IA(1) )                                  SETUP      48
            EQUIVALENCE ( A(1)  , AFRCS2(1)  )                             SETUP      49
      C                                                                    SETUP      50
260         DATA     LENGTH   /    0     /                                SETUP      51
      C                                                                    SETUP      52
      C                                                                    SETUP      53
      C   READ IN THE DIMENSIONAL PARAMETERS                               SETUP      54
      C                                                                    SETUP      55
265   C                                                                    SETUP      56
```

```
      NAMELIST / FRPCN /     IAXSYM   ,IM       ,MECHAN   ,NA
     +  ,NC       ,NF       ,NGASR    ,NR
      C
            CALL MEMSET (0.E0,ACOR,1397)
270         CALL MEMSET (0,ICM,197)
      C
            NTPLOT = 17
            NPLOT = 21
            NXP = 8
275   C
      C
            CALL MEMSET (0.E0,AAA,393)
            CALL MEMSET (0,IQUIT,24)
      C
280   C   ZERO OUT THE POINTER PART OF THE A-ARRAY
      C
            CALL MEMSET (0.E0,A,300)
      C
            READ (5,130) (TITLE(I),I=1,12)
285         IF (EOF(5)) 110,100
      100   CONTINUE
            IMDONE = 0
            MECHAN = 0
            NC = 4
290         NF = 5
            NGASR = 0
            NWORDS = 0
      C
            IWORDS = 0
295         NWRDS = 0
            NWORDS = 0
      C
            READ (5,FRPCN)
      C
300         WRITE (6,FRPCN)
      C
      C   THE FOLLOWING CALL TO POINTR COMPUTES THE POINTERS FOR THE ARRAYS
      C   WHICH ARE DYNAMICALLY DIMENSIONED
      C
305         CALL POINTR (IM,NA,NR,LENGTH,MECHAN,IQUIT,NC,NF,NGASR,NWORDS,IWORD
           +S,NWRDS,MNA,MNR)
      C
            IF (IQUIT.EQ.1) GO TO 120
            ICLOSE = 2000
310         NA = IA(2)
            NAB = 2
            NT = IA(2)-1
      C
      C   THE FOLLOWING CALL TO INITAL INITIALIZES VARIABLES BASED ON INPUT
315   C
            CALL INITAL (AFRCS2(MDHPRS),AFRCS2(MTTT),AFRCS2(MEPS22),AFRCS2(MEP
           +P2),AFRCS2(MFVFRO),AFRCS2(MSIG2),AFRCS2(MREPS2),AFRCS2(MEPSO2),AFR
           +CS2(MEP2),AFRCS2(MGAP2),AFRCS2(MR22),AFRCS2(MEREP2),AFRCS2(MPEPS2)
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      +,AFRCS2(MPEPP2),AFRCS2(MOLDT2),AFRCS2(MPEP2),AFRCS2(MODPG2),AFRCS2  SETUP   110
320   +(MODPC2),AFRCS2(MOIGP2),AFRCS2(MIGAP2),AFRCS2(MEPS0),MNR,MNA)       SETUP   111
C                                                                          SETUP   112
      IF (IQUIT.EQ.1) GO TO 120                                            SETUP   113
C                                                                          SETUP   114
C     THE FOLLOWING CALL TO PLTINP READS IN THE PLOT INPUT                 SETUP   115
C                                                                          SETUP   116
325   CALL PLTINP (NTPLOT,NPLOT,CODEID,TIME(IM),NT,NROD,IRAWI,MODLOP,TIT   SETUP   117
      +LE)                                                                 SETUP   118
C                                                                          SETUP   119
C     THE FOLLOWING CALL THE AXHEF COMPUTES THE AXIAL POWER PROFILE        SETUP   120
C                                                                          SETUP   121
330   CALL AXHEF (AVGQI,DELTAZ,FA,A(LQ),QF,X,IQ,IRI,JJC,JN,JPEAK,NT,CODE  SETUP   122
      +ID,NUNITS,MODLOP,QEND,NA,NXP,A(LDLH),A(LHA),A(LHL),TITLE)           SETUP   123
C                                                                          SETUP   124
      IF (NNFAIL(1).EQ.0) NNFAIL(1) = JPEAK-1                              SETUP   125
335   C                                                                    SETUP   126
      IF (IPLANT.EQ.-1) WRITE (6,140) (RAPOW(I),I=1,NR)                    SETUP   127
C                                                                          SETUP   128
      WRITE (6,150) NR,(A(LR+I-1),I=1,NR)                                  SETUP   129
C                                                                          SETUP   130
340   WRITE (6,160) AIRIN,AN2IN,ARGIN,FGIN,HEIN                            SETUP   131
C                                                                          SETUP   132
      GO TO 120                                                            SETUP   133
C                                                                          SETUP   134
110   CONTINUE                                                             SETUP   135
345   C                                                                    SETUP   136
      IQUIT = 1                                                            SETUP   137
C                                                                          SETUP   138
120   CONTINUE                                                             SETUP   139
C                                                                          SETUP   140
350   RETURN                                                               SETUP   141
C                                                                          SETUP   142
C                                                                          SETUP   143
130   FORMAT (12A4)                                                        SETUP   144
140   FORMAT (8X,49H THE RADIAL POWER PROFILE FROM THE SURFACE TO THE,10   SETUP   145
     +H CENTER IS,/,8X,18H RAPOW(1 TO 11) = ,11(2X,F7.4))                  SETUP   146
355   150   FORMAT (5X,10H R(I),I=1,,I2,5X,2H= ,11(2X,F7.4))               SETUP   147
      160   FORMAT (////,42X,52HXXXXXXXXXX  INITIAL PLENUM GASES (MOLES)  XXXX SETUP   148
     +XXXXXX,//,3X,6HAIR = ,E12.5,4X,11HNITROGEN = ,E12.5,4X,8HARGON = ,  SETUP   149
     +E12.5,4X,14HFISSION GAS = ,E12.5,4X,9HHELIUM = ,E12.5)               SETUP   150
360   END                                                                  SETUP   151
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CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
310	1	IA	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
312	1	IA	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 SETUP 1 350

VARIABLES	SN	TYPE	RELOCATION									
0	A	REAL	ARRAY	FAST	REFS	10	254	257	258	282	4*331	338
0	AAA	REAL	ARRAY	REALS	REFS	111	277					
0	AAHA	REAL	ARRAY	MATCNS	REFS	203						
24	AAN	REAL		REALS	REFS	111						
0	ACOR	REAL		INPTR	REFS	157	269					
1	AFAL	REAL		INPTR	REFS	157						
2	AFCR	REAL		INPTR	REFS	157						
3	AFDN	REAL		INPTR	REFS	157						
4	AFGR	REAL		INPTR	REFS	157						
0	AFRCS2	REAL	ARRAY	FAST	REFS	255	258	21*316				
5	AFSW	REAL		INPTR	REFS	157						
6	AFTC	REAL		INPTR	REFS	157						
7	AGPC	REAL		INPTR	REFS	157						
25	AIRIN	REAL		REALS	REFS	111	340					
10	AMFAIR	REAL		INPTR	REFS	157						
11	AMFARG	REAL		INPTR	REFS	157						
12	AMFFG	REAL		INPTR	REFS	157						
13	AMFHE	REAL		INPTR	REFS	157						
14	AMFH2	REAL		INPTR	REFS	157						
15	AMFH20	REAL		INPTR	REFS	157						
16	AMFKRY	REAL		INPTR	REFS	157						
17	AMFN2	REAL		INPTR	REFS	157						
20	AMFXE	REAL		INPTR	REFS	157						
26	AMGP	REAL	ARRAY	REALS	REFS	111						
30	AMGPH	REAL	ARRAY	REALS	REFS	111						
32	AMGR	REAL	ARRAY	REALS	REFS	111						
34	AMGRH	REAL	ARRAY	REALS	REFS	111						
36	AMGRN2	REAL	ARRAY	REALS	REFS	111						
40	AMWDT	REAL		REALS	REFS	111						
41	ANGI	REAL		REALS	REFS	111						
42	ANGT	REAL		REALS	REFS	111						
2555	ANRIN	REAL		INPTR	REFS	157						
43	AN2IN	REAL		REALS	REFS	111		340				
44	ARGIN	REAL		REALS	REFS	111		340				
45	ARING	REAL		REALS	REFS	111						
46	AVGQI	REAL	ARRAY	REALS	REFS	111		331				
56	B	REAL	ARRAY	REALS	REFS	111						
64	BP	REAL		REALS	REFS	111						
65	BPP	REAL		REALS	REFS	111						
66	BR	REAL	ARRAY	REALS	REFS	111						
74	BU	REAL		REALS	REFS	111						
21	BUIN	REAL	ARRAY	INPTR	REFS	157						
75	BUOLD	REAL		REALS	REFS	111						
10	BUP	REAL		PHYPRO	REFS	210						
47	CATEXF	REAL		INPTR	REFS	157						
76	CDG	REAL		REALS	REFS	111						

VARIABLES	SN	TYPE		RELOCATION				
77	CFV	REAL		REALS	REFS	111		
100	CFVA	REAL		REALS	REFS	111		
3	CHEFUS	REAL		PHYPRO	REFS	210		
50	CLDWKD	REAL		INPTR	REFS	157		
2556	CLDWKS	REAL		INPTR	REFS	157		
601	CLOS	REAL		REALS	REFS	135		
101	CMOL	REAL		REALS	REFS	111		
102	CODEID	REAL	ARRAY	REALS	REFS	111	326	331
606	COLDWK	REAL		REALS	REFS	135		
11	COMP	REAL		PHYPRO	REFS	210		
121	CONVC	REAL		REALS	REFS	111		
122	CONVER	REAL	ARRAY	REALS	REFS	111		
2557	CP	REAL		INPTR	REFS	157		
51	CPL	REAL		INPTR	REFS	157		
134	CPV	REAL		REALS	REFS	111		
2560	CR	REAL		INPTR	REFS	157		
52	CRDT	REAL		INPTR	REFS	157		
53	CRDTR	REAL		INPTR	REFS	157		
135	CRDTT	REAL		REALS	REFS	111		
2554	CREPHR	REAL		INPTR	REFS	157		
136	CRN	REAL		REALS	REFS	111		
54	CTMAX	REAL	ARRAY	INPTR	REFS	157		
2	CTMELT	REAL		PHYPRO	REFS	210		
4	CTRANB	REAL		PHYPRO	REFS	210		
5	CTRANE	REAL		PHYPRO	REFS	210		
6	CTRANZ	REAL		PHYPRO	REFS	210		
137	CVV	REAL		REALS	REFS	111		
604	CWKF	REAL		REALS	REFS	135		
605	CWNF	REAL		REALS	REFS	135		
102	DCI	REAL	ARRAY	INPTR	REFS	157		
140	DCIH	REAL		REALS	REFS	111		
141	DCIHP	REAL		REALS	REFS	111		
130	DCO	REAL	ARRAY	INPTR	REFS	157		
156	DE	REAL	ARRAY	INPTR	REFS	157		
142	DELBP	REAL		REALS	REFS	111		
143	DELBU	REAL		REALS	REFS	111		
144	DELH	REAL		REALS	REFS	111		
12	DELOXY	REAL		PHYPRO	REFS	210		
145	DELT	REAL		REALS	REFS	111		
204	DELTAZ	REAL	ARRAY	INPTR	REFS	157	331	
146	DELTCR	REAL		REALS	REFS	111		
147	DELTDB	REAL		REALS	REFS	111		
150	DELTFC	REAL		REALS	REFS	111		
151	DELTJL	REAL		REALS	REFS	111		
232	DEN	REAL		INPTR	REFS	157		
233	DENG	REAL		INPTR	REFS	157		
152	DHIC	REAL		REALS	REFS	111		
607	DISH	REAL		REALS	REFS	135		
234	DISHSD	REAL		INPTR	REFS	157		
153	DLREL	REAL		REALS	REFS	111		
154	DLROD	REAL		REALS	REFS	111		
155	DLTGC	REAL	ARRAY	REALS	REFS	111		
235	DP	REAL	ARRAY	INPTR	REFS	157		

VARIABLES	SN	TYPE		RELOCATION			
207	DPH	REAL		REALS	REFS	111	
210	DPHF	REAL		REALS	REFS	111	
211	DPHFP	REAL		REALS	REFS	111	
212	DPWP	REAL		REALS	REFS	111	
213	DRS	REAL		REALS	REFS	111	
263	DSPG	REAL		INPTR	REFS	157	
264	DSPGW	REAL		INPTR	REFS	157	
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	206	
265	ENRCH	REAL		INPTR	REFS	157	
214	ENRICH	REAL		REALS	REFS	111	
215	EOLSR	REAL		REALS	REFS	111	
266	EXO	REAL		INPTR	REFS	157	
267	FA	REAL		INPTR	REFS	157	331
216	FC	REAL	ARRAY	REALS	REFS	111	
7	FDELTA	REAL		PHYPRO	REFS	210	
217	FGIN	REAL		REALS	REFS	111	340
270	FGPAV	REAL		INPTR	REFS	157	
220	FGPAVP	REAL		REALS	REFS	111	
221	FGPAVX	REAL		REALS	REFS	122	
1	FHEFUS	REAL		PHYPRO	REFS	210	
222	FH2O	REAL		REALS	REFS	122	
223	FJJ	REAL	ARRAY	REALS	REFS	122	
225	FJJH	REAL	ARRAY	REALS	REFS	122	
271	FLUX	REAL		INPTR	REFS	157	
272	FLXDP	REAL		INPTR	REFS	157	
227	FMGP	REAL	ARRAY	REALS	REFS	122	
602	FNCK	REAL		REALS	REFS	135	
603	FNCN	REAL		REALS	REFS	135	
2552	FOTMTL	REAL		INPTR	REFS	157	
231	FPOR	REAL		REALS	REFS	122	
232	FPORI	REAL		REALS	REFS	122	
273	FQE	REAL		INPTR	REFS	157	
233	FRD	REAL		REALS	REFS	122	
234	FRDH	REAL		REALS	REFS	122	
235	FRDN	REAL		REALS	REFS	122	
0	FTMELT	REAL		PHYPRO	REFS	210	
236	G	REAL		REALS	REFS	122	
237	GASES	REAL	ARRAY	REALS	REFS	122	
246	GASIN	REAL		REALS	REFS	122	
247	GDEN	REAL		REALS	REFS	122	
274	GO	REAL	ARRAY	INPTR	REFS	157	
250	GPTH	REAL	ARRAY	REALS	REFS	122	
302	GPTHE	REAL	ARRAY	REALS	REFS	122	
334	GPTHM	REAL		REALS	REFS	122	
335	GPTHP	REAL		REALS	REFS	122	
336	GPTHPG	REAL	ARRAY	REALS	REFS	122	
370	GR	REAL		REALS	REFS	122	
441	GRNSIZ	REAL		INPTR	REFS	157	
371	HCRV	REAL		REALS	REFS	122	
372	HCV	REAL		REALS	REFS	122	
442	HDISH	REAL		INPTR	REFS	157	
373	HDSHV	REAL		REALS	REFS	122	
374	HEIN	REAL		REALS	REFS	122	340

VARIABLES	SN	TYPE		RELOCATION								
375	HFLL	REAL		REALS	REFS	122						
376	HFLMDB	REAL		REALS	REFS	122						
377	HFLMP	REAL		REALS	REFS	122						
400	HFPER	REAL		REALS	REFS	122						
401	HFV	REAL		REALS	REFS	122						
410	HGAP	REAL		REALS	REFS	122						
412	HGAPR	REAL		REALS	REFS	122						
402	HGAPT	REAL		REALS	REFS	122						
403	HGV	REAL		REALS	REFS	122						
404	HI	REAL		REALS	REFS	122						
405	HMGP	REAL	ARRAY	REALS	REFS	122						
407	HP	REAL		REALS	REFS	122						
413	HPL	REAL		REALS	REFS	122						
443	HPLT	REAL		INPTR	REFS	157						
414	HFORV	REAL		REALS	REFS	122						
415	HPV	REAL		REALS	REFS	122						
411	HSOLID	REAL		REALS	REFS	122						
416	HUPTAK	REAL		REALS	REFS	122						
417	H2OMI	REAL		REALS	REFS	122						
522	I	INTEGER			REFS	284	336	338	DEFINED	284	336	338
0	IA	INTEGER	ARRAY	FAST	REFS	254	257	310	312			
275	IAXSYM	INTEGER		INPTI	REFS	176	266					
270	ICFAC	INTEGER		POINT	REFS	103						
302	ICFCSV	INTEGER		POINT	REFS	103						
24	ICLOSE	INTEGER		INTEG	REFS	149	DEFINED	309				
0	ICM	INTEGER		INPTI	REFS	176	270					
1	ICOR	INTEGER		INPTI	REFS	176						
2	IDBG	INTEGER		INPTI	REFS	176						
271	IDG	INTEGER		POINT	REFS	103						
272	IDGSAV	INTEGER		POINT	REFS	103						
3	IDXGAS	INTEGER		INPTI	REFS	176						
303	IHLDN	INTEGER		POINT	REFS	103						
4	IM	INTEGER		INPTI	REFS	176	266	305	326			
4	IMCLAD	INTEGER		EMFLGS	REFS	190						
2	IMDENS	INTEGER		EMFLGS	REFS	190						
23	IMDONE	INTEGER		INTEG	REFS	149	DEFINED	287				
7	IMENRG	INTEGER		EMFLGS	REFS	190						
10	IMFGAS	INTEGER		EMFLGS	REFS	190						
1	IMFUEL	INTEGER		EMFLGS	REFS	190						
5	IMGAPC	INTEGER		EMFLGS	REFS	190						
0	IMPOWR	INTEGER		EMFLGS	REFS	190						
3	IMRELO	INTEGER		EMFLGS	REFS	190						
11	IMSWCH	INTEGER		EMFLGS	REFS	190						
6	IM93WC	INTEGER		EMFLGS	REFS	190						
5	IPLANT	INTEGER		INPTI	REFS	176	336					
304	IPLSTC	INTEGER		POINT	REFS	103						
273	IPRG	INTEGER		POINT	REFS	103						
6	IQ	INTEGER		INPTI	REFS	176	331					
0	IQUIT	INTEGER		INTEG	REFS	149	278	305	308	322		
					DEFINED	346						
523	IRAWI	INTEGER	ARRAY		REFS	227	326					
264	IRDOT	INTEGER		POINT	REFS	98						
1	IRI	INTEGER		INTEG	REFS	149	331					

VARIABLES	SN	TYPE		RELOCATION						
265	ISAVGS	INTEGER		POINT	REFS	98				
305	ISTRNN	INTEGER		POINT	REFS	103				
306	ISTRSS	INTEGER		POINT	REFS	103				
7	ISW	INTEGER		INPTI	REFS	176				
2	IT	INTEGER		INTEG	REFS	149				
300	ITCL	INTEGER		POINT	REFS	103				
277	ITEMP	INTEGER		POINT	REFS	103				
3	ITER	INTEGER		INTEG	REFS	149				
301	ITFS	INTEGER		POINT	REFS	103				
276	ITRAMP	INTEGER		POINT	REFS	103				
300	ITREST	INTEGER		INPTI	REFS	176				
276	IVARDM	INTEGER		INPTI	REFS	176				
274	IVFC	INTEGER		POINT	REFS	103				
275	IVFF	INTEGER		POINT	REFS	103				
302	IWORDS	INTEGER		INPTI	REFS	176	305	DEFINED	294	
267	IX	INTEGER		POINT	REFS	98				
4	J	INTEGER		INTEG	REFS	149				
10	JDLPR	INTEGER		INPTI	REFS	176				
5	JJC	INTEGER		INTEG	REFS	149	331			
11	JN	INTEGER	ARRAY	INPTI	REFS	176	331			
6	JPEAK	INTEGER		INTEG	REFS	149	331	334		
21	JST	INTEGER	ARRAY	INPTI	REFS	176				
7	K	INTEGER		INTEG	REFS	149				
10	KINDOR	INTEGER		INTEG	REFS	149				
11	KOXI	INTEGER		INTEG	REFS	149				
420	KRYIN	REAL		REALS	REFS	8	122			
216	LACE	INTEGER	ARRAY	INPTI	REFS	176				
215	LACMFG	INTEGER		POINT	REFS	82				
216	LACMHE	INTEGER		POINT	REFS	82				
217	LACMH2	INTEGER		POINT	REFS	82				
220	LACMN2	INTEGER		POINT	REFS	82				
215	LACMOD	INTEGER		INPTI	REFS	176				
152	LAK1	INTEGER		POINT	REFS	53				
153	LAK2	INTEGER		POINT	REFS	53				
221	LAMGPT	INTEGER		POINT	REFS	82				
125	LANG	INTEGER		POINT	REFS	39				
120	LANGR	INTEGER		POINT	REFS	39				
253	LANSD	INTEGER		POINT	REFS	92				
256	LANSR	INTEGER		POINT	REFS	92				
14	LARAD	INTEGER		POINT	REFS	20				
10	LAXGAP	INTEGER		POINT	REFS	20				
11	LAXLEN	INTEGER		POINT	REFS	20				
210	LB	INTEGER		POINT	REFS	72				
211	LBR	INTEGER		POINT	REFS	72				
212	LBTOLD	INTEGER		POINT	REFS	72				
12	LBU1	INTEGER		POINT	REFS	20				
13	LBU2	INTEGER		POINT	REFS	20				
172	LCC1	INTEGER		POINT	REFS	65				
173	LCC2	INTEGER		POINT	REFS	65				
213	LCHEM	INTEGER		POINT	REFS	72				
15	LCPDLT	INTEGER		POINT	REFS	20				
2	LCREP1	INTEGER		POINT	REFS	20				
154	LCRL	INTEGER		POINT	REFS	53				

VARIABLES	SN	TYPE	RELOCATION				
111	LDCHEK	INTEGER	POINT	REFS	20		
0	LDCIH	INTEGER	POINT	REFS	20		
261	LDECAY	INTEGER	POINT	REFS	92		
16	LDELBP	INTEGER	POINT	REFS	20		
17	LDENMX	INTEGER	POINT	REFS	20		
174	LDENSF	INTEGER	POINT	REFS	65		
175	LDENSP	INTEGER	POINT	REFS	65		
3	LDLH	INTEGER	POINT	REFS	20	331	
20	LDLPGE	INTEGER	POINT	REFS	20		
155	LDPL	INTEGER	POINT	REFS	53		
156	LDPLH	INTEGER	POINT	REFS	53		
157	LDPN	INTEGER	POINT	REFS	53		
176	LDPW	INTEGER	POINT	REFS	65		
177	LDPWPP	INTEGER	POINT	REFS	65		
260	LDT	INTEGER	POINT	REFS	92		
21	LDZ	INTEGER	POINT	REFS	20		
22	LDZH	INTEGER	POINT	REFS	20		
23	LDZHP	INTEGER	POINT	REFS	20		
24	LECREP	INTEGER	POINT	REFS	20		
364	LENGTH	INTEGER		REFS	305	DEFINED	260
25	LEP	INTEGER	POINT	REFS	20		
127	LEPP	INTEGER	POINT	REFS	45		
130	LEPPP	INTEGER	POINT	REFS	45		
131	LEPPSV	INTEGER	POINT	REFS	45		
147	LEPPI	INTEGER	POINT	REFS	45		
132	LEPS	INTEGER	POINT	REFS	45		
133	LEPSAV	INTEGER	POINT	REFS	45		
151	LEPSI	INTEGER	POINT	REFS	45		
100	LEPI	INTEGER	POINT	REFS	20		
167	LF	INTEGER	POINT	REFS	60		
134	LFEPS	INTEGER	POINT	REFS	45		
257	LFF	INTEGER	POINT	REFS	92		
121	LFGMGP	INTEGER	POINT	REFS	39		
170	LFH	INTEGER	POINT	REFS	60		
110	LFLAG	INTEGER	POINT	REFS	20		
254	LFLXFC	INTEGER	POINT	REFS	92		
160	LFMA	INTEGER	POINT	REFS	53		
161	LFMGPR	INTEGER	POINT	REFS	53		
122	LFMGR	INTEGER	POINT	REFS	39		
171	LFN	INTEGER	POINT	REFS	60		
26	LGAP	INTEGER	POINT	REFS	20		
222	LGASMQ	INTEGER	POINT	REFS	82		
200	LGNSIZ	INTEGER	POINT	REFS	65		
27	LGPTP	INTEGER	POINT	REFS	20		
45	LGRASS	INTEGER	GRSPTR	REFS	229		
4	LHA	INTEGER	POINT	REFS	20	331	
262	LHALF	INTEGER	POINT	REFS	92		
30	LHCOEF	INTEGER	POINT	REFS	20		
123	LHEMGP	INTEGER	POINT	REFS	39		
101	LHGAPS	INTEGER	POINT	REFS	20		
114	LHGPC	INTEGER	POINT	REFS	20		
115	LHGPR	INTEGER	POINT	REFS	20		
116	LHGPS	INTEGER	POINT	REFS	20		

VARIABLES	SN	TYPE	RELOCATION			
5	LHL	INTEGER	POINT	REFS	20	331
223	LHMGPT	INTEGER	POINT	REFS	82	
124	LHMGR	INTEGER	POINT	REFS	39	
162	LHRL	INTEGER	POINT	REFS	53	
103	LIGAP	INTEGER	POINT	REFS	20	
12	LMN	INTEGER	INTEG	REFS	149	
106	LNFAIL	INTEGER	POINT	REFS	20	
146	LNUDEP	INTEGER	POINT	REFS	45	
31	LOLAXG	INTEGER	POINT	REFS	20	
32	LOLDPC	INTEGER	POINT	REFS	20	
33	LOLDPG	INTEGER	POINT	REFS	20	
34	LOLDTC	INTEGER	POINT	REFS	20	
35	LOLDUR	INTEGER	POINT	REFS	20	
36	LOLEPS	INTEGER	POINT	REFS	20	
37	LOLFEP	INTEGER	POINT	REFS	20	
104	LOLIGP	INTEGER	POINT	REFS	20	
40	LPAXGP	INTEGER	POINT	REFS	20	
41	LPC	INTEGER	POINT	REFS	20	
42	LPECRP	INTEGER	POINT	REFS	20	
43	LPEP	INTEGER	POINT	REFS	20	
135	LPEPSV	INTEGER	POINT	REFS	45	
255	LPF	INTEGER	POINT	REFS	92	
136	LPFPSV	INTEGER	POINT	REFS	45	
44	LPG	INTEGER	POINT	REFS	20	
45	LPINT	INTEGER	POINT	REFS	20	
224	LPIT	INTEGER	POINT	REFS	82	
46	LPLDPC	INTEGER	POINT	REFS	20	
47	LPLDPG	INTEGER	POINT	REFS	20	
50	LPLDTC	INTEGER	POINT	REFS	20	
51	LPLDUR	INTEGER	POINT	REFS	20	
107	LPLIGP	INTEGER	POINT	REFS	20	
52	LPOAXG	INTEGER	POINT	REFS	20	
53	LPOFEP	INTEGER	POINT	REFS	20	
54	LPOLEP	INTEGER	POINT	REFS	20	
6	LPOROS	INTEGER	POINT	REFS	20	
201	LPORS1	INTEGER	POINT	REFS	65	
202	LPORS2	INTEGER	POINT	REFS	65	
225	LPRT10	INTEGER	POINT	REFS	82	
226	LPRT11	INTEGER	POINT	REFS	82	
227	LPRT12	INTEGER	POINT	REFS	82	
230	LPRT13	INTEGER	POINT	REFS	82	
231	LPRT14	INTEGER	POINT	REFS	82	
232	LPRT15	INTEGER	POINT	REFS	82	
233	LPRT16	INTEGER	POINT	REFS	82	
234	LPRT17	INTEGER	POINT	REFS	82	
235	LPRT18	INTEGER	POINT	REFS	82	
236	LPRT2	INTEGER	POINT	REFS	82	
237	LPRT20	INTEGER	POINT	REFS	82	
240	LPRT3	INTEGER	POINT	REFS	82	
241	LPRT4	INTEGER	POINT	REFS	82	
242	LPRT5	INTEGER	POINT	REFS	82	
243	LPRT6	INTEGER	POINT	REFS	82	
244	LPRT7	INTEGER	POINT	REFS	82	

VARIABLES	SN	TYPE	RELOCATION			
245	LPRT8	INTEGER	POINT	REFS	82	
246	LPRT9	INTEGER	POINT	REFS	82	
214	LQ	INTEGER	POINT	REFS	77	331
105	LQDP	INTEGER	POINT	REFS	20	
206	LR	INTEGER	POINT	REFS	65	338
207	LRAD	INTEGER	POINT	REFS	65	
55	LRDCOL	INTEGER	POINT	REFS	20	
137	LREPS	INTEGER	POINT	REFS	45	
141	LREPSP	INTEGER	POINT	REFS	45	
140	LREPSV	INTEGER	POINT	REFS	45	
126	LREPS2	INTEGER	POINT	REFS	39	
143	LRFEPP	INTEGER	POINT	REFS	45	
142	LRFEPS	INTEGER	POINT	REFS	45	
144	LRFPSV	INTEGER	POINT	REFS	45	
263	LRLEAS	INTEGER	POINT	REFS	92	
113	LRTRNO	INTEGER	POINT	REFS	20	
112	LRTRNP	INTEGER	POINT	REFS	20	
145	LSIG	INTEGER	POINT	REFS	45	
150	LSIGI	INTEGER	POINT	REFS	45	
266	LSTHIF	INTEGER	POINT	REFS	98	
247	LTAC	INTEGER	POINT	REFS	82	
56	LTAF	INTEGER	POINT	REFS	20	
250	LTAFA	INTEGER	POINT	REFS	82	
57	LTAG	INTEGER	POINT	REFS	20	
251	LTAGA	INTEGER	POINT	REFS	82	
60	LTBAR	INTEGER	POINT	REFS	20	
61	LTBLK	INTEGER	POINT	REFS	20	
62	LTCA	INTEGER	POINT	REFS	20	
63	LTCIDI	INTEGER	POINT	REFS	20	
64	LTCODI	INTEGER	POINT	REFS	20	
163	LTFB	INTEGER	POINT	REFS	53	
164	LTFR	INTEGER	POINT	REFS	53	
165	LTFRK	INTEGER	POINT	REFS	53	
203	LTMPDS	INTEGER	POINT	REFS	65	
205	LTMPMX	INTEGER	POINT	REFS	65	
117	LTOXO	INTEGER	POINT	REFS	20	
65	LTPS	INTEGER	POINT	REFS	20	
102	LTRTRN	INTEGER	POINT	REFS	20	
252	LTSF	INTEGER	POINT	REFS	82	
7	LUFS	INTEGER	POINT	REFS	20	
204	LUO2LL	INTEGER	POINT	REFS	65	
1	LURC	INTEGER	POINT	REFS	20	
66	LURF	INTEGER	POINT	REFS	20	
67	LVCH	INTEGER	POINT	REFS	20	
70	LVCHI	INTEGER	POINT	REFS	20	
71	LVCR	INTEGER	POINT	REFS	20	
72	LVDH	INTEGER	POINT	REFS	20	
73	LVFH	INTEGER	POINT	REFS	20	
74	LVGH	INTEGER	POINT	REFS	20	
166	LVPL	INTEGER	POINT	REFS	53	
75	LVPOR	INTEGER	POINT	REFS	20	
76	LZRO2A	INTEGER	POINT	REFS	20	
77	LZRO2B	INTEGER	POINT	REFS	20	

VARIABLES	SN	TYPE	RELOCATION							
13	M	INTEGER	INTEG	REFS	149					
0	MAXIDX	INTEGER	LACMDL	REFS	206					
166	MDBG	INTEGER	INPTI	REFS	176					
15	MDHPRS	INTEGER	PFRCS2	REFS	196	316				
271	MECHAN	INTEGER	INPTI	REFS	176	266	305	DEFINED	288	
20	MEPP2	INTEGER	PFRCS2	REFS	196	316				
24	MEPS0	INTEGER	PFRCS2	REFS	196	316				
22	MEPS02	INTEGER	PFRCS2	REFS	196	316				
17	MEPS22	INTEGER	PFRCS2	REFS	196	316				
11	MEP2	INTEGER	PFRCS2	REFS	196	316				
10	MEREP2	INTEGER	PFRCS2	REFS	196	316				
14	MFVFR0	INTEGER	PFRCS2	REFS	196	316				
2	MGAP2	INTEGER	PFRCS2	REFS	196	316				
3	MIGAP2	INTEGER	PFRCS2	REFS	196	316				
0	MNA	INTEGER	F.P.	REFS	305	316	DEFINED	1		
0	MNR	INTEGER	F.P.	REFS	305	316	DEFINED	1		
170	MODE	INTEGER	INPTI	REFS	176					
171	MODES	INTEGER	INPTI	REFS	176					
14	MODLOP	INTEGER	INTEG	REFS	149	326	331			
1	MODPC2	INTEGER	PFRCS2	REFS	196	316				
0	MODPG2	INTEGER	PFRCS2	REFS	196	316				
4	MOIGP2	INTEGER	PFRCS2	REFS	196	316				
13	MOLDT2	INTEGER	PFRCS2	REFS	196	316				
23	MPEPP2	INTEGER	PFRCS2	REFS	196	316				
6	MPEPS2	INTEGER	PFRCS2	REFS	196	316				
16	MPEP2	INTEGER	PFRCS2	REFS	196	316				
5	MREPS2	INTEGER	PFRCS2	REFS	196	316				
12	MR22	INTEGER	PFRCS2	REFS	196	316				
21	MSIG2	INTEGER	PFRCS2	REFS	196	316				
172	MTAPE	INTEGER	INPTI	REFS	176					
7	MTTT	INTEGER	PFRCS2	REFS	196	316				
266	NA	INTEGER	INPTI	REFS	176	266	305	331	DEFINED	310
43	NAA	INTEGER	PFCMI2	REFS	239					
15	NAB	INTEGER	INTEG	REFS	149	DEFINED	311			
233	NAFAIL	INTEGER	INPTI	REFS	176					
25	NALFDT	INTEGER	PFCMI2	REFS	239					
33	NBB	INTEGER	PFCMI2	REFS	239					
27	NC	INTEGER	INTEG	REFS	149	266	305	DEFINED	289	
45	NCC	INTEGER	PFCMI2	REFS	239					
11	NCOEF	INTEGER	PFCMI2	REFS	239					
272	NCRACK	INTEGER	INPTI	REFS	176					
274	NCREEP	INTEGER	INPTI	REFS	176					
173	NDBG	INTEGER	INPTI	REFS	176					
5	NDCHCK	INTEGER	PFCMI2	REFS	239					
36	NDD	INTEGER	PFCMI2	REFS	239					
7	NDEP	INTEGER	PFCMI2	REFS	239					
12	NDSIGF	INTEGER	PFCMI2	REFS	239					
21	NE	INTEGER	PFCMI2	REFS	239					
16	NECRP2	INTEGER	PFCMI2	REFS	239					
41	NEE	INTEGER	PFCMI2	REFS	239					
44	NEI	INTEGER	PFCMI2	REFS	239					
273	NELAST	INTEGER	INPTI	REFS	176					
23	NEPP2	INTEGER	PFCMI2	REFS	239					

VARIABLES	SN	TYPE		RELOCATION						
15	NEP2	INTEGER		PFCMI2	REFS	239				
270	NEWPRB	INTEGER		INPTI	REFS	176				
26	NF	INTEGER		INTEG	REFS	149	266	305	DEFINED	290
174	NFROD	INTEGER		INPTI	REFS	176				
13	NFI	INTEGER		PFCMI2	REFS	239				
14	NF2	INTEGER		PFCMI2	REFS	239				
175	NGAPC	INTEGER		INPTI	REFS	176				
176	NGASR	INTEGER		INPTI	REFS	176	266	305	DEFINED	291
35	NGG	INTEGER		PFCMI2	REFS	239				
167	NHEAL	INTEGER		INPTI	REFS	176				
30	NHH	INTEGER		PFCMI2	REFS	239				
42	NLL	INTEGER		PFCMI2	REFS	239				
34	NMM	INTEGER		PFCMI2	REFS	239				
32	NMN	INTEGER		PFCMI2	REFS	239				
234	NNFAIL	INTEGER	ARRAY	INPTI	REFS	176	334	DEFINED	334	
46	NNFF	INTEGER		PFCMI2	REFS	239				
31	NNN	INTEGER		PFCMI2	REFS	239				
25	NNNCRP	INTEGER		PFRCS2	REFS	196				
40	NNU	INTEGER		PFCMI2	REFS	239				
27	NNUDPP	INTEGER		PFCMI2	REFS	239				
177	NOFAIL	INTEGER		INPTI	REFS	176				
277	NOFRAC	INTEGER		INPTI	REFS	176				
26	NOLDPP	INTEGER		PFCMI2	REFS	239				
6	NOLSGF	INTEGER		PFCMI2	REFS	239				
200	NOPT	INTEGER		INPTI	REFS	176				
201	NPCYCL	INTEGER		INPTI	REFS	176				
0	NPIN	INTEGER		PFCMI2	REFS	239				
16	NPLAST	INTEGER		INTEG	REFS	149				
263	NPLOT	INTEGER		INPTI	REFS	176	326	DEFINED	273	
202	NPLTAB	INTEGER		INPTI	REFS	176				
1	NPOUT	INTEGER		PFCMI2	REFS	239				
304	NPRINT	INTEGER		INPTI	REFS	176				
2	NP1	INTEGER		PFCMI2	REFS	239				
3	NP2	INTEGER		PFCMI2	REFS	239				
267	NR	INTEGER		INPTI	REFS	176	266	305	336	2*338
203	NREAD	INTEGER		INPTI	REFS	176				
204	NRESTR	INTEGER		INPTI	REFS	176				
17	NRMI	INTEGER		INTEG	REFS	149				
265	NROD	INTEGER		INPTI	REFS	176	326			
205	NROLL	INTEGER		INPTI	REFS	176				
25	NSH	INTEGER		INTEG	REFS	149				
10	NSLOPE	INTEGER		PFCMI2	REFS	239				
206	NSP	INTEGER		INPTI	REFS	176				
207	NSTART	INTEGER		INPTI	REFS	176				
20	NSTEP	INTEGER		INTEG	REFS	149				
210	NSTOP	INTEGER		INPTI	REFS	176				
24	NSTRTT	INTEGER		PFCMI2	REFS	239				
211	NT	INTEGER		INPTI	REFS	176	326	331	DEFINED	312
212	NTAPE	INTEGER		INPTI	REFS	176				
20	NTN	INTEGER		PFCMI2	REFS	239				
264	NTPLOT	INTEGER		INPTI	REFS	176	326	DEFINED	272	
4	NTSAVE	INTEGER		PFCMI2	REFS	239				
17	NT2	INTEGER		PFCMI2	REFS	239				

VARIABLES	SN	TYPE		RELOCATION						
421	NU	REAL		REALS	REFS	8	122			
213	NUCFC	INTEGER		INPTI	REFS	176				
214	NUNITS	INTEGER		INPTI	REFS	176	331			
22	NV	INTEGER		PFCMI2	REFS	239				
0	NVAR1	INTEGER		GRSPTR	REFS	229				
11	NVAR10	INTEGER		GRSPTR	REFS	229				
12	NVAR11	INTEGER		GRSPTR	REFS	229				
13	NVAR12	INTEGER		GRSPTR	REFS	229				
14	NVAR13	INTEGER		GRSPTR	REFS	229				
15	NVAR14	INTEGER		GRSPTR	REFS	229				
16	NVAR15	INTEGER		GRSPTR	REFS	229				
17	NVAR16	INTEGER		GRSPTR	REFS	229				
20	NVAR17	INTEGER		GRSPTR	REFS	229				
21	NVAR18	INTEGER		GRSPTR	REFS	229				
22	NVAR19	INTEGER		GRSPTR	REFS	229				
1	NVAR2	INTEGER		GRSPTR	REFS	229				
23	NVAR20	INTEGER		GRSPTR	REFS	229				
24	NVAR21	INTEGER		GRSPTR	REFS	229				
25	NVAR22	INTEGER		GRSPTR	REFS	229				
26	NVAR23	INTEGER		GRSPTR	REFS	229				
27	NVAR24	INTEGER		GRSPTR	REFS	229				
30	NVAR25	INTEGER		GRSPTR	REFS	229				
31	NVAR26	INTEGER		GRSPTR	REFS	229				
32	NVAR27	INTEGER		GRSPTR	REFS	229				
33	NVAR28	INTEGER		GRSPTR	REFS	229				
34	NVAR29	INTEGER		GRSPTR	REFS	229				
2	NVAR3	INTEGER		GRSPTR	REFS	229				
35	NVAR30	INTEGER		GRSPTR	REFS	229				
36	NVAR31	INTEGER		GRSPTR	REFS	229				
37	NVAR32	INTEGER		GRSPTR	REFS	229				
40	NVAR33	INTEGER		GRSPTR	REFS	229				
41	NVAR34	INTEGER		GRSPTR	REFS	229				
42	NVAR35	INTEGER		GRSPTR	REFS	229				
43	NVAR36	INTEGER		GRSPTR	REFS	229				
44	NVAR37	INTEGER		GRSPTR	REFS	229				
3	NVAR4	INTEGER		GRSPTR	REFS	229				
4	NVAR5	INTEGER		GRSPTR	REFS	229				
5	NVAR6	INTEGER		GRSPTR	REFS	229				
6	NVAR7	INTEGER		GRSPTR	REFS	229				
7	NVAR8	INTEGER		GRSPTR	REFS	229				
10	NVAR9	INTEGER		GRSPTR	REFS	229				
37	NW	INTEGER		PFCMI2	REFS	239				
301	NWORDS	INTEGER		INPTI	REFS	176	305	DEFINED	292	296
303	NWRDS	INTEGER		INPTI	REFS	176	305	DEFINED	295	
21	NWRITE	INTEGER		INTEG	REFS	149				
262	NXP	INTEGER		INPTI	REFS	176	331	DEFINED	274	
22	N2	INTEGER		INTEG	REFS	149				
422	OXDROP	REAL		REALS	REFS	122				
423	OXIDE	REAL		REALS	REFS	122				
424	PECDH	REAL		REALS	REFS	122				
425	PI	REAL		REALS	REFS	122				
426	PIN	REAL	ARRAY	REALS	REFS	122				
460	PINP	REAL		REALS	REFS	122				

VARIABLES	SN	TYPE		RELOCATION			
461	PORO	REAL		REALS	REFS	122	
444	PPMH2O	REAL		INPTR	REFS	157	
445	PPMN2	REAL		INPTR	REFS	157	
462	PR	REAL		REALS	REFS	122	
463	PRESS	REAL		REALS	REFS	122	
464	PRTY	REAL		REALS	REFS	122	
465	PRT19	REAL		REALS	REFS	122	
446	P2	REAL	ARRAY	INPTR	REFS	157	
473	QAV	REAL		REALS	REFS	122	
466	QC	REAL		REALS	REFS	122	
613	QEND	REAL	ARRAY	INPTR	REFS	157	331
623	QF	REAL	ARRAY	INPTR	REFS	157	331
1333	QMPY	REAL	ARRAY	INPTR	REFS	157	
467	QP	REAL		REALS	REFS	122	
474	QPEAK	REAL		REALS	REFS	122	
470	QSP	REAL		REALS	REFS	122	
1500	RAPOW	REAL	ARRAY	INPTR	REFS	157	336
1513	RC	REAL		INPTR	REFS	157	
471	RCI	REAL		REALS	REFS	122	
472	RCO	REAL		REALS	REFS	122	
1514	RDISH	REAL		INPTR	REFS	157	
475	RFNVFF	REAL		REALS	REFS	135	
476	RHO	REAL		REALS	REFS	135	
477	RHOF	REAL		REALS	REFS	135	
500	RHOG	REAL		REALS	REFS	135	
501	RHOUO2	REAL		REALS	REFS	135	
502	RMH	REAL		REALS	REFS	135	
1515	ROUGHC	REAL		INPTR	REFS	157	
1516	ROUGHF	REAL		INPTR	REFS	157	
503	RP	REAL		REALS	REFS	135	
2551	RSNTR	REAL		INPTR	REFS	157	
504	RSTRAN	REAL		REALS	REFS	135	
505	RSTRES	REAL		REALS	REFS	135	
506	RTRAN	REAL		REALS	REFS	135	
1517	SGAPF	REAL		INPTR	REFS	157	
507	SKTC	REAL		REALS	REFS	135	
510	SKTS	REAL		REALS	REFS	135	
511	STRN	REAL		REALS	REFS	135	
512	SUMCK	REAL		REALS	REFS	135	
513	SUMDH	REAL		REALS	REFS	135	
514	SUMEXP	REAL		REALS	REFS	135	
515	SUMGP	REAL		REALS	REFS	135	
516	SUMPOR	REAL		REALS	REFS	135	
517	SUMRG	REAL		REALS	REFS	135	
520	SUMTF	REAL		REALS	REFS	135	
521	T	REAL		REALS	REFS	135	
522	TCAC	REAL		REALS	REFS	135	
1520	TCC	REAL		INPTR	REFS	157	
523	TCI	REAL		REALS	REFS	135	
524	TCO	REAL		REALS	REFS	135	
525	TFBC	REAL		REALS	REFS	135	
526	TFC	REAL		REALS	REFS	135	
527	TFGFR	REAL		REALS	REFS	135	

VARIABLES	SN	TYPE	RELOCATION						
530	THEFR	REAL		REALS	REFS	135			
531	TH2OFR	REAL		REALS	REFS	135			
1521	TIME	REAL	ARRAY	INPTR	REFS	157	326		
532	TITLE	REAL	ARRAY	REALS	REFS	135	326	331 DEFINED	284
546	TM	REAL		REALS	REFS	135			
547	TN2FR	REAL		REALS	REFS	135			
1666	TOTL	REAL		INPTR	REFS	157			
550	TOXO	REAL		REALS	REFS	135			
551	TP	REAL		REALS	REFS	135			
552	TPA	REAL		REALS	REFS	135			
553	TPAC	REAL		REALS	REFS	135			
554	TPLEN	REAL		REALS	REFS	135			
555	TRANST	REAL		REALS	REFS	135			
2553	TREF	REAL		INPTR	REFS	157			
556	TSAT	REAL		REALS	REFS	135			
1667	TSINT	REAL		INPTR	REFS	157			
557	TT	REAL		REALS	REFS	135			
1670	TW	REAL	ARRAY	INPTR	REFS	157			
560	TX	REAL		REALS	REFS	135			
561	TXA	REAL		REALS	REFS	135			
562	TXAL	REAL		REALS	REFS	135			
563	TXC	REAL		REALS	REFS	135			
2035	UBFS	REAL		INPTR	REFS	157			
2036	UMELT	REAL		INPTR	REFS	157			
2037	UOFD	REAL		INPTR	REFS	157			
0	VERS	REAL		VER	REFS	208			
564	VISC	REAL		REALS	REFS	135			
565	VPLT	REAL		REALS	REFS	135			
2040	VS	REAL		INPTR	REFS	157			
566	VSS	REAL		REALS	REFS	135			
600	VX	REAL		REALS	REFS	135			
567	W	REAL		REALS	REFS	135			
570	WT	REAL		REALS	REFS	135			
571	WTRAN	REAL		REALS	REFS	135			
2041	X	REAL	ARRAY	INPTR	REFS	157	331		
572	XEIN	REAL		REALS	REFS	135			
573	XK6	REAL		REALS	REFS	135			
574	XK7	REAL		REALS	REFS	135			
575	YY	REAL		REALS	REFS	135			
576	Z	REAL		REALS	REFS	135			
577	ZRO2WG	REAL		REALS	REFS	135			

FILE NAMES	MODE					
TAPE5	MIXED	READS	284	298		
TAPE6	MIXED	WRITES	300	336	338	340

EXTERNALS	TYPE	ARGS	REFERENCES			
AXHEF		22	331			
EOF	REAL	1	285			
INITAL		23	316			
MEMSET		3	269	277	282	
NEMSET		3	270	278		
PLTINP		9	326			

```
EXTERNALS          TYPE   ARGS       REFERENCES
       POINTR                14           305

NAMELISTS        DEF LINE     REFERENCES
       FRPCN          266       298       300

STATEMENT LABELS                DEF LINE   REFERENCES
    0  100          INACTIVE      286        285
  222  110                        344        285
  225  120                        348        308       322       342
  446  130     FMT                353        284
  450  140     FMT                354        336
  464  150     FMT                356        338
  471  160     FMT                357        340

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  204           I          338 338      10B              EXT REFS

COMMON BLOCKS   LENGTH
       FAST          1
       POINT       199
       REALS       392
       INTEG        24
       INPTR      1393
       INPTI       197
       EMFLGS       10
       PFRCS2       22
       MATCNS       12
       LACMDL       21
       VER           1
       PHYPRO       11
       GRSPTR       38
       PFCMI2       39

STATISTICS
  PROGRAM LENGTH                    547B      359
  SCM LABELED COMMON LENGTH        4470B     2360
        140000B SCM USED
```

```
      C                                                                     SIMQ       2
      C     ......................................................................SIMQ       3
      C                                                                     SIMQ       4
      C     SUBROUTINE SIMQ                                                 SIMQ       5
      C                                                                     SIMQ       6
      C     PURPOSE                                                         SIMQ       7
      C     OBTAIN SOLUTION OF A SET OF SIMULTANEOUS LINEAR EQUATIONS,      SIMQ       8
      C     AX=B                                                            SIMQ       9
      C                                                                     SIMQ      10
      C     USAGE                                                           SIMQ      11
      C     CALL SIMQ(A,B,N,KS)                                             SIMQ      12
      C                                                                     SIMQ      13
      C     DESCRIPTION OF PARAMETERS                                       SIMQ      14
      C     A - MATRIX OF COEFFICIENTS STORED COLUMNWISE.  THESE ARE        SIMQ      15
      C     DESTROYED IN THE COMPUTATION.  THE SIZE OF MATRIX A IS          SIMQ      16
      C     N BY N.                                                         SIMQ      17
      C     B - VECTOR OF ORIGINAL CONSTANTS (LENGTH N). THESE ARE          SIMQ      18
      C     REPLACED BY FINAL SOLUTION VALUES, VECTOR X.                    SIMQ      19
      C     N - NUMBER OF EQUATIONS AND VARIABLES. N MUST BE .GT. ONE.      SIMQ      20
      C     KS - OUTPUT DIGIT                                               SIMQ      21
      C     0 FOR A NORMAL SOLUTION                                         SIMQ      22
      C     1 FOR A SINGULAR SET OF EQUATIONS                               SIMQ      23
      C                                                                     SIMQ      24
      C     REMARKS                                                         SIMQ      25
      C     MATRIX A MUST BE GENERAL.                                       SIMQ      26
      C     IF MATRIX IS SINGULAR , SOLUTION VALUES ARE MEANINGLESS.        SIMQ      27
      C     AN ALTERNATIVE SOLUTION MAY BE OBTAINED BY USING MATRIX         SIMQ      28
      C     INVERSION (MINV) AND MATRIX PRODUCT (GMPRD).                    SIMQ      29
      C                                                                     SIMQ      30
      C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                   SIMQ      31
      C     NONE                                                            SIMQ      32
      C                                                                     SIMQ      33
      C     METHOD                                                          SIMQ      34
      C     METHOD OF SOLUTION IS BY ELIMINATION USING LARGEST PIVOTAL      SIMQ      35
      C     DIVISOR. EACH STAGE OF ELIMINATION CONSISTS OF INTERCHANGING    SIMQ      36
      C     ROWS WHEN NECESSARY TO AVOID DIVISION BY ZERO OR SMALL          SIMQ      37
      C     ELEMENTS.                                                       SIMQ      38
      C     THE FORWARD SOLUTION TO OBTAIN VARIABLE N IS DONE IN            SIMQ      39
      C     N STAGES. THE BACK SOLUTION FOR THE OTHER VARIABLES IS          SIMQ      40
      C     CALCULATED BY SUCCESSIVE SUBSTITUTIONS. FINAL SOLUTION          SIMQ      41
      C     VALUES ARE DEVELOPED IN VECTOR B, WITH VARIABLE 1 IN B(1),      SIMQ      42
      C     VARIABLE 2 IN B(2),.....,  VARIABLE N IN B(N).                  SIMQ      43
      C     IF NO PIVOT CAN BE FOUND EXCEEDING A TOLERANCE OF 0.0,          SIMQ      44
      C     THE MATRIX IS CONSIDERED SINGULAR AND KS IS SET TO 1. THIS      SIMQ      45
      C     TOLERANCE CAN BE MODIFIED BY REPLACING THE FIRST STATEMENT.     SIMQ      46
      C                                                                     SIMQ      47
      C     ......................................................................SIMQ      48
            SUBROUTINE SIMQ (A,B,N,KS)                                      SIMQ      49
      C     IMPLICIT  REAL * 8 (A-H,O-Z)                                    SIMQ      50
            DIMENSION A(1),B(1)                                             SIMQ      51
      C                                                                     SIMQ      52
      C     FORWARD SOLUTION                                                SIMQ      53
      C                                                                     SIMQ      54
```

```
                TOL = 0.0                                                       SIMQ       55
55              KS = 0                                                          SIMQ       56
                JJ = -N                                                         SIMQ       57
                    DO 170 J=1,N                                                SIMQ       58
                    JY = J+1                                                    SIMQ       59
                    JJ = JJ+N+1                                                 SIMQ       60
60                  BIGA = 0                                                    SIMQ       61
                    IT = JJ-J                                                   SIMQ       62
                        DO 110 I=J,N                                            SIMQ       63
          C                                                                     SIMQ       64
          C   SEARCH FOR MAXIMUM COEFFICIENT IN COLUMN                          SIMQ       65
65        C                                                                     SIMQ       66
                    IJ = IT+I                                                   SIMQ       67
                    IF (ABS(BIGA)-ABS(A(IJ))) 100,110,110                       SIMQ       68
          100       BIGA = A(IJ)                                                SIMQ       69
                    IMAX = I                                                    SIMQ       70
70        110       CONTINUE                                                    SIMQ       71
          C                                                                     SIMQ       72
          C   TEST FOR PIVOT LESS THAN TOLERANCE (SINGULAR MATRIX)              SIMQ       73
          C                                                                     SIMQ       74
                    IF (ABS(BIGA)-TOL) 120,120,130                              SIMQ       75
75        120       KS = 1                                                      SIMQ       76
                    RETURN                                                      SIMQ       77
          C                                                                     SIMQ       78
          C   INTERCHANGE ROWS IF NECESSARY                                     SIMQ       79
          C                                                                     SIMQ       80
80        130       II = J+N*(J-2)                                              SIMQ       81
                    IT = IMAX-J                                                 SIMQ       82
                        DO 140 K=J,N                                            SIMQ       83
                        II = II+N                                               SIMQ       84
                        I2 = II+IT                                              SIMQ       85
85                      SAVE = A(II)                                            SIMQ       86
                        A(II) = A(I2)                                           SIMQ       87
                        A(I2) = SAVE                                            SIMQ       88
          C                                                                     SIMQ       89
          C   DIVIDE EQUATION BY LEADING COEFFICIENT                            SIMQ       90
90        C                                                                     SIMQ       91
          140           A(II) = A(II)/BIGA                                      SIMQ       92
                    SAVE = B(IMAX)                                              SIMQ       93
                    B(IMAX) = B(J)                                              SIMQ       94
                    B(J) = SAVE/BIGA                                            SIMQ       95
95        C                                                                     SIMQ       96
          C   ELIMINATE NEXT VARIABLE                                           SIMQ       97
          C                                                                     SIMQ       98
                    IF (J-N) 150,180,150                                        SIMQ       99
          150       IQS = N*(J-1)                                               SIMQ      100
100                     DO 170 IX=JY,N                                          SIMQ      101
                        IXJ = IQS+IX                                            SIMQ      102
                        IT = J-IX                                               SIMQ      103
                            DO 160 JX=JY,N                                      SIMQ      104
                            IXJX = N*(JX-1)+IX                                  SIMQ      105
105                         JJX = IXJX+IT                                       SIMQ      106
          160               A(IXJX) = A(IXJX)-(A(IXJ)*A(JJX))                   SIMQ      107
```

```
                170          B(IX) = B(IX)-(B(J)*A(IXJ))                                SIMQ     108
                C                                                                       SIMQ     109
                C   BACK SOLUTION                                                       SIMQ     110
110             C                                                                       SIMQ     111
                180   NY = N-1                                                          SIMQ     112
                      IT = N*N                                                          SIMQ     113
                          DO 190 J=1,NY                                                 SIMQ     114
                          IA = IT-J                                                     SIMQ     115
115                       IB = N-J                                                      SIMQ     116
                          IC = N                                                        SIMQ     117
                              DO 190 K=1,J                                              SIMQ     118
                              B(IB) = B(IB)-A(IA)*B(IC)                                 SIMQ     119
                              IA = IA-N                                                 SIMQ     120
120             190           IC = IC-1                                                 SIMQ     121
                      RETURN                                                            SIMQ     122
                      END                                                               SIMQ     123
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 SIMQ 48 76 121

VARIABLES	SN	TYPE	RELOCATION										
0	A	REAL	ARRAY F.P.	REFS	50	67	68	85	86	91	3*106		
				107	118	DEFINED	48	86	87	91	106		
0	B	REAL	ARRAY F.P.	REFS	50	92	93	2*107	2*118				
				DEFINED	48	93	94	107	118				
247	BIGA	REAL		REFS	67	74	91	94	DEFINED	60	68		
251	I	INTEGER		REFS	66	69	DEFINED	62					
267	IA	INTEGER		REFS	118	119	DEFINED	114	119				
270	IB	INTEGER		REFS	2*118	DEFINED	115						
271	IC	INTEGER		REFS	118	120	DEFINED	116	120				
252	IJ	INTEGER		REFS	67	68	DEFINED	66					
253	IMAX	INTEGER		REFS	81	92	93	DEFINED	69				
260	IQS	INTEGER		REFS	101	DEFINED	99						
250	IT	INTEGER		REFS	66	84	105	114	DEFINED	61	81		
				102	112								
261	IX	INTEGER		REFS	101	102	104	2*107	DEFINED	100			
262	IXJ	INTEGER		REFS	106	107	DEFINED	101					
264	IXJX	INTEGER		REFS	105	2*106	DEFINED	104					
254	II	INTEGER		REFS	83	84	85	86	2*91				
				DEFINED	80	83							
256	I2	INTEGER		REFS	86	87	DEFINED	84					
245	J	INTEGER		REFS	58	61	62	2*80	81	82	93		
				94	98	99	102	107	114	115	117		
				DEFINED	57	113							
244	JJ	INTEGER		REFS	59	61	DEFINED	56	59				
265	JJX	INTEGER		REFS	106	DEFINED	105						
263	JX	INTEGER		REFS	104	DEFINED	103						

```
VARIABLES     SN  TYPE              RELOCATION
  246  JY         INTEGER                        REFS      100    103    DEFINED    58
  255  K          INTEGER                      DEFINED      82    117
    0  KS         INTEGER           F.P.       DEFINED      48     55        75
    0  N          INTEGER           F.P.         REFS       56     57        59      62      80      82      83
                                                   98       99    100       103     104     111     2*112   115
                                                  116      119    DEFINED    48
  266  NY         INTEGER                        REFS      113    DEFINED   111
  257  SAVE       REAL                           REFS       87     94    DEFINED    85      92
  243  TOL        REAL                           REFS       74    DEFINED    54

INLINE FUNCTIONS   TYPE   ARGS      DEF LINE  REFERENCES
      ABS          REAL      1  INTRIN          2*67      74

STATEMENT LABELS                 DEF LINE   REFERENCES
    0  100          INACTIVE        68         67
   52  110                          70         62        2*67
    0  120          INACTIVE        75        2*74
   65  130                          80         74
    0  140                          91         82
    0  150          INACTIVE        99        2*98
    0  160                         106        103
    0  170                         107         57        100
  203  180                         111         98
    0  190                         120        113       117

LOOPS  LABEL    INDEX      FROM-TO    LENGTH     PROPERTIES
   17  170      J          57  107     163B          EXITS   NOT INNER
   34  110      I          62  70       21B        OPT
   75  140      K          82  91       23B        OPT
  141  170      IX        100  107      36B                NOT INNER
  151  160      JX        103  106      17B        OPT
  211  190      J         113  120      31B                NOT INNER
  223  190      K         117  120      14B        OPT

STATISTICS
  PROGRAM LENGTH                  336B      222
        140000B SCM USED
```

```
      SUBROUTINE STORE (BU1,BU2,CC1,CC2,DENSIP,DENSIF,DPWPP,DPW,POROS1,P STOR
     +OROS2,ZRO2A,ZRO2B,IR1,NA,NR,NHEAL,ANG,RTRANP,RTRANO,BU,BUOLD,TMPDI STOR
     +S,TMPMAX)                                                         STOR
C                                                                       STOR
C     IMPLICIT REAL * 8 ( A-H,O-Z )                                     STOR
C                                                                       STOR
C     ******************************************************************STOR
C                                                                       STOR
C     THIS SUBROUTINE IS CALLER FROM MAIN AND STORES CONVERGED VALUES   STOR
C     OF PARAMETERS WHICH ARE NECESSARY FOR THE NEXT POWER-TIME STEP    STOR
C     STORE WAS CODED BY G A BERNA NOVEMBER 1977.                       STOR
C                                                                       STOR
C     ******************************************************************STOR
C                                                                       STOR
C     ******************************************************************STOR
C     INPUT  ARGUMENTS                                                  STOR
C     ******************************************************************STOR
C                                                                       STOR
C     ANG    - CUMULATIVE N2 CONSENTRATION IN THE FUEL (MOLES)          STOR
C     BU     - ROD BURNUP TO END OF POWER-TIME STEP (MWD/MTU)           STOR
C     BU2    - BURNUP (MWD/MTU)                                         STOR
C     CC2    - FISSION GAS CONSENTRATION (GM-MOLES)                     STOR
C     DENSIF - DENSIFICATION (UNITLESS FRACTION)                        STOR
C     DPW    - SWELLING (UNITLESS FRACTION)                             STOR
C     IR1    - NUMBER OF AXIAL NODES PLUS ONE                           STOR
C     NA     - MAXIMUM NUMBER OF AXIAL NODES                            STOR
C     NHEAL  - FLAG TO TURN ON PERMANENT CRACK HEALING  =0,OFF  =1,ON   STOR
C     NR     - MAXIMUM NUMBER OF RADIAL FUEL NODES                      STOR
C     POROS2 - POROSITY (UNITLESS FRACTION)                             STOR
C     RTRANP - RADIUS TO WHERE CRACKING OCCURS  (M)                     STOR
C     TMPDIS - FUEL TEMPERATURE DISTRIBUTION (F)                        STOR
C     ZRO2B  - ZIRCALOY OXIDE THICKNESS (FT)                            STOR
C                                                                       STOR
C     ******************************************************************STOR
C     OUTPUT ARGUMENTS                                                  STOR
C     ******************************************************************STOR
C                                                                       STOR
C     ANG    - CUMULATIVE N2 CONSENTRATION IN THE FUEL (MOLES)          STOR
C     BUOLD  - ROD BURNUP TO BEGINNING OF POWER-TIME STEP (MWD/MTU)     STOR
C     BU1    - BURNUP (MWD/MTU)                                         STOR
C     CC1    - FISSION GAS CONSENTRATION (GM-MOLES)                     STOR
C     DENSIP - DENSIFICATION (UNITLESS FRACTION)                        STOR
C     DPWPP  - SWELLING (UNITLESS FRACTION)                             STOR
C     POROS2 - POROSITY (UNITLESS FRACTION)                             STOR
C     RTRANO - RADIUS TO WHERE CRACKING OCCURS  (M)                     STOR
C     TMPMAX - SET OF MAXIMUM FUEL TEMPERATURES EXPERIENCED (F)         STOR
C     ZRO2A  - ZIRCALOY OXIDE THICKNESS (FT)                            STOR
C                                                                       STOR
C     ******************************************************************STOR
C                                                                       STOR
      DIMENSION     BU1(NA)        ,BU2(NA)        ,CC1(NR,NA)          STOR
     +             ,CC2(NR,NA)     ,DPW(NR,NA)     ,DPWPP(NR,NA)        STOR
     +             ,ZRO2B(NA)      ,DENSIF(NR,NA) ,DENSIP(NR,NA)        STOR
```

```
     +            ,POROS1(NR,NA) ,POROS2(NR,NA) ,ZRO2A(NA)                  STOR      55
55   +            ,ANG(NA,2)     ,RTRANP(NA)    ,RTRANO(NA)                STOR      56
     +            ,TMPDIS(NR,NA) ,TMPMAX(NR,NA)                             STOR      57
     C                                                                      STOR      58
     C                                                                      STOR      59
          BUOLD = BU                                                        STOR      60
60             DO 100 II=2,IRI                                             STOR      61
               BU1(II) = BU2(II)                                           STOR      62
               ZRO2A(II) = ZRO2B(II)                                       STOR      63
               IF (NHEAL.EQ.1) RTRANO(II) = AMAX1(RTRANO(II),RTRANP(II))   STOR      64
               ANG(II,1) = ANG(II,2)                                       STOR      65
65             DO 100 I=1,NR                                               STOR      66
               TMPMAX(I,II) = AMAX1(TMPMAX(I,II),TMPDIS(I,II))             STOR      67
               CC1(I,II) = CC2(I,II)                                       STOR      68
               POROS1(I,II) = POROS2(I,II)                                 STOR      69
               DENSIP(I,II) = DENSIF(I,II)                                 STOR      70
70        100  DPWPP(I,II) = DPW(I,II)                                      STOR      71
          RETURN                                                            STOR      72
          END                                                               STOR      73
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	STORE	1

DEF LINE: 71

REFERENCES

VARIABLES

	SN	TYPE		RELOCATION								
0	ANG	REAL	ARRAY	F.P.	REFS	51	64	DEFINED	1	64		
0	BU	REAL		F.P.	REFS	59	DEFINED	1				
0	BUOLD	REAL		F.P.	DEFINED	1	59					
0	BU1	REAL	ARRAY	F.P.	REFS	51	DEFINED	1	61			
0	BU2	REAL	ARRAY	F.P.	REFS	51	61	DEFINED	1			
0	CC1	REAL	ARRAY	F.P.	REFS	51	DEFINED	1	67			
0	CC2	REAL	ARRAY	F.P.	REFS	51	67	DEFINED	1			
0	DENSIF	REAL	ARRAY	F.P.	REFS	51	69	DEFINED	1			
0	DENSIP	REAL	ARRAY	F.P.	REFS	51	DEFINED	1	69			
0	DPW	REAL	ARRAY	F.P.	REFS	51	70	DEFINED	1			
0	DPWPP	REAL	ARRAY	F.P.	REFS	51	DEFINED	1	70			
104	I	INTEGER			REFS	3*66	2*67	2*68	2*69	2*70		
					DEFINED	65						
103	II	INTEGER			REFS	2*61	2*62	3*63	2*64	3*66	2*67	2*68
					2*69	2*70	DEFINED	60				
0	IRI	INTEGER		F.P.	REFS	60	DEFINED	1				
0	NA	INTEGER		F.P.	REFS	17*51	DEFINED	1				
0	NHEAL	INTEGER		F.P.	REFS	63	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	10*51	65	DEFINED	1			
0	POROS1	REAL	ARRAY	F.P.	REFS	51	DEFINED	1	68			
0	POROS2	REAL	ARRAY	F.P.	REFS	51	68	DEFINED	1			
0	RTRANO	REAL	ARRAY	F.P.	REFS	51	63	DEFINED	1	63		
0	RTRANP	REAL	ARRAY	F.P.	REFS	51	63	DEFINED	1			

```
VARIABLES     SN  TYPE          RELOCATION
    0  TMPDIS     REAL      ARRAY     F.P.      REFS      51      66    DEFINED      1
    0  TMPMAX     REAL      ARRAY     F.P.      REFS      51      66    DEFINED      1        66
    0  ZRO2A      REAL      ARRAY     F.P.      REFS      51  DEFINED          1       62
    0  ZRO2B      REAL      ARRAY     F.P.      REFS      51      62    DEFINED      1

INLINE FUNCTIONS   TYPE   ARGS        DEF LINE  REFERENCES
       AMAX1       REAL      0  INTRIN              63        66

STATEMENT LABELS             DEF LINE   REFERENCES
    0  100                       70         60        65

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   20  100      II          60 70       60B                NOT INNER
   42  100      I           65 70       33B        OPT

STATISTICS
  PROGRAM LENGTH                133B      91
        1400003 SCM USED
```

```
      SUBROUTINE STRAIN (SIG,EPS,EPPLAS,TEMP,RSTRAN,ANRIN,DELOXY,CWKF,CW STRN      2
     +NF,FNCK,FNCN)                                                     STRN      3
C                                                                       STRN      4
C     IMPLICIT REAL*8 (A-H,O-Z)                                         STRN      5
C                                                                       STRN      6
C     ***THIS SUBROUTINE COMPUTES UNIAXIAL STRAIN GIVEN THE             STRN      7
C     STRESS AND PREVIOUS PLASTIC STAIN. ELASTIC UNLOADING              STRN      8
C     IS PRESCRIBED, AND THE CURRENT ( WORK-HARDENED )                  STRN      9
C     YEILD STRESS IS COMPUTED FROM THE PLASTIC STRAIN                  STRN     10
C     AT EACH CALL. THE ELASTIC MODULUS IS OBTAINED                     STRN     11
C     FROM FUNCTION  *CELMOD*, AND THE LOCUS OF YEILD                   STRN     12
C     STRESSES IS OBTAINED FROM SUBROUTINE *CSTRES*                     STRN     13
C     WHICH COMPUTES STRESS FROM STRAIN IN MONOTONIC,                   STRN     14
C     UNIAXIAL TENSION.                                                 STRN     15
C     STRAIN IS CALLED FROM        CLADF, COUPLE,AND STACK              STRN     16
C                                                                       STRN     17
C     ********************************************************************STRN     18
C     INPUT  ARGUMENTS                                                  STRN     19
C     ********************************************************************STRN     20
C                                                                       STRN     21
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST     STRN     22
C     (HOOP STRAIN)/(RADIAL STRAIN)                                     STRN     23
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2) STRN     24
C     CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT        STRN     25
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED      STRN     26
C     CLADDING     (KG OXYGEN/KG ZIRCALOY)                              STRN     27
C     EPPLAS - PREVIOUS VALUE OF PLASTIC STRAIN (IN/IN)                 STRN     28
C     FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2) STRN     29
C     FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT     STRN     30
C     RSTRAN - TRUE STRAIN RATE (1/SEC)                                 STRN     31
C     SIG    - STRESS (PSI)                                             STRN     32
C     TEMP   - CLADDING AVERAGE TEMPERATURE (F)                         STRN     33
C                                                                       STRN     34
C     ********************************************************************STRN     35
C     OUTPUT ARGUMENTS                                                  STRN     36
C     ********************************************************************STRN     37
C                                                                       STRN     38
C     EPS    - STRAIN (IN/IN)                                           STRN     39
C     EPPLAS - NEW VALUE OF PLASTIC STRAIN (IN/IN)                      STRN     40
C                                                                       STRN     41
C     ********************************************************************STRN     42
C                                                                       STRN     43
C     ***                                                               STRN     44
C     NOTE                                                              STRN     45
C     BOTH *CELMOD* AND *CSTRES*  ARE IN S.I. UNITS,                    STRN     46
C     SO STRESSES ARE CONVERTED TO N/M**2 AND                           STRN     47
C     TEMPERATURES TO DEGREES KELVIN BEFORE CALLING                     STRN     48
C     THESE TWO  ROUTINES.                                              STRN     49
C     ***PROGRAMMED BY M.P. BOHN ,  NOV.18, 1974 .                      STRN     50
C                                                                       STRN     51
        T = (TEMP+459.67E+0)/1.8E+0                                     STRN     52
        E = CELMOD(T,FNCK,CWKF,DELOXY)/6.894757E+3                      STRN     53
C     GET CURRENT YEILD STRESS GIVEN EPPLAS                             STRN     54
```

```
                SIGY = 5900.0                                                          STRN       55
55              EPSTST = -10.0E0                                                       STRN       56
                CUT = 1.0E-10                                                          STRN       57
                    DO 100 K=1,30                                                      STRN       58
                    EPS = SIGY/E+EPPLAS                                                STRN       59
                    IF (ABS(EPS-EPSTST).LT.CUT) GO TO 110                              STRN       60
60                  EPSTST = EPS                                                       STRN       61
                    CALL CSTRES (T,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,EPS,SIGYPA)       STRN       62
                    SIGY = SIGYPA/6894.7573                                            STRN       63
            100     CONTINUE                                                           STRN       64
            110   CONTINUE                                                             STRN       65
65          C   CONVERT ANISOTROPIC EFFECTIVE YIELD STRESS                            STRN       66
            C   TO ISOTROPIC EFFECTIVE YIELD STRESS                                    STRN       67
                SIGY = SIGY/1.19                                                       STRN       68
                IF (SIG-SIGY) 120,120,130                                              STRN       69
            120   EPS = EPPLAS+SIG/E                                                   STRN       70
70              GO TO 140                                                              STRN       71
            130   SAG = SIG*6894.7573                                                  STRN       72
            C   CONVERT ISOTROPIC EFFECTIVE STRESS TO ANISOTROPIC EFFECTIVE STRESS    STRN       73
                SAG = SAG*1.19                                                         STRN       74
                CALL CSTRAN (T,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,SAG,EPS)              STRN       75
75          C                                                                          STRN       76
            C   THE ELASTIC COMPONENT OF STRAIN MUST BE CONSISTANT                    STRN       77
            C   WITH THE UNMODIFIED YIELD USED IN CSTRAN AND CSTRES.                   STRN       78
            C   THESE CHANGES ALLOW CONVERSION FROM ANISOTROPIC                        STRN       79
            C   THEORY TO ISOTROPIC PLASTICITY.                                        STRN       80
80          C                                                                          STRN       81
                EPPLAS = EPS-SIG*(1.19)/E                                              STRN       82
            140   CONTINUE                                                             STRN       83
                RETURN                                                                 STRN       84
                END                                                                    STRN       85
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	STRAIN	DEF LINE 1	REFERENCES 83

VARIABLES

		SN	TYPE	RELOCATION								
0	ANRIN		REAL	*UNUSED	F.P.	DEFINED	1					
176	CUT		REAL			REFS	59	DEFINED	56			
0	CWKF		REAL		F.P.	REFS	52	61	74	DEFINED	1	
0	CWNF		REAL		F.P.	REFS	61	74	DEFINED	1		
0	DELOXY		REAL		F.P.	REFS	52	61	74	DEFINED	1	
173	E		REAL			REFS	58	69	81	DEFINED	52	
0	EPPLAS		REAL		F.P.	REFS	58	69	DEFINED	1	81	
0	EPS		REAL		F.P.	REFS	59	60	61	74	81	
						DEFINED	1	58	69			
175	EPSTST		REAL			REFS	59	DEFINED	55	60		
0	FNCK		REAL		F.P.	REFS	52	61	74	DEFINED	1	

```
VARIABLES     SN  TYPE          RELOCATION
    0   FNCN      REAL          F.P.      REFS      61      74    DEFINED      1
  177   K       * INTEGER                 DEFINED   57
    0   RSTRAN    REAL          F.P.      REFS      61      74    DEFINED      1
  201   SAG       REAL                    REFS      73      74    DEFINED     71      73
    0   SIG       REAL          F.P.      REFS      68      69         71     81  DEFINED      1
  174   SIGY      REAL                    REFS      58      67         68  DEFINED     54     62      67
  200   SIGYPA    REAL                    REFS      61      62
  172   T         REAL                    REFS      52      61         74  DEFINED     51
    0   TEMP      REAL          F.P.      REFS      51  DEFINED         1

EXTERNALS          TYPE   ARGS      REFERENCES
        CELMOD     REAL      4          52
        CSTRAN               9          74
        CSTRES               9          61

INLINE FUNCTIONS   TYPE   ARGS      DEF LINE  REFERENCES
        ABS        REAL      1  INTRIN            59

STATEMENT LABELS              DEF LINE   REFERENCES
    0   100                       63         57
   66   110                       64         59
    0   120          INACTIVE     69       2*68
  102   130                       71         68
  127   140                       82         70

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES                EXT REFS    EXITS
   33  100      K           57 63       32B

STATISTICS
  PROGRAM LENGTH                  216B     142
        140000B SCM USED
```

```
      SUBROUTINE STRESS (SIG,DEP,EPPLAS,TEMP,RSTRAN,ANRIN,DELOXY,CWKF,CW STRS
     +NF,FNCK,FNCN)                                                     STRS
C                                                                       STRS
C     IMPLICIT REAL*8 (A-H,O-Z)                                         STRS
C                                                                       STRS
C     ***THIS SUBROUTINE COMPUTES STRESS GIVEN THE PREVIOUS             STRS
C     PLASTIC STRAIN VALUE AND AN INCREMENT OF PLASTIC                  STRS
C     STRAIN. THE ELASTIC MODULUS IS OBTAINED                           STRS
C     FROM FUNCTION  *CELMOD*, AND THE LOCUS OF YEILD                   STRS
C     STRESSES IS OBTAINED FROM SUBROUTINE *CSTRES*                     STRS
C     WHICH COMPUTES STRESS FROM STRAIN IN MONOTONIC,                   STRS
C     UNIAXIAL TENSION.                                                 STRS
C     STRESS IS CALLED FROM COUPLE AND STACK                            STRS
C                                                                       STRS
C     ********************************************************************STRS
C     INPUT ARGUMENTS                                                   STRS
C     ********************************************************************STRS
C                                                                       STRS
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST     STRS
C     (HOOP STRAIN)/(RADIAL STRAIN)                                     STRS
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2) STRS
C     CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT        STRS
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED      STRS
C     CLADDING     (KG OXYGEN/KG ZIRCALOY)                              STRS
C     DEP    - INCREMENT OF PLASTIC STRAIN (IN/IN)                      STRS
C     EPPLAS - PREVIOUS VALUE OF PLASTIC STRAIN (IN/IN)                 STRS
C     FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2) STRS
C     FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT     STRS
C     RSTRAN - TRUE STRAIN RATE (1/SEC)                                 STRS
C     TEMP   - CLADDING AVERAGE TEMPERATURE (F)                         STRS
C                                                                       STRS
C     ********************************************************************STRS
C     OUTPUT ARGUMENTS                                                  STRS
C     ********************************************************************STRS
C                                                                       STRS
C     EPPLAS - NEW VALUE OF PLASTIC STRAIN (IN/IN)                      STRS
C     SIG    - STRESS (PSIA)                                            STRS
C                                                                       STRS
C     ***                                                               STRS
C     NOTE                                                              STRS
C     BOTH *CELMOD* AND *CSTRES*  ARE IN S.I. UNITS,                    STRS
C     SO STRESSES ARE CONVERTED TO N/M**2 AND                           STRS
C     TEMPERATURES TO DEGREES KELVIN BEFORE CALLING                     STRS
C     THESE TWO  ROUTINES.                                              STRS
C     ***PROGRAMMED BY M.P. BOHN ,  NOV.18, 1974 .                      STRS
C                                                                       STRS
        T = (TEMP+459.67E+0)/1.8E+0                                     STRS
        E = CELMOD(T,FNCK,CWKF,DELOXY)/6.894757E+3                      STRS
C     ***DEP SHOULD NEVER BE NEGATIVE**CHECK THIS HERE                  STRS
        IF (DEP) 100,110,110                                            STRS
100     WRITE (6,140) DEP                                               STRS
        DEP = 0.0001                                                    STRS
110     CONTINUE                                                        STRS
```

```
                EPPLAS = EPPLAS+DEP                                                  STRS       55
55              SIG = 5000.0                                                         STRS       56
                EPSTST = -10.0E0                                                     STRS       57
                CUT = 1.0E-10                                                        STRS       58
                    DO 120 K=1,30                                                    STRS       59
                    EPS = SIG/E+EPPLAS                                               STRS       60
60                  IF (ABS(EPS-EPSTST).LT.CUT) GO TO 130                            STRS       61
                    EPSTST = EPS                                                     STRS       62
                    CALL CSTRES (T,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,EPS,SIGPA)      STRS       63
                    SIG = SIGPA/6894.7573                                            STRS       64
          120       CONTINUE                                                         STRS       65
65        130   CONTINUE                                                           STRS       66
          C   CONVERT ANISOTROPIC EFFECTIVE YIELD STRESS                          STRS       67
          C   TO ISOTROPIC EFFECTIVE YIELD STRESS                                 STRS       68
              SIG = SIG/1.19                                                       STRS       69
              RETURN                                                               STRS       70
70        C                                                                        STRS       71
          140   FORMAT (1H1,24X,18HERROR-NEGATIVE DEP/25X,6HDEP = ,E11.4,32HWAS PA STRS       72
               +SSED TO SUBROUTINE*STRESS*/25X,44HDEP WAS SET TO .0001- RESULTS MA STRS       73
               +Y BE INVALID)                                                      STRS       74
                END                                                                STRS       75
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 STRESS 1 69

VARIABLES	SN	TYPE	RELOCATION										
0 ANRIN		REAL	*UNUSED	F.P.	DEFINED	1							
162 CUT		REAL			REFS	60	DEFINED	57					
0 CWKF		REAL		F.P.	REFS	[illegible]	62	DEFINED	1				
0 CWNF		REAL		F.P.	REFS	62	DEFINED	1					
0 DELOXY		REAL		F.P.	REFS	48	62	DEFINED	1				
0 DEP		REAL		F.P.	REFS	50	51	54	DEFINED	1	52		
160 E		REAL			REFS	59	DEFINED	48					
0 EPPLAS		REAL		F.P.	REFS	54	59	DEFINED	1	54			
164 EPS		REAL			REFS	60	61	62	DEFINED	59			
161 EPSTST		REAL			REFS	60	DEFINED	56	61				
0 FNCK		REAL		F.P.	REFS	48	62	DEFINED	1				
0 FNCN		REAL		F.P.	REFS	62	DEFINED	1					
163 K	*	INTEGER			DEFINED	58							
0 RSTRAN		REAL		F.P.	REFS	62	DEFINED	1					
0 SIG		REAL		F.P.	REFS	59	68	DEFINED	1	55	63	68	
165 SIGPA		REAL			REFS	62	63						
157 T		REAL			REFS	48	62	DEFINED	47				
0 TEMP		REAL		F.P.	REFS	47	DEFINED	1					

```
FILE NAMES        MODE
      TAPE6       FMT                 WRITES       51

EXTERNALS           TYPE    ARGS      REFERENCES
      CELMOD        REAL       4         48
      CSTRES                   9         62

INLINE FUNCTIONS    TYPE    ARGS      DEF LINE  REFERENCES
      ABS           REAL       1  INTRIN              60

STATEMENT LABELS                    DEF LINE   REFERENCES
    0  100              INACTIVE       51         50
   32  110                             53        2*50
    0  120                             64         58
   77  130                             65         60
  126  140      FMT                    71         51

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   45  120      K           58 64       318              EXT REFS    EXITS

STATISTICS
  PROGRAM LENGTH                 200B     128
        140000B SCM USED
```

```
      SUBROUTINE SWELL (BP,DEN,DENSIF,DENSIP,DPHF,DPW,DPWPP,IT,J,NDBG,PO  SWEL
     +ROS1,POROS2,BPP,R,RAD,AFDN,TFR,TSINT,UO2LL,NRM1,NR,RSNTR,NA,COMP,E  SWEL
     +PS02,IMDENS,DP,MNA,MNR,MECHAN)                                      SWEL
C                                                                         SWEL
      IMPLICIT REAL * 8 (A-H,O-Z)                                         SWEL
C                                                                         SWEL
C     ***************************************************************** SWEL
C                                                                         SWEL
C     SWELL IS CALLED FROM MAIN.                                          SWEL
C     THIS ROUTINE COMPUTES THE FUEL RING DISPLACEMENTS WHICH INCLUDE     SWEL
C     THERMAL EXPANSION, IRRADIATION SWELLING, AND DENSIFICATION          SWEL
C                                                                         SWEL
C     ***************************************************************** SWEL
C     INPUT ARGUMENTS                                                     SWEL
C     ***************************************************************** SWEL
C                                                                         SWEL
C     AFDN   - ADDITIONAL DENSIFICATION FACTOR                            SWEL
C     BP     - BURNUP TO END OF POWER STEP (MWD/MTU)                      SWEL
C     BPP    - BURNUP TO BEGINNING OF POWER STEP (MWD/MTU)                SWEL
C     COMP   - PUO2 CONTENT OF THE FUEL (WEIGHT %)                        SWEL
C     DEN    - PERCENT OF THEORETICAL DENSITY OF THE FUEL                 SWEL
C     DENSIP - STORAGE OF PREVIOUS VALUES OF DENSIFICATION (M/M)          SWEL
C     DP     - PELLET DIAMETER (IN)                                       SWEL
C     DPHF   - FUEL DIAMETER INCLUDING EXPANSION, SWELLING, AND           SWEL
C     DENSIFICATION (IN)                                                  SWEL
C     DPWPP  - STORAGE OF PREVIOUS VALUES OF OUTWARD SWELLING (M/M)       SWEL
C     IMDENS - EM SWITCH FOR DENSIFICATION                                SWEL
C     IT     - POWER STEP INDEX                                           SWEL
C     J      - AXIAL INCREMENT INDEX                                      SWEL
C     NDBG   - DEBUG INDEX                                                SWEL
C     NA     - NUMBER OF AXIAL NODES                                      SWEL
C     NR     - MAXIMUM NUMBER OF RADIAL NODES                             SWEL
C     NRM1   - MAXIMUM NUMBER OF RADIAL NODES MINUS ONE                   SWEL
C     POROS1 - POROSITY LEFT AT BEGINNING OF POWER STEP (M/M)             SWEL
C     R      - COLD STATE FUEL RING RADII (IN)                            SWEL
C     RSNTR  - MAXIMUM DENSITY CHANGE DETERMINED BY A RESINTERING         SWEL
C     TEST OF 1973K FOR 24 HOURS (KG/M**3)                                SWEL
C     TFR    - FUEL RING BOUNDARY TEMPERATURE (F)                         SWEL
C     TSINT  - SINTERING TEMPERATURE OF THE FUEL (K)                      SWEL
C     UO2LL  - THERMAL EXPANSION OF FUEL RING (IN/IN)                     SWEL
C                                                                         SWEL
C     ***************************************************************** SWEL
C     OUTPUT ARGUMENTS                                                    SWEL
C     ***************************************************************** SWEL
C                                                                         SWEL
C     DPW    - OUTWARD SWELLING (M/M)                                     SWEL
C     DENSIF - DENSIFICATION (M/M)                                        SWEL
C     EPS02  - TOTAL PERMANENT STRAINS DUE TO DENSIFICATION AND           SWEL
C     IRRADIATION SWELLING AND IRRADIATION GROWTH (M/M)                   SWEL
C     POROS2 - POROSITY LEFT AFTER POWER STEP (M/M)                       SWEL
C     RAD    - HOT STATE FUEL RING RADII (IN)                             SWEL
C                                                                         SWEL
C     ***************************************************************** SWEL
```

```
      C
55          DIMENSION EPSO2(MNA,MNR,3)                                                    SWEL       55
            DIMENSION     DPW(NR,NA)     ,DENSIP(NR,NA) ,DENSIF(NR,NA)                    SWEL       56
           +             ,DPWPP(NR,NA)   ,POROS1(NR,NA) ,POROS2(NR,NA)                   SWEL       57
           + ,R(NR)      ,RAD(NR)        ,TFR(NR)       ,UO2LL(NR,NA)                    SWEL       58
      C                                                                                   SWEL       59
60    C   CONVERT BURNUP FROM MW-DAY/T TO MW-SEC/KG                                       SWEL       60
            BU = BP*86.4                                                                  SWEL       61
            BUP = BPP*86.4                                                                SWEL       62
      C                                                                                   SWEL       63
            IF (IMDENS.EQ.0) GO TO 100                                                    SWEL       64
65          RHO1 = ((COMP*11.46/100.0)+(1.0-COMP/100.0)*10.97)*DEN/100.0                  SWEL       65
            RHO2 = RHO1+RSNTR/1000.E0                                                     SWEL       66
            IF (RSNTR.LE.0.E0) RHO2 = RHO1*96.5/DEN                                       SWEL       67
      100   CONTINUE                                                                      SWEL       68
      C                                                                                   SWEL       69
70          FDENS = DEN*109.7                                                             SWEL       70
            IF (COMP.GT.0.E0) FDENS = (1.E0-COMP/100.E0)*FDENS+COMP*1.146                 SWEL       71
                DO 140 L=1,NRM1                                                           SWEL       72
                I = NR-L                                                                  SWEL       73
                PRVDEN = DENSIP(I,J)*100.E0                                               SWEL       74
75              FTEMP = ((TFR(I)+TFR(I+1))/2.+459.67)/1.8                                 SWEL       75
      C   THE FOLLOWING CALL TO FSWELL CALCULATES ADDITIONAL SWELLING DUE TO             SWEL       76
      C   SOLID AND GAS FISSION PRODUCTS FOR THIS TIME STEP (+M**3/M**3)                  SWEL       77
      C                                                                                   SWEL       78
                IF (BU.LT.5.184E5) GASWL = 0.E0                                           SWEL       79
80              IF (BU.LT.5.184E5) SOLDSW = 0.E0                                          SWEL       80
                IF (BU.LT.5.184E5) GO TO 110                                              SWEL       81
      C                                                                                   SWEL       82
                CALL FSWELL (FDENS,COMP,BU,BUP,FTEMP,GASWL,SOLDSW)                        SWEL       83
                DPW(I,J) = (GASWL+SOLDSW)/3.+DPWPP(I,J)                                   SWEL       84
85    C                                                                                   SWEL       85
      110       CONTINUE                                                                  SWEL       86
      C                                                                                   SWEL       87
      C   THE FOLLOWING CALL TO FUDENS CALCULATES ADDITIONAL DENSIFICATION                SWEL       88
      C   FOR THIS TIME STEP  (-M/M)                                                      SWEL       89
      C                                                                                   SWEL       90
90    C   IF THE BURNUP IS GREATER THAN 10,000(MWD/MTU),NO ADDITIONAL                     SWEL       91
      C   DENSIFICATION IS ASSUMED                                                        SWEL       92
      C                                                                                   SWEL       93
                IF (BP.GT.10000.E0) GO TO 120                                             SWEL       94
95              DELDEN = FUDENS(FTEMP,BU,FDENS,RSNTR,TSINT,COMP,PRVDEN)*AFDN/1            SWEL       95
               +    00.                                                                   SWEL       96
                IF (IMDENS.EQ.1) DELDEN = EMDNSF(BP,DP,RHO1,RHO2)*AFDN/100.E0             SWEL       97
                GO TO 130                                                                 SWEL       98
      120       CONTINUE                                                                  SWEL       99
100             DELDEN = 0.E0                                                             SWEL      100
      130       CONTINUE                                                                  SWEL      101
      C                                                                                   SWEL      102
                DELPOR = DELDEN+(GASWL+SOLDSW)/3.                                         SWEL      103
                POROS2(I,J) = POROS1(I,J)+DELPOR                                          SWEL      104
105   C   POROSITY IS NOT ALLOWED TO GO NEGATIVE                                          SWEL      105
                IF (POROS2(I,J).LT.0.0) POROS2(I,J) = 0.0                                 SWEL      106
                                                                                          SWEL      107
```

```
                IF (POROS2(I,J).LE.0.0) DELDEN = -POROS1(I,J)-(GASWL+SOLDSW)/3 SWEL      108
          +                                                                     SWEL      109
                DENSIF(I,J) = DENSIP(I,J)+DELDEN                                SWEL      110
110             RAD(NR) = R(NR)*(1.E0+UO2LL(NRM1,J)+DPW(NRM1,J)+DENSIF(NRM1,J)  SWEL      111
          +     )                                                               SWEL      112
                RAD1 = (R(I)-R(I+1))*(1.+UO2LL(I,J)+DPW(I,J)+DENSIF(I,J))+RAD(  SWEL      113
          +     I+1)                                                            SWEL      114
                RAD2 = SQRT((R(I)*R(I)-R(I+1)*R(I+1))*(1.+2.*(UO2LL(I,J)+DPW(I  SWEL      115
115       +     ,J)+DENSIF(I,J)))+RAD(I+1)*RAD(I+1))                            SWEL      116
                RAD(I) = AMAX1(RAD1,RAD2)                                       SWEL      117
          140   CONTINUE                                                        SWEL      118
           IF (MECHAN.NE.3) GO TO 160                                           SWEL      119
                DO 150 II=1,NR                                                  SWEL      120
120             IJ = NR-II+1                                                    SWEL      121
                  DO 150 IK=1,3                                                 SWEL      122
                  EPS02(J-1,IJ,IK) = DPW(II,J)+DENSIF(II,J)                     SWEL      123
          150     CONTINUE                                                      SWEL      124
          160 CONTINUE                                                          SWEL      125
125             DPHF = 2.0*RAD(1)                                               SWEL      126
              C                                                                 SWEL      127
              C                                                                 SWEL      128
                RETURN                                                          SWEL      129
                END                                                             SWEL      130
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	SWELL	1	128

VARIABLES

	SN	TYPE		RELOCATION								
0	GFDN	REAL		F.P.	REFS	95	97	DEFINED	1			
0	BP	REAL		F.P.	REFS	61	94	97	DEFINED	1		
0	BPP	REAL		F.P.	REFS	62	DEFINED	1				
374	BU	REAL			REFS	79	80	81	83	95		
					DEFINED	61						
375	BUP	REAL			REFS	83	DEFINED	62				
0	COMP	REAL		F.P.	REFS	2*65	3*71	83	95	DEFINED	1	
407	DELDEN	REAL			REFS	103	109	DEFINED	95	97	100	107
410	DELPOR	REAL			REFS	104	DEFINED	103				
0	DEN	REAL		F.P.	REFS	65	67	70	DEFINED	1		
0	DENSIF	REAL	ARRAY	F.P.	REFS	56	110	112	114	122		
					DEFINED	1	109					
0	DENSIP	REAL	ARRAY	F.P.	REFS	56	74	109	DEFINED	1		
0	DP	REAL		F.P.	REFS	97	DEFINED	1				
0	DPHF	REAL		F.P.	DEFINED	1	125					
0	DPW	REAL	ARRAY	F.P.	REFS	56	110	112	114	122		
					DEFINED	1	84					
0	DPWPP	REAL	ARRAY	F.P.	REFS	56	84	DEFINED	1			
0	EPS02	REAL	ARRAY	F.P.	REFS	55	DEFINED	1	122			

VARIABLES	SN	TYPE	RELOCATION									
400	FDENS	REAL			REFS	71	83	95	DEFINED	70	71	
404	FTEMP	REAL			REFS	83	95	DEFINED	75			
405	GASWL	REAL			REFS	83	84	103	107	DEFINED	79	
402	I	INTEGER			REFS	74	2*75	2*84	2*104	2*106	2*107	2*109
					6*112	9*114	116	DEFINED	73			
413	II	INTEGER			REFS	120	2*122	DEFINED	119			
414	IJ	INTEGER			REFS	122	DEFINED	120				
415	IK	INTEGER			REFS	122	DEFINED	121				
0	IMDENS	INTEGER		F.P.	REFS	64	97	DEFINED	1			
0	IT	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	J	INTEGER		F.P.	REFS	74	2*84	2*104	2*106	2*107	2*109	3*110
					3*112	3*114	3*122	DEFINED	1			
401	L	INTEGER			REFS	73	DEFINED	72				
0	MECHAN	INTEGER		F.P.	REFS	118	DEFINED	1				
0	MNA	INTEGER		F.P.	REFS	55	DEFINED	1				
0	MNR	INTEGER		F.P.	REFS	55	DEFINED	1				
0	NA	INTEGER		F.P.	REFS	7*56	DEFINED	1				
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NR	INTEGER		F.P.	REFS	10*56	73	2*110	119	120		
					DEFINED	1						
0	NRM1	INTEGER		F.P.	REFS	72	3*110	DEFINED	1			
0	POROS1	REAL	ARRAY	F.P.	REFS	56	104	107	DEFINED	1		
0	POROS2	REAL	ARRAY	F.P.	REFS	56	106	107	DEFINED	1	104	106
403	PRVDEN	REAL			REFS	95	DEFINED	74				
0	R	REAL	ARRAY	F.P.	REFS	56	110	2*112	4*114	DEFINED	1	
0	RAD	REAL	ARRAY	F.P.	REFS	56	112	2*114	125	DEFINED	1	110
					116							
411	RAD1	REAL			REFS	116	DEFINED	112				
412	RAD2	REAL			REFS	116	DEFINED	114				
376	RHO1	REAL			REFS	66	67	97	DEFINED	65		
377	RHO2	REAL			REFS	97	DEFINED	66	67			
0	RSNTR	REAL		F.P.	REFS	66	67	95	DEFINED	1		
406	SOLDSW	REAL			REFS	83	84	103	107	DEFINED	80	
0	TFR	REAL	ARRAY	F.P.	REFS	56	2*75	DEFINED	1			
0	TSINT	REAL		F.P.	REFS	95	DEFINED	1				
0	UO2LL	REAL	ARRAY	F.P.	REFS	56	110	112	114	DEFINED	1	

EXTERNALS	TYPE	ARGS		REFERENCES
EMDNSF	REAL	4		97
FSWELL		7		83
FUDENS	REAL	7		95
SQRT	REAL	1	LIBRARY	114

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
AMAX1	REAL	0	INTRIN		116

STATEMENT LABELS	DEF LINE	REFERENCES	
46 100	68	64	
126 110	86	61	
152 120	99	94	
155 130	101	98	
0 140	117	72	
0 150	123	119	121

```
STATEMENT LABELS                DEF LINE   REFERENCES
  314  160                          124        118

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   62  140      L           72 117      200B              EXT REFS
  267  150      II         119 123       24B              NOT INNER
  274  150      IK         121 123       14B        OPT

STATISTICS
  PROGRAM LENGTH                 507B     327
        140000B SCM USED
```

```
      SUBROUTINE TAPEGN (BUI,ZRO2A,ANG,RTRANO,CCI,POROSI,DENSIP,DPWPP,OL
     +DPG,OLEPS,OLFEPS,OLDTC,OLDPC,OLDURF,OLIGAP,REPS,RFEPS,EPP,EP,SIG,E
     +PS,CTMAX,CHEM,NA,NR,IRI,N7,IT,NREAD,NRESTR,NROLL,GASES,N3,N6,MECHA
     +N,IQUIT,TIME,BTOLD,ITREST,NWORDS,LENGTH,NGASR,AGRASS,LGRASS)
C
C
C     THIS SUBROUTINE IS CALLED FROM MAIN AND IS USED WHEN EITHER
C     WRITING OR READING A FRAPCON RESTART TAPE. FRAPCON WRITES ON TAPE2
C     AND READS FROM TAPE3.
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
C     ******************************************************************
C     INPUT OR OUTPUT  ARGUMENTS
C     ******************************************************************
C
C     AGRASS - ARRAY OF NODALLY DEPENDENT VARIABLES IN FAST/GRASS MODEL
C     ANG    - N2 CONSENTRATION (GM-MOLES)
C     BTOLD  - PREVIOUS B VALUES FOR DDLF
C     BTOLD  - PREVIOUS B VALUES FOR DDLF
C     BUI    - BURNUP (MWD/MTU)
C     CCI    - FISSION GAS CONSENTRATION (GM-MOLES)
C     CHEM   - STORAGE OF IODINE , CESIUM , HYDROGEN ETC
C     CTMAX  - MAXIMUM TEMPERATURE EXPERIENCED BY THE CLADDING (K)
C     DENSIP - FUEL DENSIFICATION STRAIN
C     DPWPP  - FUEL SWELLING STRAIN
C     EP     - EFFECTIVE PLASTIC STRAIN
C     EPS    - CLADDING STRAIN
C     EPP    - PLASTIC STRAIN
C     GASES  - MOLE FRACTIONS OF THE SEVEN ROD GASES
C     IQUIT  - TERMINATOR INDEX
C     IRI    - NUMBER OF AXIAL NODES PLUS ONE
C     IT     - TIME STEP INDEX
C     ITREST - RESTART ITERATION AT WHICH THE RESTART IS TO BEGIN
C     LENGTH - THE TOTAL LENGTH OF THE A ARRAY
C     LGRASS - STARTING LOCATION OF AGRASS ARRAY IN A ARRAY
C     ITREST - RESTART ITERATION AT WHICH THE RESTART IS TO BEGIN
C     MECHAN - MECHANICS PACKAGE INDEX
C     : 1, PNL  - PELET
C     : 2, INEL - FRACAS - I
C     : 3, INEL - FRACAS - II
C     NA     - NUMBER OF AXIAL NODES PLUS ONE
C     NGASR  - GAS MODEL INDICATOR
C     NR     - NUMBER OF RADIAL NODES
C     NREAD  - RESTART READ INDEX
C     NRESTR - RESTART WRITE INDEX
C     NROLL  - REWIND INDEX FOR RESTART WRITES
C     NWORDS - NUMBER OF STORAGE LOCATIONS REQUIRED FOR FAST GRASS
C     N3     - THREE
C     N6     - SIX
C     N7     - SEVEN
```

```
C   OLDPC  - OLD VALUES OF COOLANT PRESSURE (PSIA)                          TAPE       55
C   OLDPG  - OLD VALUES OF ROD GAS PRESSURE (PSIA)                          TAPE       56
C   OLDTC  - OLD VALUES OF CLADDING AVERAGE TEMPERATURE (F)                 TAPE       57
C   OLDURF - OLD VALUES OF FUEL SURFACE DISPLACEMENTS (IN)                  TAPE       58
C   OLEPS  - OLD VALUES OF CLADDING STRAIN                                  TAPE       59
C   OLFEPS - OLD VALUES OF FUEL STRAIN                                      TAPE       60
C   OLIGAP - OLD VALUES OF GAP CLOSURE INDEX                                TAPE       61
C   POROSI - FUEL POROSITY                                                  TAPE       62
C   REPS   - RESIDUAL CLADDING STRAIN                                       TAPE       63
C   RFEPS  - RESIDUAL FUEL STRAIN                                           TAPE       64
C   RTRANO - RADIUS TO THE CRACK REGION (M)                                 TAPE       65
C   SIG    - CLADDING STRESS (PSIA)                                         TAPE       66
C   ZRO2A  - ZIRCALOY OXIDE THICKNESS                                       TAPE       67
C                                                                           TAPE       68
      DIMENSION     BUI(NA)         ,ZRO2A(NA)      ,ANG(NA,1)            TAPE       69
     +             ,RTRANO(NA)      ,CCI(NR,NA)     ,POROSI(NR,NA)        TAPE       70
     +             ,DENSIP(NR,NA)   ,DPWPP(NR,NA)   ,OLDPG(NA)            TAPE       71
     +             ,OLEPS(NA)       ,OLFEPS(NA)     ,OLDTC(NA)            TAPE       72
     +             ,OLDPC(NA)       ,OLDURF(NA)     ,OLIGAP(NA)           TAPE       73
     +             ,REPS(NA,N3)     ,RFEPS(NA,N3)   ,EPP(NA,N3)           TAPE       74
     +             ,EP(NA)          ,SIG(NA,N3)     ,EPS(NA,N3)           TAPE       75
     +             ,CTMAX(NA)       ,CHEM(NA,N6)    ,GASES(N7)            TAPE       76
     +             ,AGRASS(NWORDS),BTOLD(NA,N6)                           TAPE       77
C                                                                           TAPE       78
      DATA              NTAPS / 2 / , NTAPI / 3 /                         TAPE       79
C                                                                           TAPE       80
C   THIS SUBROUTINE WRITES ON UNIT TAPE2 AND READS FROM UNIT TAPE3          TAPE       81
C   THIS SUBROUTINE WRITES ON UNIT TAPE2 AND READS FROM UNIT TAPE3          TAPE       82
      NAXN = NA-1                                                           TAPE       83
      IIT = IT-1                                                            TAPE       84
C                                                                           TAPE       85
C   THE FOLLOWING SET OF WRITE STATEMENTS WRITE RESTART  TAPE  FOR          TAPE       86
C   FRAPCON                                                                 TAPE       87
C                                                                           TAPE       88
      IF (NRESTR.EQ.0) GO TO 120                                            TAPE       89
      IF (NROLL.EQ.1) GO TO 100                                             TAPE       90
      REWIND NTAPS                                                          TAPE       91
100   CONTINUE                                                              TAPE       92
C                                                                           TAPE       93
      WRITE (NTAPS) TIME,IIT                                                TAPE       94
      WRITE (NTAPS) (BUI(J),ZRO2A(J),ANG(J,1),RTRANO(J),J=2,IR1)            TAPE       95
      WRITE (NTAPS) ((CCI(L,J),POROSI(L,J),DENSIP(L,J),DPWPP(L,J),J=2,IR    TAPE       96
     +1),L=1,NR)                                                            TAPE       97
C                                                                           TAPE       98
      WRITE (NTAPS) (OLEPS(J),OLFEPS(J),OLDTC(J),OLDPG(J),OLDPC(J),OLDUR    TAPE       99
     +F(J),OLIGAP(J),J=1,NAXN)                                              TAPE      100
          DO 110 L=1,N3                                                     TAPE      101
110       WRITE (NTAPS) (REPS(J,L),RFEPS(J,L),EPP(J,L),EP(J),SIG(J,L),EP    TAPE      102
     +    S(J,L),J=1,NAXN)                                                 TAPE      103
      WRITE (NTAPS) NWORDS,LENGTH,((BTOLD(J,L),J=2,IR1),L=1,N6)             TAPE      104
      IF (IIT.GT.0) WRITE (6,170) IIT                                       TAPE      105
C                                                                           TAPE      106
C   THE FOLLOWING SET OF STATEMENTS READ IN THE FRAPCON GENERATED           TAPE      107
```

```
      C   DATA FOR RESTARTING FRAPCON                                                  TAPE      108
      C                                                                                TAPE      109
      120   CONTINUE                                                                   TAPE      110
110         IF (NREAD.EQ.0) GO TO 160                                                  TAPE      111
            N = 0                                                                      TAPE      112
            REWIND NTAPI                                                               TAPE      113
      130   READ (NTAPI) STIME,IIT                                                     TAPE      114
            N = N+1                                                                    TAPE      115
115         WRITE (6,180) STIME,N,TIME                                                 TAPE      116
      C                                                                                TAPE      117
            READ (NTAPI) (BUI(J),ZRO2A(J),ANG(J,1),RTRANO(J),J=2,IR1)                  TAPE      118
            READ (NTAPI) ((CCI(L,J),POROSI(L,J),DENSIP(L,J),DPWPP(L,J),J=2,IR1         TAPE      119
           +),L=1,NR)                                                                  TAPE      120
120         READ (NTAPI) (OLEPS(J),OLFEPS(J),OLDTC(J),OLDPG(J),OLDPC(J),OLDURF         TAPE      121
           +(J),OLIGAP(J),J=1,NAXN)                                                    TAPE      122
                DO 140 L=1,N3                                                          TAPE      123
      140       READ (NTAPI) (REPS(J,L),RFEPS(J,L),EPP(J,L),EP(J),SIG(J,L),EPS       TAPE      124
           +     (J,L),J=1,NAXN)                                                     TAPE      125
125         READ (NTAPI) NWORDS,LENGTH,((BTOLD(J,L),J=2,IR1),L=1,N6)                   TAPE      126
            IRSTAR = 1                                                               TAPE      127
            IF (NGASR.EQ.-2) CALL GRASS6 (AGRASS(LGRASS),NWORDS)                       TAPE      128
            IRSTAR = 0                                                               TAPE      129
      C                                                                              TAPE      130
130   C                                                                              TAPE      131
            IF (IIT.GT.ITREST) GO TO 150                                             TAPE      132
            IF (IIT.LT.ITREST) GO TO 130                                             TAPE      133
            WRITE (6,190) STIME                                                      TAPE      134
            GO TO 160                                                                TAPE      135
135   150   CONTINUE                                                                 TAPE      136
            WRITE (6,200)                                                            TAPE      137
            IQUIT = 1                                                                TAPE      138
      160   CONTINUE                                                                 TAPE      139
      C                                                                              TAPE      140
140         RETURN                                                                   TAPE      141
      C                                                                              TAPE      142
      170   FORMAT (/,5X,52H RESTART INFORMATION HAS BEEN WRITTEN AT POWER STE       TAPE      143
           +P ,I3,/)                                                                 TAPE      144
      180   FORMAT (//,5X,7HSTIME= ,E12.5,2X,3HN= ,I3,2X,6HTIME= ,E12.5,//)          TAPE      145
145   190   FORMAT (5X,39H FRAPCON WILL BE RESTARTED FROM TIME = ,E12.5)             TAPE      146
      200   FORMAT (//,5X,70H***** RESTART WAS ATTEMPTED AT A TIME GREATER THA       TAPE      147
           +N THE SPECIFIED TIME //)                                                 TAPE      148
            END                                                                      TAPE      149
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 TAPEGN	1	140

VARIABLES	SN	TYPE		RELOCATION								
0	AGRASS	REAL	ARRAY	F.P.	REFS	68	127	DEFINED	1			
0	ANG	REAL	ARRAY	F.P.	REFS	68	94	DEFINED	1	117		
0	BTOLD	REAL	ARRAY	F.P.	REFS	68	103	DEFINED	1	125		
0	BUI	REAL	ARRAY	F.P.	REFS	68	94	DEFINED	1	117		
0	CCI	REAL	ARRAY	F.P.	REFS	68	95	DEFINED	1	118		
0	CHEM	REAL	ARRAY	F.P.	REFS	68	DEFINED	1				
0	CTMAX	REAL	ARRAY	F.P.	REFS	68	DEFINED	1				
0	DENSIP	REAL	ARRAY	F.P.	REFS	68	95	DEFINED	1	118		
0	DPWPP	REAL	ARRAY	F.P.	REFS	68	95	DEFINED	1	118		
0	EP	REAL	ARRAY	F.P.	REFS	68	101	DEFINED	1	123		
0	EPP	REAL	ARRAY	F.P.	REFS	68	101	DEFINED	1	123		
0	EPS	REAL	ARRAY	F.P.	REFS	68	101	DEFINED	1	123		
0	GASES	REAL	ARRAY	F.P.	REFS	68	DEFINED	1				
705	IIT	INTEGER			REFS	93	2*104	131	132	DEFINED	83	113
0	IQUIT	INTEGER		F.P.	DEFINED	1	137					
712	IRSTAR	INTEGER			DEFINED	126	128					
0	IRI	INTEGER		F.P.	REFS	94	95	103	117	118	125	
					DEFINED	1						
0	IT	INTEGER		F.P.	REFS	83	DEFINED	1				
0	ITREST	INTEGER		F.P.	REFS	131	132	DEFINED	1			
706	J	INTEGER			REFS	4*94	4*95	7*98	6*101	103	4*117	4*118
					7*120	6*123	125	DEFINED	94	95	98	101
					103	117	118	120	123	125		
707	L	INTEGER			REFS	4*95	5*101	103	4*118	5*123	125	
					DEFINED	95	100	103	118	122	125	
0	LENGTH	INTEGER		F.P.	REFS	103	DEFINED	1	125			
0	LGRASS	INTEGER		F.P.	REFS	127	DEFINED	1				
0	MECHAN	INTEGER	*UNUSED	F.P.	DEFINED	1						
710	N	INTEGER			REFS	114	115	DEFINED	111	114		
0	NA	INTEGER		F.P.	REFS	24*68	82	DEFINED	1			
704	NAXN	INTEGER			REFS	98	101	120	123	DEFINED	82	
0	NGASR	INTEGER		F.P.	REFS	127	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	4*68	95	118	DEFINED	1		
0	NREAD	INTEGER		F.P.	REFS	110	DEFINED	1				
0	NRESTR	INTEGER		F.P.	REFS	88	DEFINED	1				
0	NROLL	INTEGER		F.P.	REFS	89	DEFINED	1				
453	NTAPI	INTEGER			DEFINED	78	I/O REFS	112	113	117	118	120
					123	125						
452	NTAPS	INTEGER			DEFINED	78	I/O REFS	90	93	94	95	98
					101	103						
0	NWORDS	INTEGER		F.P.	REFS	68	103	127	DEFINED	1	125	
0	N3	INTEGER		F.P.	REFS	5*68	100	122	DEFINED	1		
0	N6	INTEGER		F.P.	REFS	2*68	103	125	DEFINED	1		
0	N7	INTEGER		F.P.	REFS	68	DEFINED	1				
0	OLDPC	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	OLDPG	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	OLDTC	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	OLDURF	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	OLEPS	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	OLFEPS	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	OLIGAP	REAL	ARRAY	F.P.	REFS	68	98	DEFINED	1	120		
0	POROSI	REAL	ARRAY	F.P.	REFS	68	95	DEFINED	1	118		

```
VARIABLES     SN  TYPE          RELOCATION
     0   REPS       REAL       ARRAY     F.P.        REFS        69      101    DEFINED       1       123
     0   RFEPS      REAL       ARRAY     F.P.        REFS        68      101    DEFINED       1       123
     0   RTRANO     REAL       ARRAY     F.P.        REFS        68       94    DEFINED       1       117
     0   SIG        REAL       ARRAY     F.P.        REFS        68      101    DEFINED       1       123
   711   STIME      REAL                             REFS       115      133    DEFINED     113
     0   TIME       REAL                 F.P.        REFS        93      115    DEFINED       1
     0   ZRO2A      REAL       ARRAY     F.P.        REFS        68       94    DEFINED       1       117

FILE NAMES         MODE
       TAPE6       FMT                            WRITES      104      115      133      136
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS          TYPE   ARGS       REFERENCES
       GRASS6                2           127

STATEMENT LABELS              DEF LINE   REFERENCES
    31   100                      91         89
     0   110                     101        100
   216   120                     109         88
   225   130                     113        132
     0   140                     123        122
   437   150                     135        131
   444   160                     138        110      134
   645   170      FMT            142        104
   655   180      FMT            144        115
   663   190      FMT            145        133
   672   200      FMT            146        136

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
    36          J          94  94       16B              EXT REFS
    61          I          95  95       23B              EXT REFS  NOT INNER
    62          J          95  95       17B              EXT REFS
   111          J          98  98       24B              EXT REFS
   141   110    I         100 101       30B              EXT REFS  NOT INNER
   144          J         101 101       20B              EXT REFS
   174          I         103 103       13B              EXT REFS
   236          J         117 117       16B              EXT REFS
   261          I         118 118       23B              EXT REFS  NOT INNER
   262          J         118 118       17B              EXT REFS
   311          J         120 120       24B              EXT REFS
   341   140    I         122 123       30B              EXT REFS  NOT INNER
   344          J         123 123       20B              EXT REFS
   374          I         125 125       13B              EXT REFS

STATISTICS
  PROGRAM LENGTH                 734B     476
        140000B SCM USED
```

```
      FUNCTION TERP (TT,TI,TD,N)                                        TERP
C                                                                       TERP
      DIMENSION TI(1), TD(1)                                            TERP
C                                                                       TERP
C                                                                       TERP
C     THIS SUBROUTINE INTERPOLATES TO FIND A VALUE                      TERP
C     TERP FROM THE TD (DEPENDENT) ARRAY TO CORRESPOND TO THE           TERP
C     VALUE TT FROM THE TI (INDEPENDENT) ARRAY.  N IS THE NUMBER        TERP
C     OF VALUES PRESENT IN THE TI OR TD ARRAYS.                         TERP
C                                                                       TERP
C     THE ROUTINE IS CAPABLE OF HANDLING AN INDEPENDENT ARRAY           TERP
C     ARRANGED IN EITHER INCREASING OR DECREASING ORDER.  TO            TERP
C     SPEED SOLUTION ON LARGE ARRAYS, THE ARRAYS ARE SUBDIVIDED         TERP
C     INTO TWO OR FOUR SUB-ARRAYS TO ENHANCE THE SORTING.               TERP
C                                                                       TERP
      NO2 = N/2                                                         TERP
      IF (TI(1).GT.TI(N)) GO TO 210                                     TERP
      IF (TT.LE.TI(1)) GO TO 170                                        TERP
      IF (TT.GE.TI(N)) GO TO 180                                        TERP
      IF (TT.GE.TI(NO2)) GO TO 120                                      TERP
      IF (N.LE.12) GO TO 110                                            TERP
      NO1 = NO2/2                                                       TERP
      IF (TT.GE.TI(NO1)) GO TO 100                                      TERP
      J1 = 1                                                            TERP
      J2 = NO1                                                          TERP
      GO TO 150                                                         TERP
  100 CONTINUE                                                          TERP
      J1 = NO1                                                          TERP
      J2 = NO2                                                          TERP
      GO TO 150                                                         TERP
  110 CONTINUE                                                          TERP
      J1 = 1                                                            TERP
      J2 = NO2                                                          TERP
      GO TO 150                                                         TERP
  120 CONTINUE                                                          TERP
      IF (N.LE.12) GO TO 140                                            TERP
      NO3 = (NO2+N)/2                                                   TERP
      IF (TT.GE.TI(NO3)) GO TO 130                                      TERP
      J1 = NO2                                                          TERP
      J2 = NO3                                                          TERP
      GO TO 150                                                         TERP
  130 CONTINUE                                                          TERP
      J1 = NO3                                                          TERP
      J2 = N                                                            TERP
      GO TO 150                                                         TERP
  140 CONTINUE                                                          TERP
      J1 = NO2                                                          TERP
      J2 = N                                                            TERP
  150 CONTINUE                                                          TERP
          DO 160 J=J1,J2                                                TERP
          IF (TT-TI(J)) 200,190,160                                     TERP
  160     CONTINUE                                                      TERP
      GO TO 180                                                         TERP
```

```
      170   TERP = TD(1)                                                                  TERP      55
55          RETURN                                                                        TERP      56
      180   TERP = TD(N)                                                                  TERP      57
            RETURN                                                                        TERP      58
      190   TERP = TD(J)                                                                  TERP      59
            RETURN                                                                        TERP      60
60    200   CONTINUE                                                                      TERP      61
            TERP = TD(J-1)+(TD(J)-TD(J-1))*(TT-TI(J-1))/(TI(J)-TI(J-1))                   TERP      62
            RETURN                                                                        TERP      63
      210   IF (TT.GE.TI(1)) GO TO 170                                                    TERP      64
            IF (TT.LE.TI(N)) GO TO 180                                                    TERP      65
65          IF (TT.LE.TI(NO2)) GO TO 240                                                  TERP      66
            IF (N.LE.12) GO TO 230                                                        TERP      67
            NO1 = NO2/2                                                                   TERP      68
            IF (TT.LE.TI(NO1)) GO TO 220                                                  TERP      69
            J1 = 1                                                                        TERP      70
70          J2 = NO1                                                                      TERP      71
            GO TO 270                                                                     TERP      72
      220   CONTINUE                                                                      TERP      73
            J1 = NO1                                                                      TERP      74
            J2 = NO2                                                                      TERP      75
75          GO TO 270                                                                     TERP      76
      230   CONTINUE                                                                      TERP      77
            J1 = 1                                                                        TERP      78
            J2 = NO2                                                                      TERP      79
            GO TO 270                                                                     TERP      80
80    240   CONTINUE                                                                      TERP      81
            IF (N.LE.12) GO TO 260                                                        TERP      82
            NO3 = (NO2+N)/2                                                               TERP      83
            IF (TT.LE.TI(NO3)) GO TO 250                                                  TERP      84
            J1 = NO2                                                                      TERP      85
85          J2 = NO3                                                                      TERP      86
            GO TO 270                                                                     TERP      87
      250   CONTINUE                                                                      TERP      88
            J1 = NO3                                                                      TERP      89
            J2 = N                                                                        TERP      90
90          GO TO 270                                                                     TERP      91
      260   CONTINUE                                                                      TERP      92
            J1 = NO2                                                                      TERP      93
            J2 = N                                                                        TERP      94
      270   CONTINUE                                                                      TERP      95
95              DO 280 J=J1,J2                                                            TERP      96
                IF (TT-TI(J)) 280,190,200                                                 TERP      97
      280       CONTINUE                                                                  TERP      98
            GO TO 180                                                                     TERP      99
            END                                                                           TERP     100
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES			
5	TERP	1	55	57	59	62

VARIABLES	SN	TYPE		RELOCATION								
304	J	INTEGER			REFS	51	58	6*61	96	DEFINED	50	95
301	J1	INTEGER			REFS	50	95	DEFINED	24	28	32	39
					43	47	69	73	77	84	88	92
302	J2	INTEGER			REFS	50	95	DEFINED	25	29	33	40
					44	43	70	74	78	85	89	93
0	N	INTEGER		F.P.	REFS	16	17	19	21	36	37	44
					48	56	64	66	81	82	89	93
					DEFINED	1						
300	NO1	INTEGER			REFS	23	25	28	68	70	73	
					DEFINED	22	67					
277	NO2	INTEGER			REFS	20	22	29	33	37	39	47
					65	67	74	78	82	84	92	
					DEFINED	16						
303	NO3	INTEGER			REFS	38	40	43	83	85	88	
					DEFINED	37	82					
0	TD	REAL	ARRAY	F.P.	REFS	3	54	56	58	3*61		
					DEFINED	1						
276	TERP	REAL			DEFINED	54	56	58	61			
0	TI	REAL	ARRAY	F.P.	REFS	3	2*17	18	19	20	23	38
					51	3*61	63	64	65	68	83	96
					DEFINED	1						
0	TT	REAL		F.P.	REFS	18	19	20	23	38	51	61
					63	64	65	68	83	96		
					DEFINED	1						

STATEMENT LABELS		DEF LINE	REFERENCES					
51	100	27	23					
57	110	31	21					
65	120	35	20					
105	130	42	38					
113	140	46	36					
120	150	49	26	30	34	41	45	
0	160	52	50	51				
133	170	54	18	63				
137	180	56	19	53	64	98		
144	190	58	5[illegible]	96				
151	200	60	51	96				
163	210	63	17					
215	220	72	68					
223	230	76	66					
231	240	80	65					
251	250	87	83					
257	260	91	81					
264	270	94	71	75	79	86	90	
0	280	97	95	96				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
122	160	J	50 52	7B	INSTACK	EXITS
266	280	J	95 97	7B	INSTACK	EXITS

STATISTICS
PROGRAM LENGTH 312B 202
140000B SCM USED

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      SUBROUTINE TMPSUB (Z,YY,W,NR,TPS,RP,TFR,QDP,NDBG,RC,BTOLD,B,R,J,IT
     +,NA,GAPC,GAPH,GAPT,RFSH,GASES,TRANST,ITERR,IQUIT,RTRAN,BR,RTRANO,R
     +TRANP,FOTMTL,TTT,POROS2,TRTRAN,VOLSTR,MECHAN,CFAC,IM93WC,FTMELT,MN
     +A,MNR)
C
C
C     IMPLICIT REAL * 8 ( A-H,O-Z )
C
C     ******************************************************************
C
C     THIS SUBROUTINE COMPUTES THE FUEL TEMPERATURE DISTRIBUTION USING
C     THE COEFFICIENTS B FROM THE PNL SUPPLIED ROUTINE DDLF.
C     TMPSUB IS CALLED FROM MAIN AND WAS CODED BY G A BERNA IN APRIL '78
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     CFAC   - CONDUCTIVITY FACTOR
C     FTMELT - FUEL MELT TEMPERATURE (K)
C     GAPC   - AS FABRICATED RADIOAL GAP (M)
C     GAPH   - UNRELOCATED RADIAL GAP (M)
C     GAPT   - RELOCATED   RADIAL GAP (M)
C     GASES  - ARRAY OF THE SEVEN GAS MOLE FRACTIONS
C     (1) = HELIUM
C     (2) = ARGON
C     (3) = KRYPTON
C     (4) = XENON
C     (5) = HYDROGEN
C     (6) = AIR
C     (7) = WATER VAPOR
C     J      - AXIAL NODE INDEX
C     IM93WC - EM SWITCH FOR FUEL THERMAL CONDUCTIVITY
C     IT     - POWER-TIME STEP INDEX
C     ITERR  - GAS LOOP ITERATION INDEX
C     MECHAN - FLAG FOR MECHANICAL MODEL CHOICE
C     NA     - NUMBER OF AXIAL NODES
C     NDBG   - DEBUG INDEX
C     NR     - NUMBER OF RADIAL NODES
C     POROS2 - LINEAR POROSITY FRACTION OF THE FUEL
C     QDP    - POWER  (KW/FT)
C     R      - FUEL NODE RADII (IN)
C     RFSH   - AS FABRICATED PELLET RADIUS (M)
C     RP     - RADIUS OF THE PELLET (IN)
C     RC     - PELLET CORE RADIUS (IN)
C     FOTMTL - FUEL OXYGEN TO METAL RATIO (ATOMS OXYGEN/ATOMS METAL)
C     RTRANO - MAXIMUM PREVIOUS VALUE OF RTRAN ATTAINED (M)
C     TPS    - FUEL SURFACE TEMPERATURE (F)
C     TRANST - TEMPERATURE ABOVE WHICH NO CRACKING IS ASSUMED (K)
C     VOLSTR - VOLUME STRAIN DUE TO RELOCATION (DELTA-V/VOLUME)
C     W      - FLUX DEPRESSION COEFFICIENT (1/M**2)
C     YY     - FLUX DEPRESSION COEFFICIENT (1/M)
C     Z      - FLUX DEPRESSION COEFFICIENT
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      C                                                                      TMPSUB     55
      C***********************************************************************TMPSUB     56
      C OUTPUT ARGUMENTS                                                     TMPSUB     57
      C***********************************************************************TMPSUB     58
      C                                                                      TMPSUB     59
      C B      - MWR COEFFICIENTS FOR TEMPERATURE CALCULATION ( F/M )        TMPSUB     60
      C BR     - B VALUES FOR INNER FUEL REGION                              TMPSUB     61
      C BTOLD  - PREVIOUS B VALUES                                           TMPSUB     62
      C IQUIT  - CODE STOP INDEX                                             TMPSUB     63
      C RTRAN  - RADIUS OUT TO THE REGION WHERE CRACKS BEGIN (M)             TMPSUB     64
      C RTRANP - STORAGE FOR AXIAL VALUES OF RTRAN (M)                       TMPSUB     65
      C TFR    - FUEL NODE TEMPERATURES (F)                                  TMPSUB     66
      C TRTRAN - TEMPERATURE AT THE RESTRUCTURED RADIUS, RTRAN (F)           TMPSUB     67
      C                                                                      TMPSUB     68
      C***********************************************************************TMPSUB     69
      C                                                                      TMPSUB     70
        DIMENSION  B(6)   ,BTOLD(NA,6)   ,BR(6)                              TMPSUB     71
        DIMENSION  TFR(NR),R(NR)         ,POROS2(NR,NA)                      TMPSUB     72
        DIMENSION  GASES(7)                                                  TMPSUB     73
        DIMENSION  RTRANO(NA) , RTRANP(NA)                                   TMPSUB     74
        DIMENSION  TRTRAN(NA)                                                TMPSUB     75
        DIMENSION TTT(MNA,MNR)                                               TMPSUB     76
      C                                                                      TMPSUB     77
        RII = RC*0.0254                                                      TMPSUB     78
        TFS = (TPS-32.E0)/1.8                                                TMPSUB     79
        RD = RP*0.0254                                                       TMPSUB     80
        RTRAN = 0.E0                                                         TMPSUB     81
        RID = RII/RD                                                         TMPSUB     82
        POW = QDP*3280.84                                                    TMPSUB     83
      C                                                                      TMPSUB     84
      C THE FOLLOWING COMPUTES THE AVERAGE FRACTIONAL DENSITY OF THE FUEL    TMPSUB     85
      C AT AN AXIAL NODE CONSIDERING INITIAL DENSITY AND ANY DENSIFICATION   TMPSUB     86
      C AND IRRADIATION SWELLING.                                            TMPSUB     87
      C                                                                      TMPSUB     88
        FDEN = 0.E0                                                          TMPSUB     89
        RPS = RP**2-RC**2                                                    TMPSUB     90
            DO 100 I=2,NR                                                    TMPSUB     91
            FDEN = FDEN+POROS2(I-1,J)*(R(I-1)*R(I-1)-R(I)*R(I))/RPS          TMPSUB     92
  100       CONTINUE                                                         TMPSUB     93
        FDEN = 1.E0-3.E0*FDEN                                                TMPSUB     94
      C                                                                      TMPSUB     95
      CC                                                                     TMPSUB     96
      C THE FOLLOWING CALL TO DDLF COMPUTES THE MWR COEFFICIENTS             TMPSUB     97
      C                                                                      TMPSUB     98
        CALL DDLF (TFS,RII,RD,POW,Z,YY,W,B,J,FDEN,BTOLD,IT,NA,GAPC,GAPH,GA   TMPSUB     99
       +PT,RFSH,GASES,TRANST,ITERR,IQUIT,RTRAN,BR,RTRANO,FOTMTL,MECHAN,CFA   TMPSUB    100
       +C,VOLSTR,IM93WC,FTMELT)                                              TMPSUB    101
      C                                                                      TMPSUB    102
      C                                                                      TMPSUB    103
        RTRANP(J) = RTRAN                                                    TMPSUB    104
        NRM1 = NR-1                                                          TMPSUB    105
            DO 120 I=1,NRM1                                                  TMPSUB    106
            IF (R(I)*0.0254E0.LT.RTRAN) GO TO 130                            TMPSUB    107
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                      TFRC = 0.E0                                                    TMPSUB   108
                      TTRTN = 0.E0                                                   TMPSUB   109
                          DO 110 IJ=1,6                                              TMPSUB   110
110                       IF (I.EQ.NRM1.AND.RTRAN.GT.0.E0) TTRTN = B(IJ)*(RTRAN/RD)* TMPSUB   111
                     +    *(IJ-1)+TTRTN                                              TMPSUB   112
               110       TFRC = B(IJ)*(R(I)/RP)**(IJ-1)+TFRC                        TMPSUB   113
                      TFR(I) = TFRC*1.8E0+32.E0                                      TMPSUB   114
                      IK = NR+1-I                                                    TMPSUB   115
115                   IF (MECHAN.EQ.3) TTT(J-1,IK) = TFR(I)                          TMPSUB   116
               120    CONTINUE                                                       TMPSUB   117
                    TRTRAN(J) = TTRTN*1.8E0+32.E0                                    TMPSUB   118
                    TFR(NR) = B(1)+B(2)*RID+B(3)*RID**2+B(4)*RID**3+B(5)*RID**4+B(6)*R TMPSUB   119
                   +ID**5                                                            TMPSUB   120
120                 TFR(NR) = TFR(NR)*1.8E0+32.E0                                    TMPSUB   121
                    IF (RTRAN.LE.0.E0) TRTRAN(J) = TFR(NR)                           TMPSUB   122
                    IF (MECHAN.EQ.3) TTT(J-1,1) = TFR(NR)                            TMPSUB   123
                C                                                                    TMPSUB   124
                    GO TO 160                                                        TMPSUB   125
125            130  CONTINUE                                                        TMPSUB   126
                      DO 150 II=1,NRM1                                               TMPSUB   127
                      TFRC = 0.E0                                                    TMPSUB   128
                      TTRTN = 0.E0                                                   TMPSUB   129
                          DO 140 IJ=1,6                                              TMPSUB   130
130                       IF (II.EQ.NRM1) TTRTN = BR(IJ)*(RTRAN/RD)**(IJ-1)+TTRTN    TMPSUB   131
               140       TFRC = BR(IJ)*(R(II)/RP)**(IJ-1)+TFRC                      TMPSUB   132
                      TFR(II) = TFRC*1.8E0+32.E0                                     TMPSUB   133
                      IK = NR+1-II                                                   TMPSUB   134
                      IF (MECHAN.EQ.3) TTT(J-1,IK) = TFR(II)                         TMPSUB   135
135            150    CONTINUE                                                       TMPSUB   136
                    TFR(NR) = BR(1)+BR(2)*RID+BR(3)*RID**2+BR(4)*RID**3+BR(5)*RID**4+B TMPSUB   137
                   +R(6)*RID**5                                                      TMPSUB   138
                    TRTRAN(J) = TTRTN*1.8E0+32.E0                                    TMPSUB   139
                    TFR(NR) = TFR(NR)*1.8E0+32.E0                                    TMPSUB   140
140                 IF (MECHAN.EQ.3) TTT(J-1,1) = TFR(NR)                            TMPSUB   141
                C                                                                    TMPSUB   142
                160 CONTINUE                                                         TMPSUB   143
                    RETURN                                                           TMPSUB   144
                    END                                                              TMPSUB   145
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	TMPSUB	1	143

VARIABLES	SN	TYPE		RELOCATION						
0	B	REAL	ARRAY	F.P.	REFS	70	98	110	112	6*118
					DEFINED	1				
0	BR	REAL	ARRAY	F.P.	REFS	70	98	130	131	6*136
					DEFINED	1				

VARIABLES.	SN	TYPE	RELOCATION									
0	BTOLD	REAL	ARRAY	F.P.	REFS	70	98	DEFINED	1			
0	CFAC	REAL		F.P.	REFS	98	DEFINED	1				
473	FDEN	REAL			REFS	91	93	98	DEFINED	88	91	93
0	FOTMTL	REAL		F.P.	REFS	98	DEFINED	1				
0	FTMELT	REAL		F.P.	REFS	98	DEFINED	1				
0	GAPC	REAL		F.P.	REFS	98	DEFINED	1				
0	GAPH	REAL		F.P.	REFS	98	DEFINED	1				
0	GAPT	REAL		F.P.	REFS	98	DEFINED	1				
0	GASES	REAL	ARRAY	F.P.	REFS	72	98	DEFINED	1			
475	I	INTEGER			REFS	5*91	106	110	112	113	114	115
					126	DEFINED	90	105				
503	II	INTEGER			REFS	130	131	132	133	134		
					DEFINED	126						
501	IJ	INTEGER			REFS	2*110	2*112	2*130	2*131	DEFINED	109	129
502	IK	INTEGER			REFS	115	134	DEFINED	114	133		
0	IM93WC	INTEGER		F.P.	REFS	98	DEFINED	1				
0	IQUIT	INTEGER		F.P.	REFS	98	DEFINED	1				
0	IT	INTEGER		F.P.	REFS	98	DEFINED	1				
0	ITERR	INTEGER		F.P.	REFS	98	DEFINED	1				
0	J	INTEGER		F.P.	REFS	91	98	103	115	117	121	122
					134	138	140	DEFINED				
0	MECHAN	INTEGER		F.P.	REFS	98	115	122	134	140		
					DEFINED	1						
0	MNA	INTEGER		F.P.	REFS	75	DEFINED	1				
0	MNR	INTEGER		F.P.	REFS	75	DEFINED	1				
0	NA	INTEGER		F.P.	REFS	70	71	2*73	74	98		
					DEFINED	1						
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NR	INTEGER		F.P.	REFS	3*71	90	104	114	118	2*120	121
					122	133	136	2*139	140	DEFINED	1	
476	NRM1	INTEGER			REFS	105	110	126	130	DEFINED	104	
0	POROS2	REAL	ARRAY	F.P.	REFS	71	91	DEFINED	1			
472	POW	REAL			REFS	98	DEFINED	82				
0	QDP	REAL		F.P.	REFS	82	DEFINED	1				
0	R	REAL	ARRAY	F.P.	REFS	71	4*91	106	112	131		
					DEFINED	1						
0	RC	REAL		F.P.	REFS	77	89	DEFINED	1			
470	RD	REAL			REFS	81	98	110	130	DEFINED	79	
0	RFSH	REAL		F.P.	REFS	98	DEFINED	1				
471	RID	REAL			REFS	5*118	5*136	DEFINED	81			
466	RII	REAL			REFS	81	98	DEFINED	77			
0	RP	REAL		F.P.	REFS	79	89	112	131	DEFINED	1	
474	RPS	REAL			REFS	91	DEFINED	89				
0	RTRAN	REAL		F.P.	REFS	98	103	106	2*110	121	130	
					DEFINED	1	80					
0	RTRANQ	REAL	ARRAY	F.P.	REFS	73	98	DEFINED	1			
0	RTRANP	REAL	ARRAY	F.P.	REFS	73	DEFINED	1	103			
0	TFR	REAL	ARRAY	F.P.	REFS	71	115	120	121	122	134	139
					140	DEFINED	1	113	118	120	132	136
					139							
477	TFRC	REAL			REFS	112	113	131	132	DEFINED	107	112
					127	131						
467	TFS	REAL			REFS	98	DEFINED	78				

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VARIABLES     SN  TYPE          RELOCATION
    0   TPS       REAL                F.P.      REFS      78    DEFINED      1
    0   TRANST    REAL                F.P.      REFS      98    DEFINED      1
    0   TRTRAN    REAL          ARRAY F.P.      REFS      74    DEFINED      1      117      121      138
  500   TTRTN     REAL                        REFS     110       117      130      138    DEFINED      108      110
                                            128     130
    0   TTT       REAL          ARRAY F.P.      REFS      75    DEFINED      1      115      122      134      140
    0   VOLSTR    REAL                F.P.      REFS      98    DEFINED      1
    0   W         REAL                F.P.      REFS      98    DEFINED      1
    0   YY        REAL                F.P.      REFS      98    DEFINED      1
    0   Z         REAL                F.P.      REFS      98    DEFINED      1

EXTERNALS           TYPE   ARGS       REFERENCES
      DDLF                  30           98

STATEMENT LABELS              DEF LINE   REFERENCES
    0   100                      92         90
    0   110                     112        109
    0   120                     116        105
  273   130                     125        106
    0   140                     131        129
    0   150                     135        126
  411   160                     142        124

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   45  100      I          90  92        13B       OPT
  142  120      I         105 116        63B                EXT REFS    EXITS   NOT INNER
  154  110      IJ        109 112        30B                EXT REFS
  275  150      II        126 135        56B                EXT REFS  NOT INNER
  303  140      IJ        129 131        27B                EXT REFS

STATISTICS
  PROGRAM LENGTH                  541B     353
        140000B SCM USED
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      SUBROUTINE TOTGAS (GASFR,AAN,AIRIN,ANGI,AN2IN,ARGIN,FGIN,HEIN,H2OM  TOTG    2
     +I,KRYIN,NDBG,IT,NGASR,XEIN,TFGFR,THEFR,TN2FR,TH2OFR,IRI,FMGR,HMGR,  TOTG    3
     +FMGP,HMGP,AMFHE,ACMFG,ACMN2,ACMHE,ACMH2O,GASMOL,AMFH2,ANG,ANGR,AMG  TOTG    4
     +PT,HMGPT,ANGT,AMFFG,N2,AMFKRY,AMFXE,AMFN2,NREAD)                    TOTG    5
C                                                                         TOTG    6
C   IMPLICIT REAL*8 (A-H,O-Z)                                             TOTG    7
C                                                                         TOTG    8
      REAL      KRYIN                                                     TOTG    9
C                                                                         TOTG   10
C   ***************************************************************     TOTG   11
C                                                                         TOTG   12
C   THE SUBROUTINE TOTGAS CALCULATES THE CUMULATIVE GAS RELEASE OF        TOTG   13
C   FISSION GAS, HELIUM, AND NITROGEN FOR THE ENTIRE ROD . THE TOTAL      TOTG   14
C   MOLES OF GAS AND MOLE FRACTIONS ARE ALSO COMPUTED.                    TOTG   15
C   TOTGAS IS CALLED FROM MAIN AND WAS CODED FOR FRAPCON BY G A BERNA     TOTG   16
C   IN OCTOBER 1977 USING THE ROUTINE OF THE SAME NAME IN FRAPS           TOTG   17
C                                                                         TOTG   18
C   ***************************************************************     TOTG   19
C                                                                         TOTG   20
      DIMENSION     GASFR(7) ,AMGP(2)  ,AMGPH(2) ,AMGR(2)  ,AMGRH(2)    TOTG   21
     +   ,AMGRN2(2),FJJ(2)   ,FJJH(2)            ,ANG(N2,1),FMGR(N2,1)  TOTG   22
     +   ,HMGR(N2,1)         ,FMGP(N2,1)         ,HMGP(N2,1)            TOTG   23
     +   ,AMGPT(1) ,HMGPT(1) ,ACMFG(1) ,ACMHE(1) ,ACMN2(1) ,ACMH2O(1)   TOTG   24
     +   ,ANGR(N2,1)                                                     TOTG   25
C                                                                         TOTG   26
C   ***************************************************************     TOTG   27
C   INPUT ARGUMENTS                                                       TOTG   28
C   ***************************************************************     TOTG   29
C                                                                         TOTG   30
C   AAN    - MOLE FRACTION OF AIR AND NITROGEN                            TOTG   31
C   AIRIN  - INITIAL MOLES OF AIR IN THE ROD                              TOTG   32
C   AMFH2  - ABSOLUTE MOLE FRACTION OF HYDROGEN                           TOTG   33
C   ANG    - CUMULATIVE N2 CONSENTRATION IN FUEL PER POWER STEP(MOLES)    TOTG   34
C   ANGI   - INITIAL NITROGEN CONSENTRATION IN THE FUEL (MOLES)           TOTG   35
C   ANGR   - NITROGEN RELEASE PER NODE & POWER STEP (MOLES)               TOTG   36
C   AN2IN  - INITIAL MOLES OF N2 IN THE ROD                               TOTG   37
C   ARGIN  - INITIAL MOLES OF ARGON IN THE ROD                            TOTG   38
C   FGIN   - INITIAL MOLES OF FISSION GAS IN THE ROD                      TOTG   39
C   FMGP   - FISSION GAS PRODUCTION FOR EACH NODE (MOLES)                 TOTG   40
C   FMGR   - CUMULATIVE FISSION GAS RELEASE PER NODE & TIME STEP(MOLES    TOTG   41
C   GASFR  - MOLE FRACTIONS OF GAS CONSTITUENTS                           TOTG   42
C   1 - HELIUM                                                            TOTG   43
C   2 - ARGON                                                             TOTG   44
C   3 - KRYPTON                                                           TOTG   45
C   4 - XENON                                                             TOTG   46
C   5 - HYDROGEN                                                          TOTG   47
C   6 - NITROGEN                                                          TOTG   48
C   7 - WATER VAPOR                                                       TOTG   49
C   HEIN   - INITIAL MOLES OF HELIUM IN THE ROD                           TOTG   50
C   HMGP   - HELIUM  PRODUCTION FOR EACH NODE (MOLES)                     TOTG   51
C   HMGR   - CUMULATIVE HELIUM TELEASE PER NODE & TIME STEP (MOLES)       TOTG   52
C   H2OMI  - INITIAL WATER CONTENT IN THE FUEL (MOLES)                    TOTG   53
C   IRI    - NUMBER OF AXIAL NODES PLUS ONE                               TOTG   54
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      C   IT     - POWER-TIME STEP INDEX                                          TOTG       55
55    C   KRYIN  - INITIAL MOLES OF KRYPTON IN THE ROD                           TOTG       56
      C   NDBG   - DEBUG OUTPUT INDEX                                           TOTG       57
      C   NGASR  - FISSION GAS RELEASE MODEL INDEX                              TOTG       58
      C   = 0 , MACDONALD-WEISMAN                                               TOTG       59
      C   = 1 , BOOTH DIFFUSION                                                 TOTG       60
60    C   NREAD  - RESTART READ INDEX                                           TOTG       61
      C   NTSTEP - TIME STEP INDEX                                             TOTG       62
      C   N2     - MAXIMUM NUMBER OF AXIAL  NODES                               TOTG       63
      C   XEIN   - INITIAL MOLES OF XENON IN THE ROD                            TOTG       64
      C                                                                         TOTG       65
65    C   ***************************************************************       TOTG       66
      C   OUTPUT ARGUMENTS                                                      TOTG       67
      C   ***************************************************************       TOTG       68
      C                                                                         TOTG       69
      C   ACMFG  - CUMULATIVE FISSION GAS RELEASE ( GRAM-MOLES )                TOTG       70
70    C   ACMN2  - CUMULATIVE NITROGEN    RELEASE ( GRAM-MOLES )                TOTG       71
      C   ACMHE  - CUMULATIVE HELIUM      RELEASE ( GRAM-MOLES )                TOTG       72
      C   ACMH2O - CUMULATIVE WATER VAPOR RELEASE ( GRAM-MOLES)                 TOTG       73
      C   AMFFG  - ABSOLUTE MOLE FRACTION OF FISSION GAS (GRAM-MOLES)           TOTG       74
      C   AMFHE  - ABSOLUTE MOLE FRACTION OF HELIUM                             TOTG       75
75    C   AMFKRY - ABSOLUTE MOLE FRACTION OF KRYPTON                            TOTG       76
      C   AMFN2  - ABSOLUTE MOLE FRACTION OF NITROGEN                           TOTG       77
      C   AMFXE  - ABSOLUTE MOLE FRACTION OF XENON                              TOTG       78
      C   AMGPT  - CUMULATIVE FISSION GAS PRODUCTION (GM-MOLES)                 TOTG       79
      C   ANGT   - NITROGEN CONSENTRATION (GM-MOLES)                            TOTG       80
80    C   GASMOL - GRAM-MOLES OF GAS IN ROD J                                   TOTG       81
      C   HMGPT  - CUMULATIVE HELIUM PRODUCTION (GM-MOLES)                      TOTG       82
      C   TFGFR  - CUMULATIVE FISSION GAS FRACTION RELEASE                      TOTG       83
      C   THEFR  - CUMULATIVE HELIUM      FRACTION RELEASE                      TOTG       84
      C   TH2OFR - CUMULATIVE WATER VAPOR FRACTION RELEASE                      TOTG       85
85    C   TN2FR  - CUMULATIVE NITROGEN    FRACTION RELEASE                      TOTG       86
      C                                                                         TOTG       87
      C   ***************************************************************       TOTG       88
      C                                                                         TOTG       89
            IL = IT-1                                                           TOTG       90
90          IF (IT.EQ.1) IL = IT                                                TOTG       91
            IF (NREAD.EQ.1) IL = IT                                             TOTG       92
            IF (NREAD.EQ.1.AND.IT.LE.3) AMGP(1) = 0.E0                          TOTG       93
            IF (NREAD.EQ.1.AND.IT.LE.3) AMGPH(1) = 0.E0                         TOTG       94
            IF (NREAD.EQ.1.AND.IT.LE.3) FJJH(1) = 0.E0                          TOTG       95
95          IF (NREAD.EQ.1.AND.IT.LE.3) FJJ(1) = 0.E0                           TOTG       96
            IF (NREAD.EQ.1.AND.IT.LE.3) AMGRN2(1) = 0.E0                        TOTG       97
             DO 110 LT=IL,IT                                                    TOTG       98
             I = 2+LT-IT                                                        TOTG       99
             AMGR(I) = 0.0                                                      TOTG      100
100          AMGRH(I) = 0.0                                                     TOTG      101
             AMGRN2(I) = 0.0                                                    TOTG      102
             ANGT = 0.0                                                         TOTG      103
             AMGP(I) = 0.E0                                                     TOTG      104
             AMGPH(I) = 0.E0                                                    TOTG      105
105              DO 100 JJ=2,IR1                                                TOTG      106
      C                                                                         TOTG      107
```

```
      C                                                                 TOTG      108
                  AMGR(I) = AMGR(I)+FMGR(JJ,I)                          TOTG      109
                  AMGRH(I) = AMGRH(I)+HMGR(JJ,I)                        TOTG      110
  110             AMGP(I) = AMGP(I)+FMGP(JJ,I)                          TOTG      111
                  AMGPH(I) = AMGPH(I)+HMGP(JJ,I)                        TOTG      112
                  ANGT = ANGT+ANG(JJ,2)                                 TOTG      113
  100             AMGRN2(I) = AMGRN2(I)+ANGR(JJ,I)                      TOTG      114
                FJJ(I) = AMGR(I)/AMGP(I)                                TOTG      115
  115           FJJH(I) = AMGRH(I)/AMGPH(I)                             TOTG      116
  110           CONTINUE                                                TOTG      117
              IF (IT.GT.1) GO TO 120                                    TOTG      118
              AMGPT(1) = AMGP(2)                                        TOTG      119
              HMGPT(1) = AMGPH(2)                                       TOTG      120
  120         ACMFG(IT) = AMGR(2)                                       TOTG      121
              ACMHE(IT) = AMGRH(2)                                      TOTG      122
              ACMN2(IT) = AMGRN2(2)                                     TOTG      123
              GO TO 130                                                 TOTG      124
  120         AMGPT(IT) = AMGPT(IT-1)+AMGP(2)-AMGP(1)                   TOTG      125
  125         HMGPT(IT) = HMGPT(IT-1)+AMGPH(2)-AMGPH(1)                 TOTG      126
      C                                                                 TOTG      127
      C   CALCULATION OF CUMULATIVE FISSION GAS, HELIUM AND NITROGEN     TOTG      128
      C   RELEASES IN GRAM-MOLES                                        TOTG      129
      C                                                                 TOTG      130
  130         FGR = 2.0*(FJJ(2)*AMGP(2)-FJJ(1)*AMGP(1))/(AMGP(2)*(1.-FJJ(2))+AMG TOTG      131
             +P(1)*(1.-FJJ(1)))                                         TOTG      132
              IF (NGASR.EQ.-1) ACMFG(IT) = ACMFG(IT-1)+(AMGPT(IT-1)+AMGPT(IT)-2. TOTG      133
             +*ACMFG(IT-1))*FGR/(FGR+2.)                                TOTG      134
              IF (NGASR.GE.0) ACMFG(IT) = ACMFG(IT-1)+AMGR(2)           TOTG      135
  135         IF (NGASR.EQ.-2) ACMFG(IT) = ACMFG(IT-1)+AMGR(2)          TOTG      136
              FHR = 2.*(FJJH(2)*AMGPH(2)-FJJH(1)*AMGPH(1))/(AMGPH(2)*(1.-FJJH(2) TOTG      137
             +)+AMGPH(1)*(1.-FJJH(1)))                                  TOTG      138
              ACMHE(IT) = ACMHE(IT-1)+(HMGPT(IT-1)+HMGPT(IT)-2.*ACMHE(IT-1))*FHR TOTG      139
             +/(FHR+2.)                                                 TOTG      140
  140         ACMN2(IT) = AMIN1((ACMN2(IT-1)+AMGRN2(2)-AMGRN2(1)),ANGT) TOTG      141
              IF (ACMHE(IT).GT.HMGPT(IT)) ACMHE(IT) = HMGPT(IT)         TOTG      142
              IF (ACMFG(IT).GT.AMGPT(IT)) ACMFG(IT) = AMGPT(IT)         TOTG      143
          130 CONTINUE                                                  TOTG      144
      C                                                                 TOTG      145
  145 C   CALCULATION OF TOTAL MOLES OF GAS IN GAP                       TOTG      146
      C                                                                 TOTG      147
              GASMOL = AIRIN+ARGIN+HEIN+FGIN+AN2IN+ACMFG(IT)+ACMHE(IT)+ACMN2(IT) TOTG      148
             ++ACMH2O(IT)                                               TOTG      149
      C                                                                 TOTG      150
  150 C   CALCULATION OF MOLE FRACTIONS OF GAP GASES                     TOTG      151
      C                                                                 TOTG      152
              AMFFG = (ACMFG(IT)+FGIN)/GASMOL                           TOTG      153
              AMFAIR = AIRIN/GASMOL                                     TOTG      154
              AMFN2 = (ACMN2(IT)+AN2IN)/GASMOL                          TOTG      155
  155         GASFR(1) = (ACMHE(IT)+HEIN)/GASMOL                        TOTG      156
              GASFR(2) = ARGIN/GASMOL                                   TOTG      157
              GASFR(7) = ACMH2O(IT)/GASMOL                              TOTG      158
              GASFR(3) = (0.15*ACMFG(IT)+KRYIN)/GASMOL                  TOTG      159
              GASFR(4) = (0.85*ACMFG(IT)+XEIN)/GASMOL                   TOTG      160
```

```
                      AAN = AMFAIR+AMFN2                                        TOTG  161
                      GASFR(5) = AMFH2                                          TOTG  162
                      GASFR(6) = AAN                                            TOTG  163
                      AMFHE = GASFR(1)                                          TOTG  164
                      AMFXE = GASFR(4)                                          TOTG  165
                      AMFKRY = GASFR(3)                                         TOTG  166
                C                                                               TOTG  167
                C     CALCULATION OF CUMULATIVE FRACTION RELEASES                TOTG  168
                C                                                               TOTG  169
                      IF (ABS(AMGPT(IT)).GT.0.E0) TFGFR = ACMFG(IT)/AMGPT(IT)   TOTG  170
                      IF (ABS(HMGPT(IT)).GT.0.E0) THEFR = ACMHE(IT)/HMGPT(IT)   TOTG  171
                      IF (ABS(ANGI).GT.0.E0) TN2FR = ACMN2(IT)/ANGI             TOTG  172
                      IF (ABS(H2OMI).GT.0.E0) TH2OFR = ACMH2O(IT)/H2OMI         TOTG  173
                C                                                               TOTG  174
                      RETURN                                                    TOTG  175
                      END                                                       TOTG  176
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	TOTGAS	1

DEF LINE: 174

VARIABLES

0	AAN	REAL		F.P.	REFS	162	DEFINED	1	160					
0	ACMFG	REAL	ARRAY	F.P.	REFS	20	2*132	134	135	142	147	152		
						158	159	169	DEFINED	1	120	132	134	
						135	142							
0	ACMHE	REAL	ARRAY	F.P.	REFS	20	2*138	141	147	155	170			
					DEFINED	1	121	138	141					
0	ACMH2O	REAL	ARRAY	F.P.	REFS	20	147	157	172	DEFINED	1			
0	ACMN2	REAL	ARRAY	F.P.	REFS	20	140	147	154	171				
					DEFINED	1	122	140						
0	AIRIN	REAL		F.P.	REFS	147	153	DEFINED	1					
504	AMFAIR	REAL			REFS	160	DEFINED	153						
0	AMFFG	REAL		F.P.	DEFINED	1	152							
0	AMFHE	REAL		F.P.	DEFINED	1	163							
0	AMFH2	REAL		F.P.	REFS	161	DEFINED	1						
0	AMFKRY	REAL		F.P.	DEFINED	1	165							
0	AMFN2	REAL		F.P.	REFS	160	DEFINED	1	154					
0	AMFXE	REAL		F.P.	DEFINED	1	164							
505	AMGP	REAL	ARRAY		REFS	20	110	114	118	2*124	4*130			
					DEFINED	92	103	110						
507	AMGPH	REAL	ARRAY		REFS	20	111	115	119	2*125	4*136			
					DEFINED	93	104	111						
0	AMGPT	REAL	ARRAY	F.P.	REFS	20	124	2*132	2*142	2*169				
					DEFINED	1	118	124						
511	AMGR	REAL	ARRAY		REFS	20	108	114	120	134	135			
					DEFINED	99	108							
513	AMGRH	REAL	ARRAY		REFS	20	109	115	121	DEFINED	100	109		

```
VARIABLES    SN  TYPE        RELOCATION
  515  AMGRN2     REAL        ARRAY          REFS      20      113      122     2*140   DEFINED      96      101
                                                    113
    0  ANG        REAL        ARRAY   F.P.   REFS      20      112   DEFINED       1
    0  ANGI       REAL                F.P.   REFS     140   2*171   DEFINED       1
    0  ANGR       REAL        ARRAY   F.P.   REFS      20      113   DEFINED       1
    0  ANGT       REAL                F.P.   REFS     112   DEFINED       1     102      112
    0  AN2IN      REAL                F.P.   REFS     147      154   DEFINED       1
    0  ARGIN      REAL                F.P.   REFS     147      156   DEFINED       1
    0  FGIN       REAL                F.P.   REFS     147      152   DEFINED       1
  502  FGR        REAL                       REFS   2*132   DEFINED       130
  503  FHR        REAL                       REFS   2*138   DEFINED       136
  517  FJJ        REAL        ARRAY          REFS      20    4*130   DEFINED      95      114
  521  FJJH       REAL        ARRAY          REFS      20    4*136   DEFINED      94      115
    0  FMGP       REAL        ARRAY   F.P.   REFS      20      110   DEFINED       1
    0  FMGR       REAL        ARRAY   F.P.   REFS      20      108   DEFINED       1
    0  GASFR      REAL        ARRAY   F.P.   REFS      20      163      164     165   DEFINED       1      155
                                                    156      157      158      159     161      162
    0  GASMOL     REAL                F.P.   REFS     152      153      154     155      156      157      158
                                                    159   DEFINED       1      147
    0  HEIN       REAL                F.P.   REFS     147      155   DEFINED       1
    0  HMGP       REAL        ARRAY   F.P.   REFS      20      111   DEFINED       1
    0  HMGPT      REAL        ARRAY   F.P.   REFS      20      125     2*138   2*141   2*170
                                             DEFINED       1      119      125
    0  HMGR       REAL        ARRAY   F.P.   REFS      20      109   DEFINED       1
    0  H2OMI      REAL                F.P.   REFS   2*172   DEFINED       1
  500  I          INTEGER                    REFS      99      100      101     103      104    3*108    3*109
                                             3*110   3*111    3*113    3*114   3*115   DEFINED      98
  476  IL         INTEGER                    REFS      97   DEFINED       89      90       91
    0  IRI        INTEGER             F.P.   REFS     105   DEFINED       1
    0  IT         INTEGER             F.P.   REFS      89     2*90       91      92       93       94       95
                                                     96       97       98     117     120      121      122    2*124
                                             2*125   5*132    2*134    2*135   5*138   2*140   4*141    4*142
                                             4*147     152      154      155     157      158      159    3*169
                                             3*170     171      172   DEFINED       1
  501  JJ         INTEGER                    REFS     108      109      110     111      112      113
                                             DEFINED   105
    0  KRYIN      REAL                F.P.   REFS       8      158   DEFINED       1
  477  LT         INTEGER                    REFS      98   DEFINED       97
    0  NDBG       INTEGER   *UNUSED  F.P.   DEFINED     1
    0  NGASR      INTEGER             F.P.   REFS     132      134      135   DEFINED       1
    0  NREAD      INTEGER             F.P.   REFS      91       92       93      94       95       96
                                             DEFINED     1
    0  N2         INTEGER             F.P.   REFS    6*20   DEFINED       1
    0  TFGFR      REAL                F.P.   DEFINED     1      169
    0  THEFR      REAL                F.P.   DEFINED     1      170
    0  TH2OFR     REAL                F.P.   DEFINED     1      172
    0  TN2FR      REAL                F.P.   DEFINED     1      171
    0  XEIN       REAL                F.P.   REFS      159   DEFINED       1

INLINE FUNCTIONS    TYPE    ARGS          DEF LINE  REFERENCES
       ABS         REAL       1  INTRIN              169      170      171      172
       AMINI       REAL       0  INTRIN              140
```

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	113	105
0	110	116	97
202	120	124	117
321	130	143	123

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
64	110	LT	97 116	71B	NOT INNER
105	100	JJ	105 113	37B	OPT

STATISTICS
PROGRAM LENGTH 537B 351
140000B SCM USED

```
      PROGRAM DRIVER (INPUT,OUTPUT,TAPE55=INPUT,TAPE6=OUTPUT,TAPE1=512,T UDRIVER     2
     +APE2=512,TAPE3=512,TAPE5=512,TAPE17=512,TAPE18=512,TAPE19=512,TAPE UDRIVER     3
     +20=512,TAPE21=512,TAPE22=512,TAPE25=512,TAPE30=512,TAPE44=512,TAPE UDRIVER     4
     +45=512,TAPE46=512,TAPE99=512)                                      UDRIVER     5
C                                                                        UDRIVER     6
C                                                                        UDRIVER     7
C                                                                        UDRIVER     8
C                                                                        UDRIVER     9
C                                                                        UDRIVER    10
C                                                                        UDRIVER    11
C     PROGRAM TO CALCULATE MEANS AND VARIANCES OF FRAPCON OUTPUTS GIVEN   UDRIVER    12
C     INPUT UNCERTAINTY DISTRIBUTIONS.  RESPONSE SURFACE METHOD          UDRIVER    13
C     IS USED TO OBTAIN RESULTS.                                         UDRIVER    14
C                                                                        UDRIVER    15
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),        DESNBL     2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,      DESNBL     3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES      DESNBL     4
     + ,IUNCRT                                                           DESNBL     5
      LEVEL 2,FACTOR                                                     DESNBL     6
      DIMENSION C1(4,4,15),C2(4,4,29)                                    UDRIVER    17
      DIMENSION C3(4,4,40)                                               UDRIVER    18
      DIMENSION  LSTCDC(6)                                               UDRIVER    19
      DATA  LSTCDC /0,0,0,7777,0,20/                                     UDRIVER    20
      DATA ALPHA/100*0./                                                 UDRIVER    21
      DATA ((AMU(I,J),I=1,4),J=1,100)/100*(0.,1.,0.,3.)/                 UDRIVER    22
      DATA C3 /640*0./                                                   UDRIVER    23
      DATA FACTOR     /1.,0.,1.,0.,0.,0.,0.,0.,0.,0.,                    UDRIVER    24
     +                 0.,0.,0.,0.,0.,1.,1.,1.,1.,0.,                    UDRIVER    25
     +                 0.,0.,0.,0.,0.,0.,1.,1.,0.,1.,                    UDRIVER    26
     +                 1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,                    UDRIVER    27
     +                 1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,                    UDRIVER    28
     +  50*1./                                                           UDRIVER    29
      DATA TL        /  500.0000, 3000.0000,    0.0000,    0.0000,      UDRIVER    30
     +  8*0.,                                                           UDRIVER    31
     +                 500.0000,    0.0000,    0.0000,    0.0000,      UDRIVER    32
     +               32*0.,                                            UDRIVER    33
     +                 300.0000, 1090.0000, 1300.0000,    0.0000,      UDRIVER    34
     +               12*0.,                                            UDRIVER    35
     +                1073.0000,    0.0000,    0.0000,    0.0000,      UDRIVER    36
     +                1073.0000,    0.0000,    0.0000,    0.0000,      UDRIVER    37
     +                1083.0000,    0.0000,    0.0000,    0.0000,      UDRIVER    38
     +                   0.0000,    0.0000,    0.0000,    0.0000,      UDRIVER    39
     +                 800.0000, 1090.0000, 1170.0000,    0.0000,      UDRIVER    40
     +  316*0./                                                          UDRIVER    41
      DATA C         /  .20000E-01, 0.          , 0.          , 0.     , UDRIVER    42
     +                  .12000E-01,  .16000E-04, 0.          , 0.     , UDRIVER    43
     +                  .60000E-01, 0.          , 0.          , 0.,4*0. , UDRIVER    44
     +                  .40000E+00, 0.          , 0.          , 0.,12*0., UDRIVER    45
     +                  .10000E+00, 0.          , 0.          , 0.,12*0., UDRIVER    46
     +                0.          ,  .25000E-05, 0.          , 0.     , UDRIVER    47
     +                  .12500E-02, 0.          , 0.          , 0.,8*0. , UDRIVER    48
     +                  .37000E+10, 0.          , 0.          , 0.,12*0., UDRIVER    49
     +                  .94000E-01, 0.          , 0.          ,0.,108*0., UDRIVER    50
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     +                .10000E+02, 0.          , 0.          , 0.          , UDRIVER    51
55   +                .25000E+02, 0.          , 0.          , 0.          , UDRIVER    52
     +                .10000E+03, 0.          , 0.          , 0.,4*0.     , UDRIVER    53
     +                .10100E+01, 0.          , 0.          , 0.,12*0.,   UDRIVER    54
     +                .10000E+00, 0.          , 0.          , 0. ,12*0,   UDRIVER    55
     +                .20000E+00, 0.          , 0.          , 0.,12*0./   UDRIVER    56
60    DATA C1 /       .20000E+00, 0.          , 0.          , 0.          , UDRIVER    57
     +                .50000E+00, 0.          , 0.          , 0.,8*0.     , UDRIVER    58
     +                .10000E+00, 0.          , 0.          , 0.,         UDRIVER    59
     +                .50000E+00, 0.          , 0.          , 0.,8*0.     , UDRIVER    60
     +                .10000E+00, 0.          , 0.          , 0.          , UDRIVER    61
65   +                .20000E+00, 0.          , 0.          , 0.,8*0.     , UDRIVER    62
     +                .29000E+08, 0.          , 0.          , 0.,12*0.,   UDRIVER    63
     +                .80000E-01, 0.          , 0.          , 0.          , UDRIVER    64
     +               -.91000E+00,  .12500E-02, 0.          , 0.          , UDRIVER    65
     +                .49400E+01, -.41250E-02, 0.          , 0.          , UDRIVER    66
70   +                .11000E+00, 0.          , 0.          , 0.,32*0.,   UDRIVER    67
     +               9.0E+9,0.,0.,0.,28*0.,                                 UDRIVER    68
     +               -0.00068,1.61E-5,0.,0.,12*0.,                          UDRIVER    69
     +               .05,0.,0.,0.,12*0.,                                    UDRIVER    70
     +                .25000E+00, 0.          , 0.          , 0.,12*0.,   UDRIVER    71
75   +                .10000E+02, 0.          , 0.          , 0.,12*0.,   UDRIVER    72
     +                .10000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    73
     +                .10000E 02, 0.          , 0.          , 0.,12*0./   UDRIVER    74
      DATA C2 /       .67000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    75
     +                .34000E-01, 0.          , 0.          , 0. ,12*0,   UDRIVER    76
80   +                .34000E-01, 0.          , 0.          , 0.,12*0.,   UDRIVER    77
     +                .10000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    78
     +                .34000E-01, 0.          , 0.          , 0.,12*0.,   UDRIVER    79
     +                .10000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    80
     +                .10000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    81
85   +                .10000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    82
     +                .10000E+00, 0.          , 0.          , 0.,12*0.,   UDRIVER    83
     +                .10000E+00, 0.          , 0.          , 0.,12*0.,   UDRIVER    84
     +                .34000E-01, 0.          , 0.          , 0.,12*0.,   UDRIVER    85
     +                .10000E-02, 0.          , 0.          , 0.,12*0.,   UDRIVER    86
90   +                .34000E-01, 0.          , 0.          , 0.,60*0.,   UDRIVER    87
     +                .50000E-01, 0.          , 0.          , 0.,12*0.,   UDRIVER    88
     +                .67000E-01, 0.          , 0.          , 0.,28*0.,   UDRIVER    89
     +                .80000E-01, 0.          , 0.          ,0.,156*0./   UDRIVER    90
          C                                                                 UDRIVER    91
95        CALL SYSTEMC (115,LSTCDC)                                        UDRIVER    92
          C                                                                 UDRIVER    93
               DO 100 I=1,4                                                 UDRIVER    94
                  DO 100 J=1,4                                              UDRIVER    95
                     DO 100 K=17,31                                         UDRIVER    96
100       100          C(I,J,K) = C1(I,J,K-16)                             UDRIVER    97
               DO 110 I=1,4                                                 UDRIVER    98
                  DO 110 J=1,4                                              UDRIVER    99
                     DO 110 K=32,60                                         UDRIVER   100
          110        C(I,J,K) = C2(I,J,K-31)                               UDRIVER   101
105            DO 120 I=1,4                                                 UDRIVER   102
                  DO 120 J=1,4                                              UDRIVER   103
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                      DO 120 K=61,100                                          UDRIVER   104
            120       C(I,J,K) = C3(I,J,K-60)                                  UDRIVER   105
                      C                                                        UDRIVER   106
110                   C   THE ABOVE DATA CONSTITUTES THE DEFAULT UNCERTAINTY FACTORS AND WAS  UDRIVER   107
                      C   OF NECCESITY STORED IN A ROOT SEGMENT                UDRIVER   108
                      C                                                        UDRIVER   109
                      C   IUNCRT IS THE FLAG FOR AN UNCERTAINTY ANALYSIS.  THE LOGIC  UDRIVER   110
                      C   AND PROGRAM FLOW FOR AN UNCERTAINTY ANALYSIS IS CONTAINED ENTIRELY  UDRIVER   111
115                   C   IN DRIVER AND SUBROUTINE RUNFRP.                     UDRIVER   112
                      C                                                        UDRIVER   113
                        READ (55,160) IUNCRT                                   UDRIVER   114
                        IF (IUNCRT.EQ.1) GO TO 130                             UDRIVER   115
                        CALL ECHOI (55,6,5)                                    UDRIVER   116
120                     CALL FRPCON (IAXSYM)                                   UDRIVER   117
                        IF (IAXSYM.EQ.1) CALL AXDRIV                           UDRIVER   118
                        GO TO 150                                              UDRIVER   119
            130         CALL ECHOI (55,6,99)                                   UDRIVER   120
                        CALL READIN                                            UDRIVER   121
125                     CALL ECHOI (99,6,5)                                    UDRIVER   122
                        CALL DESIGN                                            UDRIVER   123
                        CALL RUNFRP                                            UDRIVER   124
                        REWIND 99                                              UDRIVER   125
                        CALL READIN                                            UDRIVER   126
130                     CALL ECHOI (99,6,5)                                    UDRIVER   127
                        CALL DESIGN                                            UDRIVER   128
                            DO 140 K=1,100                                     UDRIVER   129
                        140 ALPHA(K) = 0.                                      UDRIVER   130
                        ICOUNT = 0                                             UDRIVER   131
135                     CALL FRPCON (IAXSYM)                                   UDRIVER   132
                        IF (IFLAG.EQ.1) GO TO 150                              UDRIVER   133
                        CALL NAMES                                             UDRIVER   134
                        CALL ANSWER                                            UDRIVER   135
                        150 CONTINUE                                           UDRIVER   136
140                     STOP                                                   UDRIVER   137
                        C                                                      UDRIVER   138
                        160 FORMAT (I5)                                        UDRIVER   139
                        END                                                    UDRIVER   140
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CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
23	1	DESNBL	NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.
45	1	C	DATA VARIABLE LIST EXCEEDS ITEM LIST, EXCESS VARIABLES NOT INITIALIZED.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
25462 DRIVER 1

VARIABLES	SN	TYPE	RELOCATION										
10464	ALPHA	REAL	ARRAY	DESNBL	REFS	15	DEFINED	24	133				
4542	AMU	REAL	ARRAY	DESNBL	REFS	15	DEFINED	25					
144	C	REAL	ARRAY	DESNBL	REFS	15	DEFINED	45	100	104	108		
25706	C1	REAL	ARRAY		REFS	20	100	DEFINED	60				
26266	C2	REAL	ARRAY		REFS	20	104	DEFINED	78				
27206	C3	REAL	ARRAY		REFS	21	108	DEFINED	26				
5362	D	REAL	ARRAY	DESNBL	REFS	15							
0	FACTOR	REAL	ARRAY	DESNBL	REFS	15	13	DEFINED	27				
25702	I	INTEGER			REFS	2*100	2*104	2*108	DEFINED	97	101	105	
25705	IAXSYM	INTEGER			REFS	120	121	135					
10631	ICON	INTEGER	ARRAY	DESNBL	REFS	15							
11173	ICOUNT	INTEGER		DESNBL	REFS	15	DEFINED	134					
11172	IFLAG	INTEGER		DESNBL	REFS	15	136						
10630	IPRINT	INTEGER		DESNBL	REFS	15							
11175	ISTART	INTEGER		DESNBL	REFS	15							
11177	IUNCRT	INTEGER		DESNBL	REFS	15	118	DEFINED	117				
25703	J	INTEGER			REFS	2*100	2*104	2*108	DEFINED	98	102	106	
25704	K	INTEGER			REFS	2*100	2*104	2*108	133	DEFINED	99	103	
					107	132							
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	15							
4541	LPB	INTEGER		DESNBL	REFS	15							
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	15							
30406	LSTCDC	INTEGER	ARRAY		REFS	22	95	DEFINED	23				
4540	LTYPE	INTEGER		DESNBL	REFS	15							
10463	NFAC	INTEGER		DESNBL	REFS	15							
7230	NODE	INTEGER	ARRAY	DESNBL	REFS	15							
11176	NRES	INTEGER		DESNBL	REFS	15							
10462	NRUN	INTEGER		DESNBL	REFS	15							
11174	NTIME	INTEGER		DESNBL	REFS	15							
3244	TL	REAL	ARRAY	DESNBL	REFS	15	DEFINED	33					

FILE NAMES	MODE
0	INPUT
2054	OUTPUT
4130	TAPE1
10410	TAPE17
11464	TAPE18
12540	TAPE19
5204	TAPE2
13614	TAPE20
14670	TAPE21
15744	TAPE22
17020	TAPE25
6260	TAPE3
20074	TAPE30
21150	TAPE44
22224	TAPE45
23300	TAPE46
7334	TAPE5

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FILE NAMES          MODE
    0   TAPE55      FMT                    READS      117
 2054   TAPE6
24354   TAPE99                             MOTION     128

EXTERNALS           TYPE    ARGS       REFERENCES
        ANSWER                 0          138
        AXDRIV                 0          121
        DESIGN                 0          126        131
        ECHO1                  3          119        123        125        130
        FRPCON                 1          120        135
        NAMES                  0          137
        READIN                 0          124        129
        RUNFRP                 0          127
        SYSTEMC                2           95

STATEMENT LABELS                 DEF LINE   REFERENCES
    0   100                         100        97         98         99
    0   110                         104       101        102        103
    0   120                         108       105        106        107
25575   130                         123       118
    0   140                         133       132
25641   150                         139       122        136
25672   160     FMT                 142       117

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
25467   100       I          97 100      21B                NOT INNER
25471   100       J          98 100      14B                NOT INNER
25473   100       K          99 100       7B     INSTACK
25512   110       I         101 104      21B                NOT INNER
25514   110       J         102 104      14B                NOT INNER
25516   110       K         103 104       7B     INSTACK
25535   120       I         105 108      21B                NOT INNER
25537   120       J         106 108      14B                NOT INNER
25541   120       K         107 108       7B     INSTACK
25621   140       K         132 133       4B     INSTACK

COMMON BLOCKS    LENGTH
        DESNBL     4736 LCM

STATISTICS
  PROGRAM LENGTH                  4450B    2344
  BUFFER LENGTH                  23744B   10212
  LCM LABELED COMMON LENGTH      11200B    4736
        140000B SCM USED
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      SUBROUTINE READIN                                                      UREADIN     2
C                                                                            UREADIN     3
C     SUBROUTINE STORES DEFAULT UNCERTAINTY VALUES AND READS IN NEW VALUES   UREADIN     4
C     AND OTHER INPUT DATA VIA NAMELIST INPUT.                               UREADIN     5
C     THIS SUBROUTINE IS CALLED FROM DRIVER                                  UREADIN     6
C                                                                            UREADIN     7
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),            DESNBL      2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,          DESNBL      3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES          DESNBL      4
     + ,IUNCRT                                                               DESNBL      5
      LEVEL 2,FACTOR                                                         DESNBL      6
      DIMENSION NAM(4,100),LAM(2)                                            UREADIN     9
C     SUBROUTINE READS IN DATA IN NAMELIST FORMAT                            UREADIN    10
C     NAMELIST IS "IN"                                                       UREADIN    11
      NAMELIST /IN/ FACTOR,C,TL,LRES, NODE,LFAC,LTYPE,LPB,AMU,IPRINT         UREADIN    12
     +,IFLAG,ISTART                                                          UREADIN    13
      DATA LAM/7HFACTOR(,5H) IS /                                            UREADIN    14
      DATA NAM(1, 1)/40HFUEL SPECIFIC HEAT                          /        UREADIN    15
      DATA NAM(1, 2)/40HFUEL THERMAL CONDUCTIVITY                   /        UREADIN    16
      DATA NAM(1, 3)/40HFUEL EMISSIVITY                             /        UREADIN    17
      DATA NAM(1, 4)/40HFUEL THERMAL EXPANSION                      /        UREADIN    18
      DATA NAM(1, 5)/40HFUEL ELASTIC MODULUS                        /        UREADIN    19
      DATA NAM(1, 6)/40HFUEL POISSON'S RATIO                        /        UREADIN    20
      DATA NAM(1, 7)/40HFUEL CREEP                                  /        UREADIN    21
      DATA NAM(1, 8)/40HFUEL FRACTURE STRENGTH                      /        UREADIN    22
      DATA NAM(1, 9)/40HFUEL SWELLING                               /        UREADIN    23
      DATA NAM(1,10)/40HFUEL RESTRUCTURING                          /        UREADIN    24
      DATA NAM(1,11)/40HFUEL DENSIFICATION                          /        UREADIN    25
      DATA NAM(1,12)/40HFISSION GAS RELEASE                         /        UREADIN    26
      DATA NAM(1,13)/40HCLADDING SPECIFIC HEAT                      /        UREADIN    27
      DATA NAM(1,14)/40HCLADDING THERMAL CONDUCTUVUTY               /        UREADIN    28
      DATA NAM(1,15)/40HZIRC OXIDE EMISSIVITY                       /        UREADIN    29
      DATA NAM(1,16)/40HZIRC OXIDE THERMAL CONDUCTIVITY             /        UREADIN    30
      DATA NAM(1,17)/40HCLADDING AXIAL THERMAL EXPANSION            /        UREADIN    31
      DATA NAM(1,18)/40HCLADDING DIAMETRAL THERMAL EXPANSION        /        UREADIN    32
      DATA NAM(1,19)/40HCLADDING ELASTIC MODULUS                    /        UREADIN    33
      DATA NAM(1,20)/40HCLADDING STRENGTH COEFFICIENT               /        UREADIN    34
      DATA NAM(1,21)/40HCLADDING CIRC. RUPTURE STRAIN               /        UREADIN    35
      DATA NAM(1,22)/40HCLADDING MEYER HARDNESS                     /        UREADIN    36
      DATA NAM(1,23)/40HCLADDING CREEP RATE                         /        UREADIN    37
      DATA NAM(1,24)/40HCLADDING POISSON'S RATIO                    /        UREADIN    38
      DATA NAM(1,25)/40HCLADDING OXIDATION                          /        UREADIN    39
      DATA NAM(1,26)/40HGAS THERMAL CONDUCTIVITY                    /        UREADIN    40
      DATA NAM(1,27)/40HGAS VISCOSITY                               /        UREADIN    41
      DATA NAM(1,28)/40HGAP HEAT TRANSFER                           /        UREADIN    42
      DATA NAM(1,29)/40HALPHA - BETA TRANSITION TEMPERATURE         /        UREADIN    43
      DATA NAM(1,30)/40HPELLET STACK HEIGHT                         /        UREADIN    44
      DATA NAM(1,31)/40HCLADDING OUTER DIAMETER                     /        UREADIN    45
      DATA NAM(1,32)/40HFUEL DENSITY                                /        UREADIN    46
      DATA NAM(1,33)/40HPELLET SHOULDER RADIUS                      /        UREADIN    47
      DATA NAM(1,34)/40HPELLET DISH DEPTH                           /        UREADIN    48
      DATA NAM(1,35)/40HPELLET HEIGHT                               /        UREADIN    49
      DATA NAM(1,36)/40HPELLET DISH VOLUME                          /        UREADIN    50
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      DATA NAM(1,37)/40HPELLET OUTER RADIUS                          /  UREADIN   51
      DATA NAM(1,38)/40HCLADDING INNER RADIUS                        /  UREADIN   52
      DATA NAM(1,39)/40HCLADDING OUTER RADIUS                        /  UREADIN   53
      DATA NAM(1,40)/40HCLADDING ROUGHNESS                           /  UREADIN   54
      DATA NAM(1,41)/40HFUEL ROUGHNESS                               /  UREADIN   55
      DATA NAM(1,42)/40HAMOUNT OF GAS IN ROD                         /  UREADIN   56
      DATA NAM(1,43)/40HPLENUM VOLUME                                /  UREADIN   57
      DATA NAM(1,44)/40HCOLD PRESSURE                                /  UREADIN   58
      DATA NAM(1,45)/40HMOLE FRACTIONS OF GAS COMPONENTS             /  UREADIN   59
      DATA NAM(1,46)/40HNORMALLY NOT USED                            /  UREADIN   60
      DATA NAM(1,47)/40HINITIAL TEMPERATURE ESTIMATE                 /  UREADIN   61
      DATA NAM(1,48)/40HPOWER HISTORY                                /  UREADIN   62
      DATA NAM(1,49)/40HANS DECAY HEAT CURVE                         /  UREADIN   63
      DATA NAM(1,50)/40HNORMALLY NOT USED                            /  UREADIN   64
      DATA NAM(1,51)/40HCHF FACTOR                                   /  UREADIN   65
      DATA NAM(1,52)/40HNORMALLY NOT USED                            /  UREADIN   66
      DATA NAM(1,53)/40HNORMALLY NOT USED                            /  UREADIN   67
      DATA NAM(1,54)/40HNORMALLY NOT USED                            /  UREADIN   68
      DATA NAM(1,55)/40HNORMALLY NOT USED                            /  UREADIN   69
      DATA NAM(1,56)/40HNORMALLY NOT USED                            /  UREADIN   70
      DATA NAM(1,57)/40HNORMALLY NOT USED                            /  UREADIN   71
      DATA NAM(1,58)/40HNORMALLY NOT USED                            /  UREADIN   72
      DATA NAM(1,59)/40HNORMALLY NOT USED                            /  UREADIN   73
      DATA NAM(1,60)/40HNORMALLY NOT USED                            /  UREADIN   74
      DATA NAM(1,61)/40HPLENUM LENGTH                                /  UREADIN   75
      DATA NAM(1,62)/40HEQUIVALENT HEATED DIAMETER                   /  UREADIN   76
      DATA NAM(1,63)/40HDIAMETER OF SPRING, OUTSIDE                  /  UREADIN   77
      DATA NAM(1,64)/40HDIAMETER OF SPRING WIRE                      /  UREADIN   78
      DATA NAM(1,65)/40HFUEL ENRICHMENT                              /  UREADIN   79
      DATA NAM(1,66)/40HMASS FLOW RATE                               /  UREADIN   80
      DATA NAM(1,67)/40HSYSTEM PRESSURE                              /  UREADIN   81
      DATA NAM(1,68)/40HAXIAL HEAT NORMALIZATION FACTORS             /  UREADIN   82
      DATA NAM(1,69)/40HFUEL STACK HEIGHT                            /  UREADIN   83
      DATA NAM(1,70)/40HINLET WATER TEMPERATURE                      /  UREADIN   84
      DATA NAM(1,71)/40HTOTAL SPRING TURNS                           /  UREADIN   85
      DATA NAM(1,72)/40HINITIAL FUEL BURNUP                          /  UREADIN   86
      DATA NAM(1,73)/40HTEXTURE FACTOR                               /  UREADIN   87
      DATA NAM(1,74)/40HCOLD WORK                                    /  UREADIN   88
      DATA NAM(1,75)/40HWEIGHT PERCENT PUO2                          /  UREADIN   89
      DATA NAM(1,76)/40HINITIAL CRUD THICKNESS                       /  UREADIN   90
      DATA NAM(1,77)/40HCRUD BUILDUP RATE                            /  UREADIN   91
      DATA NAM(1,78)/40HPOROSITY CORRECTION                          /  UREADIN   92
      DATA NAM(1,79)/40HFAST NEUTRON FLUX                            /  UREADIN   93
      DATA NAM(1,80)/40HINITIAL GRAIN SIZE                           /  UREADIN   94
      DATA NAM(1,81)/40HFUEL INITIAL WATER CONTENT                   /  UREADIN   95
      DATA NAM(1,82)/40HFUEL INITIAL NITROGEN CONTENT                /  UREADIN   96
      DATA NAM(1,83)/40HNORM. HEAT FLUX AT TOP OF FUEL STACK         /  UREADIN   97
      DATA NAM(1,84)/40HPELLET CORE RADIUS                           /  UREADIN   98
      DATA NAM(1,85)/40HFISSION GAS ATOMS PER 100 FISSIONS           /  UREADIN   99
      DATA NAM(1,86)/40HFUEL SINTERING TEMPERATURE                   /  UREADIN  100
      DATA NAM(1,87)/40HCLADDING OXIDE FAILURE CRITERION             /  UREADIN  101
      DATA NAM(1,88)/40HNORMALLY NOT USED                            /  UREADIN  102
      DATA NAM(1,89)/40HNORMALLY NOT USED                            /  UREADIN  103
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                DATA NAM(1,90)/40HNORMALLY NOT USED                                 /      UREADIN  104
                DATA NAM(1,91)/40HNORMALLY NOT USED                                 /      UREADIN  105
                DATA NAM(1,92)/40HNORMALLY NOT USED                                 /      UREADIN  106
110             DATA NAM(1,93)/40HNORMALLY NOT USED                                 /      UREADIN  107
                DATA NAM(1,94)/40HNORMALLY NOT USED                                 /      UREADIN  108
                DATA NAM(1,95)/40HNORMALLY NOT USED                                 /      UREADIN  109
                DATA NAM(1,96)/40HNORMALLY NOT USED                                 /      UREADIN  110
                DATA NAM(1,97)/40HNORMALLY NOT USED                                 /      UREADIN  111
115             DATA NAM(1,98)/40HNORMALLY NOT USED                                 /      UREADIN  112
                DATA NAM(1,99)/40HNORMALLY NOT USED                                 /      UREADIN  113
                DATA NAM(1,100)/40HNORMALLY NOT USED                                 /     UREADIN  114
                    DO 100 I=1,100                                                         UREADIN  115
            100     LFAC(I) = 0                                                            UREADIN  116
120                 DO 110 I=1,100                                                         UREADIN  117
                    LRES(I) = 0                                                            UREADIN  118
            110     NODE(I) = 1                                                            UREADIN  119
                LTYPE = 1                                                                  UREADIN  120
                LPB = 0                                                                    UREADIN  121
125             IPRINT = 0                                                                 UREADIN  122
                IFLAG = 0                                                                  UREADIN  123
                ISTART = 0                                                                 UREADIN  124
                READ (99,IN)                                                               UREADIN  125
                WRITE (6,IN)                                                               UREADIN  126
130             K = 1                                                                      UREADIN  127
                    DO 120 I=1,100                                                         UREADIN  128
                    IF (LFAC(I).GT.0) WRITE (6,130) LAM(1),K,LAM(2),(NAM(J,LFAC(I)     UREADIN  129
               +    ),J=1,4)                                                               UREADIN  130
            120     IF (LFAC(I).GT.0) K = K+1                                              UREADIN  131
135             RETURN                                                                     UREADIN  132
            C                                                                              UREADIN  133
            130 FORMAT (1H ,A7,I2,A5,4A10)                                                 UREADIN  134
                END                                                                        UREADIN  135
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CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
15	1	DESNBL	NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.
18	1	FUEL SPE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
19	1	FUEL THE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
20	1	FUEL EMI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
21	1	FUEL THE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
22	1	FUEL ELA	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
23	1	FUEL POI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
24	1	FUEL CRE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
25	1	FUEL FRA	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
26	1	FUEL SWE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
27	1	FUEL RES	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
28	1	FUEL DEN	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
29	1	FISSION	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
30	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
31	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
32	1	ZIRC OXI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
33	1	ZIRC OXI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
34	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
35	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
36	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
37	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
38	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
39	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
40	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
41	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
42	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
43	1	GAS THER	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
44	1	GAS VISC	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
45	1	GAP HEAT	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
46	1	ALPHA -	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
47	1	PELLET S	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
48	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
49	1	FUEL DEN	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
50	1	PELLET S	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
51	1	PELLET D	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
52	1	PELLET H	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
53	1	PELLET D	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
54	1	PELLET O	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
55	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
56	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
57	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
58	1	FUEL ROU	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
59	1	AMOUNT O	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
60	1	PLENUM V	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
61	1	COLD PRE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
62	1	MOLE FRA	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
63	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
64	1	INITIAL	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
65	1	POWER HI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
66	1	ANS DECA	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
67	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
68	1	CHF FACT	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
69	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
70	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
71	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
72	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
73	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
74	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
75	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
76	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
77	1	NORMALLY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
78	1	PLENUM L	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
79	1	EQUIVALE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
80	1	DIAMETER	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
81	1	DIAMETER	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
82	1	FUEL ENR	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
83	1	MASS FLO	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
84	1	SYSTEM P	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
85	1	AXIAL HE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
86	1	FUEL STA	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
87	1	INLET WA	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
88	1	TOTAL SP	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
89	1	INITIAL	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
90	1	TEXTURE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
91	1	COLD WOR	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
92	1	WEIGHT P	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
93	1	INITIAL	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
94	1	CRUD BUI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
95	1	POROSITY	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
96	1	FAST NEU	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
97	1	INITIAL	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
98	1	FUEL INI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
99	1	FUEL INI	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
100	1	NORM. HE	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
101	1	PELLET C	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
102	1	FISSION	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
103	1	FUEL SIN	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
104	1	CLADDING	HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
105	1		*** DUE TO THE MANY ERRORS NOTED, ONLY THOSE WHICH ARE FATAL WILL BE LISTED HEREAFTER.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
2	READIN	1	135

VARIABLES	SN	TYPE		RELOCATION								
10464	ALPHA	REAL	ARRAY	DESNBL	REFS	7						
4542	AMU	REAL	ARRAY	DESNBL	REFS	7	15					
144	C	REAL	ARRAY	DESNBL	REFS	7	15					
5362	D	REAL	ARRAY	DESNBL	REFS	7						
0	FACTOR	REAL	ARRAY	DESNBL	REFS	7	11	15				
155	I	INTEGER			REFS	119	121	122	2*132	134		
					DEFINED	118	120	131				
10631	ICON	INTEGER	ARRAY	DESNBL	REFS	7						
11173	ICOUNT	INTEGER		DESNBL	REFS	7						
11172	IFLAG	INTEGER		DESNBL	REFS	7	15	DEFINED	126			
10630	IPRINT	INTEGER		DESNBL	REFS	7	15	DEFINED	125			
11175	ISTART	INTEGER		DESNBL	REFS	7	15	DEFINED	127			
11177	IUNCRT	INTEGER		DESNBL	REFS	7						
157	J	INTEGER			REFS	132	DEFINED	132				
156	K	INTEGER			REFS	132	134	DEFINED	130	134		
1000	LAM	INTEGER	ARRAY		REFS	12	2*132	DEFINED	17			
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	7	15	2*132	134	DEFINED	119	
4541	LPB	INTEGER		DESNBL	REFS	7	15	DEFINED	124			
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	7	15	DEFINED	121			
4540	LTYPE	INTEGER		DESNBL	REFS	7	15	DEFINED	123			
160	NAM	INTEGER	ARRAY		REFS	12	132	DEFINED	18	19	20	21

```
VARIABLES     SN  TYPE          RELOCATION
                                                  22    23    24    25    26    27    28    29
                                                  30    31    32    33    34    35    36    37
                                                  38    39    40    41    42    43    44    45
                                                  46    47    48    49    50    51    52    53
                                                  54    55    56    57    58    59    60    61
                                                  62    63    64    65    66    67    68    69
                                                  70    71    72    73    74    75    76    77
                                                  78    79    80    81    82    83    84    85
                                                  86    87    88    89    90    91    92    93
                                                  94    95    96    97    98    99   100   101
                                                 102   103   104   105   106   107   108   109
                                                 110   111   112   113   114   115   116   117
10463  NFAC       INTEGER          DESNBL       REFS     7
 4230  NODE       INTEGER    ARRAY DESNBL       REFS     7    15    DEFINED   122
11176  NRES       INTEGER          DESNBL       REFS     7
10462  NRUN       INTEGER          DESNBL       REFS     7
11174  NTIME      INTEGER          DESNBL       REFS     7
 3244  TL         REAL       ARRAY DESNBL       REFS     7    15

FILE NAMES      MODE
      TAPE6     MIXED                WRITES     129   132
      TAPE99    NAME                  READS     128

NAMELISTS       DEF LINE    REFERENCES
      IN              15     128     129

STATEMENT LABELS          DEF LINE   REFERENCES
    0  100                   119        118
    0  110                   122        120
    0  120                   134        131
  152  130     FMT           137        132

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
    5  100      I          118 119      4B      INSTACK
   13  110      I          120 122      6B      INSTACK
   43  120      I          131 134     31B                EXT REFS  NOT INNER
   51           J          132 132     11B                EXT REFS

COMMON BLOCKS   LENGTH
      DESNBL      4736 LCM

STATISTICS
  PROGRAM LENGTH                1002B     514
  LCM LABELED COMMON LENGTH     11200B    4736
        140000B SCM USED
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      SUBROUTINE DESIGN                                                  UDESIGN     2
C                                                                        UDESIGN     3
C   SUBROUTINE DETERMINES EXPERIMENTAL DESIGN MATRIX AND CONFOUNDING     UDESIGN     4
C   ARRAY (IF NECESSARY)  FOR USER INPUT LIST OF FACTORS (LFAC) AND TYPE UDESIGN     5
C   RESPONSE EQUATION DESIRED(LTYPE).                                    UDESIGN     6
C   THIS SUBROUTINE IS CALLED FROM DRIVER                                UDESIGN     7
C                                                                        UDESIGN     8
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),        DESNBL      2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,      DESNBL      3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES      DESNBL      4
     + ,IUNCRT                                                           DESNBL      5
      LEVEL 2,FACTOR                                                     DESNBL      6
      DIMENSION IGEN(40,12),I1(12),I2(12),ID(12),IDOLD(12),IDR(12)       UDESIGN    10
      DIMENSION ISTORE(12)                                               UDESIGN    11
      DIMENSION IAL(12)                                                  UDESIGN    12
      DIMENSION PB12(11),PB20(19),NAM(5)                                 UDESIGN    13
      DATA NAM /2HF(,2H)=,1H),3H)F(,4H****/                              UDESIGN    14
      DATA (ID(LL),LL=1,12)   /1,2,0,0,0,0,0,0,0,0,0,0/                  UDESIGN    15
      DATA PB12/1.,1.,-1.,1.,1.,1.,-1.,-1.,-1.,1.,-1./                   UDESIGN    16
      DATA PB20/1.,1.,-1.,-1.,1.,1.,1.,1.,-1.,1.,-1.,1.,-1.,-1.,-1.,-1., UDESIGN    17
     +1.,1.,-1. /                                                        UDESIGN    18
          DO 100 I=1,12                                                  UDESIGN    19
              DO 100 J=1,40                                              UDESIGN    20
  100         IGEN(J,I) = 0                                              UDESIGN    21
C                                                                        UDESIGN    22
C   NUMBER OF FACTORS                                                    UDESIGN    23
C                                                                        UDESIGN    24
      ISUM = 0                                                           UDESIGN    25
          DO 110 I=1,60                                                  UDESIGN    26
  110     IF (LFAC(I).GT.0) ISUM = ISUM+1                                UDESIGN    27
      NFAC = ISUM                                                        UDESIGN    28
      IF (NFAC.GT.15) LTYPE = 1                                          UDESIGN    29
C                                                                        UDESIGN    30
C   NECESSARY NUMBER OF RUNS                                             UDESIGN    31
C                                                                        UDESIGN    32
          DO 120 I=1,6                                                   UDESIGN    33
          IF (NFAC.LT.2**I) GO TO 130                                    UDESIGN    34
  120     CONTINUE                                                       UDESIGN    35
  130 NRUN = 2**I                                                        UDESIGN    36
      IEXP = I                                                           UDESIGN    37
      IP = NFAC-IEXP                                                     UDESIGN    38
C                                                                        UDESIGN    39
C   BRANCH HERE FOR PLACKETT BURMAN                                      UDESIGN    40
C                                                                        UDESIGN    41
      IF (LPB.EQ.1) GO TO 230                                            UDESIGN    42
C                                                                        UDESIGN    43
C   DETERMINE INITIAL PART OF TWO LEVEL DESIGN                           UDESIGN    44
C                                                                        UDESIGN    45
          DO 160 J=1,IEXP                                                UDESIGN    46
          I = 1                                                          UDESIGN    47
          JEXP = 2**(IEXP-J)                                             UDESIGN    48
          JMI = 2**(J-1)                                                 UDESIGN    49
              DO 160 L=1,JEXP                                            UDESIGN    50
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                      DO 140 K=1,JM1                                                    UDESIGN    51
55                    D(I,J) = 1.                                                       UDESIGN    52
          140         I = I+1                                                           UDESIGN    53
                      DO 150 K=1,JM1                                                    UDESIGN    54
                      D(I,J) = -1.                                                      UDESIGN    55
          150         I = I+1                                                           UDESIGN    56
60        160       CONTINUE                                                          UDESIGN    57
                    C                                                                 UDESIGN    58
                    C   COMPLETE BALANCE OF DESIGN                                    UDESIGN    59
                    C                                                                 UDESIGN    60
                      IF (IEXP.GE.NFAC) GO TO 370                                     UDESIGN    61
65                    IF (IPRINT.EQ.1) WRITE (6,840)                                  UDESIGN    62
                      NEWJ = IEXP+1                                                   UDESIGN    63
                      IM1 = IEXP-1                                                    UDESIGN    64
                      IM2 = IEXP-2                                                    UDESIGN    65
                      IM3 = IEXP-3                                                    UDESIGN    66
70                        DO 180 J=1,IM1                                              UDESIGN    67
                          JP1 = J+1                                                   UDESIGN    68
                              DO 180 K=JP1,IEXP                                       UDESIGN    69
                                  DO 170 I=1,NRUN                                     UDESIGN    70
          170                     D(I,NEWJ) = D(I,J)*D(I,K)                           UDESIGN    71
75                            IGEN(NEWJ-IEXP,1) = J                                   UDESIGN    72
                              IGEN(NEWJ-IEXP,2) = K                                   UDESIGN    73
                              IGEN(NEWJ-IEXP,3) = NEWJ                                UDESIGN    74
                              IF (IPRINT.EQ.1) WRITE (6,850) NAM(1),NEWJ,NAM(2),NAM(1),J UDESIGN    75
                         +    ,NAM(4),K,NAM(3)                                        UDESIGN    76
80                            IF (NEWJ.EQ.NFAC) GO TO 370                             UDESIGN    77
          180                 NEWJ = NEWJ+1                                           UDESIGN    78
                      DO 200 J=1,IM2                                                  UDESIGN    79
                      JP1 = J+1                                                       UDESIGN    80
                          DO 200 K=JP1,IM1                                            UDESIGN    81
85                        KP1 = K+1                                                   UDESIGN    82
                              DO 200 L=KP1,IEXP                                       UDESIGN    83
                                  DO 190 I=1,NRUN                                     UDESIGN    84
          190                     D(I,NEWJ) = D(I,J)*D(I,K)*D(I,L)                    UDESIGN    85
                              IGEN(NEWJ-IEXP,1) = J                                   UDESIGN    86
90                            IGEN(NEWJ-IEXP,2) = K                                   UDESIGN    87
                              IGEN(NEWJ-IEXP,3) = L                                   UDESIGN    88
                              IGEN(NEWJ-IEXP,4) = NEWJ                                UDESIGN    89
                              IF (IPRINT.EQ.1) WRITE (6,860) NAM(1),NEWJ,NAM(2),NAM(  UDESIGN    90
                         +    1),J,NAM(4),K,NAM(4),L,NAM(3)                           UDESIGN    91
95                            IF (NEWJ.EQ.NFAC) GO TO 370                             UDESIGN    92
          200                 NEWJ = NEWJ+1                                           UDESIGN    93
                      DO 220 J=1,IM3                                                  UDESIGN    94
                      JP1 = J+1                                                       UDESIGN    95
                          DO 220 K=JP1,IM2                                            UDESIGN    96
100                       KP1 = K+1                                                   UDESIGN    97
                              DO 220 L=KP1,IM1                                        UDESIGN    98
                              LP1 = L+1                                               UDESIGN    99
                                  DO 220 M=LP1,IEXP                                   UDESIGN   100
                                      DO 210 I=1,NRUN                                 UDESIGN   101
105       210                       D(I,NEWJ) = D(I,J)*D(I,K)*D(I,L)*D(I,M)           UDESIGN   102
                                  IGEN(NEWJ-IEXP,1) = J                               UDESIGN   103
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                        IGEN(NEWJ-IEXP,2) = K                                    UDESIGN   104
                        IGEN(NEWJ-IEXP,3) = L                                    UDESIGN   105
                        IGEN(NEWJ-IEXP,4) = M                                    UDESIGN   106
                        IGEN(NEWJ-IEXP,5) = NEWJ                                 UDESIGN   107
110                     IF (IPRINT.EQ.1) WRITE (6,870) NAM(1),NEWJ,NAM(2),       UDESIGN   108
     +                 NAM(1),J,NAM(4),K,NAM(4),L,NAM(4),M,NAM(3)               UDESIGN   109
                        IF (NEWJ.EQ.NFAC) GO TO 370                              UDESIGN   110
          220           NEWJ = NEWJ+1                                            UDESIGN   111
115       C                                                                      UDESIGN   112
          C   PLACKETT-BURMAN DESIGN                                             UDESIGN   113
          C                                                                      UDESIGN   114
          230   CONTINUE                                                         UDESIGN   115
                IF (NFAC.LE.11) GO TO 240                                        UDESIGN   116
120             IF (NFAC.LE.19) GO TO 290                                        UDESIGN   117
                IF (NFAC.LE.23) GO TO 240                                        UDESIGN   118
                IF (NFAC.LE.39) GO TO 290                                        UDESIGN   119
          C                                                                      UDESIGN   120
          C   PLACKETT-BURMAN DESIGN FOR 11 FACTORS IN 12 RUNS                   UDESIGN   121
125       C                                                                      UDESIGN   122
          240       DO 250 I=1,11                                                UDESIGN   123
          250       D(I,1) = PB12(I)                                             UDESIGN   124
                    DO 270 J=2,11                                                UDESIGN   125
                        DO 270 I=1,11                                            UDESIGN   126
130                     IF (I-1.EQ.0) GO TO 260                                  UDESIGN   127
                        D(I,J) = D(I-1,J-1)                                      UDESIGN   128
                        GO TO 270                                                UDESIGN   129
          260           D(I,J) = D(I+10,J-1)                                     UDESIGN   130
          270           CONTINUE                                                 UDESIGN   131
135                 DO 280 J=1,11                                                UDESIGN   132
          280       D(12,J) = -1.                                                UDESIGN   133
                NI = 12                                                          UDESIGN   134
                NJ = 11                                                          UDESIGN   135
                NRUN = NI                                                        UDESIGN   136
140             IF (NFAC.GT.11) GO TO 340                                        UDESIGN   137
                GO TO 370                                                        UDESIGN   138
          C                                                                      UDESIGN   139
          C   PLACKETT-BURMAN DESIGN FOR 19 FACTORS IN 20 RUNS                   UDESIGN   140
          C                                                                      UDESIGN   141
145       290       DO 300 I=1,19                                                UDESIGN   142
          300       D(I,1) = PB20(I)                                             UDESIGN   143
                    DO 320 J=2,19                                                UDESIGN   144
                        DO 320 I=1,19                                            UDESIGN   145
                        IF (I-1.EQ.0) GO TO 310                                  UDESIGN   146
150                     D(I,J) = D(I-1,J-1)                                      UDESIGN   147
                        GO TO 320                                                UDESIGN   148
          310           D(I,J) = D(I+18,J-1)                                     UDESIGN   149
          320           CONTINUE                                                 UDESIGN   150
                    DO 330 J=1,19                                                UDESIGN   151
155       330       D(20,J) = -1.                                                UDESIGN   152
                NI = 20                                                          UDESIGN   153
                NJ = 19                                                          UDESIGN   154
                NRUN = NI                                                        UDESIGN   155
                IF (NFAC.GT.19) GO TO 340                                        UDESIGN   156
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      GO TO 370                                                          UDESIGN  157
C                                                                        UDESIGN  158
C   DOUBLING ROUTINE                                                     UDESIGN  159
C                                                                        UDESIGN  160
340       DO 350 I=1,NI                                                  UDESIGN  161
              DO 350 J=1,NJ                                              UDESIGN  162
              D(I+NI,J) = D(I,J)                                         UDESIGN  163
              D(I,J+NJ) = D(I,J)                                         UDESIGN  164
350           D(I+NI,J+NJ) = -D(I,J)                                     UDESIGN  165
          DO 360 I=1,NI                                                  UDESIGN  166
          D(I,2*NJ+1) = 1.                                               UDESIGN  167
360       D(I+NI,2*NJ+1) = -1.                                           UDESIGN  168
      NRUN = 2*NI                                                        UDESIGN  169
C                                                                        UDESIGN  170
C   ADD FOLDOVER DESIGN                                                  UDESIGN  171
C                                                                        UDESIGN  172
370   IF (LTYPE.NE.2.AND.LTYPE.NE.4) GO TO 470                           UDESIGN  173
      IF (NFAC.LE.2) GO TO 470                                           UDESIGN  174
          DO 380 I=1,NRUN                                                UDESIGN  175
              DO 380 J=1,NFAC                                            UDESIGN  176
380           D(I+NRUN,J) = -D(I,J)                                      UDESIGN  177
      NRUN = 2*NRUN                                                      UDESIGN  178
          DO 390 L=1,12                                                  UDESIGN  179
390       ISTORE(L) = IGEN(1,L)                                          UDESIGN  180
          DO 450 K=2,IP                                                  UDESIGN  181
          LSUM = 0                                                       UDESIGN  182
              DO 400 L=1,12                                              UDESIGN  183
400           IF (IGEN(K,L).GT.0) LSUM = LSUM+1                          UDESIGN  184
          IF (LSUM.EQ.4) GO TO 430                                       UDESIGN  185
              DO 410 L=1,12                                              UDESIGN  186
              I1(L) = ISTORE(L)                                          UDESIGN  187
410           I2(L) = IGEN(K,L)                                          UDESIGN  188
          CALL PROD (I1,I2,IAL)                                          UDESIGN  189
              DO 420 L=1,12                                              UDESIGN  190
420           IGEN(K-1,L) = IAL(L)                                       UDESIGN  191
          GO TO 450                                                      UDESIGN  192
430           DO 440 L=1,12                                              UDESIGN  193
440           IGEN(K-1,L) = IGEN(K,L)                                    UDESIGN  194
450       CONTINUE                                                       UDESIGN  195
          DO 460 L=1,12                                                  UDESIGN  196
460       IGEN(IP,L) = 0                                                 UDESIGN  197
      IP = IP-1                                                          UDESIGN  198
C                                                                        UDESIGN  199
C   ADD QUADRATIC DESIGN                                                 UDESIGN  200
C                                                                        UDESIGN  201
470   IF (LTYPE.NE.3.AND.LTYPE.NE.4) GO TO 510                           UDESIGN  202
      RAD = (NRUN**2+2*NRUN*NFAC+NRUN)**0.5                              UDESIGN  203
      ALP = ((NRUN-RAD)/(-2.))**0.5                                      UDESIGN  204
      NFAC2 = 2*NFAC                                                     UDESIGN  205
          DO 480 I=1,NFAC2                                               UDESIGN  206
              DO 480 J=1,NFAC                                            UDESIGN  207
480           D(NRUN+I,J) = 0.                                           UDESIGN  208
          DO 490 J=1,NFAC                                                UDESIGN  209
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                D(NRUN+2*J-1,J) = ALP                                          UDESIGN  210
          490   D(NRUN+2*J,J) = -ALP                                           UDESIGN  211
      215       NRUN = NRUN+2*NFAC+1                                           UDESIGN  212
                DO 500 J=1,NFAC                                                UDESIGN  213
          500   D(NRUN,J) = 0.                                                 UDESIGN  214
                C                                                              UDESIGN  215
                C   WRITE DESIGN MATRIX "D"                                    UDESIGN  216
      220       C                                                              UDESIGN  217
          510   IF (LPB.EQ.1) GO TO 520                                        UDESIGN  218
                WRITE (6,880) NFAC,IP                                          UDESIGN  219
                IF (LTYPE.EQ.2) WRITE (6,890)                                  UDESIGN  220
                IF (LTYPE.EQ.3) WRITE (6,900)                                  UDESIGN  221
      225       IF (LTYPE.EQ.4) WRITE (6,910)                                  UDESIGN  222
                GO TO 530                                                      UDESIGN  223
          520   WRITE (6,920) NFAC,NRUN                                        UDESIGN  224
          530   WRITE (6,930) (I,I=1,NFAC)                                     UDESIGN  225
                NFACP2 = NFAC+2                                                UDESIGN  226
      230       WRITE (6,940) (NAM(5),I=1,NFACP2)                              UDESIGN  227
                DO 540 I=1,NRUN                                                UDESIGN  228
          540   WRITE (6,950) I,(D(I,J),J=1,NFAC)                              UDESIGN  229
                IF (LTYPE.GE.3) WRITE (6,960) ALP                              UDESIGN  230
                C                                                              UDESIGN  231
      235       C   WRITE DESIGN GENERATORS                                     UDESIGN  232
                C                                                              UDESIGN  233
                DO 550 I=1,15                                                  UDESIGN  234
                DO 550 J=1,15                                                  UDESIGN  235
          550   ICON(I,J) = 0                                                  UDESIGN  236
      240       IF (LPB.EQ.1) RETURN                                           UDESIGN  237
                IF (NFAC.GT.15) RETURN                                         UDESIGN  238
                IF (IPRINT.EQ.1) WRITE (6,970)                                 UDESIGN  239
                DO 560 I=1,40                                                  UDESIGN  240
                IF (IGEN(I,1).EQ.0) GO TO 570                                  UDESIGN  241
      245       560   IF (IPRINT.EQ.1) WRITE (6,1010) (IGEN(I,J),J=1,12)       UDESIGN  242
                570   WRITE (6,980)                                            UDESIGN  243
                C                                                              UDESIGN  244
                C   CALL SUB IDEA TO GET 2**F PATTERN OF COMBINATIONS OF DESIGN UDESIGN  245
                C   GENERATORS NECESSARY TO FORM ALL DEFINING RELATIONS        UDESIGN  246
      250       C                                                              UDESIGN  247
                C                                                              UDESIGN  248
                C   WRITE DEFINING RELATIONS AND THEIR 2 AND 2 FACTOR ALIASES  UDESIGN  249
                C                                                              UDESIGN  250
                NUMBER = 2**IP-1-IP                                            UDESIGN  251
      255       IF (IPRINT.EQ.1) WRITE (6,990)                                 UDESIGN  252
                C                                                              UDESIGN  253
                C   WRITE 1 AND 2 FACTOR ALIASES OF GENERATORS                 UDESIGN  254
                C                                                              UDESIGN  255
                NCON = 1                                                       UDESIGN  256
      260       DO 660 I=1,IP                                                  UDESIGN  257
                KSUM = 0                                                       UDESIGN  258
                IF (IPRINT.EQ.1) WRITE (6,1010) (IGEN(I,L),L=1,12)             UDESIGN  259
                IF (IPRINT.EQ.1) WRITE (6,1020)                                UDESIGN  260
                DO 610 K=1,NFAC                                                UDESIGN  261
      265       DO 580 J=1,12                                                  UDESIGN  262
```

```
                        I2(J) = IGEN(I,J)                                                UDESIGN   263
                        IAL(J) = 0                                                       UDESIGN   264
              580       I1(J) = 0                                                        UDESIGN   265
                    I1(1) = K                                                          UDESIGN   266
270                 CALL PROD (I1,I2,IAL)                                              UDESIGN   267
                    LSUM = 0                                                           UDESIGN   268
                        DO 590 N=1,12                                                  UDESIGN   269
              590       IF (IAL(N).GT.0) LSUM = LSUM+1                                   UDESIGN   270
                    IF (LSUM.GT.2) GO TO 610                                           UDESIGN   271
275                 KSUM = KSUM+1                                                      UDESIGN   272
                    IF (ICON(K,K).GT.0) GO TO 600                                      UDESIGN   273
                    ICON(K,K) = NCON                                                   UDESIGN   274
                    ICON(IAL(1),IAL(2)) = NCON                                         UDESIGN   275
                    NCON = NCON+1                                                      UDESIGN   276
280                 GO TO 610                                                          UDESIGN   277
              600   ICON(IAL(1),IAL(2)) = ICON(K,K)                                    UDESIGN   278
              610   IF (IPRINT.EQ.1.AND.LSUM.LE.2) WRITE (6,1030) K,(IAL(J),J=         UDESIGN   279
                +   1,12)                                                             UDESIGN   280
                  NFACM1 = NFAC-1                                                      UDESIGN   281
285                 DO 650 K=1,NFACM1                                                  UDESIGN   282
                    KP1 = K+1                                                          UDESIGN   283
                        DO 650 J=KP1,NFAC                                              UDESIGN   284
                            DO 620 M=1,12                                              UDESIGN   285
                            IAL(M) = 0                                                 UDESIGN   286
290                         I2(M) = IGEN(I,M)                                          UDESIGN   287
              620           I1(M) = 0                                                  UDESIGN   288
                        I1(1) = K                                                      UDESIGN   289
                        I1(2) = J                                                      UDESIGN   290
                        CALL PROD (I1,I2,IAL)                                          UDESIGN   291
295                     LSUM = 0                                                       UDESIGN   292
                            DO 630 N=1,12                                          UDESIGN   293
              630           IF (IAL(N).GT.0) LSUM = LSUM+1                           UDESIGN   294
                        IF (LSUM.GT.2) GO TO 650                                       UDESIGN   295
                        KSUM = KSUM+1                                                  UDESIGN   296
300                     IF (KSUM.GT.3) GO TO 660                                       UDESIGN   297
                        IF (ICON(K,J).GT.0.OR.ICON(IAL(1),IAL(2)).GT.0) GO TO      UDESIGN   298
                    +   640                                                            UDESIGN   299
                        ICON(K,J) = NCON                                               UDESIGN   300
                        ICON(IAL(1),IAL(2)) = NCON                                     UDESIGN   301
305                     NCON = NCON+1                                                  UDESIGN   302
                        GO TO 650                                                      UDESIGN   303
              640       IF (ICON(K,J).GT.0) ICON(IAL(1),IAL(2)) = ICON(K,J)          UDESIGN   304
                        IF (ICON(IAL(1),IAL(2)).GT.0) ICON(K,J) = ICON(IAL(1),     UDESIGN   305
                    +   IAL(2))                                                        UDESIGN   306
310           650       IF (IPRINT.EQ.1.AND.LSUM.LE.2) WRITE (6,1040) K,J,(IAL     UDESIGN   307
                    +   (N),N=1,12)                                                    UDESIGN   308
              660   CONTINUE                                                         UDESIGN   309
                IF (NUMBER.LT.1) GO TO 820                                         UDESIGN   310
                    DO 810 I=1,NUMBER                                              UDESIGN   311
315                 KSUM = 0                                                       UDESIGN   312
                C                                                                  UDESIGN   313
                C   FORM DEFINING RELATION - IDR                                    UDESIGN   314
                C                                                                  UDESIGN   315
```

```
                      DO 670 K=1,12                                                  UDESIGN   316
320          670      IDR(K) = 0                                                     UDESIGN   317
                      DO 680 K=1,12                                                  UDESIGN   318
                      I1(K) = IGEN(ID(1),K)                                          UDESIGN   319
             680      I2(K) = IGEN(ID(2),K)                                          UDESIGN   320
                      DO 700 J=3,12                                                  UDESIGN   321
325                   CALL PROD (I1,I2,IDR)                                          UDESIGN   322
                      IF (ID(J).EQ.0) GO TO 710                                      UDESIGN   323
                          DO 690 K=1,12                                              UDESIGN   324
                          I1(K) = IDR(K)                                             UDESIGN   325
                          IDR(K) = 0                                                 UDESIGN   326
330          690          I2(K) = IGEN(ID(J),K)                                      UDESIGN   327
             700      CONTINUE                                                       UDESIGN   328
             710   IF (IPRINT.EQ.1) WRITE (6,1010) (IDR(K),K=1,12)                   UDESIGN   329
                   IF (IPRINT.EQ.1) WRITE (6,1000) (ID(K),K=1,12)                    UDESIGN   330
                      DO 720 KK=1,12                                                 UDESIGN   331
335          720      IDOLD(KK) = ID(KK)                                             UDESIGN   332
                   CALL IDEA (IDOLD,IP,ID)                                           UDESIGN   333
                   IF (IPRINT.EQ.1) WRITE (6,1020)                                   UDESIGN   334
             C                                                                       UDESIGN   335
             C   FIND 1 FACTOR ALIASES AND WRITE IF ALIAS IS 2 FACTORS OR LESS      UDESIGN   336
340          C                                                                       UDESIGN   337
                      DO 760 K=1,NFAC                                                UDESIGN   338
                          DO 730 J=1,12                                              UDESIGN   339
                          I2(J) = IDR(J)                                             UDESIGN   340
                          IAL(J) = 0                                                 UDESIGN   341
345          730          I1(J) = 0                                                  UDESIGN   342
                      I1(1) = K                                                      UDESIGN   343
                      CALL PROD (I1,I2,IAL)                                          UDESIGN   344
                      LSUM = 0                                                       UDESIGN   345
                          DO 740 N=1,12                                              UDESIGN   346
350          740          IF (IAL(N).GT.0) LSUM = LSUM+1                             UDESIGN   347
                      IF (LSUM.GT.2) GO TO 760                                       UDESIGN   348
                      KSUM = KSUM+1                                                  UDESIGN   349
                      IF (ICON(K,K).GT.0) GO TO 750                                  UDESIGN   350
                      ICON(K,K) = NCON                                               UDESIGN   351
355                   ICON(IAL(1),IAL(2)) = NCON                                     UDESIGN   352
                      NCON = NCON+1                                                  UDESIGN   353
                      GO TO 760                                                      UDESIGN   354
             750      ICON(IAL(1),IAL(2)) = ICON(K,K)                                UDESIGN   355
             760      IF (IPRINT.EQ.1.AND.LSUM.LE.2) WRITE (6,1030) K,(IAL(J),J=     UDESIGN   356
360               +   1,12)                                                          UDESIGN   357
             C                                                                       UDESIGN   358
             C   FIND 2 FACTOR ALIASES AND WRITE IF ALIAS IS 2 FACTORS OR LESS      UDESIGN   359
             C                                                                       UDESIGN   360
                   NFACM1 = NFAC-1                                                   UDESIGN   361
365                   DO 800 K=1,NFACM1                                              UDESIGN   362
                      KP1 = K+1                                                      UDESIGN   363
                          DO 800 J=KP1,NFAC                                          UDESIGN   364
                              DO 770 M=1,12                                          UDESIGN   365
                              IAL(M) = 0                                             UDESIGN   366
370                           I2(M) = IDR(M)                                         UDESIGN   367
             770              I1(M) = 0                                              UDESIGN   368
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                      II(1) = K                                                  UDESIGN   369
                      II(2) = J                                                  UDESIGN   370
                      CALL PROD (II,I2,IAL)                                      UDESIGN   371
3?5                   LSUM = 0                                                   UDESIGN   372
                          DO 780 N=1,12                                          UDESIGN   373
          780             IF (IAL(N).GT.0) LSUM = LSUM+1                         UDESIGN   374
                      IF (LSUM.GT.2) GO TO 800                                   UDESIGN   375
                      KSUM = KSUM+1                                              UDESIGN   376
380                   IF (KSUM.GT.3) GO TO 810                                   UDESIGN   377
                      IF (ICON(K,J).GT.0.OR.ICON(IAL(1),IAL(2)).GT.0) GO TO      UDESIGN   378
                     +790                                                        UDESIGN   379
                      ICON(K,J) = NCON                                           UDESIGN   380
                      ICON(IAL(1),IAL(2)) = NCON                                 UDESIGN   381
385                   NCON = NCON+1                                              UDESIGN   382
                      GO TO 800                                                  UDESIGN   383
          790         IF (ICON(K,J).GT.0) ICON(IAL(1),IAL(2)) = ICON(K,J)        UDESIGN   384
                      IF (ICON(IAL(1),IAL(2)).GT.0) ICON(K,J) = ICON(IAL(1),     UDESIGN   385
                     +IAL(2))                                                    UDESIGN   386
390       800         IF (IPRINT.EQ.1.AND.LSUM.LE.2) WRITE (6,1040) K,J,(IAL     UDESIGN   387
                     +(N),N=1,12)                                                UDESIGN   388
          810     CONTINUE                                                       UDESIGN   389
          820   WRITE (6,1050)                                                   UDESIGN   390
                WRITE (6,1060) (I,I=1,NFAC)                                      UDESIGN   391
395             WRITE (6,940) (NAM(5),I=1,NFACP2)                                UDESIGN   392
                    DO 830 N=1,NFAC                                            UDESIGN   393
          830       WRITE (6,1070) N,(ICON(N,M),M=1,NFAC)                      UDESIGN   394
                RETURN                                                           UDESIGN   395
                C                                                                UDESIGN   396
400       840   FORMAT (19H FACTOR ASSIGNMENTS,/)                                UDESIGN   397
          850   FORMAT (1H ,A2,I2,A2,A2,I1,A3,I1,A1)                             UDESIGN   398
          860   FORMAT (1H ,A2,I2,A2,A2,I1,A3,I1,A3,I1,A1)                       UDESIGN   399
          870   FORMAT (1H ,A2,I2,A2,A2,I1,A3,I1,A3,I1,A3,I1,A1)                 UDESIGN   400
          880   FORMAT (1H1,25H DESIGN MATRIX FOR A 2**(,I2,1H-,I2,22H) FRACTIONAL UDESIGN   401
405              + FACTORIAL)                                                    UDESIGN   402
          890   FORMAT (1H ,24H INCLUDING FOLDOVER RUNS,/)                       UDESIGN   403
          900   FORMAT (1H ,20H PLUS QUADRATIC RUNS,/)                           UDESIGN   404
          910   FORMAT (1H ,38H INCLUDING FOLDOVER AND QUADRATIC RUNS,/)         UDESIGN   405
          920   FORMAT (1H ,35H PLACKETT-BURMAN DESIGN MATRIX FOR ,I2,12H FACTORS UDESIGN   406
410              + IN,I3,5H RUNS,/)                                              UDESIGN   407
          930   FORMAT (1H ,8X,7HFACTORS/1H ,7H RUNS *,2014/8X,2014)             UDESIGN   408
          940   FORMAT (22A4)                                                    UDESIGN   409
          950   FORMAT (I5,4H  * ,20F4.0/9H       * ,20F4.0)                    UDESIGN   410
          960   FORMAT (1H ,9H ALPHA = ,F10.4,/)                                 UDESIGN   411
415       970   FORMAT (1H ,18H DESIGN GENERATORS,/)                             UDESIGN   412
          980   FORMAT (1H )                                                     UDESIGN   413
          990   FORMAT (1H,24H 2**P DEFINING RELATIONS,/)                        UDESIGN   414
          1000  FORMAT (1H ,6H ID = ,1213)                                       UDESIGN   415
          1010  FORMAT (1H ,7H IDR = ,1213)                                      UDESIGN   416
420       1020  FORMAT (1H ,10X,8H ALIASES,/)                                    UDESIGN   417
          1030  FORMAT (1H ,10X,I3,3H = ,1213)                                   UDESIGN   418
          1040  FORMAT (1H ,10X,213,3H = ,1213)                                  UDESIGN   419
          1050  FORMAT (1H ,18H CONFOUNDING ARRAY,//)                            UDESIGN   420
          1060  FORMAT (1H ,4X,3H * ,2014)                                       UDESIGN   421
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425          1070  FORMAT (1H ,I4,3H * ,1514)                                  UDESIGN  422
                   END                                                         UDESIGN  423
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CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

17 I DESNBL NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES

2 DESIGN 1 240 241 398

VARIABLES	SN	TYPE	RELOCATION									
2761	ALP	REAL			REFS	213	214	233	DEFINED	207		
10764	ALPHA	REAL	ARRAY	DESNBL	REFS	8						
4542	AMU	REAL	ARRAY	DESNBL	REFS	8						
144	C	REAL	ARRAY	DESNBL	REFS	8						
5362	D	REAL	ARRAY	DESNBL	REFS	8	2*74	3*88	4*105	131	133	150
						152	166	167	168	180	232	
					DEFINED	55	58	79	88	105	127	131
						133	136	146	150	152	155	166	167
						168	170	171	180	211	213	214	217
0	FACTOR	REAL	ARRAY	DESNBL	REFS	8	12					
2734	I	INTEGER			REFS	24	30	37	39	40	55	56
						58	59	3*74	4*88	5*105	2*127	130	2*131
						2*133	2*146	149	2*150	2*152	2*166	2*167	2*168
						170	171	2*180	211	228	2*232	239	244
						245	262	266	290	394	DEFINED	22	29
						36	50	56	59	73	87	104	126
						129	145	148	164	169	178	209	228
						230	231	237	243	260	314	394	395
4042	IAL	INTEGER	ARRAY		REFS	15	192	194	270	273	2*278	2*281
						282	294	297	2*301	2*304	2*307	4*308	310
						347	350	2*355	2*358	359	374	377	2*381
						2*384	2*387	4*388	390	DEFINED	267	289	344
						369							
10631	ICON	INTEGER	ARRAY	DESNBL	REFS	8	276	281	2*301	2*307	2*308	353
						358	2*381	2*387	2*388	397	DEFINED	239	277
						278	281	303	304	307	308	354	355
						358	383	384	387	388			
11173	ICOUNT	INTEGER		DESNBL	REFS	8						
3762	ID	INTEGER	ARRAY		REFS	13	322	323	326	330	333	335
						336	DEFINED	18				
3776	IDOLD	INTEGER	ARRAY		REFS	13	336	DEFINED	335			
4012	IDR	INTEGER	ARRAY		REFS	13	325	328	332	343	370	
					DEFINED	320	322					

VARIABLES SN TYPE RELOCATION

2737	IEXP	INTEGER			REFS	41	49	51	64	66	67	68
						69	73	75	76	77	86	89	90
						91	92	103	106	107	108	109	110
					DEFINED	40							
11172	IFLAG	INTEGER		DESNBL	REFS	8							
2772	IGEN	INTEGER	ARRAY		REFS	13	183	187	191	197	244	245
						262	266	290	322	323	330		
					DEFINED	24	75	76	77	89	90	91
						92	106	107	108	109	110	194	197
						200							
2746	IM1	INTEGER			REFS	70	84	101	DEFINED	67		
2747	IM2	INTEGER			REFS	82	99	DEFINED	68			
2750	IM3	INTEGER			REFS	97	DEFINED	69				
2740	IP	INTEGER			REFS	184	200	201	222	2*254	260	336
					DEFINED	41	201					
10630	IPRINT	INTEGER		DESNBL	REFS	8	65	78	93	111	242	245
						255	262	263	282	310	332	333	337
						359	390						
11175	ISTART	INTEGER		DESNBL	REFS	8							
4026	ISTORE	INTEGER	ARRAY		REFS	14	190	DEFINED	183			
2736	ISUM	INTEGER			REFS	30	31	DEFINED	28	30		
11177	IUNCRT	INTEGER		DESNBL	REFS	8						
3732	II	INTEGER	ARRAY		REFS	13	192	270	294	325	347	374
					DEFINED	190	268	269	291	292	293	322
						328	345	346	371	372	373		
3746	I2	INTEGER	ARRAY		REFS	13	192	270	294	325	347	374
					DEFINED	191	266	290	323	330	343	370
2735	J	INTEGER			REFS	24	51	52	55	58	71	74
						75	78	83	88	89	93	98	105
						106	111	2*131	2*133	136	2*150	2*152	155
						2*166	2*167	2*168	2*160	211	2*213	2*214	217
						232	239	245	2*266	267	268	282	293
						301	303	2*307	308	310	326	330	2*343
						344	345	359	373	381	383	2*387	388
						390	DEFINED	23	49	70	82	97	128
						135	147	154	165	179	210	212	216
						232	238	245	265	282	287	324	342
						359	367						
2741	JEXP	INTEGER			REFS	53	DEFINED	51				
2742	JM1	INTEGER			REFS	54	57	DEFINED	52			
2751	JP1	INTEGER			REFS	72	84	99	DEFINED	71	83	98
2744	K	INTEGER			REFS	74	76	78	85	88	90	93
						100	105	107	111	187	191	194	2*197
						269	2*276	2*277	2*281	282	286	292	301
						303	2*307	308	310	320	2*322	2*323	2*326
						329	2*330	332	333	346	2*353	2*354	2*358
						359	366	372	381	383	2*387	388	390
					DEFINED	54	57	72	84	99	184	264	
						285	319	321	327	332	333	341	365
2771	KK	INTEGER			REFS	2*335	DEFINED	334				
2752	KP1	INTEGER			REFS	86	101	287	367	DEFINED	85	100
						286	366					
2766	KSUM	INTEGER			REFS	275	299	300	352	379	380	

VARIABLES	SN	TYPE		RELOCATION								
					DEFINED	261	275	299	315	352	379	
2743	L	INTEGER			REFS	88	91	93	102	105	108	111
					2*183	187	2*190	2*191	2*194	2*197	200	262
					DEFINED	53	86	101	182	186	189	193
					196	199	262					
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	8	30					
4541	LPB	INTEGER		DESNBL	REFS	8	45	221	240			
2753	LPI	INTEGER			REFS	103	DEFINED	102				
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	8						
2757	LSUM	INTEGER			REFS	187	188	273	274	282	297	298
					310	350	351	359	377	378	390	
					DEFINED	185	187	271	273	295	297	348
					350	375	377					
4540	LTYPE	INTEGER		DESNBL	REFS	8	2*176	2*205	223	224	225	233
					DEFINED	32						
2754	M	INTEGER			REFS	105	109	111	289	2*290	291	369
					2*370	371	397	DEFINED	103	288	368	397
2767	N	INTEGER			REFS	273	297	310	350	377	390	2*397
					DEFINED	272	296	310	349	376	390	396
4114	NAM	INTEGER	ARRAY		REFS	16	5*78	6*93	7*111	230	395	
					DEFINED	17						
2765	NCON	INTEGER			REFS	277	278	279	303	304	305	354
					355	356	383	384	385	DEFINED	259	279
					305	356	385					
2745	NEWJ	INTEGER			REFS	74	75	76	2*77	78	80	81
					88	89	90	91	2*92	93	95	96
					105	106	107	108	109	2*110	111	113
					114	DEFINED	66	81	96	114		
10463	NFAC	INTEGER		DESNBL	REFS	8	32	37	41	64	80	95
					113	119	120	121	122	140	159	177
					179	206	208	210	212	215	216	222
					227	228	229	232	241	264	284	287
					341	364	367	394	396	397		
					DEFINED	31						
2770	NFACM1	INTEGER			REFS	285	365	DEFINED	284	364		
2763	NFACP2	INTEGER			REFS	230	395	DEFINED	229			
2762	NFAC2	INTEGER			REFS	209	DEFINED	208				
2755	NI	INTEGER			REFS	139	158	164	166	168	169	171
					172	DEFINED	137	156				
2756	NJ	INTEGER			REFS	165	167	168	170	171		
					DEFINED	138	157					
4230	NODE	INTEGER	ARRAY	DESNBL	REFS	8						
11176	NRES	INTEGER		DESNBL	REFS	8						
10462	NRUN	INTEGER		DESNBL	REFS	8	73	87	104	178	180	181
					3*206	207	211	213	214	215	217	227
					231	DEFINED	39	139	158	172	181	215
11174	NTIME	INTEGER		DESNBL	REFS	8						
2764	NUMBER	INTEGER			REFS	313	314	DEFINED	254			
4056	PB12	REAL	ARRAY		REFS	16	127	DEFINED	19			
4071	PB20	REAL	ARRAY		REFS	16	146	DEFINED	20			
2760	RAD	REAL			REFS	207	DEFINED	206				
3244	TL	REAL	ARRAY	DESNBL	REFS	8						

FILE NAMES MODE
TAPE6 FMT WRITES 65 78 93 111 222 223 224 225
227 228 230 232 233 242 245 246 255
262 263 282 310 332 333 337 359 390
393 394 395 397

EXTERNALS	TYPE	ARGS	REFERENCES					
IDEA		3	336					
PROD		3	192	270	294	325	347	374

	STATEMENT LABELS	DEF LINE	REFERENCES					
0	100	24	22	23				
0	110	30	29					
0	120	38	36					
56	130	39	37					
0	140	56	54					
0	150	59	57					
0	160	60	49	53				
0	170	74	73					
0	180	81	70	72				
0	190	88	87					
0	200	96	82	84	86			
0	210	105	104					
0	220	114	97	99	101	103		
453	230	118	45					
470	240	126	119	121				
0	250	127	126					
514	260	133	130					
521	270	134	128	129	132			
0	280	136	135					
552	290	145	120	122				
0	300	146	145					
576	310	152	149					
603	320	153	147	148	151			
0	330	155	154					
634	340	164	140	159				
0	350	168	164	165				
0	360	171	169					
706	370	176	64	80	95	113	141	160
0	380	180	178	179				
0	390	183	182					
0	400	187	186					
0	410	191	189					
0	420	194	193					
1017	430	196	188					
0	440	197	196					
1027	450	198	184	195				
0	460	200	199					
1045	470	205	176	177				
0	480	211	209	210				
0	490	214	212					
0	500	217	216					
1143	510	221	205					

STATEMENT LABELS			DEF LINE	REFERENCES				
1165	520		227	221				
1170	530		228	226				
0	540		232	231				
0	550		239	237	238			
0	560		245	243				
1323	570		246	244				
0	580		268	265				
0	590		273	272				
1452	600		281	276				
1460	610		282	264	274	280		
0	620		291	288				
0	630		297	296				
1577	640		307	301				
1617	650		310	285	287	298	306	
1634	660		312	260	300			
0	670		320	319				
0	680		323	321				
0	690		330	327				
0	700		331	324				
1722	710		332	326				
0	720		335	334				
0	730		345	342				
0	740		350	349				
2026	750		358	353				
2034	760		359	341	351	357		
0	770		371	368				
0	780		377	376				
2151	790		387	381				
2171	800		390	365	367	370	386	
2206	810		392	314	380			
2212	820		393	313				
0	830		397	396				
2557	840	FMT	400	65				
2563	850	FMT	401	78				
2567	860	FMT	402	93				
2574	870	FMT	403	111				
2601	880	FMT	404	222				
2611	890	FMT	406	223				
2616	900	FMT	407	224				
2622	910	FMT	408	225				
2630	920	FMT	409	227				
2641	930	FMT	411	228				
2646	940	FMT	412	230	395			
2650	950	FMT	413	232				
2655	960	FMT	414	233				
2661	970	FMT	415	242				
2665	980	FMT	416	246				
2667	990	FMT	417	255				
2674	1000	FMT	418	333				
2677	1010	FMT	419	245	262	332		
2702	1020	FMT	420	263	337			
2705	1030	FMT	421	282	359			
2710	1040	FMT	422	310	390			

STATEMENT LABELS			DEF LINE	REFERENCES
2714	1050	FMT	423	393
2720	1060	FMT	424	394
2723	1070	FMT	425	397

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
5	100	I	22 24	13B	NOT INNER
7	100	J	23 24	6B	INSTACK
24	110	I	29 30	10B	INSTACK
45	120	I	36 38	10B	EXT REFS EXITS
74	160	J	49 60	54B	EXT REFS NOT INNER
114	160	L	53 60	31B	NOT INNER
116	140	K	54 56	11B	INSTACK
131	150	K	57 59	11B	INSTACK
175	180	J	70 81	53B	EXT REFS EXITS NOT INNER
202	180	K	72 81	43B	EXT REFS EXITS NOT INNER
204	170	I	73 74	14B	
252	200	J	82 96	70B	EXT REFS EXITS NOT INNER
257	200	K	84 96	60B	EXT REFS EXITS NOT INNER
264	200	L	86 96	50B	EXT REFS EXITS NOT INNER
266	190	I	87 88	16B	
344	220	J	97 114	106B	EXT REFS EXITS NOT INNER
351	220	K	99 114	76B	EXT REFS EXITS NOT INNER
356	220	L	101 114	66B	EXT REFS EXITS NOT INNER
363	220	M	103 114	56B	EXT REFS EXITS NOT INNER
365	210	I	104 105	21B	
471	250	I	126 127	5B	INSTACK
500	270	J	128 134	27B	NOT INNER
502	270	I	129 134	22B	OPT
531	280	J	135 136	6B	INSTACK
553	300	I	145 146	5B	INSTACK
562	320	J	147 153	27B	NOT INNER
564	320	I	148 153	22B	OPT
613	330	J	154 155	6B	INSTACK
635	350	I	164 168	31B	NOT INNER
637	350	J	165 168	24B	OPT
670	360	I	169 171	13B	OPT
717	380	I	178 180	16B	NOT INNER
721	380	J	179 180	10B	
741	390	L	182 183	5B	INSTACK
750	450	K	184 198	62B	EXT REFS NOT INNER
754	400	L	186 187	11B	INSTACK
772	410	L	189 191	11B	INSTACK
1007	420	L	193 194	6B	INSTACK
1020	440	L	196 197	6B	INSTACK
1034	460	L	199 200	6B	INSTACK
1073	480	I	209 211	14B	NOT INNER
1075	480	J	210 211	7B	
1111	490	J	212 214	14B	
1133	500	J	216 217	7B	
1173		I	228 228	4B	EXT REFS
1207		I	230 230	4B	EXT REFS
1217	540	I	231 232	21B	EXT REFS NOT INNER
1222		J	232 232	11B	EXT REFS

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
1246	550	I	237 239	13B	NOT INNER
1250	550	J	238 239	6B	INSTACK
1275	560	I	243 245	25B	EXT REFS EXITS NOT INNER
1304		J	245 245	11B	EXT REFS
1342	660	I	260 312	275B	EXT REFS NOT INNER
1351		L	262 262	11B	EXT REFS
1372	610	K	264 282	77B	EXT REFS NOT INNER
1374	580	J	265 268	13B	OPT
1417	590	N	272 273	7B	INSTACK
1476	650	K	285 310	135B	EXT REFS EXITS NOT INNER
1503	650	J	287 310	125B	EXT REFS EXITS NOT INNER
1505	620	M	288 291	13B	OPT
1532	630	N	296 297	7B	INSTACK
1644	810	I	314 392	345B	EXT REFS NOT INNER
1650	670	K	319 320	4B	INSTACK
1656	680	K	321 323	14B	OPT
1674	700	J	324 331	25B	EXT REFS EXITS NOT INNER
1702	690	K	327 330	14B	OPT
1734	720	KK	334 335	4B	INSTACK
1750	760	K	341 359	75B	EXT REFS NOT INNER
1752	730	J	342 345	11B	INSTACK
1773	740	N	349 350	7B	INSTACK
2052	800	K	365 390	133B	EXT REFS EXITS NOT INNER
2057	800	J	367 390	123B	EXT REFS EXITS NOT INNER
2061	770	M	368 371	11B	INSTACK
2104	780	N	376 377	7B	INSTACK
2217		I	394 394	4B	EXT REFS
2230		I	395 395	4B	EXT REFS
2240	830	N	396 397	21B	EXT REFS NOT INNER
2243		M	397 397	11B	EXT REFS

COMMON BLOCKS	LENGTH
DESNBL	4736 LCM

STATISTICS

PROGRAM LENGTH	4121B	2129
LCM LABELED COMMON LENGTH	11200B	4736

140000B SCM USED

```
      SUBROUTINE PROD (I1,I2,IDR)                                          UPROD      2
C                                                                          UPROD      3
C   SUBROUTINE FORMS THE PRODUCT OF TWO DEFINING RELATIONS (OR CONTRASTS   UPROD      4
C   ACCORDING TO THE DEFINITION OF D.R. MULTIPLICATION (A X A = I).        UPROD      5
C   THIS SUBROUTINE IS CALLED FROM DESIGN                                  UPROD      6
C                                                                          UPROD      7
      DIMENSION I1(12),I2(12),IDR(12)                                      UPROD      8
          DO 100 L=1,12                                                    UPROD      9
  100     IDR(L) = 0                                                       UPROD     10
      DO 120 I=1,12                                                        UPROD     11
          DO 120 J=1,12                                                    UPROD     12
          IF (I1(I).EQ.I2(J)) GO TO 110                                    UPROD     13
          GO TO 120                                                        UPROD     14
  110     I1(I) = 0                                                        UPROD     15
          I2(J) = 0                                                        UPROD     16
  120     CONTINUE                                                         UPROD     17
      NEWI = 1                                                             UPROD     18
          DO 130 I=1,12                                                    UPROD     19
          IF (I1(I).EQ.0) GO TO 130                                        UPROD     20
          IDR(NEWI) = I1(I)                                                UPROD     21
          NEWI = NEWI+1                                                    UPROD     22
  130     CONTINUE                                                         UPROD     23
          DO 140 I=1,12                                                    UPROD     24
          IF (I2(I).EQ.0) GO TO 140                                        UPROD     25
          IDR(NEWI) = I2(I)                                                UPROD     26
          NEWI = NEWI+1                                                    UPROD     27
  140     CONTINUE                                                         UPROD     28
      IF (IDR(1).LT.IDR(2)) RETURN                                         UPROD     29
      ISW = IDR(1)                                                         UPROD     30
      IDR(1) = IDR(2)                                                      UPROD     31
      IDR(2) = ISW                                                         UPROD     32
      RETURN                                                               UPROD     33
      END                                                                  UPROD     34
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	PROD	1	28 32

VARIABLES		SN	TYPE		RELOCATION									
112	I		INTEGER			REFS	12	14	19	20	24	25		
						DEFINED	10	18	23					
0	IDR		INTEGER	ARRAY	F.P.	REFS	7	2*28	29	30	DEFINED	1	9	
							20	25	30	31				
115	ISW		INTEGER			REFS	31	DEFINED	29					
0	I1		INTEGER	ARRAY	F.P.	REFS	7	12	19	20	DEFINED	1	14	
0	I2		INTEGER	ARRAY	F.P.	REFS	7	12	24	25	DEFINED	1	15	
113	J		INTEGER			REFS	12	15	DEFINED	11				
111	L		INTEGER			REFS	9	DEFINED	8					

VARIABLES	SN	TYPE	RELOCATION						
114	NEWI	INTEGER		REFS	20	21	25	26	DEFINED	17	21
				26							

STATEMENT LABELS		DEF LINE	REFERENCES		
0	100	9	8		
27	110	14	12		
34	120	16	10	11	13
56	130	22	18	19	
73	140	27	23	24	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
11	100	L	8 9	4B	INSTACK	
17	120	I	10 16	23B		NOT INNER
21	120	J	11 16	16B	OPT	
46	130	I	18 22	13B	OPT	
63	140	I	23 27	13B	OPT	

STATISTICS

PROGRAM LENGTH	132B	90

140000B SCM USED

```
1                SUBROUTINE IDEA (IDOLD,IP,ID)                                  UIDEA      2
                 C                                                               UIDEA      3
                 C   SUBROUTINE FORMS THE (N+1) SEQUENCE OF ALL POSSIBLE COMBINATIONS OF  UIDEA      4
                 C   N THINGS TAKEN FROM 1 TO N TIMES GIVEN THE NTH SEQUENCE.C   UIDEA      5
5                C   THIS SUBROUTINE IS CALLED FROM DESIGN                       UIDEA      6
                 C                                                               UIDEA      7
                   DIMENSION ID(12),IDOLD(12)                                    UIDEA      8
                       DO 100 I=1,12                                             UIDEA      9
                       IF (IDOLD(I).EQ.0) GO TO 110                              UIDEA     10
10           100       CONTINUE                                                  UIDEA     11
             110   IMI = I-1                                                     UIDEA     12
                       DO 120 J=1,IMI                                            UIDEA     13
                       IF (IDOLD(I-J).EQ.IP-J+1) GO TO 120                       UIDEA     14
                       GO TO 140                                                 UIDEA     15
15           120       CONTINUE                                                  UIDEA     16
                       DO 130 K=1,I                                              UIDEA     17
             130       ID(K) = K                                                 UIDEA     18
                   GO TO 180                                                     UIDEA     19
             140   IMJMI = I-1-J                                                 UIDEA     20
20                     DO 150 K=1,IMJMI                                          UIDEA     21
                       IF (IMJMI.EQ.0) GO TO 160                                 UIDEA     22
             150       ID(K) = IDOLD(K)                                          UIDEA     23
             160   ID(I-J) = IDOLD(I-J)+1                                        UIDEA     24
                   IMJP1 = I-J+1                                                 UIDEA     25
25                     DO 170 K=IMJP1,IMI                                        UIDEA     26
                       IF (IMJP1.GT.IMI) GO TO 180                               UIDEA     27
             170       ID(K) = ID(K-1)+1                                         UIDEA     28
             180   CONTINUE                                                      UIDEA     29
                   RETURN                                                        UIDEA     30
30                 END                                                           UIDEA     31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	IDEA	1	29

VARIABLES	SN	TYPE		RELOCATION								
106	I	INTEGER			REFS	9	11	13	16	19	2*23	24
					DEFINED	8						
0	ID	INTEGER	ARRAY	F.P.	REFS	7	27	DEFINED	1	17	22	23
						27						
0	IDOLD	INTEGER	ARRAY	F.P.	REFS	7	9	13	22	23		
					DEFINED	1						
112	IMJMI	INTEGER			REFS	20	21	DEFINED	19			
113	IMJP1	INTEGER			REFS	25	26	DEFINED	24			
107	IMI	INTEGER			REFS	12	25	26	DEFINED	11		
0	IP	INTEGER		F.P.	REFS	13	DEFINED	1				
110	J	INTEGER			REFS	2*13	19	2*23	24	DEFINED	12	
111	K	INTEGER			REFS	2*17	2*22	2*27	DEFINED	16	20	25

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	10	3	
17	110	11	9	
32	120	15	12	13
0	130	17	16	
45	140	19	14	
0	150	22	20	
62	160	23	21	
0	170	27	25	
105	180	28	18	26

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
11	100	I	8 10	5B	INSTACK	EXITS
23	120	J	12 15	12B	INSTACK	EXITS
37	130	K	16 17	4B	INSTACK	
52	150	K	20 22	7B	INSTACK	EXITS
74	170	K	25 27	10B	INSTACK	EXITS

STATISTICS
PROGRAM LENGTH 124B 84
140000B SCM USED

```
      SUBROUTINE DIALOT (TEMPF,INDEX,FDIALA,FDIALM)                          UDIALOT    2
C     SUBROUTINE RETURNS THE APPROPRIATE UNCERTAINTY FACTOR TO BE USED IN    UDIALOT    3
C     THE CODE GIVEN TEMPERATURE (TEMPF) AND INDEX NUMBER.  MUST BE CALLED   UDIALOT    4
C     AT EVERY POINT IN THE CODE WHERE FACTORS NEED TO BE APPLIED.           UDIALOT    5
C                                                                            UDIALOT    6
C     NEW UNCERTAINTY FACTORS MAY BE ADDED BY ASSIGNING THEM AN UNUSED       UDIALOT    7
C     INDEX AND INCLUDING THE FOLLOWING TWO CARDS AT THE APPROPRIATE         UDIALOT    8
C     LOCATION IN THE CODE WHERE THE FACTOR IS TO BE APPLIED.                UDIALOT    9
C     CALL DIALOT(PARAMETER,INDEX,FDIALA,FDIALM)                             UDIALOT   10
C     VARIABLE=(VARIABLE+FDIALA)*FDIALM                                      UDIALOT   11
C     WHERE                                                                  UDIALOT   12
C     VARIABLE IS THE QUANTITY TO BE MODIFIED                                UDIALOT   13
C     PARAMETER IS SOMETHING THAT THE UNCERTAINTY FACTOR IS A FUNCTION       UDIALOT   14
C     OF, FOR EXAMPLE TEMPERATURE                                            UDIALOT   15
C     INDEX IS A NUMBER IDENTIFYING THE PARTICULAR FACTOR IN THE NAMELIST    UDIALOT   16
C     FDIALA AND FDIALM ARE THE RETURNED ADDITIVE OR MULTIPLICATIVE          UDIALOT   17
C     UNCERTAINTY FACTORS, RESPECTIVELY, AS THE CASE REQUIRES                UDIALOT   18
C                                                                            UDIALOT   19
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),            DESNBL     2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,          DESNBL     3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES          DESNBL     4
     + ,IUNCRT                                                               DESNBL     5
      LEVEL 2,FACTOR                                                         DESNBL     6
C                                                                            UDIALOT   21
C     FACTOR = 0 IMPLIES ADDITION                                            UDIALOT   22
C     FACTOR = 1 IMPLIES MULTIPLICATION                                      UDIALOT   23
C                                                                            UDIALOT   24
      I = INDEX                                                              UDIALOT   25
      DO 100 J=1,4                                                           UDIALOT   26
      IF (TEMPF LT.TL(J,I).OR.TL(J,I).EQ.0) GO TO 110                        UDIALOT   27
  100 CONTINUE                                                               UDIALOT   28
  110 FDIALA = C(1,J,I)+TEMPF*(C(2,J,I)+TEMPF*(C(3,J,I)+TEMPF*C(4,J,I)))     UDIALOT   29
      FDIALA = ALPHA(I)*FDIALA                                               UDIALOT   30
      FDIALM = 1.                                                            UDIALOT   31
      IF (FACTOR(I).EQ.0.) RETURN                                            UDIALOT   32
      FDIALM = FDIALA+1.                                                     UDIALOT   33
      FDIALA = 0.                                                            UDIALOT   34
      RETURN                                                                 UDIALOT   35
      END                                                                    UDIALOT   36
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

28 1 DESNBL NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE      REFERENCES
    4  DIALOT            1        35        38

VARIABLES     SN  TYPE          RELOCATION
10464  ALPHA      REAL       ARRAY    DESNBL       REFS        19       33
 4542  AMU        REAL       ARRAY    DESNBL       REFS        19
  144  C          REAL       ARRAY    DESNBL       REFS        19      4*32
 5362  D          REAL       ARRAY    DESNBL       REFS        19
    0  FACTOR     REAL       ARRAY    DESNBL       REFS        19       23        35
    0  FDIALA     REAL                  F.P.        REFS        33       36    DEFINED         1        32        33        37
    0  FDIALM     REAL                  F.P.     DEFINED         1       34        36
   55  I          INTEGER                           REFS      2*30      4*32        33        35    DEFINED        28
10631  ICON       INTEGER    ARRAY    DESNBL       REFS        19
11173  ICOUNT     INTEGER               DESNBL       REFS        19
11172  IFLAG      INTEGER               DESNBL       REFS        19
    0  INDEX      INTEGER               F.P.         REFS        28    DEFINED         1
10630  IPRINT     INTEGER               DESNBL       REFS        19
11175  ISTART     INTEGER               DESNBL       REFS        19
11177  IUNCRT     INTEGER               DESNBL       REFS        19
   56  J          INTEGER                           REFS      2*30      4*32    DEFINED        29
 4374  LFAC       INTEGER    ARRAY    DESNBL       REFS        19
 4541  LPB        INTEGER               DESNBL       REFS        19
 4064  LRES       INTEGER    ARRAY    DESNBL       REFS        19
 4540  LTYPE      INTEGER               DESNBL       REFS        19
10463  NFAC       INTEGER               DESNBL       REFS        19
 4230  NODE       INTEGER    ARRAY    DESNBL       REFS        19
11176  NRES       INTEGER               DESNBL       REFS        19
10462  NRUN       INTEGER               DESNBL       REFS        19
11174  NTIME      INTEGER               DESNBL       REFS        19
    0  TEMPF      REAL                  F.P.         REFS        30      3*32    DEFINED         1
 3244  TL         REAL       ARRAY    DESNBL       REFS        19      2*30

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       31         29
   25  110                       32         30

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   13  100      J          29 31       11B     INSTACK    EXITS

COMMON BLOCKS   LENGTH
       DESNBL     4736 LCM

STATISTICS
  PROGRAM LENGTH                    61B      49
  LCM LABELED COMMON LENGTH      11200B    4736
        140000B SCM USED
```

```
      SUBROUTINE RUNFRP                                                 URUNFRP     2
C                                                                       URUNFRP     3
C     THIS SUBROUTINE CALLS AND EXECUTES FRAPTS THE REQUIRED NUMBER OF  URUNFRP     4
C     TIMES ACCORDING TO DESIGN. IF A RESTART FROM A PREVIOUS UNCERTAINTY URUNFRP   5
C     ANALYSIS IS BEING DONE, THE OLD DATA FILE (TAPE44) IS READ AND THE URUNFRP    6
C     ANALYSIS PICKED UP WHERE THE OLD RUN LEFT OFF. NEW RESULTS ARE    URUNFRP     7
C     WRITTEN TO TAPE45.                                                URUNFRP     8
C     ICOUNT IS A COUNTER FOR THE CURRENT RUN BEING EXECUTED            URUNFRP     9
C     NTIME COUNTS THE PRINTOUT INTERVALS                               URUNFRP    10
C     IFLAG EQUAL TO 0,1, OR 2 SIGNIFIES INPUT ONLY,INPUT PLUS          URUNFRP    11
C     NOMINAL RUN, OR COMPLETE UNCERTAINTY ANALYSIS, RESPECTIVELY       URUNFRP    12
C     ISTART EQUAL TO 1 SIGNIFIES RESTART                               URUNFRP    13
C     THIS SUBROUTINE IS CALLED FROM DRIVER                             URUNFRP    14
C                                                                       URUNFRP    15
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),       DESNBL     2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,     DESNBL     3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES     DESNBL     4
     + ,IUNCRT                                                          DESNBL     5
      LEVEL 2,FACTOR                                                    DESNBL     6
      DIMENSION DUM(100)                                                URUNFRP    17
      NRES = 0                                                          URUNFRP    18
          DO 100 I=1,100                                                URUNFRP    19
  100     IF (LRES(I).GT.0) NRES = NRES+1                               URUNFRP    20
      IF (IFLAG.EQ.0) STOP                                              URUNFRP    21
      IF (ISTART.EQ.0) ICOUNT = 0                                       URUNFRP    22
      WRITE (45,210) NRUN,NRES,NFAC                                     URUNFRP    23
      IF (ISTART.EQ.0) GO TO 160                                        URUNFRP    24
      REWIND 44                                                         URUNFRP    25
      READ (44,210) NRUNO,NRESO,NFACO                                   URUNFRP    26
      IF (NRES.NE.NRESO) GO TO 110                                      URUNFRP    27
      IF (NFAC.NE.NFACO) GO TO 110                                      URUNFRP    28
      GO TO 120                                                         URUNFRP    29
  110 WRITE (6,220) NRES,NRESO,NFAC,NFACO                               URUNFRP    30
      STOP                                                              URUNFRP    31
  120 CONTINUE                                                          URUNFRP    32
C                                                                       URUNFRP    33
C   READ OLD DATA FILES TIL EOF                                         URUNFRP    34
C   LOOK FOR OLD NTIME                                                  URUNFRP    35
C                                                                       URUNFRP    36
      NTMAX = 1                                                         URUNFRP    37
  130 READ (44,230) ICOUNT,NT,(DUM(I),I=1,NRES)                         URUNFRP    38
      IF (NT.GT.NTMAX) NTMAX = NT                                       URUNFRP    39
      IF (EOF(44)) 140,130                                              URUNFRP    40
  140 REWIND 44                                                         URUNFRP    41
      REWIND 45                                                         URUNFRP    42
      IF (NT.NE.NTMAX) ICOUNT = ICOUNT-1                                URUNFRP    43
      READ (44,210) NRUNO,NRESO,NFACO                                   URUNFRP    44
      WRITE (45,210) NRUN,NRES,NFAC                                     URUNFRP    45
      NDATA = ICOUNT*NTMAX                                              URUNFRP    46
          DO 150 J=1,NDATA                                              URUNFRP    47
          READ (44,230) NDUM1,NDUM2,(DUM(I),I=1,NRES)                   URUNFRP    48
  150     WRITE (45,230) NDUM1,NDUM2,(DUM(I),I=1,NRES)                  URUNFRP    49
  160 IF (IFLAG.EQ.1) GO TO 200                                         URUNFRP    50
```

```
                    JCOUNT = ICOUNT+1                                                    URUNFRP    51
55                      DO 190 I=JCOUNT,NRUN                                             URUNFRP    52
                        ICOUNT = I                                                       URUNFRP    53
                            DO 170 K=1,100                                               URUNFRP    54
              170           ALPHA(K) = 0.                                                URUNFRP    55
                            DO 180 J=1,NFAC                                              URUNFRP    56
60            180           ALPHA(LFAC(J)) = D(I,J)                                      URUNFRP    57
                        CALL FRPCON (IAXSYM)                                             URUNFRP    58
                        REWIND 1                                                         URUNFRP    59
                        REWIND 5                                                         URUNFRP    60
                        REWIND 6                                                         URUNFRP    61
65            190       CONTINUE                                                         URUNFRP    62
              200   CONTINUE                                                             URUNFRP    63
                    RETURN                                                               URUNFRP    64
                  C                                                                      URUNFRP    65
                  210   FORMAT (315)                                                     URUNFRP    66
70                220   FORMAT (1H ,35H WARNING: NUMBER OF NEW RESPONSES (,I2,40H) NOT EQU URUNFRP    67
                     +AL TO OLD NUMBER OF RESPONSES (,I2,1H)/27H OR NUMBER OF NEW FACTOR URUNFRP    68
                     +S (,I2,38H) NOT EQUAL TO OLD NUMBER OF FACTORS (,I2,1H),/21H EXECU URUNFRP    69
                     +TION TERMINATED)                                                   URUNFRP    70
                  230   FORMAT (2I5,(10E12.5))                                         URUNFRP    71
75                      END                                                            URUNFRP    72
```

```
CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

    21     1       DESNBL     NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
2	RUNFRP	1	67

VARIABLES		SN	TYPE		RELOCATION									
10464	ALPHA		REAL	ARRAY	DESNBL	REFS	15	DEFINED	58	60				
4542	AMU		REAL	ARRAY	DESNBL	REFS	15							
144	C		REAL	ARRAY	DESNBL	REFS	15							
5362	D		REAL	ARRAY	DESNBL	REFS	15	60						
354	DUM		REAL	ARRAY		REFS	20	52	DEFINED	41	51			
0	FACTOR		REAL	ARRAY	DESNBL	REFS	15	19						
337	I		INTEGER			REFS	23	41	51	52	56	60		
						DEFINED	22	41	51	52	55			
353	IAXSYM	*	INTEGER			REFS	61							
10631	ICON		INTEGER	ARRAY	DESNBL	REFS	15							
11173	ICOUNT		INTEGER		DESNBL	REFS	15	46	49	54	DEFINED	25	41	
						46	56							
11172	IFLAG		INTEGER		DESNBL	REFS	15	24	53					

VARIABLES	SN	TYPE		RELOCATION								
10630	IPRINT	INTEGER		DESNBL	REFS	15						
11175	ISTART	INTEGER		DESNBL	REFS	15	25	27				
11177	IUNCRT	INTEGER		DESNBL	REFS	15						
346	J	INTEGER			REFS	2*60	DEFINED	50	59			
351	JCOUNT	INTEGER			REFS	55	DEFINED	54				
352	K	INTEGER			REFS	58	DEFINED	57				
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	15	60					
4541	LPB	INTEGER		DESNBL	REFS	15						
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	15	23					
4540	LTYPE	INTEGER		DESNBL	REFS	15						
345	NDATA	INTEGER			REFS	50	DEFINED	49				
347	NDUM1	INTEGER			REFS	52	DEFINED	51				
350	NDUM2	INTEGER			REFS	52	DEFINED	51				
10463	NFAC	INTEGER		DESNBL	REFS	15	26	31	33	48	59	
342	NFAC0	INTEGER			REFS	31	33	DEFINED	29	47		
4230	NODE	INTEGER	ARRAY	DESNBL	REFS	15						
11176	NRES	INTEGER		DESNBL	REFS	15	23	26	30	33	41	48
					51	52	DEFINED	21	23			
341	NRES0	INTEGER			REFS	30	33	DEFINED	29	47		
10462	NRUN	INTEGER		DESNBL	REFS	15	26	48	55			
340	NRUN0	INTEGER			DEFINED	29	47					
344	NT	INTEGER			REFS	2*42	46	DEFINED	41			
11174	NTIME	INTEGER		DESNBL	REFS	15						
343	NTMAX	INTEGER			REFS	42	46	49	DEFINED	40	42	
3244	TL	REAL	ARRAY	DESNBL	REFS	15						

FILE NAMES	MODE								
TAPE1		MOTION	62						
TAPE44	FMT	READS	29	41	47	51	MOTION	28	44
TAPE45	FMT	WRITES	26	48	52	MOTION	45		
TAPE5		MOTION	63						
TAPE6	FMT	WRITES	33	MOTION	64				

EXTERNALS	TYPE	ARGS	REFERENCES
EOF	REAL	1	43
FRPCON		1	61

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		23	22			
45	110		33	30	31		
52	120		35	32			
55	130		41	43			
0	140	INACTIVE	44	43			
0	150		52	50			
134	160		53	27			
0	170		58	57			
0	180		60	59			
0	190		65	55			
202	200		66	53			
302	210	FMT	69	26	29	47	48
304	220	FMT	70	33			
332	230	FMT	74	41	51	52	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
7	100	I	22 23	10B	INSTACK
114	150	J	50 52	17B	EXT REFS
143	190	I	55 65	36B	EXT REFS NOT INNER
147	170	K	57 58	4B	INSTACK
155	180	J	59 60	10B	

COMMON BLOCKS	LENGTH
DESNBL	4736 LCM

STATISTICS

PROGRAM LENGTH	520B	336
LCM LABELED COMMON LENGTH	11200B	4736

140000B SCM USED

```
      SUBROUTINE NAMES                                                  UNAMES     2
C                                                                       UNAMES     3
C   SUBROUTINE USED TO WRITE THE NAMES OF THE RESPONSE OUTPUTS SELECTED  UNAMES     4
C   BY THE USER AND THE VALUES OF THOSE OUTPUTS AS GENERATED BY THE CODE UNAMES     5
C   THIS SUBROUTINE IS CALLED FROM DRIVER                               UNAMES     6
C                                                                       UNAMES     7
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),       DESNBL     2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,     DESNBL     3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES     DESNBL     4
     + ,IUNCRT                                                          DESNBL     5
      LEVEL 2,FACTOR                                                    DESNBL     6
      DIMENSION DUM(100)                                                UNAMES     9
      DIMENSION NAM(4,24),LAM(3)                                        UNAMES    10
      DATA NAM(1, 1)/40HZIRCALOY-OXIDE THICKNESS (M)                 /  UNAMES    11
      DATA NAM(1, 2)/40HNET PERMANENT FUEL DEFORMATION               /  UNAMES    12
      DATA NAM(1, 3)/40HCLADDING PLASTIC HOOP STRAIN                 /  UNAMES    13
      DATA NAM(1, 4)/40HCLADDING PLASTIC AXIAL STRAIN                /  UNAMES    14
      DATA NAM(1, 5)/40HCLADDING PLASTIC RADIAL STRAIN               /  UNAMES    15
      DATA NAM(1, 6)/40HCLADDING PEAK OPER. TEMPERATURE (K)          /  UNAMES    16
      DATA NAM(1, 7)/40HOPEN POROSITY                                /  UNAMES    17
      DATA NAM(1, 8)/40HFUEL BURNUP (MWD/MTU)                        /  UNAMES    18
      DATA NAM(1, 9)/40HFUEL CENTERLINE TEMPERATURE (K)              /  UNAMES    19
      DATA NAM(1,10)/40HFUEL SURFACE TEMPERATURE (K)                 /  UNAMES    20
      DATA NAM(1,11)/40HCLADDING INNER SURFACE TEMPERATURE (K)       /  UNAMES    21
      DATA NAM(1,12)/40HCLADDING OUTER SURFACE TEMPERATURE (K)       /  UNAMES    22
      DATA NAM(1,13)/40HINTERNAL GAS PRESSURE (PA)                   /  UNAMES    23
      DATA NAM(1,14)/40HRADIAL GAS GAP (M)                           /  UNAMES    24
      DATA NAM(1,15)/40HGM--MOLES GAS IN THE ROD                     /  UNAMES    25
      DATA NAM(1,16)/40HMOLE FRACTION OF GAS IN THE ROD              /  UNAMES    26
      DATA NAM(1,17)/40HCLADDING RESIDUAL HOOP STRAINS               /  UNAMES    27
      DATA NAM(1,18)/40HCLADDING RESIDUAL AXIAL STRAINS              /  UNAMES    28
      DATA NAM(1,19)/40HCLADDING RESIDUAL RADIAL STRAINS             /  UNAMES    29
      DATA NAM(1,20)/40HFUEL RESIDUAL HOOP STRAINS                   /  UNAMES    30
      DATA NAM(1,21)/40HFUEL RESIDUAL AXIAL STRAINS                  /  UNAMES    31
      DATA NAM(1,22)/40HFUEL RESIDUAL RADIAL STRAINS                 /  UNAMES    32
      DATA NAM(1,23)/40HINTERFACE PRESSURE (PA)                      /  UNAMES    33
      DATA NAM(1,24)/40HCLADDING EFFECTIVE PLASTIC STRAIN            /  UNAMES    34
      DATA LAM/9HRESPONSE ,4H IS ,9H AT NODE /                          UNAMES    35
      WRITE (6,160)                                                     UNAMES    36
          DO 100 I=1,100                                                UNAMES    37
          IF (LRES(I).EQ.0) GO TO 100                                   UNAMES    38
          IF (LRES(I).EQ.13.OR.LRES(I).EQ.15) WRITE (6,140) LAM(1),I,LAM UNAMES    39
     +    (2),(NAM(J,LRES(I)),J=1,4)                                    UNAMES    40
          IF (LRES(I).NE.13.AND.LRES(I).NE.15) WRITE (6,150) LAM(1),I,LA UNAMES    41
     +    M(2),(NAM(J,LRES(I)),J=1,4),LAM(3),NODE(I)                    UNAMES    42
  100     CONTINUE                                                      UNAMES    43
      WRITE (6,180)                                                     UNAMES    44
      WRITE (6,190)                                                     UNAMES    45
      WRITE (6,200) (I,I=1,NRES)                                        UNAMES    46
      WRITE (6,210)                                                     UNAMES    47
      REWIND 45                                                         UNAMES    48
      READ (45,130) NDUM1,NDUM2,NDUM3                                   UNAMES    49
  110 READ (45,170) NDUM1,NDUM2,(DUM(I),I=1,NRES)                       UNAMES    50
```

```
                WRITE (6,170) NDUM1,NDUM2,(DUM(I),I=1,NRES)                    UNAMES     51
55              IF (EOF(45)) 120,110                                           UNAMES     52
          120   RETURN                                                         UNAMES     53
                C                                                              UNAMES     54
          130   FORMAT (3I5)                                                   UNAMES     55
          140   FORMAT (1H ,A9,I2,A4,4A10,/)                                   UNAMES     56
60        150   FORMAT (1H ,A9,I2,A4,4A10,A9,I2,/)                             UNAMES     57
          160   FORMAT (1H1,10X,27HUNCERTAINTY ANALYSIS OUTPUT,//)             UNAMES     58
          170   FORMAT (2I5,(10E12.5))                                         UNAMES     59
          180   FORMAT (1H ,22HRESPONSE OUTPUT VALUES,/)                       UNAMES     60
          190   FORMAT (1H ,23H  RUN  TIME  RESPONSES:,/)                      UNAMES     61
65        200   FORMAT (1H ,(5X,10I12))                                        UNAMES     62
          210   FORMAT (1H )                                                   UNAMES     63
                END                                                            UNAMES     64
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

```
  14    1     DESNBL    NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.
  14    1     ZIRCALOY  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  15    1     NET PERM  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  16    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  17    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  18    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  19    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  20    1     OPEN POR  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  21    1     FUEL BUR  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  22    1     FUEL CEN  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  23    1     FUEL SUR  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  24    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  25    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  26    1     INTERNAL  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  27    1     RADIAL G  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  28    1     GM-MOLES  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  29    1     MOLE FRA  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  30    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  31    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  32    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  33    1     FUEL RES  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  34    1     FUEL RES  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  35    1     FUEL RES  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  36    1     INTERFAC  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
  37    1     CLADDING  HOLLERITH CONSTANT .GT. 10 CHARACTERS, EXCESS CHARACTERS INITIALIZED INTO SUCCEEDING WORDS.
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
2 NAMES 1 56

VARIABLES	SN	TYPE	RELOCATION									
10464	ALPHA	REAL	ARRAY	DESNBL	REFS	7						
4542	AMU	REAL	ARRAY	DESNBL	REFS	7						
144	C	REAL	ARRAY	DESNBL	REFS	7						
5362	D	REAL	ARRAY	DESNBL	REFS	7						
276	DUM	REAL	ARRAY		REFS	12	54	DEFINED	53			
0	FACTOR	REAL	ARRAY	DESNBL	REFS	7	11					
271	I	INTEGER			REFS	41	4*42	5*44	49	53	54	
					DEFINED	40	49	53	54			
10631	ICON	INTEGER	ARRAY	DESNBL	REFS	7						
11173	ICOUNT	INTEGER		DESNBL	REFS	7						
11172	IFLAG	INTEGER		DESNBL	REFS	7						
10630	IPRINT	INTEGER		DESNBL	REFS	7						
11175	ISTART	INTEGER		DESNBL	REFS	7						
11177	IUNCRT	INTEGER		DESNBL	REFS	7						
272	J	INTEGER			REFS	42	44	DEFINED	42	44		
602	LAM	INTEGER	ARRAY		REFS	13	2*42	3*44	DEFINED	38		
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	7						
4541	LPB	INTEGER		DESNBL	REFS	7						
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	7	41	3*42	3*44			
4540	LTYPE	INTEGER		DESNBL	REFS	7						
442	NAM	INTEGER	ARRAY		REFS	13	42	44	DEFINED	14	15	16
						17	18	19	20	21	22	23	24
						25	26	27	28	29	30	31	32
						33	34	35	36	37			
273	NDUM1	INTEGER			REFS	54	DEFINED	52	53				
274	NDUM2	INTEGER			REFS	54	DEFINED	52	53				
275	NDUM3	* INTEGER			DEFINED	52							
10463	NFAC	INTEGER		DESNBL	REFS	7							
4230	NODE	INTEGER	ARRAY	DESNBL	REFS	7	44						
11176	NRES	INTEGER		DESNBL	REFS	7	49	53	54				
10462	NRUN	INTEGER		DESNBL	REFS	7							
11174	NTIME	INTEGER		DESNBL	REFS	7							
3244	TL	REAL	ARRAY	DESNBL	REFS	7							

FILE NAMES	MODE									
TAPE45	FMT	READS	52	53	MOTION	51				
TAPE6	FMT	WRITES	39	42	44	47	48	49	50	54

EXTERNALS	TYPE	ARGS	REFERENCES
EOF	REAL	1	55

STATEMENT LABELS			DEF LINE	REFERENCES	
64	100		46	40	41
113	110		53	55	
0	120	INACTIVE	56	55	
230	130	FMT	58	52	
232	140	FMT	59	42	
235	150	FMT	60	44	
241	160	FMT	61	39	

STATEMENT LABELS			DEF LINE	REFERENCES	
246	170	FMT	62	53	54
251	180	FMT	63	47	
256	190	FMT	64	48	
263	200	FMT	65	49	
266	210	FMT	66	50	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
7	100	I	40 46	60B	EXT REFS	NOT INNER
22		J	42 42	11B	EXT REFS	
45		J	44 44	11B	EXT REFS	
76		I	49 49	4B	EXT REFS	

COMMON BLOCKS	LENGTH
DESNBL	4736 LCM

STATISTICS

PROGRAM LENGTH	605B	389
LCM LABELED COMMON LENGTH	11200B	4736

140000B SCM USED

```
      SUBROUTINE ANSWER                                                 UANSWER     2
C                                                                       UANSWER     3
C     SUBROUTINE RETURNS THE RESPONSE SURFACE COEFFICIENTS AND ESTIMATED UANSWER     4
C     MEANS AND VARIANCES.                                              UANSWER     5
C     THIS SUBROUTINE IS CALLED FROM DRIVER                             UANSWER     6
C                                                                       UANSWER     7
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),       DESNBL      2
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,     DESNBL      3
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES     DESNBL      4
     + ,IUNCRT                                                          DESNBL      5
      LEVEL 2,FACTOR                                                    DESNBL      6
      DIMENSION DUM(100),Y(40,100)                                      UANSWER     9
      DIMENSION BI(40),BIJ(40,40)                                       UANSWER    10
      NTM1 = NTIME-1                                                    UANSWER    11
C                                                                       UANSWER    12
C     FIRST NESTED LOOP ON TIME INCREMENTS                              UANSWER    13
C                                                                       UANSWER    14
      DO 390 K=1,NTM1                                                   UANSWER    15
      REWIND 45                                                         UANSWER    16
      READ (45,400) NRUNO,NRESO,NFACO                                   UANSWER    17
100   READ (45,410) NCOUNT,NT,(DUM(I),I=1,NRES)                         UANSWER    18
          DO 110 I=1,NRES                                               UANSWER    19
110       IF (NT.EQ.K) Y(NCOUNT,I) = DUM(I)                             UANSWER    20
      IF (EOF(45)) 120,100                                              UANSWER    21
C                                                                       UANSWER    22
C     SECOND NESTED LOOP ON RESPONSES                                   UANSWER    23
C                                                                       UANSWER    24
120       DO 390 J=1,NRES                                               UANSWER    25
          WRITE (6,420) J,K                                             UANSWER    26
C                                                                       UANSWER    27
C     LOOP ON B0'S                                                      UANSWER    28
C                                                                       UANSWER    29
          SUM = 0.                                                      UANSWER    30
              DO 130 I=1,NRUN                                           UANSWER    31
130           SUM = SUM+Y(I,J)                                          UANSWER    32
          B0 = SUM/NRUN                                                 UANSWER    33
C                                                                       UANSWER    34
C     LOOP FOR BI'S                                                     UANSWER    35
C                                                                       UANSWER    36
              DO 150 L=1,NFAC                                           UANSWER    37
              SUM = 0.                                                  UANSWER    38
              DIV = 0.                                                  UANSWER    39
                  DO 140 I=1,NRUN                                       UANSWER    40
                  SUM = SUM+Y(I,J)*D(I,L)                               UANSWER    41
140               DIV = D(I,L)*D(I,L)+DIV                               UANSWER    42
150           BI(L) = SUM/DIV                                           UANSWER    43
C                                                                       UANSWER    44
C     LOOP FOR BIJ'S                                                    UANSWER    45
C                                                                       UANSWER    46
              DO 170 L=1,NFAC                                           UANSWER    47
                  DO 170 M=1,NFAC                                       UANSWER    48
                  SUM = 0.                                              UANSWER    49
                  DIV = 0.                                              UANSWER    50
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```
                                DO 160 I=1,NRUN                                    UANSWER   51
55                              SUM = SUM+Y(I,J)*D(I,L)*D(I,M)                     UANSWER   52
          160                   DIV = DIV+D(I,L)*D(I,L)*D(I,M)*D(I,M)              UANSWER   53
          170             BIJ(L,M) = SUM/DIV                                       UANSWER   54
                          C                                                        UANSWER   55
                          C   LOOP FOR REAL BII'S                                  UANSWER   56
60                        C                                                        UANSWER   57
                        IF (LTYPE.LT.3) GO TO 210                                  UANSWER   58
                        AM = NRUN-2.*NFAC-1.                                       UANSWER   59
                        RAD = (AM**2+2.*AM*NFAC+AM)**0.5                           UANSWER   60
                        ALP = ((AM-RAD)/(-2.))**0.5                                UANSWER   61
65                      CON = (NRUN-2.*NFAC-1.+2.*ALP**2)/NRUN                     UANSWER   62
                            DO 190 L=1,NFAC                                        UANSWER   63
                            SUM = 0.                                               UANSWER   64
                            DIV = 0.                                               UANSWER   65
                                DO 180 I=1,NRUN                                    UANSWER   66
70                              SUM = SUM+Y(I,J)*(D(I,L)*D(I,L)-CON)               UANSWER   67
          180                   DIV = DIV+(D(I,L)*D(I,L)-CON)**2                   UANSWER   68
          190               BIJ(L,L) = SUM/DIV                                     UANSWER   69
                          C                                                        UANSWER   70
                          C   CORRECTION FACTOR FOR B0 TO ACCOUNT FOR TRANSFORMATION OF XII'S  UANSWER   71
75                        C                                                        UANSWER   72
                        SUMC = 0.                                                  UANSWER   73
                            DO 200 I=1,NFAC                                        UANSWER   74
          200               SUMC = SUMC+BIJ(I,I)                                   UANSWER   75
                        B0 = B0-CON*SUMC                                           UANSWER   76
80        210           NUMBER = NFAC*(NFAC+1)/2                                   UANSWER   77
                        IF (NFAC.GT.15.OR.LPB.EQ.1) GO TO 270                      UANSWER   78
                            DO 240 M=1,NUMBER                                      UANSWER   79
                            LSUM = 0                                               UANSWER   80
                                DO 220 I=1,NFAC                                    UANSWER   81
85        220                   IF (ICON(I,I).EQ.M) LSUM = LSUM+1                  UANSWER   82
                            NFACM1 = NFAC-1                                        UANSWER   83
                                DO 240 I=1,NFACM1                                  UANSWER   84
                                IP1 = I+1                                          UANSWER   85
                                    DO 240 N=IP1,NFAC                              UANSWER   86
90                                  IF (ICON(I,N).EQ.M) LSUM = LSUM+1              UANSWER   87
                                    IF (LSUM.GT.1.AND.ICON(I,N).EQ.M) GO TO 230    UANSWER   88
                                    GO TO 240                                      UANSWER   89
          230                       BIJ(I,N) = 0.                                  UANSWER   90
                                    BIJ(N,I) = 0.                                  UANSWER   91
95        240                       CONTINUE                                       UANSWER   92
                        IF (LTYPE.GT.2) GO TO 260                                  UANSWER   93
                            DO 250 I=1,NFAC                                        UANSWER   94
          250               BIJ(I,I) = 0.                                          UANSWER   95
          260           CONTINUE                                                   UANSWER   96
100                     GO TO 290                                                  UANSWER   97
          270               DO 280 L=1,NFAC                                        UANSWER   98
                                DO 280 M=1,NFAC                                    UANSWER   99
          280                   BIJ(L,M) = 0.                                      UANSWER  100
                          C                                                        UANSWER  101
105       C   WRITE OUT COEFFICIENTS                                               UANSWER  102
          C                                                                        UANSWER  103
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```
      290         WRITE (6,430) B0                                                  UANSWER  104
                  WRITE (6,440)                                                     UANSWER  105
                  WRITE (6,470) (BI(L),L=1,NFAC)                                    UANSWER  106
110               WRITE (6,450)                                                     UANSWER  107
                  WRITE (6,460)                                                     UANSWER  108
                      DO 300 M=1,NFAC                                               UANSWER  109
      300             WRITE (6,470) (BIJ(L,M),L=1,NFAC)                             UANSWER  110
                  WRITE (6,450)                                                     UANSWER  111
115       C                                                                         UANSWER  112
          C   CALCULATE MEANS AND VARIANCES                                        UANSWER  113
          C                                                                         UANSWER  114
                  AMEAN2 = 0.                                                       UANSWER  115
                  VAR = 0.                                                          UANSWER  116
120               VAR2 = 0.                                                         UANSWER  117
                  SUMIJ = 0.                                                        UANSWER  118
                      DO 310 I=1,NFAC                                               UANSWER  119
                      AMEAN2 = AMEAN2+BIJ(I,I)                                      UANSWER  120
                      VAR = VAR+BI(I)**2                                            UANSWER  121
125       310           VAR2 = VAR2+2.*BI(I)*BIJ(I,I)*AMU(3,LFAC(I))/AMU(2,LFA      UANSWER  122
                +       C(I))**1.5+BIJ(I,I)**2*AMU(4,LFAC(I))/AMU(2,LFAC(I))**    UANSWER  123
                +       2-BIJ(I,I)**2                                             UANSWER  124
                  IF (NFAC.EQ.1) GO TO 330                                          UANSWER  125
                  NFM1 = NFAC-1                                                     UANSWER  126
130               DO 320 I=1,NFM1                                                   UANSWER  127
                  IP1 = I+1                                                         UANSWER  128
                      DO 320 N=IP1,NFAC                                             UANSWER  129
      320             SUMIJ = SUMIJ+BIJ(I,N)**2                                     UANSWER  130
      330         CONTINUE                                                          UANSWER  131
135               VAR2 = VAR2+SUMIJ+VAR                                             UANSWER  132
                  AMEAN2 = B0+AMEAN2                                                UANSWER  133
                  WRITE (6,480) B0,AMEAN2,VAR,VAR2                                  UANSWER  134
                  WRITE (6,490)                                                     UANSWER  135
                  IF (VAR2.EQ.0.) GO TO 390                                         UANSWER  136
140               DO 340 L=1,NFAC                                                   UANSWER  137
                  TERM = BI(L)**2/VAR2                                              UANSWER  138
      340         IF (TERM.GT.0.01) WRITE (6,500) L,TERM                            UANSWER  139
                  DO 350 L=1,NFAC                                                   UANSWER  140
                  TERM = BIJ(L,L)**2*(AMU(4,LFAC(L))/AMU(2,LFAC(L))**2-1            UANSWER  141
145             +   )/VAR2                                                         UANSWER  142
      350         IF (TERM.GT.0.01) WRITE (6,510) L,L,TERM                          UANSWER  143
                  DO 360 L=1,NFAC                                                   UANSWER  144
                  TERM = 2.*BI(L)*BIJ(L,L)*AMU(3,LFAC(L))/AMU(2,LFAC(L))            UANSWER  145
                +   **1.5/VAR2                                                      UANSWER  146
150       360       IF (TERM.GT.0.01) WRITE (6,520) L,L,L,TERM                      UANSWER  147
                  IF (NFAC.EQ.1) GO TO 380                                          UANSWER  148
                      DO 370 L=1,NFM1                                               UANSWER  149
                      LP1 = L+1                                                     UANSWER  150
                          DO 370 M=LP1,NFAC                                         UANSWER  151
155                       TERM = BIJ(L,M)**2/VAR2                                   UANSWER  152
      370                 IF (TERM.GT.0.01) WRITE (6,510) L,M,TERM                  UANSWER  153
      380         CONTINUE                                                          UANSWER  154
      390         CONTINUE                                                          UANSWER  155
                  RETURN                                                            UANSWER  156
```

```
      C                                                                                 UANSWER   157
      400   FORMAT (315)                                                                UANSWER   158
      410   FORMAT (215,(10E12.5))                                                      UANSWER   159
      420   FORMAT (1H ,////,10H RESPONSE ,I2,19H AT TIME INCREMENT ,I2,/)               UANSWER   160
      430   FORMAT (1H ,5HBO = ,E12.5,/)                                                UANSWER   161
      440   FORMAT (1H ,8HBI(L) = ,/)                                                   UANSWER   162
      450   FORMAT (1H )                                                                UANSWER   163
      460   FORMAT (1H ,10HBIJ(L,M) =,/)                                                UANSWER   164
      470   FORMAT ((10E12.5))                                                          UANSWER   165
      480   FORMAT (1H ,8H MEAN = ,E12.5,9H MEAN2 = ,E12.5,7H VAR = ,E12.5,8H           UANSWER   166
     +VAR2 = ,E12.5,/)                                                                UANSWER   167
      490   FORMAT (1H ,59H FRACTIONAL CONTRIBUTIONS TO THE VARIANCE GREATER T          UANSWER   168
     +HAN 0.01,/)                                                                     UANSWER   169
      500   FORMAT (1H ,3HBI(,I2,4H) : ,F4.2)                                           UANSWER   170
      510   FORMAT (1H ,4HBIJ(,I2,1H,,I2,4H) : ,F4.2)                                   UANSWER   171
      520   FORMAT (1H ,3HBI(,I2,6H)*BIJ(,I2,1H,,I2,4H) : ,F4.2)                        UANSWER   172
            END                                                                         UANSWER   173
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

14 I DESNBL NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
2 ANSWER 1 159

VARIABLES	SN	TYPE	RELOCATION									
1211	ALP	REAL			REFS	65	DEFINED	64				
10464	ALPHA	REAL	ARRAY	DESNBL	REFS	7						
1207	AM	REAL			REFS	3*63	64	DEFINED	62			
1221	AMEAN2	REAL			REFS	123	136	137	DEFINED	118	123	136
4542	AMU	REAL	ARRAY	DESNBL	REFS	7	4*125	2*144	2*148			
11234	BI	REAL	ARRAY		REFS	13	109	124	125	141	148	
					DEFINED	46						
11304	BIJ	REAL	ARRAY		REFS	13	78	113	123	3*125	133	144
						148	155	DEFINED	57	72	93	94	98
						103						
1203	BO	REAL			REFS	79	107	136	137	DEFINED	36	79
144	C	REAL	ARRAY	DESNBL	REFS	7						
1212	CON	REAL			REFS	70	71	79	DEFINED	65		
5362	D	REAL	ARRAY	DESNBL	REFS	7	44	2*45	2*55	4*56	2*70	2*71
1205	DIV	REAL			REFS	45	46	56	57	71	72	
					DEFINED	42	45	53	56	68	71	
1230	DUM	REAL	ARRAY		REFS	12	23	DEFINED	21			
0	FACTOR	REAL	ARRAY	DESNBL	REFS	7	11					

VARIABLES	SN	TYPE	RELOCATION									
1200	I	INTEGER			REFS	21	2*23	35	2*44	2*45	3*55	4*56
						3*70	2*71	2*78	2*85	88	90	91	93
						94	2*98	2*123	124	11*125	131	133	
					DEFINED	21	22	34	43	54	69	77	
						84	87	97	122	130			
10631	ICON	INTEGER	ARRAY	DESNBL	REFS	7	85	90	91				
11173	ICOUNT	INTEGER		DESNBL	REFS	7							
11172	IFLAG	INTEGER		DESNBL	REFS	7							
10630	IPRINT	INTEGER		DESNBL	REFS	7							
1217	IPI	INTEGER			REFS	89	132	DEFINED	88	131			
11175	ISTART	INTEGER		DESNBL	REFS	7							
11177	IUNCRT	INTEGER		DESNBL	REFS	7							
1201	J	INTEGER			REFS	29	35	44	55	70			
					DEFINED	28							
1172	K	INTEGER			REFS	23	29	DEFINED	18				
1204	L	INTEGER			REFS	44	2*45	46	55	2*56	57	2*70	
						2*71	2*72	103	109	113	141	142	4*144
						2*146	5*148	3*150	153	155	156		
					DEFINED	40	50	66	101	109	113	140	
						143	147	152					
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	7	4*125	2*144	2*148				
4541	LPB	INTEGER		DESNBL	REFS	7	81						
1227	LPI	INTEGER			REFS	154	DEFINED	153					
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	7							
1215	LSUM	INTEGER			REFS	85	90	91	DEFINED	83	85	90	
4540	LTYPE	INTEGER		DESNBL	REFS	7	61	96					
1206	M	INTEGER			REFS	55	2*56	57	65	90	91	103	
						113	155	156	DEFINED	51	82	102	112
						154							
1220	N	INTEGER			REFS	90	91	93	94	133			
					DEFINED	89	132						
1176	NCOUNT	INTEGER			REFS	23	DEFINED	21					
10463	NFAC	INTEGER		DESNBL	REFS	7	40	50	51	62	63	65	
						66	77	2*80	81	84	86	89	97
						101	102	109	112	113	122	128	129
						132	140	143	147	151	154		
1216	NFACMI	INTEGER			REFS	87	DEFINED	86					
1175	NFACO	* INTEGER			DEFINED	20							
1225	NFMI	INTEGER			REFS	130	152	DEFINED	129				
4230	NODE	INTEGER	ARRAY	DESNBL	REFS	7							
11176	NRES	INTEGER		DESNBL	REFS	7	21	22	28				
1174	NRESO	* INTEGER			DEFINED	20							
10462	NRUN	INTEGER		DESNBL	REFS	7	34	36	43	54	62	2*65	
						69							
1173	NRUNO	* INTEGER			DEFINED	20							
1177	NT	INTEGER			REFS	23	DEFINED	21					
11174	NTIME	INTEGER		DESNBL	REFS	7	14						
1171	NTMI	INTEGER			REFS	18	DEFINED	14					
1214	NUMBER	INTEGER			REFS	62	DEFINED	80					
1210	RAD	REAL			REFS	64	DEFINED	63					
1202	SUM	REAL			REFS	35	36	44	46	55	57	70	
						72	DEFINED	33	35	41	44	52	55
						67	70						

```
VARIABLES     SN  TYPE          RELOCATION
 1213  SUMC       REAL                        REFS      78      79    DEFINED      76      78
 1224  SUMIJ      REAL                        REFS     133     135    DEFINED     121     133
 1226  TERM       REAL                        REFS   2*142   2*146    2*150    2*156   DEFINED     141     144
                                              148     155
 3244  TL         REAL       ARRAY  DESNBL    REFS       7
 1222  VAR        REAL                        REFS     124     135     137    DEFINED     119     124
 1223  VAR2       REAL                        REFS     125     135     137     139     141     144     148
                                              155  DEFINED     120     125     135
 1374  Y          REAL       ARRAY            REFS      12      35      44      55      70
                                           DEFINED      23

FILE NAMES      MODE
      TAPE45    FMT                 READS      20      21    MOTION      19
      TAPE6     FMT                WRITES      29     107     108     109     110     111     113     114
                                       137     138     142     146     150     156

EXTERNALS         TYPE   ARGS       REFERENCES
      EOF         REAL      1          24

STATEMENT LABELS                    DEF LINE   REFERENCES
   15  100                             21         24
    0  110                             23         22
    0  120          INACTIVE           28         24
    0  130                             35         34
    0  140                             45         43
    0  150                             46         40
    0  160                             56         54
    0  170                             57         50      51
    0  180                             71         69
    0  190                             72         66
    0  200                             78         77
  310  210                             80         61
    0  220                             85         84
  371  230                             93         91
  401  240                             95         82      87      89      92
    0  250                             98         97
  425  260                             99         96
  427  270                            101         81
    0  280                            103        101     102
  445  290                            107        100
    0  300                            113        112
    0  310                            125        122
    0  320                            133        130     132
  577  330                            134        128
    0  340                            142        140
    0  350                            146        143
    0  360                            150        147
    0  370                            156        152     154
  733  380                            157        151
  734  390                            158         18      28      139
 1072  400      FMT                   161         20
 1074  410      FMT                   162         21
 1077  420      FMT                   163         29
```

STATEMENT LABELS			DEF LINE	REFERENCES	
1106	430	FMT	164	107	
1111	440	FMT	165	108	
1114	450	FMT	166	110	114
1116	460	FMT	167	111	
1121	470	FMT	168	109	113
1124	480	FMT	169	137	
1134	490	FMT	171	138	
1144	500	FMT	173	142	
1150	510	FMT	174	146	156
1154	520	FMT	175	150	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
10	390	K	18 158	732B	EXT REFS NOT INNER
25	110	I	22 23	12B	
44	390	J	28 158	673B	EXT REFS NOT INNER
52	130	I	34 35	7B	
66	150	L	40 46	33B	NOT INNER
74	140	I	43 45	20B	
123	170	L	50 57	50B	NOT INNER
125	170	M	51 57	42B	NOT INNER
133	160	I	54 56	25B	
234	190	L	66 72	36B	NOT INNER
262	180	I	69 71	22B	
276	200	I	77 78	6B	
323	240	M	82 95	67B	NOT INNER
327	220	I	84 85	10B	
344	240	I	87 95	43B	NOT INNER
351	240	N	89 95	33B	
417	250	I	97 98	5B	
430	280	L	101 103	14B	NOT INNER
432	280	M	102 103	6B	
465	300	M	112 113	13B	EXT REFS
514	310	I	122 125	32B	EXT REFS
556	320	I	130 133	20B	NOT INNER
563	320	N	132 133	10B	
616	340	L	140 142	12B	EXT REFS
632	350	L	143 146	20B	EXT REFS
654	360	L	147 150	25B	EXT REFS
706	370	L	152 156	24B	EXT REFS NOT INNER
713	370	M	154 156	14B	EXT REFS

COMMON BLOCKS	LENGTH
DESNBL	4736 LCM

STATISTICS

PROGRAM LENGTH	14404B	6404
LCM LABELED COMMON LENGTH	11200B	4736

140000B SCM USED

```
      SUBROUTINE WRITER (NA,NR,ZRO2B,UFS,EPP,EP,CTMAX,POROSA,BU2,TMPDIS,
     +TCIDIS,TCODIS,PRESS,GPTP,GASMOL,GASES,REPS,RFEPS,PINT)
C
CC    THIS SUBROUTINE WRITES THE RESPONSES TO TAPE45.  IT IS CALLED FROM
CC    FRPCON AT THE SAME PLACE AS THE RESTART TAPE IS CALLED.
C
      DIMENSION Y(100)
      DIMENSION ZRO2B(1),UFS(1),EPP(NA,1),EP(1),CTMAX(1),POROSA(1),
     + TMPDIS(NR,1),TCIDIS(1),TCODIS(1),GPTP(1),BU2(1),GASES(1),
     +REPS(NA,1),RFEPS(NA,1),PINT(1)
      COMMON /DESNBL/ FACTOR(100),C(4,4,100),TL(4,100),LRES(100),
     + NODE(100),LFAC(100),LTYPE,LPB,AMU(4,100),D(40,40),NRUN,NFAC,
     + ALPHA(100),IPRINT,ICON(15,15),IFLAG,ICOUNT,NTIME,ISTART,NRES
     + ,IUNCRT
      LEVEL 2,FACTOR
      DATA FT,PSI /0.30418,6.89475729E3/
      TK(T) = (T+459.67E0)/1.8E0
      IF (ICOUNT.EQ.0) GO TO 360
      K = 1
          DO 350 I=1,100
          IF (LRES(I).EQ.0) GO TO 350
          GO TO (100,110,120,130,140,150,160,170,180,190,200,210,220,230
     +    ,240,250,260,270,280,290,300,310,320,330), LRES(I)
C
C   ZIRCALOY-OXIDE THICKNESS (M)
C
100       Y(K) = ZRO2B(NODE(I)+1)*FT
          GO TO 340
C
C   NET PERMANENT FUEL DEFORMATION DUE TO SWELLING AND DENSIFICATION (M)
C
110       Y(K) = UFS(NODE(I))*FT
          GO TO 340
C
C   CLADDING PLASTIC HOOP,AXIAL,RADIAL STRAINS
C
120       Y(K) = EPP(NODE(I),1)
          GO TO 340
130       Y(K) = EPP(NODE(I),2)
          GO TO 340
140       Y(K) = EPP(NODE(I),3)
          GO TO 340
C
C   CLADDING PEAK TEMPERATURE DURING OPERATION (K)
C
150       Y(K) = TK(CTMAX(NODE(I)+1))
          GO TO 340
C
C   OPEN POROSITY
C
160       Y(K) = POROSA(NODE(I))
          GO TO 340
C
```

```
      C   FUEL BURNUP (MWD/MTU)                                                  UWRITER    51
      C                                                                          UWRITER    52
  170       Y(K) = BU2(NODE(I)+1)                                                UWRITER    53
            GO TO 340                                                            UWRITER    54
      C                                                                          UWRITER    55
      C   FUEL CENTERLINE, FUEL SURFACE, CLADDING INNER, CLADDING OUTER          UWRITER    56
      C   SURFACE TEMPERATURES (K)                                               UWRITER    57
      C                                                                          UWRITER    58
  180       Y(K) = TK(TMPDIS(NR,NODE(I)+1))                                      UWRITER    59
            GO TO 340                                                            UWRITER    60
  190       Y(K) = TK(TMPDIS(1,NODE(I)+1))                                       UWRITER    61
            GO TO 340                                                            UWRITER    62
  200       Y(K) = TK(TCIDIS(NODE(I)+1))                                         UWRITER    63
            GO TO 340                                                            UWRITER    64
  210       Y(K) = TK(TCODIS(NODE(I)+1))                                         UWRITER    65
            GO TO 340                                                            UWRITER    66
      C                                                                          UWRITER    67
      C   INTERNAL GAS PRESSURE (PA)                                            UWRITER    68
      C                                                                          UWRITER    69
  220       Y(K) = PRESS*PSI                                                     UWRITER    70
            GO TO 340                                                            UWRITER    71
      C                                                                          UWRITER    72
      C   RADIAL GAS GAP (M)                                                     UWRITER    73
      C                                                                          UWRITER    74
  230       Y(K) = GPTP(NODE(I)+1)*FT/24.0                                       UWRITER    75
            GO TO 340                                                            UWRITER    76
      C                                                                          UWRITER    77
      C   GM-MOLES GAS IN THE ROD                                               UWRITER    78
      C                                                                          UWRITER    79
  240       Y(K) = GASMOL                                                        UWRITER    80
            GO TO 340                                                            UWRITER    81
      C                                                                          UWRITER    82
      C   MOLE FRACTION OG ROD GASES                                             UWRITER    83
      C                                                                          UWRITER    84
  250       Y(K) = GASES(NODE(I))                                                UWRITER    85
            GO TO 340                                                            UWRITER    86
      C                                                                          UWRITER    87
      C   CLADDING RESIDUAL HOOP,AXIAL,RADIAL STRAINS                            UWRITER    88
      C                                                                          UWRITER    89
  260       Y(K) = REPS(NODE(I),1)                                               UWRITER    90
            GO TO 340                                                            UWRITER    91
  270       Y(K) = REPS(NODE(I),2)                                               UWRITER    92
            GO TO 340                                                            UWRITER    93
  280       Y(K) = REPS(NODE(I),3)                                               UWRITER    94
            GO TO 340                                                            UWRITER    95
      C                                                                          UWRITER    96
      C   FUEL RESIDUAL HOOP,AXIAL,RADIAL STRAINS                               UWRITER    97
      C                                                                          UWRITER    98
  290       Y(K) = RFEPS(NODE(I),1)                                              UWRITER    99
            GO TO 340                                                            UWRITER   100
  300       Y(K) = RFEPS(NODE(I),2)                                              UWRITER   101
            GO TO 340                                                            UWRITER   102
  310       Y(K) = RFEPS(NODE(I),3)                                              UWRITER   103
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                GO TO 340                                                    UWRITER   104
              C                                                              UWRITER   105
              C   INTERFACE PRESSURE                                         UWRITER   106
              C                                                              UWRITER   107
              320       Y(K) = PINT(NODE(I))*PSI                             UWRITER   108
                        GO TO 340                                            UWRITER   109
              C                                                              UWRITER   110
              C   CLADDING EFFECTIVE PLASTIC STRAIN                         UWRITER   111
              C                                                              UWRITER   112
              330       Y(K) = EP(NODE(I))                                   UWRITER   113
              340       K = K+1                                              UWRITER   114
              350       CONTINUE                                             UWRITER   115
                    WRITE (45,370) ICOUNT,NTIME,(Y(I),I=1,NRES)              UWRITER   116
              360   RETURN                                                   UWRITER   117
              C                                                              UWRITER   118
              370   FORMAT (215,(10E12.5))                                   UWRITER   119
                    END                                                      UWRITER   120
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

16 1 DESNBL NOT ALL ITEMS IN THIS COMMON BLOCK OCCUR IN LEVEL STATEMENTS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 WRITER 1 120

VARIABLES		SN	TYPE		RELOCATION								
10464	ALPHA		REAL	ARRAY	DESNBL	REFS	11						
4542	AMU		REAL	ARRAY	DESNBL	REFS	11						
0	BU2		REAL	ARRAY	F.P.	REFS	8	56	DEFINED	1			
144	C		REAL	ARRAY	DESNBL	REFS	11						
0	CTMAX		REAL	ARRAY	F.P.	REFS	8	46	DEFINED	1			
5362	D		REAL	ARRAY	DESNBL	REFS	11						
0	EP		REAL	ARRAY	F.P.	REFS	8	116	DEFINED	1			
0	EPP		REAL	ARRAY	F.P.	REFS	8	37	39	41	DEFINED	1	
0	FACTOR		REAL	ARRAY	DESNBL	REFS	11	15					
326	FT		REAL			REFS	27	32	78	DEFINED	16		
0	GASES		REAL	ARRAY	F.P.	REFS	8	88	DEFINED	1			
0	GASMOL		REAL		F.P.	REFS	83	DEFINED	1				
0	GPTP		REAL	ARRAY	F.P.	REFS	8	78	DEFINED	1			
345	I		INTEGER			REFS	21	22	27	32	37	39	41
							46	51	56	62	64	66	68	78
							88	93	95	97	102	104	106	111
							116	119	DEFINED	20	119		
10631	ICON		INTEGER	ARRAY	DESNBL	REFS	11						

VARIABLES	SN	TYPE		RELOCATION								
11173	ICOUNT	INTEGER		DESNBL	REFS	11	18	119				
11172	IFLAG	INTEGER		DESNBL	REFS	11						
10630	IPRINT	INTEGER		DESNBL	REFS	11						
11175	ISTART	INTEGER		DESNBL	REFS	11						
11177	IUNCRT	INTEGER		DESNBL	REFS	11						
344	K	INTEGER			REFS	27	32	37	39	41	46	51
					56	62	64	66	68	73	78	83
					88	93	95	97	102	104	106	111
					116	117	DEFINED	19	117			
4374	LFAC	INTEGER	ARRAY	DESNBL	REFS	11						
4541	LPB	INTEGER		DESNBL	REFS	11						
4064	LRES	INTEGER	ARRAY	DESNBL	REFS	11	21	22				
4540	LTYPE	INTEGER		DESNBL	REFS	11						
0	NA	INTEGER		F.P.	REFS	3*8	DEFINED	1				
10463	NFAC	INTEGER		DESNBL	REFS	11						
4230	NODE	INTEGER	ARRAY	DESNBL	REFS	11	27	32	37	39	41	46
					51	56	62	64	66	68	78	88
					93	95	97	102	104	106	111	116
0	NR	INTEGER		F.P.	REFS	8	62	DEFINED	1			
11176	NRES	INTEGER		DESNBL	REFS	11	119					
10462	NRUN	INTEGER		DESNBL	REFS	11						
11174	NTIME	INTEGER		DESNBL	REFS	11	119					
0	PINT	REAL	ARRAY	F.P.	REFS	8	111	DEFINED	1			
0	POROSA	REAL	ARRAY	F.P.	REFS	8	51	DEFINED	1			
0	PRESS	REAL		F.P.	REFS	73	DEFINED	1				
327	PSI	REAL			REFS	73	111	DEFINED	16			
0	REPS	REAL	ARRAY	F.P.	REFS	8	93	95	97	DEFINED	1	
0	RFEPS	REAL	ARRAY	F.P.	REFS	8	102	104	106	DEFINED	1	
0	TCIDIS	REAL	ARRAY	F.P.	REFS	8	66	DEFINED	1			
0	TCODIS	REAL	ARRAY	F.P.	REFS	8	68	DEFINED	1			
3244	TL	REAL	ARRAY	DESNBL	REFS	11						
0	TMPDIS	REAL	ARRAY	F.P.	REFS	8	62	64	DEFINED	1		
0	UFS	REAL	ARRAY	F.P.	REFS	8	32	DEFINED	1			
346	Y	REAL	ARRAY		REFS	7	119	DEFINED	27	32	37	39
					41	46	51	56	62	64	66	68
					73	78	83	88	93	95	97	102
					104	106	111	116				
0	ZRO2B	REAL	ARRAY	F.P.	REFS	8	27	DEFINED	1			

FILE NAMES	MODE			
TAPE45	FMT		WRITES	119

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES					
TK	REAL	1	SF	17	46	62	64	66	68	

STATEMENT LABELS		DEF LINE	REFERENCES
57	100	27	22
65	110	32	22
73	120	37	22
101	130	39	22
107	140	41	22
116	150	46	22
125	160	51	22

STATEMENT LABELS			DEF LINE	REFERENCES							
133	170		56	22							
141	180		62	22							
152	190		64	22							
163	200		66	22							
172	210		68	22							
201	220		73	22							
206	230		78	22							
215	240		83	22							
221	250		88	22							
227	260		93	22							
235	270		95	22							
243	280		97	22							
252	290		102	22							
260	300		104	22							
266	310		106	22							
275	320		111	22							
303	330		116	22							
310	340		117	28	33	38	40	42	47	52	57	63
				65	67	69	74	79	84	89	94	96
				98	103	105	107	112				
313	350		118	20	21							
325	360		120	18								
336	370	FMT	122	119								

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
15	350	I	20 118	301B	OPT

COMMON BLOCKS	LENGTH
DESNBL	4736 LCM

STATISTICS

PROGRAM LENGTH	553B	363
LCM LABELED COMMON LENGTH	11200B	4736

1400008 SCM USED

```
      SUBROUTINE ECHO1 (NIT,NOT,NDAT)                                   UECHO1      2
C     ********************************************************************* UECHO1      3
C     CODED BY R.C. GUENZLER - AUGUST 1972                              UECHO1      4
C     REVISED BY R.C.YOUNG  SEPT 76                                     UECHO1      5
C     ********************************************************************* UECHO1      6
C                                                                       UECHO1      7
      DIMENSION DATA (20)                                               UECHO1      8
C                                                                       UECHO1      9
C                                                                       UECHO1     10
C                                                                       UECHO1     11
      LINE = 0                                                          UECHO1     12
      L = 0                                                             UECHO1     13
      REWIND NDAT                                                       UECHO1     14
      WRITE (NOT,120)                                                   UECHO1     15
100   CONTINUE                                                          UECHO1     16
      READ (NIT,160) DATA                                               UECHO1     17
      IF (EOF(NIT).NE.0.) GO TO 110                                     UECHO1     18
      WRITE (NDAT,160) DATA                                             UECHO1     19
      WRITE (NOT,130) DATA                                              UECHO1     20
      L = L+1                                                           UECHO1     21
      LINE = LINE+1                                                     UECHO1     22
      IF (LINE.LT.50) GO TO 100                                         UECHO1     23
      WRITE (NOT,140)                                                   UECHO1     24
      LINE = 0                                                          UECHO1     25
      GO TO 100                                                         UECHO1     26
110   WRITE (NOT,150) L                                                 UECHO1     27
      REWIND NDAT                                                       UECHO1     28
      RETURN                                                            UECHO1     29
C                                                                       UECHO1     30
120   FORMAT (1H1,9X,"         1         2         3         4         5 UECHO1     31
     +         6         7         8",/,10X,"12345678901234567890123456 UECHO1     32
     +890123456789012345678901234567890123456789012345678901234567890",/) UECHO1     33
130   FORMAT (10X,20A4)                                                 UECHO1     34
140   FORMAT (1H0,9X,"         1         2         3         4         5 UECHO1     35
     +         6         7         8",/,10X,"12345678901234567890123456 UECHO1     36
     +890123456789012345678901234567890123456789012345678901234567890",/,1H1,9X," UECHO1     37
     +         1         2         3         4         5         6      UECHO1     38
     +  7         8",/,10X,"12345678901234567890123456789012345678901234 UECHO1     39
     +56789012345678901234567890123456789012345678901234567890",/)     UECHO1     40
150   FORMAT (1H0,9X,"         1         2         3         4         5 UECHO1     41
     +         6         7         8",/,10X,"12345678901234567890123456 UECHO1     42
     +890123456789012345678901234567890123456789012345678901234567890",/19," INPUT UECHO1     43
     + CARDS")                                                          UECHO1     44
160   FORMAT (20A4)                                                     UECHO1     45
      END                                                               UECHO1     46
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    4  ECHO1            1        28

VARIABLES     SN  TYPE          RELOCATION
  231  DATA       REAL        ARRAY                REFS          7        18        19    DEFINED        16
  230  L          INTEGER                          REFS         20        26    DEFINED        12        20
  227  LINE       INTEGER                          REFS         21        22    DEFINED        11        21        24
    0  NDAT       INTEGER                  F.P.    DEFINED       1    I/O REFS        13        18        27
    0  NIT        INTEGER                  F.P.    REFS         17    DEFINED         1    I/O REFS        16
    0  NOT        INTEGER                  F.P.    DEFINED       1    I/O REFS        14        19        23        26
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS          TYPE    ARGS       REFERENCES
       EOF        REAL       1            17

STATEMENT LABELS                 DEF LINE   REFERENCES
   17  100                           15        22        25
   46  110                           26        17
  106  120      FMT                  30        14
  131  130      FMT                  33        19
  133  140      FMT                  34        23
  200  150      FMT                  40        26
  225  160      FMT                  44        16        18

STATISTICS
  PROGRAM LENGTH                   255B      173
        140000B SCM USED
```

```
      SUBROUTINE VOLUME (CRL,DCIHF,DEN,DPHF,DPW,DENSIF,DZH,FPORI,HRL,RAD VOLM
     +,TFR,UO2LL,VCH,VCR,VDH,VFH,VGH,VPL,VPOR,IT,J,L,NDBG,FTMELT,TCC,VCH VOLM
     +I,NR,DZHP,NRMI,PI,GPTP,GAP)                                        VOLM
C                                                                         VOLM
C     IMPLICIT REAL*8 (A-H,O-Z)                                           VOLM
C                                                                         VOLM
      DIMENSION  CRL(1) ,DPW(NR,1) ,DZH(1)   ,HRL(1)   ,RAD(1)   ,TFR(1) VOLM
     +          ,VCH(1) ,UO2LL(NR,1)        ,VDH(1)   ,VFH(1)   ,VGH(1) VOLM
     +,VPOR(1)  ,VPL(1) ,DENSIF(NR,1)       ,VCHI(1)  ,DZHP(1)  ,VCR(1) VOLM
     +,GPTP(1),GAP(1)                                                    VOLM
C                                                                         VOLM
C                                                                         VOLM
C     THIE SUBROUTINE IS CALLED FROM MAIN AND CALCULATES THE VOID         VOLM
C     VOLUMES INCLUDING CRACK, DISH, GAP, AND OPEN POROSITY               VOLM
C                                                                         VOLM
C     ***************************************************************** VOLM
C     INPUT ARGUMENTS                                                     VOLM
C     ***************************************************************** VOLM
C                                                                         VOLM
C     CRL    - COLD RING LENGTH (IN)                                      VOLM
C     DCIHF  - CLADDING INSIDE DIAMETER (IN)                              VOLM
C     DEN    - TRUE DENSITY OF THE FUEL (( OF THEORETICAL)                VOLM
C     DENSIF - TOTAL DENSIFICATION BY RING + INCREMENT (IN/IN)            VOLM
C     DPHF   - DIAMETER OF THE PELLET HOT + SWELLED (IN)                  VOLM
C     DPW    - TOTAL OUTWARD SWELLING BY RING + INCREMENT (IN/IN)         VOLM
C     FPORI  - COLD FUEL OPEN POROSITY FRACTION                           VOLM
C     FTMELT - FUEL MELT TEMPERATURE (K)                                  VOLM
C     GAP    - HOT RADIAL STRUCTURAL GAP (IN)                             VOLM
C     GPTP   - HOT THERMAL GAP (IN) , DIAMETRAL                           VOLM
C     IT     - POWER STEP INDEX                                           VOLM
C     J      - AXIAL NODE INDEX (LEVEL PLUS ONE)                          VOLM
C     L      - FUEL RING INDEX                                            VOLM
C     NDBG   - DEBUG OUTPUT INDEX                                         VOLM
C     NR     - MAXIMUM NUMBER OF RADIAL NODES                             VOLM
C     NRMI   - MAXIMUM NUMBER OF RADIAL NODES MINUS ONE                   VOLM
C     PI     - THE CONSTANT 3.1415926                                     VOLM
C     RAD    - HOT FUEL RING RADIUS (IN)                                  VOLM
C     TCC    - COLD STATE CLADDING THICKNESS (IN)                         VOLM
C     TFR    - TEMPERATURE OF FUEL RING BOUNDARY (F)                      VOLM
C     UO2LL  - FUEL THERMAL EXPANSION PER RING (IN/IN)                    VOLM
C                                                                         VOLM
C     ***************************************************************** VOLM
C     OUTPUT ARGUMENTS                                                    VOLM
C     ***************************************************************** VOLM
C                                                                         VOLM
C     DZH    - MAXIMUM RING LENGTH OF AN INCREMENT (IN)                   VOLM
C     DZHP   - MAXIMUM PERMANENT AXIAL FUEL DISPLACEMENT (IN)             VOLM
C     HRL    - HOT RING LENGTH (IN)                                       VOLM
C     VCH    - VOLUME WITHIN THE CLADDING FOR AXIAL NODE J (CU IN)        VOLM
C     VCHI   - HOT CLADDING VOLUME PER INCREMENT (CU IN)                  VOLM
C     VCR    - HOT CRACK VOLUME PER INCREMENT (CU IN)                     VOLM
C     VDH    - HOT DISH VOLUME  PER INCREMENT (CU IN)                     VOLM
```

```
      C   VFH    - HOT FUEL VOLUME PER INCREMENT (CU IN)                          VOLM       55
      C   VGH    - HOT GAP VOLUME PER INCREMENT (CU IN)                           VOLM       56
      C   VPL    - FUEL VOLUME PER INCREMENT + RING (CU IN)                       VOLM       57
      C   VPOR   - HOT OPEN POROSITY VOLUME (CU IN)                              VOLM       58
      C                                                                           VOLM       59
      C   ************************************************************************VOLM       60
      C                                                                           VOLM       61
      C                                                                           VOLM       62
      C                                                                           VOLM       63
      C   CALCULATION OF HOT PELLET HEIGHT  (HRL(L)), MAXIMUM INCREMENT          VOLM       64
      C   LENGTH (DZH(J)), CRACK VOLUME (VCR(J)), AND DISH VOLUME (VDH(J))       VOLM       65
      C                                                                           VOLM       66
            TMELT = FTMELT*1.8E0-459.67E0                                         VOLM       67
            DZH(J) = 0.E0                                                         VOLM       68
            DZHP(J) = 0.E0                                                        VOLM       69
            VFH(J) = 0.E0                                                         VOLM       70
                DO 100 L=1,NRM1                                                   VOLM       71
                HRL(L) = CRL(L)*(1.+UO2LL(L,J)+DPW(L,J)+DENSIF(L,J))              VOLM       72
                IF (TFR(L).GE.TMELT.AND.L.GT.1) HRL(L) = HRL(L-1)                 VOLM       73
                DZ = HRL(L)-CRL(L)*UO2LL(L,J)                                     VOLM       74
                DZHP(J) = AMAX1(DZHP(J),DZ)                                       VOLM       75
                DZH(J) = AMAX1(DZH(J),HRL(L))                                     VOLM       76
                VFH(J) = VFH(J)+HRL(L)*(RAD(L)*RAD(L)-RAD(L+1)*RAD(L+1))          VOLM       77
          100   CONTINUE                                                          VOLM       78
            VFH(J) = VFH(J)*PI                                                    VOLM       79
            VDH(J) = PI*RAD(1)*RAD(1)*DZH(J)-VFH(J)                               VOLM       80
      C                                                                           VOLM       81
      C   CALCULATION OF HOT CLAD AND GAP VOLUMES                                VOLM       82
      C                                                                           VOLM       83
            RI = (AMAX1(DPHF,DCIHF))*0.5                                          VOLM       84
            VCH(J) = PI*RI*RI*DZH(J)                                              VOLM       85
            GV = PI*DZH(J)*(2*DCIHF*GPTP(J)-GPTP(J)**2)/4.E0                      VOLM       86
            VGH(J) = AMAX1(0.E0,GV)                                               VOLM       87
            CV = PI*DZH(J)*(DCIHF*GAP(J-1)-GAP(J-1)**2)-VGH(J)                    VOLM       88
            VCR(J) = AMAX1(0.E0,CV)                                               VOLM       89
            VCHI(J) = 2.E0*PI*RI*TCC                                              VOLM       90
      C                                                                           VOLM       91
      C   CALCULATION OF OPEN POROSITY VOLUME                                     VOLM       92
      C                                                                           VOLM       93
            VPOR(J) = 0.                                                          VOLM       94
                DO 110 L=1,NRM1                                                   VOLM       95
                IF (TFR(L+1).LE.1472.) FPOR = FPOR1                               VOLM       96
                IF (TFR(L).LT.1472..AND.TFR(L+1).GT.1472.) FPOR = FPOR1*(1472.    VOLM       97
           +    -TFR(L))/(TFR(L+1)-TFR(L))+0.5*FPOR1*((TFR(L+1)-1472.)/(TFR(L+    VOLM       98
           +    1)-TFR(L)))                                                       VOLM       99
                IF (TFR(L+1).LE.2012..AND.TFR(L).GE.1472.) FPOR = .5*FPOR1        VOLM      100
                IF (TFR(L).LT.2012..AND.TFR(L+1).GT.2012.) FPOR = .5*FPOR1*((2    VOLM      101
           +    012.-TFR(L))/(TFR(L+1)-TFR(L)))                                   VOLM      102
                IF (TFR(L+1).LE.2912..AND.TFR(L).GE.2012.) FPOR = 0.0             VOLM      103
                IF (TFR(L).LT.2912.E0.AND.TFR(L+1).GT.2912.E0) FPOR = 0.0         VOLM      104
                IF (TFR(L).GE.2912.E0) FPOR = 0.E0                                VOLM      105
                VPOR(J) = VPOR(J)+VPL(L)*FPOR                                     VOLM      106
          110   CONTINUE                                                          VOLM      107
```

```
      C
            RETURN
            END
```

VOLM 108
VOLM 109
VOLM 110

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 VOLUME 1 108

VARIABLES	SN	TYPE	RELOCATION										
0	CRL	REAL	ARRAY	F.P.	REFS	7	71	73	DEFINED	1			
300	CV	REAL			REFS	88	DEFINED	87					
0	DCIHF	REAL		F.P.	REFS	83	85	87	DEFINED	1			
0	DEN	REAL	*UNUSED	F.P.	DEFINED	1							
0	DENSIF	REAL	ARRAY	F.P.	REFS	7	71	DEFINED	1				
0	DPHF	REAL		F.P.	REFS	83	DEFINED	1					
0	DPW	REAL	ARRAY	F.P.	REFS	7	71	DEFINED	1				
275	DZ	REAL			REFS	74	DEFINED	73					
0	DZH	REAL	ARRAY	F.P.	REFS	7	75	79	84	85	87		
					DEFINED	1	67	75					
0	DZHP	REAL	ARRAY	F.P.	REFS	7	74	DEFINED	1	68	74		
301	FPOR	REAL			REFS	105	DEFINED	95	96	99	100	102	
					103	104							
0	FPOR1	REAL		F.P.	REFS	95	2*96	99	100	DEFINED	1		
0	FTMELT	REAL		F.P.	REFS	66	DEFINED	1					
0	GAP	REAL	ARRAY	F.P.	REFS	7	2*87	DEFINED	1				
0	GPTP	REAL	ARRAY	F.P.	REFS	7	2*85	DEFINED	1				
277	GV	REAL			REFS	86	DEFINED	85					
0	HRL	REAL	ARRAY	F.P.	REFS	7	72	73	75	76			
					DEFINED	1	71	72					
0	IT	INTEGER	*UNUSED	F.P.	DEFINED	1							
0	J	INTEGER		F.P.	REFS	67	68	69	3*71	73	2*74	2*75	
					2*76	2*78	3*79	2*84	3*85	86	4*87	88	
					89	93	2*105	DEFINED	1				
0	L	INTEGER		F.P.	REFS	5*71	4*72	3*73	75	5*76	95	8*96	
					2*99	5*100	2*102	2*103	104	105			
					DEFINED	1	70	94					
0	NDBG	INTEGER	*UNUSED	F.P.	DEFINED	1							
0	NR	INTEGER		F.P.	REFS	3*7	DEFINED	1					
0	NRM1	INTEGER		F.P.	REFS	70	94	DEFINED	1				
0	PI	REAL		F.P.	REFS	78	79	84	85	87	89		
					DEFINED	1							
0	RAD	REAL	ARRAY	F.P.	REFS	7	4*76	2*79	DEFINED	1			
276	RI	REAL			REFS	2*84	89	DEFINED	83				
0	TCC	REAL		F.P.	REFS	89	DEFINED	1					
0	TFR	REAL	ARRAY	F.P.	REFS	7	72	95	8*96	2*99	5*100	2*102	
					2*103	104	DEFINED	1					
274	TMELT	REAL			REFS	72	DEFINED	66					
0	UO2LL	REAL	ARRAY	F.P.	REFS	7	71	73	DEFINED	1			

```
VARIABLES     SN  TYPE          RELOCATION
    0  VCH        REAL      ARRAY     F.P.      REFS      7   DEFINED      1      84
    0  VCHI       REAL      ARRAY     F.P.      REFS      7   DEFINED      1      89
    0  VCR        REAL      ARRAY     F.P.      REFS      7   DEFINED      1      88
    0  VDH        REAL      ARRAY     F.P.      REFS      7   DEFINED      1      79
    0  VFH        REAL      ARRAY     F.P.      REFS      7      76       78      79    DEFINED      1        69
                                                  76     78
    0  VGH        REAL      ARRAY     F.P.      REFS      7      87    DEFINED      1      86
    0  VPL        REAL      ARRAY     F.P.      REFS      7     105    DEFINED      1
    0  VPOR       REAL      ARRAY     F.P.      REFS      7     105    DEFINED      1      93      105

INLINE FUNCTIONS   TYPE   ARGS        DEF LINE  REFERENCES
       AMAX1       REAL     0  INTRIN            74      75      83       86       88

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       77         70
    0  110                      106         94

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   30  100      L          70 77       45B       OPT
  173  110      L          94 106      65B       OPT

STATISTICS
  PROGRAM LENGTH              367B     247
        140000B SCM USED
```

```
STRAIN   *CALL MATCNS                                          STRAIN      27

STRESS   *CALL MATCNS                                          STRESS      26
```

CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY	MATCNS	STRANI	CREPI	CRIIP	STRESI	STRAIN	STRESS
CREEP	CONVSF	FCRNCH	CRAPX	FPRES	PRINTM	FCMI2	RATIO
PELLET	CLOSE	EQUALI	EQUAL2	GAPTX	AXRCH2	TRNSF2	CONVTR
FC2PTR	FR2PTR						

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$	TIDY	MATCNS	STRANI	CREPI	CRIIP	STRESI	STRAIN
STRESS	CREEP	CONVSF	FCRNCH	CRAPX	FPRES	PRINTM	FCMI2
RATIO	PELLFT	CLOSE	EQUALI	EQUAL2	GAPTX	AXRCH2	TRNSF2
CONVTR	FC2PTR	FR2PTR					

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

YANK$$$	TIDY	MATCNS	STRANI	CREPI	CRIIP	STRESI	STRAIN
STRESS	CREEP	CONVSF	FCRNCH	CRAPX	FPRES	PRINTM	FCMI2
RATIO	PELLET	CLOSE	EQUALI	EQUAL2	GAPTX	AXRCH2	TRNSF2
CONVTR	FC2PTR	FR2PTR					

COMMON DECKS ENCOUNTERED

MATCNS

TIDY	STRANI	CREPI	CRIIP	STRESI	STRAIN	STRESS	CREEP
CONVSF	FCRNCH	CRAPX	FPRES	PRINTM	FCM12	RATIO	PELLET
CLOSE	EQUAL1	EQUAL2	GAPTX	AXRCH2	TRNSF2	CONVTR	FC2PTR
FR2PTR							

THIS UPDATE REQUIRED 34400B WORDS OF CORE.

```
1                SUBROUTINE STRANI (TK,SAG,A,EPS,B,C)                    STRANI      2
                 IMPLICIT REAL*8 (A-H,O-Z)                               STRANI      3
                 *** TEMP PROVIDED BY "STRAIN" IS IN KELVIN              STRANI      4
                   RETURN                                                STRANI      5
5                  END                                                   STRANI      6
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	STRANI	1	4

VARIABLES

	SN	TYPE	RELOCATION			
0	A	REAL	*UNUSED	F.P.	DEFINED	1
0	B	REAL	*UNUSED	F.P.	DEFINED	1
0	C	REAL	*UNUSED	F.P.	DEFINED	1
0	EPS	REAL	*UNUSED	F.P.	DEFINED	1
0	SAG	REAL	*UNUSED	F.P.	DEFINED	1
0	TK	REAL	*UNUSED	F.P.	DEFINED	1

STATISTICS

PROGRAM LENGTH 78 7

140000B SCM USED

```
      1              FUNCTION CREP1 (T,EDOT,Z,TC,PHI,ECREEP)                  CREP1      2
                C   IMPLICIT REAL*8 (A-H,O-Z)                                CREP1      3
                    CREP1 = 0.0                                              CREP1      4
                    RETURN                                                   CREP1      5
      5             END                                                      CREP1      6
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	CREP1	1	4

VARIABLES	SN	TYPE	RELOCATION			
12	CREP1	REAL			DEFINED	3
0	ECREEP	REAL	*UNUSED	F.P.	DEFINED	1
0	EDOT	REAL	*UNUSED	F.P.	DEFINED	1
0	PHI	REAL	*UNUSED	F.P.	DEFINED	1
0	T	REAL	*UNUSED	F.P.	DEFINED	1
0	TC	REAL	*UNUSED	F.P.	DEFINED	1
0	Z	REAL	*UNUSED	F.P.	DEFINED	1

STATISTICS

PROGRAM LENGTH 13B 11

140000B SCM USED

```
1              SUBROUTINE CRIIP (SIG,DPDT,T,TC,PHI,ECREEP,JTYPE,N3)                  CRIIP      2
           C   ***THIS STEADY-STATE CREEP  DATA IS FOR ZIRCALOY AT 300 K             CRIIP      3
           C   AS TAKEN FROM THE ORIGINAL PAPER BY IBRAHIM                          CRIIP      4
           C   IMPLICIT REAL*8 (A-H,O-Z)                                            CRIIP      5
5          C   TEMP PASSED IN HERE IS IN FAHRENEIET                                CRIIP      6
              TF = TC                                                              CRIIP      7
              IF (N3.EQ.0) TF = TEMPKF(TC)                                         CRIIP      8
           C   SIGGY = 3600.0*( DPDT/5.0E-04 )**0.3333                             CRIIP      9
           C   IF(JTYPE.EQ.1.AND. TF.GE. 2046.0 )  SIG = SIGGY                     CRIIP     10
10         C   SIGGY = 3600.0*( DPDT/5.0E-04 )**0.3333                            CRIIP     11
           C   IF(JTYPE.EQ.1.AND. TF.GE.2046.0 )  SIG = SIGGY                     CRIIP     12
           C   IF(JTYPE.EQ.1.AND. TF.LT.2046.0 )  SIG = DPDT/1.0E-12             CRIIP     13
              IF (JTYPE.EQ.2) SIG = DPDT/(4.0E-10)                                 CRIIP     14
           C   CREEP RATE VS. STRESS, FROM BOHABOY ET AL                          CRIIP     15
15            IF (JTYPE.EQ.1) SIG = (DPDT/1.937E-7)**1.370                        CRIIP     16
              IF (JTYPE.EQ.1.AND.TF.GE.2813.0) SIG = (DPDT/3.742E-8)**0.901       CRIIP     17
              IF (JTYPE.EQ.1.AND.TF.GE.3002.0) SIG = (DPDT/1.271E-9)**0.588       CRIIP     18
              IF (JTYPE.EQ.1.AND.TF.GE.3182.0) SIG = (DPDT/3.149E-9)**0.5682      CRIIP     19
           C   THE FOLLOWING CARD WAS ADDED TO ELIMINATE FUEL CREEP                CRIIP     20
20            IF (JTYPE.EQ.1) SIG = 1.0E28                                        CRIIP     21
              IF (N3.EQ.0) SIG = PSIS(SIG)                                         CRIIP     22
              RETURN                                                               CRIIP     23
              END                                                                  CRIIP     24
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CRIIP	1	22

VARIABLES	SN	TYPE		RELOCATION								
0	DPDT	REAL		F.P.	REFS	13	15	16	17	18		
					DEFINED	1						
0	ECREEP	REAL	*UNUSED	F.P.	DEFINED	1						
0	JTYPE	INTEGER		F.P.	REFS	13	15	16	17	18	20	
					DEFINED	1						
0	N3	INTEGER		F.P.	REFS	7	21	DEFINED	1			
0	PHI	REAL	*UNUSED	F.P.	DEFINED	1						
0	SIG	REAL		F.P.	REFS	21	DEFINED	1	13	15	16	17
						18	20	21				
0	T	REAL	*UNUSED	F.P.	DEFINED	1						
0	TC	REAL		F.P.	REFS	6	7	DEFINED	1			
140	TF	REAL			REFS	16	17	18	DEFINED	6	7	

EXTERNALS	TYPE	ARGS	REFERENCES
PSIS	REAL	1	21
TEMPKF	REAL	1	7

STATISTICS
PROGRAM LENGTH 141B 97
140000B SCM USED

```
1                 SUBROUTINE STRES1 (TK,EPS,SIGY,E1)                    STRES1      2
                  C   IMPLICIT REAL*8 (A-H,O-Z)                         STRES1      3
                  C   *** TEMP PROVIDED BY "STRAIN" IS IN KELVIN        STRES1      4
                  C   **********************************               STRES1      5
5                 C   THIS CUTS OUT ALL FUEL PLASTICITY                 STRES1      6
                      SIGY = 12.E30                                     STRES1      7
                      RETURN                                            STRES1      8
                  100 CONTINUE                                          STRES1      9
                  C   **********************************               STRES1     10
10                    RETURN                                            STRES1     11
                      END                                               STRES1     12
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    4  STRES1          1          7        10

VARIABLES     SN  TYPE          RELOCATION
    0  EPS        REAL      *UNUSED    F.P.      DEFINED        1
    0  E1         REAL      *UNUSED    F.P.      DEFINED        1
    0  SIGY       REAL                 F.P.      DEFINED        1          6
    0  TK         REAL      *UNUSED    F.P.      DEFINED        1

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100          INACTIVE       8

STATISTICS
  PROGRAM LENGTH                  138       11
        140000B SCM USED
```

```
      SUBROUTINE STRAINX (SIG,EPS,EPPLAS,TEMP,E1,JTYPE,N3)                  STRAIN     2
C                                                                           STRAIN     3
C   ***THIS SUBROUTINE COMPUTES UNIAXIAL STRAIN GIVEN THE                   STRAIN     4
C   STRESS AND PREVIOUS PLASTIC STAIN. ELASTIC UNLOADING                    STRAIN     5
C   IS PRESCRIBED, AND THE CURRENT ( WORK-HARDENED )                        STRAIN     6
C   YEILD STRESS IS COMPUTED FROM THE PLASTIC STRAIN                        STRAIN     7
C   AT EACH CALL. THE LOCUS OF YIELD                                        STRAIN     8
C   STRESSES IS OBTAINED FROM SUBROUTINE *CSTRES*                           STRAIN     9
C   WHICH COMPUTES STRESS FROM STRAIN IN MONOTONIC,                         STRAIN    10
C   UNIAXIAL TENSION.                                                       STRAIN    11
C   INPUT                                                                   STRAIN    12
C   SIG = STRESS                                                            STRAIN    13
C   EPPLAS = PREVIOUS PLASTIC STRAIN (IN/IN)                                STRAIN    14
C   TEMP = TEMPERATURE                                                      STRAIN    15
C   E = YOUNGS MODULUS                                                      STRAIN    16
C   JTYPE  INDICATES  FUEL OR CLADDING                                      STRAIN    17
C   N3  INDICATES   SI  OR  BRITTISH UNITS                                  STRAIN    18
C   OUTPUT                                                                  STRAIN    19
C   EPS = STRAIN  (IN/IN)                                                   STRAIN    20
C   EPPLAS = NEW VALUE OF PLASTIC STRAIN (IN/IN)                            STRAIN    21
C   ***                                                                     STRAIN    22
C   NOTE                                                                    STRAIN    23
C   BOTH *CELMOD* AND *CSTRES*  ARE IN S.I. UNITS,                          STRAIN    24
C   ***PROGRAMMED BY M.P. BOHN ,  NOV.18, 1974 .                            STRAIN    25
C                                                                           STRAIN    26
C                                                                           MATCNS     2
C   THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES             MATCNS     3
C   USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM                           MATCNS     4
C                                                                           MATCNS     5
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX         MATCNS     6
     +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTHELT ,RSTRAN       MATCNS     7
C                                                                           MATCNS     8
C   ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST           MATCNS     9
C   (HOOP STRAIN)/(RADIAL STRAIN)                                           MATCNS    10
C   COMP   - PUO2 CONTENT (WT%)                                             MATCNS    11
C   CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)       MATCNS    12
C   CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT              MATCNS    13
C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED            MATCNS    14
C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                    MATCNS    15
C   FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                                MATCNS    16
C   FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)       MATCNS    17
C   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT           MATCNS    18
C   FOTMTL - FUEL OXYGEN TO METAL RAITO                                     MATCNS    19
C   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)               MATCNS    20
C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                     MATCNS    21
C   RSTRAN - TRUE STRAIN RATE (1/SEC)                                       MATCNS    22
C                                                                           MATCNS    23
C                                                                           MATCNS    24
C   IMPLICIT REAL*8 (A-H,O-Z)                                               STRAIN    28
      T = TEMP                                                              STRAIN    29
      IF (N3.EQ.1) T = TEMPS(TEMP)                                          STRAIN    30
C   GET CURRENT YEILD STRESS GIVEN EPPLAS                                   STRAIN    31
      SIGY = 5000.0                                                         STRAIN    32
```

```
                SIGY = PSIS(SIGY)                                                  STRAIN     33
55              E = EI                                                             STRAIN     34
                IF (N3.EQ.1) E = PSIS(EI)                                          STRAIN     35
                IF (N3.EQ.1) SIG = PSIS(SIG)                                       STRAIN     36
                    DO 100 K=1,30                                                  STRAIN     37
                    EPS = SIGY/E+EPPLAS                                            STRAIN     38
60                  IF (JTYPE.EQ.1) CALL STRES1 (T,EPS,SIGY,E)                     STRAIN     39
                    IF (JTYPE.EQ.2) CALL CSTRES (T,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTR STRAIN     40
               +    AN,EPS,SIGY)                                                   STRAIN     41
            100     CONTINUE                                                       STRAIN     42
            C   CONVERT ANISOTROPIC EFFECTIVE YIELD STRESS                         STRAIN     43
65          C   TO ISOTROPIC EFFECTIVE YIELD STRESS                               STRAIN     44
              IF (JTYPE.EQ.2) SIGY = SIGY/1.19                                     STRAIN     45
              IF (SIG-SIGY) 110,110,120                                            STRAIN     46
            110   EPS = EPPLAS+SIG/E                                               STRAIN     47
              GO TO 130                                                            STRAIN     48
70          120   SAG = SIG                                                        STRAIN     49
              IF (JTYPE.EQ.1) CALL STRAN1 (T,SAG,A,EPS,B,C)                        STRAIN     50
            C   CONVERT ISOTROPIC EFFECTIVE STRESS TO ANISOTROPIC EFFECTIVE STRESS STRAIN     51
              SAG = SAG*1.19                                                       STRAIN     52
              IF (JTYPE.EQ.2) CALL CSTRAN (T,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,S STRAIN     53
75           +AG,EPS)                                                            STRAIN     54
            C                                                                      STRAIN     55
            C   THE ELASTIC COMPONENT OF STRAIN MUST BE CONSISTANT                 STRAIN     56
            C   WITH THE UNMODIFIED YIELD USED IN CSTRAN AND CSTRES.               STRAIN     57
            C   THESE CHANGES ALLOW CONVERSION FROM ANISOTROPIC                    STRAIN     58
80          C   THEORY TO ISOTROPIC PLASTICITY.                                    STRAIN     59
            C                                                                      STRAIN     60
                EPPLAS = EPS-SIG*(1.19)/E                                          STRAIN     61
            130 CONTINUE                                                           STRAIN     62
                IF (N3.EQ.1) SIG = PSIB(SIG)                                       STRAIN     63
85              RETURN                                                             STRAIN     64
                END                                                                STRAIN     65
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	STRAINX	1	85

VARIABLES		SN	TYPE	RELOCATION								
215	A	*	REAL		REFS	71						
0	ANRIN		REAL	MATCNS	REFS	30						
216	B	*	REAL		REFS	71						
217	C	*	REAL		REFS	71						
1	COMP		REAL	MATCNS	REFS	30						
2	CWKF		REAL	MATCNS	REFS	30	61	74				
3	CWNF		REAL	MATCNS	REFS	30	61	74				
4	DELOXY		REAL	MATCNS	REFS	30	61	74				
212	E		REAL		REFS	59	60	68	82	DEFINED	55	56

```
VARIABLES     SN  TYPE          RELOCATION
    0  EPPLAS     REAL            F.P.      REFS      59    68    DEFINED     1      82
    0  EPS        REAL            F.P.      REFS      60    61      71       74      82
                                             DEFINED    1    59      68
    0  EI         REAL            F.P.      REFS      55    56    DEFINED     1
    5  FLUX       REAL           MATCNS     REFS      30
    6  FNCK       REAL           MATCNS     REFS      30    61      74
    7  FNCN       REAL           MATCNS     REFS      30    61      74
   10  FOTMTL     REAL           MATCNS     REFS      30
   11  FRDEN      REAL           MATCNS     REFS      30
   12  FTMELT     REAL           MATCNS     REFS      30
    0  JTYPE      INTEGER          F.P.      REFS      60    61      66       71      74
                                             DEFINED    1
  213  K        * INTEGER                   DEFINED    58
    0  N3         INTEGER          F.P.      REFS      51    56      57       84    DEFINED     1
   13  RSTRAN     REAL           MATCNS     REFS      30    61      74
  214  SAG        REAL                      REFS      71    73      74     DEFINED    70      73
    0  SIG        REAL             F.P.      REFS      57    67      68       70      82      84
                                             DEFINED    1    57      84
  211  SIGY       REAL                      REFS      54    59      60       61      66      67
                                             DEFINED   53    54      66
  210  T          REAL                      REFS      60    61      71       74    DEFINED    50      51
    0  TEMP       REAL             F.P.      REFS      50    51    DEFINED     1

EXTERNALS          TYPE    ARGS      REFERENCES
     CSTRAN                  9           74
     CSTRES                  9           61
     PSIB          REAL      1           84
     PSIS          REAL      1           54      56      57
     STRANI                  6           71
     STRESI                  4           60
     TEMPS         REAL      1           51

STATEMENT LABELS              DEF LINE    REFERENCES
    0  100                       63          58
    0  110          INACTIVE     68        2*67
  103  120                       70          67
  131  130                       83          69

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
   44  100      K            58 63       218                EXT REFS

COMMON BLOCKS   LENGTH
     MATCNS        12

STATISTICS
  PROGRAM LENGTH                  227B      151
  SCM LABELED COMMON LENGTH        14B       12
        140000B SCM USED
```

```
      SUBROUTINE STRESSX (SIG,EPPLAS,DEP,TEMP,E1,JTYPE,N3)                  STRESS     2
C                                                                           STRESS     3
C   ***THIS SUBROUTINE COMPUTES STRESS GIVEN THE PREVIOUS                   STRESS     4
C   PLASTIC STRAIN VALUE AND AN INCREMENT OF PLASTIC                        STRESS     5
C   STRAIN. THE LOCUS OF YIELD                                              STRESS     6
C   STRESSES IS OBTAINED FROM SUBROUTINE *CSTRES*                           STRESS     7
C   WHICH COMPUTES STRESS FROM STRAIN IN MONOTONIC,                         STRESS     8
C   UNIAXIAL TENSION.                                                       STRESS     9
C   INPUT                                                                   STRESS    10
C   EPPLAS = PREVIOUS PLASTIC STRAIN (IN/IN)                                STRESS    11
C   DEP = INCREMENT OF PLASTIC STRAIN (IN/IN)                               STRESS    12
C   TEMP =  TEMPERATUR                                                      STRESS    13
C   E = YOUNGS MODULUS                                                      STRESS    14
C   OUTPUT                                                                  STRESS    15
C   SIG = STRESS                                                            STRESS    16
C   EPPLAS = NEW VALUE OF PLASTIC STRAIN (IN/IN)                            STRESS    17
C   ***                                                                     STRESS    18
C   NOTE                                                                    STRESS    19
C   BOTH *CELMOD* AND *CSTRES*  ARE IN S.I. UNITS,                          STRESS    20
C   SO STRESSES ARE CONVERTED TO N/M**2 AND                                 STRESS    21
C   TEMPERATURES TO DEGREES KELVIN BEFORE CALLING                           STRESS    22
C   THESE TWO  ROUTINES.                                                    STRESS    23
C   ***PROGRAMMED BY H.P. BOHN ,  NOV.18, 1974 .                            STRESS    24
C                                                                           STRESS    25
C                                                                           MATCNS     2
C   THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES             MATCNS     3
C   USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM                           MATCNS     4
C                                                                           MATCNS     5
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX         MATCNS     6
     +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTMELT ,RSTRAN       MATCNS     7
C                                                                           MATCNS     8
C   ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST           MATCNS     9
C   (HOOP STRAIN)/(RADIAL STRAIN)                                           MATCNS    10
C   COMP   - PUO2 CONTENT (WT%)                                             MATCNS    11
C   CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)       MATCNS    12
C   CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT              MATCNS    13
C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED            MATCNS    14
C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                    MATCNS    15
C   FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                                MATCNS    16
C   FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)       MATCNS    17
C   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT           MATCNS    18
C   FOTMTL - FUEL OXYGEN TO METAL RAITO                                     MATCNS    19
C   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)               MATCNS    20
C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                     MATCNS    21
C   RSTRAN - TRUE STRAIN RATE (1/SEC)                                       MATCNS    22
C                                                                           MATCNS    23
C                                                                           MATCNS    24
C   IMPLICIT REAL*8 (A-H,O-Z)                                               STRESS    27
        T = TEMP                                                            STRESS    28
        IF (N3.EQ.1) T = TEMPS(TEMP)                                        STRESS    29
C   E = CELMOD( T,AA,BB,CC )              DELETE                            STRESS    30
C   E = E/6894.7573                 DELETE                                  STRESS    31
C   ***DEP SHOULD NEVER BE NEGATIVE**CHECK THIS HERE                        STRESS    32
```

```
                IF (DEP) 100,110,110                                                    STRESS     33
55          100 WRITE (6,130) DEP                                                       STRESS     34
                DEP = 0.0001                                                            STRESS     35
            110 CONTINUE                                                                STRESS     36
                E = E1                                                                  STRESS     37
                EPPLAS = EPPLAS+DEP                                                     STRESS     38
60              SIG = 5000.0                                                            STRESS     39
                SIG = PSIS(SIG)                                                         STRESS     40
                IF (N3.EQ.1) E = PSIS(E1)                                               STRESS     41
                   DO 120 K=1,30                                                        STRESS     42
                   EPS = SIG/E+EPPLAS                                                   STRESS     43
65                 IF (JTYPE.EQ.1) CALL STRES1 (T,EPS,SIG,E)                            STRESS     44
                   IF (JTYPE.EQ.2) CALL CSTRES (T,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTR       STRESS     45
               +   AN,EPS,SIG)                                                          STRESS     46
            120    CONTINUE                                                             STRESS     47
            C   CONVERT ANISOTROPIC EFFECTIVE YIELD STRESS                              STRESS     48
70          C   TO ISOTROPIC EFFECTIVE YIELD STRESS                                     STRESS     49
                IF (JTYPE.EQ.2) SIG = SIG/1.19                                          STRESS     50
                IF (N3.EQ.1) SIG = PSIB(SIG)                                            STRESS     51
                RETURN                                                                  STRESS     52
            C                                                                           STRESS     53
75          130 FORMAT (1H1,24X,18HERROR-NEGATIVE DEP/25X,6HDEP = ,E11.4,32HWAS PA      STRESS     54
               +SSED TO SUBROUTINE*STRESS*/25X,44HDEP WAS SET TO .0001- RESULTS MA      STRESS     55
               +Y BE INVALID)                                                           STRESS     56
                END                                                                     STRESS     57
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	STRESSX	1	73

VARIABLES

	SN	TYPE	RELOCATION							
0	ANRIN	REAL	MATCNS	REFS	29					
1	COMP	REAL	MATCNS	REFS	29					
2	CWKF	REAL	MATCNS	REFS	29	66				
3	CWNF	REAL	MATCNS	REFS	29	66				
4	DELOXY	REAL	MATCNS	REFS	29	66				
0	DEP	REAL	F.P.	REFS	54	55	59	DEFINED	1	56
160	E	REAL		REFS	64	65	DEFINED	58	62	
0	EPPLAS	REAL	F.P.	REFS	59	64	DEFINED	1	59	
162	EPS	REAL		REFS	65	66	DEFINED	64		
0	E1	REAL	F.P.	REFS	58	62	DEFINED	1		
5	FLUX	REAL	MATCNS	REFS	29					
6	FNCK	REAL	MATCNS	REFS	29	66				
7	FNCN	REAL	MATCNS	REFS	29	66				
10	FOTMTL	REAL	MATCNS	REFS	29					
11	FRDEN	REAL	MATCNS	REFS	29					
12	FTMELT	REAL	MATCNS	REFS	29					
0	JTYPE	INTEGER	F.P.	REFS	65	66	71	DEFINED	1	

```
VARIABLES     SN  TYPE          RELOCATION
  161  K       *  INTEGER                    DEFINED    63
    0  N3        INTEGER       F.P.          REFS      50    62        72   DEFINED      1
   13  RSTRAN    REAL          MATCNS        REFS      29    66
    0  SIG       REAL          F.P.          REFS      61    64        65        66      71        72
                                             DEFINED    1    60        61        71      72
  157  T         REAL                        REFS      65    66   DEFINED        49      50
    0  TEMP      REAL          F.P.          REFS      49    50   DEFINED         1

FILE NAMES      MODE
     TAPE6      FMT                  WRITES      55

EXTERNALS         TYPE   ARGS      REFERENCES
     CSTRES                 9           66
     PSIB       REAL        1           72
     PSIS       REAL        1           61        62
     STRESI                 4           65
     TEMPS      REAL        1           50

STATEMENT LABELS                DEF LINE   REFERENCES
    0  100          INACTIVE        55         54
   26  110                          57        2*54
    0  120                          68         63
  135  130      FMT                 75         55

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   51  120      K           63 68       21B              EXT REFS

COMMON BLOCKS   LENGTH
     MATCNS       12

STATISTICS
  PROGRAM LENGTH                    172B      122
  SCM LABELED COMMON LENGTH          14B       12
        140000B SCM USED
```

```
      SUBROUTINE CREEPX (SIG,EDOT,Z,TC,PHI,ECREEP,JTYPE)                CREEP      2
C     IMPLICIT REAL*8 (A-H,O-Z)                                         CREEP      3
C     ROOTING FOR ROOTS                                                 CREEP      4
      F1(T) = CREP1(T,EDOT,Z,TC,PHI,ECREEP)                             CREEP      5
      F2(T) = CRAPX(T,EDOT,Z,TC,PHI,ECREEP)                             CREEP      6
C                                                                       CREEP      7
C                                                                       CREEP      8
C     A MODIFIED FALSE POSITION ROUTINE OPERATING OVER THE INTERVAL ALPH CREEP      9
C     BETA WITH INCREMENT DX                                            CREEP     10
C                                                                       CREEP     11
      ALPHA = 0.0E0                                                     CREEP     12
      BETA = 100000.                                                    CREEP     13
      DX = 10000.                                                       CREEP     14
      CUT = 5.0                                                         CREEP     15
      CUT1 = CUT                                                        CREEP     16
      N = 0                                                             CREEP     17
C                                                                       CREEP     18
      A = ALPHA                                                         CREEP     19
      B = A+DX                                                          CREEP     20
      IF (JTYPE.EQ.1) FOFA = F1(A)                                      CREEP     21
      IF (JTYPE.EQ.2) FOFA = F2(A)                                      CREEP     22
100   IF (JTYPE.EQ.1) FOFB = F1(B)                                      CREEP     23
      IF (JTYPE.EQ.2) FOFB = F2(B)                                      CREEP     24
C     WRITE(6,80) A,FOFA,B,FOFB                                         CREEP     25
      IF (FOFA*FOFB) 110,170,190                                        CREEP     26
110   CONTINUE                                                          CREEP     27
C     HAVING BRACKETED A ROOT THE SOLUTION ITERATION COMMENCES          CREEP     28
C                                                                       CREEP     29
120   X = (A*FOFB-B*FOFA)/(FOFB-FOFA)                                   CREEP     30
      N = N+1                                                           CREEP     31
      IF (N.LT.300) GO TO 130                                           CREEP     32
      WRITE (6,220)                                                     CREEP     33
      STOP                                                              CREEP     34
C     GO TO 24                                                          CREEP     35
130   IF (JTYPE.EQ.1) FOFX = F1(X)                                      CREEP     36
      IF (JTYPE.EQ.2) FOFX = F2(X)                                      CREEP     37
C     WRITE(6,80) X,FOFX                                                CREEP     38
C     TEST THE POSSIBILITY OF THE ITERATION LOOP LANDING ON A ROOT AT X CREEP     39
C     OR PASSING BY THE ROOT                                            CREEP     40
      IF (FOFX*FOFA) 150,160,140                                        CREEP     41
140   CONTINUE                                                          CREEP     42
C     THE ROOT IS STILL BRACKETED AND THE ITERATION LOOP CONTINUES      CREEP     43
C                                                                       CREEP     44
      A = X                                                             CREEP     45
      FOFA = FOFX                                                       CREEP     46
      FOFB = .5*FOFB                                                    CREEP     47
      IF ((ABS(B-A).GT.CUT).AND.(ABS(FOFX).GT.CUT1)) GO TO 120          CREEP     48
      VX = X                                                            CREEP     49
      GO TO 210                                                         CREEP     50
150   CONTINUE                                                          CREEP     51
C     THE ITERATION SCHEME HAS REBRACKETED THE ROOT-THE BOUNDS ARE      CREEP     52
C     ADJUSTED AND THE LOOP CONTINUES                                   CREEP     53
C                                                                       CREEP     54
```

```
                B = X                                                                CREEP      55
55              FOFB = FOFX                                                          CREEP      56
                FOFA = .5*FOFA                                                       CREEP      57
                IF ((ABS(B-A).GT.CUT).AND.(ABS(FOFX).GT.CUT1)) GO TO 120             CREEP      58
                VX = X                                                               CREEP      59
                GO TO 210                                                            CREEP      60
60          160 CONTINUE                                                             CREEP      61
            C   THE ITERATION SCHEME HAS LANDED ON A ROOT AT (X,FOFX)                 CREEP      62
            C                                                                        CREEP      63
                IF (ABS(FOFA).EQ.0.0E0) GO TO 180                                    CREEP      64
                VX = X                                                               CREEP      65
65              GO TO 210                                                            CREEP      66
            170 CONTINUE                                                             CREEP      67
            C   THE BRACKETING OPERATION HAS FOUND A ROOT                           CREEP      68
            C                                                                        CREEP      69
                IF (FOFA.EQ.0.0E0) GO TO 180                                         CREEP      70
70          C   THE BRACKETING OPERATION HAS FOUND A ROOT AT (B,FOFB)                CREEP      71
                VX = B                                                               CREEP      72
                GO TO 210                                                            CREEP      73
            180 CONTINUE                                                             CREEP      74
            C   IF THIS IS THE FIRST BRACKET STEP THEN F(ALPHA)=0. IF OTHERWISE      CREEP      75
75          C   THE PREVIOUS STEP IS IN ERROR AT FOFB                              CREEP      76
                WRITE (6,230) A                                                      CREEP      77
                GO TO 210                                                            CREEP      78
            190 CONTINUE                                                             CREEP      79
            C   THE ROUTINE HAS NOT YET BRACKETED A ROOT-ADJUST THE VARIABLES TO     CREEP      80
80          C   THE NEXT MESH AND CONTINUE, ALSO TEST TO SEE IF THE INTERVAL HAS     CREEP      81
            C   BEEN EXCEEDED                                                       CREEP      82
                A = B                                                                CREEP      83
                B = B+DX                                                             CREEP      84
                FOFA = FOFB                                                          CREEP      85
85              IF (A.GT.BETA) GO TO 200                                             CREEP      86
                GO TO 100                                                            CREEP      87
            200 CONTINUE                                                             CREEP      88
            C   THE BRACKETING OPERATION HAS OVERRUN THE INTERVAL                    CREEP      89
                WRITE (6,240)                                                        CREEP      90
90              STOP                                                                 CREEP      91
            210 CONTINUE                                                             CREEP      92
            C   WRITE(6,74) VX,N                                                     CREEP      93
                SIG = VX                                                             CREEP      94
                RETURN                                                               CREEP      95
95          C                                                                        CREEP      96
            220 FORMAT (65H- THE ITERATION SCHEME HAS PASSED 100 STEPS--EXECUTION    CREEP      97
               +TERMINATED)                                                          CREEP      98
            230 FORMAT (41H,  INITIAL DATA CONTAINS A ROOT AT ALPHA=,E15.6)           CREEP      99
            240 FORMAT (48H  THE BRACKET OPERATION HAS OVERRUN THE INTERVAL)          CREEP     100
100             END                                                                  CREEP     101
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CREEPX	1	94

VARIABLES	SN	TYPE	RELOCATION							
373	A	REAL		REFS	19	20	21	29	47	57	76
					85	DEFINED	18	44	82		
365	ALPHA	REAL		REFS	18	DEFINED	11				
374	B	REAL		REFS	22	23	29	47	57	71	82
					83	DEFINED	19	54	83		
366	BETA	REAL		REFS	85	DEFINED	12				
370	CUT	REAL		REFS	15	47	57	DEFINED	14		
371	CUTI	REAL		REFS	47	57	DEFINED	15			
367	DX	REAL		REFS	19	83	DEFINED	13			
0	ECREEP	REAL	F.P.	REFS	20	21	22	23	35	36	
				DEFINED	1						
0	EDOT	REAL	F.P.	REFS	20	21	22	23	35	36	
				DEFINED	1						
375	FOFA	REAL		REFS	25	2*29	40	56	63	69	
				DEFINED	20	21	45	56	84		
376	FOFB	REAL		REFS	25	2*29	46	84	DEFINED	22	23
					46	55					
400	FOFX	REAL		REFS	40	45	47	55	57		
				DEFINED	35	36					
0	JTYPE	INTEGER	F.P.	REFS	20	21	22	23	35	36	
				DEFINED	1						
372	N	INTEGER		REFS	30	31	DEFINED	16	30		
0	PHI	REAL	F.P.	REFS	20	21	22	23	35	36	
				DEFINED	1						
0	SIG	REAL	F.P.	DEFINED	1	93					
0	TC	REAL	F.P.	REFS	20	21	22	23	35	36	
				DEFINED	1						
401	VX	REAL		REFS	93	DEFINED	48	58	64	71	
377	X	REAL		REFS	35	36	44	48	54	58	64
				DEFINED	29						
0	Z	REAL	F.P.	REFS	20	21	22	23	35	36	
				DEFINED	1						

FILE NAMES	MODE				
TAPE6	FMT	WRITES	32	76	89

EXTERNALS	TYPE	ARGS	REFERENCES		
CRAPX	REAL	6	21	23	36
CREPI	REAL	6	20	22	35

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES		
ABS	REAL	1	INTRIN		2*47	2*57	63
FI	REAL	1	SF	4	20	22	35
F2	REAL	1	SF	5	21	23	36

STATEMENT LABELS			DEF LINE	REFERENCES				
60	100		22	86				
0	110	INACTIVE	26	25				
113	120		29	47	57			
132	130		35	31				
0	140	INACTIVE	41	40				
205	150		50	40				
226	160		60	40				
235	170		66	25				
243	180		73	63	69			
247	190		78	25				
263	200		87	85				
270	210		91	49	59	65	72	77
332	220	FMT	96	32				
342	230	FMT	98	76				
351	240	FMT	99	89				

STATISTICS
  PROGRAM LENGTH 402B 258
        140000B SCM USED

```
1          C   ******                                                          CONVSF      2
           C                                                                   CONVSF      3
           C   TEMPS CHANGES FAHRENHEIT TEMPERATURES TO KELVIN                 CONVSF      4
           C                                                                   CONVSF      5
5          C   ******                                                          CONVSF      6
             FUNCTION TEMPS (T)                                                CONVSF      7
             TEMPS = (T+459.67)*(5./9.)                                        CONVSF      8
             RETURN                                                            CONVSF      9
             END                                                               CONVSF     10
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	TEMPS	6	8

VARIABLES	SN	TYPE	RELOCATION				
0	T	REAL	F.P.	REFS	7	DEFINED	6
20	TEMPS	REAL		DEFINED	7		

STATISTICS

PROGRAM LENGTH 218 17

140000B SCM USED

```
      FUNCTION TEMPKF (T)                                                CONVSF  11
C                                                                        CONVSF  12
C     ******                                                             CONVSF  13
C                                                                        CONVSF  14
C     TEMPKF CONVERTS TEMPERATURES FROM KELVIN TO FAHRENHEIT             CONVSF  15
C                                                                        CONVSF  16
C     T      - INPUT TEMPERATURE (K)                                     CONVSF  17
C     TEMPKF - OUTPUT TEMPERATURE (F)                                    CONVSF  18
C                                                                        CONVSF  19
C     ******                                                             CONVSF  20
C                                                                        CONVSF  21
      TEMPKF = 1.8E0*T-459.67E0                                          CONVSF  22
C                                                                        CONVSF  23
      RETURN                                                             CONVSF  24
      END                                                                CONVSF  25
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	TEMPKF	1	14

VARIABLES	SN	TYPE	RELOCATION				
0	T	REAL	F.P.	REFS	12	DEFINED	1
16	TEMPKF	REAL		DEFINED	12		

STATISTICS
PROGRAM LENGTH 17B 15
140000B SCM USED

```
1          C   ******
           C
           C   PSIS CHANGES  PSI  TO  NEWTONS/METER**2
           C
5          C   ******
             FUNCTION PSIS (PSI)
             PSIS = PSI*6894.7572
             RETURN
             END
```

```
CONVSF  26
CONVSF  27
CONVSF  28
CONVSF  29
CONVSF  30
CONVSF  31
CONVSF  32
CONVSF  33
CONVSF  34
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	PSIS	6	8

VARIABLES	SN	TYPE	RELOCATION				
0	PSI	REAL	F.P.	REFS	7	DEFINED	6
14	PSIS	REAL		DEFINED	7		

STATISTICS

PROGRAM LENGTH 15B 13

140000B SCM USED

```
1          C   *******                                                    CONVSF   35
           C                                                              CONVSF   36
           C   PSIB CHANGES NEWTONS/METER**2  TO PSI                      CONVSF   37
           C                                                              CONVSF   38
5          C   *******                                                    CONVSF   39
             FUNCTION PSIB (PSI)                                          CONVSF   40
             PSIB = PSI/6894.7572                                         CONVSF   41
             RETURN                                                       CONVSF   42
             END                                                          CONVSF   43
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	PSIB	6	8

VARIABLES	SN	TYPE	RELOCATION				
0	PSI	REAL	F.P.	REFS	7	DEFINED	6
14	PSIB	REAL		DEFINED	7		

STATISTICS

PROGRAM LENGTH 15B 13

140000B SCM USED

```
      SUBROUTINE FCRNCH (SIG,PG,DTIME,FVFRO,DVTOT,DV)                    FCRNCH     2
C     SIG    = INPUT RADIAL STRESS AT PELLET CLAD INTERFACE (PSI)        FCRNCH     3
C     PG     = INPUT GAP GAS PRESSURE (PSI)                              FCRNCH     4
C     DTIME  = INPUT TIME STEP SIZE (HRS)                                FCRNCH     5
C     FVFRO  = INPUT INITIAL FUEL VOID FRACTION                          FCRNCH     6
C     DVTOT  = INPUT FUEL VOID FRACTION THAT HAS BEEN REMOVED            FCRNCH     7
C     =   SUM OF PERMANENT PLASTIC STRAINS IN 3 DIRECTIONS               FCRNCH     8
C     FVFRO + DVTOT = INPUT REMAINING FUEL VOID FRACTION                 FCRNCH     9
C     DV     = OUTPUT CHANGE IN VOLUME                                   FCRNCH    10
C     THE CONSTANT A IS THE FUEL PELLETE STIFFENER KNOB (A IS INVERSLY    FCRNCH    11
C     PROPORTIONAL TO THE STIFFNESS). THE CONSTANT B IS THE INTERFACE     FCRNCH    12
C     PRESSURE SENSITIVITY KNOB (B IS PROPORTIONAL TO THE SENSITIVEITY).  FCRNCH    13
C     DV IS ZERO IF THERE IS NO REMAINING RELOCATION OR IF THE INTERFACE  FCRNCH    14
C     PRESSURE IS POSITIVE.                                              FCRNCH    15
      DV = 0.0                                                           FCRNCH    16
      FVFR = FVFRO+DVTOT                                                 FCRNCH    17
      IF (FVFR.LE.0.0) GO TO 100                                         FCRNCH    18
      SM = SIG+PG+1000.                                                  FCRNCH    19
      IF (SM.GE.0.0) GO TO 100                                           FCRNCH    20
      SM = -SM                                                           FCRNCH    21
      A = 1.0E-17                                                        FCRNCH    22
      B = 4.5                                                            FCRNCH    23
      BETA = DTIME*A*((SM)**B)                                           FCRNCH    24
      DV = -FVFR*(1.E0-EXP(-BETA))                                       FCRNCH    25
100   RETURN                                                             FCRNCH    26
      END                                                                FCRNCH    27
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FCRNCH	1	25

VARIABLES

		SN	TYPE	RELOCATION								
63	A		REAL		REFS	23	DEFINED	21				
64	B		REAL		REFS	23	DEFINED	22				
65	BETA		REAL		REFS	24	DEFINED	23				
0	DTIME		REAL	F.P.	REFS	23	DEFINED	1				
0	DV		REAL	F.P.	DEFINED	1	15	24				
0	DVTOT		REAL	F.P.	REFS	16	DEFINED	1				
61	FVFR		REAL		REFS	17	24	DEFINED	16			
0	FVFRO		REAL	F.P.	REFS	16	DEFINED	1				
0	PG		REAL	F.P.	REFS	18	DEFINED	1				
0	SIG		REAL	F.P.	REFS	18	DEFINED	1				
62	SM		REAL		REFS	19	20	23	DEFINED	16	20	

EXTERNALS

	TYPE	ARGS		REFERENCES
EXP	REAL	1	LIBRARY	24

STATEMENT LABELS

	DEF LINE	REFERENCES
46 100	25	17 19

STATISTICS

PROGRAM LENGTH 66B 54

140000B SCM USED

```
      FUNCTION CRAPX (SAG,EDOT,T,TC,PHI,ECREEP)                          CRAPX      2
C     IMPLICIT REAL*8 (A-H,O-Z)                                          CRAPX      3
C     CREEP COMPUTES EFFECTIVE STRESS AS A FUNCTION OF                   CRAPX      4
C     THE CREEP STRAIN RATE, TEMPERATURE, FAST                           CRAPX      5
C     NEUTRON FLUX AND ACCUMULATED TOTAL CREEP STRAIN                    CRAPX      6
C     INPUT                                                              CRAPX      7
C     EDOT = CREEP STRAIN RATE (1/HR)                                    CRAPX      8
C     TC = CLADDING TEMPERATURE (F)                                      CRAPX      9
C     T = TIME (HR) NOT USED IN THIS VERSION                             CRAPX     10
C                                                                        CRAPX     11
C     PHI = FLUX (NEUTRONS/M**2/SEC)                                     CRAPX     12
C     ECREEP = TOTAL ACCUMULATED CREEP STRAIN (DIMENSIONLESS)            CRAPX     13
C     OUTPUT                                                             CRAPX     14
C     SIG = EFFECTIVE STRESS (PSI)                                       CRAPX     15
C                                                                        CRAPX     16
C     THE CREEP RATE EQUATION USED IN THIS SUBROUTINE WAS BASED ON :     CRAPX     17
C     THE TIME AND STRESS DEPENDENCE TAKEN FROM "INREACTOR TUBULAR       CRAPX     18
C     CREEP OF ZIRCALOY-2 AT 260 TO 3000", E.F. IBRHAIM, J. NUCL. MATER  CRAPX     19
C     VOL 46 (1973) PP 169-182                                           CRAPX     20
C     THE FLUX DEPENDENCE WAS BASED ON ROSS-ROSS AND HUNT, J. NUCL.      CRAPX     21
C     MATER. VOL 26 (1968) PP 2 - 17                                     CRAPX     22
C     THE TEMPERATURE DEPENDENCE, DEPX(-Q/RT), WAS BASED ON A VALUE      CRAPX     23
C     OF Q = 10000 CAL/MOLE NEAR 573K FROM FIDLERIS, AECL-4766           CRAPX     24
C                                                                        CRAPX     25
C     CODED BY M.P.BOHN, DEC.28,1975 BASED ON THE MATPRO                 CRAPX     26
C     FUNCTION 'CCRPR'                                                   CRAPX     27
C                                                                        CRAPX     28
C     WRITE(6,2) SAG,EDOT,TC,PHI,ECREEP                                  CRAPX     29
      SIG = SAG*6894.7573                                                CRAPX     30
      DPDT = EDOT/3600.0                                                 CRAPX     31
      TC1 = 5.0*(TC-32.0)/9.0+273.15                                     CRAPX     32
      B = 725.2                                                          CRAPX     33
      C = 4.967E-08                                                      CRAPX     34
      AK = 5.129E-29                                                     CRAPX     35
      R = 1.987                                                          CRAPX     36
      E = ECREEP                                                         CRAPX     37
      A1 = SQRT(E*DPDT/2.0)/(AK*PHI)                                     CRAPX     38
      A2 = EXP(10000.0/(R*TC1))                                          CRAPX     39
      A3 = A1*A2                                                         CRAPX     40
      IF (T.EQ.0.E0) GO TO 100                                           CRAPX     41
      A4 = SIG+B*EXP(C*SIG)                                              CRAPX     42
      TIME = T*3600.0                                                    CRAPX     43
      CRAPX = DPDT-AK*PHI*A4*(1.0/A2)/SQRT(TIME)                         CRAPX     44
      RETURN                                                             CRAPX     45
100   CONTINUE                                                           CRAPX     46
      CRAPX = A3-B*EXP(C*SIG)-SIG                                        CRAPX     47
      RETURN                                                             CRAPX     48
C                                                                        CRAPX     49
      END                                                                CRAPX     50
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES	
5	CRAPX	1	44	47

VARIABLES	SN	TYPE	RELOCATION						
146	AK	REAL		REFS	37	43	DEFINED	34	
151	A1	REAL		REFS	39	DEFINED	37		
152	A2	REAL		REFS	39	43	DEFINED	38	
153	A3	REAL		REFS	46	DEFINED	39		
154	A4	REAL		REFS	43	DEFINED	41		
144	B	REAL		REFS	41	46	DEFINED	32	
145	C	REAL		REFS	41	46	DEFINED	33	
140	CRAPX	REAL		DEFINED	43	46			
142	DPDT	REAL		REFS	37	43	DEFINED	30	
150	E	REAL		REFS	37	DEFINED	36		
0	ECREEP	REAL	F.P.	REFS	36	DEFINED	1		
0	EDOT	REAL	F.P.	REFS	30	DEFINED	1		
0	PHI	REAL	F.P.	REFS	37	43	DEFINED	1	
147	R	REAL		REFS	38	DEFINED	35		
0	SAG	REAL	F.P.	REFS	29	DEFINED	1		
141	SIG	REAL		REFS	2*41	2*46	DEFINED	29	
0	T	REAL	F.P.	REFS	40	42	DEFINED	1	
0	TC	REAL	F.P.	REFS	31	DEFINED	1		
143	TC1	REAL		REFS	38	DEFINED	31		
155	TIME	REAL		REFS	43	DEFINED	42		

EXTERNALS	TYPE	ARGS		REFERENCES		
EXP	REAL	1	LIBRARY	38	41	46
SQRT	REAL	1	LIBRARY	37	43	

STATEMENT LABELS		DEF LINE	REFERENCES
103	100	45	40

STATISTICS

PROGRAM LENGTH 156B 110

140000B SCM USED

```
      1              SUBROUTINE FPRESS (SIGM,DVDOT,TIME,T,PHI,CRAP,JTYPE,N3)          FPRES      2
                     TC = T                                                           FPRES      3
                     IF (N3.EQ.0) TC = TEMPKF(T)                                      FPRES      4
                     SIGGY = DVDOT/5.0E-08                                            FPRES      5
      5              IF (JTYPE.EQ.1.AND.TC.GE.2046.26) SIGM = SIGGY                   FPRES      6
                     IF (JTYPE.EQ.1.AND.TC.LT.2046.26) SIGM = 1.E+27                  FPRES      7
                     IF (JTYPE.EQ.2) SIGM = 1.E+27                                    FPRES      8
                     IF (N3.EQ.0) SIGM = PSIS(SIGM)                                   FPRES      9
                     RETURN                                                           FPRES     10
     10              END                                                              FPRES     11
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

SN	ENTRY POINTS	DEF LINE	REFERENCES
4	FPRESS	1	9

VARIABLES

SN	VARIABLES	TYPE	RELOCATION									
0	CRAP	REAL	*UNUSED	F.P.	DEFINED	1						
0	DVDOT	REAL		F.P.	REFS	4	DEFINED	1				
0	JTYPE	INTEGER		F.P.	REFS	5	6	7	DEFINED	1		
0	N3	INTEGER		F.P.	REFS	3	8	DEFINED	1			
0	PHI	REAL	*UNUSED	F.P.	DEFINED	1						
57	SIGGY	REAL			REFS	5	DEFINED	4				
0	SIGM	REAL		F.P.	REFS	8	DEFINED	1	5	6	7	8
0	T	REAL		F.P.	REFS	2	3	DEFINED	1			
56	TC	REAL			REFS	5	6	DEFINED	2	3		
0	TIME	REAL	*UNUSED	F.P.	DEFINED	1						

EXTERNALS

EXTERNALS	TYPE	ARGS	REFERENCES
PSIS	REAL	1	8
TEMPKF	REAL	1	3

STATISTICS

PROGRAM LENGTH 60B 48

140000B SCM USED

```
      SUBROUTINE PRINTM (SIG,EPS,EPP,EP,ECREEP,M1,M2,M3,R,T,PG,PC,FVFRO,
     +DVHPRS,MNR,MNA,ALFDT,EPS02,EPS0)
C
      DIMENSION T(MNA,MNR),EPS(MNA,MNR,3),EPP(MNA,MNR,3)
     + ,SIG(MNA,MNR,3)
     + ,EP(MNA,MNR), R(MNA,MNR),ECREEP(MNA,MNR)
     + ,FVFRO(MNA,MNR) ,DVHPRS(MNA,MNR)
     + ,PG(MNA) ,PC(MNA) ,ALFDT(MNA,MNR,3) ,EPS02(MNA,MNR,3)
     + ,EPS0(MNA,MNR,3)
C
      WRITE (6,130)
          DO 120 J=1,M1
          WRITE (6,150)
              DO 100 I=1,M2
              WRITE (6,140) R(J,I),(EPS(J,I,M),M=1,3),(EPP(J,I,M),M=1,3)
     +        ,(SIG(J,I,M),M=1,3),DVHPRS(J,I),FVFRO(J,I)
  100         CONTINUE
          WRITE (6,150)
              DO 110 I=1,M2
              WRITE (6,140) PG(J),PC(J),(ALFDT(J,I,M),M=1,3),(EPS02(J,I,
     +        M),M=1,3),(EPS0(J,I,M),M=1,3)
  110         CONTINUE
  120     CONTINUE
      RETURN
C
  130   FORMAT (1H1,7X,1HR,8X,4HEPSR,7X,4HEPSH,7X,4HEPSA,7X,4HEPPR,7X,4HEP
     +PH,7X,4HEPPA,7X,4HSIGR,7X,4HSIGH,7X,4HSIGA,6X,6HDVHPRS,6X,5HFVFRO,
     +/,1H,12X,2HEP,7X,6HECREEP,9X,2HPG,9X,2HPC)
  140   FORMAT (1H ,12E11.3)
  150   FORMAT (1H0)
        END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	PRINTM	DEF LINE 1	REFERENCES 24

VARIABLES

	SN	TYPE		RELOCATION						
0	ALFDT	REAL	ARRAY	F.P.	REFS	4	20	DEFINED	1	
0	DVHPRS	REAL	ARRAY	F.P.	REFS	4	15	DEFINED	1	
0	ECREEP	REAL	ARRAY	F.P.	REFS	4	DEFINED	1		
0	EP	REAL	ARRAY	F.P.	REFS	4	DEFINED	1		
0	EPP	REAL	ARRAY	F.P.	REFS	4	15	DEFINED	1	
0	EPS	REAL	ARRAY	F.P.	REFS	4	15	DEFINED	1	
0	EPS0	REAL	ARRAY	F.P.	REFS	4	20	DEFINED	1	
0	EPS02	REAL	ARRAY	F.P.	REFS	4	20	DEFINED	1	
0	FVFRO	REAL	ARRAY	F.P.	REFS	4	15	DEFINED	1	
274	I	INTEGER			REFS	6*15	3*20	DEFINED	14	19
273	J	INTEGER			REFS	6*15	5*20	DEFINED	12	

VARIABLES	SN	TYPE		RELOCATION							
275	M	INTEGER			REFS	3*15	3*20	DEFINED	3*15	3*20	
0	MNA	INTEGER		F.P.	REFS	14*4	DEFINED	1			
0	MNR	INTEGER		F.P.	REFS	12*4	DEFINED	1			
0	M1	INTEGER		F.P.	REFS	12	DEFINED	1			
0	M2	INTEGER		F.P.	REFS	14	19	DEFINED	1		
0	M3	INTEGER	*UNUSED	F.P.	DEFINED	1					
0	PC	REAL	ARRAY	F.P.	REFS	4	20	DEFINED	1		
0	PG	REAL	ARRAY	F.P.	REFS	4	20	DEFINED	1		
0	R	REAL	ARRAY	F.P.	REFS	4	15	DEFINED	1		
0	SIG	REAL	ARRAY	F.P.	REFS	4	15	DEFINED	1		
0	T	REAL	ARRAY	F.P.	REFS	4	DEFINED	1			

FILE NAMES	MODE					
TAPE6	FMT	WRITES	11	13	15	18	20

STATEMENT LABELS			DEF LINE	REFERENCES		
0	100		17	14		
0	110		22	19		
0	120		23	12		
247	130	FMT	26	11		
266	140	FMT	29	15	20	
271	150	FMT	30	13	18	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
17	120	J	12 23	163B	EXT REFS	NOT INNER	
23	100	I	14 17	67B	EXT REFS	NOT INNER	
33		M	15 15	13B	EXT REFS		
50		M	15 15	13B	EXT REFS		
65		M	15 15	13B	EXT REFS		
116	110	I	19 22	61B	EXT REFS	NOT INNER	
125		M	20 20	13B	EXT REFS		
142		M	20 20	13B	EXT REFS		
157		M	20 20	13B	EXT REFS		

STATISTICS
PROGRAM LENGTH 315B 205
140000B SCM USED

```
      SUBROUTINE FCMI2 (NN,DLROD,DLREL,JJJ,RELAX,DTIME,TIME,N1,N2,N3,N4,  FCMI2       2
     +M1,M2,M3,M4,M5,M6,KFLAG,ELASTC,CRACK,VX,PG,PC,T,EPS,EPP,SIG,REPS,E  FCMI2       3
     +PS0,ECREEP,EP,DZ,GAP,R,IGAP,OLDT,OLDPG,OLDPC,OLIGAP,FVFR0,DVHPRS,E  FCMI2       4
     +P2,EPP2,ECREP2,OLDEPP,AFCMI2,NA,NR,MNA)                             FCMI2       5
C                                                                         FCMI2       6
      COMMON/PFCMI2/          NPIN                                        FCMI2       7
     +                       ,NPOUT       ,NP1         ,NP2             FCMI2       8
     +                       ,NTSAVE      ,NDCHCK      ,NOLSGF          FCMI2       9
     +                       ,NDEP        ,NSLOPE      ,NCOEF           FCMI2      10
     +                       ,NDSIGF      ,NF1         ,NF2             FCMI2      11
     +                       ,NEP2        ,NECRP2      ,NT2             FCMI2      12
     +                       ,NTN         ,NE          ,NV              FCMI2      13
     +                       ,NEPP2       ,NSTRTT      ,NALFDT          FCMI2      14
     +                       ,NOLDPP      ,NNUDPP      ,NHH             FCMI2      15
     +                       ,NNN         ,NMN         ,NBB             FCMI2      16
     +                       ,NMM         ,NGG         ,NDD             FCMI2      17
     +                       ,NW          ,NU          ,NEE             FCMI2      18
     +                       ,NLL         ,NAA         ,NEI             FCMI2      19
     +                       ,NCC         ,NFF                          FCMI2      20
C                                                                         FCMI2      21
      INTEGER        CRACK          ,ELASTC       ,IGAP(MNA)             FCMI2      22
     +              ,OLIGAP(MNA)    ,RELAX                               FCMI2      23
C                                                                         FCMI2      24
      REAL           DZ(MNA)        ,DVHPRS(MNA,NR)   ,ECREEP(MNA,NR)    FCMI2      25
     +              ,ECREP2(MNA,NR),EP(MNA,NR)        ,EP2(MNA,NR)       FCMI2      26
     +              ,EPP(MNA,NR,3) ,EPP2(MNA,NR,3)   ,EPS(MNA,NR,3)     FCMI2      27
     +              ,EPS0(MNA,NR,3),FVFR0(MNA,NR)    ,GAP(MNA)          FCMI2      28
     +              ,OLDPC(MNA)    ,OLDPG(MNA)       ,OLDT(MNA,NR)      FCMI2      29
     +              ,PC(MNA)       ,PG(MNA)          ,R(MNA,NR)         FCMI2      30
     +              ,REPS(MNA,2)   ,SIG(MNA,NR,3)    ,T(MNA,NR)         FCMI2      31
     +              ,AFCMI2(1)                                           FCMI2      32
C     WRITE(6,2)                                                          FCMI2      33
        PI = 3.1415926                                                    FCMI2      34
C     ***COMPUTE GAP ASSUMING NO PCMI                                     FCMI2      35
        F = 1.0E0                                                         FCMI2      36
          DO 100 J=JJJ,NN                                                 FCMI2      37
          DELTA = R(J,M4)-R(J,M4-1)                                       FCMI2      38
C                                                                         FCMI2      39
C     1005 FORMAT(1X,5I20)                                                FCMI2      40
          GAP(J) = GAPTX(N1,N2,N3,N4,J,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RE  FCMI2      41
     +    LAX,DTIME,TIME,KFLAG,F,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP  FCMI2      42
     +    2,EPP,EPP2,EPS,EPS0,FVFR0,OLDPC,OLDPG,OLDT,PC,PG,R,SIG,T,AFCMI  FCMI2      43
     +    2(NPIN),AFCMI2(NPOUT),AFCMI2(NT2),AFCMI2,NA,NR,MNA)           FCMI2      44
C     WRITE(6,3) J, GAP(J)                                                FCMI2      45
          IGAP(J) = 0                                                     FCMI2      46
          IF (GAP(J).LE.0.0) IGAP(J) = 1                                  FCMI2      47
  100     CONTINUE                                                        FCMI2      48
C     IGAP=1 IF GAP IS CLOSED                                             FCMI2      49
C     ***TEST FOR CLOSED GAP AND RE-SOLVE AS NECESSARY                    FCMI2      50
          DO 130 J=JJJ,NN                                                 FCMI2      51
          IF (IGAP(J).NE.1) GO TO 120                                     FCMI2      52
C     NODE J IS IN CONTACT                                                FCMI2      53
C     IF GAP HAS JUST CLOSED, SEEK POINT OF CLOSURE                       FCMI2      54
```

```
                      IF (OLIGAP(J).NE.0) GO TO 110                                    FCMI2      55
55          C                                                                          FCMI2      56
                      CALL CLOSEX (N1,N2,N3,N4,J,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RELA    FCMI2      57
                 +    X,DTIME,TIME,KFLAG,ELASTC,CRACK,VX,DVHPRS,ECREEP,ECREP2,EP,EP2   FCMI2      58
                 +    ,EPP,EPP2,EPS,EPS0,FVFRO,OLDPC,OLDPG,OLDT,PC,PG,R,REPS,SIG,T,A   FCMI2      59
                 +    FCMI2,NA,NR,MNA)                                                 FCMI2      60
60                    CALL EQUAL1 (EP,EP2,J,NR,MNA)                                    FCMI2      61
                      CALL EQUAL1 (ECREEP,ECREP2,J,NR,MNA)                             FCMI2      62
                      CALL EQUAL2 (EPP,EPP2,J,NR,MNA)                                  FCMI2      63
                110   CONTINUE                                                         FCMI2      64
                C     OBTAIN COUPLED SOLUTION                                          FCMI2      65
65                    L2 = M2                                                          FCMI2      66
                      L3 = M3                                                          FCMI2      67
                      L4 = M4                                                          FCMI2      68
                      FZ = -PC(J)*PI*R(J,M3)**2                                        FCMI2      69
                      DELTEZ = REPS(J,1)-REPS(J,2)                                     FCMI2      70
70          C                                                                          FCMI2      71
                      CALL RATIO (N1,N2,N3,N4,J,L2,L3,L4,L5,L6,FZ,DELTA,DELTEZ,RELAX   FCMI2      72
                 +    ,DTIME,TIME,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP2   FCMI2      73
                 +    ,EPP,EPP2,EPS,EPS0,FVFRO,OLDPC,OLDPG,OLDT,PC,PG,R,SIG,T,AFCMI2   FCMI2      74
                 +    (NP1),AFCMI2(NP2),AFCMI2(NTSAVE),AFCMI2(NTN),AFCMI2,NA,NR,MNA)   FCMI2      75
75                    CALL EQUAL1 (EP,EP2,J,NR,MNA)                                    FCMI2      76
                      CALL EQUAL1 (ECREEP,ECREP2,J,NR,MNA)                             FCMI2      77
                      CALL EQUAL2 (EPP,EPP2,J,NR,MNA)                                  FCMI2      78
                      GO TO 130                                                        FCMI2      79
                *******OPEN GAP SOLUTION IS APPROPRIATE                                FCMI2      80
80              120   CONTINUE                                                         FCMI2      81
                      CALL EQUAL1 (EP,EP2,J,NR,MNA)                                    FCMI2      82
                      CALL EQUAL1 (ECREEP,ECREP2,J,NR,MNA)                             FCMI2      83
                      CALL EQUAL2 (EPP,EPP2,J,NR,MNA)                                  FCMI2      84
                      REPS(J,1) = EPS(J,M4-1,3)                                        FCMI2      85
85                    REPS(J,2) = EPS(J,M4,3)                                          FCMI2      86
                C                                                                      FCMI2      87
                130   CONTINUE                                                         FCMI2      88
                C     ***COMPUTE NEW ROD LENGTH AND DISPLACEMENT                       FCMI2      89
                C     BETWEEN FUEL STACK AND UPPER END OF CLAD                         FCMI2      90
90                    DLROD = 0.0                                                      FCMI2      91
                      DLREL = 0.0                                                      FCMI2      92
                          DO 140 N=JJJ,NN                                              FCMI2      93
                          DLROD = DLROD+EPS(N,M3,3)*DZ(N)                              FCMI2      94
                C                                                                      FCMI2      95
95                        DLREL = DLREL+(EPS(N,M3,3)-EPS(N,M4-1,3))*DZ(N)              FCMI2      96
                140       CONTINUE                                                     FCMI2      97
                      RETURN                                                           FCMI2      98
                C                                                                      FCMI2      99
                      END                                                              FCMI2     100
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FCM12 1 97

VARIABLES	SN	TYPE	RELOCATION										
0	AFCM12	REAL	ARRAY	F.P.	REFS	24	4*40	56	5*71	DEFINED	1		
0	CRACK	INTEGER		F.P.	REFS	21	40	56	71	DEFINED	1		
672	DELTA	REAL			REFS	40	56	71	DEFINED	37			
674	DELTEZ	REAL			REFS	40	56	71	DEFINED	69			
0	DLREL	REAL		F.P.	REFS	95	DEFINED	1	91	95			
0	DLROD	REAL		F.P.	REFS	93	DEFINED	1	90	93			
0	DTIME	REAL		F.P.	REFS	40	56	71	DEFINED	1			
0	DVHPRS	REAL	ARRAY	F.P.	REFS	24	40	56	71	DEFINED	1		
0	DZ	REAL	ARRAY	F.P.	REFS	24	93	95	DEFINED	1			
0	ECREEP	REAL	ARRAY	F.P.	REFS	24	40	56	61	71	76	82	
					DEFINED	1							
0	ECREP2	REAL	ARRAY	F.P.	REFS	24	40	56	61	71	76	82	
					DEFINED	1							
0	ELASTC	INTEGER		F.P.	REFS	21	40	56	71	DEFINED	1		
0	EP	REAL	ARRAY	F.P.	REFS	24	40	56	60	71	75	81	
					DEFINED	1							
0	EPP	REAL	ARRAY	F.P.	REFS	24	40	56	62	71	77	83	
					DEFINED	1							
0	EPP2	REAL	ARRAY	F.P.	REFS	24	40	56	62	71	77	83	
					DEFINED	1							
0	EPS	REAL	ARRAY	F.P.	REFS	24	40	56	71	84	85	93	
					2*95	DEFINED	1						
0	EPSO	REAL	ARRAY	F.P.	REFS	24	40	56	71	DEFINED	1		
0	EP2	REAL	ARRAY	F.P.	REFS	24	40	56	60	71	75	81	
					DEFINED	1							
670	F	REAL			REFS	40	DEFINED	35					
0	FVFRO	REAL	ARRAY	F.P.	REFS	24	40	56	71	DEFINED	1		
673	FZ	REAL			REFS	40	56	71	DEFINED	68			
0	GAP	REAL	ARRAY	F.P.	REFS	24	46	DEFINED	1	40			
0	IGAP	INTEGER	ARRAY	F.P.	REFS	21	51	DEFINED	1	45	46		
671	J	INTEGER			REFS	2*37	2*40	45	2*46	51	54	56	
					60	61	62	2*68	2*69	71	75	76	
					77	81	82	83	2*84	2*85			
					DEFINED	36	50						
0	JJJ	INTEGER		F.P.	REFS	36	50	92	DEFINED	1			
0	KFLAG	INTEGER		F.P.	REFS	40	56	71	DEFINED	1			
675	L2	INTEGER			REFS	71	DEFINED	65					
676	L3	INTEGER			REFS	71	DEFINED	66					
677	L4	INTEGER			REFS	71	DEFINED	67					
700	L5	* INTEGER			REFS	71							
701	L6	* INTEGER			REFS	71							
0	MNA	INTEGER		F.P.	REFS	2*21	21*24	40	56	60	61	62	
					71	75	76	77	81	82	83		
					DEFINED	1							
0	M1	INTEGER	*UNUSED	F.P.	DEFINED	1							
0	M2	INTEGER		F.P.	REFS	40	56	65	DEFINED	1			
0	M3	INTEGER		F.P.	REFS	40	56	66	68	93	95		
					DEFINED	1							
0	M4	INTEGER		F.P.	REFS	2*37	40	56	67	84	85	95	

VARIABLES	SN	TYPE		RELOCATION								
					DEFINED	1						
0	M5	INTEGER		F.P.	REFS	40	56	DEFINED	1			
0	M6	INTEGER		F.P.	REFS	40	56	DEFINED	1			
703	N	INTEGER			REFS	2*93	3*95	DEFINED	92			
0	NA	INTEGER		F.P.	REFS	40	56	71	DEFINED	1		
43	NAA	INTEGER		PFCM12	REFS	6						
25	NALFDT	INTEGER		PFCM12	REFS	6						
33	NBB	INTEGER		PFCM12	REFS	6						
45	NCC	INTEGER		PFCM12	REFS	6						
11	NCOEF	INTEGER		PFCM12	REFS	6						
5	NDCHCK	INTEGER		PFCM12	REFS	6						
36	NDD	INTEGER		PFCM12	REFS	6						
7	NDEP	INTEGER		PFCM12	REFS	6						
12	NDSIGF	INTEGER		PFCM12	REFS	6						
21	NE	INTEGER		PFCM12	REFS	6						
16	NECRP2	INTEGER		PFCM12	REFS	6						
41	NEE	INTEGER		PFCM12	REFS	6						
44	NEI	INTEGER		PFCM12	REFS	6						
23	NEPP2	INTEGER		PFCM12	REFS	6						
15	NEP2	INTEGER		PFCM12	REFS	6						
46	NFF	INTEGER		PFCM12	REFS	6						
13	NFI	INTEGER		PFCM12	REFS	6						
14	NF2	INTEGER		PFCM12	REFS	6						
35	NGG	INTEGER		PFCM12	REFS	6						
30	NHH	INTEGER		PFCM12	REFS	6						
42	NLL	INTEGER		PFCM12	REFS	6						
34	NMM	INTEGER		PFCM12	REFS	6						
32	NMN	INTEGER		PFCM12	REFS	6						
0	NN	INTEGER		F.P.	REFS	36	50	92	DEFINED	1		
31	NNN	INTEGER		PFCM12	REFS	6						
27	NNUDPP	INTEGER		PFCM12	REFS	6						
26	NOLDPP	INTEGER		PFCM12	REFS	6						
6	NOLSGF	INTEGER		PFCM12	REFS	6						
0	NPIN	INTEGER		PFCM12	REFS	6	40					
1	NPOUT	INTEGER		PFCM12	REFS	6	40					
2	NPI	INTEGER		PFCM12	REFS	6	71					
3	NP2	INTEGER		PFCM12	REFS	6	71					
0	NR	INTEGER		F.P.	REFS	14*24	40	56	60	61	62	71
					75	76	77	81	82	83		
					DEFINED	1						
10	NSLOPE	INTEGER		PFCM12	REFS	6						
24	NSTRTT	INTEGER		PFCM12	REFS	6						
20	NTN	INTEGER		PFCM12	REFS	6	71					
4	NTSAVE	INTEGER		PFCM12	REFS	6	71					
17	NT2	INTEGER		PFCM12	REFS	6	40					
40	NU	INTEGER		PFCM12	REFS	6						
22	NV	INTEGER		PFCM12	REFS	6						
37	NW	INTEGER		PFCM12	REFS	6						
0	N1	INTEGER		F.P.	REFS	40	56	71	DEFINED	1		
0	N2	INTEGER		F.P.	REFS	40	56	71	DEFINED	1		
0	N3	INTEGER		F.P.	REFS	40	56	71	DEFINED	1		
0	N4	INTEGER		F.P.	REFS	40	56	71	DEFINED	1		
0	OLDEPP	REAL	*UNUSED	F.P.	DEFINED	1						

```
VARIABLES     SN  TYPE          RELOCATION
    0  OLDPC      REAL      ARRAY     F.P.      REFS      24      40      56      71   DEFINED      1
    0  OLDPG      REAL      ARRAY     F.P.      REFS      24      40      56      71   DEFINED      1
    0  OLDT       REAL      ARRAY     F.P.      REFS      24      40      56      71   DEFINED      1
    0  OLIGAP     INTEGER   ARRAY     F.P.      REFS      21      54  DEFINED       1
    0  PC         REAL      ARRAY     F.P.      REFS      24      40      56      68      71
                                                DEFINED      1
    0  PG         REAL      ARRAY     F.P.      REFS      24      40      56      71   DEFINED      1
  667  PI         REAL                          REFS      68  DEFINED      33
    0  R          REAL      ARRAY     F.P.      REFS      24     2*37      40      56      68      71
                                                DEFINED      1
    0  RELAX      INTEGER             F.P.      REFS      21      40      56      71   DEFINED      1
    0  REPS       REAL      ARRAY     F.P.      REFS      24      56    2*69  DEFINED       1      84      85
    0  SIG        REAL      ARRAY     F.P.      REFS      24      40      56      71   DEFINED      1
    0  T          REAL      ARRAY     F.P.      REFS      24      40      56      71   DEFINED      1
    0  TIME       REAL                F.P.      REFS      40      56      71   DEFINED       1
  702  URO      * REAL                          REFS      71
    0  VX         REAL                F.P.      REFS      56  DEFINED       1

EXTERNALS          TYPE   ARGS      REFERENCES
       CLOSEX                43          56
       EQUAL1                 5          60      61      75      76      81      82
       EQUAL2                 5          62      77      83
       GAPTX          REAL   45          40
       RATIO                 46          71

STATEMENT LABELS              DEF LINE    REFERENCES
    0  100                        47          36
  220  110                        63          54
  334  120                        80          51
  373  130                        87          50      78
    0  140                        96          92

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   21  100      J           36 47        74B              EXT REFS
  117  130      J           50 87       257B              EXT REFS
  404  140      N           92 96       238B         OPT

COMMON BLOCKS   LENGTH
       PFCM12       39

STATISTICS
  PROGRAM LENGTH                  1200B      640
  SCM LABELED COMMON LENGTH         47B       39
        140000B SCM USED
```

```
      C                                                                       FCMI2    101
            SUBROUTINE RATIO (N1,N2,N3,N4,I,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,REL RATIO      2
           +AX,DTIME,TIME,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP2,E RATIO      3
           +PP,EPP2,EPS,EPS0,FVFR0,OLDPC,OLDPG,OLDT,PC,PG,R,SIG,T,P1,P2,TSAVE, RATIO      4
      5    +TN,AFCMI2,NA,NR,MNA)                                               RATIO      5
      C                                                                       RATIO      6
            COMMON/PFCMI2/          NPIN                                      RATIO      7
           +                       ,NPOUT          ,NPI            ,NP2       RATIO      8
           +                       ,NTSAVE         ,NDCHCK         ,NOLSGF    RATIO      9
     10    +                       ,NDEP           ,NSLOPE         ,NCOEF     RATIO     10
           +                       ,NDSIGF         ,NF1            ,NF2       RATIO     11
           +                       ,NEP2           ,NECRP2         ,NT2       RATIO     12
           +                       ,NTN            ,NE             ,NV        RATIO     13
           +                       ,NEPP2          ,NSTRTT         ,NALFDT    RATIO     14
     15    +                       ,NOLDPP         ,NNUDPP         ,NHH       RATIO     15
           +                       ,NNN            ,NMN            ,NBB       RATIO     16
           +                       ,NMM            ,NGG            ,NDD       RATIO     17
           +                       ,NW             ,NU             ,NEE       RATIO     18
           +                       ,NLL            ,NAA            ,NEI       RATIO     19
     20    +                       ,NCC            ,NFF                       RATIO     20
      C                                                                       RATIO     21
            INTEGER   CRACK   ,   ELASTC    ,RELAX                            RATIO     22
      C                                                                       RATIO     23
            REAL      DVHPRS(MNA,NR)      ,ECREEP(MNA,NR)     ,ECREP2(MNA,NR) RATIO     24
     25    +         ,EP(MNA,NR)          ,EP2(MNA,NR)        ,EPP(MNA,NR,3)  RATIO     25
           +         ,EPP2(MNA,NR,3)      ,EPS(MNA,NR,3)      ,EPS0(MNA,NR,3) RATIO     26
           +         ,FVFR0(MNA,NR)       ,OLDPC(MNA)         ,OLDPG(MNA)     RATIO     27
           +         ,OLDT(MNA,NR)        ,PC(MNA)            ,PG(MNA)        RATIO     28
           +         ,R(MNA,NR)           ,SIG(MNA,NR,3)      ,T(MNA,NR)      RATIO     29
     30    +         ,P1(MNA)             ,P2(MNA)            ,TSAVE(NR)      RATIO     30
           +         ,TN(MNA,NR)          ,AFCMI2(1)                          RATIO     31
            KLK = 0                                                           RATIO     32
                DO 100 J=M2,M3                                                RATIO     33
           100      TSAVE(J) = OLDT(I,J)                                      RATIO     34
     35     PGSAV = OLDPG(I)                                                  RATIO     35
            PCSAV = OLDPC(I)                                                  RATIO     36
            DTSAVE = DTIME                                                    RATIO     37
            TMSAV = TIME                                                      RATIO     38
            CALL EQUAL1 (EP2,EP,I,NR,MNA)                                     RATIO     39
     40     CALL EQUAL2 (EPP2,EPP,I,NR,MNA)                                   RATIO     40
            CALL EQUAL1 (ECREP2,ECREEP,I,NR,MNA)                              RATIO     41
           110  CONTINUE                                                      RATIO     42
            KLK = KLK+1                                                       RATIO     43
            IF (KLK.GT.5) WRITE (6,190) KLK                                   RATIO     44
     45     IF (KLK.GT.5) WRITE (6,200)                                       RATIO     45
            IF (KLK.GT.5) STOP                                                RATIO     46
      C   KKK = 4**(KLK-1)                                                    RATIO     47
            KKK = 2**(KLK-1)                                                  RATIO     48
            N4 = 0                                                            RATIO     49
     50     OLTIME = TMSAV                                                    RATIO     50
      C   CUT DOWN CREEP STEP SIZE                                           RATIO     51
            IF (KLK.GT.1) WRITE (6,190) KLK                                   RATIO     52
            IF (RELAX.NE.1) GO TO 140                                         RATIO     53
```

```
                      DO 130 K5=1,KKK                                                    RATIO      54
55                    RKK = KKK                                                          RATIO      55
                      DTIM2 = DTSAVE/RKK                                                 RATIO      56
                      TIM2 = OLTIME+DTIM2*(K5-1)                                         RATIO      57
                      P1(I) = PG(I)                                                      RATIO      58
                      P2(I) = PC(I)                                                      RATIO      59
60                        DO 120 J=M2,M3                                                 RATIO      60
               120        TN(I,J) = T(I,J)                                               RATIO      61
               C                                                                         RATIO      62
                      CALL PELLET (N1,N2,N3,N4,I,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RELA     RATIO      63
                     +    X,DTIM2,TIM2,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREP2,EP2,EPP2,EPS RATIO      64
65                   +    ,EPSO,FVFRO,P1,P2,R,SIG,TN,AFCM12(NE),AFCM12(NV),AFCM12(NALFDT RATIO      65
                     +    ),AFCM12(NSTRTT),AFCM12,NA,NR,MNA)                            RATIO      66
                      IF (N4.NE.1) GO TO 130                                             RATIO      67
                      IF (K5.EQ.1) GO TO 110                                             RATIO      68
                      TMSAV = TIM2                                                       RATIO      69
70                    DTSAVE = DTSAVE-DTIM2*(K5-1)                                       RATIO      70
                      KLK = 1                                                            RATIO      71
                      GO TO 110                                                          RATIO      72
               130    CONTINUE                                                           RATIO      73
                    GO TO 180                                                            RATIO      74
75             C   CUT DOWN PLASTICITY LOADSTEP                                         RATIO      75
               140  CONTINUE                                                            RATIO      76
                      DO 170 K5=1,KKK                                                    RATIO      77
                      RKK = KKK                                                          RATIO      78
                      RK5 = K5                                                           RATIO      79
80                    F = RK5/RKK                                                        RATIO      80
                      P1(I) = PGSAV+F*(PG(I)-PGSAV)                                      RATIO      81
                      P2(I) = PCSAV+F*(PC(I)-PCSAV)                                      RATIO      82
                      DTIM2 = DTSAVE/RKK                                                 RATIO      83
                      TIM2 = OLTIME+DTIM2*(RK5-1.)                                       RATIO      84
85                        DO 150 J=M2,M3                                                 RATIO      85
               150        TN(I,J) = TSAVE(J)+F*(T(I,J)-TSAVE(J))                         RATIO      86
                      IF (KLK.GT.1) WRITE (6,210) P1(I),P2(I)                            RATIO      87
                      IF (KLK.GT.1) WRITE (6,210) (TN(I,M),M=M2,M3)                      RATIO      88
               C                                                                         RATIO      89
90                    CALL PELLET (N1,N2,N3,N4,I,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RELA     RATIO      90
                     +    X,DTIM2,TIM2,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREP2,EP2,EPP2,EPS RATIO      91
                     +    ,EPSO,FVFRO,P1,P2,R,SIG,TN,AFCM12(NE),AFCM12(NV),AFCM12(NALFDT RATIO      92
                     +    ),AFCM12(NSTRTT),AFCM12,NA,NR,MNA)                            RATIO      93
                      IF (N4.NE.1) GO TO 170                                             RATIO      94
95                    IF (K5.EQ.1) GO TO 110                                             RATIO      95
                      KLK = 1                                                            RATIO      96
                          DO 160 J=M2,M3                                                 RATIO      97
               160        TSAVE(J) = TSAVE(J)+((K5-1)/RKK)*(T(I,J)-TSAVE(J))             RATIO      98
                      PGSAV = PGSAV+((K5-1)/RKK)*(PG(I)-PGSAV)                           RATIO      99
100                   PCSAV = PCSAV+((K5-1)/RKK)*(PC(I)-PCSAV)                           RATIO     100
                      GO TO 110                                                          RATIO     101
               170    CONTINUE                                                           RATIO     102
               C   UPDATE PREMANENT PLASTIC STRAINS                                     RATIO     103
               180  CONTINUE                                                            RATIO     104
105                 RETURN                                                             RATIO     105
               C                                                                         RATIO     106
```

```
      190   FORMAT (1H1,5X,17HSTEP SIZE CHANGED,I5,5HTIMES)                    RATIO    107
      200   FORMAT (1H0,46HRESULTS INVALID -- CREEP STEP TOO LARGE       )     RATIO    108
      210   FORMAT (1H0,5X,10F12.4)                                           RATIO    109
110         END                                                               RATIO    110
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 RATIO 2 105

VARIABLES	SN	TYPE		RELOCATION								
0	AFCM12	REAL	ARRAY	F.P.	REFS	24	5*63	5*90	DEFINED	2		
0	CRACK	INTEGER		F.P.	REFS	22	63	90	DEFINED	2		
0	DELTA	REAL		F.P.	REFS	63	90	DEFINED	2			
0	DELTEZ	REAL		F.P.	REFS	63	90	DEFINED	2			
0	DTIME	REAL		F.P.	REFS	37	DEFINED	2				
672	DTIM2	REAL			REFS	57	63	70	84	90		
					DEFINED	56	83					
664	DTSAVE	REAL			REFS	56	70	83	DEFINED	37	70	
0	DVHPRS	REAL	ARRAY	F.P.	REFS	24	63	90	DEFINED	2		
0	ECREEP	REAL	ARRAY	F.P.	REFS	24	41	DEFINED	2			
0	ECREP2	REAL	ARRAY	F.P.	REFS	24	41	63	90	DEFINED	2	
0	ELASTC	INTEGER		F.P.	REFS	22	63	90	DEFINED	2		
0	EP	REAL	ARRAY	F.P.	REFS	24	39	DEFINED	2			
0	EPP	REAL	ARRAY	F.P.	REFS	24	40	DEFINED	2			
0	EPP2	REAL	ARRAY	F.P.	REFS	24	40	63	90	DEFINED	2	
0	EPS	REAL	ARRAY	F.P.	REFS	24	63	90	DEFINED	2		
0	EPSO	REAL	ARRAY	F.P.	REFS	24	63	90	DEFINED	2		
0	EP2	REAL	ARRAY	F.P.	REFS	24	39	63	90	DEFINED	2	
675	F	REAL			REFS	81	82	86	DEFINED	80		
0	FVFRO	REAL	ARRAY	F.P.	REFS	24	63	90	DEFINED	2		
0	FZ	REAL		F.P.	REFS	63	90	DEFINED	2			
0	I	INTEGER		F.P.	REFS	34	35	36	39	40	41	2*58
					2*59	2*61	63	2*81	2*82	2*86	2*87	88
					90	98	99	100	DEFINED	2		
661	J	INTEGER			REFS	2*34	2*61	4*86	4*98	DEFINED	33	60
					85	97						
0	KFLAG	INTEGER		F.P.	REFS	63	90	DEFINED	2			
666	KKK	INTEGER			REFS	54	55	77	78	DEFINED	48	
660	KLK	INTEGER			REFS	43	2*44	45	46	48	2*52	67
					88	DEFINED	32	43	71	96		
670	K5	INTEGER			REFS	57	68	70	79	95	98	99
					100	DEFINED	54	77				
676	M	INTEGER			REFS	88	DEFINED	88				
0	MNA	INTEGER		F.P.	REFS	21*24	39	40	41	63	90	
					DEFINED	2						
0	M2	INTEGER		F.P.	REFS	33	60	63	85	88	90	97
					DEFINED	2						
0	M3	INTEGER		F.P.	REFS	33	60	63	85	88	90	97

VARIABLES	SN	TYPE		RELOCATION								
					DEFINED	2						
0	M4	INTEGER		F.P.	REFS	63	90	DEFINED	2			
0	M5	INTEGER		F.P.	REFS	63	90	DEFINED	2			
0	M6	INTEGER		F.P.	REFS	63	90	DEFINED	2			
0	NA	INTEGER		F.P.	REFS	63	90	DEFINED	2			
43	NAA	INTEGER		PFCMI2	REFS	7						
25	NALFDT	INTEGER		PFCMI2	REFS	7	63	90				
33	NBB	INTEGER		PFCMI2	REFS	7						
45	NCC	INTEGER		PFCMI2	REFS	7						
11	NCOEF	INTEGER		PFCMI2	REFS	7						
5	NDCHCK	INTEGER		PFCMI2	REFS	7						
36	NDD	INTEGER		PFCMI2	REFS	7						
7	NDEP	INTEGER		PFCMI2	REFS	7						
12	NDSIGF	INTEGER		PFCMI2	REFS	7						
21	NE	INTEGER		PFCMI2	REFS	7	63	90				
16	NECRP2	INTEGER		PFCMI2	REFS	7						
41	NEE	INTEGER		PFCMI2	REFS	7						
44	NEI	INTEGER		PFCMI2	REFS	7						
23	NEPP2	INTEGER		PFCMI2	REFS	7						
15	NEP2	INTEGER		PFCMI2	REFS	7						
46	NFF	INTEGER		PFCMI2	REFS	7						
13	NFI	INTEGER		PFCMI2	REFS	7						
14	NF2	INTEGER		PFCMI2	REFS	7						
35	NGG	INTEGER		PFCMI2	REFS	7						
30	NHH	INTEGER		PFCMI2	REFS	7						
42	NLL	INTEGER		PFCMI2	REFS	7						
34	NMM	INTEGER		PFCMI2	REFS	7						
32	NMN	INTEGER		PFCMI2	REFS	7						
31	NNN	INTEGER		PFCMI2	REFS	7						
27	NNUDPP	INTEGER		PFCMI2	REFS	7						
26	NOLDPP	INTEGER		PFCMI2	REFS	7						
6	NOLSGF	INTEGER		PFCMI2	REFS	7						
0	NPIN	INTEGER		PFCMI2	REFS	7						
1	NPOUT	INTEGER		PFCMI2	REFS	7						
2	NP1	INTEGER		PFCMI2	REFS	7						
3	NP2	INTEGER		PFCMI2	REFS	7						
0	NR	INTEGER		F.P.	REFS	16*24	39	40	41	63	90	
					DEFINED	2						
10	NSLOPE	INTEGER		PFCMI2	REFS	7						
24	NSTRTT	INTEGER		PFCMI2	REFS	7	63	90				
20	NTN	INTEGER		PFCMI2	REFS	7						
4	NTSAVE	INTEGER		PFCMI2	REFS	7						
17	NT2	INTEGER		PFCMI2	REFS	7						
40	NU	INTEGER		PFCMI2	REFS	7						
22	NV	INTEGER		PFCMI2	REFS	7	63	90				
37	NW	INTEGER		PFCMI2	REFS	7						
0	N1	INTEGER		F.P.	REFS	63	90	DEFINED	2			
0	N2	INTEGER		F.P.	REFS	63	90	DEFINED	2			
0	N3	INTEGER		F.P.	REFS	63	90	DEFINED	2			
0	N4	INTEGER		F.P.	REFS	63	67	90	94	DEFINED	2	49
0	OLDPC	REAL	ARRAY	F.P.	REFS	24	36	DEFINED	2			
0	OLDPG	REAL	ARRAY	F.P.	REFS	24	35	DEFINED	2			
0	OLDT	REAL	ARRAY	F.P.	REFS	24	34	DEFINED	2			

VARIABLES	SN	TYPE	RELOCATION									
667	QLTIME	REAL			REFS	57	84	DEFINED	50			
0	PC	REAL	ARRAY	F.P.	REFS	24	59	32	100	DEFINED	2	
663	PCSAV	REAL			REFS	2*82	2*100	DEFINED	36	100		
0	PG	REAL	ARRAY	F.P.	REFS	24	58	81	99	DEFINED	2	
662	PGSAV	REAL			REFS	2*81	2*99	DEFINED	35	99		
0	P1	REAL	ARRAY	F.P.	REFS	24	63	87	90	DEFINED	2	58
					81							
0	P2	REAL	ARRAY	F.P.	REFS	24	63	87	90	DEFINED	2	59
					82							
0	R	REAL	ARRAY	F.P.	REFS	24	63	90	DEFINED	2		
0	RELAX	INTEGER		F.P.	REFS	22	53	63	90	DEFINED	2	
671	RKK	REAL			REFS	56	80	83	98	99	100	
					DEFINED	55	78					
674	RK5	REAL			REFS	80	84	DEFINED	79			
0	SIG	REAL	ARRAY	F.P.	REFS	24	63	90	DEFINED	2		
0	T	REAL	ARRAY	F.P.	REFS	24	61	86	98	DEFINED	2	
0	TIME	REAL		F.P.	REFS	38	DEFINED	2				
673	TIM2	REAL			REFS	63	69	90	DEFINED	57	84	
665	TMSAV	REAL			REFS	50	DEFINED	38	69			
0	TN	REAL	ARRAY	F.P.	REFS	24	63	88	90	DEFINED	2	61
					86							
0	TSAVE	REAL	ARRAY	F.P.	REFS	24	2*86	2*98	DEFINED	2	34	98
0	URO	REAL		F.P.	REFS	63	90	DEFINED	2			

FILE NAMES	MODE							
TAPE6	FMT	WRITES	44	45	52	87	88	

EXTERNALS	TYPE	ARGS	REFERENCES	
EQUAL1		5	39	41
EQUAL2		5	40	
PELLET		40	63	90

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		34	33			
73	110		42	68	72	95	101
0	120		61	60			
262	130		73	54	67		
267	140		76	53			
0	150		86	85			
0	160		98	97			
503	170		102	77	94		
507	180		104	74			
637	190	FMT	107	44	52		
644	200	FMT	108	45			
653	210	FMT	109	87	88		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
15	100	J	33 34	6B	INSTACK			
137	130	K5	54 73	126B		EXT REFS	EXITS	NOT INNER
161	120	J	60 61	6B	INSTACK			
271	170	K5	77 102	215B		EXT REFS	EXITS	NOT INNER
324	150	J	85 86	10B	INSTACK			
354		M	88 88	11B		EXT REFS		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
453	160	J	97 98	12B	INSTACK

COMMON BLOCKS	LENGTH
PFCM12	39

STATISTICS

PROGRAM LENGTH	1071B	569
SCM LABELED COMMON LENGTH	47B	39

140000B SCM USED

```
      C                                                                                                  RATIO    111
            SUBROUTINE PELLET (N1,N2,N3,N4,I,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RE                           PELLET     2
           +LAX,DTIME,TIME,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREP2,EP2,EPP2,EPS,E                          PELLET     3
           +PS0,FVFRO,PG,PC,R,SIG,T,E,V,ALFDT,STRTOT,AFCMI2,NA,NR,MNA)                                  PELLET     4
      5    C                                                                                            PELLET     5
            COMMON/PFCMI2/          NPIN                                                                PELLET     6
           +                       ,NPOUT          ,NPI            ,NP2                                 PELLET     7
           +                       ,NTSAVE         ,NDCHCK         ,NOLSGF                              PELLET     8
           +                       ,NDEP           ,NSLOPE         ,NCOEF                               PELLET     9
     10    +                       ,NDSIGF         ,NF1            ,NF2                                 PELLET    10
           +                       ,NEP2           ,NECRP2         ,NT2                                 PELLET    11
           +                       ,NTN            ,NE             ,NV                                  PELLET    12
           +                       ,NEPP2          ,NSTRTT         ,NALFDT                              PELLET    13
           +                       ,NOLDPP         ,NNUDPP         ,NHH                                 PELLET    14
     15    +                       ,NNN            ,NMN            ,NBB                                 PELLET    15
           +                       ,NMH            ,NGG            ,NDD                                 PELLET    16
           +                       ,NW             ,NU             ,NEE                                 PELLET    17
           +                       ,NLL            ,NAA            ,NEI                                 PELLET    18
           +                       ,NCC            ,NFF                                                 PELLET    19
     20    C                                                                                            PELLET    20
            INTEGER   RELAX  ,  ELASTC  , CRACK                                                         PELLET    21
           C                                                                                            PELLET    22
            REAL    DVHPRS(MNA,NR)      ,ECREP2(MNA,NR)                                                 PELLET    23
           +       ,EP2(MNA,NR)          ,EPP2(MNA,NR,3)                                               PELLET    24
     25    +                            ,EPS(MNA,NR,3)      ,EPS0(MNA,NR,3)                           PELLET    25
           +       ,FVFRO(MNA,NR)        ,PG(MNA)             ,PC(MNA)                                 PELLET    26
           +       ,R(MNA,NR)            ,SIG(MNA,NR,3)       ,T(MNA,NR)                               PELLET    27
           +       ,E(MNA,NR)            ,V(MNA,NR)           ,ALFDT(MNA,NR,3)                         PELLET    28
           +       ,STRTOT(MNA,NR,3)     ,AFCMI2(1)                                                    PELLET    29
     30    C                                                                                            PELLET    30
           C                                                                                            PELLET    31
           C   THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES                               PELLET    32
           C   USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM                                            PELLET    33
           C                                                                                            PELLET    34
     35      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX                              PELLET    35
            +              , FNCK   ,FNCN   ,FOTMTL ,FRDEN  ,FTMELT ,RSTRAN                             PELLET    36
           C                                                                                            PELLET    37
           C   ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST                             PELLET    38
           C   (HOOP STRAIN)/(RADIAL STRAIN)                                                            PELLET    39
     40    C   COMP   - PUO2 CONTENT (WT%)                                                              PELLET    40
           C   CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)                        PELLET    41
           C   CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT                               PELLET    42
           C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED                            PELLET    43
           C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                                                     PELLET    44
     45    C   FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                                                 PELLET    45
           C   FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)                        PELLET    46
           C   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT                            PELLET    47
           C   FOTMTL - FUEL OXYGEN TO METAL RAITO                                                     PELLET    48
           C   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)                                PELLET    49
     50    C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                                      PELLET    50
           C   RSTRAN - TRUE STRAIN RATE (1/SEC)                                                        PELLET    51
           C                                                                                            PELLET    52
           C                                                                                            PELLET    53
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      C                                                                      PELLET     54
      C   COMPUTE MATERIAL PROPERTIES HERE                                  PELLET     55
      C                                                                      PELLET     56
            DO 130 J=M2,M3                                                   PELLET     57
            TT = T(I,J)                                                      PELLET     58
            IF (M4.EQ.0) JTYPE = N1                                          PELLET     59
            IF (M4.NE.0.AND.J.LT.M4) JTYPE = 1                               PELLET     60
            IF (M4.NE.0.AND.J.GE.M4) JTYPE = 2                               PELLET     61
            IF (N3.EQ.1) TT = TEMPS(TT)                                      PELLET     62
            IF (JTYPE.EQ.2) GO TO 110                                        PELLET     63
            E(I,J) = FELMOD(TT,FRDEN,FOTMTL,COMP)                            PELLET     64
            FACMOT = 0.0                                                     PELLET     65
            IF (TT.GT.FTMELT) FACMOT = 1.0                                   PELLET     66
                DO 100 J1=1,3                                                PELLET     67
      100       ALFDT(I,J,J1) = FTHEXP(TT,FACMOT)                            PELLET     68
            V(I,J) = FPOIR(TT,COMP)                                          PELLET     69
            GO TO 120                                                        PELLET     70
      110   CALL CTHEXP (TT,CATHEX,CDTHEX)                                   PELLET     71
            ALFDT(I,J,1) = CDTHEX                                            PELLET     72
            ALFDT(I,J,2) = CDTHEX                                            PELLET     73
            ALFDT(I,J,3) = CATHEX                                            PELLET     74
            E(I,J) = CELMOD(TT,FNCK,CWKF,DELOXY)                             PELLET     75
            CR = CSHEAR(TT,FNCK,CWKF,DELOXY)                                 PELLET     76
            V(I,J) = E(I,J)/(2*CR)-1.                                        PELLET     77
      120   IF (N3.EQ.1) E(I,J) = PSIB(E(I,J))                               PELLET     78
            STRTOT(I,J,1) = ALFDT(I,J,1)+EPSO(I,J,1)                         PELLET     79
            STRTOT(I,J,2) = ALFDT(I,J,2)+EPSO(I,J,2)                         PELLET     80
            STRTOT(I,J,3) = ALFDT(I,J,3)+EPSO(I,J,3)                         PELLET     81
      130   CONTINUE                                                         PELLET     82
      C                                                                      PELLET     83
            M5 = 0                                                           PELLET     84
            M6 = 0                                                           PELLET     85
            IF ((M4.EQ.0).AND.(N1.EQ.2)) GO TO 150                           PELLET     86
      C   TO BYPASS CRACKING SET CRACK = 0                                   PELLET     87
            IF (CRACK.EQ.0) GO TO 150                                        PELLET     88
      C   TO SET RADIAL AND/OR AXIAL CRACKING LET M5 AND/OR M6 = K-1 BELOW   PELLET     89
      C   OTHERWISE LET M5 AND/OR M6 REMAIN ZERO                           PELLET     90
            MPEL = M4-1                                                      PELLET     91
            IF (M4.EQ.0) MPEL = M3                                           PELLET     92
            RCRACK = R(I,MPEL)/2.                                            PELLET     93
                DO 140 N=1,MPEL                                              PELLET     94
                IF (R(I,N).LT.RCRACK) GO TO 140                              PELLET     95
                M5 = N                                                       PELLET     96
                M6 = N                                                       PELLET     97
                GO TO 150                                                    PELLET     98
      140       CONTINUE                                                     PELLET     99
      150   CONTINUE                                                         PELLET    100
      C                                                                      PELLET    101
      C                                                                      PELLET    102
            CALL AXRACH (N1,N2,N3,N4,I,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RELAX,DT PELLET    103
           +IME,TIME,KFLAG,URO,ELASTC,DVHPRS,E,ECREP2,EP2,EPP2,EPS,FVFRO,PC,PG PELLET    104
           +,R,SIG,STRTOT,T,V,AFCMI2(NCOEF),AFCMI2(NDCHCK),AFCMI2(NDEP),AFCMI2 PELLET    105
           +(NDSIGF),AFCMI2(NOLSGF),AFCMI2(NSLOPE),AFCMI2(NNUDPP),AFCMI2(NOLDP PELLET    106
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                +P),AFCMI2,NA,NR,MNA)                                   PELLET   107
      C                                                                 PELLET   108
      C                                                                 PELLET   109
110             IF (N4.EQ.1) GO TO 160                                  PELLET   110
      C                                                                 PELLET   111
      C   CRACK ITERATION REMOVED                                       PELLET   112
      C                                                                 PELLET   113
      160   CONTINUE                                                    PELLET   114
115           RETURN                                                    PELLET   115
              END                                                       PELLET   116
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

110 1 160 THIS IF DEGENERATES INTO A SIMPLE TRANSFER TO THE LABEL INDICATED.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 PELLET 2 115

VARIABLES	SN	TYPE			RELOCATION								
0	AFCMI2	REAL	ARRAY	F.P.	REFS	23	9*103	DEFINED	2				
0	ALFDT	REAL	ARRAY	F.P.	REFS	23	79	80	81	DEFINED	2	68	
						72	73	74					
0	ANRIN	REAL		MATCNS	REFS	35							
501	CATHEX	REAL			REFS	71	74						
502	CDTHEX	REAL			REFS	71	72	73					
1	COMP	REAL		MATCNS	REFS	35	64	69					
503	CR	REAL			REFS	77	DEFINED	76					
0	CRACK	INTEGER		F.P.	REFS	21	88	DEFINED	2				
2	CWKF	REAL		MATCNS	REFS	35	75	76					
3	CWNF	REAL		MATCNS	REFS	35							
4	DELOXY	REAL		MATCNS	REFS	35	75	76					
0	DELTA	REAL		F.P.	REFS	103	DEFINED	2					
0	DELTEZ	REAL		F.P.	REFS	103	DEFINED	2					
0	DTIME	REAL		F.P.	REFS	103	DEFINED	2					
0	DVMPRS	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2				
0	E	REAL	ARRAY	F.P.	REFS	23	77	78	103	DEFINED	2	64	
						75	78						
0	ECREP2	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2				
0	ELASTC	INTEGER		F.P.	REFS	21	103	DEFINED	2				
0	EPP2	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2				
0	EPS	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2				
0	EPSO	REAL	ARRAY	F.P.	REFS	23	79	80	81	DEFINED	2		
0	EP2	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2				
477	FACMOT	REAL			REFS	68	DEFINED	65	66				

VARIABLES	SN	TYPE		RELOCATION								
5	FLUX	REAL		MATCNS	REFS	35						
6	FNCK	REAL		MATCNS	REFS	35	75	76				
7	FNCN	REAL		MATCNS	REFS	35						
10	FQTMTL	REAL		MATCNS	REFS	35	64					
11	FRDEN	REAL		MATCNS	REFS	35	64					
12	FTMELT	REAL		MATCNS	REFS	35	66					
0	FVFRO	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2			
0	FZ	REAL		F.P.	REFS	103	DEFINED	2				
0	I	INTEGER		F.P.	REFS	58	64	68	69	72	73	74
					75	2*77	2*78	3*79	3*80	3*81	93	95
					103	DEFINED	2					
474	J	INTEGER			REFS	58	60	61	64	68	69	72
					73	74	75	2*77	2*78	3*79	3*80	3*81
					DEFINED	57						
476	JTYPE	INTEGER			REFS	63	DEFINED	59	60	61		
500	JJ	INTEGER			REFS	68	DEFINED	67				
0	KFLAG	INTEGER		F.P.	REFS	103	DEFINED	2				
0	MNA	INTEGER		F.P.	REFS	16*23	103	DEFINED	2			
504	MPEL	INTEGER			REFS	93	94	DEFINED	91	92		
0	M2	INTEGER		F.P.	REFS	57	103	DEFINED	2			
0	M3	INTEGER		F.P.	REFS	57	92	103	DEFINED	2		
0	M4	INTEGER		F.P.	REFS	59	2*60	2*61	86	91	92	103
					DEFINED	2						
0	M5	INTEGER		F.P.	REFS	103	DEFINED	2	84	96		
0	M6	INTEGER		F.P.	REFS	103	DEFINED	2	85	97		
506	N	INTEGER			REFS	95	96	97	DEFINED	94		
0	NA	INTEGER		F.P.	REFS	103	DEFINED	2				
43	NAA	INTEGER		PFCMI2	REFS	6						
25	NALFDT	INTEGER		PFCMI2	REFS	6						
33	NBB	INTEGER		PFCMI2	REFS	6						
45	NCC	INTEGER		PFCMI2	REFS	6						
11	NCOEF	INTEGER		PFCMI2	REFS	6	103					
5	NDCHCK	INTEGER		PFCMI2	REFS	6	103					
36	NDD	INTEGER		PFCMI2	REFS	6						
7	NDEP	INTEGER		PFCMI2	REFS	6	103					
12	NDSIGF	INTEGER		PFCMI2	REFS	6	103					
21	NE	INTEGER		PFCMI2	REFS	6						
16	NECRP2	INTEGER		PFCMI2	REFS	6						
41	NEE	INTEGER		PFCMI2	REFS	6						
44	NEI	INTEGER		PFCMI2	REFS	6						
23	NEPP2	INTEGER		PFCMI2	REFS	6						
15	NEP2	INTEGER		PFCMI2	REFS	6						
46	NFF	INTEGER		PFCMI2	REFS	6						
13	NFI	INTEGER		PFCMI2	REFS	6						
14	NF2	INTEGER		PFCMI2	REFS	6						
35	NGG	INTEGER		PFCMI2	REFS	6						
30	NHH	INTEGER		PFCMI2	REFS	6						
42	NLL	INTEGER		PFCMI2	REFS	6						
34	NMM	INTEGER		PFCMI2	REFS	6						
32	NMN	INTEGER		PFCMI2	REFS	6						
31	NNN	INTEGER		PFCMI2	REFS	6						
27	NNUDPP	INTEGER		PFCMI2	REFS	6	103					
26	NOLDPP	INTEGER		PFCMI2	REFS	6	103					

VARIABLES	SN	TYPE		RELOCATION								
6	NOLSGF	INTEGER		PFCMI2	REFS	6	103					
0	NPIN	INTEGER		PFCMI2	REFS	6						
1	NPOUT	INTEGER		PFCMI2	REFS	6						
2	NP1	INTEGER		PFCMI2	REFS	6						
3	NP2	INTEGER		PFCMI2	REFS	6						
0	NR	INTEGER		F.P.	REFS	14*23	103	DEFINED	2			
10	NSLOPE	INTEGER		PFCMI2	REFS	6	103					
24	NSTRTT	INTEGER		PFCMI2	REFS	6						
20	NTN	INTEGER		PFCMI2	REFS	6						
4	NTSAVE	INTEGER		PFCMI2	REFS	6						
17	NT2	INTEGER		PFCMI2	REFS	6						
40	NU	INTEGER		PFCMI2	REFS	6						
22	NV	INTEGER		PFCMI2	REFS	6						
37	NW	INTEGER		PFCMI2	REFS	6						
0	N1	INTEGER		F.P.	REFS	59	86	103	DEFINED	2		
0	N2	INTEGER		F.P.	REFS	103	DEFINED	2				
0	N3	INTEGER		F.P.	REFS	62	78	103	DEFINED	2		
0	N4	INTEGER		F.P.	REFS	103	110	DEFINED	2			
0	PC	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2			
0	PG	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2			
0	R	REAL	ARRAY	F.P.	REFS	23	93	95	103	DEFINED	2	
505	RCRACK	REAL			REFS	95	DEFINED	93				
0	RELAX	INTEGER		F.P.	REFS	21	103	DEFINED	2			
13	RSTRAN	REAL		MATCNS	REFS	35						
0	SIG	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2			
0	STRTOT	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2	79	80	81
0	T	REAL	ARRAY	F.P.	REFS	23	58	103	DEFINED	2		
0	TIME	REAL		F.P.	REFS	103	DEFINED	2				
475	TT	REAL			REFS	62	64	66	68	69	71	75
					76	DEFINED	58	62				
0	URO	REAL		F.P.	REFS	103	DEFINED	2				
0	V	REAL	ARRAY	F.P.	REFS	23	103	DEFINED	2	69	77	

EXTERNALS	TYPE	ARGS	REFERENCES
AXRACH		45	103
CELMOD	REAL	4	75
CSHEAR	REAL	4	76
CTHEXP		3	71
FELMOD	REAL	4	64
FPGIR	REAL	2	69
FTHEXP	REAL	2	68
PSIB	REAL	1	78
TEMPS	REAL	1	62

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		68	67			
104	110		71	63			
143	120		78	70			
0	130		92	57			
246	140		99	94	95		
252	150		100	86	88	98	
0	160	INACTIVE	114	110			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
15	130	J	57 82	164B		EXT REFS	NOT INNER
64	100	J1	67 68	11B		EXT REFS	
233	140	N	94 99	16B	OPT	EXITS	

COMMON BLOCKS	LENGTH
PFCM12	39
MATCNS	12

STATISTICS

PROGRAM LENGTH	566B	374
SCM LABELED COMMON LENGTH	63B	51

140000B SCM USED

```
      C                                                                                 PELLET   117
            SUBROUTINE CLOSEX (N1,N2,N3,N4,J,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RE          CLOSE      2
           +LAX,DTIME,TIME,KFLAG,ELASTC,CRACK,VX,DVHPRS,ECREEP,ECREP2,EP,EP2,E         CLOSE      3
           +PP,EPP2,EPS,EPS0,FVFR0,OLDPC,OLDPG,OLDT,PC,PG,R,REPS,SIG,T,AFCMI2,         CLOSE      4
      5    +NA,NR,MNA)                                                                 CLOSE      5
      C                                                                                 CLOSE      6
            COMMON/PFCMI2/          NPIN                                              CLOSE      7
           +                       ,NPOUT        ,NPI          ,NP2                   CLOSE      8
           +                       ,NTSAVE       ,NDCHCK       ,NOLSGF                CLOSE      9
     10    +                       ,NDEP         ,NSLOPE       ,NCOEF                 CLOSE     10
           +                       ,NDSIGF       ,NFI          ,NF2                   CLOSE     11
           +                       ,NEP2         ,NECRP2       ,NT2                   CLOSE     12
           +                       ,NTN          ,NE           ,NV                    CLOSE     13
           +                       ,NEPP2        ,NSTRTT       ,NALFDT                CLOSE     14
     15    +                       ,NOLDPP       ,NNUDPP       ,NHH                   CLOSE     15
           +                       ,NNN          ,NMN          ,NBB                   CLOSE     16
           +                       ,NMM          ,NGG          ,NDD                   CLOSE     17
           +                       ,NW           ,NU           ,NEE                   CLOSE     18
           +                       ,NLL          ,NAA          ,NEI                   CLOSE     19
     20    +                       ,NCC          ,NFF                                 CLOSE     20
      C                                                                                 CLOSE     21
            INTEGER   CRACK  ,  ELASTC  ,  RELAX                                        CLOSE     22
      C                                                                                 CLOSE     23
            REAL   DVHPRS(MNA,NR)        ,ECREEP(MNA,NR)       ,ECREP2(MNA,NR)        CLOSE     24
     25    +      ,EP(MNA,NR)            ,EP2(MNA,NR)          ,EPP(MNA,NR,3)         CLOSE     25
           +      ,EPP2(MNA,NR,3)        ,EPS(MNA,NR,3)        ,EPS0(MNA,NR,3)        CLOSE     26
           +      ,FVFR0(MNA,NR)         ,OLDPC(MNA)           ,OLDPG(MNA)            CLOSE     27
           +      ,OLDT(MNA,NR)          ,PC(MNA)              ,PG(MNA)               CLOSE     28
           +      ,R(MNA,NR)             ,REPS(MNA,2)          ,SIG(MNA,NR,3)         CLOSE     29
     30    +      ,T(MNA,NR)             ,AFCMI2(1)                                   CLOSE     30
      C                                                                                 CLOSE     31
            F(Q) = GAPTX(N1,N2,N3,N4,J,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RELAX,DT          CLOSE     32
           +IME,TIME,KFLAG,Q,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP2,EPP,EPP2         CLOSE     33
           +,EPS,EPS0,FVFR0,OLDPC,OLDPG,OLDT,PC,PG,R,SIG,T,AFCMI2(NPIN),AFCMI2         CLOSE     34
     35    +(NPOUT),AFCMI2(NT2),AFCMI2,NA,NR,MNA)                                      CLOSE     35
      C     ROOTING FOR ROOTS                                                         CLOSE     36
      C     WRITE(6,2)                                                                CLOSE     37
      C                                                                               CLOSE     38
      C                                                                               CLOSE     39
     40    C     A MODIFIED FALSE POSITION ROUTINE OPERATING OVER THE INTERVAL ALPH     CLOSE     40
      C     BETA WITH INCREMENT DX                                                    CLOSE     41
      C                                                                               CLOSE     42
              ALPHA = 0.0D0                                                           CLOSE     43
              VX = 0.E0                                                               CLOSE     44
     45       BETA = 1.0E+00                                                          CLOSE     45
              DX = 0.5                                                                CLOSE     46
              CUT = -1.E-10                                                           CLOSE     47
              IF (N3.EQ.0) CUT = -2.54E-12                                            CLOSE     48
              N = 0                                                                   CLOSE     49
     50    C                                                                         CLOSE     50
              A = ALPHA                                                               CLOSE     51
              B = A+DX                                                                CLOSE     52
              FOFA = F(A)                                                             CLOSE     53
```

```
      100   FOFB = F(B)                                                        CLOSE      54
55          IF (FOFA*FOFB) 110,170,190                                         CLOSE      55
      110   CONTINUE                                                           CLOSE      56
      C   HAVING BRACKETED A ROOT THE SOLUTION ITERATION COMMENCES            CLOSE      57
      C                                                                      CLOSE      58
      120   X = (A*FOFB-B*FOFA)/(FOFB-FOFA)                                    CLOSE      59
60          N = N+1                                                            CLOSE      60
            IF (N.LT.100) GO TO 130                                            CLOSE      61
            WRITE (6,230)                                                      CLOSE      62
            GO TO 220                                                          CLOSE      63
      130   FOFX = F(X)                                                        CLOSE      64
65    C   TEST THE POSSIBILITY OF THE ITERATION LOOP LANDING ON A ROOT AT X    CLOSE      65
      C   OR PASSING BY THE ROOT                                             CLOSE      66
            IF (FOFX*FOFA) 150,160,140                                         CLOSE      67
      140   CONTINUE                                                           CLOSE      68
      C   THE ROOT IS STILL BRACKETED AND THE ITERATION LOOP CONTINUES         CLOSE      69
70    C                                                                      CLOSE      70
            A = X                                                              CLOSE      71
            FOFA = FOFX                                                        CLOSE      72
            FOFB = .5*FOFB                                                     CLOSE      73
            IF (FOFX.LT.CUT.OR.FOFX.GT.0.E0) GO TO 120                         CLOSE      74
75          VX = X                                                             CLOSE      75
            GO TO 210                                                          CLOSE      76
      150   CONTINUE                                                           CLOSE      77
      C   THE ITERATION SCHEME HAS REBRACKETED THE ROOT-THE BOUNDS ARE         CLOSE      78
      C   ADJUSTED AND THE LOOP CONTINUES                                    CLOSE      79
80    C                                                                      CLOSE      80
            B = X                                                              CLOSE      81
            FOFB = FOFX                                                        CLOSE      82
            FOFA = .5*FOFA                                                     CLOSE      83
            IF (FOFX.LT.CUT.OR.FOFX.GT.0.E0) GO TO 120                         CLOSE      84
85          VX = X                                                             CLOSE      85
            GO TO 210                                                          CLOSE      86
      160   CONTINUE                                                           CLOSE      87
      C   THE ITERATION SCHEME HAS LANDED ON A ROOT AT (X,FOFX)               CLOSE      88
      C                                                                      CLOSE      89
90          IF (ABS(FOFA).EQ.0.0D0) GO TO 180                                  CLOSE      90
            VX = X                                                             CLOSE      91
            GO TO 210                                                          CLOSE      92
      170   CONTINUE                                                           CLOSE      93
      C   THE BRACKETING OPERATION HAS FOUND A ROOT                           CLOSE      94
95    C                                                                      CLOSE      95
            IF (FOFA.EQ.0.0D0) GO TO 180                                       CLOSE      96
      C   THE BRACKETING OPERATION HAS FOUND A ROOT AT (B,FOFB)                CLOSE      97
            VX = B                                                             CLOSE      98
            GO TO 210                                                          CLOSE      99
100   180   CONTINUE                                                           CLOSE     100
      C   IF THIS IS THE FIRST BRACKET STEP THEN F(ALPHA)=0. IF OTHERWISE      CLOSE     101
      C   THE PREVIOUS STEP IS IN ERROR AT FOFB                              CLOSE     102
            WRITE (6,240) A                                                    CLOSE     103
            GO TO 210                                                          CLOSE     104
105   190   CONTINUE                                                           CLOSE     105
      C   BEEN EXCEEDED                                                      CLOSE     106
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                C   THE ROUTINE HAS NOT YET BRACKETED A ROOT-ADJUST THE VARIABLES TO     CLOSE     107
                C   THE NEXT MESH AND CONTINUE, ALSO TEST TO SEE IF THE INTERVAL HAS     CLOSE     108
                      A = B                                                               CLOSE     109
    110               B = B+DX                                                            CLOSE     110
                      FOFA = FOFB                                                         CLOSE     111
                      IF (A.GT.BETA) GO TO 200                                            CLOSE     112
                      GO TO 100                                                           CLOSE     113
                200   CONTINUE                                                            CLOSE     114
    115         C   THE BRACKETING OPERATION HAS OVERRUN THE INTERVAL                    CLOSE     115
                      WRITE (6,250)                                                       CLOSE     116
                210   CONTINUE                                                            CLOSE     117
                C   RESET PLASTIC STRAINS ONCE ROOT IS FOUND                            CLOSE     118
                C   UPDATE RESIDUAL STRAINS AT THIS POINT                               CLOSE     119
    120         C   REPS(J,1) IS AXIAL STRAIN AT OUTSIDE OF PELLET                      CLOSE     120
                C   REPS(J,2) IS AXIAL STRAIN AT INSIDE OF CLADDING                     CLOSE     121
                      REPS(J,1) = EPS(J,M4-1,3)                                         CLOSE     122
                      REPS(J,2) = EPS(J,M4,3)                                           CLOSE     123
                220   CONTINUE                                                          CLOSE     124
    125               RETURN                                                            CLOSE     125
                C                                                                       CLOSE     126
                230   FORMAT (65H- THE ITERATION SCHEME HAS PASSED 100 STEPS--EXECUTION  CLOSE     127
                     +TERMINATED)                                                       CLOSE     128
                240   FORMAT (41H,  INITIAL DATA CONTAINS A ROOT AT ALPHA=,E15.6)       CLOSE     129
    130         250   FORMAT (48H  THE BRACKET OPERATION HAS OVERRUN THE INTERVAL)      CLOSE     130
                      END                                                               CLOSE     131
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CLOSEX	2	125

VARIABLES

	SN	TYPE		RELOCATION								
1007	A	REAL			REFS	52	53	59	103	112		
					DEFINED	51	71	109				
0	AFCM12	REAL	ARRAY	F.P.	REFS	24	4*53	4*54	4*64	DEFINED	2	
1002	ALPHA	REAL			REFS	51	DEFINED	43				
1010	B	REAL			REFS	54	59	98	109	110		
					DEFINED	52	81	110				
1003	BETA	REAL			REFS	112	DEFINED	45				
0	CRACK	INTEGER		F.P.	REFS	22	53	54	64	DEFINED	2	
1005	CUT	REAL			REFS	74	84	DEFINED	47	48		
0	DELTA	REAL		F.P.	REFS	53	54	64	DEFINED	2		
0	DELTEZ	REAL		F.P.	REFS	53	54	64	DEFINED	2		
0	DTIME	REAL		F.P.	REFS	53	54	64	DEFINED	2		
0	DVHPRS	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
1004	DX	REAL			REFS	52	110	DEFINED	46			
0	ECREEP	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	ECREP2	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	ELASTC	INTEGER		F.P.	REFS	22	53	54	64	DEFINED	2	

VARIABLES	SN	TYPE	RELOCATION									
0	EP	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	EPP	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	EPP2	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	EPS	REAL	ARRAY	F.P.	REFS	24	53	54	6[illegible]	122	123	
					DEFINED	2						
0	EPS0	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	EP2	REAL	ARRAY	F.P.	REFS	24	53	5[illegible]	64	DEFINED	2	
1011	FOFA	REAL			REFS	55	2*59	67	83	90	96	
					DEFINED	53	72	83	111			
1012	FOFB	REAL			REFS	55	2*59	73	111	DEFINED	54	73
					82							
1014	FOFX	REAL			REFS	67	72	2*74	82	2*84		
					DEFINED	64						
0	FVFRO	REAL	ARRAY	F.P.	REFS	24	53	54	64	DEFINED	2	
0	FZ	REAL		F.P.	REFS	53	54	64	DEFINED	2		
0	J	INTEGER		F.P.	REFS	53	54	64	2*122	2*123		
					DEFINED	2						
0	KFLAG	INTEGER		F.P.	REFS	53	54	64	DEFINED	2		
0	MNA	INTEGER		F.P.	REFS	19*24	53	54	64	DEFINED	2	
0	M2	INTEGER		F.P.	REFS	53	54	64	DEFINED	2		
0	M3	INTEGER		F.P.	REFS	53	54	64	DEFINED	2		
0	M4	INTEGER		F.P.	REFS	53	54	64	122	123		
					DEFINED	2						
0	M5	INTEGER		F.P.	REFS	53	54	64	DEFINED	2		
0	M6	INTEGER		F.P.	REFS	53	54	64	DEFINED	2		
1006	N	INTEGER			REFS	60	61	DEFINED	49	60		
0	NA	INTEGER		F.P.	REFS	53	54	64	DEFINED	2		
43	NAA	INTEGER		PFCMI2	REFS	7						
25	NALFDT	INTEGER		PFCMI2	REFS	7						
33	NBB	INTEGER		PFCMI2	REFS	7						
45	NCC	INTEGER		PFCMI2	REFS	7						
11	NCOEF	INTEGER		PFCMI2	REFS	7						
5	NDCHCK	INTEGER		PFCMI2	REFS	7						
36	NDD	INTEGER		PFCMI2	REFS	7						
7	NDEP	INTEGER		PFCMI2	REFS	7						
12	NDSIGF	INTEGER		PFCMI2	REFS	7						
21	NE	INTEGER		PFCMI2	REFS	7						
16	NECRP2	INTEGER		PFCMI2	REFS	7						
41	NEE	INTEGER		PFCMI2	REFS	7						
44	NEI	INTEGER		PFCMI2	REFS	7						
23	NEPP2	INTEGER		PFCMI2	REFS	7						
15	NEP2	INTEGER		PFCMI2	REFS	7						
46	NFF	INTEGER		PFCMI2	REFS	7						
13	NFI	INTEGER		PFCMI2	REFS	7						
14	NF2	INTEGER		PFCMI2	REFS	7						
35	NGG	INTEGER		PFCMI2	REFS	7						
30	NHH	INTEGER		PFCMI2	REFS	7						
42	NLL	INTEGER		PFCMI2	REFS	7						
34	NMM	INTEGER		PFCMI2	REFS	7						
32	NMN	INTEGER		PFCMI2	REFS	7						
31	NNN	INTEGER		PFCMI2	REFS	7						
27	NNUDPP	INTEGER		PFCMI2	REFS	7						
26	NOLDPP	INTEGER		PFCMI2	REFS	7						

```
VARIABLES     SN  TYPE              RELOCATION
     6  NOLSGF      INTEGER           PFCMI2      REFS          7
     0  NPIN        INTEGER           PFCMI2      REFS          7          53        54        64
     1  NPOUT       INTEGER           PFCMI2      REFS          7          53        54        64
     2  NP1         INTEGER           PFCMI2      REFS          7
     3  NP2         INTEGER           PFCMI2      REFS          7
     0  NR          INTEGER             F.P.      REFS      14*24          53        54        64    DEFINED       2
    10  NSLOPE      INTEGER           PFCMI2      REFS          7
    24  NSTRTT      INTEGER           PFCMI2      REFS          7
    20  NTN         INTEGER           PFCMI2      REFS          7
     4  NTSAVE      INTEGER           PFCMI2      REFS          7
    17  NT2         INTEGER           PFCMI2      REFS          7          53        54        64
    40  NU          INTEGER           PFCMI2      REFS          7
    22  NV          INTEGER           PFCMI2      REFS          7
    37  NW          INTEGER           PFCMI2      REFS          7
     0  N1          INTEGER             F.P.      REFS         53          54        64    DEFINED       2
     0  N2          INTEGER             F.P.      REFS         53          54        64    DEFINED       2
     0  N3          INTEGER             F.P.      REFS         48          53        54        64    DEFINED       2
     0  N4          INTEGER             F.P.      REFS         53          54        64    DEFINED       2
     0  OLDPC       REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  OLDPG       REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  OLDT        REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  PC          REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  PG          REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  R           REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  RELAX       INTEGER             F.P.      REFS         22          53        54        64    DEFINED       2
     0  REPS        REAL      ARRAY     F.P.      REFS         24    DEFINED         2       122        123
     0  SIG         REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  T           REAL      ARRAY     F.P.      REFS         24          53        54        64    DEFINED       2
     0  TIME        REAL                F.P.      REFS         53          54        64    DEFINED       2
     0  VX          REAL                F.P.    DEFINED         2          44        75        85        91       98
  1013  X           REAL                          REFS         64          71        75        81        85       91
                                                DEFINED        59

FILE NAMES          MODE
       TAPE6        FMT                    WRITES        62        103        116

EXTERNALS           TYPE    ARGS        REFERENCES
       GAPTX        REAL      45            53        54        64

INLINE FUNCTIONS    TYPE    ARGS      DEF LINE  REFERENCES
       ABS          REAL       1  INTRIN              90
       F            REAL       1    SF             32        53        54        64

STATEMENT LABELS                    DEF LINE   REFERENCES
  145  100                             54         113
    0  110          INACTIVE           56          55
  255  120                             59          74         84
  273  130                             64          61
    0  140          INACTIVE           68          67
  420  150                             77          67
  436  160                             87          67
  445  170                             93          55
  453  180                            100          90         96
```

STATEMENT LABELS			DEF LINE	REFERENCES				
457	190		105	55				
473	200		114	112				
476	210		117	76	86	92	99	104
517	220		124	63				
746	230	FMT	127	62				
756	240	FMT	129	103				
765	250	FMT	130	116				

COMMON BLOCKS	LENGTH
PFCM12	39

STATISTICS

PROGRAM LENGTH	1015B	525
SCM LABELED COMMON LENGTH	47B	39

140000B SCM USED

```
1                SUBROUTINE EQUAL1 (A,B,KK,NR,NA)                                  EQUAL1      2
                  REAL  A(NA,NR),B(NA,NR)                                          EQUAL1      3
                     DO 100 I=1,NR                                                 EQUAL1      4
            100      A(KK,I) = B(KK,I)                                             EQUAL1      5
5                RETURN                                                            EQUAL1      6
                 END                                                               EQUAL1      7
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	EQUAL1	1	5

VARIABLES	SN	TYPE		RELOCATION						
0	A	REAL	ARRAY	F.P.	REFS	2	DEFINED	1	4	
0	B	REAL	ARRAY	F.P.	REFS	2	4	DEFINED	1	
23	I	INTEGER			REFS	2*4	DEFINED	3		
0	KK	INTEGER		F.P.	REFS	2*4	DEFINED	1		
0	NA	INTEGER		F.P.	REFS	2*2	DEFINED	1		
0	NR	INTEGER		F.P.	REFS	2*2	3	DEFINED	1	

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	4	3

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
13	100	I	3 4	6B	INSTACK

STATISTICS

PROGRAM LENGTH 31B 25

140000B SCM USED

```
      1                SUBROUTINE EQUAL2 (A,B,KK,NR,NA)                          EQUAL2     2
                        REAL  A(NA,NR,3),B(NA,NR,3)                              EQUAL2     3
                           DO 100 I=1,NR                                         EQUAL2     4
                              DO 100 J=1,3                                       EQUAL2     5
      5          100           A(KK,I,J) = B(KK,I,J)                            EQUAL2     6
                        RETURN                                                   EQUAL2     7
                        END                                                      EQUAL2     8
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 EQUAL2 1 6

VARIABLES	SN	TYPE	RELOCATION							
0	A	REAL	ARRAY	F.P.	REFS	2	DEFINED	1	5	
0	B	REAL	ARRAY	F.P.	REFS	2	5	DEFINED	1	
35	I	INTEGER			REFS	2*5	DEFINED	3		
36	J	INTEGER			REFS	2*5	DEFINED	4		
0	KK	INTEGER		F.P.	REFS	2*5	DEFINED	1		
0	NA	INTEGER		F.P.	REFS	2*2	DEFINED	1		
0	NR	INTEGER		F.P.	REFS	2*2	3	DEFINED	1	

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	5	3	4

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
15	100	I	3 5	15B	NOT INNER
17	100	J	4 5	10B	INSTACK

STATISTICS
PROGRAM LENGTH 44B 36
140000B SCM USED

```
      FUNCTION GAPTX (N1,N2,N3,N4,J,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RELAX
     +,DTIME,TIME,KFLAG,F,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP2,EPP,E
     +PP2,EPS,EPS0,FVFRO,OLDPC,OLDPG,OLDT,PC,PG,R,SIG,T,PIN,POUT,T2,AFCM
     +I2,NA,NR,MNA)
C
      COMMON/PFCMI2/        NPIN
     +                     ,NPOUT      ,NPI        ,NP2
     +                     ,NTSAVE     ,NDCHCK     ,NOLSGF
     +                     ,NDEP       ,NSLOPE     ,NCOEF
     +                     ,NDSIGF     ,NFI        ,NF2
     +                     ,NEP2       ,NECRP2     ,NT2
     +                     ,NTN        ,NE         ,NV
     +                     ,NEPP2      ,NSTRTT     ,NALFDT
     +                     ,NOLDPP     ,NNUDPP     ,NHH
     +                     ,NNN        ,NMN        ,NBB
     +                     ,NMM        ,NGG        ,NDD
     +                     ,NW         ,NU         ,NEE
     +                     ,NLL        ,NAA        ,NEI
     +                     ,NCC        ,NFF
C
      INTEGER   CRACK  ,  ELASTC  ,  RELAX
C
      REAL   DVHPRS(MNA,NR)     ,ECREEP(MNA,NR)     ,ECREP2(MNA,NR)
     +      ,EP(MNA,NR)         ,EP2(MNA,NR)        ,EPP(MNA,NR,3)
     +      ,EPP2(MNA,NR,3)     ,EPS(MNA,NR,3)      ,EPS0(MNA,NR,3)
     +      ,FVFRO(MNA,NR)      ,OLDPC(MNA)         ,OLDPG(MNA)
     +      ,OLDT(MNA,NR)       ,PC(MNA)            ,PG(MNA)
     +      ,R(MNA,NR)          ,SIG(MNA,NR,3)      ,T(MNA,NR)
     +      ,PIN(MNA)           ,POUT(MNA)          ,T2(MNA,NR)
     +      ,AFCMI2(1)
C
      DT = DTIME
      IF (RELAX.NE.1) GO TO 110
      DT = F*DTIME
      PIN(J) = PG(J)
      POUT(J) = PC(J)
          DO 100 I=M2,M3
          T2(J,I) = T(J,I)
100       CONTINUE
      GO TO 130
110   CONTINUE
      PIN(J) = OLDPG(J)+F*(PG(J)-OLDPG(J))
      POUT(J) = OLDPC(J)+F*(PC(J)-OLDPC(J))
          DO 120 I=M2,M3
120       T2(J,I) = OLDT(J,I)+F*(T(J,I)-OLDT(J,I))
C     WRITE(6,99) PIN(J), POUT(J)
C     WRITE(6,99) ( T2(J,I), I=M2,M3 )
C     WRITE(6,99) ( OLDT(J,I), I=M2,M3 )
C     WRITE(6,99) (  T(J,I), I=M2,M3 )
C     ***COMPUTE GAPS ASSUMING NO PCMI
C     IS THIS THE RIGHT PLACE FOR # 6
130   CONTINUE
      PI = 3.1415926
```

```
      C   GET FUEL RADIAL DISPLACEMENT                                          GAPTX      55
55    C   NOTE THAT FOR CYLINDER, OUTSIDE PRESSURE IS PIN(J)                     GAPTX      56
      C   SO WE TEMP CHANGE THIS HERE                                           GAPTX      57
            TPIN = PIN(J)                                                       GAPTX      58
            TPOUT = POUT(J)                                                     GAPTX      59
            POUT(J) = PIN(J)                                                    GAPTX      60
60          FZ = -(PI*R(J,M4-1)**2)*POUT(J)                                     GAPTX      61
            L2 = M2                                                             GAPTX      62
            L3 = M4-1                                                           GAPTX      63
            L4 = 0                                                              GAPTX      64
            N1 = 1                                                              GAPTX      65
65    C                                                                         GAPTX      66
            CALL RATIO (N1,N2,N3,N4,J,L2,L3,L4,L5,L6,FZ,DELTA,DELTEZ,RELAX,DT,  GAPTX      67
           +TIME,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP2,EPP,EPP2,E  GAPTX      68
           +PS,EPSO,FVFRO,OLDPC,OLDPG,OLDT,POUT,PIN,R,SIG,T2,AFCMI2(NP1),AFCMI  GAPTX      69
           +2(NP2),AFCMI2(NTSAVE),AFCMI2(NTN),AFCMI2,NA,NR,MNA)                 GAPTX      70
70          URF = URO                                                           GAPTX      71
      C   GET CLAD INSIDE RADIAL DISPLACEMENT                                   GAPTX      72
      C   NOW CHANGE PRESSURE ARRAY BACK                                        GAPTX      73
            PIN(J) = TPIN                                                       GAPTX      74
            POUT(J) = TPOUT                                                     GAPTX      75
75          L2 = M4                                                             GAPTX      76
            L3 = M3                                                             GAPTX      77
            L4 = 0                                                              GAPTX      78
            N1 = 2                                                              GAPTX      79
            FZ = (PI*R(J,M4)**2)*PIN(J)-(PI*R(J,M3)**2)*POUT(J)                 GAPTX      80
80    C                                                                         GAPTX      81
            CALL RATIO (N1,N2,N3,N4,J,L2,L3,L4,L5,L6,FZ,DELTA,DELTEZ,RELAX,DT,  GAPTX      82
           +TIME,KFLAG,URO,ELASTC,CRACK,DVHPRS,ECREEP,ECREP2,EP,EP2,EPP,EPP2,E  GAPTX      83
           +PS,EPSO,FVFRO,OLDPC,OLDPG,OLDT,POUT,PIN,R,SIG,T2,AFCMI2(NP1),AFCMI  GAPTX      84
           +2(NP2),AFCMI2(NTSAVE),AFCMI2(NTN),AFCMI2,NA,NR,MNA)                 GAPTX      85
85          URC = R(J,M4)*EPS(J,M4,2)                                           GAPTX      86
            GAPTX = URC+DELTA-URF                                               GAPTX      87
      C   WRITE(6,100) F, GAPT                                                  GAPTX      88
            RETURN                                                              GAPTX      89
      C                                                                         GAPTX      90
90          END                                                                 GAPTX      91
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	GAPTX	1	88

VARIABLES

	SN	TYPE		RELOCATION					
0	AFCMI2	REAL	ARRAY	F.P.	REFS	23	5*66	5*81	DEFINED 1
0	CRACK	INTEGER		F.P.	REFS	21	66	81	DEFINED 1
0	DELTA	REAL		F.P.	REFS	66	81	86	DEFINED 1
0	DELTEZ	REAL		F.P.	REFS	66	81	DEFINED	1
475	DT	REAL			REFS	66	81	DEFINED	32 34

```
VARIABLES     SN  TYPE          RELOCATION
     0   DTIME      REAL                    F.P.        REFS      32      34    DEFINED       1
     0   DV4PRS     REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   ECREEP     REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   ECREP2     REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   ELASTC     INTEGER                 F.P.        REFS      21      66         81   DEFINED       1
     0   EP         REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   EPP        REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   EPP2       REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   EPS        REAL          ARRAY     F.P.        REFS      23      66         81        85   DEFINED       1
     0   EPS0       REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   EP2        REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   F          REAL                    F.P.        REFS      34      42         43        45   DEFINED       1
     0   FVFR0      REAL          ARRAY     F.P.        REFS      23      66         81   DEFINED       1
     0   FZ         REAL                    F.P.        REFS      66      81    DEFINED       1        60       79
   474   GAPTX      REAL                                DEFINED      86
   476   I          INTEGER                             REFS    2*38    4*45    DEFINED      37        44
     0   J          INTEGER                 F.P.        REFS    2*35    2*36       2*38    4*42      4*43     4*45       57
                                                           58    2*59    2*60         66      73        74     4*79       81
                                                        2*85 DEFINED       1
     0   KFLAG      INTEGER                 F.P.        REFS      66      81    DEFINED       1
   502   L2         INTEGER                             REFS      66      81    DEFINED      61        75
   503   L3         INTEGER                             REFS      66      81    DEFINED      62        76
   504   L4         INTEGER                             REFS      66      81    DEFINED      63        77
   505   L5         INTEGER                             REFS      66      81
   506   L6         INTEGER                             REFS      66      81
     0   MNA        INTEGER                 F.P.        REFS   21*23      66         81   DEFINED       1
     0   M2         INTEGER                 F.P.        REFS      37      44         61   DEFINED       1
     0   M3         INTEGER                 F.P.        REFS      37      44         76        79   DEFINED       1
     0   M4         INTEGER                 F.P.        REFS      60      62         75        79      2*85
                                                        DEFINED       1
     0   M5         INTEGER   *UNUSED       F.P.        DEFINED       1
     0   M6         INTEGER   *UNUSED       F.P.        DEFINED       1
     0   NA         INTEGER                 F.P.          REFS      66         81    DEFINED       1
    43   NAA        INTEGER                 PFCMI2        REFS       6
    25   NALFDT     INTEGER                 PFCMI2        REFS       6
    33   NBB        INTEGER                 PFCMI2        REFS       6
    45   NCC        INTEGER                 PFCMI2        REFS       6
    11   NCOEF      INTEGER                 PFCMI2        REFS       6
     5   NDCHCK     INTEGER                 PFCMI2        REFS       6
    36   NDD        INTEGER                 PFCMI2        REFS       6
     7   NDEP       INTEGER                 PFCMI2        REFS       6
    12   NDSIGF     INTEGER                 PFCMI2        REFS       6
    21   NE         INTEGER                 PFCMI2        REFS       6
    16   NECRP2     INTEGER                 PFCMI2        REFS       6
    41   NEE        INTEGER                 PFCMI2        REFS       6
    44   NEI        INTEGER                 PFCMI2        REFS       6
    23   NEPP2      INTEGER                 PFCMI2        REFS       6
    15   NEP2       INTEGER                 PFCMI2        REFS       6
    46   NFF        INTEGER                 PFCMI2        REFS       6
    13   NFI        INTEGER                 PFCMI2        REFS       6
    14   NF2        INTEGER                 PFCMI2        REFS       6
    35   NGG        INTEGER                 PFCMI2        REFS       6
    30   NHH        INTEGER                 PFCMI2        REFS       6
```

VARIABLES	SN	TYPE		RELOCATION								
42	NLL	INTEGER		PFCMI2	REFS	6						
34	NMM	INTEGER		PFCMI2	REFS	6						
32	NMN	INTEGER		PFCMI2	REFS	6						
31	NNN	INTEGER		PFCMI2	REFS	6						
27	NNUDPP	INTEGER		PFCMI2	REFS	6						
26	NOLDPP	INTEGER		PFCMI2	REFS	6						
6	NOLSGF	INTEGER		PFCMI2	REFS	6						
0	NPIN	INTEGER		PFCMI2	REFS	6						
1	NPOUT	INTEGER		PFCMI2	REFS	6						
2	NP1	INTEGER		PFCMI2	REFS	6	66	81				
3	NP2	INTEGER		PFCMI2	REFS	6	66	81				
0	NR	INTEGER		F.P.	REFS	15*23	66	81	DEFINED	1		
10	NSLOPE	INTEGER		PFCMI2	REFS	6						
24	NSTRTT	INTEGER		PFCMI2	REFS	6						
20	NTN	INTEGER		PFCMI2	REFS	6	66	81				
4	NTSAVE	INTEGER		PFCMI2	REFS	6	66	81				
17	NT2	INTEGER		PFCMI2	REFS	6						
40	NU	INTEGER		PFCMI2	REFS	6						
22	NV	INTEGER		PFCMI2	REFS	6						
37	NW	INTEGER		PFCMI2	REFS	6						
0	N1	INTEGER		F.P.	REFS	66	81	DEFINED	1	64	78	
0	N2	INTEGER		F.P.	REFS	66	81	DEFINED	1			
0	N3	INTEGER		F.P.	REFS	66	81	DEFINED	1			
0	N4	INTEGER		F.P.	REFS	66	81	DEFINED	1			
0	OLDPC	REAL	ARRAY	F.P.	REFS	23	2*43	66	81	DEFINED	1	
0	OLDPG	REAL	ARRAY	F.P.	REFS	23	2*42	66	81	DEFINED	1	
0	OLDT	REAL	ARRAY	F.P.	REFS	23	2*45	66	81	DEFINED	1	
0	PC	REAL	ARRAY	F.P.	REFS	23	36	43	DEFINED	1		
0	PG	REAL	ARRAY	F.P.	REFS	23	35	42	DEFINED	1		
477	PI	REAL			REFS	60	2*79	DEFINED	53			
0	PIN	REAL	ARRAY	F.P.	REFS	23	57	59	66	79	81	
					DEFINED	1	35	42	73			
0	POUT	REAL	ARRAY	F.P.	REFS	23	58	60	66	79	91	
					DEFINED	1	36	43	59	7[illegible]		
0	R	REAL	ARRAY	F.P.	REFS	23	60	66	2*79	81	85	
					DEFINED	1						
0	RELAX	INTEGER		F.P.	REFS	21	33	66	81	DEFINED	1	
0	SIG	REAL	ARRAY	F.P.	REFS	23	66	81	DEFINED	1		
0	T	REAL	ARRAY	F.P.	REFS	23	38	45	DEFINED	1		
0	TIME	REAL		F.P.	REFS	56	81	DEFINED	1			
500	TPIN	REAL			REFS	73	DEFINED	57				
501	TPOUT	REAL			REFS	74	DEFINED	58				
0	T2	REAL	ARRAY	F.P.	REFS	23	66	81	DEFINED	1	38	45
511	URC	REAL			REFS	86	DEFINED	85				
510	URF	REAL			REFS	86	DEFINED	70				
507	URO	REAL			REFS	66	70	81				

EXTERNALS	TYPE	ARGS	REFERENCES	
RATIO		46	66	81

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	39	37
52	110	41	33

```
STATEMENT LABELS                DEF LINE    REFERENCES
    0  120                         45          44
  104  130                         52          40

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   40  100      I           37 39       10B     INSTACK
   72  120      I           44 45       11B     INSTACK

COMMON BLOCKS   LENGTH
       PFCM12       39

STATISTICS
  PROGRAM LENGTH                    525B     341
  SCM LABELED COMMON LENGTH          47B      39
        140000B SCM USED
```

```
      SUBROUTINE AXRACH (N1,N2,N3,N4,Q,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,RE
     +LAX,DTIME,TIME,KFLAG,URO,ELASTC,DVHPRS,E,ECREP2,EP2,EPP2,EPS,FVFRO
     +,PC,PG,R,SIG,ALFDT,T,V,COEF,DCHECK,DEP,DSIGF,OLSIGF,SLOPE,NUDEPP,O
     +LDEPP,AFCMI2,NA,NR,MNA)
C
      COMMON/PFCMI2/          NPIN
     +                       ,NPOUT        ,NPI          ,NP2
     +                       ,NTSAVE       ,NDCHCK       ,NOLSGF
     +                       ,NDEP         ,NSLOPE       ,NCOEF
     +                       ,NDSIGF       ,NFI          ,NF2
     +                       ,NEP2         ,NECRP2       ,NT2
     +                       ,NTN          ,NE           ,NV
     +                       ,NEPP2        ,NSTRTT       ,NALFDT
     +                       ,NOLDPP       ,NNUDPP       ,NHH
     +                       ,NNN          ,NMN          ,NBB
     +                       ,NMH          ,NGG          ,NDD
     +                       ,NW           ,NU           ,NEE
     +                       ,NLL          ,NAA          ,NEI
     +                       ,NCC          ,NFF
C
      INTEGER   DCHECK(I,NR)  ,  ELASTC  ,  Q  ,  RELAX
C
      REAL    DVHPRS(MNA,NR)     ,E(MNA,NR)          ,ECREP2(MNA,NR)
     +       ,EP2(MNA,NR)         ,EPP2(MNA,NR,3)      ,EPS(MNA,NR,3)
     +       ,FVFRO(MNA,NR)      ,PC(MNA)             ,PG(MNA)
     +       ,R(MNA,NR)          ,SIG(MNA,NR,3)       ,ALFDT(MNA,NR,3)
     +       ,T(MNA,NR)          ,V(MNA,NR)           ,COEF(I,NR)
     +       ,OLDEPP(I,NR,3)    ,DEP(I,NR)           ,DSIGF(I,NR)
     +       ,OLSIGF(I,NR)      ,SLOPE(I,NR)         ,NUDEPP(I,NR,3)
     +       ,AFCMI2(I)
C
C
C     ******************************************************************
C
C     AXRACH IS CALLED FROM PELLET
C
C     ******************************************************************
C     INPUT  ARGUMENTS
C     ******************************************************************
C
C     ALFDT  - THERMAL EXPANSION STRAIN ( RADIAL, HOOP, AND AXIAL )
C     DELTA  -
C     DELTEZ -
C     DEPP   - INCREMENT OF PLASTIC STRAIN
C     E      - YOUNG'S MODULUS (PSIA,PASCALS)
C     FVFRO  - INITIAL FUEL VOID FRACTION DUE TO RELOCATION
C     FZ     -
C     I      - CURRENT AXIAL NODE NUMBER
C     IT     - POWER-TIME STEP INDEX
C     M2     - INSIDE RADIAL NODE NUMBER OF REGION UNDER CONSIDERATION
C     M3     - OUTSIDE RADIAL NODE NUMBER OF REGION UNDER CONSIDERATION
C     M4     - INSIDE CLADDING RADIAL NODE NUMBER
C     M5     - NODE WHERE RADIAL CRACK STARTS
```

```
      C   M6     - NODE WHERE AXIAL CRACK STARTS                                  AXRCH2     55
55    C   NA     - NUMBER OF AXIAL NODES                                          AXRCH2     56
      C   NDBG   - DEBUG INDEX                                                   AXRCH2     57
      C   NR     - NUMBER OF RADIAL NODES                                         AXRCH2     58
      C   N1     -                                                                AXRCH2     59
      C   N3     - INPUT UNITS INDEX, = 0  SI UNITS, = 1  BRITISH UNITS           AXRCH2     60
60    C   N4     -                                                                AXRCH2     61
      C   PC     - COOLANT CHANNEL PRESSURE (PSIA,PASCALS)                        AXRCH2     62
      C   PG     - ROD INTERNAL GAS PRESSURE (PSIA,PASCALS)                       AXRCH2     63
      C   PI     - THE CONSTANT 3.1415726                                         AXRCH2     64
      C   R      - NODE POINT RADII (IN,M)                                        AXRCH2     65
65    C   T      - NODE POINT TEMPERATURES (F,K)                                  AXRCH2     66
      C   V      - POISSON'S RATIO                                                AXRCH2     67
      C                                                                           AXRCH2     68
      C   ************************************************************************AXRCH2     69
      C   OUTPUT ARGUMENTS                                                        AXRCH2     70
70    C   ************************************************************************AXRCH2     71
      C                                                                           AXRCH2     72
      C   AA     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     73
      C   BB     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     74
      C   CC     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     75
75    C   DD     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     76
      C   EE     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     77
      C   U      - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     78
      C   URO    -                                                                AXRCH2     79
      C   W      - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     80
80    C   ECREP2 - EFFECTIVE CREEP STRAINS                                        AXRCH2     81
      C   EI     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     82
      C   EP2     - TIME INDEPENDENT EFFECTIVE PLASTIC STRAINS                    AXRCH2     83
      C   EPP2    - RADIAL, HOOP, AND AXIAL PLASTIC STRAIN                        AXRCH2     84
      C   EPS    - RADIAL, HOOP, AND AXIAL STRAIN                                 AXRCH2     85
85    C   DVHPRS - VOLUME STRAIN FROM FUEL CRUNCH                                 AXRCH2     86
      C   FLAG   - REAL SWITCHES USED IN FUEL CRUNCH                              AXRCH2     87
      C   NCOUNT - INTEGER SWITCHES USED IN FUEL CRUNCH                           AXRCH2     88
      C   FF     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     89
      C   F1     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     90
90    C   F2     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     91
      C   GG     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     92
      C   HH     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     93
      C   IFLAG1 - HOLLOW FLAG  =0 WHEN FUEL IS HOLLOW, = 1 WHEN SOLID           AXRCH2     94
      C   IQUIT  - TERMINATOR INDEX                                               AXRCH2     95
95    C   LL     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     96
      C   MM     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     97
      C   MN     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     98
      C   NN     - TRANSFER MATRIX WORK ARRAY                                     AXRCH2     99
      C   SIG    - RADIAL, HOOP, AND AXIAL STRESS (PSIA,PASCALS)                  AXRCH2    100
100   C                                                                           AXRCH2    101
      C   ************************************************************************AXRCH2    102
      C                                                                           AXRCH2    103
            IF ((RELAX.EQ.1).AND.(DTIME.NE.0)) GO TO 130                          AXRCH2    104
      C   ***CHECK FOR ELASTIC SOLUTION****                                      AXRCH2    105
105         DO 100 I=M2,M3                                                        AXRCH2    106
            DEP(I,I) = 0.0                                                        AXRCH2    107
```

```
                      DO 100 J=1,3                                                    AXRCH2   108
                      OLDEPP(1,I,J) = 0.0                                             AXRCH2   109
                      NUDEPP(1,I,J) = 0.0                                             AXRCH2   110
110         100       CONTINUE                                                        AXRCH2   111
            C                                                                         AXRCH2   112
            C                                                                         AXRCH2   113
             CALL TRANSF (N1,N2,N3,N4,Q,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,URO,PC(Q      AXRCH2   114
           +),PG(Q),ALFDT,E,EPP2,EPS,OLDEPP,R,SIG,V,AFCMI2(NF1),AFCMI2(NF2),AF       AXRCH2   115
115        +CMI2(NDD),AFCMI2(NU),AFCMI2(NW),AFCMI2(NAA),AFCMI2(NCC),AFCMI2(NEE      AXRCH2   116
           +),AFCMI2(NE1),AFCMI2(NFF),AFCMI2(NLL),AFCMI2(NBB),AFCMI2(NGG),AFCM      AXRCH2   117
           +I2(NHH),AFCMI2(NMM),AFCMI2(NMN),AFCMI2(NNN),NA,NR,MNA)                  AXRCH2   118
            C                                                                         AXRCH2   119
            C                                                                         AXRCH2   120
120         C   ELASTC = 1  INDICATES ELASTIC SOLUTION                                AXRCH2   121
            C                                                                         AXRCH2   122
            C                                                                         AXRCH2   123
             IF ((RELAX.EQ.1).OR.(ELASTC.EQ.1)) RETURN                                AXRCH2   124
                 DO 110 J=M2,M3                                                       AXRCH2   125
125              EP1 = EP2(Q,J)                                                       AXRCH2   126
                 TC1 = T(Q,J)                                                         AXRCH2   127
                 SIGR = SIG(Q,J,1)                                                    AXRCH2   128
                 SIGH = SIG(Q,J,2)                                                    AXRCH2   129
                 SIGZ = SIG(Q,J,3)                                                    AXRCH2   130
130              TAU = 0.0                                                            AXRCH2   131
                 SIGEF1 = 0.707107*SQRT((SIGH-SIGZ)**2+(SIGZ-SIGR)**2+(SIGR-SIG      AXRCH2   132
           +     H)**2+6.0*TAU**2)                                                    AXRCH2   133
                 IF (M4.EQ.0) JTYPE = N1                                              AXRCH2   134
                 IF (M4.NE.0.AND.J.LT.M4) JTYPE = 1                                   AXRCH2   135
135              IF (M4.NE.0.AND.J.GE.M4) JTYPE = 2                                   AXRCH2   136
                 CALL STRAINX (SIGEF1,DUM,EP1,TC1,E(Q,J),JTYPE,N3)                    AXRCH2   137
                 DEP1 = EP1-EP2(Q,J)                                                  AXRCH2   138
                 IF (DEP1.GT.0.0) GO TO 130                                           AXRCH2   139
            110  CONTINUE                                                            AXRCH2   140
140              DO 120 J=M2,M3                                                       AXRCH2   141
                 DEP(1,J) = 0.0                                                       AXRCH2   142
                     DO 120 I=1,3                                                     AXRCH2   143
            120      NUDEPP(1,J,I) = 0.0                                             AXRCH2   144
                 ITER = 0                                                             AXRCH2   145
145              GO TO 360                                                            AXRCH2   146
            C                                                                         AXRCH2   147
            C                                                                         AXRCH2   148
            C                                                                         AXRCH2   149
            C   ***PLASTIC SOLUTION STARTS HERE                                       AXRCH2   150
150         C                                                                         AXRCH2   151
            C                                                                         AXRCH2   152
            C                                                                         AXRCH2   153
            C   ASSUME PLASTIC STRAIN INCREMENTS                                     AXRCH2   154
            C                                                                         AXRCH2   155
155         130       DO 140 J=M2,M3                                                  AXRCH2   156
                      DCHECK(1,J) = 0                                                 AXRCH2   157
                      NUDEPP(1,J,1) = 0.0                                             AXRCH2   158
                      NUDEPP(1,J,2) = 0.0                                             AXRCH2   159
                      NUDEPP(1,J,3) = 0.0                                             AXRCH2   160
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                      DVHPRS(Q,J) = EPP2(Q,J,1)+EPP2(Q,J,2)+EPP2(Q,J,3)                  AXRCH2   161
                      IF (KFLAG.EQ.1.AND.(OLDEPP(1,J,1).EQ.0..OR.OLDEPP(1,J,2).EQ.0.    AXRCH2   162
                     +     )) DCHECK(1,J) = 1                                           AXRCH2   163
                      IF (RELAX.EQ.0) DCHECK(1,J) = 1                                   AXRCH2   164
                      IF (RELAX.EQ.0) RATIO = 10.0                                      AXRCH2   165
                      IF (KFLAG.EQ.1.OR.RELAX.EQ.0) GO TO 140                           AXRCH2   166
                      OLDEPP(1,J,1) = 0.0000001                                         AXRCH2   167
                      OLDEPP(1,J,2) = -0.0000002                                        AXRCH2   168
                      OLDEPP(1,J,3) = -0.0000002                                        AXRCH2   169
                  140 CONTINUE                                                          AXRCH2   170
                  C   ***START ITERATIVE SOLUTION HERE                                 AXRCH2   171
                  C   BASED ON NEW VALUES OF PLASTIC STRAIN INCREMENTS                  AXRCH2   172
                    ITER = 1                                                            AXRCH2   173
                  C   CALCULATE ALL OLD EFFECTIVE STRESSES HERE                        AXRCH2   174
                  C   IF EET ITERATION SCHEME IS BEING UTILIZED                        AXRCH2   175
                      IF (RELAX.NE.0) GO TO 160                                         AXRCH2   176
                      DO 150 J=M2,M3                                                    AXRCH2   177
                      EP1 = EP2(Q,J)                                                    AXRCH2   178
                      IF (M4.EQ.0) JTYPE = N1                                           AXRCH2   179
                      IF (M4.NE.0.AND.J.LT.M4) JTYPE = 1                                AXRCH2   180
                      IF (M4.NE.0.AND.J.GE.M4) JTYPE = 2                                AXRCH2   181
                      CALL STRESSX (OLSIGF(1,J),EP1,0.000,T(Q,J),E(Q,J),JTYPE,N3)       AXRCH2   182
                      EP1 = EP2(Q,J)                                                    AXRCH2   183
                      CALL STRESSX (DSIGF(1,J),EP1,0.0001,T(Q,J),E(Q,J),JTYPE,N3)       AXRCH2   184
                      SLOPE(1,J) = (DSIGF(1,J)-OLSIGF(1,J))/0.0001                      AXRCH2   185
                      COEF(1,J) = 2.0*(1.0+V(Q,J))/(3.0*E(Q,J))                         AXRCH2   186
                  150 CONTINUE                                                          AXRCH2   187
                  160   CONTINUE                                                        AXRCH2   188
                  C                                                                     AXRCH2   189
                  C   ******** MAIN PLASTIC/CREEP ITERATION LOOP STARTS HERE           AXRCH2   190
                  C   LOOP UNTIL PLASTIC STRAIN INCREMENTS CONVERGE FOR ALL NODES      AXRCH2   191
                  C                                                                     AXRCH2   192
                  170   CONTINUE                                                        AXRCH2   193
                  C   COMPUTE "PSEUDO-ELASTIC SOLUTION HERE                           AXRCH2   194
                  C                                                                     AXRCH2   195
                  C                                                                     AXRCH2   196
                      CALL TRANSF (N1,N2,N3,N4,Q,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,URO,PC(Q AXRCH2   197
                     +),PG(Q),ALFDT,E,EPP2,EPS,OLDEPP,R,SIG,V,AFCMI2(NF1),AFCMI2(NF2),AF AXRCH2   198
                     +CMI2(NDD),AFCMI2(NU),AFCMI2(NW),AFCMI2(NAA),AFCMI2(NCC),AFCMI2(NEE AXRCH2   199
                     +),AFCMI2(NEI),AFCMI2(NFF),AFCMI2(NLL),AFCMI2(NBB),AFCMI2(NGG),AFCM AXRCH2   200
                     +I2(NHH),AFCMI2(NMM),AFCMI2(NMN),AFCMI2(NNN),NA,NR,MNA)            AXRCH2   201
                  C                                                                     AXRCH2   202
                  C                                                                     AXRCH2   203
                  C   ***NOW GET NEW DISPLACEMENTS AND STRESSES BASED ON                AXRCH2   204
                  C   NEW PLASTIC STRAIN INCREMENTS                                    AXRCH2   205
                  C   AT THIS POINT IN PROGRAM, "PSEUDO-ELASTIC SOLUTION               AXRCH2   206
                  C   FOR ASSUMED OLDEPP'S HAS BEEN FOUND.                            AXRCH2   207
                  C   ***GET EFFECTIVE STRESS FOR EACH NODE                           AXRCH2   208
                  C   BASED ON ASSUMED PLASTIC STRAIN INCREMENTS                      AXRCH2   209
                    RATIO = 0.0                                                         AXRCH2   210
                  C                                                                     AXRCH2   211
                  C   INSIDE LOOP OF PLASTIC ITERATION SCHEME                         AXRCH2   212
                  C   LOOP OVER ALL NODES TO GET NEW PLASTIC STRAIN INCREMENTS         AXRCH2   213
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      C                                                                 AXRCH2   214
            DO 310 J=M2,M3                                              AXRCH2   215
215         SIGR = SIG(Q,J,1)                                           AXRCH2   216
            SIGH = SIG(Q,J,2)                                           AXRCH2   217
            SIGZ = SIG(Q,J,3)                                           AXRCH2   218
            TAU = 0.0                                                   AXRCH2   219
            IF (RELAX.NE.0) GO TO 200                                   AXRCH2   220
220   C                                                                 AXRCH2   221
      C     ISOTROPIC PLASTIC STRAIN-TOTAL STRAIN SCHEME STARTS HERE    AXRCH2   222
      C                                                                 AXRCH2   223
            EMODR = (SIGR-V(Q,J)*(SIGH+SIGZ))/E(Q,J)+OLDEPP(1,J,1)      AXRCH2   224
            EMODH = (SIGH-V(Q,J)*(SIGR+SIGZ))/E(Q,J)+OLDEPP(1,J,2)      AXRCH2   225
225         EMODZ = (SIGZ-V(Q,J)*(SIGR+SIGH))/E(Q,J)+OLDEPP(1,J,3)      AXRCH2   226
            EMODRZ = 0.0                                                AXRCH2   227
            EET = 0.471405*SQRT((EMODH-EMODR)**2+(EMODR-EMODZ)**2+(EMODZ-E AXRCH2   228
           +    MODH)**2+6.0*EMODRZ**2)                                 AXRCH2   229
      C     CHECK TO SEE IF OLD YIELD STRESS (AT NEW TEMP) HAS BEEN     AXRCH2   230
230   C     EXCEEDED.                                                   AXRCH2   231
            SIGEFF = 0.707107*SQRT((SIGH-SIGZ)**2+(SIGZ-SIGR)**2+(SIGR-SIG AXRCH2   232
           +    H)**2+6.0*TAU**2)                                       AXRCH2   233
            IF (SIGEFF.GT.OLSIGF(1,J)) GO TO 180                        AXRCH2   234
            DEP(1,J) = 0.0                                              AXRCH2   235
235         OLDEPP(1,J,1) = 0.0                                         AXRCH2   236
            OLDEPP(1,J,2) = 0.0                                         AXRCH2   237
            OLDEPP(1,J,3) = 0.0                                         AXRCH2   238
            NUDEPP(1,J,1) = 0.0                                         AXRCH2   239
            NUDEPP(1,J,2) = 0.0                                         AXRCH2   240
240         NUDEPP(1,J,3) = 0.0                                         AXRCH2   241
            DCHECK(1,J) = 1                                             AXRCH2   242
            GO TO 310                                                   AXRCH2   243
      C     OLD YIELD STRESS HAS BEEN EXCEEDED. DEP(J) MUST BE POSITIVE. AXRCH2   244
      180   CONTINUE                                                    AXRCH2   245
245         DEP(1,J) = (EET-COEF(1,J)*OLSIGF(1,J))/(1.0+COEF(1,J)*SLOPE(1, AXRCH2   246
           +    J))                                                     AXRCH2   247
      C     CHECK MAGNITUDE OF DEP(J)                                   AXRCH2   248
            IF (DEP(1,J).GE.0.0) GO TO 190                              AXRCH2   249
            WRITE (6,380)                                               AXRCH2   250
250         WRITE (6,420) J,DEP(1,J),EET,COEF(1,J),OLSIGF(1,J),SLOPE(1,J) AXRCH2   251
            WRITE (6,390) Q,ITER,SIGEFF,SIGR,SIGH,SIGZ,EP2(Q,J)         AXRCH2   252
            WRITE (6,400) T(Q,J),E(Q,J),(OLDEPP(1,J,KO),KO=1,3),(NUDEPP(1, AXRCH2   253
           +    J,KO),KO=1,3)                                           AXRCH2   254
            IQUIT = 1                                                   AXRCH2   255
255         STOP "NEGATIVE DEP IN AXRACH"                               AXRCH2   256
      190   EM = (EMODH+EMODZ+EMODR)/3.0                                AXRCH2   257
            NUDEPP(1,J,2) = (DEP(1,J)/EET)*(EMODH-EM)                   AXRCH2   258
            NUDEPP(1,J,3) = (DEP(1,J)/EET)*(EMODZ-EM)                   AXRCH2   259
            NUDEPP(1,J,1) = -NUDEPP(1,J,3)-NUDEPP(1,J,2)                AXRCH2   260
260   C     CHECK MAGNITUDE OF DEP(J). IF THIS IS LESS THAN 1.0E-06, DON'T AXRCH2   261
      C     WANT TO KEEP ITERATING TO TIGHT TOLERANCE.  SO DIFFERENCE   AXRCH2   262
      C     BETWEEN OLD AND NUDEPP'S NOT CHECKED (IE, RATIO NOT UPDATED ) AXRCH2   263
      C     BUT NUDEPP'S ARE COMPUTED AS LONG AS FURTHER ITERATIONS ARE AXRCH2   264
      C     REQUIRED AT OTHER NODES.                                    AXRCH2   265
265         IF (DEP(1,J).LT.1.0E-12) GO TO 310                          AXRCH2   266
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                GO TO 270                                                       AXRCH2   267
          200   CONTINUE                                                        AXRCH2   268
          C     ISOTROPIC CREEP CALCULATIONS                                    AXRCH2   269
                IF (RELAX.NE.1) GO TO 230                                       AXRCH2   270
270             DEP(I,J) = 0.4714O452*SQRT((OLDEPP(I,J,1)-OLDEPP(I,J,2))**2+(O  AXRCH2   271
               +    LDEPP(I,J,2)-OLDEPP(I,J,3))**2+(OLDEPP(I,J,3)-OLDEPP(I,J,1))** AXRCH2   272
               +    2)                                                         AXRCH2   273
                DEPDOT = DEP(I,J)/DTIME                                         AXRCH2   274
                DV = OLDEPP(I,J,1)+OLDEPP(I,J,2)+OLDEPP(I,J,3)                  AXRCH2   275
275             DVDOT = DV/DTIME                                                AXRCH2   276
                IF ((M4.EQ.0).AND.(NI.EQ.1)) GO TO 220                          AXRCH2   277
                IF ((M4.NE.0).AND.(J.LT.M4)) GO TO 210                          AXRCH2   278
          C                                                                     AXRCH2   279
          C     CLADDING CREEP -  CONSTANT VOLUME                               AXRCH2   280
280             PHI = 2.4E+17                                                   AXRCH2   281
                CRPE = SCREP2(Q,J)+DEP(I,J)                                     AXRCH2   282
                JTYPE = 2                                                       AXRCH2   283
                CALL CRIIP (SIGEFF,DEPDOT,TIME,T(Q,J),PHI,CRPE,JTYPE)           AXRCH2   284
                S1 = SIGR-(SIGR+SIGH+SIGZ)/3.                                   AXRCH2   285
285             S2 = SIGH-(SIGR+SIGH+SIGZ)/3.                                   AXRCH2   286
                S3 = SIGZ-(SIGR+SIGH+SIGZ)/3.                                   AXRCH2   287
                IF (SIGEFF.LT.1.0) SIGEFF = 1.00                                AXRCH2   288
                NUDEPP(I,J,2) = 1.5*DEP(I,J)*S2/SIGEFF                          AXRCH2   289
                NUDEPP(I,J,3) = 1.5*DEP(I,J)*S3/SIGEFF                          AXRCH2   290
290             NUDEPP(I,J,1) = -NUDEPP(I,J,3)-NUDEPP(I,J,2)                    AXRCH2   291
                GO TO 220                                                       AXRCH2   292
          C                                                                     AXRCH2   293
          C     FUEL IN CONTACT WITH CLAD  -  FUEL CRUNCH IS CONSIDERED         AXRCH2   294
          210   CONTINUE                                                        AXRCH2   295
295             CALL FCRNCH (SIG(Q,M4,1),PG(Q),DTIME,FVFRO(Q,J),DVHPRS(Q,J),DV  AXRCH2   296
               +    )                                                          AXRCH2   297
          C                                                                     AXRCH2   298
          C     FUEL CREEP IS NOT CALCULATED IN THIS VERSION OF FRACAS          AXRCH2   299
          C     IF FUEL CREEP ,THEN NUDEPP = DV/3 + 1.5*DEP*S/SIGEFF            AXRCH2   300
300       C     SEE CLAD CREEP CALCULATION ABOVE                                AXRCH2   301
          C                                                                     AXRCH2   302
                NUDEPP(I,J,1) = DV/3.                                           AXRCH2   303
                NUDEPP(I,J,2) = DV/3.                                           AXRCH2   304
                NUDEPP(I,J,3) = DV/3.                                           AXRCH2   305
305             IF (ITER.LT.25) GO TO 220                                       AXRCH2   306
                NUDEPP(I,J,1) = (NUDEPP(I,J,1)+OLDEPP(I,J,1))/2.                AXRCH2   307
                NUDEPP(I,J,2) = (NUDEPP(I,J,2)+OLDEPP(I,J,2))/2.                AXRCH2   308
                NUDEPP(I,J,3) = (NUDEPP(I,J,3)+OLDEPP(I,J,3))/2.                AXRCH2   309
          220   CONTINUE                                                        AXRCH2   310
310       C                                                                     AXRCH2   311
          C     DO NOT CHECK CONVERGENCE IF DEP AND DV ARE TOO SMALL            AXRCH2   312
          C                                                                     AXRCH2   313
                DV = ABS(DV)                                                    AXRCH2   314
                IF ((DEP(I,J).LT.1.E-12).AND.(DV.LT.1.E-12)) GO TO 310          AXRCH2   315
315       C                                                                     AXRCH2   316
                GO TO 270                                                       AXRCH2   317
          230   CONTINUE                                                        AXRCH2   318
          C     ANISOTROPIC PLASTIC STRAIN SCHEME STARTS HERE                   AXRCH2   319
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                IF (RELAX.NE.2) GO TO 260                                       AXRCH2   320
320         C   ** HILL'S THEORY OF ANISOTROPY, NO PLASTIC VOLUME CHANGE         AXRCH2   321
                IF (M4.EQ.0) JTYPE = N1                                         AXRCH2   322
                IF (M4.NE.0.AND.J.LT.M4) JTYPE = 1                              AXRCH2   323
                IF (M4.NE.0.AND.J.GE.M4) JTYPE = 2                              AXRCH2   324
                IF (JTYPE.NE.1) GO TO 240                                       AXRCH2   325
325             A12 = 0.5                                                       AXRCH2   326
                A23 = 0.5                                                       AXRCH2   327
                A31 = 0.5                                                       AXRCH2   328
                GO TO 250                                                       AXRCH2   329
            240 CONTINUE                                                        AXRCH2   330
330             A12 = 0.5                                                       AXRCH2   331
                A23 = 0.5                                                       AXRCH2   332
                A31 = 0.5                                                       AXRCH2   333
                A12 = 0.15                                                      AXRCH2   334
                A23 = 0.74                                                      AXRCH2   335
335             A31 = 0.26                                                      AXRCH2   336
                A12 = 0.142                                                     AXRCH2   337
                A23 = 0.758                                                     AXRCH2   338
                A31 = 0.242                                                     AXRCH2   339
                A12 = 0.203                                                     AXRCH2   340
340             A23 = 0.655                                                     AXRCH2   341
                A31 = 0.345                                                     AXRCH2   342
            250 CONTINUE                                                        AXRCH2   343
                G = A12*A23+A23*A31+A31*A12                                     AXRCH2   344
                DEP(I,J) = A12*(A23*OLDEPP(I,J,1)-A31*OLDEPP(I,J,2))**2+A23*(A  AXRCH2   345
345           +    31*OLDEPP(I,J,2)-A12*OLDEPP(I,J,3))**2+A31*(A12*OLDEPP(I,J,3)-  AXRCH2   346
              +    A23*OLDEPP(I,J,1))**2                                        AXRCH2   347
                DEP(I,J) = SQRT(DEP(I,J))/G                                     AXRCH2   348
                EPI = EP2(Q,J)                                                  AXRCH2   349
                CALL STRESSX (SIGEF,EPI,DEP(Q,J),T(Q,J),E(Q,J),JTYPE,N3)        AXRCH2   350
350             NUDEPP(I,J,1) = (A12*(SIGR-SIGH)-A31*(SIGZ-SIGR))*DEP(I,J)/SIG  AXRCH2   351
              +    EF                                                           AXRCH2   352
                NUDEPP(I,J,2) = (A23*(SIGH-SIGZ)-A12*(SIGR-SIGH))*DEP(I,J)/SIG  AXRCH2   353
              +    EF                                                           AXRCH2   354
                NUDEPP(I,J,3) = -NUDEPP(I,J,1)-NUDEPP(I,J,2)                    AXRCH2   355
355             SIGEFF = SIGEF                                                  AXRCH2   356
                SIGM = 0.0                                                      AXRCH2   357
                DVDOT = 1.0                                                     AXRCH2   358
                IF (DEP(I,J).LT.1.0E-12) GO TO 310                              AXRCH2   359
                GO TO 270                                                       AXRCH2   360
360         260 CONTINUE                                                        AXRCH2   361
            270 CONTINUE                                                        AXRCH2   362
            C                                                                   AXRCH2   363
            C   ***START CONVERGENCE CHECK HERE  ****                           AXRCH2   364
            C                                                                   AXRCH2   365
365         C   ***CHECK MAGNITUDE OF DEP AND CUT STEP SIZE IF G.T. 1.00        AXRCH2   366
                IF (DEP(I,J).GT.0.001E0) N4 = 1                                 AXRCH2   367
                IF (DEP(I,J).GT.0.001) WRITE (6,420) J,SIGEFF,SIGM,DEP(I,J),DV  AXRCH2   368
              +    DOT,(NUDEPP(I,J,KO),KO=1,3)                                  AXRCH2   369
                IF (DEP(I,J).GT.0.001) WRITE (6,420) J,(OLDEPP(I,J,KO),KO=1,3)  AXRCH2   370
370           +    ,(EPP2(Q,J,KO),KO=1,3),ECREP2(Q,J)                          AXRCH2   371
                IF (DEP(I,J).GT.0.001) WRITE (6,420) J,S1,S2,S3,SIGR,SIGH,SIGZ  AXRCH2   372
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                      IF (DEP(I,J).GT.0.001E0) RETURN                                    AXRCH2   373
                      IF (ITER.LT.490) GO TO 280                                         AXRCH2   374
                      IF (J.EQ.1) WRITE (6,410) ITER                                     AXRCH2   375
375                   WRITE (6,420) J,SIGEFF,SIGM,DEP(I,J),DVDOT,(NUDEPP(I,J,KO),KO=     AXRCH2   376
                     +I,3)                                                               AXRCH2   377
                280   CONTINUE                                                           AXRCH2   378
                      IF (DCHECK(I,J).EQ.1) GO TO 300                                    AXRCH2   379
                          DO 290 KO=1,3                                                  AXRCH2   380
380                       IF (OLDEPP(I,J,KO).EQ.0.) GO TO 300                            AXRCH2   381
                290       CONTINUE                                                       AXRCH2   382
                      RATIO1 = (NUDEPP(I,J,1)-OLDEPP(I,J,1))/OLDEPP(I,J,1)               AXRCH2   383
                      RATIO2 = (NUDEPP(I,J,2)-OLDEPP(I,J,2))/OLDEPP(I,J,2)               AXRCH2   384
                      RATIO3 = (NUDEPP(I,J,3)-OLDEPP(I,J,3))/OLDEPP(I,J,3)               AXRCH2   385
385                   RATIO1 = ABS(RATIO1)                                               AXRCH2   386
                      RATIO2 = ABS(RATIO2)                                               AXRCH2   387
                      RATIO3 = ABS(RATIO3)                                               AXRCH2   388
                      RATIO = AMAX1(RATIO,RATIO1,RATIO2,RATIO3)                          AXRCH2   389
                      GO TO 310                                                          AXRCH2   390
390             C   THIS STATEMENT SHOULD ONLY BE REACHED IF OLD VALUE OF DEP           AXRCH2   391
                C   WAS ZERO (IE, ELASTIC ) AND NEW VALUE IS NON-ZERO. THIS            AXRCH2   392
                C   FORCES AT LEAST ONE MORE ITERATION.                                AXRCH2   393
                300       RATIO = 10.0                                                 AXRCH2   394
                          DCHECK(I,J) = 0                                              AXRCH2   395
395             310       CONTINUE                                                     AXRCH2   396
                C                                                                      AXRCH2   397
                C   END INSIDE ITERATION LOOP                                         AXRCH2   398
                C                                                                      AXRCH2   399
                      IF (RATIO-0.00010) 360,360,320                                   AXRCH2   400
400             320   ITER = ITER+1                                                    AXRCH2   401
                      IF (ITER-500) 330,350,350                                        AXRCH2   402
                330       DO 340 J=M2,M3                                             AXRCH2   403
                          OLDEPP(I,J,1) = NUDEPP(I,J,1)                              AXRCH2   404
                          OLDEPP(I,J,2) = NUDEPP(I,J,2)                              AXRCH2   405
405             340       OLDEPP(I,J,3) = NUDEPP(I,J,3)                              AXRCH2   406
                      GO TO 170                                                        AXRCH2   407
                C                                                                      AXRCH2   408
                C   ***    MAIN PLASTIC/CREEP ITERATION LOOP ENDS HERE                AXRCH2   409
                C                                                                      AXRCH2   410
410             350   CONTINUE                                                         AXRCH2   411
                      WRITE (6,430) ITER                                               AXRCH2   412
                C   ***THE ROUTINE DID NOT CONVERGE, AND                              AXRCH2   413
                C   ***AN ERROR MESSAGE IS PRINTED                                     AXRCH2   414
                C   ***PROGRAM IS TERMINATED                                          AXRCH2   415
415                   WRITE (6,440)                                                    AXRCH2   416
                      IQUIT = 1                                                        AXRCH2   417
                C   ***PLASTIC SOLUTION COMPLETE                                      AXRCH2   418
                360   CONTINUE                                                         AXRCH2   419
                          DO 370 J=M2,M3                                               AXRCH2   420
420                       EPP2(Q,J,1) = EPP2(Q,J,1)+NUDEPP(I,J,1)                      AXRCH2   421
                          EPP2(Q,J,2) = EPP2(Q,J,2)+NUDEPP(I,J,2)                      AXRCH2   422
                          EPP2(Q,J,3) = EPP2(Q,J,3)+NUDEPP(I,J,3)                      AXRCH2   423
                          IF (RELAX.NE.1) EP2(Q,J) = EP2(Q,J)+DEP(I,J)                 AXRCH2   424
                          IF (RELAX.EQ.1) ECREP2(Q,J) = ECREP2(Q,J)+DEP(I,J)           AXRCH2   425
```

```
425                   IF (RELAX.EQ.1) DVHPRS(Q,J) = EPP2(Q,J,1)+EPP2(Q,J,2)+EPP2(Q,J AXRCH2    426
                +     ,3)                                                            AXRCH2    427
          370         CONTINUE                                                       AXRCH2    428
                    RETURN                                                         AXRCH2    429
                    C                                                              AXRCH2    430
430                 380   FORMAT (1H0,4X,5HERROR,/33H NEGATIVE DEP CALCULATED IN STACK) AXRCH2    431
                    390   FORMAT (3H0Q=,I3,6HITER= ,I4,5E20.5)                     AXRCH2    432
                    400   FORMAT (1H0,5E20.5)                                      AXRCH2    433
                    410   FORMAT (1H0,4X,7HITER = ,I3)                             AXRCH2    434
                    420   FORMAT (1H0,I5,10X,7E15.6)                               AXRCH2    435
435                 430   FORMAT (1H0,20H DID NOT CONVERGE IN,1X,I4,1X,:1H ITERATIONS) AXRCH2    436
                    440   FORMAT (1H ,12H IN AXRACH  )                             AXRCH2    437
                          END                                                      AXRCH2    438
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES		
4	AXRACH	1	123	372	428

VARIABLES

	SN	TYPE	RELOCATION								
0	AFCM12	REAL	ARRAY	F.P.	REFS	23	17*113	17*196	DEFINED	1	
0	ALFDT	REAL	ARRAY	F.P.	REFS	23	113	196	DEFINED	1	
2501	A12	REAL			REFS	2*343	3*344	350	352	DEFINED	325	330
					333	336	339					
2502	A23	REAL			REFS	2*343	3*344	352	DEFINED	326	331	334
					337	340						
2503	A31	REAL			REFS	2*343	3*344	350	DEFINED	327	332	335
					338	341						
0	COEF	REAL	ARRAY	F.P.	REFS	23	2*245	250	DEFINED	1	185	
2475	CRPE	REAL			REFS	283	DEFINED	281				
0	DCHECK	INTEGER	ARRAY	F.P.	REFS	21	378	DEFINED	1	156	161	163
					241	394						
0	DELTA	REAL		F.P.	REFS	113	196	DEFINED	1			
0	DELTEZ	REAL		F.P.	REFS	113	196	DEFINED	1			
0	DEP	REAL	ARRAY	F.P.	REFS	23	248	250	257	258	265	273
					281	288	289	314	347	349	350	352
					358	366	2*367	369	371	372	375	423
					424	DEFINED	1	106	141	234	245	270
					344	347						
2471	DEPDOT	REAL			REFS	283	DEFINED	273				
2455	DEPI	REAL			REFS	138	DEFINED	137				
0	DSIGF	REAL	ARRAY	F.P.	REFS	23	183	184	DEFINED	1		
0	DTIME	REAL		F.P.	REFS	103	273	275	295	DEFINED	1	
2454	DUM	* REAL			REFS	136						
2472	DV	REAL			REFS	275	295	302	303	304	313	314
					DEFINED	274	313					
2473	DVDOT	REAL			REFS	367	375	DEFINED	275	357		
0	DVHPRS	REAL	ARRAY	F.P.	REFS	23	295	DEFINED	1	160	425	
0	E	REAL	ARRAY	F.P.	REFS	23	113	136	181	183	185	196

VARIABLES SN TYPE RELOCATION

					223	224	225	252	349	DEFINED	1		
0	ECREP2	REAL	ARRAY	F.P.	REFS	23	281	369	424	DEFINED	1		424
2464	EET	REAL			REFS	245	250	257	258	DEFINED	227		
0	ELASTC	INTEGER		F.P.	REFS	21	123	DEFINED	1				
2470	EM	REAL			REFS	257	258	DEFINED	256				
2461	EMODM	REAL			REFS	2*227	256	257	DEFINED	224			
2460	EMODR	REAL			REFS	2*227	256	DEFINED	223				
2463	EMODRZ	REAL			REFS	227	DEFINED	226					
2462	EMODZ	REAL			REFS	2*227	256	258	DEFINED	225			
0	EPP2	REAL	ARRAY	F.P.	REFS	23	113	3*160	196	369	420		421
					422	3*425	DEFINED	1	420	421	422		
0	EPS	REAL	ARRAY	F.P.	REFS	23	113	196	DEFINED	1			
2444	EPI	REAL			REFS	136	137	181	183	349			
					DEFINED	125	177	182	348				
0	EP2	REAL	ARRAY	F.P.	REFS	23	125	137	177	182	251		348
					423	DEFINED	1	423					
0	FVFRO	REAL	ARRAY	F.P.	REFS	23	295	DEFINED	1				
0	FZ	REAL		F.P.	REFS	113	196	DEFINED	1				
2504	G	REAL			REFS	347	DEFINED	343					
2442	I	INTEGER			REFS	106	108	109	143	DEFINED	105		142
2467	IQUIT	INTEGER			DEFINED	254	416						
2456	ITER	INTEGER			REFS	251	305	373	374	400	401		411
					DEFINED	144	172	400					
2443	J	INTEGER			REFS	108	109	125	126	127	128		129
					134	135	136	137	141	143	156		157
					158	159	4*160	3*161	163	166	167		168
					177	179	180	3*181	182	3*183	3*184		3*185
					215	216	217	3*223	3*224	3*225	233		234
					235	236	237	238	239	240	241		5*245
					248	5*250	251	4*252	2*257	2*258	3*259		265
					7*270	273	3*274	277	2*281	283	2*288		2*289
					3*290	2*295	302	303	304	3*306	3*307		3*308
					314	322	323	7*344	2*347	348	3*349		2*350
					2*352	3*354	358	366	4*367	5*369	2*371		372
					374	3*375	378	380	3*382	3*383	3*384		394
					2*403	2*404	2*405	3*420	3*421	3*422	3*423		3*424
					4*425	DEFINED	107	124	140	155	176		214
					402	419							
2453	JTYPE	INTEGER			REFS	136	181	183	283	324	349		
					DEFINED	133	134	135	178	179	180		282
					321	322	323						
0	KFLAG	INTEGER		F.P.	REFS	161	165	DEFINED	1				
2466	KO	INTEGER			REFS	2*252	367	2*369	375	380			
					DEFINED	2*252	367	2*369	375	379			
0	MNA	INTEGER		F.P.	REFS	14*23	113	196	DEFINED	1			
0	M2	INTEGER		F.P.	REFS	105	113	124	140	155	176		196
					214	402	419	DEFINED	1				
0	M3	INTEGER		F.P.	REFS	105	113	124	140	155	176		196
					214	402	419	DEFINED	1				
0	M4	INTEGER		F.P.	REFS	113	133	2*134	2*135	178	2*179		2*180
					196	276	2*277	295	321	2*322	2*323		
					DEFINED	1							
0	M5	INTEGER		F.P.	REFS	113	196	DEFINED	1				

VARIABLES SN TYPE RELOCATION

0	M6	INTEGER		F.P.	REFS	113	196	DEFINED	1			
0	NA	INTEGER		F.P.	REFS	113	196	DEFINED	1			
43	NAA	INTEGER		PFCMI2	REFS	6	113	196				
25	NALFDT	INTEGER		PFCMI2	REFS	6						
33	NBB	INTEGER		PFCMI2	REFS	6	113	196				
45	NCC	INTEGER		PFCMI2	REFS	6	113	196				
11	NCOEF	INTEGER		PFCMI2	REFS	6						
5	NDCHCK	INTEGER		PFCMI2	REFS	6						
36	NDD	INTEGER		PFCMI2	REFS	6	113	196				
7	NDEP	INTEGER		PFCMI2	REFS	6						
12	NDSIGF	INTEGER		PFCMI2	REFS	6						
21	NE	INTEGER		PFCMI2	REFS	6						
16	NECRP2	INTEGER		PFCMI2	REFS	6						
41	NEE	INTEGER		PFCMI2	REFS	6	113	196				
44	NEI	INTEGER		PFCMI2	REFS	6	113	196				
23	NEPP2	INTEGER		PFCMI2	REFS	6						
15	NEP2	INTEGER		PFCMI2	REFS	6						
46	NFF	INTEGER		PFCMI2	REFS	6	113	196				
13	NFI	INTEGER		PFCMI2	REFS	6	113	196				
14	NF2	INTEGER		PFCMI2	REFS	6	113	196				
35	NGG	INTEGER		PFCMI2	REFS	6	113	196				
30	NHH	INTEGER		PFCMI2	REFS	6	113	196				
42	NLL	INTEGER		PFCMI2	REFS	6	113	196				
34	NMM	INTEGER		PFCMI2	REFS	6	113	196				
32	NMN	INTEGER		PFCMI2	REFS	6	113	196				
31	NNN	INTEGER		PFCMI2	REFS	6	113	196				
27	NNUDPP	INTEGER		PFCMI2	REFS	6						
26	NOLDPP	INTEGER		PFCMI2	REFS	6						
6	NOLSGF	INTEGER		PFCMI2	REFS	6						
0	NPIN	INTEGER		PFCMI2	REFS	6						
1	NPOUT	INTEGER		PFCMI2	REFS	6						
2	NP1	INTEGER		PFCMI2	REFS	6						
3	NP2	INTEGER		PFCMI2	REFS	6						
0	NR	INTEGER		F.P.	REFS	21	19*23	113	196	DEFINED	1	
10	NSLOPE	INTEGER		PFCMI2	REFS	6						
24	NSTRTT	INTEGER		PFCMI2	REFS	6						
20	NTN	INTEGER		PFCMI2	REFS	6						
4	NTSAVE	INTEGER		PFCMI2	REFS	6						
17	NT2	INTEGER		PFCMI2	REFS	6						
40	NU	INTEGER		PFCMI2	REFS	6	113	196				
0	NUDEPP	REAL	ARRAY	F.P.	REFS	23	252	2*259	2*290	306	307	308
					2*354	367	375	382	383	384	403	404
					405	420	421	422	DEFINED	1	109	143
					157	158	159	238	239	240	257	258
					259	288	289	290	302	303	304	306
					307	308	350	352	354			
22	NV	INTEGER		PFCMI2	REFS	6						
37	NW	INTEGER		PFCMI2	REFS	6	113	196				
0	N1	INTEGER		F.P.	REFS	113	133	178	196	276	321	
					DEFINED	1						
0	N2	INTEGER		F.P.	REFS	113	196	DEFINED	1			
0	N3	INTEGER		F.P.	REFS	113	136	181	183	196	349	
					DEFINED	1						

VARIABLES SN TYPE RELOCATION

0	N4	INTEGER		F.P.	REFS	113	196	DEFINED	1	366		
0	OLDEPP	REAL	ARRAY	F.P.	REFS	23	113	2*161	196	223	224	225
					252	6*270	3*274	306	307	308	6*344	369
					380	2*382	2*383	2*384	DEFINED	1	108	166
					167	168	235	236	237	403	404	405
0	OLSIGF	REAL	ARRAY	F.P.	REFS	23	181	184	233	245	250	
					DEFINED	1						
0	PC	REAL	ARRAY	F.P.	REFS	23	113	196	DEFINED	1		
0	PG	REAL	ARRAY	F.P.	REFS	23	113	196	295	DEFINED	1	
2474	PHI	REAL			REFS	283	DEFINED	280				
0	Q	INTEGER		F.P.	REFS	21	3*113	125	126	127	128	129
					136	137	4*160	177	2*181	182	2*183	2*185
					3*196	215	216	217	2*223	2*224	2*225	2*251
					2*252	281	283	4*295	348	3*349	2*369	2*420
					2*421	2*422	2*423	2*424	4*425	DEFINED	1	
0	R	REAL	ARRAY	F.P.	REFS	23	113	196	DEFINED	1		
2457	RATIO	REAL			REFS	388	399	DEFINED	164	209	388	393
2507	RATIO1	REAL			REFS	385	388	DEFINED	382	385		
2510	RATIO2	REAL			REFS	386	388	DEFINED	383	386		
2511	RATIO3	REAL			REFS	387	388	DEFINED	384	387		
0	RELAX	INTEGER		F.P.	REFS	21	103	123	163	164	165	175
					219	269	319	423	424	425		
					DEFINED	1						
0	SIG	REAL	ARRAY	F.P.	REFS	23	113	127	128	129	196	215
					216	217	295	DEFINED	1			
2505	SIGEF	REAL			REFS	349	350	352	355			
2465	SIGEFF	REAL			REFS	233	251	283	287	288	289	367
					375	DEFINED	231	287	355			
2452	SIGEF1	REAL			REFS	136	DEFINED	131				
2447	SIGH	REAL			REFS	2*131	223	224	225	2*231	251	284
					2*285	286	350	2*352	371	DEFINED	128	216
2506	SIGM	REAL			REFS	367	375	DEFINED	356			
2446	SIGR	REAL			REFS	2*131	223	224	225	2*231	251	2*284
					285	286	2*350	352	371	DEFINED	127	215
2450	SIGZ	REAL			REFS	2*131	223	224	225	2*231	251	284
					285	2*286	350	352	371	DEFINED	129	217
0	SLOPE	REAL	ARRAY	F.P.	REFS	23	245	250	DEFINED	1	184	
2476	SI	REAL			REFS	371	DEFINED	284				
2477	S2	REAL			REFS	288	371	DEFINED	285			
2500	S3	REAL			REFS	289	371	DEFINED	286			
0	T	REAL	ARRAY	F.P.	REFS	23	126	181	183	252	283	349
					DEFINED	1						
2451	TAU	REAL			REFS	131	231	DEFINED	130	218		
2445	TCI	REAL			REFS	136	DEFINED	126				
0	TIME	REAL		F.P.	REFS	283	DEFINED	1				
0	URO	REAL		F.P.	REFS	113	196	DEFINED	1			
0	V	REAL	ARRAY	F.P.	REFS	23	113	185	196	223	224	225
					DEFINED	1						

FILE NAMES MODE

TAPE6	FMT	WRITES	249	250	251	252	367	369	371	374
		375	411	415						

EXTERNALS	TYPE	ARGS		REFERENCES					
CRIIP		7		283					
FCRNLn		6		295					
SQRT	REAL	1	LIBRARY	131	227	231	270	347	
STRAINX		7		136					
STRESSX		7		181	183	349			
TRANSF		44		113	196				

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES				
ABS	REAL	1	INTRIN	313	385	386	387	
AMAX1	REAL	0	INTRIN	388				

STATEMENT LABELS			DEF LINE	REFERENCES					
0	100		110	105	107				
0	110		139	124					
0	120		143	140	142				
320	130		155	103	138				
402	140		169	155	165				
0	150		186	176					
503	160		187	175					
504	170		192	406					
767	180		244	233					
1066	190		256	248					
1120	200		267	219					
1251	210		294	277					
1321	220		309	276	291	305			
1332	230		317	269					
1365	240		329	324					
1416	250		342	328					
1524	260		360	319					
1525	270		361	266	316	359			
1657	280		377	373					
0	290		381	379					
1730	300		393	378	380				
1735	310		395	214	242	265	314	358	389
0	320	INACTIVE	400	399					
0	330	INACTIVE	402	401					
0	340		405	402					
1771	350		410	2*401					
2000	360		418	145	2*399				
0	370		427	419					
2352	380	FMT	430	249					
2361	390	FMT	431	251					
2365	400	FMT	432	252					
2370	410	FMT	433	374					
2373	420	FMT	434	250	367	369	371	375	
2376	430	FMT	435	411					
2404	440	FMT	436	415					

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
23	100	I	105 110	228		NOT INNER	
27	100	J	107 110	138	OPT		
167	110	J	124 139	1068		EXT REFS	EXITS

LOOPS	LABEL	INDEX	FROM	TO	LENGTH	PROPERTIES		
277	120	J	140	143	15B		NOT INNER	
303	120	I	142	143	6B	INSTACK		
322	140	J	155	169	63B	OPT		
413	150	J	176	186	67B		EXT REFS	
623	310	J	214	395	1115B		EXT REFS	NOT INNER
1033		KO	252	252	11B		EXT REFS	
1046		KO	252	252	11B		EXT REFS	
1541		KO	367	367	11B		EXT REFS	
1562		KO	369	369	11B		EXT REFS	
1575		KO	369	369	13B		EXT REFS	
1643		KO	375	375	11B		EXT REFS	
1664	290	KO	379	381	7B	INSTACK	EXITS	
1752	340	J	402	405	15B	OPT		
2002	370	J	419	427	56B	OPT		

COMMON BLOCKS	LENGTH
PFCM12	39

STATISTICS

PROGRAM LENGTH	3114B	1612
SCM LABELED COMMON LENGTH	47B	39

140000B SCM USED

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      SUBROUTINE TRANSF (N1,N2,N3,N4,I,M2,M3,M4,M5,M6,FZ,DELTA,DELTEZ,UR TRNSF2     2
     +O,PC,PG,ALFDT,E,EPP2,EPS,DEPP,R,SIG,V,F1,F2,DD,U,W,AA,CC,EE,EI,FF, TRNSF2     3
     +LL,BB,GG,HH,MM,MN,NN,NA,NR,MNA)                                    TRNSF2     4
C                                                                         TRNSF2     5
      COMMON/PFCM12/          NPIN                                        TRNSF2     6
     +                       ,NPOUT       ,NP1          ,NP2            TRNSF2     7
     +                       ,NTSAVE      ,NDCHCS       ,NOLSGF         TRNSF2     8
     +                       ,NDEP        ,NSLOPE       ,NCOEF          TRNSF2     9
     +                       ,NDSIGF      ,NF1          ,NF2            TRNSF2    10
     +                       ,NEP2        ,NECRP2       ,NT2            TRNSF2    11
     +                       ,NTN         ,NE           ,NV             TRNSF2    12
     +                       ,NEPP2       ,NSTRTT       ,NALFDT         TRNSF2    13
     +                       ,NOLDPP      ,NNUDPP       ,NHH            TRNSF2    14
     +                       ,NNN         ,NMN          ,NBB            TRNSF2    15
     +                       ,NMM         ,NGG          ,NDD            TRNSF2    16
     +                       ,NW          ,NU           ,NEE            TRNSF2    17
     +                       ,NLL         ,NAA          ,NEI            TRNSF2    18
     +                       ,NCC         ,NFF                          TRNSF2    19
C                                                                         TRNSF2    20
      REAL    ALFDT(MNA,NR,3)     ,E(MNA,NR)          ,EPP2(MNA,NR,3)     TRNSF2    21
     +       ,EPS(MNA,NR,3)       ,DEPP(I,NR,3)       ,R(MNA,NR)          TRNSF2    22
     +       ,SIG(MNA,NR,3)       ,V(MNA,NR)          ,F1(I,NR)           TRNSF2    23
     +       ,F2(I,NR)           ,DD(NR,3)           ,U(NR,4)            TRNSF2    24
     +       ,W(NR,4)            ,AA(NR,3,3)         ,CC(NR,3,3)         TRNSF2    25
     +       ,EE(NR,3,3)         ,EI(NR,3,3)         ,FF(NR,3,3)         TRNSF2    26
     +       ,LL(NR,3,3)         ,BB(I,NR,3)         ,GG(I,NR,3)         TRNSF2    27
     +       ,HH(I,NR,3)         ,MM(I,NR,3)         ,MN(I,NR,3)         TRNSF2    28
     +       ,NN(I,NR,3)         ,PP(3,3)            ,PPI(3,3)           TRNSF2    29
     +       ,QQ(3)                                                        TRNSF2    30
C                                                                         TRNSF2    31
C     ***************************************************************** TRNSF2    32
C                                                                         TRNSF2    33
C     TRANSF IS CALLED FROM AXRACH AND SOLVES FOR GENERALIZED PLAIN       TRNSF2    34
C     STRAIN OF HOLLOW AND SOLID CYLINDERS IN THE ELASTIC CASE            TRNSF2    35
C                                                                         TRNSF2    36
C     ***************************************************************** TRNSF2    37
C     INPUT  ARGUMENTS                                                    TRNSF2    38
C     ***************************************************************** TRNSF2    39
C                                                                         TRNSF2    40
C     ALFDT  - THERMAL EXPANSION STRAIN ( RADIAL, HOOP, AND AXIAL )       TRNSF2    41
C     DELTA  -                                                            TRNSF2    42
C     DELTEZ -                                                            TRNSF2    43
C     DEPP   - INCREMENT OF PLASTIC STRAIN                                TRNSF2    44
C     E      - YOUNG'S MODULUS (PSIA,PASCALS)                             TRNSF2    45
C     ECREP2 - EFFECTIVE CREEP STRAINS                                    TRNSF2    46
C     EP2     - TIME INDEPENDENT EFFECTIVE PLASTIC STRAINS                TRNSF2    47
C     EPP2    - RADIAL, HOOP, AND AXIAL PLASTIC STRAIN                    TRNSF2    48
C     EPS    - RADIAL, HOOP, AND AXIAL STRAIN                             TRNSF2    49
C     FZ     -                                                            TRNSF2    50
C     I      - CURRENT AXIAL NODE NUMBER                                  TRNSF2    51
C     IQUIT  - TERMINATOR INDEX                                           TRNSF2    52
C     IT     - POWER-TIME STEP INDEX                                      TRNSF2    53
C     M2     - INSIDE RADIAL NODE NUMBER OF REGION UNDER CONSIDERATION    TRNSF2    54
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C   M3     - OUTSIDE RADIAL NODE NUMBER OF REGION UNDER CONSIDERATION    TRNSF2     55
C   M4     - INSIDE CLADDING RADIAL NODE NUMBER                          TRNSF2     56
C   M5     - NODE WHERE RADIAL CRACK STARTS                              TRNSF2     57
C   M6     - NODE WHERE AXIAL CRACK STARTS                               TRNSF2     58
C   NA     - NUMBER OF AXIAL NODES                                       TRNSF2     59
C   NDBG   - DEBUG INDEX                                                 TRNSF2     60
C   NR     - NUMBER OF RADIAL NODES                                      TRNSF2     61
C   N1     -                                                             TRNSF2     62
C   N2     -                                                             TRNSF2     63
C   N3     - INPUT UNITS INDEX, = 0  SI UNITS, = 1  BRITISH UNITS        TRNSF2     64
C   N4     -                                                             TRNSF2     65
C   PC     - COOLANT CHANNEL PRESSURE (PSIA,PASCALS)                     TRNSF2     66
C   PG     - ROD INTERNAL GAS PRESSURE (PSIA,PASCALS)                    TRNSF2     67
C   PI     - THE CONSTANT 3.1415726                                      TRNSF2     68
C   SIG    - RADIAL, HOOP, AND AXIAL STRESS (PSIA,PASCALS)               TRNSF2     69
C   R      - NODE POINT RADII (IN,M)                                     TRNSF2     70
C   T      - NODE POINT TEMPERATURES (F,K)                               TRNSF2     71
C   URO    -                                                             TRNSF2     72
C   V      - POISSON'S RATIO                                             TRNSF2     73
C                                                                        TRNSF2     74
C   ***************************************************************      TRNSF2     75
C   OUTPUT ARGUMENTS                                                     TRNSF2     76
C   ***************************************************************      TRNSF2     77
C                                                                        TRNSF2     78
C   AA     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     79
C   BB     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     80
C   CC     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     81
C   DD     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     82
C   EE     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     83
C   EI     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     84
C   FF     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     85
C   FI     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     86
C   F2     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     87
C   GG     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     88
C   HH     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     89
C   IFLAGI - HOLLOW FLAG  =0 WHEN FUEL IS HOLLOW, = 1 WHEN SOLID         TRNSF2     90
C   LL     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     91
C   MM     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     92
C   MN     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     93
C   NN     - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     94
C   U      - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     95
C   W      - TRANSFER MATRIX WORK ARRAY                                  TRNSF2     96
C                                                                        TRNSF2     97
C   ***************************************************************      TRNSF2     98
C                                                                        TRNSF2     99
C                                                                        TRNSF2    100
C                                                                        TRNSF2    101
      DET3(A11,A21,A31,A12,A22,A32,A13,A23,A33) = +(A11*A22*A33+A12*A23* TRNSF2    102
     +A31+A13*A32*A21)-(A31*A22*A13+A32*A23*A11+A33*A12*A21)             TRNSF2    103
C                                                                        TRNSF2    104
      PI = 3.1415926                                                     TRNSF2    105
      U1SUM = 0.0                                                        TRNSF2    106
      U2SUM = 0.0                                                        TRNSF2    107
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                U3SUM = 0.0                                                    TRNSF2   108
                U4SUM = 0.0                                                    TRNSF2   109
          C   FIRST COMPUTE ALL TRANSFER MATRICES                              TRNSF2   110
110             M3M1 = M3-1                                                    TRNSF2   111
                M4M1 = M4-1                                                    TRNSF2   112
                IFLAG1 = 0                                                     TRNSF2   113
                IF (R(I,M2).GE..00011.AND.N3.EQ.1) GO TO 110                   TRNSF2   114
                IF (N3.EQ.0) GO TO 100                                         TRNSF2   115
115             IFLAG1 = 1                                                     TRNSF2   116
                R(I,M2) = 1.0E-04                                              TRNSF2   117
                GO TO 110                                                      TRNSF2   118
          100   IF (R(I,M2).GE..2794E-05) GO TO 110                          TRNSF2   119
                IFLAG1 = 1                                                     TRNSF2   120
120             R(I,M2) = 2.54E-06                                             TRNSF2   121
          110   CONTINUE                                                       TRNSF2   122
                  DO 120 J=M2,M3M1                                             TRNSF2   123
                  IF (J.EQ.M4M1) GO TO 120                                     TRNSF2   124
                  R1 = R(I,J)                                                  TRNSF2   125
125               R2 = R(I,J+1)                                                TRNSF2   126
                  DR = R2-R1                                                   TRNSF2   127
                  D2R = R2*R2-R1*R1                                            TRNSF2   128
                  D3R = R2*R2*R2-R1*R1*R1                                      TRNSF2   129
                  F1(I,J) = 2.0*PI*(R2*D2R/2.0-D3R/3.0)/DR                     TRNSF2   130
130               F2(I,J) = 2.0*PI*(D3R/3.0-R1*D2R/2.0)/DR                     TRNSF2   131
                  V2 = V(I,J+1)                                                TRNSF2   132
                  V1 = V(I,J)                                                  TRNSF2   133
                  E2 = E(I,J+1)                                                TRNSF2   134
                  E1 = E(I,J)                                                  TRNSF2   135
135       C   ** COMPATIBILITY EQUATION                                        TRNSF2   136
                  EE(J,1,1) = -V2/(E2*DR)-(1.0+V2)/(2.0*E2*R2)                 TRNSF2   137
                  EE(J,1,2) = 1./(E2*DR)+(1.0+V2)/(2.0*E2*R2)                  TRNSF2   138
                  EE(J,1,3) = -V2/(E2*DR)                                      TRNSF2   139
                  FF(J,1,1) = -(V1/(E1*DR)-(1.0+V1)/(2.0*E1*R1))               TRNSF2   140
140               FF(J,1,2) = -(-1./(E1*DR)+(1.0+V1)/(2.0*E1*R1))              TRNSF2   141
                  FF(J,1,3) = -(V1/(E1*DR))                                    TRNSF2   142
                  JP = J+1                                                     TRNSF2   143
                  TT = (ALFDT(I,JP,2)+EPP2(I,JP,2))*(1./DR+0.5/R2)             TRNSF2   144
                  TT = TT+(ALFDT(I,J,2)+EPP2(I,J,2))*(-1./DR+0.5/R1)           TRNSF2   145
145               TT = TT+(ALFDT(I,JP,1)+EPP2(I,JP,1))*(-0.5/R2)               TRNSF2   146
                  TT = TT+(ALFDT(I,J,1)+EPP2(I,J,1))*(-0.5/R1)                 TRNSF2   147
                  GG(I,J,1) = -TT                                              TRNSF2   148
                  SS = DEPP(I,JP,2)*(1.0/DR+0.5/R2)                            TRNSF2   149
                  SS = SS+DEPP(I,J,2)*(-1.0/DR+0.5/R1)                         TRNSF2   150
150               SS = SS+DEPP(I,JP,1)*(-0.5/R2)                               TRNSF2   151
                  SS = SS+DEPP(I,J,1)*(-0.5/R1)                                TRNSF2   152
                  HH(I,J,1) = -SS                                              TRNSF2   153
          C   ***EQUILIBRIUM IN RADIAL DIRECTION                               TRNSF2   154
                  EE(J,2,1) = (1.0/DR+0.5/R2)                                  TRNSF2   155
155               EE(J,2,2) = -0.5/R2                                          TRNSF2   156
                  EE(J,2,3) = 0.0                                              TRNSF2   157
                  FF(J,2,1) = (1.0/DR-0.5/R1)                                  TRNSF2   158
                  FF(J,2,2) = 0.5/R1                                           TRNSF2   159
                  FF(J,2,3) = 0.0                                              TRNSF2   160
```

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                      GG(I,J,2) = 0.0                                                    TRNSF2   161
                      HH(I,J,2) = 0.0                                                    TRNSF2   162
                C     ***CONSTANT AXIAL STRAIN CONDITION                                 TRNSF2   163
                      EE(J,3,1) = -V2/E2                                                 TRNSF2   164
                C     CHECK THESE NEXT TWO CARDS----- THEY WERE DUPED WRONG MAYBE        TRNSF2   165
                      EE(J,3,2) = -V2/E2                                                 TRNSF2   166
                      EE(J,3,3) = 1.0/E2                                                 TRNSF2   167
                      FF(J,3,1) = -V1/E1                                                 TRNSF2   168
                      FF(J,3,2) = -V1/E1                                                 TRNSF2   169
                      FF(J,3,3) = 1.0/E1                                                 TRNSF2   170
                      GG(I,J,3) = -ALFDT(I,JP,3)-EPP2(I,JP,3)+ALFDT(I,J,3)+EPP2(I,J,     TRNSF2   171
                     +     3)                                                            TRNSF2   172
                      HH(I,J,3) = -DEPP(I,JP,3)+DEPP(I,J,3)                              TRNSF2   173
                      IF (NI.EQ.3) GG(I,J,3) = ALFDT(I,J,3)-ALFDT(I,JP,3)                TRNSF2   174
                      IF (NI.EQ.3) HH(I,J,3) = 0.0                                       TRNSF2   175
                C     ***INVERSION OF EE GOES HERE                                       TRNSF2   176
                      A11 = EE(J,1,1)                                                    TRNSF2   177
                      A12 = EE(J,1,2)                                                    TRNSF2   178
                      A13 = EE(J,1,3)                                                    TRNSF2   179
                      A21 = EE(J,2,1)                                                    TRNSF2   180
                      A22 = EE(J,2,2)                                                    TRNSF2   181
                      A23 = EE(J,2,3)                                                    TRNSF2   182
                      A31 = EE(J,3,1)                                                    TRNSF2   183
                      A32 = EE(J,3,2)                                                    TRNSF2   184
                      A33 = EE(J,3,3)                                                    TRNSF2   185
                      DENOM = DET3(A11,A21,A31,A12,A22,A32,A13,A23,A33)                  TRNSF2   186
                      V1 = 1.0                                                           TRNSF2   187
                      V2 = 0.0                                                           TRNSF2   188
                      V3 = 0.0                                                           TRNSF2   189
                      X1 = DET3(V1,V2,V3,A12,A22,A32,A13,A23,A33)/DENOM                  TRNSF2   190
                      X2 = DET3(A11,A21,A31,V1,V2,V3,A13,A23,A33)/DENOM                  TRNSF2   191
                      X3 = DET3(A11,A21,A31,A12,A22,A32,V1,V2,V3)/DENOM                  TRNSF2   192
                      E1(J,1,1) = X1                                                     TRNSF2   193
                      E1(J,2,1) = X2                                                     TRNSF2   194
                      E1(J,3,1) = X3                                                     TRNSF2   195
                      V1 = 0.0                                                           TRNSF2   196
                      V2 = 1.0                                                           TRNSF2   197
                      V3 = 0.0                                                           TRNSF2   198
                      X1 = DET3(V1,V2,V3,A12,A22,A32,A13,A23,A33)/DENOM                  TRNSF2   199
                      X2 = DET3(A11,A21,A31,V1,V2,V3,A13,A23,A33)/DENOM                  TRNSF2   200
                      X3 = DET3(A11,A21,A31,A12,A22,A32,V1,V2,V3)/DENOM                  TRNSF2   201
                      E1(J,1,2) = X1                                                     TRNSF2   202
                      E1(J,2,2) = X2                                                     TRNSF2   203
                      E1(J,3,2) = X3                                                     TRNSF2   204
                      V1 = 0.0                                                           TRNSF2   205
                      V2 = 0.0                                                           TRNSF2   206
                      V3 = 1.0                                                           TRNSF2   207
                      X1 = DET3(V1,V2,V3,A12,A22,A32,A13,A23,A33)/DENOM                  TRNSF2   208
                      X2 = DET3(A11,A21,A31,V1,V2,V3,A13,A23,A33)/DENOM                  TRNSF2   209
                      X3 = DET3(A11,A21,A31,A12,A22,A32,V1,V2,V3)/DENOM                  TRNSF2   210
                      E1(J,1,3) = X1                                                     TRNSF2   211
                      E1(J,2,3) = X2                                                     TRNSF2   212
                      E1(J,3,3) = X3                                                     TRNSF2   213
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                C                                                                  TRNSF2    214
                120       CONTINUE                                                 TRNSF2    215
215             C   ***COMPUTE TRANSFER MATICES HERE                               TRNSF2    216
                          DO 140 J=M2,M3M1                                         TRNSF2    217
                          IF (J.EQ.M4M1) GO TO 140                                 TRNSF2    218
                              DO 130 K=1,3                                         TRNSF2    219
                              MM(I,J,K) = 0.0                                      TRNSF2    220
220                               DO 130 M=1,3                                     TRNSF2    221
                                  MM(I,J,K) = MM(I,J,K)+EI(J,K,M)*GG(I,J,M)        TRNSF2    222
                                  LL(J,K,M) = 0.0                                  TRNSF2    223
                                      DO 130 L=1,3                                 TRNSF2    224
                                      LL(J,K,M) = LL(J,K,M)+EI(J,K,L)*FF(J,L,M)    TRNSF2    225
225             130                   CONTINUE                                     TRNSF2    226
                140       CONTINUE                                                 TRNSF2    227
                          DO 160 J=M2,M3M1                                         TRNSF2    228
                          IF (J.EQ.M4M1) GO TO 160                                 TRNSF2    229
                              DO 150 K=1,3                                         TRNSF2    230
230                           NN(I,J,K) = 0.0                                      TRNSF2    231
                                  DO 150 M=1,3                                     TRNSF2    232
                                  NN(I,J,K) = NN(I,J,K)+EI(J,K,M)*HH(I,J,M)        TRNSF2    233
                150                   CONTINUE                                     TRNSF2    234
                160       CONTINUE                                                 TRNSF2    235
235             C   ***ADD  MM AND NN  TO GET TRANSFER RELATION IN FORM             TRNSF2    236
                C                                                                  TRNSF2    237
                C   SIG(J+1) =  LL( ) SIG(J) + MN                                 TRNSF2    238
                C                                                                  TRNSF2    239
                          DO 180 J=M2,M3M1                                         TRNSF2    240
240                       IF (J.EQ.M4M1) GO TO 180                                 TRNSF2    241
                              DO 170 K=1,3                                         TRNSF2    242
                170           MN(I,J,K) = MM(I,J,K)+NN(I,J,K)                      TRNSF2    243
                180       CONTINUE                                                 TRNSF2    244
                C                                                                  TRNSF2    245
245             C                                                                  TRNSF2    246
                C   ***TRANSFER MATRICES FOR CRACKED ANNULI                        TRNSF2    247
                C   M5 IS NODE NUMBER WHERE RADIAL CRACK STARTS                    TRNSF2    248
                C                                                                  TRNSF2    249
                    IF (M5.EQ.0) GO TO 200                                         TRNSF2    250
250                 IF (M4.EQ.0) NON = M3-1                                        TRNSF2    251
                    IF (M4.NE.0) NON = M4-2                                        TRNSF2    252
                        DO 190 J=M5,NON                                            TRNSF2    253
                        LL(J,1,1) = R(I,J)/R(I,J+1)                                TRNSF2    254
                        LL(J,1,2) = 0.0                                            TRNSF2    255
255                     LL(J,1,3) = 0.0                                            TRNSF2    256
                        LL(J,2,1) = 0.0                                            TRNSF2    257
                        LL(J,2,2) = 0.0                                            TRNSF2    258
                        LL(J,2,3) = 0.0                                            TRNSF2    259
                        LL(J,3,1) = V(I,J+1)*R(I,J)/R(I,J+1)-V(I,J)*E(I,J+1)/E(I,J)  TRNSF2    260
260                     LL(J,3,2) = -V(I,J)*E(I,J+1)/E(I,J)                        TRNSF2    261
                        LL(J,3,3) = E(I,J+1)/E(I,J)                                TRNSF2    262
                        MN(I,J,1) = -(1.0-R(I,J)/R(I,J+1))*PG                      TRNSF2    263
                        MN(I,J,2) = -PG                                            TRNSF2    264
                        MN(I,J,3) = E(I,J+1)*(EPP2(I,J,3)+DEPP(I,J,3)+ALFDT(I,J,3)-EPP  TRNSF2    265
265                  +    2(I,J+1,3)-DEPP(I,J+1,3)-ALFDT(I,J+1,3))-V(I,J+1)*(-2.0+R(I,J)  TRNSF2    266
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     +    /R(I,J+1))*PG                                                                  TRNSF2   267
190       CONTINUE                                                                       TRNSF2   268
200    CONTINUE                                                                          TRNSF2   269
C   ***CALCULATION OF CRACKED RING DISPLACEMENT COEFF"S                                  TRNSF2   270
      IF (M5.EQ.0) GO TO 250                                                           TRNSF2   271
      IF (M4.EQ.0) NAN = M3                                                            TRNSF2   272
      IF (M4.NE.0) NAN = M4-1                                                          TRNSF2   273
         DO 210 J=M5,NAN                                                               TRNSF2   274
         E1 = E(I,J)                                                                   TRNSF2   275
         E2 = E(I,J+1)                                                                 TRNSF2   276
         E5 = E(I,M5)                                                                  TRNSF2   277
         V1 = V(I,J)                                                                   TRNSF2   278
         V2 = V(I,J+1)                                                                 TRNSF2   279
         V5 = V(I,M5)                                                                  TRNSF2   280
         R1 = R(I,J)                                                                   TRNSF2   281
         R2 = R(I,J+1)                                                                 TRNSF2   282
         R5 = R(I,M5)                                                                  TRNSF2   283
         W(J,1) = -V5*E1/E5+V1*R5/R1                                                   TRNSF2   284
         W(J,2) = -V5*E1/E5                                                            TRNSF2   285
         W(J,3) = E1/E5                                                                TRNSF2   286
         W(J,4) = E1*(ALFDT(I,M5,3)+EPP2(I,M5,3)+DEPP(I,M5,3))-V1*PG-V1                TRNSF2   287
     +    *PG*(1.0-R5/R1)-(ALFDT(I,J,3)+EPP2(I,J,3)+DEPP(I,J,3))*E1                     TRNSF2   288
         IF (J.NE.M5) GO TO 210                                                        TRNSF2   289
         W(J,1) = 0.0                                                                  TRNSF2   290
         W(J,2) = 0.0                                                                  TRNSF2   291
         W(J,3) = 1.0                                                                  TRNSF2   292
         W(J,4) = 0.0                                                                  TRNSF2   293
210      CONTINUE                                                                      TRNSF2   294
      IF (M4.NE.0) NON = M4-2                                                          TRNSF2   295
      IF (M4.EQ.0) NON = M3-1                                                          TRNSF2   296
         DO 230 J=M5,NON                                                               TRNSF2   297
         E1 = E(I,J)                                                                   TRNSF2   298
         E2 = E(I,J+1)                                                                 TRNSF2   299
         E5 = E(I,M5)                                                                  TRNSF2   300
         V1 = V(I,J)                                                                   TRNSF2   301
         V2 = V(I,J+1)                                                                 TRNSF2   302
         V5 = V(I,M5)                                                                  TRNSF2   303
         R1 = R(I,J)                                                                   TRNSF2   304
         R2 = R(I,J+1)                                                                 TRNSF2   305
         R5 = R(I,M5)                                                                  TRNSF2   306
         DR2 = 0.5*(R2-R1)                                                             TRNSF2   307
         IF (M6.NE.0.AND.J.LT.M6) GO TO 220                                            TRNSF2   308
C     RING CRACKED BOTH AXIALLY AND RADIALLY                                           TRNSF2   309
         U(J,1) = DR2*(R5/(R2*E2)+R5/(R1*E1))                                          TRNSF2   310
         U(J,2) = 0.0                                                                  TRNSF2   311
         U(J,3) = 0.0                                                                  TRNSF2   312
         U(J,4) = -PG*(1.0-R5/R2)/E2-PG*(1.0-R5/R1)/E1+2.0*V2*PG/E2+2.0                TRNSF2   313
     +    *V1*PG/E1+ALFDT(I,J,1)+EPP2(I,J,1)+DEPP(I,J,1)+ALFDT(I,J+1,1)+                TRNSF2   314
     +    EPP2(I,J+1,1)+DEPP(I,J+1,1)                                                   TRNSF2   315
         U(J,4) = U(J,4)*DR2                                                           TRNSF2   316
         GO TO 230                                                                     TRNSF2   317
220      CONTINUE                                                                      TRNSF2   318
C     RING CRACKED ONLY RADIALLY                                                       TRNSF2   319
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                  U(J,1) = R5/(E2*R2)+R5/(E1*R1)-V2*W(J+1,1)/E2-V1*W(J,1)/E1      TRNSF2    320
320               U(J,1) = U(J,1)*DR2                                            TRNSF2    321
                  U(J,2) = -V2*W(J+1,2)/E2-V1*W(J,2)/E1                          TRNSF2    322
                  U(J,2) = U(J,2)*DR2                                            TRNSF2    323
                  U(J,3) = -V2*W(J+1,3)/E2-V1*W(J,3)/E1                          TRNSF2    324
                  U(J,3) = U(J,3)*DR2                                            TRNSF2    325
325               U(J,4) = -PG*(1.0-R5/R2)/E2-PG*(1.0-R5/R1)/E1+V2*PG/E2+V1*PG/E TRNSF2    326
     +          1-V2*W(J+1,4)/E2-V1*W(J,4)/E1+ALFDT(I,J+1,1)+EPP2(I,J+1,1)+DEP  TRNSF2    327
     +          P(I,J+1,1)+ALFDT(I,J,1)+EPP2(I,J,1)+DEPP(I,J,1)                 TRNSF2    328
                  U(J,4) = U(J,4)*DR2                                            TRNSF2    329
            230   CONTINUE                                                       TRNSF2    330
330           U1SUM = 0.0                                                        TRNSF2    331
              U2SUM = 0.0                                                        TRNSF2    332
              U3SUM = 0.0                                                        TRNSF2    333
              U4SUM = 0.0                                                        TRNSF2    334
                  DO 240 J=M5,NON                                                TRNSF2    335
335               U1SUM = U1SUM+U(J,1)                                           TRNSF2    336
                  U2SUM = U2SUM+U(J,2)                                           TRNSF2    337
                  U3SUM = U3SUM+U(J,3)                                           TRNSF2    338
                  U4SUM = U4SUM+U(J,4)                                           TRNSF2    339
            240   CONTINUE                                                       TRNSF2    340
340         250 CONTINUE                                                         TRNSF2    341
            C                                                                    TRNSF2    342
            C                                                                    TRNSF2    343
            C   ***TRANSFER MATRICES ACROSS SURFACE OF DISCONTINUITY              TRNSF2    344
            C   M4 IS NODE NUMBER OF INSIDE OF CLADDING                         TRNSF2    345
345         C                                                                    TRNSF2    346
              IF (M4.EQ.0) GO TO 270                                             TRNSF2    347
              M4M1 = M4-1                                                        TRNSF2    348
            C   ZERO INTEGRATING ARRAYS                                         TRNSF2    349
              F1(1,M4M1) = 0.0                                                   TRNSF2    350
350           F2(1,M4M1) = 0.0                                                   TRNSF2    351
            C                                                                    TRNSF2    352
              IF (M5.NE.0) M4M1 = M5                                             TRNSF2    353
            C                                                                    TRNSF2    354
              E1 = E(I,M4M1)                                                     TRNSF2    355
355           E2 = E(I,M4)                                                       TRNSF2    356
              V1 = V(I,M4M1)                                                     TRNSF2    357
              V2 = V(I,M4)                                                       TRNSF2    358
              R1 = R(I,M4M1)                                                     TRNSF2    359
              R2 = R(I,M4)                                                       TRNSF2    360
360           R3 = R(I,M4-1)                                                     TRNSF2    361
            C   ** FILL TRANSFER ARRAYS AT INTERFACE "ANNULUS"                   TRNSF2    362
              PP(1,1) = -V1*R1/(E1*R2)+U1SUM/R2                                  TRNSF2    363
              PP(1,2) = R1/(E1*R2)+U2SUM/R2                                      TRNSF2    364
              PP(1,3) = -V1*R1/(E1*R2)+U3SUM/R2                                  TRNSF2    365
365           PP(2,1) = -V1/E1                                                   TRNSF2    366
              PP(2,2) = -V1/E1                                                   TRNSF2    367
              PP(2,3) = 1.0/E1                                                   TRNSF2    368
              PP(3,1) = R1/(R3*E2)                                               TRNSF2    369
              PP(3,2) = 0.0                                                      TRNSF2    370
370           PP(3,3) = 0.0                                                      TRNSF2    371
              QQ(I) = -(ALFDT(I,M4,2)+EPP2(I,M4,2)+DEPP(I,M4,2))+R1*(ALFDT(I,M4M TRNSF2    372
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```
     +I,2)+EPP2(I,M4MI,2)+DEPP(I,M4MI,2))/R2-DELTA/R2+U4SUM/R2                  TRNSF2   373
      QQ(2) = -(ALFDT(I,M4,3)+EPP2(I,M4,3)+DEPP(I,M4,3))+(ALFDT(I,M4MI,3       TRNSF2   374
     +)+EPP2(I,M4MI,3)+DEPP(I,M4MI,3))-DELTEZ                                  TRNSF2   375
375   QQ(3) = -PG*(1.0-R1/R3)/E2                                                TRNSF2   376
      DEN = E2/(1.0-V2*V2)                                                      TRNSF2   377
      PPI(1,1) = 0.0                                                            TRNSF2   378
      PPI(1,2) = 0.0                                                            TRNSF2   379
      PPI(1,3) = (1.0-V2*V2)*DEN                                                TRNSF2   380
380   PPI(2,1) = DEN                                                            TRNSF2   381
      PPI(2,2) = V2*DEN                                                         TRNSF2   382
      PPI(2,3) = V2*(1.0+V2)*DEN                                                TRNSF2   383
      PPI(3,1) = V2*DEN                                                         TRNSF2   384
      PPI(3,2) = DEN                                                            TRNSF2   385
385   PPI(3,3) = PPI(2,3)                                                       TRNSF2   386
      M4MI = M4-1                                                               TRNSF2   387
          DO 260 L=1,3                                                          TRNSF2   388
          MN(I,M4MI,L) = 0.0                                                    TRNSF2   389
              DO 260 M=1,3                                                      TRNSF2   390
390           LL(M4MI,L,M) = 0.0                                                TRNSF2   391
              MN(I,M4MI,L) = MN(I,M4MI,L)+PPI(L,M)*QQ(M)                        TRNSF2   392
                  DO 260 K=1,3                                                  TRNSF2   393
                  LL(M4MI,L,M) = LL(M4MI,L,M)+PPI(L,K)*PP(K,M)                  TRNSF2   394
260               CONTINUE                                                      TRNSF2   395
395   270   CONTINUE                                                            TRNSF2   396
C     ** SWEEP ACROSS CYLINDER TO GET RECURRENCE RELATION OF THE FORM           TRNSF2   397
C                                                                               TRNSF2   398
C     SIG(M3) = AA(M3-1)*SIG(M2) + BB(M3-1)                                     TRNSF2   399
C                                                                               TRNSF2   400
400         DO 280 K=1,3                                                        TRNSF2   401
            BB(I,M2,K) = MN(I,M2,K)                                             TRNSF2   402
                DO 280 M=1,3                                                    TRNSF2   403
280             AA(M2,K,M) = LL(M2,K,M)                                         TRNSF2   404
      M2P1 = M2+1                                                               TRNSF2   405
405   IF (M3.EQ.M2P1) GO TO 340                                                 TRNSF2   406
          DO 330 J=M2P1,M3M1                                                    TRNSF2   407
          JKJ = J-1                                                             TRNSF2   408
          IF (M5.EQ.0) GO TO 290                                                TRNSF2   409
          IF (M4.NE.0.AND.J.EQ.M4MI) JKJ = M5-1                                 TRNSF2   410
410       CONTINUE                                                              TRNSF2   411
290           DO 320 K=1,3                                                      TRNSF2   412
              BB(I,J,K) = 0.0                                                   TRNSF2   413
                  DO 300 L=1,3                                                  TRNSF2   414
300               BB(I,J,K) = BB(I,J,K)+LL(J,K,L)*BB(I,JKJ,L)                   TRNSF2   415
415           BB(I,J,K) = BB(I,J,K)+MN(I,J,K)                                   TRNSF2   416
                  DO 320 M=1,3                                                  TRNSF2   417
                  AA(J,K,M) = 0.0                                               TRNSF2   418
                      DO 310 L=1,3                                              TRNSF2   419
310                   AA(J,K,M) = AA(J,K,M)+LL(J,K,L)*AA(JKJ,L,M)               TRNSF2   420
420   320             CONTINUE                                                  TRNSF2   421
330       CONTINUE                                                            TRNSF2   422
340   CONTINUE                                                                TRNSF2   423
C                                                                             TRNSF2   424
C                                                                             TRNSF2   425
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      C   ** AXIAL FORCE BOUNDARY CONDITION                                    TRNSF2   426
      C   AXIAL CRACK STARTS AT NODE M6                                        TRNSF2   427
      C                                                                        TRNSF2   428
            DO 350 K=1,3                                                       TRNSF2   429
            DD(I,K) = F1(I,M2)*BB(I,M2,K)                                      TRNSF2   430
              DO 350 M=1,3                                                     TRNSF2   431
  350         CC(I,K,M) = F2(I,M2)*AA(M2,K,M)                                  TRNSF2   432
          CC(I,1,1) = CC(I,1,1)+F1(I,M2)                                       TRNSF2   433
          CC(I,2,2) = CC(I,2,2)+F1(I,M2)                                       TRNSF2   434
          CC(I,3,3) = CC(I,3,3)+F1(I,M2)                                       TRNSF2   435
          IF (M2P1.GT.M3M1) GO TO 400                                          TRNSF2   436
            DO 390 J=M2P1,M3M1                                                 TRNSF2   437
            K = 3                                                              TRNSF2   438
            IF (M6.EQ.0) GO TO 360                                             TRNSF2   439
            IF (M4.EQ.0) NON = M3-1                                            TRNSF2   440
            IF (M4.NE.0) NON = M4-2                                            TRNSF2   441
            IF (J.GE.M6.AND.J.LE.NON) GO TO 380                                TRNSF2   442
  360       CONTINUE                                                           TRNSF2   443
              DO 370 M=1,3                                                     TRNSF2   444
              CC(I,K,M) = CC(I,K,M)+F1(I,J)*AA(J-1,K,M)+F2(I,J)*AA(J,K,M       TRNSF2   445
     +        )                                                                TRNSF2   446
  370         CONTINUE                                                         TRNSF2   447
            DD(I,K) = DD(I,K)+F1(I,J)*BB(I,J-1,K)+F2(I,J)*BB(I,J,K)            TRNSF2   448
            GO TO 390                                                          TRNSF2   449
  380       CONTINUE                                                           TRNSF2   450
            DD(I,K) = DD(I,K)-PG*PI*(R(I,J+1)**2-R(I,J)**2)                    TRNSF2   451
  390       CONTINUE                                                           TRNSF2   452
  400   CONTINUE                                                             TRNSF2   453
      C   ** SET UP THREE SIMULTANEOUS EQUATIONS                              TRNSF2   454
          A11 = AA(M3M1,1,1)                                                   TRNSF2   455
          A12 = AA(M3M1,1,2)                                                   TRNSF2   456
          A13 = AA(M3M1,1,3)                                                   TRNSF2   457
          V1 = -PC-BB(I,M3M1,1)                                                TRNSF2   458
          A21 = 1.0                                                            TRNSF2   459
          A22 = 0.0                                                            TRNSF2   460
          IF (IFLAG1.EQ.1) A22 = -1.0                                          TRNSF2   461
          A23 = 0.0                                                            TRNSF2   462
          V2 = -FG                                                             TRNSF2   463
          IF (IFLAG1.EQ.1) V2 = 0.0                                            TRNSF2   464
          A31 = CC(I,3,1)                                                      TRNSF2   465
          A32 = CC(I,3,2)                                                      TRNSF2   466
          A33 = CC(I,3,3)                                                      TRNSF2   467
          V3 = FZ-DD(I,3)                                                      TRNSF2   468
          DENOM = DET3(A11,A21,A31,A12,A22,A32,A13,A23,A33)                    TRNSF2   469
          X1 = DET3(V1,V2,V3,A12,A22,A32,A13,A23,A33)/DENOM                    TRNSF2   470
          X2 = DET3(A11,A21,A31,V1,V2,V3,A13,A23,A33)/DENOM                    TRNSF2   471
          X3 = DET3(A11,A21,A31,A12,A22,A32,V1,V2,V3)/DENOM                    TRNSF2   472
          SIG(I,M2,1) = X1                                                     TRNSF2   473
          SIG(I,M2,2) = X2                                                     TRNSF2   474
          SIG(I,M2,3) = X3                                                     TRNSF2   475
          J = M2                                                               TRNSF2   476
          EPS(I,J,1) = (SIG(I,J,1)-V(I,J)*(SIG(I,J,2)+SIG(I,J,3)))/E(I,J)+EP   TRNSF2   477
         +P2(I,J,1)+DEPP(I,J,1)+ALFDT(I,J)                                     TRNSF2   478
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                EPS(I,J,2) = (SIG(I,J,2)-V(I,J)*(SIG(I,J,1)+SIG(I,J,3)))/E(I,J)+EP TRNSF2    479
               +P2(I,J,2)+DEPP(I,J,2)+ALFDT(I,J,2)                                 TRNSF2    480
480            EPS(I,J,3) = (SIG(I,J,3)-V(I,J)*(SIG(I,J,2)+SIG(I,J,1)))/E(I,J)+EP TRNSF2    481
               +P2(I,J,3)+DEPP(I,J,3)+ALFDT(I,J,3)                                 TRNSF2    482
      C     ** GET STRESSES AT EACH NODE                                           TRNSF2    483
                DO 430 J=M2P1,M3                                                    TRNSF2    484
                   DO 420 K=1,3                                                     TRNSF2    485
485                SIG(I,J,K) = 0.0                                                 TRNSF2    486
                      DO 410 L=1,3                                                  TRNSF2    487
      410             SIG(I,J,K) = SIG(I,J,K)+AA(J-1,K,L)*SIG(I,M2,L)               TRNSF2    488
                   SIG(I,J,K) = SIG(I,J,K)+BB(I,J-1,K)                              TRNSF2    489
      420          CONTINUE                                                         TRNSF2    490
490             EPS(I,J,1) = (SIG(I,J,1)-V(I,J)*(SIG(I,J,2)+SIG(I,J,3)))/E(I,J   TRNSF2    491
          +     )+EPP2(I,J,1)+DEPP(I,J,1)+ALFDT(I,J,1)                           TRNSF2    492
                EPS(I,J,2) = (SIG(I,J,2)-V(I,J)*(SIG(I,J,1)+SIG(I,J,3)))/E(I,J   TRNSF2    493
          +     )+EPP2(I,J,2)+DEPP(I,J,2)+ALFDT(I,J,2)                           TRNSF2    494
                EPS(I,J,3) = (SIG(I,J,3)-V(I,J)*(SIG(I,J,2)+SIG(I,J,1)))/E(I,J   TRNSF2    495
495       +     )+EPP2(I,J,3)+DEPP(I,J,3)+ALFDT(I,J,3)                           TRNSF2    496
      430       CONTINUE                                                         TRNSF2    497
                IF (M6.EQ.0) GO TO 450                                           TRNSF2    498
                IF (M4.EQ.0) NON = M3                                            TRNSF2    499
                IF (M4.NE.0) NON = M4-1                                          TRNSF2    500
500             N6 = M6+1                                                        TRNSF2    501
                   DO 440 J=N6,NON                                               TRNSF2    502
                   SIG(I,J,3) = -PG                                              TRNSF2    503
      440          CONTINUE                                                      TRNSF2    504
      450       CONTINUE                                                         TRNSF2    505
505             IF (M5.NE.0) URO = R(I,M5)*EPS(I,M5,2)+U1SUM*SIG(I,M5,1)+U2SUM*SIG TRNSF2    506
               +(I,M5,2)+U3SUM*SIG(I,M5,3)+U4SUM                                 TRNSF2    507
                IF (M5.EQ.0) URO = R(I,M3)*EPS(I,M3,2)                           TRNSF2    508
      C     WRITE(6,115) URO                                                     TRNSF2    509
                RETURN                                                           TRNSF2    510
510   C                                                                          TRNSF2    511
                END                                                              TRNSF2    512
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	TRANSF	1	509

VARIABLES

		SN	TYPE		RELOCATION							
0	AA		REAL	ARRAY	F.P.	REFS	20	2*419	431	2*444	454	455	456
						487	DEFINED	1	403	417	419		
0	ALFDT		REAL	ARRAY	F.P.	REFS	20	143	144	145	146	2*170	2*173
						2*264	2*286	2*312	2*325	2*371	2*373	476	478
						480	490	492	494	DEFINED	1		
3555	A11		REAL			REFS	2*185	2*190	2*191	2*199	2*200	2*208	2*209
						2*468	2*470	2*471	DEFINED	176	454		
3556	A12		REAL			REFS	2*185	2*189	2*191	2*198	2*200	2*207	2*209

VARIABLES	SN	TYPE	RELOCATION									
					2*468	2*469	2*471	DEFINED	177	455		
3557	A13	REAL			REFS	2*185	2*189	2*190	2*198	2*199	2*207	2*208
					2*468	2*469	2*470	DEFINED	178	456		
3560	A21	REAL			REFS	2*185	2*190	2*191	2*199	2*200	2*208	2*209
					2*468	2*470	2*471	DEFINED	179	458		
3561	A22	REAL			REFS	2*185	2*189	2*191	2*198	2*200	2*207	2*209
					2*468	2*469	2*471	DEFINED	180	459	460	
3562	A23	REAL			REFS	2*185	2*189	2*190	2*198	2*199	2*207	2*208
					2*468	2*469	2*470	DEFINED	181	461		
3563	A31	REAL			REFS	2*185	2*190	2*191	2*199	2*200	2*208	2*209
					2*468	2*470	2*471	DEFINED	182	464		
3564	A32	REAL			REFS	2*185	2*189	2*191	2*198	2*200	2*207	2*209
					2*468	2*469	2*471	DEFINED	183	465		
3565	A33	REAL			REFS	2*185	2*189	2*190	2*198	2*199	2*207	2*208
					2*468	2*469	2*470	DEFINED	184	466		
0	BB	REAL	ARRAY	F.P.	REFS	20	2*414	415	429	2*447	457	488
					DEFINED	1	401	412	414	415		
0	CC	REAL	ARRAY	F.P.	REFS	20	432	433	434	444	464	465
					466	DEFINED	1	431	432	433	434	444
0	DD	REAL	ARRAY	F.P.	REFS	20	447	450	467	DEFINED	1	429
					447	450						
0	DELTA	REAL		F.P.	REFS	371	DEFINED	1				
0	DELTEZ	REAL		F.P.	REFS	373	DEFINED	1				
3605	DEN	REAL			REFS	379	380	381	382	383	384	
					DEFINED	376						
3566	DENOM	REAL			REFS	189	190	191	198	199	200	207
					208	209	469	470	471	DEFINED	185	468
0	DEPP	REAL	ARRAY	F.P.	REFS	20	148	149	150	151	2*172	2*264
					2*286	2*312	2*325	2*371	2*373	476	478	480
					490	492	494	DEFINED	1			
3543	DR	REAL			REFS	129	130	136	137	138	139	140
					141	143	144	148	149	154	157	
					DEFINED	126						
3603	DR2	REAL			REFS	309	315	320	322	324	328	
					DEFINED	306						
3544	D2R	REAL			REFS	129	130	DEFINED	127			
3545	D3R	REAL			REFS	129	130	DEFINED	128			
0	E	REAL	ARRAY	F.P.	REFS	20	133	134	2*259	2*260	2*261	264
					274	275	276	297	298	299	354	355
					476	478	480	490	492	494		
					DEFINED	1						
0	EE	REAL	ARRAY	F.P.	REFS	20	176	177	178	179	180	181
					182	183	184	DEFINED	1	136	137	138
					154	155	156	163	165	166		
0	EI	REAL	ARRAY	F.P.	REFS	20	221	224	232	DEFINED	1	192
					193	194	201	202	203	210	211	212
0	EPP2	REAL	ARRAY	F.P.	REFS	20	143	144	145	146	2*170	2*264
					2*286	2*312	2*325	2*371	2*373	476	478	480
					490	492	494	DEFINED	1			
0	EPS	REAL	ARRAY	F.P.	REFS	20	505	507	DEFINED	1	476	478
					480	490	492	494				
3551	EI	REAL			REFS	2*139	2*140	141	167	168	169	283
					284	285	2*286	309	2*312	2*319	321	323

VARIABLES	SN	TYPE	RELOCATION								
					3*325	362	363	364	365	366	367	
					DEFINED	134	274	297	354			
3550	E2	REAL			REFS	2*136	2*137	138	163	165	166	309
					2*312	2*319	321	323	3*325	368	375	376
					DEFINED	133	275	298	355			
3600	E5	REAL			REFS	283	284	285	DEFINED	276	299	
0	FF	REAL	ARRAY	F.P.	REFS	20	224	DEFINED	1	139	140	141
					157	158	159	167	168	169		
0	FZ	REAL		F.P.	REFS	467	DEFINED	1				
0	FI	REAL	ARRAY	F.P.	REFS	20	432	433	434	444	447	
					DEFINED	1	129	349				
0	F2	REAL	ARRAY	F.P.	REFS	20	429	431	444	447		
					DEFINED	1	130	350				
0	GG	REAL	ARRAY	F.P.	REFS	20	221	DEFINED	1	147	160	170
					173							
0	HH	REAL	ARRAY	F.P.	REFS	20	232	DEFINED	1	152	161	172
					174							
0	I	INTEGER		F.P.	REFS	113	116	118	120	124	125	131
					132	133	134	2*143	2*144	2*145	2*146	4*170
					2*173	2*253	6*259	3*260	2*261	2*262	8*264	274
					275	276	277	278	279	280	281	282
					4*286	297	298	299	300	301	302	303
					304	305	4*312	4*325	354	355	356	357
					358	359	360	4*371	4*373	429	431	2*432
					2*433	2*434	2*444	2*447	4*450	464	465	466
					467	472	473	474	8*476	8*478	8*480	485
					3*487	2*488	8*490	8*492	8*494	502	5*505	2*507
					DEFINED	1						
3537	IFLAGI	INTEGER			REFS	460	463	DEFINED	112	115	119	
3540	J	INTEGER			REFS	123	124	125	129	130	131	132
					133	134	136	137	138	139	140	141
					142	2*144	2*146	147	149	151	152	154
					155	156	157	158	159	160	161	163
					165	166	167	168	169	3*170	2*172	2*173
					174	176	177	178	179	180	181	182
					183	184	192	193	194	201	202	203
					210	211	212	217	219	4*221	222	4*224
					228	230	4*232	240	3*242	3*253	254	255
					256	257	258	7*259	4*260	3*261	3*262	263
					11*264	274	275	277	278	280	281	283
					284	285	4*286	288	289	290	291	292
					297	298	300	301	303	304	307	309
					310	311	7*312	2*315	3*319	2*320	3*321	2*322
					3*323	2*324	9*325	2*328	335	336	337	338
					407	409	412	3*414	3*415	417	3*419	2*441
					4*444	4*447	2*450	9*476	9*478	9*480	485	3*487
					3*488	9*490	9*492	9*494	502	DEFINED	122	216
					227	239	252	273	296	334	406	436
					475	483	501					
3607	JKJ	INTEGER			REFS	414	419	DEFINED	407	409		
3552	JP	INTEGER			REFS	2*143	2*145	148	150	2*170	172	173
					DEFINED	142						
3573	K	INTEGER			REFS	219	3*221	222	3*224	230	3*232	3*242

VARIABLES	SN	TYPE			RELOCATION							
						2*393	2*401	2*403	412	3*414	3*415	417	3*419
						2*429	2*431	4*444	4*447	2*450	485	3*487	3*488
					DEFINED	218	229	241	392	400	411	428	
						437	484						
3575	L	INTEGER			REFS	2*224	388	390	3*391	3*393	2*414	2*419	
					2*487	DEFINED	223	387	413	418	486		
0	LL	REAL	ARRAY	F.P.	REFS	20	224	393	403	414	419		
					DEFINED	1	222	224	253	254	255	256	
					257	258	259	260	261	390	393		
3574	M	INTEGER			REFS	2*221	222	3*224	2*232	390	2*391	3*393	
					2*403	417	3*419	2*431	4*444	DEFINED	220	231	
					389	402	416	430	443				
0	MM	REAL	ARRAY	F.P.	REFS	20	221	242	DEFINED	1	219	221	
0	MN	REAL	ARRAY	F.P.	REFS	20	391	401	415	DEFINED	1	242	
					262	263	264	388	391				
0	MNA	INTEGER		F.P.	REFS	7*20	DEFINED	1					
0	M2	INTEGER		F.P.	REFS	113	116	118	120	122	216	227	
					239	2*401	2*403	404	2*429	2*431	432	433	
					434	472	473	474	475	487			
					DEFINED	1							
3606	M2P1	INTEGER			REFS	405	406	435	436	483			
					DEFINED	404							
0	M3	INTEGER		F.P.	REFS	110	250	271	295	405	439	483	
					498	2*507	DEFINED	1					
3535	M3M1	INTEGER			REFS	122	216	227	239	406	435	436	
					454	455	456	457	DEFINED	110			
0	M4	INTEGER		F.P.	REFS	111	250	2*251	271	2*272	2*294	295	
					346	347	355	357	359	360	3*371	3*373	
					386	409	439	2*440	498	2*499			
					DEFINED	1							
3536	M4M1	INTEGER			REFS	123	217	228	240	349	350	354	
					356	358	3*371	3*373	388	390	2*391	2*393	
					409	DEFINED	111	347	352	386			
0	M5	INTEGER		F.P.	REFS	249	252	270	273	276	279	282	
					3*286	288	296	299	302	305	334	2*352	
					408	409	6*505	507	DEFINED	1			
0	M6	INTEGER		F.P.	REFS	2*307	438	441	497	500			
					DEFINED	1							
0	NA	INTEGER	*UNUSED	F.P.	DEFINED	1							
43	NAA	INTEGER		PFCMI2	REFS	5							
25	NALFDT	INTEGER		PFCMI2	REFS	5							
3577	NAN	INTEGER			REFS	273	DEFINED	271	272				
33	NBB	INTEGER		PFCMI2	REFS	5							
45	NCC	INTEGER		PFCMI2	REFS	5							
11	NCOEF	INTEGER		PFCMI2	REFS	5							
5	NDCHCK	INTEGER		PFCMI2	REFS	5							
36	NDD	INTEGER		PFCMI2	REFS	5							
7	NDEP	INTEGER		PFCMI2	REFS	5							
12	NDSIGF	INTEGER		PFCMI2	REFS	5							
21	NE	INTEGER		PFCMI2	REFS	5							
16	NELRP2	INTEGER		PFCMI2	REFS	5							
41	NEE	INTEGER		PFCMI2	REFS	5							
44	NEI	INTEGER		PFCMI2	REFS	5							

VARIABLES	SN	TYPE		RELOCATION								
23	NEPP2	INTEGER		PFCMI2	REFS	5						
15	NEP2	INTEGER		PFCMI2	REFS	5						
46	NFF	INTEGER		PFCMI2	REFS	5						
13	NFI	INTEGER		PFCMI2	REFS	5						
14	NF2	INTEGER		PFCMI2	REFS	5						
35	NGG	INTEGER		PFCMI2	REFS	5						
30	NHH	INTEGER		PFCMI2	REFS	5						
42	NLL	INTEGER		PFCMI2	REFS	5						
34	NMM	INTEGER		PFCMI2	REFS	5						
32	NMN	INTEGER		PFCMI2	REFS	5						
0	NN	REAL	ARRAY	F.P.	REFS	20	232	242	DEFINED	1	230	232
31	NNN	INTEGER		PFCMI2	REFS	5						
27	NNUDPP	INTEGER		PFCMI2	REFS	5						
26	NOLDPP	INTEGER		PFCMI2	REFS	5						
6	NOLSGF	INTEGER		PFCMI2	REFS	5						
3576	NON	INTEGER			REFS	252	296	334	441	501		
					DEFINED	250	251	294	295	439	440	498
					499							
0	NPIN	INTEGER		PFCMI2	REFS	5						
1	NPOUT	INTEGER		PFCMI2	REFS	5						
2	NPI	INTEGER		PFCMI2	REFS	5						
3	NP2	INTEGER		PFCMI2	REFS	5						
0	NR	INTEGER		F.P.	REFS	25*20	DEFINED	1				
10	NSLOPE	INTEGER		PFCMI2	REFS	5						
24	NSTRTT	INTEGER		PFCMI2	REFS	5						
20	NTN	INTEGER		PFCMI2	REFS	5						
4	NTSAVE	INTEGER		PFCMI2	REFS	5						
17	NT2	INTEGER		PFCMI2	REFS	5						
40	NU	INTEGER		PFCMI2	REFS	5						
22	NV	INTEGER		PFCMI2	REFS	5						
37	NW	INTEGER		PFCMI2	REFS	5						
0	N1	INTEGER		F.P.	REFS	173	174	DEFINED	1			
0	N2	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	N3	INTEGER		F.P.	REFS	113	114	DEFINED	1			
0	N4	INTEGER	*UNUSED	F.P.	DEFINED	1						
3610	N6	INTEGER			REFS	501	DEFINED	500				
0	PC	REAL		F.P.	REFS	457	DEFINED	1				
0	PG	REAL		F.P.	REFS	262	263	264	2*286	4*312	4*325	375
					450	462	502	DEFINED	1			
3530	PI	REAL			REFS	129	130	450	DEFINED	104		
3611	PP	REAL	ARRAY		REFS	20	393	DEFINED	362	363	364	365
					366	367	368	369	370			
3622	PPI	REAL	ARRAY		REFS	20	385	391	393	DEFINED	377	378
					379	380	381	382	383	384	385	
3633	QQ	REAL	ARRAY		REFS	20	391	DEFINED	371	373	375	
0	R	REAL	ARRAY	F.P.	REFS	20	113	118	124	125	2*253	2*259
					2*262	2*264	280	281	282	303	304	305
					358	359	360	2*450	505	507		
					DEFINED	1	116	120				
3541	RI	REAL			REFS	126	2*127	3*128	130	139	140	144
					146	149	151	157	158	283	286	306
					309	312	319	325	362	363	364	368
					371	375	DEFINED	124	280	303	358	

VARIABLES	SN	TYPE	RELOCATION									
3542	R2	REAL			REFS	126	2*127	3*128	129	136	137	143
						145	148	150	154	155	306	309	312
						319	325	2*362	2*363	2*364	3*371		
					DEFINED	125	281	304	359				
3604	R3	REAL			REFS	368	375	DEFINED	360				
3602	R5	REAL			REFS	283	286	2*309	2*312	2*319	2*325		
					DEFINED	282	305						
0	SIG	REAL	ARRAY	F.P.	REFS	20	3*476	3*478	3*480	2*487	488	3*490	
						3*492	3*494	3*505	DEFINED	1	472	473	474
						485	487	488	502				
3554	SS	REAL			REFS	149	150	151	152	DEFINED	148	149	
						150	151						
3553	TT	REAL			REFS	144	145	146	147	DEFINED	143	144	
						145	146						
0	U	REAL	ARRAY	F.P.	REFS	20	315	320	322	324	328	335	
						336	337	338	DEFINED	1	309	310	311
						312	315	319	320	321	322	323	324
						325	328						
0	URO	REAL		F.P.	DEFINED	1	505	507					
3531	U1SUM	REAL			REFS	335	362	505	DEFINED	105	330	335	
3532	U2SUM	REAL			REFS	336	363	505	DEFINED	106	331	336	
3533	U3SUM	REAL			REFS	337	364	505	DEFINED	107	332	337	
3534	U4SUM	REAL			REFS	338	371	505	DEFINED	108	333	338	
0	V	REAL	ARRAY	F.P.	REFS	20	131	132	2*259	260	264	277	
						278	279	300	301	302	356	357	476
						478	480	490	492	494	DEFINED	1	
3547	V1	REAL			REFS	2*139	140	141	167	168	2*189	2*190	
						2*191	2*198	2*199	2*200	2*207	2*208	2*209	283
						2*286	312	319	321	323	2*325	362	364
						365	366	2*469	2*470	2*471	DEFINED	132	186
						195	204	277	300	356	457		
3546	V2	REAL			REFS	2*136	137	138	163	165	2*189	2*190	
						2*191	2*198	2*199	2*200	2*207	2*208	2*209	312
						319	321	323	2*325	2*376	2*379	381	2*382
						383	2*469	2*470	2*471	DEFINED	131	187	196
						205	278	301	357	462	463		
3567	V3	REAL			REFS	2*189	2*190	2*191	2*198	2*199	2*200	2*207	
						2*208	2*209	2*469	2*470	2*471	DEFINED	188	197
						206	467						
3601	V5	REAL			REFS	283	284	DEFINED	279	302			
0	W	REAL	ARRAY	F.P.	REFS	20	2*319	2*321	2*323	2*325			
					DEFINED	1	283	284	285	286	289	290	
						291	292						
3570	X1	REAL			REFS	192	201	210	472	DEFINED	189	198	
						207	469						
3571	X2	REAL			REFS	193	202	211	473	DEFINED	190	199	
						208	470						
3572	X3	REAL			REFS	194	203	212	474	DEFINED	191	200	
						209	471						

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES							
DET3	REAL	9	SF	101	185	189	190	191	198	199	200	207
					208	209	468	469	470	471		

STATEMENT LABELS		DEF LINE	REFERENCES			
63	100	118	114			
102	110	121	113	117	118	
1107	120	214	122	123		
0	130	225	218	220	223	
1174	140	226	216	217		
0	150	233	229	231		
1234	160	234	227	228		
0	170	242	241			
1256	180	243	239	240		
0	190	267	252			
1416	200	268	249			
1571	210	293	273	288		
1741	220	317	307			
2054	230	329	296	316		
0	240	339	334			
2115	250	340	270			
0	260	394	387	389	392	
2435	270	395	346			
0	280	403	400	402		
2506	290	410	408			
0	300	414	413			
0	310	419	418			
0	320	420	411	416		
0	330	421	406			
2600	340	422	405			
0	350	431	428	430		
2703	360	442	438			
0	370	446	443			
2736	380	449	441			
2751	390	451	436	448		
2755	400	452	435			
0	410	487	486			
0	420	489	484			
0	430	496	483			
0	440	503	501			
3453	450	504	497			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
104	120	J	122 214	1006B	OPT
1114	140	J	216 226	63B	NOT INNER
1121	130	K	218 225	52B	NOT INNER
1127	130	M	220 225	41B	NOT INNER
1150	130	L	223 225	15B	OPT
1201	160	J	227 234	36B	NOT INNER
1206	150	K	229 233	25B	NOT INNER
1214	150	M	231 233	14B	OPT
1241	180	J	239 243	20B	NOT INNER
1246	170	K	241 242	7B	INSTACK
1275	190	J	252 267	120B	OPT
1432	210	J	273 293	142B	OPT
1606	230	J	296 329	251B	OPT
2071	240	J	334 339	23B	OPT

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
2364	260	L	387 394	50B	NOT INNER
2372	260	M	389 394	37B	NOT INNER
2411	260	K	392 394	15B	OPT
2437	280	K	400 403	22B	NOT INNER
2446	280	M	402 403	10B	INSTACK
2471	330	J	406 421	106B	NOT INNER
2510	320	K	411 420	64B	NOT INNER
2516	300	L	413 414	14B	OPT
2541	320	M	416 420	30B	NOT INNER
2551	310	L	418 419	15B	OPT
2602	350	K	428 431	25B	NOT INNER
2612	350	M	430 431	12B	INSTACK
2662	390	J	436 451	72B	NOT INNER
2705	370	M	443 446	16B	OPT
3275	430	J	483 496	126B	NOT INNER
3277	420	K	484 489	47B	NOT INNER
3307	410	L	486 487	23B	OPT
3442	440	J	501 503	10B	INSTACK

COMMON BLOCKS	LENGTH
PFCM12	39

STATISTICS

PROGRAM LENGTH	4365B	2293
SCM LABELED COMMON LENGTH	47B	39

140000B SCM USED

```
      1              SUBROUTINE CONVTR (R,NPUT,M2,M3)                          CONVTR      2
                     REAL R(1,M3)                                              CONVTR      3
                     IF (NPUT.EQ.1) GO TO 110                                  CONVTR      4
                         DO 100 I=M2,M3                                        CONVTR      5
      5                  R(1,I) = R(1,I)/.0254                                 CONVTR      6
                 100     CONTINUE                                              CONVTR      7
                     RETURN                                                    CONVTR      8
                 110     DO 120 I=M2,M3                                        CONVTR      9
                         R(1,I) = R(1,I)*.0254                                 CONVTR     10
     10          120     CONTINUE                                              CONVTR     11
                     RETURN                                                    CONVTR     12
                     END                                                       CONVTR     13
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CONVTR	1	7 11

VARIABLES	SN	TYPE		RELOCATION									
36	I	INTEGER			REFS	2*5	2*9	DEFINED	4	8			
0	M2	INTEGER		F.P.	REFS	4	8	DEFINED	1				
0	M3	INTEGER		F.P.	REFS	2	4	8	DEFINED	1			
0	NPUT	INTEGER		F.P.	REFS	3	DEFINED	1					
0	R	REAL	ARRAY	F.P.	REFS	2	5	9	DEFINED	1	5	9	

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	6	4
24	110	8	3
0	120	10	8

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
14	100	I	4 6	6B	INSTACK
26	120	I	8 10	6B	INSTACK

STATISTICS

PROGRAM LENGTH 44B 36

140000B SCM USED

```
      SUBROUTINE FC2PTR (NA,NR,NWRDS,LENGTH)
C     *******************************
C     SUBROUTINE TO COMPUTE LOCATION OF NODALLY DEPENDENT VARIABLES
C     INTERNAL TO FRACAS2 (WORK ARRAYS)
C
C     NA      : NUMBER OF AXIAL NODES -- INPUT
C     NR      : NUMBER OF RADIAL NODES -- INPUT
C     NAXN    : NUMBER OF (NA) VARIABLES
C     NRAD    : NUMBER OF (NR) VARIABLES
C     NAXRAD  : NUMBER OF (NA,NR) VARIABLES
C     NAXRD3  : NUMBER OF (NA,NR,3) VARIABLES
C     NINR    : NUMBER OF (I,NR) VARIABLES
C     NINR3   : NUMBER OF (I,NR,3) VARIABLES
C     NR3     : NUMBER OF (NR,3) VARIABLES
C     NR4     : NUMBER OF (NR,4) VARIABLES
C     NR33    : NUMBER OF (NR,3,3) VARIABLES
C     NVAR    : TOTAL NUMBER OF VARIABLES
C     NWRDS   : TOTAL NUMBER OF WORDS IN AFCM12 ARRAY
C     ***********************
C
C     THE POINTERS IN IFCM12 ARE:
C     IFCM12(1)  : PIN              IFCM12(21) : STRTOT
C     IFCM12(2)  : POUT             IFCM12(22) : ALFDT
C     IFCM12(3)  : P1               IFCM12(23) : OLDEPP
C     IFCM12(4)  : P2               IFCM12(24) : NUDEPP
C     IFCM12(5)  : TSAVE            IFCM12(25) : HH
C     IFCM12(6)  : DCHECK           IFCM12(26) : NN
C     IFCM12(7)  : OLSIGF           IFCM12(27) : MN
C     IFCM12(8)  : DEP              IFCM12(28) : BB
C     IFCM12(9)  : SLOPE            IFCM12(29) : MM
C     IFCM12(10) : COEF             IFCM12(30) : GG
C     IFCM12(11) : DSIGF            IFCM12(31) : DD
C     IFCM12(12) : F1               IFCM12(32) : W
C     IFCM12(13) : F2               IFCM12(33) : U
C     IFCM12(14) : EP2              IFCM12(34) : EE
C     IFCM12(15) : ECREP2           IFCM12(35) : LL
C     IFCM12(16) : T2               IFCM12(36) : AA
C     IFCM12(17) : TN               IFCM12(37) : EI
C     IFCM12(18) : E                IFCM12(38) : CC
C     IFCM12(19) : V                IFCM12(39) : FF
C     IFCM12(20) : EPP2
C     ************************
      COMMON/FFCM12/   IFCM12(39)
C
      NAXN = 4
      NRAD = 1
      NAXRAD = 6
      NAXRD3 = 3
      NINR = 8
      NINR3 = 8
      NR3 = 1
      NR4 = 2
```

```
      NR33 = 6                                                                  FC2PTR     55
      NVAR = 39                                                                 FC2PTR     56
      NWRDS = NAXN*NA+NRAD*NR+NAXRAD*NA*NR+NAXRD3*NA*NR*3+NINR*NR+NINR3*        FC2PTR     57
     +NR*3+NR3*NR*3+NR4*NR*4+NR33*NR*3*3                                        FC2PTR     58
C                                                                               FC2PTR     59
C                                                                               FC2PTR     60
C   COMPUTE POINTERS FOR (NA) VARIABLES                                         FC2PTR     61
C                                                                               FC2PTR     62
      IFCMI2(1) = LENGTH+1                                                      FC2PTR     63
      NBEG = 2                                                                  FC2PTR     64
      NEND = NAXN+1                                                             FC2PTR     65
          DO 100 I=NBEG,NEND                                                    FC2PTR     66
          IFCMI2(I) = IFCMI2(I-1)+NA                                            FC2PTR     67
  100     CONTINUE                                                              FC2PTR     68
C                                                                               FC2PTR     69
C   COMPUTE POINTERS FOR (NR) AND (I,NR) VARIABLES                              FC2PTR     70
C                                                                               FC2PTR     71
      NBEG = NEND+1                                                             FC2PTR     72
      NEND = NEND+NRAD+NINR                                                     FC2PTR     73
          DO 110 I=NBEG,NEND                                                    FC2PTR     74
          IFCMI2(I) = IFCMI2(I-1)+NR                                            FC2PTR     75
  110     CONTINUE                                                              FC2PTR     76
C                                                                               FC2PTR     77
C   COMPUTE POINTERS FOR (NA,NR) VARIABLES                                      FC2PTR     78
C                                                                               FC2PTR     79
      NBEG = NEND+1                                                             FC2PTR     80
      NEND = NEND+NAXRAD                                                        FC2PTR     81
          DO 120 I=NBEG,NEND                                                    FC2PTR     82
          IFCMI2(I) = IFCMI2(I-1)+NA*NR                                         FC2PTR     83
  120     CONTINUE                                                              FC2PTR     84
C                                                                               FC2PTR     85
C   COMPUTE POINTERS FOR (NA,NR,3) VARIABLES                                    FC2PTR     86
C                                                                               FC2PTR     87
      NBEG = NEND+1                                                             FC2PTR     88
      NEND = NEND+NAXRD3                                                        FC2PTR     89
          DO 130 I=NBEG,NEND                                                    FC2PTR     90
          IFCMI2(I) = IFCMI2(I-1)+NA*NR*3                                       FC2PTR     91
  130     CONTINUE                                                              FC2PTR     92
C                                                                               FC2PTR     93
C   COMPUTER POINTERS FOR (I,NR,3) AND (NR,3) VARIABLES                         FC2PTR     94
C                                                                               FC2PTR     95
      NBEG = NEND+1                                                             FC2PTR     96
      NEND = NEND+NINR3+NR3                                                     FC2PTR     97
          DO 140 I=NBEG,NEND                                                    FC2PTR     98
          IFCMI2(I) = IFCMI2(I-1)+NR*3                                          FC2PTR     99
  140     CONTINUE                                                              FC2PTR    100
C                                                                               FC2PTR    101
C   COMPUTE POINTERS FOR (NR,4) VARIABLES                                       FC2PTR    102
C                                                                               FC2PTR    103
      NBEG = NEND+1                                                             FC2PTR    104
      NEND = NEND+NR4                                                           FC2PTR    105
          DO 150 I=NBEG,NEND                                                    FC2PTR    106
          IFCMI2(I) = IFCMI2(I-1)+NR*4                                          FC2PTR    107
```

```
                150       CONTINUE                                                    FC2PTR  108
                C                                                                     FC2PTR  109
                C   COMPUTE POINTERS FOR (NR,3,3) VARIABLES                         FC2PTR  110
110             C                                                                     FC2PTR  111
                      NBEG = NEND+1                                                   FC2PTR  112
                      NEND = NVAR                                                     FC2PTR  113
                          DO 160 I=NBEG,NEND                                          FC2PTR  114
                          IFCMI2(I) = IFCMI2(I-1)+NR*3*3                              FC2PTR  115
115             160       CONTINUE                                                    FC2PTR  116
                C                                                                     FC2PTR  117
                      WRITE (6,170) (I,IFCMI2(I),I=1,NVAR)                            FC2PTR  118
                      WRITE (6,180) NWRDS                                             FC2PTR  119
                      RETURN                                                          FC2PTR  120
120             C                                                                     FC2PTR  121
                170   FORMAT (1X,I5,5X,I5)                                          FC2PTR  122
                180   FORMAT (1X,"NWRDS I5",I10)                                    FC2PTR  123
                      END                                                             FC2PTR  124
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	FC2PTR	1

DEF LINE: 119

REFERENCES

VARIABLES

		SN	TYPE		RELOCATION							
273	I		INTEGER			REFS	2*66	2*74	2*82	2*90	2*98	2*106	2*114
							2*117	DEFINED	65	73	91	89	97	105
							113	117						
0	IFCMI2		INTEGER	ARRAY	PFCMI2	REFS	44	66	74	82	90	98	106
							114	117	DEFINED	62	66	74	82	90
							98	106	114					
0	LENGTH		INTEGER		F.P.	REFS	62	DEFINED	1					
0	NA		INTEGER		F.P.	REFS	3*56	66	82	90	DEFINED	1		
257	NAXN		INTEGER			REFS	56	64	DEFINED	46				
261	NAXRAD		INTEGER			REFS	56	80	DEFINED	48				
262	NAXRD3		INTEGER			REFS	56	88	DEFINED	49				
271	NBEG		INTEGER			REFS	65	73	81	89	97	105	113
						DEFINED	63	71	79	87	95	103	111
272	NEND		INTEGER			REFS	65	71	72	73	79	80	81
							87	88	89	95	96	97	103	104
							105	111	113	DEFINED	64	72	80	88
							96	104	112					
0	NR		INTEGER		F.P.	REFS	8*56	74	82	90	98	106	114
						DEFINED	1						
260	NRAD		INTEGER			REFS	56	72	DEFINED	47			
265	NR3		INTEGER			REFS	56	96	DEFINED	52			
267	NR33		INTEGER			REFS	56	DEFINED	54				
266	NR4		INTEGER			REFS	56	104	DEFINED	53			
270	NVAR		INTEGER			REFS	112	117	DEFINED	55			
0	NWRDS		INTEGER		F.P.	REFS	118	DEFINED	1	56			

```
VARIABLES     SN  TYPE          RELOCATION
  263  NINR       INTEGER                    REFS      56      72   DEFINED     50
  264  NINR3      INTEGER                    REFS      56      96   DEFINED     51

FILE NAMES        MODE
      TAPE6       FMT                  WRITES     117     118

STATEMENT LABELS          DEF LINE   REFERENCES
    0  100                    67        65
    0  110                    75        73
    0  120                    83        81
    0  130                    91        89
    0  140                    99        97
    0  150                   107       105
    0  160                   115       113
  251  170      FMT          121       117
  254  180      FMT          122       118

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   64  100      I          65 67        6B     INSTACK
  102  110      I          73 75        6B     INSTACK
  117  120      I          81 83        7B     INSTACK
  135  130      I          89 91       10B     INSTACK
  155  140      I          97 99        7B     INSTACK
  173  150      I         105 107       6B     INSTACK
  210  160      I         113 115       7B     INSTACK
  222           I         117 117       7B                EXT REFS

COMMON BLOCKS   LENGTH
      PFCM12        39

STATISTICS
  PROGRAM LENGTH                  306B      198
  SCM LABELED COMMON LENGTH        47B       39
        140000B SCM USED
```

```
      SUBROUTINE FR2PTR (NA,NR,IWORDS,LENGTH)                                  FR2PTR     2
C     ***************************************                                  FR2PTR     3
C     SUBROUTINE TO COMPUTE LOCATION OF NODALLY DEPENDENT VARIABLES            FR2PTR     4
C     PASSED TO FRACAS2 FROM FRAPCON                                           FR2PTR     5
C                                                                              FR2PTR     6
C     NA      : NUMBER OF AXIAL NODES -- INPUT                                 FR2PTR     7
C     NR      : NUMBER OF RADIAL NODES -- INPUT                                FR2PTR     8
C     NAXN    : NUMBER OF (NA) VARIABLES                                       FR2PTR     9
C     NA2     : NUMBER OF (NA,2) VARIABLES                                     FR2PTR    10
C     NAXRAD  : NUMBER OF (NA,NR) VARIABLES                                    FR2PTR    11
C     NAXRD3  : NUMBER OF (NA,NR,3) VARIABLES                                  FR2PTR    12
C     NVAR    : TOTAL NUMBER OF VARIABLES                                      FR2PTR    13
C     IWORDS  : TOTAL NUMBER OF WORDS IN AFRCS2 ARRAY                          FR2PTR    14
C     ***********************                                                  FR2PTR    15
C                                                                              FR2PTR    16
C                                                                              FR2PTR    17
C     THE POINTERS IN IFRCS2 ARE:                                              FR2PTR    18
C     IFRCS2(1)   : OLDPG2                IFRCS2(11)  : R22                    FR2PTR    19
C     IFRCS2(2)   : OLDPC2                IFRCS2(12)  : OLDT2                  FR2PTR    20
C     IFRCS2(3)   : GAP2                  IFRCS2(13)  : FVFRO                  FR2PTR    21
C     IFRCS2(4)   : IGAP2                 IFRCS2(14)  : DVHPRS                 FR2PTR    22
C     IFRCS2(5)   : OLIGP2                IFRCS2(15)  : PEP2                   FR2PTR    23
C     IFRCS2(6)   : REPS2                 IFRCS2(16)  : EPS22                  FR2PTR    24
C     IFRCS2(7)   : PREPS2                IFRCS2(17)  : EPP2                   FR2PTR    25
C     IFRCS2(8)   : TTT                   IFRCS2(18)  : SIG2                   FR2PTR    26
C     IFRCS2(9)   : ECREP2                IFRCS2(19)  : EPS02                  FR2PTR    27
C     IFRCS2(10)  : EP2                   IFRCS2(20)  : PEPP2                  FR2PTR    28
C     IFRCS2(21)  : EPS0                                                       FR2PTR    29
C     ************************                                                 FR2PTR    30
      COMMON  /PFRCS2/   IFRCS2(21)    ,   NNNCRP                              FR2PTR    31
C                                                                              FR2PTR    32
      NAXN = 5                                                                 FR2PTR    33
      NA2 = 2                                                                  FR2PTR    34
      NAXRAD = 8                                                               FR2PTR    35
      NAXRD3 = 6                                                               FR2PTR    36
      NVAR = 21                                                                FR2PTR    37
      IWORDS = NAXN*NA+NA2*NA*2+NAXRAD*NA*NR+NAXRD3*NA*NR*3                    FR2PTR    38
C                                                                              FR2PTR    39
C                                                                              FR2PTR    40
C     COMPUTE POINTERS FOR (NA) VARIABLES                                      FR2PTR    41
C                                                                              FR2PTR    42
      IFRCS2(1) = 1                                                            FR2PTR    43
      NBEG = 2                                                                 FR2PTR    44
      NEND = NAXN+1                                                            FR2PTR    45
          DO 100 I=NBEG,NEND                                                   FR2PTR    46
          IFRCS2(I) = IFRCS2(I-1)+NA                                           FR2PTR    47
  100     CONTINUE                                                             FR2PTR    48
C                                                                              FR2PTR    49
C     COMPUTE POINTERS FOR (NR,2)                                              FR2PTR    50
C                                                                              FR2PTR    51
      NBEG = NEND+1                                                            FR2PTR    52
      NEND = NEND+NA2                                                          FR2PTR    53
          DO 110 I=NBEG,NEND                                                   FR2PTR    54
```

```
                IFRCS2(I) = IFRCS2(I-1)+NA*2                                    FR2PTR     55
110             CONTINUE                                                        FR2PTR     56
C                                                                               FR2PTR     57
C   COMPUTE POINTERS FOR (NA,NR) VARIABLES                                      FR2PTR     58
C                                                                               FR2PTR     59
      NBEG = NEND+1                                                             FR2PTR     60
      NEND = NEND+NAXRAD                                                        FR2PTR     61
          DO 120 I=NBEG,NEND                                                    FR2PTR     62
          IFRCS2(I) = IFRCS2(I-1)+NA*NR                                         FR2PTR     63
120       CONTINUE                                                              FR2PTR     64
C                                                                               FR2PTR     65
C   COMPUTE POINTERS FOR (NA,NR,3) VARIABLES                                    FR2PTR     66
C                                                                               FR2PTR     67
      NBEG = NEND+1                                                             FR2PTR     68
      NEND = NVAR                                                               FR2PTR     69
          DO 130 I=NBEG,NEND                                                    FR2PTR     70
          IFRCS2(I) = IFRCS2(I-1)+NA*NR*3                                       FR2PTR     71
130       CONTINUE                                                              FR2PTR     72
          DO 140 I=1,NVAR                                                       FR2PTR     73
          IFRCS2(I) = IFRCS2(I)+LENGTH                                          FR2PTR     74
140       CONTINUE                                                              FR2PTR     75
C                                                                               FR2PTR     76
C                                                                               FR2PTR     77
      WRITE (6,150) (I,IFRCS2(I),I=1,NVAR)                                      FR2PTR     78
      WRITE (6,160) IWORDS                                                      FR2PTR     79
      RETURN                                                                    FR2PTR     80
C                                                                               FR2PTR     81
150   FORMAT (1X,I5,5X,I5)                                                      FR2PTR     82
160   FORMAT (1X,"IWORDS IS",I10)                                               FR2PTR     83
      END                                                                       FR2PTR     84
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	FR2PTR	DEF LINE 1
		REFERENCES 79

VARIABLES

		SN	TYPE		RELOCATION								
201	I		INTEGER			REFS	2*46	2*54	2*62	2*70	2*73	2*77	
						DEFINED	45	53	61	69	72	77	
0	IFRCS2		INTEGER	ARRAY	PFRCS2	REFS	30	46	54	62	70	73	77
						DEFINED	42	46	54	62	70	73	
0	IWORDS		INTEGER		F.P.	REFS	78	DEFINED	1	37			
0	LENGTH		INTEGER		F.P.	REFS	73	DEFINED	1				
0	NA		INTEGER		F.P.	REFS	4*37	46	54	62	70		
						DEFINED	1						
172	NAXN		INTEGER			REFS	37	44	DEFINED	32			
174	NAXRAD		INTEGER			REFS	37	60	DEFINED	34			
175	NAXRD3		INTEGER			REFS	37	DEFINED	35				
173	NA2		INTEGER			REFS	37	52	DEFINED	33			

VARIABLES	SN	TYPE	RELOCATION								
177	NBEG	INTEGER		REFS	45	53	61	69	DEFINED	43	51
					59	67					
200	NEND	INTEGER		REFS	45	51	52	53	59	60	61
					67	69	DEFINED	44	52	60	68
25	NNNCRP	INTEGER	PFRCS2	REFS	30						
0	NR	INTEGER	F.P.	REFS	2*37	62	70	DEFINED	1		
176	NVAR	INTEGER		REFS	68	72	77	DEFINED	36		

FILE NAMES	MODE			
TAPE6	FMT	WRITES	77	78

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		47	45
0	110		55	53
0	120		63	61
0	130		71	69
0	140		74	72
164	150	FMT	81	77
167	160	FMT	82	78

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
42	100	I	45 47	6B	INSTACK	
57	110	I	53 55	6B	INSTACK	
74	120	I	61 63	7B	INSTACK	
112	130	I	69 71	10B	INSTACK	
124	140	I	72 74	6B	INSTACK	
135		I	77 77	7B		EXT REFS

COMMON BLOCKS	LENGTH
PFRCS2	22

STATISTICS		
PROGRAM LENGTH	212B	138
SCM LABELED COMMON LENGTH	26B	22
140000B SCM USED		

```
PELET    *CALL COMC                                                    PELET       66
PELET    *CALL PELPT                                                   PELET       71
PELET    *CALL PELCOM                                                  PELET       72


ABOUND   *CALL PELCOM                                                  ABOUND      11


ALOAD    *CALL PELCOM                                                  ALOAD       17
ALOAD    *CALL COMC                                                    ALOAD       26


ASOLVE   *CALL PELPT                                                   ASOLVE       4
ASOLVE   *CALL PELCOM                                                  ASOLVE       5
ASOLVE   *CALL COMC                                                    ASOLVE       6


ASTRES   *CALL PELCOM                                                  ASTRES      11


BOUND    *CALL PELCOM                                                  BOUND        8


EFFECT   *CALL PELCOM                                                  EFFECT       9


INPAXL   *CALL PELCOM                                                  INPAXL      15
INPAXL   *CALL COMC                                                    INPAXL      16


INPUT    *CALL PELCOM                                                  INPUT        7


KREEP    *CALL PELPT                                                   KREEP       42
KREEP    *CALL PELCOM                                                  KREEP       43


LOAD     *CALL PELCOM                                                  LOAD        19
LOAD     *CALL COMC                                                    LOAD        20
```

```
RATE     *CALL PELCOM                                          RATE        13
RATE     *CALL COMC                                            RATE        14


SOLVET   *CALL PELPT                                           SOLVET      15
SOLVET   *CALL PELCOM                                          SOLVET      16
SOLVET   *CALL COMC                                            SOLVET      17


STFAXL   *CALL PELCOM                                          STFAXL      14
STFAXL   *CALL COMC                                            STFAXL      20


STIFF    *CALL PELCOM                                          STIFF       16
STIFF    *CALL COMC                                            STIFF       19


STRES    *CALL PELCOM                                          STRES       15
```

CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY	COMC	PELPT	PELCOM	QRATE	PELET	ABOUND	ALOAD
ASOLVE	ASTRES	BOUND	DMCHB	ERF	EFFECT	INPAXL	INPUT
KREEP	LOAD	MOVEAA	MOVEKA	RADIAL	RATE	SOLVET	SORTP
STFAXL	STIFF	STRES	TEMPA	TEMPB	TEMPC	TEMPD	

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$	TIDY	COMC	PELPT	PELCOM	QRATE	PELET	ABOUND
ALOAD	ASOLVE	ASTRES	BOUND	DMCHB	ERF	EFFECT	INPAXL
INPUT	KREEP	LOAD	MOVEAA	MOVEKA	RADIAL	RATE	SOLVET
SORTP	STFAXL	STIFF	STRES	TEMPA	TEMPB	TEMPC	TEMPD

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

YANK$$$	TIDY	COMC	PELPT	PELCOM	QRATE	PELET	ABOUND
ALOAD	ASOLVE	ASTRES	BOUND	DMCHB	ERF	EFFECT	INPAXL
INPUT	KREEP	LOAD	MOVEAA	MOVEKA	RADIAL	RATE	SOLVET
SORTP	STFAXL	STIFF	STRES	TEMPA	TEMPB	TEMPC	TEMPD

COMMON DECKS ENCOUNTERED

COMC	PELPT	PELCOM	QRATE

DECKS WRITTEN TO COMPILE FILE

TIDY	PELET	ABOUND	ALOAD	ASOLVE	ASTRES	BOUND	DMCHB
ERF	EFFECT	INPAXL	INPUT	KREEP	LOAD	MOVEAA	MOVEKA
RADIAL	RATE	SOLVET	SORTP	STFAXL	STIFF	STRES	TEMPA
TEMPB	TEMPC	TEMPD					

THIS UPDATE REQUIRED 34500B WORDS OF CORE.

```
      SUBROUTINE PELET (TTME,RD,DISPC,EFSTR,DSPSV,BD,TCI,TCO,NA,TELM,TW,
     +TBLK,TPLEN,TINLET,RFX,EXTP,COMPD,TREFD,KZ,PRESTO,FFDEN,RXI,RXO,IXT
     +OP,RC,NOELD,NABFD,NTAED,NARCD,NFFID,NFD,NCD,NSH,NAB2D,TCB,TFB,TEC,
     +TEF,TV,XRD,PRG,AXLEN,HLDN,PLSTC,STRNN,STRSS)
C
C
C     PELET IS THE FINITE ELEMENT MECHANICAL MODEL FROM BATTELLE"S PACIFIC
C     NORTHWEST LABS"    GAPCON-THERMAL-3 CODE.  PARTS OF THE MODEL HAVE
C     BEEN REWRITTEN FOR THIS VERSION.
C     THE PELET MECHANICAL ROUTINE INCLUDES THE FOLLOWING SUBROUTINES
C     ABOUND    ALOAD     ASOLVE    ASTRES    BOUND     DMCHB     EFFECT
C     INPAXL    INPUT     KREEP     LOAD      PELET     RATE      SOLVET
C     SORTP     STFAXL    STIFF     STRES     TEMPA     TEMPB     TEMPC
C     TEMPD
C
C     THE SUBROUTINE RADIAL IS ALSO A PART OF THE PNL MECHANICS-RELOCATION
C     PACKAGE IN FRAPCON-2.
C
C
C     PELET IS CALLED FROM MAIN
C
C
C     THE FOLLOWING VARIABLES ARE DEFINED IN SUBROUTINE POINTR
C
C     NF = NUMBER OF RADIAL BOUNDARIES IN THE FUEL
C     NC = NUMBER OF RADIAL BOUNDARIES IN THE CLADDING
C     NA = NUMBER OF AXIAL REGIONS
C     NT = NA
C     NA = NA+1
C     NABF = NA+1
C     NABT = NA+2
C     NFF=TOTAL NODES IN RADIAL MECHANICAL MODEL
C     NF4=TOTAL D.O.F. IN RADIAL MODEL OF FUEL
C     NC4=TOTAL D.O.F. IN RADIAL MODEL OF CLAD
C     NFF2=NUMBER OF D.O.F. IN COMBINED FUEL-CLAD MODEL
C     PLUS 4.
C     NOELC=NUMBER OF RADIAL CLAD ELEMENTS
C     NOELF=NUMBER OF RADIAL FUEL ELEMENTS
C     NOELC=TOTAL NUMBER OF RADIAL ELEMENTS
C     NFFI=TOTAL NUMBER OF RADIAL BOUNDARIES
C
C     AXIAL CALCULATION PARAMETERS
C
C     NARF=NUMBER OF AXIAL REGIONS IN THE FUEL
C     NART=NARC=TOTAL NUMBER OF AXIAL REAGIONS
C     NABT,NABF=NUMBER OF AZIAL BOUNDARIES IN CLAD AND FUEL,RESPECTIVELY
C     NAXBT=TOTAL NUMBER OF AXIAL BOUNDARIES
C     NAXB2=TOTAL NUMBER OF NODES IN AXIAL MODEL
C     NAXB4=TOTAL NUMBER OF D.O.F. IN AXIAL MODEL
C     NAEF=NUMBER OF ELEMENTS IN AXIAL FUEL MODEL
C     NAEC=NUMBER OF ELEMENTS IN AXIAL CLAD MODEL
C     NTAE=TOTAL NUMBER OF ELEMENTS IN THE AXIAL MODEL
C
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      C   PARAMETERS FOR CHOLESKY (MINIMUM-SPACE) STORAGE OF STIFFNESS          PELET      55
55    C   MATRICES                                                              PELET      56
      C                                                                         PELET      57
      C   MAXF=TOTAL NUMBER OF STORAGE LOCATIONS REQUIRED FOR THE FUEL          PELET      58
      C   RADIAL STIFFNESS MATRIX                                               PELET      59
      C   MAXC=STORAGE REQUIRED FOR RADIAL CLAD MATRIX                          PELET      60
60    C   MAXT=STORAGE FOR COMBINED FUEL-CLAD RADIAL MATRIX                     PELET      61
      C   MAXA=STORAGE FOR THE AXIAL MODEL MATRIX                               PELET      62
      C                                                                         PELET      63
      C                                                                         PELET      64
        COMMON / AXL / SUMM, SUMFF, SUMSAV, GROW                                PELET      65
65      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,            COMC        2
     +    ERAD(20), EAX(20)                                                    COMC        3
        COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)                       COMC        4
     +,PINOLD,POUTLD,POLD,NTOLD(20)                                             COMC        5
     + ,ICHNG,STEPS                                                           COMC        6
70      COMMON /STFMAT/ B(4,6),C(4,6),BT(6,4),PROD(4,6),XKBAR(6,6)              PELET      67
        COMMON / FAST / A(1)                                                    PELET      68
        DIMENSION IA(1), D(1)                                                   PELET      69
        EQUIVALENCE (A(1),IA(1),D(1))                                           PELET      70
        COMMON /PNTPNL/IFIRST,IAELM,IAK,IARAA,IARE,ISB,IBA,IBASAV,IBASE,        PELPT       2
75     + ISBB,IBBA,IBBSV,ICA,ICC,ICRATE,ICRPG,IDISP,IDISPC,IDSPSV,              PELPT       3
     + IEFSTR,IELM,IELSTN,ILSTNA,ILSTRA,IELSTR,IPSLA,IEPSLM,IESTNV,             PELPT       4
     + IESTSV,JIIJ,IIPOS,IKSAVE,INADET,INDC,INDF,INDT,INODET,IOLDSE,            PELPT       5
     + IPSSRT,IPSSV,IPSTS,IR,IRA,IRBR,IRBRA,IRD,ISTRES,ISTRSA,ITCB,             PELPT       6
     + ITCRP,ITEC,ITEF,ITELM,ITFB,ITHET,ITHTAX,ITHSAV,ITHXSV,ITME,              PELPT       7
80     + ITSTNR,ITSTSR,ITV,ITW,IXKT,IXLOAD,IXLODA,IXRD,                         PELPT       8
     +IY,IYACF,IZ,ILAST                                                         PELPT       9
        COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P      PELCOM      2
     +DEL,COMP                                                                  PELCOM      3
        COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE      PELCOM      4
85     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,      PELCOM      5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISSTOP,IPLAS,NKN       PELCOM      6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N       PELCOM      7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                         PELCOM      8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                                 PELCOM      9
90     +,IRZ                                                                    PELCOM     10
        COMMON /LASTIC/ E,XNU,ALPHA                                             PELCOM     11
        COMMON /CONTNT/ PI                                                      PELCOM     12
        COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                           PELCOM     13
        COMMON / PRSSV / PRSINC(20), PRSS(20)                                   PELET      73
95      DIMENSION PRG(NA)                                                       PELET      74
        DIMENSION TELM(NOELD,NABFD,2),TW(NTAED,2)                               PELET      75
        DIMENSION TTME(3)                                                       PELET      76
        DIMENSION EFSTR(NOELD,1), DSPSV(NOELD,1)                                PELET      77
        DIMENSION DISPC(NFFID,1),RD(NFFID,1)                                    PELET      78
100     DIMENSION TCI(NA),TCO(NA)                                               PELET      79
        DIMENSION BD(6,NA)                                                      PELET      80
        DIMENSION TCB(2,1),TFB(2,1),TEC(NCD,1),TEF(NFD,1),XRD(NFFID),           PELET      81
     + TV(1)                                                                    PELET      82
        DIMENSION AXLEN(NA)                                                     PELET      83
105     DIMENSION PLSTC(4,NA),STRNN(4,NA), STRSS(4,NA), HLDN(4,NA)              PELET      84
      C                                                                         PELET      85
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      C                                                                      PELET      86
      C   ***************************************************************    PELET      87
      C                                                                      PELET      88
110   C   IRZ = IT = TIME STEP COUNTER                                       PELET      89
      C   J = AXIAL NODE COUNTER IN "MAIN"                                   PELET      90
      C   KZI = KZ = ITER = GAS LOOP COUNTER                                 PELET      91
      C   ISTOP = CONVERGENCE HAS BEEN REACHED ON GAS LOOP IF ISTOP = ITER   PELET      92
      C   ICUT = IF ISTOP = ITER, CREEP IS CALLED AND THEN ICUT SAYS WHETHER  PELET      93
115   C   TO TIME CUT INTERNALLY                                             PELET      94
      C   NSH = FLAG FOR TIME HARDENING = 0                                  PELET      95
      C   STRAIN HARDENING = 1                                               PELET      96
      C                                                                      PELET      97
      C   ***************************************************************    PELET      98
120   C                                                                      PELET      99
        IF (IRZ.EQ.1) CALL MOVEKA (0,PRSINC,40)                              PELET     100
        IF (IRZ.EQ.1) CALL MOVEKA (0,PLSTC,4*NA)                             PELET     101
            DO 100 I=1,NARF                                                  PELET     102
            PRSINC(I) = PRG(I)-PRSS(I)                                       PELET     103
125         PRSS(I) = PRG(I)                                                 PELET     104
100         CONTINUE                                                         PELET     105
      C                                                                      PELET     106
      C   THE FOLLOWING REPLACEMENT STATEMENTS ELIMINATE ERROR MESSAGES---   PELET     107
      C   --VARIABLE APPEARS IN COMMON AND AS F.P.                           PELET     108
130   C                                                                      PELET     109
        RCI = RXI                                                            PELET     110
        RCO = RXO                                                            PELET     111
        RFS = RFX                                                            PELET     112
        RFO = RFS                                                            PELET     113
135     NT = NA-1                                                            PELET     114
        NF = NFD                                                             PELET     115
        NC = NCD                                                             PELET     116
        NFI = NF-1                                                           PELET     117
        NCI = NC-1                                                           PELET     118
140     NOELF = (NF-1)*2                                                     PELET     119
        NOELC = (NC-1)*2                                                     PELET     120
        NARF = NABF-1                                                        PELET     121
        NABC = NABT                                                          PELET     122
        NARC = NARCD                                                         PELET     123
145     NART = NARC                                                          PELET     124
        NAEC = NTAE-NAEF                                                     PELET     125
        ISTOP = IXTOP                                                        PELET     126
        ISSTOP = 1                                                           PELET     127
        TREF = TREFD                                                         PELET     128
150     COMP = COMPD                                                         PELET     129
        PI = 3.141592654                                                     PELET     130
      C                                                                      PELET     131
      C                                                                      PELET     132
      C                                                                      PELET     133
155     RFI = RC                                                             PELET     134
      C                                                                      PELET     135
        CALL TEMPA (TCB,TFB,TBLK,TINLET,TPLEN,NABT)                          PELET     136
      C                                                                      PELET     137
      C                                                                      PELET     138
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      C   TEF AND TEC ARE THE TEMPERATURE ARRAYS CALCULATED AT THE AXIAL       PELET  139
      C   POSITIONS WHERE FRAPCON SUPPLIES THE VALUES FOR THE B ARRAYS.         PELET  140
      C   TCB AND TFB ARE THE TEMPERATURES AT THE AXIAL BOUNDARIES AT THE       PELET  141
      C   INSIDE AND OUTSIDE SURFACES ONLY.(SO THEY ARE DIMENSIONED ONLY        PELET  142
      C   TO 2 X 20, 2 IN THE RADIAL DIRECTION.                                 PELET  143
      C                                                                         PELET  144
            DO 120 I=2,NA                                                       PELET  145
              DO 110 J=1,NFFI                                                   PELET  146
  110         XRD(J) = (RD(J,I)+RD(J,I+1))/2.                                   PELET  147
            CALL TEMPB (XRD,TEC(1,I),TEF(1,I),NF,NC,BD(1,I-1),TCI(1),TCO(I      PELET  148
     +     ),TV(I))                                                            PELET  149
  120       CONTINUE                                                            PELET  150
        CALL TEMPC (NF,NC,NFFI,NCI,NT,TPLEN,TINLET,TBLK,TEC,TEF,TCB,TFB)        PELET  151
        CALL TEMPD (NT,NOLD,NEW,NFFID,NOELD,NTAED,TELM,TREF,TFB,RD,TCB,TW,      PELET  152
       +NART,NABF,NFI,NCI,IRZ,TEC,TEF,TV,NF,NC)                                 PELET  153
        JAM = 0                                                                 PELET  154
        ICNT = 0                                                                PELET  155
        KPLAS = 0                                                               PELET  156
        RAKSUM = 0.                                                             PELET  157
        ISP = 0                                                                 PELET  158
        CALL SECOND (TM1)                                                       PELET  159
      C                                                                         PELET  160
      C   CALL INPUT AND INITIALIZE CALCULAT'ONS.                               PELET  161
        FRDEN = FFDEN                                                           PELET  162
        IF (IRZ.EQ.1) GO TO 130                                                 PELET  163
        PINNEW = PRESTO                                                         PELET  164
        POUTNW = EXTP                                                           PELET  165
        PNEW = POUTNW-PINNEW                                                    PELET  166
        PIN = PINNEW-PINOLD                                                     PELET  167
        POUT = POUTNW-POUTLD                                                    PELET  168
        PDEL = PNEW-POLD                                                        PELET  169
        IF (KZ.NE.ISTOP) GO TO 140                                              PELET  170
        POLD = PNEW                                                             PELET  171
        POUTLD = POUTNW                                                         PELET  172
        PINOLD = PINNEW                                                         PELET  173
        GO TO 140                                                               PELET  174
  130   PIN = PRESTO                                                            PELET  175
        POUT = EXTP                                                             PELET  176
        PDEL = EXTP-PRESTO                                                      PELET  177
        POLD = PDEL                                                             PELET  178
        PINOLD = PIN                                                            PELET  179
        POUTLD = POUT                                                           PELET  180
  140   CONTINUE                                                                PELET  181
      C                                                                         PELET  182
        IPREV = 0                                                               PELET  183
        ICUT = 0                                                                PELET  184
        IADJ = 1                                                                PELET  185
        TIMEF = TTME(3)                                                         PELET  186
        TIMEN = TTME(2)                                                         PELET  187
        IDF = 0                                                                 PELET  188
        IF (IRZ.GT.1) GO TO 150                                                 PELET  189
        JAM = 1                                                                 PELET  190
        DELF = RD(NF,1)/FLOAT(NF-1)                                             PELET  191
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                DELC = (RD(NFF1,1)-RD(NF+1,1))/FLOAT(NC-1)                                        PELET     192
                DELZ = (DELF+DELC)/2.                                                             PELET     193
215             CALL INPAXL (D(IAELM),D(IR),D(IRA),D(IY),D(IYACF),D(INADET),RD,NAB                PELET     194
               +T2,NFF1)                                                                          PELET     195
                CALL INPUT (D(IELM),D(INODET))                                                    PELET     196
          150   CONTINUE                                                                          PELET     197
          C                                                                                       PELET     198
220       C                                                                                       PELET     199
          C   THE NKN LOOP CONTROLS THE CALCULATION AND UPGRADING OF THE TOTAL S                  PELET     200
          C   AND STRAINS. AFTER TEMPERATURE CONVERGENCE THIS LOOP IS                           PELET     201
          C   EXCUTED TWICE. THE FIRST ITERATION AFTER CONVERGENCE CALCULATES                   PELET     202
          C   AND ADDS IN THE CURRENT ELASTIC INCREMENTS. THEN AND ONLY THEN                    PELET     203
225       C   IS SUBROUTINE CREEP CALLED TO CALCULATE THE CREEP-PLASTIC                         PELET     204
          C   INCREMENTS.                                                                       PELET     205
          C                                                                                     PELET     206
                DO 330 NKN=1,2                                                                  PELET     207
                IKL = 1                                                                         PELET     208
230       160   CONTINUE                                                                        PELET     209
                IF (ICUT.EQ.1) IKL = IADJ                                                       PELET     210
                STEP = (TIMEF-TIMEN)/FLOAT(IADJ)                                                PELET     211
          C                                                                                     PELET     212
          C   TIME CUTTING LOOP FOR CREEP                                                       PELET     213
235       C                                                                                     PELET     214
                  DO 270 ITI=1,IKL                                                              PELET     215
                  CALL MOVEKA (0,D(ITCRP),4*NOEL*NARC)                                          PELET     216
                  KZ1 = KZ                                                                      PELET     217
                  IPLAS = 0                                                                     PELET     218
240               IRAK = 0                                                                      PELET     219
                  IF (NKN.EQ.1) GO TO 210                                                       PELET     220
          170     CONTINUE                                                                      PELET     221
                  IF (ICUT.EQ.0) GO TO 180                                                      PELET     222
                  TTME(2) = TIMEN+FLOAT(ITI-1)*STEP                                             PELET     223
245               TIMEC = TTME(2)                                                               PELET     224
                  TTME(3) = TTME(2)+STEP                                                        PELET     225
          180     CONTINUE                                                                      PELET     226
                  IPLAS = 0                                                                     PELET     227
                  CALL SECOND (TM2)                                                             PELET     228
250               TMDEL = TM2-TM1                                                               PELET     229
                  WRITE (6,360) TMDEL                                                           PELET     230
                  IF (TMDEL.LT.25.) GO TO 190                                                   PELET     231
                  WRITE (6,370) TMDEL                                                           PELET     232
                  STOP                                                                          PELET     233
255       190     CONTINUE                                                                      PELET     234
                  CALL KREEP (D(ITSTSR),D(IEFSTR),D(ITSTNR),TELM,TTME,D(ITCR                    PELET     235
              +   P),D(ICRPG),D(ICRATE),NOEL,NARC,NSH)                                         PELET     236
                    DO 200 I=1,NARF                                                             PELET     237
                      DO 200 J=1,NOEL                                                           PELET     238
260                   EFSTR(J,I) = D(IEFSTR+NOEL*(I-1)+J-1)                                     PELET     239
          200         CONTINUE                                                                  PELET     240
          210     CONTINUE                                                                      PELET     241
          C                                                                                     PELET     242
          C   THE KKA LOOP CONTROLS THE RADIAL-AXIAL-RADIAL CHAINED SOLUTION                    PELET     243
265       C   THE KA LOOP RUNS THROUGH ALL AXIAL REGIONS,CALLING FOR                            PELET     244
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      C   RADIAL CALCULATIONS FOR CONTACT AND PRESELECTED REGIONS                  PELET     245
      C                                                                           PELET     246
                  DO 240 KKA=1,2                                                  PELET     247
                  IF (KKA.EQ.1) GO TO 230                                         PELET     248
270                   DO 220 KA=1,NARC                                            PELET     249
                      CALL STIFF (D(IELM),D(IR),D(IZ),RD,NFF1,D(INODET),          PELET     250
     +                D(IXKT),D(IEPSLM),D(ISTRES),D(IARE),D(IRBR),D(IXLO          PELET     251
     +                AD),D(IKSAVE),D(ICC),NOEL,TELM,NABF)                        PELET     252
                      CALL BOUND (D(IXKT),D(INODET),MAXT)                         PELET     253
275                   IPREV = ICUT                                                PELET     254
                      CALL SOLVET (D(ISB),D(ISBB),D(INODET),D(IXKT),D(IC          PELET     255
     +                C),D(ITHET),D(ILSTRA),TELM,D(IR),D(IARAA),D(IRBRA)          PELET     256
     +                ,NOEL,D(IBBSV),D(IESTSV),NFF2,MAXT,NARF,D(IESTNV),          PELET     257
     +                NABF)                                                       PELET     258
280                   IF (ICUT.EQ.1.AND.IPREV.EQ.0) GO TO 160                     PELET     259
            220       CONTINUE                                                    PELET     260
            230   CONTINUE                                                        PELET     261
                  IF (KKA.EQ.2) GO TO 240                                         PELET     262
                  CALL STFAXL (D(IAELM),D(IAK),D(IARAA),D(IPSLA),D(INADE          PELET     263
285      +        T),D(IRA),D(IRBRA),D(ISTRSA),TW,NTAE,D(IXLODA),D(IYACF          PELET     264
     +            ),D(ICA))                                                       PELET     265
                  CALL ABOUND (D(IAK),D(IDISP),D(INADET))                         PELET     266
                  CALL ASOLVE (D(IBA),D(IBBA),D(INADET),D(IAK),TW,D(IBAS          PELET     267
     +            AV))                                                          PELET     268
290         240   CONTINUE                                                        PELET     269
      C                                                                           PELET     270
      C   INTERPOLATE AND ADD IN RADIAL DISPLACEMENTS TO THE RD ARRAY            PELET     271
      C                                                                           PELET     272
                  LO = 1                                                          PELET     273
295               NFP1 = NF+1                                                     PELET     274
                      DO 260 I=1,NARC                                             PELET     275
                          DO 250 J=LO,NFF1                                        PELET     276
                          DSP = DISPC(J,I)                                        PELET     277
                          IF (ISSTOP.NE.1) GO TO 250                              PELET     278
300                       IF (ISSTOP.EQ.1.AND.NKN.EQ.1) DSPSV(J,I) = DSP          PELET     279
                          IF (NKN.EQ.2.AND.KPLAS.EQ.1) RD(J,I) = RD(J,I)-DSP      PELET     280
     +                    SV(J,I)                                               PELET     281
                          RD(J,I) = RD(J,I)+DSP                                   PELET     282
            250           CONTINUE                                                PELET     283
305         C   DECISION POINT FOR PLASTICITY ITERATION                          PELET     284
            260           CONTINUE                                                PELET     285
                  IF (ISSTOP.NE.1) GO TO 340                                      PELET     286
                  IF (KPLAS.GT.0.AND.KPLAS.LT.IPLEND) GO TO 170                   PELET     287
                  IF (KPLAS.EQ.IPLEND.AND.IPLAS.EQ.1) GO TO 170                   PELET     288
310               IF (KPLAS.EQ.IPLEND.AND.ISP.EQ.1) GO TO 170                     PELET     289
            270   CONTINUE                                                        PELET     290
                  DO 320 JC=1,NARC                                                PELET     291
      C                                                                           PELET     292
      C   THE FOLLOWING STRESS AND STRAIN ARRAYS ARE USED IN RADIAL AND FOR       PELET     293
315   C   THE OUTPUT                                                              PELET     294
      C                                                                           PELET     295
      C   LBL IS THE INDEX OF RADIAL STRESS IN THE CLAD ID ELEMENT, AXIAL         PELET     296
      C   LEVEL JC                                                              PELET     297
```

```
      C   LBLN IS THE INDEX OF RADIAL STRAIN                                  PELET  298
320   C                                                                        PELET  299
                LBL = ITSTSR+(JC-1)*NOEL*4+NOELF*4                           PELET  300
                LBLN = ITSTNR+(JC-1)*NOEL*4+NOELF*4                          PELET  301
      C                                                                      PELET  302
                STRSS(1,JC) = (D(LBL)+D(LBL+4))/2.                           PELET  303
325             STRSS(2,JC) = (D(LBL+1)+D(LBL+5))/2.                         PELET  304
                STRSS(4,JC) = (D(LBL+2)+D(LBL+6))/2.                         PELET  305
      C                                                                      PELET  306
                STRNN(1,JC) = (D(LBLN)+D(LBLN+4))/2.                         PELET  307
                STRNN(2,JC) = (D(LBLN+1)+D(LBLN+5))/2.                       PELET  308
330             STRNN(4,JC) = (D(LBLN+2)+D(LBLN+6))/2.                       PELET  309
      C                                                                      PELET  310
      C   LBLO IS THE INDEX OF HOOP STRESS IN THE CLAD OD ELEMENT,           PELET  311
      C   AXIAL LEVEL JC                                                     PELET  312
      C   LBLON IS THE INDEX OF HOOP STRAIN                                  PELET  313
335   C                                                                      PELET  314
                LBLO = LBL+(NOELC-2)*4+1                                     PELET  315
                LBLON = LBLN+(NOELC-2)*4+1                                   PELET  316
      C                                                                      PELET  317
                STRSS(3,JC) = (D(LBLO)+D(LBLO+4))/2.                         PELET  318
340             STRNN(3,JC) = (D(LBLON)+D(LBLON+4))/2.                       PELET  319
      C                                                                      PELET  320
      C   SAVE ELASTIC STRAINS                                               PELET  321
                IF (NKN.EQ.2) GO TO 290                                      PELET  322
                    DO 280 JN=1,4                                            PELET  323
345                 HLDN(JN,JC) = STRNN(JN,JC)                               PELET  324
          280       CONTINUE                                                 PELET  325
          290   CONTINUE                                                     PELET  326
      C                                                                      PELET  327
      C   FIND PLASTIC STRAINS                                              PELET  328
350               IF (NKN.EQ.1) GO TO 310                                    PELET  329
                      DO 300 JN=1,4                                          PELET  330
                      PLSTC(JN,JC) = STRNN(JN,JC)-HLDN(JN,JC)                PELET  331
          300         CONTINUE                                               PELET  332
          310       CONTINUE                                                 PELET  333
355   C                                                                      PELET  334
          320       CONTINUE                                                 PELET  335
          330     CONTINUE                                                   PELET  336
          340   CONTINUE                                                     PELET  337
      C                                                                      PELET  338
360   C   UNRAD IS UNIRRADIATED LENGTH OF CLAD                               PELET  339
      C   RAD IS IRRADIATED LENGTH OF CLAD                                   PELET  340
      C                                                                      PELET  341
        UNRAD = 0.0                                                          PELET  342
        RAD = 0.0                                                            PELET  343
365       DO 350 I=2,NA                                                      PELET  344
          UNRAD = DELZA(I)+UNRAD                                             PELET  345
          RAD = DELZA(I)*AXLEN(I)+RAD                                        PELET  346
          CONTINUE                                                           PELET  347
      C                                                                      PELET  348
370     GROW = RAD-UNRAD                                                     PELET  349
      C                                                                      PELET  350
```

```
                      CALL MOVEKA (0,D(IDISPC),NFF1*NABT)                                  PELET     351
                      RETURN                                                               PELET     352
                C                                                                          PELET     353
                C                                                                          PELET     354
      375       360   FORMAT (25X,"TIME EXPIRED IN PELET  =",F8.3)                         PELET     355
                370   FORMAT (5X,"PELET TIME LIMIT - CREEP CORRECTION TOO LARGE",5X,"TIM   PELET     356
                     +E EXPIRED  =",F8.3)                                                  PELET     357
                      END                                                                  PELET     358
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CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

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     228    I            CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
     236    I            CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
     268    I            CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
     270    I            CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES

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    4  PELET              1      373
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VARIABLES SN TYPE RELOCATION

```
    0  A          REAL    ARRAY   FAST      REFS      71        73
    2  ALPHA      REAL            LASTIC    REFS      91
    0  AXLEN      REAL    ARRAY    F.P.     REFS     104       367    DEFINED      1
    0  B          REAL    ARRAY   STFMAT    REFS      70
    0  BD         REAL    ARRAY    F.P.     REFS     101       169    DEFINED      1
   60  BT         REAL    ARRAY   STFMAT    REFS      70
   30  C          REAL    ARRAY   STFMAT    REFS      70
   14  COMP       REAL            GEOPAR    REFS      82    DEFINED    150
    0  COMPD      REAL             F.P.     REFS     150    DEFINED      1
   33  CP         REAL            LIMITS    REFS      84
   34  CR         REAL            LIMITS    REFS      84
    0  D          REAL    ARRAY   FAST      REFS      72        73     6*215    2*217     237      6*256     260
                                              12*271  2*274    13*276   11*284   3*287    5*288    2*324    2*325
                                               2*326  2*328     2*329    2*330   2*339    2*340     372
 1532  DELC       REAL                      REFS     214    DEFINED    213
 1531  DELF       REAL                      REFS     214    DEFINED    212
    5  DELR       REAL            GEOPAR    REFS      82
    6  DELZ       REAL            GEOPAR    REFS      82    DEFINED    214
    0  DELZA      REAL    ARRAY   BA        REFS      65       366     367
    0  DISPC      REAL    ARRAY    F.P.     REFS      99       298    DEFINED      1
 1540  DSP        REAL                      REFS     300       303    DEFINED    298
    0  DSPSV      REAL    ARRAY    F.P.     REFS      98       301    DEFINED      1      300
    0  E          REAL            LASTIC    REFS      91
  102  EAX        REAL    ARRAY   BA        REFS      65
```

VARIABLES	SN	TYPE	RELOCATION									
0	EFSTR	REAL	ARRAY	F.P.	REFS	98	DEFINED	1	260			
56	ERAD	REAL	ARRAY	BA	REFS	65						
0	EXTP	REAL		F.P.	REFS	186	197	198	DEFINED	1		
0	FFDEN	REAL		F.P.	REFS	183	DEFINED	1				
55	FLXR	REAL		BA	REFS	65						
35	FRDEN	REAL		LIMITS	REFS	84	DEFINED	183				
3	GROW	REAL		AXL	REFS	64	DEFINED	370				
0	HHF	REAL		FEP	REFS	67						
0	HLDN	REAL	ARRAY	F.P.	REFS	105	352	DEFINED	1	345		
1516	I	INTEGER			REFS	3*124	2*125	2*168	6*169	2*260	298	300
						3*301	2*303	366	2*367	DEFINED	123	166	258
						296	365					
0	IA	INTEGER	ARRAY	FAST	REFS	72	73					
57	IADJ	INTEGER		LIMITS	REFS	84	231	232	DEFINED	206		
1	IAELM	INTEGER		PNTPNL	REFS	74	215	284				
2	IAK	INTEGER		PNTPNL	REFS	74	284	287	288			
3	IARRA	INTEGER		PNTPNL	REFS	74	276	284				
4	IARE	INTEGER		PNTPNL	REFS	74	271					
6	IBA	INTEGER		PNTPNL	REFS	74	288					
7	IBASAV	INTEGER		PNTPNL	REFS	74	288					
10	IBASE	INTEGER		PNTPNL	REFS	74						
12	IBBA	INTEGER		PNTPNL	REFS	74	288					
13	IBBSV	INTEGER		PNTPNL	REFS	74	276					
14	ICA	INTEGER		PNTPNL	REFS	74	284					
15	ICC	INTEGER		PNTPNL	REFS	74	271	276				
103	ICHNG	INTEGER		FEP	REFS	67						
67	ICNT	INTEGER		LIMITS	REFS	84	DEFINED	176				
16	ICRATE	INTEGER		PNTPNL	REFS	74	256					
17	ICRPG	INTEGER		PNTPNL	REFS	74	256					
42	ICRPP	INTEGER		LIMITS	REFS	84						
60	ICUT	INTEGER		LIMITS	REFS	84	231	243	275	280		
						DEFINED	205					
5	IDF	INTEGER		LIMITS	REFS	84	DEFINED	209				
20	IDISP	INTEGER		PNTPNL	REFS	74	287					
21	IDISPC	INTEGER		PNTPNL	REFS	74	372					
22	IDSPSV	INTEGER		PNTPNL	REFS	74						
23	IEFSTR	INTEGER		PNTPNL	REFS	74	256	260				
24	IELM	INTEGER		PNTPNL	REFS	74	217	271				
25	IELSTN	INTEGER		PNTPNL	REFS	74						
30	IELSTR	INTEGER		PNTPNL	REFS	74						
32	IEPSLM	INTEGER		PNTPNL	REFS	74	271					
33	IESTNV	INTEGER		PNTPNL	REFS	74	276					
34	IESTSV	INTEGER		PNTPNL	REFS	74	276					
0	IFIRST	INTEGER		PNTPNL	REFS	74						
36	IIPOS	INTEGER		PNTPNL	REFS	74						
1533	IKL	INTEGER			REFS	236	DEFINED	229	231			
37	IKSAVE	INTEGER		PNTPNL	REFS	74	271					
106	ILAST	INTEGER		PNTPNL	REFS	74						
26	ILSTNA	INTEGER		PNTPNL	REFS	74						
27	ILSTRA	INTEGER		PNTPNL	REFS	74	276					
40	INADET	INTEGER		PNTPNL	REFS	74	215	284	287	288		
41	INDC	INTEGER		PNTPNL	REFS	74						
42	INDF	INTEGER		PNTPNL	REFS	74						

VARIABLES	SN	TYPE	RELOCATION							
43	INDT	INTEGER	PNTPNL	REFS	74					
44	INODET	INTEGER	PNTPNL	REFS	74	217	271	274	276	
45	IOLDSE	INTEGER	PNTPNL	REFS	74					
40	IPLAS	INTEGER	LIMITS	REFS	84	309	DEFINED	239	248	
73	IPLEND	INTEGER	LIMITS	REFS	84	308	309	310		
1527	IPREV	INTEGER		REFS	280	DEFINED	204	275		
31	IPSLA	INTEGER	PNTPNL	REFS	74	284				
46	IPSSRT	INTEGER	PNTPNL	REFS	74					
47	IPSSV	INTEGER	PNTPNL	REFS	74					
50	IPSTS	INTEGER	PNTPNL	REFS	74					
51	IR	INTEGER	PNTPNL	REFS	74	215	271	276		
52	IRA	INTEGER	PNTPNL	REFS	74	215	284			
71	IRAK	INTEGER	LIMITS	REFS	84	DEFINED	240			
53	IRBR	INTEGER	PNTPNL	REFS	74	271				
54	IRBRA	INTEGER	PNTPNL	REFS	74	276	284			
55	IRD	INTEGER	PNTPNL	REFS	74					
75	IRZ	INTEGER	LIMITS	REFS	84	121	122	173	184	210
5	ISB	INTEGER	PNTPNL	REFS	74	276				
11	ISBB	INTEGER	PNTPNL	REFS	74	276				
74	ISP	INTEGER	LIMITS	REFS	84	310	DEFINED	179		
37	ISSTOP	INTEGER	LIMITS	REFS	84	299	300	307	DEFINED	148
3	ISTOP	INTEGER	FEP	REFS	67	191	DEFINED	147		
56	ISTRES	INTEGER	PNTPNL	REFS	74	271				
57	ISTRSA	INTEGER	PNTPNL	REFS	74	284				
53	ISTRT	INTEGER	BA	REFS	65					
60	ITCB	INTEGER	PNTPNL	REFS	74					
61	ITCRP	INTEGER	PNTPNL	REFS	74	237	256			
62	ITEC	INTEGER	PNTPNL	REFS	74					
63	ITEF	INTEGER	PNTPNL	REFS	74					
64	ITELM	INTEGER	PNTPNL	REFS	74					
54	ITER	INTEGER	BA	REFS	65					
65	ITFB	INTEGER	PNTPNL	REFS	74					
66	ITHET	INTEGER	PNTPNL	REFS	74	276				
70	ITHSAV	INTEGER	PNTPNL	REFS	74					
67	ITHTAX	INTEGER	PNTPNL	REFS	74					
71	ITHXSV	INTEGER	PNTPNL	REFS	74					
63	ITI	INTEGER	LIMITS	REFS	84	244	DEFINED	236		
72	ITME	INTEGER	PNTPNL	REFS	74					
4	ITP1	INTEGER	TAPES	REFS	93					
5	ITP2	INTEGER	TAPES	REFS	93					
73	ITSTNR	INTEGER	PNTPNL	REFS	74	256	322			
74	ITSTSR	INTEGER	PNTPNL	REFS	74	256	321			
75	ITV	INTEGER	PNTPNL	REFS	74					
76	ITW	INTEGER	PNTPNL	REFS	74					
77	IXKT	INTEGER	PNTPNL	REFS	74	271	274	276		
100	IXLOAD	INTEGER	PNTPNL	REFS	74	271				
101	IXLODA	INTEGER	PNTPNL	REFS	74	284				
102	IXRD	INTEGER	PNTPNL	REFS	74					
0	IXTOP	INTEGER	F.P.	REFS	147	DEFINED	1			
103	IY	INTEGER	PNTPNL	REFS	74	215				
104	IYACF	INTEGER	PNTPNL	REFS	74	215	284			
105	IZ	INTEGER	PNTPNL	REFS	74	271				
1522	J	INTEGER		REFS	3*168	2*260	298	300	3*301	2*303

VARIABLES	SN	TYPE	RELOCATION									
				DEFINED	167	259	297					
24	JAM	INTEGER	LIMITS	REFS	84	DEFINED	175	211				
1541	JC	INTEGER		REFS	321	322	324	325	326	328	329	
				330	339	340	2*345	3*352	DEFINED	312		
35	JIIJ	INTEGER	PNTPNL	REFS	74							
1546	JN	INTEGER		REFS	2*345	3*352	DEFINED	344	351			
12	KA	INTEGER	LIMITS	REFS	84	DEFINED	270					
10	KKA	INTEGER	GEOPAR	REFS	82	269	283	DEFINED	268			
2	KKZZZ	INTEGER	FEP	REFS	67							
66	KPLAS	INTEGER	LIMITS	REFS	84	301	2*308	309	310			
				DEFINED	177							
55	KRNCH	INTEGER	LIMITS	REFS	84							
45	KRNCHC	INTEGER	LIMITS	REFS	84							
44	KRNCHF	INTEGER	LIMITS	REFS	84							
46	KRNCHT	INTEGER	LIMITS	REFS	84							
0	KZ	INTEGER	F.P.	REFS	191	238	DEFINED	1				
36	KZI	INTEGER	LIMITS	REFS	84	DEFINED	238					
1542	LBL	INTEGER		REFS	2*324	2*325	2*326	336	DEFINED	321		
1543	LBLN	INTEGER		REFS	2*328	2*329	2*330	337	DEFINED	322		
1544	LBLO	INTEGER		REFS	2*339	DEFINED	336					
1545	LBLON	INTEGER		REFS	2*340	DEFINED	337					
1536	LO	INTEGER		REFS	297	DEFINED	294					
52	MAXA	INTEGER	LIMITS	REFS	84							
43	MAXT	INTEGER	LIMITS	REFS	84	274	276					
56	MCUD	INTEGER	LIMITS	REFS	84							
0	NA	INTEGER	F.P.	REFS	95	2*100	101	104	4*105	122	135	
				166	365	DEFINED	1					
17	NABC	INTEGER	LIMITS	REFS	84	DEFINED	143					
16	NABF	INTEGER	LIMITS	REFS	84	142	173	271	276			
0	NABFD	INTEGER	F.P.	REFS	96	DEFINED	1					
31	NABF2	INTEGER	LIMITS	REFS	84							
20	NABT	INTEGER	LIMITS	REFS	84	143	157	372				
32	NABT2	INTEGER	LIMITS	REFS	84	215						
0	NAB2D	INTEGER *UNUSED	F.P.	DEFINED	1							
21	NAEC	INTEGER	LIMITS	REFS	84	DEFINED	146					
22	NAEF	INTEGER	LIMITS	REFS	84	146						
14	NARC	INTEGER	LIMITS	REFS	84	145	237	256	270	296	312	
				DEFINED	144							
0	NARCD	INTEGER	F.P.	REFS	144	DEFINED	1					
13	NARF	INTEGER	LIMITS	REFS	84	123	258	276	DEFINED	142		
15	NART	INTEGER	LIMITS	REFS	84	173	DEFINED	145				
25	NAXBT	INTEGER	LIMITS	REFS	84							
26	NAXB2	INTEGER	LIMITS	REFS	84							
27	NAXB4	INTEGER	LIMITS	REFS	84							
1	NC	INTEGER	LIMITS	REFS	84	139	141	169	172	173	213	
				DEFINED	137							
0	NCD	INTEGER	F.P.	REFS	102	137	DEFINED	1				
52	NCNN	INTEGER	BA	REFS	65							
51	NCONN	INTEGER	BA	REFS	65							
1521	NC1	INTEGER		REFS	172	173	DEFINED	139				
50	NC4	INTEGER	LIMITS	REFS	84							
7	NETOT	INTEGER	LIMITS	REFS	84							
53	NEW	INTEGER	LIMITS	REFS	84	173						

VARIABLES	SN	TYPE	RELOCATION								
10 NEWF		INTEGER	LIMITS	REFS	84						
11 NEWT		INTEGER	LIMITS	REFS	84						
0 NF		INTEGER	LIMITS	REFS	84	138	140	169	172	173	2*212
				213	295	DEFINED	136				
0 NFD		INTEGER	F.P.	REFS	102	136	DEFINED	1			
6 NFF		INTEGER	LIMITS	REFS	84						
30 NFFI		INTEGER	LIMITS	REFS	84	167	213	215	271	297	372
0 NFFID		INTEGER	F.P.	REFS	2*99	102	173	DEFINED	1		
47 NFF2		INTEGER	LIMITS	REFS	84	276					
1537 NFPI	*	INTEGER		DEFINED	295						
1520 NFI		INTEGER		REFS	172	173	DEFINED	138			
51 NF4		INTEGER	LIMITS	REFS	84						
0 NIN		INTEGER	TAPES	REFS	93						
41 NKN		INTEGER	LIMITS	REFS	84	241	300	301	343	350	
				DEFINED	228						
54 NMX		INTEGER	LIMITS	REFS	84						
50 NN		INTEGER	BA	REFS	65						
2 NOEL		INTEGER	LIMITS	REFS	84	237	256	259	260	271	276
				321	322						
4 NOELC		INTEGER	LIMITS	REFS	84	336	337	DEFINED	141		
0 NOELD		INTEGER	F.P.	REFS	96	2*98	173	DEFINED	1		
3 NOELF		INTEGER	LIMITS	REFS	84	321	322	DEFINED	140		
65 NOLD		INTEGER	LIMITS	REFS	84	173					
1 NOUT		INTEGER	TAPES	REFS	93						
2 NSCR1		INTEGER	TAPES	REFS	93						
3 NSCR2		INTEGER	TAPES	REFS	93						
0 NSH		INTEGER	F.P.	REFS	256	DEFINED	1				
1 NT		INTEGER	FEP	REFS	67	172	173	DEFINED	135		
23 NTAE		INTEGER	LIMITS	REFS	84	146	284				
0 NTAED		INTEGER	F.P.	REFS	96	173	DEFINED	1			
57 NTOLD		INTEGER ARRAY	FEP	REFS	67						
15 PDEL		REAL	GEOPAR	REFS	82	199	DEFINED	190	198		
0 PI		REAL	CONTNT	REFS	92	DEFINED	151				
11 PIN		REAL	GEOPAR	REFS	82	200	DEFINED	188	196		
1524 PINNEW		REAL		REFS	187	188	194	DEFINED	185		
54 PINOLD		REAL	FEP	REFS	67	188	DEFINED	194	200		
0 PLSTC		REAL ARRAY	F.P.	REFS	105	122	DEFINED	1	352		
1526 PNEW		REAL		REFS	190	192	DEFINED	187			
56 POLD		REAL	FEP	REFS	67	190	DEFINED	192	199		
12 POUT		REAL	GEOPAR	REFS	82	201	DEFINED	189	197		
55 POUTLD		REAL	FEP	REFS	67	189	DEFINED	193	201		
1525 POUTNW		REAL		REFS	187	189	193	DEFINED	186		
0 PRESTO		REAL	F.P.	REFS	185	196	198	DEFINED	1		
0 PRG		REAL ARRAY	F.P.	REFS	95	124	125	DEFINED	1		
110 PROD		REAL ARRAY	STFMAT	REFS	70						
0 PRSINC		REAL ARRAY	PRSSV	REFS	94	121	DEFINED	124			
24 PRSS		REAL ARRAY	PRSSV	REFS	94	124	DEFINED	125			
1550 RAD		REAL		REFS	367	370	DEFINED	364	367		
72 RAKSUM		REAL	LIMITS	REFS	84	DEFINED	178				
0 RC		REAL	F.P.	REFS	155	DEFINED	1				
2 RCI		REAL	GEOPAR	REFS	82	DEFINED	131				
3 RCO		REAL	GEOPAR	REFS	82	DEFINED	132				
0 RD		REAL ARRAY	F.P.	REFS	99	2*168	173	212	2*213	215	271

VARIABLES	SN	TYPE	RELOCATION									
					301	303	DEFINED	1	301	303		
4	RDOLD	REAL	ARRAY	FEP	REFS	67						
0	RFI	REAL		GEOPAR	REFS	82	DEFINED	155				
1	RFO	REAL		GEOPAR	REFS	82	DEFINED	134				
1517	RFS	REAL			REFS	134	DEFINED	133				
0	RFX	REAL		F.P.	REFS	133	DEFINED	1				
70	RRAKR	REAL		LIMITS	REFS	84						
30	RRSIN	REAL	ARRAY	FEP	REFS	67						
0	RXI	REAL		F.P.	REFS	131	DEFINED	1				
0	RXO	REAL		F.P.	REFS	132	DEFINED	1				
64	STEP	REAL		LIMITS	REFS	84	244	246	DEFINED	232		
104	STEPS	REAL		FEP	REFS	67						
0	STRNN	REAL	ARRAY	F.P.	REFS	105	345	352	DEFINED	1	328	329
					330	340						
0	STRSS	REAL	ARRAY	F.P.	REFS	105	DEFINED	1	324	325	326	339
1	SUMFF	REAL		AXL	REFS	64						
0	SUMM	REAL		AXL	REFS	64						
2	SUMSAV	REAL		AXL	REFS	64						
0	TBLK	REAL		F.P.	REFS	157	172	DEFINED	1			
0	TCB	REAL	ARRAY	F.P.	REFS	102	157	172	173	DEFINED	1	
0	TCI	REAL	ARRAY	F.P.	REFS	100	169	DEFINED	1			
0	TCO	REAL	ARRAY	F.P.	REFS	100	169	DEFINED	1			
0	TEC	REAL	ARRAY	F.P.	REFS	102	169	172	173	DEFINED	1	
0	TEF	REAL	ARRAY	F.P.	REFS	102	169	172	173	DEFINED	1	
0	TELM	REAL	ARRAY	F.P.	REFS	96	173	256	271	276		
					DEFINED	1						
0	TFB	REAL	ARRAY	F.P.	REFS	102	157	172	173	DEFINED	1	
61	TIMEC	REAL		LIMITS	REFS	84	DEFINED	245				
62	TIMEF	REAL		LIMITS	REFS	84	232	DEFINED	207			
1530	TIMEN	REAL			REFS	232	244	DEFINED	208			
0	TINLET	REAL		F.P.	REFS	157	172	DEFINED	1			
1535	TMDEL	REAL			REFS	251	252	253	DEFINED	250		
1523	TM1	REAL			REFS	180	250					
1534	TM2	REAL			REFS	249	250					
0	TPLEN	REAL		F.P.	REFS	157	172	DEFINED	1			
4	TREF	REAL		GEOPAR	REFS	82	173	DEFINED	149			
0	TREFD	REAL		F.P.	REFS	149	DEFINED	1				
0	TTME	REAL	ARRAY	F.P.	REFS	97	207	208	245	246	256	
					DEFINED	1	244	246				
0	TV	REAL	ARRAY	F.P.	REFS	102	169	173	DEFINED	1		
0	TW	REAL	ARRAY	F.P.	REFS	96	173	284	288	DEFINED	1	
1547	UNRAD	REAL			REFS	366	370	DEFINED	363	366		
140	XKBAR	REAL	ARRAY	STFMAT	REFS	70						
1	XNU	REAL		LASTIC	REFS	91						
0	XRD	REAL	ARRAY	F.P.	REFS	102	169	DEFINED	1	168		
7	ZDEL	REAL		GEOPAR	REFS	82						

FILE NAMES	MODE				
TAPE6	FMT		WRITES	251	253

EXTERNALS	TYPE	ARGS	REFERENCES
ABOUND		3	287
ASOLVE		6	288

EXTERNALS	TYPE	ARGS	REFERENCES			
BOUND		3	274			
INPAXL		9	215			
INPUT		2	217			
KREEP		11	256			
MOVEKA		3	121	122	237	372
SECOND		-1	180	249		
SOLVET		19	276			
STFAXL		13	284			
STIFF		17	271			
TEMPA		6	157			
TEMPB		9	169			
TEMPC		12	172			
TEMPD		22	173			

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES			
FLOAT	REAL	1	INTRIN	212	213	232	244

STATEMENT LABELS			DEF LINE	REFERENCES		
0	100		126	123		
0	110		168	167		
0	120		171	166		
304	130		196	184		
322	140		202	191	195	
410	150		218	210		
415	160		230	280		
447	170		242	308	309	310
464	180		247	243		
505	190		255	252		
0	200		261	258	259	
545	210		262	241		
0	220		281	270		
651	230		282	269		
723	240		290	268	283	
1000	250		304	297	299	
0	260		306	296		
0	270		311	236		
0	280		346	344		
1145	290		347	343		
0	300		353	251		
1162	310		354	350		
0	320		356	312		
0	330		357	228		
1171	340		358	307		
0	350		368	365		
1472	360	FMT	376	251		
1477	370	FMT	377	253		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
33	100	I	123 126	11B	INSTACK
142	120	I	166 171	32B	EXT REFS NOT INNER
144	110	J	167 168	10B	INSTACK
412	330	NKN	228 357	556B	EXT REFS EXITS NOT INNER
427	270	ITI	236 311	405B	EXT REFS EXITS NOT INNER

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
525	200	I	258 261	17B		NOT INNER		
527	200	J	259 261	12B	INSTACK			
547	240	KKA	268 290	157B		EXT REFS	EXITS	NOT INNER
554	220	KA	270 281	74B		EXT REFS	EXITS	
735	260	I	296 306	51B		NOT INNER		
737	250	J	297 304	44B	OPT			
1036	320	JC	312 356	127B		NOT INNER		
1135	280	JN	344 346	7B	INSTACK			
1152	300	JN	351 353	7B	INSTACK			
1177	350	I	365 368	12B	INSTACK			

COMMON BLOCKS	LENGTH
AXL	4
BA	86
FEP	69
STFMAT	132
FAST	1
PNTPNL	71
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
PRSSV	40

STATISTICS

PROGRAM LENGTH	1630B	920
SCM LABELED COMMON LENGTH	750B	488

140000B SCM USED

```
      SUBROUTINE ABOUND (AK,DISPA,NADET)                                ABOUND     2
C                                                                       ABOUND     3
C   THE PURPOSE OF THIS SUBROUTINE IS TO DEFINE THE INITIAL BOUNDARY    ABOUND     4
C   CONDITIONS FOR THE AXIAL FINITE ELEMENT MODEL.  IT USES THE         ABOUND     5
C   STIFFNESS MATRIX AK(I,J) WHERE I,J=ARE EQUAL TO THE TOTAL           ABOUND     6
C   DEGREES OF FREEDOM IN THE PROBLEM                                   ABOUND     7
C                                                                       ABOUND     8
C   ABOUND IS CALLED FROM PELET                                         ABOUND     9
C                                                                       ABOUND    10
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P PELCOM     2
     +DEL,COMP                                                          PELCOM     3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,    NE PELCOM     4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT, PELCOM     5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN PELCOM     6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,         N PELCOM     7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                 PELCOM     8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                         PELCOM     9
     +,IRZ                                                              PELCOM    10
      COMMON /LASTIC/ E,XNU,ALPHA                                       PELCOM    11
      COMMON /CONTNT/ PI                                                PELCOM    12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                     PELCOM    13
C                                                                       ABOUND    12
      DIMENSION AK(1), DISPA(1), NADET(1)                               ABOUND    13
      DIMENSION LKNT(26)                                                ABOUND    14
      INTEGER BND(4)                                                    ABOUND    15
C                                                                       ABOUND    16
C                                                                       ABOUND    17
      LKNT(1) = 1                                                       ABOUND    18
          DO 100 I=2,26                                                 ABOUND    19
          LKNT(I) = LKNT(I-1)+1                                         ABOUND    20
  100     CONTINUE                                                      ABOUND    21
C                                                                       ABOUND    22
C                                                                       ABOUND    23
C   THIS IS THE TOTAL DEGREES OF FREEDOM                                ABOUND    24
C                                                                       ABOUND    25
      BND(1) = 1                                                        ABOUND    26
      BND(2) = NABF+1                                                   ABOUND    27
      BND(3) = NABF*2+1                                                 ABOUND    28
      BND(4) = NABF*2+NABT+1                                            ABOUND    29
C                                                                       ABOUND    30
          DO 130 I=1,4                                                  ABOUND    31
          IOUT = BND(I)                                                 ABOUND    32
          II = NADET(IOUT)+1                                            ABOUND    33
C                                                                       ABOUND    34
          MM = MCUD                                                     ABOUND    35
          IF (II.GE.KRNCH) MM = MCUD-(II-KRNCH)-1                       ABOUND    36
              DO 110 KM=1,MM                                            ABOUND    37
              IM = (II-1)*MCUD+KM                                       ABOUND    38
              NM = II-KRNCH                                             ABOUND    39
              IF (NM.GT.0) IM = IM-LKNT(NM)                             ABOUND    40
              AK(IM) = 0.0                                              ABOUND    41
  110         CONTINUE                                                  ABOUND    42
          MA = MCUD-1                                                   ABOUND    43
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                      IF (II.LE.MA) MA = II-1                                    ABOUND     44
55                        DO 120 KM=1,MA                                         ABOUND     45
                          IJ = II-KM                                             ABOUND     46
                          IM = MCUD*(IJ-1)+II-IJ+1                               ABOUND     47
                          IF (IJ.GT.KRNCH) IM = IM-LKNT(IJ-KRNCH)                ABOUND     48
                          AK(IM) = 0.0                                           ABOUND     49
60          120           CONTINUE                                               ABOUND     50
                      IM = (II-1)*MCUD+1                                         ABOUND     51
                      NM = II-KRNCH                                              ABOUND     52
                      IF (NM.GT.0) IM = IM-LKNT(NM)                              ABOUND     53
                      AK(IM) = 1.0                                               ABOUND     54
65                    DISPA(II) = 0.0                                            ABOUND     55
              130     CONTINUE                                                   ABOUND     56
              C                                                                  ABOUND     57
              C   HAVE COMPUTED THE CORRECT BOUNDARY CONDITION                    ABOUND     58
              C                                                                  ABOUND     59
70                RETURN                                                         ABOUND     60
                  END                                                            ABOUND     61
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 ABOUND 1 70

VARIABLES	SN	TYPE		RELOCATION									
0	AK	REAL	ARRAY	F.P.	REFS	23	DEFINED	1	51	59	64		
2	ALPHA	REAL		LASTIC	REFS	19							
221	BND	INTEGER	ARRAY		REFS	25	42	DEFINED	36	37	38	39	
14	COMP	REAL		GEOPAR	REFS	10							
33	CP	REAL		LIMITS	REFS	12							
34	CR	REAL		LIMITS	REFS	12							
5	DELR	REAL		GEOPAR	REFS	10							
6	DELZ	REAL		GEOPAR	REFS	10							
0	DISPA	REAL	ARRAY	F.P.	REFS	23	DEFINED	1	65				
0	E	REAL		LASTIC	REFS	19							
35	FRDEN	REAL		LIMITS	REFS	12							
156	I	INTEGER			REFS	3*30	42	DEFINED	29	41			
57	IADJ	INTEGER		LIMITS	REFS	12							
67	ICNT	INTEGER		LIMITS	REFS	12							
42	ICRPP	INTEGER		LIMITS	REFS	12							
60	ICUT	INTEGER		LIMITS	REFS	12							
5	IDF	INTEGER		LIMITS	REFS	12							
160	II	INTEGER			REFS	2*46	48	49	2*54	56	57	61	
					62	65	DEFINED	43					
166	IJ	INTEGER			REFS	2*57	2*58	DEFINED	56				
163	IM	INTEGER			REFS	50	51	58	59	63	64		
					DEFINED	48	50	57	58	61	63		
157	IOUT	INTEGER			REFS	43	DEFINED	42					
40	IPLAS	INTEGER		LIMITS	REFS	12							

VARIABLES	SN	TYPE		RELOCATION								
73	IPLEND	INTEGER		LIMITS	REFS	12						
71	IRAK	INTEGER		LIMITS	REFS	12						
75	IRZ	INTEGER		LIMITS	REFS	12						
74	ISP	INTEGER		LIMITS	REFS	12						
37	ISSTOP	INTEGER		LIMITS	REFS	12						
63	ITI	INTEGER		LIMITS	REFS	12						
4	ITP1	INTEGER		TAPES	REFS	21						
5	ITP2	INTEGER		TAPES	REFS	21						
24	JAM	INTEGER		LIMITS	REFS	12						
12	KA	INTEGER		LIMITS	REFS	12						
10	KKA	INTEGER		GEOPAR	REFS	10						
162	KM	INTEGER			REFS	48	56	DEFINED	47	55		
66	KPLAS	INTEGER		LIMITS	REFS	12						
55	KRNCH	INTEGER		LIMITS	REFS	12	2*46	49	2*58	62		
45	KRNCHC	INTEGER		LIMITS	REFS	12						
44	KRNCHF	INTEGER		LIMITS	REFS	12						
46	KRNCHT	INTEGER		LIMITS	REFS	12						
36	KZI	INTEGER		LIMITS	REFS	12						
167	LKNT	INTEGER	ARRAY		REFS	24	30	50	58	63		
					DEFINED	28	30					
165	MA	INTEGER			REFS	54	55	DEFINED	53	54		
52	MAXA	INTEGER		LIMITS	REFS	12						
43	MAXT	INTEGER		LIMITS	REFS	12						
56	MCUD	INTEGER		LIMITS	REFS	12	45	46	48	53	57	61
161	MM	INTEGER			REFS	47	DEFINED	45	46			
17	NABC	INTEGER		LIMITS	REFS	12						
16	NABF	INTEGER		LIMITS	REFS	12	37	38	39			
31	NABF2	INTEGER		LIMITS	REFS	12						
20	NABT	INTEGER		LIMITS	REFS	12	39					
32	NABT2	INTEGER		LIMITS	REFS	12						
0	NADET	INTEGER	ARRAY	F.P.	REFS	23	43	DEFINED				
21	NAEC	INTEGER		LIMITS	REFS	12						
22	NAEF	INTEGER		LIMITS	REFS	12						
14	NARC	INTEGER		LIMITS	REFS	12						
13	NARF	INTEGER		LIMITS	REFS	12						
15	NART	INTEGER		LIMITS	REFS	12						
25	NAXBT	INTEGER		LIMITS	REFS	12						
26	NAXB2	INTEGER		LIMITS	REFS	12						
27	NAXB4	INTEGER		LIMITS	REFS	12						
1	NC	INTEGER		LIMITS	REFS	12						
50	NC4	INTEGER		LIMITS	REFS	12						
7	NETOT	INTEGER		LIMITS	REFS	12						
53	NEW	INTEGER		LIMITS	REFS	12						
10	NEWF	INTEGER		LIMITS	REFS	12						
11	NEWT	INTEGER		LIMITS	REFS	12						
0	NF	INTEGER		LIMITS	REFS	12						
6	NFF	INTEGER		LIMITS	REFS	12						
30	NFF1	INTEGER		LIMITS	REFS	12						
47	NFF2	INTEGER		LIMITS	REFS	12						
51	NF4	INTEGER		LIMITS	REFS	12						
0	NIN	INTEGER		TAPES	REFS	21						
41	NKN	INTEGER		LIMITS	REFS	12						
164	NM	INTEGER			REFS	2*50	2*63	DEFINED	49	62		

VARIABLES	SN	TYPE	RELOCATION		
54	NMX	INTEGER	LIMITS	REFS	12
2	NOEL	INTEGER	LIMITS	REFS	12
4	NOELC	INTEGER	LIMITS	REFS	12
3	NOELF	INTEGER	LIMITS	REFS	12
65	NOLD	INTEGER	LIMITS	REFS	12
1	NOUT	INTEGER	TAPES	REFS	21
2	NSCR1	INTEGER	TAPES	REFS	21
3	NSCR2	INTEGER	TAPES	REFS	21
23	NTAE	INTEGER	LIMITS	REFS	12
13	PDEL	REAL	GEOPAR	REFS	10
0	PI	REAL	CONTNT	REFS	20
11	PIN	REAL	GEOPAR	REFS	10
12	POUT	REAL	GEOPAR	REFS	10
72	RAKSUM	REAL	LIMITS	REFS	12
2	RCI	REAL	GEOPAR	REFS	10
3	RCO	REAL	GEOPAR	REFS	10
0	RFI	REAL	GEOPAR	REFS	10
1	RFO	REAL	GEOPAR	REFS	10
70	RRAKR	REAL	LIMITS	REFS	12
64	STEP	REAL	LIMITS	REFS	12
61	TIMEC	REAL	LIMITS	REFS	12
62	TIMEF	REAL	LIMITS	REFS	12
4	TREF	REAL	GEOPAR	REFS	10
1	XNU	REAL	LASTIC	REFS	19
2	ZDEL	REAL	GEOPAR	REFS	10

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	31	29
0	110	52	47
0	120	60	55
0	130	66	41

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
13	100	I	29 31	6B	INSTACK
37	130	I	41 66	115B	NOT INNER
56	110	KM	47 52	20B	OPT
107	120	KM	55 60	22B	OPT

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6

STATISTICS

PROGRAM LENGTH	233B	155
SCM LABELED COMMON LENGTH	125B	85

140000B SCM USED

```
      SUBROUTINE ALOAD (AELM,ARAA,BA,NADET,RBRA,RA,TW,CA,THETAX,XLOADA,Y
     +ACF,TCRP,NOELD,NTAED,BBA,NABTD,ARE,RBR,TSTSR,RD,Y,NFFID,NAB2D,THXS
     +V)
C
C   PURPOSE OF THIS SUBROUTINE IS TO DEFINE THE AXIAL AND RADIAL LOADS
C   FOR THE SOLUTION OF THE AXIAL PROBLEM
C   COMPUTE THE CORRECT CONCENTRATED NODAL LOADS FOR
C   A. APPLIED LOADS
C   B.THERMAL LOADS
C   C.CREEP LOADS
C   D.ELASTIC LOADS
C
C   ALOAD IS CALLED FROM ASOLVE
C
C
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P
     +DEL,COMP
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,
     +NAXB2,NAXB4,NFFI,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISSTOP,IPLAS,NKN
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP
     +,IRZ
      COMMON /LASTIC/ E,XNU,ALPHA
      COMMON /CONTNT/ PI
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2
      DIMENSION RA(1), YACF(1), NADET(1), BBA(1), BA(1), TW(NTAED,2), AR
     +AA(1),RBRA(1),XLOADA(6,4,1),THERM(6),AELM(3,1)
      DIMENSION NNA(3), IBN(4), CA(4,4,1), THETAX(4,1)
      DIMENSION AVCRP(4), TCRP(4,NOELD,1)
      DIMENSION TSTSR(4,NOELD,1), RD(NFFID,1), Y(NAB2D,1)
      DIMENSION ARE(1), RBR(1)
      DIMENSION THXSV(4,1)
C
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,
     +   ERAD(20), EAX(20)
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)
     +,PINOLD,POUTLD,POLD,NTOLD(20)
     + ,ICHNG,STEPS
C
C   NKN    - PLASTIC-ELASTIC IDENTIFIER FROM PELET
C   POUT   - SYSTEM PRESSURE
C   PIN    - ROD PRESSURE
C   RCO    - CLAD OUTER RADIUS
C   RCI    - CLAD INNER RADIUS
C   ALPHA  - THERMAL STRAIN
C   AVCRP  - CREEP STRAIN
C
C
      CALL MOVEKA (0,AVCRP,4)
      CALL MOVEKA (0,THETAX,4*NTAE)
          DO 100 I=1,6
```

```
                THERM(I) = 0.0                                                  ALOAD   40
55          100 CONTINUE                                                        ALOAD   41
            IF (NKN.EQ.2) GO TO 120                                             ALOAD   42
            NOUT = 2*NABF+NABT+1                                                ALOAD   43
      C                                                                         ALOAD   44
      C   NOW COMPUTE THE AXIAL LOAD                                            ALOAD   45
60    C   NOW DIVIDE OVER ALL OF THIS AXIAL CLAD NODES                          ALOAD   46
      C   TOTAL NODAL LINE LENGTH                                              ALOAD   47
      C                                                                         ALOAD   48
      C   COMPUTE THE LINE LOAD                                                ALOAD   49
      C                                                                         ALOAD   50
65          SIG = POUT*PI*RCO**2-PIN*PI*RCI**2                                ALOAD   51
            XLINE = PI*(2*(RCI+RCO))                                            ALOAD   52
            ZF = SIG/XLINE                                                      ALOAD   53
            ZF = -ZF                                                            ALOAD   54
            NIN = 2*NABF+NABT                                                   ALOAD   55
70          II = NADET(NIN)                                                     ALOAD   56
      C   MUST ADD 1 TO II FOR VERTICAL D.O.F.                                  ALOAD   57
            BBA(II+1) = BBA(II+1)+ZF*2*PI*RCI                                   ALOAD   58
            BA(II+1) = BBA(II+1)                                                ALOAD   59
            NOUT = 2*(NABF+NABT)                                                ALOAD   60
75          II = NADET(NOUT)                                                    ALOAD   61
            BBA(II+1) = BBA(II+1)+ZF*2*PI*RCO                                   ALOAD   62
            BA(II+1) = BBA(II+1)                                                ALOAD   63
      C   HAVE NOW COMPUTED THE LOAD VECTOR COMPONENTS DUE TO EXTERNAL          ALOAD   64
      C   PRESSURE NOW COMPUTE THE THERMAL EXPANSION LOADS.                     ALOAD   65
80    C                                                                         ALOAD   66
      C                                                                         ALOAD   67
      C   NOW COMPUTE THE RADIAL PRESSURE LOADS                                ALOAD   68
      C                                                                         ALOAD   69
            NSTART = 2*NABF                                                     ALOAD   70
85          FRO = PI*2.0*RCO*POUT                                               ALOAD   71
            FRI = PI*2.0*RCI*PIN                                                ALOAD   72
            KIN = NSTART                                                        ALOAD   73
            KOUT = NIN                                                          ALOAD   74
                DO 110 I=1,NART                                                 ALOAD   75
90              KIN = KIN+1                                                     ALOAD   76
                KOUT = KOUT+1                                                   ALOAD   77
                II = NADET(KIN)                                                 ALOAD   78
                III = NADET(KIN+1)                                              ALOAD   79
                IJ = NADET(KOUT)                                                ALOAD   80
95              IJJ = NADET(KOUT+1)                                             ALOAD   81
                FI = FRI*(YACF(KIN+1)-YACF(KIN))/2.0                            ALOAD   82
                FO = -FRO*(YACF(KOUT+1)-YACF(KOUT))/2.0                         ALOAD   83
                BBA(II) = BBA(II)+FI                                            ALOAD   84
                BA(II) = BBA(II)                                                ALOAD   85
100             BBA(III) = BBA(III)+FI                                          ALOAD   86
                BA(III) = BBA(III)                                              ALOAD   87
                BBA(IJ) = BBA(IJ)+FO                                            ALOAD   88
                BA(IJ) = BBA(IJ)                                                ALOAD   89
                BBA(IJJ) = BBA(IJJ)+FO                                          ALOAD   90
105             BA(IJJ) = BBA(IJJ)                                              ALOAD   91
          110   CONTINUE                                                        ALOAD   92
```

```
      120   CONTINUE                                                          ALOAD   93
            BIGT = 0.0                                                        ALOAD   94
                DO 130 I=1,4                                                  ALOAD   95
110             BIGT = BIGT+RBRA(I)                                           ALOAD   96
      130       CONTINUE                                                      ALOAD   97
                DO 310 K=1,NTAE                                               ALOAD   98
      C                                                                       ALOAD   99
                IF (NKN.EQ.2) GO TO 180                                       ALOAD  100
115   C   CALL TERP FOR ALPHA USING THE WEIGHTED TEMPERATURES TW(K)           ALOAD  101
      C                                                                       ALOAD  102
                IF (K.GT.NAEF) GO TO 160                                      ALOAD  103
                LA = (K+3)/4                                                  ALOAD  104
                IT = 4*LA                                                     ALOAD  105
120             BIG = 0.0                                                     ALOAD  106
                    DO 150 I=1,4                                              ALOAD  107
                    FAC = RBRA(IT-I+1)/BIGT                                   ALOAD  108
                    TWW = TW(IT-I+1,NEW)                                      ALOAD  109
                    TWC = (TWW-32.)/1.8                                       ALOAD  110
125   C   DEGREES K FOR CALLS TO MATPRO ROUTINES                              ALOAD  111
                    TWK = TWC+273.15                                          ALOAD  112
                    ALPHA = FTHEXP(TWK,0)                                     ALOAD  113
                    IF (IRZ.GT.1) GO TO 140                                   ALOAD  114
                    THET = ALPHA*FAC                                          ALOAD  115
130                 BIG = BIG+THET                                            ALOAD  116
                    GO TO 150                                                 ALOAD  117
      140           CONTINUE                                                  ALOAD  118
                    ALPH1 = ALPHA                                             ALOAD  119
                    TLD = (TW(IT-I+1,NOLD)-32.)/1.8+273.15                    ALOAD  120
135                 ALPH2 = FTHEXP(TLD,0)                                     ALOAD  121
                    THET = (ALPH1-ALPH2)*FAC                                  ALOAD  122
                    BIG = BIG+THET                                            ALOAD  123
      150           CONTINUE                                                  ALOAD  124
                THET = BIG                                                    ALOAD  125
140             GO TO 180                                                     ALOAD  126
      160       CONTINUE                                                      ALOAD  127
                TWW = TW(K,NEW)                                               ALOAD  128
                TWC = (TWW-32.)/1.8                                           ALOAD  129
                TWK = TWC+273.15                                              ALOAD  130
145             CALL CTHEXP (TWK,ALPHA,0.0)                                   ALOAD  131
                IF (IRZ.GT.1) GO TO 170                                       ALOAD  132
                THET = ALPHA                                                  ALOAD  133
                GO TO 180                                                     ALOAD  134
      170       TLD = (TW(K,NOLD)-32.)/1.8+273.15                             ALOAD  135
150             ALPH1 = ALPHA                                                 ALOAD  136
                CALL CTHEXP (TLD,ALPH2,0.0)                                   ALOAD  137
                THET = ALPH1-ALPH2                                            ALOAD  138
      180       CONTINUE                                                      ALOAD  139
                IF (NKN.EQ.2) THET = 0.0                                      ALOAD  140
155             IF (NKN.EQ.1) GO TO 240                                       ALOAD  141
      C                                                                       ALOAD  142
      C   COMPUTE BOUNDARY LIMITS FOR AVERAGING OF FINE MESH CREEP RESULTS    ALOAD  143
      C                                                                       ALOAD  144
      C   COMPUTE FUEL FIRST THEN CLAD                                       ALOAD  145
```

```
      C
            IF (K.GT.NAEF) GO TO 190
            LA = (K+3)/4
            LL1 = (NF-1)*2-3
            LL2 = (NF-1)*2
            GO TO 200
  190       CONTINUE
            LA = (K+3)/4-NAEF/4
            LL1 = NOELF+1
            LL2 = NOEL
  200       CONTINUE
                DO 230 I=1,4
                AVCRP(I) = 0.0
                TA = 0.0
                    DO 210 JK=LL1,LL2
                    TA = ARE(JK)*RBR(JK)+TA
  210               CONTINUE
                    DO 220 JK=LL1,LL2
                    AVCRP(I) = AVCRP(I)+TCRP(I,JK,LA)*ARE(JK)*RBR(JK)/TA
  220               CONTINUE
  230           CONTINUE
      C
  240       CONTINUE
            PR = 2*PI*ARAA(K)*RBRA(K)
      C
                DO 270 I=1,6
                THERM(I) = 0.0
                SUM = 0.0
                    DO 250 J=1,3
                    S = PR*XLOADA(I,J,K)*THET
                    SUM = SUM+S
  250               CONTINUE
      C
      C     ADD CREEP STRAIN TO LOAD VECTOR
      C
                SCUM = 0.0
                    DO 260 J=1,4
                    SC = PR*XLOADA(I,J,K)*AVCRP(J)
                    SCUM = SCUM+SC
  260               CONTINUE
                SUM = SCUM+SUM
                THERM(I) = SUM
  270           CONTINUE
      C
                DO 280 I=1,3
                THETAX(I,K) = THET
                IF (NKN.EQ.1.AND.ISSTOP.EQ.1) THXSV(I,K) = THETAX(I,K)
  280           CONTINUE
      C
              THETAX(4,K) = 0.0
      C     ADD CREEP STRAIN TO STRESS CORRECTION TERM
      C
                DO 290 I=1,4
```

```
                      THETAX(I,K) = THETAX(I,K)+AVCRP(I)                        ALOAD    199
              290     CONTINUE                                                  ALOAD    200
215           C   NOW COMPUTE THE CORRECT D.O.F. AND POSITION IN THE LOAD       ALOAD    201
              C                                                                 ALOAD    202
                    NNA(1) = AELM(1,K)                                          ALOAD    203
                    NNA(2) = AELM(2,K)                                          ALOAD    204
                    NNA(3) = AELM(3,K)                                          ALOAD    205
220           C                                                                 ALOAD    206
                      DO 300 I=1,3                                              ALOAD    207
                      J = 2*I-1                                                 ALOAD    208
                      NNI = NNA(I)                                              ALOAD    209
                      II = NADET(NNI)                                           ALOAD    210
225                   BBA(II) = BBA(II)+THERM(J)                                ALOAD    211
                      BA(II) = BBA(II)                                          ALOAD    212
                      BBA(II+1) = BBA(II+1)+THERM(J+1)                          ALOAD    213
                      BA(II+1) = BBA(II+1)                                      ALOAD    214
              300     CONTINUE                                                  ALOAD    215
230           310   CONTINUE                                                    ALOAD    216
              C                                                                 ALOAD    217
              C   ZERO OUT BOUNDARY CONDITIONS                                  ALOAD    218
                    IBN(1) = 1                                                  ALOAD    219
                    IBN(2) = NABF+1                                             ALOAD    220
235                 IBN(3) = NABF*2+1                                           ALOAD    221
                    IBN(4) = NABF*2+NABT+1                                      ALOAD    222
                      DO 320 I=1,4                                              ALOAD    223
                      IOUT = IBN(I)                                             ALOAD    224
                      II = NADET(IOUT)+1                                        ALOAD    225
240                   BA(II) = 0.0                                              ALOAD    226
                      BBA(II) = 0.0                                             ALOAD    227
              320     CONTINUE                                                  ALOAD    228
                      DO 330 I=1,NABF                                           ALOAD    229
                      NI = NADET(I+NABF)+1                                      ALOAD    230
245                   J = 2*NABF+1                                              ALOAD    231
                      N2 = NADET(J)+1                                           ALOAD    232
                      BBA(NI) = BBA(NI)+BBA(N2)                                 ALOAD    233
                      BBA(N2) = 0.0                                             ALOAD    234
                      BA(NI) = BBA(NI)                                          ALOAD    235
250                   BA(N2) = 0.0                                              ALOAD    236
              330     CONTINUE                                                  ALOAD    237
              C                                                                 ALOAD    238
                    RETURN                                                      ALOAD    239
                    END                                                         ALOAD    240
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 ALOAD	1	253

VARIABLES	SN	TYPE	RELOCATION									
0	AELM	REAL	ARRAY	F.P.	REFS	28	217	218	219	DEFINED	1	
2	ALPHA	REAL		LASTIC	REFS	25	129	133	145	147	150	
					DEFINED	127						
1071	ALPH1	REAL			REFS	136	152	DEFINED	133	150		
1073	ALPH2	REAL			REFS	136	151	152	DEFINED	135		
0	ARAA	REAL	ARRAY	F.P.	REFS	28	183	DEFINED	1			
0	ARE	REAL	ARRAY	F.P.	REFS	33	175	178	DEFINED	1		
1127	AVCRP	REAL	ARRAY		REFS	31	51	178	197	213		
					DEFINED	172	178					
0	BA	REAL	ARRAY	F.P.	REFS	28	DEFINED	1	73	77	99	101
					103	105	226	228	240	249	250	
0	BBA	REAL	ARRAY	F.P.	REFS	28	72	73	76	77	98	99
					100	101	102	103	104	105	225	226
					227	228	2*247	249	DEFINED	1	72	76
					98	100	102	104	225	227	241	247
					248							
1063	BIG	REAL			REFS	130	137	139	DEFINED	120	130	137
1057	BIGT	REAL			REFS	110	122	DEFINED	108	110		
0	CA	REAL	ARRAY	F.P.	REFS	30	DEFINED	1				
14	COMP	REAL		GEOPAR	REFS	16						
33	CP	REAL		LIMITS	REFS	18						
34	CR	REAL		LIMITS	REFS	18						
5	DELR	REAL		GEOPAR	REFS	16						
6	DELZ	REAL		GEOPAR	REFS	16						
0	DELZA	REAL	ARRAY	BA	REFS	36						
0	E	REAL		LASTIC	REFS	25						
102	EAX	REAL	ARRAY	BA	REFS	36						
56	ERAD	REAL	ARRAY	BA	REFS	36						
1064	FAC	REAL			REFS	129	136	DEFINED	122			
1055	FI	REAL			REFS	98	100	DEFINED	96			
55	FLXR	REAL		BA	REFS	36						
1056	FO	REAL			REFS	102	104	DEFINED	97			
35	FRDEN	REAL		LIMITS	REFS	18						
1047	FRI	REAL			REFS	96	DEFINED	86				
1046	FRO	REAL			REFS	97	DEFINED	85				
0	HHF	REAL		FEP	REFS	38						
1040	I	INTEGER			REFS	54	110	122	123	134	172	3*178
					186	189	197	201	205	2*206	3*213	222
					223	238	244	245	DEFINED	53	89	109
					121	171	185	204	212	221	237	243
57	IADJ	INTEGER		LIMITS	REFS	18						
1123	IBN	INTEGER	ARRAY		REFS	30	238	DEFINED	233	234	235	236
103	ICHNG	INTEGER		FEP	REFS	38						
67	ICNT	INTEGER		LIMITS	REFS	18						
42	ICRPP	INTEGER		LIMITS	REFS	18						
60	ICUT	INTEGER		LIMITS	REFS	18						
5	IDF	INTEGER		LIMITS	REFS	18						
1044	II	INTEGER			REFS	2*72	2*73	2*76	2*77	2*98	2*99	2*225
					2*226	2*227	2*228	240	241	DEFINED	70	75
					92	224	239					
1052	III	INTEGER			REFS	2*100	2*101	DEFINED	93			
1053	IJ	INTEGER			REFS	2*102	2*103	DEFINED	94			

VARIABLES	SN	TYPE		RELOCATION								
1054	IJJ	INTEGER			REFS	2*104	2*105	DEFINED	95			
1107	IOUT	INTEGER			REFS	239	DEFINED	238				
40	IPLAS	INTEGER		LIMITS	REFS	18						
73	IPLEND	INTEGER		LIMITS	REFS	18						
71	IRAK	INTEGER		LIMITS	REFS	18						
75	IRZ	INTEGER		LIMITS	REFS	18	128	146				
74	ISP	INTEGER		LIMITS	REFS	18						
37	ISSTOP	INTEGER		LIMITS	REFS	18	206					
3	ISTOP	INTEGER		FEP	REFS	38						
53	ISTRT	INTEGER		BA	REFS	36						
1062	IT	INTEGER			REFS	122	123	134	DEFINED	119		
54	ITER	INTEGER		BA	REFS	36						
63	ITI	INTEGER		LIMITS	REFS	18						
4	ITP1	INTEGER		TAPES	REFS	27						
5	ITP2	INTEGER		TAPES	REFS	27						
1102	J	INTEGER			REFS	189	2*197	225	227	246		
					DEFINED	188	196	222	245			
24	JAM	INTEGER		LIMITS	REFS	18						
1077	JK	INTEGER			REFS	2*175	3*178	DEFINED	174	177		
1060	K	INTEGER			REFS	117	118	142	149	161	162	167
					2*183	189	197	205	2*206	209	2*213	217
					218	219	DEFINED	112				
12	KA	INTEGER		LIMITS	REFS	18						
1050	KIN	INTEGER			REFS	90	92	93	2*96	DEFINED	87	90
10	KKA	INTEGER		GEOPAR	REFS	16						
2	KKZZZ	INTEGER		FEP	REFS	38						
1051	KOUT	INTEGER			REFS	91	94	95	2*97	DEFINED	88	91
66	KPLAS	INTEGER		LIMITS	REFS	18						
55	KRNCH	INTEGER		LIMITS	REFS	18						
45	KRNCHC	INTEGER		LIMITS	REFS	18						
44	KRNCHF	INTEGER		LIMITS	REFS	18						
46	KRNCHT	INTEGER		LIMITS	REFS	18						
36	KZI	INTEGER		LIMITS	REFS	18						
1061	LA	INTEGER			REFS	119	178	DEFINED	118	162	167	
1074	LL1	INTEGER			REFS	174	177	DEFINED	163	168		
1075	LL2	INTEGER			REFS	174	177	DEFINED	164	169		
52	MAXA	INTEGER		LIMITS	REFS	18						
43	MAXT	INTEGER		LIMITS	REFS	18						
56	MCUD	INTEGER		LIMITS	REFS	18						
17	NABC	INTEGER		LIMITS	REFS	18						
16	NABF	INTEGER		LIMITS	REFS	18	57	69	74	84	234	235
					236	243	244	245				
31	NABF2	INTEGER		LIMITS	REFS	18						
20	NABT	INTEGER		LIMITS	REFS	18	57	69	74	236		
0	NABTD	INTEGER	*UNUSED	F.P.	DEFINED	1						
32	NABT2	INTEGER		LIMITS	REFS	18						
0	NAB2D	INTEGER		F.P.	REFS	32	DEFINED	1				
0	NADET	INTEGER	ARRAY	F.P.	REFS	28	70	75	92	93	94	95
					224	239	244	246	DEFINED	1		
21	NAEC	INTEGER		LIMITS	REFS	18						
22	NAEF	INTEGER		LIMITS	REFS	18	117	161	167			
14	NARC	INTEGER		LIMITS	REFS	18						
13	NARF	INTEGER		LIMITS	REFS	18						

VARIABLES	SN	TYPE		RELOCATION								
15	NART	INTEGER		LIMITS	REFS	18	89					
25	NAXBT	INTEGER		LIMITS	REFS	18						
26	NAXB2	INTEGER		LIMITS	REFS	18						
27	NAXB4	INTEGER		LIMITS	REFS	18						
1	NC	INTEGER		LIMITS	REFS	18						
52	NCNN	INTEGER		BA	REFS	36						
51	NCONN	INTEGER		BA	REFS	36						
50	NC4	INTEGER		LIMITS	REFS	18						
7	NETOT	INTEGER		LIMITS	REFS	18						
53	NEW	INTEGER		LIMITS	REFS	18	123	142				
10	NEWF	INTEGER		LIMITS	REFS	18						
11	NEWT	INTEGER		LIMITS	REFS	18						
0	NF	INTEGER		LIMITS	REFS	18	163	164				
6	NFF	INTEGER		LIMITS	REFS	18						
30	NFFI	INTEGER		LIMITS	REFS	18						
0	NFFID	INTEGER		F.P.	REFS	32	DEFINED	1				
47	NFF2	INTEGER		LIMITS	REFS	18						
51	NF4	INTEGER		LIMITS	REFS	18						
0	NIN	INTEGER		TAPES	REFS	27	70	88	DEFINED	69		
41	NKN	INTEGER		LIMITS	REFS	18	56	114	154	155	206	
54	NMX	INTEGER		LIMITS	REFS	18						
50	NN	INTEGER		BA	REFS	36						
1120	NNA	INTEGER	ARRAY		REFS	30	223	DEFINED	217	218	219	
1106	NNI	INTEGER			REFS	224	DEFINED	223				
2	NOEL	INTEGER		LIMITS	REFS	18	169					
4	NOELC	INTEGER		LIMITS	REFS	18						
0	NOELD	INTEGER		F.P.	REFS	31	32	DEFINED	1			
3	NOELF	INTEGER		LIMITS	REFS	18	168					
65	NOLD	INTEGER		LIMITS	REFS	18	134	149				
1	NOUT	INTEGER		TAPES	REFS	27	75	DEFINED	57	74		
2	NSCR1	INTEGER		TAPES	REFS	27						
3	NSCR2	INTEGER		TAPES	REFS	27						
1045	NSTART	INTEGER			REFS	87	DEFINED	84				
1	NT	INTEGER		FEP	REFS	38						
23	NTAE	INTEGER		LIMITS	REFS	18	52	112				
0	NTAED	INTEGER		F.P.	REFS	28	DEFINED	1				
57	NTOLD	INTEGER	ARRAY	FEP	REFS	38						
1110	N1	INTEGER			REFS	2*247	2*249	DEFINED	244			
1111	N2	INTEGER			REFS	247	248	250	DEFINED	246		
13	PDEL	REAL		GEOPAR	REFS	16						
0	PI	REAL		CONTNT	REFS	26	2*65	66	72	76	85	86
						183						
11	PIN	REAL		GEOPAR	REFS	16	65	86				
54	PINOLD	REAL		FEP	REFS	38						
56	POLD	REAL		FEP	REFS	38						
12	POUT	REAL		GEOPAR	REFS	16	65	85				
55	POUTLD	REAL		FEP	REFS	38						
1100	PR	REAL			REFS	189	197	DEFINED	183			
0	RA	REAL	ARRAY	F.P.	REFS	28	DEFINED	1				
72	RAKSUM	REAL		LIMITS	REFS	18						
0	RBR	REAL	ARRAY	F.P.	REFS	33	175	178	DEFINED	1		
0	RBRA	REAL	ARRAY	F.P.	REFS	28	110	122	183	DEFINED	1	
2	RCI	REAL		GEOPAR	REFS	16	65	66	72	86		

VARIABLES	SN	TYPE		RELOCATION								
3	RCO	REAL		GEOPAR	REFS	16	65	66	76	85		
0	RD	REAL	ARRAY	F.P.	REFS	32	DEFINED	1				
4	RDOLD	REAL	ARRAY	FEP	REFS	38						
0	RFI	REAL		GEOPAR	REFS	16						
1	RFO	REAL		GEOPAR	REFS	16						
70	RRAKR	REAL		LIMITS	REFS	18						
30	RRSIN	REAL	ARRAY	FEP	REFS	38						
1103	S	REAL			REFS	190	DEFINED	189				
1105	SC	REAL			REFS	198	DEFINED	197				
1104	SCUM	REAL			REFS	198	200	DEFINED	195	198		
1041	SIG	REAL			REFS	67	DEFINED	65				
64	STEP	REAL		LIMITS	REFS	18						
104	STEPS	REAL		FEP	REFS	38						
1101	SUM	REAL			REFS	190	200	201	DEFINED	187	190	200
1076	TA	REAL			REFS	175	178	DEFINED	173	175		
0	TCRP	REAL	ARRAY	F.P.	REFS	31	178	DEFINED	1			
1112	THERM	REAL	ARRAY		REFS	28	225	227	DEFINED	54	186	201
1070	THET	REAL			REFS	130	137	189	205	DEFINED	129	136
					139	147	152	154				
0	THETAX	REAL	ARRAY	F.P.	REFS	30	52	206	213	DEFINED	1	205
					209	213						
0	THXSV	REAL	ARRAY	F.P.	REFS	34	DEFINED	1	206			
61	TIMEC	REAL		LIMITS	REFS	18						
62	TIMEF	REAL		LIMITS	REFS	18						
1072	TLD	REAL			REFS	135	151	DEFINED	134	149		
4	TREF	REAL		GEOPAR	REFS	16						
0	TSTSR	REAL	ARRAY	F.P.	REFS	32	DEFINED	1				
0	TW	REAL	ARRAY	F.P.	REFS	28	123	134	142	149		
					DEFINED	1						
1066	TWC	REAL			REFS	126	144	DEFINED	124	143		
1067	TWK	REAL			REFS	127	145	DEFINED	126	144		
1065	TWW	REAL			REFS	124	143	DEFINED	123	142		
1042	XLINE	REAL			REFS	67	DEFINED	66				
0	XLOADA	REAL	ARRAY	F.P.	REFS	28	189	197	DEFINED	1		
1	XNU	REAL		LASTIC	REFS	25						
0	Y	REAL	ARRAY	F.P.	REFS	32	DEFINED	1				
0	YACF	REAL	ARRAY	F.P.	REFS	28	2*96	2*97	DEFINED	1		
7	ZDEL	REAL		GEOPAR	REFS	16						
1043	ZF	REAL			REFS	68	72	76	DEFINED	67	68	

EXTERNALS	TYPE	ARGS	REFERENCES	
CTHEXP		3	145	151
FTHEXP	REAL	2	127	135
MOVEKA		3	51	52

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	55	53	
0	110	106	89	
225	120	107	56	
0	130	111	109	
317	140	132	128	
344	150	138	121	131
353	160	141	117	

STATEMENT LABELS		DEF LINE	REFERENCES		
400	170	149	146		
417	180	153	114	140	148
445	190	166	161		
457	200	170	165		
0	210	176	174		
0	220	179	177		
0	230	180	171		
520	240	182	155		
0	250	191	188		
0	260	199	196		
0	270	202	185		
0	280	207	204		
0	290	214	212		
0	300	229	221		
0	310	230	112		
0	320	242	237		
0	330	251	243		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
24	100	I	53 55	5B	INSTACK
137	110	I	89 106	65B	OPT
231	130	I	109 111	6B	INSTACK
241	310	K	112 230	451B	EXT REFS NOT INNER
260	150	I	121 138	67B	EXT REFS
461	230	I	171 180	36B	NOT INNER
467	210	JK	174 176	7B	INSTACK
500	220	JK	177 179	14B	OPT
526	270	I	185 202	55B	NOT INNER
534	250	J	188 191	15B	OPT
555	260	J	196 199	15B	OPT
605	280	I	204 207	17B	OPT
630	290	I	212 214	7B	INSTACK
655	300	I	221 229	32B	OPT
730	320	I	237 242	15B	OPT
747	330	I	243 251	30B	OPT

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
BA	86
FEP	69

STATISTICS

PROGRAM LENGTH	1227B	663
SCM LABELED COMMON LENGTH	360B	240

140000B SCM USED

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      SUBROUTINE ASOLVE (BA,BBA,NADET,AK,TW,BASAVE)                          ASOLVE      2
C                                                                            ASOLVE      3
      COMMON /PNTPNL/IFIRST,IAELM,IAK,IARAA,IARE,ISB,IBA,IBASAV,IBASE,       PELPT       2
     + ISBB,IBBA,IBBSV,ICA,ICC,ICRATE,ICRPG,IDISP,IDISPC,IDSPSV,             PELPT       3
     + IEFSTR,IELM,IELSTN,ILSTNA,ILSTRA,IELSTR,IPSLA,IEPSLM,IESTNV,          PELPT       4
     + IESTSV,JIIJ,IIPOS,IKSAVE,INADET,INDC,INDF,INDT,INODET,IOLDSE,         PELPT       5
     + IPSSRT,IPSSV,IPSTS,IR,IRA,IRBR,IRBRA,IRD,ISTRES,ISTRSA,ITCB,          PELPT       6
     + ITCRP,ITEC,ITEF,ITELM,ITFB,ITHET,ITHTAX,ITHSAV,ITHXSV,ITME,           PELPT       7
     + ITSTNR,ITSTSR,ITV,ITW,IXKT,IXLOAD,IXLODA,IXRD,                        PELPT       8
     +IY,IYACF,IZ,ILAST                                                      PELPT       9
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P     PELCOM      2
     +DEL,COMP                                                               PELCOM      3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE     PELCOM      4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,[illegible],JAM,NAXBT,  PELCOM  5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISST[illegible]P,IPLAS,NKN  PELCOM  6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N    PELCOM      7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                      PELCOM      8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                              PELCOM      9
     +,IRZ                                                                   PELCOM     10
      COMMON /LASTIC/ E,XNU,ALPHA                                            PELCOM     11
      COMMON /CONTNT/ PI                                                     PELCOM     12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                          PELCOM     13
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,           COMC        2
     +   ERAD(20), EAX(20)                                                   COMC        3
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)                      COMC        4
     +,PINOLD,POUTLD,POLD,NTOLD(20)                                          COMC        5
     + ,ICHNG,STEPS                                                          COMC        6
      DIMENSION AK(1)                                                        ASOLVE      7
      DIMENSION NADET(1), BBA(1), BA(1)                                      ASOLVE      8
      DIMENSION BASAVE(1)                                                    ASOLVE      9
      COMMON / FAST / D(1)                                                   ASOLVE     10
      COMMON / PRSSV / PRSINC(20), PRSS(20)                                  ASOLVE     11
C                                                                            ASOLVE     12
C     ASOLVE IS CALLED FROM PELET                                            ASOLVE     13
C                                                                            ASOLVE     14
C     PRSINC - INCREMENTAL CHANGE IN PELLET-CLAD INTERFACIAL PRESSURE        ASOLVE     15
C     DELZA  - LENGTH OF AXIAL REGION                                        ASOLVE     16
C     BA     - DISPLACEMENT ARRAY OR LOAD ARRAY                              ASOLVE     17
C     BBA    - AXIAL MODEL LOADS                                             ASOLVE     18
C                                                                            ASOLVE     19
C     PSEUDO-ELASTIC LOAD STEP.                                              ASOLVE     20
        IF (IRAK.NE.1) GO TO 120                                             ASOLVE     21
            DO 100 KK=1,NTAE                                                 ASOLVE     22
            IBAS = (KK-1)*4+ITHXSV-1                                         ASOLVE     23
            IBASTH = (KK-1)*4+ITHTAX-1                                       ASOLVE     24
                DO 100 JJ=1,4                                                ASOLVE     25
                D(IBASTH+JJ) = D(IBAS+JJ)*(1.-RRAKR)                         ASOLVE     26
  100           CONTINUE                                                     ASOLVE     27
            DO 110 J=1,NAXB4                                                 ASOLVE     28
            BA(J) = BASAVE(J)*(1.-RRAKR)                                     ASOLVE     29
  110       CONTINUE                                                         ASOLVE     30
        GO TO 150                                                            ASOLVE     31
  120   CONTINUE                                                             ASOLVE     32
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                CALL MOVEKA (0,BA,NAXB4)                                          ASOLVE     33
55              CALL MOVEKA (0,BBA,NAXB4)                                         ASOLVE     34
                CALL MOVEKA (0,D(ILSTRA),4*NTAE)                                  ASOLVE     35
                CALL MOVEKA (0,D(ILSTNA),4*NTAE)                                  ASOLVE     36
                IF (NKN.EQ.2) GO TO 140                                           ASOLVE     37
          C   ADD IN RADIAL LOADS FROM RADIAL MODEL EST, OF INTERFACIAL PRESSURE  ASOLVE     38
60              DO 130 I=1,NARF                                                   ASOLVE     39
                III = I+NABF+1                                                    ASOLVE     40
                II = III-1                                                        ASOLVE     41
                INN = NADET(III)                                                  ASOLVE     42
                IN = NADET(II)                                                    ASOLVE     43
65              JJ = III+NABF                                                     ASOLVE     44
                ICNN = NADET(JJ)                                                  ASOLVE     45
                J = II+NABF                                                       ASOLVE     46
                ICN = NADET(J)                                                    ASOLVE     47
                RLOD = PRSINC(I)*RFO*PI*DELZA(I)                                  ASOLVE     48
70              BBA(INN) = BBA(INN)-RLOD                                          ASOLVE     49
                BBA(IN) = BBA(IN)-RLOD                                            ASOLVE     50
                BA(INN) = BA(INN)-RLOD                                            ASOLVE     51
                BA(IN) = BA(IN)-RLOD                                              ASOLVE     52
                BBA(ICNN) = BBA(ICNN)+RLOD                                        ASOLVE     53
75              BBA(ICN) = BBA(ICN)+RLOD                                          ASOLVE     54
                BA(ICNN) = BA(ICNN)+RLOD                                          ASOLVE     55
                BA(ICN) = BA(ICN)+RLOD                                            ASOLVE     56
          130   CONTINUE                                                          ASOLVE     57
          140   CONTINUE                                                          ASOLVE     58
80              CALL ALOAD (D(IAELM),D(IARAA),D(IBA),D(INADET),D(IRBRA),D(IRA),TW, ASOLVE     59
               +D(ICA),D(ITHTAX),D(IXLODA),D(IYACF),D(ITCRP),NOEL,NTAE,D(IBBA),NAB ASOLVE     60
               +T,D(IARE),D(IRBR),D(ITSTSR),D(IRD),D(IY),NFF1,NABT2,D(ITHXSV))    ASOLVE     61
          150   CONTINUE                                                          ASOLVE     62
          C   SAVE CONVERGED LOAD VALUES                                         ASOLVE     63
85              IF (NKN.NE.1.OR.ISSTOP.NE.1) GO TO 170                            ASOLVE     64
                    DO 160 I=1,NAXB4                                              ASOLVE     65
                    BASAVE(I) = BA(I)                                             ASOLVE     66
          160       CONTINUE                                                      ASOLVE     67
          170   CONTINUE                                                          ASOLVE     68
90        C   CALL SOLUTION ROUTINE (BA=LOAD ARRAY GOING IN,=DISPLACEMENT ARRAY   ASOLVE     69
          C   COMING OUT)                                                        ASOLVE     70
              MUD = 25                                                            ASOLVE     71
              IF (NAXB4.LT.37) MUD = NAXB4-1                                      ASOLVE     72
              IOP = 1                                                             ASOLVE     73
95            CALL DMCHB (BA,AK,NAXB4,1,MUD,IOP,1.E-14)                           ASOLVE     74
          C   RETRIEVE DISPLACEMENTS OF FUEL NODES IN CONTACT                    ASOLVE     75
                    DO 180 I=1,NABF                                               ASOLVE     76
                    N1 = NADET(I+NABF)+1                                          ASOLVE     77
                    JJ = 2*NABF+I                                                 ASOLVE     78
100                 N2 = NADET(JJ)+1                                              ASOLVE     79
                    BA(N2) = BA(N1)                                               ASOLVE     80
                    BBA(N2) = BBA(N1)                                             ASOLVE     81
          180       CONTINUE                                                      ASOLVE     82
              CALL ASTRES (D(IAELM),D(IBA),D(IDISP),D(ILSTRA),D(ILSTNA),D(IPSLA)  ASOLVE     83
105          +,D(INADET),D(ISTRSA),D(ICA),D(ITHTAX),NAXB4)                        ASOLVE     84
              RETURN                                                              ASOLVE     85
```

END ASOLVE 86

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 ASOLVE 1 106

VARIABLES SN TYPE RELOCATION

0	AK	REAL	ARRAY	F.P.	REFS	28	95	DEFINED	1			
2	ALPHA	REAL		LASTIC	REFS	20						
0	BA	REAL	ARRAY	F.P.	REFS	29	54	72	73	76	77	87
					95	101	DEFINED	1	50	72	73	76
					77	101						
0	BASAVE	REAL	ARRAY	F.P.	REFS	50	50	DEFINED	1	87		
0	BBA	REAL	ARRAY	F.P.	REFS	29	55	70	71	74	75	102
					DEFINED	1	70	71	74	75	102	
14	COMP	REAL		GEOPAR	REFS	11						
33	CP	REAL		LIMITS	REFS	13						
34	CR	REAL		LIMITS	REFS	13						
0	D	REAL	ARRAY	FAST	REFS	31	47	56	57	18*80	10*104	
					DEFINED	47						
5	DELR	REAL		GEOPAR	REFS	11						
6	DELZ	REAL		GEOPAR	REFS	11						
0	DELZA	REAL	ARRAY	BA	REFS	23	69					
0	E	REAL		LASTIC	REFS	20						
102	EAX	REAL	ARRAY	BA	REFS	23						
56	ERAD	REAL	ARRAY	BA	REFS	23						
55	FLXR	REAL		BA	REFS	23						
35	FRDEN	REAL		LIMITS	REFS	13						
0	HHF	REAL		FEP	REFS	25						
442	I	INTEGER			REFS	61	2*69	2*87	98	99		
					DEFINED	60	86	97				
57	IADJ	INTEGER		LIMITS	REFS	13						
1	IAELM	INTEGER		PNTPNL	REFS	3	80	104				
2	IAK	INTEGER		PNTPNL	REFS	3						
3	IARAA	INTEGER		PNTPNL	REFS	3	80					
4	IARE	INTEGER		PNTPNL	REFS	3	80					
6	IBA	INTEGER		PNTPNL	REFS	3	80	104				
436	IBAS	INTEGER			REFS	47	DEFINED	44				
7	IBASAV	INTEGER		PNTPNL	REFS	3						
10	IBASE	INTEGER		PNTPNL	REFS	3						
437	IBASTH	INTEGER			REFS	47	DEFINED	45				
12	IBBA	INTEGER		PNTPNL	REFS	3	80					
13	IBBSV	INTEGER		PNTPNL	REFS	3						
14	ICA	INTEGER		PNTPNL	REFS	3	80	104				
15	ICC	INTEGER		PNTPNL	REFS	3						
103	ICHNG	INTEGER		FEP	REFS	25						
450	ICN	INTEGER			REFS	2*75	2*77	DEFINED	68			
447	ICNN	INTEGER			REFS	2*74	2*76	DEFINED	66			

VARIABLES	SN	TYPE	RELOCATION						
67	ICNT	INTEGER	LIMITS	REFS	13				
16	ICRATE	INTEGER	PNTPNL	REFS	3				
17	ICRPG	INTEGER	PNTPNL	REFS	3				
42	ICRPP	INTEGER	LIMITS	REFS	13				
60	ICUT	INTEGER	LIMITS	REFS	13				
5	IDF	INTEGER	LIMITS	REFS	13				
20	IDISP	INTEGER	PNTPNL	REFS	3	104			
21	IDISPC	INTEGER	PNTPNL	REFS	3				
22	IDSPSV	INTEGER	PNTPNL	REFS	3				
23	IEFSTR	INTEGER	PNTPNL	REFS	3				
24	IELM	INTEGER	PNTPNL	REFS	3				
25	IELSTN	INTEGER	PNTPNL	REFS	3				
30	IELSTR	INTEGER	PNTPNL	REFS	3				
32	IEPSLM	INTEGER	PNTPNL	REFS	3				
33	IESTNV	INTEGER	PNTPNL	REFS	3				
34	IESTSV	INTEGER	PNTPNL	REFS	3				
0	IFIRST	INTEGER	PNTPNL	REFS	3				
444	II	INTEGER		REFS	64	67	DEFINED	62	
443	III	INTEGER		REFS	62	63	65	DEFINED	61
36	IIPOS	INTEGER	PNTPNL	REFS	3				
37	IKSAVE	INTEGER	PNTPNL	REFS	3				
106	ILAST	INTEGER	PNTPNL	REFS	3				
26	ILSTNA	INTEGER	PNTPNL	REFS	3	57	104		
27	ILSTRA	INTEGER	PNTPNL	REFS	3	56	104		
446	IN	INTEGER		REFS	2*71	2*73	DEFINED	64	
40	INADET	INTEGER	PNTPNL	REFS	3	80	104		
41	INDC	INTEGER	PNTPNL	REFS	3				
42	INDF	INTEGER	PNTPNL	REFS	3				
43	INDT	INTEGER	PNTPNL	REFS	3				
445	INN	INTEGER		REFS	2*70	2*72	DEFINED	63	
44	INODET	INTEGER	PNTPNL	REFS	3				
45	IOLDSE	INTEGER	PNTPNL	REFS	3				
453	IOP	INTEGER		REFS	95	DEFINED	94		
40	IPLAS	INTEGER	LIMITS	REFS	13				
73	IPLEND	INTEGER	LIMITS	REFS	13				
31	IPSLA	INTEGER	PNTPNL	REFS	3	104			
46	IPSSRT	INTEGER	PNTPNL	REFS	3				
47	IPSSV	INTEGER	PNTPNL	REFS	3				
50	IPSTS	INTEGER	PNTPNL	REFS	3				
51	IR	INTEGER	PNTPNL	REFS	3				
52	IRA	INTEGER	PNTPNL	REFS	3	80			
71	IRAK	INTEGER	LIMITS	REFS	13	42			
53	IRBR	INTEGER	PNTPNL	REFS	3	80			
54	IRBRA	INTEGER	PNTPNL	REFS	3	80			
55	IRD	INTEGER	PNTPNL	REFS	3	80			
75	IRZ	INTEGER	LIMITS	REFS	13				
5	ISB	INTEGER	PNTPNL	REFS	3				
11	ISBB	INTEGER	PNTPNL	REFS	3				
74	ISP	INTEGER	LIMITS	REFS	13				
37	ISSTOP	INTEGER	LIMITS	REFS	13	85			
3	ISTOP	INTEGER	FEP	REFS	25				
56	ISTRES	INTEGER	PNTPNL	REFS	3				
57	ISTRSA	INTEGER	PNTPNL	REFS	3	104			

VARIABLES	SN	TYPE		RELOCATION								
53	ISTRT	INTEGER		BA	REFS	23						
60	ITCB	INTEGER		PNTPNL	REFS							
61	ITCRP	INTEGER		PNTPNL	REFS		80					
62	ITEC	INTEGER		PNTPNL	REFS							
63	ITEF	INTEGER		PNTPNL	REFS							
64	ITELM	INTEGER		PNTPNL	REFS							
54	ITER	INTEGER		BA	REFS	2						
65	ITFB	INTEGER		PNTPNL	REFS							
66	ITHET	INTEGER		PNTPNL	REFS							
70	ITHSAV	INTEGER		PNTPNL	REFS							
67	ITHTAX	INTEGER		PNTPNL	REFS		45	60	104			
71	ITHXSV	INTEGER		PNTPNL	REFS		44	80				
63	ITI	INTEGER		LIMITS	REFS	1						
72	ITME	INTEGER		PNTPNL	REFS							
4	ITP1	INTEGER		TAPES	REFS	22						
5	ITP2	INTEGER		TAPES	REFS	22						
73	ITSTNR	INTEGER		PNTPNL	REFS							
74	ITSTSR	INTEGER		PNTPNL	REFS		80					
75	ITV	INTEGER		PNTPNL	REFS							
76	ITW	INTEGER		PNTPNL	REFS							
77	IXKT	INTEGER		PNTPNL	REFS							
100	IXLOAD	INTEGER		PNTPNL	REFS							
101	IXLODA	INTEGER		PNTPNL	REFS		80					
102	IXRD	INTEGER		PNTPNL	REFS							
103	IY	INTEGER		PNTPNL	REFS		80					
104	IYACF	INTEGER		PNTPNL	REFS		80					
105	IZ	INTEGER		PNTPNL	REFS							
441	J	INTEGER			REFS	2*50	68	DEFINED	49	67		
24	JAM	INTEGER		LIMITS	REFS	13						
35	JIIJ	INTEGER		PNTPNL	REFS	3						
440	JJ	INTEGER			REFS	2*47	66	100	DEFINED	46	65	59
12	KA	INTEGER		LIMITS	REFS	13						
435	KK	INTEGER			REFS	44	45	DEFINED	43			
10	KKA	INTEGER		GEOPAR	REFS	11						
2	KKZZZ	INTEGER		FEP	REFS	25						
66	KPLAS	INTEGER		LIMITS	REFS	13						
55	KRNCH	INTEGER		LIMITS	REFS	13						
45	KRNCHC	INTEGER		LIMITS	REFS	13						
44	KRNCHF	INTEGER		LIMITS	REFS	13						
46	KRNCHT	INTEGER		LIMITS	REFS	13						
36	KZI	INTEGER		LIMITS	REFS	13						
52	MAXA	INTEGER		LIMITS	REFS	13						
43	MAXT	INTEGER		LIMITS	REFS	13						
56	MCUD	INTEGER		LIMITS	REFS	13						
452	MUD	INTEGER			REFS	95	DEFINED	92	93			
17	NABC	INTEGER		LIMITS	REFS	13						
16	NABF	INTEGER		LIMITS	REFS	13	61	65	67	97	98	99
31	NABF2	INTEGER		LIMITS	REFS	13						
20	NABT	INTEGER		LIMITS	REFS	13	80					
32	NABT2	INTEGER		LIMITS	REFS	13	80					
0	NADET	INTEGER	ARRAY	F.P.	REFS	29	63	64	66	68	98	100
					DEFINED	1						
21	NAEC	INTEGER		LIMITS	REFS	13						

VARIABLES	SN	TYPE		RELOCATION								
22	NAEF	INTEGER		LIMITS	REFS	13						
14	NARC	INTEGER		LIMITS	REFS	13						
13	NARF	INTEGER		LIMITS	REFS	13	60					
15	NART	INTEGER		LIMITS	REFS	13						
25	NAXBT	INTEGER		LIMITS	REFS	13						
26	NAXB2	INTEGER		LIMITS	REFS	13						
27	NAXB4	INTEGER		LIMITS	REFS 104	13	49	54	55	86	2*93	95
1	NC	INTEGER		LIMITS	REFS	13						
52	NCNN	INTEGER		BA	REFS	23						
51	NCONN	INTEGER		BA	REFS	23						
50	NC4	INTEGER		LIMITS	REFS	13						
7	NETOT	INTEGER		LIMITS	REFS	13						
53	NEW	INTEGER		LIMITS	REFS	13						
10	NEWF	INTEGER		LIMITS	REFS	13						
11	NEWT	INTEGER		LIMITS	REFS	13						
0	NF	INTEGER		LIMITS	REFS	13						
6	NFF	INTEGER		LIMITS	REFS	13						
30	NFF1	INTEGER		LIMITS	REFS	13	80					
47	NFF2	INTEGER		LIMITS	REFS	13						
51	NF4	INTEGER		LIMITS	REFS	13						
0	NIN	INTEGER		TAPES	REFS	22						
41	NKN	INTEGER		LIMITS	REFS	13	58	85				
54	NMX	INTEGER		LIMITS	REFS	13						
50	NN	INTEGER		BA	REFS	23						
2	NOEL	INTEGER		LIMITS	REFS	13	80					
4	NOELC	INTEGER		LIMITS	REFS	13						
3	NOELF	INTEGER		LIMITS	REFS	13						
65	NOLD	INTEGER		LIMITS	REFS	13						
1	NOUT	INTEGER		TAPES	REFS	22						
2	NSCR1	INTEGER		TAPES	REFS	22						
3	NSCR2	INTEGER		TAPES	REFS	22						
1	NT	INTEGER		FEP	REFS	25						
23	NTAE	INTEGER		LIMITS	REFS	13	43	56	57	80		
57	NTOLD	INTEGER	ARRAY	FEP	REFS	25						
454	N1	INTEGER			REFS	101	102	DEFINED	98			
455	N2	INTEGER			REFS	101	102	DEFINED	100			
13	PDEL	REAL		GEOPAR	REFS	11						
0	PI	REAL		CONTNT	REFS	21	69					
11	PIN	REAL		GEOPAR	REFS	11						
54	PINOLD	REAL		FEP	REFS	25						
56	POLD	REAL		FEP	REFS	25						
12	POUT	REAL		GEOPAR	REFS	11						
55	POUTLD	REAL		FEP	REFS	25						
0	PRSINC	REAL	ARRAY	PRSSV	REFS	32	69					
24	PRSS	REAL	ARRAY	PRSSV	REFS	32						
72	RAKSUM	REAL		LIMITS	REFS	13						
2	RCI	REAL		GEOPAR	REFS	11						
3	RCO	REAL		GEOPAR	REFS	11						
4	RDOLD	REAL	ARRAY	FEP	REFS	25						
0	RFI	REAL		GEOPAR	REFS	11						
1	RFO	REAL		GEOPAR	REFS	11	69					
451	RLOD	REAL			REFS	70	71	72	73	74	75	76

VARIABLES	SN	TYPE	RELOCATION						
					77	DEFINED	69		
70	RRAKR	REAL		LIMITS	REFS	13	47	50	
30	RRSIN	REAL	ARRAY	FEP	REFS	25			
64	STEP	REAL		LIMITS	REFS	13			
104	STEPS	REAL		FEP	REFS	25			
61	TIMEC	REAL		LIMITS	REFS	13			
62	TIMEF	REAL		LIMITS	REFS	13			
4	TREF	REAL		GEOPAR	REFS	11			
0	TW	REAL		F.P.	REFS	80	DEFINED	1	
1	XNU	REAL		LASTIC	REFS	20			
7	ZDEL	REAL		GEOPAR	REFS	11			

EXTERNALS	TYPE	ARGS	REFERENCES			
ALOAD		24	80			
ASTRES		11	104			
DMCHB		7	95			
MOVEKA		3	54	55	56	57

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	48	43	46
0	110	51	49	
55	120	53	42	
0	130	78	60	
175	140	79	58	
235	150	83	52	
0	160	88	86	
253	170	89	85	
0	180	103	97	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
14	100	KK	43 48	26B	NOT INNER
26	100	JJ	46 48	11B	INSTACK
44	110	J	49 51	7B	INSTACK
104	130	I	60 78	70B	OPT
244	160	I	86 88	6B	INSTACK
272	180	!	97 103	23B	OPT

COMMON BLOCKS	LENGTH
PNTPNL	71
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
BA	86
FEP	69
FAST	1
PRSSV	40

STATISTICS

PROGRAM LENGTH	505B	325
SCM LABELED COMMON LENGTH	540B	352

140000B SCM USED

```
      SUBROUTINE ASTRES (AELM,BA,DISPA,ELSTSA,ELSTNA,EPSLA,NADET,STRSA,C
     +A,THETAX,NAXBTD)
C
C   PURPOSE OF THIS SUBROUTINE IS TO COMPUTE THE STRESSES AND
C   STRAINS IN THE AXIAL FUEL MODEL FOR BOTH THE FUEL AND THE CLAD
C
C   ASTRES IS CALLED FROM ASOLVE
C
      COMMON / AXL / SUMM, SUMFF, SUMSAV, GROW
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P
     +DEL,COMP
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP
     +,IRZ
      COMMON /LASTIC/ E,XNU,ALPHA
      COMMON /CONTNT/ PI
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2
      DIMENSION AELM(3,1), NN(3), NADET(1), DISP(6), BA(1), EPSLA(4,6,1)
     +, STRSA(4,6,1), ELSTNA(4,1), ELSTSA(4,1)
C
      DIMENSION CA(4,4,1), THETAX(4,1), DISPA(NAXBTD)
C
C   ELSTSA - INCREMENTAL ELEMENT STRESSES
C   ELSTNA - INCREMENTAL ELEMENT STRAINS
C   AELM   - INCREMENTAL AXIAL ELEMENT NODE NUMBERS
C
C
      DO 140 K=1,NTAE
      NN(1) = AELM(1,K)
      NN(2) = AELM(2,K)
      NN(3) = AELM(3,K)
          DO 100 I=1,3
          J = I*2-1
          NNI = NN(I)
          IN = NADET(NNI)
          DISP(J) = BA(IN)
          DISP(J+1) = BA(IN+1)
  100     CONTINUE
C
          DO 130 I=1,4
          S = 0.0
          SS = 0.0
              DO 110 J=1,6
C
C   COMPUTE THE STRAINS
C
                  S = S+EPSLA(I,J,K)*DISP(J)
C
C   COMPUTE THE STRESSES
```

```
                C                                                                   ASTRES     44
55                        SS = SS+STRSA(I,J,K)*DISP(J)                              ASTRES     45
                110       CONTINUE                                                  ASTRES     46
                C                                                                   ASTRES     47
                C   ELEMENT STRAIN                                                  ASTRES     48
                C                                                                   ASTRES     49
60                      ELSTNA(I,K) = S                                             ASTRES     50
                C   SUBTRACT OFF THERMAL STRESS                                     ASTRES     51
                      SIGO = 0.0                                                    ASTRES     52
                          DO 120 II=1,4                                             ASTRES     53
                          SIGO = SIGO+CA(I,II,K)*THETAX(II,K)                       ASTRES     54
65              120       CONTINUE                                                  ASTRES     55
                      ELSTSA(I,K) = SS-SIGO                                         ASTRES     56
                130   CONTINUE                                                      ASTRES     57
                140       CONTINUE                                                  ASTRES     58
                C                                                                   ASTRES     59
70              C   RETAIN AXIAL DISPLACEMENTS OF THE TOP OF THE CLAD (SUMM) AND THE ASTRES     60
                C   TOP OF THE FUEL (SUMFF)                                         ASTRES     61
                      IF (ISSTOP.NE.1) GO TO 150                                    ASTRES     62
                      SUMM = SUMM+BA(NAXB4)                                         ASTRES     63
                      IWANT = NADET(NABF2)+1                                        ASTRES     64
75                    SUMFF = SUMFF+BA(IWANT)                                       ASTRES     65
                150   CONTINUE                                                      ASTRES     66
                C   HAVE NOW COMPUTED THE STRESSES AND STRAINS INT THE              ASTRES     67
                C   AXIAL MODEL                                                     ASTRES     68
                C                                                                   ASTRES     69
80                    RETURN                                                        ASTRES     70
                C                                                                   ASTRES     71
                      END                                                           ASTRES     72
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	ASTRES	1	80

VARIABLES

		SN	TYPE	RELOCATION								
0	AELM		REAL	ARRAY	F.P.	REFS	22	33	34	35	DEFINED	1
2	ALPHA		REAL		LASTIC	REFS	19					
0	BA		REAL	ARRAY	F.P.	REFS	22	40	41	73	75	
						DEFINED	1					
0	CA		REAL	ARRAY	F.P.	REFS	25	64	DEFINED	1		
14	COMP		REAL		GEOPAR	REFS	10					
33	CP		REAL		LIMITS	REFS	12					
34	CR		REAL		LIMITS	REFS	12					
5	DELR		REAL		GEOPAR	REFS	10					
6	DELZ		REAL		GEOPAR	REFS	10					
174	DISP		REAL	ARRAY		REFS	22	51	55	DEFINED	40	41
0	DISPA		REAL	ARRAY	F.P.	REFS	25	DEFINED	1			
0	E		REAL		LASTIC	REFS	19					

VARIABLES	SN	TYPE	RELOCATION									
0	ELSTNA	REAL	ARRAY	F.P.	REFS	22	DEFINED	1	60			
0	ELSTSA	REAL	ARRAY	F.P.	REFS	22	DEFINED	1	66			
0	EPSLA	REAL	ARRAY	F.P.	REFS	22	51	DEFINED	1			
35	FRDEN	REAL		LIMITS	REFS	12						
3	GROW	REAL		AXL	REFS	9						
160	I	INTEGER			REFS	37	38	51	55	60	64	66
					DEFINED	36	44					
57	IADJ	INTEGER		LIMITS	REFS	12						
67	ICNT	INTEGER		LIMITS	REFS	12						
42	ICRPP	INTEGER		LIMITS	REFS	12						
60	ICUT	INTEGER		LIMITS	REFS	12						
5	IDF	INTEGER		LIMITS	REFS	12						
167	II	INTEGER			REFS	2*64	DEFINED	63				
163	IN	INTEGER			REFS	40	41	DEFINED	39			
40	IPLAS	INTEGER		LIMITS	REFS	12						
73	IPLEND	INTEGER		LIMITS	REFS	12						
71	IRAK	INTEGER		LIMITS	REFS	12						
75	IRZ	INTEGER		LIMITS	REFS	12						
74	ISP	INTEGER		LIMITS	REFS	12						
37	ISSTOP	INTEGER		LIMITS	REFS	12	72					
63	ITI	INTEGER		LIMITS	REFS	12						
4	ITP1	INTEGER		TAPES	REFS	21						
5	ITP2	INTEGER		TAPES	REFS	21						
170	IWANT	INTEGER			REFS	75	DEFINED	74				
161	J	INTEGER			REFS	40	41	2*51	2*55	DEFINED	37	47
24	JAM	INTEGER		LIMITS	REFS	12						
157	K	INTEGER			REFS	33	34	35	51	55	60	2*64
					66	DEFINED	32					
12	KA	INTEGER		LIMITS	REFS	12						
10	KKA	INTEGER		GEOPAR	REFS	10						
66	KPLAS	INTEGER		LIMITS	REFS	12						
55	KRNCH	INTEGER		LIMITS	REFS	12						
45	KRNCHC	INTEGER		LIMITS	REFS	12						
44	KRNCHF	INTEGER		LIMITS	REFS	12						
46	KRNCHT	INTEGER		LIMITS	REFS	12						
36	KZI	INTEGER		LIMITS	REFS	12						
52	MAXA	INTEGER		LIMITS	REFS	12						
43	MAXT	INTEGER		LIMITS	REFS	12						
56	MCUD	INTEGER		LIMITS	REFS	12						
17	NABC	INTEGER		LIMITS	REFS	12						
16	NABF	INTEGER		LIMITS	REFS	12						
31	NABF2	INTEGER		LIMITS	REFS	12	74					
20	NABT	INTEGER		LIMITS	REFS	12						
32	NABT2	INTEGER		LIMITS	REFS	12						
0	NADET	INTEGER	ARRAY	F.P.	REFS	22	39	74	DEFINED	1		
21	NAEC	INTEGER		LIMITS	REFS	12						
22	NAEF	INTEGER		LIMITS	REFS	12						
14	NARC	INTEGER		LIMITS	REFS	12						
13	NARF	INTEGER		LIMITS	REFS	12						
15	NART	INTEGER		LIMITS	REFS	12						
25	NAXBT	INTEGER		LIMITS	REFS	12						
0	NAXBTD	INTEGER		F.P.	REFS	25	DEFINED	1				
26	NAXB2	INTEGER		LIMITS	REFS	12						

VARIABLES	SN	TYPE		RELOCATION							
27	NAXB4	INTEGER		LIMITS	REFS	12	73				
1	NC	INTEGER		LIMITS	REFS	12					
50	NC4	INTEGER		LIMITS	REFS	12					
7	NETOT	INTEGER		LIMITS	REFS	12					
53	NEW	INTEGER		LIMITS	REFS	12					
10	NEWF	INTEGER		LIMITS	REFS	12					
11	NEWT	INTEGER		LIMITS	REFS	12					
0	NF	INTEGER		LIMITS	REFS	12					
6	NFF	INTEGER		LIMITS	REFS	12					
30	NFF1	INTEGER		LIMITS	REFS	12					
47	NFF2	INTEGER		LIMITS	REFS	12					
51	NF4	INTEGER		LIMITS	REFS	12					
0	NIN	INTEGER		TAPES	REFS	21					
41	NKN	INTEGER		LIMITS	REFS	12					
54	NMX	INTEGER		LIMITS	REFS	12					
171	NN	INTEGER	ARRAY		REFS	22	38	DEFINED	33	34	35
162	NN1	INTEGER			REFS	39	DEFINED	38			
2	NOEL	INTEGER		LIMITS	REFS	12					
4	NOELC	INTEGER		LIMITS	REFS	12					
3	NOELF	INTEGER		LIMITS	REFS	12					
65	NOLD	INTEGER		LIMITS	REFS	12					
1	NOUT	INTEGER		TAPES	REFS	21					
2	NSCR1	INTEGER		TAPES	REFS	21					
3	NSCR2	INTEGER		TAPES	REFS	21					
23	NTAE	INTEGER		LIMITS	REFS	12	32				
13	PDEL	REAL		GEOPAR	REFS	10					
0	PI	REAL		CONTNT	REFS	20					
11	PIN	REAL		GEOPAR	REFS	10					
12	POUT	REAL		GEOPAR	REFS	10					
72	RAKSUM	REAL		LIMITS	REFS	12					
2	RCI	REAL		GEOPAR	REFS	10					
3	RCO	REAL		GEOPAR	REFS	10					
0	RFI	REAL		GEOPAR	REFS	10					
1	RFO	REAL		GEOPAR	REFS	10					
70	RRAKR	REAL		LIMITS	REFS	12					
164	S	REAL			REFS	51	60	DEFINED	45	51	
166	SIGO	REAL			REFS	64	66	DEFINED	62	64	
165	SS	REAL			REFS	55	66	DEFINED	46	55	
64	STEP	REAL		LIMITS	REFS	12					
0	STRSA	REAL	ARRAY	F.P.	REFS	22	55	DEFINED	1		
1	SUMFF	REAL		AXL	REFS	9	75	DEFINED	75		
0	SUMM	REAL		AXL	REFS	9	73	DEFINED	73		
2	SUMSAV	REAL		AXL	REFS	9					
0	THETAX	REAL	ARRAY	F.P.	REFS	25	64	DEFINED	1		
61	TIMEC	REAL		LIMITS	REFS	12					
62	TIMEF	REAL		LIMITS	REFS	12					
4	TREF	REAL		GEOPAR	REFS	10					
1	XNU	REAL		LASTIC	REFS	19					
7	ZDEL	REAL		GEOPAR	REFS	10					

STATEMENT LABELS	DEF LINE	REFERENCES
0 100	42	36
0 110	56	47

STATEMENT LABELS		DEF LINE	REFERENCES
0	120	65	63
0	130	67	44
0	140	68	32
156	150	76	72

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
11	140	K	32 68	125B	NOT INNER
27	100	I	36 42	22B	OPT
53	130	I	44 67	60B	NOT INNER
61	110	J	47 56	21B	OPT
112	120	II	63 65	12B	INSTACK

COMMON BLOCKS	LENGTH
AXL	4
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6

STATISTICS

PROGRAM LENGTH	217B	143
SCM LABELED COMMON LENGTH	131B	89

140000B SCM USED

```
      SUBROUTINE BOUND (XKT,NODET,MAXTD)                                BOUND      2
C                                                                       BOUND      3
      DIMENSION XKT(MAXTD),LKNT(6),NODET(1)                             BOUND      4
C                                                                       BOUND      5
CC                                                                      BOUND      6
C     BOUND IS CALLED FROM PELET                                        BOUND      7
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P PELCOM     2
     +DEL,COMP                                                          PELCOM     3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE PELCOM     4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAC,JAM,NAXBT, PELCOM     5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISSTOP,IPLAS,NKN PELCOM     6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N PELCOM     7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,IT1,STEP,NOLD                 PELCOM     8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                         PELCOM     9
     +,IRZ                                                              PELCOM    10
      COMMON /LASTIC/ E,XNU,ALPHA                                       PELCOM    11
      COMMON /CONTNT/ PI                                                PELCOM    12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                     PELCOM    13
C                                                                       BOUND      9
CC                                                                      BOUND     10
CC                                                                      BOUND     11
C     PURPOSE OF THIS SUBROUTINE IS TO DEFINE THE BOUNDARY CONDITIONS   BOUND     12
C     AND TO MODIFY THE STIFFNESS MATRIX FOR THE FUEL                   BOUND     13
C     THE CLAD, OR THE COMBINED SYSTEM.                                 BOUND     14
CC                                                                      BOUND     15
CC                                                                      BOUND     16
C     XKT    - RADIAL MODEL STIFFNESS ARRAY                             BOUND     17
C     NODET  - DEGREE OF FREEDOM ARRAY                                  BOUND     18
C                                                                       BOUND     19
C     AXIAL DISPLACEMENTS ON THE BOTTOM OF THE MODEL ARE FORCED TO      BOUND     20
C     VANISH.                                                           BOUND     21
C                                                                       BOUND     22
        LKNT(1) = 1                                                     BOUND     23
        LKNT(2) = 3                                                     BOUND     24
        LKNT(3) = 6                                                     BOUND     25
        LKNT(4) = 10                                                    BOUND     26
        LKNT(5) = 15                                                    BOUND     27
        LKNT(6) = 21                                                    BOUND     28
        N = NF+NC                                                       BOUND     29
            DO 120 I=1,N                                                BOUND     30
            II = NODET(I)+1                                             BOUND     31
            IIM1 = II-1                                                 BOUND     32
            LOUT = 8                                                    BOUND     33
            IF (II.GE.KRNCHT) LOUT = 7-II+KRNCHT                        BOUND     34
            IIII = 8*(II-1)+1                                           BOUND     35
            IF (II.GT.KRNCHT) IIII = IIII-LKNT(II-KRNCHT)               BOUND     36
            III = IIII                                                  BOUND     37
                DO 100 IK=1,LOUT                                        BOUND     38
                XKT(IIII) = 0.0                                         BOUND     39
                IIII = IIII+1                                           BOUND     40
  100           CONTINUE                                                BOUND     41
            ISDN = II-7                                                 BOUND     42
            IF (II.LT.8) ISDN = 1                                       BOUND     43
```

```
                      DO 110 IL=ISDN,IIMI                                                BOUND      44
55                    III = 8*(IL-1)+II-IL+1                                             BOUND      45
                      IF (IL.GT.KRNCHT) III = III-LKNT(IL-KRNCHT)                        BOUND      46
                      XKT(III) = 0.0                                                     BOUND      47
            110       CONTINUE                                                           BOUND      48
                    XKT(III) = 1.0                                                       BOUND      49
60          120     CONTINUE                                                             BOUND      50
                    C                                                                    BOUND      51
                    C   HAVE COMPUTED THE CORRECT STIFFNESS MATRIX FOR FUEL CONTACTING THE BOUND     52
                    C   CLAD.                                                           BOUND      53
                    C                                                                    BOUND      54
65                    RETURN                                                             BOUND      55
                      END                                                                BOUND      56
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	BOUND	1	65

VARIABLES

		SN	TYPE	RELOCATION							
2	ALPHA		REAL	LASTIC	REFS	16					
14	COMP		REAL	GEOPAR	REFS	7					
33	CP		REAL	LIMITS	REFS	9					
34	CR		REAL	LIMITS	REFS	9					
5	DELR		REAL	GEOPAR	REFS	7					
6	DELZ		REAL	GEOPAR	REFS	7					
0	E		REAL	LASTIC	REFS	16					
35	FRDEN		REAL	LIMITS	REFS	9					
130	I		INTEGER		REFS	41	DEFINED	40			
57	IADJ		INTEGER	LIMITS	REFS	9					
67	ICNT		INTEGER	LIMITS	REFS	9					
42	ICRPP		INTEGER	LIMITS	REFS	9					
60	ICUT		INTEGER	LIMITS	REFS	9					
5	IDF		INTEGER	LIMITS	REFS	9					
131	II		INTEGER		REFS	42	2*44	45	2*46	52	53	55
					DEFINED	41						
141	III		INTEGER		REFS	56	57	DEFINED	55	56		
134	IIII		INTEGER		REFS	46	47	49	50	DEFINED	45	46
						50						
132	IIMI		INTEGER		REFS	54	DEFINED	42				
135	III		INTEGER		REFS	59	DEFINED	47				
136	IK	*	INTEGER		DEFINED	48						
140	IL		INTEGER		REFS	2*55	2*56	DEFINED	54			
40	IPLAS		INTEGER	LIMITS	REFS	9						
73	IPLEND		INTEGER	LIMITS	REFS	9						
71	IRAK		INTEGER	LIMITS	REFS	9						
75	IRZ		INTEGER	LIMITS	REFS	9						
137	ISDN		INTEGER		REFS	54	DEFINED	52	53			
74	ISP		INTEGER	LIMITS	REFS	9						

VARIABLES	SN	TYPE		RELOCATION								
37	ISSTOP	INTEGER		LIMITS	REFS	9						
63	ITI	INTEGER		LIMITS	REFS	9						
4	ITP1	INTEGER		TAPES	REFS	18						
5	ITP2	INTEGER		TAPES	REFS	18						
24	JAM	INTEGER		LIMITS	REFS	9						
12	KA	INTEGER		LIMITS	REFS	9						
10	KKA	INTEGER		GEOPAR	REFS	7						
66	KPLAS	INTEGER		LIMITS	REFS	9						
55	KRNCH	INTEGER		LIMITS	REFS	9						
45	KRNCHC	INTEGER		LIMITS	REFS	9						
44	KRNCHF	INTEGER		LIMITS	REFS	9						
46	KRNCHT	INTEGER		LIMITS	REFS	9		2*44	2*46	2*56		
36	KZI	INTEGER		LIMITS	REFS	9						
142	LKNT	INTEGER	ARRAY		REFS	3		46	56	DEFINED	33	34 35
					36	37		38				
133	LOUT	INTEGER			REFS	48		DEFINED	43	44		
52	MAXA	INTEGER		LIMITS	REFS	9						
43	MAXT	INTEGER		LIMITS	REFS	9						
0	MAXTD	INTEGER		F.P.	REFS	3		DEFINED	1			
56	MCUD	INTEGER		LIMITS	REFS	9						
127	N	INTEGER			REFS	40		DEFINED	39			
17	NABC	INTEGER		LIMITS	REFS	9						
16	NABF	INTEGER		LIMITS	REFS	9						
31	NABF2	INTEGER		LIMITS	REFS	9						
20	NABT	INTEGER		LIMITS	REFS	9						
32	NABT2	INTEGER		LIMITS	REFS	9						
21	NAEC	INTEGER		LIMITS	REFS	9						
22	NAEF	INTEGER		LIMITS	REFS	9						
14	NARC	INTEGER		LIMITS	REFS	9						
13	NARF	INTEGER		LIMITS	REFS	9						
15	NART	INTEGER		LIMITS	REFS	9						
25	NAXBT	INTEGER		LIMITS	REFS	9						
26	NAXB2	INTEGER		LIMITS	REFS	9						
27	NAXB4	INTEGER		LIMITS	REFS	9						
1	NC	INTEGER		LIMITS	REFS	9		39				
50	NC4	INTEGER		LIMITS	REFS	9						
7	NETOT	INTEGER		LIMITS	REFS	9						
53	NEW	INTEGER		LIMITS	REFS	9						
10	NEWF	INTEGER		LIMITS	REFS	9						
11	NEWT	INTEGER		LIMITS	REFS	9						
0	NF	INTEGER		LIMITS	REFS	9		39				
6	NFF	INTEGER		LIMITS	REFS	9						
30	NFF1	INTEGER		LIMITS	REFS	9						
47	NFF2	INTEGER		LIMITS	REFS	9						
51	NF4	INTEGER		LIMITS	REFS	9						
0	NIN	INTEGER		TAPES	REFS	18						
41	NKN	INTEGER		LIMITS	REFS	9						
54	NMX	INTEGER		LIMITS	REFS	9						
0	NODET	INTEGER	ARRAY	F.P.	REFS	3		41	DEFINED	1		
2	NOEL	INTEGER		LIMITS	REFS	9						
4	NOELC	INTEGER		LIMITS	REFS	9						
3	NOELF	INTEGER		LIMITS	REFS	9						
65	NOLD	INTEGER		LIMITS	REFS	9						

VARIABLES	SN	TYPE	RELOCATION							
1	NOUT	INTEGER		TAPES	REFS	18				
2	NSCR1	INTEGER		TAPES	REFS	18				
3	NSCR2	INTEGER		TAPES	REFS	18				
23	NTAE	INTEGER		LIMITS	REFS	9				
13	PDEL	REAL		GEOPAR	REFS	7				
0	PI	REAL		CONTNT	REFS	17				
11	PIN	REAL		GEOPAR	REFS	7				
12	POUT	REAL		GEOPAR	REFS	7				
72	RAKSUM	REAL		LIMITS	REFS	9				
2	RCI	REAL		GEOPAR	REFS	7				
3	RCO	REAL		GEOPAR	REFS	7				
0	RFI	REAL		GEOPAR	REFS	7				
1	RFO	REAL		GEOPAR	REFS	7				
70	RRAKR	REAL		LIMITS	REFS	9				
64	STEP	REAL		LIMITS	REFS	9				
61	TIMEC	REAL		LIMITS	REFS	9				
62	TIMEF	REAL		LIMITS	REFS	9				
4	TREF	REAL		GEOPAR	REFS	7				
0	XKT	REAL	ARRAY	F.P.	REFS	3	DEFINED	1	49	57 59
1	XNU	REAL		LASTIC	REFS	16				
7	ZDEL	REAL		GEOPAR	REFS	7				

STATEMENT LABELS	DEF LINE	REFERENCES
0 100	51	48
0 110	58	54
0 120	60	40

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
30	120	I	40 60	75B	NOT INNER
61	100	IK	48 51	7B	INSTACK
101	110	IL	54 58	16B	OPT

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6

STATISTICS

PROGRAM LENGTH	155B	109
SCM LABELED COMMON LENGTH	125B	85

140000B SCM USED

```
      SUBROUTINE DMCHB (R,A,M,N,MUD,IOP,EPS)                                DMCHB      2
C     ......................................................................  DMCHB      3
C                                                                           DMCHB      4
C     DMCHB IS CALLED FROM SOLVET, ASOLVE                                   DMCHB      5
C                                                                           DMCHB      6
C     SUBROUTINE DMCHB                                                      DMCHB      7
C                                                                           DMCHB      8
C     PURPOSE                                                               DMCHB      9
C     FOR A GIVEN POSITIVE-DEFINITE M BY M MATRIX A WITH SYMMETRIC          DMCHB     10
C     BAND STRUCTURE AND - IF NECESSARY - A GIVEN GENERAL M BY N            DMCHB     11
C     MATRIX R, THE FOLLOWING CALCULATIONS (DEPENDENT ON THE                DMCHB     12
C     VALUE OF THE DECISION PARAMETER IOP) ARE PERFORMED                    DMCHB     13
C     (1) MATRIX A IS FACTORIZED (IF IOP IS NOT NEGATIVE), THAT             DMCHB     14
C     MEANS BAND MATRIX TU WITH UPPER CODIAGONALS ONLY IS                   DMCHB     15
C     GENERATED ON THE LOCATIONS OF A SUCH THAT                             DMCHB     16
C     TRANSPOSE(TU)*TU=A.                                                   DMCHB     17
C     (2) MATRIX R IS MULTIPLIED ON THE LEFT BY INVERSE(TU)                 DMCHB     18
C     AND/OR INVERSE(TRANSPOSE(TU)) AND THE RESULT IS STORED                DMCHB     19
C     IN THE LOCATIONS OF R.                                                DMCHB     20
C     THIS SUBROUTINE ESPECIALLY CAN BE USED TO SOLVE THE SYSTEM            DMCHB     21
C     OF SIMULTANEOUS LINEAR EQUATIONS A*X=R WITH POSITIVE-                 DMCHB     22
C     DEFINITE COEFFICIENT MATRIX A OF SYMMETRIC BAND STRUCTURE.            DMCHB     23
C                                                                           DMCHB     24
C     USAGE                                                                 DMCHB     25
C     CALL DMCHB (R,A,M,N,MUD,IOP,EPS,IER)                                  DMCHB     26
C                                                                           DMCHB     27
C     DESCRIPTION OF PARAMETERS                                             DMCHB     28
C     R      - INPUT IN CASES IOP=-3,-2,-1,1,2,3  DOUBLE PRECISION          DMCHB     29
C     M BY N RIGHT HAND SIDE MATRIX,                                        DMCHB     30
C     IN CASE IOP=0  IRRELEVANT.                                            DMCHB     31
C     OUTPUT IN CASES IOP=1,-1  INVERSE(A)*R,                               DMCHB     32
C     IN CASES IOP=2,-2  INVERSE(TU)*R,                                     DMCHB     33
C     IN CASES IOP=3,-3  INVERSE(TRANSPOSE(TU))*R,                          DMCHB     34
C     IN CASE  IOP=0     UNCHANGED.                                         DMCHB     35
C     A      - INPUT IN CASES IOP=0,1,2,3  DOUBLE PRECISION M BY M          DMCHB     36
C     POSITIVE-DEFINITE COEFFICIENT MATRIX OF                               DMCHB     37
C     SYMMETRIC BAND STRUCTURE STORED IN                                    DMCHB     38
C     COMPRESSED FORM (SEE REMARKS),                                        DMCHB     39
C     IN CASES IOP=-1,-2,-3 DOUBLE PRECISION M BY M                         DMCHB     40
C     BAND MATRIX TU WITH UPPER CODIAGONALS ONLY,                           DMCHB     41
C     STORED IN COMPRESSED FORM (SEE REMARKS).                              DMCHB     42
C     OUTPUT IN ALL CASES  BAND MATRIX TU WITH UPPER                        DMCHB     43
C     CODIAGONALS ONLY, STORED IN COMPRESSED FORM                           DMCHB     44
C     (THAT MEANS UNCHANGED IF IOP=-1,-2,-3).                               DMCHB     45
C     M      - INPUT VALUE SPECIFYING THE NUMBER OF ROWS AND                DMCHB     46
C     COLUMNS OF A AND THE NUMBER OF ROWS OF R.                             DMCHB     47
C     N      - INPUT VALUE SPECIFYING THE NUMBER OF COLUMNS OF R            DMCHB     48
C     (IRRELEVANT IN CASE IOP=0).                                           DMCHB     49
C     MUD    - INPUT VALUE SPECIFYING THE NUMBER OF UPPER                   DMCHB     50
C     CODIAGONALS OF A.                                                     DMCHB     51
C     IOP    - ONE OF THE VALUES -3,-2,-1,0,1,2,3 GIVEN AS INPUT            DMCHB     52
C     AND USED AS DECISION PARAMETER.                                       DMCHB     53
C     EPS    - SINGLE PRECISION INPUT VALUE USED AS RELATIVE                DMCHB     54
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      C   TOLERANCE FOR TEST ON LOSS OF SIGNIFICANT DIGITS.                    DMCHB      55
   55 C   IER    - RESULTING ERROR PARAMETER CODED AS FOLLOWS                   DMCHB      56
      C   IER=0  - NO ERROR,                                                   DMCHB      57
      C   IER=-1 - NO RESULT BECAUSE OF WRONG INPUT                            DMCHB      58
      C   PARAMETERS M,MUD,IOP (SEE REMARKS),                                  DMCHB      59
      C   OR BECAUSE OF A NONPOSITIVE RADICAND AT                              DMCHB      60
   60 C   SOME FACTORIZATION STEP,                                             DMCHB      61
      C   OR BECAUSE OF A ZERO DIAGONAL ELEMENT                                DMCHB      62
      C   AT SOME DIVISION STEP.                                               DMCHB      63
      C   IER=K  - WARNING DUE TO POSSIBLE LOSS OF SIGNIFI-                    DMCHB      64
      C   CANCE INDICATED AT FACTORIZATION STEP K+1                            DMCHB      65
   65 C   WHERE RADICAND WAS NO LONGER GREATER                                 DMCHB      66
      C   THAN EPS*A(K+1,K+1).                                                 DMCHB      67
      C                                                                        DMCHB      68
      C   REMARKS                                                              DMCHB      69
      C   UPPER PART OF SYMMETRIC BAND MATRIX A CONSISTING OF MAIN             DMCHB      70
   70 C   DIAGONAL AND MUD UPPER CODIAGONALS (RESP. BAND MATRIX TU              DMCHB      71
      C   CONSISTING OF MAIN DIAGONAL AND MUD UPPER CODIAGONALS)               DMCHB      72
      C   IS ASSUMED TO BE STORED IN COMPRESSED FORM, I.E. ROWWISE             DMCHB      73
      C   IN TOTALLY NEEDED M+MUD*(2M-MUD-1)/2 SUCCESSIVE STORAGE              DMCHB      74
      C   LOCATIONS. ON RETURN UPPER BAND FACTOR TU (ON THE LOCATIONS          DMCHB      75
   75 C   OF A) IS STORED IN THE SAME WAY.                                     DMCHB      76
      C   RIGHT HAND SIDE MATRIX R IS ASSUMED TO BE STORED COLUMNWISE          DMCHB      77
      C   IN N*M SUCCESSIVE STORAGE LOCATIONS. ON RETURN RESULT MATRIX         DMCHB      78
      C   INVERSE(A)*R OR INVERSE(TU)*R OR INVERSE(TRANSPOSE(TU))*R           DMCHB      79
      C   IS STORED COLUMNWISE TOO ON THE LOCATIONS OF R.                     DMCHB      80
   80 C   INPUT PARAMETERS M, MUD, IOP SHOULD SATISFY THE FOLLOWING           DMCHB      81
      C   RESTRICTIONS     MUD NOT LESS THAN ZERO,                            DMCHB      82
      C   1+MUD NOT GREATER THAN M,                                           DMCHB      83
      C   ABS(IOP) NOT GREATER THAN 3.                                        DMCHB      84
      C   NO ACTION BESIDES ERROR MESSAGE IER=-1 TAKES PLACE IF THESE          DMCHB      85
   85 C   RESTRICTIONS ARE NOT SATISFIED.                                      DMCHB      86
      C   THE PROCEDURE GIVES RESULTS IF THE RESTRICTIONS ON INPUT             DMCHB      87
      C   PARAMETERS ARE SATISFIED, IF RADICANDS AT ALL FACTORIZATION          DMCHB      88
      C   STEPS ARE POSITIVE AND/OR IF ALL DIAGONAL ELEMENTS OF                DMCHB      89
      C   UPPER BAND FACTOR TU ARE NONZERO.                                    DMCHB      90
   90 C                                                                        DMCHB      91
      C   SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                        DMCHB      92
      C   NONE                                                                 DMCHB      93
      C                                                                        DMCHB      94
      C   METHOD                                                               DMCHB      95
   95 C   FACTORIZATION IS DONE USING CHOLESKY-S SQUARE-ROOT METHOD,           DMCHB      96
      C   WHICH GENERATES THE UPPER BAND MATRIX TU SUCH THAT                   DMCHB      97
      C   TRANSPOSE(TU)*TU=A. TU IS RETURNED AS RESULT ON THE                  DMCHB      98
      C   LOCATIONS OF A. FURTHER, DEPENDENT ON THE ACTUAL VALUE OF            DMCHB      99
      C   IOP, DIVISION OF R BY TRANSPOSE(TU) AND/OR TU IS PERFORMED           DMCHB     100
  100 C   AND THE RESULT IS RETURNED ON THE LOCATIONS OF R.                    DMCHB     101
      C   FOR REFERENCE, SEE H. RUTISHAUSER, ALGORITHMUS 1 - LINEARES         DMCHB     102
      C   GLEICHUNGSSYSTEM MIT SYMMETRISCHER POSITIV-DEFINITER                 DMCHB     103
      C   BANDMATRIX NACH CHOLESKY - , COMPUTING (ARCHIVES FOR                 DMCHB     104
      C   ELECTRONIC COMPUTING), VOL.1, ISS.1 (1966), PP.77-78.                DMCHB     105
  105 C                                                                        DMCHB     106
      C   .....................................................................DMCHB     107
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                C                                                                       DMCHB     108
                C                                                                       DMCHB     109
                      DIMENSION R(75), A(500)                                           DMCHB     110
110             C                                                                       DMCHB     111
                C   TEST ON WRONG INPUT PARAMETERS                                     DMCHB     112
                      IF (IABS(IOP)-3) 100,100,490                                      DMCHB     113
                100   IF (MUD) 490,110,110                                              DMCHB     114
                110   MC = MUD+1                                                        DMCHB     115
115                   IF (M-MC) 490,120,120                                             DMCHB     116
                120   MR = M-MUD                                                        DMCHB     117
                C                                                                       DMCHB     118
                C   MC IS THE MAXIMUM NUMBER OF ELEMENTS IN THE ROWS OF ARRAY A        DMCHB     119
                C   MR IS THE INDEX OF THE LAST ROW IN ARRAY A WITH MC ELEMENTS        DMCHB     120
120             C                                                                       DMCHB     121
                C   ************************************************************    DMCHB     122
                C                                                                       DMCHB     123
                C   START FACTORIZATION OF MATRIX A                                   DMCHB     124
                      IF (IOP) 300,130,130                                              DMCHB     125
125             130   IEND = 0                                                          DMCHB     126
                      LLDST = MUD                                                       DMCHB     127
                           DO 290 K=1,M                                                 DMCHB     128
                           IST = IEND+1                                                 DMCHB     129
                           IEND = IST+MUD                                               DMCHB     130
130                        J = K-MR                                                     DMCHB     131
                           IF (J) 150,150,140                                           DMCHB     132
                140        IEND = IEND-J                                                DMCHB     133
                150        IF (J-1) 170,170,160                                         DMCHB     134
                160        LLDST = LLDST-1                                              DMCHB     135
135             170        LMAX = MUD                                                   DMCHB     136
                           J = MC-K                                                     DMCHB     137
                           IF (J) 190,190,180                                           DMCHB     138
                180        LMAX = LMAX-J                                                DMCHB     139
                190        ID = 0                                                       DMCHB     140
140                        TOL = A(IST)*EPS                                             DMCHB     141
                C                                                                       DMCHB     142
                C   START FACTORIZATION-LOOP OVER K-TH ROW                            DMCHB     143
                               DO 290 I=IST,IEND                                        DMCHB     144
                               SUM = 0.D0                                               DMCHB     145
145                            IF (LMAX) 230,230,200                                    DMCHB     146
                C                                                                       DMCHB     147
                C   PREPARE INNER LOOP                                                DMCHB     148
                200            LL = IST                                                 DMCHB     149
                               LLD = LLDST                                              DMCHB     150
150             C                                                                       DMCHB     151
                C   START INNER LOOP                                                   DMCHB     152
                                    DO 220 L=1,LMAX                                     DMCHB     153
                                    LL = LL-LLD                                         DMCHB     154
                                    LLL = LL+ID                                         DMCHB     155
155                                 SUM = SUM+A(LL)*A(LLL)                              DMCHB     156
                                    IF (LLD-MUD) 210,220,220                            DMCHB     157
                210                 LLD = LLD+1                                         DMCHB     158
                220                 CONTINUE                                            DMCHB     159
                C   END OF INNER LOOP                                                  DMCHB     160
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      C                                                                       DMCHB     161
      C   TRANSFORM ELEMENT A(I)                                             DMCHB     162
      230           SUM = A(I)-SUM                                            DMCHB     163
                    IF (I-IST) 240,240,260                                    DMCHB     164
      C                                                                       DMCHB     165
      C   A(I) IS DIAGONAL ELEMENT. ERROR TEST.                              DMCHB     166
      240           IF (SUM) 490,490,250                                      DMCHB     167
      C                                                                       DMCHB     168
      C   COMPUTATION OF PIVOT ELEMENT                                        DMCHB     169
      250           PIV = SQRT(SUM)                                           DMCHB     170
                    A(I) = PIV                                                DMCHB     171
                    PIV = 1.0/PIV                                             DMCHB     172
                    GO TO 270                                                 DMCHB     173
      C                                                                       DMCHB     174
      C   A(I) IS NOT DIAGONAL ELEMENT                                        DMCHB     175
      260           A(I) = SUM*PIV                                            DMCHB     176
      C                                                                       DMCHB     177
      C   UPDATE ID AND LMAX                                                  DMCHB     178
      270           ID = ID+1                                                 DMCHB     179
                    IF (ID-J) 290,290,280                                     DMCHB     180
      280           LMAX = LMAX-1                                             DMCHB     181
      290           CONTINUE                                                  DMCHB     182
      C                                                                       DMCHB     183
      C   END OF FACTORIZATION-LOOP OVER K-TH ROW                            DMCHB     184
      C   END OF FACTORIZATION OF MATRIX A                                    DMCHB     185
      C                                                                       DMCHB     186
      C   ********************************************************************DMCHB     187
      C                                                                       DMCHB     188
      C   PREPARE MATRIX DIVISIONS                                            DMCHB     189
            IF (IOP) 300,500,300                                              DMCHB     190
      300   ID = N*M                                                          DMCHB     191
            IEND = IABS(IOP)-2                                                DMCHB     192
            IF (IEND) 310,410,310                                             DMCHB     193
      C                                                                       DMCHB     194
      C   ********************************************************************DMCHB     195
      C                                                                       DMCHB     196
      C   START DIVISION BY TRANSPOSE OF MATRIX TU (TU IS STORED IN           DMCHB     197
      C   LOCATIONS OF A)                                                     DMCHB     198
      310   IST = 1                                                           DMCHB     199
            LMAX = 0                                                          DMCHB     200
            J = -MR                                                           DMCHB     201
            LLDST = MUD                                                       DMCHB     202
                DO 400 K=1,M                                                  DMCHB     203
                PIV = A(IST)                                                  DMCHB     204
                IF (PIV) 320,490,320                                          DMCHB     205
      320       PIV = 1.0/PIV                                                 DMCHB     206
      C                                                                       DMCHB     207
      C   STA-T BACKSUBSTITUTION-LOOP FOR K-TH ROW OF MATRIX R               DMCHB     208
                    DO 360 I=K,ID,M                                           DMCHB     209
                    SUM = 0.D0                                                DMCHB     210
                    IF (LMAX) 360,360,330                                     DMCHB     211
      C                                                                       DMCHB     212
      C   PREPARE INNER LOOP                                                 DMCHB     213
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                  330           LL = IST                                                    DMCHB     214
                                LLL = I                                                   DMCHB     215
215                             LLD = LLDST                                               DMCHB     216
                  C                                                                       DMCHB     217
                  C   START INNER LOOP                                                    DMCHB     218
                                DO 350 L=1,LMAX                                           DMCHB     219
                                LL = LL-LLD                                               DMCHB     220
220                             LLL = LLL-1                                               DMCHB     221
                                SUM = SUM+A(LL)*R(LLL)                                    DMCHB     222
                                IF (LLD-MUD) 340,350,350                                  DMCHB     223
                  340           LLD = LLD+1                                               DMCHB     224
                  350           CONTINUE                                                  DMCHB     225
225               C   END OF INNER LOOP                                                   DMCHB     226
                  C                                                                       DMCHB     227
                  C   TRANSFORM ELEMENT R(I)                                             DMCHB     228
                  360         R(I) = PIV*(R(I)-SUM)                                     DMCHB     229
                  C   END OF BACKSUBSTITUTION-LOOP FOR K-TH ROW OF MATRIX R              DMCHB     230
230               C                                                                       DMCHB     231
                  C   UPDATE PARAMETERS LMAX, IST AND LLDST                            DMCHB     232
                        IF (MC-K) 380,380,370                                             DMCHB     233
                  370   LMAX = K                                                          DMCHB     234
                  380   IST = IST+MC                                                      DMCHB     235
235                     J = J+1                                                           DMCHB     236
                        IF (J) 400,400,390                                                DMCHB     237
                  390   IST = IST-J                                                       DMCHB     238
                        LLDST = LLDST-1                                                   DMCHB     239
                  400   CONTINUE                                                          DMCHB     240
240               C                                                                       DMCHB     241
                  C   END OF DIVISION BY TRANSPOSE OF MATRIX TU                           DMCHB     242
                  C                                                                       DMCHB     243
                  C   ************************************************************        DMCHB     244
                  C                                                                       DMCHB     245
245               C   START DIVISION BY MATRIX TU (TU IS STORED ON LOCATIONS OF A)         DMCHB     246
                      IF (IEND) 410,410,500                                               DMCHB     247
                  410   IST = M+(MUD*(M+M-MC))/2+1                                      DMCHB     248
                        LMAX = 0                                                          DMCHB     249
                        K = M                                                             DMCHB     250
250                 420   IEND = IST-1                                                    DMCHB     251
                        IST = IEND-LMAX                                                   DMCHB     252
                        PIV = A(IST)                                                      DMCHB     253
                        IF (PIV) 430,490,430                                              DMCHB     254
                  430   PIV = 1.0/PIV                                                   DMCHB     255
255                     L = IST+1                                                         DMCHB     256
                  C                                                                       DMCHB     257
                  C   START BACKSUBSTITUTION-LOOP FOR K-TH ROW OF MATRIX R              DMCHB     258
                        DO 460 I=K,ID,M                                                   DMCHB     259
                        SUM = 0.D0                                                        DMCHB     260
260                     IF (LMAX) 460,460,440                                             DMCHB     261
                  440   LLL = I                                                         DMCHB     262
                  C                                                                       DMCHB     263
                  C   START INNER LOOP                                                    DMCHB     264
                            DO 450 LL=L,IEND                                              DMCHB     265
265                         LLL = LLL+1                                                   DMCHB     266
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                450           SUM = SUM+A(LL)*R(LLL)                                    DMCHB    267
                C   END OF INNER LOOP                                                   DMCHB    268
                C                                                                       DMCHB    269
                C   TRANSFORM ELEMENT R(I)                                            DMCHB    270
270             460       R(I) = PIV*(R(I)-SUM)                                         DMCHB    271
                C   END OF BACKSUBSTITUTION-LOOP FOR K-TH ROW OF MATRIX R              DMCHB    272
                C                                                                       DMCHB    273
                C   UPDATE PARAMETERS LMAX AND K                                      DMCHB    274
                      IF (K-MR) 480,480,470                                             DMCHB    275
275             470   LMAX = LMAX+1                                                     DMCHB    276
                480   K = K-1                                                           DMCHB    277
                      IF (K) 500,500,420                                                DMCHB    278
                C                                                                       DMCHB    279
                C   END OF DIVISION BY MATRIX TU                                      DMCHB    280
280             C                                                                       DMCHB    281
                C   ************************************************************    DMCHB    282
                C                                                                       DMCHB    283
                C   ERROR EXIT IN CASE OF WRONG INPUT PARAMETERS OR PIVOT ELEMENT     DMCHB    284
                C   LESS THAN OR EQUAL TO ZERO                                        DMCHB    285
285             490   CONTINUE                                                          DMCHB    286
                500   RETURN                                                            DMCHB    287
                      END                                                               DMCHB    288
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	DMCHB	1	286

VARIABLES

		SN	TYPE	RELOCATION								
0	A		REAL	ARRAY F.P.	REFS	109	140	2*155	162	203	221	252
					266	DEFINED	1	170	175			
0	EPS		REAL	F.P.	REFS	140	DEFINED	1				
454	I		INTEGER		REFS	162	163	170	175	214	2*228	261
					2*270	DEFINED	143	208	258			
452	ID		INTEGER		REFS	154	178	179	208	258		
					DEFINED	139	178	190				
444	IEND		INTEGER		REFS	128	132	143	192	246	251	264
					DEFINED	125	129	132	191	250		
0	IOP		INTEGER	F.P.	REFS	112	124	189	191	DEFINED	1	
447	IST		INTEGER		REFS	129	140	143	148	163	203	213
					234	237	250	252	255	DEFINED	128	198
					234	237	247	251				
450	J		INTEGER		REFS	131	132	133	137	138	179	235
					236	237	DEFINED	130	136	200	235	
446	K		INTEGER		REFS	130	136	208	232	233	258	274
					276	277	DEFINED	127	202	249	276	
460	L		INTEGER		REFS	264	DEFINED	152	218	255		
456	LL		INTEGER		REFS	153	154	155	219	221	266	
					DEFINED	148	153	213	219	264		

VARIABLES	SN	TYPE	RELOCATION									
457	LLD	INTEGER			REFS	153	156	157	219	222	223	
					DEFINED	149	157	215	223			
445	LLDST	INTEGER			REFS	134	149	215	238	DEFINED	126	134
						201	238					
461	LLL	INTEGER			REFS	155	220	221	265	266		
					DEFINED	154	214	220	261	265		
451	LMAX	INTEGER			REFS	138	145	152	180	210	218	251
						260	275	DEFINED	135	138	180	199	233
						248	275					
0	M	INTEGER		F.P.	REFS	115	116	127	190	202	208	3*247
						249	258	DEFINED	1			
442	MC	INTEGER			REFS	115	136	232	234	247		
					DEFINED	114						
443	MR	INTEGER			REFS	130	200	274	DEFINED	116		
0	MUD	INTEGER		F.P.	REFS	113	114	116	126	129	135	156
						201	222	247	DEFINED	1		
0	N	INTEGER		F.P.	REFS	190	DEFINED	1				
462	PIV	REAL			REFS	170	171	175	204	205	228	253
						254	270	DEFINED	169	171	203	205	252
						254						
0	R	REAL	ARRAY	F.P.	REFS	109	221	226	266	270		
					DEFINED		228	270				
455	SUM	REAL			REFS	155	162	166	169	175	221	228
						266	270	DEFINED	144	155	162	209	221
						259	266					
453	TOL	* REAL			DEFINED	140						

EXTERNALS	TYPE	ARGS	REFERENCES
SQRT	REAL	1 LIBRARY	169

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
IABS	INTEGER	1	INTRIN	112 191

STATEMENT LABELS			DEF LINE	REFERENCES
0	100	INACTIVE	113	2*112
0	110	INACTIVE	114	2*113
0	120	INACTIVE	116	2*115
0	130	INACTIVE	125	2*124
0	140	INACTIVE	132	131
56	150		133	2*131
0	160	INACTIVE	134	133
63	170		135	2*133
0	180	INACTIVE	138	137
75	190		139	2*137
0	200	INACTIVE	148	145
0	210	INACTIVE	157	156
134	220		158	152 2*156
140	230		162	2*145
0	240	INACTIVE	166	2*163
0	250	INACTIVE	169	166
162	260		175	163
166	270		178	172
0	280	INACTIVE	180	179

STATEMENT LABELS			DEF LINE	REFERENCES					
176	290		181	127	143	2*179			
207	300		190	124	2*189				
0	310	INACTIVE	198	2*192					
0	320	INACTIVE	205	2*204					
0	330	INACTIVE	213	210					
0	340	INACTIVE	223	222					
275	350		224	218	2*222				
301	360		228	208	2*210				
0	370	INACTIVE	233	232					
315	380		234	2*232					
0	390	INACTIVE	237	236					
330	400		239	202	2*236				
336	410		247	192	2*246				
350	420		250	277					
0	430	INACTIVE	254	2*253					
0	440	INACTIVE	261	260					
0	450		266	264					
413	460		270	258	2*260				
0	470	INACTIVE	275	274					
427	480		276	2*274					
435	490		285	112	113	115	2*166	204	253
436	500		286	189	246	2*277			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
40	290	K	127 181	144B		EXT REFS	EXITS	NOT INNER
103	290	I	143 181	76B		EXT REFS	EXITS	NOT INNER
115	220	L	152 158	22B	OPT			
232	400	K	202 239	101B		EXITS	NOT INNER	
243	360	I	208 228	44B		NOT INNER		
257	350	L	218 224	21B	OPT			
372	460	I	258 270	27B		NOT INNER		
402	450	LL	264 266	10B	INSTACK			

STATISTICS
PROGRAM LENGTH 512B 330
140000B SCM USED

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                FUNCTION ERF (Z)                                                    ERF      2
      C   EVALUATES ERF(Z) BY KUKI CONTINUED FRACTION EXPANSIONS                     ERF      3
      C   FOR ANY REAL VALUES OF Z                                                  ERF      4
                IF (Z) 110,100,110                                                  ERF      5
      100       CALC = 0.0                                                          ERF      6
                GO TO 180                                                           ERF      7
      110       V = ABS(Z)                                                          ERF      8
                IF (V-4.17) 130,130,120                                             ERF      9
      120       CALC = 1.0                                                          ERF     10
                GO TO 160                                                           ERF     11
      130       S = V*V                                                             ERF     12
                IF (V-1.51) 150,150,140                                             ERF     13
      140       CFL = 0.56418958*V/(S+0.5-0.5/(S+2.5-3.0/(S+4.5-7.5/(S+6.5-10.8031  ERF     14
               +34/(S+4.269024)))))                                                 ERF     15
                CALC = 1.0-CFL*EXP(-S)                                              ERF     16
                GO TO 160                                                           ERF     17
      150       CFS = 1.1283792-1.1600697*S/(S+10.215980-167.17295/(S+9.8102679+20  ERF     18
               +1.38669/(S+11.569899+31.227929/(S-1.7730436+64.244197/(S+5.5781859  ERF     19
               +)))))                                                               ERF     20
                CALC = V*CFS                                                        ERF     21
      160       IF (Z) 170,170,180                                                  ERF     22
      170       CALC = -CALC                                                        ERF     23
      180       ERF = CALC                                                          ERF     24
                RETURN                                                              ERF     25
                END                                                                 ERF     26
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	ERF	1	24

VARIABLES	SN	TYPE	RELOCATION								
146	CALC	REAL		REFS	22	23	DEFINED	5	9	15	20
					22						
151	CFL	REAL		REFS	15	DEFINED	13				
152	CFS	REAL		REFS	20	DEFINED	17				
145	ERF	REAL		DEFINED	23						
150	S	REAL		REFS	5*13	15	6*17	DEFINED	11		
147	V	REAL		REFS	8	2*11	12	13	20		
				DEFINED	7						
0	Z	REAL	F.P.	REFS	4	7	21	DEFINED	1		

EXTERNALS	TYPE	ARGS		REFERENCES
EXP	REAL	1	LIBRARY	15

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
ABS	REAL	1	INTRIN		7

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100	INACTIVE	5	4	
15	110		7	2*4	
0	120	INACTIVE	9	8	
26	130		11	2*8	
0	140	INACTIVE	13	12	
61	150		17	2*12	
103	160		21	10	16
0	170	INACTIVE	22	2*21	
110	180		23	6	21

STATISTICS

PROGRAM LENGTH 153B 107

140000B SCM USED

```
      SUBROUTINE EFFECT (EFSTR,TSTSR,NAXL,NRAD)                                 EFFECT     2
C                                                                               EFFECT     3
C   EFFECT IS CALLED FROM KREEP                                                 EFFECT     4
C                                                                               EFFECT     5
C   PURPOSE OF THIS SUBROUTINE IS TO COMPUTE THE EFFECTIVE STRESS               EFFECT     6
C   THE EFFECTIVE STRESS IS COMPUTED A NEGLECTING SHEAR                         EFFECT     7
C                                                                               EFFECT     8
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P        PELCOM     2
     +DEL,COMP                                                                  PELCOM     3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,      NE       PELCOM     4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,        PELCOM     5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,      CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN      PELCOM     6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,           N      PELCOM     7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                         PELCOM     8
     +,  KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                                PELCOM     9
     +,IRZ                                                                      PELCOM    10
      COMMON /LASTIC/ E,XNU,ALPHA                                               PELCOM    11
      COMMON /CONTNT/ PI                                                        PELCOM    12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                             PELCOM    13
      DIMENSION EFSTR(NRAD,1)                                                   EFFECT    10
      DIMENSION TSTSR(4,NRAD,1)                                                 EFFECT    11
C                                                                               EFFECT    12
C   CP,CR  - CLADDING ANISOTROPY ADJUSTMENT                                     EFFECT    13
C   EFSTR  - EFFECTIVE STRESS IN ELEMENT                                        EFFECT    14
C   TSTSR  - TOTAL STRESS ARRAY                                                 EFFECT    15
      DO 110 J=1,NAXL                                                           EFFECT    16
         DO 100 I=1,NRAD                                                        EFFECT    17
         EFSTR(I,J) = SQRT(CR/(CR+1.)*(TSTSR(3,I,J)-TSTSR(2,I,J))**             EFFECT    18
     +   2+(CR/(CP*(CR+1.)))*(TSTSR(2,I,J)-TSTSR(1,I,J))**2+1./(CR+             EFFECT    19
     +   1.)*(TSTSR(1,I,J)-TSTSR(3,I,J))**2)                                    EFFECT    20
C                                                                               EFFECT    21
100      CONTINUE                                                               EFFECT    22
110   CONTINUE                                                                  EFFECT    23
      RETURN                                                                    EFFECT    24
      END                                                                       EFFECT    25
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	EFFECT	1	34

VARIABLES	SN	TYPE	RELOCATION			
2	ALPHA	REAL	LASTIC	REFS	17	
14	COMP	REAL	GEOPAR	REFS	8	
33	CP	REAL	LIMITS	REFS	10	28
34	CR	REAL	LIMITS	REFS	10	5*28
5	DELR	REAL	GEOPAR	REFS	8	
6	DELZ	REAL	GEOPAR	REFS	8	
0	E	REAL	LASTIC	REFS	17	

VARIABLES	SN	TYPE	RELOCATION						
0	EFSTR	REAL	ARRAY	F.P.	REFS	20	DEFINED	1	28
35	FRDEN	REAL		LIMITS	REFS	10			
53	I	INTEGER			REFS	7*28	DEFINED	27	
57	IADJ	INTEGER		LIMITS	REFS	10			
67	ICNT	INTEGER		LIMITS	REFS	10			
42	ICRPP	INTEGER		LIMITS	REFS	10			
60	ICUT	INTEGER		LIMITS	REFS	10			
5	IDF	INTEGER		LIMITS	REFS	10			
40	IPLAS	INTEGER		LIMITS	REFS	10			
73	IPLEND	INTEGER		LIMITS	REFS	10			
71	IRAK	INTEGER		LIMITS	REFS	10			
75	IRZ	INTEGER		LIMITS	REFS	10			
74	ISP	INTEGER		LIMITS	REFS	10			
37	ISSTOP	INTEGER		LIMITS	REFS	10			
63	ITI	INTEGER		LIMITS	REFS	10			
4	ITP1	INTEGER		TAPES	REFS	19			
5	ITP2	INTEGER		TAPES	REFS	19			
52	J	INTEGER			REFS	7*28	DEFINED	26	
24	JAM	INTEGER		LIMITS	REFS	10			
12	KA	INTEGER		LIMITS	REFS	10			
10	KKA	INTEGER		GEOPAR	REFS	8			
66	KPLAS	INTEGER		LIMITS	REFS	10			
55	KRNCH	INTEGER		LIMITS	REFS	10			
45	KRNCHC	INTEGER		LIMITS	REFS	10			
44	KRNCHF	INTEGER		LIMITS	REFS	10			
46	KRNCHT	INTEGER		LIMITS	REFS	10			
36	KZI	INTEGER		LIMITS	REFS	10			
52	MAXA	INTEGER		LIMITS	REFS	10			
43	MAXT	INTEGER		LIMITS	REFS	10			
56	MCUD	INTEGER		LIMITS	REFS	10			
17	NABC	INTEGER		LIMITS	REFS	10			
16	NABF	INTEGER		LIMITS	REFS	10			
31	NABF2	INTEGER		LIMITS	REFS	10			
20	NABT	INTEGER		LIMITS	REFS	10			
32	NABT2	INTEGER		LIMITS	REFS	10			
21	NAEC	INTEGER		LIMITS	REFS	10			
22	NAEF	INTEGER		LIMITS	REFS	10			
14	NARC	INTEGER		LIMITS	REFS	10			
13	NARF	INTEGER		LIMITS	REFS	10			
15	NART	INTEGER		LIMITS	REFS	10			
25	NAXBT	INTEGER		LIMITS	REFS	10			
26	NAXB2	INTEGER		LIMITS	REFS	10			
27	NAXB4	INTEGER		LIMITS	REFS	10			
0	NAXL	INTEGER		F.P.	REFS	26	DEFINED	1	
1	NC	INTEGER		LIMITS	REFS	10			
50	NC4	INTEGER		LIMITS	REFS	10			
7	NETOT	INTEGER		LIMITS	REFS	10			
53	NEW	INTEGER		LIMITS	REFS	10			
10	NEWF	INTEGER		LIMITS	REFS	10			
11	NEWT	INTEGER		LIMITS	REFS	10			
0	NF	INTEGER		LIMITS	REFS	10			
6	NFF	INTEGER		LIMITS	REFS	10			
30	NFF1	INTEGER		LIMITS	REFS	10			

VARIABLES	SN	TYPE		RELOCATION						
47	NFF2	INTEGER		LIMITS	REFS	10				
51	NF4	INTEGER		LIMITS	REFS	10				
0	NIN	INTEGER		TAPES	REFS	19				
41	NKN	INTEGER		LIMITS	REFS	10				
54	NMX	INTEGER		LIMITS	REFS	10				
2	NOEL	INTEGER		LIMITS	REFS	10				
4	NOELC	INTEGER		LIMITS	REFS	10				
3	NOELF	INTEGER		LIMITS	REFS	10				
65	NOLD	INTEGER		LIMITS	REFS	10				
1	NOUT	INTEGER		TAPES	REFS	19				
0	NRAD	INTEGER		F.P.	REFS	20	21	27	DEFINED	1
2	NSCR1	INTEGER		TAPES	REFS	19				
3	NSCR2	INTEGER		TAPES	REFS	19				
23	NTAE	INTEGER		LIMITS	REFS	10				
13	PDEL	REAL		GEOPAR	REFS	8				
0	PI	REAL		CONTNT	REFS	18				
11	PIN	REAL		GEOPAR	REFS	8				
12	POUT	REAL		GEOPAR	REFS	8				
72	RAKSUM	REAL		LIMITS	REFS	10				
2	RCI	REAL		GEOPAR	REFS	8				
3	RCO	REAL		GEOPAR	REFS	8				
0	RFI	REAL		GEOPAR	REFS	8				
1	RFO	REAL		GEOPAR	REFS	8				
70	RRAKR	REAL		LIMITS	REFS	10				
64	STEP	REAL		LIMITS	REFS	10				
61	TIMEC	REAL		LIMITS	REFS	10				
62	TIMEF	REAL		LIMITS	REFS	10				
4	TREF	REAL		GEOPAR	REFS	8				
0	TSTSR	REAL	ARRAY	F.P.	REFS	21	6*28	DEFINED	1	
1	XNU	REAL		LASTIC	REFS	17				
7	ZDEL	REAL		GEOPAR	REFS	8				

EXTERNALS	TYPE	ARGS	REFERENCES
SQRT	REAL	1 LIBRARY	28

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	32	27
0	110	33	26

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
13	110	J	26 33	31B	EXT REFS NOT INNER
15	100	I	27 32	24B	EXT REFS

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6

STATISTICS

PROGRAM LENGTH	61B	49
SCM LABELED COMMON LENGTH	125B	85

STATISTICS
140000B SCM USED

```
      SUBROUTINE INPAXL (AELM,R,RA,Y,YACF,NADET,RD,NAB2D,NFF1D)
C
C     INPAXL IS CALLED FROM PELET
C
C
C     PURPOSE IS TO CREATE NODAL AND ELEMENT INFORMATION FOR THE
C     AXIAL INTRACTION ANALYSIS
C
C
C     COMPUTE THE NUMBER OF ELEMENTS IN THE FUEL
C     NABC=NUMBER OF AXIAL BOUNDS IN THE CLAD
C     NABF=NUMBER OF AXIAL BOUNDS IN THE FUEL
C     NARF=NUMBER OF AXIAL REGIONS IN THE FUEL
C     NAEF=NUMBER OF ELEMENTS IN AXIAL FUEL MODEL
C
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P
     +DEL,COMP
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP
     +,IRZ
      COMMON /LASTIC/ E,XNU,ALPHA
      COMMON /CONTNT/ PI
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,
     +    ERAD(20), EAX(20)
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)
     +,PINOLD,POUTLD,POLD,NTOLD(20)
     +  ,ICHNG,STEPS
      DIMENSION AELM(3,1)
      DIMENSION RA(1), YACF(1), NADET(1)
      DIMENSION Y(NAB2D,1), RD(NFF1D,1), R(1)
C
C     NAEC=NUMBER OF ELEMENTS IN AXIAL CLAD MODEL
C
C
C     MODIFICATIONS NEEDED FOR ADDING 4 ELEMENT QUAD.
        NATOTF = 2*NABC+2*NABF
        LL = 0
            DO 110 K=1,NTAE,4
            LL = LL+1
            L = LL
            LMF = NABF+L
            LMFF = NATOTF+L
            IF (L.LE.NARF) GO TO 100
            IF (L.EQ.NABF) LL = NABF*2+1
            L = LL
            LMF = L+NABC
            LMFF = LL+2*NABC+NARF
  100       CONTINUE
            AELM(1,K) = L
            AELM(2,K) = LMF
            AELM(3,K) = LMFF
```

```
                AELM(1,K+1) = LMF                                                  INPAXL     40
55              AELM(2,K+1) = LMF+1                                                INPAXL     41
                AELM(3,K+1) = AELM(3,K)                                            INPAXL     42
                AELM(1,K+2) = AELM(2,K+1)                                          INPAXL     43
                AELM(2,K+2) = L+1                                                  INPAXL     44
                AELM(3,K+2) = AELM(3,K)                                            INPAXL     45
60              AELM(1,K+3) = L+1                                                  INPAXL     46
                AELM(2,K+3) = L                                                    INPAXL     47
                AELM(3,K+3) = AELM(3,K)                                            INPAXL     48
          110   CONTINUE                                                           INPAXL     49
          C                                                                        INPAXL     50
65        C   DEFINE AN AXIAL ELEMENT ARRAY                                        INPAXL     51
          C   AELM(K,I)   K=ELEMENT NUMBER   I=NODE NUMBERS ASSOCIATED WITH K     INPAXL     52
          C   COMPUTE THE ELEMENT AND NODAL CONFIGURATION                         INPAXL     53
          C                                                                        INPAXL     54
          C                                                                        INPAXL     55
70        C   CREATE THE DEGREE OF FREEDOM ARRAY FOR THE FUEL                      INPAXL     56
          C                                                                        INPAXL     57
          C   CREATO NADE() FOR CORNER MODES                                       INPAXL     58
              NADET(1) = 1                                                         INPAXL     59
              NADET(2) = 9                                                         INPAXL     60
75                DO 120 K=3,NABF                                                  INPAXL     61
                  NADET(K) = 25+(K-3)*12                                         INPAXL     62
          120     CONTINUE                                                       INPAXL     63
              L = NABF+3                                                         INPAXL     64
              KK = NABF+NABF                                                     INPAXL     65
80            NADET(NABF+1) = 3                                                  INPAXL     66
              NADET(NABF+2) = 7                                                  INPAXL     67
                  DO 130 K=L,KK                                                  INPAXL     68
                  NADET(K) = 23+(K-L)*12                                         INPAXL     69
          130     CONTINUE                                                       INPAXL     70
85            L = 2*NABF+3                                                       INPAXL     71
              KK = NABF*2+NABF                                                   INPAXL     72
              IJ = NABF*2+1                                                      INPAXL     73
              NADET(IJ) = 11                                                     INPAXL     74
              NADET(IJ+1) = 19                                                   INPAXL     75
90                DO 140 K=L,KK                                                  INPAXL     76
                  NADET(K) = 31+(K-L)*12                                         INPAXL     77
          140     CONTINUE                                                       INPAXL     78
              NADET(KK+1) = NADET(KK)+6                                          INPAXL     79
              L = 2*NABF+NABC+3                                                  INPAXL     80
95            KK = NABF*2+2*NABC-1                                               INPAXL     81
              IJ = NABF*2+NABC+1                                                 INPAXL     82
              NADET(IJ) = 13                                                     INPAXL     83
              NADET(IJ+1) = 17                                                   INPAXL     84
                  DO 150 K=L,KK                                                  INPAXL     85
100               NADET(K) = 29+12*(K-L)                                         INPAXL     86
          150     CONTINUE                                                       INPAXL     87
              NADET(KK+1) = NADET(KK)+6                                          INPAXL     88
          C   CREATE NADET FOR MID NODIS START WITH THE FUEL                     INPAXL     89
              L = 2*NABF+2*NABC+2                                                INPAXL     90
105           KK = NABF*2+2*NABC+NARF                                            INPAXL     91
              IJ = NABF*2+2*NABC+1                                               INPAXL     92
```

```
                NADET(IJ) = 5                                                    INPAXL     93
                    DO 160 K=L,KK                                                INPAXL     94
                    NADET(K) = 21+12*(K-L)                                       INPAXL     95
110         160     CONTINUE                                                     INPAXL     96
                L = 2*NABF+2*NABC+NARF+2                                         INPAXL     97
                KK = (NABF+NABC+NARF)*2                                          INPAXL     98
                IJ = L-1                                                         INPAXL     99
                NADET(IJ) = 15                                                   INPAXL    100
115                 DO 170 K=L,KK                                                INPAXL    101
                    NADET(K) = 27+(K-L)*12                                       INPAXL    102
            170     CONTINUE                                                     INPAXL    103
                NADET(KK+1) = NADET(KK)+6                                        INPAXL    104
            C   HAVE NOW CREATED NADET( ) FOR FOUR CST ELEMENTS                  INPAXL    105
120         C   FOR EACH AXIAL REGION FOR BOTH THE FUEL AND THE CLAD             INPAXL    106
            C                                                                    INPAXL    107
            C   CREATE A RADIAL ARRAY WITH NODAL VALUES FOR THE AXIAL MODEL     INPAXL    108
            C                                                                    INPAXL    109
            C   RA(4*NA3T)                                                      INPAXL    110
125               Y(1,1) = 0.0                                                   INPAXL    111
                    DO 180 J=2,NABF2                                             INPAXL    112
                    Y(J,1) = Y(J-1,1)+DELZA(J-1)                                 INPAXL    113
                    NABF1 = J-NABF                                               INPAXL    114
                    IF (J.GT.NABF) Y(J,1) = Y(NABF1,1)                           INPAXL    115
130         180     CONTINUE                                                     INPAXL    116
                Y(1,2) = 0.0                                                     INPAXL    117
                    DO 190 J=2,NABT2                                             INPAXL    118
                    Y(J,2) = Y(J-1,2)+DELZA(J-1)                                 INPAXL    119
                    NABT1 = J-NABT                                               INPAXL    120
135                 IF (J.GT.NABT) Y(J,2) = Y(NABT1,2)                           INPAXL    121
            190     CONTINUE                                                     INPAXL    122
                K = 0                                                            INPAXL    123
                    DO 210 I=1,4                                                 INPAXL    124
                    NNN = NABF                                                   INPAXL    125
140                 IF (I.GT.2) NNN = NABT                                       INPAXL    126
                    NA = 1                                                       INPAXL    127
                    IF (I.EQ.2) NA = NF                                          INPAXL    128
                    IF (I.EQ.3) NA = NF+1                                        INPAXL    129
                    IF (I.EQ.4) NA = NF+NC                                       INPAXL    130
145                 L = K+1                                                      INPAXL    131
                        DO 200 J=1,NNN                                           INPAXL    132
                        K = K+1                                                  INPAXL    133
                        RA(K) = RD(NA,J)                                         INPAXL    134
                        NUP = 1                                                  INPAXL    135
150                     IF (I.GT.2) NUP = 2                                      INPAXL    136
                        YACF(K) = Y(J,NUP)                                       INPAXL    137
            200         CONTINUE                                                 INPAXL    138
            210     CONTINUE                                                     INPAXL    139
            C                                                                    INPAXL    140
155         C                                                                    INPAXL    141
                RETURN                                                           INPAXL    142
                END                                                              INPAXL    143
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

74 I NADET ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 INPAXL 1 156

VARIABLES	SN	TYPE		RELOCATION								
0	AELM	REAL	ARRAY	F.P.	REFS	31	56	57	59	62		
					DEFINED	1	51	52	53	54	55	56
						57	58	59	60	61	62	
2	ALPHA	REAL		LASTIC	REFS	23						
14	COMP	REAL		GEOPAR	REFS	14						
33	CP	REAL		LIMITS	REFS	16						
34	CR	REAL		LIMITS	REFS	16						
5	DELR	REAL		GEOPAR	REFS	14						
6	DELZ	REAL		GEOPAR	REFS	14						
0	DELZA	REAL	ARRAY	BA	REFS	26	127	133				
0	E	REAL		LASTIC	REFS	23						
102	EAX	REAL	ARRAY	BA	REFS	26						
56	ERAD	REAL	ARRAY	BA	REFS	26						
55	FLXR	REAL		BA	REFS	26						
35	FRDEN	REAL		LIMITS	REFS	16						
0	HHF	REAL		FEP	REFS	28						
535	I	INTEGER			REFS	140	142	143	144	150		
					DEFINED	138						
57	IADJ	INTEGER		LIMITS	REFS	16						
103	ICHNG	INTEGER		FEP	REFS	28						
67	ICNT	INTEGER		LIMITS	REFS	16						
42	ICRPP	INTEGER		LIMITS	REFS	16						
60	ICUT	INTEGER		LIMITS	REFS	16						
5	IDF	INTEGER		LIMITS	REFS	16						
531	IJ	INTEGER			REFS	88	89	97	98	107	114	
					DEFINED	87	96	106	113			
40	IPLAS	INTEGER		LIMITS	REFS	16						
73	IPLEND	INTEGER		LIMITS	REFS	16						
71	IRAK	INTEGER		LIMITS	REFS	16						
75	IRZ	INTEGER		LIMITS	REFS	16						
74	ISP	INTEGER		LIMITS	REFS	16						
37	ISSTOP	INTEGER		LIMITS	REFS	16						
3	ISTOP	INTEGER		FEP	REFS	28						
53	ISTRT	INTEGER		BA	REFS	26						
54	ITER	INTEGER		BA	REFS	26						
63	ITI	INTEGER		LIMITS	REFS	16						
4	ITP1	INTEGER		TAPES	REFS	25						
5	ITP2	INTEGER		TAPES	REFS	25						
532	J	INTEGER			REFS	3*127	128	2*129	3*133	134	2*135	148

VARIABLES	SN	TYPE		RELOCATION								
					151	DEFINED	126	132	146			
24	JAM	INTEGER		LIMITS	REFS	16						
524	K	INTEGER			REFS	51	52	53	54	55	2*56	2*57
					58	2*59	60	61	2*62	2*76	2*83	2*91
					2*100	2*109	2*116	145	147	148	151	
					DEFINED	40	75	82	90	99	108	115
					137	147						
12	KA	INTEGER		LIMITS	REFS	16						
530	KK	INTEGER			REFS	82	90	2*93	99	2*102	108	115
					2*118	DEFINED	79	86	95	105	112	
10	KKA	INTEGER		GEOPAR	REFS	14						
2	KKZZZ	INTEGER		FEP	REFS	28						
66	KPLAS	INTEGER		LIMITS	REFS	16						
55	KRNCH	INTEGER		LIMITS	REFS	16						
45	KRNCHC	INTEGER		LIMITS	REFS	16						
44	KRNCHF	INTEGER		LIMITS	REFS	16						
46	KRNCHT	INTEGER		LIMITS	REFS	16						
36	KZI	INTEGER		LIMITS	REFS	16						
525	L	INTEGER			REFS	43	44	45	46	48	51	58
					60	61	82	83	90	91	99	100
					108	109	113	115	116	DEFINED	42	47
					78	85	94	104	111	145		
523	LL	INTEGER			REFS	41	42	47	49	DEFINED	39	41
					46							
526	LMF	INTEGER			REFS	52	54	55	DEFINED	43	48	
527	LMFF	INTEGER			REFS	53	DEFINED	44	49			
52	MAXA	INTEGER		LIMITS	REFS	16						
43	MAXT	INTEGER		LIMITS	REFS	16						
56	MCUD	INTEGER		LIMITS	REFS	16						
537	NA	INTEGER			REFS	148	DEFINED	141	142	143	144	
17	NABC	INTEGER		LIMITS	REFS	16	38	48	49	94	95	96
					104	105	106	111	112			
16	NABF	INTEGER		LIMITS	REFS	16	38	43	2*46	75	78	2*79
					80	81	85	2*86	87	94	95	96
					104	105	106	111	112	128	129	139
533	NABF1	INTEGER			REFS	129	DEFINED	128				
31	NABF2	INTEGER		LIMITS	REFS	16	126					
20	NABT	INTEGER		LIMITS	REFS	16	134	135	140			
534	NABT1	INTEGER			REFS	135	DEFINED	134				
32	NABT2	INTEGER		LIMITS	REFS	16	132					
0	NAB2D	INTEGER		F.P.	REFS	33	DEFINED	1				
0	NADET	INTEGER	ARRAY	F.P.	REFS	32	93	102	118	DEFINED	1	73
					74	76	80	81	83	88	89	91
					93	97	98	100	102	107	109	114
					116	118						
21	NAEC	INTEGER		LIMITS	REFS	16						
22	NAEF	INTEGER		LIMITS	REFS	16						
14	NARC	INTEGER		LIMITS	REFS	16						
13	NARF	INTEGER		LIMITS	REFS	16	45	49	105	111	112	
15	NART	INTEGER		LIMITS	REFS	16						
522	NATOTF	INTEGER			REFS	44	DEFINED	38				
25	NAXBT	INTEGER		LIMITS	REFS	16						
26	NAXB2	INTEGER		LIMITS	REFS	16						

VARIABLES	SN	TYPE		RELOCATION						
27	NAXB4	INTEGER		LIMITS	REFS	16				
1	NC	INTEGER		LIMITS	REFS	16	144			
52	NCNN	INTEGER		BA	REFS	26				
51	NCONN	INTEGER		BA	REFS	26				
50	NC4	INTEGER		LIMITS	REFS	16				
7	NETOT	INTEGER		LIMITS	REFS	16				
53	NEW	INTEGER		LIMITS	REFS	16				
10	NEWF	INTEGER		LIMITS	REFS	16				
11	NEWT	INTEGER		LIMITS	REFS	16				
0	NF	INTEGER		LIMITS	REFS	16	142	143	144	
6	NFF	INTEGER		LIMITS	REFS	16				
30	NFFI	INTEGER		LIMITS	REFS	16				
0	NFFID	INTEGER		F.P.	REFS	33	DEFINED	1		
47	NFF2	INTEGER		LIMITS	REFS	16				
51	NF4	INTEGER		LIMITS	REFS	16				
0	NIN	INTEGER		TAPES	REFS	25				
41	NKN	INTEGER		LIMITS	REFS	16				
54	NMX	INTEGER		LIMITS	REFS	16				
50	NN	INTEGER		BA	REFS	26				
536	NNN	INTEGER			REFS	146	DEFINED	139	140	
2	NOEL	INTEGER		LIMITS	REFS	16				
4	NOELC	INTEGER		LIMITS	REFS	16				
3	NOELF	INTEGER		LIMITS	REFS	16				
65	NOLD	INTEGER		LIMITS	REFS	16				
1	NOUT	INTEGER		TAPES	REFS	25				
2	NSCR1	INTEGER		TAPES	REFS	25				
3	NSCR2	INTEGER		TAPES	REFS	25				
1	NT	INTEGER		FEP	REFS	28				
23	NTAE	INTEGER		LIMITS	REFS	16	40			
57	NTOLD	INTEGER	ARRAY	FEP	REFS	28				
540	NUP	INTEGER			REFS	151	DEFINED	149	150	
13	PDEL	REAL		GEOPAR	REFS	14				
0	PI	REAL		CONTNT	REFS	24				
11	PIN	REAL		GEOPAR	REFS	14				
54	PINOLD	REAL		FEP	REFS	28				
56	POLD	REAL		FEP	REFS	28				
12	POUT	REAL		GEOPAR	REFS	14				
55	POUTLD	REAL		FEP	REFS	28				
0	R	REAL	ARRAY	F.P.	REFS	33	DEFINED	1		
0	RA	REAL	ARRAY	F.P.	REFS	32	DEFINED	1	148	
72	RAKSUM	REAL		LIMITS	REFS	16				
2	RCI	REAL		GEOPAR	REFS	14				
3	RCO	REAL		GEOPAR	REFS	14				
0	RD	REAL	ARRAY	F.P.	REFS	33	148	DEFINED	1	
4	RDOLD	REAL	ARRAY	FEP	REFS	28				
0	RFI	REAL		GEOPAR	REFS	14				
1	RFO	REAL		GEOPAR	REFS	14				
70	RRAKR	REAL		LIMITS	REFS	16				
30	RRSIN	REAL	ARRAY	FEP	REFS	28				
64	STEP	REAL		LIMITS	REFS	16				
104	STEPS	REAL		FEP	REFS	28				
61	TIMEC	REAL		LIMITS	REFS	16				
62	TIMEF	REAL		LIMITS	REFS	16				

```
VARIABLES     SN  TYPE          RELOCATION
    4  TREF      REAL                GEOPAR      REFS      14
    1  XNU       REAL                LASTIC      REFS      23
    0  Y         REAL        ARRAY    F.P.       REFS      33     127   129   133   135   151
                                                 DEFINED    1     125   127   129   131   133   135
    0  YACF      REAL        ARRAY    F.P.       REFS      32  DEFINED    1   151
    7  ZDEL      REAL                GEOPAR      REFS      14

STATEMENT LABELS          DEF LINE   REFERENCES
   56  100                     50         45
    0  110                     63         40
    0  120                     77         75
    0  130                     84         82
    0  140                     92         90
    0  150                    101         99
    0  160                    110        108
    0  170                    117        115
    0  180                    130        126
    0  190                    136        132
    0  200                    152        146
    0  210                    153        138

LOOPS  LABEL   INDEX    FROM-TO    LENGTH    PROPERTIES
   22  110     K          40 63      117B       OPT
  147  120     K          75 77        7B     INSTACK
  173  130     K          82 84        7B     INSTACK
  222  140     K          90 92        7B     INSTACK
  261  150     K          99 101       7B     INSTACK
  315  160     K         108 110       7B     INSTACK
  345  170     K         115 117       7B     INSTACK
  364  180     J         126 130      16B       OPT
  407  190     J         132 136      20B       OPT
  433  210     I         138 153      64B                 NOT INNER
  467  200     J         146 152      25B       OPT

COMMON BLOCKS   LENGTH
       GEOPAR       13
       LIMITS       62
       LASTIC        3
       CONTNT        1
       TAPES         6
       BA           86
       FEP          69

STATISTICS
  PROGRAM LENGTH                    576B      382
  SCM LABELED COMMON LENGTH         360B      240
        140000B SCM USED
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```
      SUBROUTINE INPUT (ELM,NODET)                                                  INPUT       2
      DIMENSION ELM(3,1),NODET(1)                                                   INPUT       3
C                                                                                   INPUT       4
C   INPUT IS CALLED FROM PELET                                                      INPUT       5
C                                                                                   INPUT       6
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P PELCOM     2
     +DEL,COMP                                                                      PELCOM      3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE PELCOM     4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT, PELCOM     5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISSTOP,IPLAS,NKN PELCOM     6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N PELCOM     7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                             PELCOM      8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                                     PELCOM      9
     +,IRZ                                                                          PELCOM     10
      COMMON /LASTIC/ E,XNU,ALPHA                                                   PELCOM     11
      COMMON /CONTNT/ PI                                                            PELCOM     12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                                 PELCOM     13
C                                                                                   INPUT       8
C   COMPUTE ELEMENT INCIDENSE AND ELEMENT NUMBERING SCHEMES                         INPUT       9
C   ELM(J,I),I=ELEMENT, J=COORDINATE NO.                                            INPUT      10
C                                                                                   INPUT      11
C   COMPUTE NODE POINT NUMBERS FOR EACH ELEMENT                                     INPUT      12
C                                                                                   INPUT      13
      L = 0                                                                         INPUT      14
      DO 100 K=1,NOEL,2                                                             INPUT      15
      L = L+1                                                                       INPUT      16
      IF (K.EQ.(NOELF+1)) L = L+1                                                   INPUT      17
      ELM(1,K) = L                                                                  INPUT      18
      ELM(2,K) = NF+NC+L+1                                                          INPUT      19
      ELM(3,K) = NF+NC+L                                                            INPUT      20
      ELM(1,K+1) = L                                                                INPUT      21
      ELM(2,K+1) = L+1                                                              INPUT      22
      ELM(3,K+1) = ELM(2,K)                                                         INPUT      23
100   CONTINUE                                                                      INPUT      24
C                                                                                   INPUT      25
C   NOW HAVE ELEMENT NODAL INCIDENCES.                                              INPUT      26
C                                                                                   INPUT      27
      J = 1                                                                         INPUT      28
C                                                                                   INPUT      29
C   FIRST LOAD THE NODET ARRAY FOR THE FUEL IN SEQUENTIAL ORDER FROM                INPUT      30
C   THE FUEL CENTER TO THE SURFACE                                                  INPUT      31
C                                                                                   INPUT      32
      DO 110 I=1,NF                                                                 INPUT      33
      NODET(NF+NC+I) = J                                                            INPUT      34
      J = J+2                                                                       INPUT      35
      NODET(I) = J                                                                  INPUT      36
      J = J+2                                                                       INPUT      37
110   CONTINUE                                                                      INPUT      38
C                                                                                   INPUT      39
C   NOW REORDER THE FIRST ELEMENT BY ROTATING THE VALUES FOR NODET                  INPUT      40
C   ONE NODE   COUNTERCLOCKWISE AROUND THE ELEMENT                                  INPUT      41
C                                                                                   INPUT      42
      NSAVE = NODET(1)                                                              INPUT      43
```

```
                NODET(1) = NODET(NF+NC+1)                                                  INPUT      44
55              NODET(NF+NC+1) = NODET(NF+NC+2)                                            INPUT      45
                NODET(NF+NC+2) = NSAVE                                                     INPUT      46
          C                                                                                INPUT      47
          C   SET THE FIRST NODES OF THE CLAD EQUAL TO THE LAST NODES OF THE FUEL         INPUT      48
          C                                                                                INPUT      49
60              NODET(NF+1) = NODET(NF)                                                    INPUT      50
                NODET(NF+NC+NF+1) = NODET(NF+NC+NF)                                        INPUT      51
          C                                                                                INPUT      52
          C   ORDER THE CLAD NODETS FROM THE INNER TO THE OUTER SURFACES                   INPUT      53
          C                                                                                INPUT      54
65              DO 120 I=2,NC                                                            INPUT      55
                NODET(NF+I) = NODET(NF+I-1)+4                                            INPUT      56
                NODET(NF+NC+NF+I) = NODET(NF+NC+NF+I-1)+4                                INPUT      57
          120   CONTINUE                                                                 INPUT      58
          C                                                                              INPUT      59
70        C                                                                              INPUT      60
          C                                                                              INPUT      61
                RETURN                                                                   INPUT      62
          C                                                                              INPUT      63
                END                                                                      INPUT      64
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	INPUT	1	72

VARIABLES

		SN	TYPE		RELOCATION								
2	ALPHA		REAL		LASTIC	REFS	15						
14	COMP		REAL		GEOPAR	REFS	6						
33	CP		REAL		LIMITS	REFS	8						
34	CR		REAL		LIMITS	REFS	8						
5	DELR		REAL		GEOPAR	REFS	6						
6	DELZ		REAL		GEOPAR	REFS	6						
0	E		REAL		LASTIC	REFS	15						
0	ELM		REAL	ARRAY	F.P.	REFS	2	33	DEFINED	1	28	29	30
							31	32	33				
35	FRDEN		REAL		LIMITS	REFS	8						
150	I		INTEGER			REFS	44	46	2*66	2*67	DEFINED	43	65
57	IADJ		INTEGER		LIMITS	REFS	8						
67	ICNT		INTEGER		LIMITS	REFS	8						
42	ICRPP		INTEGER		LIMITS	REFS	8						
60	ICUT		INTEGER		LIMITS	REFS	8						
5	IDF		INTEGER		LIMITS	REFS	6						
40	IPLAS		INTEGER		LIMITS	REFS	8						
73	IPLEND		INTEGER		LIMITS	REFS	8						
71	IRAK		INTEGER		LIMITS	REFS	8						
75	IRZ		INTEGER		LIMITS	REFS	8						
74	ISP		INTEGER		LIMITS	REFS	8						

VARIABLES	SN	TYPE		RELOCATION								
37	ISSTOP	INTEGER		LIMITS	REFS	8						
63	ITI	INTEGER		LIMITS	REFS	8						
4	ITP1	INTEGER		TAPES	REFS	17						
5	ITP2	INTEGER		TAPES	REFS	17						
147	J	INTEGER			REFS	44	45	46	47	DEFINED	38	45
					47							
24	JAM	INTEGER		LIMITS	REFS	8						
146	K	INTEGER			REFS	27	28	29	30	31	32	2*33
					DEFINED	25						
12	KA	INTEGER		LIMITS	REFS	8						
10	KKA	INTEGER		GEOPAR	REFS	6						
66	KPLAS	INTEGER		LIMITS	REFS	8						
55	KRNCH	INTEGER		LIMITS	REFS	8						
45	KRNCHC	INTEGER		LIMITS	REFS	8						
44	KRNCHF	INTEGER		LIMITS	REFS	8						
46	KRNCHT	INTEGER		LIMITS	REFS	8						
36	KZI	INTEGER		LIMITS	REFS	8						
145	L	INTEGER			REFS	26	27	28	29	30	31	32
					DEFINED	24	26	27				
52	MAXA	INTEGER		LIMITS	REFS	8						
43	MAXT	INTEGER		LIMITS	REFS	8						
56	MCUD	INTEGER		LIMITS	REFS	8						
17	NABC	INTEGER		LIMITS	REFS	8						
16	NABF	INTEGER		LIMITS	REFS	8						
31	NABF2	INTEGER		LIMITS	REFS	8						
20	NABT	INTEGER		LIMITS	REFS	8						
32	NABT2	INTEGER		LIMITS	REFS	8						
21	NAEC	INTEGER		LIMITS	REFS	8						
22	NAEF	INTEGER		LIMITS	REFS	8						
14	NARC	INTEGER		LIMITS	REFS	8						
13	NARF	INTEGER		LIMITS	REFS	8						
15	NART	INTEGER		LIMITS	REFS	8						
25	NAXBT	INTEGER		LIMITS	REFS	8						
26	NAXB2	INTEGER		LIMITS	REFS	8						
27	NAXB4	INTEGER		LIMITS	REFS	8						
1	NC	INTEGER		LIMITS	REFS	8	29	30	44	54	2*55	56
					2*61	65	2*67					
50	NC4	INTEGER		LIMITS	REFS	8						
7	NETOT	INTEGER		LIMITS	REFS	8						
53	NEW	INTEGER		LIMITS	REFS	8						
10	NEWF	INTEGER		LIMITS	REFS	8						
11	NEWT	INTEGER		LIMITS	REFS	8						
0	NF	INTEGER		LIMITS	REFS	8	29	30	43	44	54	2*55
					56	2*60	4*61	2*66	4*67			
6	NFF	INTEGER		LIMITS	REFS	8						
30	NFF1	INTEGER		LIMITS	REFS	8						
47	NFF2	INTEGER		LIMITS	REFS	8						
51	NF4	INTEGER		LIMITS	REFS	8						
0	NIN	INTEGER		TAPES	REFS	17						
41	NKN	INTEGER		LIMITS	REFS	8						
54	NMX	INTEGER		LIMITS	REFS	8						
0	NODET	INTEGER	ARRAY	F.P.	REFS	2	53	54	55	60	61	66
					67	DEFINED	1	44	46	54	55	56

VARIABLES	SN	TYPE	RELOCATION						
				60	61	66	67		
2	NOEL	INTEGER	LIMITS	REFS	8	25			
4	NOELC	INTEGER	LIMITS	REFS	8				
3	NOELF	INTEGER	LIMITS	REFS	8	27			
65	NOLD	INTEGER	LIMITS	REFS	8				
1	NOUT	INTEGER	TAPES	REFS	17				
151	NSAVE	INTEGER		REFS	56	DEFINED	53		
2	NSCR1	INTEGER	TAPES	REFS	17				
3	NSCR2	INTEGER	TAPES	REFS	17				
23	NTAE	INTEGER	LIMITS	REFS	8				
13	PDEL	REAL	GEOPAR	REFS	6				
0	PI	REAL	CONTNT	REFS	16				
11	PIN	REAL	GEOPAR	REFS	6				
12	POUT	REAL	GEOPAR	REFS	6				
72	RAKSUM	REAL	LIMITS	REFS	8				
2	RCI	REAL	GEOPAR	REFS	6				
3	RCO	REAL	GEOPAR	REFS	6				
0	RFI	REAL	GEOPAR	REFS	6				
1	RFO	REAL	GEOPAR	REFS	6				
70	RRAKR	REAL	LIMITS	REFS	8				
64	STEP	REAL	LIMITS	REFS	8				
61	TIMEC	REAL	LIMITS	REFS	8				
62	TIMEF	REAL	LIMITS	REFS	8				
4	TREF	REAL	GEOPAR	REFS	6				
1	XNU	REAL	LASTIC	REFS	15				
7	ZDEL	REAL	GEOPAR	REFS	6				

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	34	25
0	110	48	43
0	120	68	65

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
13	100	K	25 34	44B	OPT
63	110	I	43 48	16B	OPT
130	120	I	65 68	14B	OPT

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6

STATISTICS

PROGRAM LENGTH	165B	117
SCM LABELED COMMON LENGTH	125B	85

140000B SCM USED

```
      SUBROUTINE KREEP (GSTR,EFSTR,CRP,TELM,TME,TCRP,CRPG,CRATE,NRAD,NAX KREEP     2
     +L,NSH)                                                            KREEP     3
C                                                                       KREEP     4
C     KREEP IS CALLED FROM PELET                                        KREEP     5
C                                                                       KREEP     6
C     PURPOSE OF THIS SUBROUTINE IS TO COMPUTE THE CORRECTION TO        KREEP     7
C     DISPLACEMENTS STRESSES AND STRAINS CAUSED BY CREEP IN THE FUEL AND KREEP     8
C     CLADDING.  THIS SUBROUTINE ASSUMES CONTROL OF THE SOLUTION        KREEP     9
C     ALGORITHM FROM PELLET AT THE START OF THE NEW TIME STEP           KREEP    10
C     BASE UPON THE GENERALIZED STRESSES COMPUTED IN THIS ROUTINE       KREEP    11
C     SUBROUTINE.  RATE IS CALLED THIS SUBROUTINE COMPUTES INCREMENTED  KREEP    12
C     CREEP STAINS BASED UPON STRAIN HARDENING OR TIME HARDENING        KREEP    13
C     OPTIONS.  A SET OF EQUIVALENT CRODAL LOADS ARE COMPUTED.          KREEP    14
C     DEFINE NEW VARIABLES                                              KREEP    15
C     GSTR(1,I,J)=STRESS VALUES FOR EACH ELEMENT.                       KREEP    16
C     GSTR(2,I,J)=STRESS VALUES FOR EACH ELEMENT.                       KREEP    17
C     GSTR(3,I,J)=STRESS VALUES FOR EACH ELEMENT.                       KREEP    18
C     EFSTR(I,J)=EFFECTUVE STRESS  I=RADIAL ELEMENT POSITION            KREEP    19
C     J=ARIAL ELEMENT POSITION                                          KREEP    20
C     CRP(11,J)=CREEP STRAIN COMPUTED FROM EQUIVALENT CREEP             KREEP    21
C     DISPLACEMENTS.                                                    KREEP    22
C     CRP(21,J)=CREEP STRAIN COMPUTED FROM EQUIVALENT CREEP             KREEP    23
C     DISPLACEMENTS.                                                    KREEP    24
C     CRP(31,J)=CREEP STRAIN COMPUTED FROM EQUIVALENT CREEP             KREEP    25
C     DISPLACEMENTS.                                                    KREEP    26
C                                                                       KREEP    27
C     CRATE(I,J)=CREEP STRAIN COMPUTED FROM RATE-USED TO COMPUTE THE    KREEP    28
C     INPUT LOAD VECTOR                                                 KREEP    29
C     DEPT(1,I,J)=INCREMENTAL CREEP STRAINS TRANFORMED TO THE           KREEP    30
C     R THETA AND Z COORDINATES                                         KREEP    31
C     DEPT(2,I,J)=INCREMENTAL CREEP STRAINS TRANFORMED TO THE           KREEP    32
C     R THETA AND Z COORDINATES                                         KREEP    33
C     DEPT(3,I,J)=INCREMENTAL CREEP STRAINS TRANFORMED TO THE           KREEP    34
C     R THETA AND Z COORDINATES                                         KREEP    35
C     DEPT(4,I,J)=INCREMENTAL CREEP STRAINS TRANFORMED TO THE           KREEP    36
C     R THETA AND Z COORDINATES                                         KREEP    37
C     NSH=1  MEANS STRAIN HARDENING IS USED    NSH=0 MEANS IT IS NOT    KREEP    38
C     AND A TIME HARDENING IS USED.                                     KREEP    39
C                                                                       KREEP    40
      COMMON / FAST / D(1)                                              KREEP    41
      COMMON /PNTPNL/IFIRST,IAELM,IAK,IARAA,IARE,ISB,IBA,IBASAV,IBASE,  PELPT     2
     + ISBB,IBBA,IBBSV,ICA,ICC,ICRATE,ICRPG,IDISP,IDISPC,IDSPSV,        PELPT     3
     + IEFSTR,IELM,IELSTN,ILSTNA,ILSTRA,IELSTR,IPSLA,IEPSLM,IESTNV,     PELPT     4
     + IESTSV,JIIJ,IIPOS,IKSAVE,INADET,INDC,INDF,INDT,INODET,IOLDSE,    PELPT     5
     + IPSSRT,IPSSV,IPSTS,IR,IRA,IRBR,IRBRA,IRD,ISTRES,ISTRSA,ITCB,     PELPT     6
     + ITCRP,ITEC,ITEF,ITELM,ITFB,ITHET,ITHTAX,ITHSAV,ITHXSV,ITME,      PELPT     7
     + ITSTNR,ITSTSR,ITV,ITW,IXKT,IXLOAD,IXLODA,IXRD,                   PELPT     8
     +IY,IYACF,IZ,ILAST                                                 PELPT     9
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P PELCOM    2
     +DEL,COMP                                                          PELCOM    3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE PELCOM    4
     +NF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT, PELCOM    5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN PELCOM    6
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      +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N PELCOM      7
55    +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                  PELCOM      8
      +,  KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                         PELCOM      9
      +,IRZ                                                               PELCOM     10
       COMMON /LASTIC/ E,XNU,ALPHA                                        PELCOM     11
       COMMON /CONTNT/ PI                                                 PELCOM     12
60     COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                      PELCOM     13
C                                                                         KREEP      44
       DIMENSION TME(5)                                                   KREEP      45
       DIMENSION GSTR(4,NRAD,1), EFSTR(NRAD,1), CRP(4,NRAD,1), TELM(NRAD, KREEP      46
      +NAXL,2)                                                            KREEP      47
65     DIMENSION CRATE(NRAD,1), CRPG(NRAD,1), TCRP(4,NRAD,1)              KREEP      48
       CALL MOVEKA (0,EFSTR,NOEL*NARC)                                    KREEP      49
       CALL MOVEKA (0,CRATE,NOEL*NARC)                                    KREEP      50
       CALL MOVEKA (0,CRPG,NOEL*NARC)                                     KREEP      51
C                                                                         KREEP      52
70     C  COMPUTE EFFECTIVE STRESS                                        KREEP      53
       C                                                                  KREEP      54
         CALL EFFECT (EFSTR,D(ITSTSR),NARC,NOEL)                          KREEP      55
C                                                                         KREEP      56
       C  NAXL=ARIAL DIMENSION OF THE STRESS AND STRAIN ARRAY             KREEP      57
75     C  NRAD= RADIAL DIMENSION OF THE STRESS AND STRAIN ARRAY.          KREEP      58
       C                                                                  KREEP      59
       C  NOW COMPUTE CREEP STRAINS                                       KREEP      60
       C  COMPUTE INCREMENTAL VALUE OF GENERALIZED STRAIN INCREMENT       KREEP      61
       C                                                                  KREEP      62
80       CONE = CR/(CR+1.0)                                               KREEP      63
         CTWO = CR/(CP*(CR+1.0))                                          KREEP      64
         CTHR = 1.0/(CR+1.0)                                              KREEP      65
         GEE = CONE*CTWO+CTWO*CTHR+CTHR*CONE                              KREEP      66
             DO 110 J=1,NAXL                                              KREEP      67
85               DO 100 I=1,NRAD                                          KREEP      68
                 CRR = CRP(1,I,J)                                         KREEP      69
                 CRT = CRP(2,I,J)                                         KREEP      70
                 CRZ = CRP(3,I,J)                                         KREEP      71
                 ATEST = ABS(CRP(1,I,J))                                  KREEP      72
90               IF (ATEST.LT.1.0E-10) GO TO 100                          KREEP      73
                 DEPE = (1.0/GEE)*(CONE*(CTWO*CRZ-CTHR*CRT)**2+CTWO*(CTHR*C KREEP      74
     +           RT-CONE*CRR)**2+CTHR*(CONE*CRR-CTWO*CRZ)**2)**0.5        KREEP      75
                 CRPG(I,J) = DEPE                                         KREEP      76
100              CONTINUE                                                 KREEP      77
95     110     CONTINUE                                                   KREEP      78
       C                                                                  KREEP      79
       C  HAVE COMPUTED THE GENERALIZED STRAIN INCREMENT MODIFIED FOR THE  KREEP      80
       C  HILLS ANISOTROPY COEFFICIENT R AND P.                           KREEP      81
       C                                                                  KREEP      82
100      CALL RATE (NSH,CRATE,TME,TELM,D(IEFSTR),D(ICRPG),NAXL,NRAD,D(IPSTS KREEP      83
        +),D(IPSSV),D(IPSSRT),D(JIIJ),D(IIPOS),D(IOLDSE),D(IBASE))        KREEP      84
C                                                                         KREEP      85
       C  L=TIME INCREMENT                                                KREEP      86
       C  TIME=TIME ARRAY                                                 KREEP      87
105    C  TEMP(I,J)=TEMPERATURE ARRAY IN  KALVIN                          KREEP      88
       C                                                                  KNEEP      89
```

```
      C   MUST COMPUTE SIMILAR RESULTS FOR THE FUEL                                    KREEP     90
      C   NOW USE MODIFIED PRANDLE REURS FLOW RULES TO COMPUTE STRAIN                   KREEP     91
      C   INCREMENTS                                                                    KREEP     92
110   C                                                                                 KREEP     93
            DO 130 J=1,NAXL                                                           KREEP     94
               DO 120 I=1,NRAD                                                        KREEP     95
               IF (EFSTR(I,J).LT.10.) GO TO 120                                       KREEP     96
               A = CRATE(I,J)/EFSTR(I,J)                                              KREEP     97
115            TCRP(1,I,J) = A*((CP+CR)/(CP*(1.+CR))*GSTR(1,I,J)-CR/(CP*(             KREEP     98
     +         CR+1.))*GSTR(2,I,J)-1.0/(CR+1.0)*GSTR(3,I,J))                          KREEP     99
               TCRP(2,I,J) = A*(CR*(CP+1.0)/(CP*(CR+1.0))*GSTR(2,I,J)-CR/             KREEP    100
     +         (CP*(CR+1.0))*GSTR(1,I,J)-CR/(CR+1.0)*GSTR(3,I,J))                     KREEP    101
               TCRP(3,I,J) = A*(GSTR(3,I,J)-CR/(CR+1.0)*GSTR(2,I,J)-1.0/(              KREEP    102
120    +      CR+1.0)*GSTR(1,I,J))                                                    KREEP    103
       120     CONTINUE                                                               KREEP    104
       130  CONTINUE                                                                  KREEP    105
      C                                                                               KREEP    106
            RETURN                                                                    KREEP    107
125         END                                                                       KREEP    108
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 KREEP 1 124

VARIABLES	SN	TYPE		RELOCATION								
345 A		REAL			REFS	115	117	119	DEFINED	114		
2 ALPHA		REAL		LASTIC	REFS	58						
343 ATEST		REAL			REFS	90	DEFINED	89				
14 COMP		REAL		GEOPAR	REFS	49						
332 CONE		REAL			REFS	2*83	3*91	DEFINED	80			
33 CP		REAL		LIMITS	REFS	51	81	3*115	3*117			
34 CR		REAL		LIMITS	REFS	51	2*80	2*81	82	5*115	6*117	3*119
0 CRATE		REAL	ARRAY	F.P.	REFS	65	67	100	114	DEFINED	1	
0 CRP		REAL	ARRAY	F.P.	REFS	63	86	87	88	89		
					DEFINED	1						
0 CRPG		REAL	ARRAY	F.P.	REFS	65	68	DEFINED	1	93		
340 CRR		REAL			REFS	2*91	DEFINED	86				
341 CRT		REAL			REFS	2*91	DEFINED	87				
342 CRZ		REAL			REFS	2*91	DEFINED	88				
334 CTHR		REAL			REFS	2*83	3*91	DEFINED	82			
333 CTWO		REAL			REFS	2*83	3*91	DEFINED	81			
0 D		REAL	ARRAY	FAST	REFS	40	72	9*100				
5 DELR		REAL		GEOPAR	REFS	49						
6 DELZ		REAL		GEOPAR	REFS	49						
344 DEPE		REAL			REFS	93	DEFINED	91				
0 E		REAL		LASTIC	REFS	58						
0 EFSTR		REAL	ARRAY	F.P.	REFS	63	66	72	113	114		
					DEFINED	1						

VARIABLES	SN	TYPE	RELOCATION									
35	FRDEN	REAL	LIMITS	REFS	51							
335	GEE	REAL		REFS	91	DEFINED	83					
0	GSTR	REAL	ARRAY F.P.	REFS	63	3*115	3*117	3*119	DEFINED	1		
337	I	INTEGER		REFS	86	87	88	89	93	113	2*114	
				4*115	4*117	4*119	DEFINED	85	112			
57	IADJ	INTEGER	LIMITS	REFS	51							
1	IAELM	INTEGER	PNTPNL	REFS	41							
2	IAK	INTEGER	PNTPNL	REFS	41							
3	IARAA	INTEGER	PNTPNL	REFS	41							
4	IARE	INTEGER	PNTPNL	REFS	41							
6	IBA	INTEGER	PNTPNL	REFS	41							
7	IBASAV	INTEGER	PNTPNL	REFS	41							
10	IBASE	INTEGER	PNTPNL	REFS	41	100						
12	IBBA	INTEGER	PNTPNL	REFS	41							
13	IBBSV	INTEGER	PNTPNL	REFS	41							
14	ICA	INTEGER	PNTPNL	REFS	41							
15	ICC	INTEGER	PNTPNL	REFS	41							
67	ICNT	INTEGER	LIMITS	REFS	51							
16	ICRATE	INTEGER	PNTPNL	REFS	41							
17	ICRPG	INTEGER	PNTPNL	REFS	41	100						
42	ICRPP	INTEGER	LIMITS	REFS	51							
60	ICUT	INTEGER	LIMITS	REFS	51							
5	IDF	INTEGER	LIMITS	REFS	51							
20	IDISP	INTEGER	PNTPNL	REFS	41							
21	IDISPC	INTEGER	PNTPNL	REFS	41							
22	IDSPSV	INTEGER	PNTPNL	REFS	41							
23	IEFSTR	INTEGER	PNTPNL	REFS	41	100						
24	IELM	INTEGER	PNTPNL	REFS	41							
25	IELSTN	INTEGER	PNTPNL	REFS	41							
30	IELSTR	INTEGER	PNTPNL	REFS	41							
32	IEPSLM	INTEGER	PNTPNL	REFS	41							
33	IESTNV	INTEGER	PNTPNL	REFS	41							
34	IESTSV	INTEGER	PNTPNL	REFS	41							
0	IFIRST	INTEGER	PNTPNL	REFS	41							
36	IIPOS	INTEGER	PNTPNL	REFS	41	100						
37	IKSAVE	INTEGER	PNTPNL	REFS	41							
106	ILAST	INTEGER	PNTPNL	REFS	41							
26	ILSTNA	INTEGER	PNTPNL	REFS	41							
27	ILSTRA	INTEGER	PNTPNL	REFS	41							
40	INADET	INTEGER	PNTPNL	REFS	41							
41	INDC	INTEGER	PNTPNL	REFS	41							
42	INDF	INTEGER	PNTPNL	REFS	41							
43	INDT	INTEGER	PNTPNL	REFS	41							
44	INODET	INTEGER	PNTPNL	REFS	41							
45	IOLDSE	INTEGER	PNTPNL	REFS	41	100						
40	IPLAS	INTEGER	LIMITS	REFS	51							
73	IPLEND	INTEGER	LIMITS	REFS	51							
31	IPSLA	INTEGER	PNTPNL	REFS	41							
46	IPSSRT	INTEGER	PNTPNL	REFS	41	100						
47	IPSSV	INTEGER	PNTPNL	REFS	41	100						
50	IPSTS	INTEGER	PNTPNL	REFS	41	100						
51	IR	INTEGER	PNTPNL	REFS	41							
52	IRA	INTEGER	PNTPNL	REFS	41							

VARIABLES	SN	TYPE	RELOCATION								
71	IRAK	INTEGER	LIMITS	REFS	51						
53	IRBR	INTEGER	PNTPNL	REFS	41						
54	IRBRA	INTEGER	PNTPNL	REFS	41						
55	IRD	INTEGER	PNTPNL	REFS	41						
75	IRZ	INTEGER	LIMITS	REFS	51						
5	ISB	INTEGER	PNTPNL	REFS	41						
11	ISBB	INTEGER	PNTPNL	REFS	41						
74	ISP	INTEGER	LIMITS	REFS	51						
37	ISSTOP	INTEGER	LIMITS	REFS	51						
56	ISTRES	INTEGER	PNTPNL	REFS	41						
57	ISTRSA	INTEGER	PNTPNL	REFS	41						
60	ITCB	INTEGER	PNTPNL	REFS	41						
61	ITCRP	INTEGER	PNTPNL	REFS	41						
62	ITEC	INTEGER	PNTPNL	REFS	41						
63	ITEF	INTEGER	PNTPNL	REFS	41						
64	ITELM	INTEGER	PNTPNL	REFS	41						
65	ITFB	INTEGER	PNTPNL	REFS	41						
66	ITHET	INTEGER	PNTPNL	REFS	41						
70	ITHSAV	INTEGER	PNTPNL	REFS	41						
67	ITHTAX	INTEGER	PNTPNL	REFS	41						
71	ITHXSV	INTEGER	PNTPNL	REFS	41						
63	ITI	INTEGER	LIMITS	REFS	51						
72	ITME	INTEGER	PNTPNL	REFS	41						
[illegible]	ITP1	INTEGER	TAPES	REFS	60						
5	ITP2	INTEGER	TAPES	REFS	60						
73	ITSTNR	INTEGER	PNTPNL	REFS	41						
74	ITSTSR	INTEGER	PNTPNL	REFS	41	72					
75	ITV	INTEGER	PNTPNL	REFS	41						
76	ITW	INTEGER	PNTPNL	REFS	41						
77	IXKT	INTEGER	PNTPNL	REFS	41						
100	IXLOAD	INTEGER	PNTPNL	REFS	41						
101	IXLODA	INTEGER	PNTPNL	REFS	41						
102	IXRD	INTEGER	PNTPNL	REFS	41						
103	IY	INTEGER	PNTPNL	REFS	41						
104	IYACF	INTEGER	PNTPNL	REFS	41						
105	IZ	INTEGER	PNTPNL	REFS	41						
336	J	INTEGER		REFS	86	87	88	89	93	113	2*114
				4*115	4*117	4*119	DEFINED	84	111		
24	JAM	INTEGER	LIMITS	REFS	51						
35	JIIJ	INTEGER	PNTPNL	REFS	41	100					
12	KA	INTEGER	LIMITS	REFS	51						
10	KKA	INTEGER	GEOPAR	REFS	49						
66	KPLAS	INTEGER	LIMITS	REFS	51						
55	KRNCH	INTEGER	LIMITS	REFS	51						
45	KRNCHC	INTEGER	LIMITS	REFS	51						
44	KRNCHF	INTEGER	LIMITS	REFS	51						
46	KRNCHT	INTEGER	LIMITS	REFS	51						
36	KZI	INTEGER	LIMITS	REFS	51						
52	MAXA	INTEGER	LIMITS	REFS	51						
43	MAXT	INTEGER	LIMITS	REFS	51						
56	MCUD	INTEGER	LIMITS	REFS	51						
17	NABC	INTEGER	LIMITS	REFS	51						
16	NABF	INTEGER	LIMITS	REFS	51						

VARIABLES	SN	TYPE		RELOCATION							
31	NABF2	INTEGER		LIMITS	REFS	51					
20	NABT	INTEGER		LIMITS	REFS	51					
32	NABT2	INTEGER		LIMITS	REFS	51					
21	NAEC	INTEGER		LIMITS	REFS	51					
22	NAEF	INTEGER		LIMITS	REFS	51					
14	NARC	INTEGER		LIMITS	REFS	51	66	67	68	72	
13	NARF	INTEGER		LIMITS	REFS	51					
15	NART	INTEGER		LIMITS	REFS	51					
25	NAXBT	INTEGER		LIMITS	REFS	51					
26	NAXB2	INTEGER		LIMITS	REFS	51					
27	NAXB4	INTEGER		LIMITS	REFS	51					
0	NAXL	INTEGER		F.P.	REFS	63	84	100	111	DEFINED	1
1	NC	INTEGER		LIMITS	REFS	51					
50	NC4	INTEGER		LIMITS	REFS	51					
7	NETOT	INTEGER		LIMITS	REFS	51					
53	NEW	INTEGER		LIMITS	REFS	51					
10	NEWF	INTEGER		LIMITS	REFS	51					
11	NEWT	INTEGER		LIMITS	REFS	51					
0	NF	INTEGER		LIMITS	REFS	51					
6	NFF	INTEGER		LIMITS	REFS	51					
30	NFF1	INTEGER		LIMITS	REFS	51					
47	NFF2	INTEGER		LIMITS	REFS	51					
51	NF4	INTEGER		LIMITS	REFS	51					
0	NIN	INTEGER		TAPES	REFS	60					
41	NKN	INTEGER		LIMITS	REFS	51					
54	NMX	INTEGER		LIMITS	REFS	51					
2	NOEL	INTEGER		LIMITS	REFS	51	66	67	68	72	
4	NOELC	INTEGER		LIMITS	REFS	51					
3	NOELF	INTEGER		LIMITS	REFS	51					
65	NOLD	INTEGER		LIMITS	REFS	51					
1	NOUT	INTEGER		TAPES	REFS	60					
0	NRAD	INTEGER		F.P.	REFS	4*63	3*65	85	100	112	
					DEFINED	1					
2	NSCR1	INTEGER		TAPES	REFS	60					
3	NSCR2	INTEGER		TAPES	REFS	60					
0	NSH	INTEGER		F.P.	REFS	100	DEFINED	1			
23	NTAE	INTEGER		LIMITS	REFS	51					
13	PDEL	REAL		GEOPAR	REFS	49					
0	PI	REAL		CONTNT	REFS	59					
11	PIN	REAL		GEOPAR	REFS	49					
12	POUT	REAL		GEOPAR	REFS	49					
72	RAKSUM	REAL		LIMITS	REFS	51					
2	RCI	REAL		GEOPAR	REFS	49					
3	RCO	REAL		GEOPAR	REFS	49					
0	RFI	REAL		GEOPAR	REFS	49					
1	RFO	REAL		GEOPAR	REFS	49					
70	RRAKR	REAL		LIMITS	REFS	51					
64	STEP	REAL		LIMITS	REFS	51					
0	TCRP	REAL	ARRAY	F.P.	REFS	65	DEFINED	1	115	117	119
0	TELM	REAL	ARRAY	F.P.	REFS	63	100	DEFINED	1		
61	TIMEC	REAL		LIMITS	REFS	51					
62	TIMEF	REAL		LIMITS	REFS	51					
0	TME	REAL	ARRAY	F.P.	REFS	62	100	DEFINED	1		

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VARIABLES     SN  TYPE          RELOCATION
     4  TREF      REAL              GEOPAR       REFS        49
     1  XNU       REAL              LASTIC       REFS        58
     7  ZDEL      REAL              GEOPAR       REFS        49

EXTERNALS          TYPE   ARGS      REFERENCES
       EFFECT                 4          72
       MOVEKA                 3          66        67        68
       RATE                  15         100

INLINE FUNCTIONS   TYPE   ARGS      DEF LINE  REFERENCES
       ABS        REAL      1  INTRIN              89

STATEMENT LABELS              DEF LINE   REFERENCES
   131  100                      94         35        90
     0  110                      95         84
   250  120                     121        112       113
     0  130                     122        111

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
    56  110       J        84 95        61B              EXT REFS  NOT INNER
    60  100       I        85 94        54B              EXT REFS
   171  130       J       111 122       65B              NOT INNER
   173  120       I       112 121       60B        OPT

COMMON BLOCKS   LENGTH
       FAST          1
       PNTPNL       71
       GEOPAR       13
       LIMITS       62
       LASTIC        3
       CONTNT        1
       TAPES         6

STATISTICS
  PROGRAM LENGTH                  371B      249
  SCM LABELED COMMON LENGTH       235B      157
        140000B SCM USED
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```
      SUBROUTINE LOAD (ARE,B,BB,NODET,R,RBR,THETEO,TELM,XLOAD,ELM,NOELD,  LOAD      2
     +TCRP,NABFD,THSAV)                                                   LOAD      3
C                                                                         LOAD      4
C     LOAD IS CALLED FROM SOLVET                                          LOAD      5
C                                                                         LOAD      6
C     PURPOSE OF THIS SUBROUTINE IS TO COMPUTE THE COMBINED LOAD VECTOR   LOAD      7
C     FOR SOLUTION                                                        LOAD      8
C     FOLLOWING LOADS ARE ALL COMBINED INTO THE BASED VECTOR              LOAD      9
C     APPLIED LOADS                                                       LOAD     10
C     THERMAL LOADS                                                       LOAD     11
C     CREEP LOADS                                                         LOAD     12
C     PLASTIC LOADS                                                       LOAD     13
C                                                                         LOAD     14
      DIMENSION TCRP(4,NOELD,1)                                           LOAD     15
      DIMENSION THRMSV(50),THSAV(4,NOELD,1)                               LOAD     16
      DIMENSION ARE(1),B(1),BB(1),NODET(1),R(1),RBR(1),                   LOAD     17
     +TELM(NOELD,NABFD,1),XLOAD(6,4,1),THERM(6),ELM(3,1),THETEO(4,1)      LOAD     18
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P  PELCOM    2
     +DEL,COMP                                                            PELCOM    3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE  PELCOM    4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,  PELCOM    5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN  PELCOM    6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N  PELCOM    7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                   PELCOM    8
     +,  KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                          PELCOM    9
     +,IRZ                                                                PELCOM   10
      COMMON /LASTIC/ E,XNU,ALPHA                                         PELCOM   11
      COMMON /CONTNT/ PI                                                  PELCOM   12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                       PELCOM   13
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,        COMC      2
     +   ERAD(20), EAX(20)                                                COMC      3
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)                   COMC      4
     +,PINOLD,POUTLD,POLD,NTOLD(20)                                       COMC      5
     + ,ICHNG,STEPS                                                       COMC      6
C                                                                         LOAD     21
      DIMENSION NNA(3)                                                    LOAD     22
C                                                                         LOAD     23
C     PIN    - ROD PRESSURE                                             LOAD     24
C     POUT   - SYSTEM PRESSURE                                          LOAD     25
C     B      - RADIAL MODEL DISPLACEMENTS                               LOAD     26
C     BB     - RADIAL MODEL LOADS                                       LOAD     27
C     ALPHA  - THERMAL STRAIN                                           LOAD     28
C                                                                         LOAD     29
C                                                                         LOAD     30
      CALL MOVEKA (0,THETEO,4*NOEL)                                       LOAD     31
          DO 100 I=1,6                                                    LOAD     32
          THERM(I) = 0.0                                                  LOAD     33
  100     CONTINUE                                                        LOAD     34
      IF (NKN.EQ.2) GO TO 120                                             LOAD     35
      FRAO = PI*2.0*R(NF+NC)*POUT*DELZ/2.0                                LOAD     36
      FRAI = PI*2.0*R(NF+1)*PIN*DELZ/2.0                                  LOAD     37
C                                                                         LOAD     38
C                                                                         LOAD     39
```

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      C   COMPUTE THE COMBINED LOAD VECTOR FOR CLAD CONTACT-CONTINUED SYSTEM   LOAD       40
55    C                                                                        LOAD       41
            II = NODET(NFF1)                                                   LOAD       42
            IJ = NODET(NFF)                                                    LOAD       43
            BB(II) = -FRAO                                                     LOAD       44
            BB(IJ) = -FRAO                                                     LOAD       45
60          B(II) = -FRAO                                                      LOAD       46
            B(IJ) = -FRAO                                                      LOAD       47
            II = NODET(NF+1)                                                   LOAD       48
            IJ = NODET(NFF1+NF+1)                                              LOAD       49
            BB(II) = FRAI                                                      LOAD       50
65          BB(IJ) = FRAI                                                      LOAD       51
            B(IJ) = FRAI                                                       LOAD       52
      C                                                                        LOAD       53
            IF (KKA.EQ.2) GO TO 120                                            LOAD       54
      C   IN A SIMILAR MANNER THE AXIAL LOAD VECTOR FOR TH FUEL AND CLAD       LOAD       55
70    C   MUST BE CREATED                                                      LOAD       56
      C   PAXL= AXIAL LOAD IN CLAD DUE TO EXTERNAL PRESSURE                    LOAD       57
      C                                                                        LOAD       58
            PAXL = ((POUT*PI*RCO**2)-(PIN*PI*RCI**2))                          LOAD       59
      C                                                                        LOAD       60
75    C   CLAD ELEMENTS DUE TO EXTERNAL PRESSURE NOW DIVIDE THE AXIAL LOADS    LOAD       61
      C   OVER THE NUMBER OF ELEMENTS ALONG THE TOP SURFACE OF THE CLAD       LOAD       62
      C   MODEL. THIS CAN BEST BE DONE BY COMPUTING NODAL LOAD CIRCLES.        LOAD       63
      C   DEFINE LIMITS FOR THE DEGRES OF FREEDOM IN THE LOAD VECTOR           LOAD       64
      C                                                                        LOAD       65
80          LL = 2*NF+NC+1                                                     LOAD       66
            LU = 2*(NF+NC)-1                                                   LOAD       67
      C                                                                        LOAD       68
      C   COMPUTE LOAD VECTOR FOR THE CLAD ALONG NODAL CIRCLES BASE STRESS    LOAD       69
      C   CALCULATIONS ON THE RADIAL POSITION                                  LOAD       70
85    C                                                                        LOAD       71
            TOT = PI*(R(NFF)**2-R(LL)**2)                                      LOAD       72
            SIG = -PAXL/TOT                                                    LOAD       73
      C                                                                        LOAD       74
            DO 110 I=LL,LU                                                     LOAD       75
90          AREA = PI*(R(I+1)**2-R(I)**2)                                      LOAD       76
            XLINE = PI*(2.*R(I+1)+2.*R(I))                                     LOAD       77
      C                                                                        LOAD       78
      C   COMPUTE LINE LOAD FOR NODE I                                         LOAD       79
      C                                                                        LOAD       80
95          ZF = SIG*AREA/XLINE                                                LOAD       81
            ZFS = ZF*PI*2.*R(I)                                                LOAD       82
            ZFE = ZF*PI*2.*R(I+1)                                              LOAD       83
      C                                                                        LOAD       84
      C   NOTE MUST INDEX D.O.F. TO AXIAL DIRECTION                           LOAD       85
100   C                                                                        LOAD       86
            IN = NODET(I)+1                                                    LOAD       87
            INN = NODET(I+1)+1                                                 LOAD       88
            BB(IN) = BB(IN)+ZFS                                                LOAD       89
            B(IN) = BB(IN)                                                     LOAD       90
105         BB(INN) = BB(INN)+ZFE                                              LOAD       91
            B(INN) = BB(INN)                                                   LOAD       92
```

```
      110   CONTINUE                                                          LOAD   93
C                                                                             LOAD   94
C  HAVE COMPUTED AXIAL LOADS DUE TO PRESSURE DIFFERENTIAL                     LOAD   95
110 C                                                                         LOAD   96
C  NOW COMPUTE THERMAL LOAD VECTOR. USING XLOAD(I,J,KI)                       LOAD   97
C                                                                             LOAD   98
      120  CONTINUE                                                          LOAD   99
           SUMTHF = 0.0                                                      LOAD  100
115        DO 170 KI=1,NOEL                                                  LOAD  101
C                                                                            LOAD  102
           IF (NKN.EQ.2) GO TO 160                                           LOAD  103
C                                                                            LOAD  104
           TC = TELM(KI,KA,NEW)                                              LOAD  105
120        IF (KI.GT.NOELF) GO TO 140                                        LOAD  106
           TCC = (TC-32.)/1.8                                                LOAD  107
C  DEGREES K FOR CALLS TO MATPRO ROUTINES                                    LOAD  108
           TCK = TCC+273.15                                                  LOAD  109
           ALPHA = FTHEXP(TCK,0)                                             LOAD  110
125        IF (IRZ.GT.1) GO TO 130                                           LOAD  111
           THET = ALPHA                                                      LOAD  112
           GO TO 160                                                         LOAD  113
      130  ALPH1 = ALPHA                                                     LOAD  114
           TLD = (TELM(KI,KA,NOLD)-32.)/1.8+273.15                           LOAD  115
130        TLD = (TELM(KI,KA,NOLD)-32.)/1.8+273.15                           LOAD  116
           ALPH2 = FTHEXP(TLD,0)                                             LOAD  117
           THET = ALPH1-ALPH2                                                LOAD  118
           GO TO 160                                                         LOAD  119
      140  CONTINUE                                                          LOAD  120
135        TCC = (TC-32.)/1.8                                                LOAD  121
           TCK = TCC+273.15                                                  LOAD  122
           CALL CTHEXP (TCK,0.0,ALPHA)                                       LOAD  123
           IF (IRZ.GT.1) GO TO 150                                           LOAD  124
           THET = ALPHA                                                      LOAD  125
140        GO TO 160                                                         LOAD  126
      150  ALPH1 = ALPHA                                                     LOAD  127
           TLD = (TELM(KI,KA,NOLD)-32.)/1.8+273.15                           LOAD  128
           CALL CTHEXP (TLD,0.0,ALPH2)                                       LOAD  129
           THET = ALPH1-ALPH2                                                LOAD  130
145   160  CONTINUE                                                          LOAD  131
           IF (NKN.EQ.2) THET = 0.0                                          LOAD  132
           THRMSV(KI) = THET                                                 LOAD  133
           IF (KI.GT.NOELF) GO TO 170                                        LOAD  134
           SUMTHF = SUMTHF+THET                                              LOAD  135
150   170  CONTINUE                                                          LOAD  136
      THAVF = SUMTHF/FLOAT(NOELF)                                            LOAD  137
           DO 240 KI=1,NOEL                                                  LOAD  138
           THET = THAVF                                                      LOAD  139
           IF (KI.GT.NOELF) THET = THRMSV(KI)                                LOAD  140
155   C                                                                       LOAD  141
           PR = 2.0*PI*ARE(KI)*RBR(KI)                                       LOAD  142
      C                                                                      LOAD  143
                DO 200 I=1,6                                                 LOAD  144
                SUM = 0.0                                                    LOAD  145
```

```
                        DO 180 J=1,3                                                    LOAD      146
                        S = PR*XLOAD(I,J,KI)*THET                                       LOAD      147
                        SUM = SUM+S                                                     LOAD      148
                180     CONTINUE                                                        LOAD      149
                      SCUM = 0.0                                                        LOAD      150
                        DO 190 J=1,4                                                    LOAD      151
                        SC = PR*XLOAD(I,J,KI)*TCRP(J,KI,KA)                             LOAD      152
                        SCUM = SCUM+SC                                                  LOAD      153
                190     CONTINUE                                                        LOAD      154
                      SUM = SUM+SCUM                                                    LOAD      155
                      THERM(I) = SUM                                                    LOAD      156
                200   CONTINUE                                                        LOAD      157
                C                                                                     LOAD      158
                C   NOW COMPUTE THE CORRECT DEGREES OF FREEDOM AND POSITION IN THE    LOAD      159
                C   DISPLACEMENT ARRAY OR D.O.F. TO MERGE THE INTO THE LOAD VECTORS   LOAD      160
                      DO 210 I=1,3                                                    LOAD      161
                      THETEO(I,KI) = THET                                             LOAD      162
                      IF (NKN.EQ.1.AND.ISSTOP.EQ.1.AND.KKA.EQ.2) THSAV(I,KI,KA)       LOAD      163
                     +      = THETEO(I,KI)                                           LOAD      164
                210   CONTINUE                                                        LOAD      165
                    THETEO(4,KI) = 0.0                                                LOAD      166
                C   ADD CREEP STRAIN TO STRESS CORRECTION TERM                       LOAD      167
                      DO 220 K=1,4                                                    LOAD      168
                      THETEO(K,KI) = THETEO(K,KI)+TCRP(K,KI,KA)                       LOAD      169
                220   CONTINUE                                                        LOAD      170
                C   NOW HAVE STRAIN CORRECTION TERM FOR LOAD AND STRESS              LOAD      171
                C   FOR THE FUEL, THE CLAD, AND THE COMBINED CASE                    LOAD      172
                C                                                                     LOAD      173
                      NNA(1) = ELM(1,KI)                                              LOAD      174
                      NNA(2) = ELM(2,KI)                                              LOAD      175
                      NNA(3) = ELM(3,KI)                                              LOAD      176
                C                                                                     LOAD      177
                C                                                                     LOAD      178
                C   COMPUTE LOAD VECTOR FOR CONTACT BETWEEN FUEL AND CLAD           LOAD      179
                C                                                                     LOAD      180
                      DO 230 I=1,3                                                    LOAD      181
                      J = 2*I-1                                                       LOAD      182
                      NNI = NNA(I)                                                    LOAD      183
                      II = NODET(NNI)                                                 LOAD      184
                      BB(II) = BB(II)+THERM(J)                                        LOAD      185
                      BB(II+1) = BB(II+1)+THERM(J+1)                                  LOAD      186
                      B(II) = BB(II)                                                  LOAD      187
                      B(II+1) = BB(II+1)                                              LOAD      188
                230   CONTINUE                                                        LOAD      189
                240   CONTINUE                                                        LOAD      190
                C                                                                     LOAD      191
                    II = NF+NC                                                        LOAD      192
                      DO 250 I=1,II                                                   LOAD      193
                      IN = NODET(I)+1                                                 LOAD      194
                      BB(IN) = 0.0                                                    LOAD      195
                      B(IN) = 0.0                                                     LOAD      196
                250   CONTINUE                                                        LOAD      197
                    RETURN                                                            LOAD      198
```

END LOAD 199

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 LOAD 1 212

VARIABLES	SN	TYPE			RELOCATION							
2	ALPHA	REAL			LASTIC	REFS	27	126	128	137	139	141	
						DEFINED	124						
722	ALPH1	REAL				REFS	132	144	DEFINED	128	141		
724	ALPH2	REAL				REFS	132	143	144	DEFINED	131		
0	ARE	REAL	ARRAY	F.P.		REFS	16	156	DEFINED	1			
705	AREA	REAL				REFS	95	DEFINED	90				
0	B	REAL	ARRAY	F.P.		REFS	16	DEFINED	1	60	61	66	104
						106	201	202	210				
0	BB	REAL	ARRAY	F.P.		REFS	16	103	104	105	106	199	200
						201	202	DEFINED	1	58	59	64	65
						103	105	199	200	209			
14	COMP	REAL			GEOPAR	REFS	18						
33	CP	REAL			LIMITS	REFS	20						
34	CR	REAL			LIMITS	REFS	20						
5	DELR	REAL			GEOPAR	REFS	18						
6	DELZ	REAL			GEOPAR	REFS	18	50	51				
0	DELZA	REAL	ARRAY		BA	REFS	30						
0	E	REAL			LASTIC	REFS	27						
102	EAX	REAL	ARRAY		BA	REFS	30						
0	ELM	REAL	ARRAY		F.P.	REFS	16	188	189	190	DEFINED	1	
56	ERAD	REAL	ARRAY		BA	REFS	30						
55	FLXR	REAL			BA	REFS	30						
675	FRAI	REAL				REFS	64	65	66	DEFINED	51		
674	FRAO	REAL				REFS	58	59	60	61	DEFINED	50	
35	FRDEN	REAL			LIMITS	REFS	20						
0	HHF	REAL			FEP	REFS	32						
673	I	INTEGER				REFS	47	2*90	2*91	96	97	101	102
						161	166	170	176	2*177	196	197	208
						DEFINED	46	89	158	175	195	207	
57	IADJ	INTEGER			LIMITS	REFS	20						
103	ICHNG	INTEGER			FEP	REFS	32						
67	ICNT	INTEGER			LIMITS	REFS	20						
42	ICRPP	INTEGER			LIMITS	REFS	20						
60	ICUT	INTEGER			LIMITS	REFS	20						
5	IDF	INTEGER			LIMITS	REFS	20						
676	II	INTEGER				REFS	58	60	64	2*199	2*200	2*201	2*202
						207	DEFINED	56	62	198	206		
677	IJ	INTEGER				REFS	59	61	65	66	DEFINED	57	63
712	IN	INTEGER				REFS	2*103	2*104	209	210	DEFINED	101	208
713	INN	INTEGER				REFS	2*105	2*106	DEFINED	102			
40	IPLAS	INTEGER			LIMITS	REFS	20						

VARIABLES	SN	TYPE	RELOCATION								
73	IPLEND	INTEGER	LIMITS	REFS	20						
71	IRAK	INTEGER	LIMITS	REFS	20						
75	IRZ	INTEGER	LIMITS	REFS	20	125	138				
74	ISP	INTEGER	LIMITS	REFS	20						
37	ISSTOP	INTEGER	LIMITS	REFS	20	177					
3	ISTOP	INTEGER	FEP	REFS	32						
53	ISTRT	INTEGER	BA	REFS	30						
54	ITER	INTEGER	BA	REFS	30						
63	ITI	INTEGER	LIMITS	REFS	20						
4	ITP1	INTEGER	TAPES	REFS	29						
5	ITP2	INTEGER	TAPES	REFS	29						
730	J	INTEGER		REFS	161	2*166	199	200	DEFINED	160	165
				196							
24	JAM	INTEGER	LIMITS	REFS	20						
734	K	INTEGER		REFS	3*183	DEFINED	182				
12	KA	INTEGER	LIMITS	REFS	20	119	129	130	142	166	177
				183							
715	KI	INTEGER		REFS	119	120	129	130	142	147	148
				2*154	2*156	161	2*166	176	2*177	180	3*183
				188	189	190	DEFINED	115	152		
10	KKA	INTEGER	GEOPAR	REFS	18	68	177				
2	KKZZZ	INTEGER	FEP	REFS	32						
66	KPLAS	INTEGER	LIMITS	REFS	20						
55	KRNCH	INTEGER	LIMITS	REFS	20						
45	KRNCHC	INTEGER	LIMITS	REFS	20						
44	KRNCHF	INTEGER	LIMITS	REFS	20						
46	KRNCHT	INTEGER	LIMITS	REFS	20						
36	KZI	INTEGER	LIMITS	REFS	20						
701	LL	INTEGER		REFS	86	89	DEFINED	80			
702	LU	INTEGER		REFS	89	DEFINED	81				
52	MAXA	INTEGER	LIMITS	REFS	20						
43	MAXT	INTEGER	LIMITS	REFS	20						
56	MCUD	INTEGER	LIMITS	REFS	20						
17	NABC	INTEGER	LIMITS	REFS	20						
16	NABF	INTEGER	LIMITS	REFS	20						
0	NABFD	INTEGER	F.P.	REFS	16	DEFINED	1				
31	NABF2	INTEGER	LIMITS	REFS	20						
20	NABT	INTEGER	LIMITS	REFS	20						
32	NABT2	INTEGER	LIMITS	REFS	20						
21	NAEC	INTEGER	LIMITS	REFS	20						
22	NAEF	INTEGER	LIMITS	REFS	20						
14	NARC	INTEGER	LIMITS	REFS	20						
13	NARF	INTEGER	LIMITS	REFS	20						
15	NART	INTEGER	LIMITS	REFS	20						
25	NAXBT	INTEGER	LIMITS	REFS	20						
26	NAXB2	INTEGER	LIMITS	REFS	20						
27	NAXB4	INTEGER	LIMITS	REFS	20						
1	NC	INTEGER	LIMITS	REFS	20	50	80	81	206		
52	NCNN	INTEGER	BA	REFS	30						
51	NCONN	INTEGER	BA	REFS	30						
50	NC4	INTEGER	LIMITS	REFS	20						
7	NETOT	INTEGER	LIMITS	REFS	20						
53	NEW	INTEGER	LIMITS	REFS	20	119					

VARIABLES	SN	TYPE		RELOCATION								
10	NEWF	INTEGER		LIMITS	REFS	20						
11	NEWT	INTEGER		LIMITS	REFS	20						
0	NF	INTEGER		LIMITS	REFS	20	50	51	62	63	80	81
					206							
6	NFF	INTEGER		LIMITS	REFS	20	57	86				
30	NFF1	INTEGER		LIMITS	REFS	20	56	63				
47	NFF2	INTEGER		LIMITS	REFS	20						
51	NF4	INTEGER		LIMITS	REFS	20						
0	NIN	INTEGER		TAPES	REFS	29						
41	NKN	INTEGER		LIMITS	REFS	20	49	117	146	177		
54	NMX	INTEGER		LIMITS	REFS	20						
50	NN	INTEGER		BA	REFS	30						
1026	NNA	INTEGER	ARRAY		REFS	36	197	DEFINED	188	189	190	
735	NNI	INTEGER			REFS	198	DEFINED	197				
0	NODET	INTEGER	ARRAY	F.P.	REFS	16	56	57	62	63	101	102
					198	208	DEFINED	1				
2	NOEL	INTEGER		LIMITS	REFS	20	45	115	152			
4	NOELC	INTEGER		LIMITS	REFS	20						
0	NOELD	INTEGER		F.P.	REFS	14	15	16	DEFINED	1		
3	NOELF	INTEGER		LIMITS	REFS	20	120	148	151	154		
65	NOLD	INTEGER		LIMITS	REFS	20	129	130	142			
1	NOUT	INTEGER		TAPES	REFS	29						
2	NSCR1	INTEGER		TAPES	REFS	29						
3	NSCR2	INTEGER		TAPES	REFS	29						
1	NT	INTEGER		FEP	REFS	32						
23	NTAE	INTEGER		LIMITS	REFS	20						
57	NTOLD	INTEGER	ARRAY	FEP	REFS	32						
700	PAXL	REAL			REFS	87	DEFINED	73				
13	PDEL	REAL		GEOPAR	REFS	18						
0	PI	REAL		CONTNT	REFS	28	50	51	2*73	86	90	91
					96	97	156					
11	PIN	REAL		GEOPAR	REFS	18	51	73				
54	PINOLD	REAL		FEP	REFS	32						
56	POLD	REAL		FEP	REFS	32						
12	POUT	REAL		GEOPAR	REFS	18	50	73				
55	POUTLD	REAL		FEP	REFS	32						
726	PR	REAL			REFS	161	166	DEFINED	156			
0	R	REAL	ARRAY	F.P.	REFS	16	50	51	2*86	2*90	2*91	96
					97	DEFINED	1					
72	RAKSUM	REAL		LIMITS	REFS	20						
0	RBR	REAL	ARRAY	F.P.	REFS	16	156	DEFINED	1			
2	RCI	REAL		GEOPAR	REFS	18	73					
3	RCO	REAL		GEOPAR	REFS	18	73					
4	RDOLD	REAL	ARRAY	FEP	REFS	32						
0	RFI	REAL		GEOPAR	REFS	18						
1	RFO	REAL		GEOPAR	REFS	18						
70	RRAKR	REAL		LIMITS	REFS	20						
30	RRSIN	REAL	ARRAY	FEP	REFS	32						
731	S	REAL			REFS	162	DEFINED	161				
733	SC	REAL			REFS	167	DEFINED	166				
732	SCUM	REAL			REFS	167	169	DEFINED	164	167		
704	SIG	REAL			REFS	95	DEFINED	87				
64	STEP	REAL		LIMITS	REFS	20						

```
VARIABLES     SN  TYPE          RELOCATION
  104  STEPS      REAL              FEP      REFS      32
  727  SUM        REAL                       REFS     162     169     170  DEFINED     159     162     169
  714  SUMTHF     REAL                       REFS     149     151  DEFINED     114     149
  716  TC         REAL                       REFS     121     135  DEFINED     119
  717  TCC        REAL                       REFS     123     136  DEFINED     121     135
  720  TCK        REAL                       REFS     124     137  DEFINED     123     136
    0  TCRP       REAL       ARRAY    F.P.   REFS      14     166     183  DEFINED       1
    0  TELM       REAL       ARRAY    F.P.   REFS      16     119     129     130     142
                                             DEFINED     1
  725  THAUF      REAL                       REFS     153  DEFINED     151
 1020  THERM      REAL       ARRAY          REFS      16     199     200  DEFINED      47     170
  721  THET       REAL                       REFS     147     149     161     176  DEFINED     126     132
                                             139     144     146     153     154
    0  THETEO     REAL       ARRAY    F.P.   REFS      16      45     177     183  DEFINED       1     176
                                             180     183
  736  THRMSV     REAL       ARRAY          REFS      15     154  DEFINED     147
    0  THSAV      REAL       ARRAY    F.P.   REFS      15  DEFINED       1     177
   61  TIMEC      REAL              LIMITS   REFS      20
   62  TIMEF      REAL              LIMITS   REFS      20
  723  TLD        REAL                       REFS     131     143  DEFINED     129     130     142
  703  TOT        REAL                       REFS      87  DEFINED      86
    4  TREF       REAL              GEOPAR   REFS      18
  706  XLINE      REAL                       REFS      95  DEFINED      91
    0  XLOAD      REAL       ARRAY    F.P.   REFS      16     161     166  DEFINED       1
    1  XNU        REAL              LASTIC   REFS      27
    7  ZDEL       REAL              GEOPAR   REFS      18
  707  ZF         REAL                       REFS      96      97  DEFINED      95
  711  ZFE        REAL                       REFS     105  DEFINED      97
  710  ZF5        REAL                       REFS     103  DEFINED      96

EXTERNALS          TYPE   ARGS     REFERENCES
     CTHEXP                 3          137     143
     FTHEXP        REAL     2          124     131
     MOVEKA                 3           45

INLINE FUNCTIONS   TYPE   ARGS     DEF LINE  REFERENCES
     FLOAT         REAL     1  INTRIN          151

STATEMENT LABELS          DEF LINE   REFERENCES
    0  100                    48         46
    0  110                   107         89
  222  120                   113         49      68
  264  130                   128        125
  320  140                   134        120
  340  150                   141        138
  361  160                   145        117     127     133     140
  377  170                   150        115     148
    0  180                   163        160
    0  190                   168        165
    0  200                   171        158
    0  210                   179        175
    0  220                   184        182
    0  230                   203        195
```

STATEMENT LABELS	DEF LINE	REFERENCES
0 240	204	152
0 250	211	207

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
22	100	I	46 48	5B	INSTACK	
147	110	I	89 107	52B	OPT	
226	170	KI	115 150	154B		EXT REFS
407	240	KI	152 204	211B		NOT INNER
424	200	I	158 171	56B		NOT INNER
430	180	J	160 163	15B	OPT	
451	190	J	165 168	20B	OPT	
504	210	I	175 179	23B	OPT	
533	220	K	182 184	12B	INSTACK	
563	230	I	195 203	32B	OPT	
625	250	I	207 211	12B	INSTACK	

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
BA	86
FEP	69

STATISTICS

PROGRAM LENGTH	1102B	578
SCM LABELED COMMON LENGTH	360B	240

1400008 SCM USED

```
1                SUBROUTINE MOVEKA (K,IA,N)                                  MOVEKA     2
                 DIMENSION IA(N)                                             MOVEKA     3
                     DO 100 I=1,N                                            MOVEKA     4
                     IA(I) = K                                               MOVEKA     5
5          100       CONTINUE                                                MOVEKA     6
                 RETURN                                                      MOVEKA     7
                 END                                                         MOVEKA     8
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	MOVEKA	1	6

VARIABLES	SN	TYPE		RELOCATION						
20	I	INTEGER			REFS	4	DEFINED	3		
0	IA	INTEGER	ARRAY	F.P.	REFS	2	DEFINED	1	4	
0	K	INTEGER		F.P.	REFS	4	DEFINED	1		
0	N	INTEGER		F.P.	REFS	2	3	DEFINED	1	

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	5	3

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
11	100	I	3 5	6B	INSTACK

STATISTICS

PROGRAM LENGTH	25B	21

140000B SCM USED

```
      SUBROUTINE RADIAL (CFAC,DEN,DG,DGSAV,EAX,ERAD,FRAC,ITER,NA,NF,NFFI
     +,PRG,RADIUS,RP,SIGC,SIGG,TCL,TEMP,TFS,TRAMP,VFC,VFF,VFCC,DENSF,DPW
     +,R,RC,NR,PLSTC,CFCSV)
C
C
      DIMENSION TEMP(2,NA), RADIUS(NA), VFF(NA), VFC(NA), CFAC(NA),
     +   ERAD(NA), EAX(NA), PRG(NA), DG(NA), DGSAV(NA),
     +   TCL(2,NA), TFS(2,NA), TRAMP(NA)
      DIMENSION R(NA), DENSF(NA), DPW(NA), PLSTC(4,NA)
C
      INTEGER NEW, OLD
C
CCCCC INPUT VARIABLES
CCCCC
CCCCC DEN    - UO2 PERCENT THEORETICAL DENSITY
CCCCC DENSF  - ARRAY OF DENSIFICATION VALUES
CCCCC DPW    - ARRAY OF  SWELLING VALLES
CCCCC PLSTC  - CLADDING PLASTIC STRAINS
CCCCC FRAC   - GAS CONDUCTIVITY / PURE HELIUM CONDUCTIVITY
CCCCC NA     - NUMBER OF AXIAL REGIONS IN FUEL
CCCCC NF     - NUMBER OF RADIAL NODES IN FUEL IN PELET MODEL
CCCCC NR     - NUMBER OF RADIAL NODES IN FUEL IN INEL MODELS
CCCCC TEMP   - FUEL CENTERLINE AND SURFACE TEMPERATURES (F)
CCCCC RADIUS - CLADDING INSIDE SURFACE RADIUS (INCHES)
CCCCC RC     - COLD CLAD ID (INCHES)
CCCCC RP     - COLD FUEL RADIUS (INCHES)
CCCCC SIGC   - EFFECTIVE CRACK ROUGHNESS (INCHES)
CCCCC SIGG   - EFFECTIVE GAP ROUGHNESS (INCHES)
CCCCC
CCCCC OUTPUT VARIABLES
CCCCC
CCCCC CFAC   - UO2 THERMAL CONDUCTIVITY MULTIPLIER
CCCCC ERAD   - RADIAL UO2 ELASTIC MODULUS (PSI)
CCCCC EAX    - AXIAL UO2 ELASTIC MODULUS (PSI)
CCCCC PRG    - HYDROSTATIC INTERFACIAL PRESSURE(PSI)
CCCCC
CCCCC INTERNAL VARIABLES
CCCCC
CCCCC CINTER - INTERCEPT OF CFAC VS PRG EQUATION
CCCCC CSLOPE - SLOPE OF CFAC VS PRG EQUATION
CCCCC DG     - EFFECTIVE GAP WIDTH (INCHES)
CCCCC VFF    - VOID FRACTION WITHIN FUEL
CCCCC VFC    - VOID FRACTION WITHIN CLADDING ID
CCCCC TCL    - FUEL CENTERLINE TEMPERATURE (C)
CCCCC TFS    - FUEL SURFACE TEMPERATURE (C)
CCCCC RFS    - FUEL RADIUS (INCHES)
CCCCC RCI    - CLADDING INNER RADIUS (INCHES)
CCCCC HFUL   - UO2 MEYER HARDNESS
CCCCC DELRNG - DELTA RADIUS PER FUEL RING
CCCCC DNS    - CHANGE IN RADIUS DUE TO DENSIFICATION
C     SWL    - CHANGE IN RADIUS DUE TO SWELLING
```

```
      C   RPEST  - ESTIMATED FUEL RADIUS AFTER SWELLING AND DENSIFICATION      RADIAL     55
55    C   RCEST  - ESTIMATED CLAD ID AFTER CREEP                               RADIAL     56
      C                                                                        RADIAL     57
            EXPND(T) = -1.723E-4+6.797E-6*T+2.896E-9*T*T                       RADIAL     58
            MHARD(TK,DEN) = 3*1.7E8*SQRT(1.-2.62*(1.-DEN))*EXP(-380./(1.987*TK RADIAL     59
           +))                                                                 RADIAL     60
60          TD = DEN/100.                                                      RADIAL     61
            RCRL = 0.56                                                        RADIAL     62
            RADCL = 0.56                                                       RADIAL     63
            CNUM = 6.                                                          RADIAL     64
            HCL = 1.E5                                                         RADIAL     65
65          PI = 4.*ATAN(1.)                                                   RADIAL     66
      C                                                                        RADIAL     67
            NEW = 1                                                            RADIAL     68
            OLD = 2                                                            RADIAL     69
            IF (ITER/2*2.EQ.ITER) NEW = 2                                      RADIAL     70
70          IF (NEW.EQ.2) OLD = 1                                              RADIAL     71
      C                                                                        RADIAL     72
      C                                                                        RADIAL     73
                DO 280 JRAD=2,NA                                               RADIAL     74
                TCL(NEW,JRAD) = (TEMP(1,JRAD)-32.)/1.8                         RADIAL     75
75              TFS(NEW,JRAD) = (TEMP(2,JRAD)-32.)/1.8                         RADIAL     76
                IF (ITER.GT.1) TCL(NEW,JRAD) = 0.8*TCL(NEW,JRAD)+0.2*TCL(OLD,J RADIAL     77
           +    RAD)                                                           RADIAL     78
                IF (ITER.GT.1) TFS(NEW,JRAD) = 0.8*TFS(NEW,JRAD)+0.2*TFS(OLD,J RADIAL     79
           +    RAD)                                                           RADIAL     80
80              TVOL = (TCL(NEW,JRAD)+TFS(NEW,JRAD))/2.                        RADIAL     81
      C                                                                        RADIAL     82
                DNS = 0.0                                                      RADIAL     83
                SWL = 0.0                                                      RADIAL     84
      C   EFFECTS OF SWELLING AND DENSIFICATION ARE AVERAGED FOR EACH           RADIAL     85
85    C   AXIAL REGION                                                         RADIAL     86
                DO 100 I=1,NR                                                  RADIAL     87
                L = NR+1-I                                                     RADIAL     88
                IJ = NR*(JRAD-1)+L-1                                           RADIAL     89
                DELRNG = -(R(1+L)-R(L))                                        RADIAL     90
90              DNS = DNS+DELRNG*DENSF(1+IJ)                                   RADIAL     91
                SWL = SWL+DELRNG*DPW(1+IJ)                                     RADIAL     92
      100       CONTINUE                                                       RADIAL     93
      C                                                                        RADIAL     94
      C   ADD IN EFFECTS OF SWELLING AND DENSIFICATION                         RADIAL     95
95          RPEST = SWL+DNS+RP                                                 RADIAL     96
      C   ADD IN EFFECTS OF CLADDING CREEP                                     RADIAL     97
            RCEST = RC*(1.+PLSTC(2,JRAD))                                      RADIAL     98
            SIGG = (RCEST-RPEST)/8.                                            RADIAL     99
            SIGC = (RCEST-RPEST)/5.                                            RADIAL    100
100   C                                                                        RADIAL    101
            RFS = RP*(1.0+EXPND(TVOL))                                         RADIAL    102
            RCI = RADIUS((JRAD-1)*NFF1+NF+1)                                   RADIAL    103
            IRAD = 0                                                           RADIAL    104
            DGS = DGSAV(JRAD)                                                  RADIAL    105
105         DDG = .2                                                           RADIAL    106
            IFAIL = 0                                                          RADIAL    107
```

```
                  110     CONTINUE                                                    RADIAL   108
                          K = 0                                                       RADIAL   109
                  120     CONTINUE                                                    RADIAL   110
      110                 K = K+1                                                     RADIAL   111
                  C                                                                   RADIAL   112
                          ARAG = .5*(1.-ERF(DGS))                                     RADIAL   113
                          PRG(JRAD) = HCL*ARAG/(1.-ARAG)                              RADIAL   114
                  C                                                                   RADIAL   115
      115                 DG(JRAD) = DG5*SIGG*SQRT(2.)                                RADIAL   116
                          RFSMT = RCI-DG(JRAD)                                        RADIAL   117
                          TK = TVOL+273.                                              RADIAL   118
                          IF (TK.GT.1000.) TK = 1000.                                 RADIAL   119
                          HFUL = MHARD(TK,TD)                                         RADIAL   120
      120                 HFUL = HFUL/6894.                                           RADIAL   121
                          A = 2.896E-9*TVOL*TVOL+6.797E-6*TVOL                        RADIAL   122
                          VA = PI*(RFSMT*RFSMT-RFS*RFS)                               RADIAL   123
                          CIRCL = 2.*RCRL*PI*RFSMT                                    RADIAL   124
                          RADL = CNUM*RADCL*RFSMT                                     RADIAL   125
      125                 D = VA/(CIRCL+RADL)                                         RADIAL   126
                          DS = D/(SIGC*SQRT(2.))                                      RADIAL   127
                          A = .5*(1.-ERF(DS))                                         RADIAL   128
                          PRF = HFUL*A/(1.-A)                                         RADIAL   129
                  C                                                                   RADIAL   130
      130                 PDIF = PRF-PRG(JRAD)                                        RADIAL   131
                          PERR = .01                                                  RADIAL   132
                          IF (K.LT.4) GO TO 130                                       RADIAL   133
                          PTST = ABS(DGS-ZC)/ZC                                       RADIAL   134
                          IF (PTST.LE.PERR) GO TO 210                                 RADIAL   135
      135         130     CONTINUE                                                    RADIAL   136
                          IF (K.GT.3) GO TO 170                                       RADIAL   137
                          IF (K.EQ.1) GO TO 140                                       RADIAL   138
                          IF (K.EQ.2) GO TO 150                                       RADIAL   139
                          IF (K.EQ.3) GO TO 160                                       RADIAL   140
      140         140     CONTINUE                                                    RADIAL   141
                          ZA = DGS                                                    RADIAL   142
                          FA = PDIF                                                   RADIAL   143
                          DGS = DGS+DDG                                               RADIAL   144
                          GO TO 120                                                   RADIAL   145
      145         150     CONTINUE                                                    RADIAL   146
                          ZB = DGS                                                    RADIAL   147
                          FB = PDIF                                                   RADIAL   148
                          DGS = DGS-2.*DDG                                            RADIAL   149
                          GO TO 120                                                   RADIAL   150
      150         160     CONTINUE                                                    RADIAL   151
                          ZC = DGS                                                    RADIAL   152
                          FC = PDIF                                                   RADIAL   153
                          GO TO 180                                                   RADIAL   154
                  170     CONTINUE                                                    RADIAL   155
      155                 ZA = ZB                                                     RADIAL   156
                          ZB = ZC                                                     RADIAL   157
                          ZC = DGS                                                    RADIAL   158
                          FA = FB                                                     RADIAL   159
                          FB = FC                                                     RADIAL   160
```

```
                  FC = PDIF                                                          RADIAL   161
            180   CONTINUE                                                           RADIAL   162
                  AMBI = (ZC-ZB)/(ZB-ZA)                                             RADIAL   163
                  DELTI = (ZC-ZA)/(ZB-ZA)                                            RADIAL   164
                  GI = AMBI*AMBI*FA-DELTI*DELTI*FB+(DELTI+AMBI)*FC                   RADIAL   165
                  CI = AMBI*(AMBI*FA-DELTI*FB+FC)                                    RADIAL   166
                  XI = -2.*DELTI*FC                                                  RADIAL   167
                  S = GI*GI-4.*DELTI*CI*FC                                           RADIAL   168
                  IF (S.GE.0.) GO TO 200                                             RADIAL   169
            190   CONTINUE                                                           RADIAL   170
                  IFAIL = IFAIL+1                                                    RADIAL   171
                  DGS = FLOAT(IFAIL)*.5                                              RADIAL   172
                  IF (IFAIL.GT.10) GO TO 220                                         RADIAL   173
                  GO TO 110                                                          RADIAL   174
            200   CONTINUE                                                           RADIAL   175
                  S = SQRT(S)                                                        RADIAL   176
                  IF (GI.LT.0.) S = -S                                               RADIAL   177
                  AMB = XI/(GI+S)                                                    RADIAL   178
                  Z = ZC+AMB*(ZC-ZB)                                                 RADIAL   179
                  DGS = Z                                                            RADIAL   180
                  IF (DGS.LT.0.) GO TO 190                                           RADIAL   181
                  GO TO 120                                                          RADIAL   182
            210   CONTINUE                                                           RADIAL   183
                  DGSAV(JRAD) = DGS                                                  RADIAL   184
                  IRAD = 1                                                           RADIAL   185
                  GO TO 230                                                          RADIAL   186
            220   CONTINUE                                                           RADIAL   187
            C                                                                        RADIAL   188
            230   CONTINUE                                                           RADIAL   189
                  VFF(JRAD) = 100.*((RCI-DG(JRAD))**2-RFS*RFS)/(RCI-DG(JRAD))**2     RADIAL   190
                  VFC(JRAD) = 100.*(RCI*RCI-RFS*RFS)/(RCI*RCI)                       RADIAL   191
            C                                                                        RADIAL   192
            C   CFAC CORRELATION FROM RODS 1,2,3 OF IFA-432 AND ROD 6 OF IFA-513     RADIAL   193
            C   SEE REPORT -- PNL-2709, FIG 17,18                                   RADIAL   194
            C                                                                        RADIAL   195
                  CFRAC = 1.-FRAC                                                    RADIAL   196
                  CINTER = 0.53-0.14*CFRAC-0.40*CFRAC**2                             RADIAL   197
                  CSLOPE = 0.29+0.08*CFRAC+0.04*CFRAC**2                             RADIAL   198
            C                                                                        RADIAL   199
                  IF (PRG(JRAD).LT.0.) WRITE (6,*) "PRG NEGATIVE"                    RADIAL   200
                  IF (PRG(JRAD).LT.0.) PRG(JRAD) = 50.                               RADIAL   201
                  PASCAL = ALOG10(PRG(JRAD)*6895.+1.)                                RADIAL   202
                  CFAC(JRAD) = CSLOPE*(PASCAL-6.0)+CINTER                            RADIAL   203
                  IF (CFAC(JRAD).LT.0.3) CFAC(JRAD) = 0.3                            RADIAL   204
                  IF (CFAC(JRAD).GT.1.) CFAC(JRAD) = 1.                              RADIAL   205
            C                                                                        RADIAL   206
            C   VFCC = VFC FOR COLD ROD                                              RADIAL   207
                  VRATIO = VFC(JRAD)/VFCC                                            RADIAL   208
            C   TRAMP = TEMP AT WHICH "LOCKUP" OCCURS                                RADIAL   209
            C   VLIMIT IS PERCENT GAP STILL OPEN WHEN FUEL MODULI REALLY             RADIAL   210
            C   START TO CLIMB                                                       RADIAL   211
                  VLIMIT = 0.85                                                      RADIAL   212
                  IF (VRATIO.GE.VLIMIT) TRAMP(JRAD) = TVOL                           RADIAL   213
```

```
      C
            RATIO = (TVOL-TRAMP(JRAD))/280.                                  RADIAL  214
      C                                                                      RADIAL  215
      C     EAX, ERAD CORRELATIONS FROM PNL-2709                             RADIAL  216
      C                                                                      RADIAL  217
            IF (VFC(JRAD).LT.3.5) GO TO 240                                  RADIAL  218
            VF35 = VFC(JRAD)-3.5                                             RADIAL  219
            Z1 = 9.73-0.29*VF35+0.016*VF35**2                                RADIAL  220
            Z2 = 8.61-0.03*VF35                                              RADIAL  221
            GO TO 250                                                        RADIAL  222
      240   CONTINUE                                                         RADIAL  223
            Z1 = 11.0-0.43*VFC(JRAD)+0.0189*VFC(JRAD)**2                     RADIAL  224
            Z2 = 10.5-0.54*VFC(JRAD)                                         RADIAL  225
      250   CONTINUE                                                         RADIAL  226
            Z = Z1*RATIO+Z2*(1.-RATIO)                                       RADIAL  227
      C                                                                      RADIAL  228
            IF (VFF(JRAD).LT.4.5) GO TO 260                                  RADIAL  229
            VF45 = VFF(JRAD)-4.5                                             RADIAL  230
            Y1 = 9.29-0.08*VF45                                              RADIAL  231
            Y2 = 8.96-0.08*VF45                                              RADIAL  232
            GO TO 270                                                        RADIAL  233
      260   CONTINUE                                                         RADIAL  234
            Y1 = 11.5-0.91*VFF(JRAD)+0.093*VFF(JRAD)**2                      RADIAL  235
            Y2 = 10.6-0.68*VFF(JRAD)+0.070*VFF(JRAD)**2                      RADIAL  236
      270   CONTINUE                                                         RADIAL  237
            Y = Y1*RATIO+Y2*(1.-RATIO)                                       RADIAL  238
            IF (RATIO.GT.1.) Y = Y1                                          RADIAL  239
            IF (RATIO.LT.0.) Y = Y2                                          RADIAL  240
            IF (RATIO.GT.1.) Z = Z1                                          RADIAL  241
            IF (RATIO.LT.0.) Z = Z2                                          RADIAL  242
      C     LIMITS ON Z AND Y TO ENABLE FINITE ELEMENT ANALYSIS              RADIAL  243
            IF (Y.LT.8.84) Y = 8.84                                          RADIAL  244
            IF (Z.LT.8.84) Z = 8.84                                          RADIAL  245
      C                                                                      RADIAL  246
      C     Z,Y = LOGARITHMS OF EAX,ERAD (PASCALS)                           RADIAL  247
            EAX(JRAD) = 10.**Z/6895.                                         RADIAL  248
            ERAD(JRAD) = 10.**Y/6895.                                        RADIAL  249
      C                                                                      RADIAL  250
            EAX(JRAD) = EAX(JRAD)/2.                                         RADIAL  251
            ERAD(JRAD) = ERAD(JRAD)/8.                                       RADIAL  252
      C     MODIFICATION OF MODULI NECESSARY TO CORRELATE RESULTS FROM PNL-2709 RADIAL  253
      C     WITH PELET FINITE ELEMENT MODEL                                  RADIAL  254
      C                                                                      RADIAL  255
      280   CONTINUE                                                         RADIAL  256
      C                                                                      RADIAL  257
      C                                                                      RADIAL  258
            ERAD(1) = ERAD(2)                                                RADIAL  259
            EAX(1) = EAX(2)                                                  RADIAL  260
      C     REGION NA+1 IS PLENUM - LOW MODULUS                              RADIAL  261
            ERAD(NA+1) = 1.E5                                                RADIAL  262
            EAX(NA+1) = 1.E5                                                 RADIAL  263
      C                                                                      RADIAL  264
            RETURN                                                           RADIAL  265
                                                                             RADIAL  266
```

END RADIAL 267

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 RADIAL 1 265

VARIABLES	SN	TYPE	RELOCATION										
1205	A	REAL			REFS	2*128	DEFINED	121	127				
1233	AMB	REAL			REFS	178	DEFINED	177					
1225	AMBI	REAL			REFS	3*164	2*165	DEFINED	162				
1201	ARAG	REAL			REFS	2*113	DEFINED	112					
0	CFAC	REAL	ARRAY	F.P.	REFS	6	203	204	DEFINED	1	202	203	
					204								
0	CFCSV	REAL	*UNUSED	F.P.	DEFINED	1							
1235	CFRAC	REAL			REFS	2*196	2*197	DEFINED	195				
1236	CINTER	REAL			REFS	202	DEFINED	196					
1207	CIRCL	REAL			REFS	125	DEFINED	123					
1155	CNUM	REAL			REFS	124	DEFINED	63					
1237	CSLOPE	REAL			REFS	202	DEFINED	197					
1230	CI	REAL			REFS	167	DEFINED	165					
1211	D	REAL			REFS	126	DEFINED	125					
1176	DDG	REAL			REFS	143	148	DEFINED	105				
1167	DELRNG	REAL			REFS	90	91	DEFINED	89				
1226	DELTI	REAL			REFS	3*164	165	166	167	DEFINED	163		
0	DEN	REAL		F.P.	REFS	60	DEFINED	1					
0	DENSF	REAL	ARRAY	F.P.	REFS	9	90	DEFINED	1				
0	DG	REAL	ARRAY	F.P.	REFS	6	116	2*189	DEFINED	1	115		
1175	DGS	REAL			REFS	112	115	133	141	143	146	148	
					151	157	180	183	DEFINED	104	143	148	
					171	179							
0	DGSAV	REAL	ARRAY	F.P.	REFS	6	104	DEFINED	1	183			
1162	DNS	REAL			REFS	90	95	DEFINED	82	90			
0	DPW	REAL	ARRAY	F.P.	REFS	9	91	DEFINED	1				
1212	DS	REAL			REFS	127	DEFINED	126					
0	EAX	REAL	ARRAY	F.P.	REFS	6	251	260	DEFINED	1	248	251	
					260	263							
0	ERAD	REAL	ARRAY	F.P.	REFS	6	252	259	DEFINED	1	249	252	
					259	262							
1221	FA	REAL			REFS	164	165	DEFINED	142	158			
1223	FB	REAL			REFS	158	164	165	DEFINED	147	159		
1224	FC	REAL			REFS	159	164	165	166	167			
					DEFINED	152	160						
0	FRAC	REAL		F.P.	REFS	195	DEFINED	1					
1227	GI	REAL			REFS	2*167	176	177	DEFINED	164			
1156	HCL	REAL			REFS	113	DEFINED	64					
1204	HFUL	REAL			REFS	120	128	DEFINED	119	120			
1164	I	INTEGER			REFS	87	DEFINED	86					
1177	IFAIL	INTEGER			REFS	170	171	172	DEFINED	106	170		

VARIABLES	SN	TYPE		RELOCATION								
1166	IJ	INTEGER			REFS	90	91	DEFINED	88			
1174	IRAD	INTEGER			DEFINED	103	184					
0	ITER	INTEGER		F.P.	REFS	2*69	76	78	DEFINED	1		
1160	JRAD	INTEGER			REFS	2*74	2*75	3*76	3*78	2*80	88	97
					102	104	113	115	116	130	183	3*189
					190	199	2*200	201	202	2*203	2*204	207
					212	214	218	219	2*224	225	229	230
					2*235	2*236	248	249	2*251	2*252		
					DEFINED	73						
1200	K	INTEGER			REFS	110	132	136	137	138	139	
					DEFINED	108	110					
1165	L	INTEGER			REFS	88	2*89	DEFINED	87			
0	NA	INTEGER		F.P.	REFS	13*6	4*9	73	262	263		
					DEFINED	1						
1150	NEW	INTEGER			REFS	11	70	74	75	2*76	2*78	2*80
					DEFINED	67	69					
0	NF	INTEGER		F.P.	REFS	102	DEFINED	1				
0	NFFI	INTEGER		F.P.	REFS	102	DEFINED	1				
0	NR	INTEGER		F.P.	REFS	86	87	88	DEFINED	1		
1151	OLD	INTEGER			REFS	11	76	78	DEFINED	68	70	
1240	PASCAL	REAL			REFS	202	DEFINED	201				
1214	PDIF	REAL			REFS	142	147	152	160	DEFINED	130	
1215	PERR	REAL			REFS	134	DEFINED	131				
1157	PI	REAL			REFS	122	123	DEFINED	65			
0	PLSTC	REAL	ARRAY	F.P.	REFS	9	97	DEFINED	1			
1213	PRF	REAL			REFS	130	DEFINED	128				
0	PRG	REAL	ARRAY	F.P.	REFS	6	130	199	200	201		
					DEFINED	1	113	200				
1216	PTST	REAL			REFS	134	DEFINED	133				
0	R	REAL	ARRAY	F.P.	REFS	9	2*89	DEFINED	1			
1154	RADCL	REAL			REFS	124	DEFINED	62				
0	RADIUS	REAL	ARRAY	F.P.	REFS	6	102	DEFINED	1			
1210	RADL	REAL			REFS	125	DEFINED	124				
1243	RATIO	REAL			REFS	2*227	2*238	239	240	241	242	
					DEFINED	214						
0	RC	REAL		F.P.	REFS	97	DEFINED	1				
1171	RCEST	REAL			REFS	98	99	DEFINED	97			
1173	RCI	REAL			REFS	116	2*189	4*190	DEFINED	102		
1153	RCRL	REAL			REFS	123	DEFINED	61				
1172	RFS	REAL			REFS	2*122	2*189	2*190	DEFINED	101		
1202	RFSMT	REAL			REFS	2*122	123	124	DEFINED	116		
0	RP	REAL		F.P.	REFS	95	101	DEFINED	1			
1170	RPEST	REAL			REFS	98	99	DEFINED	95			
1232	S	REAL			REFS	168	175	176	177	DEFINED	167	175
					176							
0	SIGC	REAL		F.P.	REFS	126	DEFINED	1	99			
0	SIGG	REAL		F.P.	REFS	115	DEFINED	1	98			
1163	SWL	REAL			REFS	91	95	DEFINED	83	91		
0	TCL	REAL	ARRAY	F.P.	REFS	6	2*76	80	DEFINED	1	74	76
1152	TD	REAL			REFS	119	DEFINED	60				
0	TEMP	REAL	ARRAY	F.P.	REFS	6	74	75	DEFINED	1		
0	TFS	REAL	ARRAY	F.P.	REFS	6	2*78	80	DEFINED	1	75	78
1203	TK	REAL			REFS	118	119	DEFINED	117	118		

VARIABLES	SN	TYPE	RELOCATION									
0	TRAMP	REAL	ARRAY	F.P.	REFS	6	214	DEFINED	1	212		
1161	TVOL	REAL			REFS	3*101	117	3*121	212	214		
					DEFINED	80						
1206	VA	REAL			REFS	125	DEFINED	122				
0	VFC	REAL	ARRAY	F.P.	REFS	6	207	218	219	2*224	225	
					DEFINED	1	190					
0	VFCC	REAL		F.P.	REFS	207	DEFINED	1				
0	VFF	REAL	ARRAY	F.P.	REFS	6	229	230	2*235	2*236		
					DEFINED	1	189					
1244	VF35	REAL			REFS	2*220	221	DEFINED	219			
1247	VF45	REAL			REFS	231	232	DEFINED	230			
1242	VLIMIT	REAL			REFS	212	DEFINED	211				
1241	VRATIO	REAL			REFS	212	DEFINED	207				
1231	X1	REAL			REFS	177	DEFINED	166				
1252	Y	REAL			REFS	244	249	DEFINED	238	239	240	244
1250	Y1	REAL			REFS	238	239	DEFINED	231	235		
1251	Y2	REAL			REFS	238	240	DEFINED	232	236		
1234	Z	REAL			REFS	179	245	248	DEFINED	178	227	241
					242	245						
1220	ZA	REAL			REFS	162	2*163	DEFINED	141	155		
1222	ZB	REAL			REFS	155	2*162	163	178	DEFINED	146	156
1217	ZC	REAL			REFS	2*133	156	162	163	2*178		
					DEFINED	151	157					
1245	Z1	REAL			REFS	227	241	DEFINED	220	224		
1246	Z2	REAL			REFS	227	242	DEFINED	221	225		

FILE NAMES	MODE		
TAPE6	FREE	WRITES	199

EXTERNALS	TYPE	ARGS		REFERENCES			
ALOG10	REAL	1	LIBRARY	201			
ATAN	REAL	1	LIBRARY	65			
ERF	REAL	1	LIBRARY	112	127		
EXP	REAL	1	LIBRARY	119			
SQRT	REAL	1	LIBRARY	115	119	126	175

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
ABS	REAL	1	INTRIN		133
EXPN	REAL	1	SF	57	101
FLOAT	REAL	1	INTRIN		171
MHARD	INTEGER	2	SF	58	119

STATEMENT LABELS		DEF LINE	REFERENCES		
0	100	92	86		
207	110	107	173		
212	120	109	144	149	181
343	130	135	132		
360	140	140	137		
371	150	145	138		
402	160	150	139		
410	170	154	136		
425	180	161	153		
465	190	169	180		

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STATEMENT LABELS                DEF LINE   REFERENCES
  477  200                         174        168
  523  210                         182        134
  532  220                         186        172
  533  230                         188        185
  656  240                         223        218
  671  250                         226        222
  716  260                         234        229
  733  270                         237        233
    0  280                         256         73

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   44  280      JRAD        73 256      743B              EXT REFS  NOT INNER
  113  100      I           86 92        26B         OPT

STATISTICS
  PROGRAM LENGTH                1356B     750
        140000B SCM USED
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      SUBROUTINE RATE (NSH,CRATE,DTIME,TELM,SE,CRPG,NAXL,NRAD,PSTS,PSSV, RATE      2
     +PSSRT,IJ,IPOS,OLDSE,BASE)                                          RATE      3
C                                                                        RATE      4
C     RATE IS CALLED FROM KREEP                                          RATE      5
C                                                                        RATE      6
C     SUBROUTINE RATE CALCULATES THE GENERALIZED STRAIN INCREMENT        RATE      7
C     CRATE(I,J) FOR EACH ELEMENT FOR CREEP OR PLASTIC LOAD STEPS.       RATE      8
C     THESE INCREMENTS ARE ALLOCATED TO THE R, THETA, AND Z DIRECTIONS   RATE      9
C     IN SUBROUTINE CREEP (TCRP(I,J,K))   THE TCRP"S ARE TRANSLATED      RATE     10
C     TO NODAL LOADS IN SUBROUTINES LOAD AND ALOAD.                      RATE     11
C                                                                        RATE     12
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P PELCOM     2
     +DEL,COMP                                                           PELCOM     3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE PELCOM     4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT, PELCOM     5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN PELCOM     6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N PELCOM     7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                  PELCOM     8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                          PELCOM     9
     +,IRZ                                                               PELCOM    10
      COMMON /LASTIC/ E,XNU,ALPHA                                        PELCOM    11
      COMMON /CONTNT/ PI                                                 PELCOM    12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                      PELCOM    13
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,       COMC      2
     +   ERAD(20), EAX(20)                                               COMC      3
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)                  COMC      4
     +,PINOLD,POUTLD,POLD,NTOLD(20)                                      COMC      5
     + ,ICHNG,STEPS                                                      COMC      6
      COMMON / MATCNS / ANRIN, DCOMP, CWKF, CWNF, DELOXY, FLUX, FNCK,    RATE     15
     + FNCN, FOTMTL, DRFDEN, FTMELT, RSTRAN                              RATE     16
      DIMENSION TELM(NRAD,NAXL,2), CRATE(NRAD,1), TIME(5), SE(NRAD,1)    RATE     17
      DIMENSION CRPG(NRAD,1)                                             RATE     18
      DIMENSION PSTS(NRAD,1),OLDSE(NRAD,1),PSSV(1),PSSRT(1),IJ(1),       RATE     19
     + IPOS(1),BASE(1), DTIME(5)                                         RATE     20
C                                                                        RATE     21
C***     PNL CREEP MODEL   JANUARY 1978 VERSION                  ***     RATE     22
      DATA C1/3310./,C2/.0044/,C3/5.96E14/,C5/1.05E-4/,C6/6.36E4/,       RATE     23
     +C7/1.0E-5/,C8/9.5E3/,C9/65.77/,C10/640.0/,C11/7.18E-7/             RATE     24
C                                                                        RATE     25
C   SE      - ELEMENT EFFECTIVE STRESS                                   RATE     26
C   CRATE   - INCREMENTAL STRAIN                                        RATE     27
C                                                                        RATE     28
      IPLAS = 0                                                          RATE     29
      LOW = NOELF+1                                                      RATE     30
      BIGT = 0.0                                                         RATE     31
C                                                                        RATE     32
      DO 110 J=1,NAXL                                                    RATE     33
        DO 110 I=LOW,NRAD                                                RATE     34
        TEMPK = (TELM(I,J,NEW)-32.0)/1.8+273.0                           RATE     35
        CWK = 128260.-146.5*TEMPK+.1378*TEMPK**2-.0726E-3*TEMPK**3       RATE     36
        CWN = -1.715E-2+.3583E-3*TEMPK-.7638E-6*TEMPK**2+.4954E-9*       RATE     37
     +      TEMPK**3                                                    RATE     38
        PSTS(I,J) = CWK*(CRPG(I,J))**CWN                                 RATE     39
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                      IF (PSTS(I,J).GT.SE(I,J)) GO TO 110                                RATE       40
55                    IPLAS = 1                                                          RATE       41
                      REST = SE(I,J)-PSTS(I,J)                                           RATE       42
                      IF (BIGT.LT.REST) BIGT = REST                                      RATE       43
               C   CALCULATION OF INITIAL CONDITIONS FOR PLASTICITY                      RATE       44
                      IF (KPLAS.NE.0) GO TO 100                                          RATE       45
60                    ICNT = ICNT+1                                                      RATE       46
                      IJ(ICNT) = (J-1)*NRAD+I                                            RATE       47
                      PSSV(ICNT) = SE(I,J)-PSTS(I,J)                                     RATE       48
                      BASE(ICNT) = SE(I,J)-OLDSE(I,J)                                    RATE       49
                      GO TO 110                                                          RATE       50
65             100    CONTINUE                                                           RATE       51
                      TF = TELM(I,J,NEW)                                                 RATE       52
               C   DEGREES K FOR CALLS TO MATPRO ROUTINES                               RATE       53
                      TK = (TF-32.)/1.8+273.15                                           RATE       54
                      E = CELMOD(TK,FNCK,CWKF,DELOXY)                                    RATE       55
70             C   1 PSI = 6.8948 KPA ***                                               RATE       56
                      E = E/6894.8                                                       RATE       57
                      CRATE(I,J) = ((SE(I,J)-PSTS(I,J))/E)*1.6                           RATE       58
               110    CONTINUE                                                           RATE       59
                  IRAK = 0                                                             RATE       60
75             C   DECISION POINT FOR PSEUDO-ELASTIC LOAD STEPS. IPLAS=1 IS THE         RATE       61
               C   SIGNAL THAT PLASTICITY HAS OCCURRED. KPLAS IS A COUNTER,AND         RATE       62
               C   KPLAS=IPLEND SIGNALS THE END OF THE PLASTICITY ITERATIONS.          RATE       63
                    IPLEND = ICNT+1                                                    RATE       64
                    IF (IPLAS.EQ.1.AND.BIGT.LT.500.) IPLAS = 0                         RATE       65
80                  IF (KPLAS.GE.IPLEND.AND.IPLAS.EQ.0) CALL MOVEKA (0,CRATE,NOEL*NARC RATE       66
                   +)                                                                  RATE       67
                    IF (KPLAS.EQ.0.AND.IPLAS.EQ.0) GO TO 140                           RATE       68
                    IF (KPLAS.GE.2.AND.IPLAS.EQ.1) GO TO 140                           RATE       69
                    IF (KPLAS.GE.2.AND.IPLAS.EQ.0) KPLAS = KPLAS+1                     RATE       70
85                  IF (KPLAS.GT.IPLEND) GO TO 140                                     RATE       71
                    IF (KPLAS.EQ.1) KPLAS = 2                                          RATE       72
                    IF (KPLAS.EQ.0.AND.IPLAS.EQ.1) KPLAS = 1                           RATE       73
               C   SORT PLASTIC ELEMENTS IN ASCENDING ORDER OF PLASTICITY.             RATE       74
                    IF (KPLAS.EQ.1) CALL SORTP (PSSV,ICNT,PSSRT,IPOS)                  RATE       75
90             C   START OF LOAD STEP CALCULATION. THE QUANTITY (1.-RRAKR) IS THE       RATE       76
               C   FRACTION OF TOTAL LOAD STEP TO BE TAKEN.  IRAK=1 IS THE SIGNAL      RATE       77
               C   TO TAKE A PSEUDO-ELASTIC LOAD STEP. RAKSUM IS THE CUMULATIVE FRACT  RATE       78
               C   OF THE TOTAL LOAD STEP.                                            RATE       79
                    IRAK = 1                                                           RATE       80
95                  IT = ICNT-KPLAS+1                                                  RATE       81
                    IF (IT.LE.0) IT = 1                                                RATE       82
                    IG = IPOS(IT)                                                      RATE       83
                        DO 120 J=1,NAXL                                                RATE       84
                            DO 120 I=LOW,NRAD                                          RATE       85
100                         ITEST = (J-1)*NRAD+I                                       RATE       86
                            IF (ITEST.EQ.IJ(IG)) GO TO 130                             RATE       87
               120          CONTINUE                                                   RATE       88
               130    CONTINUE                                                         RATE       89
                    IF (KPLAS.EQ.1) RRAKR = PSSRT(IT)/BASE(IG)                         RATE       90
105                 IF (KPLAS.GT.1) RRAKR = 1.-(PSTS(I,J)-SE(I,J))/BASE(IG)            RATE       91
                    RAKSUM = RAKSUM+(1.-RRAKR)                                         RATE       92
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      IF (KPLAS.EQ.IPLEND) RRAKR = RAKSUM                                RATE       93
      IF (KPLAS.EQ.IPLEND.AND.RAKSUM.GT.1.0) RRAKR = 1.0                 RATE       94
140   CONTINUE                                                           RATE       95
C                                                                        RATE       96
C   DECISION TO SKIP THE CREEP CALCULATION. ISP=1 IS THE SIGNAL          RATE       97
C   THAT THIS IS THE LAST PSEUDO-ELASTIC STEP.                           RATE       98
C                                                                        RATE       99
      IF (KPLAS.EQ.IPLEND) ISP = ISP+1                                   RATE      100
      IF (KPLAS.GT.0.AND.KPLAS.LT.IPLEND) GO TO 270                      RATE      101
      IF (KPLAS.EQ.IPLEND.AND.IPLAS.EQ.1) GO TO 270                      RATE      102
      IF (KPLAS.EQ.IPLEND.AND.ISP.EQ.1) GO TO 270                        RATE      103
C                                                                        RATE      104
C   GAS = UNIVERSAL GAS CONSTANT, CAL/MOLE-DEG F                         RATE      105
C                                                                        RATE      106
      GAS = 1.987                                                        RATE      107
      NNN = (NF+NC-2)*2                                                  RATE      108
      N = (NABT-1)                                                       RATE      109
      M = IRZ                                                            RATE      110
          DO 150 I=1,3                                                   RATE      111
          TIME(I) = DTIME(I)*24.0                                        RATE      112
150       CONTINUE                                                       RATE      113
      DLTM = TIME(3)-TIME(2)                                             RATE      114
C   STRAIN HARDENING OPTION DECISION POINT                               RATE      115
C   STRAIN HARDENING OPTION VARIABLE = NSH                               RATE      116
C   NSH = 1  MEANS THE STRAIN HARDENING OPTION IS USED                   RATE      117
C                                                                        RATE      118
      IF (NSH.EQ.1.AND.M.GT.1) GO TO 190                                 RATE      119
C                                                                        RATE      120
          DO 180 J=1,N                                                   RATE      121
C   CONVERT FLUX FROM NEU/M**2-SEC TO NEU/CM**2-SEC                      RATE      122
          FFLUX = FLXR*1.0E-4                                            RATE      123
          ILO = NOELF+1                                                  RATE      124
              DO 180 I=ILO,NNN                                           RATE      125
              TEMK = (TELM(I,J,NEW)-32.0)/1.8+273.0                      RATE      126
C                                                                        RATE      127
C                                                                        RATE      128
C                                                                        RATE      129
C   ZR CREEP CALCULATION (P.J. PANKASKIE)                                RATE      130
C   ***     PNL CREEP MODEL   JANUARY 1978 VERSION                ***    RATE      131
C                                                                        RATE      132
C   TIME HARDENING                                                       RATE      133
              CTO = C10*EXP(-C11*SE(I,J))                                RATE      134
              DELT = CTO-TEMK                                            RATE      135
C   CHANGES RECOMMENDED BY LASSE MATTILA                                 RATE      136
              TNH = -1.0                                                 RATE      137
              IF (DELT.GE.0.0) TNH = 1.0                                 RATE      138
C                                                                        RATE      139
              QA = C6-0.44*SE(I,J)                                       RATE      140
              QI = C8-.038*SE(I,J)                                       RATE      141
              TAE = -(C6*(1.-TNH)+QI*(1.+TNH))/(2.*GAS*TEMK)             RATE      142
              IF (FFLUX.LE.10.) GO TO 160                                RATE      143
              CFF = 0.85*ALOG(FFLUX)                                     RATE      144
              GO TO 170                                                  RATE      145
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160         160           CONTINUE                                                    RATE      146
                          CFF = (QA/(4.*GAS*CTO))*(3.-CTO/TEMK)                       RATE      147
            170           CONTINUE                                                    RATE      148
                          FAE = (CFF-C9)*(1.+TNH)/2.                                  RATE      149
                          ATERM = EXP(TAE+FAE)                                        RATE      150
165                       SCR = C3*ATERM*((1.-TNH)*SINH(C5*SE(I,J))+(1.+TNH)*SINH(C7  RATE      151
                +         *SE(I,J)))/2.                                               RATE      152
                          DLTC = C1*(EXP(-C2*TIME(2))-EXP(-C2*TIME(3)))               RATE      153
                          CRATE(I,J) = SCR*(DLTC+DLTM)                                RATE      154
            180           CONTINUE                                                    RATE      155
170              GO TO 250                                                            RATE      156
            C                                                                         RATE      157
            C     CHANGES TO ALLOW FOR STRAIN HARDENING OPTION                        RATE      158
            C                                                                         RATE      159
            C     START STRAIN HARDENING OPTION                                       RATE      160
175         C                                                                         RATE      161
            190   CONTINUE                                                            RATE      162
                      DO 240 J=1,N                                                    RATE      163
                          DO 240 I=ILO,NNN                                            RATE      164
            C     CONVERT FLUX FROM NEU/M**2-SEC TO NEU/CM**2-SEC                     RATE      165
180                       FFLUX = FLXR*1.0E-4                                         RATE      166
                          TEMK = (TELM(I,J,NEW)-32.0)/1.8+273.0                       RATE      167
            C                                                                         RATE      168
                          ZETA = TIME(3)                                              RATE      169
            200           CONTINUE                                                    RATE      170
185         C                                                                         RATE      171
            C     STRAIN HARDENING                                                    RATE      172
                          CTO = C10*(1.+.021*ALOG(1.+FFLUX/6.E12))*EXP(-C11*SE(I,J))  RATE      173
                          DELT = CTO-TEMK                                             RATE      174
            C     CHANGES RECOMMENDED BY LASSE MATTILA                                RATE      175
190                       TNH = -1.0                                                  RATE      176
                          IF (DELT.GE.0.0) TNH = 1.0                                  RATE      177
            C                                                                         RATE      178
                          QA = C6-.061*SE(I,J)                                        RATE      179
                          QI = C6-.038*SE(I,J)                                        RATE      180
195                       TAE = -(C6*(1.-TNH)+QI*(1.+TNH))/(2.*GAS*TEMK)              RATE      181
                          IF (FFLUX.LE.10.) GO TO 210                                 RATE      182
                          CFF = 0.85*ALOG(FFLUX)                                      RATE      183
                          GO TO 220                                                   RATE      184
            210           CONTINUE                                                    RATE      185
200                       CFF = (QA/(4.*GAS*CTO))*(3.-CTO/TEMK)                       RATE      186
            220           CONTINUE                                                    RATE      187
                          FAE = (CFF-C9)*(1.+TNH)/2.                                  RATE      188
                          ATERM = EXP(TAE+FAE)                                        RATE      189
                          SCR = C3*ATERM*((1.-TNH)*SINH(C5*SE(I,J))+(1.+TNH)*SINH(C7  RATE      190
205             +         *SE(I,J)))/2.                                               RATE      191
                          TC1 = C1*(1.-EXP(-C2*ZETA))                                 RATE      192
                          TRC1 = C1*C2*EXP(-C2*ZETA)                                  RATE      193
                          CSTR1 = SCR*(ZETA+TC1)                                      RATE      194
                          DCST1 = SCR*(1.0+TRC1)                                      RATE      195
210                       ERROR = CRPG(I,J)-CSTR1                                     RATE      196
                          XFACT = 0.001*CRPG(I,J)                                     RATE      197
                          ABERR = ABS(ERROR)                                          RATE      198
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                      IF (ABERR.LT.XFACT) GO TO 230                                  RATE      199
                      H = ERROR/DCSTI                                                RATE      200
215                   ZETA = ZETA+H                                                  RATE      201
                      GO TO 200                                                      RATE      202
            230       CONTINUE                                                       RATE      203
            C                                                                        RATE      204
            CC    NOW COMPARE INCREMENTAL STRAIN INCREMENT FOR STRAIN HARDENING     RATE      205
220         CC    MODE                                                             RATE      206
            C                                                                        RATE      207
                      ZETAN = ZETA+DLTM                                              RATE      208
            C                                                                        RATE      209
            CC    COMPUTE INCREMENTAL STRAIN FOR TIME STEP                         RATE      210
225         C                                                                        RATE      211
                      TC2 = C1*(1.-EXP(-C2*ZETAN))                                   RATE      212
                      CSTR2 = SCR*(ZETAN+TC2)                                        RATE      213
                      CRATE(I,J) = CSTR2-CSTR1                                       RATE      214
            C                                                                        RATE      215
230         240       CONTINUE                                                       RATE      216
            250   CONTINUE                                                         RATE      217
                  DO 260 I=LOW,NRAD                                                RATE      218
                      DO 260 J=1,NAXL                                              RATE      219
                      OLDSE(I,J) = SE(I,J)                                         RATE      220
235         260       CONTINUE                                                       RATE      221
            270   CONTINUE                                                         RATE      222
                  RETURN                                                           RATE      223
                  END                                                              RATE      224
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	RATE	1	237

VARIABLES

		SN	TYPE		RELOCATION								
1324	ABERR		REAL			REFS	213	DEFINED	212				
2	ALPHA		REAL		LASTIC	REFS	21						
0	ANRIN		REAL		MATCNS	REFS	29						
1312	ATERM		REAL			REFS	165	204	DEFINED	164	203		
0	BASE		REAL	ARRAY	F.P.	REFS	33	104	105	DEFINED	1	63	
1256	BIGT		REAL			REFS	57	79	DEFINED	45	57		
1310	CFF		REAL			REFS	163	202	DEFINED	158	161	197	200
14	COMP		REAL		GEOPAR	REFS	12						
33	CP		REAL		LIMITS	REFS	14						
34	CR		REAL		LIMITS	REFS	14						
0	CRATE		REAL	ARRAY	F.P.	REFS	31	80	DEFINED	1	72	168	228
0	CRPG		REAL	ARRAY	F.P.	REFS	32	53	210	211	DEFINED	1	
1320	CSTR1		REAL			REFS	210	228	DEFINED	208			
1330	CSTR2		REAL			REFS	228	DEFINED	227				
1302	CTG		REAL			REFS	149	2*161	188	2*200	DEFINED	148	187
1262	CWK		REAL			REFS	53	DEFINED	50				

VARIABLES	SN	TYPE		RELOCATION								
2	CWKF	REAL		MATCNS	REFS	29	69					
1263	CWN	REAL			REFS	53	DEFINED	51				
3	CWNF	REAL		MATCNS	REFS	29						
1202	C1	REAL			REFS	167	206	207	226	DEFINED	37	
1212	C10	REAL			REFS	148	187	DEFINED	37			
1213	C11	REAL			REFS	148	187	DEFINED	37			
1203	C2	REAL			REFS	2*167	206	2*207	226	DEFINED	37	
1204	C3	REAL			REFS	165	204	DEFINED	37			
1205	C5	REAL			REFS	165	204	DEFINED	37			
1206	C6	REAL			REFS	154	156	193	195	DEFINED	37	
1207	C7	REAL			REFS	165	204	DEFINED	37			
1210	C8	REAL			REFS	155	194	DEFINED	37			
1211	C9	REAL			REFS	163	202	DEFINED	37			
1	DCOMP	REAL		MATCNS	REFS	29						
1321	DCST1	REAL			REFS	214	DEFINED	209				
4	DELQXY	REAL		MATCNS	REFS	29	69					
5	DELR	REAL		GEOPAR	REFS	12						
1303	DELT	REAL			REFS	152	191	DEFINED	149	188		
6	DELZ	REAL		GEOPAR	REFS	12						
0	DELZA	REAL	ARRAY	BA	REFS	24						
1314	DLTC	REAL			REFS	168	DEFINED	167				
1276	DLTM	REAL			REFS	168	222	DEFINED	128			
11	DRFDEN	REAL		MATCNS	REFS	29						
0	DTIME	REAL	ARRAY	F.P.	REFS	33	126	DEFINED	1			
0	E	REAL		LASTIC	REFS	21	71	72	DEFINED	69	71	
102	EAX	REAL	ARRAY	BA	REFS	24						
56	ERAD	REAL	ARRAY	BA	REFS	24						
1322	ERROR	REAL			REFS	212	214	DEFINED	210			
1311	FAE	REAL			REFS	164	203	DEFINED	163	202		
1277	FFLUX	REAL			REFS	157	158	187	196	197		
					DEFINED	137	180					
5	FLUX	REAL		MATCNS	REFS	29						
55	FLXR	REAL		BA	REFS	24	137	180				
6	FNCK	REAL		MATCNS	REFS	29	69					
7	FNEN	REAL		MATCNS	REFS	29						
10	FOTMTL	REAL		MATCNS	REFS	29						
35	FRDEN	REAL		LIMITS	REFS	14						
12	FTMELT	REAL		MATCNS	REFS	29						
1272	GAS	REAL			REFS	156	161	195	200	DEFINED	121	
1325	H	REAL			REFS	215	DEFINED	214				
0	HHF	REAL		FEP	REFS	26						
1260	I	INTEGER			REFS	49	2*53	2*54	2*56	61	2*62	2*63
						66	3*72	100	2*105	2*126	140	148	154
						155	2*165	168	181	187	193	194	2*204
						210	211	228	2*234	DEFINED	48	99	125
						139	178	232					
57	IADJ	INTEGER		LIMITS	REFS	14						
103	ICHNG	INTEGER		FEP	REFS	26						
67	ICNT	INTEGER		LIMITS	REFS	14	60	61	62	63	78	89
						95	DEFINED	60				
42	ICRPP	INTEGER		LIMITS	REFS	14						
60	ICUT	INTEGER		LIMITS	REFS	14						
5	IDF	INTEGER		LIMITS	REFS	14						

VARIABLES	SN	TYPE		RELOCATION								
1270	IG	INTEGER			REFS	101	104	105	DEFINED	97		
0	IJ	INTEGER	ARRAY	F.P.	REFS	33	101	DEFINED	1	61		
1300	ILO	INTEGER			REFS	139	178	DEFINED	138			
40	IPLAS	INTEGER		LIMITS	REFS	14	79	80	82	83	84	87
					116	DEFINED	43	55	79			
73	IPLEND	INTEGER		LIMITS	REFS	14	80	85	107	108	114	115
					116	117	DEFINED	78				
0	IPOS	INTEGER	ARRAY	F.P.	REFS	33	89	97	DEFINED	1		
71	IRAK	INTEGER		LIMITS	REFS	14	DEFINED	74	94			
75	IRZ	INTEGER		LIMITS	REFS	14	124					
74	ISP	INTEGER		LIMITS	REFS	14	114	117	DEFINED	114		
37	ISSTOP	INTEGER		LIMITS	REFS	14						
3	ISTOP	INTEGER		FEP	REFS	26						
53	ISTRT	INTEGER		BA	REFS	24						
1267	IT	INTEGER			REFS	96	97	104	DEFINED	95	96	
54	ITER	INTEGER		BA	REFS	24						
1271	ITEST	INTEGER			REFS	101	DEFINED	100				
63	ITI	INTEGER		LIMITS	REFS	14						
4	ITP1	INTEGER		TAPES	REFS	23						
5	ITP2	INTEGER		TAPES	REFS	23						
1257	J	INTEGER			REFS	49	2*53	2*54	2*56	61	2*62	2*63
					66	3*72	100	2*105	140	148	154	155
					2*165	168	181	187	193	194	2*204	210
					211	228	2*234	DEFINED	47	98	135	177
					233							
24	JAM	INTEGER		LIMITS	REFS	14						
12	KA	INTEGER		LIMITS	REFS	14						
10	KKA	INTEGER		GEOPAR	REFS	12						
2	KKZZZ	INTEGER		FEP	REFS	26						
66	KPLAS	INTEGER		LIMITS	REFS	14	59	80	82	83	2*84	85
					86	87	89	95	104	105	107	108
					114	2*115	116	117	DEFINED	84	86	87
55	KRNCH	INTEGER		LIMITS	REFS	14						
45	KRNCHC	INTEGER		LIMITS	REFS	14						
44	KRNCHF	INTEGER		LIMITS	REFS	14						
46	KRNCHT	INTEGER		LIMITS	REFS	14						
36	KZI	INTEGER		LIMITS	REFS	14						
1255	LOW	INTEGER			REFS	48	99	232	DEFINED	44		
1275	M	INTEGER			REFS	133	DEFINED	124				
52	MAXA	INTEGER		LIMITS	REFS	14						
43	MAXT	INTEGER		LIMITS	REFS	14						
56	MCUD	INTEGER		LIMITS	REFS	14						
1274	N	INTEGER			REFS	135	177	DEFINED	123			
17	NABC	INTEGER		LIMITS	REFS	14						
16	NABF	INTEGER		LIMITS	REFS	14						
31	NABF2	INTEGER		LIMITS	REFS	14						
20	NABT	INTEGER		LIMITS	REFS	14	123					
32	NABT2	INTEGER		LIMITS	REFS	14						
21	NAEC	INTEGER		LIMITS	REFS	14						
22	NAEF	INTEGER		LIMITS	REFS	14						
14	NARC	INTEGER		LIMITS	REFS	14	80					
13	NARF	INTEGER		LIMITS	REFS	14						
15	NART	INTEGER		LIMITS	REFS	14						

VARIABLES	SN	TYPE		RELOCATION								
25	NAXBT	INTEGER		LIMITS	REFS	14						
26	NAXB2	INTEGER		LIMITS	REFS	14						
27	NAXB4	INTEGER		LIMITS	REFS	14						
0	NAXL	INTEGER		F.P.	REFS	31	47	98	233	DEFINED		
1	NC	INTEGER		LIMITS	REFS	14	122					
52	NCNN	INTEGER		BA	REFS	24						
51	NCONN	INTEGER		BA	REFS	24						
50	NC4	INTEGER		LIMITS	REFS	14						
7	NETOT	INTEGER		LIMITS	REFS	14						
53	NEW	INTEGER		LIMITS	REFS	14	49	66	140	181		
10	NEWF	INTEGER		LIMITS	REFS	14						
11	NEWT	INTEGER		LIMITS	REFS	14						
0	NF	INTEGER		LIMITS	REFS	14	122					
6	NFF	INTEGER		LIMITS	REFS	14						
30	NFF1	INTEGER		LIMITS	REFS	14						
47	NFF2	INTEGER		LIMITS	REFS	14						
51	NF4	INTEGER		LIMITS	REFS	14						
0	NIN	INTEGER		TAPES	REFS	23						
41	NKN	INTEGER		LIMITS	REFS	14						
54	NMX	INTEGER		LIMITS	REFS	14						
50	NN	INTEGER		BA	REFS	24						
1273	NNN	INTEGER			REFS	139	178	DEFINED	122			
2	NOEL	INTEGER		LIMITS	REFS	14	80					
4	NOELC	INTEGER		LIMITS	REFS	14						
3	NOELF	INTEGER		LIMITS	REFS	14	44	138				
65	NOLD	INTEGER		LIMITS	REFS	14						
1	NOUT	INTEGER		TAPES	REFS	23						
0	NRAD	INTEGER		F.P.	REFS	3*31	32	2*33	48	61	99	100
						232	DEFINED	1				
2	NSCR1	INTEGER		TAPES	REFS	23						
3	NSCR2	INTEGER		TAPES	REFS	23						
0	NSH	INTEGER		F.P.	REFS	133	DEFINED	1				
1	NT	INTEGER		FEP	REFS	26						
23	NTAE	INTEGER		LIMITS	REFS	14						
57	NTOLD	INTEGER	ARRAY	FEP	REFS	26						
0	OLDSE	REAL	ARRAY	F.P.	REFS	33	63	DEFINED	1	234		
13	PDEL	REAL		GEOPAR	REFS	12						
0	PI	REAL		CONTNT	REFS	22						
11	PIN	REAL		GEOPAR	REFS	12						
54	PINOLD	REAL		FEP	REFS	26						
56	POLD	REAL		FEP	REFS	26						
12	POUT	REAL		GEOPAR	REFS	12						
55	POUTLD	REAL		FEP	REFS	26						
0	PSSRT	REAL	ARRAY	F.P.	REFS	33	89	104	DEFINED	1		
0	PSSV	REAL	ARRAY	F.P.	REFS	33	89	DEFINED	1	62		
0	PSTS	REAL	ARRAY	F.P.	REFS	33	54	56	62	72	105	
					DEFINED	1	53					
1305	QA	REAL			REFS	161	200	DEFINED	154	193		
1306	QI	REAL			REFS	156	195	DEFINED	155	194		
72	RAKSUM	REAL		LIMITS	REFS	14	106	107	108	DEFINED	106	
2	RCI	REAL		GEOPAR	REFS	12						
3	RCO	REAL		GEOPAR	REFS	12						
4	RDOLD	REAL	ARRAY	FEP	REFS	26						

VARIABLES	SN	TYPE		RELOCATION								
1264	REST	REAL			REFS	2*57	DEFINED	56				
0	RFI	REAL		GEOPAR	REFS	12						
1	RFO	REAL		GEOPAR	REFS	12						
79	RRAKR	REAL		LIMITS	REFS	14	106	DEFINED	104	105	107	108
30	RRSIN	REAL	ARRAY	FEP	REFS	26						
13	RSTRAN	REAL		MATCNS	REFS	29						
1313	SCR	REAL			REFS	168	208	209	227	DEFINED	165	204
0	SE	REAL	ARRAY	F.P.	REFS	31	54	56	62	63	72	105
					148	154	155	2*165	187	193	194	2*204
					234	DEFINED	1					
64	STEP	REAL		LIMITS	REFS	14						
104	STEPS	REAL		FEP	REFS	26						
1307	TAE	REAL			REFS	164	203	DEFINED	156	195		
1316	TC1	REAL			REFS	208	DEFINED	206				
1327	TC2	REAL			REFS	227	DEFINED	226				
0	TELM	REAL	ARRAY	F.P.	REFS	31	49	66	140	181		
					DEFINED	1						
1301	TEMK	REAL			REFS	149	156	161	188	195	200	
					DEFINED	140	181					
1261	TEMPK	REAL			REFS	3*50	3*51	DEFINED	49			
1265	TF	REAL			REFS	68	DEFINED	66				
1331	TIME	REAL	ARRAY		REFS	31	2*128	2*167	183	DEFINED	126	
61	TIMEC	REAL		LIMITS	REFS	14						
62	TIMEF	REAL		LIMITS	REFS	14						
1266	TK	REAL			REFS	69	DEFINED	68				
1304	TNH	REAL			REFS	2*156	163	2*165	2*195	202	2*204	
					DEFINED	151	152	190	191			
1317	TRC1	REAL			REFS	209	DEFINED	207				
4	TREF	REAL		GEOPAR	REFS	12						
1323	XFACT	REAL			REFS	213	DEFINED	211				
1	XNU	REAL		LASTIC	REFS	21						
7	ZDEL	REAL		GEOPAR	REFS	12						
1315	ZETA	REAL			REFS	206	207	208	215	222		
					DEFINED	183	215					
1326	ZETAN	REAL			REFS	226	227	DEFINED	222			

EXTERNALS	TYPE	ARGS		REFERENCES						
ALOG	REAL	1	LIBRARY	158	187	197				
CELMOD	REAL	4		69						
EXP	REAL	1	LIBRARY	148	164	2*167	187	203	206	207
MOVEKA		3		80						
SINH	REAL	1	LIBRARY	2*165	2*204					
SORTP		4		89						

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
ABS	REAL	1	INTRIN		212

STATEMENT LABELS		DEF LINE	REFERENCES			
135	100	65	59			
166	110	73	47	48	54	64
0	120	102	98	99		
320	130	103	101			
363	140	109	82	83	85	

STATEMENT LABELS		DEF LINE	REFERENCES			
0	150	127	125			
543	160	160	157			
552	170	162	159			
0	180	169	135	139		
642	190	176	133			
665	200	184	216			
752	210	199	196			
761	220	201	198			
1075	230	217	213			
0	240	230	177	178		
1127	250	231	170			
0	260	235	232	233		
1147	270	236	115	116	117	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
24	110	J	47 73	150B		EXT REFS	NOT INNER
26	110	I	48 73	143B		EXT REFS	
300	120	J	98 102	17B		EXITS	NOT INNER
302	120	I	99 102	12B	INSTACK	EXITS	
424	150	I	125 127	6B	INSTACK		
444	180	J	135 169	174B		EXT REFS	NOT INNER
454	180	I	139 169	161B		EXT REFS	
644	240	J	177 230	262B		EXT REFS	NOT INNER
646	240	I	178 230	255B		EXT REFS	
1131	260	I	232 235	15B		NOT INNER	
1133	260	J	233 235	10B	INSTACK		

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
BA	86
FEP	69
MATCNS	12

STATISTICS

PROGRAM LENGTH	1415B	781
SCM LABELED COMMON LENGTH	374B	252

140000B SCM USED

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      SUBROUTINE SOLVET (B,BB,NODET,XKT,CC,THETEO,ELSTSA,TELM,R,ARAA,RBR  SOLVET     2
     +A,NOELD,BBSV,ESTSV,NFF2D,MAXTD,NARFD,ESTNV,NABFD)                   SOLVET     3
      INTEGER BASE,BASS,BASN                                              SOLVET     4
      DIMENSION ELSTSA(4,1), R(1)                                         SOLVET     5
      DIMENSION TELM(NOELD,NABFD,2)                                       SOLVET     6
      DIMENSION XKT(1),NODET(1),B(1),BB(1),CC(4,4,1),                     SOLVET     7
     +THETEO(4,1)                                                         SOLVET     8
      DIMENSION ARAA(1), RBRA(1)                                          SOLVET     9
      DIMENSION BBSV(NFF2D,NARFD),ESTSV(4,NOELD,NARFD),ESTNV(4,NOELD,     SOLVET    10
     + NARFD)                                                             SOLVET    11
C                                                                         SOLVET    12
C   SOLVET IS CALLED FROM PELET                                           SOLVET    13
C                                                                         SOLVET    14
      COMMON /PNTPNL/IFIRST,IAELM,IAK,IARAA,IARE,ISB,IBA,IBASAV,IBASE,    PELPT      2
     + ISBB,IBBA,IBBSV,ICA,ICC,ICRATE,ICRPG,IDISP,IDISPC,IDISPSV,         PELPT      3
     + IEFSTR,IELM,IELSTN,ILSTNA,ILSTRA,IELSTR,IPSLA,IEPSLM,IESTNV,       PELPT      4
     + IESTSV,JIIJ,IIPOS,IKSAVE,INADET,INDC,INDF,INDT,INODET,IOLDSE,      PELPT      5
     + IPSSRT,IPSSV,IPSTS,IR,IRA,IRBR,IRBRA,IRD,ISTRES,ISTRSA,ITCB,       PELPT      6
     + ITCRP,ITEC,ITEF,ITELM,ITFB,ITHET,ITHTAX,ITHSAV,ITHXSV,ITME,        PELPT      7
     + ITSTNR,ITSTSR,ITV,ITW,IXKT,IXLOAD,IXLODA,IXRD,                     PELPT      8
     +IY,IYACF,IZ,ILAST                                                   PELPT      9
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P  PELCOM     2
     +DEL,COMP                                                            PELCOM     3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE  PELCOM     4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,  PELCOM     5
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISSTOP,IPLAS,NKN  PELCOM     6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N  PELCOM     7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                   PELCOM     8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                           PELCOM     9
     +,IRZ                                                                PELCOM    10
      COMMON /LASTIC/ E,XNU,ALPHA                                         PELCOM    11
      COMMON /CONTNT/ PI                                                  PELCOM    12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                       PELCOM    13
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,        COMC       2
     +   ERAD(20), EAX(20)                                                COMC       3
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)                   COMC       4
     +,PINOLD,POUTLD,POLD,NTOLD(20)                                       COMC       5
     + ,ICHNG,STEPS                                                       COMC       6
C                                                                         SOLVET    18
      COMMON / FAST / D(1)                                                SOLVET    19
C                                                                         SOLVET    20
C                                                                         SOLVET    21
C   ESTSV  - SAVED VALUES INCREMENTAL STRESS                              SOLVET    22
C   ESTNV  - SAVED VALUES INCREMENTAL STRAIN                              SOLVET    23
C   KKA    - RADIAL-AXIAL LOOP IDENTIFIER FROM PELET                      SOLVET    24
      CALL MOVEKA (0,B,NFF2)                                              SOLVET    25
      CALL MOVEKA (0,BB,NFF2)                                             SOLVET    26
      CALL MOVEKA (0,D(IELSTR),NOEL*4)                                    SOLVET    27
      CALL MOVEKA (0,D(IELSTN),NOEL*4)                                    SOLVET    28
      IF (KKA.EQ.2) GO TO 100                                             SOLVET    29
      CALL MOVEKA (0,ELSTSA,4*NTAE)                                       SOLVET    30
100   CONTINUE                                                            SOLVET    31
      MIN = NF+NC+1                                                       SOLVET    32
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                MAX = 2*NF+NC-1                                                  SOLVET     33
                MM = 4*KA                                                        SOLVET     34
C     SUBTRACT OFF THE LAST ELASTIC STRESS-STRAIN INCREMENTS TO                  SOLVET     35
C     PREPARE FOR PLASTIC CALCULATION.                                           SOLVET     36
                IF (KPLAS.NE.1) GO TO 120                                        SOLVET     37
                    DO 110 J=1,NOEL                                              SOLVET     38
                    BASN = ITSTNR-1+(KA-1)*NOEL*4+4*(J-1)                        SOLVET     39
                    BASS = ITSTSR-1+(KA-1)*NOEL*4+4*(J-1)                        SOLVET     40
                        DO 110 K=1,4                                             SOLVET     41
                        D(BASS+K) = D(BASS+K)-ESTSV(K,J,KA)                      SOLVET     42
                        D(BASN+K) = D(BASN+K)-ESTNV(K,J,KA)                      SOLVET     43
110                     CONTINUE                                                 SOLVET     44
120             CONTINUE                                                         SOLVET     45
                IF (IRAK.EQ.0) GO TO 150                                         SOLVET     46
C     PSEUDO-ELASTIC LOAD STEP.                                                  SOLVET     47
                    DO 130 J=1,NMX                                               SOLVET     48
                    B(J) = BBSV(J,KA)*(1.-RRAKR)                                 SOLVET     49
130                 CONTINUE                                                     SOLVET     50
                    DO 140 KK=1,NOEL                                             SOLVET     51
                    IBASTH = NOEL*4*(KA-1)+4*(KK-1)+ITHSAV-1                     SOLVET     52
                        DO 140 JJ=1,4                                            SOLVET     53
                        THETEO(JJ,KK) = D(IBASTH+JJ)*(1.-RRAKR)                  SOLVET     54
140                     CONTINUE                                                 SOLVET     55
                GO TO 220                                                        SOLVET     56
150             CONTINUE                                                         SOLVET     57
C     IMPOSE AXIAL STRESSES (SKIP FOR KKA=1)                                     SOLVET     58
                IF (KKA.EQ.1) GO TO 210                                          SOLVET     59
                IF (KA.EQ.NARC) GO TO 180                                        SOLVET     60
C     AVERAGE THE AXIAL STRESS IN THE FUEL                                       SOLVET     61
                AVGSTS = 0.0                                                     SOLVET     62
                ITST = 4*NARC                                                    SOLVET     63
                IF (MM.EQ.ITST) GO TO 180                                        SOLVET     64
                TA = ARAA(MM)*RBRA(MM)+ARAA(MM-1)*RBRA(MM-1)+ARAA(MM-2)*RBRA(MM-2) SOLVET     65
               ++ARAA(MM-3)*RBRA(MM-3)                                           SOLVET     66
                    DO 160 II=1,4                                                SOLVET     67
                    MK = MM-(II-1)                                               SOLVET     68
                    WI = ARAA(MK)*RBRA(MK)/TA                                    SOLVET     69
                    AVGSTS = AVGSTS+WI*ELSTSA(3,MK)                              SOLVET     70
160                 CONTINUE                                                     SOLVET     71
C     IMPOSE AXIAL STRESSES ON THE FUEL                                          SOLVET     72
                    DO 170 I=MIN,MAX                                             SOLVET     73
                    AREA = R(I+1)**2-R(I)**2                                     SOLVET     74
                    XLINE = 2.0*(R(I)+R(I+1))                                    SOLVET     75
                    ZINT = AVGSTS*AREA/XLINE                                     SOLVET     76
                    ZFS = ZINT*PI*2.0*R(I)                                       SOLVET     77
                    ZFE = ZINT*R(I+1)*2.0*PI                                     SOLVET     78
                    IN = NODET(I)+1                                              SOLVET     79
                    INN = NODET(I+1)+1                                           SOLVET     80
                    BB(IN) = BB(IN)+ZFS                                          SOLVET     81
                    B(IN) = BB(IN)                                               SOLVET     82
                    BB(INN) = BB(INN)+ZFE                                        SOLVET     83
                    B(INN) = BB(INN)                                             SOLVET     84
170                 CONTINUE                                                     SOLVET     85
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      180   CONTINUE                                                                  SOLVET    86
      C   AVERAGE THE AXIAL STRESS FOR THE CLAD AND IMPOSE IT                         SOLVET    87
            MM = MM+NAEF                                                              SOLVET    88
      110   AVGSTS = 0.0                                                              SOLVET    89
            TA = ARAA(MM)*RBRA(MM)+ARAA(MM-1)*RBRA(MM-1)+ARAA(MM-2)*RBRA(MM-2)        SOLVET    90
           ++ARAA(MM-3)*RBRA(MM-3)                                                    SOLVET    91
                DO 190 II=1,4                                                         SOLVET    92
                MK = MM-(II-1)                                                        SOLVET    93
      115       WI = ARAA(MK)*RBRA(MK)/TA                                           SOLVET    94
                AVGSTS = AVGSTS+WI*ELSTSA(3,MK)                                       SOLVET    95
      190       CONTINUE                                                            SOLVET    96
            MAX = 2*NF+NC+1                                                           SOLVET    97
            MAXX = NFF-1                                                              SOLVET    98
      120       DO 200 I=MAX,MAXX                                                   SOLVET    99
                AREA = R(I+1)**2-R(I)**2                                            SOLVET   100
                XLINE = 2.0*(R(I)+R(I+1))                                           SOLVET   101
                ZINT = AVGSTS*AREA/XLINE                                            SOLVET   102
                ZFS = ZINT*PI*2.0*R(I)                                              SOLVET   103
      125       ZFE = ZINT*R(I+1)*2.0*PI                                            SOLVET   104
                IN = NODET(I)+1                                                     SOLVET   105
                INN = NODET(I+1)+1                                                  SOLVET   106
                BB(IN) = BB(IN)+ZFS                                                 SOLVET   107
                B(IN) = BB(IN)                                                      SOLVET   108
      130       BB(INN) = BB(INN)+ZFE                                               SOLVET   109
                B(INN) = BB(INN)                                                    SOLVET   110
      200       CONTINUE                                                            SOLVET   111
      210   CONTINUE                                                                SOLVET   112
      C                                                                             SOLVET   113
      135 C   PREPARE INPUT ARRAY FOR SOLUTION                                      SOLVET   114
      C                                                                             SOLVET   115
      C   CREATE LOAD VECTOR                                                        SOLVET   116
      C                                                                             SOLVET   117
            CALL LOAD (D(IARE),B,BB,NODET,D(IR),D(IRBR),D(ITHET),TELM,D(IXLOAD      SOLVET   118
      140  +),D(IELM),NOEL,D(ITCRP),NABF,D(ITHSAV))                                 SOLVET   119
      220   CONTINUE                                                                SOLVET   120
            IF (ISSTOP.NE.1) GO TO 240                                              SOLVET   121
            IF (NKN.NE.1) GO TO 240                                                 SOLVET   122
            IF (KKA.NE.2) GO TO 240                                                 SOLVET   123
      145       DO 230 J=1,NFF2                                                     SOLVET   124
                BBSV(J,KA) = BB(J)                                                  SOLVET   125
      230       CONTINUE                                                            SOLVET   126
      240   CONTINUE                                                                SOLVET   127
            IDF = 1                                                                 SOLVET   128
      150 C                                                                         SOLVET   129
            IOP = 1                                                                 SOLVET   130
            CALL DMCHB (B,XKT,NMX,1,7,IOP,1.E-14)                                   SOLVET   131
      C                                                                             SOLVET   132
            CALL STRES (B,D(IELM),D(IELSTN),D(IELSTR),D(IEPSLM),NODET,CC,THETE      SOLVET   133
      155  +O,D(ISTRES),D(ITSTNR),D(ITSTSR),D(ILSTRA),D(ILSTNA),NOEL,D(IDISPC)      SOLVET   134
           +,NFF1,D(IARAA),D(IRBRA))                                                SOLVET   135
      C                                                                             SOLVET   136
            IF (NKN.NE.1.OR.ISSTOP.NE.1.OR.KKA.NE.2) GO TO 260                      SOLVET   137
                DO 250 J=1,NOEL                                                     SOLVET   138
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                      BASE = IELSTR-1+4*(J-1)                                    SOLVET   139
                      BASN = IELSTN-1+4*(J-1)                                    SOLVET   140
                          DO 250 K=1,4                                           SOLVET   141
                          ESTSV(K,J,KA) = D(BASE+K)                              SOLVET   142
                          ESTNV(K,J,KA) = D(BASN+K)                              SOLVET   143
  250                     CONTINUE                                               SOLVET   144
  260 CONTINUE                                                                   SOLVET   145
      C                                                                          SOLVET   146
      C                                                                          SOLVET   147
      C                                                                          SOLVET   148
      C                                                                          SOLVET   149
                      RETURN                                                     SOLVET   150
      C                                                                          SOLVET   151
                      END                                                        SOLVET   152
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	SOLVET	1	171

VARIABLES

	SN	TYPE		RELOCATION									
2	ALPHA	REAL		LASTIC	REFS	31							
0	ARAA	REAL	ARRAY	F.P.	REFS	8	4*86	90	4*111	115			
					DEFINED	1							
745	AREA	REAL			REFS	97	123	DEFINED	95	121			
736	AVGSTS	REAL			REFS	91	97	116	123	DEFINED	83	91	
						110	116						
0	B	REAL	ARRAY	F.P.	REFS	6	46	139	152	154			
					DEFINED	1	70	103	105	129	131		
723	BASE	INTEGER			REFS	3	163	DEFINED	160				
725	BASN	INTEGER			REFS	3	2*64	164	DEFINED	60	161		
724	BASS	INTEGER			REFS	3	2*63	DEFINED	61				
0	BB	REAL	ARRAY	F.P.	REFS	6	47	102	103	104	105	128	
						129	130	131	139	146	DEFINED	1	102
						104	128	130					
0	BBSV	REAL	ARRAY	F.P.	REFS	9	70	DEFINED	1	146			
0	CC	REAL	ARRAY	F.P.	REFS	6	154	DEFINED	1				
14	COMP	REAL		GEOPAR	REFS	22							
33	CP	REAL		LIMITS	REFS	24							
34	CR	REAL		LIMITS	REFS	24							
0	D	REAL	ARRAY	FAST	REFS	40	48	49	63	64	75	8*139	
						12*154	163	164	DEFINED	63	64		
5	DELR	REAL		GEOPAR	REFS	22							
6	DELZ	REAL		GEOPAR	REFS	22							
0	DELZA	REAL	ARRAY	BA	REFS	34							
0	E	REAL		LASTIC	REFS	31							
102	EAX	REAL	ARRAY	BA	REFS	34							
0	ELSTSA	REAL	ARRAY	F.P.	REFS	4	51	91	116	DEFINED	1		
56	ERAD	REAL	ARRAY	BA	REFS	34							

VARIABLES	SN	TYPE	RELOCATION									
0	ESTNV	REAL	ARRAY	F.P.	REFS	9	64	DEFINED	1	164		
0	ESTSV	REAL	ARRAY	F.P.	REFS	9	63	DEFINED	1	163		
55	FLXR	REAL		BA	REFS	34						
35	FRDEN	REAL		LIMITS	REFS	24						
0	HHF	REAL		FEP	REFS	36						
744	I	INTEGER			REFS	2*95	2*96	98	99	100	101	2*121
					2*122	124	125	126	127	DEFINED	94	120
57	IADJ	INTEGER		LIMITS	REFS	24						
1	IAELM	INTEGER		PNTPNL	REFS	14						
2	IAK	INTEGER		PNTPNL	REFS	14						
3	IARAA	INTEGER		PNTPNL	REFS	14	154					
4	IARE	INTEGER		PNTPNL	REFS	14	139					
6	IBA	INTEGER		PNTPNL	REFS	14						
7	IBASAV	INTEGER		PNTPNL	REFS	14						
10	IBASE	INTEGER		PNTPNL	REFS	14						
734	IBASTH	INTEGER			REFS	75	DEFINED	73				
12	IBBA	INTEGER		PNTPNL	REFS	14						
13	IBBSV	INTEGER		PNTPNL	REFS	14						
14	ICA	INTEGER		PNTPNL	REFS	14						
15	ICC	INTEGER		PNTPNL	REFS	14						
103	ICHNG	INTEGER		FEP	REFS	36						
67	ICNT	INTEGER		LIMITS	REFS	24						
16	ICRATE	INTEGER		PNTPNL	REFS	14						
17	ICRPG	INTEGER		PNTPNL	REFS	14						
42	ICRPP	INTEGER		LIMITS	REFS	24						
60	ICUT	INTEGER		LIMITS	REFS	24						
5	IDF	INTEGER		LIMITS	REFS	24	DEFINED	149				
20	IDISP	INTEGER		PNTPNL	REFS	14						
21	IDISPC	INTEGER		PNTPNL	REFS	14	154					
22	IDSPSV	INTEGER		PNTPNL	REFS	14						
23	IEFSTR	INTEGER		PNTPNL	REFS	14						
24	IELM	INTEGER		PNTPNL	REFS	14	139	154				
25	IELSTN	INTEGER		PNTPNL	REFS	14	49	154	161			
30	IELSTR	INTEGER		PNTPNL	REFS	14	48	154	160			
32	IEPSLM	INTEGER		PNTPNL	REFS	14	154					
33	IESTNV	INTEGER		PNTPNL	REFS	14						
34	IESTSV	INTEGER		PNTPNL	REFS	14						
0	IFIRST	INTEGER		PNTPNL	REFS	14						
741	II	INTEGER			REFS	89	114	DEFINED	88	113		
36	IIPOS	INTEGER		PNTPNL	REFS	14						
37	IKSAVE	INTEGER		PNTPNL	REFS	14						
106	ILAST	INTEGER		PNTPNL	REFS	14						
26	ILSTNA	INTEGER		PNTPNL	REFS	14	154					
27	ILSTRA	INTEGER		PNTPNL	REFS	14	154					
752	IN	INTEGER			REFS	2*102	2*103	2*128	2*129	DEFINED	100	126
40	INADET	INTEGER		PNTPNL	REFS	14						
41	INDC	INTEGER		PNTPNL	REFS	14						
42	INDF	INTEGER		PNTPNL	REFS	14						
43	INDT	INTEGER		PNTPNL	REFS	14						
753	INN	INTEGER			REFS	2*104	2*105	2*130	2*131	DEFINED	101	127
44	INODET	INTEGER		PNTPNL	REFS	14						
45	IOLDSE	INTEGER		PNTPNL	REFS	14						
755	IOP	INTEGER			REFS	152	DEFINED	151				

VARIABLES	SN	TYPE	RELOCATION							
40	IPLAS	INTEGER	LIMITS	REFS	24					
73	IPLEND	INTEGER	LIMITS	REFS	24					
31	IPSLA	INTEGER	PNTPNL	REFS	14					
46	IPSSRT	INTEGER	PNTPNL	REFS	14					
47	IPSSV	INTEGER	PNTPNL	REFS	14					
50	IPSTS	INTEGER	PNTPNL	REFS	14					
51	IR	INTEGER	PNTPNL	REFS	14	139				
52	IRA	INTEGER	PNTPNL	REFS	14					
71	IRAK	INTEGER	LIMITS	REFS	24	67				
53	IRBR	INTEGER	PNTPNL	REFS	14	139				
54	IRBRA	INTEGER	PNTPNL	REFS	14	154				
55	IRD	INTEGER	PNTPNL	REFS	14					
75	IRZ	INTEGER	LIMITS	REFS	24					
5	ISB	INTEGER	PNTPNL	REFS	14					
11	ISBB	INTEGER	PNTPNL	REFS	14					
74	ISP	INTEGER	LIMITS	REFS	24					
37	ISSTOP	INTEGER	LIMITS	REFS	24	142	158			
3	ISTOP	INTEGER	FEP	REFS	36					
56	ISTRES	INTEGER	PNTPNL	REFS	14	154				
57	ISTRSA	INTEGER	PNTPNL	REFS	14					
53	ISTRT	INTEGER	BA	REFS	34					
60	ITCB	INTEGER	PNTPNL	REFS	14					
61	ITCRP	INTEGER	PNTPNL	REFS	14	139				
62	ITEC	INTEGER	PNTPNL	REFS	14					
63	ITEF	INTEGER	PNTPNL	REFS	14					
64	ITELM	INTEGER	PNTPNL	REFS	14					
54	ITER	INTEGER	BA	REFS	34					
65	ITFB	INTEGER	PNTPNL	REFS	14					
66	ITHET	INTEGER	PNTPNL	REFS	14	139				
70	ITHSAV	INTEGER	PNTPNL	REFS	14	73	139			
67	ITHTAX	INTEGER	PNTPNL	REFS	14					
71	ITHXSV	INTEGER	PNTPNL	REFS	14					
63	ITI	INTEGER	LIMITS	REFS	24					
72	ITME	INTEGER	PNTPNL	REFS	14					
4	ITP1	INTEGER	TAPES	REFS	33					
5	ITP2	INTEGER	TAPES	REFS	33					
737	ITST	INTEGER		REFS	85	DEFINED	84			
73	ITSTNR	INTEGER	PNTPNL	REFS	14	60	154			
74	ITSTSR	INTEGER	PNTPNL	REFS	14	61	154			
75	ITV	INTEGER	PNTPNL	REFS	14					
76	ITW	INTEGER	PNTPNL	REFS	14					
77	IXKT	INTEGER	PNTPNL	REFS	14					
100	IXLOAD	INTEGER	PNTPNL	REFS	14	139				
101	IXLODA	INTEGER	PNTPNL	REFS	14					
102	IXRD	INTEGER	PNTPNL	REFS	14					
103	IY	INTEGER	PNTPNL	REFS	14					
104	IYACF	INTEGER	PNTPNL	REFS	14					
105	IZ	INTEGER	PNTPNL	REFS	14					
731	J	INTEGER		REFS	60	61	63	64	2*70	2*146	160
					161	163	164	DEFINED	59	69	145	159
24	JAM	INTEGER	LIMITS	REFS	24					
35	JIIJ	INTEGER	PNTPNL	REFS	14					
735	JJ	INTEGER		REFS	2*75	DEFINED	74			

VARIABLES	SN	TYPE		RELOCATION								
732	K	INTEGER			REFS	3*63	3*64	2*163	2*164	DEFINED	62	162
12	KA	INTEGER		LIMITS	REFS	24	55	60	61	63	64	70
					73	81	146	163	164			
733	KK	INTEGER			REFS	73	75	DEFINED	72			
10	KKA	INTEGER		GEOPAR	REFS	22	50	80	144	158		
2	KKZZZ	INTEGER		FEP	REFS	36						
66	KPLAS	INTEGER		LIMITS	REFS	24	58					
55	KRNCH	INTEGER		LIMITS	REFS	24						
45	KRNCHC	INTEGER		LIMITS	REFS	24						
44	KRNCHF	INTEGER		LIMITS	REFS	24						
46	KRNCHT	INTEGER		LIMITS	REFS	24						
36	KZI	INTEGER		LIMITS	REFS	24						
727	MAX	INTEGER			REFS	94	120	DEFINED	54	118		
52	MAXA	INTEGER		LIMITS	REFS	24						
43	MAXT	INTEGER		LIMITS	REFS	24						
0	MAXTD	INTEGER	*UNUSED	F.P.	DEFINED	1						
754	MAXX	INTEGER			REFS	120	DEFINED	119				
56	MCUD	INTEGER		LIMITS	REFS	24						
726	MIN	INTEGER			REFS	94	DEFINED	53				
742	MK	INTEGER			REFS	2*90	91	2*115	116	DEFINED	89	114
730	MM	INTEGER			REFS	85	8*86	89	109	8*111	114	
					DEFINED	55	109					
17	NABC	INTEGER		LIMITS	REFS	24						
16	NABF	INTEGER		LIMITS	REFS	24	139					
0	NABFD	INTEGER		F.P.	REFS	5	DEFINED	1				
31	NABF2	INTEGER		LIMITS	REFS	24						
20	NABT	INTEGER		LIMITS	REFS	24						
32	NABT2	INTEGER		LIMITS	REFS	24						
21	NAEC	INTEGER		LIMITS	REFS	24						
22	NAEF	INTEGER		LIMITS	REFS	24	109					
14	NARC	INTEGER		LIMITS	REFS	24	81	84				
13	NARF	INTEGER		LIMITS	REFS	24						
0	NARFD	INTEGER		F.P.	REFS	3*9	DEFINED	1				
15	NART	INTEGER		LIMITS	REFS	24						
25	NAXBT	INTEGER		LIMITS	REFS	24						
26	NAXB2	INTEGER		LIMITS	REFS	24						
27	NAXB4	INTEGER		LIMITS	REFS	24						
1	NC	INTEGER		LIMITS	REFS	24	53	54	118			
52	NCNN	INTEGER		BA	REFS	34						
51	NCONN	INTEGER		BA	REFS	34						
50	NC4	INTEGER		LIMITS	REFS	24						
7	NETOT	INTEGER		LIMITS	REFS	24						
53	NEW	INTEGER		LIMITS	REFS	24						
10	NEWF	INTEGER		LIMITS	REFS	24						
11	NEWT	INTEGER		LIMITS	REFS	24						
0	NF	INTEGER		LIMITS	REFS	24	53	54	118			
6	NFF	INTEGER		LIMITS	REFS	24	119					
30	NFF1	INTEGER		LIMITS	REFS	24	154					
47	NFF2	INTEGER		LIMITS	REFS	24	46	47	145			
0	NFF2D	INTEGER		F.P.	REFS	9	DEFINED	1				
51	NF4	INTEGER		LIMITS	REFS	24						
0	NIN	INTEGER		TAPES	REFS	33						
41	NKN	INTEGER		LIMITS	REFS	24	143	158				

VARIABLES	SN	TYPE		DELOCATION									
54	NMX	INTEGER		LIMITS	REFS	24	69	152					
50	NN	INTEGER		BA	REFS	34							
0	NODET	INTEGER	ARRAY	F.P.	REFS	6	100	101	126	127	139	154	
					DEFINED	1							
2	NOEL	INTEGER		LIMITS	REFS	24	48	49	59	60	61	72	
					73	139	154	159					
4	NOELC	INTEGER		LIMITS	REFS	24							
0	NOELD	INTEGER		F.P.	REFS	5	2*9	DEFINED	1				
3	NOELF	INTEGER		LIMITS	REFS	24							
65	NOLD	INTEGER		LIMITS	REFS	24							
1	NOUT	INTEGER		TAPES	REFS	33							
2	NSCR1	INTEGER		TAPES	REFS	33							
3	NSCR2	INTEGER		TAPES	REFS	33							
1	NT	INTEGER		FEP	REFS	36							
23	NTAE	INTEGER		LIMITS	REFS	24	51						
57	NTOLD	INTEGER	ARRAY	FEP	REFS	36							
13	PDEL	REAL		GEOPAR	REFS	22							
0	PI	REAL		CONTNT	REFS	32	98	99	124	125			
11	PIN	REAL		GEOPAR	REFS	22							
54	PINOLD	REAL		FEP	REFS	36							
56	POLD	REAL		FEP	REFS	36							
12	POUT	REAL		GEOPAR	REFS	22							
55	POUTLD	REAL		FEP	REFS	36							
0	R	REAL	ARRAY	F.P.	REFS	4	2*95	2*96	98	99	2*121	2*122	
					124	125	DEFINED	1					
72	RAKSUM	REAL		LIMITS	REFS	24							
0	RARA	REAL	ARRAY	F.P.	REFS	8	4*86	90	4*111	115			
					DEFINED	1							
2	RCI	REAL		GEOPAR	REFS	22							
3	RCO	REAL		GEOPAR	REFS	22							
4	RDOLD	REAL	ARRAY	FEP	REFS	36							
0	RFI	REAL		GEOPAR	REFS	22							
1	RFO	REAL		GEOPAR	REFS	22							
70	RRAKR	REAL		LIMITS	REFS	24	70	75					
30	RRSIN	REAL	ARRAY	FEP	REFS	36							
64	STEP	REAL		LIMITS	REFS	24							
104	STEPS	REAL		FEP	REFS	36							
740	TA	REAL			REFS	90	115	DEFINED	86	111			
0	TELM	REAL	ARRAY	F.P.	REFS	5	139	DEFINED	1				
0	THETEO	REAL	ARRAY	F.P.	REFS	6	154	DEFINED	1	75			
61	TIMEC	REAL		LIMITS	REFS	24							
62	TIMEF	REAL		LIMITS	REFS	24							
4	TREF	REAL		GEOPAR	REFS	22							
743	WI	REAL			REFS	91	116	DEFINED	90	115			
0	XKT	REAL	ARRAY	F.P.	REFS	6	152	DEFINED	1				
746	XLINE	REAL			REFS	97	123	DEFINED	96	122			
1	XNU	REAL		LASTIC	REFS	31							
7	ZDEL	REAL		GEOPAR	REFS	22							
751	ZFE	REAL			REFS	104	130	DEFINED	99	125			
750	ZFS	REAL			REFS	102	128	DEFINED	98	124			
747	ZINT	REAL			REFS	98	99	124	125	DEFINED	97	123	

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EXTERNALS          TYPE   ARGS      REFERENCES
       DMCHB                7          152
       LOAD                14          139
       MOVEKA               3           46        47        48        49        51
       STRES               18          154

STATEMENT LABELS              DEF LINE   REFERENCES
   46  100                        52          50
    0  110                        65          59        62
  127  120                        66          58
    0  130                        71          69
    0  140                        76          72        74
  174  150                        78          67
    0  160                        92          86
    0  170                       106          94
  316  180                       107          81        85
    0  190                       117         113
    0  200                       132         120
  436  210                       133          80
  463  220                       141          77
    0  230                       147         145
  506  240                       148         142       143       144
    0  250                       165         159       162
  617  260                       166         158

LOOPS  LABEL    INDEX     FROM-TO     LENGTH    PROPERTIES
   64  110      J           59 65        42B          NOT INNER
  102  110      K           62 65        21B          OPT
  133  130      J           69 71        11B          INSTACK
  146  140      KK          72 76        24B          NOT INNER
  156  140      JJ          74 76        11B          INSTACK
  225  160      II          88 92        16B          OPT
  245  170      I           94 106       50B          OPT
  336  190      II         113 117       16B          OPT
  365  200      I          120 132       50B          OPT
  476  230      J          145 147        7B          INSTACK
  562  250      J          159 165       34B          NOT INNER
  574  250      K          162 165       17B          OPT

COMMON BLOCKS    LENGTH
       ENTPNL        71
       GEOPAR        13
       LIMITS        62
       LASTIC         3
       CONTNT         1
       TAPES          6
       BA            86
       FEP           69
       FAST           1

STATISTICS
  PROGRAM LENGTH                1026B      534
  SCM LABELED COMMON LENGTH      470B      312
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STATISTICS
140000B SCM USED

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      SUBROUTINE SORTP (X,N,Y,IPOS)                                     SORTP      2
C                                                                       SORTP      3
C     SORTP IS CALLED FROM RATE                                         SORTP      4
C                                                                       SORTP      5
C     THIS ROUTINE SORTS THE ELEMENTS OF THE INPUT VECTOR X AND PUTS THE SORTP      6
C     ELEMENTS INTO THE VECTOR Y.  IT ALSO CARRIES ALONG THE INDEX NUMBE SORTP      7
C     OF EACH ORDERED OBSERVATION--THAT IS, IT CARRIES ALONG THE POSITIO SORTP      8
C     THE I-TH ORDERED OBSERVATION (FOR EACH I) AS IT WAS IN THE ORIGINA SORTP      9
C     UNORDERED DATA VECTOR X.  THESE POSITIONS ARE PLACED IN THE VECTOR SORTP     10
C     THIS ROUTINE IS USEFUL IN ATTEMPTING TO LOCATE THE MINIMUM, THE MA SORTP     11
C     OR SOME OTHER ORDERED OBSERVATION OF INTEREST IN THE ORIGINAL UNOR SORTP     12
C     INPUT VECTOR X.                                                   SORTP     13
C     THE INPUT TO THIS ROUTINE IS THE SINGLE PRECISION VECTOR X OF     SORTP     14
C     (UNSORTED) OBSERVATIONS, THE INTEGER VALUE N (= SAMPLE SIZE),     SORTP     15
C     AN EMPTY SINGLE PRECISION VECTOR Y INTO WHICH THE SORTED OBSERVATI SORTP     16
C     WILL BE PLACED, AND AN EMPTY SINGLE PRECISION VECTOR XPOS INTO WHI SORTP     17
C     POSITIONS OF THE SORTED OBSERVATIONS WILL BE PLACED.              SORTP     18
C     THE OUTPUT FROM THIS ROUTINE IS THE SINGLE PRECISION VECTOR Y INTO SORTP     19
C     THE SORTED OBSERVATIONS HAVE BEEN PLACED, AND THE SINGLE PRECISION SORTP     20
C     XPOS INTO WHICH THE POSITIONS OF THE SORTED OBSERVATIONS HAVE BEEN SORTP     21
C     RESTRICTIONS ON THE MAXIMUM ALLOWABLE VALUE OF N--THE DIMENSIONS  SORTP     22
C     OF VECTORS IU AND IL (DEFINED AND USED INTERNALLY WITHIN THIS ROUT SORTP     23
C     DETERMINE THE MAXIMUM ALLOWABLE VALUE OF N FOR THIS               SORTP     24
C     ROUTINE.  IF IU AND IL EACH HAVE DIMENSION K, THEN N MAY NOT EXCEE SORTP     25
C     2**(K+1) - 1.  FOR THIS ROUTINE AS WRITTEN, THE DIMENSIONS OF IU A SORTP     26
C     HAVE BEEN SET TO 36, THUS THE MAXIMUM ALLOWABLE VALUE OF N IS     SORTP     27
C     APPROXIMATELY 137 BILLION.  SINCE THIS EXCEEDS THE MAXIMUM ALLOWAB SORTP     28
C     VALUE FOR AN INTEGER VARIABLE IN MANY COMPUTERS, AND SINCE A SORT  SORTP     29
C     BILLION ELEMENTS IS PRESENTLY IMPRACTICAL AND UNLIKELY, THEREFORE  SORTP     30
C     TEST FOR WHETHER THE INPUT SAMPLE SIZE N EXCEEDS 137 BILLION HAS B SORTP     31
C     INCORPORATED INTO THIS ROUTINE.  IT IS THUS ASSUMED THAT THERE IS  SORTP     32
C     (PRACTICAL) RESTRICTION ON THE MAXIMUM VALUE OF N FOR THIS ROUTINE SORTP     33
C     PRINTING--NONE UNLESS AN ERROR CONDITION EXISTS                   SORTP     34
C     THIS ROUTINE IS SINGLE PRECISION IN INTERNAL OPERATION.           SORTP     35
C     SUBROUTINES NEEDED--NONE                                          SORTP     36
C     SORTING METHOD--BINARY SORT                                       SORTP     37
C     REFERENCE--CACM MARCH 1969, PAGE 186 (BINARY SORT ALGORITHM BY RIC SORTP     38
C     C. SINGLETON.                                                     SORTP     39
C     --CACM JANUARY 1970, PAGE 54.                                     SORTP     40
C     --CACM OCTOBER 1970, PAGE 624.                                    SORTP     41
C     --JACM JANUARY 1961, PAGE 41.                                     SORTP     42
C     WRITTEN BY JAMES J. FILLIBEN, STATISTICAL ENGINEERING LABORATORY ( SORTP     43
C     NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C. 20234       JUNE 19 SORTP     44
        DIMENSION X(1),Y(1),IPOS(1)                                     SORTP     45
        COMMON /IODEV/ IPR,IRD                                          SORTP     46
        DIMENSION IU(36),IL(36)                                         SORTP     47
C     CHECK THE INPUT ARGUMENTS FOR ERRORS                              SORTP     48
        IPR = 6                                                         SORTP     49
        IF (N.LT.1) GO TO 120                                           SORTP     50
        IF (N.EQ.1) GO TO 130                                           SORTP     51
        HOLD = X(1)                                                     SORTP     52
            DO 100 I=2,N                                                SORTP     53
            IF (X(I).NE.HOLD) GO TO 140                                 SORTP     54
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```
      100       CONTINUE                                                  SORTP      55
55          WRITE (IPR,300) HOLD                                        SORTP      56
            DO 110 I=1,N                                                SORTP      57
            Y(I) = X(I)                                                 SORTP      58
            IPOS(I) = I                                                 SORTP      59
      110       CONTINUE                                                  SORTP      60
60          RETURN                                                      SORTP      61
      120   WRITE (IPR,310)                                             SORTP      62
            WRITE (IPR,330) N                                           SORTP      63
            RETURN                                                      SORTP      64
      130   WRITE (IPR,320)                                             SORTP      65
65          Y(1) = X(1)                                                 SORTP      66
            IPOS(1) = 1.0                                               SORTP      67
            RETURN                                                      SORTP      68
      140   CONTINUE                                                    SORTP      69
            C                                                           SORTP      70
70          C   COPY THE VECTOR X INTO THE VECTOR Y                     SORTP      71
            DO 150 I=1,N                                                SORTP      72
            Y(I) = X(I)                                                 SORTP      73
      150       CONTINUE                                                  SORTP      74
            C                                                           SORTP      75
75          C   DEFINE THE IPOS (POSITION) VECTOR.  BEFORE SORTING, THIS WILL  SORTP  76
            C   BE A VECTOR WHOSE I-TH ELEMENT IS EQUAL TO I.           SORTP      77
            C                                                           SORTP      78
            DO 160 I=1,N                                                SORTP      79
            IPOS(I) = I                                                 SORTP      80
80          160       CONTINUE                                          SORTP      81
            C                                                           SORTP      82
            C   CHECK TO SEE IF THE INPUT VECTOR IS ALREADY SORTED       SORTP      83
            C                                                           SORTP      84
            NM1 = N-1                                                   SORTP      85
85          DO 170 I=1,NM1                                              SORTP      86
            IP1 = I+1                                                   SORTP      87
            IF (Y(I).LE.Y(IP1)) GO TO 170                               SORTP      88
            GO TO 180                                                   SORTP      89
      170       CONTINUE                                                  SORTP      90
90          RETURN                                                      SORTP      91
      180   M = 1                                                       SORTP      92
            I = 1                                                       SORTP      93
            J = N                                                       SORTP      94
      190   IF (I.GE.J) GO TO 260                                       SORTP      95
95    200   K = I                                                       SORTP      96
            MID = (I+J)/2                                               SORTP      97
            AMED = Y(MID)                                               SORTP      98
            IMED = IPOS(MID)                                            SORTP      99
            IF (Y(I).LE.AMED) GO TO 210                                 SORTP     100
100         Y(MID) = Y(I)                                               SORTP     101
            IPOS(MID) = IPOS(I)                                         SORTP     102
            Y(I) = AMED                                                 SORTP     103
            IPOS(I) = IMED                                              SORTP     104
            AMED = Y(MID)                                               SORTP     105
105         IMED = IPOS(MID)                                            SORTP     106
      210   L = J                                                       SORTP     107
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```
                IF (Y(J).GE.AMED) GO TO 230                                     SORTP   108
                Y(MID) = Y(J)                                                   SORTP   109
                IPOS(MID) = IPOS(J)                                             SORTP   110
110             Y(J) = AMED                                                     SORTP   111
                IPOS(J) = IMED                                                  SORTP   112
                AMED = Y(MID)                                                   SORTP   113
                IMED = IPOS(MID)                                                SORTP   114
                IF (Y(I).LE.AMED) GO TO 230                                     SORTP   115
115             Y(MID) = Y(I)                                                   SORTP   116
                IPOS(MID) = IPOS(I)                                             SORTP   117
                Y(I) = AMED                                                     SORTP   118
                IPOS(I) = IMED                                                  SORTP   119
                AMED = Y(MID)                                                   SORTP   120
120             IMED = IPOS(MID)                                                SORTP   121
                GO TO 230                                                       SORTP   122
          220   Y(L) = Y(K)                                                     SORTP   123
                IPOS(L) = IPOS(K)                                               SORTP   124
                Y(K) = TT                                                       SORTP   125
125             IPOS(K) = ITT                                                   SORTP   126
          230   L = L-1                                                         SORTP   127
                IF (Y(L).GT.AMED) GO TO 230                                     SORTP   128
                TT = Y(L)                                                       SORTP   129
                ITT = IPOS(L)                                                   SORTP   130
130       240   K = K+1                                                         SORTP   131
                IF (Y(K).LT.AMED) GO TO 240                                     SORTP   132
                IF (K.LE.L) GO TO 220                                           SORTP   133
                LMI = L-1                                                       SORTP   134
                JMK = J-K                                                       SORTP   135
135             IF (LMI.LE.JMK) GO TO 250                                       SORTP   136
                IL(M) = I                                                       SORTP   137
                IU(M) = L                                                       SORTP   138
                I = K                                                           SORTP   139
                M = M+1                                                         SORTP   140
140             GO TO 270                                                       SORTP   141
          250   IL(M) = K                                                       SORTP   142
                IU(M) = J                                                       SORTP   143
                J = L                                                           SORTP   144
                M = M+1                                                         SORTP   145
145             GO TO 270                                                       SORTP   146
          260   M = M-1                                                         SORTP   147
                IF (M.EQ.0) RETURN                                              SORTP   148
                I = IL(M)                                                       SORTP   149
                J = IU(M)                                                       SORTP   150
150       270   JMI = J-I                                                       SORTP   151
                IF (JMI.GE.11) GO TO 200                                        SORTP   152
                IF (I.EQ.1) GO TO 190                                           SORTP   153
                I = I-1                                                         SORTP   154
          280   I = I+1                                                         SORTP   155
155             IF (I.EQ.J) GO TO 260                                           SORTP   156
                AMED = Y(I+1)                                                   SORTP   157
                IMED = IPOS(I+1)                                                SORTP   158
                IF (Y(I).LE.AMED) GO TO 280                                     SORTP   159
                K = I                                                           SORTP   160
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160          290   Y(K+1) = Y(K)                                                    SORTP   161
                   IPOS(K+1) = IPOS(K)                                              SORTP   162
                   K = K-1                                                          SORTP   163
                   IF (AMED.LT.Y(K)) GO TO 290                                      SORTP   164
                   Y(K+1) = AMED                                                    SORTP   165
165                IPOS(K+1) = IMED                                                 SORTP   166
                   GO TO 280                                                        SORTP   167
             C                                                                      SORTP   168
             300   FORMAT (1H ,108H***** NON-FATAL DIAGNOSTIC--THE FIRST  INPUT ARGUM SORTP   169
                  +ENT (A VECTOR) TO THE SORTP  SUBROUTINE HAS ALL ELEMENTS =,E15.8,6 SORTP   170
170               +H *****)                                                        SORTP   171
             310   FORMAT (1H ,91H***** FATAL ERROR--THE SECOND INPUT ARGUMENT TO THE SORTP   172
                  + SORTP  SUBROUTINE IS NON-POSITIVE *****)                       SORTP   173
             320   FORMAT (1H ,100H***** NON-FATAL DIAGNOSTIC--THE SECOND INPUT ARGUM SORTP   174
                  +ENT TO THE SORTP  SUBROUTINE HAS THE VALUE 1 *****)             SORTP   175
175          330   FORMAT (1H ,35H***** THE VALUE OF THE ARGUMENT IS ,I8,6H *****)  SORTP   176
                   END                                                              SORTP   177
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES				
4	SORTP	1	60	63	67	90	147

VARIABLES

SN		TYPE			RELOCATION								
611	AMED	REAL			REFS	99	102	107	110	114	117	127	
						131	158	163	164	DEFINED	97	104	112
						119	156						
601	HOLD	REAL			REFS	53	55	DEFINED	51				
602	I	INTEGER			REFS	53	2*57	2*58	2*72	2*79	86	87	
						94	95	96	99	100	101	102	103
						114	115	116	117	118	133	136	150
						152	153	154	155	156	157	158	159
						DEFINED	52	56	71	78	85	92	138
						148	153	154					
665	IL	INTEGER	ARRAY		REFS	46	148	DEFINED	136	141			
612	IMED	INTEGER			REFS	103	111	118	165	DEFINED	98	105	
						113	120	157					
0	IPOS	INTEGER	ARRAY	F.P.	REFS	44	98	101	105	109	113	116	
						120	123	129	157	161	DEFINED	1	58
						66	79	101	103	109	111	116	118
						123	125	161	165				
0	IPR	INTEGER		IODEV	REFS	45	DEFINED	48	I/O REFS	55	61	62	
						64							
604	IP1	INTEGER			REFS	87	DEFINED	86					
1	IRD	INTEGER		IODEV	REFS	45							
615	ITT	INTEGER			REFS	125	DEFINED	129					
621	IU	INTEGER	ARRAY		REFS	46	149	DEFINED	137	142			
606	J	INTEGER			REFS	94	96	106	107	108	109	110	
						111	134	142	150	155	DEFINED	93	143

VARIABLES	SN	TYPE	RELOCATION									
					149							
620	JMI	INTEGER			REFS	151	DEFINED	150				
617	JMK	INTEGER			REFS	135	DEFINED	134				
607	K	INTEGER			REFS	122	123	124	125	130	131	132
					134	138	141	2*160	2*161	162	163	164
					165	DEFINED	95	159	162			
613	L	INTEGER			REFS	122	123	126	127	128	129	132
					133	137	143	DEFINED	106	126		
616	LMI	INTEGER			REFS	135	DEFINED	133				
605	M	INTEGER			REFS	136	137	139	141	142	144	146
					147	148	149	DEFINED	91	139	144	146
610	MID	INTEGER			REFS	97	98	100	101	104	105	108
					109	112	113	115	116	119	120	
					DEFINED	96						
0	N	INTEGER		F.P.	REFS	49	50	52	56	62	71	78
					84	93	DEFINED	1				
603	NMI	INTEGER			REFS	85	DEFINED	84				
614	TT	REAL			REFS	124	DEFINED	128				
0	X	REAL	ARRAY	F.P.	REFS	44	51	53	57	65	72	
					DEFINED	1						
0	Y	REAL	ARRAY	F.P.	REFS	44	2*87	97	99	100	104	107
					108	112	114	115	119	122	127	128
					131	156	158	160	163	DEFINED	1	57
					65	72	100	102	108	110	115	117
					122	124	160	164				

VARIABLES USED AS FILE NAMES, SEE ABOVE

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		54	52			
0	110		59	56			
47	120		61	49			
55	130		64	50			
67	140		68	53			
0	150		73	71			
0	160		80	78			
124	170		89	85	87		
131	180		91	88			
137	190		94	152			
143	200		95	151			
213	210		106	99			
303	220		122	132			
322	230		126	107	114	121	127
341	240		130	131			
377	250		141	135			
412	260		146	94	155		
425	270		150	140	145		
440	280		154	158	166		
462	290		160	163			
523	300	FMT	168	55			
542	310	FMT	171	61			
555	320	FMT	173	64			
571	330	FMT	175	62			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
23	100	I	52 54	6B	INSTACK	EXITS
35	110	I	56 59	10B	INSTACK	
71	150	I	71 73	6B	INSTACK	
101	160	I	78 80	5B	INSTACK	
113	170	I	85 89	14B	OPT	EXITS

COMMON BLOCKS	LENGTH
IODEV	2

STATISTICS

PROGRAM LENGTH	747B	487
SCM LABELED COMMON LENGTH	2B	2

140000B SCM USED

```
      SUBROUTINE STFAXL (AELM,AK,ARAA,EPSLA,NADET,RA,RBRA,STRSA,TW,NTAED
     +,XLOADA,YACF,CA)
C
C   STFAXL IS CALLED FROM PELET
C
C   PURPOSE OF THE SUBROUTINE IS TO COMPUTE THE AXIAL STIFFNESS
C   MODEL FOR THE FURL AND FOR THE CLAD.
C   FORM THE ELEMENT STIFFNESS MATRIX AND MERGE THEM INTO THE TOTAL
C   MATRIX BASED UPON CONTACT CRITERIA(ICON.EQ.1) NOT THAT CONTACT
C   ALONG THE AXIS OF THE FUEL PIN MUST BE KNOWN INORDER TO DEFINE
C   THE MERGING OPERATION OF THE TOTAL STIFFNESS MATRIX.
C
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P
     +DEL,COMP
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP
     +,IRZ
      COMMON /LASTIC/ E,XNU,ALPHA
      COMMON /CONTNT/ PI
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2
C
      DIMENSION AKBAR(6,6)
      DIMENSION AELM(3,1),                    RA(1), TW(NTAED,2), YACF(1
     +),NADET(1),AK(1),EPSLA(4,6,1),STRS
     +A(4,6,1), XLOADA(6,4,1), RBRA(1), ARAA(1)
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,
     +   ERAD(20), EAX(20)
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)
     +,PINOLD,POUTLD,POLD,NTOLD(20)
     + ,ICHNG,STEPS
      COMMON /STFMAT/ B(4,6),C(4,6),BT(6,4),PROD(4,6),XKBAR(6,6)
      COMMON / MATCNS / ANRIN, DCOMP, CWKF, CWNF, DELOXY, FLUX, FNCK,
     + FNCN, FOTMTL, DRFDEN, FTMELT, RSTRAN
      EQUIVALENCE (AKBAR(1,1),XKBAR(1,1))
      DIMENSION CA(4,4,1)
      DIMENSION LKNT(26)
C
C   ERAD,EAX - FUEL ELASTIC MODULI FROM SUBROUTINE RADIAL
C
      CALL MOVEKA (0,AK,MAXA)
C   DEFINE CORRECTION ARRAY
      LKNT(1) = 1
          DO 100 I=2,26
          LKNT(I) = LKNT(I-1)+1
  100     CONTINUE
      KRNCH = NAXB4-24
      MCUD = 26
      IF (NAXB4.LT.37) MCUD = NAXB4
      IF (NAXB4.LT.37) KRNCH = MCUD-2
```

```
                      DO 380 K=1,NTAE                                          STFAXL     40
55                    N1 = AELM(1,K)                                           STFAXL     41
                      N2 = AELM(2,K)                                           STFAXL     42
                      N3 = AELM(3,K)                                           STFAXL     43
                      R1 = RA(N1)                                              STFAXL     44
                      R2 = RA(N2)                                              STFAXL     45
60                    Z1 = YACF(N1)                                            STFAXL     46
                      Z2 = YACF(N2)                                            STFAXL     47
               C   COMPUTE LOCATION OF QUADRILATRIAL MID NODE BASED ON CORNER   STFAXL     48
               C   COORDINATES.                                                STFAXL     49
                      LL = (K-(K/4)*4)                                         STFAXL     50
65                    KL = LL                                                  STFAXL     51
                      IF (KL.EQ.0) KL = 4                                      STFAXL     52
                      IF (KL.GT.1) GO TO 110                                   STFAXL     53
                      R3 = (R1+R2)/2.0                                         STFAXL     54
                      NN2 = AELM(2,K+1)                                        STFAXL     55
70                    ZZ2 = YACF(NN2)                                          STFAXL     56
                      Z3 = (ZZ2+Z2)/2.0                                        STFAXL     57
               110    CONTINUE                                                 STFAXL     58
               C                                                               STFAXL     59
               C   FORM MEAN VALUE LOCATION COORDINATES CENTROID OF EACH ELEMENT STFAXL     60
75             C                                                               STFAXL     61
                      RBAR = (R1+R2+R3)/3.0                                    STFAXL     62
                      AREA = (R2*Z3+R1*Z2+R3*Z1-R2*Z1-R3*Z2-R1*Z3)/2.0         STFAXL     63
               C                                                               STFAXL     64
               C   COMPUTE AREA COORDINATE AND COEF.                           STFAXL     65
80             C                                                               STFAXL     66
                      B1 = Z2-Z3                                               STFAXL     67
                      B2 = Z3-Z1                                               STFAXL     68
                      B3 = Z1-Z2                                               STFAXL     69
                      A1 = R3-R2                                               STFAXL     70
85                    A2 = R1-R3                                               STFAXL     71
                      A3 = R2-R1                                               STFAXL     72
                      XL1 = 1.0/3.0                                            STFAXL     73
                      XL2 = 1./3.                                              STFAXL     74
                      XL3 = 1./3.                                              STFAXL     75
90             C                                                               STFAXL     76
               C   COMPUTE  THE B MATRIX                                       STFAXL     77
               C                                                               STFAXL     78
                      B(1,1) = B1                                              STFAXL     79
                      B(2,1) = 2.*AREA*XL1/RBAR                                STFAXL     80
95                    B(3,1) = 0.0                                             STFAXL     81
                      B(4,1) = A1                                              STFAXL     82
                      B(1,2) = 0.0                                             STFAXL     83
                      B(2,2) = 0.0                                             STFAXL     84
                      B(3,2) = A1                                              STFAXL     85
100                   B(4,2) = B1                                              STFAXL     86
                      B(1,3) = B2                                              STFAXL     87
                      B(2,3) = 2.*AREA*XL2/RBAR                                STFAXL     88
                      B(3,3) = 0.0                                             STFAXL     89
                      B(4,3) = A2                                              STFAXL     90
105                   B(1,4) = 0.0                                             STFAXL     91
                      B(2,4) = 0.0                                             STFAXL     92
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                      B(3,4) = A2                                                    STFAXL     93
                      B(4,4) = B2                                                    STFAXL     94
                      B(1,5) = B3                                                    STFAXL     95
110                   B(2,5) = 2.*AREA*XL3/RBAR                                      STFAXL     96
                      B(3,5) = 0.0                                                   STFAXL     97
                      B(4,5) = A3                                                    STFAXL     98
                      B(1,6) = 0.0                                                   STFAXL     99
                      B(2,6) = 0.0                                                   STFAXL    100
115                   B(3,6) = A3                                                    STFAXL    101
                      B(4,6) = B3                                                    STFAXL    102
                          DO 120 J=1,6                                               STFAXL    103
                              DO 120 I=1,4                                           STFAXL    104
                              B(I,J) = B(I,J)/(2.*AREA)                              STFAXL    105
120             120           CONTINUE                                               STFAXL    106
                C                                                                    STFAXL    107
                C   NOW FOR THE C MATRIX                                            STFAXL    108
                C                                                                    STFAXL    109
                      TF = TW(K,NEW)                                                 STFAXL    110
125                   IF (K.GT.NAEF) GO TO 130                                       STFAXL    111
                C   EA AND XNUA ARE AXIAL E AND XNU                                 STFAXL    112
                C   ER AND XNUR ARE RADIAL E AND XNU                                STFAXL    113
                C   ERAT IS RATIO OF ER TO EA                                       STFAXL    114
                      XNUR = .25                                                     STFAXL    115
130                   XNUA = .25                                                     STFAXL    116
                      KAX = (K/4)+1                                                  STFAXL    117
                      ER = ERAD(KAX)                                                 STFAXL    118
                      EA = EAX(KAX)                                                  STFAXL    119
                      IF (ER.LT.1.E5) ER = 1.E5                                      STFAXL    120
135                   IF (EA.LT.1.E5) EA = 1.E5                                      STFAXL    121
                C   FUEL STIFFNESS                                                  STFAXL    122
                      ERAT = ER/EA                                                   STFAXL    123
                      CONST = ERAT*XNUA*XNUA                                         STFAXL    124
                      COEFA = ER/(1.+XNUR)/(1.-XNUR-2.*CONST)                        STFAXL    125
140                   C(1,1) = COEFA*(1.-CONST)                                      STFAXL    126
                      C(2,1) = COEFA*(XNUR+CONST)                                    STFAXL    127
                      C(3,1) = COEFA*XNUA*(1.+XNUR)                                  STFAXL    128
                      C(4,1) = 0.0                                                   STFAXL    129
                      C(1,2) = C(2,1)                                                STFAXL    130
145                   C(2,2) = C(1,1)                                                STFAXL    131
                      C(3,2) = C(3,1)                                                STFAXL    132
                      C(4,2) = 0.0                                                   STFAXL    133
                      C(1,3) = C(3,1)                                                STFAXL    134
                      C(2,3) = C(3,2)                                                STFAXL    135
150                   C(3,3) = COEFA*(1.-XNUR*XNUR)/ERAT                             STFAXL    136
                      C(4,3) = 0.0                                                   STFAXL    137
                      C(1,4) = 0.0                                                   STFAXL    138
                      C(2,4) = 0.0                                                   STFAXL    139
                      C(3,4) = 0.0                                                   STFAXL    140
155                   C(4,4) = COEFA*(1.+XNUR)*(1.-XNUR-2.*CONST)/(ERAT*2.*(1.+XNUA) STFAXL    141
                +     )                                                              STFAXL    142
                      GO TO 160                                                      STFAXL    143
                130   CONTINUE                                                       STFAXL    144
                C                                                                    STFAXL    145
```

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      C   DEGREES K FOR NATPRO CALL                                                  STFAXL   146
      C   6894.8 PA PER PSI                                                          STFAXL   147
            TK = (TF-32.)/1.8+273.15                                                 STFAXL   148
            E = CELMOD(TK,FNCK,CWKF,DELOXY)/6894.8                                   STFAXL   149
            XNU = E/(2.*(CSHEAR(TK,FNCK,CWKF,DELOXY)/6894.8))-1.                     STFAXL   150
            COEF = E/((1.+XNU)*(1.-2.*XNU))                                          STFAXL   151
                DO 150 J=1,4                                                         STFAXL   152
                    DO 140 I=1,3                                                     STFAXL   153
                    C(I,J) = XNU*COEF                                                STFAXL   154
                    IF (I.EQ.J) C(I,J) = (1.-XNU)*COEF                               STFAXL   155
                    IF (J.EQ.4) C(I,J) = 0.0                                         STFAXL   156
      140           CONTINUE                                                         STFAXL   157
                C(4,J) = 0.0                                                         STFAXL   158
      150       CONTINUE                                                           STFAXL   159
            C(4,4) = ((1.-2.*XNU)/2.)*COEF                                           STFAXL   160
      160   CONTINUE                                                               STFAXL   161
      C                                                                            STFAXL   162
      C   NOW COMPUTE THE TRANSPOSE OF B                                          STFAXL   163
      C                                                                            STFAXL   164
                DO 170 J=1,4                                                       STFAXL   165
                    DO 170 I=1,6                                                   STFAXL   166
                    BT(I,J) = B(J,I)                                               STFAXL   167
      170           CONTINUE                                                       STFAXL   168
      C                                                                            STFAXL   169
      C   NOW COMPUTE ELEMENTAL STIFFNESS MATRIX FIRST FORM MATRIX                  STFAXL   170
      C   PRODUCT   B**T*C*B                                                       STFAXL   171
      C                                                                            STFAXL   172
                DO 190 JJ=1,6                                                      STFAXL   173
                    DO 190 III=1,4                                                 STFAXL   174
                    SUM = 0.0                                                      STFAXL   175
                    PROD(III,JJ) = 0.0                                             STFAXL   176
                        DO 180 JJJ=1,4                                             STFAXL   177
                        S = C(III,JJJ)*B(JJJ,JJ)                                   STFAXL   178
                        SUM = SUM+S                                                STFAXL   179
      180               CONTINUE                                                   STFAXL   180
                    PROD(III,JJ) = SUM                                             STFAXL   181
      190           CONTINUE                                                       STFAXL   182
      C                                                                            STFAXL   183
      C   NOW FORM THE FINAL PRODUCT                                               STFAXL   184
      C                                                                            STFAXL   185
                DO 220 J=1,6                                                       STFAXL   186
                    DO 210 I=1,6                                                   STFAXL   187
                    AKBAR(I,J) = 0.0                                               STFAXL   188
                        DO 200 II=1,4                                              STFAXL   189
                        AKBAR(I,J) = AKBAR(I,J)+BT(I,II)*PROD(II,J)                STFAXL   190
      200               CONTINUE                                                   STFAXL   191
                    AKBAR(I,J) = AKBAR(I,J)*RBAR*2.*PI*AREA                        STFAXL   192
      210           CONTINUE                                                       STFAXL   193
      220       CONTINUE                                                           STFAXL   194
      C                                                                            STFAXL   195
      C   FORM AN ARRAY OF ALL THE AXIAL ELEMENTS                                  STFAXL   196
      C                                                                            STFAXL   197
            IF (K.GT.NAEF) GO TO 260                                               STFAXL   198
```

```
                      L = 0                                                                    STFAXL   199
                      LL = 0                                                                   STFAXL   200
215             C                                                                              STFAXL   201
                          DO 250 I=1,6                                                         STFAXL   202
                          IF (L.GE.2) L = 0                                                    STFAXL   203
                          NNN = NADET(N1)                                                      STFAXL   204
                          IF (I.GT.2) NNN = NADET(N2)                                          STFAXL   205
220                       IF (I.GT.4) NNN = NADET(N3)                                          STFAXL   206
                          LL = 0                                                               STFAXL   207
                C                                                                              STFAXL   208
                              DO 240 J=1,6                                                     STFAXL   209
                              IF (LL.GE.2) LL = 0                                              STFAXL   210
225                           ND = NADET(N1)                                                   STFAXL   211
                              IF (J.GT.2) ND = NADET(N2)                                       STFAXL   212
                              IF (J.GT.4) ND = NADET(N3)                                       STFAXL   213
                C                                                                              STFAXL   214
                C   COMPUTE COORDINATES OF THE MASTER STIFFNESS MATRIX FOR THE FUEL          STFAXL   215
230             C                                                                              STFAXL   216
                              II = NNN+L                                                       STFAXL   217
                              JJ = ND+LL                                                       STFAXL   218
                              IF (II.GT.JJ) GO TO 230                                          STFAXL   219
                              III = MCUD*(II-1)+JJ-II+1                                        STFAXL   220
235                           IF (II.GT.KRNCH) III = III-LKNT(II-KRNCH)                        STFAXL   221
                              AK(III) = AK(III)+AKBAR(I,J)                                     STFAXL   222
                230           CONTINUE                                                         STFAXL   223
                              LL = LL+1                                                        STFAXL   224
                240           CONTINUE                                                         STFAXL   225
240                       L = L+1                                                              STFAXL   226
                250       CONTINUE                                                             STFAXL   227
                          GO TO 300                                                            STFAXL   228
                260       CONTINUE                                                             STFAXL   229
                          L = 0                                                                STFAXL   230
245                       LL = 0                                                               STFAXL   231
                              DO 290 I=1,6                                                     STFAXL   232
                              IF (L.GE.2) L = 0                                                STFAXL   233
                              NNN = NADET(N1)                                                  STFAXL   234
                              IF (I.GT.2) NNN = NADET(N2)                                      STFAXL   235
250                           IF (I.GT.4) NNN = NADET(N3)                                      STFAXL   236
                              LL = 0                                                           STFAXL   237
                                  DO 280 J=1,6                                                 STFAXL   238
                                  IF (LL.GE.2) LL = 0                                          STFAXL   239
                                  ND = NADET(N1)                                               STFAXL   240
255                               IF (J.GT.2) ND = NADET(N2)                                   STFAXL   241
                                  IF (J.GT.4) ND = NADET(N3)                                   STFAXL   242
                C                                                                              STFAXL   243
                C   COMPUTE THE COORDINATES OF MASTER AXIAL STIFFNESS FOR THE CLAD           STFAXL   244
                C                                                                              STFAXL   245
260                               II = NNN+L                                                   STFAXL   246
                                  JJ = ND+LL                                                   STFAXL   247
                                  IF (II.GT.JJ) GO TO 270                                      STFAXL   248
                                  III = MCUD*(II-1)+JJ-II+1                                    STFAXL   249
                                  IF (II.GT.KRNCH) III = III-LKNT(II-KRNCH)                    STFAXL   250
265                               AK(III) = AK(III)+AKBAR(I,J)                                 STFAXL   251
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                  270             CONTINUE                                                    STFAXL   252
                                  LL = LL+1                                                   STFAXL   253
                  280             CONTINUE                                                    STFAXL   254
                              L = L+1                                                         STFAXL   255
270               290           CONTINUE                                                      STFAXL   256
                  300       CONTINUE                                                        STFAXL   257
                  C   HAVE MERGED TOTAL STIFFNESS FOR THE FUEL AND CLADAXIAL MODEL         STFAXL   258
                  C                                                                         STFAXL   259
                  C   NOW DELELOPE THE STEESS AND STRAIN MATRIX FOR EACH AXIAL             STFAXL   260
275               C   ELEMENT                                                               STFAXL   261
                  C                                                                         STFAXL   262
                              DO 320 J=1,6                                                  STFAXL   263
                                  DO 310 I=1,4                                              STFAXL   264
                                  EPSLA(I,J,K) = B(I,J)                                     STFAXL   265
280                               STRSA(I,J,K) = PROD(I,J)                                  STFAXL   266
                  310             CONTINUE                                                  STFAXL   267
                  320         CONTINUE                                                      STFAXL   268
                  C                                                                         STFAXL   269
                  C   DEFINE LOAD VECTOR INNER PRODUCT XLOADA                               STFAXL   270
285               C                                                                         STFAXL   271
                              DO 350 J=1,4                                                  STFAXL   272
                                  DO 340 I=1,6                                              STFAXL   273
                                  SUM = 0.0                                                 STFAXL   274
                                      DO 330 II=1,4                                         STFAXL   275
290                                   SUM = SUM+BT(I,II)*C(II,J)                            STFAXL   276
                  330                 CONTINUE                                            STFAXL   277
                                  XLOADA(I,J,K) = SUM                                       STFAXL   278
                  340             CONTINUE                                                  STFAXL   279
                  350         CONTINUE                                                      STFAXL   280
295               C                                                                         STFAXL   281
                  C   COMPUTE THE AREA                                                      STFAXL   282
                  C                                                                         STFAXL   283
                              ARAA(K) = AREA                                                STFAXL   284
                  C                                                                         STFAXL   285
300               C   COMPUTE MEAN RADIUS                                                  STFAXL   286
                  C                                                                         STFAXL   287
                              RBRA(K) = RBAR                                                STFAXL   288
                                  DO 370 J=1,4                                              STFAXL   289
                                      DO 360 I=1,4                                          STFAXL   290
305                                   CA(I,J,K) = C(I,J)                                    STFAXL   291
                  360                 CONTINUE                                            STFAXL   292
                  370             CONTINUE                                                  STFAXL   293
                  380         CONTINUE                                                      STFAXL   294
                  C                                                                         STFAXL   295
310                           DO 450 I=1,NABF                                               STFAXL   296
                              JJ = I+NABF                                                   STFAXL   297
                              N1 = NADET(JJ)+1                                              STFAXL   298
                              J = 2*NABF+1                                                  STFAXL   299
                              N2 = NADET(J)+1                                               STFAXL   300
315                           ISAV1 = MCUD*(N1-1)+1                                         STFAXL   301
                              IF (N1.GT.KRNCH) ISAV1 = ISAV1-LKNT(N1-KRNCH)                 STFAXL   302
                              ISAV2 = MCUD*(N2-1)+1                                         STFAXL   303
                              IF (N2.GT.KRNCH) ISAV2 = ISAV2-LKNT(N2-KRNCH)                 STFAXL   304
```

```
                SAV1 = AK(ISAV1)                                                STFAXL   305
320             SAV2 = AK(ISAV2)                                                STFAXL   306
      C   INTRODUCE CONSTRAINTS ON CLADDING                                     STFAXL   307
                MAX = N2-N1-1                                                   STFAXL   308
                  DO 390 KM=1,MAX                                               STFAXL   309
                  IJ = (N1+KM-1)*MCUD+N2-N1+1-KM                                STFAXL   310
325               IM = (N1-1)*MCUD+KM+1                                         STFAXL   311
                  NM = N1-KRNCH                                                 STFAXL   312
                  IF (NM.GT.0) IM = IM-LKNT(NM)                                 STFAXL   313
                  NJ = N2-KRNCH                                                 STFAXL   314
                  II = N1+KM                                                    STFAXL   315
330               IF (II.GT.KRNCH) IJ = IJ-LKNT(II-KRNCH)                       STFAXL   316
                  AK(IM) = AK(IM)+AK(IJ)                                        STFAXL   317
      390         CONTINUE                                                      STFAXL   318
                IN = MCUD-(N2-N1)-1                                             STFAXL   319
                II = IN+N2                                                      STFAXL   320
335             IF (II.GT.NAXB4) IN = IN-(II-NAXB4)                             STFAXL   321
                  DO 400 KM=1,IN                                                STFAXL   322
                  IM = (N1-1)*MCUD+N2-N1+1+KM                                   STFAXL   323
                  IJ = (N2-1)*MCUD+1+KM                                         STFAXL   324
                  NM = N1-KRNCH                                                 STFAXL   325
340               IF (NM.GT.0) IM = IM-LKNT(NM)                                 STFAXL   326
                  NJ = N2-KRNCH                                                 STFAXL   327
                  IF (NJ.GT.0) IJ = IJ-LKNT(NJ)                                 STFAXL   328
                  AK(IM) = AK(IM)+AK(IJ)                                        STFAXL   329
      400         CONTINUE                                                      STFAXL   330
345   C                                                                         STFAXL   331
      C   NOW INTERCHANGE COL,S                                                 STFAXL   332
                INN = N1-1                                                      STFAXL   333
                IN = MCUD-(N2-N1)-1                                             STFAXL   334
                IF (INN.LT.IN) IN = INN                                         STFAXL   335
350             IF (IN.LE.0) GO TO 420                                          STFAXL   336
      C                                                                         STFAXL   337
                  DO 410 KM=1,IN                                                STFAXL   338
                  II = N1-KM                                                    STFAXL   339
                  IM = MCUD*(II-1)+1+KM                                         STFAXL   340
355               IF (II.GT.KRNCH) IM = IM-LKNT(II-KRNCH)                       STFAXL   341
                  IJ = IM+(N2-N1)                                               STFAXL   342
                  AK(IM) = AK(IM)+AK(IJ)                                        STFAXL   343
      410         CONTINUE                                                      STFAXL   344
      420       CONTINUE                                                        STFAXL   345
360   C                                                                         STFAXL   346
      C                                                                         STFAXL   347
      C   NOW ZERO OUT TERMS ROW                                                STFAXL   348
              MM = MCUD                                                         STFAXL   349
              IF (N2.GE.KRNCH) MM = MCUD-(N2-KRNCH)-1                           STFAXL   350
365             DO 430 KM=1,MM                                                  STFAXL   351
                IM = (N2-1)*MCUD+KM                                             STFAXL   352
                NM = N2-KRNCH                                                   STFAXL   353
                IF (NM.GT.0) IM = IM-LKNT(NM)                                   STFAXL   354
                AK(IM) = 0.0                                                    STFAXL   355
370   430       CONTINUE                                                        STFAXL   356
      C   ZERO OUT COL                                                          STFAXL   357
```

```
                      MA = MCUD-1                                                                  STFAXL   358
                      IF (N2.LE.MA) MA = N2-1                                                      STFAXL   359
                          DO 440 KM=1,MA                                                           STFAXL   360
375                       II = N2-KM                                                               STFAXL   361
                          IM = MCUD*(II-1)+N2-II+1                                                 STFAXL   362
                          IF (II.GT.KRNCH) IM = IM-LKNT(II-KRNCH)                                  STFAXL   363
                          AK(IM) = 0.0                                                             STFAXL   364
               440        CONTINUE                                                                 STFAXL   365
380            C    NOW PUT A 1.0 ON DIAGONAL                                                      STFAXL   366
                      AK(ISAV2) = 1.0                                                              STFAXL   367
                      AK(ISAV1) = SAV1+SAV2                                                        STFAXL   368
               450    CONTINUE                                                                     STFAXL   369
                    RETURN                                                                         STFAXL   370
385                 END                                                                            STFAXL   371
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 STFAXL 1 384

VARIABLES	SN	TYPE		RELOCATION								
0	AELM	REAL	ARRAY	F.P.	REFS	27	55	56	57	69		
					DEFINED	1						
0	AK	REAL	ARRAY	F.P.	REFS	27	44	236	265	319	320	2*331
					2*343	2*357	DEFINED	1	236	265	331	343
					357	369	378	381	382			
140	AKBAR	REAL	ARRAY	STFMAT	REFS	26	38	204	206	236	265	
					DEFINED	202	204	206				
2	ALPHA	REAL		LASTIC	REFS	22						
0	ANRIN	REAL		MATCNS	REFS	36						
0	ARAA	REAL	ARRAY	F.P.	REFS	27	DEFINED	1	298			
1621	AREA	REAL			REFS	94	102	110	119	206	298	
					DEFINED	77						
1625	A1	REAL			REFS	96	99	DEFINED	84			
1626	A2	REAL			REFS	104	107	DEFINED	85			
1627	A3	REAL			REFS	112	115	DEFINED	86			
0	B	REAL	ARRAY	STFMAT	REFS	35	119	181	192	279		
					DEFINED	93	94	95	96	97	98	99
					100	101	102	103	104	105	106	107
					108	109	110	111	112	113	114	115
					116	119						
60	BT	REAL	ARRAY	STFMAT	REFS	35	204	290	DEFINED	181		
1622	B1	REAL			REFS	93	100	DEFINED	81			
1623	B2	REAL			REFS	101	108	DEFINED	82			
1624	B3	REAL			REFS	109	116	DEFINED	83			
30	C	REAL	ARRAY	STFMAT	REFS	35	144	145	146	148	149	1??
					290	305	DEFINED	140	141	1??	143	1??
					145	146	147	148	149	150	151	152
					153	154	155	168	169	170	172	174

VARIABLES	SN	TYPE	RELOCATION									
0	CA	REAL	ARRAY	F.P.	REFS	39	DEFINED	1	305			
1646	COEF	REAL			REFS	168	169	174	DEFINED	165		
1644	COEFA	REAL			REFS	140	141	142	150	155		
					DEFINED	139						
14	COMP	REAL		GEOPAR	REFS	13						
1643	CONST	REAL			REFS	139	140	141	155	DEFINED	138	
33	CP	REAL		LIMITS	REFS	15						
34	CR	REAL		LIMITS	REFS	15						
2	CWKF	REAL		MATCNS	REFS	36	163	164				
3	CWNF	REAL		MATCNS	REFS	36						
1	DCOMP	REAL		MATCNS	REFS	36						
4	DELOXY	REAL		MATCNS	REFS	36	163	164				
5	DELR	REAL		GEOPAR	REFS	13						
6	DELZ	REAL		GEOPAR	REFS	13						
0	DELZA	REAL	ARRAY	BA	REFS	30						
11	DRFDEN	REAL		MATCNS	REFS	36						
0	E	REAL		LASTIC	REFS	22	164	165	DEFINED	163		
1641	EA	REAL			REFS	135	137	DEFINED	133	135		
102	EAX	REAL	ARRAY	BA	REFS	30	133					
0	EPSLA	REAL	ARRAY	F.P.	REFS	27	DEFINED	1	279			
1640	ER	REAL			REFS	134	137	139	DEFINED	132	134	
56	ERAD	REAL	ARRAY	BA	REFS	30	132					
1642	ERAT	REAL			REFS	138	150	155	DEFINED	137		
5	FLUX	REAL		MATCNS	REFS	36						
55	FLXR	REAL		BA	REFS	30						
6	FNCK	REAL		MATCNS	REFS	36	163	164				
7	FNCN	REAL		MATCNS	REFS	36						
10	FOTMTL	REAL		MATCNS	REFS	36						
35	FRDEN	REAL		LIMITS	REFS	15						
12	FTMELT	REAL		MATCNS	REFS	36						
0	HHF	REAL		FEP	REFS	32						
1601	I	INTEGER			REFS	3*48	2*119	168	2*169	170	2*181	202
						3*204	2*206	219	220	236	249	250	265
						2*279	2*280	290	292	2*305	311	313	
					DEFINED	47	118	167	180	201	216	246	
						278	287	304	310				
57	IADJ	INTEGER		LIMITS	REFS	15						
103	ICHNG	INTEGER		FEP	REFS	32						
67	ICNT	INTEGER		LIMITS	REFS	15						
42	ICRPP	INTEGER		LIMITS	REFS	15						
60	ICUT	INTEGER		LIMITS	REFS	15						
5	IDF	INTEGER		LIMITS	REFS	15						
1654	II	INTEGER			REFS	2*204	233	2*237	2*235	262	2*263	2*264
						2*290	2*330	2*335	357	2*355	2*376	2*377	
					DEFINED	203	231	260	289	329	334	353	
						375							
1650	III	INTEGER			REFS	190	192	195	235	2*236	264	2*265	
					DEFINED	188	234	235	263	264			
1666	IJ	INTEGER			REFS	330	331	342	343	357			
					DEFINED	324	330	338	342	356			
1667	IM	INTEGER			REFS	327	2*331	340	2*343	355	356	2*357	
						368	369	377	378	DEFINED	325	327	337
						340	354	355	366	368	376	377	

VARIABLES	SN	TYPE		RELOCATION							
1672	IN	INTEGER			REFS	334	335	336	349	350	352
					DEFINED	333	335	348	349		
1673	INN	INTEGER			REFS	2*349	DEFINED	347			
40	IPLAS	INTEGER		LIMITS	REFS	15					
73	IPLEND	INTEGER		LIMITS	REFS	15					
71	IRAK	INTEGER		LIMITS	REFS	15					
75	IRZ	INTEGER		LIMITS	REFS	15					
1660	ISAV1	INTEGER			REFS	316	319	382	DEFINED	315	316
1661	ISAV2	INTEGER			REFS	318	320	381	DEFINED	317	318
74	ISP	INTEGER		LIMITS	REFS	15					
37	ISTOP	INTEGER		LIMITS	REFS	15					
3	ISTOP	INTEGER		FEP	REFS	32					
53	ISTRT	INTEGER		BA	REFS	30					
54	ITER	INTEGER		BA	REFS	30					
63	ITI	INTEGER		LIMITS	REFS	15					
4	ITP1	INTEGER		TAPES	REFS	24					
5	ITP2	INTEGER		TAPES	REFS	24					
1633	J	INTEGER			REFS	2*119	168	2*169	2*170	172	2*181	202
						3*204	2*206	226	227	236	255	256	265
						2*279	2*280	290	292	2*305	314		
					DEFINED	117	166	179	200	223	252	277
						286	303	313					
21	JAM	INTEGER		LIMITS	REFS	15					
1647	JJ	INTEGER			REFS	190	192	195	233	234	262	263
						312	DEFINED	187	232	261	311		
1652	JJJ	INTEGER			REFS	2*192	DEFINED	191				
1602	K	INTEGER			REFS	55	56	57	2*64	69	124	125
						131	212	279	280	292	298	302	305
					DEFINED	54							
12	KA	INTEGER		LIMITS	REFS	15					
1637	KAX	INTEGER			REFS	132	133	DEFINED	131				
10	KKA	INTEGER		GEOPAR	REFS	13							
2	KKZZZ	INTEGER		FEP	REFS	32							
1613	KL	INTEGER			REFS	66	67	DEFINED	65	66			
1665	KM	INTEGER			REFS	2*324	325	329	337	338	353	354
						366	375	DEFINED	323	336	352	365	374
66	KPLAS	INTEGER		LIMITS	REFS	15					
55	KRNCH	INTEGER		LIMITS	REFS	15	2*235	2*264	2*316	2*318	326	328
						2*330	339	341	2*355	2*364	367	2*377	
					DEFINED	50	53						
45	KRNCHC	INTEGER		LIMITS	REFS	15					
44	KRNCHF	INTEGER		LIMITS	REFS	15					
46	KRNCHT	INTEGER		LIMITS	REFS	15					
36	KZI	INTEGER		LIMITS	REFS	15					
1655	L	INTEGER			REFS	217	231	240	247	260	269	
					DEFINED	213	217	240	244	247	269	
1676	LKNT	INTEGER	ARRAY		REFS	40	48	235	263	316	318	327
						330	340	342	355	363	377		
					DEFINED	46	48						
1612	LL	INTEGER			REFS	65	224	232	238	253	261	267
					DEFINED	64	214	221	224	238	245	251
						253	267						
1675	MA	INTEGER			REFS	373	374	DEFINED	372	373			

VARIABLES	SN	TYPE		RELOCATION								
1664	MAX	INTEGER			REFS	323	DEFINED	322				
52	MAXA	INTEGER		LIMITS	REFS	15	44					
43	MAXT	INTEGER		LIMITS	REFS	15						
56	MCUD	INTEGER		LIMITS	REFS	15	53	234	263	315	317	324
					325	333	337	338	348	354	363	364
					366	372	376	DEFINED	51	52		
1674	MM	INTEGER			REFS	365	DEFINED	363	36[illegible]			
17	NABC	INTEGER		LIMITS	REFS	15						
16	NABF	INTEGER		LIMITS	REFS	15	310	311	313			
31	NABF2	INTEGER		LIMITS	REFS	15						
20	NABT	INTEGER		LIMITS	REFS	15						
32	NABT2	INTEGER		LIMITS	REFS	15						
0	NADET	INTEGER	ARRAY	F.P.	REFS	27	218	219	220	225	226	227
					248	249	250	254	255	256	312	314
					DEFINED	1						
21	NAE[illegible]	INTEGER		LIMITS	REFS	15						
22	NAE[illegible]	INTEGER		LIMITS	REFS	15	125	212				
14	NARC	INTEGER		LIMITS	REFS	15						
13	NARF	INTEGER		LIMITS	REFS	15						
15	NART	INTEGER		LIMITS	REFS	15						
25	NAXBT	INTEGER		LIMITS	REFS	15						
26	NAXB2	INTEGER		LIMITS	REFS	15						
27	NAXB4	INTEGER		LIMITS	REFS	15	50	2*52	53	2*335		
1	NC	INTEGER		LIMITS	REFS	15						
52	NCNN	INTEGER		BA	REFS	30						
51	NCONN	INTEGER		BA	REFS	30						
50	NC4	INTEGER		LIMITS	REFS	15						
1657	ND	INTEGER			REFS	232	261	DEFINED	225	226	227	254
					255	256						
7	NETOT	INTEGER		LIMITS	REFS	15						
53	NEW	INTEGER		LIMITS	REFS	15	124					
10	NEWF	INTEGER		LIMITS	REFS	15						
11	NEWT	INTEGER		LIMITS	REFS	15						
0	NF	INTEGER		LIMITS	REFS	15						
6	NFF	INTEGER		LIMITS	REFS	15						
30	NFF1	INTEGER		LIMITS	REFS	15						
47	NFF2	INTEGER		LIMITS	REFS	15						
51	NF4	INTEGER		LIMITS	REFS	15						
0	NIN	INTEGER		TAPES	REFS	24						
1671	NJ	INTEGER			REFS	2*342	DEFINED	328	341			
41	NKN	INTEGER		LIMITS	REFS	15						
1670	NM	INTEGER			REFS	2*327	2*340	2*368	DEFINED	326	339	367
54	NMX	INTEGER		LIMITS	REFS	15						
50	NN	INTEGER		BA	REFS	30						
1656	NNN	INTEGER			REFS	231	260	DEFINED	218	219	220	248
					249	250						
1615	NN2	INTEGER			REFS	70	DEFINED	69				
2	NOEL	INTEGER		LIMITS	REFS	15						
4	NOELC	INTEGER		LIMITS	REFS	15						
3	NOELF	INTEGER		LIMITS	REFS	15						
65	NOLD	INTEGER		LIMITS	REFS	15						
1	NOUT	INTEGER		TAPES	REFS	24						
2	NSCR1	INTEGER		TAPES	REFS	24						

VARIABLES	SN	TYPE		RELOCATION								
3	NSCR2	INTEGER		TAPES	REFS	24						
1	NT	INTEGER		FEP	REFS	32						
23	NTAE	INTEGER		LIMITS	REFS	15	54					
0	NTAED	INTEGER		F.P.	REFS	27	DEFINED	1				
57	NTOLD	INTEGER	ARRAY	FEP	REFS	32						
1603	NI	INTEGER			REFS	58	60	218	225	248	254	315
					2*316	322	2*324	325	326	329	333	2*337
					339	347	348	353	356	DEFINED	55	312
1604	N2	INTEGER			REFS	59	61	219	226	249	255	317
					2*318	322	324	328	333	334	337	338
					341	348	356	2*364	366	367	2*373	375
					376	DEFINED	56	314				
1605	N3	INTEGER			REFS	220	227	250	256	DEFINED	57	
13	PDEL	REAL		GEOPAR	REFS	13						
0	PI	REAL		CONTNT	REFS	23	206					
11	PIN	REAL		GEOPAR	REFS	13						
54	PINOLD	REAL		FEP	REFS	32						
56	POLD	REAL		FEP	REFS	32						
12	POUT	REAL		GEOPAR	REFS	13						
55	POUTLD	REAL		FEP	REFS	32						
110	PROD	REAL	ARRAY	STFMAT	REFS	35	204	280	DEFINED	190	195	
0	RA	REAL	ARRAY	F.P.	REFS	27	58	59	DEFINED	1		
72	RAKSUM	REAL		LIMITS	REFS	15						
1620	RBAR	REAL			REFS	94	102	110	206	302		
					DEFINED	76						
0	RBRA	REAL	ARRAY	F.P.	REFS	27	DEFINED	1	302			
2	RCI	REAL		GEOPAR	REFS	13						
3	RCO	REAL		GEOPAR	REFS	13						
4	RDOLD	REAL	ARRAY	FEP	REFS	32						
0	RFI	REAL		GEOPAR	REFS	13						
1	RFO	REAL		GEOPAR	REFS	13						
70	RRAKR	REAL		LIMITS	REFS	15						
30	RRSIN	REAL	ARRAY	FEP	REFS	32						
13	RSTRAN	REAL		MATCNS	REFS	36						
1606	R1	REAL			REFS	68	76	2*77	85	86		
					DEFINED	58						
1607	R2	REAL			REFS	68	76	2*77	84	86		
					DEFINED	59						
1614	R3	REAL			REFS	76	2*77	84	85	DEFINED	68	
1653	S	REAL			REFS	193	DEFINED	192				
1662	SAV1	REAL			REFS	382	DEFINED	319				
1663	SAV2	REAL			REFS	382	DEFINED	320				
64	STEP	REAL		LIMITS	REFS	15						
104	STEPS	REAL		FEP	REFS	32						
0	STRSA	REAL	ARRAY	F.P.	REFS	27	DEFINED	1	280			
1651	SUM	REAL			REFS	193	195	290	292	DEFINED	189	193
					288	290						
1634	TF	REAL			REFS	162	DEFINED	124				
61	TIMEC	REAL		LIMITS	REFS	15						
62	TIMEF	REAL		LIMITS	REFS	15						
1645	TK	REAL			REFS	163	164	DEFINED	162			
4	TREF	REAL		GEOPAR	REFS	13						
0	TW	REAL	ARRAY	F.P.	REFS	27	124	DEFINED	1			

```
VARIABLES     SN  TYPE          RELOCATION
  140   XKBAR       REAL        ARRAY    STFMAT      REFS      35      38
    0   XLOADA      REAL        ARRAY     F.P.       REFS      27  DEFINED     !     292
 1630   XL1         REAL                             REFS      94  DEFINED    87
 1631   XL2         REAL                             REFS     102  DEFINED    88
 1632   XL3         REAL                             REFS     110  DEFINED    89
    1   XNU         REAL                  LASTIC     REFS      22    2*165   168     169     174
                                                    DEFINED    164
 1636   XNUA        REAL                             REFS   2*138     142   155  DEFINED     130
 1635   XNUR        REAL                             REFS   2*139     141   142    2*150    2*155
                                                    DEFINED    129
    0   YACF        REAL        ARRAY     F.P.       REFS      27      60    61      70  DEFINED       1
    7   ZDEL        REAL                  GEOPAR     REFS      13
 1616   ZZ2         REAL                             REFS      71  DEFINED    70
 1610   Z1          REAL                             REFS    2*77      82    83  DEFINED      60
 1611   Z2          REAL                             REFS      71    2*77    81      83  DEFINED      61
 1617   Z3          REAL                             REFS    2*77      81    82  DEFINED      71

EXTERNALS           TYPE    ARGS      REFERENCES
       CELMOD       REAL       4          163
       CSHEAR       REAL       4          164
       MOVEKA                  3           44

STATEMENT LABELS              DEF LINE   REFERENCES
    0   100                      49         47
  132   110                      72         67
    0   120                     120        117       118
  434   130                     158        125
    0   140                     171        167
    0   150                     173        166
  521   160                     175        157
    0   170                     182        179       180
    0   180                     194        191
    0   190                     196        187       188
    0   200                     205        203
    0   210                     207        201
    0   220                     208        200
  751   230                     237        233
    0   240                     239        223
    0   250                     241        216
  765   260                     243        212
 1071   270                     266        262
    0   280                     268        252
    0   290                     270        246
 1104   300                     271        242
    0   310                     281        278
    0   320                     282        277
    0   330                     291        289
    0   340                     293        287
    0   350                     294        286
    0   360                     306        304
    0   370                     307        303
    0   380                     308         54
    0   390                     332        323
```

STATEMENT LABELS		DEF LINE	REFERENCES
0	400	344	336
0	410	358	352
1455	420	359	350
0	430	370	365
0	440	379	374
0	450	383	310

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
21	100	I	47 49	6B	INSTACK
47	380	K	54 308	1147B	EXT REFS NOT INNER
270	120	J	117 120	14B	NOT INNER
272	120	I	118 120	7B	INSTACK
462	150	J	166 173	31B	NOT INNER
464	140	I	167 171	22B	OPT
523	170	J	179 182	15B	NOT INNER
525	170	I	180 182	10B	INSTACK
542	190	JJ	187 196	37B	NOT INNER
544	190	III	188 196	32B	NOT INNER
553	180	JJJ	191 194	14B	OPT
603	220	J	200 208	37B	NOT INNER
605	210	I	201 207	32B	NOT INNER
613	200	II	203 205	13B	OPT
653	250	I	216 241	110B	NOT INNER
677	240	J	223 239	57B	OPT
773	290	I	246 270	110B	NOT INNER
1017	280	J	252 268	57B	OPT
1106	320	J	277 282	22B	NOT INNER
1110	310	I	278 281	15B	OPT
1132	350	J	286 294	34B	NOT INNER
1134	340	I	287 293	27B	NOT INNER
1140	330	II	289 291	12B	INSTACK
1176	370	J	303 307	15B	NOT INNER
1200	360	I	304 306	10B	INSTACK
1220	450	I	310 383	332B	NOT INNER
1271	390	KM	323 332	43B	OPT
1351	400	KM	336 344	36B	OPT
1426	410	KM	352 358	26B	OPT
1466	430	KM	365 370	20B	OPT
1517	440	KM	374 379	22B	OPT

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
BA	86
FEP	69
STFMAT	132
MATCNS	12

```
STATISTICS
  PROGRAM LENGTH                2005B     1029
  SCM LABELED COMMON LENGTH      600B      384
        140000B SCM USED
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```
      SUBROUTINE STIFF (ELM,R,Z,RD,NFFID,NODET,XKT,EPSLM,STRESS,ARE,RBR,  STIFF     2
     +XLOAD,XKSAVE,CC,NOELD,TELM,NABFD)                                   STIFF     3
C                                                                         STIFF     4
C   STIFF IS CALLED FROM PELET                                            STIFF     5
C                                                                         STIFF     6
C   PURPOSE OF THIS SUBROUTINE IS TO CALCULATE THE STIFFNESS MATRICES     STIFF     7
C   FOR FUEL-CLAD COMBINED SYSTEM (XKT)                                   STIFF     8
C                                                                         STIFF     9
C                                                                         STIFF    10
      DIMENSION R(1),Z(1),LKNT(6),ELM(3,1),NODET(1),XKT(1),               STIFF    11
     +TELM(NOELD,NABFD,1),EPSLM(4,6,1),STRESS(4,6,1)                      STIFF    12
      DIMENSION ARE(1), RBR(1), XLOAD(6,4,1), XKSAVE(6,6,1), CC(4,4,1)    STIFF    13
      DIMENSION RD(NFFID,1)                                               STIFF    14
C                                                                         STIFF    15
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P  PELCOM    2
     +DEL,COMP                                                            PELCOM    3
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE  PELCOM    4
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,  PELCOM    5
     +NAXB2,NAXB4,NFFI,NABF2,NABT2,     CP,CR,FRDEN,KZI,ISSTOP,IPLAS,NKN  PELCOM    6
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N  PELCOM    7
     +MX,KRNCH,MCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD                   PELCOM    8
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP                           PELCOM    9
     +,IRZ                                                                PELCOM   10
      COMMON /LASTIC/ E,XNU,ALPHA                                         PELCOM   11
      COMMON /CONTNT/ PI                                                  PELCOM   12
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2                       PELCOM   13
      COMMON /STFMAT/ B(4,6),C(4,6),BT(6,4),PROD(4,6),XKBAR(6,6)          STIFF    17
C                                                                         STIFF    18
      COMMON / BA / DELZA(40), NN, NCONN, NCNN, ISTRT, ITER, FLXR,        COMC     2
     +   ERAD(20), EAX(20)                                                COMC     3
      COMMON/FEP/HHF,NT,KKZZZ,ISTOP,RDOLD(20),RRSIN(20)                   COMC     4
     +,PINOLD,POUTLD,POLD,NTOLD(20)                                       COMC     5
     + ,ICHNG,STEPS                                                       COMC     6
C                                                                         STIFF    20
      COMMON / MATCNS / ANRIN, DCOMP, CWKF, CWNF, DELOXY, FLUX, FNCK,     STIFF    21
     + FNCN, FOTMTL, DRFDEN, FTMELT, RSTRAN                               STIFF    22
C                                                                         STIFF    23
C   ERAD.EAX - FUEL ELASTIC MODULI FROM SUBROUTINE RADIAL                 STIFF    24
C                                                                         STIFF    25
      DO 100 J=1,NFFI                                                     STIFF    26
      Z(J) = 0.0                                                          STIFF    27
      Z(J+NFFI) = DELZ                                                    STIFF    28
      R(J) = (RD(J,KA)+RD(J,KA+1))/2.                                     STIFF    29
      R(J+NFFI) = R(J)                                                    STIFF    30
100   CONTINUE                                                            STIFF    31
      LKNT(1) = 1                                                         STIFF    32
      LKNT(2) = 3                                                         STIFF    33
      LKNT(3) = 6                                                         STIFF    34
      LKNT(4) = 10                                                        STIFF    35
      LKNT(5) = 15                                                        STIFF    36
      LKNT(6) = 21                                                        STIFF    37
      KRNCHF = NF4-6                                                      STIFF    38
      KRNCHC = NC4-6                                                      STIFF    39
```

```
                NMX = 4*NFF1-4                                                  STIFF  40
                KRNCHT = NMX-6                                                  STIFF  41
                NF4 = NF*4                                                      STIFF  42
      C                                                                         STIFF  43
      C   FORM STIFFNESS MATRIX ON ELEMENT BY ELEMENT BASIS AND MERGE INTO      STIFF  44
      C   TOTAL STIFFNESS MATRIX. STRESS MATRIX WILL ALSO BE FORMED            STIFF  45
      C                                                                         STIFF  46
                CALL MOVEKA (0,STRESS,24*NOEL)                                  STIFF  47
                CALL MOVEKA (0,XKT,MAXT)                                        STIFF  48
      C                                                                         STIFF  49
                    DO 380 KI=1,NOEL                                            STIFF  50
                    N1 = ELM(1,KI)                                              STIFF  51
                    N2 = ELM(2,KI)                                              STIFF  52
                    N3 = ELM(3,KI)                                              STIFF  53
                    R1 = R(N1)                                                  STIFF  54
                    R2 = R(N2)                                                  STIFF  55
                    R3 = R(N3)                                                  STIFF  56
                    Z1 = Z(N1)                                                  STIFF  57
                    Z2 = Z(N2)                                                  STIFF  58
                    Z3 = Z(N3)                                                  STIFF  59
      C   FORM MEAN VALUE LOCATION COORDINATES (CENTROID OF EACH ELEMENT)       STIFF  60
                    RBAR = (R1+R2+R3)/3.0                                       STIFF  61
                    AREA = (R2*Z3+R1*Z2+R3*Z1-R2*Z1-R3*Z2-R1*Z3)/2.0            STIFF  62
      C   COMPUTE AREA COORDINATE AND COEFFICIENT                               STIFF  63
                    B1 = Z2-Z3                                                  STIFF  64
                    B2 = Z3-Z1                                                  STIFF  65
                    B3 = Z1-Z2                                                  STIFF  66
                    A1 = R3-R2                                                  STIFF  67
                    A2 = R1-R3                                                  STIFF  68
                    A3 = R2-R1                                                  STIFF  69
                    XL1 = 1.0/3.0                                               STIFF  70
                    XL2 = 1.0/3.0                                               STIFF  71
                    XL3 = 1.0/3.0                                               STIFF  72
      C                                                                         STIFF  73
      C   COMPUTE THE B MATRIX                                                  STIFF  74
      C                                                                         STIFF  75
                    B(1,1) = B1                                                 STIFF  76
                    B(2,1) = 2.0*AREA*XL1/RBAR                                  STIFF  77
                    B(3,1) = 0.0                                                STIFF  78
                    B(4,1) = A1                                                 STIFF  79
                    B(1,2) = 0.0                                                STIFF  80
                    B(2,2) = 0.0                                                STIFF  81
                    B(3,2) = A1                                                 STIFF  82
                    B(4,2) = B1                                                 STIFF  83
                    B(1,3) = B2                                                 STIFF  84
                    B(2,3) = 2.0*AREA*XL2/RBAR                                  STIFF  85
                    B(3,3) = 0.0                                                STIFF  86
                    B(4,3) = A2                                                 STIFF  87
                    B(1,4) = 0.0                                                STIFF  88
                    B(2,4) = 0.0                                                STIFF  89
                    B(3,4) = A2                                                 STIFF  90
                    B(4,4) = B2                                                 STIFF  91
                    B(1,5) = B3                                                 STIFF  92
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                    B(2,5) = 2.0*AREA*XL3/RBAR                                      STIFF      93
                    B(3,5) = 0.0                                                    STIFF      94
                    B(4,5) = A3                                                     STIFF      95
110                 B(1,6) = 0.0                                                    STIFF      96
                    B(2,6) = 0.0                                                    STIFF      97
                    B(3,6) = A3                                                     STIFF      98
                    B(4,6) = B3                                                     STIFF      99
                        DO 120 J=1,6                                                STIFF     100
115                         DO 110 I=1,4                                            STIFF     101
                            B(I,J) = B(I,J)/(2.0*AREA)                              STIFF     102
              110           CONTINUE                                                STIFF     103
              120       CONTINUE                                                    STIFF     104
              C                                                                     STIFF     105
120           C   NOW FOR THE C MATRIX                                              STIFF     106
              C                                                                     STIFF     107
                    TF = TELM(KI,KA,NEW)                                            STIFF     108
                    IF (KI.GT.NOELF) GO TO 130                                      STIFF     109
              C   EA AND XNUA ARE AXIAL E AND XNU                                   STIFF     110
125           C   ER AND XNUR ARE RADIAL E AND XNU                                  STIFF     111
              C   ERAT IS RATIO OF ER TO EA                                        STIFF     112
                    XNUR = .25                                                      STIFF     113
                    XNUA = .25                                                      STIFF     114
                    ER = ERAD(KA)                                                   STIFF     115
130                 EA = EAX(KA)                                                    STIFF     116
                    IF (ER.LT.1.E5) ER = 1.E5                                       STIFF     117
                    IF (EA.LT.1.E5) EA = 1.E5                                       STIFF     118
              C   FUEL STIFFNESS                                                    STIFF     119
                    ERAT = ER/EA                                                    STIFF     120
135                 CONST = ERAT*XNUA*XNUA                                          STIFF     121
                    COEFA = ER/(1.+XNUR)/(1.-XNUR-2.*CONST)                         STIFF     122
                    C(1,1) = COEFA*(1.-CONST)                                       STIFF     123
                    C(2,1) = COEFA*(XNUR+CONST)                                     STIFF     124
                    C(3,1) = COEFA*XNUA*(1.+XNUR)                                   STIFF     125
140                 C(4,1) = 0.0                                                    STIFF     126
                    C(1,2) = C(2,1)                                                 STIFF     127
                    C(2,2) = C(1,1)                                                 STIFF     128
                    C(3,2) = C(3,1)                                                 STIFF     129
                    C(4,2) = 0.0                                                    STIFF     130
145                 C(1,3) = C(3,1)                                                 STIFF     131
                    C(2,3) = C(3,2)                                                 STIFF     132
                    C(3,3) = COEFA*(1.-XNUR*XNUR)/ERAT                              STIFF     133
                    C(4,3) = 0.0                                                    STIFF     134
                    C(1,4) = 0.0                                                    STIFF     135
150                 C(2,4) = 0.0                                                    STIFF     136
                    C(3,4) = 0.0                                                    STIFF     137
                    C(4,4) = COEFA*(1.+XNUR)*(1.-XNUR-2.*CONST)/(ERAT*2.*(1.+XNUA)  STIFF     138
                +   )                                                               STIFF     139
                    GO TO 160                                                       STIFF     140
155           130   CONTINUE                                                        STIFF     141
              C                                                                     STIFF     142
              C   DEGREES K FOR MATPRO CALL                                        STIFF     143
              C   6894.8 PA PER PSI                                                STIFF     144
                    TK = (TF-32.)/1.8+273.15                                        STIFF     145
```

```
                      E = CELMOD(TK,FNCK,CWKF,DELOXY)/6894.8                          STIFF  146
                      XNU = E/(2.*(CSHEAR(TK,FNCK,CWKF,DELOXY)/6894.8))-1.            STIFF  147
                      COEF = E/((1.+XNU)*(1.-2.*XNU))                                 STIFF  148
                          DO 150 J=1,3                                                STIFF  149
                          C(4,J) = 0.0                                                STIFF  150
                          C(J,4) = 0.0                                                STIFF  151
                              DO 140 I=1,3                                            STIFF  152
                              C(I,J) = XNU*COEF                                       STIFF  153
                              IF (I.EQ.J) C(I,J) = (1.0-XNU)*COEF                     STIFF  154
              140             CONTINUE                                                STIFF  155
              150         CONTINUE                                                    STIFF  156
                      C(4,4) = ((1.0-2.0*XNU)/2.0)*COEF                               STIFF  157
              160     CONTINUE                                                        STIFF  158
                      C                                                               STIFF  159
                      C   NOW COMPUTE THE TRANSPOSE OF B                              STIFF  160
                      C                                                               STIFF  161
                          DO 180 J=1,4                                                STIFF  162
                              DO 170 I=1,6                                            STIFF  163
                              BT(I,J) = B(J,I)                                        STIFF  164
              170             CONTINUE                                                STIFF  165
              180         CONTINUE                                                    STIFF  166
                      C                                                               STIFF  167
                      C   NOW COMPUTE ELEMENT STIFFNESS MATRIX FIRST FORM MATRIX      STIFF  168
                      C                                                               STIFF  169
                      C   PRODUCT BT*C*B                                              STIFF  170
                      C                                                               STIFF  171
                          DO 210 JJ=1,6                                               STIFF  172
                              DO 200 III=1,4                                          STIFF  173
                              SUM = 0.0                                               STIFF  174
                                  DO 190 JJJ=1,4                                      STIFF  175
                                  S = C(III,JJJ)*B(JJJ,JJ)                            STIFF  176
                                  SUM = SUM+S                                         STIFF  177
              190                 CONTINUE                                            STIFF  178
                              PROD(III,JJ) = SUM                                      STIFF  179
              200             CONTINUE                                                STIFF  180
              210         CONTINUE                                                    STIFF  181
                      C                                                               STIFF  182
                      C   NOW FORM FINAL PRODUCT                                      STIFF  183
                      C                                                               STIFF  184
                          DO 240 J=1,6                                                STIFF  185
                              DO 230 I=1,6                                            STIFF  186
                              SUM = 0.0                                               STIFF  187
                                  DO 220 II=1,4                                       STIFF  188
                                  S = BT(I,II)*PROD(II,J)                             STIFF  189
                                  SUM = SUM+S                                         STIFF  190
              220                 CONTINUE                                            STIFF  191
                              XKBAR(I,J) = SUM                                        STIFF  192
                              XKBAR(I,J) = XKBAR(I,J)*RBAR*2.0*PI*AREA                STIFF  193
              230             CONTINUE                                                STIFF  194
              240         CONTINUE                                                    STIFF  195
                      C                                                               STIFF  196
                      C                                                               STIFF  197
                      C   SET UP STIFFNESS FOR CONTACT CORRELATION BETWEEN THE FUEL AND STIFF  198
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      C   CLAD                                                                  STIFF    199
      C                                                                         STIFF    200
215         K = 0                                                               STIFF    201
            KK = 0                                                              STIFF    202
              DO 260 I=1,6                                                      STIFF    203
              IF (K.GE.2) K = 0                                                 STIFF    204
              NNN = NODET(N1)                                                   STIFF    205
220           IF (I.GT.2) NNN = NODET(N2)                                       STIFF    206
              IF (I.GT.4) NNN = NODET(N3)                                       STIFF    207
              KK = 0                                                            STIFF    208
                DO 250 J=1,6                                                    STIFF    209
                IF (KK.GE.2) KK = 0                                             STIFF    210
225             ND = NODET(N1)                                                  STIFF    211
                IF (J.GT.2) ND = NODET(N2)                                      STIFF    212
                IF (J.GT.4) ND = NODET(N3)                                      STIFF    213
      C                                                                         STIFF    214
      C   COMPUTE COORDINATES FOR THE MASTER STIFFNESS MATRIX FOR THE TOTAL      STIFF    215
230   C                                                                         STIFF    216
                II = NNN+K                                                      STIFF    217
                JJ = ND+KK                                                      STIFF    218
                KK = KK+1                                                       STIFF    219
                IF (JJ.LT.II) GO TO 250                                         STIFF    220
235             III = 8*(II-1)+JJ-II+1                                          STIFF    221
                IF (II.GT.KRNCHT) III = III-LKNT(II-KRNCHT)                     STIFF    222
                XKT(III) = XKT(III)+XKBAR(I,J)                                  STIFF    223
      250       CONTINUE                                                        STIFF    224
              K = K+1                                                           STIFF    225
240   260     CONTINUE                                                          STIFF    226
      C   DEVELOPE STRESS AND STRAIN MATRIX USING PROD(I,J) AND B(I,J)         STIFF    227
      C   WHERE STRESSES COME FROM S=PROD(I,J)*DISPLACEMENTS AND STRAINS        STIFF    228
      C   ARE EPSOLON=PROD(I,J)                                                 STIFF    229
      C                                                                         STIFF    230
245   C   CREATE  STRAIN MATRIX EPSLM(I,J,K) WHERE K IS THE VALUE OF            STIFF    231
      C   THE ELEMENT NO.                                                       STIFF    232
      C                                                                         STIFF    233
      C   CREATE STRESS MATRIX STRESS(I,J,K)                                    STIFF    234
      C                                                                         STIFF    235
250           DO 280 J=1,6                                                      STIFF    236
                DO 270 I=1,4                                                    STIFF    237
                EPSLM(I,J,KI) = B(I,J)                                          STIFF    238
                STRESS(I,J,KI) = PROD(I,J)                                      STIFF    239
      270       CONTINUE                                                        STIFF    240
255   280     CONTINUE                                                          STIFF    241
      C                                                                         STIFF    242
      C   DEFINE THE ARRAY XLOAD(I,J,KI).                                      STIFF    243
      C                                                                         STIFF    244
              DO 310 J=1,4                                                      STIFF    245
260             DO 300 I=1,6                                                    STIFF    246
                SUM = 0.                                                        STIFF    247
                  DO 290 II=1,4                                                 STIFF    248
                  SUM = SUM+BT(I,II)*C(II,J)                                    STIFF    249
      290         CONTINUE                                                      STIFF    250
265             XLOAD(I,J,KI) = SUM                                             STIFF    251
```

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      300            CONTINUE                                                  STIFF  252
      310          CONTINUE                                                    STIFF  253
           C                                                                   STIFF  254
           C   COMPUTE AREA ARRAY FOR EACH ELEMENT.                            STIFF  255
      270  C                                                                   STIFF  256
                 ARE(KI) = AREA                                                STIFF  257
           C                                                                   STIFF  258
           C   COMPUTE MEAN RADIUS ARRAY                                       STIFF  259
           C                                                                   STIFF  260
      275        RBR(KI) = RBAR                                                STIFF  261
           C                                                                   STIFF  262
                 IF (KI.EQ.NOELF+1) GO TO 320                                  STIFF  263
                 GO TO 350                                                     STIFF  264
           320   CONTINUE                                                      STIFF  265
      280  C                                                                   STIFF  266
           C   SAVE THE STIFFNESS MATRIX FOR THE INTERFACIAL ELEMENT.          STIFF  267
           C                                                                   STIFF  268
                    DO 340 I=1,6                                               STIFF  269
                       DO 330 J=1,6                                            STIFF  270
      285              XKSAVE(I,J,1) = XKBAR(I,J)                              STIFF  271
           330         CONTINUE                                                STIFF  272
           340      CONTINUE                                                   STIFF  273
           C                                                                   STIFF  274
           350   CONTINUE                                                      STIFF  275
      290  C   MATERIALS INFORMATION FOR THERMAL STRESS CORRECTION             STIFF  276
                 DO 370 J=1,4                                                  STIFF  277
                    DO 360 I=1,4                                               STIFF  278
                    CC(I,J,KI) = C(I,J)                                        STIFF  279
           360      CONTINUE                                                   STIFF  280
      295  370   CONTINUE                                                      STIFF  281
           380   CONTINUE                                                      STIFF  282
           C                                                                   STIFF  283
                 RETURN                                                        STIFF  284
                 END                                                           STIFF  285
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	STIFF	1	298

VARIABLES

	SN	TYPE		RELOCATION								
2	ALPHA	REAL		LASTIC	REFS	24						
0	ANRIN	REAL		MATCNS	REFS	35						
0	ARE	REAL	ARRAY	F.P.	REFS	12	DEFINED	1	271			
1174	AREA	REAL			REFS	91	99	107	116	207	271	
					DEFINED	76						
1200	A1	REAL			REFS	93	96	DFFINED	81			
1201	A2	REAL			REFS	101	104	DEFINED	82			
1202	A3	REAL			REFS	109	112	DEFINED	83			

VARIABLES	SN	TYPE	RELOCATION									
0	B	REAL	ARRAY	STFMAT	REFS	27	116	178	190	252		
					DEFINED	90	91	92	93	94	95	96
					97	98	99	100	101	102	103	104
					105	106	107	108	109	110	111	112
					113	116						
60	BT	REAL	ARRAY	STFMAT	REFS	27	203	263	DEFINED	178		
1175	B1	REAL			REFS	90	97	DEFINED	78			
1176	B2	REAL			REFS	98	105	DEFINED	79			
1177	B3	REAL			REFS	106	113	DEFINED	80			
30	C	REAL	ARRAY	STFMAT	REFS	27	141	142	143	145	146	190
					263	293	DEFINED	137	138	139	140	141
					142	143	144	145	146	147	148	149
					150	151	152	164	165	167	168	171
0	CC	REAL	ARRAY	F.P.	REFS	12	DEFINED	1	293			
1220	COEF	REAL			REFS	167	168	171	DEFINED	162		
1216	COEFA	REAL			REFS	137	138	139	147	152		
					DEFINED	136						
14	COMP	REAL		GEOPAR	REFS	15						
1215	CONST	REAL			REFS	136	137	138	152	DEFINED	135	
33	CP	REAL		LIMITS	REFS	17						
34	CR	REAL		LIMITS	REFS	17						
2	CWKF	REAL		MATCNS	REFS	35	160	161				
3	CWNF	REAL		MATCNS	REFS	35						
1	DCOMP	REAL		MATCNS	REFS	35						
4	DELOXY	REAL		MATCNS	REFS	35	160	161				
5	DELR	REAL		GEOPAR	REFS	15						
6	DELZ	REAL		GEOPAR	REFS	15	42					
0	DELZA	REAL	ARRAY	BA	REFS	29						
11	DRFDEN	REAL		MATCNS	REFS	35						
0	E	REAL		LASTIC	REFS	24	161	162	DEFINED	160		
1213	EA	REAL			REFS	132	134	DEFINED	130	132		
102	EAX	REAL	ARRAY	BA	REFS	29	130					
0	ELM	REAL	ARRAY	F.P.	REFS	10	65	66	67	DEFINED	1	
0	EPSLM	REAL	ARRAY	F.P.	REFS	10	DEFINED	1	252			
1212	ER	REAL			REFS	131	134	136	DEFINED	129	131	
56	ERAD	REAL	ARRAY	BA	REFS	29	129					
1214	ERAT	REAL			REFS	135	147	152	DEFINED	134		
5	FLUX	REAL		MATCNS	REFS	35						
55	FLXR	REAL		BA	REFS	29						
6	FNCK	REAL		MATCNS	REFS	35	160	161				
7	FNCN	REAL		MATCNS	REFS	35						
10	FOTMTL	REAL		MATCNS	REFS	35						
35	FRDEN	REAL		LIMITS	REFS	17						
12	FTMELT	REAL		MATCNS	REFS	35						
0	HHF	REAL		FEP	REFS	31						
1206	I	INTEGER			REFS	2*116	167	2*168	2*178	203	206	2*207
					220	221	237	2*252	2*253	263	265	2*285
					2*293	DEFINED	115	166	177	200	217	251
					260	283	292					
57	IADJ	INTEGER		LIMITS	REFS	17						
103	ICHNG	INTEGER		FEP	REFS	31						
67	ICNT	INTEGER		LIMITS	REFS	17						
42	ICRPP	INTEGER		LIMITS	REFS	17						

VARIABLES	SN	TYPE	RELOCATION									
60	ICUT	INTEGER	LIMITS	REFS	17							
5	IDF	INTEGER	LIMITS	REFS	17							
1226	II	INTEGER		REFS	2*203	234	2*235	2*236	2*263			
				DEFINED	202	231	262					
1222	III	INTEGER		REFS	190	193	236	2*237	DEFINED	187	235	
				236								
40	IPLAS	INTEGER	LIMITS	REFS	17							
73	IPLEND	INTEGER	LIMITS	REFS	17							
71	IRAK	INTEGER	LIMITS	REFS	17							
75	IRZ	INTEGER	LIMITS	REFS	17							
74	ISP	INTEGER	LIMITS	REFS	17							
37	ISSTOP	INTEGER	LIMITS	REFS	17							
3	ISTOP	INTEGER	FEP	REFS	31							
53	ISTRT	INTEGER	BA	REFS	29							
54	ITER	INTEGER	BA	REFS	29							
63	ITI	INTEGER	LIMITS	REFS	17							
4	ITP1	INTEGER	TAPES	REFS	26							
5	ITP2	INTEGER	TAPES	REFS	26							
1160	J	INTEGER		REFS	41	42	3*43	2*44	2*116	164	165	
				167	2*168	2*178	203	206	2*207	226	227	
				237	2*252	2*253	263	265	2*285	2*293		
				DEFINED	40	114	163	176	199	223	250	
				259	284	291						
24	JAM	INTEGER	LIMITS	REFS	17							
1221	JJ	INTEGER		REFS	190	193	234	235	DEFINED	186	232	
1224	JJJ	INTEGER		REFS	2*190	DEFINED	189					
1227	K	INTEGER		REFS	218	231	239	DEFINED	215	218	239	
12	KA	INTEGER	LIMITS	REFS	17	2*43	122	129	130			
1161	KI	INTEGER		REFS	65	66	67	122	123	252	253	
				265	271	275	277	293	DEFINED	64		
1230	KK	INTEGER		REFS	224	232	233	DEFINED	216	222	224	
				233								
10	KKA	INTEGER	GEOPAR	REFS	15							
2	KKZZZ	INTEGER	FEP	REFS	31							
66	KPLAS	INTEGER	LIMITS	REFS	17							
55	KRNCH	INTEGER	LIMITS	REFS	17							
45	KRNCHC	INTEGER	LIMITS	REFS	17	DEFINED	53					
44	KRNCHF	INTEGER	LIMITS	REFS	17	DEFINED	52					
46	KRNCHT	INTEGER	LIMITS	REFS	17	2*236	DEFINED	55				
36	KZI	INTEGER	LIMITS	REFS	17							
1235	LINT	INTEGER ARRAY		REFS	10	236	DEFINED	46	47	48	49	
				50	51							
52	MAXB	INTEGER	LIMITS	REFS	17							
43	MAXT	INTEGER	LIMITS	REFS	17	62						
56	MCUT	INTEGER	LIMITS	REFS	17							
17	NABC	INTEGER	LIMITS	REFS	17							
16	NABF	INTEGER	LIMITS	REFS	17							
0	NABFD	INTEGER	F.P.	REFS	10	DEFINED	1					
31	NABF2	INTEGER	LIMITS	REFS	17							
20	NABT	INTEGER	LIMITS	REFS	17							
32	NABT2	INTEGER	LIMITS	REFS	17							
21	NAEC	INTEGER	LIMITS	REFS	17							
22	NAEF	INTEGER	LIMITS	REFS	17							

VARIABLES	SN	TYPE		RELOCATION								
14	NARC	INTEGER		LIMITS	REFS	17						
13	NARF	INTEGER		LIMITS	REFS	17						
15	NART	INTEGER		LIMITS	REFS	17						
25	NAXBT	INTEGER		LIMITS	REFS	17						
26	NAXB2	INTEGER		LIMITS	REFS	17						
27	NAXB4	INTEGER		LIMITS	REFS	17						
1	NC	INTEGER		LIMITS	REFS	17						
52	NCNN	INTEGER		BA	REFS	29						
51	NCONN	INTEGER		BA	REFS	29						
50	NC4	INTEGER		LIMITS	REFS	17	53					
1232	ND	INTEGER			REFS	232	DEFINED	225	226	227		
7	NETOT	INTEGER		LIMITS	REFS	17						
53	NEW	INTEGER		LIMITS	REFS	17	122					
10	NEWF	INTEGER		LIMITS	REFS	17						
11	NEWT	INTEGER		LIMITS	REFS	17						
0	NF	INTEGER		LIMITS	REFS	17	56					
6	NFF	INTEGER		LIMITS	REFS	17						
30	NFF1	INTEGER		LIMITS	REFS	17	40	42	44	54		
0	NFF1D	INTEGER		F.P.	REFS	13	DEFINED	1				
47	NFF2	INTEGER		LIMITS	REFS	17						
51	NF4	INTEGER		LIMITS	REFS	17	52	DEFINED	56			
0	NIN	INTEGER		TAPES	REFS	26						
41	NKN	INTEGER		LIMITS	REFS	17						
54	NMX	INTEGER		LIMITS	REFS	17	55	DEFINED	54			
50	NN	INTEGER		BA	REFS	29						
1231	NNN	INTEGER			REFS	231	DEFINED	219	220	221		
0	NODET	INTEGER	ARRAY	F.P.	REFS	10	219	220	221	225	226	227
					DEFINED	1						
2	NOEL	INTEGER		LIMITS	REFS	17	61	64				
4	NOELC	INTEGER		LIMITS	REFS	17						
0	NOELD	INTEGER		F.P.	REFS	10	DEFINED	1				
3	NOELF	INTEGER		LIMITS	REFS	17	123	277				
65	NOLD	INTEGER		LIMITS	REFS	17						
1	NOUT	INTEGER		TAPES	REFS	26						
2	NSCR1	INTEGER		TAPES	REFS	26						
3	NSCR2	INTEGER		TAPES	REFS	26						
1	NT	INTEGER		FEP	REFS	31						
23	NTAE	INTEGER		LIMITS	REFS	17						
57	NTOLD	INTEGER	ARRAY	FEP	REFS	31						
1162	N1	INTEGER			REFS	68	71	219	225	DEFINED	65	
1163	N2	INTEGER			REFS	69	72	220	226	DEFINED	66	
1164	N3	INTEGER			REFS	70	73	221	227	DEFINED	67	
13	PDEL	REAL		GEOPAR	REFS	15						
0	PI	REAL		CONTNT	REFS	25	207					
11	PIN	REAL		GEOPAR	REFS	15						
54	PIMOLD	REAL		FEP	REFS	31						
56	POLD	REAL		FEP	REFS	31						
12	POUT	REAL		GEOPAR	REFS	15						
55	POUTLD	REAL		FEP	REFS	31						
110	PROD	REAL	ARRAY	STFMAT	REFS	27	203	253	DEFINED	193		
0	R	REAL	ARRAY	F.P.	REFS	10	44	68	69	70		
					DEFINED	1	43	44				
72	RAKSUM	REAL		LIMITS	REFS	17						

VARIABLES	SN	TYPE	RELOCATION										
1173	RBAR	REAL			REFS	91	99	107	207	275			
					DEFINED	75							
0	RBR	REAL	ARRAY	F.P.	REFS	12	DEFINED	1	275				
2	RCI	REAL		GEOPAR	REFS	15							
3	RCO	REAL		GEOPAR	REFS	15							
0	RD	REAL	ARRAY	F.P.	REFS	13	2*43	DEFINED	1				
4	RDOLD	REAL	ARRAY	FEP	REFS	31							
0	RFI	REAL		GEOPAR	REFS	15							
1	RFO	REAL		GEOPAR	REFS	15							
70	RRAKR	REAL		LIMITS	REFS	17							
30	RRSIN	REAL	ARRAY	FEP	REFS	31							
13	RSTRAN	REAL		MATCNS	REFS	35							
1165	R1	REAL			REFS	75	2*76	82	83	DEFINED	68		
1166	R2	REAL			REFS	75	2*76	81	83	DEFINED	69		
1167	R3	REAL			REFS	75	2*76	81	82	DEFINED	70		
1225	S	REAL			REFS	191	204	DEFINED	190	203			
64	STEP	REAL		LIMITS	REFS	17							
104	STEPS	REAL		FEP	REFS	31							
0	STRESS	REAL	ARRAY	F.P.	REFS	10	61	DEFINED	1	253			
1223	SUM	REAL			REFS	191	193	204	206	263	265		
					DEFINED	188	191	201	204	261	263		
0	TELM	REAL	ARRAY	F.P.	REFS	10	122	DEFINED	1				
1207	TF	REAL			REFS	159	DEFINED	122					
61	TIMEC	REAL		LIMITS	REFS	17							
62	TIMEF	REAL		LIMITS	REFS	17							
1217	TK	REAL			REFS	160	161	DEFINED	159				
4	TREF	REAL		GEOPAR	REFS	15							
140	XKBAR	REAL	ARRAY	STFMAT	REFS	27	207	237	285	DEFINED	206	207	
0	XKSAVE	REAL	ARRAY	F.P.	REFS	12	DEFINED	1	285				
0	XKT	REAL	ARRAY	F.P.	REFS	10	62	237	DEFINED	1	237		
0	XLOAD	REAL	ARRAY	F.P.	REFS	12	DEFINED	1	265				
1203	XL1	REAL			REFS	91	DEFINED	84					
1204	XL2	REAL			REFS	99	DEFINED	85					
1205	XL3	REAL			REFS	107	DEFINED	86					
1	XNU	REAL		LASTIC	REFS	24	2*162	167	168	171			
					DEFINED	161							
1211	XNUA	REAL			REFS	2*135	139	152	DEFINED	128			
1210	XNUR	REAL			REFS	2*136	138	139	2*147	2*152			
					DEFINED	127							
0	Z	REAL	ARRAY	F.P.	REFS	10	71	72	73	DEFINED	1	41	
					42								
7	ZDEL	REAL		GEOPAR	REFS	15							
1170	Z1	REAL			REFS	2*76	79	80	DEFINED	71			
1171	Z2	REAL			REFS	2*76	78	80	DEFINED	72			
1172	Z3	REAL			REFS	2*76	78	79	DEFINED	73			

EXTERNALS	TYPE	ARGS	REFERENCES	
CELMOD	REAL	4	160	
CSHEAR	REAL	4	161	
MOVEKA		3	61	62

STATEMENT	LABELS	DEF LINE	REFERENCES
0	100	45	40
0	110	117	115
0	120	118	114
443	130	155	123
0	140	169	166
0	150	170	163
525	160	172	154
0	170	179	177
0	180	180	176
0	190	192	189
0	200	194	187
0	210	195	186
0	220	205	202
0	230	208	200
0	240	209	199
753	250	238	223 234
0	260	240	217
0	270	254	251
0	280	255	250
0	290	264	262
0	300	266	260
0	310	267	259
1060	320	279	277
0	330	286	284
0	340	287	283
1100	350	289	278
0	360	294	292
0	370	295	291
0	380	296	64

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
16	100	J	40 45	21B	OPT
104	380	KI	64 296	1016B	EXT REFS NOT INNER
300	120	J	114 118	14B	NOT INNER
302	110	I	115 117	7B	INSTACK
471	150	J	163 170	26B	NOT INNER
477	140	I	166 169	15B	OPT
527	180	J	176 180	15B	NOT INNER
531	170	I	177 179	10B	INSTACK
546	210	JJ	186 195	34B	NOT INNER
550	200	III	187 194	27B	NOT INNER
554	190	JJJ	189 192	14B	OPT
604	240	J	199 209	42B	NOT INNER
606	230	I	200 208	35B	NOT INNER
612	220	II	202 205	14B	OPT
654	260	I	217 240	107B	NOT INNER
700	250	J	223 238	56B	OPT
765	280	J	250 255	22B	NOT INNER
767	270	I	251 254	15B	OPT
1011	310	J	259 267	34B	NOT INNER
1013	300	I	260 266	27B	NOT INNER
1017	290	II	262 264	12B	INSTACK

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
1062	340	I	283 287	158	NOT INNER
1064	330	J	284 286	108	INSTACK
1102	370	J	291 295	158	NOT INNER
1104	360	I	292 294	108	INSTACK

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62
LASTIC	3
CONTNT	1
TAPES	6
STFMAT	132
BA	86
FEP	69
MATCNS	12

STATISTICS

PROGRAM LENGTH	1301B	705
SCM LABELED COMMON LENGTH	600B	384

140000B SCM USED

```
      SUBROUTINE STRES (B,ELM,ELSTN,ELSTRS,EPSLM,NODET,CC,THETEO,STRESS,
     +TSTNR,TSTSR,ELSTSA,ELSTNA,NOELD,DISPC,NFFID,ARAA,RBRA)
C
C   STRES IS CALLED FROM SOLVET
C
C   THIS SUBROUTINE CALCULATES THE INCREMENTAL ELEMENT STRAINS (ELSTN)
C   AND STRESSES (ELSTRS) FROM THE NODAL DISPLACEMENTS(BB OR BC)
C   NOTE THAT THE STRESS EQUIVALENT OF THE ELEMENT THERMAL STRAINS
C   (THETEO) ARE SUBTRACTED OFF.  THE INCREMENTAL STRESSES AND STRAINS
C   ARE ADDED TO THE TOTAL STRESS-STRAIN ARRAY-TSTSR, TSTNR.
C
C   BEGIN LOOP FOR ADDING THE INCREMENTAL STRESSES AND STRAINS TO THE
C   TOTAL ARRAY
      COMMON /GEOPAR/ RFI,RFO,RCI,RCO,TREF,DELR,DELZ,ZDEL,KKA,PIN,POUT,P
     +DEL,COMP
      COMMON/LIMITS/ NF, NC, NOEL, NOELF, NOELC, IDF, NFF, NETOT,     NE
     +WF,NEWT,KA,NARF,NARC,NART,NABF,NABC,NABT,NAEC,NAEF,NTAE,JAM,NAXBT,
     +NAXB2,NAXB4,NFF1,NABF2,NABT2,     CP,CR,FRDEN,KZ1,ISSTOP,IPLAS,NKN
     +,ICRPP,MAXT,KRNCHF,KRNCHC,KRNCHT,NFF2,NC4,NF4,MAXA,NEW,          N
     +MX,KRNCH,NCUD,IADJ,ICUT,TIMEC,TIMEF,ITI,STEP,NOLD
     +, KPLAS,ICNT,RRAKR,IRAK,RAKSUM,IPLEND,ISP
     +,IRZ
      COMMON /LASTIC/ E,XNU,ALPHA
      COMMON /CONTNT/ PI
      COMMON /TAPES/ NIN,NOUT,NSCR1,NSCR2,ITP1,ITP2
C
      DIMENSION B(1),ELM(3,1),EPSLM(4,6,1),ELSTN(4,1),ELSTRS(4,1),
     +NODET(1),STRESS(4,6,1)
      DIMENSION NN(3), CC(4,4,1), THETEO(4,1)
      DIMENSION DISP(6),DISPC(NFFID,1)
      DIMENSION TSTNR(4,NOELD,1), TSTSR(4,NOELD,1), ELSTSA(4,1), ELSTN
     +4,1)
      DIMENSION ARAA(1), RBRA(1)
C
          DO 210 KI=1,NOEL
          NN(1) = ELM(1,KI)
          NN(2) = ELM(2,KI)
          NN(3) = ELM(3,KI)
C
              DO 100 I=1,3
              J = I*2-1
              NNI = NN(I)
              IN = NODET(NNI)
              DISP(J) = B(IN)
              DISP(J+1) = B(IN+1)
              IDN = NNI
              IF (NNI.GT.NFFID) IDN = NNI-NFFID
              DISPC(IDN,KA) = B(IN)
  100         CONTINUE
C
C   USE ELEMENT NODAL DISPLACEMENTS TO OBTAIN ELEMENT STRAINS
C   AND STRESSES
C
```

```
                      DO 130 I=1,4                                                  STRES      44
55                    S = 0.0                                                       STRES      45
                      SS = 0.0                                                      STRES      46
                          DO 110 J=1,6                                              STRES      47
               C                                                                    STRES      48
               C   COMPUTE STRAIN                                                   STRES      49
60             C                                                                    STRES      50
                          S = S+EPSLM(I,J,KI)*DISP(J)                               STRES      51
               C                                                                    STRES      52
               C   CPMPUTE STRESSES                                                STRES      53
               C                                                                    STRES      54
65                        SS = SS+STRESS(I,J,KI)*DISP(J)                           STRES      55
               110        CONTINUE                                                 STRES      56
               C                                                                    STRES      57
               C   ELEMENT STRAIN                                                  STRES      58
                      ELSTN(I,KI) = S                                               STRES      59
70             C                                                                    STRES      60
               C   ELEMENT STRESS                                                  STRES      61
               C                                                                    STRES      62
                      SIGO = 0.0                                                    STRES      63
                          DO 120 II=1,4                                             STRES      64
75                        SIGO = SIGO+CC(I,II,KI)*THETEO(II,KI)                    STRES      65
               120        CONTINUE                                                 STRES      66
                      ELSTRS(I,KI) = SS-SIGO                                        STRES      67
               130    CONTINUE                                                     STRES      68
                    IF (ISSTOP.NE.1.OR.KKA.EQ.1) GO TO 210                          STRES      69
80                  DO 200 I=1,4                                                  STRES      70
                    IF (IRZ.EQ.1.AND.NKN.EQ.1.AND.ISSTOP.EQ.1) GO TO 140          STRES      71
                    GO TO 170                                                     STRES      72
               140  CONTINUE                                                      STRES      73
                    IF (I.EQ.3) GO TO 150                                         STRES      74
85                  TSTNR(I,KI,KA) = ELSTN(I,KI)                                  STRES      75
                    TSTSR(I,KI,KA) = ELSTRS(I,KI)                                 STRES      76
                    GO TO 200                                                     STRES      77
               150  MM = 4*KA                                                     STRES      78
                    IF (KI.GT.NOELF) MM = 4*KA+NAEF                               STRES      79
90             C                                                                  STRES      80
               C                                                                  STRES      81
               C   MUST DEFINE A VOLUME WEIGHT FOR AXIAL STRESS TO MESH WITH TOTAL ST  STRES  82
                    STS = 0.0                                                     STRES      83
                    STN = 0.0                                                     STRES      84
95                  TA = ARAA(MM)*RBRA(MM)+ARAA(MM-1)*RBRA(MM-1)+ARAA(MM-2)*RB    STRES      85
                  + RA(MM-2)+ARAA(MM-3)*RBRA(MM-3)                                STRES      86
                        DO 160 II=1,4                                             STRES      87
                        MK = MM-(II-1)                                            STRES      88
                        WI = ARAA(MK)*RBRA(MK)/TA                                 STRES      89
100                     STS = STS+WI*ELSTSA(3,MK)                                 STRES      90
                        STN = STN+WI*ELSTNA(3,MK)                                 STRES      91
               160      CONTINUE                                                  STRES      92
                    TSTNR(3,KI,KA) = STN                                          STRES      93
                    TSTSR(3,KI,KA) = STS                                          STRES      94
105                 ELSTN(3,KI) = STN                                             STRES      95
                    ELSTRS(3,KI) = STS                                            STRES      96
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```
                      GO TO 200                                                  STRES      97
              170     IF (I.EQ.3) GO TO 180                                      STRES      98
                      TSTNR(I,KI,KA) = TSTNR(I,KI,KA)+ELSTN(I,KI)                STRES      99
110                   TSTSR(I,KI,KA) = TSTSR(I,KI,KA)+ELSTRS(I,KI)               STRES     100
                      GO TO 200                                                  STRES     101
              180     MM = 4*KA                                                  STRES     102
                      IF (KI.GT.NOELF) MM = 4*KA+NAEF                            STRES     103
                      STS = 0.0                                                  STRES     104
115                   STN = 0.0                                                  STRES     105
                      TA = ARAA(MM)*RBRA(MM)+ARAA(MM-1)*RBRA(MM-1)+ARAA(MM-2)*RB STRES     106
                  +   RA(MM-2)+ARAA(MM-3)*RBRA(MM-3)                             STRES     107
                          DO 190 II=1,4                                          STRES     108
                          MK = MM-(II-1)                                         STRES     109
120                       WI = ARAA(MK)*RBRA(MK)/TA                              STRES     110
                          STS = STS+WI*ELSTSA(3,MK)                              STRES     111
                          STN = STN+WI*ELSTNA(3,MK)                              STRES     112
              190         CONTINUE                                               STRES     113
                      TSTNR(3,KI,KA) = TSTNR(I,KI,KA)+STN                        STRES     114
125                   ELSTRS(3,KI) = STS                                         STRES     115
                      ELSTN(3,KI) = STN                                          STRES     116
                      TSTSR(3,KI,KA) = TSTSR(I,KI,KA)+STS                        STRES     117
              200     CONTINUE                                                   STRES     118
                    IF (KA.EQ.NARC.AND.KI.LE.NOELF) TSTSR(3,KI,KA) = 0.0         STRES     119
130           210   CONTINUE                                                     STRES     120
                    C                                                            STRES     121
                    C   TIME CUTTING FOR CREEP CALCULATIONS                      STRES     122
                    C   SKIP TIME CUTTING FOR ELASTIC AND PLASTIC CALCULATIONS.  STRES     123
                    C   TIME CUTTING FOR CREEP CALCULATIONS                      STRES     124
135                 C   SKIP TIME CUTTING FOR ELASTIC AND PLASTIC CALCULATIONS   STRES     125
                      IF (KPLAS.GT.0.AND.KPLAS.LT.IPLEND) GO TO 250              STRES     126
                      IF (KPLAS.EQ.IPLEND.AND.IPLAS.EQ.1) GO TO 250              STRES     127
                      IF (KPLAS.EQ.IPLEND.AND.ISP.EQ.1) GO TO 250                STRES     128
                      IF (ISSTOP.NE.1) GO TO 250                                 STRES     129
140                   IF (ICUT.EQ.1.AND.KKA.EQ.2) GO TO 220                      STRES     130
                      IF (NKN.NE.2) GO TO 240                                    STRES     131
                      IF (ICUT.EQ.1) GO TO 240                                   STRES     132
              220   CONTINUE                                                     STRES     133
                      IF (KA.EQ.1) BSCHK = 0.0                                   STRES     134
145                   IF (KA.EQ.1) BIG = 0.0                                     STRES     135
                        DO 230 I=1,NOEL                                          STRES     136
                        BIGCHK = ABS(TSTSR(2,I,KA))                              STRES     137
                        CHK = ABS(ELSTRS(2,I)/TSTSR(2,I,KA))                     STRES     138
                        IF (CHK.LT.BSCHK.OR.BIGCHK.LT.2000.) GO TO 230           STRES     139
150                     IF (BIGCHK.LT.5000..AND.I.LE.NOELF) GO TO 230            STRES     140
                        BSCHK = CHK                                              STRES     141
                        BIG = BIGCHK                                             STRES     142
                        MAXI = I                                                 STRES     143
                        KASV = KA                                                STRES     144
155           230       CONTINUE                                                 STRES     145
                      IF (KA.NE.NARC) GO TO 240                                  STRES     146
                      IF (BIG.LT.2000) GO TO 250                                 STRES     147
                      IF (ICUT.EQ.1) GO TO 240                                   STRES     148
                      IF (BSCHK.LT..05) GO TO 240                                STRES     149
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160                 IADJ = IFIX(BSCHK/0.05)                                          STRES     150
                    ICUT = 1                                                         STRES     151
                    IF (IADJ.GT.0) WRITE (6,260) KASV,MAXI,IADJ                      STRES     152
                    IF (IADJ.EQ.1) GO TO 240                                         STRES     153
                    STEP = (TIMEF-TIMEC)/FLOAT(IADJ-1)                               STRES     154
165           240   CONTINUE                                                         STRES     155
              250   CONTINUE                                                         STRES     156
                    RETURN                                                           STRES     157
              C                                                                      STRES     158
              C                                                                      STRES     159
170           C                                                                      STRES     160
              260   FORMAT (5X,"CREEP CORRECTION IS TOO LARGE IN REGION",I5,"ELEMENT", STRES     161
                   +I5,"REQUIRED SUBSTEPS=",I5)                                      STRES     162
                    END                                                              STRES     163
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	STRES	1	167

VARIABLES

	SN	TYPE		RELOCATION								
2	ALPHA	REAL		LASTIC	REFS	23						
0	ARAA	REAL	ARRAY	F.P.	REFS	33	4*95	99	4*116	120		
					DEFINED	1						
0	B	REAL	ARRAY	F.P.	REFS	27	44	45	48	DEFINED	1	
660	BIG	REAL			REFS	157	DEFINED	145	152			
661	BIGCHK	REAL			REFS	149	150	152	DEFINED	147		
657	BSCHK	REAL			REFS	149	159	160	DEFINED	144	151	
0	CC	REAL	ARRAY	F.P.	REFS	29	75	DEFINED	1			
662	CHK	REAL			REFS	149	151	DEFINED	148			
14	COMP	REAL		GEOPAR	REFS	14						
33	CP	REAL		LIMITS	REFS	16						
34	CR	REAL		LIMITS	REFS	16						
5	DELR	REAL		GEOPAR	REFS	14						
6	DELZ	REAL		GEOPAR	REFS	14						
670	DISP	REAL	ARRAY		REFS	30	61	65	DEFINED	44	45	
0	DISPC	REAL	ARRAY	F.P.	REFS	30	DEFINED	1	48			
0	E	REAL		LASTIC	REFS	23						
0	ELM	REAL	ARRAY	F.P.	REFS	27	36	37	38	DEFINED	1	
0	ELSTN	REAL	ARRAY	F.P.	REFS	27	85	109	DEFINED	1	69	105
					126							
0	ELSTNA	REAL	ARRAY	F.P.	REFS	31	101	122	DEFINED	1		
0	ELSTRS	REAL	ARRAY	F.P.	REFS	27	86	110	148	DEFINED	1	77
					106	125						
0	ELSTSA	REAL	ARRAY	F.P.	REFS	31	100	121	DEFINED	1		
0	EPSLM	REAL	ARRAY	F.P.	REFS	27	61	DEFINED	1			
35	FRDEN	REAL		LIMITS	REFS	16						
640	I	INTEGER			REFS	41	42	61	65	69	75	77
					84	2*85	2*86	108	3*109	3*110	124	127

VARIABLES	SN	TYPE	RELOCATION								
				147	2*148	150	153	DEFINED	40	54	80
				146							
57	IADJ	INTEGER	LIMITS	REFS	16	2*162	163	164	DEFINED	160	
67	ICNT	INTEGER	LIMITS	REFS	16						
42	ICRPP	INTEGER	LIMITS	REFS	16						
60	ICUT	INTEGER	LIMITS	REFS	16	140	142	158	DEFINED	161	
5	IDF	INTEGER	LIMITS	REFS	16						
644	IDN	INTEGER		REFS	48	DEFINED	46	47			
650	II	INTEGER		REFS	2*75	98	119	DEFINED	74	97	118
643	IN	INTEGER		REFS	44	45	48	DEFINED	43		
40	IPLAS	INTEGER	LIMITS	REFS	16	137					
73	IPLEND	INTEGER	LIMITS	REFS	16	136	137	138			
71	IRAK	INTEGER	LIMITS	REFS	16						
75	IRZ	INTEGER	LIMITS	REFS	16	81					
74	ISP	INTEGER	LIMITS	REFS	16	138					
37	ISSTOP	INTEGER	LIMITS	REFS	16	79	81	139			
63	ITI	INTEGER	LIMITS	REFS	16						
4	ITP1	INTEGER	TAPES	REFS	25						
5	ITP2	INTEGER	TAPES	REFS	25						
641	J	INTEGER		REFS	44	45	2*61	2*65	DEFINED	41	57
24	JAM	INTEGER	LIMITS	REFS	16						
12	KA	INTEGER	LIMITS	REFS	16	48	85	86	88	89	103
				104	2*109	2*110	112	113	2*124	2*127	2*129
				144	145	147	148	154	156		
664	KASV	INTEGER		REFS	162	DEFINED	154				
637	KI	INTEGER		REFS	36	37	38	61	65	69	2*75
				77	2*85	2*86	89	103	104	105	106
				3*109	3*110	113	2*124	125	126	2*127	2*129
				DEFINED	35						
10	KKA	INTEGER	GEOPAR	REFS	14	79	140				
66	KPLAS	INTEGER	LIMITS	REFS	16	2*136	137	138			
55	KRNCH	INTEGER	LIMITS	REFS	16						
45	KRNCHC	INTEGER	LIMITS	REFS	16						
44	KRNCHF	INTEGER	LIMITS	REFS	16						
46	KRNCHT	INTEGER	LIMITS	REFS	16						
36	KZI	INTEGER	LIMITS	REFS	16						
52	MAXA	INTEGER	LIMITS	REFS	16						
663	MAXI	INTEGER		REFS	162	DEFINED	153				
43	MAXT	INTEGER	LIMITS	REFS	16						
56	MCUD	INTEGER	LIMITS	REFS	16						
655	MK	INTEGER		REFS	2*99	100	101	2*120	121	122	
				DEFINED	98	119					
651	MM	INTEGER		REFS	8*95	98	8*116	119	DEFINED	88	89
				112	113						
17	NABC	INTEGER	LIMITS	REFS	16						
16	NABF	INTEGER	LIMITS	REFS	16						
31	NABF2	INTEGER	LIMITS	REFS	16						
20	NABT	INTEGER	LIMITS	REFS	16						
32	NABT2	INTEGER	LIMITS	REFS	16						
21	NAEC	INTEGER	LIMITS	REFS	16						
22	NAEF	INTEGER	LIMITS	REFS	16	89	113				
14	NARC	INTEGER	LIMITS	REFS	16	129	156				
13	NARF	INTEGER	LIMITS	REFS	16						

VARIABLES	SN	TYPE		RELOCATION								
15	NART	INTEGER		LIMITS	REFS	16						
25	NAXBT	INTEGER		LIMITS	REFS	16						
26	NAXB2	INTEGER		LIMITS	REFS	16						
27	NAXB4	INTEGER		LIMITS	REFS	16						
1	NC	INTEGER		LIMITS	REFS	16						
50	NC4	INTEGER		LIMITS	REFS	16						
7	NETOT	INTEGER		LIMITS	REFS	16						
53	NEW	INTEGER		LIMITS	REFS	16						
10	NEWF	INTEGER		LIMITS	REFS	16						
11	NEWT	INTEGER		LIMITS	REFS	16						
0	NF	INTEGER		LIMITS	REFS	16						
6	NFF	INTEGER		LIMITS	REFS	16						
30	NFF1	INTEGER		LIMITS	REFS	16						
0	NFF1D	INTEGER		F.P.	REFS	30	2*47	DEFINED	1			
47	NFF2	INTEGER		LIMITS	REFS	16						
51	NF4	INTEGER		LIMITS	REFS	16						
0	NIN	INTEGER		TAPES	REFS	25						
41	NKN	INTEGER		LIMITS	REFS	16	81	141				
54	NMX	INTEGER		LIMITS	REFS	16						
665	NN	INTEGER	ARRAY		REFS	29	42	DEFINED	36	37	38	
642	NNI	INTEGER			REFS	43	46	2*47	DEFINED	42		
0	NODET	INTEGER	ARRAY	F.P.	REFS	27	43	DEFINED	1			
2	NOEL	INTEGER		LIMITS	REFS	16	35	146				
4	NOELC	INTEGER		LIMITS	REFS	16						
0	NOELD	INTEGER		F.P.	REFS	2*31	DEFINED	1				
3	NOELF	INTEGER		LIMITS	REFS	16	89	113	129	150		
65	NOLD	INTEGER		LIMITS	REFS	16						
1	NOUT	INTEGER		TAPES	REFS	25						
2	NSCR1	INTEGER		TAPES	REFS	25						
3	NSCR2	INTEGER		TAPES	REFS	25						
23	NTAE	INTEGER		LIMITS	REFS	16						
13	PDEL	REAL		GEOPAR	REFS	14						
0	PI	REAL		CONTNT	REFS	24						
11	PIN	REAL		GEOPAR	REFS	14						
12	POUT	REAL		GEOPAR	REFS	14						
72	RAKSUM	REAL		LIMITS	REFS	16						
0	RBRA	REAL	ARRAY	F.P.	REFS	33	4*95	99	4*116	120		
					DEFINED	1						
2	RCI	REAL		GEOPAR	REFS	14						
3	RCO	REAL		GEOPAR	REFS	14						
0	RFI	REAL		GEOPAR	REFS	14						
1	RFO	REAL		GEOPAR	REFS	14						
70	RRAKR	REAL		LIMITS	REFS	16						
645	S	REAL			REFS	61	69	DEFINED	55	61		
647	SIGO	REAL			REFS	75	77	DEFINED	73	75		
646	SS	REAL			REFS	65	77	DEFINED	56	65		
64	STEP	REAL		LIMITS	REFS	16	DEFINED	164				
653	STN	REAL			REFS	101	103	105	122	124	126	
					DEFINED	94	101	115	122			
0	STRESS	REAL	ARRAY	F.P.	REFS	27	65	DEFINED	1			
652	STS	REAL			REFS	100	104	106	121	125	127	
					DEFINED	93	100	114	121			
654	TA	REAL			REFS	99	120	DEFINED	95	116		

VARIABLES	SN	TYPE	RELOCATION								
0	THETEO	REAL	ARRAY	F.P.	REFS	29	75	DEFINED	1		
61	TIMEC	REAL		LIMITS	REFS	16	164				
62	TIMEF	REAL		LIMITS	REFS	16	164				
4	TREF	REAL		GEOPAR	REFS	14					
0	TSTNR	REAL	ARRAY	F.P.	REFS	31	109	124	DEFINED	1	85	103
					109	124						
0	TSTSR	REAL	ARRAY	F.P.	REFS	31	110	127	147	148		
					DEFINED	1	86	104	110	127	129	
656	WI	REAL			REFS	100	101	121	122	DEFINED	99	120
1	XNU	REAL		LASTIC	REFS	23						
7	ZDEL	REAL		GEOPAR	REFS	14						

FILE NAMES	MODE		
TAPE6	FMT	WRITES	162

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
ABS	REAL	1	INTRIN		147	148
FLOAT	REAL	1	INTRIN		164	
IFIX	INTEGER	1	INTRIN		160	

STATEMENT LABELS			DEF LINE	REFERENCES					
0	100		49	40					
0	110		66	57					
0	120		76	74					
0	130		78	54					
171	140		83	81					
212	150		88	84					
0	160		102	97					
303	170		108	82					
325	180		112	108					
0	190		123	118					
421	200		128	80	87	107	111		
435	210		130	35	79				
477	220		143	140					
547	230		155	146	149	150			
610	240		165	141	142	156	158	159	163
611	250		166	136	137	138	139	157	
622	260	FMT	171	162					

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
15	210	KI	35 130	423B	NOT INNER
33	100	I	40 49	35B	OPT
72	130	I	54 78	60B	NOT INNER
100	110	J	57 66	21B	OPT
131	120	II	74 76	12B	INSTACK
161	200	I	80 128	243B	NOT INNER
237	160	II	97 102	22B	OPT
352	190	II	118 123	22B	OPT
511	230	I	146 155	41B	OPT

COMMON BLOCKS	LENGTH
GEOPAR	13
LIMITS	62

```
COMMON BLOCKS   LENGTH
       LASTIC        3
       CONTNT        1
       TAPES         6

STATISTICS
  PROGRAM LENGTH                760B     496
  SCM LABELED COMMON LENGTH     125B      85
        140000B SCM USED
```

```
1                SUBROUTINE TEMPA (TCB,TFB,TBLK,TINLET,TPLEN,NABT)                TEMPA      2
                 C                                                                TEMPA      3
                 C   TEMPA IS CALLED FROM PELET                                   TEMPA      4
                 C                                                                TEMPA      5
5                  DIMENSION TCB(2,NABT),TFB(2,NABT)                              TEMPA      6
                 C   TEMPA CALCULATES TCB + TFB AT TOP AND BOTTOM OF STACK        TEMPA      7
                 C                                                                TEMPA      8
                 C   NABT - NUMBER OF AXIAL BOUNDARIES                           TEMPA      9
                 C   TBLK - TEMPERATURE OF THE COOLANT                           TEMPA     10
10               C   TCB - CLAD TEMP ARRAY AT AXIAL BOUNDARIES                    TEMPA     11
                 C   TFB - FUEL TEMP ARRAY AT AXIAL BOUNDARIES                   TEMPA     12
                 C   TINLET - INLET COOLANT TEMPERATURE                          TEMPA     13
                 C   TPLEN - PLENUM TEMPERATURE                                  TEMPA     14
                 C                                                                TEMPA     15
15                 TCB(1,1) = TINLET                                              TEMPA     16
                   TCB(2,1) = TINLET                                              TEMPA     17
                   TFB(1,1) = TINLET                                              TEMPA     18
                   TFB(2,1) = TINLET                                              TEMPA     19
                   TCB(1,NABT) = TPLEN                                            TEMPA     20
20                 TCB(2,NABT) = TBLK                                             TEMPA     21
                   RETURN                                                         TEMPA     22
                   END                                                            TEMPA     23
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	TEMPA	1	21

VARIABLES

	SN	TYPE		RELOCATION								
0	NABT	INTEGER		F.P.	REFS	2*5	19	20	DEFINED	1		
0	TBLK	REAL		F.P.	REFS	20	DEFINED	1				
0	TCB	REAL	ARRAY	F.P.	REFS	5	DEFINED	1	15	16	19	20
0	TFB	REAL	ARRAY	F.P.	REFS	5	DEFINED	1	17	18		
0	TINLET	REAL		F.P.	REFS	15	16	17	18	DEFINED	1	
0	TPLEN	REAL		F.P.	REFS	19	DEFINED	1				

STATISTICS

PROGRAM LENGTH 32B 26

140000B SCM USED

```
      SUBROUTINE TEMPB (RD,TEC,TEF,NF,NC,BI,TCI,TCO,TV)                 TEMPB    2
      DIMENSION RD(1),TEC(NC),TEF(NF),BI(6),X(6)                        TEMPB    3
C                                                                       TEMPB    4
C     TEMPB IS CALLED FROM PELET                                        TEMPB    5
C                                                                       TEMPB    6
C     TEMPB CALCULATES REGION TEMPERATURES                              TEMPB    7
C                                                                       TEMPB    8
C     BI - B ARRAY FROM DDLF                                            TEMPB    9
C     RD - RADIUS ARRAY                                                 TEMPB   10
C     TCI - TEMPERATURE OF THE CLAD INNER SURFACE                       TEMPB   11
C     TCO - TEMPERATURE OF THE CLAD OUTER SURFACE                       TEMPB   12
C     TEC - CLAD TEMP ARRAY AT AXIAL REGIONS                            TEMPB   13
C     TEF - FUEL TEMP ARRAY AT AXIAL REGIONS                            TEMPB   14
C     TV - TEMPERATURE AT THE CENTER OF THE AXIAL REGION                TEMPB   15
C                                                                       TEMPB   16
      DO 110 J=1,NF                                                     TEMPB   17
      TEF(J) = 0.0                                                      TEMPB   18
      X(1) = 1.                                                         TEMPB   19
      X(2) = RD(J)/RD(NF)                                               TEMPB   20
      X(3) = X(2)*X(2)                                                  TEMPB   21
      X(4) = X(2)*X(3)                                                  TEMPB   22
      X(5) = X(2)*X(4)                                                  TEMPB   23
      X(6) = X(2)*X(5)                                                  TEMPB   24
          DO 100 K=1,6                                                  TEMPB   25
          BB = BI(K)                                                    TEMPB   26
          TEF(J) = TEF(J)+BB*X(K)                                       TEMPB   27
  100     CONTINUE                                                      TEMPB   28
      TEF(J) = TEF(J)*1.8+32.                                           TEMPB   29
  110 CONTINUE                                                          TEMPB   30
      TEC(1) = TCI                                                      TEMPB   31
      DIF = (TCI-TCO)/FLOAT(NC-1)                                       TEMPB   32
          DO 120 I=2,NC                                                 TEMPB   33
  120     TEC(I) = TEC(I-1)-DIF                                         TEMPB   34
C     TV IS THE TEMPERATURE AT THE CENTER OF EACH AXIAL REGION IN THE FUEL TEMPB   35
      TV = 0.0                                                          TEMPB   36
      X(1) = 1.                                                         TEMPB   37
      YY = (RD(1)+RD(NF))/2.                                            TEMPB   38
      X(2) = YY/RD(NF)                                                  TEMPB   39
      X(3) = X(2)*X(2)                                                  TEMPB   40
      X(4) = X(3)*X(2)                                                  TEMPB   41
      X(5) = X(4)*X(2)                                                  TEMPB   42
      X(6) = X(5)*X(2)                                                  TEMPB   43
          DO 130 K=1,6                                                  TEMPB   44
          BB = BI(K)                                                    TEMPB   45
          TV = TV+BB*X(K)                                               TEMPB   46
  130     CONTINUE                                                      TEMPB   47
      TV = TV*1.8+32.                                                   TEMPB   48
      RETURN                                                            TEMPB   49
      END                                                               TEMPB   50
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    4  TEMPB           1       48

VARIABLES     SN  TYPE          RELOCATION
  157  BB         REAL                        REFS     26      45    DEFINED      25      44
    0  BI         REAL       ARRAY    F.P.    REFS      2      25         44 DEFINED       1
  160  DIF        REAL                        REFS     33 DEFINED      31
  161  I          INTEGER                     REFS   2*33 DEFINED      32
  155  J          INTEGER                     REFS     17      19    2*26    2*28 DEFINED      16
  156  K          INTEGER                     REFS     25      26      44      45 DEFINED      24      43
    0  NC         INTEGER             F.P.    REFS      2      31      32 DEFINED       1
    0  NF         INTEGER             F.P.    REFS      2      16      19      37      38
                                              DEFINED       1
    0  RD         REAL       ARRAY    F.P.    REFS      2   2*19    2*37      38 DEFINED       1
    0  TCI        REAL                F.P.    REFS     30      31 DEFINED       1
    0  TCO        REAL                F.P.    REFS     31 DEFINED       1
    0  TEC        REAL       ARRAY    F.P.    REFS      2      33 DEFINED       1      30      33
    0  TEF        REAL       ARRAY    F.P.    REFS      2      26      28 DEFINED       1      17      26
                                              28
    0  TV         REAL                F.P.    REFS     45      47 DEFINED       1      35      45      47
  163  X          REAL       ARRAY            REFS      2   2*20    2*21    2*22    2*23      26   2*39
                                               2*40  2*41    2*42      45 DEFINED      18      19      20
                                               21      22      23      36      38      39      40      41
                                               42
  162  YY         REAL                        REFS     38 DEFINED      37

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE  REFERENCES
      FLOAT      REAL      1  INTRIN                31

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       27         24
    0  110                       29         16
    0  120                       33         32
    0  130                       46         43

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   11  110      J           16 29       46B                 NOT INNER
   36  100      K           24 27       12B     INSTACK
   72  120      I           32 33        5B     INSTACK
  131  130      K           43 46       12B     INSTACK

STATISTICS
  PROGRAM LENGTH                206B     134
        140000B SCM USED
```

```
      SUBROUTINE TEMPC (NF,NC,NF1,NC1,NT,TPLEN,TINLET,TBLK,TEC,TEF,TCB,T
     +FB)
C
C     TEMPC IS CALLED FROM PELET
C
C
C     TEMPC CALCULATES BOUNDARY TEMPERATURES
C
C     NC - NUMBER OF RADIAL BOUNDARIES IN CLAD
C     NF - NUMBER OF RADIAL BOUNDARIES IN FUEL
C     NT - NUMBER OF AXIAL REGIONS
C     TCB - CLAD TEMP ARRAY AT AXIAL BOUNDARIES
C     TFB - FUEL TEMP ARRAY AT AXIAL BOUNDARIES
C     TEC - CLAD TEMP ARRAY AT AXIAL REGIONS
C     TEF - FUEL TEMP ARRAY AT AXIAL REGIONS
C     TBLK - TEMPERATURE OF THE COOLANT
C     TINLET - INLET COOLANT TEMPERATURE
C     TPLEN - PLENUM TEMPERATURE
C
      DIMENSION TEC(NC,1),TEF(NF,1),TCB(2,1),TFB(2,1)
      NT1 = NT+1
      NT2 = NT+2
C     LOADS ARRAY REPRESENTING AREA OVER FUEL WITH PLENUM TEMPERATURE
      DO 100 I=1,NF,NF1
      TEF(I,NT2) = TEF(I,NT1)
  100 CONTINUE
C     TEMPERATURES OF BOTTOM HALF-INCH REGION
      DO 110 I=1,NF
      TEF(I,1) = TEF(I,2)
  110 CONTINUE
      DO 120 I=1,NC
      TEC(I,1) = TEC(I,2)
  120 CONTINUE
C     TEMPERATURES OF CLADDING AROUND PLENUM
      DO 130 I=1,NC
      TEC(I,NT2) = TEC(I,NT1)
  130 CONTINUE
C     CALCULATE "BOUNDARY" TEMPERATURES AT SURFACE AND CENTERLINE OF FUEL
C     AND SURFACES OF CLADDING FROM "REGION" TEMPERATURES
      DO 140 J=1,NT1
      TCB(1,J+1) = (TEC(1,J)+TEC(1,J+1))/2.
      TCB(2,J+1) = (TEC(NC,J)+TEC(NC,J+1))/2.
      TFB(1,J+1) = (TEF(1,J)+TEF(1,J+1))/2.
      TFB(2,J+1) = (TEF(NF,J)+TEF(NF,J+1))/2.
  140 CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 TEMPC	1	46

VARIABLES	SN	TYPE	RELOCATION									
140	I	INTEGER			REFS	2*25	2*29	2*32	2*36	DEFINED	24	28
					31	35						
141	J	INTEGER			REFS	3*41	3*42	3*43	3*44	DEFINED	40	
0	NC	INTEGER		F.P.	REFS	20	31	35	2*42	DEFINED	1	
0	NCI	INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NF	INTEGER		F.P.	REFS	20	24	28	2*44	DEFINED	1	
0	NFI	INTEGER		F.P.	REFS	24	DEFINED	1				
0	NT	INTEGER		F.P.	REFS	21	22	DEFINED	1			
136	NTI	INTEGER			REFS	25	36	40	DEFINED	21		
137	NT2	INTEGER			REFS	25	36	DEFINED	22			
0	TBLK	REAL	*UNUSED	F.P.	DEFINED	1						
0	TCB	REAL	ARRAY	F.P.	REFS	20	DEFINED	1	41	42		
0	TEC	REAL	ARRAY	F.P.	REFS	20	32	36	2*41	2*42		
					DEFINED	1	32	36				
0	TEF	REAL	ARRAY	F.P.	REFS	20	25	29	2*43	2*44		
					DEFINED	1	25	29				
0	TFB	REAL	ARRAY	F.P.	REFS	20	DEFINED	1	43	44		
0	TINLET	REAL	*UNUSED	F.P.	DEFINED	1						
0	TPLEN	REAL	*UNUSED	F.P.	DEFINED	1						

STATEMENT LABELS	DEF LINE	REFERENCES
0 100	26	24
0 110	30	28
0 120	33	31
0 130	37	35
0 140	45	40

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
23	100	I	24 26	12B	INSTACK
37	110	I	28 30	7B	INSTACK
50	120	I	31 33	7B	INSTACK
61	130	I	35 37	11B	INSTACK
74	140	J	40 45	35B	OPT

STATISTICS

PROGRAM LENGTH 176B 126

140000B SCM USED

```
      SUBROUTINE TEMPD (NT,K,N,NFFID,NOELD,NTAED,TELM,TREF,TFB,RD,TCB,TW
     +,NART,NABF,NF1,NC1,IRZ,TEC,TEF,TV,NF,NC)
      DIMENSION TELM(NOELD,NABF,2),RD(NFFID,1),TCB(2,1),TFB(2,1),
     + TW(NTAED,2),TEF(NF,1),TEC(NC,1),TV(1)
C
C   TEMPD IS CALLED FROM PELET
C
C   TEMPD CALCULATES FUEL AND CLADDING ELEMENT TEMPERATURES FOR USE BY
C   PELET.
C
C   IRZ - TIME STEP COUNTER
C   K - NOLD
C   N - NEW
C   NC - NUMBER OF RADIAL BOUNDARIES IN CLAD
C   NF - NUMBER OF RADIAL BOUNDARIES IN FUEL
C   RD - RADIUS ARRAY
C   TCB - CLAD TEMP ARRAY AT AXIAL BOUNDARIES
C   TFB - FUEL TEMP ARRAY AT AXIAL BOUNDARIES
C   TEC - CLAD TEMP ARRAY AT AXIAL REGIONS
C   TEF - FUEL TEMP ARRAY AT AXIAL REGIONS
C   TELM - FINITE ELEMENT TEMPERATURES
C   TREF - REFERENCE TEMPERATURE, USUALLY 70 F(19 C)
C   TW - FINITE ELEMENT TEMPERATURES
C
      NT1 = NT+1
      IF (IRZ.NE.1) GO TO 130
C   INITIALIZE TEMPERATURE ARRAY - RADIAL MODEL
          DO 120 I=1,NART
              DO 100 M=1,NF1
              J = 2*M-1
              TELM(J,I,K) = TREF
              TELM(J+1,I,K) = TREF
  100         CONTINUE
          NO = 2*NF1
              DO 110 M=1,NC1
              J = 2*M-1+NO
              TELM(J,I,K) = TREF
              TELM(J+1,I,K) = TREF
  110         CONTINUE
  120     CONTINUE
  130   CONTINUE
          DO 170 I=1,NABF
          IF (I.EQ.NABF) GO TO 150
C   LOADS RADIAL ELEMENT ARRAY IN FUEL
              DO 140 J=1,NF1
              JO = 2*J-1
              TELM(JO,I,N) = (2.*TEF(J,I)+TEF(J+1,I))/3.
              TELM(JO+1,I,N) = (TEF(J,I)+2.*TEF(J+1,I))/3.
  140         CONTINUE
  150     CONTINUE
C   LOADS RADIAL ELEMENT ARRAY IN CLADDING
          NO = 2*NF1
              DO 160 J=1,NC1
```

```
                        JO = 2*J-1+NO                                                    TEMPD      55
55                      TELM(JO,I,N) = (2.*TEC(J,I)+TEC(J+1,I))/3.                       TEMPD      56
                        TELM(JO+1,I,N) = (TEC(J,I)+2.*TEC(J+1,I))/3.                     TEMPD      57
              160       CONTINUE                                                         TEMPD      58
              170     CONTINUE                                                           TEMPD      59
                    IF (IRZ.NE.1) GO TO 190                                            TEMPD      60
60            C   INITIALIZE TEMPERATURE ARRAY -AXIAL MODEL                            TEMPD      61
                    DO 180 J=1,NTAED                                                   TEMPD      62
                    TW(J,K) = TREF                                                     TEMPD      63
              180   CONTINUE                                                           TEMPD      64
              190 CONTINUE                                                             TEMPD      65
65            C   LOADS AXIAL ELEMENT ARRAY - CLADDING                                TEMPD      66
                    DO 200 I=1,NABF                                                    TEMPD      67
                    A1 = TCB(2,I)                                                      TEMPD      68
                    A2 = TCB(2,I+1)                                                    TEMPD      69
                    A3 = TCB(1,I+1)                                                    TEMPD      70
70                  A4 = TCB(1,I)                                                      TEMPD      71
                    TAV = 0.25*(A1+A2+A3+A4)                                           TEMPD      72
                    J = 1+(I-1)*4+4*NTI                                                TEMPD      73
                    TW(J,N) = (TAV+A4+A1)/3.                                           TEMPD      74
                    TW(J+1,N) = (TAV+A1+A2)/3.                                         TEMPD      75
75                  TW(J+2,N) = (TAV+A2+A3)/3.                                         TEMPD      76
                    TW(J+3,N) = (TAV+A3+A4)/3.                                         TEMPD      77
              200   CONTINUE                                                           TEMPD      78
              C   LOADS AXIAL ELEMENT ARRAY IN FUEL                                   TEMPD      79
              C   FOR REGION 1 IN THE FUEL                                            TEMPD      80
80              I = 1                                                                  TEMPD      81
                A1 = TFB(2,I)                                                          TEMPD      82
                A2 = TFB(2,I+1)                                                        TEMPD      83
                A3 = TFB(1,I+1)                                                        TEMPD      84
                A4 = TFB(1,I)                                                          TEMPD      85
85              TAV = 0.25*(A1+A2+A3+A4)                                               TEMPD      86
                TW(1,N) = (TAV+A1+A4)/3.                                               TEMPD      87
                TW(2,N) = (TAV+A1+A2)/3.                                               TEMPD      88
                TW(3,N) = (TAV+A2+A3)/3.                                               TEMPD      89
                TW(4,N) = (TAV+A3+A4)/3.                                               TEMPD      90
90            C   FOR REGIONS TWO THRU THE TOP OF THE FUEL                           TEMPD      91
                  DO 210 I=2,NTI                                                       TEMPD      92
                  A1 = TFB(2,I)                                                        TEMPD      93
                  A2 = TFB(2,I+1)                                                      TEMPD      94
                  A3 = TFB(1,I+1)                                                      TEMPD      95
95                A4 = TFB(1,I)                                                        TEMPD      96
                  L = 1+(I-1)*4                                                        TEMPD      97
                  TW(L,N) = (TV(I)+A1+A4)/3.                                           TEMPD      98
                  TW(L+1,N) = (TV(I)+A1+A2)/3.                                         TEMPD      99
                  TW(L+2,N) = (TV(I)+A2+A3)/3.                                         TEMPD     100
100               TW(L+3,N) = (TV(I)+A3+A4)/3.                                         TEMPD     101
              210 CONTINUE                                                           TEMPD     102
              C                                                                      TEMPD     103
                RETURN                                                               TEMPD     104
                END                                                                  TEMPD     105
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 TEMPD 1 103

VARIABLES	SN	TYPE		RELOCATION								
505	A1	REAL			REFS	71	73	74	85	86	87	97
					98	DEFINED	67	81	92			
506	A2	REAL			REFS	71	74	75	85	87	88	98
					99	DEFINED	68	82	93			
507	A3	REAL			REFS	71	75	76	85	88	89	99
					100	DEFINED	69	83	94			
510	A4	REAL			REFS	71	73	76	85	86	89	97
					100	DEFINED	70	84	95			
500	I	INTEGER			REFS	31	32	37	38	43	3*47	3*48
					3*55	3*56	67	68	69	70	72	81
					82	83	84	92	93	94	95	96
					97	98	99	100	DEFINED	28	42	66
					80	91						
0	IRZ	INTEGER		F.P.	REFS	26	59	DEFINED				
502	J	INTEGER			REFS	31	32	37	38	46	2*47	2*48
					54	2*55	2*56	62	73	74	75	76
					DEFINED	30	36	45	53	61	72	
504	JO	INTEGER			REFS	47	48	55	56	DEFINED	46	54
0	K	INTEGER		F.P.	REFS	31	32	37	38	62		
					DEFINED	1						
512	L	INTEGER			REFS	97	98	99	100	DEFINED	96	
501	M	INTEGER			REFS	30	36	DEFINED	29	35		
0	N	INTEGER		F.P.	REFS	47	48	55	56	73	74	75
					76	86	87	88	89	97	98	99
					100	DEFINED	1					
0	NABF	INTEGER		F.P.	REFS	3	42	43	66	DEFINED	1	
0	NART	INTEGER		F.P.	REFS	28	DEFINED	1				
0	NC	INTEGER		F.P.	REFS	3	DEFINED	1				
0	NCI	INTEGER		F.P.	REFS	35	53	DEFINED	1			
0	NF	INTEGER		F.P.	REFS	3	DEFINED	1				
0	NFFID	INTEGER		F.P.	REFS	3	DEFINED	1				
0	NFI	INTEGER		F.P.	REFS	29	34	45	52	DEFINED	1	
503	NO	INTEGER			REFS	36	54	DEFINED	34	52		
0	NOELD	INTEGER		F.P.	REFS	3	DEFINED	1				
0	NT	INTEGER		F.P.	REFS	25	DEFINED	1				
0	NTAED	INTEGER		F.P.	REFS	3	61	DEFINED	1			
477	NTI	INTEGER			REFS	72	91	DEFINED	25			
0	RD	REAL	ARRAY	F.P.	REFS	3	DEFINED	1				
511	TAV	REAL			REFS	73	74	75	76	86	87	88
					89	DEFINED	71	85				
0	TCB	REAL	ARRAY	F.P.	REFS	3	67	68	69	70		
					DEFINED	1						
0	TEC	REAL	ARRAY	F.P.	REFS	3	2*55	2*56	DEFINED	1		
0	TEF	REAL	ARRAY	F.P.	REFS	3	2*47	2*48	DEFINED	1		
0	TELM	REAL	ARRAY	F.P.	REFS	3	DEFINED	1	31	32	37	38
					47	48	55	56				

```
VARIABLES     SN  TYPE          RELOCATION
     0  TFB        REAL        ARRAY     F.P.      REFS          3      81     82     83     84     92     93
                                                                 94      95  DEFINED      1
     0  TREF       REAL                  F.P.      REFS         31      32     37     38     62
                                                    DEFINED       1
     0  TV         REAL        ARRAY     F.P.      REFS          3      97     98     99    100
                                                    DEFINED       1
     0  TW         REAL        ARRAY     F.P.      REFS          3  DEFINED      1     62     73     74     75
                                                                 76      86      87     88     89     97     98     99
                                                                100

STATEMENT LABELS              DEF LINE    REFERENCES
     0  100                       33          29
     0  110                       39          35
     0  120                       40          28
   107  130                       41          26
     0  140                       49          45
   151  150                       50          43
     0  160                       57          53
     0  170                       58          42
     0  180                       63          61
   230  190                       64          59
     0  200                       77          66
     0  210                      101          91

LOOPS  LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
    30  120      I          28 40        56B                  NOT INNER
    32  100      M          29 33        22B       OPT
    60  110      M          35 39        23B       OPT
   111  170      I          42 58       102B                  NOT INNER
   116  140      J          45 49        32B       OPT
   155  160      J          53 57        33B       OPT
   220  180      J          61 63         7B       INSTACK
   232  200      I          66 77        65B       OPT
   404  210      I          91 101       62B       OPT

STATISTICS
  PROGRAM LENGTH                 616B     398
        140000B SCM USED
```

AXIWRT *CALL MATCNS AXIWRT 44

CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY	MATCNS	AXI2IN	AXILOAD	AXIMODL	ZCOR	AXI2	AXIOUT
AXSCRP	CLOSAX	ELAST	ELEMI	EOCALC	FILL	GAPADD	GAPSEM
GPFORC	GAPTST	IFPRES	KTIE	NULOAD	PASPSI	AXPLAS	PSIPAS
RADFRC	STRNAD	STRNAV	STRSAV	SIGCLC	TEMPFK	TF	XGAPSM
XLFRC	XLLOK	CRIIP	AXDRIV	AXIWRT			

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$	TIDY	MATCNS	AXI2IN	AXILOAD	AXIMODL	ZCOR	AXI2
AXIOUT	AXSCRP	CLOSAX	ELAST	ELEMI	EOCALC	FILL	GAPADD
GAPSEM	GPFORC	GAPTST	IFPRES	KTIE	NULOAD	PASPSI	AXPLAS
PSIPAS	RADFRC	STRNAD	STRNAV	STRSAV	SIGCLC	TEMPFK	TF
XGAPSM	XLFRC	XLLOK	CRIIP	AXDRIV	AXIWRT		

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

YANK$$$	TIDY	MATCNS	AXI2IN	AXILOAD	AXIMODL	ZCOR	AXI2
AXIOUT	AXSCRP	CLOSAX	ELAST	ELEMI	EOCALC	FILL	GAPADD
GAPSEM	GPFORC	GAPTST	IFPRES	KTIE	NULOAD	PASPSI	AXPLAS
PSIPAS	RADFRC	STRNAD	STRNAV	STRSAV	SIGCLC	TEMPFK	TF
XGAPSM	XLFRC	XLLOK	CRIIP	AXDRIV	AXIWRT		

COMMON DECKS ENCOUNTERED

MATCNS

TIDY	AXI2IN	AXILOAD	AXIMODL	ZCOR	AXI2	AXIOUT	AXSCRP
CLOSAX	ELAST	ELEMI	EOCALC	FILL	GAPADD	GAPSEM	GPFORC
GAPTST	IFPRES	KTIE	NULOAD	PASPSI	AXPLAS	PSIPAS	RADFRC
STRNAD	STRNAV	STRSAV	SIGCLC	TEMPFK	TF	XGAPSM	XLFRC
XLLOK	CRIIP	AXDRIV	AXIWRT				

THIS UPDATE REQUIRED 34500B WORDS OF CORE.

```
      1              SUBROUTINE AXI2IN (N,M,L,IAXI2,NUMGAP,NNODES,NNELEM,LOADST,NUMX,NT  AXI2IN      2
                    +IES,IUNIT)                                                         AXI2IN      3
                C                                                                       AXI2IN      4
                      IUNIT = 20                                                        AXI2IN      5
      5               IAXI2 = 1                                                         AXI2IN      6
                      N = 11                                                            AXI2IN      7
                      REWIND IUNIT                                                      AXI2IN      8
                      M = 3                                                             AXI2IN      9
                      L = 12                                                            AXI2IN     10
     10               NUMGAP = L                                                        AXI2IN     11
                      NNODES = (M+N)*L+(M+N-2)*(L-1)                                    AXI2IN     12
                      NNELEM = ((N-1)*(L-1)+(M-1)*(L-1))*4+L                            AXI2IN     13
                C                                                                       AXI2IN     14
                      LOADST = 1                                                        AXI2IN     15
     15               NTIES = M                                                         AXI2IN     16
                      NUMX = 2*NNODES                                                   AXI2IN     17
                      RETURN                                                            AXI2IN     18
                      END                                                               AXI2IN     19
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 AXI2IN 1 17

VARIABLES	SN	TYPE	RELOCATION									
0 IAXI2		INTEGER	F.P.	DEFINED	1	5						
0 IUNIT		INTEGER	F.P.	DEFINED	1	4	I/O REFS	7				
0 L		INTEGER	F.P.	REFS	10	2*11	3*12	DEFINED	1	9		
0 LOADST		INTEGER	F.P.	DEFINED	1	14						
0 M		INTEGER	F.P.	REFS	2*11	12	15	DEFINED	1	8		
0 N		INTEGER	F.P.	REFS	2*11	12	DEFINED	1	6			
0 NNELEM		INTEGER	F.P.	DEFINED	1	12						
0 NNODES		INTEGER	F.P.	REFS	16	DEFINED	1	11				
0 NTIES		INTEGER	F.P.	DEFINED	1	15						
0 NUMGAP		INTEGER	F.P.	DEFINED	1	10						
0 NUMX		INTEGER	F.P.	DEFINED	1	16						

VARIABLES USED AS FILE NAMES, SEE ABOVE

STATISTICS
PROGRAM LENGTH 53B 43
140000B SCM USED

```
      SUBROUTINE AXILOD (CLADR,COORD,NELEM,IPRES,IUNIT,IZPRES,L,LOADST,M AXILOAD     2
     +,N,NNELEM,NLOAD2,NNODES,NTPS,PC,PG,PRESFC,R,SPDAFC,T,TCLAD1,TCLAD2 AXILOAD     3
     +,TP,THICK,ZPRES)                                                   AXILOAD     4
C                                                                        AXILOAD     5
C*****************************************************************     AXILOAD     6
C  AXILOAD                                                              AXILOAD     7
C*****************************************************************     AXILOAD     8
C  THIS ROUTINE WRITES TO TAPE THE                                       AXILOAD     9
C  PRESSURE AND TEMPERATURE LOADS FOR THE EXECUTION                      AXILOAD    10
C  OF THE 2-D FINITE ELEMENT CODE- AXISYM - AT EACH LOADSTEP             AXILOAD    11
C                                                                        AXILOAD    12
C                                                                        AXILOAD    13
C*****************************************************************     AXILOAD    14
C                                                                        AXILOAD    15
C  INPUTS                                                                AXILOAD    16
C  CLADR  - (R)  CLAD RADIUS                                             AXILOAD    17
C  COORD  - (R)  CLAD COORDINATES FROM AXIMODL                           AXILOAD    18
C  NELEM   - (I)  NODE MESH FROM AXIMODL                                 AXILOAD    19
C  IPRES  - (I)  WORK ARRAY FROM AXIMODL                                 AXILOAD    20
C  IUNIT  - (I)  TAPE UNIT WHERE LOADS ARE TO BE WRITTEN                 AXILOAD    21
C  IZPRES -(I) WORK ARRAY FROM AXIMODL                                   AXILOAD    22
C  L      -(I) NO. OF AXIAL NODES                                        AXILOAD    23
C  LOADST -(I) LOADSTEP                                                  AXILOAD    24
C  M      -(I) NO. OF NODES IN THE CLAD                                  AXILOAD    25
C  N      -(I) NO.OF NODES IN THE FUEL                                   AXILOAD    26
C  NNELEM  -(I) NO.OF ELEMENTS                                           AXILOAD    27
C  NNODES -(I) NO.OF NODES                                               AXILOAD    28
C  NTPS   -(I) NO. OF CREEP STEPS                                        AXILOAD    29
C  PC     -(R)  COOLANT PRESSURE                                         AXILOAD    30
C  PG     -(R)  GAS PRESSURE                                             AXILOAD    31
C  PRESFC -(R)  WORK VALUES FROM AXIMODL                                 AXILOAD    32
C  R      -(R)  RADIAL LOCATIONS OF INPUT TEMPERATURES(FUEL ONLY)        AXILOAD    33
C  SPDAFC -(R)  WORK ARRAY FROM AXIMODL                                  AXILOAD    34
C  TCLAD1 -(R)  CLAD INSIDE TEMPERATURE                                  AXILOAD    35
C  TCLAD2 -(R)  CLAD OUTSIDE TEMPERATURE                                 AXILOAD    36
C  TP   -(R)  TEMPERATURES AT   THE R VALUES (FUEL ONLY)                 AXILOAD    37
C  THICK  -(R)  CLADDING THICKNESS                                       AXILOAD    38
C  ZPRES  -(R)  WORK ARRAY FROM AXIMODL                                  AXILOAD    39
C                                                                        AXILOAD    40
C  OUTPUTS                                                               AXILOAD    41
C                                                                        AXILOAD    42
C  T      - (R)  WORK ARRAY                                              AXILOAD    43
C                                                                        AXILOAD    44
C                                                                        AXILOAD    45
      DIMENSION SPDAFC(2),PRESFC(L,3),IPRES(L,3),TP(NTPS)                AXILOAD    46
      DIMENSION COORD(NNODES,2),NELEM(NNELEM,3),RELEM(4),R(NTPS)         AXILOAD    47
      DIMENSION T(NNELEM)                                                AXILOAD    48
      DIMENSION ZPRES(N),IZPRES(N)                                       AXILOAD    49
C                                                                        AXILOAD    50
      DT = TCLAD2-TCLAD1                                                 AXILOAD    51
      REWIND IUNIT                                                       AXILOAD    52
      FZ = 0.                                                            AXILOAD    53
      CLAD1 = CLADR-THICK                                                AXILOAD    54
```

```
      C                                                                 AXILOAD    55
55          NLOADS = 3*L+N-1                                            AXILOAD    56
            NLOAD2 = NLOADS*2                                           AXILOAD    57
            WRITE (IUNIT,190) NLOADS                                    AXILOAD    58
                DO 100 I=1,L                                            AXILOAD    59
      C                                                                 AXILOAD    60
60                FR1 = -PG*PRESFC(I,1)                                 AXILOAD    61
                  FR2 = PG*PRESFC(I,2)                                  AXILOAD    62
                  FR3 = -PC*PRESFC(I,3)                                 AXILOAD    63
                  IF (I.EQ.L) FZ = ZPRES(N)*(-PG)                       AXILOAD    64
                  WRITE (IUNIT,200) IPRES(I,1),FR1,FZ                   AXILOAD    65
65                FZ = 0.                                               AXILOAD    66
                  WRITE (IUNIT,200) IPRES(I,2),FR2,FZ                   AXILOAD    67
      100         WRITE (IUNIT,200) IPRES(I,3),FR3,FZ                   AXILOAD    68
            FR = 0.                                                     AXILOAD    69
            NM1 = N-1                                                   AXILOAD    70
70              DO 110 I=1,NM1                                          AXILOAD    71
                FZ = ZPRES(I)*(-PG)                                     AXILOAD    72
      110       WRITE (IUNIT,200) IZPRES(I),FR,FZ                       AXILOAD    73
      C                                                                 AXILOAD    74
      C                                                                 AXILOAD    75
75    C   COMPUTE TEMPERATURE OF EACH NODE                             AXILOAD    76
      C                                                                 AXILOAD    77
            K1 = M+N-2                                                  AXILOAD    78
                DO 140 I=1,K1                                           AXILOAD    79
                    DO 120 J=1,4                                        AXILOAD    80
80                  K2 = J+(I-1)*4                                      AXILOAD    81
                    RELEM(J) = 0.                                       AXILOAD    82
                        DO 120 K=1,3                                    AXILOAD    83
                        RELEM(J) = COORD(NELEM(K2,K),1)/3.+RELEM(J)     AXILOAD    84
      120               CONTINUE                                        AXILOAD    85
85                  K5 = (M+N-2)*4                                      AXILOAD    86
                    K4 = L-1                                            AXILOAD    87
                        DO 130 J=1,K4                                   AXILOAD    88
                            DO 130 K=1,4                                AXILOAD    89
                            IF (I.LT.N) CALL TF (RELEM(K),R,TP,NTPS,TC) AXILOAD    90
90                          IF (I.GE.N) TC = TCLAD1+((RELEM(K)-CLAD1)/THICK)*DT AXILOAD 91
                            K2 = K+(I-1)*4+(J-1)*K5                     AXILOAD    92
      130                   T(K2) = TC                                  AXILOAD    93
      140           CONTINUE                                            AXILOAD    94
                K5 = NNELEM-L                                           AXILOAD    95
95              WRITE (IUNIT,210) K5                                    AXILOAD    96
                    DO 150 I=1,K5                                       AXILOAD    97
      150           WRITE (IUNIT,210) I,T(I)                            AXILOAD    98
                IF (LOADST.GT.1) GO TO 180                              AXILOAD    99
                REWIND 25                                               AXILOAD   100
100             READ (25,210) NDSPS                                     AXILOAD   101
                WRITE (IUNIT,210) NDSPS                                 AXILOAD   102
                    DO 160 I=1,NDSPS                                    AXILOAD   103
                    READ (25,220) J,IU,UU                               AXILOAD   104
      160           WRITE (IUNIT,220) J,IU,UU                           AXILOAD   105
105             READ (25,210) NTIES                                     AXILOAD   106
                WRITE (IUNIT,210) NTIES                                 AXILOAD   107
```

```
                      DO 170 I=1,NTIES                                  AXILOAD  108
                      READ (25,210) J                                   AXILOAD  109
                      WRITE (IUNIT,210) J                               AXILOAD  110
110          170      CONTINUE                                          AXILOAD  111
             180  SPDA = SPDAFC(2)*PC-SPDAFC(1)*PG                       AXILOAD  112
                  SPDA = -SPDA                                          AXILOAD  113
                  WRITE (IUNIT,230) SPDA                                AXILOAD  114
                  REWIND IUNIT                                          AXILOAD  115
115               RETURN                                                AXILOAD  116
                C                                                       AXILOAD  117
             190  FORMAT (I5,5X,2F10.5)                                 AXILOAD  118
             200  FORMAT (I5,5X,2E20.5)                                 AXILOAD  119
             210  FORMAT (I5,5X,F10.5)                                  AXILOAD  120
120          220  FORMAT (2I5,F10.5)                                    AXILOAD  121
             230  FORMAT (F10.5)                                        AXILOAD  122
                  END                                                   AXILOAD  123
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 AXILOD 1 115

VARIABLES	SN	TYPE												
511	CLADI	REAL			REFS	90	DEFINED	53						
0	CLADR	REAL		F.P.	REFS	53	DEFINED	1						
0	COORD	REAL	ARRAY	F.P.	REFS	46	83	DEFINED	1					
507	DT	REAL			REFS	90	DEFINED	50						
517	FR	REAL			REFS	72	DEFINED	68						
514	FR1	REAL			REFS	64	DEFINED	60						
515	FR2	REAL			REFS	66	DEFINED	61						
516	FR3	REAL			REFS	67	DEFINED	62						
510	FZ	REAL			REFS	64	66	67	72	DEFINED	52	63		
						65	71							
513	I	INTEGER			REFS	60	61	62	63	64	66	67		
						71	72	80	89	90	91	2*97		
					DEFINED	58	70	78	96	102	107			
0	IPRES	INTEGER	ARRAY	F.P.	REFS	45	64	66	67	DEFINED	1			
531	IU	INTEGER			REFS	104	DEFINED	103						
0	IUNIT	INTEGER		F.P.	DEFINED	1	I/O REFS	51	57	64	66	67		
					72	95	97	101	104	106	109	113		
					114									
0	IZPRES	INTEGER	ARRAY	F.P.	REFS	48	72	DEFINED	1					
522	J	INTEGER			REFS	80	81	2*83	91	104	109			
					DEFINED	79	87	103	108					
524	K	INTEGER			REFS	83	89	90	91	DEFINED	82	88		
521	K1	INTEGER			REFS	78	DEFINED	77						
523	K2	INTEGER			REFS	63	92	DEFINED	80	91				
526	K4	INTEGER			REFS	87	DEFINED	86						
525	K5	INTEGER			REFS	91	95	96	DEFINED	85	94			

VARIABLES	SN	TYPE		RELOCATION								
0	L	INTEGER		F.P.	REFS	2*45	55	58	63	86	94	
					DEFINED	1						
0	LOADST	INTEGER		F.P.	REFS	98	DEFINED	1				
0	M	INTEGER		F.P.	REFS	77	85	DEFINED	1			
0	N	INTEGER		F.P.	REFS	2*48	55	63	69	77	85	89
					90	DEFINED	1					
530	NDSPS	INTEGER			REFS	101	102	DEFINED	100			
0	NELEM	INTEGER	ARRAY	F.P.	REFS	46	83	DEFINED	1			
512	NLOADS	INTEGER			REFS	56	57	DEFINED	55			
0	NLOAD2	INTEGER		F.P.	DEFINED	1	56					
520	NMI	INTEGER			REFS	70	DEFINED	69				
0	NNELEM	INTEGER		F.P.	REFS	46	47	94	DEFINED	1		
0	NNODES	INTEGER		F.P.	REFS	46	DEFINED	1				
533	NTIES	INTEGER			REFS	106	107	DEFINED	105			
0	NTPS	INTEGER		F.P.	REFS	45	46	89	DEFINED	1		
0	PC	REAL		F.P.	REFS	62	111	DEFINED	1			
0	PG	REAL		F.P.	REFS	60	61	63	71	111		
					DEFINED	1						
0	PRESFC	REAL	ARRAY	F.P.	REFS	45	60	61	62	DEFINED	1	
0	R	REAL	ARRAY	F.P.	REFS	46	89	DEFINED	1			
535	RELEM	REAL	ARRAY		REFS	46	83	89	90	DEFINED	81	83
534	SPDA	REAL			REFS	112	113	DEFINED	111	112		
0	SPDAFC	REAL	ARRAY	F.P.	REFS	45	2*111	DEFINED	1			
0	T	REAL	ARRAY	F.P.	REFS	47	97	DEFINED	1	92		
527	TC	REAL			REFS	89	92	DEFINED	90			
0	TCLAD1	REAL		F.P.	REFS	50	90	DEFINED	1			
0	TCLAD2	REAL		F.P.	REFS	50	DEFINED	1				
0	THICK	REAL		F.P.	REFS	53	90	DEFINED	1			
0	TP	REAL	ARRAY	F.P.	REFS	45	89	DEFINED	1			
532	UU	REAL			REFS	104	DEFINED	103				
0	ZPRES	REAL	ARRAY	F.P.	REFS	48	63	71	DEFINED	1		

FILE NAMES	MODE									
TAPE25	FMT	READS	100	103	105	108	MOTION	99		
VARIABLES USED AS FILE NAMES, SEE ABOVE										

EXTERNALS	TYPE	ARGS	REFERENCES
TF		5	89

STATEMENT LABELS			DEF LINE	REFERENCES						
0	100		67	58						
0	110		72	70						
0	120		84	79	82					
0	130		92	87	88					
0	140		93	78						
0	150		97	96						
0	160		104	102						
0	170		110	107						
320	180		111	98						
470	190	FMT	117	57						
473	200	FMT	118	64	66	67	72			
476	210	FMT	119	95	97	100	101	105	106	108	109
501	220	FMT	120	103	104					

```
STATEMENT LABELS                DEF LINE   REFERENCES
  504  230      FMT                121        113

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   40  100      I           58 67       46B              EXT REFS
  115  110      I           70 72       13B              EXT REFS
  136  140      I           78 93      103B              EXT REFS  NOT INNER
  140  120      J           79 84       25B              NOT INNER
  150  120      K           82 84       12B    INSTACK
  176  130      J           87 92       40B              EXT REFS  NOT INNER
  200  130      K           88 92       33B              EXT REFS
  250  150      I           96 97       10B              EXT REFS
  273  160      I          102 104       7B              EXT REFS
  310  170      I          107 110       7B              EXT REFS

STATISTICS
  PROGRAM LENGTH                601B     385
        140000B SCM USED
```

```
      SUBROUTINE AXIMDL (CR,COORD,DISH,NELEM,G,IPRES,IZPRES,L,LENGTH,LTY AXIMODL     2
     +PE,M,MAT1,MAT2,N,NNELEM,NNODES,NTIES,NUMGAP,N1,N2,N3,PRESFC,SH,SPD AXIMODL     3
     +AFC,T,ZPRES)                                                       AXIMODL     4
C                                                                        AXIMODL     5
C     AXIMODL                                                            AXIMODL     6
C     ***************************************************************** AXIMODL     7
C     THE AXIMODL SUBROUTINE            SETS UP THE                      AXIMODL     8
C     FINITE ELEMENT MESH FOR THE  2-D AXISYM ANALYSIS                   AXIMODL     9
C     ***************************************************************** AXIMODL    10
C                                                                        AXIMODL    11
C     INPUTS                                                             AXIMODL    12
C                                                                        AXIMODL    13
C     CR - (R)  CLADDING OUTSIDE RADIUS(SI OR BRITISH)                   AXIMODL    14
C     DISH  - (R)  DISH DEPTH (ST OR BRITISH)                            AXIMODL    15
C     G   - (R)  COLD GAP (SI OR BRITISH)                                AXIMODL    16
C     L     - (I)  NO. OF AXIAL NODES                                    AXIMODL    17
C     LENGTH- (R)  PELLET LENGTH/2.                                      AXIMODL    18
C                                                                        AXIMODL    19
C     M     - (I)  NO. OF NODES IN THE CLAD                              AXIMODL    20
C     M     - (I)  NO. OF NODES IN THE FUEL                              AXIMODL    21
C     NNELEM - (I)  NO. OF ELEMENTS                                      AXIMODL    22
C     NNODES- (I)  NO. OF NODES                                          AXIMODL    23
C     NITES - (I)  NO. OF TIED NODES                                     AXIMODL    24
C     NUMGAP- (I)  NO. OF GAP ELEMENTS                                   AXIMODL    25
C     NUMX   - (I)  NO. OF NODES X 2.                                    AXIMODL    26
C     N1     - (I)   =N+M                                                AXIMODL    27
C     N2     - (I)   =N+M-1                                              AXIMODL    28
C     N3     - (I)   =L-1                                                AXIMODL    29
C     SH     - (R)   PELLET SHOULDER WIDTH (SI OR BRITISH)               AXIMODL    30
C     T  - (R)   CLADDING THICKNESS    (SI OR BRITISH)                   AXIMODL    31
C     OUTPUTS                                                            AXIMODL    32
C     COORD  - (R)                                                       AXIMODL    33
C     NELEM  - (I)                                                       AXIMODL    34
C     IPRES  - (I)                                                       AXIMODL    35
C     IZPRES - (I)                                                       AXIMODL    36
C     LTYPE  - (I)                                                       AXIMODL    37
C     MAT1   - (I)                                                       AXIMODL    38
C     MAT2   - (I)                                                       AXIMODL    39
C     PRESFC - (R)                                                       AXIMODL    40
C     SPDAFC - (R)                                                       AXIMODL    41
C     ZPRES  - (R)                                                       AXIMODL    42
C                                                                        AXIMODL    43
      REAL LENGTH                                                        AXIMODL    44
      INTEGER NELEM(NNELEM,3),LTYPE(NNELEM),MAT1(N1,L),MAT2(N2,N3)       AXIMODL    45
      REAL COORD(NNODES,2) ,PRESFC(NUMGAP,3),SPDAFC(2)                   AXIMODL    46
      DIMENSION ZPRES(N),IZPRES(N)                                       AXIMODL    47
      INTEGER IPRES(NUMGAP,3)                                            AXIMODL    48
      DATA PI/3.14159265/                                                AXIMODL    49
C     GENERATE COORDINATES CMAT1 AND FILL GRID WITH NODES                AXIMODL    50
      RF = CR-T-G                                                        AXIMODL    51
C                                                                        AXIMODL    52
C     THIS ROUTINE SETS UP THE FINITE ELEMENT MESH AND                   AXIMODL    53
C     WILL ONLY  BE  CALLED ONCE                                         AXIMODL    54
```

```
      C                                                                 AXIMODL    55
           KI = N+M                                                     AXIMODL    56
                DO 100 I=1,L                                            AXIMODL    57
                    DO 100 J=1,KI                                       AXIMODL    58
                    IF (J.LE.N) R = (CR-T-G)*FLOAT(J-1)/FLOAT(N-1)      AXIMODL    59
                    IF (J.GT.N) R = CR-T+FLOAT((J-N-1))*T/FLOAT(M-1)    AXIMODL    60
                    Z = FLOAT(I-1)*LENGTH/FLOAT(L-1)                    AXIMODL    61
      C                                                                 AXIMODL    62
      C   ZCOR IS THE CORRECTION TO THE AXIAL END COORDINATE            AXIMODL    63
      C   TO ACCOUNT FOR DISHING                                       AXIMODL    64
      C                                                                 AXIMODL    65
                    IF (I.EQ.L.AND.J.LE.N) Z = Z-ZCOR(R,RP,SH,DISH)     AXIMODL    66
                    MAT1(J,I) = J+(I-1)*(2*(N+M-1))                     AXIMODL    67
                    COORD(MAT1(J,I),1) = R                              AXIMODL    68
                    COORD(MAT1(J,I),2) = Z                              AXIMODL    69
      C                                                                 AXIMODL    70
                    IF (J.EQ.N) IPRES(I,1) = MAT1(J,I)                  AXIMODL    71
                    NP1 = N+1                                           AXIMODL    72
                    IF (J.EQ.NP1) IPRES(I,2) = MAT1(J,I)                AXIMODL    73
                    IF (J.EQ.KI) IPRES(I,3) = MAT1(J,I)                 AXIMODL    74
      C                                                                 AXIMODL    75
      C                                                                 AXIMODL    76
      100           CONTINUE                                            AXIMODL    77
      C                                                                 AXIMODL    78
      C                                                                 AXIMODL    79
                DO 130 I=1,N                                            AXIMODL    80
                R1 = COORD(MAT1(I,1),1)                                 AXIMODL    81
                R2 = COORD(MAT1(I+1,1),1)                               AXIMODL    82
                Q1 = 0.                                                 AXIMODL    83
                Q2 = 0.                                                 AXIMODL    84
                IF (I.EQ.N) GO TO 110                                   AXIMODL    85
                Q1 = 2.*PI*((R2**3-R1**3)/3.-R2*(R2**2-R1**2)/2.)/(R1-R2)  AXIMODL  86
                IF (I.EQ.1) GO TO 120                                   AXIMODL    87
      110       R2 = R1                                                 AXIMODL    88
                R1 = COORD(MAT1(I-1,1),1)                               AXIMODL    89
                Q2 = 2.*PI*(R1*(R2**2-R1**2)/2.-(R2**3-R1**3)/3.)/(R1-R2)  AXIMODL  90
      120       ZPRES(I) = Q1+Q2                                        AXIMODL    91
                IZPRES(I) = MAT1(I,L)                                   AXIMODL    92
      130       CONTINUE                                                AXIMODL    93
                DO 140 I=1,L                                            AXIMODL    94
                    DO 140 J=1,3                                        AXIMODL    95
                    PRESFC(I,J) = LENGTH/FLOAT(L-1)*PI*2.*COORD(IPRES(I,J),1)  AXIMODL  96
                    IF (I.EQ.1.OR.I.EQ.L) PRESFC(I,J) = PRESFC(I,J)/2.  AXIMODL    97
      140           CONTINUE                                            AXIMODL    98
           SPDAFC(1) = PI*COORD(MAT1(N+1,L),1)**2                       AXIMODL    99
           SPDAFC(2) = PI*COORD(MAT1(KI,L),1)**2                        AXIMODL   100
      C                                                                 AXIMODL   101
      C   GENERATE MAT2 COORDINATES AND FILL GRID                       AXIMODL   102
           K2 = L-1                                                     AXIMODL   103
           K3 = M+N-1                                                   AXIMODL   104
                DO 150 I=1,K2                                           AXIMODL   105
                    DO 150 J=1,K3                                       AXIMODL   106
                    IF (J.LT.N) MAT2(J,I) = N+M+J+(I-1)*(2*(N+M-1))     AXIMODL   107
```

```
                      IF (J.EQ.N) MAT2(J,I) = 0                                          AXIMODL  108
                      Z = (FLOAT(I-1)+.5)*LENGTH/FLOAT(L-1)                              AXIMODL  109
                      IF (J.GT.N) MAT2(J,I) = N+M+J-1+(I-1)*(2*(N+M-1))                  AXIMODL  110
110                   IF (J.LE.N) R = (CR-T-G)*(FLOAT(J-1)/FLOAT(N-1)+0.5/FLOAT(         AXIMODL  111
                     +     N-1))                                                         AXIMODL  112
                      IF (J.GT.N) R = CR-T+(0.5+FLOAT(J-N-1))*T/FLOAT(M-1)               AXIMODL  113
                      IF (J.NE.N) COORD(MAT2(J,I),1) = R                                 AXIMODL  114
                      IF (J.NE.N) COORD(MAT2(J,I),2) = Z                                 AXIMODL  115
115        150        CONTINUE                                                           AXIMODL  116
                   DO 160 I=1,K3                                                         AXIMODL  117
                      DO 160 J=1,K2                                                      AXIMODL  118
                      IF (I.EQ.N) GO TO 160                                              AXIMODL  119
                      IF (I.LT.N) NN = 1+(I-1)*4+(J-1)*(N+M-2)*4                         AXIMODL  120
120                   IF (I.GT.N) NN = 1+(I-2)*4+(J-1)*(N+M-2)*4                         AXIMODL  121
                      NELEM(NN,1) = MAT1(I,J)                                            AXIMODL  122
                      NELEM(NN+1,1) = MAT1(I,J+1)                                        AXIMODL  123
                      NELEM(NN+2,1) = MAT1(I+1,J+1)                                      AXIMODL  124
                      NELEM(NN+3,1) = MAT1(I+1,J)                                        AXIMODL  125
125                   NELEM(NN,3) = NELEM(NN+1,1)                                        AXIMODL  126
                      NELEM(NN+1,3) = NELEM(NN+2,1)                                      AXIMODL  127
                      NELEM(NN+2,3) = NELEM(NN+3,1)                                      AXIMODL  128
                      NELEM(NN+3,3) = NELEM(NN,1)                                        AXIMODL  129
                      NELEM(NN,2) = MAT2(I,J)                                            AXIMODL  130
130                   NELEM(NN+1,2) = MAT2(I,J)                                          AXIMODL  131
                      NELEM(NN+2,2) = MAT2(I,J)                                          AXIMODL  132
                      NELEM(NN+3,2) = MAT2(I,J)                                          AXIMODL  133
                      IF (I.LT.N) LTYPE(NN) = 6HPELLET                                   AXIMODL  134
                      IF (I.LT.N) LTYPE(NN+1) = 6HPELLET                                 AXIMODL  135
135                   IF (I.LT.N) LTYPE(NN+2) = 6HPELLET                                 AXIMODL  136
                      IF (I.LT.N) LTYPE(NN+3) = 6HPELLET                                 AXIMODL  137
                      IF (I.GT.N) LTYPE(NN) = 4HCLAD                                     AXIMODL  138
                      IF (I.GT.N) LTYPE(NN+1) = 4HCLAD                                   AXIMODL  139
                      IF (I.GT.N) LTYPE(NN+2) = 4HCLAD                                   AXIMODL  140
140                   IF (I.GT.N) LTYPE(NN+3) = 4HCLAD                                   AXIMODL  141
                  160 CONTINUE                                                           AXIMODL  142
                   DO 170 I=1,L                                                          AXIMODL  143
                   NN = NNELEM-L+I                                                       AXIMODL  144
                   LTYPE(NN) = 3HGAP                                                     AXIMODL  145
145                IF (I.EQ.1.OR.I.EQ.L) LTYPE(NN) = 7HGAP END                           AXIMODL  146
                   K4 = (N-1)*4+(I-1)*((N-1)*4+(M-1)*4)                                  AXIMODL  147
                   IF (K4.GT.NNELEM) K4 = (N-1)*4+(I-2)*((N-1)*4+(M-1)*4)-1              AXIMODL  148
                   NELEM(NN,1) = NELEM(K4,1)                                             AXIMODL  149
                   NELEM(NN,2) = NELEM(NN,1)+1                                           AXIMODL  150
150                NELEM(NN,3) = 1                                                       AXIMODL  151
                  170 CONTINUE                                                           AXIMODL  152
                  C                                                                      AXIMODL  153
                  C   SET BOUNDARY CONDITIONS                                            AXIMODL  154
                  C                                                                      AXIMODL  155
155                  NNODES = (M+N)*L+(M+N-2)*(L-1)                                      AXIMODL  156
                     REWIND 25                                                           AXIMODL  157
                     NDISPS = M+N+L                                                      AXIMODL  158
                     UU = 0.0                                                            AXIMODL  159
                     K1 = M+N                                                            AXIMODL  160
```

```
160               K2 = (M+N-1)*2                                          AXIMODL  161
                  NTIES = M                                               AXIMODL  162
                  ITWO = 2                                                AXIMODL  163
                  IONE = 1                                                AXIMODL  164
                C                                                         AXIMODL  165
165               WRITE (25,210) NDISPS                                   AXIMODL  166
                      DO 180 I=1,K1                                       AXIMODL  167
                      WRITE (25,210) I,ITWO,UU                            AXIMODL  168
                180   CONTINUE                                            AXIMODL  169
                      DO 190 I=1,NNODES,K2                                AXIMODL  170
170                   WRITE (25,210) I,IONE,UU                            AXIMODL  171
                190   CONTINUE                                            AXIMODL  172
                  K3 = NNODES-M+1                                         AXIMODL  173
                  WRITE (25,210) M                                        AXIMODL  174
                      DO 200 I=K3,NNODES                                  AXIMODL  175
175               200   WRITE (25,210) I                                  AXIMODL  176
                  C                                                       AXIMODL  177
                  C                                                       AXIMODL  178
                      RETURN                                              AXIMODL  179
                C                                                         AXIMODL  180
180             210   FORMAT (215,F10.5)                                  AXIMODL  181
                      END                                                 AXIMODL  182
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	AXIMDL	1

DEF LINE: 178

VARIABLES

0	COORD	REAL	ARRAY	F.P.	REFS	45	80	81	88	95	98	99
					DEFINED	1	67	68	113	114		
0	CR	REAL		F.P.	REFS	50	58	59	110	112		
					DEFINED	1						
0	DISH	REAL		F.P.	REFS	65	DEFINED	1				
0	G	REAL		F.P.	REFS	50	58	110	DEFINED	1		
1057	I	INTEGER			REFS	60	65	2*66	67	68	2*70	2*72
						2*73	80	81	84	86	88	90	2*91
						2*95	4*96	2*106	107	108	2*109	113	114
						118	2*119	2*120	121	122	123	124	129
						130	131	132	133	134	135	136	137
						138	139	140	143	2*145	146	147	167
						170	175	DEFINED	56	79	93	104	116
						142	166	169	174				
1077	IONE	INTEGER			REFS	170	DEFINED	163					
0	IPRES	INTEGER	ARRAY	F.P.	REFS	47	95	DEFINED	1	70	72	73
1076	ITWO	INTEGER			REFS	167	DEFINED	162				
0	IZPRES	INTEGER	ARRAY	F.P.	REFS	46	DEFINED	1	91			
1060	J	INTEGER			REFS	2*58	2*59	65	2*66	67	68	2*70
						2*72	2*73	2*95	2*96	3*106	2*107	3*109	2*110

VARIABLES	SN	TYPE		RELOCATION								
					2*112	2*113	2*114	119	120	121	122	123
					124	129	130	131	132	DEFINED	57	94
					105	117						
1056	K1	INTEGER			REFS	57	73	99	166	DEFINED	55	159
1070	K2	INTEGER			REFS	104	117	169	DEFINED	102	160	
1071	K3	INTEGER			REFS	105	116	174	DEFINED	103	172	
1073	K4	INTEGER			REFS	147	148	DEFINED	146	147		
0	L	INTEGER		F.P.	REFS	44	56	60	65	91	93	95
					96	98	99	102	108	142	143	145
					2*155	157	DEFINED	1				
0	LENGTH	REAL		F.P.	REFS	43	60	95	108	DEFINED	1	
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	44	DEFINED	1	133	134	135	136
					137	138	139	140	144	145		
0	M	INTEGER		F.P.	REFS	55	59	66	103	2*106	2*109	112
					119	120	146	147	2*155	157	159	160
					161	172	173	DEFINED	1			
0	MAT1	INTEGER	ARRAY	F.P.	REFS	44	67	68	70	72	73	80
					81	88	91	98	99	121	122	123
					124	DEFINED	1	66				
0	MAT2	INTEGER	ARRAY	F.P.	REFS	44	113	114	129	130	131	132
					DEFINED	1	106	107	109			
0	N	INTEGER		F.P.	REFS	2*46	55	2*58	2*59	65	66	70
					71	79	84	98	103	3*106	107	3*109
					3*110	2*112	113	114	118	2*119	2*120	133
					134	135	136	137	138	139	140	2*146
					2*147	2*155	157	159	160	DEFINED	1	
1074	NDISPS	INTEGER			REFS	165	DEFINED	157				
0	NELEM	INTEGER	ARRAY	F.P.	REFS	44	125	126	127	128	148	149
					DEFINED	1	121	122	123	124	125	126
					127	128	129	130	131	132	148	149
					150							
1072	NN	INTEGER			REFS	121	122	123	124	2*125	2*126	2*127
					2*128	129	130	131	132	133	134	135
					136	137	138	139	140	144	145	148
					2*149	150	DEFINED	119	120	143		
0	NNELEM	INTEGER		F.P.	REFS	2*44	143	147	DEFINED	1		
0	NNODES	INTEGER		F.P.	REFS	45	169	172	174	DEFINED	1	155
1063	NPI	INTEGER			REFS	72	DEFINED	71				
0	NTIES	INTEGER		F.P.	DEFINED	1	161					
0	NUMGAP	INTEGER		F.P.	REFS	45	47	DEFINED	1			
0	N1	INTEGER		F.P.	REFS	44	DEFINED	1				
0	N2	INTEGER		F.P.	REFS	44	DEFINED	1				
0	N3	INTEGER		F.P.	REFS	44	DEFINED	1				
1011	PI	REAL			REFS	85	89	95	98	99		
					DEFINED	48						
0	PRESFC	REAL	ARRAY	F.P.	REFS	45	96	DEFINED	1	95	96	
1066	Q1	REAL			REFS	90	DEFINED	82	85			
1067	Q2	REAL			REFS	90	DEFINED	83	89			
1061	R	REAL			REFS	65	67	113	DEFINED	58	59	110
					112							
1055	RP	REAL			REFS	65	DEFINED	50				
1064	R1	REAL			REFS	3*85	87	4*89	DEFINED	80	88	
1065	R2	REAL			REFS	4*85	3*89	DEFINED	81	87		

```
VARIABLES     SN  TYPE          RELOCATION
    0  SH         REAL          F.P.       REFS      65   DEFINED     1
    0  SPDAFC     REAL    ARRAY F.P.       REFS      45   DEFINED     1          98        99
    0  T          REAL          F.P.       REFS      50        58     2*59      110     2*112
                                            DEFINED    1
 1075  UU         REAL                     REFS     167       170   DEFINED     158
 1062  Z          REAL                     REFS      65        68      114   DEFINED      60        65       108
    0  ZPRES      REAL    ARRAY F.P.       REFS      46   DEFINED     1          90

FILE NAMES        MODE
       TAPE25     FMT                WRITES     165       167       170       173       175     MOTION       156

EXTERNALS          TYPE   ARGS       REFERENCES
       ZCOR       REAL     4            65

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE  REFERENCES
       FLOAT      REAL     1  INTRIN             2*58      2*59      2*60        95      2*108     3*110     2*112

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       76        56        57
  206  110                       87        84
  224  120                       90        86
    0  130                       92        79
    0  140                       97        93        94
    0  150                      115       104       105
  625  160                      141       116       117       118
    0  170                      151       142
    0  180                      168       166
    0  190                      171       169
    0  200                      175       174
 1043  210      FMT             180       165       167       170       173       175

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   30  100      I           56 76      123B              EXT REFS  NOT INNER
   32  100      J           57 76      116B              EXT REFS
  155  130      I           79 92       62B        OPT
  241  140      I           93 97       32B                  NOT INNER
  243  140      J           94 97       25B        OPT
  324  150      I          104 115     105B                  NOT INNER
  326  150      J          105 115     100B        OPT
  433  160      I          116 141     200B                  NOT INNER
  435  160      J          117 141     173B        OPT
  635  170      I          142 151      50B        OPT
  745  180      I          166 168       5B              EXT REFS
  754  190      I          169 171       6B              EXT REFS
  772  200      I          174 175       5B              EXT REFS

STATISTICS
  PROGRAM LENGTH                1314B     716
          140000B SCM USED
```

```
      1              FUNCTION ZCOR (R,RP,SH,DISH)                                ZCOR        2
                     Y = RP-SH                                                   ZCOR        3
                     IF (R.GE.RP-SH) ZCOR = 0.0                                  ZCOR        4
                     IF (R.GE.RP-SH) RETURN                                      ZCOR        5
      5              CR = (DISH**2+Y**2)/(2.*DISH)                               ZCOR        6
                     ZCOR = SQRT(CR**2-R**2)+DISH-CR                             ZCOR        7
                     RETURN                                                      ZCOR        8
                     END                                                         ZCOR        9
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
5 ZCOR 1 4 7

VARIABLES	SN	TYPE	RELOCATION							
46 CR		REAL		REFS	2*6	DEFINED	5			
0 DISH		REAL	F.P.	REFS	2*5	6	DEFINED	1		
0 R		REAL	F.P.	REFS	3	4	6	DEFINED	1	
0 RP		REAL	F.P.	REFS	2	3	5	DEFINED	1	
0 SH		REAL	F.P.	REFS	2	3	4	DEFINED	1	
45 Y		REAL		REFS	5	DEFINED	2			
44 ZCOR		REAL		DEFINED	3	6				

EXTERNALS	TYPE	ARGS	REFERENCES
SQRT	REAL	1 LIBRARY	6

STATISTICS
PROGRAM LENGTH 47B 39
140000B SCM USED

```
      SUBROUTINE AXI2 (ALFDT,CLOSE,COEF,COORD,DEL,DELGAP,DELOLD,DEP,FI,D
     +PH,DPLAS,DTIME,E,ECREEP,ELEM,EP,EPP,F,F1,F2,GFLAG,ICLOSE,ID,IFAP,I
     +UNIT,IXLSET,KPRINT,LOADST,LST,LTYPE,MATPRO,MBNDOL,NCRP,NDISPS,NELE
     +M,NEWHT,NNODES,NSIZEX,NTIES,NLOAD2,NUMGAP,NUNIT,NUMX,NUMY,OLDEPP,O
     +LDGAP,OLSIGF,OVRLAP,PG,PC,PFLAG,PRESFC,SIGMA,SLOPE,SPDA,TC,TIE,TIM
     +E,TYPE,V)
C
C*****************************************************************
C  AXISYM
C
C  THE AXISYM PROGRAM PERFORMS A TWO DIMENSIONAL R-Z
C  ANALYSIS OF A SINGLE FUEL PELLET AND ITS ASSOCIATED
C  CLADDING ,ASSUMING AXISYMMETRY
C
C*****************************************************************
C
C  INPUT ARGUMENTS
C
C*****************************************************************
C
C  BU(R) - BURNUP
C  CFLUX(R) - CLADDING FLUX
C  CLOSE(R) - LOADST FRACTION AT CLOSURE AS DETERMINED BY FRACAS-II
C
C  COMP(R) -
C
C  COORD(R)- MESH NODAL COORDINATES SUPPLIED BY SUBROUTINE AXIMODL
C
C  DTIME(R)- CREEP TIME INCREMENT
C
C  ELEM(I)-MESH NODALIZATION
C
C  FACHOT(R)-
C
C  FLUX(R)-
C
C  FRADEN(R)-
C
C  FTMELT(R)-
C
C  GFLAG(I)-IF GFLAG=1,ONLY AN ELASTIC SOLUTION IS
C  CALCULATED,GFLAG=0 ELASTIC-PLASTIC SOLUTION
C  IS CALCULATED
C
C  ICLOSE(I)-LOADST WHERE FRACAS II PREDICTS GAP CLOSURE
C
C  IUNIT(I)-TAPE UNIT WHERE LOADS ARE WRITTEN
C
C  KINDOR(I)-
C
C  KPRINT(I)=0 FOR NORMAL OUTPUT; =1 FOR DEBUG
C
C  LST(I)=500 - NO. OF ITERATIONS ALLOWED FOR AXIS CONVERGENCE
```

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      C                                                                      AXI2       55
      C  LTYPE(I) - CONTAINS ELEMENT TYPES,SPECIFIED IN AXIMODL              AXI2       56
      C                                                                      AXI2       57
      C  NCRP(I) - NO. OF CREEP STEPS PER LOAD STEP                          AXI2       58
      C                                                                      AXI2       59
      C  NELEM(I) - NO. OF ELEMENTS                                          AXI2       60
      C                                                                      AXI2       61
      C  NNODES(I) - NO. OF NODES                                            AXI2       62
      C                                                                      AXI2       63
      C  NTIES(I) - NO. OF TIED NODES                                        AXI2       64
      C                                                                      AXI2       65
      C  NUMGAP(I) - NO. OF GAP ELEMENTS                                     AXI2       66
      C                                                                      AXI2       67
      C  NUNIT(I) - INDICATES SI OR BRITISH UNITS                            AXI2       68
      C  NUNIT = 1 -BBRITISH                                                 AXI2       69
      C  NUNIT = 0 - SI                                                      AXI2       70
      C                                                                      AXI2       71
      C  NUMX(I) - =2*NNODES                                                 AXI2       72
      C                                                                      AXI2       73
      C  PFLAG(I) - =0 ELASTIC-PLASTIC SOLUTION                              AXI2       74
      C  PFLAG - =1 EALSTIC SOLUTION ONLY                                    AXI2       75
      C                                                                      AXI2       76
      C  PRESFC(R) - FORCE INFLUENCE CONSTANTS SUPPLIED BY AXIMODL           AXI2       77
      C                                                                      AXI2       78
      C  RSTRAN(R) -                                                         AXI2       79
      C                                                                      AXI2       80
      C  TIME(R)  = TIME IN SECONDS                                          AXI2       81
      C  TIMECL(R)  = TIME IN SECONDS                                        AXI2       82
      C                                                                      AXI2       83
      C                                                                      AXI2       84
      C                                                                      AXI2       85
      C                                                                      AXI2       86
      C                                                                      AXI2       87
      C  ************************************************************************AXI2   88
      C  OUTPUTS                                                             AXI2       89
      C  ************************************************************************AXI2   90
      C  **NOTE*  ALL INDICES ARE  1-AXIAL ,2- RADIAL ,3-HOOP  **            AXI2       91
      C  COEF (R)    - AXI2 WORK ARRAY-                                      AXI2       92
      C  CRPSUM (R) - AXI2 WORK ARRAY-IS USED DURING CREEP                   AXI2       93
      C  CTMAX (R)  - AXI2 WORK ARRAY-                                       AXI2       94
      C  DCHECK (R) - AXI2 WORK ARRAY-                                       AXI2       95
      C  DELOLD (R) - EOCALC WORK ARRAY-CONTAINS  OLD GAP SIZES              AXI2       96
      C  DEP (R)     - AXI2 WORK ARRAY-                                      AXI2       97
      C  DI (R)      - AXI2 WORK ARRAY- CONTAINS BOUNDARY CONDITIONS         AXI2       98
      C  DSIGF(R)    - AXI2 WORK ARRAY-                                      AXI2       99
      C  E (R)       - AXI2 WORK ARRAY- CONTAINS YOUNG'S MODULUS             AXI2      100
      C  ECREEP (R) - AXI2 WORK ARRAY- CONTAINS CUMMULATIVE EFFECTIVE CREEP  AXI2      101
      C  EP (R)      - RETURNS EQUIVELENT PLASTIC STRAIN                     AXI2      102
      C  EPP(R)      - RETURNS CUMMULATIVE PLASTIC AND CREEP STRAINS         AXI2      103
      C  F  (R)      - AXI2 WORK ARRAY - CONTAINS APPLIED FORCES             AXI2      104
      C  FI (R)      - RETURNS NODAL DISPLACEMENTS IN METERS OR INCHES       AXI2      105
      C  F2 (R)      - AXI2 WORK ARRAY - CONTAINS APPLIED FORCES             AXI2      106
      C  ID (I)      - AXI2 WORK ARRAY -                                     AXI2      107
```

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      C   IXLSET (I) - INDEX TELLING CODE IF AXIAL LOCKUP HAS OCCURED          AXI2    108
      C   LOADST (I) - AXI2 COUNTER FOR LOADSTEP                               AXI2    109
      C   NEWWT (R) - WORK ARRAY USED IN EOCALC                                AXI2    110
  110 C   NSIZEX (I) - AXI2 LIMIT ON LEVEL2 ARRAY K                           AXI2    111
      C   NUDEPP (I) - RETURNS INCREMENTS OF PLASTIC STRAIN                    AXI2    112
      C   NUMY   (I) - AXI2 LIMIT ON LEVEL2 ARRAY K                           AXI2    113
      C   OLDEPP (R) - LAST VALUES OF PLASTIC STRAIN                           AXI2    114
      C   OLDGAP (R) - OLD  GAP SIZES                                          AXI2    115
  115 C   OLSIGF (R) - AXI2 WORK ARRAY -                                       AXI2    116
      C   SIGMA  (R) - RETURNS STRESSES IN EITHER N/M**2 OR PSI(1-Z,2-R,3-H)   AXI2    117
      C   SLOPE  (R) - AXI2 WORK ARRAY                                        AXI2    118
      C   SPDA   (R) - AXI2-AXIAL LOAD                                        AXI2    119
      C   TC     (R) - AXI2- ELEMENT TEMPERATURES                             AXI2    120
  120 C   TIE    (R) - AXI2- TIED NODES                                       AXI2    121
      C   V      (R) - AXI2- POISSON'S RATIO                                   AXI2    122
            REAL K,K1,K2                                                      AXI2    123
             REAL DPH(NUMGAP),DEL(NUMGAP),DPLAS(NUMGAP),NEWWT(NUMGAP)         AXI2    124
             REAL TYPE(NUMGAP),DELGAP(NUMGAP),OVRLAP(NUMGAP)                  AXI2    125
  125       INTEGER GAP,PELLET,CLAD,ELEM,GAPEND,PFLAG,GFLAG,TIE               AXI2    126
            INTEGER RELAX                                                     AXI2    127
            INTEGER IGAP(NUMGAP)                                              AXI2    128
            REAL ALFDT(NELEM,3),COEF(NELEM),COORD(NNODES,2)                   AXI2    129
            REAL DELOLD(NUMGAP),DEP(NELEM),DI(NDISPS)                         AXI2    130
  130       DIMENSION ELEM(NELEM,3),EP(NELEM),EPP(NELEM,4)                    AXI2    131
            DIMENSION F(NUMX),F1(NUMX),F2(NLOAD2)                             AXI2    132
            DIMENSION LTYPE(NELEM),ID(NDISPS)                                 AXI2    133
            DIMENSION OLDEPP(NELEM,4),OLDGAP(NUMGAP)                          AXI2    134
            REAL OLSIGF(NELEM),SIGMA(NELEM,4)                                 AXI2    135
  135       DIMENSION SLOPE(NELEM),TC(NELEM),TIE(NTIES),V(NELEM)              AXI2    136
            DIMENSION E(NELEM) , ECREEP(NELEM)                                AXI2    137
            REAL PRESFC(NUMGAP,3), MATPRO(11)                                 AXI2    138
            COMMON/DOT/K(900,60)                                              AXI2    139
             LEVEL2,K                                                         AXI2    140
  140       C                                                                 AXI2    141
            C                                                                 AXI2    142
            C   ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST  AXI2    143
            C   (HOOP STRAIN)/(RADIAL STRAIN)                                 AXI2    144
            C   COMP   - PUO2 CONTENT (WT;)                                   AXI2    145
  145       C   CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)  AXI2    146
            C   CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT     AXI2    147
            C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED   AXI2    148
            C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                          AXI2    149
            C   FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)  AXI2    150
  150       C   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT   AXI2    151
            C   FOTMTL - FUEL OXYGEN TO METAL RAITO                           AXI2    152
            C   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)     AXI2    153
            C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)           AXI2    154
            C   RSTRAN - TRUE STRAIN RATE (1/SEC)                             AXI2    155
  155       C                                                                 AXI2    156
            PELLET = 6HPELLET                                                 AXI2    157
            CLAD = 4HCLAD                                                     AXI2    158
            GAP = 3HGAP                                                       AXI2    159
            GAPEND = 7HGAP END                                                AXI2    160
```

```
      C   ************************************                              AXI2  161
        NSIZEX = 900                                                        AXI2  162
        NUMY = 60                                                           AXI2  163
        KRPKNT = NCRP                                                       AXI2  164
      C                                                                     AXI2  165
      C   THE FOLLOWING CARDS ARE GAP CONSTANTS                            AXI2  166
      C                                                                     AXI2  167
        ISAVE = 1                                                           AXI2  168
        ICLOSE = 1000                                                       AXI2  169
        RELAX = 0                                                           AXI2  170
        BETAI = 40.                                                         AXI2  171
        KI = 0.                                                             AXI2  172
        IF (LOADST.GT.1) GO TO 130                                          AXI2  173
        ISAVE = 0                                                           AXI2  174
            DO 100 I=1,NUMGAP                                               AXI2  175
  100       IGAP(I) = 0                                                     AXI2  176
        NUMGAP = 0                                                          AXI2  177
        CALL FILL (NLOAD2,F2)                                               AXI2  178
        IXLSET = 0                                                          AXI2  179
      C   IXLSET  INDICATES  IF AXIAL  LOCKUP  HAS OCCURED                  AXI2  180
      C                                                                     AXI2  181
            DO 110 I=1,NELEM                                                AXI2  182
      C                                                                     AXI2  183
      C                                                                     AXI2  184
            EP(I) = 0.0                                                     AXI2  185
            ECREEP(I) = 0.0                                                 AXI2  186
                DO 110 J=1,4                                                AXI2  187
                EPP(I,J) = 0.0                                              AXI2  188
  110           CONTINUE                                                    AXI2  189
        CALL FILL (NELEM,DEP)                                               AXI2  190
      C                                                                     AXI2  191
      C   IF THE SOLUTION INCLUDES PLASTICITY  SET  PFLAG=1                 AXI2  192
      C   IF THE SOLUTION INCLUDES A GAP ELEMENT SET  GFLAG=1               AXI2  193
      C                                                                     AXI2  194
        NUMX = 2.0*NNODES                                                   AXI2  195
        IF (NUMX.GT.NSIZEX) WRITE (6,330)                                   AXI2  196
        IF (NUMX.GT.NSIZEX) STOP                                            AXI2  197
        MBAND = 0                                                           AXI2  198
            DO 120 I=1,NELEM                                                AXI2  199
            LL = I                                                          AXI2  200
      C                                                                     AXI2  201
      C                                                                     AXI2  202
      C                                                                     AXI2  203
      C   LGAP(LL) CONTAINS GAP ELEMENT NUMBERS                            AXI2  204
      C   K VALUES FOR THE 1ST AND LAST GAP ELEMENTS ARE 0.5 * OTHER        AXI2  205
      C   K VALUES                                                          AXI2  206
      C                                                                     AXI2  207
            IF (LTYPE(LL).EQ.GAP.OR.LTYPE(LL).EQ.GAPEND) NUMGAP = NUMGAP+1  AXI2  208
      C   ***COMPUTE BANDWIDTH HERE                                         AXI2  209
            IF (IABS(ELEM(LL,1)-ELEM(LL,2)).GT.MBAND) MBAND = IABS(ELEM(LL  AXI2  210
       +    ,1)-ELEM(LL,2))                                                 AXI2  211
            IF (LTYPE(LL).EQ.GAP.OR.LTYPE(LL).EQ.GAPEND) GO TO 120          AXI2  212
            IF (IABS(ELEM(LL,2)-ELEM(LL,3)).GT.MBAND) MBAND = IABS(ELEM(LL  AXI2  213
```

```
                     +    ,2)-ELEM(LL,3))                                                    AXI2      214
                          IF (IABS(ELEM(LL,3)-ELEM(LL,1)).GT.MBAND) MBAND = IABS(ELEM(LL AXI2      215
215                  +    ,3)-ELEM(LL,1))                                                    AXI2      216
               120        CONTINUE                                                           AXI2      217
                        MBAND = 2*(MBAND+1)                                                 AXI2      218
                        IF (MBAND.GT.NUMY) GO TO 300                                        AXI2      219
                        CALL FILL (NUMGAP,OLDGAP)                                           AXI2      220
220             130     CONTINUE                                                            AXI2      221
                        CALL NULOAD (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST,MBA AXI2      222
                       +ND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIES,NU AXI2      223
                       +MGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,F2,ID,LTYP AXI2      224
                       +E,OLDEPP,SPDA,TC,TIE,V)                                             AXI2      225
225                     IFLAG = 0                                                           AXI2      226
                C                                                                           AXI2      227
                C   ***TO HERE, F(I) CONTAINS TERMS DUE TO APPLIED LOADS, THERMAL         AXI2      228
                C   STRAINS, OLD TOTAL PLASTIC STRAIN COMPONENTS, AND DUE TO               AXI2      229
                C   THE SPECIFIED DISPLACEMENTS TRANSPOSED TO THE R.H.S.                   AXI2      230
230             C   VECTOR F(I) IS NOT CHANGED DURING THE ITERATION FOR                     AXI2      231
                C   THE NEW PLASTIC STRAIN INCREMENTS.                                      AXI2      232
                C                                                                           AXI2      233
                        DO 140 I=1,NUMX                                                     AXI2      234
                140     F1(I) = F(I)                                                        AXI2      235
235             C                                                                           AXI2      236
                C   SOLVE SYSTEM OF EQUATIONS FOR DISPLACEMENTS(F1)                         AXI2      237
                C                                                                           AXI2      238
                      CALL ELAST (F1,NUMX,MBAND,0)                                          AXI2      239
                C   ***COMPUTE STRESSES HERE ****                                           AXI2      240
240                   REWIND 18                                                             AXI2      241
                      CALL SIGCLC (NELEM,LTYPE,GAP,GAPEND,ELEM,ALFDT,EPP,OLDEPP,F1,SIGMA AXI2      242
                     +,V,E,KPRINT,NUMX,IFLAG)                                               AXI2      243
                      IF (ICLOSE.EQ.-1) GO TO 230                                           AXI2      244
                C                                                                           AXI2      245
245             C   CHECK FOR GAPCLOSURE AT THE CENTERNODE                                 AXI2      246
                C                                                                           AXI2      247
                      CLOSE = 2.                                                            AXI2      248
                      CALL GPFORC (F1,NUMX,GAPSIZ,FORCE,IGAP,NUMGAP,IXLSET,CLOSE)           AXI2      249
                      IF (GAPSIZ.GE.0..AND.IXLSET.EQ.0) GO TO 240                           AXI2      250
250                   IF (FORCE.GE.0.) GO TO 190                                            AXI2      251
                      IF (IXLSET.EQ.1) GO TO 240                                            AXI2      252
                C                                                                           AXI2      253
                C                                                                           AXI2      254
                C   THE FOLLOWING CODING IS EXECUTED IF THE GAP WAS FORMERLY OPEN          AXI2      255
255             C   AND THE MIDDLE GAP ELEMENT IS NOW CLOSED                               AXI2      256
                C   ALL THE GAP ELEMENTS ARE FORCED CLOSED AND THE MIDDLE                   AXI2      257
                C   GAP ELELIST,1300-1500                                                   AXI2      258
                C   IF VALID,CLOSURE IS FORCED EVERYWHERE                                   AXI2      259
                C   IF NOT VALID, CLOSURE AT EACH GAP NODE IS DETERMINED                    AXI2      260
260             C   NUMERICALLY IN THE SUBROUTINE AXPLAS.                                  AXI2      261
                C                                                                           AXI2      262
                C   ALSO, IF VALID, THE ROOT FINDER ROUTINE CLOSEX DETERMINES               AXI2      263
                C   WHERE CLOSURE JUST OCCURS IN ORDER TO ENFORCE AXIAL LOCKUP              AXI2      264
                C                                                                           AXI2      265
265             C                                                                           AXI2      266
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```
                ISAVE = 0                                                                AX12    267
                CLOSE = 1.0                                                              AX12    268
                ICLOSE = LOADST                                                          AX12    269
                N = NLOADS+NTEMPS+3                                                      AX12    270
      270           DO 150 I=1,N                                                         AX12    271
          150       BACKSPACE IUNIT                                                      AX12    272
                CALL NULOAD (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST,MBA     AX12    273
               +ND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIES,NU     AX12    274
               +MGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,F2,ID,LTYP     AX12    275
      275      +E,OLDEPP,SPDA,TC,TIE,V)                                                 AX12    276
          C                                                                            AX12    277
                DO 160 I=1,NUMX                                                        AX12    278
          160   FI(I) = F(I)                                                           AX12    279
                CALL ELAST (FI,NUMX,MBAND,0)                                           AX12    280
      280       CALL GPFORC (FI,NUMX,GAPSIZ,FORCE,IGAP,NUMGAP,IXLSET,CLOSE)            AX12    281
                IF (FORCE.GT.0.0) GO TO 240                                            AX12    282
                DO 170 I=1,N                                                           AX12    283
          170   BACKSPACE IUNIT                                                        AX12    284
                ICLOSE = LOADST                                                        AX12    285
      285       CALL CLOSAX (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST,MBA     AX12    286
               +ND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIES,NU     AX12    287
               +MGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,FI,F2,ID,L     AX12    288
               +TYPE,OLDEPP,SPDA,TC,TIE,V)                                             AX12    289
                DO 180 I=1,NUMGAP                                                      AX12    290
      290       180 IGAP(I) = 1                                                        AX12    291
                CALL XLLOK (NUMGAP,FI,NUMX)                                            AX12    292
                ICLOSE = -1                                                            AX12    293
                IXLSET = 1                                                             AX12    294
                REWIND 19                                                              AX12    295
      295       GO TO 130                                                            AX12    296
          190   IXLSET = 0                                                             AX12    297
                ICLOSE = 1000.                                                         AX12    298
                DO 200 I=1,NUMGAP                                                      AX12    299
          200   IGAP(I) = 0                                                            AX12    300
      300       DO 210 I=1,N                                                         AX12    301
          210   BACKSPACE IUNIT                                                        AX12    302
                ISAVE = 0                                                              AX12    303
                CALL NULOAD (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST,MBA     AX12    304
               +ND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIES,NU     AX12    305
      305      +MGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,F2,ID,LTYP     AX12    306
               +E,OLDEPP,SPDA,TC,TIE,V)                                                AX12    307
                DO 220 I=1,NUMX                                                        AX12    308
          220   FI(I) = F(I)                                                           AX12    309
                CALL ELAST (FI,NUMX,MBAND,0)                                           AX12    310
      310       GO TO 240                                                            AX12    311
          230   ICLOSE = 1                                                             AX12    312
          240   CONTINUE                                                               AX12    313
                ITER = 1                                                               AX12    314
                IF (PFLAG.EQ.0.AND.IXLSET.EQ.1) GO TO 280                              AX12    315
      315       IF (GFLAG.EQ.1.AND.IXLSET.NE.1) GO TO 260                            AX12    316
          C                                                                            AX12    317
          C                                                                            AX12    318
          C   THE INITIAL TEST FOR EFFECTIVE STRESS IS VALID ONLY IF NO GAP           AX12    319
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      C   INTERATION IS BEING MADE                                                    AX12   320
320   C                                                                               AX12   321
            DO 250 J=1,NELEM                                                          AX12   322
            IF (LTYPE(J).EQ.PELLET.OR.LTYPE(J).EQ.GAP.OR.LTYPE(J).EQ.GAPEN            AX12   323
     +      D) GO TO 250                                                             AX12   324
            EPI = EP(J)                                                               AX12   325
325         TCI = TC(J)                                                               AX12   326
            SIGZ = SIGMA(J,1)                                                         AX12   327
            SIGR = SIGMA(J,2)                                                         AX12   328
            SIGH = SIGMA(J,3)                                                         AX12   329
            TAU = SIGMA(J,4)                                                          AX12   330
330         SIGEFI = 0.707107*SQRT((SIGH-SIGZ)**2+(SIGZ-SIGR)**2+(SIGR-SIG            AX12   331
     +      H)**2+6.0*TAU**2)                                                        AX12   332
            EI = E(J)                                                                 AX12   333
            IF (NUNIT.EQ.0) EI = PASPSI(EI)                                           AX12   334
            IF (NUNIT.EQ.0) TCI = TEMPKF(TCI)                                         AX12   335
335         IF (NUNIT.EQ.0) SIGEFI = PASPSI(SIGEFI)                                   AX12   336
            JTYPE = 1                                                                 AX12   337
            IF (LTYPE(J).EQ.CLAD) JTYPE = 2                                           AX12   338
            CALL STRAINX (SIGEFI,DUM,EPI,TCI,EI,JTYPE,NUNIT)                          AX12   339
            DEPI = EPI-EP(J)                                                          AX12   340
340         IF (DEPI.GT.0.0) GO TO 260                                                AX12   341
      250   CONTINUE                                                                  AX12   342
            CALL FILL (NELEM,DEP)                                                     AX12   343
            GO TO 280                                                                 AX12   344
      260   CALL AXPLAS (GFLAG,IFLAG,ITER,IXLSET,KI,MATPRO,MEAND,NDISPS,NELEM,       AX12   345
345        +NTIES,NUMGAP,NUMX,NUNIT,PFLAG,RATIO,RELAX,TIME,ALFDT,COEF,DEP,DI,D       AX12   346
           +TIME,E,ECREEP,ELEM,EP,EPP,F,FI,ID,LTYPE,OLDEPP,OLDGAP,OLSIGF,SIGMA       AX12   347
           +,SLOPE,TC,TIE,V)                                                          AX12   348
      C                                                                               AX12   349
      C                                                                               AX12   350
350   C   THE EOCALC SUBROUTINE CALCULATES THE NEW EQ TERMS FROM THE LAST            AX12   351
      C   DISPLACEMENT CALCULATIONS FOR THE GAP CLOSURE ITERATION                     AX12   352
      C                                                                               AX12   353
      C                                                                               AX12   354
            IF (GFLAG.NE.0.AND.IXLSET.NE.1) CALL EOCALC (K1,K2,OLDGAP,BETA1,PF        AX12   355
355        +LAG,FI,NUMGAP,RATIO,DELOLD,KPRINT,NUMX,DPH,DEL,DPLAS,TYPE,DELGAP,0       AX12   356
           +VRLAP,NEWHT)                                                              AX12   357
            IF (RATIO-0.0001) 280,280,270                                             AX12   358
      270   ITER = ITER+1                                                             AX12   359
      C                                                                               AX12   360
360   C                                                                               AX12   361
      C   LST IS THE MAXIMUM NUMBER  OF ITERATIONS  ALLOWED                          AX12   362
      C                                                                               AX12   363
            IF (ITER.LE.LST) GO TO 260                                                AX12   364
            WRITE (6,340) ITER                                                        AX12   365
365   C   ***EVEN THO ROUTINE DID NOT CONVERGE                                        AX12   366
      C   ***LAST COMPUTED VALUES ARE RETURNED, AND                                   AX12   367
      C   ***AN ERROR MESSAGE IS PRINTED                                            AX12   368
            CALL AXIOUT (ALFDT,CLAD,DTIME,E,ELEM,EPP,FI,GAP,GAPEND,IXLSET,KI,K      AX12   369
           +PRINT,LOADST,LTYPE,NELEM,NNODES,NUMGAP,NUMX,NUNIT,OLDEPP,PG,PC,PRE      AX12   370
370        +SFC,RELAX,SIGMA,SPDA,TC,TIME,V)                                           AX12   371
            RETURN                                                                    AX12   372
```

```
      C   ***PLASTIC SOLUTION COMPLETE                                          AX12     373
      280       DO 290 J=1,NELEM                                               AX12     374
                IF (LTYPE(J).EQ.GAP.OR.LTYPE(J).EQ.GAPEND) GO TO 290           AX12     375
375             EPP(J,1) = EPP(J,1)+OLDEPP(J,1)                                AX12     376
                EPP(J,2) = EPP(J,2)+OLDEPP(J,2)                                AX12     377
                EPP(J,3) = EPP(J,3)+OLDEPP(J,3)                                AX12     378
                EPP(J,4) = EPP(J,4)+OLDEPP(J,4)                                AX12     379
                IF (RELAX.NE.1) EP(J) = EP(J)+DEP(J)                           AX12     380
380             IF (RELAX.EQ.1) ECREEP(J) = ECREEP(J)+DEP(J)                   AX12     381
      290       CONTINUE                                                       AX12     382
                IF (RELAX.EQ.0) CALL AXIOUT (ALFDT,CLAD,DTIME,E,ELEM,EPP,FI,GAP,GA AX12  383
               +PEND,IXLSET,KI,KPRINT,LOADST,LTYPE,NELEM,NNODES,NUMGAP,NUMX,NUNIT, AX12  384
               +OLDEPP,PG,PC,PRESFC,RELAX,SIGMA,SPDA,TC,TIME,V)                 AX12     385
385             IF (RELAX.NE.0.AND.KRPKNT.EQ.0) CALL AXIOUT (ALFDT,CLAD,DTIME,E,EL AX12  386
               +EM,EPP,FI,GAP,GAPEND,IXLSET,KI,KPRINT,LOADST,LTYPE,NELEM,NNODES,NU AX12  387
               +MGAP,NUMX,NUNIT,OLDEPP,PG,PC,PRESFC,RELAX,SIGMA,SPDA,TC,TIME,V)  AX12  388
      300       CONTINUE                                                       AX12     389
                IF (DTIME.EQ.0.0.OR.KRPKNT.EQ.0) GO TO 320                     AX12     390
390             IF (KRPKNT.EQ.NCRP) GO TO 310                                  AX12     391
                REWIND 18                                                      AX12     392
                CALL STRNAD (NELEM,LTYPE,GAP,GAPEND,ELEM,OLDEPP,F,NUMX)        AX12     393
      310       RELAX = 1                                                      AX12     394
                TIME = TIME+DTIME                                              AX12     395
395             KRPKNT = KRPKNT-1                                              AX12     396
                IFLAG = 0                                                      AX12     397
                ITER = 1                                                       AX12     398
                GO TO 260                                                      AX12     399
      320       LOADST = LOADST+1                                              AX12     400
400             RETURN                                                         AX12     401
      C                                                                        AX12     402
      330   FORMAT (1H1,9X,15HTOO MANY NODES )                                 AX12     403
      340   FORMAT (1H0,20H DID NOT CONVERGE IN,1X,I4,1X,11H ITERATIONS)       AX12     404
            END                                                                AX12     405
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES	
4	AX12	1	371	400

VARIABLES

	SN	TYPE		RELOCATION								
0	ALFDT	REAL	ARRAY	F.P.	REFS	128	221	241	272	285	303	344
					368	382	385	DEFINED	1			
2207	BETAI	REAL			REFS	354	DEFINED	170				
2202	CLAD	INTEGER			REFS	125	337	368	382	385		
					DEFINED	157						
0	CLOSE	REAL		F.P.	REFS	221	248	272	280	285	303	
					DEFINED	1	247	267				
0	COEF	REAL	ARRAY	F.P.	REFS	128	344	DEFINED	1			
0	COORD	REAL	ARRAY	F.P.	REFS	128	221	272	285	303		

VARIABLES	SN	TYPE	RELOCATION									
					DEFINED	1						
0	DEL	REAL	ARRAY	F.P.	REFS	123	354	DEFINED	1			
0	DELGAP	REAL	ARRAY	F.P.	REFS	124	354	DEFINED	1			
0	DELOLD	REAL	ARRAY	F.P.	REFS	129	221	272	285	303	354	
					DEFINED	1						
0	DEP	REAL	ARRAY	F.P.	REFS	129	189	342	344	379	380	
					DEFINED	1						
2235	DEPI	REAL			REFS	340	DEFINED	339				
0	DI	REAL	ARRAY	F.P.	REFS	129	221	272	285	303	344	
					DEFINED	1						
0	DPH	REAL	ARRAY	F.P.	REFS	123	354	DEFINED	1			
0	DPLAS	REAL	ARRAY	F.P.	REFS	123	354	DEFINED	1			
0	DTIME	REAL		F.P.	REFS	344	368	382	385	389	394	
					DEFINED	1						
2234	DUM	* REAL			REFS	338						
0	E	REAL	ARRAY	F.P.	REFS	136	221	241	272	285	303	332
						344	368	382	385	DEFINED	1	
0	ECREEP	REAL	ARRAY	F.P.	REFS	136	344	380	DEFINED	1	185	380
0	ELEM	INTEGER	ARRAY	F.P.	REFS	125	130	4*209	4*212	4*214	221	241
						272	285	303	344	368	382	385
					DEFINED	1						392
0	EP	REAL	ARRAY	F.P.	REFS	130	324	339	344	379		
					DEFINED	1	184	379				
0	EPP	REAL	ARRAY	F.P.	REFS	130	221	241	272	285	303	344
						368	375	376	377	378	382	385
					DEFINED	1	187	375	376	377	378	
2223	EPI	REAL			REFS	338	339	DEFINED	324			
2232	EI	REAL			REFS	333	338	DEFINED	332	333		
0	F	REAL	ARRAY	F.P.	REFS	131	221	234	272	278	285	303
						308	344	392	DEFINED	1		
2220	FORCE	REAL			REFS	248	250	280	281			
0	FI	REAL	ARRAY	F.P.	REFS	131	238	241	248	279	280	285
						291	309	344	354	368	382	385
					DEFINED	1	234	278	308			
0	F2	REAL	ARRAY	F.P.	REFS	131	177	221	272	285	303	
					DEFINED	1						
2200	GAP	INTEGER			REFS	125	207	211	241	322	348	374
						382	385	392	DEFINED	158		
2203	GAPEND	INTEGER			REFS	125	207	211	241	322	368	374
						382	385	392	DEFINED	159		
2217	GAPSIZ	REAL			REFS	248	249	280				
0	GFLAG	INTEGER		F.P.	REFS	125	315	344	354	DEFINED	1	
2210	I	INTEGER			REFS	175	184	185	187	199	2*234	2*278
						290	299	2*308	DEFINED	174	181	198	233
						270	277	282	289	298	300	307	
0	ICLOSE	INTEGER		F.P.	REFS	221	243	272	285	303		
					DEFINED	1	168	268	284	292	297	311
0	ID	INTEGER	ARRAY	F.P.	REFS	132	221	272	285	303	344	
					DEFINED	1						
2216	IFLAG	INTEGER			REFS	241	344	DEFINED	225	396		
0	IGAP	INTEGER	ARRAY	F.P.	REFS	127	221	248	272	280	285	303
					DEFINED	1	175	290	299			
2206	ISAVE	INTEGER			REFS	221	272	285	303	DEFINED	167	173

VARIABLES	SN	TYPE		RELOCATION								
					266	302						
2222	ITER	INTEGER			REFS	344	358	363	364	DEFINED	313	358
					397							
0	IUNIT	INTEGER		F.P.	REFS	221	272	285	303	DEFINED	1	
					I/O REFS	271	283	301				
0	IXLSET	INTEGER		F.P.	REFS	221	248	249	251	272	280	285
					303	314	315	344	354	368	382	385
					DEFINED	1	178	293	296			
2211	J	INTEGER			REFS	187	3*322	324	325	326	327	328
					329	332	337	339	2*374	3*375	3*376	3*377
					3*378	3*379	3*380	DEFINED	186	321	373	
2233	JTYPE	INTEGER			REFS	338	DEFINED	336	337			
0	K	REAL	ARRAY	DOT	REFS	122	138	139				
0	KPRINT	INTEGER		F.P.	REFS	241	354	368	382	385		
					DEFINED	1						
2205	KRPKNT	INTEGER			REFS	385	389	390	395	DEFINED	163	395
2176	KI	REAL			REFS	122	221	272	285	303	344	354
					368	382	385	DEFINED	171			
2177	KZ	REAL			REFS	122	221	272	285	303	354	
2213	LL	INTEGER			REFS	2*207	4*209	2*211	4*212	4*214		
					DEFINED	199						
0	LOADST	INTEGER		F.P.	REFS	172	221	268	272	284	285	303
					368	382	385	399	DEFINED	1	399	
0	LST	INTEGER		F.P.	REFS	363	DEFINED	1				
0	LTYPE	INTEGER	ARRAY	F.P	REFS	132	2*207	2*211	221	241	272	285
					303	3*322	337	344	368	2*374	382	385
					392	DEFINED	1					
0	MATPRO	REAL	ARRAY	F.P.	REFS	137	221	272	285	303	344	
					DEFINED	1						
2212	MBAND	INTEGER			REFS	209	212	214	217	218	221	238
					272	279	285	303	309	344		
					DEFINED	197	209	212	214	217		
0	MBNDOL	INTEGER		F.P.	REFS	221	272	285	303	DEFINED	1	
2221	N	INTEGER			REFS	270	282	300	DEFINED	269		
0	NCRP	INTEGER		F.P.	REFS	163	390	DEFINED	1			
0	NDISPS	INTEGER		F.P.	REFS	129	132	221	272	285	303	344
					DEFINED	1						
0	NELEM	INTEGER		F.P.	REFS	2*128	129	3*130	132	133	2*134	3*135
					2*136	181	189	198	221	241	272	285
					303	321	342	344	368	373	382	385
					392	DEFINED	1					
0	NEWWT	REAL	ARRAY	F.P.	REFS	123	354	DEFINED	1			
2214	NLOADS	INTEGER			REFS	221	269	272	285	303		
0	NLOAD2	INTEGER		F.P.	REFS	131	177	221	272	285	303	
					DEFINED	1						
0	NNODES	INTEGER		F.P.	REFS	128	194	221	272	285	303	368
					382	385	DEFINED	1				
0	NSIZEX	INTEGER		F.P.	REFS	195	196	DEFINED	1	161		
2215	NTEMPS	INTEGER			REFS	221	269	272	285	303		
0	NTIES	INTEGER		F.P.	REFS	135	221	272	285	303	344	
					DEFINED	1						
0	NUMGAP	INTEGER		F.P.	REFS	4*123	3*124	127	129	133	137	174
					207	219	221	248	272	280	285	289

VARIABLES	SN	TYPE	RELOCATION									
					291	298	303	344	354	368	382	385
					DEFINED	1	176	207				
0	NUMX	INTEGER		F.P.	REFS	2*131	195	196	221	233	238	241
					248	272	277	279	280	285	291	303
					307	309	344	354	368	382	385	392
					DEFINED	1	194					
0	NUMY	INTEGER		F.P.	REFS	218	221	272	285	303		
					DEFINED	1	162					
0	NUNIT	INTEGER		F.P.	REFS	221	272	285	303	333	334	335
					338	344	368	382	385	DEFINED	1	
0	OLDEPP	REAL	ARRAY	F.P.	REFS	133	221	241	272	285	303	344
					368	375	376	377	378	382	385	392
					DEFINED	1						
0	OLDGAP	REAL	ARRAY	F.P.	REFS	133	219	344	354	DEFINED	1	
0	OLSIGF	REAL	ARRAY	F.P.	REFS	134	344	DEFINED	1			
0	OVRLAP	REAL	ARRAY	F.P.	REFS	124	354	DEFINED	1			
0	PC	REAL		F.P.	REFS	368	382	385	DEFINED	1		
2201	PELLET	INTEGER			REFS	125	322	DEFINED	156			
0	PFLAG	INTEGER		F.P.	REFS	125	314	344	354	DEFINED	1	
0	PG	REAL		F.P.	REFS	368	382	385	DEFINED	1		
0	PRESFC	REAL	ARRAY	F.P.	REFS	137	368	382	385	DEFINED	1	
2236	RATIO	REAL			REFS	344	354	357				
2204	RELAX	INTEGER			REFS	126	344	368	379	380	2*382	2*385
					DEFINED	169	393					
2231	SIGEFI	REAL			REFS	335	338	DEFINED	330	335		
2227	SIGH	REAL			REFS	2*330	DEFINED	328				
0	SIGMA	REAL	ARRAY	F.P.	REFS	134	241	326	327	328	329	344
					368	382	385	DEFINED	1			
2226	SIGR	REAL			REFS	2*330	DEFINED	327				
2225	SIGZ	REAL			REFS	2*330	DEFINED	326				
0	SLOPE	REAL	ARRAY	F.P.	REFS	135	344	DEFINED	1			
0	SPDA	REAL		F.P.	REFS	221	272	285	303	368	382	385
					DEFINED	1						
2230	TAU	REAL			REFS	330	DEFINED	329				
0	TC	REAL	ARRAY	F.P.	REFS	135	221	272	285	303	325	344
					368	382	385	DEFINED	1			
2224	TCI	REAL			REFS	334	338	DEFINED	325	334		
0	TIE	INTEGER	ARRAY	F.P.	REFS	125	135	221	272	285	303	344
					DEFINED	1						
0	TIME	REAL		F.P.	REFS	344	368	382	385	394		
					DEFINED	1	394					
0	TYPE	REAL	ARRAY	F.P.	REFS	124	354	DEFINED	1			
0	V	REAL	ARRAY	F.P.	REFS	135	221	241	272	285	303	344
					368	382	385	DEFINED	1			

FILE NAMES	MODE			
TAPE18		MOTION	240	391
TAPE19		MOTION	294	
TAPE6	FMT	WRITES	195	364

VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS	TYPE	ARGS		REFERENCES				
AXIOUT		29		368	382	385		
AXPLAS		39		344				
CLOSAX		40		285				
ELAST		4		238	279	309		
EQCALC		18		354				
FILL		2		177	189	219	342	
GPFORC		8		248	280			
NULOAD		39		221	272	303		
PASPSI	REAL	1		333	335			
SIGCLC		15		241				
SQRT	REAL	1	LIBRARY	330				
STRAINX		7		338				
STRNAD		8		392				
TEMPKF	REAL	1		334				
XLLOK		3		291				

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES		
IABS	INTEGER	1	INTRIN		2*209	2*212	2*214

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		175	174			
0	110		188	181	186		
201	120		216	198	211		
220	130		220	172	295		
0	140		234	233			
0	150		271	270			
0	160		278	277			
0	170		283	282			
0	180		290	289			
645	190		296	250			
0	200		299	298			
0	210		301	300			
0	220		308	307			
767	230		311	243			
772	240		312	249	251	281	310
1120	250		341	321	322		
1132	260		344	315	340	363	398
0	270	INACTIVE	358	357			
1324	280		373	314	343	2*357	
1366	290		381	373	374		
1507	300		388	218			
1534	310		393	390			
1550	320		399	389			
2150	330	FMT	402	195			
2154	340	FMT	403	364			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
50	100	I	174 175	4B	INSTACK
67	110	I	181 188	20B	NOT INNER
75	110	J	186 188	7B	INSTACK
136	120	I	198 216	46B	OPT
305	140	I	233 234	5B	INSTACK

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
407	150	I	270 271	5B		EXT REFS	
477	160	I	277 278	5B	INSTACK		
527	170	I	282 283	5B		EXT REFS	
623	180	I	289 290	4B	INSTACK		
653	200	I	298 299	4B	INSTACK		
661	210	I	300 301	5B		EXT REFS	
753	220	I	307 308	5B	INSTACK		
1011	250	J	321 341	112B		EXT REFS	EXITS
1325	290	J	373 381	44B	OPT		

COMMON BLOCKS	LENGTH
DOT	54000 LCM

STATISTICS

PROGRAM LENGTH	2332B	1242
LCM LABELED COMMON LENGTH	151360B	54000

140000B SCM USED

```
      SUBROUTINE AXIOUT (ALFDT,CLAD,DTIME,E,ELEM,EPP,FI,GAP,GAPEND,IXLSE
     +T,KI,KPRINT,LOADST,LTYPE,NELEM,NNODES,NUMGAP,NUMX,NUNIT,OLDEPP,PG,
     +PC,PRESFC,RELAX,SIGMA,SPDA,TC,TIME,V)
      INTEGER CLAD,GAPEND,GAP,ELEM(NELEM,3),LTYPE(NELEM),RELAX
      REAL ALFDT(NELEM,3),EPP(NELEM,4),FI(NUMX),OLDEPP(NELEM,4)
      REAL SIGMA(NELEM,4),V(NELEM),E(NELEM),TC(NELEM),KI
      REAL PRESFC(NUMGAP,3)
C
C
C
C     THIS SUBROUTINE CONTROLS AXISYM OUTPUT
C
C
C
      IF (RELAX.NE.0) GO TO 110
      WRITE (6,280)
      IP = LOADST-1
      CALL AXI2IN (N,M,L,15,16,17,18,19,110,111,112)
      WRITE (6,230) IP
      WRITE (6,240) PG,PC
      WRITE (6,250)
      NX = (N-1)*4+(M-1)*4
      WRITE (6,260)
          DO 100 I=1,NX
  100     WRITE (6,270) I,TC(I),E(I),V(I),ALFDT(I,1),ALFDT(I,2),ALFDT(I,
     +    3)
      WRITE (6,290)
      GO TO 120
  110 WRITE (6,300) TIME
      WRITE (6,310)
  120 CONTINUE
      REWIND 30
      WRITE (6,320)
          DO 130 I=1,NELEM,4
          IF (LTYPE(I).EQ.CLAD) NSV = I
          IF (LTYPE(I).EQ.CLAD) GO TO 140
          CALL STRSAV (SIGMA,I,SIGZAV,SIGRAV,SIGHAV,TAUAV,NELEM)
          CALL STRNAV (I,SIGZAV,SIGRAV,SIGHAV,TAUAV,E1,E2,E3,E4,NELEM,E,
     +    V,EPP,ALFDT)
          I3 = I+3
          WRITE (6,330) I,I3,SIGZAV,SIGRAV,SIGHAV,TAUAV
  130     WRITE (30) I,E1,E2,E3,E4
  140 CONTINUE
      WRITE (6,340)
      WRITE (6,350)
      REWIND 30
      NP = NSV-1
          DO 150 I=1,NP,4
          READ (30) J,E1,E2,E3,E4
          J3 = J+3
  150     WRITE (6,330) J,J3,E1,E2,E3,E4
      WRITE (6,360)
      REWIND 30
```

```
                K = 0                                                                  AXIOUT     55
55              WRITE (6,320)                                                          AXIOUT     56
                    DO 160 I=NSV,NELEM,4                                               AXIOUT     57
                    IF (LTYPE(I).NE.CLAD) GO TO 160                                    AXIOUT     58
                    CALL STRSAV (SIGMA,I,SIGZAV,SIGRAV,SIGHAV,TAUAV,NELEM)             AXIOUT     59
                    CALL STRNAV (I,SIGZAV,SIGRAV,SIGHAV,TAUAV,E1,E2,E3,E4,NELEM,E,     AXIOUT     60
60              +   V,EPP,ALFDT)                                                       AXIOUT     61
                    I3 = I+3                                                           AXIOUT     62
                    WRITE (6,330) I,I3,SIGZAV,SIGRAV,SIGHAV,TAUAV                      AXIOUT     63
                    WRITE (30) I,I3,E1,E2,E3,E4                                        AXIOUT     64
                    K = K+1                                                            AXIOUT     65
65          160     CONTINUE                                                           AXIOUT     66
                REWIND 30                                                              AXIOUT     67
                WRITE (6,370)                                                          AXIOUT     68
                WRITE (6,350)                                                          AXIOUT     69
                    DO 170 I=1,K                                                       AXIOUT     70
70                  READ (30) J,J3,E1,E2,E3,E4                                         AXIOUT     71
            170     WRITE (6,330) J,J3,E1,E2,E3,E4                                     AXIOUT     72
                REWIND 30                                                              AXIOUT     73
                WRITE (6,380)                                                          AXIOUT     74
                WRITE (6,350)                                                          AXIOUT     75
75                  DO 180 I=1,K                                                       AXIOUT     76
                    READ (30) J,J3                                                     AXIOUT     77
                        DO 180 L=J,J3                                                  AXIOUT     78
                        IF (EPP(L,1).EQ.0.0.AND.EPP(L,2).EQ.0.0.AND.EPP(L,3).EQ.0.     AXIOUT     79
                +       0.AND.EPP(L,4).EQ.0.0) GO TO 180                               AXIOUT     80
80                      WRITE (6,390) L,(EPP(L,LI),LI=1,4)                             AXIOUT     81
            180         CONTINUE                                                       AXIOUT     82
                CALL IFPRES (IXLSET,FI,NUMGAP,PRESFC,KI,NUMX,NELEM)                    AXIOUT     83
                WRITE (6,400)                                                          AXIOUT     84
            C                                                                          AXIOUT     85
85              WRITE (6,410)                                                          AXIOUT     86
                    DO 190 I=1,NUMGAP                                                  AXIOUT     87
                    NN = NELEM-NUMGAP+I                                                AXIOUT     88
                    NX = ELEM(NN,1)                                                    AXIOUT     89
                    DR = FI(NX*2-1)                                                    AXIOUT     90
90                  DZ = FI(NX*2)                                                      AXIOUT     91
            190     WRITE (6,440) NX,DR,DZ                                             AXIOUT     92
            C                                                                          AXIOUT     93
            C   FUEL END                                                              AXIOUT     94
            C                                                                          AXIOUT     95
95              NI = N-1                                                               AXIOUT     96
                    DO 200 I=1,NI                                                      AXIOUT     97
                    NX = NX-1                                                          AXIOUT     98
                    DR = FI(NX*2-1)                                                    AXIOUT     99
                    DZ = FI(NX*2)                                                      AXIOUT    100
100         200     WRITE (6,440) NX,DR,DZ                                             AXIOUT    101
                WRITE (6,420)                                                          AXIOUT    102
            C                                                                          AXIOUT    103
            C   CLADDING DISPLACEMENT                                                  AXIOUT    104
                WRITE (6,410)                                                          AXIOUT    105
105                 DO 210 I=1,NUMGAP                                                  AXIOUT    106
                    NN = NELEM-NUMGAP+I                                                AXIOUT    107
```

```
                      NX = ELEM(NN,2)                                                  AXIOUT    108
                      NO = NX+M-1                                                      AXIOUT    109
                      DR = FI(NX*2-1)                                                  AXIOUT    110
110                   DZ = FI(NX*2)                                                    AXIOUT    111
                      DRO = FI(NO*2-1)                                                 AXIOUT    112
                      DZO = FI(NO*2)                                                   AXIOUT    113
            210       WRITE (6,430) NX,DR,DZ,NO,DRO,DZO                                AXIOUT    114
                  IF (KPRINT.NE.2) RETURN                                              AXIOUT    115
115               WRITE (6,450)                                                        AXIOUT    116
                  WRITE (6,320)                                                        AXIOUT    117
                      DO 220 I=1,NELEM                                                 AXIOUT    118
                      IF (LTYPE(I).EQ.GAP.OR.LTYPE(I).EQ.GAPEND) GO TO 220             AXIOUT    119
                      WRITE (6,390) I,(SIGMA(I,J),J=1,4)                               AXIOUT    120
120           220       CONTINUE                                                       AXIOUT    121
                  RETURN                                                               AXIOUT    122
                  C                                                                    AXIOUT    123
                  230   FORMAT (1H0,9X,13H POWER STEP =,I2)                            AXIOUT    124
                  240   FORMAT (1H0,10X,22HFISSION GAS PRESSURE =,F7.2,10X,18HCOOLANT PRES AXIOUT    125
125               +SURE =,F7.2)                                                        AXIOUT    126
                  250   FORMAT (///,1H0,6X,56HRADIAL VARIATION IN TEMPERATURE AND MATERIAL AXIOUT    127
                  +  PROPERTIES)                                                       AXIOUT    128
                  260   FORMAT (1H0,31X,7HELASTIC,4X,9HPOISSON'S,4X,15HTHERMAL STRAINS,/,1 AXIOUT    129
                  +H0,8X,7HELEMENT,13H  TEMPERATURE,3X,7HMODULUS,5X,5HRATIO,7X,5HAXIA AXIOUT    130
130               +L,7X,6HRADIAL,7X,4HHOOP)                                            AXIOUT    131
                  270   FORMAT (1H0,9X,I3,4X,F10.2,5E12.5)                             AXIOUT    132
                  280   FORMAT (1H1,20X,40H****************************************,21H*** AXIOUT    133
                  +******************,/,1H0,30X,42HELASTIC-PLASTIC(TIME-INDEPENDENT)   AXIOUT    134
                  +RESULTS )                                                           AXIOUT    135
135               290   FORMAT (1H1,20X,39HFUEL CENTERLINE STRESSES(4-CST AVERAGE))    AXIOUT    136
                  300   FORMAT (1H1,10X,53H**************************************************** AXIOUT    137
                  +****  ,/,20X,13HCREEP RESULTS,8H TIME = ,F12.3)                     AXIOUT    138
                  310   FORMAT (1H0,20X,39HFUEL CENTERLINE STRESSES(4-CST AVERAGE))    AXIOUT    139
                  320   FORMAT (4H0   ,8HELEMENTS,12X,12HAXIAL STRESS,13X,13HRADIAL STRESS AXIOUT    140
140               +,12X,11HHOOP STRESS,14X,16HR-Z SHEAR STRESS)                        AXIOUT    141
                  330   FORMAT (1H0,I5,1H-,I3,4E25.5)                                  AXIOUT    142
                  340   FORMAT (1H0,20X,38HFUEL CENTERLINE STRAINS(4-CST AVERAGE))     AXIOUT    143
                  350   FORMAT (4H0   ,8HELEMENTS,12X,12HAXIAL STRAIN,13X,13HRADIAL STRAIN AXIOUT    144
                  +,12X,11HHOOP STRAIN,14X,16HR-Z SHEAR STRAIN)                        AXIOUT    145
145               360   FORMAT (1H0,20X,33HCLADDING STRESSES (4-CST AVERAGE))          AXIOUT    146
                  370   FORMAT (1H0,20X,38HCLADDING TOTAL STRAINS (4-CST AVERAGE))     AXIOUT    147
                  380   FORMAT (1H0,20X,40HCLADDING PLASTIC STRAIN FOR EACH ELEMENT,/,1H0, AXIOUT    148
                  +20X,37H-**-ONLY NON-ZERO VALUES ARE PRINTED )                       AXIOUT    149
                  390   FORMAT (1H0,I5,5X,4E25.5)                                      AXIOUT    150
150               400   FORMAT (1H0,20X,26HFUEL SURFACE DISPLACEMENTS)                 AXIOUT    151
                  410   FORMAT (1H0,5H NODE,20X,19HRADIAL DISPLACEMENT,6X,18HAXIAL DISPLAC AXIOUT    152
                  +EMENT)                                                              AXIOUT    153
                  420   FORMAT (1H0,20X,30HCLADDING SURFACE DISPLACEMENTS)             AXIOUT    154
                  430   FORMAT (1H0,I5,5X,2E25.5,/,1H0,I5,5X,2E25.5)                   AXIOUT    155
155               440   FORMAT (1H0,I5,5X,2E25.5)                                      AXIOUT    156
                  450   FORMAT (1H0,26HSTRESSES FOR EVERY ELEMENT)                     AXIOUT    157
                        END                                                            AXIOUT    158
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 AXIOUT 1 114 121

VARIABLES SN TYPE RELOCATION

0	ALFDT		REAL	ARRAY	F.P.	REFS	5	3*25	38	59	DEFINED	1
0	CLAD		INTEGER		F.P.	REFS	4	35	36	57	DEFINED	1
1370	DR		REAL			REFS	91	100	113	DEFINED	89	98	109
1374	DRO		REAL			REFS	113	DEFINED	111				
0	DTIME		REAL	*UNUSED	F.P.	DEFINED	1						
1371	DZ		REAL			REFS	91	100	113	DEFINED	90	99	110
1375	DZO		REAL			REFS	113	DEFINED	112				
0	E		REAL	ARRAY	F.P.	REFS	6	25	38	59	DEFINED	1	
0	ELEM		INTEGER	ARRAY	F.P.	REFS	4	88	107	DEFINED	1		
0	EPP		REAL	ARRAY	F.P.	REFS	5	38	59	4*78	80		
						DEFINED	1						
1355	E1		REAL			REFS	38	42	51	59	63	71	
						DEFINED	49	70					
1356	E2		REAL			REFS	38	42	51	59	63	71	
						DEFINED	49	70					
1357	E3		REAL			REFS	38	42	51	59	63	71	
						DEFINED	49	70					
1360	E4		REAL			REFS	38	42	51	59	63	71	
						DEFINED	49	70					
0	F1		REAL	ARRAY	F.P.	REFS	5	82	89	90	98	99	109
						110	111	112	DEFINED	1			
0	GAP		INTEGER		F.P.	REFS	4	118	DEFINED	1			
0	GAPEND		INTEGER		F.P.	REFS	4	118	DEFINED	1			
1347	I		INTEGER			REFS	7*25	2*35	36	37	38	40	41
						42	57	58	59	61	62	63	87
						106	2*118	2*119	DEFINED	24	34	48	56
						69	75	86	96	105	117		
1332	IP		INTEGER			REFS	19	DEFINED	17				
0	IXLSET		INTEGER		F.P.	REFS	82	DEFINED	1				
1343	I10	*	INTEGER			REFS	18						
1344	I11	*	INTEGER			REFS	18						
1345	I12	*	INTEGER			REFS	18						
1361	I3		INTEGER			REFS	41	62	63	DEFINED	40	61	
1336	I5	*	INTEGER			REFS	18						
1337	I6	*	INTEGER			REFS	18						
1340	I7	*	INTEGER			REFS	18						
1341	I8	*	INTEGER			REFS	18						
1342	I9	*	INTEGER			REFS	18						
1363	J		INTEGER			REFS	50	51	71	77	119		
						DEFINED	49	70	76	119			
1364	J3		INTEGER			REFS	51	71	77	DEFINED	50	70	76
1365	K		INTEGER			REFS	64	69	75	DEFINED	54	64	
0	KPRINT		INTEGER		F.P.	REFS	114	DEFINED	1				
0	K1		REAL		F.P.	REFS	6	82	DEFINED	1			
1335	L		INTEGER			REFS	18	4*78	2*80	DEFINED	77		
0	LOADST		INTEGER		F.P.	REFS	17	DEFINED	1				

VARIABLES	SN	TYPE	RELOCATION									
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	4	35	36	57	2*118		
					DEFINED	1						
1366	LI	INTEGER			REFS	80	DEFINED	80				
1334	M	INTEGER			REFS	18	22	108				
1333	N	INTEGER			REFS	18	22	95				
0	NELEM	INTEGER		F.P.	REFS	2*4	3*5	4*6	34	37	38	56
					58	59	82	87	106	117		
					DEFINED	1						
1367	NN	INTEGER			REFS	88	107	DEFINED	87	106		
0	NNODES	INTEGER	*UNUSED	F.P.	DEFINED	1						
1373	NO	INTEGER			REFS	111	112	113	DEFINED	108		
1362	NP	INTEGER			REFS	48	DEFINED	47				
1350	NSV	INTEGER			REFS	47	56	DEFINED	35			
0	NUMGAP	INTEGER		F.P.	REFS	7	82	86	87	105	106	
					DEFINED	1						
0	NUMX	INTEGER		F.P.	REFS	5	82	DEFINED	1			
0	NUNIT	INTEGER	*UNUSED	F.P.	DEFINED	1						
1346	NX	INTEGER			REFS	24	89	90	91	97	98	99
					100	108	109	110	113	DEFINED	22	88
					97	107						
1372	NI	INTEGER			REFS	96	DEFINED	95				
0	OLDEPP	REAL	ARRAY	F.P.	REFS	5	DEFINED	1				
0	PC	REAL		F.P.	REFS	20	DEFINED	1				
0	PG	REAL		F.P.	REFS	20	DEFINED	1				
0	PRESFC	REAL	ARRAY	F.P.	REFS	7	82	DEFINED	1			
0	RELAX	INTEGER		F.P.	REFS	4	15	DEFINED	1			
1353	SIGHAV	REAL			REFS	37	38	41	58	59	62	
0	SIGMA	REAL	ARRAY	F.P.	REFS	6	37	58	119	DEFINED	1	
1352	SIGRAV	REAL			REFS	37	38	41	58	59	62	
1351	SIGZAV	REAL			REFS	37	38	41	58	59	62	
0	SPDA	REAL	*UNUSED	F.P.	DEFINED	1						
1354	TAUAV	REAL			REFS	37	38	41	58	59	62	
0	TC	REAL	ARRAY	F.P.	REFS	6	25	DEFINED	1			
0	TIME	REAL		F.P.	REFS	29	DEFINED	1				
0	V	REAL	ARRAY	F.P.	REFS	6	25	38	59	DEFINED	1	

FILE NAMES	MODE									
TAPE30	UNFMT	WRITES	42	63	READS	49	70	76		
		MOTION	32	46	53	66	72			
TAPE6	FMT	WRITES	16	19	20	21	23	25	27	29
		30	33	41	44	45	51	52	55	62
		67	68	71	73	74	80	83	85	91
		100	101	104	113	115	116	119		

EXTERNALS	TYPE	ARGS	REFERENCES		
AXI2IN		11	18		
IFPRES		7	82		
STRNAV		14	38	59	
STRSAV		7	37	58	

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	25	24
64	110	29	15

STATEMENT LABELS			DEF LINE	REFERENCES				
71	120		31	28				
0	130		42	34				
134	140		43	36				
0	150		51	48				
223	160		65	56	57			
0	170		71	69				
312	180		81	75	77	78		
0	190		91	86				
0	200		100	96				
0	210		113	105				
503	220		120	117	118			
1067	230	FMT	123	19				
1073	240	FMT	124	20				
1103	250	FMT	126	21				
1113	260	FMT	128	23				
1131	270	FMT	131	25				
1135	280	FMT	132	16				
1153	290	FMT	135	27				
1161	300	FMT	136	29				
1174	310	FMT	138	30				
1202	320	FMT	139	33	55	116		
1215	330	FMT	141	41	51	62	71	
1220	340	FMT	142	44				
1226	350	FMT	143	45	68	74		
1241	360	FMT	145	52				
1247	370	FMT	146	67				
1255	380	FMT	147	73				
1270	390	FMT	149	80	119			
1273	400	FMT	150	83				
1300	410	FMT	151	95	104			
1307	420	FMT	153	101				
1315	430	FMT	154	113				
1322	440	FMT	155	91	100			
1325	450	FMT	156	115				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
40	100	I	24 25	21B	EXT REFS	
77	130	I	34 42	34B	EXT REFS	EXITS
147	150	I	48 51	12B	EXT REFS	
173	160	I	56 65	33B	EXT REFS	
236	170	I	69 71	7B	EXT REFS	
255	180	I	75 81	43B	EXT REFS	NOT INNER
261	180	L	77 81	34B	EXT REFS	NOT INNER
276		L1	80 80	1B	EXT REFS	
341	190	I	86 91	21B	EXT REFS	
367	200	I	96 100	15B	EXT REFS	
412	210	I	105 113	33B	EXT REFS	
456	220	I	117 120	30B	EXT REFS	NOT INNER
467		J	119 119	1B	EXT REFS	

STATISTICS

PROGRAM LENGTH	1465B	821

140000B SCM USED

```
      SUBROUTINE AXSCRP (NELEM,NNODES,ELEM,COORD,NUMGAP,LTYPE,N,M,L)
      INTEGER ELEM(NELEM,3),LTYPE(NELEM)
      REAL COORD(NNODES,2),BLOCK(13)
      STAR = 10H**********
          DO 100 I=1,13
  100     BLOCK(I) = STAR
      WRITE (6,130) BLOCK
      WRITE (6,140) BLOCK
      WRITE (6,160) (BLOCK(I),I=1,10)
      WRITE (6,150) (BLOCK(I),I=1,10)
      WRITE (6,160) (BLOCK(I),I=1,10)
      WRITE (6,140) BLOCK
      WRITE (6,140) BLOCK
      WRITE (6,170)
      NN = NELEM-NUMGAP
      WRITE (6,180) NNODES,NN,NUMGAP
      WRITE (6,190) N,M,L
      WRITE (6,200)
      WRITE (6,210)
          DO 110 I=1,NELEM
  110     WRITE (6,220) I,(ELEM(I,J),J=1,3),LTYPE(I)
      WRITE (6,230)
          DO 120 I=1,NNODES
  120     WRITE (6,240) I,COORD(I,1),COORD(I,2)
      RETURN
C
  130  FORMAT (1H1,13A10)
  140  FORMAT (1H ,13A10)
  150  FORMAT (1H ,5A10,5X,20H AXISYM  OUTPUT     ,5X,5A10)
  160  FORMAT (1H ,5A10,30X,5A10)
  170  FORMAT (1H0,40X,40HAXISYM FINITE ELEMENT MODEL DESCRIPTION )
  180  FORMAT (/,19H0 NUMBER OF NODES =,I3,/,15H0THE NUMBER OF 50HAXISYMM
     +ETRIC CONSTANT-STRAIN-TRIANGULAR ELEMENTS =,I3,/,38H0THE NUMBER OF
     + BILINEAR GAP ELEMENTS =,I2)
  190  FORMAT (1H0,/,1H0,5X,10HTHERE ARE ,I2,61H NODES IN THE RADIAL DIRE
     +CTION DEFINING THE FUEL MIDPLANE AND,/,5X,I2," NODES IN THE RADIAL
     + DIRECTION DEFINIING THE PLANE OF SYMMETRY IN THE CLADDING ",/,1H0
     +,5X,24HIN THE Z-DIRECTION ARE  ,I2,32H NODES ALONG THE FUEL CENTER
     +LINE)
  200  FORMAT (1H0,20X,28HELEMENT NODAL CONNECTIVITY  )
  210  FORMAT (1H0,14HELEMENT NUMBER,3X,13H NODALIZATION,10X,13HELEMENT T
     +YPE )
  220  FORMAT (5X,I5,5X,3I5,12X,A10)
  230  FORMAT (1H1,30X,17HNODAL COORDINATES,/,1H0,20X,4HNODE,10X,1HR,10X,
     +1HZ)
  240  FORMAT (1H ,20X,I4,5X,2F10.7)
       END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	AXSCRP	1	25

VARIABLES	SN	TYPE		RELOCATION							
364	BLOCK	REAL	ARRAY		REFS	3	7	8	9	10	11	12
						13	DEFINED	6				
0	COORD	REAL	ARRAY	F.P.	REFS	3	2*24	DEFINED	1			
0	ELEM	INTEGER	ARRAY	F.P.	REFS	2	21	DEFINED	1			
361	I	INTEGER			REFS	6	9	10	11	3*21	3*24	
					DEFINED	5	9	10	11	20	23	
363	J	INTEGER			REFS	21	DEFINED	21				
0	L	INTEGER		F.P.	REFS	17	DEFINED	1				
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	2	21	DEFINED	1			
0	M	INTEGER		F.P.	REFS	17	DEFINED	1				
0	N	INTEGER		F.P.	REFS	17	DEFINED	1				
0	NELEM	INTEGER		F.P.	REFS	2*2	15	20	DEFINED	1		
362	NN	INTEGER			REFS	16	DEFINED	15				
0	NNODES	INTEGER		F.P.	REFS	3	16	23	DEFINED	1		
0	NUMGAP	INTEGER		F.P.	REFS	15	16	DEFINED	1			
360	STAR	REAL			REFS	6	DEFINED	4				

FILE NAMES	MODE										
TAPE6	FMT	WRITES	7	8	9	10	11	12	13	14	
		16	17	18	19	21	22	24			

STATEMENT LABELS			DEF LINE	REFERENCES		
0	100		6	5		
0	110		21	20		
0	120		24	23		
227	130	FMT	27	7		
231	140	FMT	28	8	12	13
233	150	FMT	29	10		
241	160	FMT	30	9	11	
244	170	FMT	31	14		
253	180	FMT	32	16		
273	190	FMT	35	17		
326	200	FMT	40	18		
333	210	FMT	41	19		
342	220	FMT	43	21		
345	230	FMT	44	22		
354	240	FMT	46	24		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
17	100	I	5 6	4B	INSTACK		
60	110	I	20 21	24B		EXT REFS	NOT INNER
63		J	21 21	11B		EXT REFS	
110	120	I	23 24	12B		EXT REFS	

STATISTICS
PROGRAM LENGTH 410B 264
140000B SCM USED

```
      SUBROUTINE CLOSAX (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOAD
     +ST,MBAND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NT
     +IES,NUMGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,FI,F
     +2,ID,LTYPE,OLDEPP,SPDA,TC,TIE,V)
      INTEGER GAP,GAPEND,CLAD,ELEM(NELEM,3),ID(NDISPS), TIE(NTIES)
      INTEGER LTYPE(NELEM),IGAP(NUMGAP)
      REAL F(NUMX),F2(NLOAD2),DELOLD(NUMGAP),TC(NELEM)
      REAL OLDEPP(NELEM,4),E(NELEM),V(NELEM),ALFDT(NELEM,3)
      REAL MATPRO(9) ,FI(NUMX)
      REAL COORD(NNODES,2),EPP(NELEM,4),DI(NDISPS),K,K1,K2
      COMMON/DOT/ K(900,60)
      LEVEL2,K
      DATA GAP,GAPEND,CLAD/3HGAP,7HGAP END ,4HCLAD /
C
C
C     THIS ROOT FINDER IS USED TO FIND THE ELASTIC LOAD AT WHICH
C     CLOSURE OCCURS.
C
C
      Q(H) = GAPTST(H,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST,MBAND,
     +MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIES,NUMGA
     +P,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,FI,F2,ID,LTYP
     +E,OLDEPP,SPDA,TC,TIE,V)
C     ROOTING FOR ROOTS
      WRITE(6,2)
C
C
C     A MODIFIED FALSE POSITION ROUTINE OPERATING OVER THE INTERVAL ALPH
C     BETA WITH INCREMENT DX
C
      ALPHA = 0.0D0
      BETA = 1.0E+00
      DX = 0.5
      CUT = 1.0E-09
      IF (IUNIT.EQ.0) CUT = 2.54E-11
      N = 0
C
      A = ALPHA
      B = A+DX
      FOFA = Q(A)
100   FOFB = Q(B)
      IF (FOFA*FOFB) 110,170,190
110   CONTINUE
C     HAVING BRACKETED A ROOT THE SOLUTION ITERATION COMMENCES
C
120   X = (A*FOFB-B*FOFA)/(FOFB-FOFA)
      N = N+1
      IF (N.LT.25) GO TO 130
      WRITE (6,230)
      GO TO 220
130   FOFX = Q(X)
C     TEST THE POSSIBILITY OF THE ITERATION LOOP LANDING ON A ROOT AT X
C     OR PASSING BY THE ROOT
```

```
      IF (FOFX*FOFA) 150,160,140                                        CLOSAX     55
140   CONTINUE                                                          CLOSAX     56
C  THE ROOT IS STILL BRACKETED AND THE ITERATION LOOP CONTINUES        CLOSAX     57
C                                                                       CLOSAX     58
      A = X                                                             CLOSAX     59
      FOFA = FOFX                                                       CLOSAX     60
      IF (ABS(FOFX).GT.CUT) GO TO 120                                   CLOSAX     61
      VX = X                                                            CLOSAX     62
      GO TO 210                                                         CLOSAX     63
150   CONTINUE                                                          CLOSAX     64
C  THE ITERATION SCHEME HAS REBRACKETED THE ROOT-THE BOUNDS ARE         CLOSAX     65
C  ADJUSTED AND THE LOOP CONTINUES                                      CLOSAX     66
C                                                                       CLOSAX     67
      B = X                                                             CLOSAX     68
      FOFB = FOFX                                                       CLOSAX     69
      IF (ABS(FOFX).GT.CUT) GO TO 120                                   CLOSAX     70
      VX = X                                                            CLOSAX     71
      GO TO 210                                                         CLOSAX     72
160   CONTINUE                                                          CLOSAX     73
C  THE ITERATION SCHEME HAS LANDED ON A ROOT AT (X,FOFX)                CLOSAX     74
C                                                                       CLOSAX     75
      IF (ABS(FOFA).EQ.0.0D0) GO TO 180                                 CLOSAX     76
      VX = X                                                            CLOSAX     77
      GO TO 210                                                         CLOSAX     78
170   CONTINUE                                                          CLOSAX     79
C  THE BRACKETING OPERATION HAS FOUND A ROOT                            CLOSAX     80
C                                                                       CLOSAX     81
      IF (FOFA.EQ.0.0D0) GO TO 180                                      CLOSAX     82
C  THE BRACKETING OPERATION HAS FOUND A ROOT AT (B,FOFB)                CLOSAX     83
      VX = B                                                            CLOSAX     84
      GO TO 210                                                         CLOSAX     85
180   CONTINUE                                                          CLOSAX     86
C  IF THIS IS THE FIRST BRACKET STEP THEN F(ALPHA)=0. IF OTHERWISE      CLOSAX     87
C  THE PREVIOUS STEP IS IN ERROR AT FOFB                                CLOSAX     88
      WRITE (6,240) A                                                   CLOSAX     89
      GO TO 210                                                         CLOSAX     90
190   CONTINUE                                                          CLOSAX     91
C  BEEN EXCEEDED                                                        CLOSAX     92
C  THE ROUTINE HAS NOT YET BRACKETED A ROOT-ADJUST THE VARIABLES TO     CLOSAX     93
C  THE NEXT MESH AND CONTINUE, ALSO TEST TO SEE IF THE INTERVAL HAS     CLOSAX     94
      A = B                                                             CLOSAX     95
      B = B+DX                                                          CLOSAX     96
      FOFA = FOFB                                                       CLOSAX     97
      IF (A.GT.BETA) GO TO 200                                          CLOSAX     98
      GO TO 100                                                         CLOSAX     99
200   CONTINUE                                                          CLOSAX    100
C  THE BRACKETING OPERATION HAS OVERRUN THE INTERVAL                    CLOSAX    101
      WRITE (6,250)                                                     CLOSAX    102
      GO TO 210                                                         CLOSAX    103
210   CONTINUE                                                          CLOSAX    104
220   CONTINUE                                                          CLOSAX    105
      RETURN                                                            CLOSAX    106
C                                                                       CLOSAX    107
```

```
                230   FORMAT (67H- THE ITERATION SCHEME HAS PASSED 25 STEPS-- EXECUTION  CLOSAX   108
               + TERMINATED )                                                          CLOSAX   109
                240   FORMAT (41H,  INITIAL DATA CONTAINS A ROOT AT ALPHA=,E15.6)       CLOSAX   110
    110         250   FORMAT (48H  THE BRACKET OPERATION HAS OVERRUN THE INTERVAL)      CLOSAX   111
                      END                                                               CLOSAX   112
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CLOSAX	1	105

VARIABLES

	SN	TYPE			RELOCATION							
705	A	REAL			REFS	39	40	46	88	97		
					DEFINED	38	58	94				
0	ALFDT	REAL	ARRAY	F.P.	REFS	8	40	41	51	DEFINED	1	
700	ALPHA	REAL			REFS	38	DEFINED	31				
706	B	REAL			REFS	41	46	83	94	95		
					DEFINED	39	67	95				
701	BETA	REAL			REFS	97	DEFINED	32				
632	CLAD	INTEGER			REFS	5	DEFINED	13				
0	CLOSE	REAL	*UNUSED	F.P.	DEFINED	1						
0	COORD	REAL	ARRAY	F.P.	REFS	10	40	41	51	DEFINED	1	
703	CUT	REAL			REFS	60	69	DEFINED	34	35		
0	DELOLD	REAL	ARRAY	F.P.	REFS	7	40	41	51	DEFINED	1	
0	DI	REAL	ARRAY	F.P.	REFS	10	40	41	51	DEFINED	1	
702	DX	REAL			REFS	39	95	DEFINED	33			
0	E	REAL	ARRAY	F.P.	REFS	8	40	41	51	DEFINED	1	
0	ELEM	INTEGER	ARRAY	F.P.	REFS	5	40	41	51	DEFINED	1	
0	EPP	REAL	ARRAY	F.P.	REFS	10	40	41	51	DEFINED	1	
0	F	REAL	ARRAY	F.P.	REFS	7	40	41	51	DEFINED	1	
707	FOFA	REAL			REFS	42	2*46	54	75	81		
					DEFINED	40	59	96				
710	FOFB	REAL			REFS	42	2*46	96	DEFINED	41	68	
712	FOFX	REAL			REFS	54	59	60	68	69		
					DEFINED	51						
0	F1	REAL	ARRAY	F.P.	REFS	9	40	41	51	DEFINED	1	
0	F2	REAL	ARRAY	F.P.	REFS	7	40	41	51	DEFINED	1	
630	GAP	INTEGER			REFS	5	DEFINED	13				
631	GAPEND	INTEGER			REFS	5	DEFINED	13				
0	ICLOSE	INTEGER		F.P.	REFS	40	41	51	DEFINED	1		
0	ID	INTEGER	ARRAY	F.P.	REFS	5	40	41	51	DEFINED	1	
0	IGAP	INTEGER	ARRAY	F.P.	REFS	6	40	41	51	DEFINED	1	
0	ISAVE	INTEGER		F.P.	REFS	40	41	51	DEFINED	1		
0	IUNIT	INTEGER		F.P.	REFS	35	40	41	51	DEFINED	1	
0	IXLSET	INTEGER		F.P.	REFS	40	41	51	DEFINED	1		
0	K	REAL	ARRAY	DOT	REFS	10	11	12				
0	K1	REAL		F.P.	REFS	10	40	41	51	DEFINED	1	
0	K2	REAL		F.P.	REFS	10	40	41	51	DEFINED	1	
0	LOADST	INTEGER		F.P.	REFS	40	41	51	DEFINED	1		

VARIABLES	SN	TYPE		RELOCATION							
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	6	40	41	51	DEFINED	1
0	MATPRO	REAL	ARRAY	F.P.	REFS	9	40	41	51	DEFINED	1
0	MBAND	INTEGER		F.P.	REFS	40	41	51	DEFINED	1	
0	MBNDOL	INTEGER		F.P.	REFS	40	41	51	DEFINED	1	
704	N	INTEGER			REFS	47	48	DEFINED	36	47	
0	NDISPS	INTEGER		F.P.	REFS	5	10	40	41	51	
					DEFINED	1					
0	NELEM	INTEGER		F.P.	REFS	5	6	7	48	10	40	41
					51	DEFINED	1				
0	NLOADS	INTEGER		F.P.	REFS	40	41	51	DEFINED	1	
0	NLOAD2	INTEGER		F.P.	REFS	7	40	41	51	DEFINED	1
0	NNODES	INTEGER		F.P.	REFS	10	40	41	51	DEFINED	1
0	NTEMPS	INTEGER		F.P.	REFS	40	41	51	DEFINED	1	
0	NTIES	INTEGER		F.P.	REFS	5	40	41	51	DEFINED	1
0	NUMGAP	INTEGER		F.P.	REFS	6	7	40	41	51	
					DEFINED	1					
0	NUMX	INTEGER		F.P.	REFS	7	9	40	41	51	
					DEFINED	1					
0	NUMY	INTEGER		F.P.	REFS	40	41	51	DEFINED	1	
0	NUNIT	INTEGER		F.P.	REFS	40	41	51	DEFINED	1	
0	OLDEPP	REAL	ARRAY	F.P.	REFS	8	40	41	51	DEFINED	1
0	SPDA	REAL		F.P.	REFS	40	41	51	DEFINED	1	
0	TC	REAL	ARRAY	F.P.	REFS	7	40	41	51	DEFINED	1
0	TIE	INTEGER	ARRAY	F.P.	REFS	5	40	41	51	DEFINED	1
0	V	REAL	ARRAY	F.P.	REFS	8	40	41	51	DEFINED	1
713	VX	REAL			DEFINED	61	70	76	83		
711	X	REAL			REFS	51	58	61	67	70	76
					DEFINED	46					

FILE NAMES	MODE					
TAPE6	FMT	WRITES	49	88	101	

EXTERNALS	TYPE	ARGS	REFERENCES		
GAPTST	REAL	40	40	41	51

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES		
ABS	REAL	1	INTRIN		60	69	75
Q	REAL	1	SF	20	40	41	51

STATEMENT LABELS			DEF LINE	REFERENCES					
126	100		41	98					
0	110	INACTIVE	43	42					
226	120		46	60	69				
244	130		51	48					
0	140	INACTIVE	55	54					
357	150		63	54					
373	160		72	54					
402	170		78	42					
410	180		85	75	81				
414	190		90	42					
430	200		99	97					
433	210		103	62	71	77	84	89	102
434	220		104	50					

```
STATEMENT LABELS                DEF LINE   REFERENCES
  645  230      FMT                107         49
  656  240      FMT                109         88
  665  250      FMT                110        101

COMMON BLOCKS   LENGTH
       DOT       54000 LCM

STATISTICS
  PROGRAM LENGTH                   714B      460
  LCM LABELED COMMON LENGTH     151360B    54000
        140000B SCM USED
```

```
      SUBROUTINE ELAST (FI,NUMX,MBAND,IFOR)                                  ELAST      2
      REAL FI(NUMX)  , K                                                     ELAST      3
      COMMON/DOT/K(900,60)                                                   ELAST      4
      LEVEL2,K                                                               ELAST      5
C                                                                            ELAST      6
C   THIS ROUTINE IS A BANDED GAUSSIAN ELIMINATION EQUATION  SOLVER           ELAST      7
C                                                                            ELAST      8
      IF (IFOR.EQ.1) GO TO 130                                               ELAST      9
C                                                                            ELAST     10
C                                                                            ELAST     11
C   ***OBTAIN SOLUTION OF DISPLACEMENT EQUATIONS HERE                        ELAST     12
C   FORWARD REDUCTION OF BANDED-FORMAT MATRIX                                ELAST     13
      DO 120 N=1,NUMX                                                        ELAST     14
         DO 110 L=2,MBAND                                                    ELAST     15
         IF (K(N,L).EQ.0.0) GO TO 110                                        ELAST     16
         I = N+L-1                                                           ELAST     17
         CC = K(N,L)/K(N,1)                                                  ELAST     18
         J = 0                                                               ELAST     19
            DO 100 KJ=L,MBAND                                                ELAST     20
            J = J+1                                                          ELAST     21
  100       K(I,J) = K(I,J)-CC*K(N,KJ)                                       ELAST     22
         K(N,L) = CC                                                         ELAST     23
  110    CONTINUE                                                            ELAST     24
  120 CONTINUE                                                               ELAST     25
C   FORWARD REDUCTION OF CONSTANTS                                           ELAST     26
  130 DO 150 N=1,NUMX                                                        ELAST     27
         DO 140 L=2,MBAND                                                    ELAST     28
         IF (K(N,L).EQ.0.0) GO TO 140                                        ELAST     29
         I = N+L-1                                                           ELAST     30
            FI(I) = FI(I)-K(N,L)*FI(N)                                       ELAST     31
  140    CONTINUE                                                            ELAST     32
  150 FI(N) = FI(N)/K(N,1)                                                   ELAST     33
C   SOLVE FOR UNKNOWNS BY BACK-SUBSTITUTION                                  ELAST     34
      DO 170 M=2,NUMX                                                        ELAST     35
      N = NUMX+1-M                                                           ELAST     36
         DO 160 L=2,MBAND                                                    ELAST     37
         IF (K(N,L).EQ.0.0) GO TO 160                                        ELAST     38
         KJ = N+L-1                                                          ELAST     39
            FI(N) = FI(N)-K(N,L)*FI(KJ)                                      ELAST     40
  160    CONTINUE                                                            ELAST     41
  170 CONTINUE                                                               ELAST     42
      RETURN                                                                 ELAST     43
      END                                                                    ELAST     44
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 ELAST	1	42

VARIABLES	SN	TYPE	RELOCATION									
155	CC	REAL			REFS	21	22	DEFINED	17			
0	FI	REAL	ARRAY	F.P.	REFS	2	2*30	32	2*39	DEFINED	1	30
						32	39					
154	I	INTEGER			REFS	2*21	2*30	DEFINED	16	29		
0	IFOR	INTEGER		F.P.	REFS	8	DEFINED	1				
156	J	INTEGER			REFS	20	2*21	DEFINED	18	20		
0	K	REAL	ARRAY	DOT	REFS	2	3	4	15	2*17	2*21	28
						30	32	37	39	DEFINED	21	22
157	KJ	INTEGER			REFS	21	39	DEFINED	19	38		
153	L	INTEGER			REFS	15	16	17	19	22	28	29
						30	37	38	39	DEFINED	14	27	36
160	M	INTEGER			REFS	35	DEFINED	34				
0	MBAND	INTEGER		F.P.	REFS	14	19	27	36	DEFINED	1	
152	N	INTEGER			REFS	15	16	2*17	21	22	28	29
						2*30	3*32	37	38	3*39	DEFINED	13	26
						35						
0	NUMX	INTEGER		F.P.	REFS	2	13	26	34	35		
					DEFINED	1						

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	21	19	
56	110	23	14	15
0	120	24	13	
65	130	26	8	
106	140	31	27	28
0	150	32	26	
143	160	40	36	37
0	170	41	34	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
14	120	N	13 24	50B	NOT INNER
16	110	L	14 23	43B	NOT INNER
36	100	KJ	19 21	13B	OPT
66	150	N	26 32	30B	NOT INNER
70	140	L	27 31	21B	OPT
120	170	M	34 41	31B	NOT INNER
125	160	L	36 40	21B	OPT

COMMON BLOCKS	LENGTH
DOT	54000 LCM

STATISTICS

PROGRAM LENGTH	177B	127
LCM LABELED COMMON LENGTH	151360B	54000

140000B SCM USED

```
      SUBROUTINE ELEM1 (R,Z,DISP,E,NU,KE,EPS0,FEPS0,AT,D,TT,RBAR,DELTA)
C     IMPLICIT REAL*8 (A-H, O-Z)
      REAL   NU,KE(6,6),BB(4,6),R(3),Z(3),A(3),B(3),C(3),D(4,4),
     +       TT(6,4),EPS0(4),FEPS0(6),DISP(6),AT(4,6)
      RBAR = (R(1)+R(2)+R(3))/3.0
      ZBAR = (Z(1)+Z(2)+Z(3))/3.0
      DELTA = R(2)*Z(3)+R(1)*Z(2)+Z(1)*R(3)-(R(2)*Z(1)+R(3)*Z(2)+Z(3)*R(
     +1))
      DELTA = DELTA/2.0
      DDD = 2.0*DELTA
C     WRITE(6,51) DELTA
      A(1) = R(2)*Z(3)-R(3)*Z(2)
      A(2) = R(3)*Z(1)-R(1)*Z(3)
      A(3) = R(1)*Z(2)-R(2)*Z(1)
      B(1) = Z(2)-Z(3)
      B(2) = Z(3)-Z(1)
      B(3) = Z(1)-Z(2)
      C(1) = R(3)-R(2)
      C(2) = R(1)-R(3)
      C(3) = R(2)-R(1)
          DO 100 K=1,3
          J = 2*K-1
          JP = J+1
          BB(1,J) = 0.0
          BB(1,JP) = C(K)/DDD
          BB(2,J) = B(K)/DDD
          BB(2,JP) = 0.0
          BB(3,J) = (A(K)/RBAR+B(K)+C(K)*ZBAR/RBAR)/DDD
          BB(3,JP) = 0.0
          BB(4,J) = C(K)/DDD
100       BB(4,JP) = B(K)/DDD
C     WRITE(6,50) ((BB(I,K),K=1,6),I=1,4)
      D(1,2) = NU/(1.0-NU)
      D(1,3) = D(1,2)
      D(1,4) = 0.0
      D(2,1) = D(1,2)
      D(2,2) = 1.0
      D(2,3) = D(1,2)
      D(1,1) = 1.0
      D(2,4) = 0.0
      D(3,1) = D(1,3)
      D(3,2) = D(2,3)
      D(3,3) = 1.0
      D(3,4) = 0.0
      D(4,1) = D(1,4)
      D(4,2) = D(2,4)
      D(4,3) = D(3,4)
      D(4,4) = (1.0-2.0*NU)/(2.0*(1.0-NU))
C     WRITE(6,51) (( D(I,K),K=1,4),I=1,4)
          DO 110 I=1,4
              DO 110 J=1,4
110           D(I,J) = D(I,J)*E*(1.0-NU)/((1.0+NU)*(1.0-2.0*NU))
          DO 120 I=1,6
```

```
                      DO 120 K=1,4                                                  ELEMI      55
55                    TT(I,K) = 0.0                                                 ELEMI      56
                          DO 120 J=1,4                                              ELEMI      57
                          TT(I,K) = TT(I,K)+BB(J,I)*D(J,K)                          ELEMI      58
            120           CONTINUE                                                  ELEMI      59
            C     WRITE(6,51) ((TT(I,K),K=1,4),I=1,6)                             ELEMI      60
60                  DO 130 I=1,6                                                  ELEMI      61
                      DO 130 K=1,6                                                ELEMI      62
                      KE(I,K) = 0.0                                               ELEMI      63
                          DO 130 J=1,4                                            ELEMI      64
            130           KE(I,K) = KE(I,K)+TT(I,J)*BB(J,K)                       ELEMI      65
65                  DO 140 I=1,6                                                  ELEMI      66
                      DO 140 J=1,6                                                ELEMI      67
            140       KE(I,J) = KE(I,J)*6.28318*RBAR*DELTA                        ELEMI      68
            C     WRITE(6,50) ((KE(I,K),K=1,6),I=1,6)                             ELEMI      69
            C     *****THERMAL STRAIN FORCES*****                                 ELEMI      70
70                  DO 160 I=1,6                                                  ELEMI      71
                    FEPSO(I) = 0.0                                                ELEMI      72
                      DO 150 J=1,4                                                ELEMI      73
            150       FEPSO(I) = FEPSO(I)+TT(I,J)*EPSO(J)                         ELEMI      74
            C     14 FEPSO(I) =-6.28318*FEPSO(I)*RBAR*DELTA                       ELEMI      75
75          160       FEPSO(I) = +6.28318*FEPSO(I)*RBAR*DELTA                     ELEMI      76
                      DO 170 I=1,4                                                ELEMI      77
                      DO 170 K=1,6                                                ELEMI      78
                      AT(I,K) = 0.0                                               ELEMI      79
                          DO 170 J=1,4                                            ELEMI      80
80          170           AT(I,K) = AT(I,K)+D(I,J)*BB(J,K)                        ELEMI      81
                  RETURN                                                          ELEMI      82
            C                                                                     ELEMI      83
                  END                                                             ELEMI      84
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS — DEF LINE — REFERENCES

ENTRY POINTS	DEF LINE	REFERENCES
4 ELEMI	1	81

VARIABLES	SN	TYPE		RELOCATION										
474 A		REAL	ARRAY		REFS	3	28	DEFINED	12	13	14			
0 AT		REAL	ARRAY	F.P.	REFS	3	80	DEFINED	1	78	80			
477 B		REAL	ARRAY		REFS	3	26	29	31	DEFINED	15	16		
					17									
444 BB		REAL	ARRAY		REFS	3	57	64	80	DEFINED	24	25		
					26	27	28	29	30	31				
502 C		REAL	ARRAY		REFS	3	25	28	30	DEFINED	18	19		
					20									
0 D		REAL	ARRAY	F.P.	REFS	3	34	36	38	41	42	45		
					46	47	52	57	80	DEFINED	1	33		
					34	35	36	37	38	39	40	41		
					42	43	44	45	46	47	48	52		

VARIABLES	SN	TYPE		RELOCATION							
437	DDD	REAL			REFS	25	26	28	30	31	
					DEFINED	10					
0	DELTA	REAL		F.P.	REFS	9	10	67	75	DEFINED	1	7
						9					
0	DISP	REAL	ARRAY	F.P.	REFS	3	DEFINED	1			
0	E	REAL		F.P.	REFS	52	DEFINED	1			
0	EPSO	REAL	ARRAY	F.P.	REFS	3	73	DEFINED	1		
0	FEPSO	REAL	ARRAY	F.P.	REFS	3	73	75	DEFINED	1	71	73
						75					
443	I	INTEGER			REFS	2*52	55	3*57	62	3*64	2*67	71
						3*73	2*75	78	3*80	DEFINED	50	53	60
						65	70	76				
441	J	INTEGER			REFS	23	24	26	28	30	2*52	2*57
						2*64	2*67	2*73	2*80	DEFINED	22	51	56
						63	66	72	79			
442	JP	INTEGER			REFS	25	27	29	31	DEFINED	23	
440	K	INTEGER			REFS	22	25	26	3*28	30	31	55
						3*57	62	3*64	78	3*80	DEFINED	21	54
						61	77					
0	KE	REAL	ARRAY	F.P.	REFS	3	64	67	DEFINED	1	62	64
						67						
0	NU	REAL		F.P.	REFS	3	2*33	2*48	3*52	DEFINED	1	
0	R	REAL	ARRAY	F.P.	REFS	3	3*5	6*7	2*12	2*13	2*14	2*18
						2*19	2*20	DEFINED	1			
0	RBAR	REAL		F.P.	REFS	2*28	67	75	DEFINED	1	5	
0	TT	REAL	ARRAY	F.P.	REFS	3	57	64	73	DEFINED	1	55
						57						
0	Z	REAL	ARRAY	F.P.	REFS	3	3*6	6*7	2*12	2*13	2*14	2*15
						2*16	2*17	DEFINED	1			
436	ZBAR	REAL			REFS	28	DEFINED	6				

STATEMENT LABELS		DEF LINE	REFERENCES			
0	100	31	21			
0	110	52	50	51		
0	120	58	53	54	56	
0	130	64	60	61	63	
0	140	67	65	66		
0	150	73	72			
0	160	75	70			
0	170	80	76	77	79	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
103	100	K	21 31	46B	OPT	
232	110	I	50 52	17B		NOT INNER
234	110	J	51 52	12B	INSTACK	
253	120	I	53 58	31B		NOT INNER
255	120	K	54 58	24B		NOT INNER
263	120	J	56 58	13B	OPT	
306	130	I	60 64	30B		NOT INNER
310	130	K	61 64	23B		NOT INNER
316	130	J	63 64	12B	INSTACK	
340	140	I	65 67	15B		NOT INNER
342	140	J	66 67	10B	INSTACK	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
357	160	I	70 75	22B	NOT INNER
363	150	J	72 73	10B	INSTACK
403	170	I	76 80	25B	NOT INNER
405	170	K	77 80	20B	NOT INNER
412	170	J	79 80	10B	INSTACK

STATISTICS
PROGRAM LENGTH 535B 349
140000B SCM USED

```
      SUBROUTINE EOCALC (R1,R2,OLDGAP,BETA1,PFLAG,F,NUMGAP,RATIO,DELOLD,  EOCALC      2
     +KPRINT,NUMX,DPH,DEL,DPLAS,TYPE,DELGAP,OVRLAP,NEWWT)                 EOCALC      3
C                                                                         EOCALC      4
C   THIS SUBROUTINE CALCULATES THE EO STRAINS  THAT ARE MULTIPLIED        EOCALC      5
C   BY THE SOFT GAP SPRING CONSTANT K1 TO ADD EQUIVALENT NODAL FORCES     EOCALC      6
C   TO FORCE GAP CLOSURE. THESE FORCES ARE ADDED TO FI IN GAPADD.         EOCALC      7
C                                                                         EOCALC      8
      DIMENSION DPH(NUMGAP),NA(6),R(3),Z(3)                               EOCALC      9
      DIMENSION U(4),F(NUMX),N(2),OLDGAP(NUMGAP)                          EOCALC     10
      INTEGER PFLAG                                                       EOCALC     11
      REAL DELOLD(NUMGAP), DEL(NUMGAP),DPLAS(NUMGAP)                      EOCALC     12
      REAL K1,K2,TYPE(NUMGAP)                                             EOCALC     13
      REAL DELGAP(NUMGAP),OVRLAP(NUMGAP),NEWWT(NUMGAP)                    EOCALC     14
      REAL K                                                              EOCALC     15
      COMMON/DOT/K(900,50)                                                EOCALC     16
      LEVEL2,K                                                            EOCALC     17
      CALL FILL (NUMGAP,DPH)                                              EOCALC     18
      SUM = 0.                                                            EOCALC     19
      PI = 3.141592654                                                    EOCALC     20
      REWIND 19                                                           EOCALC     21
          DO 130 N1=1,NUMGAP                                              EOCALC     22
          K1 = R1                                                         EOCALC     23
          K2 = R2                                                         EOCALC     24
C   SPRING STIFFNESSES OF END SPRINGS ARE 0.5 * OTHER SPRING              EOCALC     25
C   CONSTANTS                                                           EOCALC     26
          RATIO1 = 0.                                                     EOCALC     27
          READ (19) R,Z,N,NA,CS,SN,TYPE(N1)                               EOCALC     28
          K1 = K1*TYPE(N1)                                                EOCALC     29
          K2 = K2*TYPE(N1)                                                EOCALC     30
              DO 100 J=1,2                                                EOCALC     31
              U(J*2-1) = F(N(J)*2-1)                                      EOCALC     32
              U(J*2) = F(N(J)*2)                                          EOCALC     33
100           CONTINUE                                                    EOCALC     34
          DEL(N1) = SQRT((R(2)-R(1))**2+(Z(2)-Z(1))**2)                   EOCALC     35
          UNITI = (R(2)-R(1))/DEL(N1)                                     EOCALC     36
          UNITJ = (Z(2)-Z(1))/DEL(N1)                                     EOCALC     37
          DELR = (R(2)-R(1)+U(3)-U(1))*UNITI                              EOCALC     38
          DELZ = (Z(2)-Z(1)+U(4)-U(2))*UNITJ                              EOCALC     39
C                                                                         EOCALC     40
C   TO MAKE CLOSURE  OCCUR  AT  SOME  PER CENT                            EOCALC     41
C   OF THE  ORIGINAL  GAP LENGTH   SET  DEL=DEL* PER CENT                 EOCALC     42
C                                                                         EOCALC     43
          OVRLAP(N1) = (DELR+DELZ)/DEL(N1)                                EOCALC     44
C                                                                         EOCALC     45
C   E-EC = OVRLAP                                                         EOCALC     46
C                                                                         EOCALC     47
          IF (PFLAG.EQ.0) DPLAS(N1) = 0.                                  EOCALC     48
          IF (PFLAG.EQ.0) GO TO 120                                       EOCALC     49
          IF (TYPE(N1).EQ.1) GO TO 110                                    EOCALC     50
          IF (N1.EQ.1) DPLAS(N1) = DPH(N1)*(R(1))/DEL(N1)                 EOCALC     51
          IF (N1.NE.1) DPLAS(N1) = DPH(N1-1)*(R(1))/DEL(N1)               EOCALC     52
          GO TO 120                                                       EOCALC     53
110       DPLAS(N1) = (DPH(N1-1)+DPH(N1))*(R(1))/(DEL(N1)*2.)             EOCALC     54
```

```
      120       CONTINUE                                                          EOCALC     55
55              DELGAP(NI) = ((-K2+K1)/K2)*(OVRLAP(NI)+DPLAS(NI))-K1*OLDGAP(NI    EOCALC     56
     +          )/K2                                                              EOCALC     57
                IF (DELGAP(NI).LT.0.0.AND.OLDGAP(NI).EQ.0.0) GO TO 130            EOCALC     58
                SUM = SUM+ABS(DELGAP(NI))                                         EOCALC     59
      130       CONTINUE                                                          EOCALC     60
60          C   IELAS=0                                                          EOCALC     61
            C   DO 95 I=1,NUMGAP                                                 EOCALC     62
            C   IF(DPLAS(I).NE.0.) IELAS=1                                       EOCALC     63
            C   95 CONTINUE                                                      EOCALC     64
            C   ZZZ=0.19                                                        EOCALC     65
65          C   ZZ=0.                                                           EOCALC     66
            C   DO 150 NI=1,NUMGAP                                             EOCALC     67
            C   IF(DELOLD(NI    ) .NE.0.0)                                     EOCALC     68
            C   * ZZZ=ABS((DELOLD(NI    )-DELGAP(NI    ))/DELOLD(NI    ))     EOCALC     69
            C   ZZZ=AMAX1(ZZ,ZZZ)                                               EOCALC     70
70          C   150 CONTINUE                                                    EOCALC     71
            C   IF(ZZZ.GT.0.19) BETA1 = BETA1-1.                               EOCALC     72
            C   IF(ZZZ.LT.0.19) BETA1 = BETA1 + 1.                             EOCALC     73
              BETA = BETA1                                                      EOCALC     74
                DO 140 NI=1,NUMGAP                                              EOCALC     75
75              K1 = R1*TYPE(NI)                                                EOCALC     76
                IF (SUM.EQ.0.0) SUM = 1.                                        EOCALC     77
                NEWWT(NI) = ABS(DELGAP(NI)/SUM)**2                              EOCALC     78
                K2 = R2*TYPE(NI)                                                EOCALC     79
            C   SPRING STIFFNESSES OF END SPRINGS ARE 0.5 * OTHER SPRING        EOCALC     80
80          C   CONSTANTS                                                       EOCALC     81
            C   IF(IELAS.EQ.0)                                                  EOCALC     82
            C   * DELGAP(NI)=BB*DELGAP(NI) + (1.-BB) * DELOLD(NI)              EOCALC     83
            C   IF(IELAS.EQ.0) NEWWT(NI) =1.                                   EOCALC     84
            C   IF(IELAS.EQ.0) BETA=5.                                         EOCALC     85
85                  PRES = (OLDGAP(NI)-(OVRLAP(NI)-1.)*DEL(NI))*K1/(PI*(-.2762*2.) EOCALC  86
     +              *.0548)                                                     EOCALC     87
                    OLDGAP(NI) = OLDGAP(NI)+DELGAP(NI)*BETA*NEWWT(NI)           EOCALC     88
            C   OLDGAP(NI)=OLDGAP(NI) + DELGAP(NI)*BETA                         EOCALC     89
                IF (OVRLAP(NI).GT.0.0.AND.OLDGAP(NI).LE.0) OLDGAP(NI) = 0.0     EOCALC     90
90              IF (OLDGAP(NI).NE.0.) RATIO1 = ABS(DELGAP(NI)/OLDGAP(NI))       EOCALC     91
                RATIO = AMAX1(RATIO,RATIO1)                                     EOCALC     92
                DELOLD(NI) = DELGAP(NI)                                         EOCALC     93
      140       CONTINUE                                                        EOCALC     94
              RETURN                                                            EOCALC     95
95            END                                                               EOCALC     96
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	EOCALC	1	94

VARIABLES	SN	TYPE	RELOCATION										
326	BETA	REAL			REFS	87	DEFINED	73					
0	BETAI	REAL		F.P.	REFS	73	DEFINED	1					
317	CS	* REAL			DEFINED	27							
0	DEL	REAL	ARRAY	F.P.	REFS	11	35	36	43	50	51	53	
					85	DEFINED	1	34					
0	DELGAP	REAL	ARRAY	F.P.	REFS	13	57	58	77	87	90	92	
					DEFINED	1	55						
0	DELOLD	REAL	ARRAY	F.P.	REFS	11	DEFINED	1	92				
324	DELR	REAL			REFS	43	DEFINED	37					
325	DELZ	REAL			REFS	43	DEFINED	38					
0	DPH	REAL	ARRAY	F.P.	REFS	8	17	50	51	2*53			
					DEFINED	1							
0	DPLAS	REAL	ARRAY	F.P.	REFS	11	55	DEFINED	1	47	50	51	
					53								
0	F	REAL	ARRAY	F.P.	REFS	9	31	32	DEFINED	1			
321	J	INTEGER			REFS	2*31	2*32	DEFINED	30				
0	K	REAL	ARRAY	DOT	REFS	14	15	16					
0	KPRINT	INTEGER	*UNUSED	F.P.	DEFINED	1							
311	K1	REAL			REFS	12	28	2*55	85	DEFINED	22	28	
					75								
312	K2	REAL			REFS	12	29	3*55	DEFINED	23	29	78	
350	N	INTEGER	ARRAY		REFS	9	31	32	DEFINED	27			
330	NA	INTEGER	ARRAY		REFS	8	DEFINED	27					
0	NEWWT	REAL	ARRAY	F.P.	REFS	13	87	DEFINED	1	77			
0	NUMGAP	INTEGER		F.P.	REFS	8	9	3*11	12	3*13	17	21	
					74	DEFINED	1						
0	NUMX	INTEGER		F.P.	REFS	9	DEFINED	1					
315	NI	INTEGER			REFS	27	28	2*3	34	35	36	2*43	
					47	49	4*50	4*51	4*53	4*55	2*57	58	
					75	2*77	78	3*85	4*87	3*89	3*90	2*92	
					DEFINED	21	74						
0	OLDGAP	REAL	ARRAY	F.P.	REFS	9	55	57	85	87	89	2*90	
					DEFINED	1	87	89					
0	OVRLAP	REAL	ARRAY	F.P.	REFS	13	55	85	89	DEFINED	1	43	
0	PFLAG	INTEGER		F.P.	REFS	10	47	48	DEFINED	1			
314	PI	REAL			REFS	85	DEFINED	19					
327	PRES	* REAL			DEFINED	85							
336	R	REAL	ARRAY		REFS	8	2*34	2*35	2*37	50	51	53	
					DEFINED	27							
0	RATIO	REAL		F.P.	REFS	91	DEFINED	1	91				
316	RATIOI	REAL			REFS	91	DEFINED	26	90				
0	RI	REAL		F.P.	REFS	22	75	DEFINED	1				
0	R2	REAL		F.P.	REFS	23	78	DEFINED	1				
320	SN	* REAL			DEFINED	27							
313	SUM	REAL			REFS	58	76	77	DEFINED	18	58	76	
0	TYPE	REAL	ARRAY	F.P.	REFS	12	28	29	49	75	78		
					DEFINED	1	27						
344	U	REAL	ARRAY		REFS	9	2*37	2*38	DEFINED	31	32		
322	UNITI	REAL			REFS	37	DEFINED	35					
323	UNITJ	REAL			REFS	38	DEFINED	36					
341	Z	REAL	ARRAY		REFS	8	2*34	2*36	2*38	DEFINED	27		

```
FILE NAMES        MODE
      TAPE19     UNFMT                    READS       27     MOTION       20

EXTERNALS          TYPE   ARGS       REFERENCES
      FILL                  2            17
      SQRT        REAL      1 LIBRARY    34

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE  REFERENCES
      ABS         REAL      1  INTRIN              58        77        90
      AMAX1       REAL      0  INTRIN              91

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       33         30
  146  110                       53         49
  154  120                       54         48        52
  174  130                       59         21        57
    0  140                       93         74

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   24  130      N1          21 59      153B              EXT REFS  NOT INNER
   47  100      J           30 33       13B        OPT
  203  140      N1          74 93       55B        OPT

COMMON BLOCKS   LENGTH
      DOT        45000 LCM

STATISTICS
  PROGRAM LENGTH                 440B     288
  LCM LABELED COMMON LENGTH   127710B   45000
        140000B SCM USED
```

```
      1                SUBROUTINE FILL (N,ARRAY)                                  FILL        2
                       DIMENSION ARRAY(1)                                         FILL        3
                           DO 100 I=1,N                                           FILL        4
                           ARRAY(I) = 0.0                                         FILL        5
      5          100       CONTINUE                                               FILL        6
                       RETURN                                                     FILL        7
                       END                                                        FILL        8
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	FILL	1	6

VARIABLES	SN	TYPE	RELOCATION					
0	ARRAY	REAL	ARRAY	F.P.	REFS	2	DEFINED	1 4
17	I	INTEGER			REFS	4	DEFINED	3
0	N	INTEGER		F.P.	REFS	3	DEFINED	1

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	5	3

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
11	100	I	3 5	5B	INSTACK

STATISTICS

PROGRAM LENGTH 23B 19

140000B SCM USED

```
                      SUBROUTINE GAPADD (F,OLDGAP,KZ,NUMGAP,NUMX)                    GAPADD      2
                C                                                                    GAPADD      3
                C     THIS ROUTINE ADDS THE E-ZERO TERMS TO THE F-MATRIX             GAPADD      4
                C     FOR THE GAP CLOSURE ITERATION SCHEME.                          GAPADD      5
                C                                                                    GAPADD      6
                C                                                                    GAPADD      7
                      DIMENSION F(NUMX),OLDGAP(NUMGAP),R(3),Z(3),L(2),NA(6)          GAPADD      8
                       REAL KI     ,KZ                                             GAPADD      9
                      REWIND 19                                                      GAPADD     10
                          DO 100 N=1,NUMGAP                                          GAPADD     11
                          KI = KZ                                                    GAPADD     12
                C                                                                    GAPADD     13
                C     SPRING STIFFNESSES OF END SPRINGS ARE 0.5 * OTHER SPRING       GAPADD     14
                C     CONSTANTS                                                      GAPADD     15
                          READ (19) R,Z,L,NA,CS,SN,TYPE                              GAPADD     16
                          F(NA(1)) = F(NA(1))-KI*CS*OLDGAP(N)*TYPE                   GAPADD     17
                          F(NA(3)) = F(NA(3))+KI*CS*OLDGAP(N)*TYPE                   GAPADD     18
                          F(NA(2)) = F(NA(2))-KI*SN*OLDGAP(N)*TYPE                   GAPADD     19
                          F(NA(4)) = F(NA(4))+KI*SN*OLDGAP(N)*TYPE                   GAPADD     20
                100       CONTINUE                                                   GAPADD     21
                      RETURN                                                         GAPADD     22
                      END                                                            GAPADD     23
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	GAPADD	1	21

VARIABLES

		SN	TYPE		RELOCATION									
70	CS		REAL			REFS	16	17	DEFINED	15				
0	F		REAL	ARRAY	F.P.	REFS	7	16	17	18	19			
						DEFINED	1	16	17	18	19			
0	KZ		REAL		F.P.	REFS	8	11	DEFINED	1				
66	KI		REAL			REFS	8	16	17	18	19			
						DEFINED	11							
101	L		INTEGER	ARRAY		REFS	7	DEFINED	15					
67	N		INTEGER			REFS	16	17	18	19	DEFINED	10		
103	NA		INTEGER	ARRAY		REFS	7	2*16	2*17	2*18	2*19			
						DEFINED	15							
0	NUMGAP		INTEGER		F.P.	REFS	7	10	DEFINED	1				
0	NUMX		INTEGER		F.P.	REFS	7	DEFINED	1					
0	OLDGAP		REAL	ARRAY	F.P.	REFS	7	16	17	18	19			
						DEFINED	1							
73	R		REAL	ARRAY		REFS	7	DEFINED	15					
71	SN		REAL			REFS	18	19	DEFINED	15				
72	TYPE		REAL			REFS	16	17	18	19	DEFINED	15		
76	Z		REAL	ARRAY		REFS	7	DEFINED	15					

```
FILE NAMES          MODE
      TAPE19    UNFMT                 READS       15    MOTION       9

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       20         10

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   13  100      N           10 20       37B              EXT REFS

STATISTICS
  PROGRAM LENGTH                 124B      84
        140000B SCM USED
```

```
      SUBROUTINE GAPSEM (R,Z,KZ,N1,N2,KK,ISAVE,TYPE,IXLSET,ITEST,IGAP)
C
C   THIS ROUTINE ASSEMBLES LOCAL STIFFNESS FOR A PARTICULAR
C   GAP ELEMENT
C
C   SMIN IS THE STIFFNESS OF THE SOFT SPRING
C
C   A TAPE RECORD IS MADE FOR EACH GAP ELEMENT OF
C   RADIAL AND AXIAL COORDINATES
C   END NODES
C   GLOBAL MATRIX COORDINATES
C   COS AND SIN OF ELEMENT ANGLE TO GLOBAL COORDINATES
C   ELEMENT STIFFNESS IN GLOBAL COORDINATES
C
C
      REAL K1 ,KZ
      REAL K
      REAL KLOC
      DIMENSION TK(4,4),R(3),Z(3),KK(6) ,TLOK(4,4)
      COMMON/DOT/K(900,50)
      LEVEL2,K
      CALL FILL (16,TK)
      CALL FILL (16,TLOK)
      KLOC = 0.0
      IF (IXLSET.EQ.1.OR.ITEST.EQ.1) KLOC = KZ*1000.*TYPE
      IF (IXLSET.EQ.1) CALL XGAPSM (TLOK,KLOC)
      K1 = KZ
C
C   SPRING STIFFNESSES OF END SPRINGS ARE 0.5 * OTHER SPRING
C   CONSTANTS
      RL = SQRT((R(2)-R(1))**2+(Z(2)-Z(1))**2)
      CS = (R(2)-R(1))/RL
      SN = (Z(2)-Z(1))/RL
      SMIN = K1*1.E-07*TYPE
C
      IF (IXLSET.EQ.1.OR.ITEST.EQ.1) SMIN = KLOC
      IF (IGAP.EQ.0) SMIN = K1*1.E-07*TYPE
C
      TK(1,1) = CS**2
      TK(1,2) = CS*SN
      TK(1,3) = -CS**2
      TK(1,4) = -CS*SN
      TK(2,1) = CS*SN
      TK(2,2) = SN**2
      TK(2,3) = -SN*CS
      TK(2,4) = -SN**2
      TK(3,1) = -CS**2
      TK(3,2) = -CS*SN
      TK(3,3) = CS**2
      TK(3,4) = CS*SN
      TK(4,1) = -SN*CS
      TK(4,2) = -SN**2
      TK(4,3) = SN*CS
```

```
                TK(4,4) = SN**2                                                  GAPSEM     55
55          C                                                                    GAPSEM     56
                DO 100 I=1,16                                                    GAPSEM     57
                TK(I) = TK(I)*SMIN                                               GAPSEM     58
            100 CONTINUE                                                         GAPSEM     59
            C                                                                    GAPSEM     60
60          C                                                                    GAPSEM     61
            WRITE (19) R,Z,N1,N2,KK,CS,SN,TYPE                                   GAPSEM     62
            C                                                                    GAPSEM     63
            C   GLOBAL ASSEMBLY IN BANDED FORMAT                                 GAPSEM     64
            C                                                                    GAPSEM     65
65          DO 110 I=1,4                                                         GAPSEM     66
            II = KK(I)                                                           GAPSEM     67
            DO 110 J=1,4                                                         GAPSEM     68
            C   WRITE(6,1)II,JJ,ISAVE                                           GAPSEM     69
            JJ = KK(J)                                                           GAPSEM     70
70          IF (II.GT.JJ) GO TO 110                                              GAPSEM     71
            IF (JJ-II.GT.ISAVE) GO TO 110                                        GAPSEM     72
            K(II,JJ-II+1) = K(II,JJ-II+1)+TK(I,J)+TLOK(I,J)                      GAPSEM     73
            110 CONTINUE                                                         GAPSEM     74
            RETURN                                                               GAPSEM     75
75          C                                                                    GAPSEM     76
            END                                                                  GAPSEM     77
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GAPSEM 1 74

VARIABLES	SN	TYPE			RELOCATION							
252	CS	REAL				REFS	39	40	41	42	43	45	47
							48	49	50	51	53	61	
						DEFINED	32						
255	I	INTEGER				REFS	2*57	66	2*72	DEFINED	56	65	
0	IGAP	INTEGER			F.P.	REFS	37	DEFINED	1				
256	II	INTEGER				REFS	70	71	4*72	DEFINED	66		
0	ISAVE	INTEGER			F.P.	REFS	71	DEFINED	1				
0	ITEST	INTEGER			F.P.	REFS	25	36	DEFINED	1			
0	IXLSET	INTEGER			F.P.	REFS	25	26	36	DEFINED	1		
257	J	INTEGER				REFS	69	2*72	DEFINED	67			
260	JJ	INTEGER				REFS	70	71	2*72	DEFINED	69		
0	K	REAL	ARRAY	DOT		REFS	17	20	21	72	DEFINED	72	
0	KK	INTEGER	ARRAY		F.P.	REFS	19	61	66	69	DEFINED	1	
250	KLOC	REAL				REFS	18	26	36	DEFINED	24	25	
0	KZ	REAL			F.P.	REFS	16	25	27	DEFINED	1		
247	K1	REAL				REFS	16	34	37	DEFINED	27		
0	N1	INTEGER			F.P.	REFS	61	DEFINED	1				
0	N2	INTEGER			F.P.	REFS	61	DEFINED	1				
0	R	REAL	ARRAY		F.P.	REFS	19	2*31	2*32	61	DEFINED	1	

```
VARIABLES     SN  TYPE          RELOCATION
  251  RL         REAL                        REFS      32      33    DEFINED      31
  254  SMIN       REAL                        REFS      57  DEFINED      34      36      37
  253  SN         REAL                        REFS      40      42      43      44      45      46      48
                                                 50      51      52      53      54      61
                                              DEFINED     33
  261  TK         REAL          ARRAY         REFS      19      22      57      72  DEFINED      39      40
                                                 41      42      43      44      45      46      47      48
                                                 49      50      51      52      53      54      57
  301  TLOK       REAL          ARRAY         REFS      19      23      26      72
    0  TYPE       REAL                F.P.    REFS      25      34      37      61  DEFINED       1
    0  Z          REAL          ARRAY F.P.    REFS      19    2*31    2*33      61  DEFINED       1

FILE NAMES       MODE
     TAPE19      UNFMT                 WRITES      61

EXTERNALS          TYPE   ARGS       REFERENCES
     FILL                    2            22      23
     SQRT          REAL      1 LIBRARY      31
     XGAPSM                  2            26

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       58         56
  207  110                       73         65      67      70      71

LOOPS  LABEL   INDEX    FROM-TO    LENGTH    PROPERTIES
  145  100     I          56 58        66     INSTACK
  157  110     I          65 73       36B                 NOT INNER
  164  110     J          67 73       26B      OPT

COMMON BLOCKS   LENGTH
     DOT         45000 LCM

STATISTICS
  PROGRAM LENGTH                    325B      213
  LCM LABELED COMMON LENGTH      127710B    45000
        140000B SCM USED
```

```
1                SUBROUTINE GPFORC (F,NUMX,GAPSIZ,FORCE,IGAP,NUMGAP,IXLSET,CLOSE)   GPFORC     2
                 REAL R(3),Z(3) ,F(NUMX)   , U(4)                                   GPFORC     3
                 INTEGER NA(6),N(2),IGAP(NUMGAP)                                    GPFORC     4
                 GAPSIZ = -10.                                                      GPFORC     5
5                REWIND 19                                                          GPFORC     6
                     DO 110 I=1,NUMGAP                                              GPFORC     7
           C                                                                        GPFORC     8
           C    THE FIRST GAP ELEMENT MUST CORRESPOND TO THE PELLET MIDPLANE       GPFORC     9
           C                                                                        GPFORC    10
10                   READ (19) R,Z,N,NA                                           GPFORC    11
                         DO 100 J=1,2                                             GPFORC    12
                         U(J*2-1) = F(N(J)*2-1)                                   GPFORC    13
           100           U(J*2) = F(N(J)*2)                                       GPFORC    14
                     DEL = SQRT((R(2)-R(1))**2+(Z(2)-Z(1))**2)                    GPFORC    15
15                   UNITI = (R(2)-R(1))/DEL                                      GPFORC    16
                     UNITJ = (Z(2)-Z(1))/DEL                                      GPFORC    17
                     DELR = (R(2)-R(1)+U(3)-U(1))*UNITI                           GPFORC    18
                     DELZ = (Z(2)-Z(1)+U(4)-U(2))*UNITJ                           GPFORC    19
                     OVRLAP = (DELR+DELZ)/DEL                                     GPFORC    20
20                   IF (IXLSET.NE.1.AND.OVRLAP.LE.GAPSIZ.AND.CLOSE.EQ.2..AND.I.EQ. GPFORC  21
                +    NUMGAP) IGAP(I) = 1                                         GPFORC    22
                     IF (I.GT.1) GO TO 110                                        GPFORC    23
                     GAPSIZ = OVRLAP                                              GPFORC    24
                     FORCE = GAPSIZ                                               GPFORC    25
25           110     CONTINUE                                                     GPFORC    26
                 RETURN                                                         GPFORC    27
                 END                                                            GPFORC    28
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	GPFORC	1

DEF LINE: 26

VARIABLES

0	CLOSE	REAL		F.P.	REFS	20	DEFINED	1				
141	DEL	REAL			REFS	15	16	19	DEFINED	14		
144	DELR	REAL			REFS	19	DEFINED	17				
145	DELZ	REAL			REFS	19	DEFINED	18				
0	F	REAL	ARRAY	F.P.	REFS	2	12	13	DEFINED	1		
0	FORCE	REAL		F.P.	DEFINED	1	24					
0	GAPSIZ	REAL		F.P.	REFS	20	24	DEFINED	1	4	23	
137	I	INTEGER			REFS	2*20	22	DEFINED	6			
0	IGAP	INTEGER	ARRAY	F.P.	REFS	3	DEFINED	1	20			
0	IXLSET	INTEGER		F.P.	REFS	20	DEFINED	1				
140	J	INTEGER			REFS	2*12	2*13	DEFINED	11			
167	N	INTEGER	ARRAY		REFS	3	12	13	DEFINED	10		
161	NA	INTEGER	ARRAY		REFS	3	DEFINED	10				
0	NUMGAP	INTEGER		F.P.	REFS	3	6	20	DEFINED	1		
0	NUMX	INTEGER		F.P.	REFS	2	DEFINED	1				

```
VARIABLES     SN  TYPE          RELOCATION
  146  OVRLAP     REAL                          REFS       20       23    DEFINED       19
  147  R          REAL      ARRAY               REFS        2     2*14      2*15     2*17   DEFINED       10
  155  U          REAL      ARRAY               REFS        2     2*17      2*18   DEFINED       12       13
  142  UNITI      REAL                          REFS       17   DEFINED        15
  143  UNITJ      REAL                          REFS       18   DEFINED        16
  152  Z          REAL      ARRAY               REFS        2     2*14      2*16     2*18   DEFINED       10

FILE NAMES        MODE
       TAPE19     UNFMT                 READS       10     MOTION        5

EXTERNALS          TYPE   ARGS       REFERENCES
       SQRT       REAL      1 LIBRARY      14

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100                       13         11
  115  110                       25          6        22

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   15  110      I           6 25       103B                EXT REFS  NOT INNER
   21  100      J          11 13       12B     INSTACK

STATISTICS
  PROGRAM LENGTH              205B     133
        140000B SCM USED
```

```
      FUNCTION GAPTST (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST GAPTST      2
     +,MBAND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIE GAPTST      3
     +S,NUMGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,F1,F2, GAPTST      4
     +ID,LTYPE,OLDEPP,SPDA,TC,TIE,V)                                    GAPTST      5
      INTEGER GAP,GAPEND,CLAD,ELEM(NELEM,3),ID(NDISPS), TIE(NTIES)      GAPTST      6
      INTEGER LTYPE(NELEM),IGAP(NUMGAP)                                 GAPTST      7
      REAL F(NUMX),F2(NLOAD2),DELOLD(NUMGAP),TC(NELEM)                  GAPTST      8
      REAL OLDEPP(NELEM,4),E(NELEM),V(NELEM),ALFDT(NELEM,3)             GAPTST      9
      REAL MATPRO(9) ,F1(NUMX)                                          GAPTST     10
      REAL COORD(NNODES,2),EPP(NELEM,4),DI(NDISPS),K,K1,K2              GAPTST     11
      COMMON/DOT/ K(900,60)                                             GAPTST     12
      LEVEL2,K                                                          GAPTST     13
      DATA GAP,GAPEND,CLAD/3HGAP,7HGAP END ,4HCLAD /                    GAPTST     14
C                                                                       GAPTST     15
C   THIS FUNCTION DETERMINES FORCE IN THE CENTER GAP SPRING FOR         GAPTST     16
C   VARIOUS VALUES OF CLOSE, AS FOUND BY CLOSEX.                        GAPTST     17
C                                                                       GAPTST     18
      ISAVE = 0                                                         GAPTST     19
      N = NLOADS+NTEMPS+3                                               GAPTST     20
      REWIND 22                                                         GAPTST     21
          DO 100 I=1,NLOADS                                             GAPTST     22
  100     READ (22) J,F2(J),K1,F2(K1)                                   GAPTST     23
          DO 110 I=1,NTEMPS                                             GAPTST     24
  110     READ (22) J,TC(J)                                             GAPTST     25
      READ (22) SPDA                                                    GAPTST     26
      CALL NULOAD (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOADST,MBA GAPTST     27
     +ND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NTIES,NU GAPTST     28
     +MGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,F2,ID,LTYP GAPTST     29
     +E,OLDEPP,SPDA,TC,TIE,V)                                           GAPTST     30
          DO 120 I=1,N                                                  GAPTST     31
  120     BACKSPACE IUNIT                                               GAPTST     32
          DO 130 I=1,NUMX                                               GAPTST     33
  130     F1(I) = F(I)                                                  GAPTST     34
      CALL ELAST (F1,NUMX,MBAND,0)                                      GAPTST     35
      CALL GPFORC (F1,NUMX,GAPSIZ,FORCE,IGAP,NUMGAP,IXLSET,CLOSE)       GAPTST     36
      GAPTST = FORCE                                                    GAPTST     37
      RETURN                                                            GAPTST     38
      END                                                               GAPTST     39
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

5	GAPTST	DEF LINE 1
		REFERENCES 37

VARIABLES

0	ALFDT	REAL	ARRAY	F.P.	REFS	8	26	DEFINED	1	
301	CLAD	INTEGER			REFS	5	DEFINED	13		
0	CLOSE	REAL		F.P.	REFS	26	35	DEFINED	1	
0	COORD	REAL	ARRAY	F.P.	REFS	10	26	DEFINED	1	

VARIABLES

SN		TYPE	RELOCATION									
0	DELOLD	REAL	ARRAY	F.P.	REFS	7	26	DEFINED	1			
0	DI	REAL	ARRAY	F.P.	REFS	10	26	DEFINED	1			
0	E	REAL	ARRAY	F.P.	REFS	8	26	DEFINED	1			
0	ELEM	INTEGER	ARRAY	F.P.	REFS	5	26	DEFINED	1			
0	EPP	REAL	ARRAY	F.P.	REFS	10	26	DEFINED	1			
0	F	REAL	ARRAY	F.P.	REFS	7	26	33	DEFINED	1		
335	FORCE	REAL			REFS	35	36					
0	F1	REAL	ARRAY	F.P.	REFS	9	34	35	DEFINED	1	33	
0	F2	REAL	ARRAY	F.P.	REFS	7	26	DEFINED	1	2*22		
277	GAP	INTEGER			REFS	5	DEFINED	13				
300	GAPEND	INTEGER			REFS	5	DEFINED	13				
334	GAPSIZ *	REAL			REFS	35						
330	GAPTST	REAL			DEFINED	36						
332	I	INTEGER			REFS	2*33	DEFINED	21	23	30	32	
0	ICLOSE	INTEGER		F.P.	REFS	26	DEFINED	1				
0	ID	INTEGER	ARRAY	F.P.	REFS	5	26	DEFINED	1			
0	IGAP	INTEGER	ARRAY	F.P.	REFS	6	26	35	DEFINED	1		
0	ISAVE	INTEGER		F.P.	REFS	26	DEFINED	1	18			
0	IUNIT	INTEGER		F.P.	REFS	26	DEFINED	1	I/O REFS	31		
0	IXLSET	INTEGER		F.P.	REFS	26	35	DEFINED	1			
333	J	INTEGER			REFS	22	24	DEFINED	22	24		
0	K	REAL	ARRAY	DOT	REFS	10	11	12				
0	K1	REAL		F.P.	REFS	10	22	26	DEFINED	1	22	
0	K2	REAL		F.P.	REFS	10	26	DEFINED	1			
0	LOADST	INTEGER		F.P.	REFS	26	DEFINED	1				
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	6	26	DEFINED	1			
0	MATPRO	REAL	ARRAY	F.P.	REFS	9	26	DEFINED	1			
0	MBAND	INTEGER		F.P.	REFS	26	34	DEFINED	1			
0	MBNDOL	INTEGER		F.P.	REFS	26	DEFINED	1				
331	N	INTEGER			REFS	30	DEFINED	19				
0	NDISPS	INTEGER		F.P.	REFS	5	10	26	DEFINED	1		
0	NELEM	INTEGER		F.P.	REFS	5	6	7	4*8	10	26	
					DEFINED	1						
0	NLOADS	INTEGER		F.P.	REFS	19	21	26	DEFINED	1		
0	NLOAD2	INTEGER		F.P.	REFS	7	26	DEFINED	1			
0	NNODES	INTEGER		F.P.	REFS	10	26	DEFINED	1			
0	NTEMPS	INTEGER		F.P.	REFS	19	23	26	DEFINED	1		
0	NTIES	INTEGER		F.P.	REFS	5	26	DEFINED	1			
0	NUMGAP	INTEGER		F.P.	REFS	6	7	26	35	DEFINED	1	
0	NUMX	INTEGER		F.P.	REFS	7	9	26	32	34	35	
					DEFINED	1						
0	NUMY	INTEGER		F.P.	REFS	26	DEFINED	1				
0	NUNIT	INTEGER		F.P.	REFS	26	DEFINED	1				
0	OLDEPP	REAL	ARRAY	F.P.	REFS	8	26	DEFINED	1			
0	SPDA	REAL		F.P.	REFS	26	DEFINED	1	25			
0	TC	REAL	ARRAY	F.P.	REFS	7	26	DEFINED	1	24		
0	TIE	INTEGER	ARRAY	F.P.	REFS	5	26	DEFINED	1			
0	V	REAL	ARRAY	F.P.	REFS	8	26	DEFINED	1			

FILE NAMES	MODE					
TAPE22	UNFMT	READS	22	24	25	MOTION 20

VARIABLES USED AS FILE NAMES, SEE ABOVE

```
EXTERNALS            TYPE    ARGS        REFERENCES
       ELAST                    4              34
       GPFORC                   8              35
       NULOAD                  39              26

STATEMENT LABELS                  DEF LINE    REFERENCES
    0  100                           22          21
    0  110                           24          23
    0  120                           31          30
    0  130                           33          32

LOOPS  LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
   22  100      I            21 22        16B                EXT REFS
   42  110      I            23 24        11B                EXT REFS
  152  120      I            30 31         5B                EXT REFS
  161  130      I            32 33         5B      INSTACK

COMMON BLOCKS   LENGTH
       DOT       54000 LCM

STATISTICS
  PROGRAM LENGTH                    350B      232
  LCM LABELED COMMON LENGTH      151360B    54000
        140000B SCM USED
```

```
      SUBROUTINE IFPRES (IXLSET,F,NUMGAP,PRESFC,KI,NUMX,NELEM)                  IFPRES     2
      INTEGER NA(6),N(2)                                                        IFPRES     3
      REAL F(NUMX),PRESFC(NUMGAP,3),U(4),R(3),Z(3)                              IFPRES     4
      REAL KI                                                                   IFPRES     5
      REWIND 19                                                                 IFPRES     6
      IF (IXLSET.EQ.1) WRITE (6,130)                                            IFPRES     7
      IF (IXLSET.NE.1) WRITE (6,140)                                            IFPRES     8
          DO 120 I=1,NUMGAP                                                     IFPRES     9
          READ (19) R,Z,N,NA,CS,SN                                              IFPRES    10
              DO 100 J=1,2                                                      IFPRES    11
              U(J*2-1) = F(N(J)*2-1)                                            IFPRES    12
  100         U(J*2) = F(N(J)*2)                                                IFPRES    13
          DEL = SQRT((R(2)-R(1))**2+(Z(2)-Z(1))**2)                             IFPRES    14
          UNITI = (R(2)-R(1))/DEL                                               IFPRES    15
          UNITJ = (Z(2)-Z(1))/DEL                                               IFPRES    16
          DELR = (R(2)-R(1)+U(3)-U(1))*UNITI                                    IFPRES    17
          DELZ = (Z(2)-Z(1)+U(4)-U(2))*UNITJ                                    IFPRES    18
          OVRLAP = (DELR+DELZ)/DEL                                              IFPRES    19
          NX = NELEM-NUMGAP+I                                                   IFPRES    20
          IF (IXLSET.EQ.1) GO TO 110                                            IFPRES    21
          GAPSZ = OVRLAP*DEL                                                    IFPRES    22
          WRITE (6,150) NX,GAPSZ                                                IFPRES    23
          GO TO 120                                                             IFPRES    24
  110     CONTINUE                                                              IFPRES    25
          TYPE = 1.                                                             IFPRES    26
          IF (I.EQ.1.OR.I.EQ.NUMGAP) TYPE = 0.5                                 IFPRES    27
          PRES = OVRLAP*KI*1000.*TYPE*DEL*1.0E+07/PRESFC(I,2)                   IFPRES    28
          WRITE (6,160) NX,PRES                                                 IFPRES    29
  120     CONTINUE                                                              IFPRES    30
      RETURN                                                                    IFPRES    31
C                                                                               IFPRES    32
  130 FORMAT (28H0ALL GAP ELEMENTS ARE CLOSED,/,1H0,25H INTERFACE PRESSU        IFPRES    33
     +RES ARE )                                                                 IFPRES    34
  140 FORMAT (1H0,30X,10HGAP SIZES )                                            IFPRES    35
  150 FORMAT (1H0,15HFOR GAP ELEMENT,I4,15H THE GAP SIZE =,E15.5)               IFPRES    36
  160 FORMAT (1H0,15HFOR GAP ELEMENT,I4,21HINTERFACE PRESSURE = ,E15.5)         IFPRES    37
      END                                                                       IFPRES    38
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	IFPRES	1	30

VARIABLES		SN	TYPE	RELOCATION						
244	CS	*	REAL		DEFINED	9				
247	DEL		REAL		REFS	14	15	18	21	27
					DEFINED	13				
252	DELR		REAL		REFS	18	DEFINED	16		
253	DELZ		REAL		REFS	18	DEFINED	17		

```
VARIABLES     SN  TYPE          RELOCATION
    0  F          REAL      ARRAY     F.P.      REFS          3      11      12   DEFINED       1
  256  GAPSZ      REAL                          REFS         22  DEFINED      21
  243  I          INTEGER                       REFS         19     2*26      27   DEFINED       8
    0  IXLSET     INTEGER                F.P.   REFS          6        7      20   DEFINED       1
  246  J          INTEGER                       REFS       2*11     2*12 DEFINED      10
    0  KI         REAL                   F.P.   REFS          4       27 DEFINED       1
  267  N          INTEGER   ARRAY               REFS          2       11      12   DEFINED       9
  261  NA         INTEGER   ARRAY               REFS          2  DEFINED       9
    0  NELEM      INTEGER                F.P.   REFS         19  DEFINED       1
    0  NUMGAP     INTEGER                F.P.   REFS          3        8      19      26   DEFINED       1
    0  NUMX       INTEGER                F.P.   REFS          3  DEFINED       1
  255  NX         INTEGER                       REFS         22       28 DEFINED      19
  254  OVRLAP     REAL                          REFS         21       27 DEFINED      18
  260  PRES       REAL                          REFS         28  DEFINED      27
    0  PRESFC     REAL      ARRAY     F.P.      REFS          3       27 DEFINED       1
  275  R          REAL      ARRAY               REFS          3     2*13    2*14    2*16   DEFINED       9
  245  SN       * REAL                       DEFINED         9
  257  TYPE       REAL                          REFS         27  DEFINED      25      26
  271  U          REAL      ARRAY               REFS          3     2*16    2*17   DEFINED      11      12
  250  UNITI      REAL                          REFS         16  DEFINED      14
  251  UNITJ      REAL                          REFS         17  DEFINED      15
  300  Z          REAL      ARRAY               REFS          3     2*13    2*15    2*17   DEFINED       9

FILE NAMES       MODE
     TAPE19      UNFMT                READS          9     MOTION          5
     TAPE6       FMT                  WRITES         6          7      22      28

EXTERNALS          TYPE    ARGS       REFERENCES
     SQRT          REAL       1 LIBRARY      13

STATEMENT LABELS                  DEF LINE    REFERENCES
    0  100                           12          10
  120  110                           24          20
  144  120                           29           8          23
  206  130      FMT                  32           6
  216  140      FMT                  34           7
  222  150      FMT                  35          22
  230  160      FMT                  36          28

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   25  120      I           8 29       122B                    EXT REFS  NOT INNER
   31  100      J          10 12        12B     INSTACK

STATISTICS
  PROGRAM LENGTH                      315B      205
          140000B SCM USED
```

```
      SUBROUTINE KTIE (NTIES,TIE,MBAND,NUMX,NUMY)                       KTIE       2
      INTEGER TIE(1)                                                    KTIE       3
       REAL K(900,60)                                                   KTIE       4
      COMMON/DOT/K                                                      KTIE       5
      LEVEL2,K                                                          KTIE       6
C                                                                       KTIE       7
C                                                                       KTIE       8
C   THIS SUBROUTINE CHANGES THE STIFFNESS MATRIX TO ENFORCE CLADDING    KTIE       9
C   END CONDITIONS AT THE                                               KTIE      10
C                                                                       KTIE      11
      NMBAND = 0                                                        KTIE      12
      NM1 = NTIES-1                                                     KTIE      13
      K2 = 1                                                            KTIE      14
      K1 = NUMX                                                         KTIE      15
          DO 100 I=1,NTIES                                              KTIE      16
          IF (TIE(I).LT.K1) K1 = TIE(I)                                 KTIE      17
  100     IF (TIE(I).GT.K2) K2 = TIE(I)                                 KTIE      18
      K1 = K1-MBAND+1                                                   KTIE      19
      IF (K1.LE.0) K1 = 1                                               KTIE      20
          DO 150 I=1,NM1                                                KTIE      21
          KT = IABS(TIE(NTIES)-TIE(I))                                  KTIE      22
          IF ((MBAND+KT).GT.NMBAND) NMBAND = MBAND+KT                   KTIE      23
          IF (NMBAND.GT.NUMX) NMBAND = NUMX                             KTIE      24
          IF (NMBAND.GT.NUMY) WRITE (6,160) MBAND                       KTIE      25
          IF (NMBAND.GT.NUMY) STOP                                      KTIE      26
C                                                                       KTIE      27
C                                                                       KTIE      28
            DO 150 J=K1,K2                                              KTIE      29
            II = TIE(NTIES)                                             KTIE      30
            IF (J.NE.TIE(I)) GO TO 110                                  KTIE      31
            KL = IABS(II-J)+1                                           KTIE      32
            KZ = J                                                      KTIE      33
            IF (J.GT.II) KZ = II                                        KTIE      34
            K(II,1) = K(II,1)+K(KZ,KL)                                  KTIE      35
  110       IF (J.LT.II) GO TO 130                                      KTIE      36
            JJ = J-II+1                                                 KTIE      37
            IF (JJ.EQ.1) GO TO 150                                      KTIE      38
            KL = TIE(I)                                                 KTIE      39
            KZ = J-KL+1                                                 KTIE      40
            IF (KL.GT.J) KZ = KL-J+1                                    KTIE      41
            IF (KL.GT.J) KL = J                                         KTIE      42
            IF (KZ.GT.NMBAND) GO TO 150                                 KTIE      43
            IF (JJ.GT.NMBAND) GO TO 120                                 KTIE      44
            K(II,JJ) = K(II,JJ)+K(KL,KZ)                                KTIE      45
  120       K(KL,KZ) = 0.                                               KTIE      46
            IF (J.EQ.TIE(I)) K(KL,KZ) = -K(II,JJ)                       KTIE      47
            GO TO 150                                                   KTIE      48
  130       JJ = II-J+1                                                 KTIE      49
            II = J                                                      KTIE      50
            KZ = J-TIE(I)+1                                             KTIE      51
            IF (KZ.LE.0) GO TO 140                                      KTIE      52
            IF (JJ.GT.NMBAND) GO TO 150                                 KTIE      53
            K(II,JJ) = K(II,JJ)+K(TIE(I),KZ)                            KTIE      54
```

```
                        K(TIE(I),KZ) = 0.                                          KTIE    55
   55                   KL = TIE(I)                                                KTIE    56
                        IF (J.EQ.TIE(I)) K(KL,KZ) = -K(II,JJ)                      KTIE    57
                        GO TO 150                                                  KTIE    58
              140       K(II,JJ) = K(II,JJ)+K(J,(TIE(I)-J+1))                      KTIE    59
                        K(J,(TIE(I)-J+1)) = 0.                                     KTIE    60
   60         150       CONTINUE                                                   KTIE    61
                   MBAND = NMBAND                                                  KTIE    62
                   RETURN                                                          KTIE    63
                  C                                                                KTIE    64
                   160  FORMAT (1H0,52HMBAND IS LARGER THEN MAX DIMENSIONS OF THE K-MATRIX KTIE    65
   65                 + ,/,8H MBAND =,I5)                                          KTIE    66
                   END                                                             KTIE    67
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 KTIE	1	62

VARIABLES	SN	TYPE			RELOCATION							
332	I	INTEGER			REFS	2*16	2*17	21	30	38	46	50
					53	54	55	56	58	59		
					DEFINED	15	20					
335	II	INTEGER			REFS	31	2*33	2*34	35	36	2*44	46
					48	2*53	56	2*58	DEFINED	29	49	
334	J	INTEGER			REFS	30	31	32	33	35	36	39
					2*40	2*41	46	48	49	50	56	2*58
					2*59	DEFINED	28					
340	JJ	INTEGER			REFS	37	43	2*44	46	52	2*53	56
					2*58	DEFINED	36	48				
0	K	REAL	ARRAY	DOT	REFS	3	4	5	2*34	2*44	46	2*53
					56	2*58	DEFINED	34	44	45	46	53
					54	56	58	59				
336	KL	INTEGER			REFS	34	39	2*40	41	44	45	46
					56	DEFINED	31	38	41	55		
333	KT	INTEGER			REFS	2*22	DEFINED	21				
337	KZ	INTEGER			REFS	34	42	44	45	46	51	53
					54	56	DEFINED	32	33	39	40	50
331	KI	INTEGER			REFS	16	18	19	28	DEFINED	14	16
					18	19						
330	K2	INTEGER			REFS	17	28	DEFINED	13	17		
0	MBAND	INTEGER		F.P.	REFS	18	2*22	24	DEFINED	1	61	
326	NMBAND	INTEGER			REFS	22	23	24	25	42	43	52
					61	DEFINED	11	22	23			
327	NMI	INTEGER			REFS	20	DEFINED	12				
0	NTIES	INTEGER		F.P.	REFS	12	15	21	29	DEFINED	1	
0	NUMX	INTEGER		F.P.	REFS	14	2*23	DEFINED	1			
0	NUMY	INTEGER		F.P.	REFS	24	25	DEFINED	1			
0	TIE	INTEGER	ARRAY	F.P.	REFS	2	2*16	2*17	2*21	29	30	38

```
VARIABLES     SN  TYPE          RELOCATION
                                                  46        50        53        54        55        56        58        59
                                                DEFINED      1

FILE NAMES        MODE
      TAPE6     FMT                    WRITES       24

INLINE FUNCTIONS   TYPE    ARGS        DEF LINE  REFERENCES
      IABS       INTEGER    1  INTRIN                21        31

STATEMENT LABELS                 DEF LINE   REFERENCES
    0   100                         17         15
  123   110                         35         30
  171   120                         45         43
  207   130                         48         35
  260   140                         58         51
  277   150                         60         20        28        37        42        47        52        57
  314   160     FMT                 64         24

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   22   100     I          15 17       138B        OPT
   45   150     I          20 60       240B                  EXT REFS  NOT INNER
   74   150     J          28 60       206B        OPT

COMMON BLOCKS   LENGTH
      DOT        54000 LCM

STATISTICS
  PROGRAM LENGTH                  370B      248
  LCM LABELED COMMON LENGTH    151360B    54000
        140000B SCM USED
```

```
      SUBROUTINE NULOAD (CLOSE,ICLOSE,IGAP,ISAVE,IUNIT,IXLSET,K1,K2,LOAD
     +ST,MBAND,MBNDOL,MATPRO,NDISPS,NELEM,NLOADS,NLOAD2,NNODES,NTEMPS,NT
     +IES,NUMGAP,NUMX,NUMY,NUNIT,ALFDT,COORD,DI,DELOLD,E,ELEM,EPP,F,F2,I
     +D,LTYPE,OLDEPP,SPDA,TC,TIE,V)
      INTEGER GAP,GAPEND,CLAD,ELEM(NELEM,3),ID(NDISPS), TIE(NTIES)
      INTEGER KK(6) ,LTYPE(NELEM)
      INTEGER IGAP(NUMGAP)
      REAL R(3),Z(3),EPSO(4),AT(4,6),D(4,4),TT(6,4),DISP(6),KE(6,6)
      REAL FE(6),F(NUMX),F2(NLOAD2),DELOLD(NUMGAP),TC(NELEM)
      REAL OLDEPP(NELEM,4),E(NELEM),V(NELEM),ALFDT(NELEM,3)
       REAL MATPRO(11)
      REAL COORD(NNODES,2),EPP(NELEM,4),DI(NDISPS),K,K1,K2
      COMMON/DOT/ K(900,60)
      LEVEL2,K
      GAP = 3HGAP
      GAPEND = 7HGAP END
      CLAD = 4HCLAD
      IF (LOADST.GT.1) MBAND = MBNDOL
      COMP = MATPRO(2)
      CWKF = MATPRO(3)
      DELOXY = MATPRO(5)
      FNCK = MATPRO(6)
      FOTMTL = MATPRO(8)
      FRDEN = MATPRO(9)
      FTMELT = MATPRO(10)
C
C
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST
C     (HOOP STRAIN)/(RADIAL STRAIN)
C     COMP   - PUO2 CONTENT (WT;)
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)
C     CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT
C     DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED
C     CLADDING      (KG OXYGEN/KG ZIRCALOY)
C     FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)
C     FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT
C     FOTMTL - FUEL OXYGEN TO METAL RAITO
C     FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)
C     FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)
C     RSTRAN - TRUE STRAIN RATE (1/SEC)
C
        REWIND 22
        ITEST = 0
        IF (LOADST.EQ.ICLOSE) ITEST = 1
C     ***ZERO STRUCTURAL MATRIX AND FORCE MATRIX HERE****
C     NOT OPERATIVE FOR F
            DO 100 I=1,NUMX
            F(I) = 0.0
                DO 100 J=1,NUMY
  100           K(I,J) = 0.0
        CALL FILL (NUMGAP,DELOLD)
C     ***READ NEW LOADS HERE FOR EACH LOADSTEP
C     TEMPORY
```

```
                READ (IUNIT,340) NLOADS                                                 NULOAD     55
55              IF (NLOADS.EQ.0) GO TO 120                                              NULOAD     56
                    DO 110 I=1,NLOADS                                                   NULOAD     57
C                                                                                       NULOAD     58
CCC                                                                                     NULOAD     59
CCC   NOD CODING FOR INCREMENTING LOADS FOR AXIAL LOCKUP                                NULOAD     60
60    CCC                                                                               NULOAD     61
CCC   DON T KNOW IF LOADS NEED TO BE READ EACH TIME EITHER                              NULOAD     62
CCC                                                                                     NULOAD     63
C                                                                                       NULOAD     64
                    READ (IUNIT,350) NODE,FR,FZ                                         NULOAD     65
65                  L2 = 2*NODE                                                         NULOAD     66
                    L1 = L2-1                                                           NULOAD     67
                    L3 = I+NLOADS                                                       NULOAD     68
                    IF (LOADST.EQ.ICLOSE) F(L1) = (FR-F2(I))*CLOSE+F2(I)                NULOAD     69
                    IF (LOADST.EQ.ICLOSE) F(L2) = (FZ-F2(L3))*CLOSE+F2(L3)              NULOAD     70
70                  IF (LOADST.EQ.ICLOSE) GO TO 110                                     NULOAD     71
                    F(L1) = FR                                                          NULOAD     72
                    F(L2) = FZ                                                          NULOAD     73
                    IF (ISAVE.EQ.1) WRITE (22) I,F2(I),L3,F2(L3)                        NULOAD     74
                    F2(I) = FR                                                          NULOAD     75
75                  F2(L3) = FZ                                                         NULOAD     76
110             CONTINUE                                                                NULOAD     77
120         CONTINUE                                                                    NULOAD     78
            READ (IUNIT,360) NTEMPS                                                     NULOAD     79
                DO 130 I=1,NTEMPS                                                       NULOAD     80
80              READ (IUNIT,360) NEL,TCC                                                NULOAD     81
                IF (ISAVE.EQ.1) WRITE (22) NEL,TC(NEL)                                  NULOAD     82
                IF (LOADST.EQ.ICLOSE) TC(NEL) = TC(NEL)+CLOSE*(TCC-TC(NEL))             NULOAD     83
                IF (LOADST.EQ.ICLOSE) GO TO 130                                         NULOAD     84
                TC(NEL) = TCC                                                           NULOAD     85
85          130 CONTINUE                                                                NULOAD     86
            L1 = 4*NELEM                                                                NULOAD     87
            CALL FILL (L1,OLDEPP)                                                       NULOAD     88
                DO 170 J=1,NELEM                                                        NULOAD     89
                IF (LTYPE(J).EQ.GAP.OR.LTYPE(J).EQ.GAPEND) GO TO 170                    NULOAD     90
90              TP = TC(J)                                                              NULOAD     91
                IF (NUNIT.EQ.1) TP = TEMPFK(TP)                                         NULOAD     92
                IF (LTYPE(J).EQ.CLAD) GO TO 150                                         NULOAD     93
                E(J) = FELMOD(TP,FRDEN,FOTMTL,COMP)                                     NULOAD     94
                FACMOT = 0.0                                                            NULOAD     95
95              IF (TP.GT.FTMELT) FACMOT = 1.0                                          NULOAD     96
C   FACMOT IS THE FRACTION OF MOLTEN FUEL                                               NULOAD     97
                V(J) = FPOIR(TP,COMP)                                                   NULOAD     98
                    DO 140 I=1,3                                                        NULOAD     99
            140     ALFDT(J,I) = FTHEXP(TP,FACMOT)                                      NULOAD    100
100             GO TO 160                                                               NULOAD    101
            150 E(J) = CELMOD(TP,FNCK,CWKF,DELOXY)                                      NULOAD    102
                CR = CSHEAR(TP,FNCK,CWKF,DELOXY)                                        NULOAD    103
                V(J) = E(J)/(2.*CR)-1.                                                  NULOAD    104
                CALL CTHEXP (TP,CATHEX,CDTHEX)                                          NULOAD    105
105             ALFDT(J,1) = CATHEX                                                     NULOAD    106
                ALFDT(J,2) = CDTHEX                                                     NULOAD    107
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                ALFDT(J,3) = CDTHEX                                                 NULOAD    108
          160   CONTINUE                                                            NULOAD    109
                IF (NUNIT.EQ.1) E(J) = PASPSI(E(J))                                 NULOAD    110
110       170   CONTINUE                                                            NULOAD    111
              REWIND 21                                                           NULOAD    112
              REWIND 18                                                           NULOAD    113
              REWIND 19                                                           NULOAD    114
              J1 = 1                                                              NULOAD    115
115               DO 190 N=1,NELEM                                                NULOAD    116
                  N1 = ELEM(N,1)                                                  NULOAD    117
                  N2 = ELEM(N,2)                                                  NULOAD    118
                  N3 = ELEM(N,3)                                                  NULOAD    119
                  R(1) = COORD(N1,1)                                              NULOAD    120
120               R(2) = COORD(N2,1)                                              NULOAD    121
                  R(3) = COORD(N3,1)                                              NULOAD    122
                  Z(1) = COORD(N1,2)                                              NULOAD    123
                  Z(2) = COORD(N2,2)                                              NULOAD    124
                  Z(3) = COORD(N3,2)                                              NULOAD    125
125               KK(2) = 2*ELEM(N,1)                                             NULOAD    126
                  KK(4) = 2*ELEM(N,2)                                             NULOAD    127
                  KK(6) = 2*ELEM(N,3)                                             NULOAD    128
                  KK(1) = KK(2)-1                                                 NULOAD    129
                  KK(3) = KK(4)-1                                                 NULOAD    130
130               KK(5) = KK(6)-1                                                 NULOAD    131
C                                                                                 NULOAD    132
C                                                                                 NULOAD    133
C   GAP ELEMENTS ARE ASSEMBLED IN GAPSEM                                          NULOAD    134
C                                                                                 NULOAD    135
135 C                                                                             NULOAD    136
C   AS DONE NOW GAP ELEMENTS MUST BE NUMBERED LAST TO GET                         NULOAD    137
C   CORRECT VALUES FOR K1 & K2 OR TO OBTAIN CORRECT NUMBERS FOR                   NULOAD    138
C   AVERAGE STRESSES                                                              NULOAD    139
C                                                                                 NULOAD    140
140 C                                                                             NULOAD    141
              FACT = 1.0                                                          NULOAD    142
              IF (LTYPE(N).EQ.GAPEND) FACT = 0.5                                  NULOAD    143
              IF (LTYPE(N).EQ.GAP.OR.LTYPE(N).EQ.GAPEND) CALL GAPSEM (R,Z,K1      NULOAD    144
             +  ,N1,N2,KK,MBAND,FACT,IXLSET,ITEST,IGAP(J1))                       NULOAD    145
145           IF (LTYPE(N).EQ.GAP.OR.LTYPE(N).EQ.GAPEND) J1 = J1+1                NULOAD    146
              IF (LTYPE(N).EQ.GAP.OR.LTYPE(N).EQ.GAPEND) GO TO 190                NULOAD    147
C                                                                                 NULOAD    148
              EPSO(1) = ALFDT(N,1)+EPP(N,1)                                       NULOAD    149
              EPSO(2) = ALFDT(N,2)+EPP(N,2)                                       NULOAD    150
150           EPSO(3) = ALFDT(N,3)+EPP(N,3)                                       NULOAD    151
              EPSO(4) = EPP(N,4)                                                  NULOAD    152
              CALL ELEMI (R,Z,DISP,E(N),V(N),KE,EPSO,FE,AT,D,TT,RBAR,DELTA)       NULOAD    153
              WRITE (18) AT,D,TT,RBAR,DELTA                                       NULOAD    154
                  DO 180 I=1,6                                                    NULOAD    155
155               II = KK(I)                                                      NULOAD    156
                  F(II) = F(II)+FE(I)                                             NULOAD    157
                      DO 180 J=1,6                                                NULOAD    158
                      JJ = KK(J)                                                  NULOAD    159
                      IF (II.GT.JJ) GO TO 180                                     NULOAD    160
```

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                      IF (JJ-II.GT.MBAND) GO TO 180                                  NULOAD    161
                      JJ = JJ-II+1                                                   NULOAD    162
                      K(II,JJ) = K(II,JJ)+KE(I,J)                                    NULOAD    163
                      KI = AMAX1(KI,K(II,JJ))                                        NULOAD    164
                180   CONTINUE                                                       NULOAD    165
                190 CONTINUE                                                         NULOAD    166
                C                                                                    NULOAD    167
                CCC                                                                  NULOAD    168
                CCC FOR K1 AND K2 TO BE CORRECT ALL GAP ELEMENTS MUST BE NUMBERED LAST NULOAD    169
                CCC                                                                  NULOAD    170
                C                                                                    NULOAD    171
                  K2 = KI*10.                                                        NULOAD    172
                C                                                                    NULOAD    173
                CCC TO CHANGE THE STIFFNESS OF THE GAP ELEMENT SPRING                NULOAD    174
                C   A CHANGE MUST ALSO BE MADE IN GAPSEM                           NULOAD    175
                  KI = KI*1.E-07                                                     NULOAD    176
                C                                                                    NULOAD    177
                CCC                                                                  NULOAD    178
                CC  ******                                                           NULOAD    179
                C   ***SET DISPLACEMENT BOUNDARY CONDITIONS HERE****                NULOAD    180
                  REWIND 21                                                          NULOAD    181
                  REWIND 19                                                          NULOAD    182
                      DO 200 I=1,NUMGAP                                              NULOAD    183
                      R22 = K2                                                       NULOAD    184
                      IF (IGAP(I).EQ.0) R22 = 0                                      NULOAD    185
                      IF (IXLSET.EQ.1) CALL XLFRC (F,NUMGAP,R22,NUMX,I)              NULOAD    186
                200   CONTINUE                                                       NULOAD    187
                  REWIND 19                                                          NULOAD    188
                      DO 210 I=1,NUMGAP                                              NULOAD    189
                      R22 = K2                                                       NULOAD    190
                      IF (IGAP(I).EQ.0) R22 = 0                                      NULOAD    191
                      IF (IXLSET.EQ.1.OR.ICLOSE.EQ.LOADST) CALL RADFRC (F,R22,NUMX,I NULOAD    192
                +     )                                                              NULOAD    193
                210   CONTINUE                                                       NULOAD    194
                  REWIND 19                                                          NULOAD    195
                  IF (LOADST.GT.1) GO TO 230                                         NULOAD    196
                  READ (IUNIT,370) NDISPS                                            NULOAD    197
                  IF (NDISPS.EQ.0) GO TO 330                                         NULOAD    198
                      DO 220 I=1,NDISPS                                              NULOAD    199
                      READ (IUNIT,380) NODE,IDISP,UU                                 NULOAD    200
                      IF (IDISP.EQ.1) ID(I) = 2*NODE-1                               NULOAD    201
                      IF (IDISP.EQ.2) ID(I) = 2*NODE                                 NULOAD    202
                      DI(I) = UU                                                     NULOAD    203
                220   CONTINUE                                                       NULOAD    204
                230   IF (NDISPS.EQ.0) GO TO 330                                     NULOAD    205
                      DO 270 I=1,NDISPS                                              NULOAD    206
                      LL = ID(I)                                                     NULOAD    207
                      LLM = LL-1                                                     NULOAD    208
                      IF (LL.EQ.1) GO TO 250                                         NULOAD    209
                          DO 240 JJ=1,LLM                                            NULOAD    210
                          J = LL-JJ+1                                                NULOAD    211
                          IF (J.GT.MBAND) GO TO 240                                  NULOAD    212
                          F(JJ) = F(JJ)-K(JJ,J)*DI(I)                                NULOAD    213
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                        K(JJ,J) = 0.0                                          NULOAD   214
                240     CONTINUE                                               NULOAD   215
215             250   CONTINUE                                                 NULOAD   216
                      IF (LL.EQ.NUMX) GO TO 270                                NULOAD   217
                      LLP = LL+1                                               NULOAD   218
                        DO 260 JJ=LLP,NUMX                                     NULOAD   219
                        J = JJ-LL+1                                            NULOAD   220
220                     IF (J.GT.MBAND) GO TO 260                              NULOAD   221
                        F(JJ) = F(JJ)-K(LL,J)*DI(I)                            NULOAD   222
                260     CONTINUE                                               NULOAD   223
                270   CONTINUE                                                 NULOAD   224
                C   ZERO ALL ROWS WITH SPECIFIED DISPLACEMENTS                  NULOAD   225
225                   DO 280 I=1,NDISPS                                        NULOAD   226
                      LL = ID(I)                                               NULOAD   227
                      K(LL,1) = 1.0                                            NULOAD   228
                      F(LL) = DI(I)                                            NULOAD   229
                        DO 280 J=2,MBAND                                       NULOAD   230
230             280     K(LL,J) = 0.0                                          NULOAD   231
                C                                                              NULOAD   232
                C   READ # OF CLAD NODES TO BE TIED IN THE Z-DIRECTION          NULOAD   233
                C                                                              NULOAD   234
                C   SAVE K MATRIX                                             NULOAD   235
235                   IF (LOADST.GT.1) GO TO 300                               NULOAD   236
                      READ (IUNIT,370) NTIES                                   NULOAD   237
                      IF (NTIES.EQ.0) GO TO 330                                NULOAD   238
                C   MAXIMUM ALLOWABLE NTIES = 5                               NULOAD   239
                      DO 290 I=1,NTIES                                         NULOAD   240
240                   READ (IUNIT,370) TIE(I)                                  NULOAD   241
                290   TIE(I) = TIE(I)*2                                        NULOAD   242
                C                                                              NULOAD   243
                C   SUBROUTINE KTIE  ENFORCES END CONDITIONS FOR THE CLADDING  NULOAD   244
                C   AT THE PELLET-TO-PELLET INTERFACE                          NULOAD   245
245             C                                                              NULOAD   246
                C                                                              NULOAD   247
                      MBNDOL = MBAND                                           NULOAD   248
                300   CALL KTIE (NTIES,TIE,MBAND,NUMX,NUMY)                    NULOAD   249
                C                                                              NULOAD   250
250             C                                                              NULOAD   251
                C   SET F MATRIX MEMBERS  AT EACH LOAD STEP TO ENFORCE CLAD END CONDITIO NULOAD   252
                C                                                              NULOAD   253
                      READ (IUNIT,390) XSPDA                                   NULOAD   254
                      IF (ISAVE.EQ.1) WRITE (22) SPDA                          NULOAD   255
255                   IF (ICLOSE.EQ.LOADST) SPDA = SPDA+(XSPDA-SPDA)*CLOSE     NULOAD   256
                      IF (ICLOSE.EQ.LOADST) GO TO 310                          NULOAD   257
                      SPDA = XSPDA                                             NULOAD   258
                310   CONTINUE                                                 NULOAD   259
                      F(TIE(NTIES)) = SPDA+F(TIE(NTIES))                       NULOAD   260
260                   KT = NTIES-1                                             NULOAD   261
                        DO 320 I=1,KT                                          NULOAD   262
                        F(TIE(NTIES)) = F(TIE(NTIES))+F(TIE(I))                NULOAD   263
                320     F(TIE(I)) = 0.0                                        NULOAD   264
                330   CONTINUE                                                 NULOAD   265
265                   RETURN                                                   NULOAD   266
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                C                                                                  NULOAD   267
                340   FORMAT (515)                                                 NULOAD   268
                350   FORMAT (I5,5X,2E20.5)                                        NULOAD   269
                360   FORMAT (I5,5X,2F10.2)                                        NULOAD   270
    270         370   FORMAT (I5)                                                  NULOAD   271
                380   FORMAT (2I5,F10.1)                                           NULOAD   272
                390   FORMAT (F10.5)                                               NULOAD   273
                      END                                                          NULOAD   274
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

SN	ENTRY POINTS	DEF LINE	REFERENCES
4	NULOAD	1	265

VARIABLES

SN	VARIABLES	TYPE		RELOCATION									
0	ALFDT	REAL	ARRAY	F.P.	REFS	10	148	149	150	DEFINED	1	99	
						105	106	107					
1556	AT	REAL	ARRAY		REFS	8	152	153					
1512	CATHEX	REAL			REFS	104	105						
1513	CDTHEX	REAL			REFS	104	106	107					
1464	CLAD	INTEGER			REFS	5	92	DEFINED	17				
0	CLOSE	REAL		F.P.	REFS	68	69	82	255	DEFINED	1		
1465	COMP	REAL			REFS	93	97	DEFINED	19				
0	COORD	REAL	ARRAY	F.P.	REFS	12	119	120	121	122	123	124	
					DEFINED	1							
1511	CR	REAL			REFS	103	DEFINED	102					
1466	CWKF	REAL			REFS	101	102	DEFINED	20				
1606	D	REAL	ARRAY		REFS	8	152	153					
0	DELOLD	REAL	ARRAY	F.P.	REFS	9	51	DEFINED	1				
1467	DELOXY	REAL			REFS	101	102	DEFINED	21				
1523	DELTA	REAL			REFS	152	153						
0	DI	REAL	ARRAY	F.P.	REFS	12	212	221	228	DEFINED	1	202	
1656	DISP	REAL	ARRAY		REFS	8	152						
0	E	REAL	ARRAY	F.P.	REFS	10	103	109	152	DEFINED	1	93	
						101	109						
0	ELEM	INTEGER	ARRAY	F.P.	REFS	5	116	117	118	125	126	127	
					DEFINED	1							
0	EPP	REAL	ARRAY	F.P.	REFS	12	148	149	150	151			
					DEFINED	1							
1552	EPSO	REAL	ARRAY		REFS	8	152	DEFINED	148	149	150	151	
0	F	REAL	ARRAY	F.P.	REFS	9	156	185	191	212	221	259	
					2*262	DEFINED	1	48	68	69	71	72	
					156	212	221	228	259	262	263		
1510	FACMOT	REAL			REFS	99	DEFINED	94	95				
1521	FACT	REAL			REFS	143	DEFINED	141	142				
1730	FE	REAL	ARRAY		REFS	9	152	156					
1470	FNCK	REAL			REFS	101	102	DEFINED	22				
1471	FQTMTL	REAL			REFS	93	DEFINED	23					
1500	FR	REAL			REFS	68	71	74	DEFINED	64			

VARIABLES	SN	TYPE	RELOCATION									
1472	FRDEN	REAL			REFS	93	DEFINED	24				
1473	FINELT	REAL			REFS	95	DEFINED	25				
1501	FZ	REAL			REFS	69	72	75	DEFINED	64		
0	F2	REAL	ARRAY	F.P.	REFS	9	2*68	2*69	2*73	DEFINED	1	74
					75							
1462	GAP	INTEGER			REFS	5	89	143	145	146		
					DEFINED	15						
1463	GAPEND	INTEGER			REFS	5	89	142	143	145	146	
					DEFINED	16						
1475	I	INTEGER			REFS	48	50	67	2*68	2*73	74	99
					155	156	162	184	185	190	191	200
					201	202	206	212	221	226	228	240
					2*241	262	263	DEFINED	47	56	79	98
					154	182	188	198	205	225	239	26.
0	ICLOSE	INTEGER		F.P.	REFS	44	68	69	70	82	83	191
					255	256	DEFINED	1				
0	ID	INTEGER	ARRAY	F.P.	REFS	5	206	226	DEFINED	1	200	201
1527	IDISP	INTEGER			REFS	200	201	DEFINED	199			
0	IGAP	INTEGER	ARRAY	F.P.	REFS	7	143	184	190	DEFINED	1	
1524	II	INTEGER			REFS	2*156	159	160	161	2*162	163	
					DEFINED	155						
0	ISAVE	INTEGER		F.P.	REFS	73	81	254	DEFINED	1		
1474	ITEST	INTEGER			REFS	143	DEFINED	43	44			
0	IUNIT	INTEGER		F.P.	DEFINED	1	I/O REFS	54	64	78	80	196
					199	236	240	253				
0	IXLSET	INTEGER		F.P.	REFS	143	185	191	DEFINED	1		
1476	J	INTEGER			REFS	50	2*89	90	92	93	97	99
					101	2*103	105	106	107	2*109	158	162
					211	212	213	220	221	230		
					DEFINED	49	88	157	210	219	229	
1525	JJ	INTEGER			REFS	159	160	161	2*162	163	210	3*212
					213	219	2*221	DEFINED	158	161	209	218
1514	JI	INTEGER			REFS	143	145	DEFINED	114	145		
0	K	REAL	ARRAY	DOT	REFS	12	13	14	162	163	212	221
					DEFINED	50	162	213	227	230		
1664	KE	REAL	ARRAY		REFS	8	152	162				
1536	KK	INTEGER	ARRAY		REFS	6	128	129	130	143	155	158
					DEFINED	125	126	127	128	129	130	
1535	KT	INTEGER			REFS	261	DEFINED	260				
0	KI	REAL		F.P.	REFS	12	143	163	171	175		
					DEFINED	1	163	175				
0	K2	REAL		F.P.	REFS	12	183	189	DEFINED	1	171	
1531	LL	INTEGER			REFS	207	208	210	216	217	219	221
					227	228	230	DEFINED	206	226		
1532	LLM	INTEGER			REFS	209	DEFINED	207				
1533	LLP	INTEGER			REFS	218	DEFINED	217				
0	LOADST	INTEGER		F.P.	REFS	18	44	68	69	70	82	83
					191	195	235	255	256	DEFINED	1	
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	6	2*89	92	142	2*143	2*145	2*146
					DEFINED	1						
1503	L1	INTEGER			REFS	68	71	87	DEFINED	66	86	
1502	L2	INTEGER			REFS	66	69	72	DEFINED	65		
1504	L3	INTEGER			REFS	2*69	2*73	75	DEFINED	67		

VARIABLES	SN	TYPE	RELOCATION									
0	MATPRO	REAL	ARRAY	F.P.	REFS	11	19	20	21	22	23	24
						25	DEFINED	1				
0	MBAND	INTEGER		F.P.	REFS	143	160	211	220	229	247	248
					DEFINED	1	18					
0	MBNDOL	INTEGER		F.P.	REFS	18	DEFINED	1	247			
1515	N	INTEGER			REFS	116	117	118	125	126	127	142
						2*143	2*145	2*146	2*148	2*149	2*150	151	2*152
					DEFINED	115						
0	NDISPS	INTEGER		F.P.	REFS	5	12	197	198	204	205	225
					DEFINED	1	196					
1505	NEL	INTEGER			REFS	2*81	3*82	84	DEFINED	80		
0	NELEM	INTEGER		F.P.	REFS	5	6	9	4*10	12	86	88
						115	DEFINED	1				
0	NLOADS	INTEGER		F.P.	REFS	55	56	67	DEFINED	1	54	
0	NLOAD2	INTEGER		F.P.	REFS	9	DEFINED	1				
0	NNODES	INTEGER		F.P.	REFS	12	DEFINED	1				
1477	NODE	INTEGER			REFS	65	200	201	DEFINED	64	199	
0	NTEMPS	INTEGER		F.P.	REFS	79	DEFINED	1	78			
0	NTIES	INTEGER		F.P.	REFS	5	237	239	248	2*259	260	2*262
					DEFINED	1	236					
0	NUMGAP	INTEGER		F.P.	REFS	7	9	51	182	185	188	
					DEFINED	1						
0	NUMX	INTEGER		F.P.	REFS	9	47	185	191	216	218	248
					DEFINED	1						
0	NUMY	INTEGER		F.P.	REFS	49	248	DEFINED	1			
0	NUNIT	INTEGER		F.P.	REFS	91	109	DEFINED	1			
1516	N1	INTEGER			REFS	119	122	143	DEFINED	116		
1517	N2	INTEGER			REFS	120	123	143	DEFINED	117		
1520	N3	INTEGER			REFS	121	124	DEFINED	118			
0	OLDEPP	REAL	ARRAY	F.P.	REFS	10	87	DEFINED	1			
1544	R	REAL	ARRAY		REFS	8	143	152	DEFINED	119	120	121
1522	R3&R	REAL			REFS	152	153					
1526	R22	REAL			REFS	185	191	DEFINED	183	184	189	190
0	SPDA	REAL		F.P.	REFS	254	2*255	259	DEFINED	1	255	257
0	TC	REAL	ARRAY	F.P.	REFS	9	81	2*82	90	DEFINED	1	82
						84						
1506	TCC	REAL			REFS	82	84	DEFINED	80			
0	TIE	INTEGER	ARRAY	F.P.	REFS	5	241	248	2*259	3*262	263	
					DEFINED	1	240	241				
1507	TP	REAL			REFS	91	93	95	97	99	101	102
						104	DEFINED	90	91			
1626	TT	REAL	ARRAY		REFS	8	152	153				
1530	UU	REAL			REFS	202	DEFINED	199				
0	V	REAL	ARRAY	F.P.	REFS	10	152	DEFINED	1	97	103	
1534	XSPDA	REAL			REFS	255	257	DEFINED	253			
1547	Z	REAL	ARRAY		REFS	8	143	152	DEFINED	122	123	124

FILE NAMES	MODE							
TAPE18	UNFMT		WRITES	153	MOTION	112		
TAPE19			MOTION	113	181	187	194	
TAPE21			MOTION	111	180			
TAPE22	UNFMT		WRITES	73	81	254	MOTION	42

VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS	TYPE	ARGS	REFERENCES		
CELMOD	REAL	4	101		
CSHEAR	REAL	4	102		
CTHEXP		3	104		
ELEMI		13	152		
FELMOD	REAL	4	93		
FILL		2	51	87	
FPOIR	REAL	2	97		
FTHEXP	REAL	2	99		
GAPSEM		11	143		
KTIE		5	248		
PASPSI	REAL	1	109		
RADFRC		4	191		
TEMPFK	REAL	1	91		
XLFRC		5	185		

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
AMAX1	REAL	0	INTRIN	163

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		50	47	49		
176	110		76	56	70		
202	120		77	55			
234	130		85	79	83		
0	140		99	98			
320	150		101	92			
347	160		108	100			
357	170		110	88	89		
614	180		164	154	157	159	160
623	190		165	115	146		
0	200		186	182			
0	210		193	188			
0	220		203	198			
744	230		204	195			
1004	240		214	209	211		
1010	250		215	208			
1036	260		222	218	220		
1042	270		223	205	216		
0	280		230	225	229		
0	290		241	239			
1121	300		248	235			
1153	310		258	256			
0	320		263	261			
1201	330		264	197	204	237	
1433	340	FMT	267	54			
1435	350	FMT	268	64			
1440	360	FMT	269	78	80		
1443	370	FMT	270	196	236	240	
1445	380	FMT	271	199			
1450	390	FMT	272	253			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
65	100	I	47 50	15B	NOT INNER	
71	100	J	49 50	6B	INSTACK	
115	110	I	56 76	64B	EXT REFS	
206	130	I	79 85	31B	EXT REFS	
250	170	J	88 110	112B	EXT REFS	NOT INNER
307	140	I	98 99	7B	EXT REFS	
374	190	N	115 165	232B	EXT REFS	NOT INNER
550	180	I	154 164	52B	NOT INNER	
561	180	J	157 164	36B	OPT	
642	200	I	182 186	17B	EXT REFS	
665	210	I	188 193	21B	EXT REFS	
721	220	I	198 203	22B	EXT REFS	
750	270	I	205 223	75B	NOT INNER	
763	240	JJ	209 214	24B	OPT	
1020	260	JJ	218 222	21B	OPT	
1047	280	I	225 230	24B	NOT INNER	
1062	280	J	229 230	6B	INSTACK	
1104	290	I	239 241	11B	EXT REFS	
1166	320	I	261 263	12B	INSTACK	

COMMON BLOCKS	LENGTH
DOT	54000 LCM

STATISTICS

PROGRAM LENGTH	2137B	1119
LCM LABELED COMMON LENGTH	151360B	54000

140000B SCM USED

```
      1               FUNCTION PASPSI (PASCAL)                                  PASPSI      2
                    C ***********                                               PASPSI      3
                    C THIS FUNCTION CHANGES PASCALS TO PSI                      PASPSI      4
                    C                                                           PASPSI      5
      5             C ***********                                               PASPSI      6
                      PASPSI = PASCAL/6894.7572                                 PASPSI      7
                      RETURN                                                    PASPSI      8
                      END                                                       PASPSI      9
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	PASPSI	1	7

VARIABLES	SN	TYPE	RELOCATION				
0	PASCAL	REAL	F.P.	REFS	6	DEFINED	1
14	PASPSI	REAL		DEFINED	6		

STATISTICS

PROGRAM LENGTH 15B 13

140000B SCM USED

```
      SUBROUTINE AXPLAS (GFLAG,IFLAG,ITER,IXLSET,KI,MATPRO,MBAND,NDISPS,
     +NELEM,NTIES,NUMGAP,NUMX,NUNIT,PFLAG,RATIO,RELAX,TIME,ALFDT,COEF,DE
     +P,DI,DTIME,E,ECREEP,ELEM,EP,EPP,F,FI,ID,LTYPE,OLDEPP,OLDGAP,OLSIGF
     +,SIGMA,SLOPE,TC,TIE,V)
C
C     THIS ROUTINE CALCULATES THE INCREMENTS OF PLASTIC
C     OR CREEP STRAINS  AS WELL AS THE PSEUDO LOADS FOR
C     GAP CLOSURE
C
      INTEGER LTYPE(NELEM),ELEM(NELEM,3),ID(NDISPS),TIE(NTIES)
      INTEGER PELLET,CLAD,GAP,GAPEND,RELAX,GFLAG,PFLAG
      REAL MATPRO(9),NUDEPP(4),EPP(NELEM,4)
      REAL OLDEPP(NELEM,4)   , EP(NELEM)   ,TC(NELEM)
      REAL E(NELEM) ,OLSIGF(NELEM) ,SLOPE(NELEM) , COEF(NELEM)
      REAL KI
      REAL V(NELEM) ,FI(NUMX) ,F(NUMX)   ,OLDGAP(NUMGAP) ,ECREEP(NELEM)
      REAL DI(NDISPS)   , SIGMA(NELEM,4),DEP(NELEM) ,ALFDT(NELEM,3)
      GAP = 3HGAP
      GAPEND = 7HGAP END
      CLAD = 4HCLAD
      PELLET = 6HPELLET
      IF (ITER.GT.1.OR.PFLAG.EQ.0) GO TO 130
C     ***PLASTIC SOLUTION STARTS HERE
C     ASSUME PLASTIC STRAIN INCREMENTS
            DO 100 J=1,NELEM
            IF (LTYPE(J).EQ.PELLET.AND.RELAX.EQ.0) GO TO 100
            OLDEPP(J,1) = 1.0E-07
            OLDEPP(J,2) = 1.0E-07
            OLDEPP(J,3) = 1.E-07
            OLDEPP(J,4) = 1.0E-07
  100       CONTINUE
C     ***START ITERATIVE SOLUTION HERE
C     BASED ON NEW VALUES OF PLASTIC STRAIN INCREMENTS
C     CALCULATE ALL OLD EFFECTIVE STRESSES HERE
C     IF EET ITERATION SCHEME IS BEING UTILIZED
        IF (RELAX.NE.0) GO TO 120
            DO 110 J=1,NELEM
            IF (LTYPE(J).EQ.GAP.OR.LTYPE(J).EQ.GAPEND.OR.LTYPE(J).EQ.PELLE
     +      T) GO TO 110
            EPI = EP(J)
            TCI = TC(J)
            EI = E(J)
            IF (NUNIT.EQ.0) TCI = TEMPKF(TCI)
            JTYPE = 1
            IF (LTYPE(J).EQ.CLAD) JTYPE = 2
            CALL STRESSX (OLSIGF(J),EPI,0.000,TCI,EI,JTYPE,NUNIT)
            IF (NUNIT.EQ.0) OLSIGF(J) = PSIPAS(OLSIGF(J))
C     WRITE(6,72) J,OLSIGF(J)
            EPI = EP(J)
            CALL STRESSX (DSIGF,EPI,0.0001,TCI,EI,JTYPE,NUNIT)
            IF (NUNIT.EQ.0) DSIGF = PSIPAS(DSIGF)
            SLOPE(J) = (DSIGF-OLSIGF(J))/.0001
            COEF(J) = 2.0*(1.0+V(J))/(3.0*E(J))
```

```
      110       CONTINUE                                                      AXPLAS     55
55    120     CONTINUE                                                        AXPLAS     56
      130     CONTINUE                                                        AXPLAS     57
      C     COMPUTE "PSEUDO-ELASTIC SOLUTION HERE                           AXPLAS     58
      C     ***FIRST ADD NEW TERMS TO VECTOR FI(N) DUE TO INITIAL           AXPLAS     59
      C     STRAINS CAUSED BY NEW PLASTIC STRAIN INCREMENTS                 AXPLAS     60
60          REWIND 18                                                       AXPLAS     61
                DO 140 I=1,NUMX                                           AXPLAS     62
      140       FI(I) = F(I)                                                AXPLAS     63
            IF (PFLAG.EQ.0) GO TO 150                                       AXPLAS     64
            CALL STRNAD (NELEM,LTYPE,GAP,GAPEND,ELEM,OLDEPP,FI,NUMX)        AXPLAS     65
65    C     ***RE-SET APPROPRIATE DISPLACEMENT CONDITIONS FOR FI HERE       AXPLAS     66
      C                                                                     AXPLAS     67
      C     E-ZERO(OLDGAP) VALUES ARE ADDED TO F-MATRIX IN GAPADD           AXPLAS     68
      C     DELTA E-ZERO VALUES ARE CALCULATED & ADDED TO E-ZERO VALUES     AXPLAS     69
      C     IN THE SUBROUTINE EOCALC                                        AXPLAS     70
70    C                                                                     AXPLAS     71
      C                                                                     AXPLAS     72
      C                                                                     AXPLAS     73
      150   IF (GFLAG.NE.0.AND.IXLSET.NE.1) CALL GAPADD (FI,OLDGAP,KI,NUMGAP,N AXPLAS     74
           +UMX)                                                            AXPLAS     75
75              DO 160 I=1,NDISPS                                           AXPLAS     76
                LL = ID(I)                                                  AXPLAS     77
                FI(LL) = DI(I)                                              AXPLAS     78
      160       CONTINUE                                                    AXPLAS     79
            KT = NTIES-1                                                    AXPLAS     80
80              DO 170 I=1,KT                                               AXPLAS     81
                FI(TIE(NTIES)) = FI(TIE(NTIES))+FI(TIE(I))                  AXPLAS     82
      170       FI(TIE(I)) = 0.                                             AXPLAS     83
      C                                                                     AXPLAS     84
      C     ***NOW GET NEW DISPLACEMENTS AND STRESSES BASED ON              AXPLAS     85
85    C     NEW PLASTIC STRAIN INCREMENTS                                   AXPLAS     86
            IFLAG = 1                                                       AXPLAS     87
            CALL ELAST (FI,NUMX,MBAND,IFLAG)                                AXPLAS     88
      C     AT THIS POINT IN PROGRAM, "PSEUDO-ELASTIC SOLUTION              AXPLAS     89
      C     FOR ASSUMED OLDEPP'S HAS BEEN FOUND.                            AXPLAS     90
90    C     ***GET EFFECTIVE STRESS FOR EACH NODE                           AXPLAS     91
      C     BASED ON ASSUMED PLASTIC STRAIN INCREMENTS                      AXPLAS     92
            RATIO = 0.0                                                     AXPLAS     93
            IF (PFLAG.EQ.0) RETURN                                          AXPLAS     94
      C     NOW GET NEW PLASTIC STRAIN INCREMENTS                           AXPLAS     95
95          REWIND 18                                                       AXPLAS     96
            CALL SIGCLC (NELEM,LTYPE,GAP,GAPEND,ELEM,ALFDT,EPP,OLDEPP,FI,SIGMA AXPLAS     97
           +,V,E,KPRINT,NUMX,IFLAG)                                         AXPLAS     98
                DO 260 J=1,NELEM                                            AXPLAS     99
                IF (RELAX.NE.0.AND.LTYPE(J).NE.GAP.AND.LTYPE(J).NE.GAPEND) GO AXPLAS    100
100              +    TO 200                                                AXPLAS    101
                IF (LTYPE(J).EQ.GAP.OR.LTYPE(J).EQ.GAPEND.OR.LTYPE(J).EQ.PELLE AXPLAS    102
                +    T) GO TO 260                                          AXPLAS    103
      C     ISOTROPIC PLASTIC STRAIN-TOTAL STRAIN SCHEME STARTS HERE        AXPLAS    104
                SIGZ = SIGMA(J,1)                                           AXPLAS    105
105             SIGR = SIGMA(J,2)                                           AXPLAS    106
                SIGH = SIGMA(J,3)                                           AXPLAS    107
```

```
                  TAU = SIGMA(J,4)                                                  AXPLAS    108
                  EMODZ = (SIGZ-V(J)*(SIGR+SIGH))/E(J)+OLDEPP(J,1)                  AXPLAS    109
                  EMODR = (SIGR-V(J)*(SIGH+SIGZ))/E(J)+OLDEPP(J,2)                  AXPLAS    110
110               EMODH = (SIGH-V(J)*(SIGR+SIGZ))/E(J)+OLDEPP(J,3)                  AXPLAS    111
                  EMODRZ = TAU*(1.0+V(J))/E(J)+OLDEPP(J,4)                          AXPLAS    112
                  EET = 0.471405*SQRT((EMODH-EMODR)**2+(EMODR-EMODZ)**2+(EMODZ-E    AXPLAS    113
                 +    MODH)**2+6.0*EMODRZ**2)                                      AXPLAS    114
                  SIGEFF = 0.707107*SQRT((SIGH-SIGZ)**2+(SIGZ-SIGR)**2+(SIGR-SIG   AXPLAS    115
115              +    H)**2+6.0*TAU**2)                                            AXPLAS    116
            C     CHECK TO SEE IF OLD YIELD STRESS (AT NEW TEMP) HAS BEEN           AXPLAS    117
            C     EXCEEDED.                                                         AXPLAS    118
                  IF (SIGEFF.GT.OLSIGF(J)) GO TO 180                                AXPLAS    119
                  DEP(J) = 0.0                                                      AXPLAS    120
120               NUDEPP(1) = 0.0                                                   AXPLAS    121
                  NUDEPP(2) = 0.0                                                   AXPLAS    122
                  NUDEPP(3) = 0.0                                                   AXPLAS    123
                  NUDEPP(4) = 0.0                                                   AXPLAS    124
                  NUDEPP(1) = (NUDEPP(1)+OLDEPP(J,1))/2.                            AXPLAS    125
125               NUDEPP(2) = (NUDEPP(2)+OLDEPP(J,2))/2.                            AXPLAS    126
                  NUDEPP(3) = (NUDEPP(3)+OLDEPP(J,3))/2.                            AXPLAS    127
                  NUDEPP(4) = (NUDEPP(4)+OLDEPP(J,4))/2.                            AXPLAS    128
                  OLDEPP(J,1) = 0.0                                                 AXPLAS    129
                  OLDEPP(J,2) = 0.0                                                 AXPLAS    130
130               OLDEPP(J,3) = 0.0                                                 AXPLAS    131
                  OLDEPP(J,4) = 0.0                                                 AXPLAS    132
            C     WRITE(6,9001) J,SIGEFF, ( NUDEPP(J,KO),KO=1,4)                    AXPLAS    133
                  GO TO 260                                                         AXPLAS    134
            C     OLD YIELD STRESS HAS BEEN EXCEEDED. DEP(J) MUST BE POSITIVE.      AXPLAS    135
135         180   CONTINUE                                                          AXPLAS    136
                  DEP(J) = (EET-COEF(J)*OLSIGF(J))/(1.0+COEF(J)*SLOPE(J))           AXPLAS    137
            C     CHECK MAGNITUDE OF DEP(J)                                         AXPLAS    138
                  IF (DEP(J).GE.0.0) GO TO 190                                      AXPLAS    139
                  WRITE (6,270) J                                                   AXPLAS    140
140               STOP                                                              AXPLAS    141
            190   EM = (EMODH+EMODZ+EMODR)/3.0                                      AXPLAS    142
                  NUDEPP(1) = (DEP(J)/EET)*(EMODZ-EM)                               AXPLAS    143
                  NUDEPP(2) = (DEP(J)/EET)*(EMODR-EM)                               AXPLAS    144
                  NUDEPP(3) = -NUDEPP(1)-NUDEPP(2)                                  AXPLAS    145
145               NUDEPP(4) = (DEP(J)/EET)*EMODRZ                                   AXPLAS    146
                  NUDEPP(1) = (NUDEPP(1)+OLDEPP(J,1))/2.                            AXPLAS    147
                  NUDEPP(2) = (NUDEPP(2)+OLDEPP(J,2))/2.                            AXPLAS    148
                  NUDEPP(3) = (NUDEPP(3)+OLDEPP(J,3))/2.                            AXPLAS    149
                  NUDEPP(4) = (NUDEPP(4)+OLDEPP(J,4))/2.                            AXPLAS    150
150         C     CHECK MAGNITUDE OF DEP(J). IF THIS IS LESS THAN 1.0E-06, DON'T    AXPLAS    151
            C     WANT TO KEEP ITERATING TO TIGHT TOLERANCE.  SO DIFFERENCE         AXPLAS    152
            C     BETWEEN OLD AND NUDEPP'S NOT CHECKED (IE, RATIO NOT UPDATED )     AXPLAS    153
            C     BUT NUDEPP'S ARE COMPUTED AS LONG AS FURTHER ITERATIONS ARE       AXPLAS    154
            C     REQUIRED AT OTHER NODES.                                          AXPLAS    155
155               IF (DEP(J).LT.1.0E-07) GO TO 260                                  AXPLAS    156
                  GO TO 230                                                         AXPLAS    157
            200   CONTINUE                                                          AXPLAS    158
            C     ISOTROPIC CREEP CALCULATIONS                                      AXPLAS    159
                  IF (RELAX.NE.1) GO TO 210                                         AXPLAS    160
```

```
                      SIGZ = SIGMA(J,1)                                                 AXPLAS   161
                      SIGR = SIGMA(J,2)                                                 AXPLAS   162
                      SIGH = SIGMA(J,3)                                                 AXPLAS   163
                      TAU = SIGMA(J,4)                                                  AXPLAS   164
                      EMODZ = (SIGZ-V(J)*(SIGR+SIGH))/E(J)+OLDEPP(J,1)                  AXPLAS   165
                      EMODR = (SIGR-V(J)*(SIGH+SIGZ))/E(J)+OLDEPP(J,2)                  AXPLAS   166
                      EMODH = (SIGH-V(J)*(SIGR+SIGZ))/E(J)+OLDEPP(J,3)                  AXPLAS   167
                      EMODRZ = TAU*(1.0+V(J))/E(J)+OLDEPP(J,4)                          AXPLAS   168
                      DEP(J) = 0.47140452*SQRT((OLDEPP(J,1)-OLDEPP(J,2))**2+(OLDEPP(   AXPLAS   169
                     +    J,2)-OLDEPP(J,3))**2+(OLDEPP(J,3)-OLDEPP(J,1))**2+6.0*OLDEPP(J AXPLAS   170
                     +    ,4)**2)                                                      AXPLAS   171
                      DEPDOT = DEP(J)/DTIME                                             AXPLAS   172
                      PHI = 2.4E+17                                                     AXPLAS   173
                      CRAP = ECREEP(J)+DEP(J)                                           AXPLAS   174
               C   CALL CREEP(SIGEFF,DEPDOT,TIME,TC(J),PHI,CRAP )                      AXPLAS   175
               C   ***DEVIATOR STRESSES                                                 AXPLAS   176
                      CALL CRIIPX (SIGEFF,DEPDOT,TIME,TC(J),PHI,CRAP,LTYPE(J),NUNIT)    AXPLAS   177
                      SM = (SIGH+SIGR+SIGZ)/3.                                          AXPLAS   178
                      S3 = SIGH-(SIGZ+SIGH+SIGR)/3.                                     AXPLAS   179
                      IF (SM.GT.0.) SM = 0.                                             AXPLAS   180
                      DV = OLDEPP(J,1)+OLDEPP(J,2)+OLDEPP(J,3)                          AXPLAS   181
                      DV = ABS(DV)                                                      AXPLAS   182
                      DVDOT = DV/DTIME                                                  AXPLAS   183
                      CALL FPRESS (SIGM,DVDOT,TIME,TC(J),PHI,CRAP,LTYPE(J),NUNIT)       AXPLAS   184
                      IF (LTYPE(J).EQ.PELLET) SIGEFF = 1.E+27                           AXPLAS   185
                      IF (SIGEFF.LE.1.) SIGEFF = 1.                                     AXPLAS   186
                      IF (SIGM.LE.1.) SIGM = 1.                                         AXPLAS   187
                      S1 = SIGZ-(SIGZ+SIGH+SIGR)/3.0                                    AXPLAS   188
                      S2 = SIGR-(SIGZ+SIGH+SIGR)/3.0                                    AXPLAS   189
                      NUDEPP(1) = 1.5*DEP(J)*S1/SIGEFF                                  AXPLAS   190
                      NUDEPP(2) = 1.5*DEP(J)*S2/SIGEFF                                  AXPLAS   191
                      NUDEPP(3) = 1.5*DEP(J)*S3/SIGEFF                                  AXPLAS   192
                      NUDEPP(1) = NUDEPP(1)+DV*SM/(3.0*SIGM)                            AXPLAS   193
                      NUDEPP(2) = NUDEPP(2)+DV*SM/(3.0*SIGM)                            AXPLAS   194
                      NUDEPP(3) = NUDEPP(3)+DV*SM/(3.0*SIGM)                            AXPLAS   195
                      NUDEPP(4) = 1.5*DEP(J)*TAU/SIGEFF                                 AXPLAS   196
                      GO TO 230                                                         AXPLAS   197
               210    CONTINUE                                                          AXPLAS   198
               C   ANISOTROPIC PLASTIC STRAIN SCHEME STARTS HERE                        AXPLAS   199
                      IF (RELAX.NE.2) GO TO 220                                         AXPLAS   200
               220    CONTINUE                                                          AXPLAS   201
               230    CONTINUE                                                          AXPLAS   202
                      IF (OLDEPP(J,1).NE.0.0.AND.OLDEPP(J,2).NE.0.0.AND.OLDEPP(J,3).    AXPLAS   203
                     +    NE.0.0.AND.OLDEPP(J,4).NE.0.0) GO TO 240                     AXPLAS   204
               C   THIS FORCES AT LEAST ONE ITERATION IF OLDEPPS ARE ZERO               AXPLAS   205
                      RATIO = 10.                                                       AXPLAS   206
                      GO TO 250                                                         AXPLAS   207
               240    RATIO1 = (NUDEPP(1)-OLDEPP(J,1))/OLDEPP(J,1)                     AXPLAS   208
                      RATIO2 = (NUDEPP(2)-OLDEPP(J,2))/OLDEPP(J,2)                     AXPLAS   209
                      RATIO3 = (NUDEPP(3)-OLDEPP(J,3))/OLDEPP(J,3)                     AXPLAS   210
                      RATIO4 = (NUDEPP(4)-OLDEPP(J,4))/OLDEPP(J,4)                     AXPLAS   211
                      IF (ABS(NUDEPP(1)).LT.1.E-07.AND.ABS(OLDEPP(J,1)).LT.1.E-07) R   AXPLAS   212
                     +    ATIO1 = 0.                                                   AXPLAS   213
```

```
                      IF (ABS(NUDEPP(2)).LT.1.E-07.AND.ABS(OLDEPP(J,2)).LT.1.E-07) R AXPLAS    214
                     +    ATI02 = 0.                                                    AXPLAS    215
215                   IF (ABS(NUDEPP(3)).LT.1.E-07.AND.ABS(OLDEPP(J,3)).LT.1.E-07) R AXPLAS    216
                     +    ATI03 = 0.                                                    AXPLAS    217
                      IF (ABS(NUDEPP(4)).LT.1.E-07.AND.ABS(OLDEPP(J,4)).LT.1.E-07) R AXPLAS    218
                     +    ATI04 = 0.                                                    AXPLAS    219
                      RATI01 = ABS(RATI01)                                              AXPLAS    220
220                   RATI02 = ABS(RATI02)                                              AXPLAS    221
                      RATI03 = ABS(RATI03)                                              AXPLAS    222
                      RATI04 = ABS(RATI04)                                              AXPLAS    223
                      RATIO = AMAX1(RATIO,RATI01,RATI02,RATI03,RATI04)                  AXPLAS    224
             250      OLDEPP(J,1) = NUDEPP(1)                                           AXPLAS    225
225                   OLDEPP(J,2) = NUDEPP(2)                                           AXPLAS    226
                      OLDEPP(J,3) = NUDEPP(3)                                           AXPLAS    227
                      OLDEPP(J,4) = NUDEPP(4)                                           AXPLAS    228
             260      CONTINUE                                                          AXPLAS    229
                    RETURN                                                              AXPLAS    230
230                 C                                                                   AXPLAS    231
             270    FORMAT (1H0,4X,5HERROR,/43H NEGATIVE DEP CALCULATED IN STACK   J=   AXPLAS    232
                   +    ,I6)                                                           AXPLAS    233
                    END                                                                 AXPLAS    234
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

159 I 220 THIS IF DEGENERATES INTO A SIMPLE TRANSFER TO THE LABEL INDICATED.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES	
4	AXPLAS	1	93	229

VARIABLES

	SN	TYPE		RELOCATION									
0	ALFDT	REAL	ARRAY	F.P.	REFS	17	96	DEFINED	1				
1421	CLAD	INTEGER			REFS	11	45	DEFINED	20				
0	COEF	REAL	ARRAY	F.P.	REFS	14	2*136	DEFINED	1	53			
1453	CRAP	REAL			REFS	176	183	DEFINED	173				
0	DEP	REAL	ARRAY	F.P.	REFS	17	138	142	143	145	155	171	
						173	189	190	191	195	DEFINED	1	119
						136	168						
1451	DEPDOT	REAL			REFS	176	DEFINED	171					
0	DI	REAL	ARRAY	F.P.	REFS	17	77	DEFINED	1				
1431	DSIGF	REAL			REFS	50	51	52	DEFINED	51			
0	DTIME	REAL		F.P.	REFS	171	182	DEFINED	1				
1456	DV	REAL			REFS	181	182	192	193	194			
					DEFINED	180	181						
1457	DVDOT	REAL			REFS	183	DEFINED	182					

VARIABLES	SN	TYPE	RELOCATION										
0	E	REAL	ARRAY	F.P.	REFS	14	42	53	96	108	109	110	
						111	164	165	166	167	DEFINED	1	
0	ECREEP	REAL	ARRAY	F.P.	REFS	16	173	DEFINED	1				
1446	EET	REAL			REFS	136	142	143	145	DEFINED	112		
0	ELEM	INTEGER	ARRAY	F.P.	REFS	10	64	96	DEFINED	1			
1450	EM	REAL			REFS	142	143	DEFINED	141				
1444	EMODH	REAL			REFS	2*112	141	DEFINED	110	166			
1443	EMODR	REAL			REFS	2*112	141	143	DEFINED	109	165		
1445	EMODRZ	REAL			REFS	112	145	DEFINED	111	167			
1442	EMODZ	REAL			REFS	2*112	141	142	DEFINED	108	164		
0	EP	REAL	ARRAY	F.P.	REFS	13	40	49	DEFINED	1			
0	EPP	REAL	ARRAY	F.P.	REFS	12	96	DEFINED	1				
1425	EPI	REAL			REFS	46	50	DEFINED	40	49			
1427	EI	REAL			REFS	46	50	DEFINED	42				
0	F	REAL	ARRAY	F.P.	REFS	16	62	DEFINED	1				
0	FI	REAL	ARRAY	F.P.	REFS	16	64	73	2*81	87	96		
					DEFINED	1	62	77	81	82			
1422	GAP	INTEGER			REFS	11	38	64	96	99	101		
					DEFINED	18							
1423	GAPEND	INTEGER			REFS	11	38	64	96	99	101		
					DEFINED	19							
0	GFLAG	INTEGER		F.P.	REFS	11	73	DEFINED	1				
1432	I	INTEGER			REFS	2*62	76	77	81	82			
					DEFINED	61	75	80					
0	ID	INTEGER	ARRAY	F.P.	REFS	10	76	DEFINED	1				
0	IFLAG	INTEGER		F.P.	REFS	87	96	DEFINED	1	86			
0	ITER	INTEGER		F.P.	REFS	22	DEFINED	1					
0	IXLSET	INTEGER		F.P.	REFS	73	DEFINED	1					
1424	J	INTEGER			REFS	26	27	28	29	30	3*38	40	
						41	42	45	46	2*47	49	2*52	3*53
						2*99	3*101	104	105	106	107	3*108	3*109
						3*110	3*111	118	119	124	125	126	127
						128	129	130	131	5*136	138	139	142
						143	145	146	147	148	149	155	160
						161	162	163	3*164	3*165	3*166	3*167	8*168
						171	2*173	2*176	3*180	2*183	184	189	190
						191	195	4*202	2*207	2*208	2*209	2*210	211
						213	215	217	224	225	226	227	
					DEFINED	25	37	98					
1430	JTYPE	INTEGER			REFS	46	50	DEFINED	44	45			
1435	KPRINT	* INTEGER			REFS	96							
1434	KT	INTEGER			REFS	80	DEFINED	79					
0	KI	REAL		F.P.	REFS	15	73	DEFINED	1				
1433	LL	INTEGER			REFS	77	DEFINED	76					
0	LTYPE	INTEGER	ARRAY	F.P.	REFS	10	26	3*38	45	64	96	2*99	
						3*101	176	183	184	DEFINED	1		
0	MATPRO	REAL	ARRAY	F.P.	REFS	12	DEFINED	1					
0	MBAND	INTEGER		F.P.	REFS	87	DEFINED	1					
0	NDISPS	INTEGER		F.P.	REFS	10	17	75	DEFINED	1			
0	NELEM	INTEGER		F.P.	REFS	2*10	12	3*13	4*14	2*16	3*17	25	
						37	64	96	98	DEFINED	1		
0	NTIES	INTEGER		F.P.	REFS	10	79	2*81	DEFINED	1			
1467	NUDEPP	REAL	ARRAY		REFS	12	124	125	126	127	2*144	146	

VARIABLES	SN	TYPE		RELOCATION								
						147	148	149	192	193	194	207	208
						209	210	211	213	215	217	224	225
						226	227	DEFINED	120	121	122	123	124
						125	126	127	142	143	144	145	146
						147	148	149	189	190	191	192	193
						194	195						
0	NUMGAP	INTEGER		F.P.	REFS	16	73	DEFINED	1				
0	NUMX	INTEGER		F.P.	REFS	2*16	61	64	73	87	96		
					DEFINED	1							
0	NUNIT	INTEGER		F.P.	REFS	43	46	47	50	51	176	183	
					DEFINED	1							
0	OLDEPP	REAL	ARRAY	F.P.	REFS	13	64	96	108	109	110	111	
						124	125	126	127	146	147	148	149
						164	165	166	167	7*168	3*180	4*202	2*207
						2*208	2*209	2*210	211	213	215	217	
					DEFINED	1	27	28	29	30	128	129	
						130	131	224	225	226	227		
0	OLDGAP	REAL	ARRAY	F.P.	REFS	16	73	DEFINED	1				
0	OLSIGF	REAL	ARRAY	F.P.	REFS	14	46	47	52	118	136		
					DEFINED	1	47						
1420	PELLET	INTEGER			REFS	11	26	38	101	184			
					DEFINED	21							
0	PFLAG	INTEGER		F.P.	REFS	11	22	63	93	DEFINED	1		
1452	PHI	REAL			REFS	176	183	DEFINED	172				
0	RATIO	REAL		F.P.	REFS	223	DEFINED	1	92	205	223		
1463	RATIO1	REAL			REFS	219	223	DEFINED	207	211	219		
1464	RATIO2	REAL			REFS	220	223	DEFINED	208	213	220		
1465	RATIO3	REAL			REFS	221	223	DEFINED	209	215	221		
1466	RATIO4	REAL			REFS	222	223	DEFINED	210	217	222		
0	RELAX	INTEGER		F.P.	REFS	11	26	36	99	159	199		
					DEFINED	1							
1447	SIGEFF	REAL			REFS	118	176	185	189	190	191	195	
					DEFINED	114	184	185					
1440	SIGH	REAL			REFS	108	109	110	2*114	164	165	166	
						177	2*178	187	188	DEFINED	106	162	
1460	SIGM	REAL			REFS	183	186	192	193	194			
					DEFINED	186							
0	SIGMA	REAL	ARRAY	F.P.	REFS	17	96	104	105	106	107	160	
						161	162	163	DEFINED	1			
1437	SIGR	REAL			REFS	108	109	110	2*114	164	165	166	
						177	178	187	2*188	DEFINED	105	161	
1436	SIGZ	REAL			REFS	108	109	110	2*114	164	165	166	
						177	178	2*187	188	DEFINED	104	160	
0	SLOPE	REAL	ARRAY	F.P.	REFS	14	136	DEFINED	1	52			
1454	SM	REAL			REFS	179	192	193	194	DEFINED	177	179	
1461	S1	REAL			REFS	189	DEFINED	187					
1462	S2	REAL			REFS	190	DEFINED	188					
1455	S3	REAL			REFS	191	DEFINED	178					
1441	TAU	REAL			REFS	111	114	167	195	DEFINED	107	163	
0	TC	REAL	ARRAY	F.P.	REFS	13	41	176	183	DEFINED	1		
1426	TC1	REAL			REFS	43	46	50	DEFINED	41	43		
0	TIE	INTEGER	ARRAY	F.P.	REFS	10	3*81	82	DEFINED	1			
0	TIME	REAL		F.P.	REFS	176	183	DEFINED	1				

```
VARIABLES     SN  TYPE          RELOCATION
    0  V          REAL      ARRAY     F.P.        REFS      16       53       96      108      109      110      111
                                                    164      165      166      167  DEFINED        1

FILE NAMES        MODE
      TAPE18                                 MOTION      60       95
      TAPE6       FMT                        WRITES     139

EXTERNALS           TYPE   ARGS        REFERENCES
      CRIIPX                   8             176
      ELAST                    4              87
      FPRESS                   8             183
      GAPADD                   5              73
      PSIPAS        REAL       1              47        51
      SIGCLC                  15              96
      SQRT          REAL       1  LIBRARY    112       114      168
      STRESSX                  7              46        50
      STRNAD                   8              64
      TEMPKF        REAL       1              43

INLINE FUNCTIONS    TYPE   ARGS        DEF LINE  REFERENCES
      ABS           REAL       1  INTRIN              181     2*211    2*213    2*215    2*217      219      220      221
                                                       222
      AMAX1         REAL       0  INTRIN              223

STATEMENT LABELS                    DEF LINE   REFERENCES
   55  100                             31        25       26
  157  110                             54        37       38
  163  120                             55        36
  164  130                             56        22
    0  140                             62        61
  212  150                             73        63
    0  160                             78        75
    0  170                             82        80
  530  180                            135       118
  546  190                            141       138
  623  200                            157        99
 1073  210                            197       159
    0  220              INACTIVE      200       199
 1074  230                            201       156       196
 1112  240                            207       202
 1215  250                            224       206
 1233  260                            228        98       101      133      155
 1365  270  FMT                       231       139

LOOPS  LABEL    INDEX      FROM-TO     LENGTH    PROPERTIES
   30  100      J            25 31       30B        OPT
   64  110      J            37 54       76B                  EXT REFS
  170  140      I            61 62        5B      INSTACK
  231  160      I            75 78       11B      INSTACK
  247  170      I            80 82       12B      INSTACK
  324  260      J            98 228     712B                  EXT REFS
```

```
STATISTICS
  PROGRAM LENGTH                1715B     973
        140000B SCM USED
```

```
1                 FUNCTION PSIPAS (PSI)                                          PSIPAS      2
                C*******                                                         PSIPAS      3
                C THIS FUNCTION  CHANGES PSI TO PASCALS                          PSIPAS      4
                C                                                                PSIPAS      5
5               C******                                                          PSIPAS      6
                  PSIPAS = PSI*6894.7572                                         PSIPAS      7
                  RETURN                                                         PSIPAS      8
                  END                                                            PSIPAS      9
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	PSIPAS	1	7

VARIABLES	SN	TYPE	RELOCATION				
0	PSI	REAL	F.P.	REFS	6	DEFINED	1
14	PSIPAS	REAL		DEFINED	6		

STATISTICS

PROGRAM LENGTH 15B 13

140000B SCM USED

```
      SUBROUTINE RADFRC (F,K2,NUMX,I)                                   RADFRC     2
       REAL K2,KZ                                                       RADFRC     3
      REAL R(3),Z(3),F(NUMX)                                            RADFRC     4
       INTEGER   KK(6)                                                  RADFRC     5
      KZ = K2*100.                                                      RADFRC     6
C                                                                       RADFRC     7
C   THIS ROUTINE ADDS  FORCE CONSTANTS  NECESSARY FOR                   RADFRC     8
C   RADIAL LOCKUP AFTER COMPLETE CLOSURE                                RADFRC     9
C                                                                       RADFRC    10
      READ (19) R,Z,N1,N2,KK,CS,SN,TYPE                                 RADFRC    11
      DEL = SQRT((R(2)-R(1))**2+(Z(2)-Z(1))**2)                         RADFRC    12
      DEL = -DEL                                                        RADFRC    13
      F(KK(1)) = F(KK(1))-KZ*CS*DEL*TYPE                                RADFRC    14
      F(KK(3)) = F(KK(3))+KZ*CS*DEL*TYPE                                RADFRC    15
      F(KK(2)) = F(KK(2))-KZ*SN*DEL*TYPE                                RADFRC    16
      F(KK(4)) = F(KK(4))+KZ*SN*DEL*TYPE                                RADFRC    17
100   CONTINUE                                                          RADFRC    18
      RETURN                                                            RADFRC    19
      END                                                               RADFRC    20
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	RADFRC	1

DEF LINE: 18

VARIABLES

		SN	TYPE		RELOCATION									
100	CS		REAL			REFS	13	14	DEFINED	10				
103	DEL		REAL			REFS	12	13	14	15	16			
						DEFINED	11	12						
0	F		REAL	ARRAY	F.P.	REFS	3	13	14	15	16			
						DEFINED	1	13	14	15	16			
0	I		INTEGER	*UNUSED	F.P.	DEFINED	1							
112	KK		INTEGER	ARRAY		REFS	4	2*13	2*14	2*15	2*16			
						DEFINED	10							
75	KZ		REAL			REFS	2	13	14	15	16			
						DEFINED	5							
0	K2		REAL		F.P.	REFS	2	5	DEFINED	1				
0	NUMX		INTEGER		F.P.	REFS	3	DEFINED	1					
76	N1	*	INTEGER			DEFINED	10							
77	N2	*	INTEGER			DEFINED	10							
104	R		REAL	ARRAY		REFS	3	2*11	DEFINED	10				
101	SN		REAL			REFS	15	16	DEFINED	10				
102	TYPE		REAL			REFS	13	14	15	16	DEFINED	10		
107	Z		REAL	ARRAY		REFS	3	2*11	DEFINED	10				

FILE NAMES

	MODE		
TAPE19	UNFMT	READS	10

```
EXTERNALS          TYPE   ARGS       REFERENCES
      SQRT       REAL      1 LIBRARY     11

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100          INACTIVE     17

STATISTICS
  PROGRAM LENGTH                  120B      80
        140000B SCM USED
```

```
      SUBROUTINE STRNAD (NELEM,LTYPE,GAP,GAPEND,ELEM,OLDEPP,F,NUMX)
C
C   THIS SUBROUTINE  CONVERTS ELEMENT STRAINS TO EQUIVALENT
C   FORCES AND ADDS THEM TO THE FORCE VECTOR
C
      INTEGER  LTYPE(NELEM),GAP,GAPEND,ELEM(NELEM,3),KK(6)
      REAL OLDEPP(NELEM,4),F(NUMX),AT(4,6),TT(6,4),D(4,4),FE(6)
      REAL EPSO(4)
          DO 120 N=1,NELEM
          IF (LTYPE(N).EQ.GAP.OR.LTYPE(N).EQ.GAPEND) GO TO 120
          READ (18) AT,D,TT,RBAR,DELTA
          KK(2) = 2*ELEM(N,1)
          KK(4) = 2*ELEM(N,2)
          KK(6) = 2*ELEM(N,3)
          KK(1) = KK(2)-1
          KK(3) = KK(4)-1
          KK(5) = KK(6)-1
          EPSO(1) = OLDEPP(N,1)
          EPSO(2) = OLDEPP(N,2)
          EPSO(3) = OLDEPP(N,3)
          EPSO(4) = OLDEPP(N,4)
              DO 110 JJ=1,6
              II = KK(JJ)
              FE(JJ) = 0.0
                  DO 100 I=1,4
  100             FE(JJ) = FE(JJ)+TT(JJ,I)*EPSO(I)*RBAR*DELTA*6.28318
  110         F(II) = F(II)+FE(JJ)
  120     CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	STRNAD	1	29

VARIABLES

		SN	TYPE		RELOCATION									
151	AT		REAL	ARRAY		REFS	7	DEFINED	11					
231	D		REAL	ARRAY		REFS	7	DEFINED	11					
137	DELTA		REAL			REFS	26	DEFINED	11					
0	ELEM		INTEGER	ARRAY	F.P.	REFS	6	12	13	14	DEFINED	1		
257	EPSO		REAL	ARRAY		REFS	8	26	DEFINED	18	19	20	21	
0	F		REAL	ARRAY	F.P.	REFS	7	27	DEFINED	1	27			
251	FE		REAL	ARRAY		REFS	7	26	27	DEFINED	24	26		
0	GAP		INTEGER		F.P.	REFS	6	10	DEFINED	1				
0	GAPEND		INTEGER		F.P.	REFS	6	10	DEFINED	1				
142	I		INTEGER			REFS	2*26	DEFINED	25					
141	II		INTEGER			REFS	2*27	DEFINED	23					
140	JJ		INTEGER			REFS	23	24	3*26	27	DEFINED	22		

```
VARIABLES     SN  TYPE          RELOCATION
  143  KK         INTEGER       ARRAY                REFS      6      15      16      17      23
                                                     DEFINED   12      13      14      15      16      17
    0  LTYPE      INTEGER       ARRAY      F.P.      REFS      6    2*10 DEFINED       1
  135  N          INTEGER                             REFS    2*10      12      13      14      18      19      20
                                                        21 DEFINED       9
    0  NELEM      INTEGER                  F.P.      REFS    2*6       7       9 DEFINED       1
    0  NUMX       INTEGER                  F.P.      REFS      7 DEFINED       1
    0  OLDEPP     REAL          ARRAY      F.P.      REFS      7      18      19      20      21
                                                     DEFINED   1
  136  RBAR       REAL                                REFS     26 DEFINED      11
  201  TT         REAL          ARRAY                 REFS      7      26 DEFINED      11

FILE NAMES        MODE
     TAPE18       UNFMT                    READS      11

STATEMENT LABELS                DEF LINE   REFERENCES
    0  100                         26         25
    0  110                         27         22
  117  120                         28          9      10

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   13  120      N           9 28      107B              EXT REFS  NOT INNER
   70  110      JJ         22 27       26B              NOT INNER
   77  100      I          25 26       12B     INSTACK

STATISTICS
  PROGRAM LENGTH              300B     192
        140000B SCM USED
```

```
1                SUBROUTINE STRNAV (I,SIGZAV,SIGRAV,SIGHAV,TAUAV,E1,E2,E3,E4,NELEM,  STRNAV     2
                +E,V,EPP,A)                                                          STRNAV     3
                 REAL E(NELEM),V(NELEM),EPP(NELEM,4),A(NELEM,3)                      STRNAV     4
              C                                                                      STRNAV     5
5             C   THIS ROUTINE CALCULATES AVERAGE STRAINS FOR A SET OF               STRNAV     6
              C   4-CST ELEMENTS                                                     STRNAV     7
              C                                                                      STRNAV     8
                 VAV = (V(I)+V(I+1)+V(I+2)+V(I+3))/4.                                STRNAV     9
                 EAV = (E(I)+E(I+1)+E(I+2)+E(I+3))/4.                                STRNAV    10
10            C                                                                      STRNAV    11
                 E1 = (SIGZAV-VAV*(SIGRAV+SIGHAV))/EAV                               STRNAV    12
                 E2 = (SIGRAV-VAV*(SIGHAV+SIGZAV))/EAV                               STRNAV    13
                 E3 = (SIGHAV-VAV*(SIGZAV+SIGRAV))/EAV                               STRNAV    14
                 E4 = TAUAV*(1.0+VAV)/EAV                                            STRNAV    15
15            C                                                                      STRNAV    16
                 E1 = E1+(EPP(I,1)+EPP(I+1,1)+EPP(I+2,1)+EPP(I+3,1))/4.              STRNAV    17
                 E2 = E2+(EPP(I,2)+EPP(I+1,2)+EPP(I+2,2)+EPP(I+3,2))/4.              STRNAV    18
                 E3 = E3+(EPP(I,3)+EPP(I+1,3)+EPP(I+2,3)+EPP(I+3,3))/4.              STRNAV    19
                 E4 = E4+(EPP(I,4)+EPP(I+1,4)+EPP(I+2,4)+EPP(I+3,4))/4.              STRNAV    20
20               E1 = E1+(A(I,1)+A(I+1,1)+A(I+2,1)+A(I+3,1))/4.                      STRNAV    21
                 E2 = E2+(A(I,2)+A(I+1,2)+A(I+2,2)+A(I+3,2))/4.                      STRNAV    22
                 E3 = E3+(A(I,3)+A(I+1,3)+A(I+2,3)+A(I+3,3))/4.                      STRNAV    23
                 RETURN                                                              STRNAV    24
                 END                                                                 STRNAV    25
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	STRNAV	1

DEF LINE: 1

REFERENCES: 23

VARIABLES

SN		TYPE	RELOCATION									
0	A	REAL	ARRAY	F.P.	REFS	3	4*20	4*21	4*22	DEFINED	1	
0	E	REAL	ARRAY	F.P.	REFS	3	4*9	DEFINED	1			
161	EAV	REAL			REFS	11	12	13	14	DEFINED	9	
0	EPP	REAL	ARRAY	F.P.	REFS	3	4*16	4*17	4*18	4*19		
					DEFINED	1						
0	E1	REAL		F.P.	REFS	16	20	DEFINED	1	11	16	20
0	E2	REAL		F.P.	REFS	17	21	DEFINED	1	12	17	21
0	E3	REAL		F.P.	REFS	18	22	DEFINED	1	13	18	22
0	E4	REAL		F.P.	REFS	19	DEFINED	1	14	19		
0	I	INTEGER		F.P.	REFS	4*8	4*9	4*16	4*17	4*18	4*19	4*20
					4*21	4*22	DEFINED	1				
0	NELEM	INTEGER		F.P.	REFS	4*3	DEFINED	1				
0	SIGHAV	REAL		F.P.	REFS	11	12	13	DEFINED	1		
0	SIGRAV	REAL		F.P.	REFS	11	12	13	DEFINED	1		
0	SIGZAV	REAL		F.P.	REFS	11	12	13	DEFINED	1		
0	TAUAV	REAL		F.P.	REFS	14	DEFINED	1				
0	V	REAL	ARRAY	F.P.	REFS	3	4*8	DEFINED	1			
160	VAV	REAL			REFS	11	12	13	14	DEFINED	8	

STATISTICS
PROGRAM LENGTH 162B 114
140000B SCM USED

```
      1              SUBROUTINE STRSAV (SIGMA,I,SIGZAV,SIGRAV,SIGHAV,TAUAV,NELEM)      STRSAV     2
                     REAL SIGMA(NELEM,4)                                               STRSAV     3
                C                                                                      STRSAV     4
                C    THIS SUBROUTINE AVERAGES STRESSES OVER 4-CST ELEMENTS             STRSAV     5
      5         C                                                                      STRSAV     6
                     SIGZAV = (SIGMA(I,1)+SIGMA(I+1,1)+SIGMA(I+2,1)+SIGMA(I+3,1))/4.   STRSAV     7
                     SIGRAV = (SIGMA(I,2)+SIGMA(I+1,2)+SIGMA(I+2,2)+SIGMA(I+3,2))/4.   STRSAV     8
                     SIGHAV = (SIGMA(I,3)+SIGMA(I+1,3)+SIGMA(I+2,3)+SIGMA(I+3,3))/4.   STRSAV     9
                     TAUAV = (SIGMA(I,4)+SIGMA(I+1,4)+SIGMA(I+2,4)+SIGMA(I+3,4))/4.    STRSAV    10
     10              RETURN                                                            STRSAV    11
                     END                                                               STRSAV    12
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	STRSAV	1

DEF LINE: 1 — REFERENCES: 10

VARIABLES

	SN		TYPE		RELOCATION								
0	I		INTEGER		F.P.	REFS	4*6	4*7	4*8	4*9	DEFINED	1	
0	NELEM		INTEGER		F.P.	REFS	2	DEFINED	1				
0	SIGHAV		REAL		F.P.	DEFINED	1	8					
0	SIGMA		REAL	ARRAY	F.P.	REFS	2	4*6	4*7	4*8	4*9		
						DEFINED	1						
0	SIGRAV		REAL		F.P.	DEFINED	1	7					
0	SIGZAV		REAL		F.P.	DEFINED	1	6					
0	TAUAV		REAL		F.P.	DEFINED	1	9					

STATISTICS

PROGRAM LENGTH 57B 47

140000B SCM USED

```
      SUBROUTINE SIGCLC (NELEM,LTYPE,GAP,GAPEND,ELEM,ALFDT,EPP,OLDEPP,FI SIGCLC     2
     +,SIGMA,V,E,KPRINT,NUMX,IFLAG)                                     SIGCLC     3
      INTEGER LTYPE(NELEM),GAP,GAPEND,ELEM(NELEM,3)                     SIGCLC     4
      REAL ALFDT(NELEM,3),EPP(NELEM,4),OLDEPP(NELEM,4)                  SIGCLC     5
      REAL FI(NUMX),SIGMA(NELEM,4),V(NELEM),E(NELEM)                    SIGCLC     6
      REAL EPSO(4),DISP(6),AT(4,6),D(4,4),TT(6,4),SIG(4)                SIGCLC     7
          DO 130 N=1,NELEM                                              SIGCLC     8
          IF (LTYPE(N).EQ.GAP.OR.LTYPE(N).EQ.GAPEND) GO TO 130          SIGCLC     9
          N1 = ELEM(N,1)                                                SIGCLC    10
          N2 = ELEM(N,2)                                                SIGCLC    11
          N3 = ELEM(N,3)                                                SIGCLC    12
          EPSO(1) = ALFDT(N,1)+EPP(N,1)+OLDEPP(N,1)                     SIGCLC    13
          EPSO(2) = ALFDT(N,2)+EPP(N,2)+OLDEPP(N,2)                     SIGCLC    14
          EPSO(3) = ALFDT(N,3)+EPP(N,3)+OLDEPP(N,3)                     SIGCLC    15
          EPSO(4) = EPP(N,4)+OLDEPP(N,4)                                SIGCLC    16
          DISP(1) = FI(2*N1-1)                                          SIGCLC    17
          DISP(2) = FI(2*N1)                                            SIGCLC    18
          DISP(3) = FI(2*N2-1)                                          SIGCLC    19
          DISP(4) = FI(2*N2)                                            SIGCLC    20
          DISP(5) = FI(2*N3-1)                                          SIGCLC    21
          DISP(6) = FI(2*N3)                                            SIGCLC    22
          READ (18) AT,D,TT                                             SIGCLC    23
              DO 120 I=1,4                                              SIGCLC    24
              SIG(I) = 0.0                                              SIGCLC    25
                  DO 100 J=1,6                                          SIGCLC    26
  100             SIG(I) = SIG(I)+AT(I,J)*DISP(J)                       SIGCLC    27
                  DO 110 J=1,4                                          SIGCLC    28
  110             SIG(I) = SIG(I)-D(I,J)*EPSO(J)                        SIGCLC    29
              SIGMA(N,I) = SIG(I)                                       SIGCLC    30
  120         CONTINUE                                                  SIGCLC    31
  130     CONTINUE                                                      SIGCLC    32
          RETURN                                                        SIGCLC    33
          END                                                           SIGCLC    34
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	SIGCLC	1	32

VARIABLES

		SN	TYPE		RELOCATION								
0	ALFDT		REAL	ARRAY	F.P.	REFS	4	12	13	14	DEFINED	1	
174	AT		REAL	ARRAY		REFS	6	26	DEFINED	22			
224	D		REAL	ARRAY		REFS	6	28	DEFINED	32			
166	DISP		REAL	ARRAY		REFS	6	26	DEFINED	16	17	18	19
							20	21					
0	E		REAL	ARRAY	F.P.	REFS	5	DEFINED	1				
0	ELEM		INTEGER	ARRAY	F.P.	REFS	3	9	10	11	DEFINED	1	
0	EPP		REAL	ARRAY	F.P.	REFS	4	12	13	14	15		
						DEFINED	1						

```
VARIABLES     SN  TYPE          RELOCATION
  162  EPS0       REAL      ARRAY          REFS      6      28     DEFINED     12      13      14      15
    0  FI         REAL      ARRAY  F.P.    REFS      5      16        17       18      19      20      21
                                           DEFINED   1
    0  GAP        INTEGER           F.P.    REFS      3       8     DEFINED     1
    0  GAPEND     INTEGER           F.P.    REFS      3       8     DEFINED     1
  160  I          INTEGER                   REFS     24    3*26       3*28    2*29  DEFINED         23
    0  IFLAG      INTEGER   *UNUSED F.P.    DEFINED   1
  161  J          INTEGER                   REFS   2*26    2*28     DEFINED     25      27
    0  KPRINT     INTEGER   *UNUSED F.P.    DEFINED   1
    0  LTYPE      INTEGER    ARRAY  F.P.    REFS      3     2*8     DEFINED     1
  154  N          INTEGER                   REFS    2*8       9        10       11    3*12    3*13    3*14
                                           2*15     29  DEFINED        7
    0  NELEM      INTEGER           F.P.    REFS    2*3     3*4        3*5      7  DEFINED         1
    0  NUMX       INTEGER           F.P.    REFS      5  DEFINED        1
  155  N1         INTEGER                   REFS     16      17     DEFINED     9
  156  N2         INTEGER                   REFS     18      19     DEFINED    10
  157  N3         INTEGER                   REFS     20      21     DEFINED    11
    0  OLDEPP     REAL      ARRAY  F.P.    REFS      4      12        13       14      15
                                           DEFINED   1
  274  SIG        REAL      ARRAY          REFS      6      26        28       29  DEFINED         24      26
                                           28
    0  SIGMA      REAL      ARRAY  F.P.    REFS      5  DEFINED        1       29
  244  TT         REAL      ARRAY          REFS      6  DEFINED       22
    0  V          REAL      ARRAY  F.P.    REFS      5  DEFINED        1

FILE NAMES       MODE
     TAPE18      UNFMT                 READS      22

STATEMENT LABELS                 DEF LINE   REFERENCES
    0  100                          26         25
    0  110                          28         27
    0  120                          30         23
  141  130                          31          7          8

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   13  130      N           7 31       131B              EXT REFS  NOT INNER
  105  120      I          23 30        33B              NOT INNER
  111  100      J          25 26         7B    INSTACK
  122  110      J          27 28         7B    INSTACK

STATISTICS
  PROGRAM LENGTH                    332B     218
        140000B SCM USED
```

```
1                FUNCTION TEMPFK (T)                                          TEMPFK     2
                 C   *********                                                TEMPFK     3
                 C   THIS FUNCTION CHANGES FAHRENHEIT TEMPERATURES TO KELUIN  TEMPFK     4
                 C                                                            TEMPFK     5
5                C   *********                                                TEMPFK     6
                   TEMPFK = (T+459.67)*(5./9.)                                TEMPFK     7
                   RETURN                                                     TEMPFK     8
                   END                                                        TEMPFK     9
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	TEMPFK	1	7

VARIABLES	SN	TYPE	RELOCATION				
0	T	REAL	F.P.	REFS	6	DEFINED	1
20	TEMPFK	REAL		DEFINED	6		

STATISTICS

PROGRAM LENGTH 218 17

140000B SCM USED

```
      SUBROUTINE TF (X,R,T,NTPS,TCI)                                    TF        2
      REAL X,R(NTPS),T(NTPS)                                            TF        3
      NMAX = NTPS                                                       TF        4
      NMI = NMAX-1                                                      TF        5
      IF (X.GT.R(NMAX)) WRITE (6,140)                                   TF        6
      IF (X.GT.R(NMAX)) STOP                                            TF        7
          DO 100 I=1,NMI                                                TF        8
          IF (X.LT.R(I)) GO TO 100                                      TF        9
          IF (X.GT.R(I).AND.X.LT.R(I+1)) NI = I                         TF       10
          IF (X.GT.R(I).AND.X.LT.R(I+1)) GO TO 110                      TF       11
          IF (X.GT.R(I).AND.X.GT.R(I+1)) GO TO 100                      TF       12
          IF (X.EQ.R(I)) TCI = T(I)                                     TF       13
          IF (X.EQ.R(I)) RETURN                                         TF       14
          IF (X.EQ.R(I+1)) TCI = T(I+1)                                 TF       15
          IF (X.EQ.R(I+1)) RETURN                                       TF       16
  100     CONTINUE                                                      TF       17
C     ***PARABOLIC INTERPOLATE                                          TF       18
  110   CONTINUE                                                        TF       19
      IF (NI.NE.1) GO TO 120                                            TF       20
      A = R(1)                                                          TF       21
      B = R(2)                                                          TF       22
      C = R(3)                                                          TF       23
      TA = T(1)                                                         TF       24
      TB = T(2)                                                         TF       25
      TC = T(3)                                                         TF       26
      GO TO 130                                                         TF       27
  120   CONTINUE                                                        TF       28
      A = R(NI-1)                                                       TF       29
      B = R(NI)                                                         TF       30
      C = R(NI+1)                                                       TF       31
      TA = T(NI-1)                                                      TF       32
      TB = T(NI)                                                        TF       33
      TC = T(NI+1)                                                      TF       34
  130   CONTINUE                                                        TF       35
      TCI = TA*(X-B)*(X-C)/((A-B)*(A-C))+TB*(X-A)*(X-C)/((B-A)*(B-C))+TC TF       36
     +*(X-A)*(X-B)/((C-A)*(C-B))                                        TF       37
      RETURN                                                            TF       38
C                                                                       TF       39
  140   FORMAT (1H1,4X,16HERROR X GT RMAX )                             TF       40
      END                                                               TF       41
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES		
4	TF	1	13	15	37

VARIABLES	SN	TYPE	RELOCATION					
212	A	REAL		REFS	6*35	DEFINED	20	28
213	B	REAL		REFS	6*35	DEFINED	21	29

VARIABLES	SN	TYPE	RELOCATION									
214	C	REAL			REFS	6*35	DEFINED	22	30			
210	I	INTEGER			REFS	8	3*9	2*10	2*11	2*12	13	2*14
					15	DEFINED	7					
206	NMAX	INTEGER			REFS	4	5	6	DEFINED	3		
207	NMI	INTEGER			REFS	7	DEFINED	4				
0	NTPS	INTEGER		F.P.	REFS	2*2	3	DEFINED	1			
211	NI	INTEGER			REFS	19	28	29	30	31	32	33
					DEFINED	9						
0	R	REAL	ARRAY	F.P.	REFS	2	5	6	8	2*9	2*10	2*11
					12	13	14	15	20	21	22	28
					29	30	DEFINED	1				
0	T	REAL	ARRAY	F.P.	REFS	2	12	14	23	24	25	31
					32	33	DEFINED	1				
215	TA	REAL			REFS	35	DEFINED	23	31			
216	TB	REAL			REFS	35	DEFINED	24	32			
217	TC	REAL			REFS	35	DEFINED	25	33			
0	TCI	REAL		F.P.	DEFINED	1	12	14	35			
3	X	REAL		F.P.	REFS	2	5	6	8	2*9	2*10	2*11
					12	13	14	15	6*35	DEFINED	1	

FILE NAMES	MODE		
TAPE6	FMT	WRITES	5

STATEMENT LABELS			DEF LINE	REFERENCES		
75	100		16	7	8	11
101	110		18	10		
126	120		27	19		
155	130		34	26		
201	140	FMT	39	5		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
31	100	I	7 16	47B	EXITS

STATISTICS
PROGRAM LENGTH 245B 165
140000B SCM USED

```
      SUBROUTINE XGAPSM (TLOK,KLOC)                                     XGAPSM     2
       REAL KLOC                                                        XGAPSM     3
       REAL TLOK(4,4)                                                   XGAPSM     4
C                                                                       XGAPSM     5
C                                                                       XGAPSM     6
C     THIS ROUTINE CALCULATES  THE LOCAL STIFFNESS DUE TO               XGAPSM     7
C     AXIAL LOCKUP IN THE GAP ELEMENT                                   XGAPSM     8
C                                                                       XGAPSM     9
      READ (21) DEL,CS,SN                                               XGAPSM    10
      SN = -SN                                                          XGAPSM    11
      TLOK(1,1) = CS**2                                                 XGAPSM    12
      TLOK(1,2) = CS*SN                                                 XGAPSM    13
      TLOK(1,3) = -CS**2                                                XGAPSM    14
      TLOK(1,4) = -CS*SN                                                XGAPSM    15
      TLOK(2,1) = CS*SN                                                 XGAPSM    16
      TLOK(2,2) = SN**2                                                 XGAPSM    17
      TLOK(2,3) = -SN*CS                                                XGAPSM    18
      TLOK(2,4) = -SN**2                                                XGAPSM    19
      TLOK(3,1) = -CS**2                                                XGAPSM    20
      TLOK(3,2) = -CS*SN                                                XGAPSM    21
      TLOK(3,3) = CS**2                                                 XGAPSM    22
      TLOK(3,4) = CS*SN                                                 XGAPSM    23
      TLOK(4,1) = -SN*CS                                                XGAPSM    24
      TLOK(4,2) = -SN**2                                                XGAPSM    25
      TLOK(4,3) = SN*CS                                                 XGAPSM    26
      TLOK(4,4) = SN**2                                                 XGAPSM    27
          DO 100 I=1,16                                                 XGAPSM    28
  100     TLOK(I) = TLOK(I)*KLOC                                        XGAPSM    29
      RETURN                                                            XGAPSM    30
      END                                                               XGAPSM    31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	XGAPSM	1	29

VARIABLES		SN	TYPE		RELOCATION								
106	CS		REAL			REFS	11	12	13	14	15	17	19
							20	21	22	23	25	DEFINED	9
105	DEL	*	REAL			DEFINED	9						
110	I		INTEGER			REFS	2*28	DEFINED	27				
0	KLOC		REAL		F.P.	REFS	2	28	DEFINED	1			
107	SN		REAL			REFS	10	12	14	15	16	17	18
							20	22	23	24	25	26	
						DEFINED	9	10					
0	TLOK		REAL	ARRAY	F.P.	REFS	3	28	DEFINED	1	11	12	13
							14	15	16	17	18	19	20	21
							22	23	24	25	26	28	

```
FILE NAMES          MODE
     TAPE21         UNFMT                    READS       9

STATEMENT LABELS                 DEF LINE   REFERENCES
    0  100                          28         27

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   71  100      I          27 28       5B      INSTACK

STATISTICS
  PROGRAM LENGTH                     114B       76
        140000B SCM USED
```

```
      SUBROUTINE XLFRC (F,NUMGAP,K2,NUMX,I)                                  XLFRC       2
       REAL K2,KZ                                                            XLFRC       3
      REAL D(6),F(NUMX)                                                      XLFRC       4
       INTEGER   KK(6)                                                       XLFRC       5
      KZ = K2*100.                                                           XLFRC       6
C                                                                            XLFRC       7
C   THIS ROUTINE ADDS  FORCE CONSTANTS  NECESSARY FOR                        XLFRC       8
C   AXIAL LOCKUP                                                           XLFRC       9
C                                                                            XLFRC      10
      READ (21) DEL,CS,SN                                                    XLFRC      11
      READ (19) D,N1,N2,KK,Z1,Z2,TYPE                                        XLFRC      12
      F(KK(1)) = F(KK(1))-KZ*CS*DEL*TYPE                                     XLFRC      13
      F(KK(3)) = F(KK(3))+KZ*CS*DEL*TYPE                                     XLFRC      14
      F(KK(2)) = F(KK(2))-KZ*SN*DEL*TYPE                                     XLFRC      15
      F(KK(4)) = F(KK(4))+KZ*SN*DEL*TYPE                                     XLFRC      16
  100 CONTINUE                                                               XLFRC      17
      RETURN                                                                 XLFRC      18
      END                                                                    XLFRC      19
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	XLFRC	1	17

VARIABLES		SN	TYPE	RELOCATION									
71	CS		REAL			REFS	12	13	DEFINED	10			
100	D		REAL	ARRAY		REFS	3	DEFINED	11				
70	DEL		REAL			REFS	12	13	14	15	DEFINED	10	
0	F		REAL	ARRAY	F.P.	REFS	3	12	13	14	15		
						DEFINED	1	12	13	14	15		
0	I		INTEGER	*UNUSED	F.P.	DEFINED	1						
106	KK		INTEGER	ARRAY		REFS	4	2*12	2*13	2*14	2*15		
						DEFINED	11						
67	KZ		REAL			REFS	2	12	13	14	15		
						DEFINED	5						
0	K2		REAL		F.P.	REFS	2	5	DEFINED	1			
0	NUMGAP		INTEGER	*UNUSED	F.P.	DEFINED	1						
0	NUMX		INTEGER		F.P.	REFS	3	DEFINED	1				
73	N1	*	INTEGER			DEFINED	11						
74	N2	*	INTEGER			DEFINED	11						
72	SN		REAL			REFS	14	15	DEFINED	10			
77	TYPE		REAL			REFS	12	13	14	15	DEFINED	11	
75	Z1	*	REAL			DEFINED	11						
76	Z2	*	REAL			DEFINED	11						

FILE NAMES	MODE		
TAPE19	UNFMT	READS	11
TAPE21	UNFMT	READS	10

STATEMENT LABELS

			DEF LINE	REFERENCES
0	100	!NACTIVE	16	

STATISTICS

PROGRAM LENGTH	114B	76
140000B SCM USED		

```
      SUBROUTINE XLLOK (NUMGAP,FI,NUMX)                                  XLLOK      2
       INTEGER KK(6)                                                     XLLOK      3
      REAL R(3),Z(3),FI(NUMX)                                            XLLOK      4
      REWIND 21                                                          XLLOK      5
      REWIND 19                                                          XLLOK      6
C                                                                        XLLOK      7
C                                                                        XLLOK      8
C     THIS ROUTINE  CALCULATES AXIAL DISPLACEMENT IN THE  GAP            XLLOK      9
C     SPRINGS  FOR  SETTING  AXIAL  LOCKUP                               XLLOK     10
C                                                                        XLLOK     11
      DO 100 MI=1,NUMGAP                                                 XLLOK     12
      READ (19) R,Z,N1,N2,KK,CS,SN                                       XLLOK     13
      UNITI = SN                                                         XLLOK     14
      UNITJ = -CS                                                        XLLOK     15
C                                                                        XLLOK     16
C                                                                        XLLOK     17
      DISPR1 = FI(KK(1))                                                 XLLOK     18
      DISPR2 = FI(KK(3))                                                 XLLOK     19
      DISPZ1 = FI(KK(2))                                                 XLLOK     20
      DISPZ2 = FI(KK(4))                                                 XLLOK     21
C                                                                        XLLOK     22
      DELR = (R(2)+DISPR2-(R(1)+DISPR1))*UNITI                           XLLOK     23
      DELZ = (Z(2)+DISPZ2-(Z(1)+DISPZ1))*UNITJ                           XLLOK     24
C                                                                        XLLOK     25
      DEL = DELR+DELZ                                                    XLLOK     26
C                                                                        XLLOK     27
      WRITE (21) DEL,UNITI,UNITJ                                         XLLOK     28
  100 CONTINUE                                                           XLLOK     29
      RETURN                                                             XLLOK     30
      END                                                                XLLOK     31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	XLLOK	1	29

VARIABLES	SN	TYPE			RELOCATION							
110	CS	REAL				REFS	14	DEFINED	12			
122	DEL	REAL				REFS	27	DEFINED	25			
120	DELR	REAL				REFS	25	DEFINED	22			
121	DELZ	REAL				REFS	25	DEFINED	23			
114	DISPR1	REAL				REFS	22	DEFINED	17			
115	DISPR2	REAL				REFS	22	DEFINED	18			
116	DISPZ1	REAL				REFS	23	DEFINED	19			
117	DISPZ2	REAL				REFS	23	DEFINED	20			
0	FI	REAL	ARRAY	F.P.		REFS	3	17	18	19	20	
						DEFINED	1					
123	KK	INTEGER	ARRAY			REFS	2	17	18	19	20	
						DEFINED	12					

```
VARIABLES     SN  TYPE          RELOCATION
  105  MI      *  INTEGER                        DEFINED      11
    0  NUMGAP     INTEGER                F.P.      REFS      11    DEFINED       1
    0  NUMX       INTEGER                F.P.      REFS       3    DEFINED       1
  106  N1      *  INTEGER                        DEFINED      12
  107  N2      *  INTEGER                        DEFINED      12
  131  R          REAL          ARRAY            REFS       3      2*22   DEFINED      12
  111  SN         REAL                           REFS      13    DEFINED      12
  112  UNITI      REAL                           REFS      22        27   DEFINED      13
  113  UNITJ      REAL                           REFS      23        27   DEFINED      14
  134  Z          REAL          ARRAY            REFS       3      2*23   DEFINED      12

FILE NAMES      MODE
      TAPE19    UNFMT                  READS      12    MOTION       5
      TAPE21    UNFMT                 WRITES      27    MOTION       4

STATEMENT LABELS          DEF LINE   REFERENCES
    0  100                    28        11

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   15  100      MI          11 28      46B                EXT REFS

STATISTICS
  PROGRAM LENGTH              145B     101
        140000B SCM USED
```

```
      1                SUBROUTINE CRIIPX (SIG,DPDT,T,TC,PHI,ECREEP,LTYPE,IUNIT)                CRIIP       2
                       ICLAD = 4HCLAD                                                          CRIIP       3
                       JTYPE = 1                                                               CRIIP       4
                       IF (LTYPE.EQ.ICLAD) JTYPE = 2                                           CRIIP       5
      5                IF (IUNIT.EQ.0) TF = TEMPKF(TC)                                         CRIIP       6
                 C     ***THIS STEADY-STATE CREEP  DATA IS FOR ZIRCALOY AT 300 K               CRIIP       7
                 C     AS TAKEN FROM THE ORIGINAL PAPER BY IBRAHIM                             CRIIP       8
                 C     IMPLICIT REAL*8 (A-H,O-Z)                                               CRIIP       9
                 C     TEMP PASSED IN HERE IS IN FAHRENEIET                                    CRIIP      10
     10                TF = TC                                                                 CRIIP      11
                       IF (JTYPE.EQ.2) SIG = DPDT/(4.0E-10)                                    CRIIP      12
                 C     CREEP RATE VS. STRESS, FROM BOHABOY ET AL                               CRIIP      13
                       IF (JTYPE.EQ.1) SIG = (DPDT/1.937E-7)**1.370                            CRIIP      14
                       IF (JTYPE.EQ.1.AND.TF.GE.2813.0) SIG = (DPDT/3.742E-8)**0.901           CRIIP      15
     15                IF (JTYPE.EQ.1.AND.TF.GE.3002.0) SIG = (DPDT/1.271E-9)**0.588           CRIIP      16
                       IF (JTYPE.EQ.1.AND.TF.GE.3182.0) SIG = (DPDT/3.149E-9)**0.5682          CRIIP      17
                       IF (IUNIT.EQ.0) SIG = PASPSI(SIG)                                       CRIIP      18
                       RETURN                                                                  CRIIP      19
                       END                                                                     CRIIP      20
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

4	CRIIPX	1

DEF LINE: 1 — REFERENCES: 18

VARIABLES

SN		TYPE		RELOCATION									
0	DPDT	REAL		F.P.	REFS	11	13	14	15	16			
					DEFINED	1							
0	ECREEP	REAL	*UNUSED	F.P.	DEFINED	1							
141	ICLAD	INTEGER			REFS	4	DEFINED	2					
0	IUNIT	INTEGER		F.P.	REFS	5	17	DEFINED	1				
142	JTYPE	INTEGER			REFS	11	13	14	15	16			
					DEFINED	3	4						
0	LTYPE	INTEGER		F.P.	REFS	4	DEFINED	1					
0	PHI	REAL	*UNUSED	F.P.	DEFINED	1							
0	SIG	REAL		F.P.	REFS	17	DEFINED	1	11	13	14	15	
					16	17							
0	T	REAL	*UNUSED	F.P.	DEFINED	1							
0	TC	REAL		F.P.	REFS	5	10	DEFINED	1				
143	TF	REAL			REFS	14	15	16	DEFINED	5	10		

EXTERNALS

	TYPE	ARGS	REFERENCES
PASPSI	REAL	1	17
TEMPKF	REAL	1	5

STATISTICS

PROGRAM LENGTH 144B 100

140000B SCM USED

```
      SUBROUTINE AXDRIV                                                      AXDRIV     2
C                                                                            AXDRIV     3
      REAL  LENGTH                                                           AXDRIV     4
C                                                                            AXDRIV     5
      INTEGER  ELEM , PFLAG , GFLAG , TIE                                    AXDRIV     6
C                                                                            AXDRIV     7
      DIMENSION SPDAFC(2) , IPRES(12,3),TIE(3)                               AXDRIV     8
      DIMENSION TEMP(20),R(20)                                               AXDRIV     9
      DIMENSION MAT1(14,12),MAT2(13,11),PRESFC(12,3)                         AXDRIV    10
      DIMENSION ZPRES(11),IZPRES(11)                                         AXDRIV    11
       INTEGER IGAP(12)                                                      AXDRIV    12
      REAL MATPRO(11)                                                        AXDRIV    13
       REAL DPH(12),DEL(12),DPLAS(12),TYPE(12),DELGAP(12)                    AXDRIV    14
       REAL OVRLAP(12),NEWWT(12)                                             AXDRIV    15
      DIMENSION ALFDT(540,3) , COEF(540)                                     AXDRIV    16
     +              ,DELOLD(12)    ,F(600)        ,F1(600)                  AXDRIV    17
     + ,EP(540)     ,EPP(540,4)    ,F2(92)       ,OLDGAP(12)                AXDRIV    18
     + ,OLDEPP(540,4)   ,ID(26)    ,T(540)                                  AXDRIV    19
     + ,V(540)          ,DI(26)                                             AXDRIV    20
     + ,DEP(540)    ,E(540)        ,ECREEP(540)    ,SLOPE(540)              AXDRIV    21
     + ,TC(540)     ,SIGMA(540,4)  ,OLSIGF(540)    ,ELEM(540,3)             AXDRIV    22
     + ,LTYPE(540) ,COORD(300,2)                                             AXDRIV    23
C                                                                            AXDRIV    24
      DATA  K /46/                                                           AXDRIV    25
C                                                                            AXDRIV    26
      REWIND K                                                               AXDRIV    27
C                                                                            AXDRIV    28
      CALL AXI2IN (N,M,L,IAXI,NUMGAP,NNODES,NELEM,LOADST,NUMX,NTIES,IUNI     AXDRIV    29
     +T)                                                                     AXDRIV    30
C                                                                            AXDRIV    31
      LST = 500                                                              AXDRIV    32
      KPRINT = 1                                                             AXDRIV    33
      TIME = 0.0                                                             AXDRIV    34
      PFLAG = 1                                                              AXDRIV    35
      GFLAG = 1                                                              AXDRIV    36
C                                                                            AXDRIV    37
      READ (K,130) NPSTEP,NTPS                                               AXDRIV    38
      WRITE (6,190) NPSTEP,NTPS                                              AXDRIV    39
C                                                                            AXDRIV    40
      READ (K,170) (R(I),I=1,NTPS)                                           AXDRIV    41
      WRITE (6,200) (R(I),I=1,NTPS)                                          AXDRIV    42
C                                                                            AXDRIV    43
      READ (K,170) SH,DISH                                                   AXDRIV    44
      WRITE (6,200) SH,DISH                                                  AXDRIV    45
C                                                                            AXDRIV    46
      READ (K,140) CLADR,THICK,GAP,LENGTH,NUNIT                              AXDRIV    47
      WRITE (6,210) CLADR,THICK,GAP,LENGTH,NUNIT                             AXDRIV    48
C                                                                            AXDRIV    49
          DO 110 J=1,NPSTEP                                                  AXDRIV    50
C                                                                            AXDRIV    51
          READ (K,150) (MATPRO(I),I=1,11)                                    AXDRIV    52
          WRITE (6,160) (MATPRO(I),I=1,11)                                   AXDRIV    53
C                                                                            AXDRIV    54
```

```
                      READ (K,180) CLOSE,ICLOSE                                  AXDRIV     55
55                    WRITE (6,220) CLOSE,ICLOSE                                 AXDRIV     56
                C                                                                AXDRIV     57
                      READ (K,170) (TEMP(I),I=1,NTPS)                            AXDRIV     58
                      WRITE (6,200) (TEMP(I),I=1,NTPS)                           AXDRIV     59
                C                                                                AXDRIV     60
60              C   LENGTH IS THE PELLET LENGTH DIVIDED BY 2                      AXDRIV     61
                C                                                                AXDRIV     62
                      IF (EOF(5)) 120,100                                        AXDRIV     63
                100   CONTINUE                                                   AXDRIV     64
                      READ (K,170) TCLAD1,TCLAD2                                 AXDRIV     65
65                    WRITE (6,200) TCLAD1,TCLAD2                                AXDRIV     66
                C                                                                AXDRIV     67
                      READ (K,180) DTIME,NCRP                                    AXDRIV     68
                      WRITE (6,220) DTIME,NCRP                                   AXDRIV     69
                C                                                                AXDRIV     70
70                    READ (K,170) PG,PC                                         AXDRIV     71
                      WRITE (6,200) PG,PC                                        AXDRIV     72
                C                                                                AXDRIV     73
                      N1 = N+M                                                   AXDRIV     74
                      N2 = N+M-1                                                 AXDRIV     75
75                    N3 = L-1                                                   AXDRIV     76
                C                                                                AXDRIV     77
                      IF (IAX1.EQ.1.AND.LOADST.EQ.1) CALL AXIMDL (CLADR,COORD,DISH,E AXDRIV     78
                     +LEM,GAP,IPRES,IZPRES,L,LENGTH,LTYPE,M,MAT1,MAT2,N,NELEM,NNODES AXDRIV     79
                     +,NTIES,NUMGAP,N1,N2,N3,PRESFC,SH,SPDAFC,THICK,ZPRES)       AXDRIV     80
80              C                                                                AXDRIV     81
                      IF (IAX1.EQ.1) CALL AXILOD (CLADR,COORD,ELEM,IPRES,IUNIT,IZPRE AXDRIV     82
                     +S,L,LOADST,M,N,NELEM,NLOAD2,NNODES,NTPS,PC,PG,PRESFC,R,SPDAFC, AXDRIV     83
                     +T,TCLAD1,TCLAD2,TEMP,THICK,ZPRES)                          AXDRIV     84
                C                                                                AXDRIV     85
85                    IF (LOADST.EQ.1) CALL AXSCRP (NELEM,NNODES,ELEM,COORD,NUMGAP,L AXDRIV     86
                     +TYPE,N,M,L)                                                AXDRIV     87
                      CALL AX12 (ALFDT,CLOSE,COEF,COORD,DEL,DELGAP,DELOLD,DEP,DI,DPH AXDRIV     88
                     +,DPLAS,DTIME,E,ECREEP,ELEM,EP,EPP,F,F1,F2,GFLAG,ICLOSE,ID,IGAP AXDRIV     89
                     +,IUNIT,IXLSET,KPRINT,LOADST,LST,LTYPE,MATPRO,MBNDOL,NCRP,NDISP AXDRIV     90
90                   +S,NELEM,NEWHT,NNODES,NSIZEX,NTIES,NLOAD2,NUMGAP,NUNIT,NUMX,NUM AXDRIV     91
                     +Y,OLDEPP,OLDGAP,OLSIGF,OVRLAP,PG,PC,PFLAG,PRESFC,SIGMA,SLOPE,S AXDRIV     92
                     +PDA,TC,TIE,TIME,TYPE,V)                                    AXDRIV     93
                C                                                                AXDRIV     94
                110   CONTINUE                                                   AXDRIV     95
95              120   CONTINUE                                                   AXDRIV     96
                      RETURN                                                     AXDRIV     97
                C                                                                AXDRIV     98
                130   FORMAT (2I5)                                               AXDRIV     99
                140   FORMAT (4E12.5,2I5)                                        AXDRIV    100
100             150   FORMAT (11E12.5)                                           AXDRIV    101
                160   FORMAT (1H ,10E12.5)                                       AXDRIV    102
                170   FORMAT (8E12.5)                                            AXDRIV    103
                180   FORMAT (E12.5,I5)                                          AXDRIV    104
                190   FORMAT (1H ,2I5)                                           AXDRIV    105
105             200   FORMAT (1H ,8F10.5)                                        AXDRIV    106
                210   FORMAT (1H ,4F12.4,2I5)                                    AXDRIV    107
```

```
      220   FORMAT (1H ,F10.2,I5)                                   AXDRIV   108
            END                                                     AXDRIV   109
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
2 AXDRIV 1 96

VARIABLES	SN	TYPE	RELOCATION								
5056 ALFDT		REAL	ARRAY	REFS	15	87					
626 CLADR		REAL		REFS	47	77	81	DEFINED	46		
633 CLOSE		REAL		REFS	55	87	DEFINED	54			
10202 COEF		REAL	ARRAY	REFS	15	87					
43136 COORD		REAL	ARRAY	REFS	15	77	81	85	87		
4746 DEL		REAL	ARRAY	REFS	13	87					
5012 DELGAP		REAL	ARRAY	REFS	13	87					
11236 DELOLD		REAL	ARRAY	REFS	15	87					
27452 DEP		REAL	ARRAY	REFS	15	87					
27420 DI		REAL	ARRAY	REFS	15	87					
625 DISH		REAL		REFS	44	77	DEFINED	43			
4732 DPH		REAL	ARRAY	REFS	13	87					
4762 DPLAS		REAL	ARRAY	REFS	13	87					
637 DTIME		REAL		REFS	68	87	DEFINED	67			
30506 E		REAL	ARRAY	REFS	15	87					
31542 ECREEP		REAL	ARRAY	REFS	15	87					
655 ELEM		INTEGER	ARRAY	REFS	5	15	77	81	85	87	
13532 EP		REAL	ARRAY	REFS	15	87					
14566 EPP		REAL	ARRAY	REFS	15	87					
11252 F		REAL	ARRAY	REFS	15	87					
12402 F1		REAL	ARRAY	REFS	15	67					
20746 F2		REAL	ARRAY	REFS	15	87					
630 GAP		REAL		REFS	47	77	DEFINED	46			
602 GFLAG		INTEGER		REFS	5	87	DEFINED	35			
623 I		INTEGER		REFS	40	41	51	52	57	58	
				DEFINED	40	41	51	52	57	58	
606 IAXI		INTEGER		REFS	28	77	81				
634 ICLOSE		INTEGER		REFS	55	87	DEFINED	54			
25276 ID		INTEGER	ARRAY	REFS	15	87					
4703 IGAP		INTEGER	ARRAY	REFS	11	87					
4006 IPRES		INTEGER	ARRAY	REFS	7	77	81				
615 IUNIT		INTEGER		REFS	28	81	87				
647 IXLSET	*	INTEGER		REFS	87						
4670 IZPRES		INTEGER	ARRAY	REFS	10	77	81				
632 J	*	INTEGER		DEFINED	49						
366 K		INTEGER		DEFINED	24	170 REFS	26	37	40	43	46
				51	54	57	64	67	70		
617 KPRINT		INTEGER		REFS	87	DEFINED	32				
605 L		INTEGER		REFS	28	75	77	81	85		
600 LENGTH		REAL		REFS	3	47	77	DEFINED	46		

VARIABLES	SN	TYPE	RELOCATION							
612 LOADST		INTEGER		REFS	28	77	81	85	87	
616 LST		INTEGER		REFS	87	DEFINED	31			
42102 LTYPE		INTEGER	ARRAY	REFS	15	77	85	87		
604 M		INTEGER		REFS	28	73	74	77	81	85
4717 MATPRO		REAL	ARRAY	REFS	12	52	87	DEFINED	51	
4122 MATI		INTEGER	ARRAY	REFS	9	77				
4372 MAT2		INTEGER	ARRAY	REFS	9	77				
650 MBNDOL	*	INTEGER		REFS	87					
603 N		INTEGER		REFS	28	73	74	77	81	85
640 NCRP		INTEGER		REFS	68	87	DEFINED	67		
651 NDISPS	*	INTEGER		REFS	87					
611 NELEM		INTEGER		REFS	28	77	81	85	87	
5042 NEWWT		REAL	ARRAY	REFS	14	87				
646 NLOAD2		INTEGER		REFS	81	87				
610 NNODES		INTEGER		REFS	28	77	81	85	87	
621 NPSTEP		INTEGER		REFS	38	49	DEFINED	37		
652 NSIZEX	*	INTEGER		REFS	87					
614 NTIES		INTEGER		REFS	28	77	87			
622 NTPS		INTEGER		REFS	38	40	41	57	58	81
				DEFINED	37					
607 NUMGAP		INTEGER		REFS	28	77	85	87		
613 NUMX		INTEGER		REFS	28	87				
653 NUMY	*	INTEGER		REFS	87					
631 NUNIT		INTEGER		REFS	47	87	DEFINED	46		
643 N1		INTEGER		REFS	77	DEFINED	73			
644 N2		INTEGER		REFS	77	DEFINED	74			
645 N3		INTEGER		REFS	77	DEFINED	75			
21116 OLDEPP		REAL	ARRAY	REFS	15	87				
21102 OLDGAP		REAL	ARRAY	REFS	15	87				
41046 OLSIGF		REAL	ARRAY	REFS	15	87				
5026 OVRLAP		REAL	ARRAY	REFS	14	87				
642 PC		REAL		REFS	71	81	87	DEFINED	70	
601 PFLAG		INTEGER		REFS	5	87	DEFINED	34		
641 PG		REAL		REFS	71	81	87	DEFINED	70	
4611 PRESFC		REAL	ARRAY	REFS	9	77	81	87		
4076 R		REAL	ARRAY	REFS	8	41	81	DEFINED	40	
624 SH		REAL		REFS	44	77	DEFINED	43		
34666 SIGMA		REAL	ARRAY	REFS	15	87				
32576 SLOPE		REAL	ARRAY	REFS	15	87				
654 SPDA	*	REAL		REFS	87					
4004 SPDAFC		REAL	ARRAY	REFS	7	77	81			
25330 T		REAL	ARRAY	REFS	15	81				
33632 TC		REAL	ARRAY	REFS	15	87				
635 TCLAD1		REAL		REFS	65	81	DEFINED	64		
636 TCLAD2		REAL		REFS	65	81	DEFINED	64		
4052 TEMP		REAL	ARRAY	REFS	8	58	81	DEFINED	57	
627 THICK		REAL		REFS	47	77	81	DEFINED	46	
4001 TIE		INTEGER	ARRAY	REFS	5	7	87			
620 TIME		REAL		REFS	87	DEFINED	33			
4776 TYPE		REAL	ARRAY	REFS	13	87				
26364 V		REAL	ARRAY	REFS	15	87				
4655 ZPRES		REAL	ARRAY	REFS	10	77	81			

```
FILE NAMES        MODE
      TAPE6       FMT                 WRITES      38        41        44        47        52        55        58        65
                                        68        71

      VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS           TYPE    ARGS      REFERENCES
      AXILOD                  25        81
      AXIMDL                  26        77
      AXI2                    60        87
      AXI2IN                  11        28
      AXSCRP                   9        85
      EOF           REAL       1        62

STATEMENT LABELS                    DEF LINE   REFERENCES
    0  100              INACTIVE        63        62
    0  110                             94        49
  153  120                             95        62
  546  130      FMT                    98        37
  550  140      FMT                    99        46
  553  150      FMT                   100        51
  555  160      FMT                   101        52
  560  170      FMT                   102        40        43        57        64        70
  562  180      FMT                   103        54        67
  564  190      FMT                   104        38
  566  200      FMT                   105        41        44        58        65        71
  571  210      FMT                   106        47
  574  220      FMT                   107        55        68

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
   53  110      J            49 94      77B                 EXT REFS    EXITS

STATISTICS
  PROGRAM LENGTH                    44266B    18614
        140000B SCM USED
```

```
      SUBROUTINE AXIWRT (NUNIT,HPLT,TMPDIS,TCLAD1,TCLAD2,DTIME,NCRP,PG,P
     +C,NOUT,NA,NR,JPEAK,IT,GAP,NPSTEP,NTPS,R,SH,DISH,CLADR,THICK,CLOSE,
     +ICLOSE)
C
C     IMPLICIT  REAL * 8 (A-H,O-Z)
C
C     ******************************************************************
C
C     THIS SUBROUITNE IS CALLED FROM MAIN AND IS USED TO WRITE OUT
C     THE INFORMATION FOR A RUN OF AXISYM SUBCODE
C
C     ******************************************************************
C     INPUT ARGUMENTS
C     ******************************************************************
C
C     CLADR  - CLADDING OUTSIDE RADIUS (IN)
C     CLOSE  - LOAD STEP FRACTION AT CLOSURE FROM FRACAS-2
C     DISH   - DISHING DEPTH (IN)
C     DMW1   - WORK ARRAY
C     DTIME  - CREEP TIME INCREMENT (HRS)
C     GAP    - COLD STATE RADIAL GAP (IN)
C     HPLT   - PELLET LENGTH (IN)
C     ICLOSE - LOAD STEP WHERE FRACAS-2 PREDICTS CLOSURE
C     IT     - POWER-TIME STEP INDEX
C     JPEAK  - AXIAL NODE NUMBER BEING ANALYZED ( PEAK POWER NODE )
C     NA     - NUMBER OF AXIAL  NODES
C     NCRP   - NUMBER OF CREEP STEPS PER LOAD STEP
C     NOUT   - OUTPUT WRITE UNIT NUMBER
C     NPSTEP - NUMBER OF POWER-TIME STEPS
C     NR     - NUMBER OF RADIAL NODES
C     NTPS   - NUMBER OF TEMPERATURE POINTS IN THE FUEL
C     NUNIT  - UNITS =1, BRITISH  =0, SI
C     PC     - COOLANT CHANNEL PRESSURE (PASCALS)
C     PG     - ROD INTERNAL GAS PRESSURE (PASCALS)
C     R      - RADIAL NODE LOCATION WHERE TEMPERATURES ARE GIVEN (IN)
C     SH     - DISH SHOULDER WIDTH (IN)
C     TCLAD1 - CLADDING INSIDE TEMPERATURE  (F)
C     TCLAD2 - CLADDING OUTSIDE TEMPERATURE (F)
C     THICK  - CLADDING THICKNESS (IN)
C     TMPDIS - FUEL ROD TEMPERATURE DISTRIBUTION (F)
C
C     ******************************************************************
C
C     THE FOLLOWING COMMON BLOCK CONSISTES OF MATERIAL PROPERTIES
C     USED IN FRACAS 1, FRACAS 2, FRAIL, AND AXISYM
C
      COMMON /MATCNS/ ANRIN  ,COMP   ,CWKF   ,CWNF   ,DELOXY ,FLUX
     +              , FNCK   ,FNCN   ,FOTHTL ,FRDEN  ,FTHELT ,RSTRAN
C
C     ANRIN  - CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSIL TEST
C     (HOOP STRAIN)/(RADIAL STRAIN)
C     COMP   - PUO2 CONTENT (WT%)
C     CWKF   - EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT (M**2/M**2)
```

```
      C   CWNF   - EFFECTIVE COLD WORK FOR STRAIN HARDENING EXPONENT          MATCNS     13
55    C   DELOXY - CHANGE FROM THE OXYGEN CONCENTRATION OF AS RECEIVED        MATCNS     14
      C   CLADDING     (KG OXYGEN/KG ZIRCALOY)                               MATCNS     15
      C   FLUX   - FAST NEUTRON FLUX  (N/M**2-SEC)                           MATCNS     16
      C   FNCK   - EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT (N/M**2)  MATCNS     17
      C   FNCN   - EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING EXPONENT      MATCNS     18
60    C   FOTMTL - FUEL OXYGEN TO METAL RAITO                               MATCNS     19
      C   FRDEN  - (FUEL ACTUAL DENSITY)/(FUEL THEORITICAL DENSITY)          MATCNS     20
      C   FTMELT - UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)                MATCNS     21
      C   RSTRAN - TRUE STRAIN RATE (1/SEC)                                  MATCNS     22
      C                                                                      MATCNS     23
65    C                                                                      MATCNS     24
      C                                                                      AXIWRT     45
            DIMENSION     TMPDIS(NR,NA) , R(NR) , DMWI(I)                  AXIWRT     46
      C                                                                      AXIWRT     47
            REAL  LENGTH                                                   AXIWRT     48
70          DTIMEH = DTIME/3600.E0                                         AXIWRT     49
      C                                                                      AXIWRT     50
            IF (IT.GT.1) GO TO 110                                         AXIWRT     51
      C                                                                      AXIWRT     52
            LENGTH = XPLT/2.E0                                             AXIWRT     53
75    C                                                                      AXIWRT     54
                DO 100 I=1,NR                                              AXIWRT     55
                II = NR-I+1                                                AXIWRT     56
                DMWI(I) = R(II)                                            AXIWRT     57
      100       CONTINUE                                                   AXIWRT     58
80    C                                                                      AXIWRT     59
      C                                                                      AXIWRT     60
            WRITE (NOUT,130) NPSTEP,NTPS                                   AXIWRT     61
      C                                                                      AXIWRT     62
            WRITE (NOUT,160) (DMWI(I),I=1,NTPS)                            AXIWRT     63
85    C                                                                      AXIWRT     64
            WRITE (NOUT,160) SH,DISH                                       AXIWRT     65
      C                                                                      AXIWRT     66
            WRITE (NOUT,140) CLADR,THICK,GAP,LENGTH,NUNIT                  AXIWRT     67
      C                                                                      AXIWRT     68
90    110   CONTINUE                                                       AXIWRT     69
      C                                                                      AXIWRT     70
            RSTRAN = 1.E-5                                                 AXIWRT     71
      C                                                                      AXIWRT     72
            WRITE (NOUT,150) ANRIN,COMP,CWKF,CWNF,DELOXY,FNCK,FNCN,FOTMTL,FRDE AXIWRT  73
95         +N,FTMELT,RSTRAN                                                AXIWRT     74
      C                                                                      AXIWRT     75
            WRITE (NOUT,170) CLOSE,ICLOSE                                  AXIWRT     76
      C                                                                      AXIWRT     77
                DO 120 I=1,NR                                              AXIWRT     78
100             II = NR-I+1                                                AXIWRT     79
                DMWI(I) = TMPDIS(II,JPEAK)                                 AXIWRT     80
      120       CONTINUE                                                   AXIWRT     81
      C                                                                      AXIWRT     82
            WRITE (NOUT,160) (DMWI(I),I=1,NTPS)                            AXIWRT     83
105   C                                                                      AXIWRT     84
            WRITE (NOUT,160) TCLAD1,TCLAD2                                 AXIWRT     85
```

```
                C
                      WRITE (NOUT,170) DTIMEH,NCRP                                  AXIWRT     86
                C                                                                   AXIWRT     87
                                                                                    AXIWRT     88
110                   WRITE (NOUT,160) PG,PC                                        AXIWRT     89
                C                                                                   AXIWRT     90
                      RETURN                                                        AXIWRT     91
                C                                                                   AXIWRT     92
                130   FORMAT (215)                                                  AXIWRT     93
115             140   FORMAT (4E12.5,215)                                           AXIWRT     94
                150   FORMAT (11E12.5)                                              AXIWRT     95
                160   FORMAT (8E12.5)                                               AXIWRT     96
                170   FORMAT (E12.5,I5)                                             AXIWRT     97
                      END                                                           AXIWRT     98
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	AXIWRT	1	112

VARIABLES

SN		TYPE		RELOCATION								
0	ANRIN	REAL		MATCNS	REFS	47	94					
0	CLADR	REAL		F.P.	REFS	88	DEFINED	1				
0	CLOSE	REAL		F.P.	REFS	97	DEFINED	1				
1	COMP	REAL		MATCNS	REFS	47	94					
2	CWKF	REAL		MATCNS	REFS	47	94					
3	CWNF	REAL		MATCNS	REFS	47	94					
4	DELOXY	REAL		MATCNS	REFS	47	94					
0	DISH	REAL		F.P.	REFS	86	DEFINED	1				
234	DMWI	REAL	ARRAY		REFS	67	84	104	DEFINED	78	101	
0	DTIME	REAL		F.P.	REFS	70	DEFINED	1				
231	DTIMEH	REAL			REFS	108	DEFINED	70				
5	FLUX	REAL		MATCNS	REFS	47						
6	FNCK	REAL		MATCNS	REFS	47	94					
7	FNCN	REAL		MATCNS	REFS	47	94					
10	FOTMTL	REAL		MATCNS	REFS	47	94					
11	FRDEN	REAL		MATCNS	REFS	47	94					
12	FTMELT	REAL		MATCNS	REFS	47	94					
0	GAP	REAL		F.P.	REFS	88	DEFINED	1				
0	HPLT	REAL		F.P.	REFS	74	DEFINED	1				
232	I	INTEGER			REFS	77	78	84	100	101	104	
					DEFINED	76	84	99	104			
0	ICLOSE	INTEGER		F.P.	REFS	97	DEFINED	1				
233	II	INTEGER			REFS	78	101	DEFINED	77	100		
0	IT	INTEGER		F.P.	REFS	72	DEFINED	1				
0	JPEAK	INTEGER		F.P.	REFS	101	DEFINED	1				
230	LENGTH	REAL			REFS	69	88	DEFINED	74			
0	NA	INTEGER		F.P.	REFS	67	DEFINED	1				
0	NCRP	INTEGER		F.P.	REFS	108	DEFINED	1				
0	NOUT	INTEGER		F.P.	DEFINED	1	I/O REFS	82	84	86	88	94

VARIABLES	SN	TYPE		RELOCATION							
						97	104	106	108	110	
0	NPSTEP	INTEGER		F.P.	REFS	82	DEFINED	1			
0	NR	INTEGER		F.P.	REFS	2*67	76	77	99	100	
					DEFINED	1					
0	NTPS	INTEGER		F.P.	REFS	82	84	104	DEFINED	1	
0	NUNIT	INTEGER		F.P.	REFS	88	DEFINED	1			
0	PC	REAL		F.P.	REFS	110	DEFINED	1			
0	PG	REAL		F.P.	REFS	110	DEFINED	1			
0	R	REAL	ARRAY	F.P.	REFS	67	78	DEFINED	1		
13	RSTRAN	REAL		MATCNS	REFS	47	94	DEFINED	92		
0	SH	REAL		F.P.	REFS	86	DEFINED	1			
0	TCLAD1	REAL		F.P.	REFS	106	DEFINED	1			
0	TCLAD2	REAL		F.P.	REFS	106	DEFINED	1			
0	THICK	REAL		F.P.	REFS	88	DEFINED	1			
0	TMPDIS	REAL	ARRAY	F.P.	REFS	67	101	DEFINED	1		

VARIABLES USED AS FILE NAMES, SEE ABOVE

STATEMENT LABELS			DEF LINE	REFERENCES				
0	100		79	76				
53	110		90	72				
0	120		102	99				
211	130	FMT	114	82				
213	140	FMT	115	88				
216	150	FMT	116	94				
220	160	FMT	117	84	86	104	106	110
222	170	FMT	118	97	108			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
24	100	I	76 79	11B	INSTACK
63	120	I	99 102	13B	OPT

COMMON BLOCKS	LENGTH
MATCNS	12

STATISTICS

PROGRAM LENGTH	245B	165
SCM LABELED COMMON LENGTH	14B	12

140000B SCM USED

CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY	PRPID	PHYPR	CAGRW	CANEL	CANSO	CBRTL	CCLPS
CCP	CCRPR	CELST	CELMD	CESID	CFATG	CHITX	CHSCP
CHPTK	CKMN	CMHRD	CMLMT	COBLD	COROS	CSHER	CSIGM
CSRPT	CSTRN	CSTRS	CSTRNI	CTHCN	CTHXP	CTXTR	FCP
FCREP	FELMD	FEMIS	FRACS	FGSRL	FHTPS	FPOIR	FRSTR
FSWEL	FTHCN	FTHXP	FUDNS	FVPRS	GTHCN	GVSCO	ZOMIS
ZTCN	EMCTN	EMCPR	EMCXP	EMFCP	EMFD	EMFPR	EMFS
EMFTN	EMCCP	EMCLM	EMFXP	EMSTN	EMGTN		

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$	TIDY	PRPID	PHYPR	CAGRW	CANEL	CANSO	CBRTL
CCLPS	CCP	CCRPR	CELST	CELMD	CESID	CFATG	CHITX
CHSCP	CHPTK	CKMN	CMHRD	CMLMT	COBLD	COROS	CSHER
CSIGM	CSRPT	CSTRN	CSTRS	CSTRNI	CTHCN	CTHXP	CTXTR
FCP	FCREP	FELMD	FEMIS	FRACS	FGSRL	FHTPS	FPOIR
FRSTR	FSWEL	FTHCN	FTHXP	FUDNS	FVPRS	GTHCN	GVSCO
ZOMIS	ZTCN	EMCTN	EMCPR	EMCXP	EMFCP	EMFD	EMFPR
EMFS	EMFTN	EMCCP	EMCLM	EMFXP	EMSTN	EMGTN	

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

YANK$$$	TIDY	PRPID	PHYPR	CAGRW	CANEL	CANSO	CBRTL
CCLPS	CCP	CCRPR	CELST	CELMD	CESID	CFATG	CHITX
CHSCP	CHPTK	CKMN	CMHRD	CMLMT	COBLD	COROS	CSHER
CSIGM	CSRPT	CSTRN	CSTRS	CSTRNI	CTHCN	CTHXP	CTXTR
FCP	FCREP	FELMD	FEMIS	FRACS	FGSRL	FHTPS	FPOIR
FRSTR	FSWEL	FTHCN	FTHXP	FUDNS	FVPRS	GTHCN	GVSCO
ZOMIS	ZTCN	EMCTN	EMCPR	EMCXP	EMFCP	EMFD	EMFPR
EMFS	EMFTN	EMCCP	EMCLM	EMFXP	EMSTN	EMGTN	

TIDY	PRPID	PHYPR	CAGRW	CANEL	CANSO	CBRTL	CCLPS
CCP	CCRPR	CELST	CELMD	CESID	CFATG	CHITX	CHSCP
CHPTK	CKMN	CMHRD	CMLMT	COBLD	COROS	CSHER	CSIGM
CSRPT	CSTRN	CSTRS	CSTRNI	CTHCN	CTHXP	CTXTR	FCP
FCREP	FELMD	FEMIS	FRACS	FGSRL	FHTPS	FPOIR	FRSTR
FSWEL	FTHCN	FTHXP	FUDNS	FVPRS	GTHCN	GVSCO	ZOMIS
ZTCN	EMCTN	EMCPR	EMCXP	EMFCP	EMFD	EMFPR	EMFS
EMFTN	EMCCP	EMCLM	EMFXP	EMSTN	EMGTN		

THIS UPDATE REQUIRED 35000B WORDS OF CORE.

```
      SUBROUTINE PROPID (A)                                                  PRPID      2
C                                                                            PRPID      3
C   SUBROUTINE IDENTIFIES CURRENT MATERIAL PROPERTY MODULE MOD.NUMBER        PRPID      4
C   AT TOP OF EACH PAGE OF PRINTOUT WHEN CALLED.                             PRPID      5
C                                                                            PRPID      6
      COMMON   / LACMDL / MAXIDX, EMFLAG                                     PRPID      7
      DIMENSION CODEID(3), A(3)                                              PRPID      8
      DIMENSION  EMCODE (3) ,                                                PRPID      9
     +           EMFLAG(1)                                                   PRPID     10
      DATA  NMAX  /3    /,                                                   PRPID     11
     +       ON    /2HON /,                                                  PRPID     12
     +        OFF   /3HOFF/,                                                 PRPID     13
     +         LOCIDX/  1  /                                                 PRPID     14
C                                                                            PRPID     15
C   * DATA STATEMENT BELOW SHOULD BE UPDATED EVERY TIME THE MATERIAL          PRPID     16
C   * PROPERTY MODULE IS CHANGED.  UPDATE ONLY THE MODIFICATION NUMBER.      PRPID     17
C                                                                            PRPID     18
      DATA CODEID / 8H MAT PRO,8H MOD 11 ,8H REV 1  /,                       PRPID     19
     +     EMCODE / 8H MAT PRO,8H MOD 11 ,8H EMODEL /                        PRPID     20
C                                                                            PRPID     21
          DO 100 J=1,NMAX                                                    PRPID     22
          IF (EMFLAG(LOCIDX).EQ.ON) A(J) = EMCODE(J)                         PRPID     23
          IF (EMFLAG(LOCIDX).EQ.OFF) A(J) = CODEID(J)                        PRPID     24
  100     CONTINUE                                                           PRPID     25
      RETURN                                                                 PRPID     26
      END                                                                    PRPID     27
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	PROPID	1	25

VARIABLES	SN	TYPE		RELOCATION							
0	A	REAL	ARRAY	F.P.	REFS	7	DEFINED	1	22	23	
34	CODEID	REAL	ARRAY		REFS	7	23	DEFINED	18		
37	EMCODE	REAL	ARRAY		REFS	8	22	DEFINED	18		
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	6	8	22	23		
33	J	INTEGER			REFS	2*22	2*23	DEFINED	21		
32	LOCIDX	INTEGER			REFS	22	23	DEFINED	10		
0	MAXIDX	INTEGER		LACMDL	REFS	6					
27	NMAX	INTEGER			REFS	21	DEFINED	10			
31	OFF	REAL			REFS	23	DEFINED	10			
30	ON	REAL			REFS	22	DEFINED	10			

STATEMENT LABELS		DEF LINE	REFERENCES
0	100	24	21

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
11	100	J	21 24	15B	OPT

COMMON BLOCKS	LENGTH
LACMDL	2

STATISTICS

PROGRAM LENGTH	45B	37
SCM LABELED COMMON LENGTH	2B	2

140000B SCM USED

```
      SUBROUTINE PHYPRP                                                 PHYPR       2
C                                                                       PHYPR       3
C     PHYPRP RETURNS UO2, (U,PU)O2, AND ZIRCALOY MELTING POINTS         PHYPR       4
C     AND HEATS OF  FUSION, AND ZIRCONIUM AND ZIRCALOY ALPHA TO BETA    PHYPR       5
C     TRANSITION TEMPERATURES.                                          PHYPR       6
C                                                                       PHYPR       7
      COMMON  / PHYPRO / FTMELT,FHEFUS,CTMELT,CHEFUS,CTRANB,            PHYPR       8
     +                   CTRANE,CTRANZ FDELTA,BU,COMP,DELOXY           PHYPR       9
C                                                                       PHYPR      10
C     FTMELT : OUTPUT UO2 OR MIXED OXIDE FUEL MELTING POINTS (K)        PHYPR      11
C     FHEFUS : OUTPUT UO2 OR MIXED OXIDE FUEL HEAT OF FUSION (J/KG)     PHYPR      12
C     CTMELT : OUTPUT ZR CLAD MELTING POINT (K)                         PHYPR      13
C     CHEFUS : OUTPUT ZR CLAD HEAT OF FUSION (J/KG).                    PHYPR      14
C     CTRANB : OUTPUT START OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)  PHYPR      15
C     CTRANE : OUTPUT END OF ZR-4 ALPHA-BETA TRANSUS TEMPERATURE (K)    PHYPR      16
C     CTRANZ : OUTPUT ZR ISOTHERMAL ALPHA-BETA TRANSUS TEMPERATURE (K)  PHYPR      17
C     FDELTA : OUTPUT LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)    PHYPR      18
C                                                                       PHYPR      19
C     BU     : INPUT BURNUP (MW-S/KG-U)                                 PHYPR      20
C     COMP   : INPUT PUO2 CONTENT (WT%)                                 PHYPR      21
C     DELOXY : INPUT OXYGEN CONCENTRATION - OXYGEN CONCENTRATION        PHYPR      22
C     OF AS RECEIVED CLADDING (KG OXYGEN/KG ZIRCALOY)                   PHYPR      23
C                                                                       PHYPR      24
C     THE UO2 AND ZR CLADDING  MELTING POINTS AND HEATS OF FUSION ARE   PHYPR      25
C     TAKEN FROM THE FOLLOWING REFERENCES.  UO2 FUEL MELTING POINT OF   PHYPR      26
C     3113K FROM H.C.BRASSFIELD ET AL GEMP-482. UO2 HEAT OF FUSION      PHYPR      27
C     OF 17.7 KCAL/MOLE FROM L.LEIBOWITZ ET AL, J.NUC.MAT. 39 P 115     PHYPR      28
C     (1971). CLADDING MELTING POINT OF 2098 K FROM M.L. PICKLESIMER    PHYPR      29
C     PRIVATE COMMUNICATION. CLADDING HEAT OF FUSION OF 4.9 KCAL/MOL    PHYPR      30
C     FROM BRASSFIELD ET AL, GEMP-482.                                  PHYPR      31
C                                                                       PHYPR      32
C     BEGINNING AND END OF ALPHA-BETA TRANSUS ARE FROM DATA IN          PHYPR      33
C     FIGURE III.33 OF ANL-76-49                                        PHYPR      34
C     ISOTHERMAL ZIRCONIUM ALPHA-BETA TRANSUS TEMPERATURE IS 1135 K     PHYPR      35
C     TAKEN FROM B.LUSTMAN & F.KERZE "THE METALLURGY OF ZIRCONIUM"      PHYPR      36
C     MCGRAW-HILL BOOK CO., NEW YORK, 1955                              PHYPR      37
C                                                                       PHYPR      38
C     MIXED OXIDE MELTING POINT  WAS OBTAINED FROM LYON ET AL, J. NUC.  PHYPR      39
C     MAT., 22 (1967) P 332                                             PHYPR      40
C                                                                       PHYPR      41
C     PHYPRO WAS CODED BY V.F. BASTON IN MAY 1974                       PHYPR      42
C     MODIFIED BY C.S. OLSEN IN FEB. 1975                               PHYPR      43
C     MODIFIED BY B.W. BURNHAM IN NOV. 1977                             PHYPR      44
C     MODIFIED BY D.L. HAGRMAN IN JUNE 1979                             PHYPR      45
C                                                                       PHYPR      46
      COMMON   / LACMDL / MAXIDX, EMFLAG                                PHYPR      47
      DIMENSION   EMFLAG(1)                                             PHYPR      48
      DATA     ON       / 2HON    /,                                    PHYPR      49
     +           OFF      / 3HOFF   /,                                  PHYPR      50
     +           LOCIDX   / 2       /                                  PHYPR      51
C                                                                       PHYPR      52
      SLDUS(C) = 2840.0-5.41395*C+7.468390E-3*C*C                       PHYPR      53
      LIQDUS(C) = 2840.0-3.21860*C-1.448518E-2*C*C                      PHYPR      54
```

```
                      FBU = BU/86.4                                                    PHYPR      55
55                    IF (COMP.GT.0.0) GO TO 100                                       PHYPR      56
                C                                                                      PHYPR      57
                      FTMELT = 3113.15-32.0*FBU/10000.0                                PHYPR      58
                      FDELTA = 1.0E-10                                                 PHYPR      59
                      GO TO 110                                                        PHYPR      60
60              C                                                                      PHYPR      61
                100   CI = COMP                                                        PHYPR      62
                      FTMELT = SLDUS(CI)+273.15-32.0*FBU/10000.0                       PHYPR      63
                      FDELTA = LIQDUS(CI)-SLDUS(CI)-32.0*FBU/10000.0                   PHYPR      64
                C                                                                      PHYPR      65
65              110   FHEFUS = 27.4E+4                                                 PHYPR      66
                      CTMELT = 2098.15                                                 PHYPR      67
                      CHEFUS = 22.5E+04                                                PHYPR      68
                C                                                                      PHYPR      69
                      WFOX = DELOXY+0.0012                                             PHYPR      70
70                    CTRANB = 1094.+WFOX*(-1.289E+03+WFOX*7.914E+05)                  PHYPR      71
                      IF (WFOX.LT.0.025) GO TO 120                                     PHYPR      72
                      CTRANB = 1556.4+3.8281E+04*(WFOX-0.025)                          PHYPR      73
                120   CTRANE = 392.46*((100.*DELOXY+0.1242807)**2+3.1417)              PHYPR      74
                      IF (DELOXY.LT.4.7308937E-03) GO TO 130                           PHYPR      75
75                    CTRANE = (100.*DELOXY+0.12)*491.157+1081.7413                    PHYPR      76
                130   CONTINUE                                                         PHYPR      77
                      CTRANZ = 1135.15                                                 PHYPR      78
                C                                                                      PHYPR      79
                      CALL DIALOT (DELOXY,29,FDIALA,FDIALM)                            PHYPR      80
80                    CTRANB = (CTRANB+FDIALA)*FDIALM                                  PHYPR      81
                      CTRANE = (CTRANE+FDIALA)*FDIALM                                  PHYPR      82
                      CTRANZ = (CTRANZ+FDIALA)*FDIALM                                  PHYPR      83
                      RETURN                                                           PHYPR      84
                      END                                                              PHYPR      85
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
2	PHYPRP	1	83

VARIABLES		SN	TYPE		RELOCATION								
10	BU		REAL		PHYPRO	REFS	7	54					
3	CHEFUS		REAL		PHYPRO	REFS	7	DEFINED	67				
11	COMP		REAL		PHYPRO	REFS	7	55	61				
2	CTMELT		REAL		PHYPRO	REFS	7	DEFINED	66				
4	CTRANB		REAL		PHYPRO	REFS	7	80	DEFINED	70	72	80	
5	CTRANE		REAL		PHYPRO	REFS	7	81	DEFINED	73	75	81	
6	CTRANZ		REAL		PHYPRO	REFS	7	82	DEFINED	77	82		
203	CI		REAL			REFS	3*62	6*63	DEFINED	61			
12	DELOXY		REAL		PHYPRO	REFS	7	69	73	74	75	79	
1	EMFLAG		REAL	ARRAY	LACMDL	REFS	46	47					
202	FBU		REAL			REFS	57	62	63	DEFINED	54		

VARIABLES	SN	TYPE	RELOCATION							
7	FDELTA	REAL	PHYPRO	REFS	7	DEFINED	58	63		
205	FDIALA	REAL		REFS	79	80	81	82		
206	FDIALM	REAL		REFS	79	80	81	82		
1	FHEFUS	REAL	PHYPRO	REFS	7	DEFINED	65			
0	FTMELT	REAL	PHYPRO	REFS	7	DEFINED	57	62		
142	LOCIDX	* INTEGER		DEFINED	48					
0	MAXIDX	INTEGER	LACMDL	REFS	46					
141	OFF	* REAL		DEFINED	48					
140	ON	* REAL		DEFINED	48					
204	WFOX	REAL		REFS	2*70	71	72	DEFINED	69	

EXTERNALS	TYPE	ARGS	REFERENCES
DIALOT		4	79

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
LIQDUS	INTEGER	1	SF	53	63	
SLDUS	REAL	1	SF	52	62	63

STATEMENT LABELS		DEF LINE	REFERENCES
20	100	61	55
50	110	65	59
77	120	73	71
115	130	76	74

COMMON BLOCKS	LENGTH
PHYPRO	11
LACMDL	2

STATISTICS

PROGRAM LENGTH	207B	135
SCM LABELED COMMON LENGTH	15B	13

140000B SCM USED

```
      C                                                                      PHYPR   86
      C                                                                      PHYPR   87
            FUNCTION CAGROW (CTEMP,CFLUX,TIME,CATEXF,COLDW)                  CAGRW    2
      C                                                                      CAGRW    3
      C     CAGROW CALCULATES AXIAL CLADDING GROWTH STRAIN AS A FUNCTION OF  CAGRW    4
      C     TEMPERATURE (CTEMP), FAST NEUTRON FLUX (CFLUX), TIME,            CAGRW    5
      C     AXIAL TEXTURE FACTOR (CATEXF), AND COLD WORK (COLDW).            CAGRW    6
      C                                                                      CAGRW    7
      C     CTEMP  = INPUT CLADDING TEMPERATURE (K)                          CAGRW    8
      C     CFLUX  = INPUT FAST NEUTRON FLUX ((NEUTRONS/M**2)/S)             CAGRW    9
      C     TIME   = INPUT TIME AT TEMPERATURE (S)                           CAGRW   10
      C     CATEXF = INPUT TEXTURE FACTOR FOR THE AXIAL DIRECTION (UNITLESS) CAGRW   11
      C     COLDW  = INPUT COLD WORK (METERS**2/METER**2)                    CAGRW   12
      C     CAGROW = OUTPUT AXIAL CLADDING GROWTH STRAIN (M/M)               CAGRW   13
      C                                                                      CAGRW   14
      C     THE EQUATION USED IN THIS SUBROUTINE WAS BASED ON DATA FROM      CAGRW   15
      C     (1) P.H. KREYNS QUOTED BY E. DUNCOMBE, J.E. MAYER AND W.A. COFFMAN CAGRW  16
      C     COMPARISONS WITH EXPERIMENT OF CALCULATED CHANGES AND            CAGRW   17
      C     FAILURE ANALYSIS OF IRRADIATED BULK OXIDE FUEL TEST RODS         CAGRW   18
      C     USING THE CYGRO-1 COMPUTER PROGRAM, WESTINGHOUSE REPORT          CAGRW   19
      C     WAPD-TM-583, 1966                                                CAGRW   20
      C     (2) J.E. HARBOTTLE  "THE TEMPERATURE AND NEUTRON DOSE DEPENDENCE CAGRW   21
      C     OF IRRADIATION GROWTH IN ZIRCALOY-2" IN ASTM-STP-484 (1970)      CAGRW   22
      C     (3) R.C. DANIEL, "IN-PILE DIMENSIONAL CHANGES OF ZIRCALOY-4 TUBING CAGRW  23
      C     HAVING LOW HOOP STRESSES (LWBR DEVELOPMENT PROGRAM)",            CAGRW   24
      C     NUCLEAR TECH. 14 (1972)                                          CAGRW   25
      C     (4) R.B. ADAMSON  FROM FIDLERIS, AECL-4766                       CAGRW   26
      C                                                                      CAGRW   27
      C     CAGROW CODED BY D.L. HAGRMAN, AUGUST 1975                        CAGRW   28
      C                                                                      CAGRW   29
            T = CTEMP                                                        CAGRW   30
            IF (T.GT.633.0) T = 633.0                                        CAGRW   31
            IF (T.LT.313.0) T = 313.0                                        CAGRW   32
      C                                                                      CAGRW   33
            CAGROW = 1.407E-16*EXP(2.408E+2/T)*SQRT(CFLUX*TIME)*(1.0-3.0*CATEX CAGRW 34
           +F)*(1.0+0.02*COLDW)                                              CAGRW   35
            RETURN                                                           CAGRW   36
            END                                                              CAGRW   37
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	CAGROW	3	37

VARIABLES

		SN	TYPE	RELOCATION					
57	CAGROW		REAL		DEFINED	35			
0	CATEXF		REAL	F.P.	REFS	35	DEFINED	3	
0	CFLUX		REAL	F.P.	REFS	35	DEFINED	3	
0	COLDW		REAL	F.P.	REFS	35	DEFINED	3	

```
VARIABLES     SN  TYPE          RELOCATION
    0  CTEMP      REAL               F.P.        REFS      31    DEFINED      3
   60  T          REAL                           REFS      32         33     35    DEFINED      31      32      33
    0  TIME       REAL               F.P.        REFS      35    DEFINED      3

EXTERNALS          TYPE   ARGS      REFERENCES
       EXP         REAL     1 LIBRARY     35
       SQRT        REAL     1 LIBRARY     35

STATISTICS
  PROGRAM LENGTH                 61B      49
        140000B SCM USED
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```
      C                                                                      CAGRW   38
      C                                                                      CAGRW   39
            SUBROUTINE CANEAL (CFLUX,DELH,CTEMP,RTEMP,FNCK,FNCN,CWKF,CWNF)   CANEL    2
      C                                                                      CANEL    3
      C     CANEAL CALCULATES THE CHANGE IN EFFECTIVE FLUENCE AND            CANEL    4
      C     EFFECTIVE COLD WORK DURING A TIME STEP                           CANEL    5
      C                                                                      CANEL    6
      C     FNCK  : OUTPUT EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT   CANEL    7
      C     AT TIME STEP FINISH (NEUTRONS/(M**2))                            CANEL    8
      C     FNCN  : OUTPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING       CANEL    9
      C     EXPONENT AT TIME STEP FINISH (NEUTRONS/(M**2))                   CANEL   10
      C     CWKF  : OUTPUT EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT      CANEL   11
      C     AT TIME STEP FINISH (UNITLESS RATIO OF AREAS)                    CANEL   12
      C     CWNF  : OUTPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING          CANEL   13
      C     EXPONENT AT TIME STEP FINISH (UNITLESS RATIO OF AREAS)           CANEL   14
      C                                                                      CANEL   15
      C     CFLUX : INPUT FAST NEUTRON FLUX ((NEUTRONS/M**2)/S)              CANEL   16
      C     DELH  : INPUT TIME STEP SIZE (S)                                 CANEL   17
      C     CTEMP : INPUT CLADDING TEMPERATURE AT START OF TIME STEP (K)     CANEL   18
      C     RTEMP : INPUT AVERAGE RATE OF CHANGE OF TEMPERATURE (K/S)        CANEL   19
      C     FNCK  : INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH COEFFICIENT    CANEL   20
      C     AT TIME STEP START (NEUTRONS/(M**2))                             CANEL   21
      C     FNCN  : INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING        CANEL   22
      C     EXPONENT AT TIME STEP START (NEUTRONS/(M**2))                    CANEL   23
      C     CWKF  : INPUT EFFECTIVE COLD WORK FOR STRENGTH COEFFICIENT       CANEL   24
      C     AT TIME STEP START (UNITLESS RATIO OF AREAS)                     CANEL   25
      C     CWNF  : INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING           CANEL   26
      C     EXPONENT AT TIME STEP START (UNITLESS RATIO OF AREAS)            CANEL   27
      C                                                                      CANEL   28
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     CANEL   29
      C     (1)  A. A. BAUER, L. M. LOWRY, AND J. S. PERRIN, EVALUATING      CANEL   30
      C     STRENGTH AND DUCTILITY OF IRRADIATED ZIRCALOY. QUARTERLY         CANEL   31
      C     PROGRESS REPORT FOR APRIL THROUGH JUNE 1976,                     CANEL   32
      C     BMI-NUREG-1956 (JULY 1976)                                       CANEL   33
      C     (2)  A. A. BAUER, L. M. LOWRY, AND J. S. PERRIN, EVALUATING      CANEL   34
      C     STRENGTH AND DUCTILITY OF IRRADIATED ZIRCALOY.                   CANEL   35
      C     QUARTERLY PROGRESS REPORT FOR JULY THROUGH                       CANEL   36
      C     SEPTEMBER, 1976, BMI-NUREG-1961 (OCTOBER 1976)                   CANEL   37
      C     (3)  A. A. BAUER, L. M. LOWRY, AND J. S. PERRIN, EVALUATING      CANEL   38
      C     STRENGTH AND DUCTILITY OF IRRADIATED ZIRCALOY. QUARTERLY         CANEL   39
      C     PROGRESS REPORT FOR OCTOBER THROUGH DECEMBER 1976,               CANEL   40
      C     BMI-NUREG-1967 (JANUARY 1977)                                    CANEL   41
      C                                                                      CANEL   42
      C     CODED BY D. L. HAGRMAN OCTOBER 1977                              CANEL   43
      C     MODIFIED BY G. A. REYMANN AND M. A. MORGAN MARCH 1978            CANEL   44
      C     MODIFIED BY D. L. HAGRMAN JUNE 1978                              CANEL   45
      C                                                                      CANEL   46
            T = CTEMP                                                        CANEL   47
      C                                                                      CANEL   48
      C     UPDATE FLUENCE                                                   CANEL   49
            FNCK = FNCK+CFLUX*DELH                                           CANEL   50
            FNCN = FNCN+CFLUX*DELH                                           CANEL   51
      C                                                                      CANEL   52
```

```
      C   ANNEALING MODEL                                                    CANEL      53
   55       IF (T.LE.5.0E+02) GO TO 140                                      CANEL      54
            IF (CWKF.LE.1.0E-20) GO TO 100                                   CANEL      55
            QK = 2.33E+18                                                    CANEL      56
            BK = (1.504E+00)*(1.0E+00+(2.2E-25)*FNCK)                        CANEL      57
            DISOK = QK*RTEMP*DELH*(T**(-7))*6.0                              CANEL      58
   60       IF (ABS(DISOK).LT.1.0E-04) FNISOK = 1.0                          CANEL      59
            IF (ABS(DISOK).GE.1.5E+02) GO TO 130                             CANEL      60
            IF (ABS(DISOK).GE.1.0E-04) FNISOK = (EXP(DISOK)-1.0)/DISOK       CANEL      61
            CWKF = EXP(-BK*DELH*EXP(-QK*(T**(-6)))*FNISOK)*CWKF              CANEL      62
      100   IF (CWNF.LE.1.0E-20) GO TO 110                                   CANEL      63
   65       C                                                                CANEL      64
            QN = 2.33E+18                                                    CANEL      65
            BN = (1.504E+00)*(1.0E+00+(2.2E-25)*FNCN)*8.0                    CANEL      66
            DISON = QN*RTEMP*DELH*(T**(-7))*6.0                              CANEL      67
            IF (ABS(DISON).LT.1.0E-04) FNISON = 1.0                          CANEL      68
   70       IF (ABS(DISON).GE.1.0E-04) FNISON = (EXP(DISON)-1.0)/DISON       CANEL      69
            IF (ABS(DISON).GE.1.50E+02) GO TO 130                            CANEL      70
            CWNF = EXP(-BN*DELH*EXP(-QN*(T**(-6)))*FNISON)*CWNF              CANEL      71
      110   IF (FNCK.LE.1.0E+14) GO TO 120                                   CANEL      72
            C                                                                CANEL      73
   75       BKI = 2.49E-06                                                   CANEL      74
            QKI = 5.35E+23                                                   CANEL      75
            DISOKI = QKI*RTEMP*DELH*(T**(-9))*8.0                            CANEL      76
            IF (ABS(DISOKI).LT.1.0E-04) FNISKI = 1.0                         CANEL      77
            IF (ABS(DISOKI).GE.1.5E+02) GO TO 130                            CANEL      78
   80       IF (ABS(DISOKI).GE.1.0E-04) FNISKI = (EXP(DISOKI)-1.0)/DISOKI    CANEL      79
            FNCK = FNCK/1.0E+20                                              CANEL      80
            FNCK = (BKI*DELH*(EXP(-QKI*(T**(-8))))*FNISKI+(FNCK)**(-1))**(-1) CANEL     81
            FNCK = FNCK*1.0E+20                                              CANEL      82
            C                                                                CANEL      83
   85       120   IF (FNCN.LE.1.0E+14) GO TO 140                             CANEL      84
            BNI = BKI*1000.                                                  CANEL      85
            QNI = QKI                                                        CANEL      86
            FNISNI = FNISKI                                                  CANEL      87
            FNCN = FNCN/1.0E+20                                              CANEL      88
   90       FNCN = (BNI*DELH*(EXP(-QNI*(T**(-8))))*FNISNI+(FNCN)**(-1))**(-1) CANEL     89
            FNCN = FNCN*1.0E+20                                              CANEL      90
            GO TO 140                                                        CANEL      91
      130   WRITE 150                                                        CANEL      92
            C                                                                CANEL      93
   95       140   CONTINUE                                                   CANEL      94
            RETURN                                                           CANEL      95
            C                                                                CANEL      96
      150   FORMAT (51H  TIME STEP TOO LARGE FOR CLADDING ANNEALING MODEL )  CANEL      97
            END                                                              CANEL      98
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CANEAL 3 96

VARIABLES	SN	TYPE	RELOCATION									
412	BK	REAL		REFS	63	DEFINED	58					
421	BKI	REAL		REFS	82	86	DEFINED	75				
416	BN	REAL		REFS	72	DEFINED	67					
425	BNI	REAL		REFS	90	DEFINED	86					
0	CFLUX	REAL	F.P.	REFS	51	52	DEFINED	3				
0	CTEMP	REAL	F.P.	REFS	48	DEFINED	3					
0	CWKF	REAL	F.P.	REFS	56	63	DEFINED	3	63			
0	CWNF	REAL	F.P.	REFS	64	72	DEFINED	3	72			
0	DELH	REAL	F.P.	REFS	51	52	59	63	68	72	77	
				82	90	DEFINED	3					
413	DISOK	REAL		REFS	60	61	3*62	DEFINED	59			
423	DISOKI	REAL		REFS	78	79	3*80	DEFINED	77			
417	DISON	REAL		REFS	69	3*70	71	DEFINED	68			
0	FNCK	REAL	F.P.	REFS	51	58	73	81	82	83		
				DEFINED	3	51	81	82	83			
0	FNCN	REAL	F.P.	REFS	52	67	85	89	90	91		
				DEFINED	3	52	89	90	91			
424	FNISKI	REAL		REFS	82	88	DEFINED	78	80			
427	FNISNI	REAL		REFS	90	DEFINED	88					
414	FNISOK	REAL		REFS	63	DEFINED	60	62				
420	FNISON	REAL		REFS	72	DEFINED	69	70				
411	QK	REAL		REFS	59	63	DEFINED	57				
422	QKI	REAL		REFS	77	82	87	DEFINED	76			
415	QN	REAL		REFS	68	72	DEFINED	66				
426	QNI	REAL		REFS	90	DEFINED	87					
0	RTEMP	REAL	F.P.	REFS	59	68	77	DEFINED	3			
410	T	REAL		REFS	55	59	63	68	72	77	82	
				90	DEFINED	48						

FILE NAMES	MODE			
OUTPUT	FMT	WRITES	93	

EXTERNALS	TYPE	ARGS		REFERENCES							
EXP	REAL	1	LIBRARY	62	2*63	70	2*72	80	82	90	

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES							
ABS	REAL	1	INTRIN		60	61	62	69	70	71	78	79
					80							

STATEMENT LABELS			DEF LINE	REFERENCES		
103	100		64	56		
163	110		73	64		
253	120		85	73		
317	130		93	61	71	79
322	140		95	55	85	92
362	150	FMT	98	93		

STATISTICS
PROGRAM LENGTH 430B 280
140000B SCM USED

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      C                                                                      CANEL      99
      C                                                                      CANEL     100
            SUBROUTINE CANISO (DEP1,DEP2,DEP3,CTEMP,F1P,F2P,F3P,A1D,A2D,A3D,A1 CANSO       2
           +S,A2S,A3S,A1E,A2E,A3E)                                           CANSO       3
      C                                                                      CANSO       4
      C     CANISO CALCULATES COEFFICIENTS OF ANISOTROPY FOR RELATING         CANSO       5
      C     EFFECTIVE STRESS TO STRESS COMPONENTS AND RELATING               CANSO       6
      C     EFFECTIVE STRAIN TO STRAIN COMPONENTS                            CANSO       7
      C                                                                      CANSO       8
      C     A1S   = OUTPUT COEFFICIENT OF ANISOTROPY FOR CALCULATING         CANSO       9
      C     EFFECTIVE STRESS (UNITLESS)                                      CANSO      10
      C     A2S   = OUTPUT COEFFICIENT OF ANISOTROPY FOR CALCULATING         CANSO      11
      C     EFFECTIVE STRESS (UNITLESS)                                      CANSO      12
      C     A3S   = OUTPUT COEFFICIENT OF ANISOTROPY FOR CALCULATING         CANSO      13
      C     EFFECTIVE STRESS (UNITLESS)                                      CANSO      14
      C                                                                      CANSO      15
      C     THE FORM OF THE EQUATION FOR EFFECTIVE STRESS IS ASSUMED TO BE   CANSO      16
      C     EFFECTIVE STRESS = ( A1S * (SIGMA 1 - SIGMA 2)**2 +              CANSO      17
      C     A2S * (SIGMA 2 - SIGMA 3)**2 +                                   CANSO      18
      C     A3S * (SIGMA 3 - SIGMA 1)**2 )**0.5                              CANSO      19
      C     WHERE SIGMA 1, SIGMA 2 AND SIGMA 3 ARE PRINCIPAL AXIS            CANSO      20
      C     STRESS COMPONENTS                                                CANSO      21
      C                                                                      CANSO      22
      C     A1E   = OUTPUT COEFFICIENT OF ANISOTROPY FOR CALCULATING         CANSO      23
      C     EFFECTIVE STRAIN                                                 CANSO      24
      C     A2E   = OUTPUT COEFFICIENT OF ANISOTROPY FOR CALCULATING         CANSO      25
      C     EFFECTIVE STRAIN                                                 CANSO      26
      C     A3E   = OUTPUT COEFFICIENT OF ANISOTROPY FOR CALCULATING         CANSO      27
      C     EFFECTIVE STRAIN                                                 CANSO      28
      C                                                                      CANSO      29
      C     THE FORM OF THE EQUATION FOR EFFECTIVE STRAIN IS ASSUMED TO BE   CANSO      30
      C     EFFECTIVE STRAIN = SUM OF EFFECTIVE STRAIN INCREMENTS            CANSO      31
      C                                                                      CANSO      32
      C     WITH THE STRAIN INCREMENTS DEFINED IN TERMS OF STRAIN            CANSO      33
      C     INCREMENT COMPONENTS BY                                          CANSO      34
      C                                                                      CANSO      35
      C     DEL EFFECTIVE STRAIN = (1.0/(A1E*A2E + A2E*A3E + A3EA1E)) *      CANSO      36
      C     A1E * (A2E * DEP1 - A3E * DEP2)**2) +                            CANSO      37
      C     A2E * (A3E * DEP2 - A1E * DEP3)**2) +                            CANSO      38
      C     A3E * (A1E * DEP3 - A2E * DEP1)**2))**0.5                        CANSO      39
      C                                                                      CANSO      40
      C     WHERE DEP1, DEP2 AND DEP3 ARE PLASTIC STRAIN INCREMENT           CANSO      41
      C     COMPONENTS                                                       CANSO      42
      C                                                                      CANSO      43
      C     F1P   = OUTPUT VOLUME WEIGHTED AVERAGE COSINE OF THE ANGLE       CANSO      44
      C     BETWEEN BASAL POLES AND COORDINATE AXIS 1 AT THE END             CANSO      45
      C     OF THE CURRENT TIME STEP                                         CANSO      46
      C     F2P   = OUTPUT VOLUME WEIGHTED AVERAGE COSINE OF THE ANGLE       CANSO      47
      C     BETWEEN BASAL POLES AND COORDINATE AXIS 2 AT THE END             CANSO      48
      C     OF THE CURRENT TIME STEP                                         CANSO      49
      C     F3P   = OUTPUT VOLUME WEIGHTED AVERAGE COSINE OF THE ANGLE       CANSO      50
      C     BETWEEN BASAL POLES AND COORDINATE AXIS 3 AT THE END             CANSO      51
      C     OF THE CURRENT TIME STEP                                         CANSO      52
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      C                                                                      CANSO      53
      C   AID   = OUTPUT HIGH TEMPERATURE STRAIN ANISOTROPY COEFFICIENT       CANSO      54
      C   AT THE END OF THE CURRENT TIME STEP (UNITLESS)                      CANSO      55
      C   A2D   = OUTPUT HIGH TEMPERATURE STRAIN ANISOTROPY COEFFICIENT       CANSO      56
      C   AT THE END OF THE CURRENT TIME STEP (UNITLESS)                      CANSO      57
      C   A3D   = OUTPUT HIGH TEMPERATURE STRAIN ANISOTROPY COEFFICIENT       CANSO      58
      C   AT THE END OF THE CURRENT TIME STEP (UNITLESS)                      CANSO      59
      C                                                                      CANSO      60
      C   CTEMP = INPUT CLADDING TEMPERATURE (K)                            CANSO      61
      C   DEP1  = INPUT CLADDING PLASTIC STRAIN INCREMENT ALONG 1 ST         CANSO      62
      C   AXIS DURRING THE CURRENT TIME STEP (UNITLESS)                      CANSO      63
      C   DEP2  = INPUT CLADDING PLASTIC STRAIN INCREMENT ALONG 2 ND         CANSO      64
      C   AXIS DURRING THE CURRENT TIME STEP (UNITLESS)                      CANSO      65
      C   DEP3  = INPUT CLADDING PLASTIC STRAIN INCREMENT ALONG 3 RD         CANSO      66
      C   AXIS DURRING THE CURRENT TIME STEP (UNITLESS)                      CANSO      67
      C   F1P   = INPUT VOLUME WEIGHTED AVERAGE COSINE OF THE ANGLE          CANSO      68
      C   BETWEEN BASAL POLES AND COORDINATE AXIS 1 AT THE START             CANSO      69
      C   OF THE CURRENT TIME STEP                                           CANSO      70
      C   F2P   = INPUT VOLUME WEIGHTED AVERAGE COSINE OF THE ANGLE          CANSO      71
      C   BETWEEN BASAL POLES AND COORDINATE AXIS 2 AT THE START             CANSO      72
      C   OF THE CURRENT TIME STEP                                           CANSO      73
      C   F3P   = INPUT VOLUME WEIGHTED AVERAGE COSINE OF THE ANGLE          CANSO      74
      C   BETWEEN BASAL POLES AND COORDINATE AXIS 3 AT THE START             CANSO      75
      C   OF THE CURRENT TIME STEP                                           CANSO      76
      C   A1D   = INPUT HIGH TEMPERATURE STRAIN ANISOTROPY COEFFICIENT       CANSO      77
      C   AT THE START OF THE CURRENT TIME STEP.  SET = 0.5                  CANSO      78
      C   FOR THE FIRST STEP                                                 CANSO      79
      C   A2D   = INPUT HIGH TEMPERATURE STRAIN ANISOTROPY COEFFICIENT       CANSO      80
      C   AT THE START OF THE CURRENT TIME STEP.  SET = 0.5                  CANSO      81
      C   FOR THE FIRST STEP                                                 CANSO      82
      C   A3D   = INPUT HIGH TEMPERATURE STRAIN ANISOTROPY COEFFICIENT       CANSO      83
      C   AT THE START OF THE CURRENT TIME STEP.  SET = 0.5                  CANSO      84
      C   FOR THE FIRST STEP                                                 CANSO      85
      C                                                                      CANSO      86
      C   THE CORRELATIONS USED IN THIS SUBCODE ARE BASED ON DATA FROM:      CANSO      87
      C   C. R. HANN ET. AL.,  TRANSIENT DEFORMATION PROPERTIES              CANSO      88
      C   OF ZIRCALOY FOR LOCA SIMULATION, NP-526, VOLUME 3 (MARCH 1978).    CANSO      89
      C                                                                      CANSO      90
      C   CANISO WAS CODED BY D. L. HAGRMAN OCTOBER 1978                     CANSO      91
      C   MODIFIED BY D. L. HAGRMAN IN JUNE 1979                             CANSO      92
      C                                                                      CANSO      93
      C                                                                      CANSO      94
      C   CONVERT F FACTORS TO APPROPRIATE ANISOTROPY COEFFECIENTS           CANSO      95
            A3P = 1.5*F2P                                                    CANSO      96
            A2P = 1.5*F1P                                                    CANSO      97
            A1P = 1.5*F3P                                                    CANSO      98
      C                                                                      CANSO      99
            SA0 = 1.0                                                        CANSO     100
            IF (CTEMP.GE.1090.) SA0 = 7.6060606-CTEMP*6.060606E-03           CANSO     101
            IF (CTEMP.GE.1255.) SA0 = 0.0                                    CANSO     102
            SP0 = 1.0/(EXP((CTEMP-725.)/18.)+1.0)                            CANSO     103
            RAC = -2.757+CTEMP*1.343E-02                                     CANSO     104
            IF (CTEMP.LE.644.0) RAC = 0.52762                                CANSO     105
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      IF (CTEMP.GE.1090.) RAC = 6.5174                                  CANSO  106
      APN = 1.0                                                         CANSO  107
      IF (A1P.GT.1.48) APN = 0.0                                        CANSO  108
110   IF (A2P.GT.1.48) APN = 0.0                                        CANSO  109
      IF (A3P.GT.1.48) APN = 0.0                                        CANSO  110
      IF (A1P.LT.0.02) APN = 0.0                                        CANSO  111
      IF (A2P.LT.0.02) APN = 0.0                                        CANSO  112
      IF (A3P.LT.0.02) APN = 0.0                                        CANSO  113
115   ADN = 1.0                                                         CANSO  114
      IF (A1D.GT.1.48) ADN = 0.0                                        CANSO  115
      IF (A2D.GT.1.48) ADN = 0.0                                        CANSO  116
      IF (A3D.GT.1.48) ADN = 0.0                                        CANSO  117
      IF (A1D.LT.0.02) ADN = 0.0                                        CANSO  118
120   IF (A2D.LT.0.02) ADN = 0.0                                        CANSO  119
      IF (A3D.LT.0.02) ADN = 0.0                                        CANSO  120
      A1P = A1P-RAC*APN*DEP3                                            CANSO  121
      A2P = A2P-RAC*APN*DEP1                                            CANSO  122
      A3P = A3P-RAC*APN*DEP2                                            CANSO  123
125   IF (A1P.GT.1.50) PRINT 100                                        CANSO  124
      IF (A2P.GT.1.50) PRINT 110                                        CANSO  125
      IF (A3P.GT.1.50) PRINT 120                                        CANSO  126
      IF (A1P.LT.0.00) PRINT 130                                        CANSO  127
      IF (A2P.LT.0.00) PRINT 140                                        CANSO  128
130   IF (A3P.LT.0.00) PRINT 150                                        CANSO  129
      A1D = A1D-RAC*ADN*DEP3                                            CANSO  130
      A2D = A2D-RAC*ADN*DEP1                                            CANSO  131
      A3D = A3D-RAC*ADN*DEP2                                            CANSO  132
      IF (A1D.GT.1.50) PRINT 100                                        CANSO  133
135   IF (A2D.GT.1.50) PRINT 110                                        CANSO  134
      IF (A3D.GT.1.50) PRINT 120                                        CANSO  135
      IF (A1D.LT.0.00) PRINT 130                                        CANSO  136
      IF (A2D.LT.0.00) PRINT 140                                        CANSO  137
      IF (A3D.LT.0.00) PRINT 150                                        CANSO  138
140   A1E = (A1P*SPO+A1D*(1.0-SPO))*SAO+0.5*(1.0-SAO)                   CANSO  139
      A2E = (A2P*SPO+A2D*(1.0-SPO))*SAO+0.5*(1.0-SAO)                   CANSO  140
      A3E = (A3P*SPO+A3D*(1.0-SPO))*SAO+0.5*(1.0-SAO)                   CANSO  141
      A1S = A1P*SAO+0.5*(1.0-SAO)                                       CANSO  142
      A2S = A2P*SAO+0.5*(1.0-SAO)                                       CANSO  143
145   A3S = A3P*SAO+0.5*(1.0-SAO)                                       CANSO  144
C                                                                       CANSO  145
C   CONVERT ANISOTROPY COEFFICITNTS TO F FACTORS                        CANSO  146
      F1P = A2P/1.5                                                     CANSO  147
      F2P = A3P/1.5                                                     CANSO  148
150   F3P = A1P/1.5                                                     CANSO  149
C                                                                       CANSO  150
      RETURN                                                            CANSO  151
C                                                                       CANSO  152
100   FORMAT (94H  ERROR IN ANISOTROPIC CLADDING DEFORMATION            CANSO  153
155  +  A1 TOO LARGE. TRY SMALLER TIME STEPS.)                          CANSO  154
110   FORMAT (94H  ERROR IN ANISOTROPIC CLADDING DEFORMATION            CANSO  155
     +  A2 TOO LARGE. TRY SMALLER TIME STEPS.)                         CANSO  156
120   FORMAT (94H  ERROR IN ANISOTROPIC CLADDING DEFORMATION            CANSO  157
     +  A3 TOO LARGE. TRY SMALLER TIME STEPS.)                         CANSO  158
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                130   FORMAT (94H  ERROR IN ANISOTROPIC CLADDING DEFORMATION          CANSO   159
               +  A1 TOO SMALL. TRY SMALLER TIME STEPS.)                            CANSO   160
                140   FORMAT (94H  ERROR IN ANISOTROPIC CLADDING DEFORMATION         CANSO   161
               +  A2 TOO SMALL. TRY SMALLER TIME STEPS.)                            CANSO   162
                150   FORMAT (94H  ERROR IN ANISOTROPIC CLADDING DEFORMATION         CANSO   163
               +  A3 TOO SMALL. TRY SMALLER TIME STEPS.)                            CANSO   164
                      END                                                           CANSO   165
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CANISO	3	152

VARIABLES

		SN	TYPE	RELOCATION								
543	ADN		REAL		REFS	131	132	133	DEFINED	115	116	117
					118	119	120	121				
542	APN		REAL		REFS	122	123	124	DEFINED	108	109	110
					111	112	113	114				
0	AID		REAL	F.P.	REFS	116	119	131	134	137	140	
					DEFINED	3	131					
0	AIE		REAL	F.P.	DEFINED	3	140					
536	AIP		REAL		REFS	109	112	122	125	128	140	143
					150	DEFINED	99	122				
0	AIS		REAL	F.P.	DEFINED	3	143					
0	A2D		REAL	F.P.	REFS	117	120	132	135	138	141	
					DEFINED	3	132					
0	A2E		REAL	F.P.	DEFINED	3	141					
535	A2P		REAL		REFS	110	113	123	126	129	141	144
					148	DEFINED	98	123				
0	A2S		REAL	F.P.	DEFINED	3	144					
0	A3D		REAL	F.P.	REFS	118	121	133	136	139	142	
					DEFINED	3	133					
0	A3E		REAL	F.P.	DEFINED	3	142					
534	A3P		REAL		REFS	111	114	124	127	130	142	145
					149	DEFINED	97	124				
0	A3S		REAL	F.P.	DEFINED	3	145					
0	CTEMP		REAL	F.P.	REFS	2*102	103	104	105	106	107	
					DEFINED	3						
0	DEP1		REAL	F.P.	REFS	123	132	DEFINED	3			
0	DEP2		REAL	F.P.	REFS	124	133	DEFINED	3			
0	DEP3		REAL	F.P.	REFS	122	131	DEFINED	3			
0	FIP		REAL	F.P.	REFS	98	DEFINED	3	148			
0	F2P		REAL	F.P.	REFS	97	DEFINED	3	149			
0	F3P		REAL	F.P.	REFS	99	DEFINED	3	150			
541	RAC		REAL		REFS	122	123	124	131	132	133	
					DEFINED	105	106	107				
537	SAO		REAL		REFS	2*140	2*141	2*142	2*143	2*144	2*145	
					DEFINED	101	102	103				
540	SPO		REAL		REFS	2*140	2*141	2*142	DEFINED	104		

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FILE NAMES          MODE
      OUTPUT        FMT                 WRITES      125       126       127       128       129       130       134       135
                                          136       137       138       139

EXTERNALS             TYPE    ARGS        REFERENCES
      EXP             REAL      1 LIBRARY     104

STATEMENT LABELS                DEF LINE    REFERENCES
  412   100       FMT               154         125         134
  425   110       FMT               156         126         135
  440   120       FMT               158         127         136
  453   130       FMT               160         128         137
  466   140       FMT               162         129         138
  501   150       FMT               164         130         139

STATISTICS
  PROGRAM LENGTH                   544B        356
          140000B SCM USED
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      C                                                                       CANSO    166
      C                                                                       CANSO    167
            FUNCTION CBRTTL (AM5,Y8,Y88,Y9,Y99,Y100,CTEMP,BWTFRO,RCOOL,AA1,AB CBRTL      2
           +,AC1,AD1,AE1,AF1,AG1,AH1,AI1,S)                                   CBRTL      3
      5     C                                                                 CBRTL      4
            C   THE FUNCTION CBRTTL DESCRIBES THE ONSET OF ZIRCALOY CLADDING   CBRTL      5
            C   EMBRITTLEMENT BY OXYGEN ABSORPTION.                           CBRTL      6
            C                                                                 CBRTL      7
            C   CBRTTL  = OUTPUT CLADDING EMBRITTLEMENT INDEX. IF CBRTTL      CBRTL      8
     10     C   .GT. 0.0 THE CLADDING IS CONSIDERED BRITTLE.                  CBRTL      9
            C                                                                 CBRTL     10
            C   AM5     = INPUT ORIGINAL CLADDING CLADDING WALL THICKNESS (M) CBRTL     11
            C   Y8      = INPUT OUTSIDE OXIDE THICKNESS (M)                   CBRTL     12
            C   Y88     = INPUT INSIDE  OXIDE THICKNESS (M)                   CBRTL     13
     15     C   Y9      = INPUT OUTSIDE OXYGEN STABILIZED ALPHA THICKNESS (M) CBRTL     14
            C   Y99     = INPUT INSIDE  OXYGEN STABILIZED ALPHA THICKNESS (M) CBRTL     15
            C   Y100    = INPUT SUM OF OTHER INSIDE LAYERS (M)                 CBRTL     16
            C   CTEMP   = INPUT CLADDING TEMPERATURE (K)                      CBRTL     17
            C   BWTFRO  = INPUT CLADDING AVERAGE OXYGEN CONCENTRATION IN EXCESS CBRTL     18
     20     C   OF AS-FABRICATED AMOUNT (WEIGHT FRACTION)                     CBRTL     19
            C   RCOOL   = INPUT COOLING RATE BEFORE QUENCH (K/S)              CBRTL     20
            C   AA1-AI1 = INPUT OXYGEN  CONCENTRATIONS IN PRIOR BETA AT NINE CBRTL     21
            C   EQUIDISTANT NODES. AA1 IS THE CONCENTRATION AT THE           CBRTL     22
            C   BETA/ALPHA+BETA INTERFACE AND AI1 IS THE                      CBRTL     23
     25     C   CONCENTRATION AT                                             CBRTL     24
            C   A) THE INNER CLADDING SURFACE FOR OUTSIDE OXIDATION           CBRTL     25
            C   ONLY, OR                                                     CBRTL     26
            C   B) THE MINIMUM CONCENTRATION FOR TWO-SIDED OXIDATION         CBRTL     27
            C   (WEIGHT FRACTION)                                           CBRTL     28
     30     C   S       = INPUT INDEX, 1.0 FOR OUTSIDE OXIDATION ONLY,        CBRTL     29
            C   2.0 FOR TWO-SIDED OXIDATION                                  CBRTL     30
            C                                                                 CBRTL     31
            C   THE CORRELATIONS USED IN THIS FUNCTION ARE BASED ON THE      CBRTL     32
            C   FOLLOWING REFERENCES.                                        CBRTL     33
     35     C   (1) R.E. PAWEL, JOURNAL OF NUCLEAR MATERIALS,50 (1974)        CBRTL     34
            C   (2) H.M. CHUNG, A.M. GARDE, AND T.F. KASSNER --              CBRTL     35
            C   A. ANL-78-49 (JUNE 1978).                                    CBRTL     36
            C   B. ANL-78-3  (JANUARY 1978).                                 CBRTL     37
            C   C. ANL-78-25 (MAY 1978).                                     CBRTL     38
     40     C   (3) D.O. HOBSON AND P.L. RITTENHOUSE, ORNL-4758 (JAN. 1972).  CBRTL     39
            C   (4) S.L. SEIFFERT AND R.R. HOBBINS, TFBP-TR-292 (OCTOBER 1978). CBRTL   40
            C                                                                 CBRTL     41
            C   CBRTTL WAS ORIGINALLY CODED BY G.A. REYMANN IN FEB. 1979.     CBRTL     42
            C                                                                 CBRTL     43
     45        DIMENSION AN(9)                                                CBRTL     44
               IF (CTEMP.LT.1244.0) GO TO 160                                 CBRTL     45
               CBRTTL = 0.0                                                   CBRTL     46
      C                                                                       CBRTL     47
               IF (RCOOL.GT.100.0) GO TO 140                                  CBRTL     48
     50     C                                                                 CBRTL     49
            C   LOW COOLING RATE CALCULATION                                  CBRTL     50
            C                                                                 CBRTL     51
               AN(1) = AA1                                                    CBRTL     52
```

```
      AN(2) = ABI                                                        CBRTL   53
      AN(3) = ACI                                                        CBRTL   54
      AN(4) = ADI                                                        CBRTL   55
      AN(5) = AEI                                                        CBRTL   56
      AN(6) = AFI                                                        CBRTL   57
      AN(7) = AGI                                                        CBRTL   58
      AN(8) = AHI                                                        CBRTL   59
      AN(9) = AII                                                        CBRTL   60
C                                                                        CBRTL   61
      Y2 = (AM5-2.*(Y8+Y88)/3.-(Y9+Y99)-Y100)*100.0/8.0                  CBRTL   62
C   Y2    = INTERNODAL SPACING IN THE BETA.                            CBRTL   63
      IF (AN(1).LT.1.0E-02) GO TO 120                                    CBRTL   64
C                                                                        CBRTL   65
          DO 100 J=2,9                                                   CBRTL   66
          K = J                                                          CBRTL   67
          IF (AN(J).LT.1.0E-02) GO TO 110                                CBRTL   68
100       CONTINUE                                                       CBRTL   69
C                                                                        CBRTL   70
110   ANUMB = 9.0-FLOAT(K)                                               CBRTL   71
C   BCRIT = BETA THICKNESS WITH LESS THAN 1.0: OXYGEN BY WEIGHT.         CBRTL   72
      BCRIT = ANUMB*Y2+((.01-AN(K))/(AN(K-1)-AN(K)))*Y2                  CBRTL   73
      GO TO 130                                                          CBRTL   74
120   BCRIT = 8.0*Y2                                                     CBRTL   75
C                                                                        CBRTL   76
130   BCRIT = 5*BCRIT                                                    CBRTL   77
      IF (BCRIT.LT.0.03) CBRTTL = 1.0                                    CBRTL   78
      GO TO 160                                                          CBRTL   79
C                                                                        CBRTL   80
C   HIGH COOLING RATE CALCULATION                                        CBRTL   81
C                                                                        CBRTL   82
140   IF (CTEMP.GT.1700.0) CBRTTL = 1.0                                  CBRTL   83
      IF (CTEMP.GT.1700.0) GO TO 160                                     CBRTL   84
C                                                                        CBRTL   85
      BCON = (BWTFRO+0.0012)*100.0                                       CBRTL   86
C   BCON  = AVERAGE CONCENTRATION IN THE BETA (WEIGHT PER CENT).         CBRTL   87
      IF (BCON.GT.0.65) CBRTTL = 1.0                                     CBRTL   88
C                                                                        CBRTL   89
C   CALCULATION OF SATURATION CONCENTRATION IN THE BETA FOLLOWS.         CBRTL   90
C                                                                        CBRTL   91
      SAT = 0.12                                                         CBRTL   92
C   SAT   = SATURATION CONCENTRATION IN THE BETA (WEIGHT PER CENT).      CBRTL   93
      IF (CTEMP.LT.1239.0) GO TO 150                                     CBRTL   94
      SAT = -4.287E-03+SQRT((CTEMP/392.46)-3.1417)                       CBRTL   95
      IF (CTEMP.LT.1373.0) GO TO 150                                     CBRTL   96
      SAT = (CTEMP-1081.7)/491.157                                       CBRTL   97
150   CONTINUE                                                           CBRTL   98
C                                                                        CBRTL   99
      BSAT = 1.0E04*(BWTFRO+.0012)/SAT                                   CBRTL  100
C   BSAT  = PER CENT OF SATURATION CONCENTRATION IN THE BETA.            CBRTL  101
      IF (BSAT.GT.90.0) CBRTTL = 1.0                                     CBRTL  102
C                                                                        CBRTL  103
160   CONTINUE                                                           CBRTL  104
      RETURN                                                             CBRTL  105
```

END CBRTL 106

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
5 CBRTTL 3 106

VARIABLES	SN	TYPE	RELOCATION										
0	AAI	REAL	F.P.	REFS	53	DEFINED	3						
0	ABI	REAL	F.P.	REFS	54	DEFINED	3						
0	ACI	REAL	F.P.	REFS	55	DEFINED	3						
0	ADI	REAL	F.P.	REFS	56	DEFINED	3						
0	AEI	REAL	F.P.	REFS	57	DEFINED	3						
0	AFI	REAL	F.P.	REFS	58	DEFINED	3						
0	AGI	REAL	F.P.	REFS	59	DEFINED	3						
0	AHI	REAL	F.P.	REFS	60	DEFINED	3						
0	AII	REAL	F.P.	REFS	61	DEFINED	3						
0	AM5	REAL	F.P.	REFS	63	DEFINED	3						
243	AN	REAL	ARRAY	REFS	45	65	69	3*74	DEFINED	53	54		
					55	56	57	58	59	60	61		
236	ANUMB	REAL		REFS	74	DEFINED	72						
240	BCON	REAL		REFS	89	DEFINED	87						
237	BCRIT	REAL		REFS	78	79	DEFINED	74	76	78			
242	BSAT	REAL		REFS	103	DEFINED	101						
0	BWTFRO	REAL	F.P.	REFS	87	101	DEFINED	3					
232	CBRTTL	REAL		DEFINED	47	79	84	89	103				
0	CTEMP	REAL	F.P.	REFS	46	84	85	95	96	97	98		
				DEFINED	3								
234	J	INTEGER		REFS	68	69	DEFINED	67					
235	K	INTEGER		REFS	72	3*74	DEFINED	68					
0	RCOOL	REAL	F.P.	REFS	49	DEFINED	3						
0	S	REAL	F.P.	REFS	78	DEFINED	3						
241	SAT	REAL		REFS	101	DEFINED	93	96	98				
0	Y100	REAL	F.P.	REFS	63	DEFINED	3						
233	Y2	REAL		REFS	2*74	76	DEFINED	63					
0	Y8	REAL	F.P.	REFS	63	DEFINED	3						
0	Y88	REAL	F.P.	REFS	63	DEFINED	3						
0	Y9	REAL	F.P.	REFS	63	DEFINED	3						
0	Y99	REAL	F.P.	REFS	63	DEFINED	3						

EXTERNALS	TYPE	ARGS	REFERENCES
SQRT	REAL	1 LIBRARY	96

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
FLOAT	REAL	1 INTRIN		72

STATEMENT LABELS	DEF LINE	REFERENCES
0 100	70	67
71 110	72	69

STATEMENT LABELS		DEF LINE	REFERENCES		
105	120	76	65		
110	130	78	75		
120	140	84	49		
163	150	99	95	97	
175	160	105	46	80	85

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
60	100	J	67 70	108	INSTACK	EXITS

STATISTICS
PROGRAM LENGTH 254B 172
140000B SCM USED

```
      C                                                                                 CBRTL    107
      C                                                                                 CBRTL    108
            FUNCTION CCLAPS (PTPGAP,PTCGAP,CMDPH,CTEMP)                                 CCLPS      2
      C                                                                                 CCLPS      3
      C     PTCGAP = INPUT PELLET TO CLADDING GAP (M)                                   CCLPS      4
      C     PTPGAP = INPUT LARGEST PELLET TO PELLET GAP IN NODE (M)                     CCLPS      5
      C     CMDPH  = INPUT ROOM TEMPERATURE MIDWALL DIAMOND PYRAMID                     CCLPS      6
      C     HARDNESS NUMBER (KG/MILLIMETER**2)                                          CCLPS      7
      C     CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)                           CCLPS      8
      C                                                                                 CCLPS      9
      C     CCLAPS = OUTPUT COLLAPSE PRESSURE (PA)                                      CCLPS     10
      C                                                                                 CCLPS     11
      C     THE EQUATIONS USED IN THIS FUNCTION ARE BASED ON DATA FROM                  CCLPS     12
      C     (1) D. O. HOBSON, QUARTERLY PROGRESS REPORT ON THE CREEPDOWN                CCLPS     13
      C     AND COLLAPSE OF ZIRCALOY FUEL CLADDING PROGRAM SPONSORED                    CCLPS     14
      C     BY THE NRC DIVISION OF REACTOR SAFETY RESEARCH FOR                          CCLPS     15
      C     JANUARY- MARCH 1976, ORNL/NUREG/TM-51                                       CCLPS     16
      C     (2) D. O. HOBSON, QUARTERLY PROGRESS REPORT ON THE CREEPDOWN                CCLPS     17
      C     AND COLLAPSE OF ZIRCALOY FUEL CLADDING PROGRAM SPONSORED                    CCLPS     18
      C     BY THE NRC DIVISION OF REACTOR SAFETY RESEARCH FOR APRIL-                   CCLPS     19
      C     JUNE 1976, ORNL/NUREG/TM-52                                                 CCLPS     20
      C                                                                                 CCLPS     21
      C     CCLAPS CODED BY D. L. HAGRMAN JUNE 1977                                     CCLPS     22
      C                                                                                 CCLPS     23
      C                                                                                 CCLPS     24
            PPSI = 15660.+PTPGAP/(2.17E-04*PTPGAP-4.57E-07)+CMDPH*(-183.+CMDPH          CCLPS     25
           +*(0.729-CMDPH*7.4E-04))-3.762*CTEMP                                         CCLPS     26
      C                                                                                 CCLPS     27
            CCLAPS = 6895.0*PPSI                                                        CCLPS     28
      C                                                                                 CCLPS     29
            RETURN                                                                      CCLPS     30
            END                                                                         CCLPS     31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	CCLAPS	3	31

VARIABLES	SN	TYPE	RELOCATION						
40	CCLAPS	REAL			DEFINED	29			
0	CMDPH	REAL		F.P.	REFS	3*26	DEFINED	3	
0	CTEMP	REAL		F.P.	REFS	26	DEFINED	3	
41	PPSI	REAL			REFS	29	DEFINED	26	
0	PTCGAP	REAL	*UNUSED	F.P.	DEFINED	3			
0	PTPGAP	REAL		F.P.	REFS	2*26	DEFINED	3	

STATISTICS

PROGRAM LENGTH 42B 34

140000B SCM USED

```
      C                                                                      CCLPS     32
      C                                                                      CCLPS     33
            FUNCTION CCP (CTEMP)                                             CCP       2
      C                                                                      CCP       3
      C     CCP CALCULATES THE SPECIFIC HEAT AT CONSTANT PRESSURE            CCP       4
      C     FOR ZIRCALOYS                                                    CCP       5
      C                                                                      CCP       6
      C     CCP   = OUTPUT CLADDING SPECIFIC HEAT AT CONSTANT                CCP       7
      C     PRESSURE (J/KG-K)                                                CCP       8
      C     CTEMP = INPUT CLADDING TEMPERATURE (K)                           CCP       9
      C                                                                      CCP      10
      C     THIS CODE IS BASED ON DATA FROM                                  CCP      11
      C     (1) C. R. BROOKS AND E. E. STANSBURY, "THE SPECIFIC HEAT OF      CCP      12
      C     OF ZIRCALOY-2 FROM 50 TO 700 C", JOURNAL OF NUCLEAR              CCP      13
      C     MATERIALS 18 (1966) P 233                                        CCP      14
      C     (2) E. A. ELDRIDGE AND H. W. DEEM, SPECIFIC HEATS AND HEATS      CCP      15
      C     OF TRANSFORMATION OF ZIRCALOY-2 AND LOW NICKEL ZIRCALOY-2        CCP      16
      C     BMI-1803 (MAY 31, 1967)                                          CCP      17
      C                                                                      CCP      18
      C     CONVERSION FROM J/(KG*K) TO CAL/(GM*C) IS                        CCP      19
      C     2.39006D-4 (CAL/(GM*C))/(J/(KG*K))                               CCP      20
      C                                                                      CCP      21
      C     ESTIMATED STANDARD ERROR OF THE PREDICTION OF                    CCP      22
      C     CCP FOR THE SPECIFIC HEAT OF ZIRCALOY CLADDING                   CCP      23
      C     SAMPLES -- (SUM OF SQUARED RESIDUALS/(NUMBER OF                  CCP      24
      C     RESIDUALS-DEGREES OF FREEDOM))**0.5 -- IS                        CCP      25
      C     (1) FOR TEMPERATURE LESS THAN 1090 K, 10J/KG-K)                  CCP      26
      C     (2) FOR TEMPERATURE 1090 K TO 1300 K, 25J/KG-K)                  CCP      27
      C     (3) FOR TEMPERATURE ABOVE 1300 K ,   100J/KG-K)                  CCP      28
      C                                                                      CCP      29
      C     CCP CODED BY R. L. MILLER OCTOBER 1974                           CCP      30
      C     MODIFIED BY D. L. HAGRMAN MAY 1976                               CCP      31
      C                                                                      CCP      32
            COMMON   / LACMDL / MAXIDX, EMFLAG                               CCP      33
            DIMENSION   EMFLAG(1)                                            CCP      34
      C                                                                      CCP      35
            DIMENSION CPDATA(26)                                             CCP      36
            DATA CPDATA/   281., 300.,  302., 400.,  331.,640.,              CCP      37
           +  375.,1090.,  502.,1093.,  590.,1113.,  615.,1133.,             CCP      38
           +  719.,1153.,  816.,1173.,  770.,1193.,  619.,1213.,             CCP      39
           +  469.,1233.,  356.,1248. /                                       CCP      40
            DATA NPCP, IU / 13,1/                                            CCP      41
      C                                                                      CCP      42
            DATA      ON        / 2HON    /,                                 CCP      43
           +          OFF       / 3HOFF   /,                                 CCP      44
           +          LOCIDX    /  4      /                                  CCP      45
            IF (EMFLAG(LOCIDX).EQ.ON) GO TO 110                              CCP      46
      C                                                                      CCP      47
            IF (CTEMP.GE.1248.0) GO TO 100                                   CCP      48
            CCP = POLATE(CPDATA,CTEMP,NPCP,IU)                               CCP      49
            GO TO 120                                                        CCP      50
      100   CCP = 356.                                                       CCP      51
            GO TO 120                                                        CCP      52
```

```
                110   CCP = EMCCP(CTEMP)                                                    CCP        53
     55         120   CONTINUE                                                              CCP        54
                C                                                                           CCP        55
                      CALL DIALOT (CTEMP,13,FDIALA,FDIALM)                                  CCP        56
                      CCP = (CCP+FDIALA)*FDIALM                                             CCP        57
                      RETURN                                                                CCP        58
     60               END                                                                   CCP        59
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	CCP	3	59

VARIABLES	SN	TYPE		RELOCATION								
70	CCP	REAL			REFS	58	DEFINED	50	52	54	58	
73	CPDATA	REAL	ARRAY		REFS	37	50	DEFINED	38			
0	CTEMP	REAL		F.P.	REFS	49	50	54	57	DEFINED	3	
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	34	35	47				
71	FDIALA	REAL			REFS	57	58					
72	FDIALM	REAL			REFS	57	58					
61	IU	INTEGER			REFS	50	DEFINED	42				
64	LOCIDX	INTEGER			REFS	47	DEFINED	44				
0	MAXIDX	INTEGER		LACMDL	REFS	34						
60	NPCP	INTEGER			REFS	50	DEFINED	42				
63	OFF	* REAL			DEFINED	44						
62	ON	REAL			REFS	47	DEFINED	44				

EXTERNALS	TYPE	ARGS	REFERENCES
DIALOT		4	57
EMCCP	REAL	1	54
POLATE	REAL	4	50

STATEMENT LABELS		DEF LINE	REFERENCES	
24	100	52	49	
30	110	54	47	
35	120	55	51	53

COMMON BLOCKS	LENGTH
LACMDL	2

STATISTICS

PROGRAM LENGTH	125B	85
SCM LABELED COMMON LENGTH	2B	2

140000B SCM USED

```
      C                                                                      CCP       60
      C                                                                      CCP       61
            SUBROUTINE CCRPR (CTEMP,CHSTRS,CFLUX,DELT,STRNPH,STRNIH,STRANH,RST CCRPR       2
           +RNH)                                                             CCRPR       3
      C                                                                      CCRPR       4
      C     CCRPR CALCULATES THE PRIMARY AND IRRADIATION-CAUSED              CCRPR       5
      C     CIRCUMFERENTIAL COMPONENTS OF CLADDING CREEP STRAIN              CCRPR       6
      C     AS A FUNCTION OF CLADDING TEMPERATURE,THE CIRCUMFERENTIAL        CCRPR       7
      C     COMPONENT OF CLADDING STRESS, FAST NEUTRON FLUX,                 CCRPR       8
      C     TIME STEP SIZE, AND THE PRIMARY CIRCUMFERENTIAL                  CCRPR       9
      C     COMPONENT OF CLADDING STRAIN AT THE START OF A TIME              CCRPR      10
      C     STEP.  THE STRAIN RATE AT THE START OF THE TIME STEP             CCRPR      11
      C     IS ALSO CALCULATED.                                              CCRPR      12
      C                                                                      CCRPR      13
      C     STRANH = OUTPUT TOTAL CIRCUMFERENTIAL COMPONENT OF CLADDING      CCRPR      14
      C     CREEP STRAIN AT THE END OF A TIME STEP                           CCRPR      15
      C     (UNITLESS RATIO)                                                 CCRPR      16
      C     STRNPH = OUTPUT PRIMARY PART OF CIRCUMFERENTIAL COMPONENT OF     CCRPR      17
      C     CLADDING CREEP STRAIN AT THE END OF A TIME STEP                  CCRPR      18
      C     (UNITLESS RATIO)                                                 CCRPR      19
      C     STRNIH = OUTPUT IRRADIATION-CAUSED PART OF CURCUMFERENTIAL       CCRPR      20
      C     COMPONENT OF CLADDING CREEP STRAIN AT THE END                    CCRPR      21
      C     OF A TIME STEP (UNITLESS RATIO)                                  CCRPR      22
      C     RSTRNH = OUTPUT CIRCUMFERENTIAL COMPONENT OF CLADDING            CCRPR      23
      C     CREEP STRAIN RATE AT THE INPUT PRIMARY                           CCRPR      24
      C     CIRCUMFERENTIAL CREEP STRAIN (S**(-1))                           CCRPR      25
      C     UTRANH = OUTPUT EXPECTED STANDARD ERROR OF STRANH                CCRPR      26
      C                                                                      CCRPR      27
      C     CTEMP  = INPUT CLADDING TEMPERATURE (K)                          CCRPR      28
      C     CHSTRS = INPUT CIRCUMFERENTIAL COMPONENT OF CLADDING             CCRPR      29
      C     STRESS (PA)                                                      CCRPR      30
      C     CFLUX  = INPUT FAST NEUTRON FLUX (NEUTRONS/((M**2)*S))           CCRPR      31
      C     DELT   = INPUT TIME STEP SIZE (S)                                CCRPR      32
      C     STRNPH = INPUT PRIMARY PART OF CIRCUMFERENTIAL                   CCRPR      33
      C     COMPONENT OF CLADDING CREEP STRAIN AT THE                        CCRPR      34
      C     START OF A TIME STEP (UNITLESS RATIO)                            CCRPR      35
      C     STRANH = INPUT CIRCUMFERENTIAL COMPONENT OF CLADDING             CCRPR      36
      C     CREEP STRAIN AT THE START OF A TIME STEP                         CCRPR      37
      C     (UNITLESS RATIO)                                                 CCRPR      38
      C                                                                      CCRPR      39
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     CCRPR      40
      C     (1) D. O. HOBSON, CREEPDOWN OF ZIRCALOY FUEL CLADDING            CCRPR      41
      C     INITIAL TESTS, ORNL/NUREG/TM-181 (APRIL 1978)                    CCRPR      42
      C     (2) A. A. BAUER, L. M. LOWRY AND J. S. PERRIN, PROGRESS ON       CCRPR      43
      C     EVALUATING STRENGTH AND DUCTILITY OF IRRADIATED ZIRCALOY         CCRPR      44
      C     DURING JULY THROUGH SEPTEMBER 1975, BMI-1938 (SEPTEMBER          CCRPR      45
      C     1975)                                                            CCRPR      46
      C     (3) A. A. BAUER, L. M. LOWRY AND J. S. PERRIN, EVALUATING        CCRPR      47
      C     STRENGTH AND DUCTILITY OF IRRADIATED ZIRCALOY. QUARTERLY         CCRPR      48
      C     PROGRESS REPORT JANUARY THROUGH MARCH 1977, BMI-NUREG-1971       CCRPR      49
      C     (APRIL 1977)                                                     CCRPR      50
      C     (4) R. D. WARDA, V. FIDLERIS AND E. TEGHTSOONIAN, DYNAMIC        CCRPR      51
      C     STRAIN AGING DURING CREEP OF A-ZR, METALLURGICAL                 CCRPR      52
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      C   TRANSACTIONS 4 (1973) PP 1201-1206                                  CCRPR   53
55    C                                                                        CCRPR   54
      C   CCRPR WAS CODED BY C. E. DIXON JUNE 1975                             CCRPR   55
      C   MODIFIED BY G. A. REYMANN NOV 1976                                   CCRPR   56
      C   MODIFIED BY D. L. HAGRMAN JAN 1980                                   CCRPR   57
      C                                                                        CCRPR   58
60          T = CTEMP                                                        CCRPR   59
            IF (CTEMP.LT.500.0) T = 500.0                                    CCRPR   60
            IF (CTEMP.GT.645.0) T = 645.0                                    CCRPR   61
            AQ = 2.1427E+05+T*(-5.324E+02+T*(1.17889E-01+T*3.3486E-04))      CCRPR   62
            EX = (EXP(-AQ/T))/2.76E-07                                       CCRPR   63
65          A = (1.26E-12)*EX*(CHSTRS**3.)/ABS(CHSTRS)                       CCRPR   64
            B = (1.81E-16)*EX*(CHSTRS**2.)                                   CCRPR   65
            C = (2.20E-07)*(EXP(-5000./T))*CHSTRS/(T**7)                     CCRPR   66
            RSTNPH = B*(A-STRNPH)                                            CCRPR   67
            RSTNIH = 0.0                                                     CCRPR   68
70          IF (CFLUX.GT.1.0E+00) RSTNIH = C*(CFLUX**0.65)                   CCRPR   69
            CALL DIALOT (CTEMP,23,FDIALA,FDIALM)                             CCRPR   70
            RSTNPH = (RSTNPH+FDIALA)*FDIALM                                  CCRPR   71
            RSTNIH = (RSTNIH+FDIALA)*FDIALM                                  CCRPR   72
            STRNIH = RSTNIH*DELT+STRANH-STRNPH                               CCRPR   73
75          STRNPH = (A-STRNPH)*(1.-EXP(-B*DELT))+STRNPH                     CCRPR   74
            STRANH = STRNPH+STRNIH                                           CCRPR   75
            RSTRNH = RSTNPH+RSTNIH                                           CCRPR   76
            UTRANH = STRANH/2.0                                              CCRPR   77
      C                                                                      CCRPR   78
80          RETURN                                                           CCRPR   79
            END                                                              CCRPR   80
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CCRPR	3	80

VARIABLES

		SN	TYPE	RELOCATION								
174	A		REAL		REFS	68	75	DEFINED	65			
172	AQ		REAL		REFS	64	DEFINED	63				
175	B		REAL		REFS	68	75	DEFINED	66			
176	C		REAL		REFS	70	DEFINED	67				
0	CFLUX		REAL	F.P.	REFS	2*70	DEFINED	3				
0	CHSTRS		REAL	F.P.	REFS	2*65	66	67	DEFINED	3		
0	CTEMP		REAL	F.P.	REFS	60	61	62	71	DEFINED	3	
0	DELT		REAL	F.P.	REFS	74	75	DEFINED	3			
173	EX		REAL		REFS	65	66	DEFINED	64			
202	FDALM	*	REAL		REFS	71						
201	FDIALA		REAL		REFS	71	72	73				
203	FDIALM		REAL	*UNDEF	REFS	72	73					
200	RSTNIH		REAL		REFS	73	74	77	DEFINED	69	70	73
177	RSTNPH		REAL		REFS	72	77	DEFINED	68	72		

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VARIABLES     SN  TYPE          RELOCATION
    0   RSTRNH    REAL          F.P.      DEFINED     3      77
    0   STRANH    REAL          F.P.        REFS     74      78    DEFINED      3      76
    0   STRNIH    REAL          F.P.        REFS     76  DEFINED       3      74
    0   STRNPH    REAL          F.P.        REFS     68      74     2*75      76    DEFINED      3      75
  171   T         REAL                      REFS   3*63      64     2*67  DEFINED     60     61     62
  204   UTRANH  * REAL                    DEFINED     78

EXTERNALS           TYPE   ARGS       REFERENCES
      DIALOT                  4                  71
      EXP         REAL        1 LIBRARY     64        67        75

INLINE FUNCTIONS    TYPE   ARGS         DEF LINE  REFERENCES
      ABS         REAL        1  INTRIN                 65

STATISTICS
  PROGRAM LENGTH                 205B     133
        140000B SCM USED
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      C                                                                      CCRPR      81
      C                                                                      CCRPR      82
            SUBROUTINE CELAST (COSTH2,COSTH4,COSF12,COSF14,CT2CF2,CT2CF4,CT4CF CELST       2
           +2,CT4CF4,CTEMP,FNCK,CWKF,DELOXY,CRS)                             CELST       3
      5     C                                                                CELST       4
            DIMENSION CC(12),CS(12),CRS(9)                                   CELST       5
      C                                                                      CELST       6
      C     CELAST CALCULATES ELASTIC COMPLIANCE CONSTANTS OF ZIRCALOY        CELST       7
      C     FROM ORIENTATION PARAMETERS.                                     CELST       8
     10     C                                                                CELST       9
      C     IN THE FOLLOWING, THETA IS THE ANGLE BETWEEN THE RADIAL          CELST      10
      C     OR NORMAL DIRECTION OF THE SAMPLE AND THE BASAL POLE             CELST      11
      C     DIRECTION. PHI IS THE ANGLE BETWEEN THE PROJECTION OF THE        CELST      12
      C     BASAL POLE DIRECTION ONTO THE PLANE CONTAINING THE AXIAL         CELST      13
     15     C     AND CIRCUMFERENTIAL DIRECTIONS AND THE CIRCUMFERENTIAL     CELST      14
      C     DIRECTION. ALPHA IS THE COMPLEMENT OF PHI.                       CELST      15
      C                                                                      CELST      16
      C     CRS(I) = OUTPUT ELASTIC COMPLIANCE CONSTANTS (1/PA).  S MATRIX   CELST      17
      C     ELEMENTS ARE                                                     CELST      18
     20     C                                                                CELST      19
      C     ( CRS(1)  CRS(7)  CRS(9)    0       0       0    )               CELST      20
      C                                                                      CELST      21
      C     ( CRS(7)  CRS(2)  CRS(8)    0       0       0    )               CELST      22
      C                                                                      CELST      23
     25     C     ( CRS(9)  CRS(8)  CRS(3)    0       0       0    )         CELST      24
      C                                                                      CELST      25
      C     (   0       0       0     CRS(4)    0       0    )               CELST      26
      C                                                                      CELST      27
      C     (   0       0       0       0     CRS(5)    0    )               CELST      28
     30     C                                                                CELST      29
      C     (   0       0       0       0       0     CRS(6) )               CELST      30
      C                                                                      CELST      31
      C                                                                      CELST      32
      C     WHERE DIRECTION 1 IS CIRCUMFERENTIAL OR TRANSVERSE               CELST      33
     35     C     2 IS AXIAL OR LONGITUDINAL                                 CELST      34
      C     3 IS RADIAL OR NORMAL                                            CELST      35
      C                                                                      CELST      36
      C     COSTH2 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE SQUARED   CELST      37
      C     COSINE OF THETA (UNITLESS)                                       CELST      38
     40     C     COSTH4 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE     CELST      39
      C     FOURTH POWER OF THE COSINE OF THETA (UNITLESS)                   CELST      40
      C     COSF12 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE SQUARED   CELST      41
      C     COSINE OF ALPHA (UNITLESS RATIO)                                 CELST      42
      C     COSF14 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE           CELST      43
     45     C     FOURTH POWER OF THE COSINE OF ALPHA (UNITLESS)             CELST      44
      C     CT2CF2 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT   CELST      45
      C     OF THE SQUARED COSINE OF THETA AND THE SQUARED COSINE            CELST      46
      C     OF ALPHA (UNITLESS)                                              CELST      47
      C     CT2CF4 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT   CELST      48
     50     C     OF THE SQUARED COSINE OF THETA AND THE FOURTH POWER OF      CELST      49
      C     THE COSINE OF ALPHA (UNITLESS)                                   CELST      50
      C     CT4CF2 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT   CELST      51
      C     OF THE FOURTH POWER OF THE COSINE OF THETA AND THE               CELST      52
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      C   SQUARED COSINE OF ALPHA (UNITLESS)                                  CELST     53
      C   CT4CF4 = INPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT       CELST     54
      C   OF THE FOURTH POWER OF THE COSINE OF THETA AND THE                  CELST     55
      C   FOURTH POWER OF THE COSINE OF ALPHA (UNITLESS)                       CELST     56
      C   CTEMP  = INPUT CLADDING TEMPERATURE (K)                             CELST     57
      C   FNCK   = INPUT EFFECTIVE FAST FLUENCE (NEUTRONS/(M**2))             CELST     58
      C   CWKF   = INPUT EFFECTIVE COLD WORK (UNITLESS RATIO OF AREAS)        CELST     59
      C   DELOXY = INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING              CELST     60
      C   OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                       CELST     61
      C   AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                       CELST     62
      C                                                                       CELST     63
      C   THE ELASTIC COMPLIANCE CONSTANTS ARE BASED ON DATA FROM             CELST     64
      C   (1) L. R. BUNNELL, G. B. MELLINGER  AND J. L. BATES, HIGH           CELST     65
      C   TEMPERATURE PROPERTIES OF ZIRCALOY - OXYGEN ALLOYS, EPRI            CELST     66
      C   REPORT NP - 524 (1977)                                              CELST     67
      C   (2) E. S. FISHER AND C. J. RENKEN, PHYSICAL REVIEW 135 2A           CELST     68
      C   (20 JULY,1964)  PP A482 - 494.                                      CELST     69
      C   (3) P. E. ARMSTRONG AND H. L. BROWN, TRANSACTIONS OF THE            CELST     70
      C   METALLURGICAL SOCIETY OF AIME 230 (AUGUST 1964)                     CELST     71
      C   PP 962 - 966                                                        CELST     72
      C   (4) A. PADEL AND A. GROFF, JOURNAL OF NUCLEAR MATERIALS 59          CELST     73
      C   (1976) PP 325 - 326                                                 CELST     74
      C   (5) W. R. SMALLEY, SAXTON CORE II FUEL PERFORMANCE EVALUATION.      CELST     75
      C   PART I: MATERIALS, WCAP-3385-56 (SEPTEMBER 1971)                    CELST     76
      C                                                                       CELST     77
      C   CELAST WAS CODED BY D. L. HAGRMAN IN DECEMBER 1977                  CELST     78
      C                                                                       CELST     79
            CC(1) = 1.562E+11-4.484E+07*CTEMP                                 CELST     80
            CC(2) = 1.746E+11-3.282E+07*CTEMP                                 CELST     81
            CC(3) = 3.565E+10-1.281E+07*CTEMP                                 CELST     82
            CC(5) = 6.448E+10+CTEMP*(3.1882E+07-CTEMP*1.2318E+04)             CELST     83
            CC(6) = 6.518E+10-6.817E+05*CTEMP                                 CELST     84
            IF (CC(1).LT.(0.999*CC(5))) CC(5) = 0.999*CC(1)                   CELST     85
            CC(4) = (CC(1)-CC(5))/2.                                          CELST     86
            FACTOR = (CC(1)-CC(5))*((CC(1)+CC(5))*CC(2)-2*((CC(6)**2)))       CELST     87
            CS(1) = 0.102841E-10+CTEMP*(-0.541683E-14+CTEMP*0.147552E-16)     CELST     88
            CS(2) = (CC(1)+CC(5))*(CC(1)-CC(5))/FACTOR                        CELST     89
            CS(3) = 0.390354E-10+CTEMP*(-0.81186E-14+CTEMP*0.211523E-16)      CELST     90
            CS(4) = 1.0/CC(4)                                                 CELST     91
            CS(5) = ((CC(6))**2-(CC(5)*CC(2)))/FACTOR                         CELST     92
            CS(6) = (CC(5)-CC(1))*CC(6)/FACTOR                                CELST     93
            B = (1.16E+11+CTEMP*1.037E+08)*5.7015                             CELST     94
            BS = (1.24E+11-CTEMP*0.406E+08)*5.7015                            CELST     95
            C2 = 1.0                                                          CELST     96
            IF (FNCK.GT.1.0E+22) C2 = 0.88*(1.0-EXP(-FNCK/1.0E+25))+EXP(-FNCK/CELST     97
           +1.0E+25)                                                          CELST     98
            C3 = -2.6E+10                                                     CELST     99
            CS(1) = C2/(1.0/CS(1)+B*DELOXY+C3*CWKF)                           CELST    100
            CS(2) = C2/(1.0/CS(2)+B*DELOXY+C3*CWKF)                           CELST    101
            CS(3) = C2/(1.0/CS(3)+BS*DELOXY)                                  CELST    102
            CS(5) = C2/(1.0/CS(5)+B*DELOXY+C3*CWKF)                           CELST    103
            CS(6) = C2/(1.0/CS(6)+B*DELOXY+C3*CWKF)                           CELST    104
            IF (CS(1).LT.(0.999*CS(5))) CS(5) = 0.999*CS(1)                   CELST    105
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      CS(4) = 2*(CS(1)-CS(5))                                                    CELST     106
      CRS(1) = (COSF14-2*CT2CF4+CT4CF4+2*CT2CF2-2*CT4CF2+COSTH4)*CS(1)+(         CELST     107
     +1.0-2*COSF12+COSF14-2*COSTH2+4*CT2CF2-2*CT2CF4+COSTH4-2*CT4CF2+CT4         CELST     108
110  +CF4)*CS(2)+(-COSF14+2*CT2CF4-CT4CF4+COSF12-3*CT2CF2+2*CT4CF2+COSTH        CELST     109
     +2-COSTH4)*(2*CS(6)+CS(3))                                                 CELST     110
      CRS(2) = (COSF14-2*CT2CF4+CT4CF4-2*COSF12+2*CT2CF2+1.0)*CS(1)+(COS         CELST     111
     +F14-2*CT2CF4+CT4CF4)*CS(2)+(COSF12-COSF14+2*CT2CF4-CT2CF2-CT4CF4)*        CELST     112
     +(2*CS(6)+CS(3))                                                           CELST     113
115   CRS(3) = (1.0-2*COSTH2+COSTH4)*CS(1)+(COSTH2-COSTH4)*(2*CS(6)+CS(3         CELST     114
     +))+COSTH4*CS(2)                                                           CELST     115
      CRS(4) = (2*(1.0-COSTH2-COSF12)+6*CT2CF2-4*CT4CF2)*CS(1)+4*(CT2CF2         CELST     116
     +-CT4CF2)*CS(2)+(COSTH2+COSF12-5*CT2CF2+4*CT4CF2)*CS(3)+2*(-1.0+COS        CELST     117
     +TH2+COSF12-CT2CF2)*CS(5)+8*(-CT2CF2+CT4CF2)*CS(6)                         CELST     118
120   CRS(5) = (COSTH2-COSTH4+0.5*COSF12-1.5*CT2CF2+CT4CF2)*CS(1)+(COSTH         CELST     119
     +2-COSTH4-CT2CF2+CT4CF2)*CS(2)+(1.0-4*COSTH2+4*COSTH4-COSF12+5*CT2C        CELST     120
     +F2-4*CT4CF2)*0.25*CS(3)-0.5*(COSF12-CT2CF2)*CS(5)-2*(COSTH2-COSTH4        CELST     121
     +-CT2CF2+CT4CF2)*CS(6)                                                     CELST     122
      CRS(5) = 4.0*CRS(5)                                                       CELST     123
125   CRS(6) = (0.5*COSTH2+COSF12-COSF14-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4         CELST     124
     +)*CS(1)+(COSF12-COSF14-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)*CS(2)+(1.0        CELST     125
     +-4*COSF12+4*COSF14-COSTH2+8*CT2CF2-8*CT2CF4-4*CT4CF2+4*CT4CF4)*0.2        CELST     126
     +5*CS(3)-0.5*COSTH2*CS(5)-2.0*(COSF12-COSF14-2*CT2CF2+2*CT2CF4+CT4C        CELST     127
     +F2-CT4CF4)*CS(6)                                                          CELST     128
130   CRS(6) = 4.0*CRS(6)                                                       CELST     129
      CRS(7) = (COSF12-COSF14-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)*CS(1)+(CO        CELST     130
     +SF12-COSF14-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)*(CS(2)-CS(3))+COSTH2*        CELST     131
     +CS(5)+(1.0-COSTH2-2*COSF12+2*COSF14+4*CT2CF2-4*CT2CF4-2*CT4CF2+2*C        CELST     132
     +T4CF4)*CS(6)                                                              CELST     133
135   CRS(8) = (CT2CF2-CT4CF2)*(CS(1)+CS(2)-CS(3))+(1.0-COSTH2-COSF12+CT         CELST     134
     +2CF2)*CS(5)+(COSTH2+COSF12-3*CT2CF2+2*CT4CF2)*CS(6)                       CELST     135
      CRS(9) = (COSTH2-COSTH4-CT2CF2+CT4CF2)*(CS(1)+CS(2)-CS(3))+(COSF12         CELST     136
     +-CT2CF2)*CS(5)+(1.0-2*COSTH2+2*COSTH4-COSF12+3*CT2CF2-2*CT4CF2)*CS        CELST     137
     +(6)                                                                       CELST     138
140   IF (CTEMP.LT.1090.) GO TO 130                                             CELST     139
C                                                                               CELST     140
C   CALCULATE A TO A + B AND A + B TO B BOUNDARIES                              CELST     141
      WFOX = DELOXY+0.0002                                                      CELST     142
      TAAB = 1094.+WFOX*(-1.289E+03+WFOX*7.914E+05)                             CELST     143
145   IF (WFOX.LT.0.025) GO TO 100                                              CELST     144
      TAAB = 1556.4+3.8281E+04*(WFOX-0.025)                                     CELST     145
100   TABB = 392.46*((100*DELOXY+0.1242807)**2+3.1417)                          CELST     146
      IF (DELOXY.LT.4.73)8937E-03) GO TO 110                                    CELST     147
      TABB = (100*DELOXY-0.12)*491.157+1081.7413                                CELST     148
150   110  CONTINUE                                                             CELST     149
C                                                                               CELST     150
      IF (CTEMP.LT.TAAB) GO TO 130                                              CELST     151
      IF (CTEMP.GT.TABB) GO TO 120                                              CELST     152
      CC(7) = 1.562E+11-4.484E+07*TAAB                                          CELST     153
155   CC(8) = 1.746E+11-3.282E+07*TAAB                                          CELST     154
      CC(9) = 3.565E+10-1.281E+07*TAAB                                          CELST     155
      CC(11) = 6.448E+10+TAAB*(3.1882E+07-TAAB*1.2318E+04)                      CELST     156
      CC(12) = 6.518E+10-6.817E+05*TAAB                                         CELST     157
      IF (CC(7).LT.(0.999*CC(11))) CC(11) = 0.999*CC(7)                         CELST     158
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      FXCTOR = (CC(7)-CC(11))*((CC(7)+CC(11))*CC(8)-2*((CC(12)**2)))     CELST     159
      CS(7) = 0.102841E-10+TAAB*(-0.541683E-14+TAAB*0.147552E-16)        CELST     160
      CS(8) = (CC(7)+CC(11))*(CC(7)-CC(11))/FXCTOR                       CELST     161
      CS(9) = 0.390354E-10+TAAB*(-0.81186E-14+TAAB*0.211523E-16)         CELST     162
      CS(11) = ((CC(12))**2-(CC(11)*CC(8)))/FXCTOR                       CELST     163
      CS(12) = (CC(11)-CC(7))*CC(12)/FXCTOR                              CELST     164
      BT = (1.16E+11+TAAB*1.037E+08)*5.7015                              CELST     165
      BST = (1.24E+11-TAAB*0 406E+08)*5.7015                             CELST     166
      CS(7) = C2/(1.0/CS(7)+BT*DELOXY+C3*CWKF)                           CELST     167
      CS(8) = C2/(1.0/CS(8)+BT*DELOXY+C3*CWKF)                           CELST     168
      CS(9) = C2/(1.0/CS(9)+BST*DELOXY)                                  CELST     169
      CS(11) = C2/(1.0/CS(11)+BT*DELOXY+C3*CWKF)                         CELST     170
      CS(12) = C2/(1.0/CS(12)+BT*DELOXY+C3*CWKF)                         CELST     171
      IF (CS(7).LT.(0.999*CS(11))) CS(11) = 0.999*CS(7)                  CELST     172
      CS(10) = 2*(CS(7)-CS(11))                                          CELST     173
      CL51 = (COSFI4-2*CT2CF4+CT4CF4+2*CT2CF2-2*CT4CF2+COSTH4)*CS(7)+(1. CELST     174
     +0-2*COSFI2+COSFI4-2*COSTH2+4*CT2CF2-2*CT2CF4+COSTH4-2*CT4CF2+CT4CF CELST     175
     +4)*CS(8)+(-COSFI4+2*CT2CF4-CT4CF4+COSFI2-3*CT2CF2+2*CT4CF2+COSTH2- CELST     176
     +COSTH4)*(2*CS(12)+CS(9))                                           CELST     177
      CL52 = (COSFI4-2*CT2CF4+CT4CF4-2*COSFI2+2*CT2CF2+1.0)*CS(7)+(COSFI CELST     178
     +4-2*CT2CF4+CT4CF4)*CS(8)+(COSFI2-COSFI4+2*CT2CF4-CT2CF2-CT4CF4)*(2 CELST     179
     +*CS(12)+CS(9))                                                     CELST     180
      CL53 = (1.0-2*COST 2+COSTH4)*CS(7)+(COSTH2-COSTH4)*(2*CS(12)+CS(9) CELST     181
     +)+COSTH4*CS(8)                                                     CELST     182
      CL54 = (2*(1.0-CO  H2-COSFI2)+6*CT2CF2-4*CT4CF2)*CS(7)+4*(CT2CF2-C CELST     183
     +T4CF2)*CS(8)+(COSTH2+COSFI2-5*CT2CF2+4*CT4CF2)*CS(9)+2*(-1.0+COSTH CELST     184
     +2+COSFI2-CT2CF2)*CS(11)+8*(-CT2CF2+CT4CF2)*CS(12)                  CELST     185
      CL55 = (COSTH2-COSTH4+0.5*COSFI2-1.5*CT2CF2+CT4CF2)*CS(7)+(COSTH2- CELST     186
     +COSTH4-CT2CF2+CT4CF2)*CS(8)+(1.0-4*COSTH2+4*COSTH4-COSFI2+5*CT2CF2 CELST     187
     +-4*CT4CF2)*0.25*CS(9)-0.5*(COSFI2-CT2CF2)*CS(11)-2*(COSTH2-COSTH4- CELST     188
     +CT2CF2+CT4CF2)*CS(12)                                              CELST     189
      CL55 = CL55*4.0                                                    CELST     190
      CL56 = (0.5*COSTH2+COSFI2-COSFI4-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)* CELST     191
     +CS(7)+(COSFI2-COSFI4-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)*CS(8)+(1.0-4 CELST     192
     +*COSFI2+4*COSFI4-COSTH2+8*CT2CF2-8*CT2CF4-4*CT4CF2+4*CT4CF4)*0.25* CELST     193
     +CS(9)-0.5*COSTH2*CS(11)-2.0*(COSFI2-COSFI4-2*CT2CF2+2*CT2CF4+CT4CF CELST     194
     +2-CT4CF4)*CS(12)                                                   CELST     195
      CL56 = CL56*4.0                                                    CELST     196
      CL57 = (COSFI2-COSFI4-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)*CS(7)+(COSF CELST     197
     +I2-COSFI4-2*CT2CF2+2*CT2CF4+CT4CF2-CT4CF4)*(CS(8)-CS(9))+COSTH2*CS CELST     198
     +(11)+(1.0-COSTH2-2*COSFI2+2*COSFI4+4*CT2CF2-4*CT2CF4-2*CT4CF2+2*CT CELST     199
     +4CF4)*CS(12)                                                       CELST     200
      CL58 = (CT2CF2-CT4CF2)*(CS(7)+CS(8)-CS(9))+(1.0-COSTH2-COSFI2+CT2C CELST     201
     +F2)*CS(11)+(COSTH2+COSFI2-3*CT2CF2+2*CT4CF2)*CS(12)                CELST     202
      CL59 = (COSTH2-COSTH4-CT2CF2+CT4CF2)*(CS(7)+CS(8)-CS(9))+(COSFI2-C CELST     203
     +T2CF2)*CS(11)+(1.0-2*COSTH2+2*COSTH4-COSFI2+3*CT2CF2-2*CT4CF2)*CS( CELST     204
     +12)                                                                CELST     205
      CTS1 = 9.21E+10-TAAB*4.05E+07                                      CELST     206
      CTS2 = CTS1                                                        CELST     207
      CTS3 = CTS1                                                        CELST     208
      CTS4 = 3.49E+10-TAAB*1.66E+07                                      CELST     209
      CTS5 = CTS4                                                        CELST     210
      CTS6 = CTS4                                                        CELST     211
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                CTS7 = (2*CTS4*CTS1)/(2*CTS4-CTS1)                                    CELST    212
                CTS8 = CTS7                                                           CELST    213
                CTS9 = CTS7                                                           CELST    214
      215       CRS(1) = 1.0/((1.0/CLS1)+(CTEMP-TAAB)*(CTS1-(1.0/CLS1))/(TABB-TAAB  CELST    215
               +))                                                                    CELST    216
                CRS(2) = 1.0/((1.0/CLS2)+(CTEMP-TAAB)*(CTS2-(1.0/CLS2))/(TABB-TAAB  CELST    217
               +))                                                                    CELST    218
      220       CRS(3) = 1.0/((1.0/CLS3)+(CTEMP-TAAB)*(CTS3-(1.0/CLS3))/(TABB-TAAB  CELST    219
               +))                                                                    CELST    220
                CRS(4) = 1.0/((1.0/CLS4)+(CTEMP-TAAB)*(CTS4-(1.0/CLS4))/(TABB-TAAB  CELST    221
               +))                                                                    CELST    222
                CRS(5) = 1.0/((1.0/CLS5)+(CTEMP-TAAB)*(CTS5-(1.0/CLS5))/(TABB-TAAB  CELST    223
      225       +))                                                                    CELST    224
                CRS(6) = 1.0/((1.0/CLS6)+(CTEMP-TAAB)*(CTS6-(1.0/CLS6))/(TABB-TAAB  CELST    225
               +))                                                                    CELST    226
                CRS(7) = 1.0/((1.0/CLS7)+(CTEMP-TAAB)*(CTS7-(1.0/CLS7))/(TABB-TAAB  CELST    227
               +))                                                                    CELST    228
      230       CRS(8) = 1.0/((1.0/CLS8)+(CTEMP-TAAB)*(CTS8-(1.0/CLS8))/(TABB-TAAB  CELST    229
               +))                                                                    CELST    230
                CRS(9) = 1.0/((1.0/CLS9)+(CTEMP-TAAB)*(CTS9-(1.0/CLS9))/(TABB-TAAB  CELST    231
               +))                                                                    CELST    232
                GO TO 130                                                             CELST    233
      235     C                                                                       CELST    234
          120   CRS(1) = 1.0/(9.21E+10-CTEMP*4.05E+07)                                CELST    235
                CRS(2) = CRS(1)                                                       CELST    236
                CRS(3) = CRS(1)                                                       CELST    237
                CRS(4) = 1.0/(3.49E+10-CTEMP*1.66E+07)                                CELST    238
      240       CRS(5) = CRS(4)                                                       CELST    239
                CRS(6) = CRS(4)                                                       CELST    240
                CRS(7) = CRS(1)-0.5*CRS(4)                                            CELST    241
                CRS(8) = CRS(7)                                                       CELST    242
                CRS(9) = CRS(7)                                                       CELST    243
      245       130   CONTINUE                                                      CELST    244
                C                                                                   CELST    245
                      RETURN                                                        CELST    246
                      END                                                           CELST    247
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CELAST	3	247

VARIABLES		SN	TYPE		RELOCATION								
1612	B		REAL			REFS	101	102	104	105	DEFINED	95	
1613	BS		REAL			REFS	103	DEFINED	96				
1623	BST		REAL			REFS	170	DEFINED	167				
1622	BT		REAL			REFS	168	169	171	172	DEFINED	166	
1646	CC		REAL	ARRAY		REFS	6	3*86	2*87	6*88	4*90	92	3*93
							3*94	3*159	6*160	4*162	3*164	3*165	

VARIABLES	SN	TYPE	RELOCATION								
					DEFINED	81	82	83	84	85	86	87
					154	155	156	157	158	159		
1624	CLS1	REAL			REFS	2*216	DEFINED	175				
1625	CLS2	REAL			REFS	2*218	DEFINED	179				
1626	CLS3	REAL			REFS	2*220	DEFINED	182				
1627	CLS4	REAL			REFS	2*222	DEFINED	184				
1630	CLS5	REAL			REFS	191	2*224	DEFINED	187	191		
1631	CLS6	REAL			REFS	197	2*226	DEFINED	192	197		
1632	CLS7	REAL			REFS	2*228	DEFINED	198				
1633	CLS8	REAL			REFS	2*230	DEFINED	202				
1634	CLS9	REAL			REFS	2*232	DEFINED	204				
0	COSFI2	REAL		F.P.	REFS	2*108	2*112	3*117	3*120	4*125	3*131	2*135
					2*137	2*175	2*179	3*184	3*187	4*192	3*198	2*202
					2*204	DEFINED	3					
0	COSFI4	REAL		F.P.	REFS	3*108	3*112	4*125	3*131	3*175	3*179	4*192
					3*198	DEFINED	3					
0	COSTH2	REAL		F.P.	REFS	2*108	2*115	3*117	4*120	3*125	2*131	2*135
					2*137	2*175	2*182	3*184	4*187	3*192	2*198	2*202
					2*204	DEFINED	3					
0	COSTH4	REAL		F.P.	REFS	3*108	3*115	4*120	2*137	3*175	3*182	4*187
					2*204	DEFINED	3					
0	CRS	REAL	ARRAY	F.P.	REFS	6	124	130	237	239	240	241
					2*242	243	244	DEFINED	3	108	112	115
					117	120	124	125	130	131	135	137
					216	218	220	222	224	226	228	230
					232	236	237	238	239	240	241	242
					243	244						
1662	CS	REAL	ARRAY		REFS	6	101	102	103	104	105	3*106
					2*107	4*108	4*112	4*115	5*117	5*120	5*125	5*131
					5*135	5*137	168	169	170	171	172	3*173
					2*174	4*175	4*179	4*182	5*184	5*187	5*192	5*198
					5*202	5*204	DEFINED	89	90	91	92	93
					94	101	102	103	104	105	106	107
					161	162	163	164	165	168	169	170
					171	172	173	174				
0	CTEMP	REAL		F.P.	REFS	81	82	83	2*84	85	2*89	2*91
					95	96	140	152	153	216	218	220
					222	224	226	228	230	232	236	239
					DEFINED	3						
1635	CTS1	REAL			REFS	208	209	2*213	216	DEFINED	207	
1636	CTS2	REAL			REFS	218	DEFINED	208				
1637	CTS3	REAL			REFS	220	DEFINED	209				
1640	CTS4	REAL			REFS	211	212	2*213	222	DEFINED	210	
1641	CTS5	REAL			REFS	224	DEFINED	211				
1642	CTS6	REAL			REFS	226	DEFINED	212				
1643	CTS7	REAL			REFS	214	215	228	DEFINED	213		
1644	CTS8	REAL			REFS	230	DEFINED	214				
1645	CTS9	REAL			REFS	232	DEFINED	215				
0	CT2CF2	REAL		F.P.	REFS	3*108	2*112	5*117	5*120	4*125	3*131	3*135
					3*137	3*175	2*179	5*184	5*187	4*192	3*198	3*202
					3*204	DEFINED	3					
0	CT2CF4	REAL		F.P.	REFS	3*108	3*112	4*125	3*131	3*175	3*179	4*192
					3*198	DEFINED	3					

VARIABLES	SN	TYPE	RELOCATION							
0	CT4CF2	REAL	F.P.	REFS	3*108	4*117	4*120	4*125	3*131	2*135	2*137
				3*175	4*184	4*187	4*192	3*198	2*202	2*204	
				DEFINED	3						
0	CT4CF4	REAL	F.P.	REFS	3*108	3*112	4*125	3*131	3*175	3*179	4*192
				3*198	DEFINED	3					
0	CWKF	REAL	F.P.	REFS	101	102	104	105	168	169	171
				172	DEFINED	3					
1614	C2	REAL		REFS	101	102	103	104	105	168	169
				170	171	172	DEFINED	97	98		
1615	C3	REAL		REFS	101	102	104	105	168	169	171
				172	DEFINED	100					
0	DELOXY	REAL	F.P.	REFS	101	102	103	104	105	143	147
				148	149	168	169	170	171	172	
				DEFINED	3						
1611	FACTOR	REAL		REFS	90	93	94	DEFINED	88		
0	FNCK	REAL	F.P.	REFS	3*98	DEFINED	3				
1621	FXCTOR	REAL		REFS	162	164	165	DEFINED	160		
1617	TAAB	REAL		REFS	152	154	155	156	2*157	158	2*161
				2*163	166	167	2*216	2*218	2*220	2*222	2*224
				2*226	2*228	2*230	2*232	DEFINED	144	146	
1620	TABB	REAL		REFS	153	207	210	216	218	220	222
				224	226	228	230	232	DEFINED	147	149
1616	WFOX	REAL		REFS	2*144	145	146	DEFINED	143		

EXTERNALS	TYPE	ARGS	REFERENCES
EXP	REAL	1 LIBRARY	2*98

STATEMENT LABELS		DEF LINE	REFERENCES		
563	100	147	145		
602	110	150	148		
1443	120	236	153		
1501	130	245	140	152	234

STATISTICS
PROGRAM LENGTH 1676B 958
140000B SCM USED

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      C                                                                      CELST   248
      C                                                                      CELST   249
            FUNCTION CELMOD (CTEMP,FNCK,CWKF,DELOXY)                         CELMD     2
      C                                                                      CELMD     3
      C     CELMOD CALCULATES CLADDING YOUNG'S MODULUS AS A FUNCTION         CELMD     4
      C     OF TEMPERATURE, FAST NEUTRON FLUENCE, COLD WORK, AND AVERAGE     CELMD     5
      C     OXYGEN CONCENTRATION.  GRAIN ORIENTATION IS ASSUMED RANDOM.      CELMD     6
      C     THE EXPECTED STANDARD ERROR IS COMPUTED BUT NOT RETURNED         CELMD     7
      C     (UCELMD).                                                        CELMD     8
      C                                                                      CELMD     9
      C     CELMOD = OUTPUT YOUNG'S MODULUS FOR ZIRCALOY 2 AND 4             CELMD    10
      C     WITH RANDOM TEXTURE (PA)                                         CELMD    11
      C     UCELMD = OUTPUT STANDARD ERROR EXPECTED IN CELMOD (PA)           CELMD    12
      C     (NOT CURRENTLY RETURNED)                                         CELMD    13
      C                                                                      CELMD    14
      C     CTEMP  = INPUT CLADDING TEMPERATURE (K)                          CELMD    15
      C     FNCK   = INPUT EFFECTIVE FAST FLUENCE (NEUTRONS/(M**2))          CELMD    16
      C     CWKF   = INPUT EFFECTIVE COLD WORK (UNITLESS RATIO OF AREAS)     CELMD    17
      C     DELOXY = INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING            CELMD    18
      C     OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                    CELMD    19
      C     AS-RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                    CELMD    20
      C                                                                      CELMD    21
      C     THE YOUNG'S MODULUS CALCULATED BY THIS FUNCTION IS BASED ON      CELMD    22
      C     DATA FROM THE FOLLOWING REFERENCES                               CELMD    23
      C     (1) L. R. BUNNELL, G. B. MELLINGER  AND J. L. BATES, HIGH        CELMD    24
      C     TEMPERATURE PROPERTIES OF ZIRCALOY - OXYGEN ALLOYS, EPRI         CELMD    25
      C     REPORT NP - 524 (1977).                                          CELMD    26
      C     (2) E. S. FISHER AND C. J. RENKEN, PHYSICAL REVIEW 135 2A        CELMD    27
      C     (20 JULY 1964) PP A482 - 494.                                    CELMD    28
      C     (3) P. E. ARMSTRONG AND H. L. BROWN, TRANSACTIONS OF THE         CELMD    29
      C     METALLURGICAL SOCIETY OF AIME 230 (AUGUST 1964)                  CELMD    30
      C     PP 962 - 966                                                     CELMD    31
      C     (4) A. PADEL AND A. GROFF, JOURNAL OF NUCLEAR MATERIALS 59       CELMD    32
      C     (1976) PP 325-326                                                CELMD    33
      C     (5) W. R. SMALLEY, SAXTON CORE II FUEL PERFORMANCE EVALUATION.   CELMD    34
      C     PART I: MATERIALS, WCAP-3385-56 (SEPTEMBER 1971)                 CELMD    35
      C                                                                      CELMD    36
      C     THE EXPECTED STANDARD ERROR WAS DERIVED USING ADDITIONAL         CELMD    37
      C     DATA FROM THE FOLLOWING REFERENCES                               CELMD    38
      C     (1) C. C. BUSBY AND C.R. WOODS (EDS.) "PROPERTIES OF ZIRCALOY-4  CELMD    39
      C     TUBING", USAEC REPORT WAPD-TM-585 (DECEMBER 1966) P 65           CELMD    40
      C     (2) Z. SPASIC, M. PAVLOVIC AND G. SIMIS, CONFERENCE ON           CELMD    41
      C     THE USE OF ZIRCONIUM ALLOYS IN NUCLEAR REACTORS, MARIANSKE       CELMD    42
      C     LANZE, CZECH. CONF-681086 (1968) PP 277 - 284                    CELMD    43
      C     (3) R. L. MEHAN, MODULUS OF ELASTICITY OF ZIRCALOY-2 BETWEEN     CELMD    44
      C     ROOM TEMPERATURE AND 1000 F, KAPL-M-RLM-16 (JULY 1958)           CELMD    45
      C     (4) D. O. NORTHWOOD, I. M LONDON, AND L. E. BAHEN, JOURNAL       CELMD    46
      C     OF NUCLEAR MATERIALS 55 (1975) PP 299-310                        CELMD    47
      C     (5) F. R. SHOBER, J. A. VAN ECHO, L. L. MARSH JR. AND            CELMD    48
      C     J. R. KEELER, THE MECHANICAL PROPERTIES OF ZIRCONIUM  AND        CELMD    49
      C     ZIRCALOY-2, BMI-1168 (1957)                                      CELMD    50
      C                                                                      CELMD    51
      C     CELMOD WAS CODED BY R. L. MILLER IN MARCH 1974.                  CELMD    52
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      C   UPDATED AND CORRECTED BY B. W. BURNHAM IN OCTOBER 1975                CELMD      53
55    C   MODIFIED BY B. W. BURNHAM OCTOBER 1977                                 CELMD      54
      C   MODIFIED BY D. L. HAGRMAN DECEMBER 1977                                CELMD      55
      C                                                                          CELMD      56
            COMMON   / LACMDL / MAXIDX, EMFLAG                                   CELMD      57
          DIMENSION   EMFLAG(1)                                                  CELMD      58
60    C                                                                          CELMD      59
          DATA     ON       / 2HON  /,                                          CELMD      60
         +         OFF      / 3HOFF /,                                          CELMD      61
         +         LOCIDX   /   5   /                                           CELMD      62
          IF (EMFLAG(LOCIDX).EQ.ON) GO TO 130                                    CELMD      63
65    C                                                                          CELMD      64
      C   BEST ESTIMATE MODEL YOUNG'S MODULUS                                    CELMD      65
          C1 = (1.16E+11+CTEMP*1.037E+08)*5.7015                                 CELMD      66
          C2 = 1.0                                                               CELMD      67
          IF (FNCK.GT.1.0E+22) C2 = 0.88*(1.0-EXP(-FNCK/1.0E+25))+EXP(-FNCK/     CELMD      68
70       +1.0E+25)                                                               CELMD      69
          C3 = -2.6E+10                                                          CELMD      70
          CELMOD = (1.088E+11-5.475E+07*CTEMP+C1*DELOXY+C3*CWKF)/C2              CELMD      71
          IF (CTEMP.LT.1090.) GO TO 140                                          CELMD      72
      C                                                                          CELMD      73
75    C   CALCULATE A TO A + B AND A + B TO B BOUNDARIES                         CELMD      74
          WFOX = DELOXY+0.0012                                                   CELMD      75
          TAAB = 1094.+WFOX*(-1.289E+03+WFOX*7.914E+05)                          CELMD      76
          IF (WFOX.LT.0.025) GO TO 100                                           CELMD      77
          TAAB = 1556.4+3.8281E+04*(WFOX-0.025)                                  CELMD      78
80    100   TABB = 392.46*((100*DELOXY+0.1242807)**2+3.1417)                     CELMD      79
          IF (DELOXY.LT.4.7308937E-03) GO TO 110                                 CELMD      80
          TABB = (100*DELOXY+0.12)*491.157+1081.7413                             CELMD      81
      110 CONTINUE                                                               CELMD      82
      C                                                                          CELMD      83
85        IF (CTEMP.LT.TAAB) GO TO 140                                           CELMD      84
          IF (CTEMP.GT.TABB) GO TO 120                                           CELMD      85
          AMODL = (1.088E+11-5.475E+07*TAAB+C1*DELOXY+C3*CWKF)/C2                CELMD      86
          AMODR = 9.21E+10-TABB*4.05E+07                                         CELMD      87
          CELMOD = AMODL+(CTEMP-TAAB)*(AMODR-AMODL)/(TABB-TAAB)                  CELMD      88
90        GO TO 140                                                              CELMD      89
      120 CELMOD = 9.21E+10-CTEMP*4.05E+07                                       CELMD      90
          GO TO 140                                                              CELMD      91
      C                                                                          CELMD      92
      C   EM MODEL YOUNG'S MODULUS                                              CELMD      93
95    130 CELMOD = EMCLEM(CTEMP)                                                 CELMD      94
      140 CONTINUE                                                               CELMD      95
          IF (CELMOD.LT.1.0) CELMOD = 1.0                                        CELMD      96
          UCELMD = 6.4E+09                                                       CELMD      97
      C                                                                          CELMD      98
100       CALL DIALOT (CTEMP,19,FDIALA,FDIALM)                                   CELMD      99
          CELMOD = (CELMOD+FDIALA)*FDIALM                                        CELMD     100
          RETURN                                                                 CELMD     101
          END                                                                    CELMD     102
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
5 CELMOD 3 102

VARIABLES	SN	TYPE		RELOCATION								
267 AMODL		REAL			REFS	2*89	DEFINED	87				
270 AMODR		REAL			REFS	89	DEFINED	88				
260 CELMOD		REAL			REFS	97	101	DEFINED	72	89	91	95
						97	101					
0 CTEMP		REAL		F.P.	REFS	67	72	73	85	86	89	91
						95	100	DEFINED	3			
0 CWKF		REAL		F.P.	REFS	72	87	DEFINED	3			
261 C1		REAL			REFS	72	87	DEFINED	67			
262 C2		REAL			REFS	72	87	DEFINED	68	69		
263 C3		REAL			REFS	72	87	DEFINED	71			
0 DELOXY		REAL		F.P.	REFS	72	76	80	81	82	87	
					DEFINED	3						
1 EMFLAG		REAL	ARRAY	LACMDL	REFS	58	59	64				
272 FDIALA		REAL			REFS	100	101					
273 FDIALM		REAL			REFS	100	101					
0 FNCK		REAL		F.P.	REFS	3*69	DEFINED	3				
220 LOCIDX		INTEGER			REFS	64	DEFINED	61				
0 MAXIDX		INTEGER		LACMDL	REFS	58						
217 OFF	*	REAL			DEFINED	61						
216 ON		REAL			REFS	64	DEFINED	61				
265 TAAB		REAL			REFS	85	87	2*89	DEFINED	77	79	
266 TABB		REAL			REFS	86	88	89	DEFINED	80	82	
271 UCELMD	*	REAL			DEFINED	98						
264 WFOX		REAL			REFS	2*77	78	79	DEFINED	76		

EXTERNALS	TYPE	ARGS		REFERENCES
DIALOT		4		100
EMCLEM	REAL	1		95
EXP	REAL	1	LIBRARY	2*69

STATEMENT LABELS		DEF LINE	REFERENCES			
77	100	80	78			
116	110	83	81			
152	120	91	86			
157	130	95	64			
164	140	96	73	85	90	92

COMMON BLOCKS	LENGTH
LACMDL	2

STATISTICS

PROGRAM LENGTH	274B	188
SCM LABELED COMMON LENGTH	2B	2
140000B SCM USED		

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      C                                                                       CELMD     103
      C                                                                       CELMD     104
            SUBROUTINE CESIOD (TIME,FTMAX,DELBU,DTIME,FTEMP,FRADEN,CS,ROID)   CESID       2
      C                                                                       CESID       3
            DIMENSION ROID(8),CS(5)                                           CESID       4
      C                                                                       CESID       5
      C     CESIOD CALCULATES THE AMOUNTS OF CESIUM AND IODINE ISOTOPES        CESID       6
      C     AVAILABLE TO THE FUEL ROD GAP.                                    CESID       7
      C                                                                       CESID       8
      C     ROID(1) = OUTPUT NET SPECIFIC RELEASE OF IODINE                   CESID       9
      C     (KG IODINE /KG FUEL)                                              CESID      10
      C     ROID(2) = OUTPUT NET SPECIFIC RELEASE OF IODINE 127               CESID      11
      C     (KG IODINE 127/KG FUEL) STABLE                                    CESID      12
      C     ROID(3) = OUTPUT NET SPECIFIC RELEASE OF IODINE 129               CESID      13
      C     (KG IODINE 129/KG FUEL) HALF LIFE 1.72E07 YEARS                   CESID      14
      C     ROID(4) = OUTPUT NET SPECIFIC RELEASE OF IODINE 131               CESID      15
      C     (KG IODINE 131/KG FUEL) HALF LIFE 8.05 DAYS                       CESID      16
      C     ROID(5) = OUTPUT NET SPECIFIC RELEASE OF IODINE 132               CESID      17
      C     (KG IODINE 132/KG FUEL) HALF LIFE 2.3 HOURS                       CESID      18
      C     ROID(6) = OUTPUT NET SPECIFIC RELEASE OF IODINE 133               CESID      19
      C     (KG IODINE 133/KG FUEL) HALF LIFE 21 HOURS                        CESID      20
      C     ROID(7) = OUTPUT NET SPECIFIC RELEASE OF IODINE 134               CESID      21
      C     (KG IODINE 134/KG FUEL) HALF LIFE 52 MINUTES                      CESID      22
      C     ROID(8) = OUTPUT NET SPECIFIC RELEASE OF IODINE 135               CESID      23
      C     (KG IODINE 135/KG FUEL) HALF LIFE 6.7 HOURS                       CESID      24
      C     CS(1)   = OUTPUT NET SPECIFIC RELEASE OF CESIUM                   CESID      25
      C     (KG CESIUM/KG FUEL)                                               CESID      26
      C     CS(2)   = OUTPUT NET SPECIFIC RELEASE OF CESIUM 133               CESID      27
      C     (KG CESIUM 133/KG FUEL) STABLE                                    CESID      28
      C     CS(3)   = OUTPUT NET SPECIFIC RELEASE OF CESIUM 135               CESID      29
      C     (KG CESIUM 135/KG FUEL) HALF LIFE 2.9E06 YEARS                    CESID      30
      C     CS(4)   = OUTPUT NET SPECIFIC RELEASE OF CESIUM 137               CESID      31
      C     (KG CESIUM 137/KG FUEL) HALF LIFE 33 YEARS                        CESID      32
      C     CS(5)   = OUTPUT NET SPECIFIC RELEASE OF CESIUM 138               CESID      33
      C     (KG CESIUM 138/KG FUEL) HALF LIFE 32.2 MINUTES                    CESID      34
      C     FTMAX   = OUTPUT MAXIMUM TEMPERATURE ATTAINED BY THE MESHPOINT    CESID      35
      C     DURING OPERATION TO THE END OF THE BURNUP STEP                    CESID      36
      C     CONSIDERED (K)                                                    CESID      37
      C                                                                       CESID      38
      C     TIME    = INPUT TIME AT OPERATING TEMPERATURE AT END OF STEP (S)  CESID      39
      C     FTMAX   = INPUT MAXIMUM TEMPERATURE ATTAINED BY THE MESHPOINT     CESID      40
      C     DURING OPERATION PRIOR TO BURNUP STEP CONSIDERED (K)              CESID      41
      C     DELBU   = INPUT BURNUP DURING THE STEP CONSIDERED (MW-S/KG METAL)  CESID      42
      C     DTIME   = INPUT DURATION OF THE BURNUP STEP CONSIDERED (S)        CESID      43
      C     FTEMP   = INPUT FUEL MESHPOINT TEMPERATURE (K)                    CESID      44
      C     FRADEN  = INPUT FRACTIONAL FUEL DENSITY (RATIO OF ACTUAL          CESID      45
      C     DENSITY TO THEORETICAL DENSITY)                                   CESID      46
      C                                                                       CESID      47
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM      CESID      48
      C     (1) J.    BELLE   URANIUM DIOXIDE. PROPERTIES AND NUCLEAR         CESID      49
      C     APPLICATIONS (JULY 1961)                                          CESID      50
      C     (2) S.    KATCOFF NUCLEONICS 16 (APRIL 1958) PP 78-85             CESID      51
      C     (3) S.    KATCOFF NUCLEONICS 18 (NOV 1960) PP 201-208             CESID      52
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      C   (4) B. F. RIDER,  A SURVEY AND EVALUATION OF THERMAL FISSION
      C   YIELDS FOR U-235, PU-239, U-233, AND PU-241
      C   GEAP-5356 (SEPT 1967)
      C
      C   THIS MODEL IS FOR LWR REACTORS ONLY
      C
      C   CESIOD WAS CODED BY D. L. HAGRMAN JANUARY 1977
      C
            COMMON  / PHYPRO / FTMELT,FHEFUS,CTMELT,CHEFUS,CTRANB,
           +                   CTRANE,CTRANZ,FDELTA,BU,COMP,DELOXY
      C
      C
            DATA YUID2 / 9.50E-12/, YUID3 / 5.94E-11/,  YUID4 / 3.10E-02 /
            DATA YUID5 / 4.30E-02/, YUID6 / 6.90E-02/,  YUID7 / 7.90E-02 /
            DATA YUID8 / 6.10E-02/
            DATA YUCS2 / 5.04E-10/, YUCS3 / 4.98E-10/,  YUCS4 / 4.85E-10 /
            DATA YUCS5 / 6.60E-02/
            DATA ALMDI4/ 9.97E-07/, ALMDI5/ 9.17E-06/,  ALMDI6/ 8.37E-05 /
            DATA ALMDI7/ 2.22E-04/, ALMDI8/ 2.87E-05/,  ALMDC5/ 3.59E-04 /
      C
      C   UNITS CONVERSION
      C
            B = BU*0.88
            FISR = DELBU*0.88/(1.732E19*DTIME)
      C
            IF (FTEMP.GT.FTMAX) FTMAX = FTEMP
      C
      C   FIND DIFFUSION RADIUS AND DIFFUSION CONSTANTS
      C
            A = 3.0*FRADEN*(10.0**(20.61-FRADEN*(67.90-46.0*FRADEN)))
            DMAX = 6.6E-06/EXP(3.6086E04/FTMAX)
            DNOW = 6.6E-06/EXP(3.6086E04/FTEMP)
            IF (FTMAX.LE.1134.054) DMAX = 1.0E-19
            IF (FTEMP.LE.1134.054) DNOW = 1.0E-19
      C
      C   FIND ESCAPE RATE COEFFICIENTS
      C
            ANUI4 = 3.0*((DNOW*ALMDI4)**0.5)/A
            ANUI5 = 3.0*((DNOW*ALMDI5)**0.5)/A
            ANUI6 = 3.0*((DNOW*ALMDI6)**0.5)/A
            ANUI7 = 3.0*((DNOW*ALMDI7)**0.5)/A
            ANUI8 = 3.0*((DNOW*ALMDI8)**0.5)/A
            ANUC5 = 3.0*((DNOW*ALMDC5)**0.5)/A
      C
      C   FIND SPECIFIC RELEASE FOR LONG LIVED ISOTOPES
      C
      C   CHECK FOR FUEL MELT
      C
            IF (FTMAX.LT.FTMELT) GO TO 110
      100   ROID(2) = YUID2*B
            ROID(3) = YUID3*B
            CS(2) = YUCS2*B
            CS(3) = YUCS3*B
```

```
                      CS(4) = YUCS4*B                                                    CESID    106
                      GO TO 120                                                          CESID    107
                C                                                                        CESID    108
110             C   SPECIFIC RELEASES WITHOUT MELT FOLLOW                                CESID    109
                C                                                                        CESID    110
                C   CHECK TO SEE IF RELEASE FRACTION IS GREATER THAN ONE                 CESID    111
                C                                                                        CESID    112
                110   F = 2.257*((DMAX*TIME)**0.5)/A-1.5*DMAX*TIME/(A**2)                CESID    113
115                   IF (F.GT.1.0) GO TO 100                                            CESID    114
                C                                                                        CESID    115
                      ROID(2) = YUID2*B*F                                                CESID    116
                      ROID(3) = YUID3*B*F                                                CESID    117
                      CS(2) = YUCS2*B*F                                                  CESID    118
120                   CS(3) = YUCS3*B*F                                                  CESID    119
                      CS(4) = YUCS4*B*F                                                  CESID    120
                C                                                                        CESID    121
                C   FIND SPECIFIC RELEASES FOR SHORT LIVED ISOTOPES                      CESID    122
                C                                                                        CESID    123
125             120   ROID(4) = FISR*131*YUID4*ANUI4/((ANUI4+ALMDI4)*ALMDI4)             CESID    124
                      ROID(5) = FISR*132*YUID5*ANUI5/((ANUI5+ALMDI5)*ALMDI5)             CESID    125
                      ROID(6) = FISR*133*YUID6*ANUI6/((ANUI6+ALMDI6)*ALMDI6)             CESID    126
                      ROID(7) = FISR*134*YUID7*ANUI7/((ANUI7+ALMDI7)*ALMDI7)             CESID    127
                      ROID(8) = FISR*135*YUID8*ANUI8/((ANUI8+ALMDI8)*ALMDI8)             CESID    128
130                   CS(5) = FISR*138*YUCS5*ANUC5/((ANUC5+ALMDC5)*ALMDC5)               CESID    129
                C                                                                        CESID    130
                C   CALCULATE SUMS                                                       CESID    131
                C                                                                        CESID    132
                      ROID(1) = ROID(2)+ROID(3)+ROID(4)+ROID(5)+ROID(6)+ROID(7)+ROID(8)  CESID    133
135                   CS(1) = CS(2)+CS(3)+CS(4)+CS(5)                                    CESID    134
                C                                                                        CESID    135
                      RETURN                                                             CESID    136
                      END                                                                CESID    137
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CESIOD	3	137

VARIABLES	SN	TYPE	RELOCATION							
356	A	REAL		REFS	91	92	93	94	95	96	2*114
				DEFINED	83						
326	ALMDC5	REAL		REFS	96	2*130	DEFINED	72			
321	ALMDI4	REAL		REFS	91	2*125	DEFINED	71			
322	ALMDI5	REAL		REFS	92	2*126	DEFINED	71			
323	ALMDI6	REAL		REFS	93	2*127	DEFINED	71			
324	ALMDI7	REAL		REFS	94	2*128	DEFINED	72			
325	ALMDI8	REAL		REFS	95	2*129	DEFINED	72			
366	ANUC5	REAL		REFS	2*130	DEFINED	96				
361	ANUI4	REAL		REFS	2*125	DEFINED	91				

VARIABLES	SN	TYPE	RELOCATION									
362	ANU15	REAL			REFS	2*126	DEFINED	92				
363	ANU16	REAL			REFS	2*127	DEFINED	93				
364	ANU17	REAL			REFS	2*128	DEFINED	94				
365	ANU18	REAL			REFS	2*129	DEFINED	95				
354	B	REAL			REFS	103	104	105	106	107	117	118
						119	120	121	DEFINED	76		
10	BU	REAL		PHYPRO	REFS	62	76					
3	CHEFUS	REAL		PHYPRO	REFS	62						
11	COMP	REAL		PHYPRO	REFS	62						
0	CS	REAL	ARRAY	F.P.	REFS	5	4*135	DEFINED	3	105	106	107
						119	120	121	130	135		
2	CTMELT	REAL		PHYPRO	REFS	62						
4	CTRANB	REAL		PHYPRO	REFS	62						
5	CTRANE	REAL		PHYPRO	REFS	62						
6	CTRANZ	REAL		PHYPRO	REFS	62						
0	DELBU	REAL		F.P.	REFS	77	DEFINED	3				
12	DELOXY	REAL		PHYPRO	REFS	62						
357	DMAX	REAL			REFS	2*114	DEFINED	84	86			
360	DNOW	REAL			REFS	91	92	93	94	95	96	
					DEFINED	85	87					
0	DTIME	REAL		F.P.	REFS	77	DEFINED	3				
367	F	REAL			REFS	115	117	118	119	120	121	
					DEFINED	114						
7	FDELTA	REAL		PHYPRO	REFS	62						
1	FHEFUS	REAL		PHYPRO	REFS	62						
355	FISR	REAL			REFS	125	126	127	128	129	130	
					DEFINED	77						
0	FRADEN	REAL		F.P.	REFS	3*83	DEFINED	3				
0	FTEMP	REAL		F.P.	REFS	2*79	85	87	DEFINED	3		
0	FTMAX	REAL		F.P.	REFS	79	84	86	102	DEFINED	3	79
0	FTMELT	REAL		PHYPRO	REFS	62	102					
0	ROID	REAL	ARRAY	F.P.	* REFS	5	7*134	DEFINED	3	103	104	117
						118	125	126	127	128	129	134
0	TIME	REAL		F.P.	REFS	2*114	DEFINED	3				
315	YUCS2	REAL			REFS	105	119	DEFINED	69			
316	YUCS3	REAL			REFS	106	120	DEFINED	69			
317	YUCS4	REAL			REFS	107	121	DEFINED	69			
320	YUCS5	REAL			REFS	130	DEFINED	70				
306	YUID2	REAL			REFS	103	117	DEFINED	66			
307	YUID3	REAL			REFS	104	118	DEFINED	66			
310	YUID4	REAL			REFS	125	DEFINED	66				
311	YUID5	REAL			REFS	126	DEFINED	67				
312	YUID6	REAL			REFS	127	DEFINED	67				
313	YUID7	REAL			REFS	128	DEFINED	67				
314	YUID8	REAL			REFS	129	DEFINED	68				

EXTERNALS	TYPE	ARGS	REFERENCES	
EXP	REAL	1	LIBRARY	84 85

STATEMENT LABELS	DEF LINE	REFERENCES
132 100	103	115
153 110	114	102
215 120	125	108

```
COMMON BLOCKS   LENGTH
       PHYPRO       11

STATISTICS
  PROGRAM LENGTH                 370B     248
  SCM LABELED COMMON LENGTH       13B      11
        140000B SCM USED
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```
      C                                                                      CESID    138
      C                                                                      CESID    139
            SUBROUTINE CFATIG (CTEMP,FFNCE,HICOEF,HIEXP,THRSH,ALOCOF,ALOEXP) CFATG      2
      C                                                                      CFATG      3
      C     CFATIG CALCULATES COEFFICIENTS AND EXPONENTS FOR HIGH            CFATG      4
      C     AND LOW CYCLE FATIGUE FAILURE EXPRESSIONS OF THE FOLLOWING       CFATG      5
      C     FORMS.                                                           CFATG      6
      C                                                                      CFATG      7
      C     FOR HIGH CYCLE FAILURE IN ZIRCALOY                               CFATG      8
      C     DL/DN = HICOEF*(STRESS INTENSITY CHANGE)**HIEXP                  CFATG      9
      C     FOR LOW CYCLE FAILURE IN ZIRCALOY                                CFATG     10
      C     DL/DN = ALOCOF*L*(PLASTIC STRAIN RANGE)**ALOEXP                  CFATG     11
      C     WHERE DL/DN IS THE CHANGE IN CRACK LENGTH PER CYCLE (M/CYCLE)    CFATG     12
      C     AND L IS THE CRACK LENGTH (M)                                    CFATG     13
      C                                                                      CFATG     14
      C     HICOEF = OUTPUT HIGH CYCLE EXPRESSION COEFFICIENT((M/CYCLE)/     CFATG     15
      C     (1.0E06 NEUTRONS/METER**1.5)**HIEXP)                             CFATG     16
      C     HIEXP  = OUTPUT HIGH CYCLE EXPRESSION EXPONENT (UNITLESS)        CFATG     17
      C     THRSH  = OUTPUT MINIMUM STRESS INTENSITY FOR CRACK (MPA)         CFATG     18
      C     ALOCOF = OUTPUT LOW CYCLE EXPRESSION COEFFICIENT ((M/CYCLE)/M)   CFATG     19
      C     ALOEXP = OUTPUT LOW CYCLE EXPRESSION EXPONENT (UNITLESS)         CFATG     20
      C                                                                      CFATG     21
      C     CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)                CFATG     22
      C     FFNCE  = INPUT FAST NEUTRON FLUENCE (NEUTRONS/M**2)              CFATG     23
      C                                                                      CFATG     24
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     CFATG     25
      C     (1) V. S. RAO, HIGH CYCLE FATIGUE CRACK GROWTH OF TWO ZIRCONIUM  CFATG     26
      C     ALLOYS, AE-486  (MARCH 1974)                                     CFATG     27
      C     (2) T. J. WALKER AND J. N. KASS, VARIATION OF ZIRCALOY FRACTURE  CFATG     28
      C     TOUGHNESS IN IRRADIATION, ASTM-STP-551, (1970) PP 328-354        CFATG     29
      C     (3) K. PETTERSSON, "LOW CYCLE FATIGUE PROPERTIES OF ZIRCALOY     CFATG     30
      C     CLADDING", J. NUCLEAR MATERIALS 56 (1975) PP 91-102.             CFATG     31
      C                                                                      CFATG     32
      C     INPUT CTEMP IS NOT USED IN THIS VERSION OF CFATIG                CFATG     33
      C                                                                      CFATG     34
      C     CODED BY D. L. HAGRMAN FEBRUARY 1977                             CFATG     35
      C     UPDATED BY D.L. HAGRMAN SEPT 1977                                CFATG     36
      C                                                                      CFATG     37
      C                                                                      CFATG     38
      C     CALCULATE HIGH CYCLE CONSTANTS                                   CFATG     39
      C                                                                      CFATG     40
            HICOEF = 1.0165786E-25                                           CFATG     41
            IF (FFNCE.GT.1.0E25) GO TO 100                                   CFATG     42
            HICOEF = 2.0E-11*(15.531432**(12.0*(EXP(-FFNCE/1.0E24)-1)))      CFATG     43
      100   HIEXP = 15.0-12.0*EXP(-FFNCE/1.0E24)                             CFATG     44
            THRSH = 9.5                                                      CFATG     45
      C                                                                      CFATG     46
      C     CALCULATE LOW CYCLE CONSTANTS                                    CFATG     47
      C                                                                      CFATG     48
            ALOCOF = 10.7                                                    CFATG     49
            ALOEXP = 1.67                                                    CFATG     50
      C                                                                      CFATG     51
            RETURN                                                           CFATG     52
```

```
                    END                                                    CFATG      53


        SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE     REFERENCES
    4  CFATIG           3       53

VARIABLES     SN  TYPE           RELOCATION
    0  ALOCOF     REAL                F.P.      DEFINED        3       50
    0  ALOEXP     REAL                F.P.      DEFINED        3       51
    0  CTEMP      REAL       *UNUSED  F.P.      DEFINED
    0  FFNCE      REAL                F.P.        REFS         4       44        45    DEFINED        3
    0  HICOEF     REAL                F.P.      DEFINED        3       42        44
    0  HIEXP      REAL                F.P.      DEFINED        3       45
    0  THRSH      REAL                F.P.      DEFINED        3       46

EXTERNALS          TYPE    ARGS       REFERENCES
       EXP         REAL       1 LIBRARY      44          45

STATEMENT LABELS              DEF LINE    REFERENCES
   27  100                       45          43

STATISTICS
  PROGRAM LENGTH                  67B       55
        140000B SCM USED
```

```
      C                                                                      CFATG     54
      C                                                                      CFATG     55
            SUBROUTINE CHITOX (T1,T2,X2,X1,DT,X12,X11,DROD2,DROD,Q)          CHITX      2
      C                                                                      CHITX      3
      C     CHITOX COMPUTES THE ZIRCALOY OXIDE AND X1 LAYER THICKNESSES      CHITX      4
      C     AT THE END OF A TIME STEP, THE POWER GENERATED IN THE CLADDING   CHITX      5
      C     DURING THE TIME STEP DUE TO THE METAL-WATER CHEMICAL REACTION,   CHITX      6
      C     AND THE DIAMETER OF THE REMAINING UNOXIDIZED PORTION OF THE      CHITX      7
      C     ROD.                                                             CHITX      8
      C                                                                      CHITX      9
      C     X2    : OUTPUT ZRO2 THICKNESS AT THE END OF A TIME STEP (M)      CHITX     10
      C     X12   : OUTPUT X1 THICKNESS AT THE END OF A TIME STEP (M)        CHITX     11
      C     DROD2 : OUTPUT OUTER DIAMETER OF UNOXIDIZED PART OF CLADDING     CHITX     12
      C     AT THE END OF THE TIME STEP (M)                                  CHITX     13
      C     (EXPANSION OF THE LATTICE DUE TO DISSOLVED OXYGEN IS             CHITX     14
      C     NEGLECTED)                                                       CHITX     15
      C     Q     : OUTPUT RATE OF HEAT GENERATION PER METER FOR A ROD OF    CHITX     16
      C     INITIAL DIAMETER DROD (W/M)                                      CHITX     17
      C                                                                      CHITX     18
      C     T1    : INPUT CLADDING TEMPERATURE AT START OF A TIME STEP (K)   CHITX     19
      C     T2    : INPUT CLADDING TEMPERATURE AT END OF A TIME STEP (K)     CHITX     20
      C     X1    : INPUT ZRO2 THICKNESS AT START OF A TIME STEP (M)         CHITX     21
      C     DT    : INPUT TIME STEP DURATION (S)                             CHITX     22
      C     X11   : INPUT X1 THICKNESS AT START OF A TIME STEP (M)           CHITX     23
      C     DROD  : INPUT UNOXIDIZED ROD OUTER DIAMETER (M)                  CHITX     24
      C                                                                      CHITX     25
      C     THE CORRELATIONS WERE DERIVED FROM THE PARABOLIC RATE EQUATIONS   CHITX     26
      C     OF J.V. CATHCART, ORNL/NUREG/TM-41 (AUGUST 1976)                 CHITX     27
      C                                                                      CHITX     28
      C     CHITOX WAS CODED BY G.A. REYMANN    SEPTEMBER 1976               CHITX     29
      C     UPDATED BY G.A. REYMANN  DEC 1976                                CHITX     30
      C                                                                      CHITX     31
      C                                                                      CHITX     32
            DATA  RHOZ, HRZ / 6.5E03 , 6.4E06/                               CHITX     33
            TAVE = (T1+T2)/2.                                                CHITX     34
            IF (TAVE.LT.1.0E03) GO TO 110                                    CHITX     35
      C                                                                      CHITX     36
            X2 = SQRT((X1)**2+2.25E-06*EXP(-18063./TAVE)*DT)                 CHITX     37
            X12 = SQRT((X11)**2+6.824E-5*EXP(-2.1E4/TAVE)*DT)                CHITX     38
      C                                                                      CHITX     39
      100   DROD2 = DROD-1.38*X2                                             CHITX     40
            Q = (RHOZ*HRZ*2.17*DROD*(X2-X1))/DT                              CHITX     41
            GO TO 120                                                        CHITX     42
      C                                                                      CHITX     43
      110   X2 = X1                                                          CHITX     44
            X12 = X11                                                        CHITX     45
            GO TO 100                                                        CHITX     46
      C                                                                      CHITX     47
      120   RETURN                                                           CHITX     48
            END                                                              CHITX     49
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CHITOX 3 49

VARIABLES	SN	TYPE	RELOCATION								
0	DROD	REAL	F.P.	REFS	41	42	DEFINED	3			
0	DROD2	REAL	F.P.	DEFINED	3	41					
0	DT	REAL	F.P.	REFS	38	39	42	DEFINED	3		
101	HRZ	REAL		REFS	42	DEFINED	34				
0	Q	REAL	F.P.	DEFINED	3	42					
100	RHOZ	REAL		REFS	42	DEFINED	34				
113	TAVE	REAL		REFS	36	38	39	DEFINED	35		
0	T1	REAL	F.P.	REFS	35	DEFINED	3				
0	T2	REAL	F.P.	REFS	35	DEFINED	3				
0	X1	REAL	F.P.	REFS	38	42	45	DEFINED	3		
0	X11	REAL	F.P.	REFS	39	46	DEFINED	3			
0	X12	REAL	F.P.	DEFINED	3	39	46				
0	X2	REAL	F.P.	REFS	41	42	DEFINED	3	38	45	

EXTERNALS	TYPE	ARGS		REFERENCES	
EXP	REAL	1	LIBRARY	38	39
SQRT	REAL	1	LIBRARY	38	39

STATEMENT LABELS		DEF LINE	REFERENCES
44	100	41	47
62	110	45	36
71	120	49	43

STATISTICS

PROGRAM LENGTH	114B	76
140000B SCM USED		

```
      C                                                                       CHITX      50
      C                                                                       CHITX      51
            FUNCTION CHSCP (PPMHYD,CTEMP,ICOR,ICM,DCO,DCI,TIME,WOXO,CHORG,PPMH CHSCP       2
           +20,DP)                                                            CHSCP      3
      C                                                                       CHSCP      4
      C     CHSCP CALCULATES THE APPARENT ADDITION TO SPECIFIC HEAT           CHSCP      5
      C     BECAUSE OF ENERGY USED IN SOLUTION OF HYDRIDES PRESENT            CHSCP      6
      C     IN ZIRCALOYS                                                      CHSCP      7
      C                                                                       CHSCP      8
      C     CHSCP  = OUTPUT APPARENT ADDITION TO SPECIFIC HEAT BECAUSE        CHSCP      9
      C     OF HYDRIDES PRESENT IN ZIRCALOYS (J/KG-K)                         CHSCP     10
      C                                                                       CHSCP     11
      C     PPMHYD = INPUT CONCENTRATION OF HYDROGEN IN THE SAMPLE (PPM)      CHSCP     12
      C     CTEMP  = INPUT TEMPERATURE (K)                                    CHSCP     13
      C                                                                       CHSCP     14
      C     THE FOLLOWING INPUTS ARE USED ONLY IF PPMHYD IS                   CHSCP     15
      C     NOT A POSITIVE NUMBER (SEE CHUPTK DESCRIPTION)                    CHSCP     16
      C                                                                       CHSCP     17
      C     ICOR   = INPUT REACTOR CHEMISTRY INDEX                            CHSCP     18
      C     .GE.2 FOR PWR                                                     CHSCP     19
      C     .LT.2 FOR BWR                                                     CHSCP     20
      C     ICM    = INPUT CLADDING MATERIAL INDEX (2= ZIRC2, 4 = ZIRC4)      CHSCP     21
      C     DCO    = INPUT CLADDING OUTSIDE DIAMETER (INCHES)                 CHSCP     22
      C     DCI    = INPUT CLADDING INSIDE DIAMETER (INCHES)                  CHSCP     23
      C     TIME   = INPUT TIME AT TEMPERATURE (S)                            CHSCP     24
      C     WOXO   = INPUT INITIAL OXIDE FILM WEIGHT (MG/DM**2)               CHSCP     25
      C     CHORG  = INPUT INITIAL HYDROGEN CONTENT (PPM)                     CHSCP     26
      C     PPMH2O = INPUT FUEL WATER CONTENT (PPM)                           CHSCP     27
      C     DP     = INPUT FUEL PELLET DIAMETER (INCHES)                      CHSCP     28
      C                                                                       CHSCP     29
      C     THIS CODE IS BASED ON DATA FROM                                   CHSCP     30
      C     J. SCOTT, A CALORIMETRIC INVESTIGATION OF ZIRCONIUM,              CHSCP     31
      C     TITANIUM AND ZIRCONIUM ALLOYS FROM 60 TO 960 C.  PHD              CHSCP     32
      C     THESIS (UNIVERSITY OF TENNESSEE, 1957)                            CHSCP     33
      C                                                                       CHSCP     34
      C     CHSCP CODED BY D. L. HAGRMAN MAY 1976                             CHSCP     35
      C                                                                       CHSCP     36
      C     CONVERSION FROM J/(KG*K) TO CAL/(G*K) IS                          CHSCP     37
      C     2.39006E-04 (CAL/(G*C))/(J/(KG*K))                                CHSCP     38
      C                                                                       CHSCP     39
      C     ESTIMATED STANDARD ERROR OF THE PREDICTION OF                     CHSCP     40
      C     CHSCP FOR THE APPARENT ADDITION TO SPECIFIC HEAT                  CHSCP     41
      C     BECAUSE OF ENERGY USED IN SOLUTION OF HYDRIDES PRESENT            CHSCP     42
      C     IN ZIRCALOY CLADDING SAMPLES -- (SUM OF SQUARED                   CHSCP     43
      C     RESIDUALS/(NUMBER OF RESIDUALS-DEGREES OF FREEDOM))**0.5 --       CHSCP     44
      C     IS HALF OF THE PREDICTED VALUE                                    CHSCP     45
      C                                                                       CHSCP     46
            A = 1.332E05                                                      CHSCP     47
            B = 4.401E03                                                      CHSCP     48
            C = 4.570E01                                                      CHSCP     49
            IF (PPMHYD.GT.0.0) GO TO 100                                      CHSCP     50
            PPMHYD = CHUPTK(CTEMP,ICOR,ICM,DCO,DCI,TIME,WOXO,CHORG,PPMH2O,DP) CHSCP     51
      100   T = CTEMP                                                         CHSCP     52
```

```
                IF (PPMHYD.LE.0.0) PPMHYD = 1.0                                  CHSCP      53
     55         TSOL = B/(ALOG(A/PPMHYD))                                        CHSCP      54
                CHSCP = C*A*B/(T**2)*EXP(-B/T)*(1/(EXP((T-TSOL)/(TSOL/50))+1))   CHSCP      55
          C                                                                      CHSCP      56
                RETURN                                                           CHSCP      57
                END                                                              CHSCP      58
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

	DEF LINE	REFERENCES
5 CHSCP	3	58

VARIABLES

	SN	TYPE	RELOCATION								
124	A	REAL		REFS	55	56	DEFINED	48			
125	B	REAL		REFS	55	2*56	DEFINED	49			
126	C	REAL		REFS	56	DEFINED	50				
0	CHORG	REAL	F.P.	REFS	52	DEFINED	3				
123	CHSCP	REAL		DEFINED	56						
0	CTEMP	REAL	F.P.	REFS	52	53	DEFINED	3			
0	DCI	REAL	F.P.	REFS	52	DEFINED	3				
0	DCO	REAL	F.P.	REFS	52	DEFINED	3				
0	DP	REAL	F.P.	REFS	52	DEFINED	3				
0	ICM	INTEGER	F.P.	REFS	52	DEFINED	3				
0	ICOR	INTEGER	F.P.	REFS	52	DEFINED	3				
0	PPMHYD	REAL	F.P.	REFS	51	54	55	DEFINED	3	52	54
0	PPMH2O	REAL	F.P.	REFS	52	DEFINED	3				
127	T	REAL		REFS	3*56	DEFINED	53				
0	TIME	REAL	F.P.	REFS	52	DEFINED	3				
130	TSOL	REAL		REFS	2*56	DEFINED	55				
0	WOXO	REAL	F.P.	REFS	52	DEFINED	3				

EXTERNALS

	TYPE	ARGS		REFERENCES
ALOG	REAL	1	LIBRARY	55
CHUPTK	REAL	10		52
EXP	REAL	1	LIBRARY	2*56

STATEMENT LABELS

	DEF LINE	REFERENCES
41 100	53	51

STATISTICS

PROGRAM LENGTH 1318 89

140000B SCM USED

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      C                                                                       CHSCP      59
      C                                                                       CHSCP      60
            SUBROUTINE CHUPTK (CHORG,PPMH2O,DP,ICM,DCO,DCI,ICOR,ZRO2AI,ZRO2BI, CHPTK       2
           +TCOI,QCI,ZOXKI,CHYDAI,CHYDBI,CHCONC)                              CHPTK      3
      5     C                                                                 CHPTK      4
            C   CHUPTK CALCULATES AVERAGE CONCENTRATION OF HYDROGEN IN ZIRCALOY CHPTK     5
            C   CLADDING.                                                     CHPTK      6
            C                                                                 CHPTK      7
            C   CHCONC = OUTPUT AVERAGE CONCENTRATION OF                      CHPTK      8
     10     C   HYDROGEN IN CLADDING AT END OF TIME STEP (PPM)                CHPTK      9
            C   CHYDBI = OUTPUT HYDROGEN FROM COOLANT IN CLADDING AT END      CHPTK     10
            C   OF TIME STEP (PPM)                                           CHPTK     11
            C                                                                 CHPTK     12
            C   CHORG  = INPUT INITIAL HYDROGEN IN CLADDING (PPM)            CHPTK     13
     15     C   PPMH2O = INPUT INITIAL FUEL WATER CONTENT (PPM)              CHPTK     14
            C   DP     = INPUT FUEL PELLET DIAMETER (M)                      CHPTK     15
            C   ICM    = INPUT CLADDING MATERIAL FLAG (ICM = 2 FOR ZIRCALOY 2, CHPTK    16
            C   ICM = 4 FOR ZIRCALOY 4)                                      CHPTK     17
            C   DCO    = INPUT CLADDING OUTSIDE DIAMETER (M)                 CHPTK     18
     20     C   DCI    = INPUT CLADDING INSIDE DIAMETER (M)                  CHPTK     19
            C   ICOR   = INPUT REACTOR CHEMISTRY .GE. 2 FOR PWR, .LT. 2 FOR BWR CHPTK    20
            C   ZRO2AI = INPUT OXIDE THICKNESS AT START OF CURRENT TIME STEP (M) CHPTK    21
            C   ZRO2BI = INPUT OXIDE THICKNESS AT END OF CURRENT TIME STEP (M) CHPTK    22
            C   TCOI   = INPUT ZRO2-COOLANT INTERFACE TEMPERATURE (K)         CHPTK     23
     25     C   QCI    = INPUT AXIAL INCREMENT HEAT FLUX (WATT/METER**2)      CHPTK     24
            C   ZOXKI  = INPUT ZIRCALOY OXIDE THERMAL CONDUCTIVITY (W/(M-K)) CHPTK     25
            C   CHYDAI = INPUT HYDROGEN FROM COOLANT IN CLADDING AT START     CHPTK     26
            C   OF TIME STEP (PPM)                                           CHPTK     27
            C                                                                 CHPTK     28
     30     C   THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM  CHPTK     29
            C   (1) E. HILLNER, HYDROGEN ABSORPTION IN ZIRCALOY DURING ACQUEOUS CHPTK    30
            C   CORROSION, EFFECT OF ENVIRONMENT, WESTINGHOUSE REPORT        CHPTK     31
            C   WAPD-411  (1964)                                             CHPTK     32
            C   (2) A. VAN DER LINDE, CALCULATION OF THE SAFE LIFETIME EXPECTANCY CHPTK   33
     35     C   OF ZIRCONIUM ALLOY CANNING IN THE FUEL ELEMENTS OF THE NERO   CHPTK     34
            C   REACTOR, REPORT RCN-41 (1965)                                 CHPTK     35
            C   (3) F. H. MEGERTH, C. P. RUIZ, U. E. WOLFF, ZIRCALOY-CLAD UO2 CHPTK     36
            C   FUEL ROD EVALUATION PROGRAM FINAL REPORT, GENERAL ELECTRIC     CHPTK     37
            C   REPORT GEAP 10371 (1971)                                      CHPTK     38
     40     C   (4) W. R. SMALLEY, SAXTON CORE II FUEL PERFORMANCE EVALUATION  CHPTK     39
            C   PART I MATERIALS, WESTINGHOUSE REPORT WCAP-3385-56 (1971)     CHPTK     40
            C   (5) W. R. SMALLEY, EVALUATION OF SAXTON CORE III FUEL         CHPTK     41
            C   MATERIALS PERFORMANCE, WESTINGHOUSE REPORT WCAP-3385-57       CHPTK     42
            C   (1974)                                                        CHPTK     43
     45     C   (6) E. HILLNER, CORROSION AND HYDRIDING PERFORMANCE OF ZIRCALOY CHPTK    44
            C   TUBING AFTER EXTENDED EXPOSURE IN THE SHIPPINGPORT PWR,       CHPTK     45
            C   SYMPOSIUM ON ZIRCONIUM IN NUCLEAR APPLICATIONS, ASTM STP      CHPTK     46
            C   551 (1974)                                                    CHPTK     47
            C                                                                 CHPTK     48
     50     C   THIS MODEL SHOULD NOT BE USED OUTSIDE THE TEMPERATURE RANGE   CHPTK     49
            C   523.15 - 673.15 K (250 - 400 C).                              CHPTK     50
            C                                                                 CHPTK     51
            C   CHUPTK CODED BY D. L. HAGRMAN FEBRUARY 1977                   CHPTK     52
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      C   MODIFIED BY D. L. HAGRMAN JUNE 1978                                  CHPTK      53
55    C                                                                         CHPTK      54
            IF (TCOI.LE.366.5) GO TO 140                                        CHPTK      55
            IF (ZRO2AI.LE.0.0) ZRO2AI = 1.0E-10                                 CHPTK      56
            TCOIC = TCOI+QCI*ZRO2AI/ZOXKI                                       CHPTK      57
            WTRAN = 7.7490E-06*EXP(-7.90E02/TCOIC)                              CHPTK      58
60          IF (ICOR.GE.2) GO TO 100                                            CHPTK      59
      C                                                                         CHPTK      60
      C   BWR ENVIRONMENT                                                      CHPTK      61
            A = 4.840E05*EXP(-1.945E-02*TCOI)                                   CHPTK      62
            IF (TCOI.LE.500.) A = 28.92887                                      CHPTK      63
65          B = 0.12                                                            CHPTK      64
            IF (ICM.LE.2) B = 0.29                                              CHPTK      65
            GO TO 110                                                           CHPTK      66
      C                                                                         CHPTK      67
      C   PWR ENVIRONMENT                                                      CHPTK      68
70    100   A = 1.203E02*EXP(-7.118E-03*TCOI)                                   CHPTK      69
            IF (TCOI.LE.500.) A = 3.424614                                      CHPTK      70
            B = 0.12                                                            CHPTK      71
            IF (ICM.LE.2) B = 0.48                                              CHPTK      72
      110   IF (TCOI.GT.673.) A = 1.0                                           CHPTK      73
75          C = 1.0                                                             CHPTK      74
            IF (ICM.LE.2) C = 1.0/B                                             CHPTK      75
      C                                                                         CHPTK      76
      C   FIND HYDROGEN UPTAKE FROM COOLANT DURING CURRENT TIME STEP           CHPTK      77
      C                                                                         CHPTK      78
80          D = (9.0E+05)*DCO/(DCO**2-DCI**2)                                   CHPTK      79
            IF (ZRO2AI.GT.WTRAN) GO TO 130                                      CHPTK      80
            IF (ZRO2BI.GE.WTRAN) GO TO 120                                      CHPTK      81
      C                                                                         CHPTK      82
      C   ALL OXIDATION PRETRANSITION                                          CHPTK      83
85          CHUPC = D*(B/(8*A))*(ZRO2BI-ZRO2AI)                                 CHPTK      84
            GO TO 150                                                           CHPTK      85
      C                                                                         CHPTK      86
      C   PART OF OXIDATION PRETRANSITION                                      CHPTK      87
      120   CHUPC = D*((B/(8*A))*(WTRAN-ZRO2AI)+(C*B/(8*A))*(ZRO2BI-WTRAN))     CHPTK      88
90          GO TO 150                                                           CHPTK      89
      C                                                                         CHPTK      90
      C   ALL OXIDATION POST - TRANSITION                                      CHPTK      91
      130   CHUPC = D*(C*B/(8*A))*(ZRO2BI-ZRO2AI)                               CHPTK      92
            GO TO 150                                                           CHPTK      93
95    C                                                                         CHPTK      94
      140   CHUPC = 0.0                                                         CHPTK      95
      C                                                                         CHPTK      96
      C   SUM HYDROGEN FROM COOLANT                                           CHPTK      97
      150   CHYDBI = CHYDA.+CHUPC                                               CHPTK      98
100   C                                                                         CHPTK      99
      C   SUM HYDROGEN FROM ALLOY, FUEL MOISTURE AND COOLANT                    CHPTK     100
            CHCONC = CHORG+0.186*PPMH2O*((DP**2)/(DCO**2-DCI**2))+CHYDBI        CHPTK     101
      C                                                                         CHPTK     102
            RETURN                                                              CHPTK     103
105         END                                                                 CHPTK     104
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CHUPTK 3 104

VARIABLES SN TYPE RELOCATION

235	A	REAL		REFS	85	2*89	93	DEFINED	63	64	70
					71	74					
236	B	REAL		REFS	76	85	2*89	93	DEFINED	65	66
					72	73					
237	C	REAL		REFS	89	93	DEFINED	75	76		
0	CHCONC	REAL	F.P.	DEFINED	3	102					
0	CHORG	REAL	F.P.	REFS	102	DEFINED	3				
241	CHUPC	REAL		REFS	99	DEFINED	85	89	93	96	
0	CHYDAI	REAL	F.P.	REFS	99	DEFINED	3				
0	CHYDBI	REAL	F.P.	REFS	102	DEFINED	3	99			
240	D	REAL		REFS	85	89	93	DEFINED	80		
0	DCI	REAL	F.P.	REFS	80	102	DEFINED	3			
0	DCO	REAL	F.P.	REFS	2*80	102	DEFINED	3			
0	DP	REAL	F.P.	REFS	102	DEFINED	3				
0	ICM	INTEGER	F.P.	REFS	66	73	76	DEFINED	3		
0	ICOR	INTEGER	F.P.	REFS	60	DEFINED	3				
0	PPMH2O	REAL	F.P.	REFS	102	DEFINED	3				
0	QCI	REAL	F.P.	REFS	58	DEFINED	3				
0	TCOI	REAL	F.P.	REFS	56	58	63	64	70	71	74
				DEFINED	3						
233	TCOIC	REAL		REFS	59	DEFINED	58				
234	WTRAN	REAL		REFS	81	82	2*89	DEFINED	59		
0	ZOXKI	REAL	F.P.	REFS	58	DEFINED	3				
0	ZRO2AI	REAL	F.P.	REFS	57	58	81	85	89	93	
				DEFINED	3	57					
0	ZRO2BI	REAL	F.P.	REFS	82	85	89	93	DEFINED	3	

EXTERNALS	TYPE	ARGS		REFERENCES		
EXP	REAL	1	LIBRARY	59	63	70

STATEMENT LABELS		DEF LINE	REFERENCES		
60	100	70	60		
103	110	74	67		
141	120	89	82		
154	130	93	81		
165	140	96	56		
167	150	99	86	90	94

STATISTICS
PROGRAM LENGTH 242B 162
140000B SCM USED

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      C                                                                      CHPTK     105
      C                                                                      CHPTK     106
            SUBROUTINE CKMN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,AK,AN,AM) CKMN        2
      C                                                                      CKMN        3
      C     CKMN CALCULATES PARAMETERS FOR THE CLADDING EQUATION OF STATE    CKMN        4
      C     AS A FUNCTION OF TEMPERATURE, AVERAGE OXYGEN CONCENTRATION,      CKMN        5
      C     FAST NEUTRON FLUENCE, AND COLD WORK.                             CKMN        6
      C                                                                      CKMN        7
      C     AK    : OUTPUT STRENGTH COEFFICIENT (PA)                         CKMN        8
      C     AN    : OUTPUT STRAIN HARDENING EXPONENT (UNITLESS)              CKMN        9
      C     AM    : OUTPUT STRAIN RATE SENSITIVITY EXPONENT (UNITLESS)       CKMN       10
      C     UM    : ESTIMATED  UNCERTAINTY OF AM                             CKMN       11
      C     (NOT CURRENTLY RETURNED)                                         CKMN       12
      C     UN    : ESTIMATED UNCERTAINTY OF AN                              CKMN       13
      C     (NOT CURRENTLY RETURNED)                                         CKMN       14
      C     NOTE  AN - UN IS NEGATIVE NEAR 1000K                             CKMN       15
      C     UK    : ESTIMATED UNCERTAINTY OF AK                              CKMN       16
      C     (NOT CURRENTLY RETURNED)                                         CKMN       17
      C                                                                      CKMN       18
      C     CTEMP  : INPUT CLADDING MESHPOINT TEMPERATURE (K)                CKMN       19
      C     DELOXY : INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING            CKMN       20
      C     OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                    CKMN       21
      C     AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                    CKMN       22
      C     FNCK   : INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH               CKMN       23
      C     COEFFICIENT (NEUTRONS/(M**2))                                    CKMN       24
      C     FNCN   : INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING       CKMN       25
      C     EXPONENT (NEUTRONS/(M**2))                                       CKMN       26
      C     CWKF   : INPUT EFFECTIVE COLD WORK FOR STRENGTH                  CKMN       27
      C     COEFFICIENT (UNITLESS RATIO OF AREAS)                            CKMN       28
      C     CWNF   : INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING          CKMN       29
      C     EXPONENT (UNITLESS RATIO OF AREAS)                               CKMN       30
      C     RSTRAN : INPUT EFFECTIVE TRUE PLASTIC STRAIN RATE (S**(-1))      CKMN       31
      C                                                                      CKMN       32
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     CKMN       33
      C     (1) C.R. WOODS, PROPERTIES OF ZIRCALOY-4 TUBING, WAPD-TM-585     CKMN       34
      C     (1966)                                                           CKMN       35
      C     (2) ULTIMATE STRENGTH DATA OF H.C. BRASSFIELD,ET AL.             CKMN       36
      C     GEMP-482(1968)                                                   CKMN       37
      C     (3) A.L. BEMENT, JR., EFFECTS OF COLD WORK AND NEUTRON           CKMN       38
      C     IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2,             CKMN       39
      C     HW-74955                                                         CKMN       40
      C     (4) A. COWAN AND W.J. LANGFORD J.NUCLEAR MATER.                  CKMN       41
      C     30 (1969) PP 271-281                                             CKMN       42
      C     (5) L.M. HOWE AND W.R. THOMAS, J. NUCLEAR  MATER.                CKMN       43
      C     1 (1960) P 248                                                   CKMN       44
      C     (6) A. M. GARDE LIGHT-WATER-REACTOR SAFETY RESEARCH              CKMN       45
      C     PROGRAM QUARTERLY PROGRESS REPORT APRIL - JUNE 1975              CKMN       46
      C     ANL-75-58                                                        CKMN       47
      C     (7) A. M. GARDE LIGHT-WATER-REACTOR SAFETY RESEARCH              CKMN       48
      C     PROGRAM QUARTERLY PROGRESS REPORT JULY - SEPTEMBER 1975          CKMN       49
      C     ANL-75-72                                                        CKMN       50
      C     (8) R.L. MEHAN AND F.W. WIESINGER, MECHANICAL PROPERTIES         CKMN       51
      C     OF ZIRCALOY-2, KAPL-2110                                         CKMN       52
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      C   (9) D. LEE AND W.A. BACKOFEN TMS-AIME 239  (1967) PP 1034-1040       CKMN       53
      C   (10) P. J. CRESCIMANNO, HIGH STRAIN RATE TENSILE TESTS               CKMN       54
      C   OF ZIRCALOY AT 550F, WAPD-TM-1263 (FEBRUARY 1976).                   CKMN       55
      C   (11) C. R. HANN ET AL, TRANSIENT DEFORMATION PROPERTIES               CKMN       56
      C   OF ZIRCALOY FOR  LOCA SIMULATION, EPRI NP-526                        CKMN       57
      C   VOLUME 3 (MARCH 1978)                                                CKMN       58
      C                                                                        CKMN       59
      C   CODED BY D. L. HAGRMAN AUGUST 1977                                   CKMN       60
      C   MODIFIED BY G. A. REYMANN AND M. A. MORGAN MARCH 1978                CKMN       61
      C   MODIFIED BY D. L. HAGRMAN OCTOBER, 1978                              CKMN       62
      C                                                                        CKMN       63
            T = CTEMP                                                          CKMN       64
      C                                                                        CKMN       65
      C   LIMIT STRAIN RATE TO A MINIMUM OF 1.0E-05                            CKMN       66
            IF (RSTRAN.LT.1.0E-05) RSTRAN = 1.0E-05                            CKMN       67
      C                                                                        CKMN       68
      C   FIND STRAIN RATE EXPONENT, AM                                        CKMN       69
            IF (T.LE.730.) AM = 0.02                                           CKMN       70
      C                                                                        CKMN       71
            A = 20.63172161                                                    CKMN       72
            B = -0.07704552983                                                 CKMN       73
            C = 9.504843067E-05                                                CKMN       74
            D = -3.860960716E-08                                               CKMN       75
            IF (T.GT.730.) AM = A+T*(B+T*(C+T*D))                              CKMN       76
            IF (T.GE.900.) AM = -6.47E-02+T*2.203E-04                          CKMN       77
      C                                                                        CKMN       78
      C   MODIFY STRAIN RATE EXPONENT, AM, IN ALPHA - BETA REGION             CKMN       79
            IF (RSTRAN.GE.6.34E-03) GO TO 110                                  CKMN       80
            IF (T.LE.1090.0) GO TO 110                                         CKMN       81
            IF (T.GE.1255.0) GO TO 110                                         CKMN       82
            IF (T.GT.1172.5) GO TO 100                                         CKMN       83
            AM = AM+6.78E-2*ALOG(6.34E-3/RSTRAN)*((T-1090.)/82.5)              CKMN       84
            GO TO 110                                                          CKMN       85
      100   AM = AM+6.78E-2*ALOG(6.34E-3/RSTRAN)*((1255.-T)/82.5)              CKMN       86
      C                                                                        CKMN       87
      C   FIND UNCERTAINTY                                                    CKMN       88
      110   IF (T.LE.700.) UM = 0.01                                           CKMN       89
            IF (T.GT.700.) UM = -2.97992E-02+T*5.6856E-05                      CKMN       90
            IF (T.GT.900.) UM = 0.16*AM                                        CKMN       91
            AM = AM*EXP(-69.*DELOXY)                                           CKMN       92
      C                                                                        CKMN       93
      C   FIND STRAIN HARDENING EXPONENT, AN                                  CKMN       94
      C                                                                        CKMN       95
            AN = -9.490E-02+T*(1.165E-03+T*(-1.992E-06+T*9.558E-10))           CKMN       96
            IF (T.GE.1099.0722) AN = -0.22655119+2.5E-04*T                     CKMN       97
            IF (T.GE.1600.000) AN = 0.17344880                                 CKMN       98
      C                                                                        CKMN       99
      C   FIND UNCERTAINTY                                                    CKMN      100
            IF (T.LE.700.) UN = 0.017                                          CKMN      101
            IF (T.GT.700.) UN = -2.8405405E-02+T*6.4864864E-05                 CKMN      102
            IF (T.GT.1255.) UN = 0.053                                         CKMN      103
            AN = (8.47E-01*EXP(-3.92E+01*CWNF)+1.53E-01+CWNF*(-9.16E-02+CWNF*2 CKMN      104
           +.29E-01))*EXP(-((FNCN)**0.33)/(3.73E+07+2.0E+08*CWNF))*AN          CKMN      105
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                AN = AN*(1.+(1250.-(1250./(EXP((T-1380.)/20.)+1.)))*DELOXY)          CKMN      106
              C                                                                      CKMN      107
              C   FIND STRENGTH COEFFICIENT, AK                                      CKMN      108
110             AK = 1.17628E+09+T*(4.54859E+05+T*(-3.28185E+03+T*1.72752))          CKMN      109
                IF (T.GE.750.0) AK = 2.5224880E+06*EXP(2.8500027E+06/(T**2.0))       CKMN      110
                IF (T.GE.1090.) AK = 184.1376039E+06-1.4345448E+05*T                 CKMN      111
                IF (T.GE.1255.) AK = 4.330E+07+T*(-6.685E+04+T*(3.7579+01-T*7.33E-   CKMN      112
               +03))                                                                 CKMN      113
115             IF (T.GT.2100.) AK = 0.0                                             CKMN      114
              C                                                                      CKMN      115
              C   FIND UNCERTAINTY                                                   CKMN      116
                IF (T.LE.700.) UK = 77.00E+06                                        CKMN      117
                IF (T.GT.700.) UK = 110.43693E+06-T*4.7767045E+04                    CKMN      118
120             IF (T.GT.800.) UK = AK/3.0                                           CKMN      119
                AK = AK*(1.0+5.46E-01*CWKF)                                          CKMN      120
                AK = AK+FNCK*5.54E-18                                                CKMN      121
                AK = AK*(1.+(1120.-(990./(EXP((T-1301.5)/61.)+1.)))*DELOXY)          CKMN      122
              C                                                                      CKMN      123
125             CALL DIALOT (CTEMP,20,FDIALA,FDIALM)                                 CKMN      124
                AK = (AK+FDIALA)*FDIALM                                              CKMN      125
                RETURN                                                               CKMN      126
                END                                                                  CKMN      127
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CKMN	3	127

VARIABLES

		SN	TYPE	RELOCATION									
473	A		REAL		REFS	77	DEFINED	73					
0	AK		REAL	F.P.	REFS	120	121	122	123	126			
					DEFINED	3	110	111	112	113	115	121	
					122	123	126						
0	AM		REAL	F.P.	REFS	85	87	92	93	DEFINED	3	71	
					77	78	85	87	93				
0	AN		REAL	F.P.	REFS	105	107	DEFINED	3	97	98	99	
					105	107							
474	B		REAL		REFS	77	DEFINED	74					
475	C		REAL		REFS	77	DEFINED	75					
0	CTEMP		REAL	F.P.	REFS	65	125	DEFINED	3				
0	CWKF		REAL	F.P.	REFS	121	DEFINED	3					
0	CWNF		REAL	F.P.	REFS	4*105	DEFINED	3					
476	D		REAL		REFS	77	DEFINED	76					
0	DELOXY		REAL	F.P.	REFS	93	107	123	DEFINED	3			
502	FDIALA		REAL		REFS	125	126						
503	FDIALM		REAL		REFS	125	126						
0	FNCK		REAL	F.P.	REFS	122	DEFINED	3					
0	FNCN		REAL	F.P.	REFS	105	DEFINED	3					
0	RSTRAN		REAL	F.P.	REFS	68	81	85	87	DEFINED	3	68	

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VARIABLES     SN  TYPE          RELOCATION
  472  T          REAL                          REFS      71      4*77     2*78      82      83      84      85
                                                  87      90      2*91      92      3*97    2*98      99     102
                                                2*103     104      107     3*110    2*111   2*112   4*113     115
                                                 118    2*119      120      123    DEFINED    65
  501  UK         REAL                        DEFINED     118      119      120
  477  UM         REAL                        DEFINED      90       91       92
  500  UN         REAL                        DEFINED     102      103      104

EXTERNALS           TYPE    ARGS       REFERENCES
       ALOG         REAL       1 LIBRARY      85        87
       DIALOT                  4              125
       EXP          REAL       1 LIBRARY      93      2*105      107      111      123

STATEMENT LABELS              DEF LINE    REFERENCES
   74  100                       87          84
  106  110                       90          81        82        83        86

STATISTICS
  PROGRAM LENGTH                 504B        324
        14000CB SCM USED
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      C                                                                 CKMN     128
      C                                                                 CKMN     129
            FUNCTION CMHARD (CTEMP)                                     CMHRD      2
      C                                                                 CMHRD      3
      C     THE ROUTINE CMHARD CALCULATES MEYER HARDNESS AS A FUNCTION OF CMHRD      4
      C     CLADDING TEMPERATURE.                                       CMHRD      5
      C                                                                 CMHRD      6
      C     CMHARD = OUTPUT MEYER HARDNESS OF ZIRCALOY CLADDING (N/M**2)CMHRD      7
      C                                                                 CMHRD      8
      C     CTEMP  = INPUT CLADDING TEMPERATURE (K)                     CMHRD      9
      C                                                                 CMHRD     10
      C     THE EQUATIONS USED IN THIS FUNCTION ARE BASED ON DATA FROM  CMHRD     11
      C     (1) A. M. ROSS AND R. L. STOUTE, HEAT TRANSFER COEFFICIENT  CMHRD     12
      C     BETWEEN UO2 AND ZIRCALOY - 2, AECL - 1552 (JUNE 1962)       CMHRD     13
      C     (2) I. D. PEGGS AND D. P. GODIN, THE YIELD STRENGTH - HOT   CMHRD     14
      C     HARDNESS RELATIONSHIP OF ZIRCALOY - 4, JOURNAL OF NUCLEAR   CMHRD     15
      C     MATERIALS 57 PP 246 - 248 (1975)                            CMHRD     16
      C                                                                 CMHRD     17
      C     CMHARD WAS CODED BY V.F.BASTON IN MAY 1974.                 CMHRD     18
      C     MODIFIED BY M. A. MORGAN JUNE 1978                          CMHRD     19
      C                                                                 CMHRD     20
            T = CTEMP                                                   CMHRD     21
            CMHARD = EXP(2.6034E01-2.6394E-02*T+4.3502E-05*T**2-2.5621E-08*T** CMHRD     22
           +3)                                                          CMHRD     23
            CALL DIALOT (CTEMP,22,FDIALA,FDIALM)                        CMHRD     24
            CMHARD = (CMHARD+FDIALA)*FDIALM                             CMHRD     25
            RETURN                                                      CMHRD     26
            END                                                         CMHRD     27
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	CMHARD	3	27

VARIABLES

		SN	TYPE	RELOCATION						
46	CMHARD		REAL		REFS	26	DEFINED	23	26	
0	CTEMP		REAL	F.P.	REFS	22	25	DEFINED	3	
50	FDIALA		REAL		REFS	25	26			
51	FDIALM		REAL		REFS	25	26			
47	T		REAL		REFS	3*23	DEFINED	22		

EXTERNALS

	TYPE	ARGS		REFERENCES
DIALOT		4		25
EXP	REAL	1	LIBRARY	23

STATISTICS

PROGRAM LENGTH 52B 42

140000B SCM USED

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      C                                                                       CMHRD   28
      C                                                                       CMHRD   29
            SUBROUTINE CMLIMT (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,CINWID,CINRAD, CMLMT   30
           +CDPRES,CAXRAD,CAXSTR,RSTRAN,DELTMP,STRNYT,STRNYE,STRNUE,STRNIE,STS CMLMT   31
           +RPT,STRRPE,CYLDST,CYLDSE,CULTSE,CBRSTE,CBRSST,CTSTRT)              CMLMT   32
      C                                                                       CMLMT   33
      CCC   CMLIMT CALCULATES THE FOLLOWING LIMIT POINTS OF MECHANICAL        CMLMT   34
      CCC   DEFORMATION. (1) TRUE TANGENTIAL STRESS AT BURST IS               CMLMT   35
      CCC   CALCULATED AS A FUNCTION OF TEMPERATURE, FAST NEUTRON FLUENCE     CMLMT   36
      CCC   AND COLD WORK.  (2) TRUE TANGENTIAL STRAIN AT FAILURE             CMLMT   37
      CCC   FOR AZIMUTHALLY SYMMETRIC DEFORMATION IS CALCULATED FROM THE      CMLMT   38
      CCC   TRUE TANGENTIAL BURST STRESS, THE PRESSURE AT BURST, THE AXIAL    CMLMT   39
      CCC   RADIUS OF CURVATURE AT BURST, THE AXIAL STRESS AT BURST AND       CMLMT   40
      CCC   THE INITIAL MIDWALL RADIUS.  (3) CLADDING STRESS AND STRAIN       CMLMT   41
      CCC   AT THE TRANSITION BETWEEN ELASTIC AND PLASTIC DEFORMATION         CMLMT   42
      CCC   (YIELD) ARE CALCULATED AS A FUNCTION OF TEMPERATURE,              CMLMT   43
      CCC   FAST NEUTRON FLUENCE, COLD WORK, AVERAGE OXYGEN CONCENTRATION     CMLMT   44
      CCC   AND STRAIN RATE.  (4) TYPICAL INSTABILITY STRAINS,                CMLMT   45
      CCC   BURST PRESSURES (ENGINEERING HOOP STRESS) AND CIRCUMFERENTIAL     CMLMT   46
      CCC   ELONGATIONS AT FAILURE ARE ALSO CALCULATED AND RETURNED.          CMLMT   47
      CCC                                                                     CMLMT   48
      CCC   STRNYT : OUTPUT TRUE STRAIN AT YIELD (M/M)                        CMLMT   49
      CCC   STRNYE : OUTPUT ENGINEERING STRAIN AT YIELD (M/M)                 CMLMT   50
      CCC   STRNUE : OUTPUT UNIFORM STRAIN (M/M)                              CMLMT   51
      CCC   STRNIE : OUTPUT TYPICAL CIRCUMFERENTIAL ENGINEERING STRAIN        CMLMT   52
      CCC   AT INSTABILITY (M/M)                                              CMLMT   53
      CCC   STSRPT : OUTPUT TRUE TANGENTIAL FAILURE STRAIN FOR                CMLMT   54
      CCC   AZIMUTHALLY SYMMETRIC DEFORMATION (M/M)                           CMLMT   55
      CCC   STRRPE : OUTPUT TYPICAL CIRCUMFERENTIAL ENGINEERING               CMLMT   56
      CCC   STRAIN AT RUPTURE(M/M)                                            CMLMT   57
      CCC   CYLDST : OUTPUT TRUE YIELD STRENGTH (PA)                          CMLMT   58
      CCC   CYLDSE : OUTPUT ENGINEERING YIELD STRENGTH (PA)                   CMLMT   59
      CCC   CULTSE : OUTPUT ENGINEERING ULTIMATE STRENGTH (PA)                CMLMT   60
      CCC   CBRSST : OUTPUT EFFECTIVE TRUE TANGENTIAL STRESS AT BURST         CMLMT   61
      CCC   FOR IDEALIZED SYMMETRIC DEFORMATION WITH CIRCUMFERENCE            CMLMT   62
      CCC   EQUAL TO THE ACTUAL CLADDING CIRCUMFERENCE (PA)                   CMLMT   63
      CCC   CTSTRT : OUTPUT TRUE TANGENTIAL COMPONENT OF STRESS AT            CMLMT   64
      CCC   BURST (PA)                                                        CMLMT   65
      CCC   CBRSTE : OUTPUT TYPICAL ENGINEERING HOOP STRESS AT BURST (PA)     CMLMT   66
      CCC   UCTSTT : OUTPUT ESTIMATED UNCERTAINTY OF CTSTRT (PA)              CMLMT   67
      CCC   (NOT CURRENTLY RETURNED)                                          CMLMT   68
      CCC                                                                     CMLMT   69
      CCC   CTEMP  : INPUT AVERAGE CLADDING TEMPERATURE (K)                   CMLMT   70
      CCC   DELOXY : INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING             CMLMT   71
      CCC   OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                     CMLMT   72
      CCC   AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                     CMLMT   73
      CCC   FNCK   : INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH                CMLMT   74
      CCC   COEFFICIENT (NEUTRONS/(M**2))                                     CMLMT   75
      CCC   FNCN   : INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING        CMLMT   76
      CCC   EXPONENT (NEUTRONS/(M**2))                                        CMLMT   77
      CCC   CWKF   : INPUT EFFECTIVE COLD WORK FOR STRENGTH                   CMLMT   78
      CCC   COEFFICIENT (UNITLESS RATIO OF AREAS)                             CMLMT   79
      CCC   CWNF   : INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING           CMLMT   80
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      C   EXPONENT (UNITLESS RATIO OF AREAS)                                  CMLMT      53
      C   CINWID : INPUT INITIAL CLADDING WALL THICKNESS (M)                   CMLMT      54
   55 C   CINRAD : INPUT INITIAL CLADDING MIDWALL RADIUS (M)                   CMLMT      55
      C   CDPRES : INPUT PRESSURE DIFFERENTIAL ACROSS CLADDING AT             CMLMT      56
      C   BURST (PA)                                                          CMLMT      57
      C   CAXRAD : INPUT AXIAL RADIUS OF CURVATURE (M)                        CMLMT      58
   60 C   CAXSTR : INPUT TRUE AXIAL STRESS (M).  SET EQUAL TO ZERO            CMLMT      59
      C   IN THE SUBCODE IF CAXRAD IS GREATER THAN 10 METERS                 CMLMT      60
      C   RSTRAN : INPUT STRAIN RATE. (1./S)                                  CMLMT      61
      C   DELTMP : INPUT CIRCUMFERENTIAL TEMPERATURE VARIATION.               CMLMT      62
      C   USED ONLY TO FIND TYPICAL VALUES (K)                                CMLMT      63
   65 C                                                                       CMLMT      64
      C   ESTIMATED VALUES OF DELTMP ARE                                      CMLMT      65
      C   (A) FOR CLADDING WITH EXTERNAL THERMOCOUPLES AND IN FILM            CMLMT      66
      C   BOILING  DELTMP = 150K                                              CMLMT      67
      C   (B) FOR CLADDING WITH INTERNAL HEATING IN STEAM AND                 CMLMT      68
   70 C   WITHOUT EXTERNAL THERMOCOUPLES                                      CMLMT      69
      C   DELTMP = 10K IF THE TEMPERATURE IS ABOVE 1255K                      CMLMT      70
      C   = 50 * (1255 - TEMPERATURE) / 165 + 10 IF                           CMLMT      71
      C   TEMPERATURE IS BETWEEN 1090 AND 1255K                             CMLMT      72
      C   = 50K IF TEMPERATURE IS BELOW 1090K                                CMLMT      73
   75 C   (C) FOR CLADDING IN A FURNACE                                       CMLMT      74
      C   DELTMP = 10K                                                       CMLMT      75
      C   (D) FOR SELF - RESISTANCE HEATED CLADDING WITH COOL FILLER         CMLMT      76
      C   DELTMP = (HEATING RATE)/1000K/S) * VALUES OF (B)                    CMLMT      77
      C                                                                       CMLMT      78
   80 C   THE SUBCODES USED IN THIS SUBROUTINE ARE CKMN AND CELMOD.           CMLMT      79
      C                                                                       CMLMT      80
      C                                                                       CMLMT      81
      C   THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM        CMLMT      82
      C   (1)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY           CMLMT      83
   85 C   REPORT FOR APRIL - JUNE 1977, ORNL/NUREG/TM-135 (1977).             CMLMT      84
      C   (2)  R. H. CHAPMAN, J. L. CROWLEY. A. W. LONGEST AND E. G.          CMLMT      85
      C   SEWELL, EFFECT OF CREEP TIME AND HEATING RATE ON                    CMLMT      86
      C   DEFORMATION OF ZIRCALOY-4 TUBES TESTED IN STEAM WITH                CMLMT      87
      C   INTERNAL HEATERS, ORNL/NUREG/TM-245 AND NUREG/CR-0345               CMLMT      88
   90 C   (1978).                                                             CMLMT      89
      C   (3)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY           CMLMT      90
      C   PROGRESS REPORT FOR APRIL - JUNE 1976,                              CMLMT      91
      C   ORNL/NUREG/TM-74,  (1977)                                           CMLMT      92
      C   (4)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM PROGRESS            CMLMT      93
   95 C   REPORT FOR JULY - DECEMBER 1977, ORNL/NUREG/TM-200 AND              CMLMT      94
      C   NUREG/CR-0103  (1978).                                              CMLMT      95
      C   (5)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM PROGRESS            CMLMT      96
      C   REPORT FOR JANUARY - MARCH 1978, ORNL/NUREG/TM-217 AND              CMLMT      97
      C   NUREG/CR-0225  (1978).                                              CMLMT      98
  100 C   (6)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY           CMLMT      99
      C   PROGRESS REPORT FOR JANUARY - MARCH 1976,                           CMLMT     100
      C   ORNL/NUREG/TM-36  (1976).                                           CMLMT     101
      C   (7)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY           CMLMT     102
      C   PROGRESS REPORT FOR OCTOBER - DECEMBER 1976,                        CMLMT     103
  105 C   ORNL/NUREG/TM-95  (1977).                                           CMLMT     104
      C   (8)  R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY           CMLMT     105
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      C   PROGRESS REPORT FOR JANUARY - MARCH 1977,                                  CMLMT  106
      C   ORNL/NUREG/TM-108  (1977).                                                 CMLMT  107
      C   (9)  D. O. HOBSON AND P. L. RITTENHOUSE, DEFORMATION AND                   CMLMT  108
  110 C   RUPTURE BEHAVIOR OF LIGHT WATER REACTOR FUEL CLADDING,                     CMLMT  109
      C   ORNL-4727  (1971)                                                          CMLMT  110
      C   (10) H. M. CHUNG AND T. F. KASSNER, DEFORMATION                            CMLMT  111
      C   CHARACTERISTICS OF ZIRCALOY CLADDING IN VACUUM AND                         CMLMT  112
      C   STEAM UNDER TRANSIENT-HEATING CONDITIONS.  SUMMARY                         CMLMT  113
  115 C   REPORT, ANL-77-31 AND NUREG/CR-0344 (1978).                                CMLMT  114
      C   (11) A. A. BAUER, W. J. GALLAGHER, L. M. LOWRY AND                         CMLMT  115
      C   A. J. MARKWORTH, EVALUATING STRENGTH AND DUCTILITY                         CMLMT  116
      C   OF IRRADIATED ZIRCALOY. QUARTERLY PROGRESS REPORT JULY                     CMLMT  117
      C   THROUGH SEPTEMBER, 1977, BMI-NUREG-1985  (1977).                          CMLMT  118
  120 C   (12) T. F. COOK, S. A. PLOGER AND R. R. HOBBINS,                           CMLMT  119
      C   POSTIRRADIATION EXAMINATION RESULTS FOR THE IRRADIATION                    CMLMT  120
      C   EFFECTS TEST IE-5, TREE-NUREG-1201  (1978).                                CMLMT  121
      C   (13) E. H. KARB, RESULTS OF THE FR-2 NUCLEAR TESTS ON THE                  CMLMT  122
      C   BEHAVIOR OF ZIRCALOY CLAD FUEL RODS, PAPER PRESENTED                       CMLMT  123
  125 C                                                                              CMLMT  124
      C   MEETING, GAITHERSBURG, MD,  (1978).                                        CMLMT  125
      C   (14) K. WIEHR AND HE. SCHMIDT, OUT-OF-PILE-VERSUCHE ZUM                    CMLMT  126
      C   AUFBLAHVORGANG VON ZIRKALOY-HULLEN, KFK 2345,  (1977).                     CMLMT  127
      C   (15) K. WIEHR, F. ERBACHER, U. HARTEN, W. JUST, H. J. NEITZEL,             CMLMT  128
  130 C   P. SCHAFFNER AND H. SCHMIDT, JAHRESKOLLOQUIUM 1977 DES                     CMLMT  129
      C   PROJECT NUKLEARE SICHERHEIT, KFK REPORT  (1977).                           CMLMT  130
      C                                                                              CMLMT  131
      C   THE CORRELATION FOR TYPICAL ENGINERING HOOP STRESS AT BURST                CMLMT  132
      C   WAS TAKEN FROM                                                             CMLMT  133
  135 C   (1)  J. D. KERRIGAN: FRAIL. A FUEL ROD SUBCODE,                            CMLMT  134
      C   SRD-137-76  (1976).                                                        CMLMT  135
      C                                                                              CMLMT  136
      C   MODIFIED BY D. L. HAGRMAN MAY 1979                                         CMLMT  137
      C                                                                              CMLMT  138
  140       CALL CKMN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,AK,AN,AM)             CMLMT  139
            ELMOD = CELMOD(CTEMP,FNCK,CWKF,DELOXY)                                   CMLMT  140
            T = CTEMP                                                                CMLMT  141
            AG = AK*((RSTRAN/1.0E-03)**AM)                                           CMLMT  142
      C                                                                              CMLMT  143
  145 C   CALCULATE STRAIN AT YIELD                                                  CMLMT  144
            STRNYT = ((AG/ELMOD)**(1.0/(1.0-AN)))                                    CMLMT  145
            STRNYE = EXP(STRNYT)-1.0                                                 CMLMT  146
      C                                                                              CMLMT  147
      C   CALCULATE YIELD STRENGTH                                                   CMLMT  148
  150       CYLDST = (AG/(ELMOD**AN))**(1.0/(1.0-AN))                                CMLMT  149
            CYLDSE = CYLDST/EXP(STRNYT)                                              CMLMT  150
      C                                                                              CMLMT  151
      C   CALCULATE STRAIN AT MAXIMUM ONE DIMENSIONAL LOAD                          CMLMT  152
            STRNUT = AN/(1.0+AM)                                                     CMLMT  153
  155       STRNUE = EXP(STRNUT)-1.0                                                 CMLMT  154
      C                                                                              CMLMT  155
      C   CALCULATE ULTIMATE ENGINEERING STRENGTH                                   CMLMT  156
            CULTSE = (AG*(STRNUT**AN))/EXP(STRNUT)                                   CMLMT  157
      C                                                                              CMLMT  158
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      C   CALCULATE TANGENTIAL COMPONENT OF TRUE STRESS AT BURST                  CMLMT  159
            IF (T.LT.1050.) RATIO = 46.861429*EXP(-(1.9901087E-06/(T**2)))      CMLMT  160
            IF (T.LE.750.0) RATIO = 1.36                                        CMLMT  161
            IF (T.GE.1050.) RATIO = 7.7                                         CMLMT  162
      C   FIND ANNEALED STATE STRENGTH COEFFICIENT                             CMLMT  163
            AKA = (AK/(1.+(1120.-(990./(EXP((T-1301.5)/61.)+1.)))*DELOXY)-(5.5  CMLMT  164
           +4E-18)*FNCK)/(1.+0.546*CWKF)                                        CMLMT  165
            CTSTRT = RATIO*AKA+0.4*(5.54E-18*FNCK+0.546*CWKF*AKA)               CMLMT  166
      C                                                                         CMLMT  167
      C   FIND UNCERTAINTY ESTIMATE FOR CTSTRT                                 CMLMT  168
            UCTSTT = 0.17*CTSTRT                                                CMLMT  169
      C                                                                         CMLMT  170
      C   FIND TRUE TANGENTIAL FAILURE STRAIN FOR AZIMUTHALLY SYMMETRIC        CMLMT  171
      C   DEFORMATION                                                           CMLMT  172
            IF (CAXRAD.LT.1.0E-03) CAXRAD = 1.0E-03                             CMLMT  173
            IF (CAXRAD.GT.1.0E+01) CAXSTR = 0.0                                 CMLMT  174
            AXFAC = CAXSTR*CINWID/(2.0*CDPRES*CAXRAD)                           CMLMT  175
            STSRPT = ALOG((CTSTRT*CINWID/(CDPRES*CINRAD))**0.5+AXFAC*(1.0+0.5*  CMLMT  176
           +AXFAC))                                                             CMLMT  177
      C                                                                         CMLMT  178
      C   FIND TYPICAL CIRCUMFERENTIAL ENGINEERING STRAIN AT RUPTURE           CMLMT  179
            STRRPE = ((CTSTRT*CINWID/(CDPRES*CINRAD))**0.5-1.0)*EXP(-0.01*DELT  CMLMT  180
           +MP)                                                                 CMLMT  181
      C                                                                         CMLMT  182
      C   FIND EFFECTIVE TRUE TANGENTIAL STRESS AT BURST FOR IDEALIZED         CMLMT  183
      C   SYMMETRIC DEFORMATION AND TYPICAL CIRCUMFERENTIAL STRAIN              CMLMT  184
            CBRSST = (CDPRES*CINRAD/CINWID)*((1.0+STRRPE)**2.0)                 CMLMT  185
      C                                                                         CMLMT  186
      C   FIND TYPICAL CIRCUMFERENTIAL ENGINEERING STRAIN AT INSTABILITY       CMLMT  187
            STRNIE = ((AK*CINWID*(10.**(2.*AM))/(CDPRES*CINRAD*(0.866**(1.+AM+  CMLMT  188
           +AN))))**0.5-1.0)                                                    CMLMT  189
            IF (STRNIE.LT.0.05) STRNIE = 0.05                                   CMLMT  190
            STRNIE = STRNIE*EXP(-0.01*DELTMP)                                   CMLMT  191
      C                                                                         CMLMT  192
      C   FIND TYPICAL ENGINEERING HOOP STRESS AT BURST                        CMLMT  193
            FT = (CTEMP-273.15)*1.8+32.                                         CMLMT  194
            CBRSTE = (10**(5.00E+00+FT*(3.27E-04-FT*(1.14E-06-FT*2.56E-10))))/  CMLMT  195
           +1.4505E-04                                                          CMLMT  196
            CALL DIALOT (CTEMP,21,FDIALA,FDIALM)                                CMLMT  197
            STSRPT = (STSRPT+FDIALA)*FDIALM                                     CMLMT  198
            RETURN                                                              CMLMT  199
            END                                                                 CMLMT  200
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 CMLIMT	3	200

VARIABLES	SN	TYPE	RELOCATION									
461	AG	REAL		REFS	146	150	158	DEFINED	143			
454	AK	REAL		REFS	140	143	165	189				
464	AKA	REAL		REFS	2*167	DEFINED	165					
456	AM	REAL		REFS	140	143	154	2*189				
455	AN	REAL		REFS	140	146	2*150	154	158	189		
466	AXFAC	REAL		REFS	2*177	DEFINED	176					
0	CAXRAD	REAL	F.P.	REFS	174	175	176	DEFINED	3	174		
0	CAXSTR	REAL	F.P.	REFS	176	DEFINED	3	175				
0	CBRSST	REAL	F.P.	DEFINED	3	186						
0	CBRSTE	REAL	F.P.	DEFINED	3	196						
0	CDPRES	REAL	F.P.	REFS	176	177	181	186	189			
				DEFINED	3							
0	CINRAD	REAL	F.P.	REFS	177	181	186	189	DEFINED	3		
0	CINWID	REAL	F.P.	REFS	176	177	181	186	89			
				DEFINED	3							
0	CTEMP	REAL	F.P.	REFS	140	141	142	195	198			
				DEFINED	3							
0	CTSTRT	REAL	F.P.	REFS	170	177	181	DEFINED	3	167		
0	CULTSE	REAL	F.P.	DEFINED	3	158						
0	CWKF	REAL	F.P.	REFS	140	141	165	167	DEFINED	3		
0	CWNF	REAL	F.P.	REFS	140	DEFINED	3					
0	CYLDSE	REAL	F.P.	DEFINED	3	151						
0	CYLDST	REAL	F.P.	REFS	151	DEFINED	3	150				
0	DELOXY	REAL	F.P.	REFS	140	141	165	DEFINED	3			
0	DELTMP	REAL	F.P.	REFS	181	192	DEFINED	3				
457	ELMOD	REAL		REFS	146	150	DEFINED	141				
470	FDIALA	REAL		REFS	198	199						
471	FDIALM	REAL		REFS	198	199						
0	FNCK	REAL	F.P.	REFS	140	141	165	167	DEFINED	3		
0	FNCN	REAL	F.P.	REFS	140	DEFINED	3					
467	FT	REAL		REFS	3*196	DEFINED	195					
463	RATIO	REAL		REFS	167	DEFINED	161	162	163			
0	RSTRAN	REAL	F.P.	REFS	140	143	DEFINED	3				
0	STRNIE	REAL	F.P.	REFS	191	192	DEFINED	3	189	191	192	
0	STRNUE	REAL	F.P.	DEFINED	3	155						
462	STRNUT	REAL		REFS	155	2*158	DEFINED	154				
0	STRNYE	REAL	F.P.	DEFINED	3	147						
0	STRNYT	REAL	F.P.	REFS	147	151	DEFINED	3	146			
0	STRRPE	REAL	F.P.	REFS	186	DEFINED	3	181				
0	STSRPT	REAL	F.P.	REFS	199	DEFINED	3	177	199			
460	T	REAL		REFS	2*161	162	163	165	DEFINED	142		
465	UCTSTT *	REAL		DEFINED	170							

EXTERNALS	TYPE	ARGS	REFERENCES							
ALOG	REAL	1 LIBRARY	177							
CELMOD	REAL	4	141							
CKMN		10	140							
DIALOT		4	198							
EXP	REAL	1 LIBRARY	147	151	155	158	161	165	181	192

STATISTICS
PROGRAM LENGTH 472B 314
140000B SCM USED

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      C                                                                       CMLMT   201
      C                                                                       CMLMT   202
            SUBROUTINE COBILD (T1,T2,DT,AM5,DROD,PINT,IP,IP2,Y8,Y9,Y9A,Y9B,AAO COBLD     2
           +,ABO,ACO,ADO,AEO,AFO,AGO,AHO,AIO,AAI,ABI,ACI,ADI,AEI,AFI,AGI,AHI,A COBLD     3
           +II,WI,P,PERSAT,BWTFR,AL8)                                         COBLD     4
      C                                                                       COBLD     5
      CC  *** COBILD IS VALID ONLY BETWEEN 1273 AND 1773 K ***                COBLD     6
      CC                                                                      COBLD     7
      CC  THIS PROGRAM WAS ADAPTED FROM THE PROGRAM "BUILD5" WRITTEN BY       COBLD     8
      CC  R.E. PAWEL OF OAK RIDGE NATIONAL LABORATORY (ORNL).                 COBLD     9
      CC                                                                      COBLD    10
      CC  DATA AND ANALYSES FROM J.V. CATHCART OF ORNL ARE USED TO COMPUTE    COBLD    11
      CC  THE ZRO2 AND OXYGEN-STABILIZED ALPHA THICKNESSES ON THE CLADDING    COBLD    12
      CC  OUTER SURFACE AND SIMILAR EQUATIONS FROM P. HOFMANN OF THE          COBLD    13
      CC  KERNFORSCHUNGSZENTRUM KARLSRUHE (KFK) FOR OXYGEN-STABILIZED         COBLD    14
      CC  ALPHA LAYERS ON THE CLADDING INNER SURFACE WHEN THERE IS FUEL       COBLD    15
      CC  PELLET-CLADDING MECHANICAL INTERACTION (PCMI).                      COBLD    16
      CC                                                                      COBLD    17
      CC  OXYGEN PROFILES ARE COMPUTED ON THE BASIS OF A                      COBLD    18
      CC  FINITE DIFFERENCE METHOD ASSUMING THE TRANSIENT TO BE COMPOSED      COBLD    19
      CC  OF A SERIES OF ISOTHERMAL SEGMENTS.                                 COBLD    20
      C                                                                       COBLD    21
            DIMENSION AA(6),AB(6),AC(6),AD(6),AE(6),AF(6),AG(6),AH(6),AI(6)   COBLD    22
      C                                                                       COBLD    23
      CC  T1     : INPUT CLADDING TEMPERATURE AT START OF TIME STEP (K).      COBLD    24
      CC  T2     : INPUT CLADDING TEMPERATURE AT END OF TIME STEP (K).        COBLD    25
      CC  DT     : INPUT DURATION OF TIME STEP (S).                           COBLD    26
      CC  AM5    : INPUT WALL THICKNESS OF AS-FABRICATED ROD (M).             COBLD    27
      CC  DROD   : INPUT DIAMETER  OF AS-FABRICATED ROD (M).                  COBLD    28
      CC  PINT   : INPUT PELLET-CLADDING INTERFACE PRESSURE (PA).             COBLD    29
      CC                                                                      COBLD    30
      CC  IP     : OUTPUT/INPUT PCMI PARAMETER                                COBLD    31
      CC  IP  : 0 IMPLIES NO PCMI                                             COBLD    32
      CC  IP  : 1 IMPLIES PCMI.                                               COBLD    33
      CC  IP2    : OUTPUT/INPUT PCMI PARAMETER                                COBLD    34
      CC  IP2 : 0 IMPLIES NO PCMI                                             COBLD    35
      CC  IP2 : 2 IMPLIES PCMI                                                COBLD    36
      CC  (THIS SECOND PCMI PARAMETER IS NEEDED TO CORRECTLY                  COBLD    37
      CC  CALCULATE THE BETA THICKNESS WHEN PELLET-CLADDING                   COBLD    38
      CC  CONTACT HAS BEEN MADE AND THEN BROKEN).                             COBLD    39
      CC  Y8     : OUTPUT/INPUT OXIDE THICKNESS(M).                           COBLD    40
      CC  Y9     : OUTPUT/INPUT THICKNESS OF OXYGEN-STABILIZED ALPHA          COBLD    41
      CC  NEAREST TO THE OUTER CLADDING SURFACE (M).                          COBLD    42
      CC  Y9A    : OUTPUT/INPUT THICKNESS OF OXYGEN-STABILIZED ALPHA          COBLD    43
      CC  NEAREST TO THE UO2 FUEL (M).                                        COBLD    44
      CC  Y9B    : OUTPUT/INPUT THICKNESS OF OXYGEN-STABILIZED ALPHA          COBLD    45
      CC  BETWEEN Y9 AND Y9A (M).                                             COBLD    46
      CC  AAO TO                                                              COBLD    47
      CC  AIO  : OUTPUT/INPUT OXYGEN CONCENTRATIONS AT EQUIDISTANT NODES      COBLD    48
      CC  IN THE BETA                                                         COBLD    49
      CC  AAO : CONCENTRATION AT THE ALPHA-BETA INTERFACE AND                 COBLD    50
      CC  AIO : CONCENTRATION AT THE INNER BETA SURFACE IF                    COBLD    51
      C   THERE IS NO PCMI OR AT THE BETA MIDPOINT IF                        COBLD    52
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      C   THERE IS PCMI.                                                    COBLD      53
      C   AAI TO                                                           COBLD      54
      C   AII  = OUTPUT/INPUT OXYGEN CONCENTRATIONS AT EQUIDISTANT NODES   COBLD      55
      C   IN THE INNER HALF OF THE BETA IF THERE IS PCMI.                  COBLD      56
      C   AAI = THE CONCENTRATION AT THE INNER ALPHA-BETA                  COBLD      57
      C   INTERFACE AND                                                    COBLD      58
      C   AII = THE CONCENTRATION AT THE BETA MIDPOINT.                    COBLD      59
      C   ALL CONCENTRATIONS ARE IN WEIGHT FRACTION OF OXYGEN.             COBLD      60
      C   WI     = OUTPUT/INPUT OXYGEN UPTAKE THROUGH THE OUTER CLADDING   COBLD      61
      C   SURFACE (KG/M**2).                                              COBLD      62
      C   P      = OUTPUT LINEAR POWER GENERATED BY THE ZR+O2 = ZRO2       COBLD      63
      C   REACTION(W/M).                                                  COBLD      64
      C   PERSAT = OUTPUT PER CENT SATURATION OF THE BETA (UNITLESS).      COBLD      65
      C   BWTFR  = OUTPUT AVERAGE OXYGEN CONCENTRATION IN BETA            COBLD      66
      C   (WEIGHT FRACTION).                                              COBLD      67
      C   AL8    = OUTPUT BETA THICKNESS (M).                             COBLD      68
      C                                                                    COBLD      69
      C   RECOMMENDED INPUT VALUES FOR A FRESH ROD ARE:                   COBLD      70
      C   PINT = 0.0                                                       COBLD      71
      C   AAO TO AIO, ALL = 0.0012                                         COBLD      72
      C   AAI TO AII, ALL = 0.0                                           COBLD      73
      C   Y8,Y9,Y9A,Y9B, AND WI, ALL = 0.0                                COBLD      74
      C   IP AND IP2, BOTH = 0.0                                          COBLD      75
      C                                                                    COBLD      76
      C   COBILD WAS CODED BY G.A. REYMANN IN JULY 1977.                   COBLD      77
      C   LAST UPDATED BY G.A. REYMANN IN APRIL 1979.                      COBLD      78
      C                                                                    COBLD      79
            Y9A = 100.*Y9A                                                 COBLD      80
            Y9B = 100.*Y9B                                                 COBLD      81
            Y8 = 100.*Y8                                                   COBLD      82
            Y9 = 100.*Y9                                                   COBLD      83
            WI = WI/10.                                                    COBLD      84
            AG20 = 0.0                                                     COBLD      85
            AL80 = 0.0                                                     COBLD      86
            AM5 = 100.*AM5                                                 COBLD      87
      C                                                                    COBLD      88
            IPINT = INT(PINT)                                              COBLD      89
            IF (IPINT.NE.0) AM5 = AM5/2.                                   COBLD      90
            Y8I = (WI/(5.82*0.26))*0.01                                    COBLD      91
      C                                                                    COBLD      92
            IF (IPINT.NE.0.AND.IP.EQ.0) GO TO 100                          COBLD      93
            IF (IPINT.EQ.0.AND.IP.NE.0) GO TO 110                          COBLD      94
            GO TO 120                                                      COBLD      95
      C                                                                    COBLD      96
      100   IP2 = 2                                                        COBLD      97
            AAI = AIO                                                      COBLD      98
            ABI = (AHO+AIO)/2.                                             COBLD      99
            ACI = AHO                                                      COBLD     100
            ADI = (AGO+AHO)/2.                                             COBLD     101
            AEI = AGO                                                      COBLD     102
            AFI = (AFO+AGO)/2.                                             COBLD     103
            AGI = AFO                                                      COBLD     104
            AHI = (AEO+AFO)/2.                                             COBLD     105
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                AII = AEO                                                  COBLD  106
                AIO = AEO                                                  COBLD  107
                AHO = (ADO+AEO)/2.                                         COBLD  108
110             AGO = ADO                                                  COBLD  109
                AFO = (ACO+ADO)/2.                                         COBLD  110
                AEO = ACO                                                  COBLD  111
                ADO = (ABO+ACO)/2.                                         COBLD  112
                ACO = ABO                                                  COBLD  113
115             ABO = (3.*AAO+6.*ABO-AEO)/8.                               COBLD  114
                GO TO 120                                                  COBLD  115
          C                                                                COBLD  116
          110   IP2 = 0                                                    COBLD  117
                ABO = ACO                                                  COBLD  118
120             ACO = AEO                                                  COBLD  119
                ADO = AGO                                                  COBLD  120
                AEO = (AIO+AII)/2.                                         COBLD  121
                AFO = AGI                                                  COBLD  122
                AGO = AEI                                                  COBLD  123
125             AHO = ACI                                                  COBLD  124
                AIO = AAI                                                  COBLD  125
                AAI = 0.                                                   COBLD  126
                ABI = 0.                                                   COBLD  127
                ACI = 0.                                                   COBLD  128
130             ADI = 0.                                                   COBLD  129
                AEI = 0.                                                   COBLD  130
                AFI = 0.                                                   COBLD  131
                AGI = 0.                                                   COBLD  132
                AHI = 0.                                                   COBLD  133
135             AII = 0.                                                   COBLD  134
          C                                                                COBLD  135
          120   IP = 0                                                     COBLD  136
                AA(I) = 100.*AAO                                           COBLD  137
                AB(I) = 100.*ABO                                           COBLD  138
140             AC(I) = 100.*ACO                                           COBLD  139
                AD(I) = 100.*ADO                                           COBLD  140
                AE(I) = 100.*AEO                                           COBLD  141
                AF(I) = 100.*AFO                                           COBLD  142
                AG(I) = 100.*AGO                                           COBLD  143
145             AH(I) = 100.*AHO                                           COBLD  144
                AI(I) = 100.*AIO                                           COBLD  145
                GO TO 140                                                  COBLD  146
          C                                                                COBLD  147
          130   AA(I) = 100.*AAI                                           COBLD  148
150             AB(I) = 100.*ABI                                           COBLD  149
                AC(I) = 100.*ACI                                           COBLD  150
                AD(I) = 100.*ADI                                           COBLD  151
                AE(I) = 100.*AEI                                           COBLD  152
                AF(I) = 100.*AFI                                           COBLD  153
155             AG(I) = 100.*AGI                                           COBLD  154
                AH(I) = 100.*AHI                                           COBLD  155
                AI(I) = 100.*AII                                           COBLD  156
          C                                                                COBLD  157
          140   AM2 = 1.0E10                                               COBLD  158
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      C   AM2 = ARTIFICIALLY LARGE MODULUS.                                  COBLD  159
            AL2 = AM5-(1-IP)*(2.0*Y8/3.0+Y9)-IP*(Y9A+Y9B)                    COBLD  160
            IF (IP2.LT.1) AL2 = AL2-(Y9A+Y9B)                                COBLD  161
      C   AL2 = BETA THICKNESS AT START OF EACH TIME STEP.                   COBLD  162
      C                                                                      COBLD  163
            AZ3 = DT/5.0                                                     COBLD  164
      C   AZ3 IS THE TIME INCREMENT FOR THE INTEGRATION.                     COBLD  165
      C                                                                      COBLD  166
            AR = (T2-T1)/DT                                                  COBLD  167
      C                                                                      COBLD  168
            Y5 = AZ3                                                         COBLD  169
      150   AZ8 = T1+AR*Y5-AZ3*AR/2                                          COBLD  170
      C   AZ8 = AV. TEMP. DURING INCREMENT                                   COBLD  171
            IF (IP.EQ.1) GO TO 160                                           COBLD  172
      C                                                                      COBLD  173
            Y6 = 2.0*(1.12569E-02)*EXP(-3.58908E04/(1.987*AZ8))              COBLD  174
            Y7 = 2.00*0.761490*EXP(-4.81418E04/(1.987*AZ8))                  COBLD  175
      C                                                                      COBLD  176
            Y8 = SQRT(Y8**2+Y6*AZ3)                                          COBLD  177
      C   Y8 = OXIDE LAYER THICKNESS AFTER INCREMENT.                        COBLD  178
      C                                                                      COBLD  179
            Y9 = SQRT(Y9**2+Y7*AZ3)                                          COBLD  180
      C   Y9 = ALPHA LAYER THICKNESS AFTER INCREMENT                         COBLD  181
      C                                                                      COBLD  182
            W2 = 2.0*0.16800*EXP(-39870.0/(1.987*AZ8))                       COBLD  183
      C                                                                      COBLD  184
            W1 = SQRT(W1**2+W2*AZ3)                                          COBLD  185
      C   W1 =  TOTAL OXY. CONC. AFTER INCREMENT                            COBLD  186
            W11 = Y8*(5.82)*.26                                              COBLD  187
      C   W11 IS THE MINIMUM OXYGEN IN (GM/CM**2) NECESSARY TO FORM THE      COBLD  188
      C   OXIDE LAYER.                                                       COBLD  189
            IF ((W1-W11).LE.0.0) W1 = W11                                    COBLD  190
            IF (IP.EQ.0) GO TO 170                                           COBLD  191
      C                                                                      COBLD  192
      160   Y7A = 0.32*EXP(-4.9E04/(1.987*AZ8))                              COBLD  193
            Y7B = 0.70*EXP(-4.4E04/(1.987*AZ8))                              COBLD  194
      C                                                                      COBLD  195
            Y9A = SQRT(Y9A**2+Y7A*AZ3)                                       COBLD  196
            Y9B = SQRT(Y9B**2+Y7B*AZ3)                                       COBLD  197
      C                                                                      COBLD  198
      170   Y5 = Y5+AZ3                                                      COBLD  199
            IF (Y5-DT) 150,150,180                                           COBLD  200
      C                                                                      COBLD  201
      180   CONTINUE                                                         COBLD  202
            AZ8 = (T1+T2)/2.0                                                COBLD  203
      C   AZ8 = THE TEMPERATURE DURING THE INTERVAL, (K).                    COBLD  204
      C                                                                      COBLD  205
      C   IN STEPS 2100 TO 2106 THE BETA SATURATION CONCENTRATION IN         COBLD  206
      C   WEIGHT PER CENT IS CALCULATED.                                     COBLD  207
            AS1 = 0.12                                                       COBLD  208
            IF (AZ8.LT.1239.0) GO TO 190                                     COBLD  209
            AS1 = -0.0042807+SQRT((AZ8/392.46)-3.1417)                       COBLD  210
            IF (AZ8.LT.1373.) GO TO 190                                      COBLD  211
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                  ASI = (AZ8-1081.7)/491.157                                      COBLD  212
              190 CONTINUE                                                        COBLD  213
215           C                                                                   COBLD  214
                  AL5 = (SQRT(9.E00/8.))*(2.480E-02)*EXP(-2.820E04/(1.987*AZ8))   COBLD  215
              C   AL5 = D(OX IN BETA), (CM**2/SEC), DICK PERKINS '76 DATA          COBLD  216
              C                                                                   COBLD  217
                  AL8 = AM5-(1-IP)*(2.0*Y8/3.0+Y9)-IP*(Y9A+Y9B)                   COBLD  218
220               IF (IP2.LT.1) AL8 = AL8-(Y9A+Y9B)                               COBLD  219
                  IF (IP.EQ.0) AL80 = AL8                                         COBLD  220
              C   AL8 = BETA THICKNESS AT END OF EACH TIME STEP.                  COBLD  221
              C                                                                   COBLD  222
                  AL4 = AL2-AL8                                                   COBLD  223
225           C   AL4 = DELTA BETA DURING STEP                                    COBLD  224
              C                                                                   COBLD  225
                  AL7 = AL2/8.0                                                   COBLD  226
                  IF (AL4.GT.AL7) GO TO 230                                       COBLD  227
              C                                                                   COBLD  228
230               AM3 = AL4/(2.0*AL2)                                             COBLD  229
                  AM4 = (AL4**2)/(2.0*(AL2**2))                                   COBLD  230
                  AL6 = AL8/8.0                                                   COBLD  231
              C   AL6 = H(X), THE DISTANCE INCREMENT FOR FD NETWORK.              COBLD  232
              C                                                                   COBLD  233
235               AM1 = (AL6**2)/(AL5*AZ3)                                        COBLD  234
                  IF (AM1.LT.2.0) GO TO 240                                       COBLD  235
                  IF (AM1.LT.AM2) AM2 = AM1                                       COBLD  236
              C   STORES SMALLEST MODULUS FOR STABILITY CRITERION CHECK.          COBLD  237
              C                                                                   COBLD  238
240           C                                                                   COBLD  239
              C   IN STEPS 2260 TO 2320 THE INITIAL OXYGEN CONCENTRATIONS ARE     COBLD  240
              C   CALCULATED BY PARABOLIC INTERPOLATION. THIS IS NECESSARY DUE TO COBLD  241
              C   THE DECREASE IN BETA THICKNESS AS THE OTHER LAYERS GROW.        COBLD  242
              C                                                                   COBLD  243
245               AA(I) = ASI                                                     COBLD  244
              C                                                                   COBLD  245
                  AB(I) = AB(I)+7.*AM3*(4.*AC(I)-3.*AB(I)-AD(I))+49.0*AM4*(AD(I)+AB( COBLD  246
                 +I)-2.*AC(I))                                                    COBLD  247
              C                                                                   COBLD  248
250               AC(I) = AC(I)+6.*AM3*(4.*AD(I)-3.*AC(I)-AE(I))+36.0*AM4*(AE(I)+AC( COBLD  249
                 +I)-2.*AD(I))                                                    COBLD  250
              C                                                                   COBLD  251
                  AD(I) = AD(I)+5.*AM3*(4.*AE(I)-3.*AD(I)-AF(I))+25.0*AM4*(AF(I)+AD( COBLD  252
                 +I)-2.*AE(I))                                                    COBLD  253
255           C                                                                   COBLD  254
                  AE(I) = AE(I)+4.*AM3*(4.*AF(I)-3.*AE(I)-AG(I))+16.0*AM4*(AG(I)+AE( COBLD  255
                 +I)-2.*AF(I))                                                    COBLD  256
              C                                                                   COBLD  257
                  AF(I) = AF(I)+3.*AM3*(4.*AG(I)-3.*AF(I)-AH(I))+9.0*AM4*(AH(I)+AF(I COBLD  258
260               +)-2.*AG(I))                                                    COBLD  259
              C                                                                   COBLD  260
                  AG(I) = AG(I)+2.*AM3*(4.*AH(I)-3.*AG(I)-AI(I))+4.0*AM4*(AI(I)+AG(I COBLD  261
                 +)-2.*AH(I))                                                     COBLD  262
              C                                                                   COBLD  263
265               AH(I) = AH(I)+1.*AM3*(4.*AI(I)-3.*AH(I)-AH(I))+1.0*AM4*(AH(I)+AH(I COBLD  264
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     +)-2.*AI(I))                                                                                                    COBLD   265
C                                                                                                                    COBLD   266
      DO 200 J=2,6                                                                                                   COBLD   267
C                                                                                                                    COBLD   268
      AA(J) = AS1                                                                                                    COBLD   269
      AB(J) = (AA(J-1)+(AMI-2.)*AB(J-1)+AC(J-1))/(AMI)                                                               COBLD   270
      AC(J) = (AB(J-1)+(AMI-2.)*AC(J-1)+AD(J-1))/(AMI)                                                               COBLD   271
      AD(J) = (AC(J-1)+(AMI-2.)*AD(J-1)+AE(J-1))/(AMI)                                                               COBLD   272
      AE(J) = (AD(J-1)+(AMI-2.)*AE(J-1)+AF(J-1))/(AMI)                                                               COBLD   273
      AF(J) = (AE(J-1)+(AMI-2.)*AF(J-1)+AG(J-1))/(AMI)                                                               COBLD   274
      AG(J) = (AF(J-1)+(AMI-2.)*AG(J-1)+AH(J-1))/(AMI)                                                               COBLD   275
      AH(J) = (AG(J-1)+(AMI-2.)*AH(J-1)+AI(J-1))/(AMI)                                                               COBLD   276
      AI(J) = ((AMI-2.)*AI(J-1)+2.*AH(J-1))/AMI                                                                      COBLD   277
C                                                                                                                    COBLD   278
200   CONTINUE                                                                                                       COBLD   279
     AQ2 = (6.49*AL6)/300.0                                                                                          COBLD   280
     AQ2 = AQ2*(AA(6)+AI(6)+2.*(AC(6)+AE(6)+AG(6))+4.*(AB(6)+AD(6)+AF(6                                              COBLD   281
    +)+AH(6)))                                                                                                       COBLD   282
     IF (IP.EQ.0) AQ20 = AQ2                                                                                         COBLD   283
C   AQ2 IS THE OXYGEN IN THE BETA,GM/CM**2,(BY SIMPSON'S RULE).                                                      COBLD   284
     IF (IP.EQ.1) GO TO 210                                                                                          COBLD   285
C                                                                                                                    COBLD   286
     AAO = AA(6)/100.                                                                                                COBLD   287
     ABO = AB(6)/100.                                                                                                COBLD   288
     ACO = AC(6)/100.                                                                                                COBLD   289
     ADO = AD(6)/100.                                                                                                COBLD   290
     AEO = AE(6)/100.                                                                                                COBLD   291
     AFO = AF(6)/100.                                                                                                COBLD   292
     AGO = AG(6)/100.                                                                                                COBLD   293
     AHO = AH(6)/100.                                                                                                COBLD   294
     AIO = AI(6)/100.                                                                                                COBLD   295
C                                                                                                                    COBLD   296
     IF (IPINT.NE.0) IP = 1                                                                                          COBLD   297
     IF (IP.EQ.1) GO TO 130                                                                                          COBLD   298
     GO TO 220                                                                                                       COBLD   299
C                                                                                                                    COBLD   300
210  AAI = AA(6)/100.                                                                                                COBLD   301
     ABI = AB(6)/100.                                                                                                COBLD   302
     ACI = AC(6)/100.                                                                                                COBLD   303
     ADI = AD(6)/100.                                                                                                COBLD   304
     AEI = AE(6)/100.                                                                                                COBLD   305
     AFI = AF(6)/100.                                                                                                COBLD   306
     AGI = AG(6)/100.                                                                                                COBLD   307
     AHI = AH(6)/100.                                                                                                COBLD   308
     AII = AI(6)/100.                                                                                                COBLD   309
     AM5 = 2.0*AM5                                                                                                   COBLD   310
     AL8 = AL8+AL80                                                                                                  COBLD   311
     AQ2 = AQ2+AQ20                                                                                                  COBLD   312
C                                                                                                                    COBLD   313
220  PERSAT = 1.0E04*AQ2/(AS1*AL8*6.49)                                                                              COBLD   314
C                                                                                                                    COBLD   315
     Y8F = (WI/(5.82*0.26))*0.01                                                                                     COBLD   316
     P = (6490.*6.45E06)*2.10*DROD*(Y8F-Y8I)/DT                                                                      COBLD   317
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                BWTFR = (AQ2/(6.49*AL8))-0.0012                                  COBLD    318
320             IF (BWTFR.LT.0.0) BWTFR = 0.0                                    COBLD    319
      C   AWTFR = WEIGHT FRACTION OXYGEN IN THE ALPHA ZIRCALOY.                   COBLD    320
      C   AWTFR TYPICALLY = 0.047.                                               COBLD    321
      C                                                                          COBLD    322
      C   CONVERSION TO SI UNITS;                                                COBLD    323
325             WI = 10.*WI                                                      COBLD    324
                Y8 = Y8/100.                                                     COBLD    325
                Y9 = Y9/100.                                                     COBLD    326
                Y9A = Y9A/100.                                                   COBLD    327
                Y9B = Y9B/100.                                                   COBLD    328
330             AM5 = AM5/100.                                                   COBLD    329
                AL8 = AL8/100.                                                   COBLD    330
                GO TO 250                                                        COBLD    331
      C                                                                          COBLD    332
      230   CONTINUE                                                           COBLD    333
335             WRITE 260, DT                                                    COBLD    334
                STOP                                                             COBLD    335
      C                                                                          COBLD    336
      240   WRITE 270                                                          COBLD    337
                STOP                                                             COBLD    338
340   C                                                                          COBLD    339
      250   CONTINUE                                                           COBLD    340
                RETURN                                                           COBLD    341
      C                                                                          COBLD    342
      260   FORMAT (//20X,*DELTA BETA IS TOO LARGE FOR*,E15.5,*SEC INCREMENTS  COBLD    343
345     + - SORRY*)                                                            COBLD    344
      270   FORMAT (//20X,*DIFFUSION IS OCCURRING TOO RAPIDLY FOR THIS ROUTINE COBLD    345
            + TO ACCURATELY CALCULATE OXYGEN CONCENTRATIONS - SORRY*)           COBLD    346
                END                                                              COBLD    347
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	COBILD	3	342

VARIABLES	SN	TYPE		RELOCATION								
1470	AA	REAL	ARRAY		REFS	23	271	282	288	302		
					DEFINED	138	149	245	270			
0	AAI	REAL		F.P.	REFS	126	149	DEFINED	3	99	127	302
0	AAO	REAL		F.P.	REFS	115	138	DEFINED	3	288		
1476	AB	REAL	ARRAY		REFS	23	3*247	271	272	282	289	303
					DEFINED	139	150	247	271			
0	ABI	REAL		F.P.	REFS	150	DEFINED	3	100	128	303	
0	ABO	REAL		F.P.	REFS	113	114	115	139	DEFINED	3	115
					119	289						
1504	AC	REAL	ARRAY		REFS	23	2*247	3*250	271	272	273	282
					290	304	DEFINED	140	151	250	272	
0	ACI	REAL		F.P.	REFS	125	151	DEFINED	3	101	129	304

VARIABLES	SN	TYPE		RELOCATION								
0	ACO	REAL		F.P.	REFS	111	112	113	119	140		
					DEFINED	3	114	120	290			
1512	AD	REAL	ARRAY		REFS	23	2*247	2*250	3*253	272	273	274
						282	291	305	DEFINED	141	152	253	273
0	ADI	REAL		F.P.	REFS	152	DEFINED	3	102	130	305	
0	ADO	REAL		F.P.	REFS	109	110	111	141	DEFINED	3	113
						121	291					
1520	AE	REAL	ARRAY		REFS	23	2*250	2*253	3*256	273	274	275
						282	292	306	DEFINED	142	153	256	274
0	AEI	REAL		F.P.	REFS	124	153	DEFINED	3	103	131	306
0	AEO	REAL		F.P.	REFS	106	107	108	109	115	120	142
					DEFINED	3	112	122	292			
1526	AF	REAL	ARRAY		REFS	23	2*253	2*256	3*259	274	275	276
						282	293	307	DEFINED	143	154	259	275
0	AFI	REAL		F.P.	REFS	154	DEFINED	3	104	132	307	
0	AFO	REAL		F.P.	REFS	104	105	106	143	DEFINED	3	111
						123	293					
1534	AG	REAL	ARRAY		REFS	23	2*256	2*259	3*262	275	276	277
						282	294	308	DEFINED	144	155	262	276
0	AGI	REAL		F.P.	REFS	123	155	DEFINED	3	105	133	308
0	AGO	REAL		F.P.	REFS	102	103	104	121	144		
					DEFINED	3	110	124	294			
1542	AH	REAL	ARRAY		REFS	23	2*259	2*262	5*265	276	277	278
						282	295	309	DEFINED	145	156	265	277
0	AHI	REAL		F.P.	REFS	156	DEFINED	3	106	134	309	
0	AHO	REAL		F.P.	REFS	100	101	102	145	DEFINED	3	109
						125	295					
1550	AI	REAL	ARRAY		REFS	23	2*262	2*265	277	278	282	296
						310	DEFINED	146	157	278		
0	AII	REAL		F.P.	REFS	122	157	DEFINED	3	107	135	310
0	AIO	REAL		F.P.	REFS	99	100	122	146	DEFINED	3	108
						126	296					
1442	AL2	REAL			REFS	162	224	227	230	231		
					DEFINED	161	162					
1457	AL4	REAL			REFS	228	230	231	DEFINED	224		
1456	AL5	REAL			REFS	235	DEFINED	216				
1463	AL6	REAL			REFS	235	281	DEFINED	232			
1460	AL7	REAL			REFS	228	DEFINED	227				
0	AL8	REAL		F.P.	REFS	220	221	224	232	312	315	319
						331	DEFINED	3	219	220	312	331
1436	AL80	REAL			REFS	312	DEFINED	87	221			
1464	AM1	REAL			REFS	236	2*237	2*271	2*272	2*273	2*274	2*275
						2*276	2*277	2*278	DEFINED	235		
1441	AM2	REAL			REFS	237	DEFINED	159	237			
1461	AM3	REAL			REFS	247	250	253	256	259	262	265
					DEFINED	230						
1462	AM4	REAL			REFS	247	250	253	256	259	262	265
					DEFINED	231						
0	AM5	REAL		F.P.	REFS	88	91	161	219	311	330	
					DEFINED	3	88	91	311	330		
1466	AQ2	REAL			REFS	282	284	313	315	319		
					DEFINED	281	282	313				
1435	AQ20	REAL			REFS	313	DEFINED	86	284			

VARIABLES SN TYPE RELOCATION

1444	AR	REAL		REFS	2*171	DEFINED	168					
1455	AS1	REAL		REFS	245	270	315	DEFINED	209	211	213	
1443	AZ3	REAL		REFS	170	171	178	181	186	197	198	
				200	235	DEFINED	165					
1446	AZ8	REAL		REFS	175	176	184	194	195	210	211	
				212	213	216	DEFINED	171	204			
0	BWTFR	REAL	F.P.	REFS	320	DEFINED	3	319	320			
0	DROD	REAL	F.P.	REFS	318	DEFINED	3					
0	DT	REAL	F.P.	REFS	165	168	201	318	335			
				DEFINED	3							
0	IP	INTEGER	F.P.	REFS	94	95	2*161	173	192	2*219	221	
				284	286	299	DEFINED	3	137	298		
1437	IPINT	INTEGER		REFS	91	94	95	298	DEFINED	90		
0	IP2	INTEGER	F.P.	REFS	162	220	DEFINED	3	98	118		
1465	J	INTEGER		REFS	270	4*271	4*272	4*273	4*274	4*275	4*276	
				4*277	3*278	DEFINED	268					
0	P	REAL	F.P.	DEFINED	3	318						
0	PERSAT	REAL	F.P.	DEFINED	3	315						
0	PINT	REAL	F.P.	REFS	90	DEFINED	3					
0	T1	REAL	F.P.	REFS	168	171	204	DEFINED	3			
0	T2	REAL	F.P.	REFS	168	204	DEFINED	3				
0	W1	REAL	F.P.	REFS	85	92	186	191	317	325		
				DEFINED	3	85	186	191	325			
1452	W11	REAL		REFS	2*191	DEFINED	188					
1451	W2	REAL		REFS	186	DEFINED	184					
1445	Y5	REAL		REFS	171	200	201	DEFINED	170	200		
1447	Y6	REAL		REFS	178	DEFINED	175					
1450	Y7	REAL		REFS	181	DEFINED	176					
1453	Y7A	REAL		REFS	197	DEFINED	194					
1454	Y7B	REAL		REFS	198	DEFINED	195					
0	Y8	REAL	F.P.	REFS	83	161	178	188	219	326		
				DEFINED	3	83	178	326				
1467	Y8F	REAL		REFS	318	DEFINED	317					
1440	Y81	REAL		REFS	318	DEFINED	92					
0	Y9	REAL	F.P.	REFS	84	161	181	219	327			
				DEFINED	3	84	181	327				
0	Y9A	REAL	F.P.	REFS	81	161	162	197	219	220	328	
				DEFINED	3	81	197	328				
0	Y9B	REAL	F.P.	REFS	82	161	162	198	219	220	329	
				DEFINED	3	82	198	329				

FILE NAMES	MODE				
OUTPUT	FMT	WRITES	335	338	

EXTERNALS	TYPE	ARGS	REFERENCES						
EXP	REAL	1 LIBRARY	175	176	184	194	195	216	
SQRT	REAL	1 LIBRARY	178	181	186	197	198	211	216

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES
INT	INTEGER	1 INTRIN		90

STATEMENT LABELS			DEF LINE	REFERENCES	
63	100		98	94	
165	110		118	95	
242	120		137	96	116
300	130		149	299	
333	140		159	147	
370	150		171	2*201	
465	160		194	173	
522	170		200	192	
0	180	INACTIVE	203	201	
560	190		214	210	212
0	200		280	268	
1143	210		302	286	
1206	220		315	300	
1265	230		334	228	
1272	240		338	236	
1277	250		341	332	
1317	260	FMT	344	335	
1330	270	FMT	346	338	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
764	200	J	268 280	66B	OPT

STATISTICS
PROGRAM LENGTH 1556B 878
140000B SCM USED

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      C                                                                      COBLD  348
      C                                                                      COBLD  349
            SUBROUTINE CORROS (TCOI,QCI,ZRO2AI,ZRO2BI,ZOXKI,ICOR,DELHI)      COROS    2
      C                                                                      COROS    3
      C     CORROS CALCULATES THE THICKNESS OF THE OXIDE LAYER ON            COROS    4
      C     THE OUTSIDE OF ZIRCALOY CLADDING BETWEEN 366 AND 670 K           COROS    5
      C                                                                      COROS    6
      C     ZRO2BI : OUTPUT NEW OXIDE THICKNESS (M)                          COROS    7
      C                                                                      COROS    8
      C     TCOI   : INPUT ZRO2-COOLANT INTERFACE TEMPERATURE (K)            COROS    9
      C     QCI    : INPUT AXIAL INCREMENT HEAT FLUX (W/M**2)                COROS   10
      C     ZRO2AI : INPUT OXIDE THICKNESS AT END OF PREVIOUS TIME STEP (M)  COROS   11
      C     ZOXKI  : INPUT ZIRCONIUM OXIDE THERMAL CONDUCTIVITY (W/M-K)      COROS   12
      C     ICOR   : INPUT REACTOR CHEMISTRY INDEX                           COROS   13
      C     .GE.2 FOR PWR                                                    COROS   14
      C     .LT.2 FOR BWR                                                    COROS   15
      C     DELHI  : INPUT TIME STEP (S)                                     COROS   16
      C                                                                      COROS   17
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     COROS   18
      C     (1) A. VAN DER LINDE, CALCULATION OF THE SAFE LIFETIME EXPECTANCY COROS   19
      C     OF ZIRCONIUM ALLOY CANNING IN THE FUEL ELEMENTS OF THE           COROS   20
      C     NERO REACTOR, RCN-41 (1965)                                      COROS   21
      C     (2) F. H. MEGERTH, C. P. RUIZ, U. E. WOLFF, ZIRCALOY-CLAD UO2    COROS   22
      C     FUEL ROD EVALUATION PROGRAM FINAL REPORT, GEAP-10371 (1971)      COROS   23
      C     (3) W. R. SMALLEY, SAXTON CORE II FUEL PERFORMANCE EVALUATION    COROS   24
      C     PART I: MATERIALS, WCAP-3385-56 (1971)                           COROS   25
      C     (4) W.R.  SMALLEY, EVALUATION OF SAXTON CORE III FUEL            COROS   26
      C     MATERIALS PERFORMANCE, WCAP-3385-57 (1974)                       COROS   27
      C     (5) E. HILLNER, CORROSION AND HYDRIDING PERFORMANCE OF ZIRCALOY  COROS   28
      C     TUBING AFTER EXTENDED EXPOSURE IN THE SHIPPINGPORT PWR,          COROS   29
      C     SYMPOSIUM ON ZIRCONIUM IN NUCLEAR APPLICATIONS, ASTM STP 551     COROS   30
      C     (1974)                                                           COROS   31
      C                                                                      COROS   32
      C     THIS MODEL SHOULD NOT BE USED OUTSIDE THE TEMPERATURE RANGE      COROS   33
      C     523.15 - 673.15K (250-400 C)                                     COROS   34
      C                                                                      COROS   35
      C     CONVERSION FROM (MG/DM**2) OXIDE WEIGHT GAIN TO:                 COROS   36
      C     (1)OXIDE THICKNESS IN DM    IS 6.3E-7 DM/(MG/DM**2)              COROS   37
      C     (2)OXIDE THICKNESS IN MILS IS 2.5E-3 MILS/(MG/DM**2)             COROS   38
      C     (3)OXIDE THICKNESS IN MICROMETERS IS .063 MICROMETER/(MG/DM**2)  COROS   39
      C                                                                      COROS   40
      C     CORROS WAS CODED BY D.L. HAGRMAN IN JANUARY 1977.                COROS   41
      C                                                                      COROS   42
            OXIDE1 = 0.0                                                     COROS   43
            OXIDE2 = 0.0                                                     COROS   44
      C                                                                      COROS   45
            IF (TCOI.LE.366.5) GO TO 170                                     COROS   46
            IF (ZRO2AI.LE.0.0) ZRO2AI = 1.0E-10                              COROS   47
            TCOIC = TCOI+QCI*ZRO2AI/ZOXKI                                    COROS   48
            WTRAN = 7.7490E-06*EXP(-7.90E02/TCOIC)                           COROS   49
            IF (TCOI.GT.673.0) GO TO 110                                     COROS   50
            IF (ICOR.GE.2) GO TO 100                                         COROS   51
      C                                                                      COROS   52
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      C   BWR ENVIRONMENT                                                    CORROS     53
55          A = 4.840E05*EXP(-1.945E-02*TCOI)                                CORROS     54
            IF (TCOI.LE.500.) A = 28.92887                                   CORROS     55
            GO TO 120                                                        CORROS     56
      C                                                                      CORROS     57
      C   PWR ENVIRONMENT                                                   CORROS     58
60    100   A = 1.203E02*EXP(-7.118E-03*TCOI)                                CORROS     59
            IF (TCOI.LE.500.) A = 3.424614                                   CORROS     60
            GO TO 120                                                        CORROS     61
      C                                                                      CORROS     62
      110   A = 1.0                                                          CORROS     63
65    C                                                                      CORROS     64
      120   IF (ZRO2AI.GT.WTRAN) GO TO 150                                   CORROS     65
      C                                                                      CORROS     66
            OXIDE1 = ZRO2AI                                                  CORROS     67
                DO 130 I=1,2                                                 CORROS     68
70    130       OXIDE1 = (4.976E-09*A*EXP(-1.566E04/(TCOI+QCI*OXIDE1/ZOXKI))*( CORROS     69
           +    DELHI/8.64E4)+ZRO2AI**3.)**0.333                             CORROS     70
            IF (OXIDE1.LT.WTRAN) GO TO 180                                   CORROS     71
      C                                                                      CORROS     72
            OXIDE2 = ZRO2AI                                                  CORROS     73
75              DO 140 I=1,2                                                 CORROS     74
      140       OXIDE2 = 8.288E01*A*EXP(-1.408E04/(TCOI+QCI*OXIDE2/ZOXKI))*DEL CORROS     75
           +    HI/8.64E04+((ZRO2AI**3)/(WTRAN**2))                          CORROS     76
            GO TO 190                                                        CORROS     77
      C                                                                      CORROS     78
80    150   OXIDE2 = ZRO2AI                                                  CORROS     79
                DO 160 I=1,2                                                 CORROS     80
      160       OXIDE2 = 8.288E01*A*EXP(-1.408E04/(TCOI+QCI*OXIDE2/ZOXKI))*DEL CORROS     81
           +    HI/8.64E04+ZRO2AI                                            CORROS     82
            GO TO 190                                                        CORROS     83
85    170   ZRO2BI = ZRO2AI                                                  CORROS     84
            GO TO 200                                                        CORROS     85
      180   ZRO2BI = OXIDE1                                                  CORROS     86
            GO TO 200                                                        CORROS     87
      190   ZRO2BI = OXIDE2                                                  CORROS     88
90    200   CONTINUE                                                         CORROS     89
      C                                                                      CORROS     90
            CALL DIALOT (TCOI,25,FDIALA,FDIALM)                              CORROS     91
            ZRO2BI = (ZRO2BI+FDIALA)*FDIALM                                  CORROS     92
            RETURN                                                           CORROS     93
95          END                                                              CORROS     94
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 CORROS	3	94

VARIABLES	SN	TYPE	RELOCATION									
276	A	REAL		REFS	70	76	82	DEFINED	55	56	60	
				61	64							
0	DELHI	REAL	F.P.	REFS	70	76	82	DEFINED	3			
300	FDIALA	REAL		REFS	92	93						
301	FDIALM	REAL		REFS	92	93						
277	I	INTEGER		DEFINED	69	75	81					
0	ICOR	INTEGER	F.P.	REFS	52	DEFINED	3					
272	OXIDE1	REAL		REFS	70	72	87	DEFINED	44	68	70	
273	OXIDE2	REAL		REFS	76	82	89	DEFINED	45	74	76	
				80	82							
0	QC1	REAL	F.P.	REFS	49	70	76	82	DEFINED	3		
0	TCO1	REAL	F.P.	REFS	47	49	51	55	56	60	61	
				70	76	82	92	DEFINED	3			
274	TCO1C	REAL		REFS	50	DEFINED	49					
275	WTRAN	REAL		REFS	66	72	76	DEFINED	50			
0	ZOXK1	REAL	F.P.	REFS	49	70	76	82	DEFINED	3		
0	ZRO2A1	REAL	F.P.	REFS	48	49	66	68	70	74	76	
				80	82	85	DEFINED	3	48			
0	ZRO2B1	REAL	F.P.	REFS	93	DEFINED	3	85	87	89	93	

EXTERNALS	TYPE	ARGS		REFERENCES						
DIALOT		4		92						
EXP	REAL	1	LIBRARY	50	55	60	70	76	82	

STATEMENT LABELS		DEF LINE	REFERENCES		
61	100	60	52		
76	110	64	51		
101	120	66	57	62	
0	130	70	69		
0	140	76	75		
162	150	80	66		
0	160	82	81		
206	170	85	47		
212	180	87	72		
216	190	89	78	84	
221	200	90	86	88	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
110	130	I	69 70	21B	EXT REFS
140	140	I	75 76	20B	EXT REFS
166	160	I	81 82	16B	EXT REFS

STATISTICS

PROGRAM LENGTH 322B 210

140000B SCM USED

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      FUNCTION CSHEAR (CTEMP,FNCK,CWKF,DELOXY)                          CSHER    2
C                                                                       CSHER    3
C     CSHEAR CALCULATES THE SHEAR MODULUS OF ZIRCALOY-2 AND -4          CSHER    4
C     AS A FUNCTION OF TEMPERATURE, FAST NEUTRON FLUENCE,               CSHER    5
C     COLD WORK, AND AVERAGE OXYGEN CONCENTRATION.  GRAIN               CSHER    6
C     ORIENTATION IS ASSUMED RANDOM.                                    CSHER    7
C     THE EXPECTED STANDARD ERROR IS COMPUTED BUT NOT RETURNED          CSHER    8
C     (UCSHER)                                                          CSHER    9
C                                                                       CSHER   10
C     CSHEAR = OUTPUT SHEAR MODULUS FOR ZIRCALOY-2 AND -4               CSHER   11
C     WITH RANDOM TEXTURE (PA)                                          CSHER   12
C     UCSHER = OUTPUT STANDARD ERROR EXPECTED IN CSHEAR (PA)            CSHER   13
C     (NOT CURRENTLY RETURNED)                                          CSHER   14
C                                                                       CSHER   15
C     CTEMP  : INPUT CLADDING TEMPERATURE (K)                           CSHER   16
C     FNCK   : INPUT EFFECTIVE FAST FLUENCE (NEUTRONS/(M**2))           CSHER   17
C     CWKF   : INPUT EFFECTIVE COLD WORK (UNITLESS RATIO OF AREAS)      CSHER   18
C     DELOXY : INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING             CSHER   19
C     OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                     CSHER   20
C     AS-RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                     CSHER   21
C                                                                       CSHER   22
C     THE SHEAR MODULUS CALCULATED BY THIS FUNCTION IS BASED ON         CSHER   23
C     DATA FROM THE FOLLOWING REFERENCES                                CSHER   24
C                                                                       CSHER   25
C     (1) L. R. BUNNELL, G. B. MELLINGER  AND J. L. BATES, HIGH         CSHER   26
C     TEMPERATURE PROPERTIES OF ZIRCALOY - OXYGEN ALLOYS, EPRI          CSHER   27
C     REPORT NP - 524 (1977)                                            CSHER   28
C     (2) E. S. FISHER AND C. J. RENKEN, PHYSICAL REVIEW 135 2A         CSHER   29
C     (20 JULY 1964) PP A482 - 494.                                     CSHER   30
C     (3) P. E. ARMSTRONG AND H. L. BROWN, TRANSACTIONS OF THE          CSHER   31
C     METALLURGICAL SOCIETY OF AIME 230 (AUGUST 1964)                   CSHER   32
C     PP 962 - 966                                                      CSHER   33
C     (4) A. PADEL AND A. GROFF, JOURNAL OF NUCLEAR MATERIALS 59        CSHER   34
C     (1976) PP 325 - 326.                                              CSHER   35
C     (5) W. R. SMALLEY, SAXTON CORE II FUEL PERFORMANCE EVALUATION.    CSHER   36
C     PART I: MATERIALS, WCAP-3385-56 (SEPTEMBER 1971)                  CSHER   37
C                                                                       CSHER   38
C     CSHEAR WAS CODED BY R. L. MILLER, JUNE 1974                       CSHER   39
C     MODIFIED BY D. L. HAGRMAN DECEMBER 1977                           CSHER   40
C                                                                       CSHER   41
        C1 = 7.07E+11-CTEMP*2.315E+08                                   CSHER   42
        C2 = 1.0                                                        CSHER   43
        IF (FNCK.GT.1.0E+22) C2 = 0.88*(1.0-EXP(-FNCK/1.0E+25))+EXP(-FNCK/ CSHER   44
       +1.0E+25)                                                        CSHER   45
        C3 = -.867E+10                                                  CSHER   46
        CSHEAR = (4.04E+10-2.168E+07*CTEMP+C1*DELOXY+C3*CWKF)/C2        CSHER   47
        IF (CTEMP.LT.1090.) GO TO 130                                   CSHER   48
C                                                                       CSHER   49
C     CALCULATE A TO A + B AND A + B TO B BOUNDARIES                    CSHER   50
        WFOX = DELOXY+0.0012                                            CSHER   51
        TAAB = 1094.+WFOX*(-1.289E+03+WFOX*7.914E+05)                   CSHER   52
        IF (WFOX.LT.0.025) GO TO 100                                    CSHER   53
        TAAB = 1556.4+3.8281E+04*(WFOX-0.025)                           CSHER   54
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          100   TABB = 392.46*((100*DELOXY+0.1242807)**2+3.1417)                    CSHER      55
55              IF (DELOXY.LT.4.7308937E-03) GO TO 110                              CSHER      56
                TABB = (100*DELOXY+0.12)*491.157+1081.7413                          CSHER      57
          110   CONTINUE                                                            CSHER      58
                C                                                                   CSHER      59
                IF (CTEMP.LT.TAAB) GO TO 130                                        CSHER      60
60              IF (CTEMP.GT.TABB) GO TO 120                                        CSHER      61
                AMODL = (4.04E+10-2.168E+07*TAAB+C1*DELOXY+C3*CWKF)/C2              CSHER      62
                AMODR = 3.49E+10-TABB*1.66E+07                                      CSHER      63
                CSHEAR = AMODL+(CTEMP-TAAB)*(AMODR-AMODL)/(TABB-TAAB)               CSHER      64
                GO TO 130                                                           CSHER      65
65        120   CSHEAR = 3.49E+10-CTEMP*1.66E+07                                    CSHER      66
          130   CONTINUE                                                            CSHER      67
                IF (CSHEAR.LT.1.0) CSHEAR = 1.0                                     CSHER      68
                UCSHER = 9.0E+09                                                    CSHER      69
                C                                                                   CSHER      70
70              CALL DIALOT (CTEMP,24,FDIALA,FDIALM)                                CSHER      71
                CSHEAR = (CSHEAR+FDIALA)*FDIALM                                     CSHER      72
                RETURN                                                              CSHER      73
                END                                                                 CSHER      74
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
5 CSHEAR 1 72

VARIABLES	SN	TYPE	RELOCATION								
247 AMODL		REAL		REFS	2*63	DEFINED	61				
250 AMODR		REAL		REFS	63	DEFINED	62				
240 CSHEAR		REAL		REFS	67	71	DEFINED	46	63	65	67
				71							
0 CTEMP		REAL	F.P.	REFS	41	46	47	59	60	63	65
				70	DEFINED	1					
0 CWKF		REAL	F.P.	REFS	46	61	DEFINED	1			
241 C1		REAL		REFS	46	61	DEFINED	41			
242 C2		REAL		REFS	46	61	DEFINED	42	43		
243 C3		REAL		REFS	46	61	DEFINED	45			
0 DELOXY		REAL	F.P.	REFS	46	50	54	55	56	61	
				DEFINED	7						
252 FDIALA		REAL		REFS	70	71					
253 FDIALM		REAL		REFS	70	71					
0 FNCK		REAL	F.P.	REFS	3*43	DEFINED	1				
245 TAAB		REAL		REFS	59	61	2*63	DEFINED	51	53	
246 TABB		REAL		REFS	60	62	63	DEFINED	54	56	
251 UCSHER	*	REAL		DEFINED	68						
244 WFOX		REAL		REFS	2*51	52	53	DEFINED	50		

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EXTERNALS          TYPE   ARGS       REFERENCES
      DIALOT                4            70
      EXP        REAL       1 LIBRARY    2*43

STATEMENT LABELS             DEF LINE   REFERENCES
   73  100                      54         52
  112  110                      57         55
  146  120                      65         60
  152  130                      66         47        59        64

STATISTICS
  PROGRAM LENGTH               254B      172
        140000B SCM USED
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      SUBROUTINE CSIGMA (CTEMP,DELOXY,ANRIN,FNCK,FNCN,CWKF,CWNF,RSTRAN,S
     +TRANT,STREST,A1,A2,A3)
C
C   CSIGMA CALCULATES POWER LAW TRUE STRESS AS A FUNCTION OF
C   TRUE CLADDING STRAIN, TRUE CLADDING STRAIN RATE,
C   CLADDING TEMPERATURE, AVERAGE OXYGEN CONCENTRATION
C   IN CLADDING, FAST NEUTRON FLUENCE, AND COLD WORK
C
C   A1,A2, AND A3 = OUTPUT COEFFICIENTS OF ANISOTROPY (UNITLESS)
C   STREST = OUTPUT POWER LAW TRUE STRESS (PA)
C
C   STRANT = INPUT TRUE STRAIN (UNITLESS )
C   RSTRAN = INPUT TRUE STRAIN RATE (S**(-1))
C   CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)
C   DELOXY = INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING
C   OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF
C   AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)
C   ANRIN  = INPUT CONTRACTILE STRAIN RATIO DURING UNIAXIAL TENSILE
C   TEST. CIRCUMFERENTIAL STRAIN/RADIAL STRAIN.
C   IF UNKNOWN, INPUT ZERO OR NEGATIVE NUMBER (M/M)
C   FNCK   = INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH
C   COEFFICIENT (NEUTRONS/(M**2))
C   FNCN   = INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING
C   EXPONENT (NEUTRONS/(M**2))
C   CWKF   = INPUT EFFECTIVE COLD WORK FOR STRENGTH
C   COEFFICIENT (UNITLESS RATIO OF AREAS)
C   CWNF   = INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING
C   EXPONENT (UNITLESS RATIO OF AREAS)
C
C   CONVERSION FROM PA  TO  PSI  IS 1.4505E-04 (PSI/PA)
C
C   CSIGMA WAS CODED BY M. BOHN AND MODIFIED BY D. L. HAGRMAN
C   IN FEBRUARY 1977
C   MODIFIED BY D. L. HAGRMAN OCTOBER 1977
C
      CALL CKMN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,AK,AN,AM)
      T = CTEMP
C
C   ANISOTROPY CONSTANTS
      IF (T.GT.1203.233) GO TO 100
      IF (STRANT.GT.0.3) GO TO 100
      RR = 2.65+T*(1.36E-03-T*2.27E-06)
      IF (STRANT.LT.0.15) GO TO 110
      RR = 1.+(STRANT*(1.-RR)/2.25E-02)*(STRANT-3.0E-01)
      GO TO 110
  100 RR = 1.0
  110 IF (ANRIN.GT.0.) RR = ANRIN
      A1 = RR/(RR+1.0)
      A2 = -(RR-5.4)/(4.4*(RR+1.0))
      A3 = 1.0/(RR+1.0)
C
      STREST = AK*(STRANT**AN)*((RSTRAN/1.0E-3)**AM)
```

```
      C
   55 RETURN                                                          CSIGM  55
      END                                                             CSIGM  56
                                                                      CSIGM  57
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CSIGMA 1 55

VARIABLES	SN	TYPE	RELOCATION									
143	AK	REAL		REFS	37	53						
145	AM	REAL		REFS	37	53						
144	AN	REAL		REFS	37	53						
0	ANRIN	REAL	F.P.	REFS	2*48	DEFINED	1					
0	A1	REAL	F.P.	DEFINED	1	49						
0	A2	REAL	F.P.	DEFINED	1	50						
0	A3	REAL	F.P.	DEFINED	1	51						
0	CTEMP	REAL	F.P.	REFS	37	38	DEFINED	1				
0	CWKF	REAL	F.P.	REFS	37	DEFINED	1					
0	CWNF	REAL	F.P.	REFS	37	DEFINED	1					
0	DELOXY	REAL	F.P.	REFS	37	DEFINED	1					
0	FNCK	REAL	F.P.	REFS	37	DEFINED	1					
0	FNCN	REAL	F.P.	REFS	37	DEFINED	1					
147	RR	REAL		REFS	45	2*49	2*50	51	DEFINED	43	45	
				47	48							
0	RSTRAN	REAL	F.P.	REFS	37	53	DEFINED	1				
0	STRANT	REAL	F.P.	REFS	42	44	2*45	53	DEFINED	1		
0	STREST	REAL	F.P.	DEFINED	1	53						
146	T	REAL		REFS	41	2*43	DEFINED	38				

EXTERNALS	TYPE	ARGS	REFERENCES
CKMN		10	37

STATEMENT LABELS		DEF LINE	REFERENCES	
51	100	47	41	42
54	110	48	44	46

STATISTICS
PROGRAM LENGTH 150B 104
140000B SCM USED

```
      C                                                                      CSIGM      58
      C                                                                      CSIGM      59
            SUBROUTINE CSRUPT (CTEMP,FNCN,CWNF,DELTMP,STRRPE,USTRPE,STRRPT,UST CSRPT       2
           +RTP,USTRTN)                                                      CSRPT      3
      C                                                                      CSRPT      4
      C     CSRUPT CALCULATES THE FRACTIONAL INCREASE IN CLADDING            CSRPT      5
      C     CIRCUMFERENCE AT FAILURE IN A STEAM ENVIRONMENT AS A             CSRPT      6
      C     FUNCTION OF TEMPERATURE, FAST NEUTRON FLUENCE, AND               CSRPT      7
      C     COLD WORK.  THE EXPECTED STANDARD ERROR IS ALSO RETURNED.        CSRPT      8
      C                                                                      CSRPT      9
      C     STRRPE = OUTPUT AVERAGE CIRCUMFERENTIAL ENGINEERING STRAIN       CSRPT     10
      C     AT RUPTURE (M/M)                                                 CSRPT     11
      C     USTRPE = OUTPUT EXPECTED STANDARD ERROR IN STRRPE (M/M)          CSRPT     12
      C     STRRPT = OUTPUT TRUE STRAIN AT RUPTURE (M/M)                     CSRPT     13
      C     USTRTP = OUTPUT POSITIVE STANDARD ERROR OF STRRPT WHICH          CSRPT     14
      C     CORRESPONDS TO USTRPE (M/M)                                      CSRPT     15
      C     USTRTN = OUTPUT NEGATIVE STANDARD ERROR OF STRRPT WHICH          CSRPT     16
      C     CORRESPONDS TO USTRPE (M/M)                                      CSRPT     17
      C                                                                      CSRPT     18
      C     NOTE  A NON-SYMMETRIC DISTRIBUTION IS OBTAINED IN TERMS OF       CSRPT     19
      C     STRESS BECAUSE THE TRANSFORMATION FROM ENGINEERING STRESS        CSRPT     20
      C     TO TRUE STRESS IS NON-LINEAR                                     CSRPT     21
      C                                                                      CSRPT     22
      C                                                                      CSRPT     23
      C     CTEMP  = INPUT AVERAGE CLADDING TEMPERATURE (K)                  CSRPT     24
      C     FNCN   = INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING       CSRPT     25
      C     EXPONENT (NEUTRONS/(M**2))                                       CSRPT     26
      C     CWNF   = INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING          CSRPT     27
      C     EXPONENT (UNITLESS RATIO OF AREAS)                               CSRPT     28
      C     DELTMP = INPUT CIRCUMFERENTIAL TEMPERATURE VARIATION             CSRPT     29
      C     --HOTTEST LESS COLDEST TEMPERATURES (K)                          CSRPT     30
      C     ESTIMATED VALUES OF DELTMP ARE                                   CSRPT     31
      C     (A) FOR CLADDING WITH EXTERNAL THERMOCOUPLES AND IN FILM         CSRPT     32
      C     BOILING  DELTMP = 150K                                           CSRPT     33
      C     (B) FOR CLADDING WITH INTERNAL HEATING IN STEAM AND              CSRPT     34
      C     WITHOUT EXTERNAL THERMOCOUPLES                                   CSRPT     35
      C     DELTMP = 0 IF TEMPERATURE IS ABOVE 1255K                         CSRPT     36
      C     = 50 * (1255 - TEMPERATURE) / 165 IF                             CSRPT     37
      C     TEMPERATURE IS BETWEEN 1090 AND 1255K                            CSRPT     38
      C     = 50K IF TEMPERATURE IS BELOW 1090K                              CSRPT     39
      C     (C) FOR CLADDING IN A FURNACE                                    CSRPT     40
      C     DELTMP = 0K                                                      CSRPT     41
      C     (D) FOR SELF - RESISTANCE HEATED CLADDING WITH COOL FILLER       CSRPT     42
      C     DELTMP = (HEATING RATE)/(1000K/S) * VALUES FROM (B)              CSRPT     43
      C                                                                      CSRPT     44
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     CSRPT     45
      C     (1) C.C. BUSBY AND K.B. MARSH, HIGH TEMPERATURE DEFORMATION      CSRPT     46
      C     BURST CHARACTERISTICS OF RECRYSTALLIZED ZIRCALOY-4 TUBING        CSRPT     47
      C     WAPD-TM-900 (1970)                                               CSRPT     48
      C     (2) D.G. HARDY,  HIGH TEMPERATURE EXPANSION AND RUPTURE          CSRPT     49
      C     BEHAVIOR OF ZIRCALOY TUBING   IN TOPICAL MEETING ON              CSRPT     50
      C     WATER REACTOR SAFETY CONF-7303 (1973)                            CSRPT     51
      C     (3) D.O. HOBSON AND P.L. RITTENHOUSE,  DEFORMATION AND RUPTURE   CSRPT     52
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      C   BEHAVIOR OF LIGHT WATER REACTOR FUEL CLADDING ORNL-4727                CSRPT     53
      C   (1971)                                                                  CSRPT     54
      C   (4) D. O. HOBSON, M. F. OSBORNE, AND G. W. PARKER,  COMPARISON          CSRPT     55
      C   OF RUPTURE DATA FROM IRRADIATED FUEL RODS AND UNIRRADIATED              CSRPT     56
      C   CLADDING,  NUCL. TECH. 17 (AUGUST 1971) P 479                          CSRPT     57
      C   (5) R. A. LORENZ, D. O. HOBSON AND G. W. PARKER,  FUEL ROD              CSRPT     58
      C   FAILURE UNDER LOSS OF COOLANT CONDITIONS IN TREAT,  NUCL.               CSRPT     59
      C   TECH. 17 (AUGUST 1971) P 502                                           CSRPT     60
      C   (6) R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY               CSRPT     61
      C   REPORT FOR JULY - SEPTEMBER, 1975, ORNL-TM-5154                        CSRPT     62
      C   (DECEMBER 1975)                                                        CSRPT     63
      C   (7) R. H. CHAPMAN, MULTIROD BURST TEST PROGRAM QUARTERLY               CSRPT     64
      C   REPORT FOR OCTOBER - DECEMBER, 1975,  ORNL/NUREG/TM-10                 CSRPT     65
      C   (MAY 1976)                                                             CSRPT     66
      C   (8) A. A. BAUER, L. M. LOWRY, AND J. S. PERRIN, EVALUATING             CSRPT     67
      C   STRENGTH AND DUCTILITY OF IRRADIATED ZIRCALOY. QUARTERLY               CSRPT     68
      C   PROGRESS REPORT FOR JANUARY THROUGH MARCH, 1976, BMI-NUREG-            CSRPT     69
      C   1948 (MARCH 1976)                                                      CSRPT     70
      C   (9) A. L. BEMENT, JR., EFFECTS OF COLD WORK AND NEUTRON                CSRPT     71
      C   IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2,                   CSRPT     72
      C   USAEC REPORT HW-74955                                                  CSRPT     73
      C                                                                          CSRPT     74
      C   CODED BY D. L. HAGRMAN JULY 1976                                       CSRPT     75
      C   MODIFIED BY D.L. HAGRMAN JUNE 1978.                                    CSRPT     76
      C                                                                          CSRPT     77
            T = CTEMP                                                            CSRPT     78
      C   CALCULATE  STRAIN AT RUPTURE FOR SYMMETRIC CASE                        CSRPT     79
            P = 1.0                                                              CSRPT     80
            Q = 1.0                                                              CSRPT     81
            IF (T.GT.1090.) GO TO 100                                            CSRPT     82
            STRRPE = 1.98E-1+T*(4.16E-04+T*2.06E-07)                             CSRPT     83
            P = (EXP(-2.1E01*CWNF)+3.3E-01)/1.33                                 CSRPT     84
            IF (FNCN.GE.1.0E21) Q = (1.0+2.0*EXP(-FNCN/1.0E23))/3.0              CSRPT     85
            STRRPE = STRRPE*P*Q                                                  CSRPT     86
            GO TO 130                                                            CSRPT     87
      100   IF (T.GT.1170.) GO TO 110                                            CSRPT     88
            STRRPE = 9.06231055-T*7.491855E-03                                   CSRPT     89
            GO TO 130                                                            CSRPT     90
      110   IF (T.GT.1600.) GO TO 120                                            CSRPT     91
            STRRPE = -1.436+T*(2.045E-03-T*4.82E-07)                             CSRPT     92
            GO TO 130                                                            CSRPT     93
      120   STRRPE = 6.0208E-1                                                   CSRPT     94
      130   CONTINUE                                                             CSRPT     95
      C                                                                          CSRPT     96
      C   MODIFY STRAIN AT RUPTURE FOR TEMPERATURE GRADIENT EFFECTS             CSRPT     97
            STRRPE = STRRPE*EXP(-1.11E-02*DELTMP)                                CSRPT     98
      C                                                                          CSRPT     99
            USTRPE = 8.0E-02                                                     CSRPT    100
            IF (T.LT.800.) GO TO 140                                             CSRPT    101
            USTRPE = (3.6E-01/2.90E+02)*(T-8.00E+02)+8.00E-02                    CSRPT    102
            IF (T.LT.1090.) GO TO 140                                            CSRPT    103
            USTRPE = -4.125E-03*(T-1.09E+03)+4.4E-01                             CSRPT    104
            IF (T.LT.1170.) GO TO 140                                            CSRPT    105
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```
                  USTRPE = 1.1E-01                                                  CSRPT  106
              140 IF (USTRPE.GT.(0.9*STRRPE)) USTRPE = 0.9*STRRPE                   CSRPT  107
                  C                                                                 CSRPT  108
      110         C   CONVERSION TO TRUE STRAINS FOLLOWS                           CSRPT  109
                    STRRPT = ALOG(1.0+STRRPE)                                       CSRPT  110
                    USTRTP = ALOG(1.0+STRRPE+USTRPE)-STRRPT                         CSRPT  111
                    USTRTN = STRRPT-ALOG(1.0+STRRPE-USTRPE)                         CSRPT  112
                  C                                                                 CSRPT  113
      115         RETURN                                                            CSRPT  114
                  END                                                               CSRPT  115
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CSRUPT	3	115

VARIABLES

	SN	TYPE	RELOCATION									
0	CTEMP	REAL	F.P.	REFS	79	DEFINED	3					
0	CWNF	REAL	F.P.	REFS	85	DEFINED	3					
0	DELTMP	REAL	F.P.	REFS	99	DEFINED	3					
0	FNCN	REAL	F.P.	REFS	2*86	DEFINED	3					
232	P	REAL		REFS	87	DEFINED	81	85				
233	Q	REAL		REFS	87	DEFINED	82	86				
0	STRRPE	REAL	F.P.	REFS	87	99	2*108	111	112	113		
				DEFINED	3	84	87	90	93	95	99	
0	STRRPT	REAL	F.P.	REFS	112	113	DEFINED	3	111			
231	T	REAL		REFS	83	2*84	89	90	92	2*93	102	
				103	104	105	106	DEFINED	79			
0	USTRPE	REAL	F.P.	REFS	108	112	113	DEFINED	3	101	103	
				105	107	108						
0	USTRTN	REAL	F.P.	DEFINED	3	113						
0	USTRTP	REAL	F.P.	DEFINED	3	112						

EXTERNALS

	TYPE	ARGS	REFERENCES		
ALOG	REAL	1 LIBRARY	111	112	113
EXP	REAL	1 LIBRARY	85	86	99

STATEMENT LABELS

		DEF LINE	REFERENCES		
52	100	89	83		
62	110	92	89		
73	120	95	92		
76	130	96	88	91	94
135	140	108	102	104	106

STATISTICS

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  PROGRAM LENGTH      234B     156
        140000B SCM USED
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```
      C                                                                       CSRPT    116
      C                                                                       CSRPT    117
            SUBROUTINE CSTRAN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,STREST, CSTRN      2
           +STRANT)                                                           CSTRN      3
      C                                                                       CSTRN      4
      C     CSTRAN CALCULATES CLADDING STRAIN AS A FUNCTION OF                CSTRN      5
      C     TRUE CLADDING STRESS, TRUE CLADDING STRAIN RATE,                  CSTRN      6
      C     CLADDING TEMPERATURE, AVERAGE OXYGEN CONCENTRATION                CSTRN      7
      C     IN CLADDING, FAST NEUTRON FLUENCE, AND COLD WORK.                 CSTRN      8
      C     NO INTERNAL ITERATIONS ARE CONTAINED IN CSTRAN.  IT IS            CSTRN      9
      C     ASSUMED THAT THE USER WILL ITERATE THE INPUT VALUE                CSTRN     10
      C     OF RSTRAN.  SEE SUBCODE CSTRNI FOR ITERATED VERSION.              CSTRN     11
      C                                                                       CSTRN     12
      C     STRANT = OUTPUT EFFECTIVE TRUE PLASTIC STRAIN (UNITLESS)          CSTRN     13
      C                                                                       CSTRN     14
      C     STREST = INPUT EFFECTIVE TRUE STRESS (PA)                         CSTRN     15
      C     RSTRAN = INPUT EFFECTIVE TRUE PLASTIC STRAIN RATE (S**(-1))       CSTRN     16
      C     CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)                 CSTRN     17
      C     DELOXY = INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING             CSTRN     18
      C     OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                     CSTRN     19
      C     AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                     CSTRN     20
      C     FNCK   = INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH                CSTRN     21
      C     COEFFICIENT (NEUTRONS/(M**2))                                     CSTRN     22
      C     FNCN   = INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING        CSTRN     23
      C     EXPONENT (NEUTRONS/(M**2))                                        CSTRN     24
      C     CWKF   = INPUT EFFECTIVE COLD WORK FOR STRENGTH                   CSTRN     25
      C     COEFFICIENT (UNITLESS RATIO OF AREAS)                             CSTRN     26
      C     CWNF   = INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING           CSTRN     27
      C     EXPONENT (UNITLESS RATIO OF AREAS)                                CSTRN     28
      C                                                                       CSTRN     29
      C     THE SUBCODE CKMN IS USED IN THIS SUBROUTINE                       CSTRN     30
      C                                                                       CSTRN     31
      C     CONVERSION FROM PA  TO  PSI  IS 1.4505E-04 (PSI/PA)               CSTRN     32
      C                                                                       CSTRN     33
      C     CSTRAN WAS CODED BY R. L. MILLER AND R. R. HOBBINS                CSTRN     34
      C     IN MARCH 1974                                                     CSTRN     35
      C     MODIFIED BY D. L. HAGRMAN OCTOBER, 1978                           CSTRN     36
      C                                                                       CSTRN     37
              CALL CKMN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,AK,AN,AM)    CSTRN     38
              STRANT = (STREST/(AK*((RSTRAN/1.0E-03)**AM)))**(1.0/AN)          CSTRN     39
      C                                                                       CSTRN     40
              RETURN                                                          CSTRN     41
              END                                                             CSTRN     42
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CSTRAN	3	42

```
VARIABLES     SN  TYPE          RELOCATION
   63  AK         REAL                        REFS      39        40
   65  AM         REAL                        REFS      39        40
   64  AN         REAL                        REFS      39        40
    0  CTEMP      REAL                F.P.    REFS      39    DEFINED         3
    0  CWKF       REAL                F.P.    REFS      39    DEFINED         3
    0  CWNF       REAL                F.P.    REFS      39    DEFINED         3
    0  DELOXY     REAL                F.P.    REFS      39    DEFINED         3
    0  FNCK       REAL                F.P.    REFS      39    DEFINED         3
    0  FNCN       REAL                F.P.    REFS      39    DEFINED         3
    0  RSTRAN     REAL                F.P.    REFS      39        40    DEFINED         3
    0  STRANT     REAL                F.P.  DEFINED      3        40
    0  STREST     REAL                F.P.    REFS      40    DEFINED         3

EXTERNALS          TYPE   ARGS       REFERENCES
      CKMN                 10            39

STATISTICS
  PROGRAM LENGTH                 66B      54
        140000B SCM USED
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```
      C                                                                       CSTRN      43
      C                                                                       CSTRN      44
            SUBROUTINE CSTRES (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,STRANT, CSTRS       2
           +STRESS)                                                           CSTRS      3
      5     C                                                                 CSTRS      4
            C   CSTRES CALCULATES CLADDING EFFECTIVE STRESS AS A FUNCTION OF   CSTRS      5
            C   TRUE CLADDING STRAIN, TRUE CLADDING STRAIN RATE,               CSTRS      6
            C   CLADDING TEMPERATURE, AVERAGE OXYGEN CONCENTRATION            CSTRS      7
            C   IN CLADDING, FAST NEUTRON FLUENCE, AND COLD WORK.             CSTRS      8
     10     C                                                                 CSTRS      9
            C   STRESS = OUTPUT EFFECTIVE TRUE STRESS (PA)                    CSTRS     10
            C                                                                 CSTRS     11
            C   STRANT = INPUT EFFECTIVE TRUE PLASTIC STRAIN (UNITLESS)       CSTRS     12
            C   RSTRAN = INPUT EFFECTIVE TRUE PLASTIC STRAIN RATE (S**(-1))  CSTRS     13
     15     C   CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)             CSTRS     14
            C   DELOXY = INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING        CSTRS     15
            C   OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF                CSTRS     16
            C   AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)                CSTRS     17
            C   FNCK   = INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH           CSTRS     18
     20     C   COEFFICIENT (NEUTRONS/(M**2))                                CSTRS     19
            C   FNCN   = INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING   CSTRS     20
            C   EXPONENT (NEUTRONS/(M**2))                                   CSTRS     21
            C   CWKF   = INPUT EFFECTIVE COLD WORK FOR STRENGTH              CSTRS     22
            C   COEFFICIENT (UNITLESS RATIO OF AREAS)                       CSTRS     23
     25     C   CWNF   = INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING      CSTRS     24
            C   EXPONENT (UNITLESS RATIO OF AREAS)                          CSTRS     25
            C                                                                 CSTRS     26
            C   THE SUBCODE CKMN IS USED IN THIS SUBROUTINE                  CSTRS     27
            C                                                                 CSTRS     28
     30     C   CONVERSION FROM PA  TO  PSI  IS 1.4505E-04 (PSI/PA)           CSTRS     29
            C                                                                 CSTRS     30
            C   CSTRES WAS ADAPTED FROM CSTRAN (A SUBROUTINE BY R.L. MILLER AND CSTRS     31
            C   R.R. HOBBINS) BY G.A. BERNA IN APRIL 1975                     CSTRS     32
            C   MODIFIED BY D.L. HAGRMAN OCTOBER 1, 1978                     CSTRS     33
     35     C                                                                 CSTRS     34
              CALL CKMN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,AK,AN,AM)    CSTRS     35
              ARG = AK*((RSTRAN/1.0E-3)**AM)                                  CSTRS     36
              STREST = ARG*(STRANT**AN)                                       CSTRS     37
            C                                                                 CSTRS     38
     40       RETURN                                                         CSTRS     39
              END                                                            CSTRS     40
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	CSTRES	3	40

```
VARIABLES     SN  TYPE          RELOCATION
   60  AK         REAL                        REFS      36        37
   62  AM         REAL                        REFS      36        37
   61  AN         REAL                        REFS      36        38
   63  ARG        REAL                        REFS      38   DEFINED        37
    0  CTEMP      REAL              F.P.      REFS      36   DEFINED         3
    0  CWKF       REAL              F.P.      REFS      36   DEFINED         3
    0  CWNF       REAL              F.P.      REFS      36   DEFINED         3
    0  DELOXY     REAL              F.P.      REFS      36   DEFINED         3
    0  FNCK       REAL              F.P.      REFS      36   DEFINED         3
    0  FNCN       REAL              F.P.      REFS      36   DEFINED         3
    0  RSTRAN     REAL              F.P.      REFS      36        37   DEFINED        3
    0  STRANT     REAL              F.P.      REFS      38   DEFINED         3
    0  STREST     REAL              F.P.   DEFINED       3        38

EXTERNALS          TYPE    ARGS       REFERENCES
      CKMN                   10            36

STATISTICS
  PROGRAM LENGTH                 64B      52
        140000B SCM USED
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```
      C                                                                       CSTRS     41
      C                                                                       CSTRS     42
            SUBROUTINE CSTRNI (DELH,CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,STREST,ST CSTRNI     2
           +RANT)                                                             CSTRNI     3
      5     C                                                                 CSTRNI     4
            C   CSTRNI CALCULATES CLADDING STRAIN AS A FUNCTION OF           CSTRNI     5
            C   TRUE CLADDING STRESS, INITIAL TRUE CLADDING STRAIN,           CSTRNI     6
            C   TIME STEP SIZE, CLADDING TEMPERATURE, AVERAGE OXYGEN         CSTRNI     7
            C   CONCENTRATION IN CLADDING, FAST NEUTRON FLUENCE,             CSTRNI     8
     10     C   AND COLD WORK.                                               CSTRNI     9
            C                                                                 CSTRNI    10
            C   STRANT = OUTPUT EFFECTIVE TRUE PLASTIC STRAIN AT THE END OF  CSTRNI    11
            C   THE CURRENT TIME STEP (UNITLESS)                            CSTRNI    12
            C                                                                 CSTRNI    13
     15     C   STREST = INPUT EFFECTIVE TRUE STRESS (PA)                     CSTRNI    14
            C   STRANT = INPUT EFFECTIVE TRUE PLASTIC STRAIN AT THE START    CSTRNI    15
            C   OF THE CURRENT TIME STEP (UNITLESS)                         CSTRNI    16
            C   DELH   = INPUT TIME STEP SIZE (S)                           CSTRNI    17
            C   CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)           CSTRNI    18
     20     C   DELOXY = INPUT AVERAGE OXYGEN CONCENTRATION EXCLUDING       CSTRNI    19
            C   OXIDE LAYER - AVERAGE OXYGEN CONCENTRATION OF               CSTRNI    20
            C   AS RECEIVED CLADDING  (KG OXYGEN/KG ZIRCALOY)               CSTRNI    21
            C   FNCK   = INPUT EFFECTIVE FAST FLUENCE FOR STRENGTH          CSTRNI    22
            C   COEFFICIENT (NEUTRONS/(M**2))                              CSTRNI    23
     25     C   FNCN   = INPUT EFFECTIVE FAST FLUENCE FOR STRAIN HARDENING  CSTRNI    24
            C   EXPONENT (NEUTRONS/(M**2))                                  CSTRNI    25
            C   CWKF   = INPUT EFFECTIVE COLD WORK FOR STRENGTH             CSTRNI    26
            C   COEFFICIENT (UNITLESS RATIO OF AREAS)                       CSTRNI    27
            C   CWNF   = INPUT EFFECTIVE COLD WORK FOR STRAIN HARDENING     CSTRNI    28
     30     C   EXPONENT (UNITLESS RATIO OF AREAS)                          CSTRNI    29
            C                                                               CSTRNI    30
            C   THE SUBCODE CKMN IS USED IN THIS SUBROUTINE                 CSTRNI    31
            C                                                               CSTRNI    32
            C   CONVERSION FROM PA  TO  PSI  IS 1.4505E-04 (PSI/PA)         CSTRNI    33
     35     C                                                               CSTRNI    34
            C   CSTRNI WAS CODED BY D. L. HAGRMAN OCTOBER 1977              CSTRNI    35
            C   MODIFIED BY D. L. HAGRMAN OCTOBER 1978                      CSTRNI    36
            C                                                               CSTRNI    37
              RSTRAN = 1.0E-03                                              CSTRNI    38
     40       CALL CKMN (CTEMP,DELOXY,FNCK,FNCN,CWKF,CWNF,RSTRAN,AK,AN,AM)  CSTRNI    39
              T = CTEMP                                                     CSTRNI    40
            C                                                               CSTRNI    41
              IF (STRANT.LT.1.0E-15) STRANT = 1.0E-15                       CSTRNI    42
              STRAN4 = STRANT                                               CSTRNI    43
     45       II = 0                                                        CSTRNI    44
     100      STRANT = ((AN/AM+1.0)*(1.0E-03)*((STREST/AK)**(1/AM))*DELH+(STRAN4 CSTRNI    45
             +)**(AN/AM+1.0))**(AM/(AN+AM))                                 CSTRNI    46
              RSTRAN = (STRANT-STRAN4)/DELH                                 CSTRNI    47
            C   CORRECT AM FOR REVISED RSTRAN IF NECESSARY                  CSTRNI    48
     50       IF (T.LT.1090.) GO TO 140                                     CSTRNI    49
              IF (T.GT.1255.) GO TO 140                                     CSTRNI    50
              IF (RSTRAN.GT.6.34E-03) GO TO 140                             CSTRNI    51
              II = II+1                                                     CSTRNI    52
```

```
                AM = -6.4E-02+T*2.203E-04                                          CSTRNI     53
55              IF (T-1172.5) 110,110,120                                          CSTRNI     54
          110   AM = AM+6.78E-02*ALOG(6.34E-03/RSTRAN)*((T-1090.)/82.5)            CSTRNI     55
                GO TO 130                                                          CSTRNI     56
          120   AM = AM+6.78E-02*ALOG(6.34E-03/RSTRAN)*((1255.-T)/82.5)            CSTRNI     57
          130   AM = AM+EXP(-69.*DELOXY)                                           CSTRNI     58
60              IF (II.LT.10) GO TO 100                                            CSTRNI     59
          C                                                                        CSTRNI     60
          140   CONTINUE                                                           CSTRNI     61
                RETURN                                                           CSTRNI     62
                END                                                              CSTRNI     63
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CSTRNI	3	63

VARIABLES

		SN	TYPE	RELOCATION							
221	AK		REAL		REFS	40	46				
223	AM		REAL		REFS	40	5*46	56	58	59	
					DEFINED	54	56	58			
222	AN		REAL		REFS	40	3*46				
0	CTEMP		REAL	F.P.	REFS	40	41	DEFINED	3		
0	CWKF		REAL	F.P.	REFS	40	DEFINED	3			
0	CWNF		REAL	F.P.	REFS	40	DEFINED	3			
0	DELH		REAL	F.P.	REFS	46	48	DEFINED	3		
0	DELOXY		REAL	F.P.	REFS	40	59	DEFINED	3		
0	FNCK		REAL	F.P.	REFS	40	DEFINED	3			
0	FNCN		REAL	F.P.	REFS	40	DEFINED	3			
226	II		INTEGER		REFS	53	60	DEFINED	45	53	
220	RSTRAN		REAL		REFS	40	52	56	58	DEFINED	39	48
0	STRANT		REAL	F.P.	REFS	43	44	48	DEFINED	3	43	46
225	STRAN4		REAL		REFS	46	48	DEFINED	44			
0	STREST		REAL	F.P.	REFS	46	DEFINED	3				
224	T		REAL		REFS	50	51	54	55	56	58	
					DEFINED	41						

EXTERNALS

	TYPE	ARGS		REFERENCES		
ALOG	REAL	1	LIBRARY	56	58	
CKMN		10		40		
EXP	REAL	1	LIBRARY	59		

STATEMENT LABELS

			DEF LINE	REFERENCES		
35	100		46	60		
0	110	INACTIVE	56	2*55		
123	120		58	55		
135	130		59	57		
147	140		62	50	51	52

STATISTICS
  PROGRAM LENGTH 227B 151
      140000B SCM USED

```
      C                                                                      CSTRNI     64
      C                                                                      CSTRNI     65
            SUBROUTINE CTHCON (CTEMP,TIME,FLUX,COLDW,CCON,CDKDT)             CTHCN       2
      C                                                                      CTHCN       3
      C     CTHCON CALCULATES CLADDING THERMAL CONDUCTIVITY AS A FUNCTION    CTHCN       4
      C     OF TEMPERATURE, TIME, FLUX, AND COLD WORK                        CTHCN       5
      C                                                                      CTHCN       6
      C     CCON   = OUTPUT THERMAL CONDUCTIVITY OF ZIRCALOY-4 (W/M-K)       CTHCN       7
      C     CDKDT  = OUTPUT DERIVATIVE OF THERMAL CONDUCTIVITY WITH          CTHCN       8
      C     RESPECT TO TEMPERATURE                                           CTHCN       9
      C                                                                      CTHCN      10
      C     CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)                CTHCN      11
      C     TIME   = INPUT TIME AT TEMPERATURE AND FLUX (S)                  CTHCN      12
      C     FLUX   = INPUT FAST NEUTRON FLUX ((NEUTRONS/M**2)/S)             CTHCN      13
      C     COLDW  = INPUT COLD WORK (UNITLESS RATIO OF AREAS)               CTHCN      14
      C                                                                      CTHCN      15
      C     THE EQUATION USED IN THIS SUBCODE IS BASED ON DATA FROM          CTHCN      16
      C     W.K. ANDERSON, C.J. BECK, A.R. KEPHART AND J.S. THEILACKER       CTHCN      17
      C     ASTM-STP-314, 1962, PP 62 - 93                                   CTHCN      18
      C     J.N. CHIRIGOS, C. KASS, W.S. KIRK AND G.J. SALVAGGIO             CTHCN      19
      C     FUEL ELEMENT FABRICATION, ACADEMIC PRESS, 1961, PP 19 - 55       CTHCN      20
      C     A.D. FEITH, GEMP-669 (OCT 1966)                                  CTHCN      21
      C     C.F. LUCKS AND H.W. DEEM, BMI-1273 (1958) PP 7-9                 CTHCN      22
      C     A.E. POWERS, KAPL-2146 (1961)                                    CTHCN      23
      C     D.B. SCOTT, WCAP-3269-41 (1965) PP 5-9                           CTHCN      24
      C                                                                      CTHCN      25
      C     THIS VERSION OF CTHCON DOES NOT USE TIME, FLUX OR COLDWORK       CTHCN      26
      C     AS PARAMETERS IN CALCULATION OF ZIRCALOY THERMAL CONDUCTIVITY     CTHCN      27
      C                                                                      CTHCN      28
      C     ONE STANDARD DEVIATION OF THIS FUNCTION = 1.01 W/M-K             CTHCN      29
      C                                                                      CTHCN      30
      C     THIS VERSION OF CTHCON WAS DEVELOPED BY R.L. MILLER, DEC 1975    CTHCN      31
      C     LAST MODIFIED BY E.R. CARLSON IN JUNE 1978.                      CTHCN      32
      C                                                                      CTHCN      33
            COMMON   / LACMDL / MAXIDX, EMFLAG                               CTHCN      34
            DIMENSION EMFLAG(1)                                              CTHCN      35
            DATA     ON       / 2HON    /,                                   CTHCN      36
           +         OFF      / 3HOFF   /,                                   CTHCN      37
           +         LOCIDX   /   7     /                                   CTHCN      38
            IF (EMFLAG(LOCIDX).EQ.ON) GO TO 100                              CTHCN      39
      C                                                                      CTHCN      40
            CCON = 7.511+CTEMP*(2.088E-2+CTEMP*(-1.450E-5+CTEMP*7.668E-09))  CTHCN      41
            CDKDT = 2.088E-2+CTEMP*(-2.9E-5+CTEMP*2.3E-8)                    CTHCN      42
            GO TO 110                                                        CTHCN      43
      C                                                                      CTHCN      44
      100   CALL EMCTON (CTEMP,TIME,FLUX,COLDW,CCON,CDKDT)                   CTHCN      45
      110   CONTINUE                                                         CTHCN      46
            CALL DIALOT (CTEMP,14,FDIALA,FDIALM)                             CTHCN      47
            CCON = (CCON+FDIALA)*FDIALM                                      CTHCN      48
            RETURN                                                           CTHCN      49
            END                                                              CTHCN      50
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CTHCON 3 50

VARIABLES	SN	TYPE		RELOCATION							
0 CCON		REAL		F.P.	REFS	46	49	DEFINED	3	42	49
0 CDKDT		REAL		F.P.	REFS	46	DEFINED	3	43		
0 COLDW		REAL		F.P.	REFS	46	DEFINED	3			
0 CTEMP		REAL		F.P.	REFS	3*42	2*43	46	48	DEFINED	3
1 EMFLAG		REAL	ARRAY	LACMDL	REFS	35	36	40			
100 FDIALA		REAL			REFS	48	49				
101 FDIALM		REAL			REFS	48	49				
0 FLUX		REAL		F.P.	REFS	46	DEFINED	3			
70 LOCIDX		INTEGER			REFS	40	DEFINED	37			
0 MAXIDX		INTEGER		LACMDL	REFS	35					
67 OFF	*	REAL			DEFINED	37					
66 ON		REAL			REFS	40	DEFINED	37			
0 TIME		REAL		F.P.	REFS	46	DEFINED	3			

EXTERNALS	TYPE	ARGS	REFERENCES
DIALOT		4	48
EMCTON		6	46

STATEMENT LABELS	DEF LINE	REFERENCES
27 100	46	40
42 110	47	44

COMMON BLOCKS	LENGTH
LACMDL	2

STATISTICS

PROGRAM LENGTH	102B	66
SCM LABELED COMMON LENGTH	2B	2

140000B SCM USED

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      C                                                                      CTHCN      51
      C                                                                      CTHCN      52
            SUBROUTINE CTHEXP (CTEMP,CATHEX,CDTHEX)                          CTHXP       2
      C                                                                      CTHXP       3
      C     CTHEXP CALCULATES AXIAL AND DIAMETRAL THERMAL EXPANSION OF       CTHXP       4
      C     ZIRCALOY LWR CLADDING.                                           CTHXP       5
      C                                                                      CTHXP       6
      C     CATHEX = OUTPUT AXIAL THERMAL EXPANSION OF ZIRCALOY (M/M)        CTHXP       7
      C     CDTHEX = OUTPUT DIAMETRAL THERMAL EXPANSION OF ZIRCALOY (M/M)    CTHXP       8
      C                                                                      CTHXP       9
      C     CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)                CTHXP      10
      C                                                                      CTHXP      11
      C     DATA FOR THE CORRELATION FROM ROOM TEMPERATURE TO 1273K ARE      CTHXP      12
      C     TAKEN FROM R.L. MEHAN AND F.W. WIESINGER, "MECHANICAL PROPERTIES CTHXP      13
      C     OF ZIRCALOY-2", USAEC REPORT KAPL-2110 (1961),  D.B. SCOTT,      CTHXP      14
      C     "PHYSICAL AND MECHANICAL PROPERTIES OF ZIRCALOY-2 AND -4",       CTHXP      15
      C     WCAP-3269-41 (1965), AND J.J. KEARNS, "THERMAL EXPANSION         CTHXP      16
      C     AND PREFERRED ORIENTATION IN ZIRCALOY", WAPD-TM-472 (1965)       CTHXP      17
      C                                                                      CTHXP      18
      C     ABOVE 1273K THE COEFFICIENT OF THERMAL EXPANSION USED IS THE     CTHXP      19
      C     CONSTANT VALUE 9.7E-06/K RECOMMENDED BY B. LUSTMAN AND F. KERZE, CTHXP      20
      C     "THE METALLURGY OF ZIRCONIUM", MC GRAW-HILL BOOK COMPANY, NEW    CTHXP      21
      C     YORK (1955) PAGE 355.                                            CTHXP      22
      C                                                                      CTHXP      23
      C     BETWEEN 1073 AND 1273K (APPROXIMATELY THE ALPHA-BETA TRANSITION  CTHXP      24
      C     RANGE FOR ZIRCALOY) CTHEXP USES THE LINEAR INTERPOLATION ROUTINE CTHXP      25
      C     POLATE TO FIND THE THERMAL EXPANSION.                            CTHXP      26
      C                                                                      CTHXP      27
      C     CTHEXP WAS ORIGINALLY CODED BY R.L. MILLER IN NOV. 1974.         CTHXP      28
      C     LAST UPDATED BY G.A. REYMANN IN JUNE 1978.                       CTHXP      29
      C                                                                      CTHXP      30
            DIMENSION CATHXD (44)                                            CTHXP      31
            DIMENSION DTHEXP (44)                                            CTHXP      32
      C                                                                      CTHXP      33
            DATA CATHXD/                          0.0          ,   293.15   ,  CTHXP      34
           +   3.52774E-03,      1073.15  ,   3.53000E-03,    1083.15   ,  CTHXP      35
           +   3.50000E-03,      1093.15  ,   3.46000E-03,    1103.15   ,  CTHXP      36
           +   3.41900E-03,      1113.15  ,   3.33000E-03,    1123.15   ,  CTHXP      37
           +   3.21000E-03,      1133.15  ,   3.07000E-03,    1143.15   ,  CTHXP      38
           +   2.80000E-03,      1153.15  ,   2.50000E-03,    1163.15   ,  CTHXP      39
           +   2.00000E-03,      1173.15  ,   1.50000E-03,    1183.15   ,  CTHXP      40
           +   1.30000E-03,      1193.15  ,   1.16000E-03,    1203.15   ,  CTHXP      41
           +   1.13000E-03,      1213.15  ,   1.10000E-03,    1223.15   ,  CTHXP      42
           +   1.11000E-03,      1233.15  ,   1.13000E-03,    1243.15   ,  CTHXP      43
           +   1.20000E-03,      1253.15  ,   1.30000E-03,    1263.15   ,  CTHXP      44
           +   1.40000E-03,      1273.15  /                                 CTHXP      45
      C                                                                      CTHXP      46
            DATA NPCATX, IU / 22,1 /                                         CTHXP      47
      C                                                                      CTHXP      48
            DATA DTHEXP/                                  4.3480E-04,  373.15,  CTHXP      49
           + 5.1395E-03, 1073.15,  5.2200E-03, 1083.15,  5.2500E-03, 1093.15,  CTHXP      50
           + 5.2800E-03, 1103.15,  5.2800E-03, 1113.15,  5.2400E-03, 1123.15,  CTHXP      51
           + 5.2200E-03, 1133.15,  5.1500E-03, 1143.15,  5.0800E-03, 1153.15,  CTHXP      52
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                + 4.9000E-03, 1163.15,  4.7000E-03, 1173.15,  4.4500E-03, 1183.15,  CTHXP   53
55              + 4.1000E-03, 1193.15,  3.5000E-03, 1203.15,  3.1300E-03, 1213.15,  CTHXP   54
                + 2.9700E-03, 1223.15,  2.9200E-03, 1233.15,  2.8700E-03, 1243.15,  CTHXP   55
                + 2.8600E-03, 1253.15,  2.8800E-03, 1263.15,  2.9000E-03, 1273.15/  CTHXP   56
          C                                                                         CTHXP   57
                DATA NPDEXP, IU / 22,1 /                                            CTHXP   58
60        C                                                                         CTHXP   59
                IF (CTEMP.LE.1073.15) GO TO 100                                     CTHXP   60
                IF (CTEMP.GE.1273.15) GO TO 110                                     CTHXP   61
          C                                                                         CTHXP   62
                CATHEX = POLATE(CATHXD,CTEMP,NPCATX,IU)                             CTHXP   63
65              CDTHEX = POLATE(DTHEXP,CTEMP,NPDEXP,IU)                             CTHXP   64
                GO TO 120                                                           CTHXP   65
          C                                                                         CTHXP   66
          100   CATHEX = -2.5060E-05+(CTEMP-273.15)*4.440E-06                       CTHXP   67
                CDTHEX = -2.3730E-04+(CTEMP-273.15)*6.720E-06                       CTHXP   68
70              GO TO 120                                                           CTHXP   69
          C                                                                         CTHXP   70
          110   CATHEX = -8.300E-03+(CTEMP-273.15)*9.70E-06                         CTHXP   71
                CDTHEX = -6.800E-03+(CTEMP-273.15)*9.70E-06                         CTHXP   72
          120   CONTINUE                                                            CTHXP   73
75        C                                                                         CTHXP   74
                CALL DIALOT (CTEMP,17,FDIALA,FDIALM)                                CTHXP   75
                CATHEX = (CATHEX+FDIALA)*FDIALM                                     CTHXP   76
                CALL DIALOT (CTEMP,18,FDIALA,FDIALM)                                CTHXP   77
                CDTHEX = (CDTHEX+FDIALA)*FDIALM                                     CTHXP   78
80              RETURN                                                              CTHXP   79
                END                                                                 CTHXP   80
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CTHEXP	3	80

VARIABLES

		SN	TYPE		RELOCATION								
0	CATHEX		REAL		F.P.	REFS	77	DEFINED	3	64	68	72	77
143	CATHXD		REAL	ARRAY		REFS	32	64	DEFINED	35			
0	CDTHEX		REAL		F.P.	REFS	79	DEFINED	3	65	69	73	79
0	CTEMP		REAL		F.P.	REFS	61	62	64	65	68	69	72
							73	76	78	DEFINED	3		
217	DTHEXP		REAL	ARRAY		REFS	33	65	DEFINED	50			
141	FDIALA		REAL			REFS	76	77	78	79			
142	FDIALM		REAL			REFS	76	77	78	79			
123	IU		INTEGER			REFS	64	65	DEFINED	48	59		
122	NPCATX		INTEGER			REFS	64	DEFINED	48				
124	NPDEXP		INTEGER			REFS	65	DEFINED	59				

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EXTERNALS            TYPE   ARGS       REFERENCES
      DIALOT                  4            76          78
      POLATE    REAL          4            64          65

STATEMENT LABELS                 DEF LINE   REFERENCES
   30  100                          68         61
   44  110                          72         62
   57  120                          74         66          70

STATISTICS
  PROGRAM LENGTH                    273B      187
        140000B SCM USED
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      C                                                                       CTHXP   81
      C                                                                       CTHXP   82
            SUBROUTINE CTXTUR (TENSTY,COSTH2,COSTH4,COSFI2,COSFI4,CT2CF2,CT2CF CTXTR    2
           +4,CT4CF2,CT4CF4)                                                  CTXTR    3
      C                                                                       CTXTR    4
            DIMENSION TENSTY(9,9),COS2TH(9,9),COS4TH(9,9),COS2FI(9,9),        CTXTR    5
           +COS4FI(9,9),C2TC2F(9,9),C2TC4F(9,9),C4TC4F(9,9),AN(9),C2(9),C4(9), CTXTR    6
           +C4TC2F(9,9),B2(9),B4(9),CA(9)                                     CTXTR    7
      C                                                                       CTXTR    8
      C   CTXTUR CALCULATES ORIENTATION PARAMETERS FROM BASAL POLE             CTXTR    9
      C   FIGURE INTENSITY GRIDS                                              CTXTR   10
      C                                                                       CTXTR   11
      C   IN THE FOLLOWING, THETA IS THE ANGLE BETWEEN THE RADIAL             CTXTR   12
      C   OR NORMAL DIRECTION OF THE SAMPLE AND THE BASAL POLE                CTXTR   13
      C   DIRECTION. PHI IS THE ANGLE BETWEEN THE PROJECTION OF THE           CTXTR   14
      C   BASAL POLE DIRECTION ONTO THE PLANE CONTAINING THE AXIAL            CTXTR   15
      C   AND CIRCUMFERENTIAL DIRECTIONS AND THE CIRCUMFERENTIAL              CTXTR   16
      C   DIRECTION. ALPHA IS THE COMPLEMENT OF PHI.                          CTXTR   17
      C                                                                       CTXTR   18
      C   COSTH2 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE SQUARED     CTXTR   19
      C   COSINE OF THETA (UNITLESS)                                          CTXTR   20
      C   COSTH4 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE             CTXTR   21
      C   FOURTH POWER OF THE COSINE OF THETA (UNITLESS)                      CTXTR   22
      C   COSFI2 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE SQUARED     CTXTR   23
      C   COSINE OF ALPHA (UNITLESS RATIO)                                    CTXTR   24
      C   COSFI4 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE             CTXTR   25
      C   FOURTH POWER OF THE COSINE OF ALPHA (UNITLESS)                      CTXTR   26
      C   CT2CF2 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT     CTXTR   27
      C   OF THE SQUARED COSINE OF THETA AND THE SQUARED COSINE               CTXTR   28
      C   OF ALPHA (UNITLESS)                                                 CTXTR   29
      C   CT2CF4 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT     CTXTR   30
      C   OF THE SQUARED COSINE OF THETA AND THE FOURTH POWER OF              CTXTR   31
      C   THE COSINE OF ALPHA (UNITLESS)                                      CTXTR   32
      C   CT4CF2 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT     CTXTR   33
      C   OF THE FOURTH POWER OF THE COSINE OF THETA AND THE                  CTXTR   34
      C   SQUARED COSINE OF ALPHA (UNITLESS)                                  CTXTR   35
      C   CT4CF4 = OUTPUT VOLUME FRACTION WEIGHTED AVERAGE OF THE PRODUCT     CTXTR   36
      C   OF THE FOURTH POWER OF THE COSINE OF THETA AND THE                  CTXTR   37
      C   FOURTH POWER OF THE COSINE OF ALPHA (UNITLESS)                      CTXTR   38
      C                                                                       CTXTR   39
      C   TENSTY = INPUT DIMENSIONED ARRAY OF BASAL POLE INTENSITIES          CTXTR   40
      C   FROM A POLE FIGURE. ELEMENT TENSTY(1,1) IS THE AVERAGE              CTXTR   41
      C   INTENSITY FOR THETA FROM 0 TO 10 DEGREES AND PHI                    CTXTR   42
      C   FROM 0 TO 10 DEGREES. ELEMENT TENSTY(1,2) IS THE                    CTXTR   43
      C   AVERAGE INTENSITY FOR THETA FROM 0 TO 10 DEGREES                    CTXTR   44
      C   AND PHI FROM 10 TO 20 DEGREES. ETC. FOR THE                         CTXTR   45
      C   ENTIRE POLE FIGURE. (ARBITRARY UNITS)                               CTXTR   46
      C                                                                       CTXTR   47
      C   THE CALCULATION OF ORIENTATION PARAMETERS IS BASED ON               CTXTR   48
      C   AN APPROACH SUGGESTED BY THE FOLLOWING REFERENCES                   CTXTR   49
      C   (1) J. J. KEARNS, THERMAL EXPANSION AND PREFERRED ORIENTATION       CTXTR   50
      C   IN ZIRCALOY, WAPD-TM-472 (NOV. 1965)                               CTXTR   51
      C   (2) H. S. ROSENBAUM AND J. E. LEWIS, USE OF POLE FIGURE DATA        CTXTR   52
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      C   TO COMPUTE ELASTICITY COEFFICIENTS OF ZIRCONIUM SHEET,                CTXTR      53
55    C   JOURNAL OF NUCLEAR MATERIALS 67 (1977) PP 273-282                     CTXTR      54
      C                                                                         CTXTR      55
      C   CTXTUR WAS CODED BY D. L. HAGRMAN IN DECEMBER 1977                    CTXTR      56
      C                                                                         CTXTR      57
      C   FIND ANGLES AT GRID CENTERS                                           CTXTR      58
60          DO 100 J=1,9                                                      CTXTR      59
            AN(J) = (2*J-1)*8.726646E-02                                      CTXTR      60
            CA(J) = 1.570796-AN(J)                                            CTXTR      61
      C                                                                         CTXTR      62
            B2(J) = (COS(CA(J)))**2                                           CTXTR      63
65          B4(J) = (B2(J))**2                                                CTXTR      64
            C2(J) = (COS(AN(J)))**2                                           CTXTR      65
      100   C4(J) = (C2(J))**2                                                CTXTR      66
      C                                                                         CTXTR      67
      C   FIND NORMALIZATION CONSTANT                                         CTXTR      68
70      TNSTYN = 0.0                                                          CTXTR      69
            DO 110 J=1,9                                                      CTXTR      70
                DO 110 I=1,9                                                  CTXTR      71
      110       TNSTYN = TNSTYN+TENSTY(I,J)*SIN(AN(I))                        CTXTR      72
      C                                                                         CTXTR      73
75    C   FIND RHO * SINE(THETA)                                              CTXTR      74
            DO 120 J=1,9                                                      CTXTR      75
                DO 120 I=1,9                                                  CTXTR      76
      120       TENSTY(I,J) = TENSTY(I,J)*SIN(AN(I))/TNSTYN                   CTXTR      77
      C                                                                         CTXTR      78
80    C   FIND RHO * SINE(THETA) * ARGUMENT                                   CTXTR      79
            DO 130 J=1,9                                                      CTXTR      80
                DO 130 I=1,9                                                  CTXTR      81
                COS2TH(I,J) = TENSTY(I,J)*C2(I)                               CTXTR      82
                COS4TH(I,J) = TENSTY(I,J)*C4(I)                               CTXTR      83
85              COS2FI(I,J) = TENSTY(I,J)*B2(J)                               CTXTR      84
                COS4FI(I,J) = TENSTY(I,J)*B4(J)                               CTXTR      85
                C2TC2F(I,J) = TENSTY(I,J)*C2(I)*B2(J)                         CTXTR      86
                C2TC4F(I,J) = TENSTY(I,J)*C2(I)*B4(J)                         CTXTR      87
                C4TC2F(I,J) = TENSTY(I,J)*C4(I)*B2(J)                         CTXTR      88
90      130     C4TC4F(I,J) = TENSTY(I,J)*C4(I)*B4(J)                         CTXTR      89
      C                                                                         CTXTR      90
      C   FIND VOLUME WEIGHTED AVERAGES                                       CTXTR      91
          COSTH2 = 0.0                                                        CTXTR      92
          COSTH4 = 0.0                                                        CTXTR      93
95        COSFI2 = 0.0                                                        CTXTR      94
          COSFI4 = 0.0                                                        CTXTR      95
          CT2CF2 = 0.0                                                        CTXTR      96
          CT2CF4 = 0.0                                                        CTXTR      97
          CT4CF2 = 0.0                                                        CTXTR      98
100       CT4CF4 = 0.0                                                        CTXTR      99
              DO 140 J=1,9                                                    CTXTR     100
                  DO 140 I=1,9                                                CTXTR     101
                  COSTH2 = COSTH2+COS2TH(I,J)                                 CTXTR     102
                  COSTH4 = COSTH4+COS4TH(I,J)                                 CTXTR     103
105               COSFI2 = COSFI2+COS2FI(I,J)                                 CTXTR     104
                  COSFI4 = COSFI4+COS4FI(I,J)                                 CTXTR     105
```

```
                        CT2CF2 = CT2CF2+C2TC2F(I,J)                                  CTXTR   106
                        CT2CF4 = CT2CF4+C2TC4F(I,J)                                  CTXTR   107
                        CT4CF2 = CT4CF2+C4TC2F(I,J)                                  CTXTR   108
  110          140      CT4CF4 = CT4CF4+C4TC4F(I,J)                                  CTXTR   109
               C                                                                     CTXTR   110
                     RETURN                                                          CTXTR   111
                     END                                                             CTXTR   112
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 CTXTUR 3 112

VARIABLES SN TYPE RELOCATION

1371	AN	REAL	ARRAY		REFS	6	62	66	73	78	
					DEFINED	61					
1545	B2	REAL	ARRAY		REFS	6	65	85	87	89	
					DEFINED	64					
1556	B4	REAL	ARRAY		REFS	6	86	88	90	DEFINED	65
1567	CA	REAL	ARRAY		REFS	6	64	DEFINED	62		
0	COSFI2	REAL		F.P.	REFS	105	DEFINED	3	95	105	
0	COSFI4	REAL		F.P.	REFS	106	DEFINED	3	96	106	
0	COSTH2	REAL		F.P.	REFS	103	DEFINED	3	93	103	
0	COSTH4	REAL		F.P.	REFS	104	DEFINED	3	94	104	
544	COS2FI	REAL	ARRAY		REFS	6	105	DEFINED	85		
302	COS2TH	REAL	ARRAY		REFS	6	103	DEFINED	83		
665	COS4FI	REAL	ARRAY		REFS	6	106	DEFINED	86		
423	COS4TH	REAL	ARRAY		REFS	6	104	DEFINED	84		
0	CT2CF2	REAL		F.P.	REFS	107	DEFINED	3	97	107	
0	CT2CF4	REAL		F.P.	REFS	108	DEFINED	3	98	108	
0	CT4CF2	REAL		F.P.	REFS	109	DEFINED	3	99	109	
0	CT4CF4	REAL		F.P.	REFS	110	DEFINED	3	100	110	
1402	C2	REAL	ARRAY		REFS	6	67	83	87	88	
					DEFINED	66					
1006	C2TC2F	REAL	ARRAY		REFS	6	107	DEFINED	87		
1127	C2TC4F	REAL	ARRAY		REFS	6	108	DEFINED	88		
1413	C4	REAL	ARRAY		REFS	6	84	89	90	DEFINED	67
1424	C4TC2F	REAL	ARRAY		REFS	6	109	DEFINED	89		
1250	C4TC4F	REAL	ARRAY		REFS	6	110	DEFINED	90		
301	I	INTEGER			REFS	2*73	3*78	3*83	3*84	2*85	2*86
						3*88	3*89	3*90	103	104	105
						108	109	110	DEFINED	72	77
277	J	INTEGER			REFS	2*61	2*62	2*64	2*65	2*66	2*67
						2*78	2*83	2*84	3*65	3*86	3*87
						3*90	103	104	105	106	107
						110	DEFINED	60	71	76	81
0	TENSTY	REAL	ARRAY	F.P.	REFS	6	73	78	83	84	85
						87	88	89	90	DEFINED	3
300	TNSTYN	REAL			REFS	73	78	DEFINED	70	73	

3*87			
107			
102			
73			
3*89			
109			
86			

```
EXTERNALS          TYPE   ARGS       REFERENCES
      COS          REAL      1 LIBRARY     64          66
      SIN          REAL      1 LIBRARY     73          78

STATEMENT LABELS                 DEF LINE   REFERENCES
    0  100                          67          60
    0  110                          73          71          72
    0  120                          78          76          77
    0  130                          90          81          82
    0  140                         110         101         102

LOOPS  LABEL    INDEX      FROM-TO     LENGTH    PROPERTIES
   11  100      J            60 67        32B              EXT REFS
   47  110      J            71 73        17B              EXT REFS  NOT INNER
   51  110      I            72 73        12B              EXT REFS
   70  120      J            76 78        17B              EXT REFS  NOT INNER
   72  120      I            77 78        12B              EXT REFS
  111  130      J            81 90        57B              NOT INNER
  113  130      I            82 90        52B        OPT
  212  140      J           101 110       56B              NOT INNER
  214  140      I           102 110       51B        OPT

STATISTICS
  PROGRAM LENGTH                1623B      915
        140000B SCM USED
```

```
      C                                                                      CTXTR   113
      C                                                                      CTXTR   114
            FUNCTION FCP (FTEMP,FACMOT,FOTMTL)                               FCP       2
      C                                                                      FCP       3
      C     THE FUNCTION FCP IS USED TO CALCULATE THE SPECIFIC HEAT CAPACITY FCP       4
      C     OF UO2, PUO2, AND (U,PU)O2 FUELS AS A FUNCTION OF TEMPERATURE,   FCP       5
      C     FRACTION OF FUEL WHICH IS MOLTEN, PUO2 CONTENT, AND OXYGEN-TO-   FCP       6
      C     METAL RATIO.                                                     FCP       7
      C                                                                      FCP       8
      C     FCP    = OUTPUT FUEL SPECIFIC HEAT CAPACITY (J/(KG*K))           FCP       9
      C                                                                      FCP      10
      C     FTEMP  = INPUT FUEL MESHPOINT TEMPERATURE (K)                    FCP      11
      C     FACMOT = INPUT FUEL FRACTION MOLTEN (UNITLESS)                   FCP      12
      C     FACMOT = 1.0 - FUEL IS ALL MOLTEN                                FCP      13
      C     FACMOT = 0.0 - FUEL IS ALL SOLID                                 FCP      14
      C     FOTMTL = INPUT OXYGEN TO METAL RATIO (UNITLESS)                  FCP      15
      C     FOTMTL = (ATOMS OXYGEN)/(ATOMS METAL) IF NOT KNOWN,              FCP      16
      C     ENTER 2.0                                                        FCP      17
      C     UFCP   = ESTIMATED STANDARD ERROR FOR UO2 (J/(KG*K))             FCP      18
      C     (NOT CURRENTLY RETURNED)                                         FCP      19
      C     PUFCP  = ESTIMATED STANDARD ERROR FOR PUO2 (J/(KG*K))            FCP      20
      C     (NOT CURRENTLY RETURNED)                                         FCP      21
      C                                                                      FCP      22
      C     THE EQUATIONS USED IN THIS FUNCTION ARE BASED ON DATA FROM;      FCP      23
      C     (1) J.KERRISK AND D.CLIFTON, NUCLEAR TECHNOLOGY,16 (1972).       FCP      24
      C     (2) O.KRUGER AND H.SAVAGE, JOURNAL OF CHEMICAL PHYSICS,45        FCP      25
      C     (1966).                                                          FCP      26
      C                                                                      FCP      27
      C     THE EFFECT OF OXYGEN-TO-METAL RATIO WAS ESTIMATED FROM           FCP      28
      C     EQUATIONS PUBLISHED BY;                                          FCP      29
      C     (3) C.AFFORTIT AND J.MARCON, REVUE INTERNATIONALE DES HAUTES     FCP      30
      C     TEMPERATURES ET DES REFRACTAIRES,7 (1970).                       FCP      31
      C     THE SPECIFIC HEAT CAPACITY OF MOLTEN UO2 WAS TAKEN FROM          FCP      32
      C     (4) L.LEIBOWITZ ET AL, JOURNAL OF NUCLEAR MATERIALS,39 (1970)    FCP      33
      C                                                                      FCP      34
      C     FCP WAS ORIGINALLY CODED BY V.F.BASTON IN MARCH 1974.            FCP      35
      C     LAST MODIFIED BY G.A.REYMANN IN MAY 1978.                        FCP      36
      C                                                                      FCP      37
      C                                                                      FCP      38
            COMMON  / PHYPRO / FTMELT,FHEFUS,CTMELT,CHEFUS,CTRANB,           FCP      39
           +                   CTRANE,CTRANZ,FDELTA,BU,COMP,DELOXY           FCP      40
      C                                                                      FCP      41
      C     THE PHYPRO COMMON BLOCK IS SET BY CALL TO THE SUBROUTINE         FCP      42
      C     PHYPRO WHICH IS PART OF THE MATERIALS PROPERTIES PACKAGE         FCP      43
      C     USED AT THE INEL.                                                FCP      44
      C     QUANTITIES CONTAINED IN IT USED IN THIS SUBCODE ARE;             FCP      45
      C     FTMELT = FUEL MELTING TEMPERATURE (K)                            FCP      46
      C     FDELTA = LIQUID-SOLID COEXISTENCE TEMPERATURE (K)                FCP      47
      C     COMP   = PUO2 CONTENT (WT.%)                                     FCP      48
      C     WHEN THE FUNCTION FCP IS USED ALONE, NOT AS PART OF THE          FCP      49
      C     INEL CODE, VALUES FOR FTMELT, FDELTA, AND COMP MUST BE           FCP      50
      C     INPUT.                                                           FCP      51
      C                                                                      FCP      52
```

```
                DATA C1U ,C2U ,C3U ,THU ,EDU / 296.7   , 2.43E-02, 8.745E07,      FCP        53
55             +                               535.285, 1.577E05 /               FCP        54
                DATA C1PU,C2PU,C3PU,THPU,EDPU/ 347.4   , 3.95E-04, 3.860E07,      FCP        55
               +                               571.0   , 1.967E05 /              FCP        56
                CP(C1,C2,C3,TH,ED,T,FOTMTL) = C1*(TH**2)*EXP(TH/T)/((T**2)*((EXP(T FCP        57
               +H/T)-1.)**2))+C2*T+(FOTMTL/2.)*(C3*ED/(8.314*(T**2)))*EXP(-ED/(8.3 FCP        58
60             +14*T))                                                           FCP        59
          C                                                                      FCP        60
                T = FTEMP                                                        FCP        61
                R = FACMOT                                                       FCP        62
                TM = FTMELT                                                      FCP        63
65              FCOMP = COMP/100.0                                               FCP        64
                FCPMOL = 503.0                                                   FCP        65
          C     FCPMOL = SPECIFIC HEAT CAPACITY OF MOLTEN FUEL (J/(KG*K))        FCP        66
          C                                                                      FCP        67
                IF (T.GT.(TM+FDELTA)) GO TO 100                                  FCP        68
70        C                                                                      FCP        69
                FCP = CP(C1U,C2U,C3U,THU,EDU,T,FOTMTL)*(1.0-FCOMP)+CP(C1PU,C2PU,C3 FCP        70
               +PU,THPU,EDPU,T,FOTMTL)*FCOMP                                     FCP        71
          C                                                                      FCP        72
                IF (T.LT.(TM-0.1)) GO TO 110                                     FCP        73
75              FCP = (1.0-R)*FCP+R*FCPMOL                                       FCP        74
                GO TO 110                                                        FCP        75
          C                                                                      FCP        76
          100   FCP = FCPMOL                                                     FCP        77
                CPCP = 2.0                                                       FCP        78
80              PUFCP = 5.6                                                      FCP        79
          C                                                                      FCP        80
          110   CALL DIALOT (FTEMP,1,FDIALA,FDIALM)                              FCP        81
                FCP = (FCP+FDIALA)*FDIALM                                        FCP        82
                RETURN                                                           FCP        83
85              END                                                              FCP        84
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	FCP	3	84

VARIABLES

		SN	TYPE	RELOCATION					
10	BU		REAL	PHYPRO	REFS	40			
3	CHEFUS		REAL	PHYPRO	REFS	40			
11	COMP		REAL	PHYPRO	REFS	40	65		
2	CTMELT		REAL	PHYPRO	REFS	40			
4	CTRANB		REAL	PHYPRO	REFS	40			
5	CTRANE		REAL	PHYPRO	REFS	40			
6	CTRANZ		REAL	PHYPRO	REFS	40			
220	C1PU		REAL		REFS	71	DEFINED	56	
213	C1U		REAL		REFS	71	DEFINED	54	
221	C2PU		REAL		REFS	71	DEFINED	56	

VARIABLES	SN	TYPE	RELOCATION									
214	C2U	REAL		REFS	71	DEFINED	54					
222	C3PU	REAL		REFS	71	DEFINED	56					
215	C3U	REAL		REFS	71	DEFINED	54					
12	DELOXY	REAL	PHYPRO	REFS	40							
224	EDPU	REAL		REFS	2*71	DEFINED	56					
217	EDU	REAL		REFS	2*71	DEFINED	54					
0	FACMCT	REAL	F.P.	REFS	63	DEFINED	3					
242	FCOMP	REAL		REFS	2*71	DEFINED	65					
236	FCP	REAL		REFS	75	83	DEFINED	71	75	78	83	
243	FCPMOL	REAL		REFS	75	78	DEFINED	66				
7	FDELTA	REAL	PHYPRO	REFS	40	69						
246	FDIALA	REAL		REFS	82	83						
247	FDIALM	REAL		REFS	82	83						
1	FHEFUS	REAL	PHYPRO	REFS	40							
0	FOTMTL	REAL	F.P.	REFS	2*71	DEFINED	3					
0	FTEMP	REAL	F.P.	REFS	62	82	DEFINED	3				
0	FTMELT	REAL	PHYPRO	REFS	40	64						
245	PUFCP	* REAL		DEFINED	80							
240	R	REAL		REFS	2*75	DEFINED	63					
237	T	REAL		REFS	69	12*71	74	DEFINED	62			
223	THPU	REAL		REFS	3*71	DEFINED	56					
216	THU	REAL		REFS	3*71	DEFINED	54					
241	TM	REAL		REFS	69	74	DEFINED	64				
244	UFCP	* REAL		DEFINED	79							

EXTERNALS	TYPE	ARGS		REFERENCES
DIALOT		4		82
EXP	REAL	1	LIBRARY	6*71

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES
CP	REAL	7	SF	58	2*71

STATEMENT LABELS		DEF LINE	REFERENCES		
134	100	78	69		
143	110	82	74	76	

COMMON BLOCKS	LENGTH
PHYPRO	11

STATISTICS

PROGRAM LENGTH	250B	168
SCM LABELED COMMON LENGTH	13B	11

140000B SCM USED

```
      C                                                                       FCP        85
      C                                                                       FCP        86
            FUNCTION FCREEP (FTEMP,FSTRES,FDENS,FGRN,FIS,COMP,FOM,TIME,IT,TLAS FCREP       2
           +T,PSTRES)                                                         FCREP      3
      5     C                                                                 FCREP      4
            C   THIS FUNCTION CALCULATES THE TOTAL CREEP FOR UO2 OR (U,PU)O2  FCREP      5
            C   FUEL                                                          FCREP      6
            C                                                                 FCREP      7
            C   FTEMP  = INPUT TEMPERATURE OF THE FUEL RING (K)              FCREP      8
     10     C   FSTRES = INPUT STRESS (PA)                                   FCREP      9
            C   FDENS  = INPUT INITIAL DENSITY OF THE FUEL (KG/M**3)         FCREP     10
            C   FGRN   = INPUT GRAIN SIZE (MICRONS)                         FCREP     11
            C   FIS    = INPUT FISSION RATE ((FISSIONS/M**3)/S)              FCREP     12
            C   COMP   = INPUT PLUTONIA CONTENT (WEIGHT PERCENT)            FCREP     13
     15     C   FOM    = INPUT FUEL OXYGEN TO METAL RATIO                    FCREP     14
            C   TIME   = INPUT TIME TO END OF TIME STEP (S)                 FCREP     15
            C   TLAST  = INPUT TIME TO END OF LAST TIME STEP (S)            FCREP     16
            C   PSTRES = INPUT STRESS ON FUEL DURING PREVIOUS TIME STEP (PA) FCREP     17
            C   L      = INPUT FUEL RING INDEX (1 - 10)                     FCREP     18
     20     C   IT     = INPUT TIME STEP NUMBER                             FCREP     19
            C                                                               FCREP     20
            C   FCREEP = OUTPUT STRAIN RATE ((M/M)/S)                       FCREP     21
            C                                                               FCREP     22
            C   FCREEP WAS DEVELOPED USING THE FOLLOWING DATA               FCREP     23
     25     C   BURTON AND REYNOLDS ACTA METALLURGICA 21 (1973)             FCREP     24
            C   SELTZER  JOURNAL OF NUCLEAR MATERIALS 34 (1970)             FCREP     25
            C   PERRIN BMI - 1899 (1971)                                    FCREP     26
            C   POTEAT AND YUST  ORNL-P-2371                                FCREP     27
            C   WOLFE AND KAUFMAN  WAPD - TM - 587 (1967)                   FCREP     28
     30     C   BOHABOY ET AL  GEAP - 10054 (1969)                          FCREP     29
            C                                                               FCREP     30
            C   FCREEP WAS DEVELOPED AND CODED BY C. S. OLSEN (NOVEMBER 1974). FCREP   31
            C   FCREEP WAS MODIFIED BY R. E. MASON (NOVEMBER 1978).         FCREP     32
            C                                                               FCREP     33
     35           STRANS = 16547416.8/(FGRN**0.5714)                        FCREP     34
                  ROTH = 11.45*COMP/100.+(1.-COMP/100.)*10.97               FCREP     35
                  D = 0.1*FDENS/ROTH                                        FCREP     36
                  IF (IT.LE.1) XTIME = 0.0                                  FCREP     37
                  IF (COMP.GT.0.0) GO TO 110                                FCREP     38
     40           IF (FOM.LT.2.0) FOM = 2.0                                 FCREP     39
                  XLFOM = -ALOG10(FOM-1.99999)/2.5                          FCREP     40
                  QU1 = 9000.0                                              FCREP     41
                  QU2 = 10000.0                                             FCREP     42
                  Q1 = QU1/(EXP(8.0*(1.0-XLFOM)/XLFOM)+1.0)+36294.4         FCREP     43
     45           Q2 = QU2/(EXP(8.0*(1.0-XLFOM)/XLFOM)+1.0)+56431.8         FCREP     44
            C                                                               FCREP     45
                  IF (FSTRES.GT.PSTRES) XTIME = TLAST                       FCREP     46
                  TTIME = TIME-XTIME                                        FCREP     47
                  UPRURY = 2.5*EXP(-1.2E-06*TTIME)+1.0                      FCREP     48
     50           ERUF = 3.72264E-35*FIS*FSTRES*EXP(-2617.0/FTEMP)          FCREP     49
                  IF (COMP.GT.0.0) GO TO 110                                FCREP     50
            C                                                               FCREP     51
            C   LOW STRESS UO2 CREEP CALCULATION                            FCREP     52
```

```
      C                                                                      FCREP      53
55          IF (FSTRES.GT.STRANS) GO TO 100                                  FCREP      54
            UCR[illegible] = (0.391924+1.31E-19*FIS)*FSTRES*EXP(-Q1/FTEMP)/((-87.7+D)* FCREP      55
           +FGRN*[illegible])                                                FCREP      56
      C                                                                      FCREP      57
            FCREEP = U[illegible]URY*(UCREPL+ERUF)                           FCREP      58
60          GO TO 130                                                        FCREP      59
      100   CONTINUE                                                         FCREP      60
      C                                                                      FCREP      61
      C   HIGH STRESS UO2 CALCULATIONS                                       FCREP      62
      C                                                                      FCREP      63
65          UCREPL = (0.391924+1.31E-19*FIS)*STRANS*EXP(-Q1/FTE[illegible])/((-87.7+D)* FCREP      64
           +FGRN*FGRN)                                                       FCREP      65
            UCREPH = 2.0391E-25*(FSTRES**4.5)*EXP(-Q2/FTEMP)/(-90.[illegible]+D)  FCREP      66
      C                                                                      FCREP      67
            FCREEP = UPRURY*(UCREPL+UCREPH+ERUF)                             FCREP      68
70          GO TO 130                                                        FCREP      69
      C                                                                      FCREP      70
      110   CONTINUE                                                         FCREP      71
      C   CALCULATION OF MIXED OXIDE CREEP                                  FCREP      72
      C                                                                      FCREP      73
75    C   LOW STRESS (U,PU)O2 CALCULATIONS                                   FCREP      74
      C                                                                      FCREP      75
            IF (FSTRES.GT.STRANS) GO TO 120                                  FCREP      76
            PCREPL = (0.1007+7.57E-20*FIS)*FSTRES/(FGRN*FGRN)*EXP(-50327.1/FTE FCREP      77
           +MP+33.3*(1.-.01*D)+.014*COMP)                                    FCREP      78
80    C                                                                      FCREP      79
            FCREEP = PCREPL                                                  FCREP      80
      C                                                                      FCREP      81
            GO TO 130                                                        FCREP      82
      120   CONTINUE                                                         FCREP      83
85    C                                                                      FCREP      84
      C   HIGH STRESS (U,PU)O2 CALCULATIONS                                  FCREP      85
      C                                                                      FCREP      86
            PCREPH = 6.4691E-25*(FSTRES**4.5)*EXP(-70458.0/FTEMP+10.3*(1.-0.01 FCREP      87
           +*D)+0.014*COMP)                                                  FCREP      88
90          PCREPL = (0.1007+7.57E-20*FIS)*STRANS/(FGRN*FGRN)*EXP(-50327.1/FTE FCREP      89
           +MP+33.3*(1.-.01*D)+.014*COMP)                                    FCREP      90
      C                                                                      FCREP      91
            FCREEP = PCREPL+PCREPH                                           FCREP      92
      C                                                                      FCREP      93
95    C   THE FOLLOWING CALCULATIONS PROVIDE THE UPPER AND LOWER BOUNDS      FCREP      94
      C   TO THE CREEP RATE EQUATIONS AND ARE NOT AN OUTPUT OF THE           FCREP      95
      C   FUNCTION FCREEP UNLESS THE USER DESIRES TO MODIFY THE              FCREP      96
      C   SUBCODE APPROPRIATELY.                                             FCREP      97
      C                                                                      FCREP      98
100   C   UCREPH IS THE UPPER BOUND                                          FCREP      99
            UCREPH = FCREEP*17.78                                            FCREP     100
      C   UCREPL IS THE LOWER BOUND                                          FCREP     101
            UCREPL = FCREEP*0.0562                                           FCREP     102
      C                                                                      FCREP     103
105   130   CONTINUE                                                         FCREP     104
            CALL DIALOT (FTEMP,7,FDIALA,FDIALM)                              FCREP     105
```

```
      FCREEP = (FCREEP+FDIALA)*FDIALM                          FCREP   106
      RETURN                                                   FCREP   107
      END                                                      FCREP   108
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	FCREEP	3	108

VARIABLES

	SN	TYPE	RELOCATION							
0	COMP	REAL	F.P.	REFS	2*36	39	51	78	88	90
				DEFINED	3					
415	D	REAL		REFS	56	65	67	78	88	90
				DEFINED	37					
426	ERUF	REAL		REFS	59	69	DEFINED	50		
412	FCREEP	REAL		REFS	101	103	107	DEFINED	59	69	81
					93	107				
0	FDENS	REAL	F.P.	REFS	37	DEFINED	3			
433	FDIALA	REAL		REFS	106	107				
434	FDIALM	REAL		REFS	106	107				
0	FGRN	REAL	F.P.	REFS	35	2*56	2*65	2*78	2*90	
				DEFINED	3					
0	FIS	REAL	F.P.	REFS	50	56	65	78	90	
				DEFINED	3					
0	FOM	REAL	F.P.	REFS	40	41	DEFINED	3	40	
0	FSTRES	REAL	F.P.	REFS	47	50	55	56	67	77	78
					88	DEFINED	3			
0	FTEMP	REAL	F.P.	REFS	50	56	65	67	78	88	90
					106	DEFINED	3			
0	IT	INTEGER	F.P.	REFS	38	DEFINED	3			
432	PCREPH	REAL		REFS	93	DEFINED	88			
431	PCREPL	REAL		REFS	81	93	DEFINED	78	90	
0	PSTRES	REAL	F.P.	REFS	47	DEFINED	3			
420	QU1	REAL		REFS	44	DEFINED	42			
421	QU2	REAL		REFS	45	DEFINED	43			
422	Q1	REAL		REFS	56	65	DEFINED	44		
423	Q2	REAL		REFS	67	DEFINED	45			
414	ROTH	REAL		REFS	37	DEFINED	36			
413	STRANS	REAL		REFS	55	65	77	90	DEFINED	35
0	TIME	REAL	F.P.	REFS	48	DEFINED	3			
0	TLAST	REAL	F.P.	REFS	47	DEFINED	3			
424	TTIME	REAL		REFS	49	DEFINED	48			
430	UCREPH	REAL		REFS	69	DEFINED	67	101		
427	UCREPL	REAL		REFS	59	69	DEFINED	56	65	103
425	UPRURY	REAL		REFS	59	69	DEFINED	49		
417	XLFOM	REAL		REFS	2*44	2*45	DEFINED	41		
416	XTIME	REAL		REFS	48	DEFINED	38	47		

EXTERNALS	TYPE	ARGS	REFERENCES							
ALOG10	REAL	1 LIBRARY	41							
DIALOT		4	106							
EXP	REAL	1 LIBRARY	44	45	49	50	56	65	67	78	88
			90							

STATEMENT LABELS		DEF LINE	REFERENCES		
157	100	61	55		
216	110	72	39	51	
245	120	84	77		
316	130	105	60	70	83

STATISTICS
PROGRAM LENGTH 435B 285
140000B SCM USED

```
      C                                                                      FCREP     109
      C                                                                      FCREP     110
            FUNCTION FELMOD (FTEMP,FRADEN,FOTMTL,FCOMP)                      FELMD       2
      C                                                                      FELMD       3
      C   FELMOD CALCULATES FUEL ELASTIC MODULUS AS A FUNCTION OF            FELMD       4
      C   TEMPERATURE, FRACTIONAL DENSITY, OXYGEN TO METAL RATIO AND         FELMD       5
      C   PUO2 CONTENT                                                       FELMD       6
      C                                                                      FELMD       7
      C   FTEMP  = INPUT FUEL TEMPERATURE (K)                              FELMD       8
      C   FRADEN = INPUT FRACTIONAL FUEL DENSITY (RATIO OF ACTUAL          FELMD       9
      C   DENSITY TO THEORETICAL DENSITY)                                  FELMD      10
      C   FOTMTL = INPUT OXYGEN TO METAL RATIO OF FUEL (ATOMS OXYGEN/      FELMD      11
      C   ATOMS METAL)                                                     FELMD      12
      C   FCOMP  = INPUT PUO2 CONTENT OF FUEL (WEIGHT FRACTION)            FELMD      13
      C                                                                      FELMD      14
      C   FELMOD = OUTPUT FUEL YOUNG'S MODULUS (N/M**2)                    FELMD      15
      C   UFELMD = OUTPUT STANDARD ERROR EXPECTED IN FELMOD (N/M**2)       FELMD      16
      C   (NOT CURRENTLY RETURNED)                                         FELMD      17
      C                                                                      FELMD      18
      C   THE EQUATIONS USED IN THIS FUNCTION ARE BASED ON DATA FROM       FELMD      19
      C   (1) A. PADEL AND C. DE NOVION, J. NUCL. MAT. 33 (1969)           FELMD      20
      C   PP 40 - 51                                                       FELMD      21
      C   (2) J. BELLE AND B. LUSTMAN, FUEL ELEMENTS CONFERENCE,           FELMD      22
      C   TID-7546 (1958) PP 480-481                                       FELMD      23
      C   (3) A. R. HALL, J. NUCL. MAT. 37 (1970) PP 314 - 323             FELMD      24
      C                                                                      FELMD      25
      C   FELMOD CODED BY V. F. BASTON MARCH 1974                          FELMD      26
      C   MODIFIED BY C. S. OLSEN IN FEBRUARY AND JULY 1975                FELMD      27
      C   MODIFIED BY D. L. HAGRMAN, E. T. LAATS, AND M. A. MORGAN         FELMD      28
      C   JUNE 1977                                                        FELMD      29
      C                                                                      FELMD      30
            YS = 23.34E10*(1.-(2.752*(1.-FRADEN)))*(1.-1.0915E-04*FTEMP)     FELMD      31
            UFELMD = 6.0E09                                                  FELMD      32
            IF (FTEMP.LT.1.6E030) GO TO 100                                  FELMD      33
            UFELMD = UFELMD+YS*(FTEMP-1.6E03)/6.0526E03                      FELMD      34
            IF (FTEMP.LT.3113.15) GO TO 100                                  FELMD      35
            YS = 1.E6                                                        FELMD      36
            UFELMD = 0.0                                                     FELMD      37
            GO TO 120                                                        FELMD      38
      100   UNSTOC = ABS(FOTMTL-2.0)                                         FELMD      39
            IF (UNSTOC.GT.1.0E-03) GO TO 110                                 FELMD      40
            IF (FCOMP.LT.1.0E-03) GO TO 120                                  FELMD      41
      110   B = 1.34                                                         FELMD      42
            IF (FOTMTL.LT.2.0) B = 1.75                                      FELMD      43
            Y = YS*EXP(-B*UNSTOC)*(1.+0.15*FCOMP)                            FELMD      44
            UFELMD = (UFELMD**2+(Y-YS)**2)**0.5                              FELMD      45
            YS = Y                                                           FELMD      46
      120   FELMOD = YS                                                      FELMD      47
      C                                                                      FELMD      48
            CALL DIALOT (FTEMP,5,FDIALA,FDIALM)                              FELMD      49
            FELMOD = (FELMOD+FDIALA)*FDIALM                                  FELMD      50
            RETURN                                                           FELMD      51
            END                                                              FELMD      52
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE     REFERENCES
    5  FELMOD          3       52

VARIABLES     SN  TYPE          RELOCATION
  155  B          REAL                        REFS     45   DEFINED     43        44
    0  FCOMP      REAL                F.P.    REFS     42        45   DEFINED    3
  157  FDIALA     REAL                        REFS     50        51
  160  FDIALM     REAL                        REFS     50        51
  151  FELMOD     REAL                        REFS     51   DEFINED     48        51
    0  FOTMTL     REAL                F.P.    REFS     40        44   DEFINED    3
    0  FRADEN     REAL                F.P.    REFS     32   DEFINED      3
    0  FTEMP      REAL                F.P.    REFS     32        34        35        36        50
                                              DEFINED   3
  153  UFELMD     REAL                        REFS     35        46   DEFINED     33        35        38        46
  154  UNSTOC     REAL                        REFS     41        45   DEFINED     40
  156  Y          REAL                        REFS     46        47   DEFINED     45
  152  YS         REAL                        REFS     35        45        46        48   DEFINED      32        37
                                              47

EXTERNALS          TYPE    ARGS       REFERENCES
       DIALOT                 4            50
       EXP        REAL        1 LIBRARY    45

INLINE FUNCTIONS   TYPE    ARGS       DEF LINE  REFERENCES
       ABS        REAL        1  INTRIN            40

STATEMENT LABELS                    DEF LINE   REFERENCES
   41  100                             40         34        36
   53  110                             43         41
  104  120                             48         39        42

STATISTICS
  PROGRAM LENGTH                      161B       113
        140000B SCM USED
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```
      C                                                                      FELMD      53
      C                                                                      FELMD      54
            FUNCTION FEMISS (FTEMP)                                          FEMIS       2
      C                                                                      FEMIS       3
      C   FEMISS CALCULATES FUEL EMISSIVITY AS A FUNCTION OF TEMPERATURE.    FEMIS       4
      C                                                                      FEMIS       5
      C   FTEMP  = INPUT FUEL TEMPERATURE (K)                               FEMIS       6
      C   FEMISS = OUTPUT FUEL EMISSIVITY (UNITLESS)                        FEMIS       7
      C                                                                      FEMIS       8
      C   DATA USED TO DEVELOP THE MODEL ARE                                FEMIS       9
      C   HELD AND WILDER, JOURN. AMER. CERAM. SOC.                          FEMIS      10
      C   VOL. 52, (1969)                                                    FEMIS      11
      C   CABANNES, ET AT, C. R. ACAD. SCI., PARIS, SER. B                   FEMIS      12
      C   (1967)                                                             FEMIS      13
      C                                                                      FEMIS      14
      C   FEMISS WAS CODED BY R. E. MASON IN OCTOBER 1978.                   FEMIS      15
      C                                                                      FEMIS      16
            FEMISS = 0.78557+1.5263E-05*FTEMP                                FEMIS      17
      C                                                                      FEMIS      18
      C   THE FOLLOWING CALCULATIONS PROVIDE THE UPPER AND LOWER BOUNDS.     FEMIS      19
      C   THE UPPER AND LOWER BOUNDS ARE NOT AN OUTPUT UNLESS THE USER       FEMIS      20
      C   DESIRES TO MODIFY THE SUBCODE APPROPRIATELY.                       FEMIS      21
      C   FEMISU IS THE UPPER BOUND                                          FEMIS      22
            FEMISU = FEMISS*(1.+0.06796)                                     FEMIS      23
      C   FEMISL IS THE LOWER BOUND                                          FEMIS      24
            FEMISL = FEMISS*(1.-0.06796)                                     FEMIS      25
      100   CONTINUE                                                         FEMIS      26
      C                                                                      FEMIS      27
            CALL DIALOT (FTEMP,3,FDIALA,FDIALM)                              FEMIS      28
            FEMISS = (FEMISS+FDIALA)*FDIALM                                  FEMIS      29
            RETURN                                                           FEMIS      30
            END                                                              FEMIS      31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	FEMISS	3	31

VARIABLES		SN	TYPE	RELOCATION								
47	FDIALA		REAL		REFS	29	30					
50	FDIALM		REAL		REFS	29	30					
46	FEMISL	*	REAL		DEFINED	26						
44	FEMISS		REAL		REFS	24	26	30	DEFINED	18	30	
45	FEMISU	*	REAL		DEFINED	24						
0	FTEMP		REAL	F.P.	REFS	18	29	DEFINED	3			

EXTERNALS	TYPE	ARGS	REFERENCES
DIALOT		4	29

```
STATEMENT LABELS                DEF LINE   REFERENCES
    0  100          INACTIVE       27

STATISTICS
  PROGRAM LENGTH                   518      41
        140000B SCM USED
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```
      C                                                                     FEMIS      32
      C                                                                     FEMIS      33
            FUNCTION FFRACS (FTEMP,FRADEN)                                  FRACS       2
      C                                                                     FRACS       3
      C     FFRACS CALCULATES THE UO2 FRACTURE STRESS AS A FUNCTION OF      FRACS       4
      C     TEMPERATURE AND FRACTIONAL DENSITY.                             FRACS       5
      C                                                                     FRACS       6
      C     FFRACS = OUTPUT UO2 FRACTURE STRENGTH (PA)                      FRACS       7
      C                                                                     FRACS       8
      C     FTEMP  = INPUT FUEL TEMPERATURE (K)                             FRACS       9
      C     FRADEN = INPUT FRACTIONAL FUEL DENSITY (RATIO OF ACTUAL DENSITY TO FRACS      10
      C     THEORETICAL DENSITY).                                           FRACS      11
      C                                                                     FRACS      12
      C     THE CORRELATION FOR UO2 FRACTURE STRENGTH IS BASED ON THE       FRACS      13
      C     FOLLOWING DATA:                                                 FRACS      14
      C     J. T. A. ROBERTS AND Y. UEDA, J. AMER. CER. SOC. 55 117(1972)   FRACS      15
      C     R. F. CANNON ET AL, J. AMER. CERAM. SOC. 54 105(1971).          FRACS      16
      C     J. KATANIC-POPOVIC AND PETROVIC, PHYS. SINTERING 5 95(1973).    FRACS      17
      C     F. KNUDSEN ET AL, J. AMER. CER. SOC. 43 641(1960).              FRACS      18
      C     M. BURDICK AND H. PARKER, J. AMER. CER. SOC. 39 181(1956).      FRACS      19
      C                                                                     FRACS      20
      C     FFRACS WAS PROGRAMMED BY C. S. OLSEN IN SEPTEMBER 1975          FRACS      21
      C     MODIFIED BY G. A. REYMANN IN SEPTEMBER 1977.                    FRACS      22
      C                                                                     FRACS      23
            STRU(T,F,A,B,C,Q) = A*(1.-B*(1.-F))**C*EXP(-Q/(1.987*T))        FRACS      24
            DATA  AI, BI, CI, QI / 1.70E08, 2.62, 0.5, 380. /               FRACS      25
            TI = FTEMP                                                      FRACS      26
            FI = FRADEN                                                     FRACS      27
            IF (TI.GT.1000.0) TI = 1000.                                    FRACS      28
      C                                                                     FRACS      29
            FFRACS = STRU(TI,FI,AI,BI,CI,QI)                                FRACS      30
      C                                                                     FRACS      31
            CALL DIALOT (FTEMP,8,FDIALA,FDIALM)                             FRACS      32
            FFRACS = (FFRACS+FDIALA)*FDIALM                                 FRACS      33
            RETURN                                                          FRACS      34
            END                                                             FRACS      35
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	FFRACS	3	35

VARIABLES	SN	TYPE	RELOCATION					
57	AI	REAL		REFS	31	DEFINED	26	
60	BI	REAL		REFS	31	DEFINED	26	
61	CI	REAL		REFS	31	DEFINED	26	
72	FDIALA	REAL		REFS	33		34	
73	FDIALM	REAL		REFS	33		34	
67	FFRACS	REAL		REFS	34	DEFINED	31	34

```
VARIABLES     SN  TYPE          RELOCATION
     0  FRADEN     REAL              F.P.        REFS        28    DEFINED         3
     0  FTEMP      REAL              F.P.        REFS        27         33    DEFINED         3
    71  FI         REAL                          REFS        31    DEFINED        28
    62  QI         REAL                          REFS        31    DEFINED        26
    70  TI         REAL                          REFS        29         31    DEFINED        27        29

EXTERNALS           TYPE    ARGS       REFERENCES
       DIALOT                  4              33
       EXP         REAL        1 LIBRARY      31

INLINE FUNCTIONS    TYPE    ARGS         DEF LINE  REFERENCES
       STRU        REAL       6    SF        25        31

STATISTICS
  PROGRAM LENGTH                  74B       60
        140000B SCM USED
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      C                                                                       FRACS      36
      C                                                                       FRACS      37
            SUBROUTINE FGASRL (FTEMP,FDENS,BU,FGRN,COMP,FMGPR,IT,TIME,CC2,CC1, FGSRL       2
           +GBBG,FMGR,GBGOUT,FMGROT)                                          FGSRL       3
      5     C                                                                 FGSRL       4
            C   FGASRL CALCULATES THE FISSION GAS RELEASE AS A FUNCTION        FGSRL       5
            C   OF TEMPERATURE, FUEL POROSITY,TIME, GRAIN SIZE, AND BURNUP.   FGSRL       6
            C                                                                 FGSRL       7
            C   FTEMP  = INPUT FUEL RING AVERAGE TEMPERATURE (K)              FGSRL       8
     10     C   FDENS  = INPUT FUEL DENSITY (KG/M**3)                        FGSRL       9
            C   BU     = INPUT FUEL BURNUP (MW-S/KG-U)                       FGSRL      10
            C   FGRN   = INPUT FUEL GRAIN SIZE (MICRONS)                     FGSRL      11
            C   COMP   = INPUT PLUTONIA CONTENT (WEIGHT PERCENT)             FGSRL      12
            C   FMGPR  = INPUT FISSION GAS PRODUCED IN THE L FUEL RING (MOLES) FGSRL     13
     15     C   IT     = INPUT POWER STEP NUMBER                             FGSRL      14
            C   TIME   = INPUT TIME STEP LENGTH (S)                          FGSRL      15
            C   CC2    = INPUT CONCENTRATION OF GRAIN TRAPPED FISSION GAS     FGSRL      16
            C   PER RING (MOLES/RING)                                        FGSRL      17
            C   GBBG   = INPUT CONCENTRATION OF GRAIN BOUNDARY TRAPPED FISSION FGSRL     18
     20     C   GAS PER RING (MOLES/RING)                                    FGSRL      19
            C   FMGR   = INPUT CUMULATIVE FISSION  GAS RELEASED PER FUEL     FGSRL      20
            C   RING (MOLES)                                                 FGSRL      21
            C                                                                 FGSRL      22
            C   CC1    = OUTPUT CONCENTRATION OF GRAIN TRAPPED FISSION GAS    FGSRL      23
     25     C   PER RING (MOLES/RING)                                        FGSRL      24
            C   GBGOUT = OUTPUT CONCENTRATION OF GRAIN BOUNDARY TRAPPED FISSION FGSRL     25
            C   GAS PER RING (MOLES/RING)                                    FGSRL      26
            C   FMGROT = OUTPUT CUMULATIVE FISSION GAS RELEASED PER FUEL     FGSRL      27
            C   RING (MOLES)                                                 FGSRL      28
     30     C                                                                 FGSRL      29
            C   THE FGASRL CORRELATION WAS BASED ON THE FOLLOWING DATA        FGSRL      30
            C   M.J.F. NOTLEY AND J.R. MACEWAN, AECL - 2230                   FGSRL      31
            C   M.J.F. NOTLEY, ET AL., AECL - 1676                            FGSRL      32
            C   W.R. SMALLEY, WCAP - 3385 - 56                                FGSRL      33
     35     C   C.E. BEYER AND C.R.HANN BNWL - 1876                           FGSRL      34
            C                                                                 FGSRL      35
            C   AN APPROXIMATION FOR THE ERROR FUNCTION WAS USED TO EVALUATE  FGSRL      36
            C   THE CONSTANTS IN THE FOLLOWING EQUATIONS                      FGSRL      37
            C   THE APPROXIMATION WAS TAKEN FROM                              FGSRL      38
     40     C   C.H.HASTINGS,JR., APPROXIMATIONS FOR DIGITAL COMPUTERS        FGSRL      39
            C   PRINCETON UNIVERSITY PRESS 1955                               FGSRL      40
            C                                                                 FGSRL      41
            C   THE CORRELATION USED TO CALCULATE FISSION GAS RELEASE IS THAT FGSRL      42
            C   DEVELOPED BY J. WEISMAN AND P. E. MACDONALD, ANS TRANSACTIONS, FGSRL      43
     45     C   VOL. 12, NUMBER 2 (NOVEMBER 1969).                            FGSRL      44
            C                                                                 FGSRL      45
            C   FGASRL WAS CODED BY G. A. REYMANN (JULY 1976).                FGSRL      46
            C   FGASRL WAS MODIFIED BY R. E. MASON (NOVEMBER 1978).           FGSRL      47
            C                                                                 FGSRL      48
     50       ERF(X) = 1.0-0.348024*1.0/(1.0+0.47047*X)+0.0958798*(1.0/(1.0+0.47 FGSRL     49
           +047*X))**2.0-0.7478556*(1.0/(1.0+0.47047*X))**3.0+0.000025        FGSRL      50
            C                                                                 FGSRL      51
            C   - PROGRAM -                                                   FGSRL      52
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      C                                                                 FGSRL      53
55          B = BU                                                      FGSRL      54
            T = TIME                                                    FGSRL      55
            IF (IT.EQ.1) FMAA = 0.0                                     FGSRL      56
            IF (IT.EQ.1) FMGR = 0.0                                     FGSRL      57
            IF (IT.EQ.1) CC2 = 0.0                                      FGSRL      58
60          IF (BU.LE.0.0) B = 1.0                                      FGSRL      59
      C                                                                 FGSRL      60
      C   CALCULATION OF THE HIGH BURNUP FACTOR                        FGSRL      61
      C                                                                 FGSRL      62
            BUNKEL = 1.25E14/((B/86.4)**3.0)                            FGSRL      63
65          IF (BUNKEL.GE.400.0) BUNKEL = 400.0                         FGSRL      64
      C                                                                 FGSRL      65
      C   CALCULATION OF FUEL GRAIN RELEASE                            FGSRL      66
      C                                                                 FGSRL      67
            AK1 = 9.0E07*(EXP(-45289.86/FTEMP))+0.0005                  FGSRL      68
70          AK2 = 0.00005*AK1*(1.0-1.0/(EXP((FTEMP-1900.0)/40.0)+1.0)+EXP(-BUN FGSRL      69
           +KEL))                                                       FGSRL      70
            IF (TIME.LE.0.0) T = 1.0                                    FGSRL      71
            IF (AK2*TIME.LE.1.0E-10) AK2 = 1.0E-10/T                    FGSRL      72
            F = (1.0-(1.0-AK1)*((1.0-EXP(-AK2*T))/(AK2*T)))             FGSRL      73
75    C                                                                 FGSRL      74
            IF (F.GT.1.0) F = 1.0                                       FGSRL      75
            IF (F.LE.0.0) F = 0.0                                       FGSRL      76
      C                                                                 FGSRL      77
            FMA = F*FMGPR+CC2*(1.0-EXP(-AK2*T))                         FGSRL      78
80    C                                                                 FGSRL      79
      C   THE FOLLOWING CALCULATIONS PROVIDE UPPER AND LOWER BOUNDS     FGSRL      80
      C   TO THE FGASRL EQUATION AND ARE NOT AN OUTPUT OF THE SUBCODE   FGSRL      81
      C   UNLESS THE USER DESIRES TO MODIFY THE SUBCODE APPROPRIATELY.  FGSRL      82
      C   IF THE UPPER OR LOWER BOUND IS USED IT SHOULD REPLACE FMA IN THE FGSRL      83
85    C   SUBCODE.                                                     FGSRL      84
      C                                                                 FGSRL      85
      C   UFGASH IS THE UPPER BOUND                                    FGSRL      86
            UFGASH = 1.6*FMA                                            FGSRL      87
            IF (UFGASH.GE.FMGPR+CC2) UFGASH = FMGPR+CC2                 FGSRL      88
90    C   UFGASL IS THE LOWER BOUND                                    FGSRL      89
            UFGASL = 0.4*FMA                                            FGSRL      90
      C                                                                 FGSRL      91
            IF (GBBG.LE.0.0) GBBG = FMA*1.0E-06                         FGSRL      92
            GBBG = GBBG+FMA                                             FGSRL      93
95    C                                                                 FGSRL      94
      C   FISSION GAS WHICH IS NOT RELEASED FROM THE GRAIN BOUNDARY IS  FGSRL      95
      C   LABELED GBBG(L)                                              FGSRL      96
      C                                                                 FGSRL      97
      C   CALCULATION OF GRAIN BOUNDARY GAS RELEASE                    FGSRL      98
100   C                                                                 FGSRL      99
            ROTH = 11.45*COMP/100.+(1.-COMP/100.)*10.97                 FGSRL     100
            FP = 1.0-0.001*FDENS/ROTH                                   FGSRL     101
            P = 1.0/(1.0+(1.0/FP-1.0)*1.0E05/(FGRN**3.0))               FGSRL     102
            FBR = (1.0-ERF(P))+EXP(-BUNKEL)                             FGSRL     103
105         IF (FTEMP.GT.2100.) FBR = 1.0-(1.0-FBR)/(FTEMP-2099.)       FGSRL     104
            IF (FBR.LE.0.0) FBR = 0.0                                   FGSRL     105
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                      IF (FBR.GT.1.0) FBR = 1.0                                  FGSRL  106
                C                                                                FGSRL  107
                      FMAA = FBR*GBBG                                            FGSRL  108
  110                 CC1 = CC2+FMGPR-FMA                                        FGSRL  109
                      GBGOUT = GBBG-FMAA                                         FGSRL  110
                      FMGROT = FMGR+FMAA                                         FGSRL  111
                C                                                                FGSRL  112
                      CALL DIALOT (FTEMP,12,FDIALA,FDIALM)                       FGSRL  113
  115                 FMGROT = (FMGROT+FDIALA)*FDIALM                            FGSRL  114
                      RETURN                                                     FGSRL  115
                      END                                                        FGSRL  116
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FGASRL	3	116

VARIABLES

	SN	TYPE	RELOCATION								
331	AK1	REAL		REFS	70	74	DEFINED	69			
332	AK2	REAL		REFS	73	2*74	79	DEFINED	70	73	
325	B	REAL		REFS	64	DEFINED	55	60			
0	BU	REAL	F.P.	REFS	55	60	DEFINED	3			
330	BUNKEL	REAL		REFS	65	70	104	DEFINED	64	65	
0	CC1	REAL	F.P.	DEFINED	3	110					
0	CC2	REAL	F.P.	REFS	79	2*89	110	DEFINED	3	59	
0	COMP	REAL	F.P.	REFS	2*101	DEFINED	3				
333	F	REAL		REFS	76	77	79	DEFINED	74	76	77
342	FBR	REAL		REFS	105	106	107	109	DEFINED	104	105
				106	107						
0	FDENS	REAL	F.P.	REFS	102	DEFINED	3				
343	FDIALA	REAL		REFS	114	115					
344	FDIALM	REAL		REFS	114	115					
0	FGRN	REAL	F.P.	REFS	103	DEFINED	3				
334	FMA	REAL		REFS	88	91	93	94	110		
				DEFINED	79						
327	FMAA	REAL		REFS	111	112	DEFINED	57	109		
0	FMGPR	REAL	F.P.	REFS	79	2*89	110	DEFINED	3		
0	FMGR	REAL	F.P.	REFS	112	DEFINED	3	58			
0	FMGROT	REAL	F.P.	REFS	115	DEFINED	3	112	115		
340	FP	REAL		REFS	103	DEFINED	102				
0	FTEMP	REAL	F.P.	REFS	69	70	2*105	114	DEFINED	3	
0	GBBG	REAL	F.P.	REFS	93	94	109	111	DEFINED	3	93
				94							
0	GBGOUT	REAL	F.P.	DEFINED	3	111					
0	IT	INTEGER	F.P.	REFS	57	58	59	DEFINED	3		
341	P	REAL		REFS	3*104	DEFINED	103				
337	ROTH	REAL		REFS	102	DEFINED	101				
326	T	REAL		REFS	73	2*74	79	DEFINED	56	72	
0	TIME	REAL	F.P.	REFS	56	72	73	DEFINED	3		

```
VARIABLES     SN  TYPE          RELOCATION
  335  UFGASH     REAL                        REFS       89    DEFINED      88       89
  336  UFGASL   * REAL                      DEFINED      91

EXTERNALS          TYPE   ARGS       REFERENCES
      DIALOT                4          114
      EXP          REAL     1 LIBRARY    69      2*70      74       79      104

INLINE FUNCTIONS   TYPE   ARGS        DEF LINE  REFERENCES
      ERF          REAL     1    SF       50      104

STATISTICS
  PROGRAM LENGTH              345B     229
        140000B SCM USED
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```
      C                                                                      FGSRL     117
      C                                                                      FGSRL     118
            SUBROUTINE FHOTPS (COMP,FOM,HSTRES,TIME,FTEMP,TLAST,SINPOR,FVC)  FHTPS       2
      C                                                                      FHTPS       3
      C     FHOTPS RETURNS THE FRACTIONAL VOLUME CHANGE FOR UO2 AND          FHTPS       4
      C     MIXED OXIDES DUE TO PRESSURE ON THE FUEL                         FHTPS       5
      C                                                                      FHTPS       6
      C     COMP   = INPUT PLUTONIA CONTENT (WEIGHT PERCENT)                 FHTPS       7
      C     FOM    = INPUT FUEL OXYGEN TO METAL RATIO                        FHTPS       8
      C     HSTRES = INPUT HYDROSTATIC STRESS ON THE FUEL PELLET (PA)        FHTPS       9
      C     TIME   = INPUT TIME TO END OF TIME STEP (S)                      FHTPS      10
      C     TLAST  = INPUT TIME TO END OF LAST TIME STEP (S)                 FHTPS      11
      C     FTEMP  = INPUT TEMPERATURE OF THE FUEL RING (K)                  FHTPS      12
      C     SINPOR = INPUT FRACTIONAL POROSITY WHICH CAN BE SINTERED         FHTPS      13
      C                                                                      FHTPS      14
      C     FVC    = OUTPUT FRACTIONAL VOLUME CHANGE                         FHTPS      15
      C                                                                      FHTPS      16
      C     THE UO2 PRESSURE SINTERING CORRELATION IS BASED ON THE FOLLOWING FHTPS      17
      C     DATA                                                             FHTPS      18
      C     WOLFE AND KAUFMAN, WAPD-TM-587(1967)                             FHTPS      19
      C     WARREN AND CHAKLADER, METALLURGICAL TRANSACTIONS 1(1970)         FHTPS      20
      C                                                                      FHTPS      21
      C     THE (U,PU)O2 PRESSURE SINTERING CORRELATION IS BASED ON THE      FHTPS      22
      C     FOLLOWING DATA                                                   FHTPS      23
      C     VOGLEWEDE, ANL-RDP-22                                            FHTPS      24
      C                                                                      FHTPS      25
      C     FHOTPS WAS DEVELOPED AND PROGRAMMED BY R. E. MASON - AUGUST 1977 FHTPS      26
      C                                                                      FHTPS      27
      C     IF HSTRES IS NOT DETERMINED IN THE CODE USING THIS SUBCODE       FHTPS      28
      C     THEN SET HSTRES EQUAL TO A DEFAULT VALUE OF 1.0E+06              FHTPS      29
      C                                                                      FHTPS      30
      C     - PROGRAM -                                                      FHTPS      31
      C                                                                      FHTPS      32
            DIMENSION C(7)                                                   FHTPS      33
            Y(V,VT) = ((VT/(V-VT))**2.4)/V                                   FHTPS      34
            ROTH = 11.45*COMP/100.+(1.-COMP/100.)*10.97                      FHTPS      35
      C                                                                      FHTPS      36
            IF (HSTRES.EQ.0.0) GO TO 190                                     FHTPS      37
            B = 30.0                                                         FHTPS      38
            M = 0.0                                                          FHTPS      39
      C                                                                      FHTPS      40
            IF (COMP.GT.0.0) GO TO 100                                       FHTPS      41
            IF (FOM.LT.2.0) FOM = 2.0                                        FHTPS      42
            XX = ABS(ALOG10(FOM-1.9999)/2.5)                                 FHTPS      43
            Q = 40431.8/(EXP(8*(1.-XX)/XX)+1.)+26000.                        FHTPS      44
            GO TO 110                                                        FHTPS      45
      100   CONTINUE                                                         FHTPS      46
            B = 22.0                                                         FHTPS      47
            Q = 9.0E04                                                       FHTPS      48
      110   CONTINUE                                                         FHTPS      49
            H = 4.0/3.0                                                      FHTPS      50
            TCHG = TIME-TLAST                                                FHTPS      51
            Z = B*TCHG*(HSTRES**H)*(EXP(-Q/FTEMP))                           FHTPS      52
```

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      C                                                                 FHTPS      53
55          IF (Z.EQ.0.0) GO TO 190                                     FHTPS      54
            VT = (0.1097*COMP+(1.0-0.01*COMP)*11.46)/125.72             FHTPS      55
            IF (SINPOR.LE.0.0) GO TO 190                                FHTPS      56
            V1 = 1.0/(ROTH*(1.0-SINPOR))                                FHTPS      57
            VF = V1                                                     FHTPS      58
60          V2 = VT+1.0E-07                                             FHTPS      59
            A = ABS(VF-V2)                                              FHTPS      60
            C(1) = Y(VF,VT)                                             FHTPS      61
            C(7) = Y(V2,VT)                                             FHTPS      62
            V = VF                                                      FHTPS      63
65    C                                                                 FHTPS      64
            DO 120 I=2,6                                                FHTPS      65
            V = V-A/6                                                   FHTPS      66
            IF (V.LT.VT) GO TO 190                                      FHTPS      67
            C(I) = Y(V,VT)                                              FHTPS      68
70    120   CONTINUE                                                    FHTPS      69
      C                                                                 FHTPS      70
            SIM = A*(C(1)+4.0*(C(2)+C(4)+C(6))+2.0*(C(3)+C(5))+C(7))/18.0 FHTPS    71
            IF (SIM/Z.LE.1.0) GO TO 210                                 FHTPS      72
            V2 = -(ABS(V1-VT))*0.5+V1                                   FHTPS      73
75          A = ABS(VF-V2)                                              FHTPS      74
            C(1) = Y(VF,VT)                                             FHTPS      75
            C(7) = Y(V2,VT)                                             FHTPS      76
            V = VF                                                      FHTPS      77
      C                                                                 FHTPS      78
80          DO 130 I=2,6                                                FHTPS      79
            V = V-A/6                                                   FHTPS      80
            C(I) = Y(V,VT)                                              FHTPS      81
      130   CONTINUE                                                    FHTPS      82
      C                                                                 FHTPS      83
85          SIM = A*(C(1)+4.0*(C(2)+C(4)+C(6))+2.0*(C(3)+C(5))+C(7))/18.0 FHTPS    84
            IF (SIM/Z.GE.0.990.AND.SIM/Z.LE.1.011) GO TO 200            FHTPS      85
            IF (SIM/Z.LT.1.0) GO TO 140                                 FHTPS      86
      C                                                                 FHTPS      87
            V3 = V2                                                     FHTPS      88
90          V2 = ((ABS(V1-V2))/2.0)+V2                                  FHTPS      89
            GO TO 150                                                   FHTPS      90
      C                                                                 FHTPS      91
      140   CONTINUE                                                    FHTPS      92
            V1 = V2                                                     FHTPS      93
95          V2 = ((ABS(V2-VT))*0.5)+VT                                  FHTPS      94
            V3 = VT                                                     FHTPS      95
      C                                                                 FHTPS      96
      150   CONTINUE                                                    FHTPS      97
            IF (M.GE.15) GO TO 200                                      FHTPS      98
100         M = M+1                                                     FHTPS      99
            A = ABS(VF-V2)                                              FHTPS     100
            C(1) = Y(VF,VT)                                             FHTPS     101
            C(7) = Y(V2,VT)                                             FHTPS     102
            V = VF                                                      FHTPS     103
105             DO 160 I=2,6                                            FHTPS     104
                V = V-A/6                                               FHTPS     105
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```
                      IF (V-VT.LE.0.0) GO TO 200                                  FHTPS    106
                      C(I) = Y(V,VT)                                              FHTPS    107
                C                                                                 FHTPS    108
110             160       CONTINUE                                                FHTPS    109
                      SIM = A*(C(1)+4.0*(C(2)+C(4)+C(6))+2.0*(C(3)+C(5))+C(7))/18.0  FHTPS  110
                      IF (SIM/Z.GE.0.990.AND.SIM/Z.LE.1.011) GO TO 200            FHTPS    111
                      IF (SIM/Z.GT.1.0) GO TO 170                                 FHTPS    112
                      IF (SIM/Z.LT.1.0) GO TO 180                                 FHTPS    113
115             C                                                                 FHTPS    114
                170   CONTINUE                                                    FHTPS    115
                      V3 = V2                                                     FHTPS    116
                      V2 = ((ABS(V1-V2))/2.0)+V2                                  FHTPS    117
                      GO TO 150                                                   FHTPS    118
120             180   CONTINUE                                                    FHTPS    119
                      V1 = V2                                                     FHTPS    120
                      V2 = ((ABS(V2-V3))/2.0)+V3                                  FHTPS    121
                      GO TO 150                                                   FHTPS    122
                C                                                                 FHTPS    123
125             190   CONTINUE                                                    FHTPS    124
                      FVC = 0.0                                                   FHTPS    125
                      GO TO 220                                                   FHTPS    126
                200   CONTINUE                                                    FHTPS    127
                      FVC = (V2-VF)/VF                                            FHTPS    128
130                   GO TO 220                                                   FHTPS    129
                210   CONTINUE                                                    FHTPS    130
                      FVC = (VT-V1)/V1                                            FHTPS    131
                220   CONTINUE                                                    FHTPS    132
                      IF (ABS(FVC).GE.SINPOR) FVC = -SINPOR                       FHTPS    133
135             C                                                                 FHTPS    134
                      RETURN                                                      FHTPS    135
                      END                                                         FHTPS    136
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	FHOTPS	3	136

VARIABLES

		SN	TYPE		RELOCATION								
564	A		REAL			REFS	67	72	81	85	106	111	
						DEFINED	61	75	101				
551	B		REAL			REFS	53	DEFINED	39	48			
571	C		REAL	ARRAY		REFS	34	7*72	7*85	7*111	DEFINED	62	63
							69	76	77	82	102	103	108
0	COMP		REAL		F.P.	REFS	2*36	42	2*56	DEFINED	3		
0	FOM		REAL		F.P.	REFS	43	44	DEFINED	3	43		
0	FTEMP		REAL		F.P.	REFS	53	DEFINED	3				
0	FVC		REAL		F.P.	REFS	134	DEFINED	3	126	129	132	134
555	H		REAL			REFS	53	DEFINED	51				
0	HSTRES		REAL		F.P.	REFS	38	53	DEFINED	3			

VARIABLES	SN	TYPE	RELOCATION								
566	I	INTEGER		REFS	69	82	108	DEFINED	66	80	105
552	M	INTEGER		REFS	99	100	DEFINED	40	100		
554	Q	REAL		REFS	53	DEFINED	45	49			
550	ROTH	REAL		REFS	58	DEFINED	36				
567	SIM	REAL		REFS	73	2*86	87	2*112	113	114	
				DEFINED	72	85	111				
0	SINPOR	REAL	F.P.	REFS	57	58	2*134	DEFINED	3		
556	TCHG	REAL		REFS	53	DEFINED	52				
0	TIME	REAL	F.P.	REFS	52	DEFINED	3				
0	TLAST	REAL	F.P.	REFS	52	DEFINED	3				
565	V	REAL		REFS	67	68	2*69	81	2*82	106	107
				2*108	DEFINED	64	67	78	81	104	106
562	VF	REAL		REFS	61	2*62	64	75	2*76	78	101
				2*102	104	2*129	DEFINED	59			
560	VT	REAL		REFS	60	2*62	2*63	68	2*69	74	2*76
				2*77	2*82	2*95	96	2*102	2*103	107	2*108
				132	DEFINED	56					
561	V1	REAL		REFS	59	2*74	90	118	2*132		
				DEFINED	58	94	121				
563	V2	REAL		REFS	61	2*63	75	2*77	89	2*90	94
				95	101	2*103	117	2*118	121	122	129
				DEFINED	60	74	90	95	118	122	
570	V3	REAL		REFS	2*122	DEFINED	89	96	117		
553	XX	REAL		REFS	2*45	DEFINED	44				
557	Z	REAL		REFS	55	73	2*86	87	2*112	113	114
				DEFINED	53						

EXTERNALS	TYPE	ARGS		REFERENCES
ALOG10	REAL	1	LIBRARY	44
EXP	REAL	1	LIBRARY	45 53

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES							
ABS	REAL	1	INTRIN		44	61	74	75	90	95	101	118
					122	134						
Y	REAL	2	SF	35	62	63	69	76	77	82	102	103
					108							

STATEMENT LABELS		DEF LINE	REFERENCES			
52	100	47	42			
57	110	50	46			
0	120	70	66			
0	130	83	82			
316	140	93	87			
330	150	98	91	119	123	
0	160	110	105			
434	170	116	113			
445	180	120	114			
456	190	125	38	55	57	68
462	200	128	83	99	107	112
467	210	131	73			
473	220	133	127	130		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
152	120	I	66 70	20B		EXT REFS	EXITS
244	130	I	80 83	15B		EXT REFS	
363	160	I	105 110	20B		EXT REFS	EXITS

STATISTICS
PROGRAM LENGTH 600B 384
140000B SCM USED

```
      C                                                                      FHTPS    137
      C                                                                      FHTPS    138
            FUNCTION FPOIR (FTEMP,COMP)                                      FPOIR      2
      C                                                                      FPOIR      3
      C     FPOIR RETURNS POISSON'S RATIO FOR UO2 AND MIXED OXIDES           FPOIR      4
      C                                                                      FPOIR      5
      C     FPOIR = OUTPUT POISSON'S RATIO FOR UO2 (UNITLESS)                FPOIR      6
      C                                                                      FPOIR      7
      C     FTEMP = INPUT FUEL TEMPERATURE (K)                               FPOIR      8
      C     COMP  = INPUT PLUTONIA CONTENT (WEIGHT PERCENT)                  FPOIR      9
      C                                                                      FPOIR     10
      C     POISSON'S  RATIO FOR UO2 USED IN THIS ROUTINE WAS EVALUATED      FPOIR     11
      C     FROM THE MEAN OF THE DATA PRESENTED BY WACHTMAN ET AL., J. NUC.   FPOIR     12
      C     MAT. 16 (1965) PP 39-41                                          FPOIR     13
      C     POISSON'S RATIO FOR MIXED OXIDES IS THE VALUE DETERMINED BY NUTT FPOIR     14
      C     AND ALLEN, J. AMER. CERAM. SOC., 53 (1970) P 205                 FPOIR     15
      C                                                                      FPOIR     16
      C     FPOIR WAS ORIGINALLY CODED BY V.F. BASTON IN MARCH 1974.         FPOIR     17
      C     FPOIR WAS MODIFIED BY C.S. OLSEN IN FEB 1975.                    FPOIR     18
      C                                                                      FPOIR     19
            COMMON   / LACMDL / MAXIDX, EMFLAG                               FPOIR     20
            DIMENSION EMFLAG(1)                                              FPOIR     21
            DATA     ON       / 2HON    /,                                  FPOIR     22
           +           OFF      / 3HOFF   /,                                  FPOIR     23
           +            LOCIDX   /   1I    /                                FPOIR     24
      C                                                                      FPOIR     25
            IF (EMFLAG(LOCIDX).EQ.ON) GO TO 100                              FPOIR     26
      C                                                                      FPOIR     27
            T = FTEMP                                                        FPOIR     28
            FPOIR = 0.316                                                    FPOIR     29
            IF (COMP.GT.0.0) FPOIR = 0.276                                   FPOIR     30
            GO TO 110                                                        FPOIR     31
      100   FPOIR = EMFPIR(FTEMP)                                            FPOIR     32
      110   CONTINUE                                                         FPOIR     33
      C                                                                      FPOIR     34
            CALL DIALOT (FTEMP,6,FDIALA,FDIALM)                              FPOIR     35
            FPOIR = (FPOIR+FDIALA)*FDIALM                                    FPOIR     36
            RETURN                                                           FPOIR     37
            END                                                              FPOIR     38
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	FPOIR	3	38

VARIABLES	SN	TYPE		RELOCATION					
0	COMP	REAL		F.P.	REFS	31	DEFINED	3	
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	21	22		27
57	FDIALA	REAL			REFS	36	37		

```
VARIABLES     SN  TYPE          RELOCATION
   60  FDIALM     REAL                          REFS      36      37
   55  FPOIR      REAL                          REFS      37  DEFINED      30      31      33      37
    0  FTEMP      REAL                F.P.      REFS      29      33      36  DEFINED      3
   51  LOCIDX     INTEGER                       REFS      27  DEFINED      23
    0  MAXIDX     INTEGER             LACMDL    REFS      21
   50  OFF      * REAL                        DEFINED     23
   47  ON         REAL                          REFS      27  DEFINED      23
   56  T        * REAL                        DEFINED     29

EXTERNALS          TYPE   ARGS      REFERENCES
      DIALOT                 4              36
      EMFPIR     REAL        1              33

STATEMENT LABELS            DEF LINE   REFERENCES
   24  100                     33         27
   31  110                     34         32

COMMON BLOCKS   LENGTH
      LACMDL         2

STATISTICS
  PROGRAM LENGTH                  61B       49
  SCM LABELED COMMON LENGTH        2B        2
        140000B SCM USED
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      C                                                                       FPOIR      39
      C                                                                       FPOIR      40
            SUBROUTINE FRESTR (FTEMP,TIMEST,GRNINT,GRADT,POWDEN,GRNSIZ,NSHATR, FRSTR       2
           +FDENS,COLGRN,NCOLGN)                                              FRSTR      3
      C                                                                       FRSTR      4
      C     FRESTR CALCULATES FUEL RESTRUCTURING WHICH INCLUDES;              FRSTR      5
      C     . CALCULATION OF EQUIAXED GRAIN GROWTH                            FRSTR      6
      C     . CALCULATION OF COLUMNAR GRAIN GROWTH.                           FRSTR      7
      C     . CALCULATION OF FUEL SHATTERING.                                 FRSTR      8
      C     . CALCULATION OF FUEL DENSITY IN COLUMNAR GRAINS.                 FRSTR      9
      C     POWDEN = INPUT POWER DENSITY IN FUEL REGION (J/M**3).             FRSTR      10
      C     FTEMP  = INPUT FUEL TEMPERATURE (K).                              FRSTR      11
      C     GRADT  = INPUT TEMPERATURE GRADIENT (K/M)                         FRSTR      12
      C     TIMEST = INPUT TIME STEP  (S).                                    FRSTR      13
      C     GRNINT = INPUT FUEL GRAIN SIZE (M).                               FRSTR      14
      C     BU     = INPUT TOTAL BURNUP OF FUEL (MWS/KG).                     FRSTR      15
      C                                                                       FRSTR      16
      C     THE FOLLOWING FIVE PARAMETERS MUST BE STORED IN AN ARRAY          FRSTR      17
      C     EXTERNAL TO THIS SUBROUTINE. THE ARRAY SIZE SHOULD BE EQUAL TO    FRSTR      18
      C     THE NUMBER OF RADIAL NODES BEING CONSIDERED.                      FRSTR      19
      C     GRNSIZ = OUTPUT EQUIAXED FUEL GRAIN SIZE(M).                      FRSTR      20
      C     NCOLGN = INPUT/OUTPUT; 1 IF COLUMNAR GRAINS FORMED AND 0 IF NOT.  FRSTR      21
      C     NSHATR = INPUT/OUTPUT; 1 IF FUEL IS SHATTERED AND 0 IF NOT.       FRSTR      22
      C     FDENS  = INPUT/OUTPUT FUEL DENSITY (KG/M**3).                     FRSTR      23
      C     COLGRN = OUTPUT COLUMNAR GRAIN LENGTH (M)                         FRSTR      24
      C                                                                       FRSTR      25
      C     FRESTR WAS CODED BY C.S.OLSEN  NOVEMBER 1975.                     FRSTR      26
      C     FRESTR WAS RECODED BY R.E.MASON JULY 1979.                        FRSTR      27
      C                                                                       FRSTR      28
      C     FRESTR WAS DEVELOPED FROM THE FOLLOWING SOURCES.                  FRSTR      29
      C                                                                       FRSTR      30
      C     J. B. AINSCOUGH, B. W. OLDFIELD AND J. O. WARE, "ISOTHERMAL       FRSTR      31
      C     GRAIN GROWTH KINETICS IN SINTERED UO2 PELLETS," JOURNAL OF        FRSTR      32
      C     NUCLEAR MATERIALS, 49 (1973/74).                                  FRSTR      33
      C                                                                       FRSTR      34
      C     R. N. SINGH, "ISOTHERMAL GRAIN-GROWTH KINETICS IN SINTERED        FRSTR      35
      C     UO2 PELLETS," JOURNAL OF NUCLEAR MATERIALS, 64 (1977).            FRSTR      36
      C                                                                       FRSTR      37
      C     J. R. MACEWAN, GRAIN GROWTH IN SINTERED URANIUM DIOXIDE,          FRSTR      38
      C     AECL-1184 (1961).                                                 FRSTR      39
      C                                                                       FRSTR      40
      C     V. H. STEHLE, "KORNWACHSTUM VON UO2," BERICHT DER DEUTSCHEN       FRSTR      41
      C     KERAMISCHE GESELLSCHAFT, 40 (1963).                               FRSTR      42
      C     40 (1963).                                                        FRSTR      43
      C                                                                       FRSTR      44
      C     D. W. BRITE ET AL, EEI/EPRI FUEL DENSIFICATION PROJECT 131        FRSTR      45
      C     FINAL REPORT (1975).                                              FRSTR      46
      C                                                                       FRSTR      47
      C     M. D. FRESHLEY ET AL, PLUTONIA FUEL STUDY, EPRI NP-637 (1978).    FRSTR      48
      C                                                                       FRSTR      49
      C     H. KAWAMATA, H. KANEKO, H. FURUYA, AND M. KOIZUMI, "MIGRATION     FRSTR      50
      C     RATE OF LENTICULAR VOIDS IN UO2 UNDER THE INFLUENCE OF            FRSTR      51
      C     TEMPERATURE GRADIENT," JOURNAL OF NUCLEAR MATERIALS (1977).       FRSTR      52
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      C                                                                      FRSTR      53
      CC    B. J. BUESCHER AND R. O. MEYER,"THERMAL-GRADIENT MIGRATION OF    FRSTR      54
      CC    HELIUM BUBBLES IN URANIUM DIOXIDE," JOURNAL OF NUCLEAR           FRSTR      55
      CC    MATERIALS, 48 (1973).                                            FRSTR      56
      CC                                                                     FRSTR      57
      CC    W. OLDFIELD AND J. B. BROWN, JR., "BUBBLE MIGRATION IN UO2       FRSTR      58
      CC    - A STUDY USING LASER IMAGE FURNACE," MATERIAL SCIENCE AND       FRSTR      59
      CC    ENGINEERING, 6 (1970).                                           FRSTR      60
      CC                                                                     FRSTR      61
      CC    C. RONCHI AND C. SARI, "PROPERTIES OF LENTICULAR PORES IN        FRSTR      62
      CC    UO2, (U,PU)O2, AND PUO2," JOURNAL OF NUCLEAR MATERIALS, 50       FRSTR      63
      CC    (1974).                                                          FRSTR      64
      CC                                                                     FRSTR      65
      CC                                                                     FRSTR      66
      CC    PROGRAM;                                                         FRSTR      67
      C                                                                      FRSTR      68
            COMMON  / PHYPRO / FTMELT,FHEFUS,CTMELT,CHEFUS,CTRANB,           FRSTR      69
           +                   CTRANE,CTRANZ,FDELTA,BU,COMP,DELOXY           FRSTR      70
      C                                                                      FRSTR      71
      CC    CALCULATION OF COLUMNAR GRAIN GROWTH PARAMETERS.                 FRSTR      72
      C                                                                      FRSTR      73
            VELENT = 49.2227*GRADT*EXP(-44980.0/FTEMP)/(FTEMP*FTEMP)         FRSTR      74
            IF (NCOLGN.EQ.1) GO TO 100                                       FRSTR      75
            NCOLGN = 0                                                       FRSTR      76
            IF (VELENT*TIMEST.LE.0.0005) GO TO 100                           FRSTR      77
      C     THE UNCERTAINITY OF THE COLUMNAR GRAIN GROWTH THRESHOLD          FRSTR      78
      C     IS + OR - 100 K.                                                 FRSTR      79
            COLGRN = TIMEST*VELENT                                           FRSTR      80
            CALL DIALOT (FTEMP,10,FDIALA,FDIALM)                             FRSTR      81
            COLGRN = (COLGRN+FDIALA)*FDIALM                                  FRSTR      82
            NCOLGN = 1                                                       FRSTR      83
            NSHATR = 0                                                       FRSTR      84
      C                                                                      FRSTR      85
      100   CONTINUE                                                         FRSTR      86
            IF (NCOLGN.EQ.1) FDENS = 10750.6                                 FRSTR      87
      C     CALCULATION OF EQUIAXED GRAIN GROWTH OR COLUMNAR GRAIN WIDTH     FRSTR      88
      C                                                                      FRSTR      89
            GRNSIZ = (GRNINT**4.+.102667E-12*EXP(-35873.2/FTEMP)*TIMEST/(FTEMP FRSTR      90
           +*(1.-5.74664E-6*BU)*(1.-5.74664E-6*BU)))**.25                    FRSTR      91
            CALL DIALOT (FTEMP,10,FDIALA,FDIALM)                             FRSTR      92
            GRNSIZ = (GRNSIZ+FDIALA)*FDIALM                                  FRSTR      93
      C     THE STANDARD ERROR OF ESTIMATE OF EQUIAXED GRAIN SIZES IS        FRSTR      94
      C     + OR - 8.400E-06.                                                FRSTR      95
      C                                                                      FRSTR      96
      C     CALCULATION OF FUEL SHATTERING                                   FRSTR      97
      C                                                                      FRSTR      98
            IF ((NSHATR.EQ.1).OR.(NCOLGN.EQ.1)) GO TO 110                    FRSTR      99
            NSHATR = 0                                                       FRSTR     100
            IF (FTEMP.GE.FTMELT) GO TO 110                                   FRSTR     101
            EFRACS = 6.*(0.24-6.E-4*(FTEMP-1673.))/GRNSIZ                    FRSTR     102
            IF (POWDEN.GE.EFRACS) NSHATR = 1                                 FRSTR     103
      C                                                                      FRSTR     104
      110   CONTINUE                                                         FRSTR     105
```

```
                    RETURN                                                                  FRSTR     106
                    END                                                                     FRSTR     107
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	FRESTR	3	107

VARIABLES	SN	TYPE	RELOCATION							
10	BU	REAL	PHYPRO	REFS	70	2*91				
3	CHEFUS	REAL	PHYPRO	REFS	70					
170	COLGRM	* REAL		DEFINED	83					
0	COLGRN	REAL	F.P.	REFS	83	DEFINED	3	81		
11	COMP	REAL	PHYPRO	REFS	70					
2	CTMELT	REAL	PHYPRO	REFS	70					
4	CTRANB	REAL	PHYPRO	REFS	70					
5	CTRANE	REAL	PHYPRO	REFS	70					
6	CTRANZ	REAL	PHYPRO	REFS	70					
12	DELOXY	REAL	PHYPRO	REFS	70					
171	EFRACS	REAL		REFS	104	DEFINED	103			
7	FDELTA	REAL	PHYPRO	REFS	70					
0	FDENS	REAL	F.P.	DEFINED	3	88				
166	FDIALA	REAL		REFS	82	83	93	94		
167	FDIALM	REAL		REFS	82	83	93	94		
1	FHEFUS	REAL	PHYPRO	REFS	70					
0	FTEMP	REAL	F.P.	REFS	3*75	82	2*91	93	102	103
				DEFINED	3					
0	FTMELT	REAL	PHYPRO	REFS	70	102				
0	GRADT	REAL	F.P.	REFS	75	DEFINED	3			
0	GRNINT	REAL	F.P.	REFS	91	DEFINED	3			
0	GRNSIZ	REAL	F.P.	REFS	94	103	DEFINED	3	91	94
0	NCOLGN	INTEGER	F.P.	REFS	76	88	100	DEFINED	3	77 84
0	NSHATR	INTEGER	F.P.	REFS	100	DEFINED	3	85	101	104
0	POWDEN	REAL	F.P.	REFS	104	DEFINED	3			
0	TIMEST	REAL	F.P.	REFS	78	81	91	DEFINED	3	
165	VELENT	REAL		REFS	78	81	DEFINED	75		

EXTERNALS	TYPE	ARGS		REFERENCES	
DIALOT		4		82	93
EXP	REAL	1	LIBRARY	75	91

STATEMENT LABELS	DEF LINE	REFERENCES	
47 100	87	76	78
131 110	106	100	102

COMMON BLOCKS	LENGTH
PHYPRO	11

```
STATISTICS
  PROGRAM LENGTH                172B      122
  SCM LABELED COMMON LENGTH      13B       11
        140000B SCM USED
```

```
      C                                                                      FRSTR     108
      C                                                                      FRSTR     109
            SUBROUTINE FSWELL (FDENS,COMP,BU,BUL,FTEMP,GASWL,SOLDSW)         FSWEL       2
      C                                                                      FSWEL       3
      C     COMP   : INPUT PLUTONIA CONTENT (WEIGHT PERCENT)                 FSWEL       4
      C     FDENS  : INPUT INITIAL DENSITY OF THE FUEL (KG/M**3)             FSWEL       5
      C     FTEMP  : INPUT TEMPERATURE OF THE FUEL RING (K)                  FSWEL       6
      C     BU     : INPUT BURNUP TO END OF TIME STEP (MW-S/KG-U)            FSWEL       7
      C     BUL    : INPUT BURNUP TO END OF LAST TIME STEP (MW-S/KG-U)       FSWEL       8
      C                                                                      FSWEL       9
      C     GASWL  : OUTPUT FUEL SWELLING DUE TO GAS FISSION PRODUCTS        FSWEL      10
      C     (FRACTION)                                                       FSWEL      11
      C     SOLDSW : OUTPUT FUEL SWELLING DUE TO SOLID FISSION PRODUCTS      FSWEL      12
      C     (FRACTION)                                                       FSWEL      13
      C                                                                      FSWEL      14
      C     FSWELL WAS DEVELOPED AND PROGRAMMED BY R. E. MASON - JUNE 1978.  FSWEL      15
      C                                                                      FSWEL      16
      C     THE UO2 SWELLING CORRELATION IS BASED ON THE FOLLOWING DATA      FSWEL      17
      C     CHUBB,ET AL., NUCLEAR TECHNOLOGY 18 (1973)                       FSWEL      18
      C     TURNBULL, JOURN. NUCL. MATER., 50 (1974)                         FSWEL      19
      C     BANKS, JOURN. NUCL. MATER., 54 (1974)                            FSWEL      20
      C     DANIEL ET AL., WAPD - 263 (1962)                                 FSWEL      21
      C                                                                      FSWEL      22
      C     - PROGRAM -                                                      FSWEL      23
      C                                                                      FSWEL      24
            BUS = FDENS*2.974E+10*(BU-BUL)                                   FSWEL      25
            SOLDSW = BUS*2.5E-23                                             FSWEL      26
            IF (FTEMP.LT.2300.) GO TO 100                                    FSWEL      27
            GASWL = 0.0                                                      FSWEL      28
            GO TO 110                                                        FSWEL      29
      100   CONTINUE                                                         FSWEL      30
            GASWL = (8.80E-50*((2800.-FTEMP)**11.73)*EXP(-2.4E-10*BU*FDENS)*EX FSWEL      31
           +P(-0.0162*(2800.-FTEMP)))*BUS                                    FSWEL      32
      110   CONTINUE                                                         FSWEL      33
            CALL DIALOT (FTEMP,9,FDIALA,FDIALM)                              FSWEL      34
            GASWL = (GASWL+FDIALA)*FDIALM                                    FSWEL      35
            SOLDSW = (SOLDSW+FDIALA)*FDIALM                                  FSWEL      36
            RETURN                                                           FSWEL      37
            END                                                              FSWEL      38
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	FSWELL	3	38

VARIABLES	SN	TYPE	RELOCATION					
0	BU	REAL	F.P.	REFS	26	32	DEFINED	3
0	BUL	REAL	F.P.	REFS	26	DEFINED 3		
120	BUS	REAL		REFS	27	32	DEFINED	26

```
VARIABLES     SN  TYPE          RELOCATION
    0   COMP      REAL      *UNUSED     F.P.      DEFINED      3
    0   FDENS     REAL                  F.P.        REFS      26       32     DEFINED        3
  121   FDIALA    REAL                                REFS      35       36          37
  122   FDIALM    REAL                                REFS      35       36          37
    0   FTEMP     REAL                  F.P.        REFS      28     2*32          35     DEFINED        3
    0   GASWL     REAL                  F.P.        REFS      36   DEFINED          3          29          32          36
    0   SOLDSW    REAL                  F.P.        REFS      37   DEFINED          3          27          37

EXTERNALS           TYPE   ARGS       REFERENCES
      DIALOT                 4              35
      EXP         REAL       1 LIBRARY    2*32

STATEMENT LABELS              DEF LINE   REFERENCES
   25  100                       31          28
   53  110                       34          30

STATISTICS
  PROGRAM LENGTH                 123B       83
        140000B SCM USED
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      C                                                                      FSWEL      39
      C                                                                      FSWEL      40
            SUBROUTINE FTHCON (FTEMP,FRADEN,FOTMTL,CON,DKDT)                 FTHCN       2
      C                                                                      FTHCN       3
      C     FTHCON CALCULATES THE FUEL THERMAL CONDUCTIVITY AND ITS          FTHCN       4
      C     DERIVATIVE WITH RESPECT TO TEMPERATURE AS A FUNCTION OF          FTHCN       5
      C     TEMPERATURE, DENSITY, OXYGEN TO METAL RATIO, COMPOSITION         FTHCN       6
      C     AND BURNUP                                                       FTHCN       7
      C                                                                      FTHCN       8
      C     CON    = OUTPUT FUEL THERMAL CONDUCTIVITY (W/(M*K))              FTHCN       9
      C     DKDT   = OUTPUT DERIVATIVE OF FUEL THERMAL CONDUCTIVITY          FTHCN      10
      C     WITH RESPECT TO TEMPERATURE (W/M*K*K))                           FTHCN      11
      C                                                                      FTHCN      12
      C     FTEMP  = INPUT FUEL TEMPERATURE (K)                              FTHCN      13
      C     FRADEN = INPUT FUEL DENSITY (RATIO OF ACTUAL DENSITY TO          FTHCN      14
      C     THEORETICAL DENSITY)                                             FTHCN      15
      C     FOTMTL = INPUT OXYGEN TO METAL RATIO OF FUEL (ATOMS OXYGEN/      FTHCN      16
      C     ATOMS METAL)                                                     FTHCN      17
      C                                                                      FTHCN      18
      C     THE FOLLOWING INPUTS ARE BY COMMON BLOCK                         FTHCN      19
      C     COMP       = INPUT PUO2 CONTENT OF FUEL (PERCENT PUO2            FTHCN      20
      C     IN TOTAL FUEL WEIGHT)                                            FTHCN      21
      C     BU         = INPUT BURNUP (MW-S/KG-U)                            FTHCN      22
      C     EMFLAG(12) = INPUT SWITCH FOR EVALUATION MODEL. IF THIS          FTHCN      23
      C     VARIABLE IS EQUAL TO ON THE MATPRO MODEL FOR                     FTHCN      24
      C     FUEL THERMAL CONDUCTIVITY IS REPLACED BY THE                     FTHCN      25
      C     SUBCODE EMFTON                                                   FTHCN      26
      C                                                                      FTHCN      27
      C     THE FOLLOWING UNCERTAINTY IS COMPUTED BUT NOT RETURNED           FTHCN      28
      C     UCON   = OUTPUT EXPECTED STANDARD ERROR OF THE FUEL              FTHCN      29
      C     THERMAL CONDUCTIVITY (W/(M*K))                                   FTHCN      30
      C                                                                      FTHCN      31
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     FTHCN      32
      C     (1)  J. A. CHRISTENSEN ET AL., URANIUM DIOXIDE THERMAL           FTHCN      33
      C     CONDUCTIVITY, TRANSACTIONS OF THE AMERICAN NUCLEAR               FTHCN      34
      C     SOCIETY  7 (1964) PP. 391 - 392                                  FTHCN      35
      C     (2)  T. G. GODFREY ET AL., THERMAL CONDUCTIVITY OF               FTHCN      36
      C     URANIUM DIOXIDE AND ARMCO IRON BY AN IMPROVED                    FTHCN      37
      C     HEAT FLOW TECHNIQUE, ORNL-3556 (1954)                            FTHCN      38
      C     (3)  J. L. BATES, HIGH TEMPERATURE THERMAL CONDUCTIVITY          FTHCN      39
      C     OF ROUND ROBIN URANIUM DIOXIDE, BNWL-1431 (1970)                 FTHCN      40
      C     (4)  R. L. GIBBY, THE EFFECT OF PLUTONIUM CONTENT ON THE         FTHCN      41
      C     THERMAL CONDUCTIVITY OF (U,PU)O2 SOLID SOLUTIONS,                FTHCN      42
      C     JOURNAL OF NUCLEAR MATERIALS 38 (1971) PP 163 - 177              FTHCN      43
      C     (5)  J. C. WEILBACHER, DIFFUSIVITE THERMIQUE DE L OXIDE          FTHCN      44
      C     D URANIUM ET DE L OXIDE DE THORIUM A HAUTE TEMPERATURE,          FTHCN      45
      C     HIGH TEMPERATURES - HIGH PRESSURE 4, (1972) PP 431 - 438         FTHCN      46
      C     (6)  L. A. GOLDSMITH AND J. A. M. DOUGLAS, MEASUREMENTS          FTHCN      47
      C     THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE AT 670 -             FTHCN      48
      C     1270 K, JOURNAL OF NUCLEAR MATERIALS 47, (1973) PP 31 - 42       FTHCN      49
      C     (7)  I. C. HOBSON ET AL., EFFECT OF POROSITY AND STOICHIOMETRY   FTHCN      50
      C     ON THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE, JOURNAL          FTHCN      51
      C     OF PHYSICS SECTION D: APPLIED PHYSICS 7 (1974)                   FTHCN      52
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      C   PP 1003 - 1015                                                          FTHCN      53
      C   (8)  R. L. GIBBY, THE THERMAL DIFFUSIVITY AND THERMAL                   FTHCN      54
      C   CONDUCTIVITY OF STOICHIOMETRIC (U0.8,PU0.2)02, BNWL-704                 FTHCN      55
      C   (1968)                                                                  FTHCN      56
      C   (9)  R. L. GIBBY, THE EFFECT OF OXYGEN STOICHIOMETRY ON THE             FTHCN      57
      C   THERMAL DIFFUSIVITY AND CONDUCTIVITY OF (U0.75,PU0.25)                  FTHCN      58
      C   02-X BNWL-927 (1969)                                                    FTHCN      59
      C   (10) L. A. GOLDSMITH AND J. A. M. DOUGLAS, THE THERMAL                  FTHCN      60
      C   CONDUCTIVITY OF PLUTIONIUM-URANIUM DIOXIDE AT                           FTHCN      61
      C   TEMPERATURES UP TO 1373 K, JOURNAL OF NUCLEAR MATERIALS                 FTHCN      62
      C   43 (1972) PP 225 - 233                                                  FTHCN      63
      C   (11) H. E. SCHMIDT, DIE WAERMELEITFAEHIGKEIT VON URAN AND               FTHCN      64
      C   URAN-PLUTINIUM DIOXYD BEI HOHEN TEMPERATUREN, FORSCHUNG                 FTHCN      65
      C   INGENIEUR-WEISEN 38 (1976) PP 149 - 151                                 FTHCN      66
      C   (12) D. R. OLANDER, FUNDAMENTAL ASPECTS OF NUCLEAR REACTOR              FTHCN      67
      C   FUEL ELEMENTS, TID-26711-P1 (1976)                                      FTHCN      68
      C                                                                           FTHCN      69
      C   FTHCON WAS ORIGIONALLY CODED BY C. S. OLSEN FEB 1975                    FTHCN      70
      C   MODIFIED BY G. A. REYMANN AUGUST 1978                                   FTHCN      71
      C   MODIFIED BY D. L. HAGRMAN JANUARY 1979                                  FTHCN      72
      C                                                                           FTHCN      73
            COMMON  / PHYPRO / FTMELT,FHEFUS,CTMELT,CHEFUS,CTRANB,                FTHCN      74
           +                   CTRANE,CTRANZ,FDELTA,BU,COMP,DELOXY                FTHCN      75
      C                                                                           FTHCN      76
            COMMON   / LACMDL / MAXIDX, EMFLAG                                    FTHCN      77
            DIMENSION EMFLAG(1)                                                   FTHCN      78
            DIMENSION C(2)                                                        FTHCN      79
            DATA      ON       / 2HON    /,                                       FTHCN      80
           +          OFF      / 3HOFF   /,                                       FTHCN      81
           +          LOCIDX   /  12     /                                       FTHCN      82
      C                                                                           FTHCN      83
      C   FIND CONSTANTS                                                          FTHCN      84
      C                                                                           FTHCN      85
            FRPU = COMP/100.                                                      FTHCN      86
            A = 0.339+12.6*ABS(2.0-FOTMTL)                                        FTHCN      87
            IF (FRPU.GT.0.75) FRPU = 0.75                                         FTHCN      88
            B = 6.867E-02*(1.0+0.623*FRPU)                                        FTHCN      89
            T = FTEMP                                                             FTHCN      90
            I = 1                                                                 FTHCN      91
      C                                                                           FTHCN      92
      C   FIND SPECIFIC HEAT AT CONST. VOL. AND VOLUME CHANGE                    FTHCN      93
      C                                                                           FTHCN      94
      100   TR = 535.285/T                                                        FTHCN      95
            CV = 296.7*TR*TR*EXP(TR)/((EXP(TR)-1.0)**2)                           FTHCN      96
            DV = 1.0+3.0*(1.0E-05*T-3.0E-03+4.0E-02*EXP(-5.0E+03/T))              FTHCN      97
            IF (FRPU.LT.0.0001) GO TO 110                                         FTHCN      98
      C                                                                           FTHCN      99
      C   USE RULE OF MIXTURES FOR MIXED OXIDES                                  FTHCN     100
            TR = 571.0/T                                                          FTHCN     101
            CV = CV*(1.0-FRPU)+(347.4*TR*TR*EXP(TR)/((EXP(TR)-1.0)**2))*FRPU      FTHCN     102
            DV = (DV-1.0)*(1.0-FRPU)+3.0*(9.0E-06*T-2.7E-03+7.0E-02*EXP(-5.072    FTHCN     103
           +E+03/T))*FRPU+1.0                                                     FTHCN     104
      C                                                                           FTHCN     105
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                C   FIND POROSITY CORRECTION                                                    FTHCN     106
                C                                                                              FTHCN     107
                110   BETA = 6.50-4.69E-03*T                                                   FTHCN     108
110                   IF (T.GE.1364.647) BETA = 15.811308-T*(.01833647-T*5.E-6)                FTHCN     109
                      IF (T.GT.1833.647) BETA = -1.0                                           FTHCN     110
                C                                                                              FTHCN     111
                C   FIND ELECTRONIC CONTRIBUTION                                             FTHCN     112
                C                                                                              FTHCN     113
115                   CONE = (5.2997E-03*T*EXP(-13358.0/T))*(1.0+0.169*((13358.0/T+2.0)*       FTHCN     114
                     +*2))                                                                     FTHCN     115
                      BTEMP = T                                                                FTHCN     116
                      IF (T.GE.1800.) BTEMP = -3240.+T*(4.6-T*0.001)                           FTHCN     117
                      IF (T.GE.2300.) BTEMP = 2050.                                            FTHCN     118
120             C                                                                              FTHCN     119
                C   FIND CONDUCTIVITY                                                         FTHCN     120
                C                                                                              FTHCN     121
                      C(I) = (CV*FRADEN)/(DV*(A+B*BTEMP)*(1.0+BETA*(1.0-FRADEN)))+CONE         FTHCN     122
                      CALL DIALOT (FTEMP,2,FDIALA,FDIALM)                                      FTHCN     123
125                   C(I) = (C(I)+FDIALA)*FDIALM                                              FTHCN     124
                C                                                                              FTHCN     125
                C   FIND DERIVATIVE OF FUEL CONDUCTIVITY                                      FTHCN     126
                C                                                                              FTHCN     127
                      I = I+1                                                                  FTHCN     128
130                   T = FTEMP+((-1.0)**I)                                                    FTHCN     129
                      IF (I.LT.3) GO TO 100                                                    FTHCN     130
                      CON = C(1)                                                               FTHCN     131
                      DKDT = (C(2)-C(1))                                                       FTHCN     132
                C                                                                              FTHCN     133
135             C   FIND UNCERTAINTY                                                          FTHCN     134
                C                                                                              FTHCN     135
                      UCON = (0.2*(1.0-FRPU)+0.7*FRPU)*(1.)+ABS(2.0-FOTMTL)*10.)               FTHCN     136
                      IF (FTEMP.GE.FTMELT) UCON = C(1)/2.0                                     FTHCN     137
                      IF (EMFLAG(LOCIDX).EQ.ON) CALL EMFTON (FTEMP,FRADEN,FTMELT,CON,DKD       FTHCN     138
140                  +T)                                                                       FTHCN     139
                C                                                                              FTHCN     140
                      RETURN                                                                   FTHCN     141
                      END                                                                      FTHCN     142
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES							
4	FTHCON	3	142							
VARIABLES	**SN**	**TYPE**	**RELOCATION**							
357	A	REAL		REFS	123	DEFINED	88			
360	B	REAL		REFS	123	DEFINED	90			
366	BETA	REAL		REFS	123	DEFINED	109	110	111	
370	BTEMP	REAL		REFS	123	DEFINED	117	118	119	
10	BU	REAL	PHYPRO	REFS	75					

VARIABLES	SN	TYPE	RELOCATION								
374	C	REAL	ARRAY		REFS	80	125	132	2*133	138	
					DEFINED	123	125				
3	CHEFUS	REAL		PHYPRO	REFS	75					
11	COMP	REAL		PHYPRO	REFS	75	87				
0	CON	REAL		F.P.	REFS	139	DEFINED	3	132		
367	CONE	REAL			REFS	123	DEFINED	115			
2	CTMELT	REAL		PHYPRO	REFS	75					
4	CTRANB	REAL		PHYPRO	REFS	75					
5	CTRANE	REAL		PHYPRO	REFS	75					
6	CTRANZ	REAL		PHYPRO	REFS	75					
364	CV	REAL			REFS	103	123	DEFINED	97	103	
12	DELOXY	REAL		PHYPRO	REFS	75					
0	DKDT	REAL		F.P.	REFS	139	DEFINED	3	133		
365	DV	REAL			REFS	104	123	DEFINED	98	104	
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	78	79	139			
7	FDELTA	REAL		PHYPRO	REFS	75					
371	FDIALA	REAL			REFS	124	125				
372	FDIALM	REAL			REFS	124	125				
1	FHEFUS	REAL		PHYPRO	REFS	75					
0	FOTMTL	REAL		F.P.	REFS	88	137	DEFINED	3		
0	FRADEN	REAL		F.P.	REFS	2*123	139	DEFINED	3		
356	FRPU	REAL			REFS	89	90	99	2*103	2*104	2*137
					DEFINED	87	89				
0	FTEMP	REAL		F.P.	REFS	91	124	130	138	139	
					DEFINED	3					
0	FTMELT	REAL		PHYPRO	REFS	75	138	139			
362	I	INTEGER			REFS	123	2*125	129	130	131	138
					DEFINED	92	129				
301	LOCIDX	INTEGER			REFS	139	DEFINED	81			
0	MAXIDX	INTEGER		LACMDL	REFS	78					
300	OFF *	REAL			DEFINED	81					
277	ON	REAL			REFS	139	DEFINED	81			
361	T	REAL			REFS	96	2*98	102	2*104	109	3*110	111
					3*115	117	3*118	119	DEFINED	91	130
363	TR	REAL			REFS	4*97	4*103	DEFINED	96	102	
373	UCON	REAL			DEFINED	137	138				

EXTERNALS	TYPE	ARGS		REFERENCES					
DIALOT		4		124					
EMFTON		5		139					
EXP	REAL	1	LIBRARY	2*97	98	2*103	104	115	

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
ABS	REAL	1	INTRIN		88	137

STATEMENT LABELS		DEF LINE	REFERENCES
33	100	96	131
117	110	109	99

COMMON BLOCKS	LENGTH
PHYPRO	11
LACMDL	2

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STATISTICS
  PROGRAM LENGTH                376B      254
  SCM LABELED COMMON LENGTH      15B       13
        140000B SCM USED
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      C                                                                       FTHCN    143
      C                                                                       FTHCN    144
            FUNCTION FTHEXP (FTEMP,FACMOT)                                    FTHXP      2
      C                                                                       FTHXP      3
      C     THE SUBPROGRAM FTHEXP IS USED TO CALCULATE THE STRAIN OF THE      FTHXP      4
      C     FUEL CAUSED BY THERMAL EXPANSION.                                 FTHXP      5
      C     THERMAL EXPANSION STRAIN IS CALCULATED FOR UO2,PUO2, OR (U,PU)O2  FTHXP      6
      C     AS A FUNCTION OF TEMPERATURE, PUO2 CONTENT, AND FRACTION OF       FTHXP      7
      C     THE FUEL WHICH IS MOLTEN.                                         FTHXP      8
      C     THE CORRELATIONS WERE DERIVED WITH THE ASSUMPTION THAT THE        FTHXP      9
      C     THERMAL EXPANSION STRAIN IS ZERO AT 300K.                         FTHXP     10
      C                                                                       FTHXP     11
      C     FTHEXP = OUTPUT FUEL STRAIN DUE TO THERMAL EXPANSION (UNITLESS)   FTHXP     12
      C     UFTHEX = ESTIMATED STANDARD ERROR OF FTHEXP (PER CENT)            FTHXP     13
      C     (NOT CURRENTLY RETURNED).                                         FTHXP     14
      C                                                                       FTHXP     15
      C     FTEMP  = INPUT FUEL TEMPERATURE (K)                               FTHXP     16
      C     FACMOT = INPUT FUEL FRACTION WHICH IS MOLTEN (UNITLESS)           FTHXP     17
      C     FACMOT = 1.0 - FUEL IS ALL MOLTEN                                 FTHXP     18
      C     FACMOT = 0.0 - FUEL IS ALL SOLID                                  FTHXP     19
      C                                                                       FTHXP     20
      C     THE CORRELATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM:  FTHXP     21
      C     (1) P.J.BALDOCK ET AL, JOURNAL OF NUCLEAR MATERIALS, 18 (1966)    FTHXP     22
      C     (2) N.H.BRETT AND L.E.RUSSEL, PROCEEDINGS OF THE 2ND              FTHXP     23
      C     INTERNATIONAL CONFERENCE ON PLUTONIUM METALLURGY, GRENOBLE,        FTHXP     24
      C     FRANCE (1960) PP 397-410.                                         FTHXP     25
      C     (3) M.D.BURDOCK AND H.S.PARKER, JOURNAL OF THE AMERICAN           FTHXP     26
      C     CERAMIC SOCIETY,39 (1956) PP 181-187.                             FTHXP     27
      C     (4) J.A.CHRISTENSEN, JOURNAL OF THE AMERICAN CERAMIC SOCIETY,     FTHXP     28
      C     46 (1963) PP 607-608.                                             FTHXP     29
      C     (5) J.B.CONWAY ET AL, TRANSACTIONS OF THE AMERICAN NUCLEAR        FTHXP     30
      C     SOCIETY,6 (1963).                                                 FTHXP     31
      C     (6) F.GRONVOLD, JOURNAL OF INORGANIC AND NUCLEAR CHEMISTRY,1      FTHXP     32
      C     (1955) PP 357-370.                                                FTHXP     33
      C     (7) M.HOCH AND A.C.KOMIN, HIGH TEMPERATURES-HIGH PRESSURES,1      FTHXP     34
      C     (1969) PP 401-407.                                                FTHXP     35
      C     (8) C.P.KEMPTER AND R.O.ELLIOTT, THE JOURNAL OF CHEMICAL          FTHXP     36
      C     PHYSICS,30 (1958) PP 1524-1526.                                   FTHXP     37
      C     (9) W.A.LAMBERTSON AND J.H.HANDWERK, ANL-5053 (1956).             FTHXP     38
      C     (10)M.TOKAR ET AL, NUCLEAR TECHNOLOGY, 17 (1973) PP 147-152.      FTHXP     39
      C                                                                       FTHXP     40
      C     FTHEXP WAS ORIGINALLY CODED BY V.F.BASTON IN MARCH 1974           FTHXP     41
      C     MODIFIED BY C.S.OLSEN IN FEB. 1975                                FTHXP     42
      C     LAST MODIFIED BY G.A.REYMANN IN JULY 1978                         FTHXP     43
      C                                                                       FTHXP     44
            COMMON  / PHYPRO / FTMELT,FHEFUS,CTMELT,CHEFUS,CTRANB,            FTHXP     45
           +                   CTRANE,CTRANZ,FDELTA,BU,COMP,DELOXY            FTHXP     46
      C                                                                       FTHXP     47
      C     THE PHYPRO COMMON BLOCK IS SET BY CALL TO THE SUBROUTINE          FTHXP     48
      C     PHYPRO WHICH IS PART OF THE MATERIALS PROPERTIES PACKAGE          FTHXP     49
      C     USED AT THE INEL.                                                 FTHXP     50
      C     QUANTITIES CONTAINED IN IT USED IN THIS SUBCODE ARE;              FTHXP     51
      C     COMP   = PUO2 CONTENT (WT. %)                                     FTHXP     52
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      C   FTMELT = FUEL MELTING TEMPERATURE (K)                                  FTHXP      53
55    C   FDELTA = LIQUID-SOLID COEXISTENCE TEMPERATURE RANGE (K)                 FTHXP      54
      C   WHEN THE FUNCTION FTHEXP IS USED ALONE, NOT AS PART OF                 FTHXP      55
      C   THE INEL CODE, VALUES FOR COMP, FTMELT, AND FDELTA MUST                FTHXP      56
      C   BE INPUT.                                                              FTHXP      57
      C                                                                          FTHXP      58
60          DATA C1U ,C2U ,C3U ,EDU / 1.0E-05, 3.0E-03, 4.0E-02, 6.9E-20 /     FTHXP      59
            DATA C1PU,C2PU,C3PU,EDPU/ 9.0E-06, 2.7E-03, 7.0E-02, 7.0E-20 /     FTHXP      60
      C                                                                          FTHXP      61
            FTX(C1,C2,C3,ED,BK,T) = C1*T-C2+C3*EXP(-ED/(BK*T))                   FTHXP      62
      C                                                                          FTHXP      63
65          T = FTEMP                                                          FTHXP      64
            BK = 1.38E-23                                                      FTHXP      65
      C   BK     = BOLTZMANN'S CONSTANT (J/K)                                   FTHXP      66
            FCOMP = COMP/100.0                                                 FTHXP      67
      C                                                                          FTHXP      68
70          IF (T.GT.FTMELT) GO TO 100                                         FTHXP      69
      C                                                                          FTHXP      70
            FTHEXP = FTX(C1U,C2U,C3U,EDU,BK,T)*(1.0-FCOMP)+FTX(C1PU,C2PU,C3PU, FTHXP      71
           +EDPU,BK,T)*FCOMP                                                   FTHXP      72
            GO TO 120                                                          FTHXP      73
75    C                                                                        FTHXP      74
      100   FTHEXM = FTX(C1U,C2U,C3U,EDU,BK,FTMELT)*(1.0-FCOMP)+FTX(C1PU,C2PU, FTHXP      75
           +C3PU,EDPU,BK,FTMELT)*(FCOMP)                                       FTHXP      76
      C                                                                        FTHXP      77
            IF (T.GE.(FTMELT+FDELTA)) GO TO 110                                FTHXP      78
80    C                                                                        FTHXP      79
            FTHEXP = FTHEXM+.043+FACMOT                                        FTHXP      80
            GO TO 120                                                          FTHXP      81
      C                                                                        FTHXP      82
      110   FTHEXP = FTHEXM+.043+3.6E-05*(T-(FTMELT+FDELTA))                   FTHXP      83
85    C                                                                        FTHXP      84
      120   CONTINUE                                                           FTHXP      85
            UFTHEX = 10.0                                                      FTHXP      86
      C                                                                        FTHXP      87
            CALL DIALOT (FTEMP,4,FDIALA,FDIALM)                                FTHXP      88
90          FTHEXP = (FTHEXP+FDIALA)*FDIALM                                    FTHXP      89
            RETURN                                                             FTHXP      90
            END                                                                FTHXP      91
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
5	FTHEXP	3	91

VARIABLES

		SN	TYPE	RELOCATION					
164	BK		REAL		REFS	2*72	2*76	DEFINED	66
10	BU		REAL	PHYPRO	REFS	46			
3	CHEFUS		REAL	PHYPRO	REFS	46			

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VARIABLES      SN  TYPE          RELOCATION
    11  COMP       REAL          PHYPRO      REFS     46      68
     2  CTMELT     REAL          PHYPRO      REFS     46
     4  CTRANB     REAL          PHYPRO      REFS     46
     5  CTRANE     REAL          PHYPRO      REFS     46
     6  CTRANZ     REAL          PHYPRO      REFS     46
   147  C1PU       REAL                      REFS     72      76      DEFINED      61
   143  C1U        REAL                      REFS     72      76      DEFINED      60
   150  C2PU       REAL                      REFS     72      76      DEFINED      61
   144  C2U        REAL                      REFS     72      76      DEFINED      60
   151  C3PU       REAL                      REFS     72      76      DEFINED      61
   145  C3U        REAL                      REFS     72      76      DEFINED      60
    12  DELOXY     REAL          PHYPRO      REFS     46
   152  EDPU       REAL                      REFS     72      76      DEFINED      61
   146  EDU        REAL                      REFS     72      76      DEFINED      60
     0  FACMOT     REAL          F.P.        REFS     81  DEFINED       3
   165  FCOMP      REAL                      REFS   2*72    2*76      DEFINED      68
     7  FDELTA     REAL          PHYPRO      REFS     46      79          84
   170  FDIALA     REAL                      REFS     89      90
   171  FDIALM     REAL                      REFS     89      90
     1  FHEFUS     REAL          PHYPRO      REFS     46
     0  FTEMP      REAL          F.P.        REFS     65      89      DEFINED       3
   166  FTHEXM     REAL                      REFS     81      84      DEFINED      76
   162  FTHEXP     REAL                      REFS     90  DEFINED        72        81          84          90
     0  FTMELT     REAL          PHYPRO      REFS     46      70        4*76        79          84
   163  T          REAL                      REFS     70    4*72          79        84    DEFINED       65
   167  UFTHEX   * REAL                    DEFINED    87

EXTERNALS          TYPE    ARGS      REFERENCES
           DIALOT                4          89
           EXP        REAL       1 LIBRARY  2*72      2*76

INLINE FUNCTIONS    TYPE    ARGS        DEF LINE  REFERENCES
           FTX        REAL       6    SF      63      2*72      2*76

STATEMENT LABELS                  DEF LINE   REFERENCES
    50  100                          76          70
   107  110                          84          79
   116  120                          86          74          82

COMMON BLOCKS    LENGTH
           PHYPRO      11

STATISTICS
  PROGRAM LENGTH                    172B       122
  SCM LABELED COMMON LENGTH          13B        11
        140000B SCM USED
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      C                                                                      FTHXP      92
      C                                                                      FTHXP      93
            FUNCTION FUDENS (FTEMP,BU,FDENS,RSNTR,TSINT,COMP,PRVDEN)         FUDNS       2
      C                                                                      FUDNS       3
      C   FUDENS CALCULATES IRRADIATION-INDUCED DENSIFICATION.               FUDNS       4
      C                                                                      FUDNS       5
      C   FUDENS = OUTPUT FUEL DIMENSIONAL CHANGE (%)                        FUDNS       6
      C                                                                      FUDNS       7
      C   FTEMP  = INPUT FUEL TEMPERATURE (K)                                FUDNS       8
      C   BU     = INPUT BURNUP (MW-S/KG-U)                                  FUDNS       9
      C   FDENS  = INPUT FUEL DENSITY (KG/M**3)                             FUDNS      10
      C   RSNTR  = INPUT MAXIMUM DENSITY CHANGE DETERMINED BY A RESINTERING  FUDNS      11
      C   TEST OF 1973 K FOR 24 HOURS (KG/M**3)                            FUDNS      12
      C   TSINT  = INPUT FUEL SINTERING TEMPERATURE (K)                     FUDNS      13
      C   COMP   = INPUT PLUTONIA CONTENT (WEIGHT PERCENT)                  FUDNS      14
      C   PRVDEN = INPUT TOTAL DENSIFICATION FROM PREVIOUS TIME STEP (%)    FUDNS      15
      C                                                                      FUDNS      16
      C   FUDENS WAS DEVELOPED AND PROGRAMMED BY C. S. OLSEN (JANUARY 1975). FUDNS      17
      C   UPDATED AND CORRECTED BY B. W. BURNHAM (OCTOBER 1975).             FUDNS      18
      C   FUDENS WAS MODIFIED BY R. E. MASON (NOVEMBER 1978).                FUDNS      19
      C                                                                      FUDNS      20
            DIMENSION C(2),B(5)                                              FUDNS      21
            DATA C / 10.97, 11.46/                                           FUDNS      22
            DATA B / 3.0, 1.00, 3.0, 2.00, 35.00 /                           FUDNS      23
      C                                                                      FUDNS      24
            DLEN2(ALEN,BU,ABU) = -B(1)+ALEN+B(2)*EXP(-B(3)*(BU+ABU))+B(4)*EXP( FUDNS      25
           +-B(5)*(BU+ABU))                                                  FUDNS      26
            DLEN3(BU) = -B(2)*B(3)*EXP(-B(3)*BU)-B(4)*B(5)*EXP(-B(5)*BU)     FUDNS      27
            FBU = BU*1.0202E-05                                              FUDNS      28
            TS = TSINT-2.7315E02                                             FUDNS      29
      C   IF RSNTR OR TSINT IS NOT DEFINED BY USER, THE DEFAULT VALUE IS     FUDNS      30
      C   TSINT = 1873 K.                                                    FUDNS      31
            IF (TSINT.LE.0.0) TS = 1600.0                                    FUDNS      32
            ROTH = C(1)*C(2)/(0.01*COMP*C(1)+(1.0-0.01*COMP)*C(2))           FUDNS      33
            DE = FDENS/(ROTH*10.0)                                           FUDNS      34
      C                                                                      FUDNS      35
            IF ((FTEMP.GE.1000.).AND.(RSNTR.GT.0.)) DLEN1 = 0.00285*RSNTR    FUDNS      36
            IF ((FTEMP.LT.1000.).AND.(RSNTR.GT.0.)) DLEN1 = 0.00150*RSNTR    FUDNS      37
            IF ((FTEMP.GE.1000.).AND.(RSNTR.LE.0.)) DLEN1 = 66.6*(100.0-DE)/(T FUDNS      38
           +S-1180.0)                                                        FUDNS      39
            IF ((FTEMP.LT.1000.).AND.(RSNTR.LE.0.)) DLEN1 = 22.2*(100.0-DE)/(T FUDNS      40
           +S-1180.0)                                                        FUDNS      41
      C                                                                      FUDNS      42
            X3 = 0.0                                                         FUDNS      43
            X4 = 1.0                                                         FUDNS      44
            AL1 = DLEN1                                                      FUDNS      45
            AL3 = 3.0-AL1                                                    FUDNS      46
            AL4 = 0.0                                                        FUDNS      47
            IF (AL3.LE.4.27E-03) GO TO 130                                   FUDNS      48
      C                                                                      FUDNS      49
                DO 100 I=1,6                                                 FUDNS      50
                Y2 = DLEN2(AL3,X4,AL4)                                       FUDNS      51
                Y1 = DLEN2(AL3,X3,AL4)                                       FUDNS      52
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                      IF (Y1*Y2.LE.0.) GO TO 110                                FUDNS      53
55                    X3 = X4                                                   FUDNS      54
                      X4 = X4+1.0                                               FUDNS      55
                      IF (I.EQ.6) GO TO 160                                     FUDNS      56
               100    CONTINUE                                                  FUDNS      57
                     C                                                          FUDNS      58
60             110   CONTINUE                                                   FUDNS      59
                     X1 = X3                                                    FUDNS      60
                     C                                                          FUDNS      61
                      DO 120 J=1,50                                             FUDNS      62
                      X = X1-DLEN2(AL3,X1,AL4)/DLEN3(X1)                        FUDNS      63
65                    ERR = ABS((X-X1)*100.0/X)                                 FUDNS      64
                      IF (ERR.LE.2.0E-04) GO TO 140                             FUDNS      65
                      X1 = X                                                    FUDNS      66
               120    CONTINUE                                                  FUDNS      67
                     C                                                          FUDNS      68
70             130   AL3 = 2.996                                                FUDNS      69
                     AL2 = 5.384                                                FUDNS      70
                     GO TO 150                                                  FUDNS      71
                     C                                                          FUDNS      72
                     140   AL2 = X                                              FUDNS      73
75                   150   CONTINUE                                             FUDNS      74
                     FUDEN = DLEN2(AL3,FBU,AL2)                                 FUDNS      75
                     IF (BU.LT.1728) FUDEN = 0.0                                FUDNS      76
                     GO TO 170                                                  FUDNS      77
                     C                                                          FUDNS      78
80                   160   PRINT 180                                            FUDNS      79
                     FUDEN = 0.0                                                FUDNS      80
                     170   CONTINUE                                             FUDNS      81
                     IF (ABS(FUDEN).LE.ABS(PRVDEN)) FUDENS = 0.0                FUDNS      82
                     IF (ABS(FUDEN).GT.ABS(PRVDEN)) FUDENS = FUDEN-PRVDEN       FUDNS      83
85                   C                                                          FUDNS      84
                     CALL DIALOT (FTEMP,11,FDIALA,FDIALM)                       FUDNS      85
                     FUDENS = (FUDENS+FDIALA)*FDIALM                            FUDNS      86
                     RETURN                                                     FUDNS      87
                     C                                                          FUDNS      88
90                   180   FORMAT (1X,/45H NO ROOTS FOUND BETWEEN 0 AND 6000 MWS/MT U02)  FUDNS  89
                     END                                                        FUDNS      90
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	FUDENS	3	88

VARIABLES	SN	TYPE	RELOCATION							
425	AL1	REAL		REFS	47	DEFINED	46			
437	AL2	REAL		REFS	2*76	DEFINED	71	74		
426	AL3	REAL		REFS	49	52	53	64	76	
				DEFINED	47	70				

VARIABLES	SN	TYPE	RELOCATION								
427	AL4	REAL			REFS	2*52	2*53	2*64	DEFINED	48	
445	B	REAL	ARRAY		REFS	22	5*52	5*53	11*64	5*76	
					DEFINED	24					
0	BU	REAL		F.P.	REFS	29	77	DEFINED	3		
443	C	REAL	ARRAY		REFS	22	4*34	DEFINED	23		
0	COMP	REAL		F.P.	REFS	2*34	DEFINED	3			
421	DE	REAL			REFS	39	41	DEFINED	35		
422	DLEN1	REAL			REFS	46	DEFINED	37	38	39	41
436	ERR	REAL			REFS	66	DEFINED	65			
416	FBU	REAL			REFS	2*76	DEFINED	29			
0	FDENS	REAL		F.P.	REFS	35	DEFINED	3			
441	FDIALA	REAL			REFS	86	87				
442	FDIALM	REAL			REFS	87	87				
0	FTEMP	REAL		F.P.	REFS	37	38	39	41	86	
					DEFINED	3					
440	FUDEN	REAL			REFS	83	2*84	DEFINED	76	77	81
415	FUDENS	REAL			REFS	87	DEFINED	83	84	87	
430	I	INTEGER			REFS	57	DEFINED	51			
434	J	* INTEGER			DEFINED	63					
0	PRVDEN	REAL		F.P.	REFS	83	2*84	DEFINED	3		
420	ROTH	REAL			REFS	35	DEFINED	34			
0	RSNTR	REAL		F.P.	REFS	2*37	2*38	39	41	DEFINED	3
417	TS	REAL			REFS	39	41	DEFINED	30	33	
0	TSINT	REAL		F.P.	REFS	30	33	DEFINED	3		
435	X	REAL			REFS	2*65	67	74	DEFINED	64	
433	X1	REAL			REFS	5*64	65	DEFINED	61	67	
423	X3	REAL			REFS	2*53	61	DEFINED	44	55	
424	X4	REAL			REFS	2*52	55	56	DEFINED	45	56
432	Y1	REAL			REFS	54	DEFINED	53			
431	Y2	REAL			REFS	54	DEFINED	52			

FILE NAMES	MODE			
OUTPUT	FMT	WRITES	80	

EXTERNALS	TYPE	ARGS		REFERENCES			
DIALOT		4		86			
EXP	REAL	1	LIBRARY	2*52	2*53	4*64	2*76

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES			
ABS	REAL	1	INTRIN		65	2*83	2*84	
DLEN2	REAL	3	SF	26	52	53	64	76
DLEN3	REAL	1	SF	28	64			

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		58	51
166	110		60	54
0	120		68	63
245	130		70	49
253	140		74	66
256	150		75	72
303	160		80	57
310	170		82	78
362	180	FMT	90	80

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES		
111	100	I	51 58	54B		EXT REFS	EXITS
172	120	J	63 68	52B		EXT REFS	EXITS

STATISTICS
PROGRAM LENGTH 452B 298
140000B SCM USED

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      C                                                                       FUDNS      91
      C                                                                       FUDNS      92
      C                                                                       FUDNS      93
            SUBROUTINE FVAPRS (FTEMP,FOM,FRPU,UO2VAP,PUOVAP,VAPMIX,UOXVAP,DIOV FVPRS       2
     5     +AP)                                                              FVPRS       3
      C                                                                       FVPRS       4
      C   FTEMP  = INPUT FUEL TEMPERATURE(K).                                FVPRS       5
      C   FOM    = INPUT FUEL OXYGEN TO METAL RATIO(UNITLESS)                 FVPRS       6
      C   FRPU   = INPUT PUO2 IN FUEL(WEIGHT FRACTION)                       FVPRS       7
     10 C                                                                     FVPRS       8
      C   UO2VAP = OUTPUT TOTAL VAPOR PRESSURE OF URANIA                     FVPRS       9
      C   VAPOR SPECIES (LOG(PA))                                            FVPRS      10
      C   PUOVAP = OUTPUT TOTAL VAPOR PRESSURE OF PLUTONIA                   FVPRS      11
      C   VAPOR SPECIES (LOG(PA))                                            FVPRS      12
     15 C   VAPMIX = OUTPUT TOTAL VAPOR PRESSURE OF MIXED OXIDE              FVPRS      13
      C   VAPOR SPECIES (LOG(PA))                                            FVPRS      14
      C   UOXVAP = OUTPUT VAPOR PRESSURE OF MONATOMIC OXYGEN (LOG(PA))       FVPRS      15
      C   DIOVAP = OUTPUT VAPOR PRESSURE OF DIATOMIC OXYGEN (LOG(PA))        FVPRS      16
      C                                                                       FVPRS      17
     20 C   - DATA BASE -                                                    FVPRS      18
      C   URANIA;                                                           FVPRS      19
      C   M. TETENBAUM AND P. D. HUNT, "TOTAL PRESSURE OF                    FVPRS      20
      C   URANIA-BEARING SPECIES OVER OXYGEN-DEFICIENT URANIA,"             FVPRS      21
      C   JOURNAL OF NUCLEAR MATERIALS, 34 (1970).                          FVPRS      22
     25 C   R. SZWARC AND R. E. LATTA, "VAPOR PRESSURE OF                   FVPRS      23
      C   HYPOSTOICHIOMETRIC URANIA AS A FUNCTION OF                        FVPRS      24
      C   COMPOSITION," JOURNAL OF THE AMERICAN CERAMIC                     FVPRS      25
      C   SOCIETY, 51 (1968).                                               FVPRS      26
      C   M. BOBER, H. U. KAROW AND K. SCHRETZMANN, "VAPOR                  FVPRS      27
     30 C   PRESSURE MEASUREMENTS OF OXIDE FUEL BETWEEN 3000 AND            FVPRS      28
      C   5000 K USING LASER HEATING LASER HEATING," NUCLEAR                FVPRS      29
      C   TECHNOLOGY, 26 (1975).                                            FVPRS      30
      C   G. T. REEDY AND M. G. CHASANOV, "TOTAL PRESSURE OF                FVPRS      31
      C   URANIUM BEARING SPECIES OVER MOLTEN URANIA,"JOURNAL               FVPRS      32
     35 C   OF NUCLEAR MATERIALS, 42 (1972).                                FVPRS      33
      C   R. J. ACKERMANN, E. G. RAUH, M. S. CHANDRASEKHARAIAH,             FVPRS      34
      C   "A THERMODYNAMIC STUDY OF THE URANIA-URANIUM SYSTEM"              FVPRS      35
      C   JOURNAL OF  PHYSICAL CHEMISTRY, 73 (1969).                        FVPRS      36
      C   G. BENEZECH, J. P. COUTURES AND M. FOX, TRANSPIRATION             FVPRS      37
     40 C   STUDY OF URANIUM DIOXIDE VAPORIZATION PROCESSES                 FVPRS      38
      C   BETWEEN 2200 K AND 2600 K, ANL-TRANS-972 (1974).                  FVPRS      39
      C   R. W. OHSE, P. G. BERRIE, H. G. BOGENSBERGER,                     FVPRS      40
      C   E. A. FISCHER, "EXTENSION OF VAPOR PRESSURE                       FVPRS      41
      C   MEASUREMENTS OF NUCLEAR FUELS (U,PU)O2 AND UO2 TO                 FVPRS      42
     45 C   7000 K FOR FAST REACTOR SAFETY ANALYSIS," JOURNAL               FVPRS      43
      C   OF NUCLEAR MATERIALS, 59 (1976).                                  FVPRS      44
      C   C. A. ALEXANDER, J. S. OGDEN, AND G. W. CUNNINGHAM,               FVPRS      45
      C   THERMAL STABILITY OF ZIRCONIA-AND THORIA BASED FUELS,             FVPRS      46
      C   BMI-1789 (1967).                                                  FVPRS      47
     50 C   R. W. OHSE, "HIGH-TEMPERATURE VAPOR-PRESSURE STUDIES            FVPRS      48
      C   OF UO2 BY THE EFFUSION METHOD AND ITS THERMODYNAMIC               FVPRS      49
      C   INTERPRETATION," JOURNAL OF CHEMICAL PHYSICS, 44                  FVPRS      50
      C   (1966).                                                           FVPRS      51
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C   D. A. BENSION, APPLICATION OF PULSED ELECTRON BEAM                FVPRS      52
55  C   VAPORIZATION TO STUDIES OF UO2, SAND-77-0429 (1977).          FVPRS      53
C   J. R. BABELOT, G. D. BRUMME, P. R. KINSMANN AND                   FVPRS      54
C   R. W. OHSE, "VAPOR PRESSURE MEASUREMENT OVER                      FVPRS      55
C   LIQUID UO2 AND (U,PU)O2 BY LASER SURFACE HEATING                  FVPRS      56
C   UP TO 5000 K," ATOMWIRTSCHAFT (1977).                             FVPRS      57
60  C                                                                 FVPRS      58
C   PLUTONIA;                                                         FVPRS      59
C   R. J. ACKERMANN, R. L. FAIRCLOTH, M. H. RAND,                     FVPRS      60
C   "A THERMODYNAMIC STUDY OF THE VAPORIZATION BEHAVIOR               FVPRS      61
C   OF THE SUBSTOICHIOMETRIC PLUTONIUM DIOXIDE PHASE,"                FVPRS      62
65  C   JOURNAL OF PYSICAL CHEMISTRY, 70 (1966).                      FVPRS      63
C   R. W. OHSE AND C. CIANI, "EVAPORATION BEHAVIOR                    FVPRS      64
C   AND HIGH-TEMPERATURE THERMAL ANALYSIS OF                          FVPRS      65
C   SUBSTOICHIOMETRIC PLUTONIUM OXIDE FOR                             FVPRS      66
C   1.51<O/PU<2.00,"THERMODYNAMICS OF NUCLEAR MATERIALS,              FVPRS      67
70  C   IAEA, VIENNA (1968).                                          FVPRS      68
C                                                                     FVPRS      69
C   OXYGEN;                                                           FVPRS      70
C   C. A. ALEXANDER, J. S. OGDEN, AND G. W. CUNNINGHAM,               FVPRS      71
C   THERMAL STABILITY OF ZIRCONIA-AND THORIA BASED FUELS,             FVPRS      72
75  C   BMI-1789 (1967).                                              FVPRS      73
C   M.TETENBAUM AND P. D. HUNT, "HIGH TEMPERATURE                     FVPRS      74
C   THERMODYNAMIC PROPERTIES OF OXYGEN-DEFICIENT                      FVPRS      75
C   URANIA," JOURNAL OF CHEMICAL PHYSICS, 49 (1968).                  FVPRS      76
C   T. L. MARKIN, V. J. WHEELER AND R. J. BONES,                      FVPRS      77
80  C   "HIGH TEMPERATURE THERMODYNAMIC DATA FOR UO2+X,"               FVPRS      78
C   JOURNAL OF INORGANIC NUCLEAR CHEMISTRY, 30 (1968).                FVPRS      79
C   V. J. WHEELER, "HIGH TEMPERATURE THERMODYNAMIC                    FVPRS      80
C   DATA FOR UO2-X," JOURNAL OF NUCLEAR MATERIALS, 39                 FVPRS      81
C   (1972).                                                           FVPRS      82
85  C   K. HAGEMARK AND M. BROLI, "EQUILIBRIUM OXYGEN                 FVPRS      83
C   PRESSURES OVER NONSTOICHIOMETRIC URANIUM OXIDES                   FVPRS      84
C   BETWEEN UO2+X AND U3O8-Z AT HIGHER TEMPERATURES,"                 FVPRS      85
C   JOURNAL OF INORGANIC NUCLEAR CHEMISTRY, 28 (1966).                FVPRS      86
C   P. E. BLACKBURN, "OXYGEN DISSOCIATION PRESSURES                   FVPRS      87
90  C   OVER URANIUM OXIDES," JOURNAL OF PHYSICAL CHEMISTRY           FVPRS      88
C   8 (1958).                                                         FVPRS      89
C   S. ARONSON AND U. BELLE, "NONSTOICHIOMETRY IN URANIUM             FVPRS      90
C   DIOXIDE," JOURNAL OF CHEMICAL PHYSICS, 29 (1958).                 FVPRS      91
C   K. KIUKKOLA, "HIGH-TEMPERATURE ELECTROCHEMICAL STUDY              FVPRS      92
95  C   OF URANIUM OXIDES IN THE UO2-U3O8 REGION," ACTA               FVPRS      93
C   CHEMICA SCANDINAVICA 16 (1962).                                   FVPRS      94
C   T. L. MARKIN AND R. J. BONES, THE DETERMINATION OF                FVPRS      95
C   SOME THERMODYNAMIC PROPERTIES OF URANIUM OXIDES                   FVPRS      96
C   WITH O/U RATIOS BETWEEN 2.00 AND 2.03 USING A                     FVPRS      97
100 C   HIGH TEMPERATURE GALVANIC CELL, AERE-R 4178 (1962).           FVPRS      98
C                                                                     FVPRS      99
C   THE CONSTANTS LISTED IN THE DATA STATEMENTS BELOW ARE FOR         FVPRS     100
C   THE FOLLOWING MATERIALS  IN THIS ORDER ;                          FVPRS     101
C                                                                     FVPRS     102
105 C   PUO2                                                          FVPRS     103
C   UO2                                                               FVPRS     104
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      C  0                                                                  FVPRS      105
      C  02                                                                 FVPRS      106
      C                                                                     FVPRS      107
110   C  PROGRAM                                                            FVPRS      108
      C                                                                     FVPRS      109
      C  CODED BY RICHARD E. MASON APRIL 1979.                              FVPRS      110
      C                                                                     FVPRS      111
            DIMENSION A(7), B(7), C(7), D(7), E(7)                          FVPRS      112
115   C                                                                     FVPRS      113
      C                                                                     FVPRS      114
      C  X < 1.99        X > 2.00                                           FVPRS      115
            DATA A /-0.5404056E+04,  0.1788581E+05,                         FVPRS      116
           +          -0.1119149E+05,  0.0         ,                       FVPRS      117
120        +           -0.4953488E+05, -0.1463821E+05,                       FVPRS      118
           +                           -0.1463821E+05/                      FVPRS      119
      C                                                                     FVPRS      120
            DATA B / 0.1816551E+02,  0.3058922E+02,                         FVPRS      121
           +          0.9993252E+01,  0.0         ,                       FVPRS      122
125        +           0.0         ,  0.0         ,                       FVPRS      123
           +                           0.0         /                       FVPRS      124
      C                                                                     FVPRS      125
            DATA C /-0.3389145E-02, -0.4706266E-02,                         FVPRS      126
           +          -0.1318286E-02,  0.0         ,                       FVPRS      127
130        +           0.0         ,  0.0         ,                       FVPRS      128
           +                           0.0         /                       FVPRS      129
      C                                                                     FVPRS      130
            DATA D /-0.1306529E+03, -0.2337348E+03,                         FVPRS      131
           +          -0.6917448E+02,  0.0         ,                       FVPRS      132
135        +           0.1518089E+02,  0.6206205E+01,                       FVPRS      133
           +                           0.6293306E+01/                       FVPRS      134
      C                                                                     FVPRS      135
            DATA E / 0.6854587E+04,  0.0         ,                          FVPRS      136
           +          0.0         ,  0.0         ,                         FVPRS      137
140        +          -0.1418138E+04,  0.2177517E+02,                       FVPRS      138
           +                           0.1803860E+01/                       FVPRS      139
      C                                                                     FVPRS      140
      C                                                                     FVPRS      141
            VAPEQN(A,B,C,D,E,X,T) = (A+E*X)/T+B*ALOG(T)+C*T+D               FVPRS      142
145         IF (FOM.LE.0.0) FOM = 2.0                                       FVPRS      143
            X = ABS(FOM-2.)                                                 FVPRS      144
            IF (FRPU.GE.1.0) GO TO 150                                      FVPRS      145
      C                                                                     FVPRS      146
      C  PARTIAL PRESSURE OF OXIDE VAPOR.                                   FVPRS      147
150   C                                                                     FVPRS      148
      C  - STOP -                                                           FVPRS      149
      C  PARTIAL PRESSURES OF MONATOMIC OXYGEN ARE CALCULATED UP            FVPRS      150
      C  TO OXYGEN TO METAL RATIOS OF 2.000 AFTER WHICH DIATOMIC            FVPRS      151
      C  OXYGEN PRESSURES ARE CALCULATED.                                   FVPRS      152
155   C                                                                     FVPRS      153
            IF (FOM.LE.1.990) GO TO 110                                     FVPRS      154
            IF (FOM.GE.2.004) GO TO 120                                     FVPRS      155
            IF (FOM.LE.2.000) GO TO 100                                     FVPRS      156
            GO TO 130                                                       FVPRS      157
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      100   CONTINUE                                                        FVPRS  158
            UOXVAP = D(5)+(A(5)+E(5)*6.9078)/FTEMP                          FVPRS  159
            DIOVAP = 0.0                                                    FVPRS  160
            GO TO 140                                                       FVPRS  161
      C                                                                     FVPRS  162
      110   CONTINUE                                                        FVPRS  163
            UOXVAP = D(5)+(A(5)+E(5)*ALOG(X))/FTEMP                         FVPRS  164
      C   FOR FOM < 1.999 THE UNCERTAINITY IS + OR - 0.801                  FVPRS  165
            DIOVAP = 0.0                                                    FVPRS  166
            GO TO 140                                                       FVPRS  167
      C                                                                     FVPRS  168
      120   CONTINUE                                                        FVPRS  169
            DIOVAP = D(6)+A(6)/FTEMP+E(6)*X                                 FVPRS  170
      C   FOR FOM < 2.004 THE UNCERTAINITY IS + OR - 0.976                  FVPRS  171
            UOXVAP = 0.0                                                    FVPRS  172
            GO TO 140                                                       FVPRS  173
      C                                                                     FVPRS  174
      130   CONTINUE                                                        FVPRS  175
            O = D(5)+(A(5)+E(5)*6.9078)/FTEMP                               FVPRS  176
            O02 = 2.*(O+13384.87/FTEMP-3.52)                                FVPRS  177
            O2 = D(7)+A(7)/FTEMP+E(7)*ALOG(2.004-FOM)                       FVPRS  178
            IF (O02.GE.O2) DIOVAP = O02                                     FVPRS  179
            IF (O02.LT.O2) DIOVAP = O2                                      FVPRS  180
            UOXVAP = 0.0                                                    FVPRS  181
      C   THE TOTAL UNCERTAINITY IS + OR - 0.0000.                          FVPRS  182
      C                                                                     FVPRS  183
      C   PARTIAL PRESSURE OF URANIA VAPOR SPECIES.                         FVPRS  184
      140   CONTINUE                                                        FVPRS  185
      C                                                                     FVPRS  186
            UO2VAP = VAPEQN(A(3),B(3),C(3),D(3),E(3),0.0,FTEMP)             FVPRS  187
      C   THE TOTAL UNCERTAINITY IS + OR - 0.206                           FVPRS  188
            IF (FRPU.LE.0.0) GO TO 160                                      FVPRS  189
      C                                                                     FVPRS  190
      C   PARTIAL PRESSURE OVER PLUTONIA                                    FVPRS  191
      150   CONTINUE                                                        FVPRS  192
            IF (FOM.GE.2.) X = 0.0                                          FVPRS  193
      C                                                                     FVPRS  194
            M = 1                                                           FVPRS  195
            PUOVAP = VAPEQN(A(1),B(1),C(1),D(1),E(1),X,FTEMP)               FVPRS  196
      C   UNCERTAINITY IS + OR - 0.559                                      FVPRS  197
            IF (FRPU.GE.1.0) GO TO 160                                      FVPRS  198
      C                                                                     FVPRS  199
      C   PARTIAL PRESSURE OF MIXED OXIDES.                                FVPRS  200
      C                                                                     FVPRS  201
            VAPMIX = ALOG10((10.**UO2VAP)*(1.-FRPU)+FRPU*(10.**PUOVAP))     FVPRS  202
      C   THE UNCERTAINITY IS + OR - 0.442                                 FVPRS  203
      C   VAPMIX = VAPEQN (A(2),B(2),C(2),D(2),E(2),X,FTEMP)                FVPRS  204
      160   CONTINUE                                                        FVPRS  205
      C                                                                     FVPRS  206
            RETURN                                                          FVPRS  207
            END                                                             FVPRS  208
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 FVAPRS 4 209

VARIABLES	SN	TYPE	RELOCATION								
252	A	REAL	ARRAY	[illegible]	114	161	166	172	178	180	189
				DEFINED	118						
261	B	REAL	ARRAY	[illegible]	114	189	198	DEFINED	123		
270	C	REAL	ARRAY	REFS	114	189	198	DEFINED	128		
277	D	REAL	ARRAY	REFS	114	161	166	172	178	180	189
				198	DEFINED	133					
0	DIOVAP	REAL	F.P.	DEFINED	4	162	168	172	181	182	
306	E	REAL	ARRAY	REFS	114	161	166	172	178	180	189
				198	DEFINED	138					
0	FOM	REAL	F.P.	REFS	145	146	156	157	158	180	195
				DEFINED	4	145					
0	FRPU	REAL	F.P.	REFS	147	191	200	2*204	DEFINED	4	
0	FTEMP	REAL	F.P.	REFS	161	166	172	178	179	180	3*189
				3*198	DEFINED	4					
251	M	* INTEGER		DEFINED	197						
246	O	REAL		REFS	179	DEFINED	178				
247	O02	REAL		REFS	2*181	182	DEFINED	179			
250	O2	REAL		REFS	181	2*182	DEFINED	180			
0	PUOVAP	REAL	F.P.	REFS	204	DEFINED	4	198			
0	UOXVAP	REAL	F.P.	DEFINED	4	161	166	174	183		
0	UO2VAP	REAL	F.P.	REFS	204	DEFINED	4	189			
0	VAPMIX	REAL	F.P.	DEFINED	4	204					
245	X	REAL		REFS	166	172	198	DEFINED	146	195	

EXTERNALS	TYPE	ARGS	REFERENCES			
ALOG	REAL	1 LIBRARY	166	180	189	198
ALOG10	REAL	1 LIBRARY	204			

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES		
ABS	REAL	1 INTRIN		146		
VAPEQN	REAL	7 SF	144	189	198	

STATEMENT LABELS		DEF LINE	REFERENCES		
34	100	160	158		
46	110	165	156		
61	120	171	157		
73	130	177	159		
133	140	187	163	169	175
150	150	194	147		
214	160	207	191	200	

STATISTICS
PROGRAM LENGTH 315B 205
140000B SCM USED

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      C                                                                      FVPRS    209
      C                                                                      FVPRS    210
            FUNCTION GTHCON (GMIX,GTEMP,GPRES,GPTHK)                         GTHCN      2
      C                                                                      GTHCN      3
      C   GTHCON CALCULATES GAS THERMAL CONDUCTIVITY AS A FUNCTION OF        GTHCN      4
      C   TEMPERATURE AND GAS FRACTION FOR SEVEN GASES:                      GTHCN      5
      C                                                                      GTHCN      6
      C   GTHCON  = OUTPUT GAS THERMAL CONDUCTIVITY (W/M-K).                 GTHCN      7
      C                                                                      GTHCN      8
      C   GMIX(I) = INPUT MOLE FRACTIONS OF THE GAS MIXTURE                  GTHCN      9
      C   THE SEVEN ELEMENTS OF GMIX MUST SUM TO 1.0                         GTHCN     10
      C   CONSTITUENT GAS NUMBER KEY                                         GTHCN     11
      C   1 HELIUM                                                           GTHCN     12
      C   2 ARGON                                                            GTHCN     13
      C   3 KRYPTON                                                          GTHCN     14
      C   4 XENON                                                            GTHCN     15
      C   5 HYDROGEN                                                         GTHCN     16
      C   6 NITROGEN                                                         GTHCN     17
      C   7 WATER VAPOR                                                      GTHCN     18
      C                                                                      GTHCN     19
      C   GTEMP   = INPUT GAS TEMPERATURE (K)                               GTHCN     20
      C   GPRES   = INPUT GAS PRESSURE (PA)                                 GTHCN     21
      C   USED FOR KNUDSEN DOMAIN CORRECTION AND FOR STEAM                  GTHCN     22
      C   NOT USED IF 0.                                                     GTHCN     23
      C   GPTHK   = INPUT EFFECTIVE GAP THICKNESS FOR KNUDSEN DOMAIN (M)     GTHCN     24
      C   (MAXIMUM OF GAP DIMENSION OR SURFACE ROUGHNESS)                    GTHCN     25
      C   NOT USED IF 0.                                                     GTHCN     26
      C                                                                      GTHCN     27
      C   FORMULA FOR GAS MIXTURES IS FROM  R.S.BROKAW, REPORT NASA TR R-81  GTHCN     28
      C   (1960). CONDUCTIVITY OF RARE GASES IS BASED ON  J.M.GANDHI AND     GTHCN     29
      C   S.C.SAXENA, JOUR. CHEM. AND ENG. DATA, VOL.13, NO.3 (1968)        GTHCN     30
      C   ALSO: WISCONSIN ELECTRIC POWER CO., DOCKET NO. 50-301 (JAN 1973)   GTHCN     31
      C   THE ACCOMMODATION FACTOR IS FROM  R.A.DEAN, CVNA-127 (1962)        GTHCN     32
      C   STEAM EQUATION IS FROM  MEYER, ET.AL., "THERMODYNAMIC AND          GTHCN     33
      C   TRANSPORT PROPERTIES OF STEAM", THE AMERICAN SOCIETY OF            GTHCN     34
      C   MECHANICAL ENGINEERS (1967)                                        GTHCN     35
      C                                                                      GTHCN     36
      C   GTHCON CODED BY R.C.YOUNG  MARCH 1975                              GTHCN     37
      C   ADAPTED FROM ROUTINE CMIX BY P.E.MACDONALD                         GTHCN     38
      C                                                                      GTHCN     39
            COMMON   / LACMDL / MAXIDX, EMFLAG                               GTHCN     40
            DIMENSION EMFLAG(1)                                              GTHCN     41
      C                                                                      GTHCN     42
            DIMENSION GMIX(7), A(7), C(7), R(7), AA(6), BB(6)                GTHCN     43
            DATA A  /4.003    , 39.944  ,83.80   ,131.30    , 2.016   ,28.8   , GTHCN     44
           +        18.016   /                                               GTHCN     45
      C   R = SQRT(A)                                                        GTHCN     46
            DATA R  /2.00075 ,  6.3201 , 9.1542  ,11.4586  , 1.41986 ,       GTHCN     47
           +         5.3666  ,  4.2445 /                                     GTHCN     48
      C                                                                      GTHCN     49
            DATA AA /1.314E-3,  1.31E-4, 1.588E-5, 1.395E-5, 5.834E-4,7.35E-5/ GTHCN     50
            DATA BB /0.668   ,  0.701  , 0.92331 , 0.872   , 0.8213  ,0.846  / GTHCN     51
            DATA EPS/1.E-9   /                                               GTHCN     52
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      C                                                                                 GTHCN      53
55          DATA      ON     / 2HON  /,                                                GTHCN      54
           +          OFF    / 3HOFF /,                                                GTHCN      55
           +          LOCIDX /  16   /                                                 GTHCN      56
      C                                                                                 GTHCN      57
            IF (EMFLAG(LOCIDX).EQ.ON) GTHCON = EMGTON(GMIX,GTEMP,GPRES,GPTHK)           GTHCN      58
60          IF (EMFLAG(LOCIDX).EQ.ON) GO TO 170                                         GTHCN      59
      C                                                                                 GTHCN      60
      C   CONVERT TEMP TO RANKINE                                                       GTHCN      61
            TR = GTEMP*1.8                                                              GTHCN      62
            IF (TR.GT.10000.) GO TO 100                                                 GTHCN      63
65          IF (TR.GT.0.0000) GO TO 110                                                 GTHCN      64
      100   WRITE (6,180) GTEMP,GMIX                                                    GTHCN      65
            STOP                                                                        GTHCN      66
      110   L = 0                                                                       GTHCN      67
      C   CALCULATE SMALL GAP CORRECTION                                               GTHCN      68
70          FACC = GPRES*GPTHK                                                          GTHCN      69
            IF (FACC.GT.EPS) FACC = SQRT(TR)*1.7863/FACC                                GTHCN      70
      C                                                                                 GTHCN      71
                DO 120 I=1,6                                                            GTHCN      72
                IF (GMIX(I).LE.EPS) GO TO 120                                           GTHCN      73
75              L = I                                                                   GTHCN      74
                C(I) = AA(I)*TR**BB(I)                                                  GTHCN      75
                IF (FACC.LE.0.) GO TO 120                                               GTHCN      76
                IF (I.EQ.1.OR.I.EQ.5) C(I) = C(I)/(1.0+C(I)*FACC)                       GTHCN      77
      120       CONTINUE                                                              GTHCN      78
80    C                                                                               GTHCN      79
            IF (GMIX(7).LE.EPS) GO TO 140                                             GTHCN      80
            L = 7                                                                     GTHCN      81
      C   STEAM                                                                       GTHCN      82
            TC = GTEMP-273.15                                                         GTHCN      83
85          C(7) = 17.6E-3+TC*(5.87E-5+TC*(1.04E-7-4.51E-11*TC))                      GTHCN      84
            IF (GPRES.LE.1.E5) GO TO 130                                              GTHCN      85
      C   USE IDEAL GAS LAW FOR DENSITY - OK FOR CORRECTION AT HIGH TEMP.            GTHCN      86
            DEN = 2.1668E-6*GPRES/GTEMP                                               GTHCN      87
            C(7) = C(7)+DEN*(103.51E-3+TC*(0.4198E-3-2.771E-8*TC)+2.1482E11*DE        GTHCN      88
90         +N/TC**4.2)                                                                GTHCN      89
      130   C(7) = C(7)/1.73073467                                                    GTHCN      90
      140   IF (L.LE.0) GO TO 100                                                     GTHCN      91
      C                                                                               GTHCN      92
            GTHCON = 0.                                                             GTHCN      93
95              DO 160 I=1,L                                                        GTHCN      94
                IF (GMIX(I).LE.EPS) GO TO 160                                       GTHCN      95
                SUM = 0.                                                            GTHCN      96
                    DO 150 J=1,L                                                    GTHCN      97
                    IF (J.EQ.I) GO TO 150                                           GTHCN      98
100                 IF (GMIX(J).LE.EPS) GO TO 150                                   GTHCN      99
                    RC = C(I)/C(J)                                                  GTHCN     100
                    RA = A(I)/A(J)                                                  GTHCN     101
                    FIJ = 1.+2.41*(RA-1.)*(RA-.142)/(1.+RA)**2                      GTHCN     102
                    GIJ = (1.+SQRT(RC*R(I)/R(J)))**2/SQRT(8.*(1.+RA))               GTHCN     103
105                 SUM = SUM+FIJ*GIJ*GMIX(J)                                       GTHCN     104
      150           CONTINUE                                                        GTHCN     105
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                GTHCON = GTHCON+C(I)*GMIX(I)/(GMIX(I)+SUM)                      GTHCN     106
            160 CONTINUE                                                        GTHCN     107
            C   CONVERT FROM BTU/HR.FT.F  TO  W/M-K                             GTHCN     108
    110       GTHCON = GTHCON*1.73073467                                        GTHCN     109
            170 CONTINUE                                                        GTHCN     110
            C                                                                   GTHCN     111
                CALL DIALOT (GTEMP,26,FDIALA,FDIALM)                            GTHCN     112
                GTHCON = (GTHCON+FDIALA)*FDIALM                                 GTHCN     113
    115         RETURN                                                          GTHCN     114
            C                                                                   GTHCN     115
            180 FORMAT (25H1GTHCON INPUT BAD. GTEMP=,1PE12.4,2H K,/10HOFRACTIONS,( GTHCN     116
               +10E12.4))                                                       GTHCN     117
                END                                                             GTHCN     118
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

5	GTHCON	3

DEF LINE: 3

REFERENCES: 115

VARIABLES

406	A	REAL	ARRAY		REFS	44	2*102	DEFINED	45			
433	AA	REAL	ARRAY		REFS	44	76	DEFINED	51			
441	BB	REAL	ARRAY		REFS	44	76	DEFINED	52			
415	C	REAL	ARRAY		REFS	44	2*78	89	91	2*101	107	
					DEFINED	76	78	85	89	91		
375	DEN	REAL			REFS	2*89	DEFINED	88				
1	EMFLAG	REAL	ARRAY	LACMDL	REFS	41	42	59	60			
320	EPS	REAL			REFS	71	74	81	96	100		
					DEFINED	53						
372	FACC	REAL			REFS	2*71	77	78	DEFINED	70	71	
404	FDIALA	REAL			REFS	113	114					
405	FDIALM	REAL			REFS	113	114					
402	FIJ	REAL			REFS	105	DEFINED	103				
403	GIJ	REAL			REFS	105	DEFINED	104				
0	GMIX	REAL	ARRAY	F.P.	REFS	44	59	66	74	81	96	100
						105	2*107	DEFINED	3			
0	GPRES	REAL		F.P.	REFS	59	70	86	88	DEFINED	3	
0	GPTHK	REAL		F.P.	REFS	59	70	DEFINED	3			
0	GTEMP	REAL		F.P.	REFS	59	63	66	84	88	113	
					DEFINED	3						
367	GTHCON	REAL			REFS	107	110	114	DEFINED	59	94	107
						110	114					
373	I	INTEGER			REFS	74	75	3*76	5*78	96	99	101
						102	104	3*107	DEFINED	73	95	
377	J	INTEGER			REFS	99	100	101	102	104	105	
					DEFINED	98						
371	L	INTEGER			REFS	92	95	98	DEFINED	68	75	82
323	LOCIDX	INTEGER			REFS	59	60	DEFINED	55			
0	MAXIDX	INTEGER		LACMDL	REFS	41						

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VARIABLES     SN  TYPE          RELOCATION
  322  OFF     *  REAL                          DEFINED    55
  321  ON        REAL                            REFS     59      60     DEFINED      55
  424  R         REAL          ARRAY             REFS     44    2*104    DEFINED      48
  401  RA        REAL                            REFS   3*103     104    DEFINED     102
  400  RC        REAL                            REFS     104   DEFINED      101
  376  SUM       REAL                            REFS     105     107    DEFINED      97      105
  374  TC        REAL                            REFS    3*85    3*89    DEFINED      84
  370  TR        REAL                            REFS      64      65        71       76    DEFINED      63

FILE NAMES      MODE
      TAPE6     FMT                        WRITES      66

EXTERNALS         TYPE    ARGS       REFERENCES
      DIALOT                4              113
      EMGTON    REAL        4               59
      SQRT      REAL        1 LIBRARY       71      2*104

STATEMENT LABELS            DEF LINE   REFERENCES
   37  100                     66         64        92
   44  110                     68         65
  106  120                     79         73        74        77
  151  130                     91         86
  154  140                     92         81
  241  150                    106         98        99       100
  252  160                    108         95        96
  260  170                    111         60
  331  180     FMT            117         66

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   60  120      I           73 79       31B              EXT REFS
  162  160      I           95 108      73B              EXT REFS  NOT INNER
  171  150      J           98 106      53B              EXT REFS

COMMON BLOCKS   LENGTH
      LACMDL         2

STATISTICS
  PROGRAM LENGTH                  455B      301
  SCM LABELED COMMON LENGTH         2B        2
        140000B SCM USED
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```
      C                                                                      GTHCN     119
      C                                                                      GTHCN     120
            FUNCTION GVISCO (GMIX,GTEMP)                                     GVSCO       2
      C                                                                      GVSCO       3
      C     GVISCO CALCULATES THE GAS VISCOSITY AS A FUNCTION OF             GVSCO       4
      C     TEMPERATURE AND GAS MOLE FRACTIONS.                              GVSCO       5
      C                                                                      GVSCO       6
      C     GVISCO  = OUTPUT GAS VISCOSITY (KG/M-S)                          GVSCO       7
      C                                                                      GVSCO       8
      C     GMIX(I) = INPUT ARRAY OF GAS MOLAR FRACTIONS                     GVSCO       9
      C     THE SEVEN ELEMENTS OF GMIX MUST SUM TO 1.0                       GVSCO      10
      C     I = 1  HELIUM                                                    GVSCO      11
      C     I = 2  ARGON                                                     GVSCO      12
      C     I = 3  KRYPTON                                                   GVSCO      13
      C     I = 4  XENON                                                     GVSCO      14
      C     I = 5  HYDROGEN                                                  GVSCO      15
      C     I = 6  NITROGEN                                                  GVSCO      16
      C     I = 7  STEAM - FROM 1967 ASME AT 1 BAR PRESSURE                  GVSCO      17
      C     GTEMP=INPUT GAS TEMPERATURE (K).                                 GVSCO      18
      C                                                                      GVSCO      19
      C     THE GAS VISCOSITY RELATIONSHIPS USED IN THIS FUNCTION            GVSCO      20
      C     ARE THOSE STATED BY BIRD,STEWART,AND LIGHTFOOT,                  GVSCO      21
      C     "TRANSPORT PHENOMENA",P 26 AND P 258 (1954).                     GVSCO      22
      C     BIRD, HIRSCHFELDER, CURTISS, TRANS. ASME 76 (1954) 1011-1038,    GVSCO      23
      C     OR   HANDBOOK OF PHYSICS, SECTION 5.5 (MCGRAW-HILL) 1954.        GVSCO      24
      C                                                                      GVSCO      25
      C     STEAM EQUATION IS FROM  MAYER, ET AL, "THERMODYNAMIC AND         GVSCO      26
      C     TRANSPORT PROPERTIES OF STEAM", THE AMERICAN SOCIETY OF          GVSCO      27
      C     MECHANICAL ENGINEERS (1967)                                      GVSCO      28
      C                                                                      GVSCO      29
      C     CODED BY R.C.YOUNG  MARCH 1975                                   GVSCO      30
      C                                                                      GVSCO      31
            DIMENSION SIGMA2(6), EOK(6), IM(6)                               GVSCO      32
            DIMENSION A(7), R(7), VIS(7), GMIX(7)                            GVSCO      33
            DIMENSION TABLE(164)                                             GVSCO      34
            DATA EPS, NT, IM / 1.E-8, 82, 6*1 /                              GVSCO      35
      C                                                                      GVSCO      36
      C     DATA SIGMA / 2.576, 3.418, 3.498, 4.055, 2.915, 3.617/           GVSCO      37
            DATA SIGMA2 / 6.635776, 11.682724, 12.236004, 16.443025,         GVSCO      38
           +              8.497225, 13.082689/                               GVSCO      39
            DATA  EOK  /  10.2,  124.,  225.,  229.,  38.0,  97.0/           GVSCO      40
            DATA   A   / 4.003,39.944, 83.80, 131.3, 2.016, 28.97, 18.016/   GVSCO      41
      C     R = SQRT(A)                                                      GVSCO      42
            DATA R / 2.00075  , 6.3201  , 9.1542  , 11.4586  , 1.41986  ,    GVSCO      43
           +         5.3666   , 4.2445  /                                    GVSCO      44
      C                                                                      GVSCO      45
            DATA TABLE / 2.785,.30, 2.626,.35, 2.492,.40, 2.368,.45, 2.257,.5, GVSCO      46
           +2.156,.55, 2.065,.60, 1.982,.65, 1.908,.70, 1.841,.75, 1.780,.80, GVSCO      47
           +1.725,.85, 1.675,.90, 1.629,.95, 1.587,1.0, 1.549,1.05, 1.514,1.1, GVSCO      48
           +1.482,1.15,1.452,1.2, 1.424,1.25,1.399,1.3, 1.375,1.35,1.353,1.4, GVSCO      49
           +1.333,1.45,1.314,1.5, 1.296,1.55,1.279,1.6, 1.264,1.65,1.248,1.7, GVSCO      50
           +1.234,1.75,1.221,1.8, 1.209,1.85,1.197,1.9, 1.186,1.95,1.175,2.0, GVSCO      51
           +1.156,2.1, 1.138,2.2, 1.122,2.3, 1.107,2.4, 1.093,2.5, 1.081,2.6, GVSCO      52
```

```
     +1.069,2.7, 1.058,2.8, 1.048,2.9, 1.039,3.0, 1.030,3.1, 1.022,3.2,   GVSCO      53
55   +1.014,3.3, 1.007,3.4, .9999,3.5, .9932,3.6, .9870,3.7, .9811,3.8,   GVSCO      54
     +.9755,3.9, .9700,4.0, .9649,4.1, .9600,4.2, .9553,4.3, .9507,4.4,   GVSCO      55
     +.9464,4.5, .9422,4.6, .9382,4.7, .9343,4.8, .9305,4.9, .9269,5.0,   GVSCO      56
     +.8963,6.0, .8727,7.0, .8538,8.0, .8378,9.0, .8242,10., .7432,20.,   GVSCO      57
     +.7005,30., .6718,40., .6504,50., .6335,60., .6194,70., .6076,80.,   GVSCO      58
60   +.5973,90., .5882,100., .5320,200., .5000,300., .4811,400./          GVSCO      59
     C                                                                    GVSCO      60
      L = 0                                                               GVSCO      61
          DO 100 I=1,6                                                    GVSCO      62
          IF (GMIX(I).LE.EPS) GO TO 100                                   GVSCO      63
65        L = I                                                           GVSCO      64
          TKOE = GTEMP/EOK(I)                                             GVSCO      65
          IF (TKOE.GT.400.) TKOE = 400.                                   GVSCO      66
          OMEGA = POLATE(TABLE,TKOE,NT,IM(I))                             GVSCO      67
          VIS(I) = 2.6693E-6*SQRT(A(I)*GTEMP)/(SIGMA2(I)*OMEGA)           GVSCO      68
70   100  CONTINUE                                                        GVSCO      69
      IF (GMIX(7).LE.EPS) GO TO 110                                       GVSCO      70
      L = 7                                                               GVSCO      71
     C   VIS(7) = 1.E-7 * ( 0.407*(GTEMP-273.15) + 80.4 )                 GVSCO      72
      VIS(7) = 0.407E-7*GTEMP-30.77E-7                                    GVSCO      73
75   C                                                                    GVSCO      74
     110  IF (L.LE.0) WRITE (6,140) GMIX,GTEMP                           GVSCO      75
          IF (L.LE.0) STOP                                                GVSCO      76
          GVISCO = 0.0                                                    GVSCO      77
     C                                                                    GVSCO      78
80        DO 130 I=1,L                                                    GVSCO      79
          IF (GMIX(I).LE.EPS) GO TO 130                                   GVSCO      80
          SUM = 0.                                                        GVSCO      81
          DO 120 J=1,L                                                    GVSCO      82
          IF (J.EQ.I) GO TO 120                                           GVSCO      83
85        IF (GMIX(J).LE.EPS) GO TO 120                                   GVSCO      84
          RV = VIS(I)/VIS(J)                                              GVSCO      85
          PHI = (1.+SQRT(RV*R(J)/R(I)))**2/SQRT(8.*(1.+A(I)/A(J)))        GVSCO      86
          SUM = SUM+GMIX(J)*PHI                                           GVSCO      87
     120  CONTINUE                                                        GVSCO      88
90   GVISCO = GVISCO+GMIX(I)*VIS(I)/(GMIX(I)+SUM)                        GVSCO      89
     130  CONTINUE                                                        GVSCO      90
     C                                                                    GVSCO      91
      CALL DIALOT (GTEMP,27,FDIALA,FDIALM)                               GVSCO      92
      GVISCO = (GVISCO+FDIALA)*FDIALM                                    GVSCO      93
95    RETURN                                                            GVSCO      94
     C                                                                    GVSCO      95
     140  FORMAT (28H ERROR IN GVISCO WITH GMIX= ,7(E10.4,3X),/,12H AND GTEM GVSCO      96
     +P= ,E10.4)                                                         GVSCO      97
      END                                                                GVSCO      98
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE      REFERENCES
    5  GVISCO            3       95

VARIABLES     SN  TYPE          RELOCATION
  273  A          REAL        ARRAY                    REFS      34      69      2*87    DEFINED     42
  257  EOK        REAL        ARRAY                    REFS      33      66    DEFINED     41
  207  EPS        REAL                                 REFS      64      71        81        85    DEFINED     36
  247  FDIALA     REAL                                 REFS      93      94
  250  FDIALM     REAL                                 REFS      93      94
    0  GMIX       REAL        ARRAY       F.P.         REFS      34      64        71        76        81        85        88
                                                       2*90    DEFINED       3
    0  GTEMP      REAL                    F.P.         REFS      66      69        74        76        93
                                                     DEFINED       3
  236  GVISCO     REAL                                 REFS      90      94    DEFINED     78        90        94
  240  I          INTEGER                              REFS      64      65        66        68      3*69        81        84
                                                         86    2*87    3*90    DEFINED     63        80
  265  IM         INTEGER     ARRAY                    REFS      33      68    DEFINED     36
  244  J          INTEGER                              REFS      84      85        86      2*87        88
                                                     DEFINED      83
  237  L          INTEGER                              REFS      76      77        80        83    DEFINED     62        65
                                                         72
  210  NT         INTEGER                              REFS      68  DEFINED       36
  242  OMEGA      REAL                                 REFS      69  DEFINED       68
  246  PHI        REAL                                 REFS      89  DEFINED       87
  302  R          REAL        ARRAY                    REFS      34    2*87    DEFINED     44
  245  RV         REAL                                 REFS      87  DEFINED       86
  251  SIGMA2     REAL        ARRAY                    REFS      33      69    DEFINED     39
  243  SUM        REAL                                 REFS      88      90    DEFINED     82        88
  320  TABLE      REAL        ARRAY                    REFS      35      68    DEFINED     47
  241  TKOE       REAL                                 REFS      67      68    DEFINED     66        67
  311  VIS        REAL        ARRAY                    REFS      34    2*86        90    DEFINED     69        74

FILE NAMES        MODE
      TAPE6       FMT                        WRITES       76

EXTERNALS           TYPE    ARGS       REFERENCES
      DIALOT                   4             93
      POLATE      REAL         4             68
      SQRT        REAL         1 LIBRARY     69        2*87

STATEMENT LABELS                 DEF LINE    REFERENCES
   46  100                           70          63          64
   63  110                           76          71
  143  120                           89          83          84          85
  154  130                           91          80          81
  216  140       FMT                 97          76

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   14  100      I           63 70       358                 EXT REFS
   75  130      I           80 91       628                 EXT REFS   NOT INNER
  104  120      J           83 89       428                 EXT REFS
```

STATISTICS
PROGRAM LENGTH 574B 380
140000B SCM USED

```
      C                                                                      GVSCO      99
      C                                                                      GVSCO     100
            SUBROUTINE ZOEMIS (CTMAX,ZROXID,EMISSV)                          ZOMIS       2
      C                                                                      ZOMIS       3
      C     ZOEMIS CALCULATES THE EMISSIVITY OF THE CLADDING SURFACE         ZOMIS       4
      C     AS A FUNCTION OF MAXIMUM CLADDING TEMPERATURE AND                ZOMIS       5
      C     OXIDE THICKNESS.  EXPECTED STANDARD ERROR OF THE                 ZOMIS       6
      C     CALCULATED EMISSIVITY COMPARED TO IN-REACTOR                     ZOMIS       7
      C     DATA IS ALSO RETURNED.                                           ZOMIS       8
      C                                                                      ZOMIS       9
      C     EMISSV = OUTPUT CLADDING SURFACE EMISSIVITY (UNITLESS)           ZOMIS      10
      C     PUEMIS = OUTPUT POSITIVE STANDARD ERROR EXPECTED IN EMISSV       ZOMIS      11
      C     WHEN COMPARED TO IN-REACTOR DATA (NOT CURRENTLY RETURNED)        ZOMIS      12
      C     UUEMIS = OUTPUT NEGATIVE STANDARD ERROR EXPECTED IN EMISSV       ZOMIS      13
      C     WHEN COMPARED TO IN-REACTOR DATA (NOT CURRENTLY RETURNED)        ZOMIS      14
      C                                                                      ZOMIS      15
      C     CTMAX  = INPUT MAXIMUM CLADDING TEMPERATURE (K)                  ZOMIS      16
      C     ZROXID = INPUT OXIDE LAYER THICKNESS (M)                         ZOMIS      17
      C                                                                      ZOMIS      18
      C     THE EQUATIONS USED IN THIS SUBROUTINE ARE BASED ON DATA FROM     ZOMIS      19
      C     (1) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM PROGRESS         ZOMIS      20
      C     REPORT NO. 76, USAEC REPORT GEMP - 1006 (1968). SECTION BY       ZOMIS      21
      C     E. F. JUENKE AND S. J. SJODAHL, P  239                           ZOMIS      22
      C     (2) T. B. BURGOYNE AND A. GARLICK, PAPER PRESENTED AT            ZOMIS      23
      C     SPECIALISTS MEETING ON THE BEHAVIOUR OF WATER REACTOR            ZOMIS      24
      C     FUEL ELEMENTS UNDER ACCIDENT CONDITIONS, SPATIND NORWAY          ZOMIS      25
      C     (SEPTEMBER 1976)                                                 ZOMIS      26
      C     (3) E. V. MURPHY AND F. HAVELOCK, EMISSIVITY OF ZIRCONIUM        ZOMIS      27
      C     ALLOYS IN AIR IN THE TEMPERATURE RANGE 100 - 400 C               ZOMIS      28
      C     J. NUC. MAT., 60 (1976) PP 167-176                               ZOMIS      29
      C                                                                      ZOMIS      30
      C     ZOEMIS CODED BY R. L. MILLER SEPT 1974                           ZOMIS      31
      C     MODIFIED BY D. L. HAGRMAN OCTOBER 1976                           ZOMIS      32
      C                                                                      ZOMIS      33
      C     MODEL FOR TEMPERATURES BELOW 1500K FOLLOWS                       ZOMIS      34
            IF (ZROXID.GE.3.88E-06) GO TO 100                                ZOMIS      35
            EMISSV = 3.25E-01+1.246E05*ZROXID                                ZOMIS      36
            GO TO 110                                                        ZOMIS      37
      100   EMISSV = 8.08642E-01-5.00E01*ZROXID                              ZOMIS      38
      110   PUEMIS = 0.1                                                     ZOMIS      39
            UUEMIS = 0.1                                                     ZOMIS      40
            IF (CTMAX.LE.1500.) GO TO 120                                    ZOMIS      41
      C                                                                      ZOMIS      42
      C     MODIFICATION FOR MAXIMUM TEMPERATURES ABOVE 1500 K FOLLOWS       ZOMIS      43
            EMISSV = EMISSV*EXP((1.50E03-CTMAX)/3.00E02)                     ZOMIS      44
            IF (EMISSV.LT.0.325) EMISSV = 0.325                              ZOMIS      45
            PUEMIS = PUEMIS/EXP((1.50E03-CTMAX)/3.00E02)                     ZOMIS      46
            UUEMIS = PUEMIS                                                  ZOMIS      47
      C                                                                      ZOMIS      48
      C     STANDARD ERROR CUT OFF AT IMPOSSIBLE VALUES FOLLOWS              ZOMIS      49
            IF (PUEMIS.GT.(1.00-EMISSV)) PUEMIS = 1.00-EMISSV                ZOMIS      50
            IF (UUEMIS.GT.EMISSV) UUEMIS = EMISSV                            ZOMIS      51
      C                                                                      ZOMIS      52
```

```
                120   CALL DIALOT (CTMAX,15,FDIALA,FDIALM)                    ZOMIS      53
     55               EMISSV = (EMISSV+FDIALA)*FDIALM                         ZOMIS      54
                      RETURN                                                  ZOMIS      55
                      END                                                     ZOMIS      56
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	ZOEMIS	3	56

VARIABLES	SN	TYPE	RELOCATION									
0	CTMAX	REAL	F.P.	REFS	42	45	47	54	DEFINED	3		
0	EMISSV	REAL	F.P.	REFS	45	46	2*51	2*52	55			
				DEFINED	3	37	39	45	46	55		
123	FDIALA	REAL		REFS	54	55						
124	FDIALM	REAL		REFS	54	55						
121	PUEMIS	REAL		REFS	47	48	51	DEFINED	40	47	51	
122	UUEMIS	REAL		REFS	52	DEFINED	41	48	52			
0	ZROXID	REAL	F.P.	REFS	36	37	39	DEFINED	3			

EXTERNALS	TYPE	ARGS		REFERENCES	
DIALOT		4		54	
EXP	REAL	1	LIBRARY	45	47

STATEMENT LABELS		DEF LINE	REFERENCES
17	100	39	36
24	110	40	38
67	120	54	42

STATISTICS

PROGRAM LENGTH	125B	85

140000B SCM USED

```
      C                                                                 ZOMIS      57
      C                                                                 ZOMIS      58
            FUNCTION ZOTCON (CTEMP)                                     ZTCN        2
      C                                                                 ZTCN        3
      C   ZOTCON CALCULATES ZIRCONIUM DIOXIDE THERMAL CONDUCTIVITY AS A ZTCN        4
      C   FUNCTION OF TEMPERATURE.                                      ZTCN        5
      C                                                                 ZTCN        6
      C   ZOTCON = OUTPUT THERMAL CONDUCTIVITY OF ZRO2 (W/M-K)          ZTCN        7
      C   CTEMP  = INPUT CLADDING MESHPOINT TEMPERATURE (K)             ZTCN        8
      C                                                                 ZTCN        9
      C   THE DATA USED TO GENERATE THIS CORRELATION WERE TAKEN FROM:   ZTCN       10
      C   W.D. KINGERY, J. FRANCL, R.L. COBLE AND T. VASILOS            ZTCN       11
      C   J. AMER. CERAM. SOC., 37 NO.1 (1954) PP 107-110               ZTCN       12
      C                                                                 ZTCN       13
      C   ZOTCON WAS CODED BY R.L.MILLER IN MARCH 1974.                 ZTCN       14
      C   MODIFIED BY R.L. MILLER  MAY 1974                             ZTCN       15
      C                                                                 ZTCN       16
      C   USE CAUTION ABOVE 1700K                                       ZTCN       17
      C                                                                 ZTCN       18
            T = CTEMP                                                   ZTCN       19
            ZOTCON = 1.9599-T*(2.41E-4-T*(6.43E-7-T*1.946E-10))         ZTCN       20
            CALL DIALOT (CTEMP,16,FDIALA,FDIALM)                        ZTCN       21
            ZOTCON = (ZOTCON+FDIALA)*FDIALM                             ZTCN       22
            RETURN                                                      ZTCN       23
            END                                                         ZTCN       24
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	ZOTCON	3	24

VARIABLES	SN	TYPE	RELOCATION						
0	CTEMP	REAL	F.P.	REFS	20	22	DEFINED	3	
42	FDIALA	REAL		REFS	22	23			
43	FDIALM	REAL		REFS	22	23			
41	T	REAL		REFS	3*21	DEFINED	20		
40	ZOTCON	REAL		REFS	23	DEFINED	21	23	

EXTERNALS	TYPE	ARGS	REFERENCES
DIALOT		4	22

STATISTICS

PROGRAM LENGTH 44B 36

140000B SCM USED

```
      SUBROUTINE EMCTON (CTEMP,TIME,FLUX,COLDW,CCON,CDKDT)                  EMCTN      2
C                                                                           EMCTN      3
C   CTHCON CALCULATES CLADDING THERMAL CONDUCTIVITY AS A FUNCTION OF        EMCTN      4
C   TEMPERATURE.          VERSION OF MATPRO3                                EMCTN      5
C                                                                           EMCTN      6
C   CTEMP = INPUT CLADDING MESHPOINT TEMPERATURE (DEG K)                    EMCTN      7
C   FLUX = INPUT FAST NEUTRON FLUX, N/M**2-SEC.                             EMCTN      8
C   TIME = INPUT TIME AT TEMPERATURE AND FLUX, SECONDS.                     EMCTN      9
C   CCON = OUTPUT THERMAL CONDUCTIVITY OF ZIRCALOY-4, WATTS/M-K             EMCTN     10
C   CDKDT= OUTPUT DIRIVITIVE OF THERMAL CONDUCTIVITY WITH                   EMCTN     11
C   RESPECT TO TEMPERATURE                                                  EMCTN     12
C                                                                           EMCTN     13
C   THE DATA USED TO GENERATE THIS THIRD DEGREE CORRELATION OF              EMCTN     14
C   THERMAL CONDUCTIVITY AS A FUNCTION OF TEMPERATURE WERE TAKEN FROM       EMCTN     15
C   (1) J.N. CHIRIGOS, ET AL. DEVELOPMENT OF ZIRCALOY-4, FUEL ELEMENT       EMCTN     16
C   FABRICATION-I, INTERNATIONAL ATOMIC ENERGY AGENCY, 196!, P 45.          EMCTN     17
C   (2) A.D. FEITH, HIGH TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT      EMCTN     18
C   NO 61, GE-NMPO, USAEC REPORT GEMP-61, SEPT 30, 1966, P 153.             EMCTN     19
C                                                                           EMCTN     20
C   CTHCON WAS CODED BY R.L MILLER IN MARCH 1974.                           EMCTN     21
C   MODIFIED BY R.L.MILLER, APRIL "74, MAY "74                              EMCTN     22
C                                                                           EMCTN     23
C   USE CORRELATION ABOVE 1500C WITH CAUTION.                               EMCTN     24
C                                                                           EMCTN     25
      T = CTEMP                                                             EMCTN     26
      CCON = -3.198E0+T*(5.117E-2-T*(4.114E-5-1.522E-8*T))                  EMCTN     27
      CDKDT = 5.177E-2+T*(-8.228E-5+T*4.566E-8)                             EMCTN     28
      RETURN                                                                EMCTN     29
      END                                                                   EMCTN     30
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	EMCTON	1	28

VARIABLES

	SN	TYPE		RELOCATION						
0	CCON	REAL		F.P.	DEFINED	1	26			
0	CDKDT	REAL		F.P.	DEFINED	1	27			
0	COLDW	REAL	*UNUSED	F.P.	DEFINED	1				
0	CTEMP	REAL		F.P.	REFS	25	DEFINED	1		
0	FLUX	REAL	*UNUSED	F.P.	DEFINED	1				
33	T	REAL			REFS	3*26	2*27	DEFINED	25	
0	TIME	REAL	*UNUSED	F.P.	DEFINED	1				

STATISTICS

PROGRAM LENGTH 348 28

140000B SCM USED

```
      FUNCTION EMCPIR (CTEMP)                                                EMCPR  2
C                                                                            EMCPR  3
C     FUNCTION COMPUTES POISSON"S RATIO                                      EMCPR  4
C     T = CLADDING TEMPERATURE (KELVIN)                                      EMCPR  5
C                                                                            EMCPR  6
C     THIS FUNCTION IS A CONVERSION TO KELVIN TEMPERATURES OF                EMCPR  7
C     AN EXPRESSION RECOMMENDED FOR USE IN EVALUATION MODELS                 EMCPR  8
C     BY F.COFFMAN OF AEC-REGULATORY, APRIL 1974.                            EMCPR  9
C     CPOIR=.32+5.E-5*T     (FAHRENHEIT)                                     EMCPR 10
      T = CTEMP                                                              EMCPR 11
C                                                                            EMCPR 12
      CPOIR = 0.32E0+5.E-5*(T*1.8-459.67E0)                                  EMCPR 13
      EMCPIR = CPOIR                                                         EMCPR 14
      RETURN                                                                 EMCPR 15
      END                                                                    EMCPR 16
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	EMCPIR	1	14

VARIABLES	SN	TYPE	RELOCATION					
27	CPOIR	REAL			REFS	13	DEFINED	12
0	CTEMP	REAL		F.P.	REFS	10	DEFINED	1
25	EMCPIR	REAL			DEFINED	13		
26	T	REAL			REFS	12	DEFINED	10

STATISTICS
PROGRAM LENGTH 30B 24
140000B SCM USED

```
      C                                                                          EMCPR   17
            FUNCTION EMCTXP (CTEMP)                                              EMCXP    2
      C                                                                          EMCXP    3
      C   CTEMP = INPUT CLADDING TEMPERATURE (K)                                 EMCXP    4
      C   CTHEXP = OUTPUT TOTAL THERMAL STRAIN OF ZIRCALOY CLAD, NO UNITS.      EMCXP    5
      C   = ( L(CTEMP) - L(293) ) / L(293)                                       EMCXP    6
      C                                                                          EMCXP    7
      C   THIS FUNCTION IS A CONVERSION TO KELVIN TEMPERATURES OF               EMCXP    8
      C   AN EXPRESSION RECOMMENDED FOR USE IN EVALUATION MODELS                 EMCXP    9
      C   BY F.COFFMAN OF AEC-REGULATORY, APRIL 1974.                            EMCXP   10
      C   FOR CLADDING HEATED FROM TI TO T2 (FAHRENHEIT) --                      EMCXP   11
      C   CTH = 3.2E-6*(T2-TI)                    , T2.LE.1550 F                 EMCXP   12
      C   = 3.2E-6*(1550.-TI)                  , 1550.LT. T2 .LE.1775F           EMCXP   13
      C   = 3.2E-6*(1550.-TI) + 5.3E-6*(T2-1775)  , T2.GT.1775 F                 EMCXP   14
      C                                                                          EMCXP   15
            DATA TO   ,    TA       ,    TB       ,   CA    ,   CB    /         EMCXP   16
           + 293.15E0, 1116.4833E0, 1241.4833E0, 5.76E-6, 9.54E-6/              EMCXP   17
      C                                                                          EMCXP   18
            T = CTEMP-TO                                                         EMCXP   19
            CTHEXP = CA*T                                                        EMCXP   20
            IF (CTEMP.LE.TA) RETURN                                              EMCXP   21
            CTHEXP = CA*(TA-TO)                                                  EMCXP   22
            T = CTEMP-TB                                                         EMCXP   23
            IF (T.LE.0.) RETURN                                                  EMCXP   24
            CTHEXP = CTHEXP+CB*T                                                 EMCXP   25
            EMCTXP = CTHEXP                                                      EMCXP   26
            RETURN                                                               EMCXP   27
            END                                                                  EMCXP   28
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    5  EMCTXP          2       21        24        27

VARIABLES     SN  TYPE          RELOCATION
   42  CA         REAL                        REFS      20      22    DEFINED     16
   43  CB         REAL                        REFS      25  DEFINED     16
    0  CTEMP      REAL                F.P.    REFS      19      21      23    DEFINED      2
   46  CTHEXP     REAL                        REFS      25      26    DEFINED     20      22      25
   44  EMCTXP     REAL                    DEFINED       26
   45  T          REAL                        REFS      20      24      25    DEFINED     19      23
   40  TA         REAL                        REFS      21      22    DEFINED     16
   41  TB         REAL                        REFS      23  DEFINED     16
   37  TO         REAL                        REFS      19      22    DEFINED     16

STATISTICS
  PROGRAM LENGTH                  478       39
        140000B SCM USED
```

```
      FUNCTION EMFCP (FTEMP,FACMOT,FTMELT)
C
C     FCP CALCULATES FUEL HEAT CAPACITY FOR U02 AS A FUNCTION OF
C     TEMPERATURE ONLY
C
C     FTEMP    =  INPUT FUEL TEMPERATURE (K)
C
C
C     THIS HEAT CAPACITY RELATION IS TAKEN FROM THE WREM DOCUMENT
C     TABLE 2.4 PAGE 2-30.
C
C     WREM; WATER REACTOR EVALUATION MODEL  ( REVISION 1 ) MAY1975.
C     NUREG-75/056
C
C     FCP WAS CODED BY B.W. BURNHAM  JULY 1978.
C
C
      DIMENSION  XY(32)
C
      DATA       NN ,IK  /   16   , 1          /
C     DATA       XY      /  34.45  ,    32.0
     +                        38.35  ,   122.0  ,
     +                        40.95  ,   212.0  ,
     +                        43.55  ,   392.0  ,
     +                        46.80  ,   752.0  ,
     +                        51.35  ,  2012.0  ,
     +                        52.65  ,  2732.0  ,
     +                        56.55  ,   309
     +    2.0  ,
     +     3452.0  ,
     +    0   ,  3812.0  ,
     +    09.70   ,  4352.0  ,
     +        94.25   ,  4532.0  ,
     +            98.15   ,  4712.0  ,
     +                100.10   ,  4892.0  ,
     +                    101.40   ,  5144.0  ,
     +                        101.40   , 8000.0   /
C
C     CONVERT THE INPUT TEMPERATURE FROM  K  TO  F .
C
      XX = FTEMP*1.8E0-459.67E0
C
C     SET THE INDEX TO EXTRAPOLATE FROM THE TABLE
C
      NG = -NN
C
C     CALL POLATE AND RETURN
```

```
                C
     55               EMFCP = POLATE(XY,XX,NG,IK)
                      RETURN
                      END
```

```
EMFCP      55
EMFCP      56
EMFCP      57
EMFCP      58
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	EMFCP	1	56

VARIABLES	SN	TYPE		RELOCATION							
32	EMFCP	REAL				DEFINED	55				
0	FACMOT	REAL	*UNUSED	F.P.		DEFINED	1				
0	FTEMP	REAL		F.P.		REFS	47	DEFINED	1		
0	FTMELT	REAL	*UNUSED	F.P.		DEFINED	1				
27	IK	INTEGER				REFS	55	DEFINED	24		
34	NG	INTEGER				REFS	55	DEFINED	51		
26	NN	INTEGER				REFS	51	DEFINED	24		
33	XX	REAL				REFS	55	DEFINED	47		
35	XY	REAL	ARRAY			REFS	21	55	DEFINED	26	

EXTERNALS	TYPE	ARGS	REFERENCES
POLATE	REAL	4	55

STATISTICS
PROGRAM LENGTH 75B 61
140000B SCM USED

```
      C                                                                 EMFCP    59
            FUNCTION EMFEOD (FTEMP,FRADEN)                              EMFD      2
      C                                                                 EMFD      3
      C   FELMOD CALCULATES FUEL ELASTIC MODULUS AS A FUNCTION OF       EMFD      4
      C   TEMPERATURE AND FRACTIONAL DENSITY.                           EMFD      5
      C                                                                 EMFD      6
      C   FTEMP=INPUT FUEL TEMPERATURE(K)                               EMFD      7
      C   FRADEN=INPUT FRACTIONAL FUEL DENSITY(RATIO OF ACTUAL DENSITY TO EMFD      8
      C   THEORTICAL DENSITY)                                           EMFD      9
      C   FELMOD=OUTPUT FUEL MODULUS OF ELASTICITY(N/M**2).             EMFD     10
      C                                                                 EMFD     11
      C   THE MODULUS OF ELASTICITY RELATIONSHIP USED IN THIS SUBROUTINE IS EMFD 12
      C   BASED ON THE CORRELATIONS PRESENTED BY D. VOLLATH IN EURFNR-968. EMFD 13
      C   THE TEMPERATURE DEPENDENCE IS GIVEN TO 1973K,CONSEQUENTLY ABOVE EMFD 14
      C   2000K THE ROUTINE ASSUMES A CONSTANT VALUE OF 7.0E8 N/M**2.   EMFD     15
      C                                                                 EMFD     16
      C   FELMOD WAS CODED BY V.F.BASTON IN MARCH 1974.                 EMFD     17
      C   RECODED BY R.C.YOUNG, MAR 1975.                               EMFD     18
      C                                                                 EMFD     19
            IF (FTEMP.GT.2000.) GO TO 110                               EMFD     20
      C   T = FTEMP           D = FRADEN                                EMFD     21
      C   FELMOD=(1671500-924.4*(T-273.15))*(1.-2.28*(1.-D))/1.02D-5   EMFD     22
            FELMOD = (1.8863E11-9.0627E7*FTEMP)*(2.28E0*FRADEN-1.28E0)  EMFD     23
      100   EMFEOD = FELMOD                                             EMFD     24
            RETURN                                                      EMFD     25
      110   FELMOD = 7.0E8                                              EMFD     26
            GO TO 100                                                   EMFD     27
            END                                                         EMFD     28
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	EMFEOD	2	25

VARIABLES	SN	TYPE	RELOCATION						
37	EMFEOD	REAL		DEFINED	24				
40	FELMOD	REAL		REFS	24	DEFINED	23		26
0	FRADEN	REAL	F.P.	REFS	23	DEFINED	2		
0	FTEMP	REAL	F.P.	REFS	20	23	DEFINED	2	

STATEMENT LABELS		DEF LINE	REFERENCES
22	100	24	27
26	110	26	20

STATISTICS

PROGRAM LENGTH 418 33

140000B SCM USED

```
FUNCTION EMFPIR     76/176  OPT=0 TRACE STATIC          FTN 4.8+508       10/21/80  14.34.01       PAGE     1

      1          C                                                                          EMFD       29
                       FUNCTION EMFPIR (FTEMP)                                            EMFPR       2
                 C                                                                        EMFPR       3
                 C     FPOIR RETURNS POISSON'S  RATIO FOR UO2.                            EMFPR       4
      5          C                                                                        EMFPR       5
                 C     FTEMP=INPUT FUEL TEMPERATURE(K).                                   EMFPR       6
                 C     FPOIR=OUTPUT POISSON'S  RATIO FOR UO2.                             EMFPR       7
                 C                                                                        EMFPR       8
                 C     POISSON'S RATIO FOR UO2 USED IN THIS ROUTINE WAS EVALUATED         EMFPR       9
     10          C     FROM THE MEAN OF THE DATA PRESENTED BY WATCHMAN ET AL.             EMFPR      10
                 C     REFERENCE:WATCHMAN ET AL.,JOURNAL OF NUCLEAR MATERIALS VOL.16(1)   EMFPR      11
                 C     PP.39-41(1965).                                                    EMFPR      12
                 C                                                                        EMFPR      13
                 C     FPOIR WAS CODED BY V.F.BASTON IN MARCH 1974.                       EMFPR      14
     15          C                                                                        EMFPR      15
                       EMFPIR = 0.316                                                     EMFPR      16
                       RETURN                                                             EMFPR      17
                       END                                                                EMFPR      18


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    5  EMFPIR          2       17

VARIABLES     SN  TYPE           RELOCATION
   13  EMFPIR     REAL                        DEFINED       16
    0  FTEMP      REAL       *UNUSED    F.P.  DEFINED        2

STATISTICS
  PROGRAM LENGTH                  148      12
        140000B SCM USED
```

```
      C                                                                      EMFPR      19
        FUNCTION EMFESS (FTEMP)                                              EMFS        2
      C                                                                      EMFS        3
      C   FEMISS CALCULATES FUEL EMISSIVITY AS A FUNCTION OF TEMPERATURE.   EMFS        4
      C                                                                      EMFS        5
      C   FTEMP=INPUT FUEL TEMPERATURE(K)                                    EMFS        6
      C   FEMISS=OUTPUT FUEL EMISSIVITY(UNITLESS,RATIO OF RADIANCE)          EMFS        7
      C                                                                      EMFS        8
      C   THE EMISSIVITY RELATIONSHIP USED IN THIS SUBROUTINE IS A FIFTH     EMFS        9
      C   ORDER POLYNOMIAL FIT TO THE TABULATED DATA PRESENTED BY J.BELLE    EMFS       10
      C   (900K<FTEMP<2300K):  REFERENCE; U02 PROPERTIES AND NUCLEAR         EMFS       11
      C   APPLICATIONS,BY J.BELLE P.197.                                     EMFS       12
      C                                                                      EMFS       13
      C   FEMISS WAS CODED BY V.F.BASTON IN MARCH 1974.                      EMFS       14
      C   CODING REVISED BY R.C.YOUNG  NOV 74.                               EMFS       15
      C                                                                      EMFS       16
        DATA     A,          B,          C,          D,          E,          F/EMFS       17
       + 19.324E0, -6.68E-2, 9.396E-5, -6.397E-8, 2.10E-11, -2.667E-15/     EMFS       18
        DATA T1,     E1 ,     T2,     E2 /                                   EMFS       19
       +   900., 0.83E0, 2300., 0.40E0/                                      EMFS       20
      C                                                                      EMFS       21
        T = FTEMP                                                            EMFS       22
        IF (T.LT.T1) GO TO 100                                               EMFS       23
        IF (T.GT.T2) GO TO 110                                               EMFS       24
        FEMISS = A+T*(B+T*(C+T*(D+T*(E+T*F))))                               EMFS       25
        GO TO 120                                                            EMFS       26
  100   FEMISS = E1                                                          EMFS       27
        GO TO 120                                                            EMFS       28
  110   FEMISS = E2                                                          EMFS       29
  120   EMFESS = FEMISS                                                      EMFS       30
        RETURN                                                               EMFS       31
        END                                                                  EMFS       32
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
5	EMFESS	2	31

VARIABLES	SN	TYPE	RELOCATION							
44	A	REAL		REFS	25	DEFINED	17			
45	B	REAL		REFS	25	DEFINED	17			
46	C	REAL		REFS	25	DEFINED	17			
47	D	REAL		REFS	25	DEFINED	17			
50	E	REAL		REFS	25	DEFINED	17			
56	EMFESS	REAL		DEFINED	30					
53	E1	REAL		REFS	27	DEFINED	19			
55	E2	REAL		REFS	29	DEFINED	19			
51	F	REAL		REFS	25	DEFINED	17			
60	FEMISS	REAL		REFS	30	DEFINED	25	27	29	

VARIABLES	SN	TYPE	RELOCATION							
0	FTEMP	REAL	F.P.	REFS	22	DEFINED	2			
57	T	REAL		REFS	23	24	5*25	DEFINED	22	
52	T1	REAL		REFS	23	DEFINED	19			
54	T2	REAL		REFS	24	DEFINED	19			

STATEMENT LABELS		DEF LINE	REFERENCES	
32	100	27	23	
36	110	29	24	
41	120	30	26	28

STATISTICS
PROGRAM LENGTH 61B 49
140000B SCM USED

```
      SUBROUTINE EMFTON (FTEMP,FRADEN,FTMELT,CON,DKDT)                  EMFTN     2
C                                                                       EMFTN     3
C     EMFTON CALCULATES FUEL THERMAL CONDUCTIVITY AS A FUNCTION OF      EMFTN     4
C     TEMPERATURE AND FRACTIONAL DENSITY.                               EMFTN     5
C                                                                       EMFTN     6
C     FTEMP=INPUT FUEL TEMPERATURE(K)                                   EMFTN     7
C     FRADEN=INPUT FRACTIONAL FUEL DENSITY(RATIO OF ACTUAL DENSITY TO   EMFTN     8
C     THEORTICAL DENSITY)                                               EMFTN     9
C     FTMELT= FUEL MELTING POINT                                        EMFTN    10
C     CON= OUTPUT FUEL THERMAL CONDUCTIVITY (W/M*K)                     EMFTN    11
C     DKDT= OUTPUT DIRIVITIVE OF FUEL THERMAL CONDUCTIVITY WITH         EMFTN    12
C     RESPECT TO TEMPERATURE   (W/M*K*K)                                EMFTN    13
C                                                                       EMFTN    14
C     THE THERMAL CONDUCTIVITY RELATIONSHIP USED IN THIS SUBROUTINE IS  EMFTN    15
C     BASED ON THE DATA OF LYONS ET AL. PLUS THE MAXWELL-EUCKEN         EMFTN    16
C     CORRECTION FOR POROSITY WITH A PORE SHAPE COEFFICIENT OF 0.5 .    EMFTN    17
C     REFERENCES;TRANS.AM.NUC.SOC.VOL7 NO.1 P.107 JUNE 1966 AND         EMFTN    18
C     BNWL-1778.                                                        EMFTN    19
C                                                                       EMFTN    20
C     FTHCON(EMFTON) WAS CODED BY V.F.BASTON IN MARCH 1974.             EMFTN    21
C     CODING REVISED BY R.C.YOUNG - NOV 74                              EMFTN    22
C                                                                       EMFTN    23
C     BETA = POROSITY COEFF.    PC100= (1.025/0.95)*100.                EMFTN    24
      DATA BETA,    PC100   ,   A     ,    B    ,  C       /           EMFTN    25
     +      0.5, 1.078947E2, 38.24E0, 129.4E0, 6.125E-13/               EMFTN    26
      IF (FTEMP.GT.FTMELT) GO TO 100                                    EMFTN    27
      CON = (PC100*FRADEN/(1.+BETA*(1.-FRADEN)))*(A/(B+FTEMP)+C*(FTEMP** EMFTN    28
     +3))                                                               EMFTN    29
      DKDT = (PC100*FRADEN/(1.+BETA*(1.-FRADEN)))*(3.*C*(FTEMP**2)-A/((B EMFTN    30
     ++FTEMP)**2))                                                      EMFTN    31
      GO TO 110                                                         EMFTN    32
  100 CON = 3.0                                                         EMFTN    33
      DKDT = 0.0                                                        EMFTN    34
  110 RETURN                                                            EMFTN    35
      END                                                               EMFTN    36
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	EMFTON	1	34

VARIABLES

		SN	TYPE	RELOCATION						
51	A		REAL		REFS	27	29	DEFINED	24	
52	B		REAL		REFS	27	29	DEFINED	24	
47	BETA		REAL		REFS	27	29	DEFINED	24	
53	C		REAL		REFS	27	29	DEFINED	24	
0	CON		REAL	F.P.	DEFINED	1	27	32		
0	DKDT		REAL	F.P.	DEFINED	1	29	33		
0	FRADEN		REAL	F.P.	REFS	2*27	2*29	DEFINED	1	

```
VARIABLES     SN  TYPE          RELOCATION
    0  FTEMP      REAL               F.P.        REFS      26      2*27      2*29   DEFINED        1
    0  FTMELT     REAL               F.P.        REFS      26   DEFINED         1
   50  PC100      REAL                           REFS      27        29   DEFINED       24

STATEMENT LABELS              DEF LINE   REFERENCES
   41  10                        32         26
   46  110                       34         31

STATISTICS
  PROGRAM LENGTH                 56B       46
        140000B SCM USED
```

```
      FUNCTION EMCCP (CTEMP)                                                EMCCP      2
C                                                                           EMCCP      3
C     CCP CALCULATES CLADDING HEAT CAPACITY AS A FUNCTION OF TEMPERATURE    EMCCP      4
C                                                                           EMCCP      5
C     CTEMP = INPUT CLADDING MESHPOINT TEMPERATURE (DEG K)                  EMCCP      6
C     CCP = OUTPUT CLADDING HEAT CAPACITY -SI UNITS- JOULES/KG-K            EMCCP      7
C                                                                           EMCCP      8
C     THE HEAT CAPACITY DATA USED IN THIS SECOND DEGREE CORRELATION ARE     EMCCP      9
C     TAKEN FROM C.R. BROOKS AND E.E. STANSBURY, J NUCLEAR MATERIALS,       EMCCP     10
C     VOL 18, PP 233, (1966)                                                EMCCP     11
        IF (CTEMP.GT.1000.0) GO TO 100                                      EMCCP     12
C                                                                           EMCCP     13
C     CCP WAS CODED BY R.L.MILLER IN MARCH 1974.                            EMCCP     14
C     MODIFIED BY R.L.MILLER, APRIL '74, MAY '74                            EMCCP     15
C                                                                           EMCCP     16
        CCP = 2.40900E02+CTEMP*(0.16800-CTEMP*4.3600E-05)                   EMCCP     17
        EMCCP = CCP                                                         EMCCP     18
        RETURN                                                              EMCCP     19
  100   CCP = 365.303                                                       EMCCP     20
        EMCCP = CCP                                                         EMCCP     21
        RETURN                                                              EMCCP     22
        END                                                                 EMCCP     23
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

SN	ENTRY POINTS	DEF LINE	REFERENCES
5	EMCCP	1	18 21

VARIABLES

SN	VARIABLES	TYPE	RELOCATION							
36	CCP	REAL			REFS	17	20	DEFINED	16	19
0	CTEMP	REAL		F.P.	REFS	11	2*16	DEFINED	1	
35	EMCCP	REAL			DEFINED	17	20			

STATEMENT LABELS

	STATEMENT LABELS	DEF LINE	REFERENCES
23	100	19	11

STATISTICS

PROGRAM LENGTH 378 31

140000B SCM USED

```
      C                                                                      EMCCP    24
        FUNCTION EMCLEM (CTEMP)                                              EMCLM     2
      C FUNCTION CELMOD(CTEMP, TIME, FLUX, COLDW)                            EMCLM     3
      C                                                                      EMCLM     4
      C CELMOD CALCULATES CLADDING ELASTIC MODULUS AS A FUNCTION OF          EMCLM     5
      C TEMPERATURE,TIME,FLUX,AND, COLD WORK.                                EMCLM     6
      C                                                                      EMCLM     7
      C CTEMP = INPUT CLADDING MESHPOINT TEMPERATURE (DEG K)                 EMCLM     8
      C FLUX = INPUT FAST NEUTRON FLUX, N/M**2-SEC.                          EMCLM     9
      C TIME = INPUT TIME AT TEMPERATURE AND FLUX, HOURS.                    EMCLM    10
      C CELMOD = OUTPUT MODULUS OF ELASTICITY FOR ZIRCALOY-4 (N/M**2)        EMCLM    11
      C CONVERSION TO PSI //  1.45037738E-4 ( PSI / (N/M**2) )               EMCLM    12
      C                                                                      EMCLM    13
      C THE MODULUS OF ELASTICITY USED IN THIS SUBROUTINE IS IS TAKEN FROM   EMCLM    14
      C THE DATA AND CORRELATIONS FROM THE FOLLWOWNG REFERENCES              EMCLM    15
      C (1)  C.C. BUSBY, IN WAPD-TM-585, PROPERTIES OF ZIRCALOY-4 TUBING,    EMCLM    16
      C C.R. WOODS, ED, PAGES 65FF.                                          EMCLM    17
      C (2) Z. SPASIC, M. PAVLOVIC, G. SIMIC, CONFERENCE ON THE USE OF       EMCLM    18
      C ZIRCONIUM ALLOYS IN NUCLEAR REACTORS, PIZEN, CHECH, 1968, PP 277-84  EMCLM    19
      C CATALOGUED AS USAEC REPORT  CONF-691086                              EMCLM    20
      C (3) R.L. MEHAN AND F.W. WIESINGER, MECHANICAL PROPERTIES OF          EMCLM    21
      C ZIRCALOY-2, USAEC REPORT KAPL-2110.                                  EMCLM    22
      C                                                                      EMCLM    23
      C CELMOD WAS CODED ON APRIL 17,1974   NEW VERSION                      EMCLM    24
      C                                                                      EMCLM    25
      C CAUTION SHOULD BE EXERCISED IN USING THIS CORRELATION BEYOND         EMCLM    26
      C 700 DEG K (800 DEG F).                                               EMCLM    27
      C                                                                      EMCLM    28
            T = CTEMP                                                        EMCLM    29
            IF (T.GT.750.0) GO TO 100                                        EMCLM    30
            CELMOD = 114.8E9-0.0599E9*T                                      EMCLM    31
            EMCLEM = CELMOD                                                  EMCLM    32
            RETURN                                                           EMCLM    33
      100   CELMOD = 1.07981E11-T*5.02236E7                                  EMCLM    34
            EMCLEM = CELMOD                                                  EMCLM    35
            RETURN                                                           EMCLM    36
            END                                                              EMCLM    37
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES	
5	EMCLEM	2	33	36

VARIABLES	SN	TYPE	RELOCATION							
41	CELMOD	REAL		REFS	32	35	DEFINED	31	34	
0	CTEMP	REAL	F.P.	REFS	29	DEFINED	2			
37	EMCLEM	REAL		DEFINED	32	35				
40	T	REAL		REFS	30	31	34	DEFINED	29	

STATEMENT LABELS	DEF LINE	REFERENCES
24 100	34	30

STATISTICS

PROGRAM LENGTH	42B	34

140000B SCM USED

```
      C                                                                      EMCLM    38
      C                                                                      EMCLM    39
            FUNCTION EMFTXP (FTEMP,FACMOT,FTMELT)                            EMFXP     2
      C                                                                      EMFXP     3
      C   FTHEXP CALCULATES FUEL LINEAR THERMAL EXPANSION FOR SOLID AND      EMFXP     4
      C   LIQUID PHASES AS A FUNCTION OF TEMPERATURE AND LIQUID FRACTION.    EMFXP     5
      C                                                                      EMFXP     6
      C   FTEMP=INPUT FUEL TEMPERATURE(K)                                    EMFXP     7
      C   FACMOT=INPUT FUEL FRACTION MOLTEN.  FACMOT=0. FUEL ALL SOLID       EMFXP     8
      C   =1. FUEL ALL MOLTEN                                                EMFXP     9
      C   FTMELT=INPUT FUEL MELTING TEMPERATURE (K)                          EMFXP    10
      C   FTHEXP=OUTPUT FRACTIONAL FUEL THERMAL EXPANSION                    EMFXP    11
      C   NO UNITS        (LT - L298)/L298                                   EMFXP    12
      C                                                                      EMFXP    13
      C   THE THERMAL EXPANSION RELATIONSHIPS USED IN THIS SUBROUTINE ARE    EMFXP    14
      C   (1)SOLID IS BASED ON DATA OF CONWAY ET AL (1000C TO 2250C) WITH    EMFXP    15
      C   EXTRAPOLATION OF DATA DOWN TO 200C AND UP TO 2800C,                EMFXP    16
      C   REFERENCE= TRANS.AM.NUC.SOC.VOL6(1) JUNE 1963;                     EMFXP    17
      C   (2)MOLTEN IS BASED ON DATA OF CHRISTENSEN (MELTING TO 3200C),      EMFXP    18
      C   REFERENCE= J.AM.CER.SOC. VOL46(12) DECEMBER 1963.                  EMFXP    19
      C                                                                      EMFXP    20
      C   FTHEXP WAS SET UP BY V.F.BASTON IN MARCH 1974.                     EMFXP    21
      C   RECODED BY R.C.YOUNG, APRIL 74                                     EMFXP    22
      C                                                                      EMFXP    23
            DATA A, B, C, D / -1.723 E-4, 6.707 E-6, 2.896 E-9, 3.103 E-2 /  EMFXP    24
      C   D = EXPANSION AT MELTING = 1.096**(1/3) - 1.                       EMFXP    25
            DATA E / 3.5 E-5 /, EPS / 1.E-10 /, CK / 273.15 E0 /             EMFXP    26
      C                                                                      EMFXP    27
            TM = FTEMP-FTMELT                                                EMFXP    28
            IF (TM+EPS.GE.0.) GO TO 110                                      EMFXP    29
      C   SOLID                                                             EMFXP    30
            TC = FTEMP-CK                                                    EMFXP    31
            FM = 0.                                                          EMFXP    32
      100   FTHEXP = FM+A+TC*(B+TC*C)                                        EMFXP    33
            EMFTXP = FTHEXP                                                  EMFXP    34
            RETURN                                                           EMFXP    35
      C                                                                      EMFXP    36
      110   TC = FTMELT-CK                                                   EMFXP    37
            IF (TM.GT.EPS) GO TO 120                                         EMFXP    38
      C   MELTING                                                            EMFXP    39
            FM = D*FACMOT                                                    EMFXP    40
            GO TO 100                                                        EMFXP    41
      C   MOLTEN                                                            EMFXP    42
      120   FM = D+E*TM                                                      EMFXP    43
            GO TO 100                                                        EMFXP    44
            END                                                              EMFXP    45
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE     REFERENCES
    5  EMFTXP           3       36

VARIABLES     SN  TYPE            RELOCATION
   53  A          REAL                          REFS      34    DEFINED      25
   54  B          REAL                          REFS      34    DEFINED      25
   55  C          REAL                          REFS      34    DEFINED      25
   61  CK         REAL                          REFS      32       38    DEFINED      27
   56  D          REAL                          REFS      41       44    DEFINED      25
   57  E          REAL                          REFS      44    DEFINED      27
   62  EMFTXP     REAL                       DEFINED      35
   60  EPS        REAL                          REFS      30       39    DEFINED      27
    0  FACMOT     REAL              F.P.        REFS      41    DEFINED       3
   65  FM         REAL                          REFS      34    DEFINED      33       41       44
    0  FTEMP      REAL              F.P.        REFS      29       32    DEFINED       3
   66  FTHEXP     REAL                          REFS      35    DEFINED      34
    0  FTMELT     REAL              F.P.        REFS      29       38    DEFINED       3
   64  TC         REAL                          REFS    2*34    DEFINED      32       38
   63  TM         REAL                          REFS      30       39       44    DEFINED      29

STATEMENT LABELS          DEF LINE   REFERENCES
   23  100                    34        42        45
   34  110                    38        30
   47  120                    44        39

STATISTICS
  PROGRAM LENGTH              67B       55
        140000B SCM USED
```

```
      C                                                                      EMFXP      46
        SUBROUTINE EMSTRN (TEMP,DELP,EPLAS,BLOCK,IFAIL)                      EMSTN       2
      C                                                                      EMSTN       3
      C   CALCULATES ZIRCALOY STRAIN AS FUNCTION OF TEMPERATURE AND STRESS   EMSTN       4
      C   INPUT                                                              EMSTN       5
      C   TEMP = TEMPERATURE   (FAHRENHEIT)                                  EMSTN       6
      C   DELP = PRESSURE DIFFERENCE  (PSI)                                  EMSTN       7
      C   OUTPUT                                                             EMSTN       8
      C   EPLAS  = PLASTIC STRAIN  --  UNITLESS RATIO OF LENGTHS             EMSTN       9
      C   FOLLOWING SET ONLY AT CLAD FAILURE                                 EMSTN      10
      C   BLOCK  = UNIT CELL FLOW BLOCKAGE (PERCENT)                         EMSTN      11
      C   IFAIL  = FAILURE FLAG - SET TO 1 AT RUPTURE                       EMSTN      12
      C                                                                      EMSTN      13
      C   PLASTIC STRAIN IS CALCULATED BY A PROCEDURE RECOMMENDED           EMSTN      14
      C   FOR EVALUATION MODEL BY F.COFFMAN OF AEC-REG, APRIL 1974.         EMSTN      15
      C   BASED ON HARDY"S DATA                                             EMSTN      16
      C                                                                      EMSTN      17
      C   THIS SUBROUTINE WAS MODIFIED BY B.W. BURNHAM  JULY -1977 TO        EMSTN      18
      C   INCLUDE THE REM DATA DIRECTLY IN THE ROUTINE VIA DATA              EMSTN      19
      C   STATEMENTS RATHER THAN ALLOW THE INPUT OPTION OF REMFRAP-MOD1      EMSTN      20
      C                                                                      EMSTN      21
        DIMENSION     TABLE1(28 ),                                           EMSTN      22
       +              TABLE2(28 ),                                           EMSTN      23
       +              TABLE3(28 )                                            EMSTN      24
      C                                                                      EMSTN      25
        DATA    TABLE1    / 2500.   ,    0.0  , 2200.   ,  100.   ,          EMSTN      26
       +                    1850.   ,  200.   , 1730.   ,  400.   ,          EMSTN      27
       +                    1660.   ,  600.   , 1600.   ,  800.   ,          EMSTN      28
       +                    1540.   , 1000.   , 1480.   , 1200.   ,          EMSTN      29
       +                    1440.   , 1400.   , 1400.   , 1600.   ,          EMSTN      30
       +                    1370.   , 1800.   , 1335.   , 2000.   ,          EMSTN      31
       +                    1310.   , 2200.   , 1287.   , 2400.              EMSTN      32
       +   /                                                                  EMSTN      33
        DATA    TABLE2    /.5992    ,    0.0  ,.5992       100.   ,          EMSTN      34
       +                    .3217    ,  200.   ,.2478     ,  400.   ,          EMSTN      35
       +                    .3502    ,  600.   ,.4584     ,  800.   ,          EMSTN      36
       +                    .5387    , 1000.   ,.5992     , 1200.   ,          EMSTN      37
       +                    .6189    , 1400.   ,.6189     , 1600.   ,          EMSTN      38
       +                    .5591    , 1800.   ,.4799     , 2000.   ,          EMSTN      39
       +                    .3780    , 2200.   ,.2976     , 2400.              EMSTN      40
       +   /                                                                  EMSTN      41
        DATA    TABLE3    /  123.   ,    0.0  ,  123.   ,  100.   ,          EMSTN      42
       +                     59.   ,  200.   ,   44.   ,  400.   ,          EMSTN      43
       +                     65.   ,  600.   ,   89.   ,  800.   ,          EMSTN      44
       +                    108.   , 1000.   ,  123.   , 1200.   ,          EMSTN      45
       +                    128.   , 1400.   ,  128.   , 1600.   ,          EMSTN      46
       +                    113.   , 1800.   ,   94.   , 2000.   ,          EMSTN      47
       +                     71.   , 2200.   ,   54.   , 2400.              EMSTN      48
       +   /                                                                  EMSTN      49
        DATA    ITABLE / 14    /,                                            EMSTN      50
       +        ISTART / 7     /                                             EMSTN      51
        EPLAS = 0.                                                           EMSTN      52
        IF (DELP.LE.0.) RETURN                                               EMSTN      53
```

```
                C   DETERMINE TEMPERATURE AT WHICH PIN WOULD FAIL                  EMSTN      54
55                    TRUPT = POLATE(TABLE1,DELP,ITABLE,ISTART)                    EMSTN      55
                C   CALCULATE DIFFERENCE FROM PRESENT TEMP.  (F)                   EMSTN      56
                      DELTR = TRUPT-TEMP                                           EMSTN      57
                      IF (DELTR.GT.200.) RETURN                                    EMSTN      58
                C   NOW CALCULATE CLADDING EXPANSION AFTER RUPTURE                 EMSTN      59
60                    EXR = POLATE(TABLE2,DELP,ITABLE,ISTART)                      EMSTN      60
                      IF (DELTR.LT.0.) GO TO 100                                   EMSTN      61
                C   CALCULATE PLASTIC STRAIN                                      EMSTN      62
                      EPLAS = EXR*0.2E0*EXP(-.0153E0*DELTR)                        EMSTN      63
                      RETURN                                                       EMSTN      64
65              C   RUPTURE INDICATED                                             EMSTN      65
                100   EPLAS = EXR*0.2                                            EMSTN      66
                      BLOCK = POLATE(TABLE3,DELP,ITABLE,ISTART)                    EMSTN      67
                      IFAIL = 1                                                    EMSTN      68
                      RETURN                                                       EMSTN      69
70                    END                                                          EMSTN      70
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 EMSTRN 2 53 58 64 69

VARIABLES	SN	TYPE		RELOCATION								
0	BLOCK	REAL		F.P.	DEFINED	2	67					
0	DELP	REAL		F.P.	REFS	53	55	60	67	DEFINED	2	
110	DELTR	REAL			REFS	58	61	63	DEFINED	57		
0	EPLAS	REAL		F.P.	DEFINED	2	52	63	66			
111	EXR	REAL			REFS	63	66	DEFINED	60			
0	IFAIL	INTEGER		F.P.	DEFINED	2	68					
103	ISTART	INTEGER			REFS	55	60	67	DEFINED	50		
102	ITABLE	INTEGER			REFS	55	60	67	DEFINED	50		
112	TABLE1	REAL	ARRAY		REFS	22	55	DEFINED	26			
146	TABLE2	REAL	ARRAY		REFS	22	60	DEFINED	34			
202	TABLE3	REAL	ARRAY		REFS	22	67	DEFINED	42			
0	TEMP	REAL		F.P.	REFS	57	DEFINED	2				
107	TRUPT	REAL			REFS	57	DEFINED	55				

EXTERNALS	TYPE	ARGS		REFERENCES		
EXP	REAL	1	LIBRARY	63		
POLATE	REAL	4		55	60	67

STATEMENT LABELS		DEF LINE	REFERENCES
46	100	66	61

STATISTICS
PROGRAM LENGTH 236B 158
1400008 SCM USED

```
      C                                                                      EMSTN      71
        FUNCTION EMGTON (GMIX,GTEMP,GPRES,GPTHK)                             EMGTN       2
      C                                                                      EMGTN       3
      C   GTHCON CALCULATES GAS THERMAL CONDUCTIVITY AS A FUNCTION OF       EMGTN       4
      C   TEMPERATURE AND GAS MOLE FRACTIONS.                                EMGTN       5
      C                                                                      EMGTN       6
      C   GTHCON=OUTPUT GAS THERMAL CONDUCTIVITY (W/M-K).                    EMGTN       7
      C                                                                      EMGTN       8
      C   GMIX(I) = INPUT ARRAY OF GAS MOLAR FRACTIONS                       EMGTN       9
      C   THE SEVEN ELEMENTS OF GMIX MUST SUM TO 1.0                         EMGTN      10
      C   CONSTITUENT GAS NUMBER KEY                                         EMGTN      11
      C   I = 1  HELIUM                                                      EMGTN      12
      C   I = 2  ARGON                                                       EMGTN      13
      C   I = 3  KRYPTON                                                     EMGTN      14
      C   I = 4  XENON                                                       EMGTN      15
      C   I = 5  HYDROGEN                                                    EMGTN      16
      C   I = 6  NITROGEN                                                    EMGTN      17
      C   I = 7  STEAM                                                       EMGTN      18
      C                                                                      EMGTN      19
      C   GTEMP=INPUT GAS TEMPERATURE (K).                                  EMGTN      20
      C   GPRES= NPUT GAS PRESSURE (N/M**2)                                  EMGTN      21
      C   USED FOR KNUDSEN DOMAIN CORRECTION AND FOR STEAM                   EMGTN      22
      C   NOT USED IF 0.                                                     EMGTN      23
      C   GPTHK=INPUT EFFECTIVE GAP THICKNESS FOR KNUDSEN DOMAIN (M)         EMGTN      24
      C   = MAX(GAP DIMENSION, SURFACE ROUGHNESS)                           EMGTN      25
      C   NOT USED IF 0.                                                     EMGTN      26
      C                                                                      EMGTN      27
      C   THE GAS CONDUCTIVITY RELATIONSHIPS USED IN THIS FUNCTION ROUTINE  EMGTN      28
      C   ARE THOSE STATED BY BIRD,STEWART,AND LIGHTFOOT,                    EMGTN      29
      C   "TRANSPORT PHENOMENA",P.26 AND P.258 (1960).                       EMGTN      30
      C   BIRD, HIRSCHFELDER, CURTISS, TRANS. ASME 76(1954)1011-1038,        EMGTN      31
      C   OR   HANDBOOK OF PHYSICS, CHAPTER 5.5 (MCGRAW-HILL) 1954.          EMGTN      32
      C                                                                      EMGTN      33
      C   STEAM EQUATION IS FROM  MAYER, ET.AL., "THERMODYNAMIC AND          EMGTN      34
      C   TRANSPORT PROPERTIES OF STEAM", THE AMERICAN SOCIETY OF            EMGTN      35
      C   MECHANICAL ENGINEERS (1967)                                        EMGTN      36
      C                                                                      EMGTN      37
      C   CODED BY R.C.YOUNG AT INEL IN MAR 1975.                            EMGTN      38
      C                                                                      EMGTN      39
            DIMENSION SIGMA2(6), EOK(6), IM(6)                               EMGTN      40
            DIMENSION A(7), R(7), CON(7), GMIX(7)                            EMGTN      41
            DIMENSION TABLE(164)                                             EMGTN      42
            DATA EPS, NT, IM / 1.E-8, 82, 6*1 /                              EMGTN      43
      C                                                                      EMGTN      44
      C   DATA SIGMA / 2.576, 3.418, 3.498, 4.055, 2.915, 3.681/             EMGTN      45
            DATA SIGMA2 / 6.635776, 11.682724, 12.236004, 16.443025,         EMGTN      46
           + 8.497225, 13.549761/                                            EMGTN      47
            DATA  EOK  /  10.2,  124.,  225.,  229.,  38.0,  91.5/           EMGTN      48
            DATA   A   / 4.003,39.944, 83.80, 131.3, 2.016, 28.02, 18.016/   EMGTN      49
      C   R = SQRT(A)                                                        EMGTN      50
            DATA R / 2.00075E0, 6.3201E0, 9.1542E0, 11.4586E0, 1.41986E0,    EMGTN      51
           +  5.2934E0, 4.2445E0/                                            EMGTN      52
            DATA TABLE / 2.785,.30, 2.628,.35, 2.492,.40, 2.368,.45, 2.257,.5, EMGTN    53
```

```
     +2.156,.55, 2.065,.60, 1.982,.65, 1.908,.70, 1.841,.75, 1.780,.80,   EMGTN      54
55   +1.725,.85, 1.675,.90, 1.629,.95, 1.587,1.0, 1.549,1.05,1.514,1.1,   EMGTN      55
     +1.482,1.15,1.452,1.2, 1.424,1.25,1.399,1.3, 1.375,1.35,1.353,1.4,   EMGTN      56
     +1.333,1.45,1.314,1.5, 1.296,1.55,1.279,1.6, 1.264,1.65,1.248,1.7,   EMGTN      57
     +1.234,1.75,1.221,1.8, 1.209,1.85,1.197,1.9, 1.186,1.95,1.175,2.0,   EMGTN      58
     +1.156,2.1, 1.138,2.2, 1.122,2.3, 1.107,2.4, 1.093,2.5, 1.081,2.6,   EMGTN      59
60   +1.069,2.7, 1.058,2.8, 1.048,2.9, 1.039,3.0, 1.030,3.1, 1.022,3.2,   EMGTN      60
     +1.014,3.3, 1.007,3.4, .9999,3.5, .9932,3.6, .9870,3.7, .9811,3.8,   EMGTN      61
     +.9755,3.9, .9700,4.0, .9649,4.1, .9600,4.2, .9553,4.3, .9507,4.4,   EMGTN      62
     +.9464,4.5, .9422,4.6, .9382,4.7, .9343,4.8, .9305,4.9, .9269,5.0,   EMGTN      63
     +.8963,6.0, .8727,7.0, .8538,8.0, .8379,9.0, .8242,10., .7432,20.,   EMGTN      64
65   +.7005,30., .6716,40., .6504,50., .6335,60., .6194,70., .6076,80.,   EMGTN      65
     +.5973,90., .5882,100., .5320,200., .5016,300., .4811,400./          EMGTN      66
     C                                                                    EMGTN      67
      IF (GTEMP.GT.10000.) GO TO 100                                      EMGTN      68
      IF (GTEMP.GT.0.) GO TO 110                                          EMGTN      69
70   100  WRITE (6,160) GTEMP,GMIX                                        EMGTN      70
     110  L = 0                                                           EMGTN      71
          DO 120 I=1,6                                                    EMGTN      72
          IF (GMIX(I).LE.EPS) GO TO 120                                   EMGTN      73
          L = I                                                           EMGTN      74
75        TKOE = GTEMP/EOK(I)                                             EMGTN      75
          IF (TKOE.GT.400.) TKOE = 400.                                   EMGTN      76
          OMEGA = POLATE(TABLE,TKOE,NT,IM(I))                             EMGTN      77
          CON(I) = 0.083224*SQRT(GTEMP/A(I))/(SIGMA2(I)*OMEGA)            EMGTN      78
          IF (I.LT.5) GO TO 120                                           EMGTN      79
80   C   FOR DIATOMIC GASES, CON=(CSUBP*4/15R + 1/3)*CON(MONATOMIC)       EMGTN      80
          IF (I.EQ.5) CON(5) = CON(5)*(1.26566E0+GTEMP*(6.4526E-8*GTEMP-  EMGTN      81
         +    2.684E-5))                                                 EMGTN      82
          IF (I.EQ.6) CON(6) = CON(6)*(1.20889E0+GTEMP*(1.6776E-4-1.3421  EMGTN      83
         +    E-10*GTEMP))                                               EMGTN      84
85   120  CONTINUE                                                        EMGTN      85
        IF (GMIX(7).LE.EPS) GO TO 130                                     EMGTN      86
        L = 7                                                             EMGTN      87
     C  STEAM                                                             EMGTN      88
        TC = GTEMP-273.15E0                                               EMGTN      89
90      CON(7) = 17.6E-3+TC*(5.87E-5+TC*(1.04E-7-4.51E-11*TC))            EMGTN      90
        IF (GPRES.LE.1.E5) GO TO 130                                      EMGTN      91
     C  USE IDEAL GAS LAW FOR DENSITY - OK FOR CORRECTION AT HI TEMP.     EMGTN      92
        DEN = 2.1668E-6*GPRES/GTEMP                                       EMGTN      93
        CON(7) = CON(7)+DEN*(103.51E-3+TC*(0.4198E-3-2.771E-8*TC)+2.1482E1 EMGTN      94
95     +1*DEN/TC**4.20E0)                                                 EMGTN      95
     130  IF (L.LE.0) GO TO 100                                           EMGTN      96
     C                                                                    EMGTN      97
        GTHCON = 0.                                                       EMGTN      98
        EMMIX = 0.                                                        EMGTN      99
100         DO 150 I=1,L                                                  EMGTN     100
            IF (GMIX(I).LE.EPS) GO TO 150                                 EMGTN     101
            EMMIX = EMMIX+GMIX(I)*A(I)                                    EMGTN     102
            SUM = 0.                                                      EMGTN     103
                DO 140 J=1,L                                              EMGTN     104
105             IF (J.EQ.I) GO TO 140                                     EMGTN     105
                IF (GMIX(J).LE.EPS) GO TO 140                             EMGTN     106
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```
                        RK = CON(I)/CON(J)                                                  EMGTN     107
                        PHI = (1.+SQRT(RK*R(I)/R(J)))**2/SQRT(8.*(1.+A(I)/A(J)))            EMGTN     108
                        SUM = SUM+GMIX(J)*PHI                                               EMGTN     109
110          140        CONTINUE                                                            EMGTN     110
                   GTHCON = GTHCON+GMIX(I)*CON(I)/(GMIX(I)+SUM)                             EMGTN     111
             150        CONTINUE                                                            EMGTN     112
             C    SMALL GAP CORRECTION ON AVERAGE MASS, AS GAPCON                          EMGTN     113
                   FACC = GPRES*GPTHK                                                       EMGTN     114
115                IF (FACC.GT.EPS) GTHCON = GTHCON/(1.0+0.12049*(GTHCON/FACC)*SQRT(G      EMGTN     115
                  +TEMP*EMMIX))                                                             EMGTN     116
                   EMGTON = GTHCON                                                          EMGTN     117
                   RETURN                                                                   EMGTN     118
                 C                                                                          EMGTN     119
120          160   FORMAT (25HIGTHCON INPUT BAD. GTEMP=,1PE12.4,2H K,/10HOFRACTIONS,(       EMGTN     120
                  +10E12.4))                                                                EMGTN     121
                   END                                                                      EMGTN     122
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

5	EMGTON	DEF LINE 2

REFERENCES: 118

VARIABLES

407	A	REAL	ARRAY	RELOCATION	REFS	41	78	102	2*108	DEFINED	49	
425	CON	REAL	ARRAY		REFS	41	81	83	94	2*107	111	
					DEFINED	78	81	83	90	94		
355	DEN	REAL			REFS	2*94	DEFINED	93				
347	EMGTON	REAL			DEFINED	117						
357	EMMIX	REAL			REFS	102	115	DEFINED	99	102		
373	EOK	REAL	ARRAY		REFS	40	75	DEFINED	48			
300	EPS	REAL			REFS	73	86	101	106	115		
					DEFINED	43						
364	FACC	REAL			REFS	2*115	DEFINED	114				
0	GMIX	REAL	ARRAY	F.P.	REFS	41	70	73	86	101	102	106
					109	2*111	DEFINED	2				
0	GPRES	REAL		F.P.	REFS	91	93	114	DEFINED	2		
0	GPTHK	REAL		F.P.	REFS	114	DEFINED	2				
0	GTEMP	REAL		F.P.	REFS	68	69	70	75	78	2*81	2*83
					89	93	115	DEFINED	2			
356	GTHCON	REAL			REFS	111	2*115	117	DEFINED	98	111	115
351	I	INTEGER			REFS	73	74	75	77	3*78	79	81
					83	101	2*102	105	107	2*108	3*111	
					DEFINED	72	100					
401	IM	INTEGER	ARRAY		REFS	40	77	DEFINED	43			
361	J	INTEGER			REFS	105	106	107	2*108	109		
					DEFINED	104						
350	L	INTEGER			REFS	96	100	104	DEFINED	71	74	87
301	NT	INTEGER			REFS	77	DEFINED	43				
353	OMEGA	REAL			REFS	78	DEFINED	77				

```
VARIABLES      SN  TYPE          RELOCATION
  363  PHI        REAL                        REFS      109    DEFINED      108
  416  R          REAL          ARRAY         REFS       41      2*108    DEFINED       51
  362  RK         REAL                        REFS      108    DEFINED      107
  365  SIGMA2     REAL          ARRAY         REFS       40       78     DEFINED       46
  360  SUM        REAL                        REFS      109      111     DEFINED      103      109
  434  TABLE      REAL          ARRAY         REFS       42       77     DEFINED       53
  354  TC         REAL                        REFS     3*90     3*94     DEFINED       89
  352  TKOE       REAL                        REFS       76       77     DEFINED       75       76

FILE NAMES        MODE
     TAPE6        FMT                  WRITES      70

EXTERNALS          TYPE    ARGS       REFERENCES
     POLATE       REAL       4            77
     SQRT         REAL       1 LIBRARY    78      2*108      115

STATEMENT LABELS              DEF LINE   REFERENCES
   17  100                       70        68        96
   22  110                       71        69
  100  120                       85        72        73        79
  143  130                       96        86        91
  225  140                      110       104       105       106
  236  150                      112       100       101
  307  160     FMT              120        70

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   25  120      I          72 85       56B              EXT REFS
  153  150      I         100 112      66B              EXT REFS  NOT INNER
  166  140      J         104 110      42B              EXT REFS

STATISTICS
  PROGRAM LENGTH                 713B     459
        140000B SCM USED
```

CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY CALLGR GRASS0 GRASS1 GRASS2 GRASS3 GRASS4 GRASS5
GRASS6 GRASS7 GRASS8 GRASS9

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$ TIDY CALLGR GRASS0 GRASS1 GRASS2 GRASS3 GRASS4
GRASS5 GRASS6 GRASS7 GRASS8 GRASS9

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

YANK$$$ TIDY CALLGR GRASS0 GRASS1 GRASS2 GRASS3 GRASS4
GRASS5 GRASS6 GRASS7 GRASS8 GRASS9

DECKS WRITTEN TO COMPILE FILE

TIDY CALLGR GRASS0 GRASS1 GRASS2 GRASS3 GRASS4 GRASS5
GRASS6 GRASS7 GRASS8 GRASS9

THIS UPDATE REQUIRED 34300B WORDS OF CORE.

```
      SUBROUTINE CALLGR (DEL,NF,KF,FL,PLENP,TIT,GRT,IRSTAR,NPRINT,AGRASS CALLGR      2
     +,NWORDS)                                                          CALLGR      3
      COMMON/GRSPTR/NVAR1,NVAR2,NVAR3,NVAR4,NVAR5,NVAR6,NVAR7,NVAR8,    CALLGR      4
     +NVAR9,NVAR10,NVAR11,NVAR12,NVAR13,NVAR14,NVAR15,NVAR16,NVAR17,    CALLGR      5
     +NVAR18,NVAR19,NVAR20,NVAR21,NVAR22,NVAR23,NVAR24,NVAR25,NVAR26,   CALLGR      6
     +NVAR27,NVAR28,NVAR29,NVAR30,NVAR31,NVAR32,NVAR33,NVAR34,NVAR35,   CALLGR      7
     +NVAR36,NVAR37,LGRASS                                              CALLGR      8
      COMMON/BDG02D/                                                    CALLGR      9
     +TGASIN,TGASR,EPSI,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02               CALLGR     10
     +,RM,TSO                                                           CALLGR     11
      DIMENSION AGRASS(NWORDS)                                          CALLGR     12
      KFI = KF+1                                                        CALLGR     13
      CALL GRASS (DEL,NF,KF,FL,TIT,PLENP,IRSTAR,NPRINT,GRT,BVST,KFI,AGRA CALLGR     14
     +SS(NVAR1),AGRASS(NVAR2),AGRASS(NVAR3),AGRASS(NVAR4),AGRASS(NVAR5), CALLGR     15
     +AGRASS(NVAR6),AGRASS(NVAR7),AGRASS(NVAR8),AGRASS(NVAR9),AGRASS(NVA CALLGR     16
     +R10),AGRASS(NVAR11),AGRASS(NVAR12),AGRASS(NVAR13),AGRASS(NVAR14),A CALLGR     17
     +GRASS(NVAR15),AGRASS(NVAR16),AGRASS(NVAR17),AGRASS(NVAR18),AGRASS( CALLGR     18
     +NVAR19),AGRASS(NVAR20),AGRASS(NVAR21),AGRASS(NVAR22),AGRASS(NVAR23 CALLGR     19
     +),AGRASS(NVAR24),AGRASS(NVAR25),AGRASS(NVAR26),AGRASS(NVAR27),AGRA CALLGR     20
     +SS(NVAR28),AGRASS(NVAR29),AGRASS(NVAR30),AGRASS(NVAR31),AGRASS(NVA CALLGR     21
     +R32),AGRASS(NVAR33),AGRASS(NVAR34),AGRASS(NVAR35),AGRASS(NVAR36),A CALLGR     22
     +GRASS(NVAR37))                                                    CALLGR     23
C     WRITE(6,30)(I,AGRASS(I),I=LGRASS,LGRSSN)                          CALLGR     24
      RETURN                                                            CALLGR     25
      END                                                               CALLGR     26
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CALLGR	1	24

VARIABLES

		SN	TYPE	RELOCATION						
0	AGRASS		REAL	ARRAY	F.P.	REFS	11	37*13	DEFINED	1
222	BVST	*	REAL			REFS	13			
0	DEL		REAL		F.P.	REFS	13	DEFINED	1	
2	EPSI		REAL		BDG02D	REFS	8			
0	FL		REAL		F.P.	REFS	13	DEFINED	1	
0	GRT		REAL		F.P.	REFS	13	DEFINED	1	
0	IRSTAR		INTEGER		F.P.	REFS	13	DEFINED	1	
4	JFIRST		INTEGER		BDG02D	REFS	8			
0	KF		INTEGER		F.P.	REFS	12	13	DEFINED	1
5	KFIRST		INTEGER		BDG02D	REFS	8			
221	KFI		INTEGER			REFS	13	DEFINED	12	
6	KPRINT		INTEGER		BDG02D	REFS	8			
45	LGRASS		INTEGER		GRSPTR	REFS	3			
0	NF		INTEGER		F.P.	REFS	13	DEFINED	1	
7	NMAX		INTEGER		BDG02D	REFS	8			
0	NPRINT		INTEGER		F.P.	REFS	13	DEFINED	1	
0	NVAR1		INTEGER		GRSPTR	REFS	3	13		

VARIABLES	SN	TYPE	RELOCATION				
11	NVAR10	INTEGER	GRSPTR	REFS	3	13	
12	NVAR11	INTEGER	GRSPTR	REFS	3	13	
13	NVAR12	INTEGER	GRSPTR	REFS	3	13	
14	NVAR13	INTEGER	GRSPTR	REFS	3	13	
15	NVAR14	INTEGER	GRSPTR	REFS	3	13	
16	NVAR15	INTEGER	GRSPTR	REFS	3	13	
17	NVAR16	INTEGER	GRSPTR	REFS	3	13	
20	NVAR17	INTEGER	GRSPTR	REFS	3	13	
21	NVAR18	INTEGER	GRSPTR	REFS	3	13	
22	NVAR19	INTEGER	GRSPTR	REFS	3	13	
1	NVAR2	INTEGER	GRSPTR	REFS	3	13	
23	NVAR20	INTEGER	GRSPTR	REFS	3	13	
24	NVAR21	INTEGER	GRSPTR	REFS	3	13	
25	NVAR22	INTEGER	GRSPTR	REFS	3	13	
26	NVAR23	INTEGER	GRSPTR	REFS	3	13	
27	NVAR24	INTEGER	GRSPTR	REFS	3	13	
30	NVAR25	INTEGER	GRSPTR	REFS	3	13	
31	NVAR26	INTEGER	GRSPTR	REFS	3	13	
32	NVAR27	INTEGER	GRSPTR	REFS	3	13	
33	NVAR28	INTEGER	GRSPTR	REFS	3	13	
34	NVAR29	INTEGER	GRSPTR	REFS	3	13	
2	NVAR3	INTEGER	GRSPTR	REFS	3	13	
35	NVAR30	INTEGER	GRSPTR	REFS	3	13	
36	NVAR31	INTEGER	GRSPTR	REFS	3	13	
37	NVAR32	INTEGER	GRSPTR	REFS	3	13	
40	NVAR33	INTEGER	GRSPTR	REFS	3	13	
41	NVAR34	INTEGER	GRSPTR	REFS	3	13	
42	NVAR35	INTEGER	GRSPTR	REFS	3	13	
43	NVAR36	INTEGER	GRSPTR	REFS	3	13	
44	NVAR37	INTEGER	GRSPTR	REFS	3	13	
3	NVAR4	INTEGER	GRSPTR	REFS	3	13	
4	NVAR5	INTEGER	GRSPTR	REFS	3	13	
5	NVAR6	INTEGER	GRSPTR	REFS	3	13	
6	NVAR7	INTEGER	GRSPTR	REFS	3	13	
7	NVAR8	INTEGER	GRSPTR	REFS	3	13	
10	NVAR9	INTEGER	GRSPTR	REFS	3	13	
0	NWORDS	INTEGER	F.P.	REFS	11	DEFINED	1
3	PI	REAL	BDG02D	REFS	8		
0	PLENP	REAL	F.P.	REFS	13	DEFINED	1
11	RM	REAL	BDG02D	REFS	8		
0	TGASIN	REAL	BDG02D	REFS	8		
1	TGASR	REAL	BDG02D	REFS	8		
0	TIT	REAL	F.P.	REFS	13	DEFINED	1
12	TS0	REAL	BDG02D	REFS	8		
10	TS02	REAL	BDG02D	REFS	8		

EXTERNALS	TYPE	ARGS	REFERENCES
GRASS		48	13

COMMON BLOCKS	LENGTH
GRSPTR	38
BDG02D	11

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STATISTICS
  PROGRAM LENGTH                223B      147
  SCM LABELED COMMON LENGTH      61B       49
        140000B SCM USED
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      C   GRASS-SST(MOD6)      NOVEMBER,1979                                          GRASS0     2
      C   WITH STEADY-STATE AND TRANSIENT CAPABILITIES                               GRASS0     3
      C                                                                              GRASS0     4
      C   BY J.REST. TELEPHONE NUMBER=312-972-5026                                   GRASS0     5
      C   ARGONNE NATIONAL LABORATORY                                                GRASS0     6
      C                                                                              GRASS0     7
            SUBROUTINE GRASS (DEL,NF,KF,FL,TIT,PLENP,IRSTAR,NPRINT,GRT,BVST,KF      GRASS0     8
           +I,BVS,GR,POW,RGTJ,FDP,FODSLC,FOGBDY,PRF,RHODSL,TAUA,TGRAD,BV,CO,GA     GRASS0     9
           +SGEN,GESWF,GIP,GOUT,GRSIZ,GS,HH,HOLD,NMAXBK,POROS,PRFOLD,PRSO,RH,R     GRASS0    10
           +HOLD,RS,TFO,TK,TKOLD,TS,BLKMGO,GBYMGO,BULK,DSLC,GBDY)                  GRASS0    11
      C                                                                              GRASS0    12
      C   INPUT QUANTITIES                                                         GRASS0    13
      C   DEL=TIME STEP(S)                                                         GRASS0    14
      C   NF=TOTAL NUMBER OF AXIAL FUEL SECTIONS                                   GRASS0    15
      C   KF=TOTAL NUMBER OF RADIAL RINGS                                          GRASS0    16
      C   FL=LENGTH OF FUEL ROD(CM)                                                GRASS0    17
      C   RH(J,K)=FUEL DENSITY IN ZONE (J,K) (GM/CM**3)                           GRASS0    18
      C   TK(J,K)=AVERAGE TEMPERATURE IN ZONE (J,K) (K)                           GRASS0    19
      C   PRSO(J,K)=HYDROSTATIC PRESSURE IN ZONE (J,K) (PSI)                      GRASS0    20
      C   POW(J)=LINEAR POWER IN AXIAL SECTION J (KW/FT)                          GRASS0    21
      C   RS(J,K)=INNER RADIUS OF ZONE (J,K) (CM)                                 GRASS0    22
      C   TS(J,K)=TEMPERATURE AT RS(J,K) (C)                                      GRASS0    23
      C   GRSIZ(J,K)=GRAIN DIAMETER IN REGION (J,K) (CM)                          GRASS0    24
      C   POROS(J,K)=FRACTIONAL POROSITY IN REGION (J,K)                          GRASS0    25
      C   FDP(K)=RADIAL FLUX DEPRESSION FACTOR IN REGION K                        GRASS0    26
      C   TIT=IRRADIATION TIME (S)                                                GRASS0    27
      C   PLENP=PLENUM PRESSURE (PSI)                                             GRASS0    28
      C   IRSTAR=RESTART INDICATOR (1=RESTART,12=DUMP,13=TRANSIENT,               GRASS0    29
      C   0=STEADY-POWER IRRADIATION)                                             GRASS0    30
      C   NPRINT=LEVEL OF FASTGRASS PRINTOUT (1-4)                                GRASS0    31
      C   GRT=TOTAL FISSION-GAS RELEASE (MOLES)--INITIAL AMOUNT IN PLENUM         GRASS0    32
      C   MUST BE SPECIFIED                                                       GRASS0    33
      C                                                                          GRASS0    34
      C   OUTPUT QUANTITIES                                                       GRASS0    35
      C   GS(J,K)=AMOUNT OF RETAINED GAS IN REGION (J,K) (MOLES)                  GRASS0    36
      C   GR(J)=AMOUNT OF GAS RELEASED FROM AXIAL SECTION (J) (MOLES)             GRASS0    37
      C   DURING DEL(SECONDS)                                                     GRASS0    38
      C   GRT=TOTAL FISSION GAS RELEASED (MOLES)                                  GRASS0    39
      C   BV(J,K)=FISSION-GAS SWELLING/VOLUME IN REGION (J,K)                     GRASS0    40
      C   BVS(J)=FISSION-GAS SWELLING/VOLUME IN AXIAL SECTION (J)                 GRASS0    41
      C   BVST=TOTAL FISSION-GAS SWELLING/VOLUME                                  GRASS0    42
      C                                                                          GRASS0    43
            COMMON/GR0235/AVN,GASIN,SAVG,J,K,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,      GRASS0    44
           +NMAXG,NXBD,NXBDG,RAD,VOLUME                                          GRASS0    45
            COMMON/GR0A2/TKI,TFPV,TGRADI,HY,AREA,GRD,T2,AGBY,FBDEN,FBSAT,DELT    GRASS0    46
           +,SPT                                                                 GRASS0    47
            COMMON/GR0A3/GESW,JKF,KI                                             GRASS0    48
            COMMON/GR0A4/IMAXI,TPASS,Y,H,KK                                      GRASS0    49
            COMMON/BDG02D/                                                       GRASS0    50
           +TG9SIN,TGASR,EPSI,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02                  GRASS0    51
           +,RM,TS0                                                              GRASS0    52
            COMMON/BDGR/A1,R9,FPWS,NAME(4),RHOOLD,TCONV,PDSC,PI43,BCF,CO1,       GRASS0    53
           +BKLO,BKHI,CPOW,SIGPI,FGPF,BVCRIT,GRF0,PTPL                           GRASS0    54
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      COMMON/GRSFTR/NVAR1,NVAR2,NVAR3,NVAR4,NVAR5,NVAR6,NVAR7,NVAR8,
     +NVAR9,NVAR10,NVAR11,NVAR12,NVAR13,NVAR14,NVAR15,NVAR16,NVAR17,
     +NVAR18,NVAR19,NVAR20,NVAR21,NVAR22,NVAR23,NVAR24,NVAR25,NVAR26,
     +NVAR27,NVAR28,NVAR29,NVAR30,NVAR31,NVAR32,NVAR33,NVAR34,NVAR35,
     +NVAR36,NVAR37,LGRASS
C    WRITE(6,50)NF
C
      DIMENSION RS(NF,KF1),TS(NF,KF1),GRSIZ(NF,KF),POROS(NF,KF),FDP(KF)
      DIMENSION TK(NF,KF),BLKMGO(KF,20),GS(NF,KF),BV(NF,KF),BVS(NF)
     +,GBYMGO(KF,20),PRSO(NF,20),RH(NF,20),Y(82),SAVG(20),
     +RAD(21),TAUA(KF1),TGRAD(KF),GR(NF),POW(NF),RGTJ(NF),PRF(KF)
     +,CO(NF,KF),GASGEN(NF,KF),GESWF(NF,KF),GIP(NF,KF),GOUT(NF,KF),
     +HH(NF,KF),HOLD(NF,KF),NMAXBK(NF,KF),
     +PRFOLD(NF,KF),RHOLD(NF,KF),TFO(NF,KF),
     +TKOLD(NF,KF),BULK(NF,KF,20),DSLC(NF,KF,20),GBDY(NF,
     +KF,20),FODSLC(KF),FOGBDY(KF),RHODSL(KF)
C
      IF (DEL.LE.0.) GO TO 600
      IF (JFIRST.NE.0) GO TO 110
C     -----INITIALIZATION OF GRASS
C     RM IS THE SIZE INCREMENT BETWEEN BUBBLE SIZE RANGES
      SAVG(1) = 1
          DO 100 N=2,NMAX
100       SAVG(N) = SAVG(N-1)*RM
      IF (IRSTAR.NE.13) GO TO 110
      CO1 = TGASIN-TGASR
      GRF0 = TGASR
      TS0 = 0.0
      TS02 = 0.0
110   KF1 = KF+1
      IF (NPRINT.GT.1) WRITE (6,620)
C     -----CONVERT TO CGS UNITS
      DELT = DEL*TCONV
      T2 = TIT*TCONV
      TMAX = .90*DELT
      IF (NPRINT.GT.1.AND.IRSTAR.NE.13) WRITE (6,630) T2
      IF (NPRINT.GT.1.AND.IRSTAR.EQ.13) WRITE (6,640) T2
C     -----DO AXIAL SECTIONS ONE BY ONE
      VOLT = 0.
      BVST = 0.
      GGDT = 0.
      GRDT = 0.
      RGT = 0.
      RGP = 0.
      RGG = 0.
          DO 580 J=1,NF
          VOLJ = 0.
          BVSBJ = 0.
          BVSGJ = 0.
          BVSEJ = 0.
          RTGAS = 0.
          GASINJ = 0.
          KTBF = KF
```

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                      IF (NPRINT.GE.3) KPRINT = 2                                    GRASS0   108
                C     -----CONVERT KW/FT TO W/CM                                     GRASS0   109
                      POWERL = POW(J)*CPOW                                           GRASS0   110
  110                 TOTFIS = FPWS*POWERL                                           GRASS0   111
                          DO 190 K=1,KF                                              GRASS0   112
                          IF (JFIRST.EQ.0.AND.IRSTAR.EQ.0) GESWF(J,K) = 0.           GRASS0   113
                          TAUA(K) = 0.                                               GRASS0   114
                          WRITE (6,610) K,TGRAD(K),TS(J,K+1),TS(J,K-1),RS(J,K+1),RS( GRASS0   115
  115              +      J,K-1)                                                     GRASS0   116
                          IF (POW(J).GT.0) GO TO 120                                 GRASS0   117
                          IF (K.EQ.1) GO TO 120                                      GRASS0   118
                          TGRAD(K) = (TS(J,K+1)-TS(J,K-1))/(RS(J,K+1)-RS(J,K-1))     GRASS0   119
                          GO TO 130                                                  GRASS0   120
  120             120     TGRAD(K) = (TS(J,K+1)-TS(J,K))/(RS(J,K+1)-RS(J,K))         GRASS0   121
                  130     IF (TGRAD(K).GT.0) TGRAD(K) = 0                            GRASS0   122
                C     ** COMPUTE PERCOLATION PROBABILITY PRF(K) *****                GRASS0   123
                      GESFPD = POROS(J,K)-PTPL                                       GRASS0   124
                      GESFP = AMAX1(0.0,GESFPD)                                      GRASS0   125
  125                 PRFC = (BVCRIT-GESFP-GESWF(J,K))/(1.4147*SIGPI)                GRASS0   126
                      PRF(K) = (1.0-ERF(PRFC))*.50                                   GRASS0   127
                      IF (JFIRST.EQ.0.AND.IRSTAR.EQ.0) GO TO 140                     GRASS0   128
                      RHOOLD = RH(J,K)/RHOLD(J,K)                                    GRASS0   129
                      IF (JFIRST.EQ.0.AND.IRSTAR.EQ.13) TKOLD(J,K) = TK(J,K)         GRASS0   130
  130                 GO TO 170                                                      GRASS0   131
                C     DETERMINE INITIAL NUMBER OF BUBBLE SIZE RANGES FOR RADIAL REGIONS GRASS0 132
                  140 FK = FLOAT(K)                                                  GRASS0   133
                      FKM = FLOAT(KF)                                                GRASS0   134
                      IF (FKM.EQ.1.0) GO TO 150                                      GRASS0   135
  135           C     BKLO IS INITIAL NUMBER OF SIZE RANGES FOR OUTERMOST FUEL REGION GRASS0   136
                C     BKHI IS INITIAL NUMBER OF SIZE RANGES FOR INNERMOST FUEL REGION GRASS0   137
                      B = ALOG(BKHI/BKLO)/(FKM-1.0)                                  GRASS0   138
                      A = BKHI*EXP(B)                                                GRASS0   139
                      NMAXBK(J,K) = A*EXP(-B*FK)+.4                                  GRASS0   140
  140                 HOLD(J,K) = 0.0                                                GRASS0   141
                      IF (J.GT.1) GO TO 160                                          GRASS0   142
                      GO TO 160                                                      GRASS0   143
                  150 NMAXBK(J,K) = (BKLO+BKHI)/2.0                                  GRASS0   144
                  160 GOUT(J,K) = 0.0                                                GRASS0   145
  145                 GASGEN(J,K) = 0.0                                              GRASS0   146
                      TKOLD(J,K) = TK(J,K)                                           GRASS0   147
                      PRFOLD(J,K) = PRF(K)                                           GRASS0   148
                  170     DO 180 N=1,NMAX                                            GRASS0   149
                          BULK(J,K,N) = BULK(J,K,N)*RHOOLD                           GRASS0   150
  150                     DSLC(J,K,N) = DSLC(J,K,N)*RHOOLD                           GRASS0   151
                          GBDY(J,K,N) = GBDY(J,K,N)*RHOOLD                           GRASS0   152
                          BLKMGO(K,N) = 0.                                           GRASS0   153
                  180     GBYMGO(K,N) = 0.                                           GRASS0   154
                  190 RHOLD(J,K) = RH(J,K)                                           GRASS0   155
  155               HITEI = FL/NF                                                    GRASS0   156
                C     ----- DO RADIAL SECTIONS                                      GRASS0   157
                      TAUA(KF1) = DELT                                               GRASS0   158
                      K = KF                                                         GRASS0   159
                      GASOUT = 0.                                                    GRASS0   160
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```
                      GO TO 470                                                  GRASSO   161
              200     KI = K+1                                                   GRASSO   162
                      VOLUME = PI*HITEI*(RS(J,KI)*RS(J,KI)-RS(J,K)*RS(J,K))      GRASSO   163
                      AREA = 2.*PI*RS(J,K)*HITEI                                 GRASSO   164
                      TFPV = TOTFIS*FDP(K)/(PI*RS(J,KFI)*RS(J,KFI))              GRASSO   165
                      GASIN = TFPV*FGPF                                          GRASSO   166
                      IF (K.EQ.KF) GO TO 210                                     GRASSO   167
                      JKF = 2                                                    GRASSO   168
                      NMAXBK(J,K) = MAXO(NMAXBK(J,K),NMAXBK(J,KI))               GRASSO   169
                      GO TO 220                                                  GRASSO   170
              210     JKF = 1                                                    GRASSO   171
              220     NMAXB = NMAXBK(J,K)                                        GRASSO   172
                      PRSG = PRSO(J,K)                                           GRASSO   173
                      IF (PRSO(J,K).LE.PLENP) PRSG = PLENP                       GRASSO   174
                      HY = PRSG*PDSC                                             GRASSO   175
                      GRD = GRSIZ(J,K)                                           GRASSO   176
                      TKI = TK(J,K)                                              GRASSO   177
                      TGRADI = TGRAD(K)                                          GRASSO   178
                      TKOJK = TKOLD(J,K)                                         GRASSO   179
                      IF (NPRINT.NE.4) KPRINT = 1                                GRASSO   180
                      IF (NPRINT.NE.4) GO TO 230                                 GRASSO   181
                      WRITE (6,650) J,K                                          GRASSO   182
                      WRITE (6,660) RS(J,K),RS(J,K+1),TS(J,K),TS(J,K+1),FDP(K),H,PRF GRASSO   183
                    + (K),PRFOLD(J,K),GESWF(J,K),RHOOLD                          GRASSO   184
              230     CALL GRASS2 (H,TKOJK,IRSTAR,GR,POW,RGTJ,FDP,FODSLC,FOGBDY,RHOD GRASSO   185
                    + SL,CO,GIP,HH,TFO,BULK,DSLC,GBDY,NF,KF)                     GRASSO   186
                      I = 0                                                      GRASSO   187
                          DO 240 N=1,NMAXB                                       GRASSO   188
                          I = I+1                                                GRASSO   189
              240         Y(I) = BULK(J,K,N)                                     GRASSO   190
                      IF (JNCDI.EQ.1) GO TO 260                                  GRASSO   191
                          DO 250 N=1,NCDI                                        GRASSO   192
                          I = I+1                                                GRASSO   193
              250         Y(I) = DSLC(J,K,N)                                     GRASSO   194
              260     IF (JNCGBI.EQ.1) GO TO 280                                 GRASSO   195
                          DO 270 N=1,NCGBI                                       GRASSO   196
                          I = I+1                                                GRASSO   197
              270         Y(I) = GBDY(J,K,N)                                     GRASSO   198
              280     IMAXI = I                                                  GRASSO   199
                      NXBDG = IMAXI                                              GRASSO   200
                      NXBD = NMAXB+NCDI                                          GRASSO   201
              290     TSAVE = TAUA(K)                                            GRASSO   202
                      TPASS = TAUA(K)                                            GRASSO   203
                      HT = H                                                     GRASSO   204
                      CALL GRASS4 (BLKMGO,GBYMGO,NF,KF)                          GRASSO   205
                      IF (KK.LT.0) NPRINT = 4                                    GRASSO   206
                      TAUA(K) = TPASS                                            GRASSO   207
                      DT = TPASS-TSAVE                                           GRASSO   208
                      HOLD(J,K) = DT                                             GRASSO   209
                      GASINK = GASIN*DT*VOLUME                                   GRASSO   210
                      GGDT = GGDT+GASINK                                         GRASSO   211
                      GASGEN(J,K) = GASGEN(J,K)+GASINK                           GRASSO   212
                      TGASIN = TGASIN+GASINK                                     GRASSO   213
```

```
                      I = 0                                                          GRASS0    214
                      EGRE = 0.0                                                     GRASS0    215
215                   ESWE = 0.0                                                     GRASS0    216
                          DO 300 N=1,NMAXB                                           GRASS0    217
                          I = I+1                                                    GRASS0    218
               300        BULK(J,K,N) = Y(I)                                         GRASS0    219
                      IF (JNCDI.EQ.1) GO TO 320                                      GRASS0    220
220                       DO 310 N=1,NCDI                                           GRASS0    221
                          I = I+1                                                    GRASS0    222
               310        DSLC(J,K,N) = Y(I)                                         GRASS0    223
               320    IF (JNCGBI.EQ.1) GO TO 340                                     GRASS0    224
                          DO 330 N=1,NCGBI                                           GRASS0    225
225                       I = I+1                                                    GRASS0    226
                          IF (FBDEN.LT.FBSAT) GO TO 330                              GRASS0    227
                          YVB = Y(I)*VOLUME*BCF                                      GRASS0    228
                          EGRE = EGRE+YVB*SAVG(N)                                    GRASS0    229
                          ESWE = ESWE+YVB*RAD(N)**3*PI43                             GRASS0    230
230                       Y(I) = Y(I)*(1.0-BCF)                                      GRASS0    231
               330        GBDY(J,K,N) = Y(I)                                         GRASS0    232
               340    I = I+1                                                        GRASS0    233
                      FP = POROS(J,K)+GESWF(J,K)                                     GRASS0    234
                      GKIN = Y(I)*VOLUME+EGRE                                        GRASS0    235
235                   I = I+1                                                        GRASS0    236
                      GESW = Y(I)                                                    GRASS0    237
                      IF (PRFOLD(J,K).EQ.1.0) GO TO 350                              GRASS0    238
                      DPRF = (PRF(K)-PRFOLD(J,K))/(1.0-PRFOLD(J,K))                  GRASS0    239
                      GO TO 360                                                      GRASS0    240
240            350    DPRF = 0.0                                                     GRASS0    241
               360    EPRF = AMAX1(0.0,DPRF)*GIP(J,K)                                GRASS0    242
                      GKOUT = GKIN*PRF(K)+EPRF                                       GRASS0    243
                      TGIP = GIP(J,K)+GKIN                                           GRASS0    244
                      IF (GKOUT.GE.TGIP) GKOUT = TGIP                                GRASS0    245
245                   IF (EPRF.GT.0) GESWF(J,K) = GESWF(J,K)*(1.0-DPRF)              GRASS0    246
                      GESWF(J,K) = GESWF(J,K)*TK(J,K)/TKOLD(J,K)+ESWE*(1.0-PRF(K))/V GRASS0    247
                     +OLUME                                                          GRASS0    248
                      GESWF(J,K) = GESWF(J,K)+GESW*PI43*(1.0-PRF(K))                 GRASS0    249
                      GIP(J,K) = GIP(J,K)+GKIN-GKOUT                                 GRASS0    250
250                   GASOUT = GASOUT+GKOUT                                          GRASS0    251
                      GOUT(J,K) = GOUT(J,K)+GKOUT                                    GRASS0    252
                      TGASR = TGASR+GKOUT                                            GRASS0    253
                      IF (DT.EQ.0.) GO TO 410                                        GRASS0    254
                      DTI = 1./DT                                                    GRASS0    255
255                   GASMGO = 0.                                                    GRASS0    256
                      GO TO (370,370,370,390), JNCGBI                                GRASS0    257
               370        DO 380 N=NMAXG,NMAXB                                       GRASS0    258
                          I = I+1                                                    GRASS0    259
                          GBYMGO(K,N) = 0.                                           GRASS0    260
260                       BLKMGO(K,N) = Y(I)*DTI                                     GRASS0    261
               380        GASMGO = GASMGO+Y(I)*SAVG(N)                               GRASS0    262
                      GO TO (410,390,390,390), JNCGBI                                GRASS0    263
               390        DO 400 N=1,NCGBI                                           GRASS0    264
                          I = I+1                                                    GRASS0    265
265                       BLKMGO(K,N) = 0.                                           GRASS0    266
```

```
                     GBYMGO(K,N) = Y(I)*DTI                                    GRASSO    267
              400    GASMGO = GASMGO+Y(I)*SAVG(N)                              GRASSO    268
                   IF (K.NE.1) GO TO 410                                       GRASSO    269
                   GASOUT = GASOUT+GASMGO                                      GRASSO    270
270                TGASR = TGASR+GASMGO                                        GRASSO    271
                   GOUT(J,K) = GOUT(J,K)+GASMGO                                GRASSO    272
              410  IF (.NOT.(NPRINT.EQ.4.OR.(NPRINT.EQ.3.AND.K.EQ.KTBF.AND.TAUA(K GRASSO    273
                +  ).GE.DELT))) GO TO 430                                      GRASSO    274
                   PRINT 680, TAUA(K),DT,H,HH(J,K),KK,IMAXI                    GRASSO    275
275                PRINT 690, NAME(1),K,(BULK(J,K,N),N=1,NMAXB)                GRASSO    276
                   IF (NCDI.LE.0) GO TO 420                                    GRASSO    277
                   PRINT 690, NAME(2),K,(DSLC(J,K,N),N=1,NCDI)                 GRASSO    278
              420  IF (NCGBI.LE.0) GO TO 430                                   GRASSO    279
                   PRINT 690, NAME(3),K,(GBDY(J,K,N),N=1,NCGBI)                GRASSO    280
280                PRINT 700, NAME(4),K,POROS(J,K),FP,GRSIZ(J,K),AGBY          GRASSO    281
              430  IF (KK.GT.0) GO TO 440                                      GRASSO    282
                   NPRINT = 4                                                  GRASSO    283
                   PRINT 710, J,K                                              GRASSO    284
                   GO TO 550                                                   GRASSO    285
285           440  IF (H.GT.HH(J,K).OR.H.LT.HT) HH(J,K) = H                    GRASSO    286
                   NFLAG = 1                                                   GRASSO    287
                   IF ((BULK(J,K,NMAXB)+DSLC(J,K,NMAXB)+GBDY(J,K,NMAXB))*SAVG(NMA GRASSO    288
                +  XB).LT.EPSI.OR.NMAXB.GE.NMAX) GO TO 450                     GRASSO    289
                   NMAXBK(J,K) = NMAXB+1                                       GRASSO    290
290                NFLAG = 2                                                   GRASSO    291
              450  IF (K.EQ.KTBF.AND.TAUA(K).GE.TAUA(KF1)) GO TO 510           GRASSO    292
              460  IF (K.EQ.1) GO TO 480                                       GRASSO    293
                   K = K-1                                                     GRASSO    294
              470  NFLAG = 2                                                   GRASSO    295
295           480  HT = TAUA(K+1)-TAUA(K)                                      GRASSO    296
                   IF (HT) 490,490,500                                         GRASSO    297
              490  K = K+1                                                     GRASSO    298
                   GO TO 470                                                   GRASSO    299
              500  H = AMIN1(HT,HH(J,K))                                       GRASSO    300
300                IF (H.GT.TMAX) H = DELT                                     GRASSO    301
                   GO TO (290,200), NFLAG                                      GRASSO    302
              510  RIC0 = RAD(1)**3                                            GRASSO    303
                   RIC = RIC0                                                  GRASSO    304
                   SBRCB = 0.                                                  GRASSO    305
305                SBRCG = 0.                                                  GRASSO    306
                   SATMC = 0.                                                  GRASSO    307
                   SUMATB = (BULK(J,K,1)+DSLC(J,K,1))*SAVG(1)                  GRASSO    308
                   SUMATG = GBDY(J,K,1)*SAVG(1)                                GRASSO    309
                     DO 520 N=2,NMAXB                                          GRASSO    310
310                  RIC = RIC*RM                                              GRASSO    311
                     RAD2C = RAD(N)**3                                         GRASSO    312
                     SUMB = BULK(J,K,N)+DSLC(J,K,N)                            GRASSO    313
                     SUMG = GBDY(J,K,N)                                        GRASSO    314
                     SUMAB = SUMB*SAVG(N)                                      GRASSO    315
315                  SUMAG = SUMG*SAVG(N)                                      GRASSO    316
                     SUMA = SUMAB+SUMAG                                        GRASSO    317
                     IF (RAD2C.LE.RIC/1.0001) GO TO 520                        GRASSO    318
                     RAD2C = RAD2C-RIC                                         GRASSO    319
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```
                      SBRCB = SBRCB+RAD2C*SUMB                                  GRASS0    320
320                   SBRCG = SBRCG+RAD2C*SUMG                                  GRASS0    321
                      SATMC = SATMC+SUMA                                        GRASS0    322
                      SUMATB = SUMATB+SUMAB                                     GRASS0    323
            520       SUMATG = SUMATG+SUMAG                                     GRASS0    324
                  SBRC = SBRCB+SBRCG                                            GRASS0    325
325               SUMATM = SUMATB+SUMATG                                        GRASS0    326
            C   CALCULATE OUTPUT QUANTITIES                                     GRASS0    327
            C                                                                   GRASS0    328
            C   IN ANNULAR REGION (J,K):                                       GRASS0    329
            C   BVC=COMPRESSIBLE FISSION GAS VOLUME (CM**3)                    GRASS0    330
330         C   RP=FRACTION OF RETAINED FISSION GAS RESIDING IN BUBBLES         GRASS0    331
            C   PG=EFFECTIVE SURFACE TENSION INDUCED PRESSURE (PSI)            GRASS0    332
            C   BVI=VOLUME PER MOLE OF DISSOLVED FISSION GAS (INCHES**3)       GRASS0    333
            C   GOUTJK=AMOUNT OF FISSION GAS RELEASED (MOLES)                  GRASS0    334
            C   BULKFR=FRACTION OF FISSION GAS RETAINED IN BULK                GRASS0    335
335         C   GBDYFR=FRACTION OF FISSION GAS RETAINED ON GRAIN BOUNDARIES     GRASS0    336
            C   EDGEFR=FRACTION OF FISSION GAS RETAINED IN EDGE TUNNELS         GRASS0    337
            C   FTGRJK=FRACTION OF FISSION GAS RELEASED FROM REGION             GRASS0    338
            C   GGTJK=AMOUNT OF FISSION GAS GENERATED IN REGION (MOLES)         GRASS0    339
            C                                                                   GRASS0    340
340         C   BVSBJ=STRAIN IN SECTION J DUE TO BULK BUBBLES                   GRASS0    341
            C   BVSGJ=STRAIN IN SECTION J DUE TO GRAIN BOUNDARY BUBBLES         GRASS0    342
            C   BVSEJ=STRAIN IN SECTION J DUE TO GRAIN EDGE SWELLING            GRASS0    343
            C                                                                   GRASS0    344
            C   GGT=TOTAL AMOUNT OF GAS PRODUCED BY FISSION IN FUEL            GRASS0    345
345         C   RTGAS=TOTAL AMOUNT OF RETAINED GAS IN FUEL (MOLES)             GRASS0    346
            C   GRFT=TOTAL AMOUNT OF FISSION GAS RELEASED FROM FUEL (MOLES)    GRASS0    347
            C   FTGR=FRACTION OF FISSION GAS RELEASED FROM FUEL                GRASS0    348
            C   TFGR=FRACTION OF FISSION GAS RELEASED DURING TRANSIENT(IRSTAR=13) GRASS0  349
            C   FGGP=FRACTION OF GENERATED GAS TRAPPED IN CLOSED POROSITY      GRASS0    350
350         C   FGGB=FRACTION OF GENERATED GAS TRAPPED ON GRAIN BOUNDARIES     GRASS0    351
            C   RG(J)=AMOUNT OF RETAINED FISSION GAS IN AXIAL SECTION J (MOLES) GRASS0    352
            C                                                                   GRASS0    353
                  BVCBT = PI43*SBRC*VOLUME                                      GRASS0    354
                  BVIBT = PI43*RICO*SUMATM*VOLUME                               GRASS0    355
355               FCBGED = BVCBT/(BVCBT+BVIBT)                                  GRASS0    356
                  BVC = BVCBT+GESWF(J,K)*FCBGED*VOLUME                          GRASS0    357
                  BV(J,K) = (BVC+BVIBT)/VOLUME+GESWF(J,K)*(1.0-FCBGED)          GRASS0    358
                  BVJK = BV(J,K)                                                GRASS0    359
                  BVSB = PI43*(RICO*SUMATB+SBRCB)                               GRASS0    360
360               BVSG = PI43*(RICO*SUMATG+SBRCG)                               GRASS0    361
                  BVCE = BVC/16.387                                             GRASS0    362
                  BVISP = RICO*PI43/16.387*AVN                                  GRASS0    363
                  BVI = BVISP                                                   GRASS0    364
                  RP = SATMC/SUMATM                                             GRASS0    365
365               SUMATM = SUMATM+GIP(J,K)/VOLUME                               GRASS0    366
                  BULKFR = SUMATB/SUMATM                                        GRASS0    367
                  GBDYFR = SUMATG/SUMATM                                        GRASS0    368
                  EDGEFR = GIP(J,K)/VOLUME/SUMATM                               GRASS0    369
                  GSJK = SUMATM/AVN                                             GRASS0    370
370               GS(J,K) = GSJK*VOLUME                                         GRASS0    371
                  RTGAS = RTGAS+GS(J,K)                                         GRASS0    372
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                    GGT = TGASIN/AVN                                                                    GRASSO    373
                    FTGR = TGASR/TGASIN                                                                 GRASSO    374
                    GRFT = TGASR/AVN                                                                    GRASSO    375
375                 IF (BVCE.LE.1.E-20) GO TO 530                                                       GRASSO    376
                    IF (RP.LT.0.) RP = 0.                                                               GRASSO    377
                    PG = GSJK*R9/BVCE*TK(J,K)*RP-PRSG                                                   GRASSO    378
                    IF (PG.LT.0.) PG = 0.                                                               GRASSO    379
                    GO TO 540                                                                           GRASSO    380
380         530     PG = AI                                                                             GRASSO    381
            540     CONTINUE                                                                            GRASSO    382
                    GGTJK = GASGEN(J,K)/AVN                                                             GRASSO    383
                    GOUTJK = GOUT(J,K)/AVN                                                              GRASSO    384
                    FTGRJK = GOUTJK/GGTJK                                                               GRASSO    385
385                 DR = (RS(J,K+1)-RS(J,K))/2.0                                                        GRASSO    386
                    RATIO = (RS(J,K)+DR)/RS(J,KF1)                                                      GRASSO    387
            550     IF (NPRINT-2) 570,560,560                                                           GRASSO    388
            560     PRINT 670                                                                           GRASSO    389
                    PRINT 730, J,K,PG,RP,BVI,GS(J,K),PRSG,BVC,GESW,VOLUME,SUMATM,F                      GRASSO    390
390               + TGRJK,GOUTJK,GGTJK,BULKFR,EGRE,BVJK,BVSB,BVSG,GESWF(J,K),GBDYF                      GRASSO    391
                  + R,ESWE,GKIN,RATIO,TKOLD(J,K),SPT,EDGEFR,EPRF                                        GRASSO    392
                    IF (KK.LT.0) GO TO 590                                                              GRASSO    393
            570     TKOLD(J,K) = TK(J,K)                                                                GRASSO    394
                    PRFOLD(J,K) = PRF(K)                                                                GRASSO    395
395                 ADP = AI                                                                            GRASSO    396
                    IF (PG.GT.ADP) PG = ADP                                                             GRASSO    397
                    IF (RP.GT.1.) RP = 1.                                                               GRASSO    398
                    BVSBJ = BVSBJ+BVSB*VOLUME                                                           GRASSO    399
                    BVSGJ = BVSGJ+BVSG*VOLUME                                                           GRASSO    400
400                 BVSEJ = BVSEJ+GESWF(J,K)*VOLUME                                                     GRASSO    401
                    VOLJ = VOLJ+VOLUME                                                                  GRASSO    402
                    KTBF = KTBF-1                                                                       GRASSO    403
                    RGP = RGP+GIP(J,K)/AVN                                                              GRASSO    404
                    RGG = RGG+SUMATG*VOLUME/AVN                                                         GRASSO    405
405                 IF (NPRINT.GE.3.AND.KTBF.NE.0) KPRINT = 2                                           GRASSO    406
                    IF (KTBF.GT.0.AND.KK.GE.0) GO TO 460                                                GRASSO    407
                    GRDT = GRDT+GASOUT                                                                  GRASSO    408
                    GR(J) = GASOUT/AVN                                                                  GRASSO    409
                    RGTJ(J) = RTGAS                                                                     GRASSO    410
410                 RGT = RGT+RGTJ(J)                                                                   GRASSO    411
                    GRT = GRT+GR(J)                                                                     GRASSO    412
                    BVSJ = BVSBJ+BVSGJ+BVSEJ                                                            GRASSO    413
                    BVST = BVST+BVSJ                                                                    GRASSO    414
                    VOLT = VOLT+VOLJ                                                                    GRASSO    415
415                 BVSJ = BVSJ/VOLJ                                                                    GRASSO    416
                    BVSBJ = BVSBJ/VOLJ                                                                  GRASSO    417
                    BVSGJ = BVSGJ/VOLJ                                                                  GRASSO    418
                    BVSEJ = BVSEJ/VOLJ                                                                  GRASSO    419
                    BVS(J) = BVSBJ+BVSGJ+BVSEJ                                                          GRASSO    420
420                 GASINJ = GASINJ/AVN                                                                 GRASSO    421
                    IF (NPRINT.GT.2) PRINT 720, GR(J),RGTJ(J),BVSJ,BVSBJ,BVSGJ,BVS                     GRASSO    422
                  + EJ                                                                                  GRASSO    423
            580     CONTINUE                                                                            GRASSO    424
                  IF (IRSTAR.NE.13) CO1 = TGASIN                                                        GRASSO    425
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      TFGR = (GRFT*AVN-GRF0)/C01                                                GRASS0    426
      IF (TFGR.LE.0) TFGR = 0.0                                                 GRASS0    427
      IF (GGDT.EQ.0.OR.IRSTAR.EQ.13) GGDT = C01                                 GRASS0    428
      FGRDT = GRDT/GGDT                                                         GRASS0    429
      BVST = BVST/VOLT                                                          GRASS0    430
      ERROR = ABS((RGT+GRFT-GGT)/GGT)                                           GRASS0    431
      FGGP = RGP/GGT                                                            GRASS0    432
      FGGB = RGG/GGT                                                            GRASS0    433
      IF (NPRINT.GE.2) WRITE (6,740) GRT,GRFT,GGT,RGT,FGGP,FGGB,BVST,FGR        GRASS0    434
     +DT,FTGR,TFGR,ERROR                                                        GRASS0    435
      JFIRST = 1                                                                GRASS0    436
      TS0 = T2                                                                  GRASS0    437
  590 IF (KK.LT.0) NPRINT = -9                                                  GRASS0    438
      IF (NPRINT.GT.1) WRITE (6,750)                                            GRASS0    439
  600 CONTINUE                                                                  GRASS0    440
      RETURN                                                                    GRASS0    441
C                                                                               GRASS0    442
  610 FORMAT (1X,I5,5E12.4)                                                     GRASS0    443
  620 FORMAT (///36X,54H********** GRASS OUTPUT **********                     GRASS0    444
     +*****,/)                                                                  GRASS0    445
  630 FORMAT (50X,6HTIME= ,1E16.9,//)                                           GRASS0    446
  640 FORMAT (45X,16HTRANSIENT TIME= ,1E16.9,//)                                GRASS0    447
  650 FORMAT (//22H ------ AXIAL SECTION=,I3,16H RADIAL SECTION=,I3,//)         GRASS0    448
  660 FORMAT (9H RS(J,K)=,D14.6,11H RS(J,K+1)=,D14.6,9H TS(J,K)=,D14.6,1        GRASS0    449
     +1H TS(J,K+1)=,D12.6,9H FDP(K) =,D14.6,10H H(INPUT)=,E13.6,11H PRF         GRASS0    450
     +(K)   =,E14.6,9H PRFOLD =,E14.6,12H GESWF(J,K)=,E11.5,9H RHOOLD =,        GRASS0    451
     +E14.6)                                                                    GRASS0    452
  670 FORMAT (//3X,1HJ,2X,1HK,13X,2HPG,13X,2HRP,12X,3HBVI,13X,2HGS,11X,4        GRASS0    453
     +HPRSG,12X,3HBVC,11X,4HGESW,12X,3HVOL)                                     GRASS0    454
  680 FORMAT (/5H TAU=,E14.6,11H H(ACTUAL)=,E14.6,9H H(SUGG)=,E14.6,4H H        GRASS0    455
     +H=,E14.6,4H KK=,I2,7H IMAXI=,I2,23H   DISTRIBUTIONS FOLLOW/)              GRASS0    456
  690 FORMAT (1X,A4,2X,6HREGION,I2,8E12.4,4(/15X,8E12.4))                       GRASS0    457
  700 FORMAT (/1X,A4,2X,6HREGION,I2,2X,11HPOROS(J,K)=,E11.4,14H  EPOROS(        GRASS0    458
     +J,K)=,E12.4,12H GRSIZ(J,K)=,E12.4,7H  AGBY=,E12.4)                        GRASS0    459
  710 FORMAT (32H GRASS NOT CONVERGING, AXL SECT#,I3,12HRADIAL SCT #,I3)        GRASS0    460
  720 FORMAT (/7H GR(J)=,D14.7,9H RGTJ(J)=,E12.5,6H BVSJ=,E15.7,7H BVSBJ        GRASS0    461
     +=,E14.7,7H BVSGJ=,E14.7,8H  BVSEJ=,E14.7)                                 GRASS0    462
  730 FORMAT (1X,2I3,5D15.6,3E15.6,//8H SUMATM=,E13.6,8H FTGRJK=,E13.6,8        GRASS0    463
     +H GOUTJK=,E13.6,8H GGTJK=,E14.7,8H BULKFR=,E13.6,7H  EGRE=,E14.7/6        GRASS0    464
     +H BV=  ,E15.7,6H BVSB=,E15.7,6H BVSG=,E15.7,6H BVSE=,E15.7,8H GBDY        GRASS0    465
     +FR=,E13.6,7H  ESWE=,E14.7,/7H GKIN =,E14.7,9H RATIO=  ,E12.6,7H TK        GRASS0    466
     +OLD=,E14.7,6H SPT= ,E15.7,8H EDGEFR=,E13.6,7H  EPRF=,E14.7)               GRASS0    467
  740 FORMAT (/6H GRT= ,E15.7,6H GRFT=,E15.7,6H GGT= ,E15.7,6H RGT= ,E15        GRASS0    468
     +.7,6H FGGP=,E15.7,7H  FGGB=,E15.7/6H BVST=,E15.7,7H FGRDT=,E14.7,6        GRASS0    469
     +H FTGR=,E15.7,6H TFGR=,E15.7,7H ERROR=,E14.7)                             GRASS0    470
  750 FORMAT (//27X,80H********** END OF GRASS OUTPUT FOR THIS                  GRASS0    471
     + TIME STEP **********,//)                                                 GRASS0    472
      END                                                                       GRASS0    473
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

99 I CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
111 I CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
301 I AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GRASS 7 440

VARIABLES	SN	TYPE		RELOCATION								
3241	A	REAL			REFS	139	DEFINED	138				
3336	ADP	REAL			REFS	2*396	DEFINED	395				
7	AGBY	REAL		GR0A2	REFS	45	280					
4	AREA	REAL		GR0A2	REFS	45	DEFINED	163				
0	AVN	REAL		GR0235	REFS	43	362	369	372	374	382	383
					403	404	408	420	425			
0	AI	REAL		BDGR	REFS	52	380	395				
3240	B	REAL			REFS	138	139	DEFINED	137			
13	BCF	REAL		BDGR	REFS	52	227	230				
16	BKHI	REAL		BDGR	REFS	52	137	138	143			
15	BKLO	REAL		BDGR	REFS	52	137	143				
0	BLKMGO	REAL	ARRAY	F.P.	REFS	62	204	DEFINED	7	152	260	265
0	BULK	REAL	ARRAY	F.P.	REFS	62	149	184	189	275	287	307
					312	DEFINED	7	149	218			
3321	BULKFR	REAL			REFS	389	DEFINED	366				
0	BV	REAL	ARRAY	F.P.	REFS	62	358	DEFINED	7	357		
3311	BVC	REAL			REFS	357	361	389	DEFINED	356		
3306	BVCBT	REAL			REFS	2*355	356	DEFINED	353			
3315	BVCE	REAL			REFS	375	377	DEFINED	361			
22	BVCRIT	REAL		BDGR	REFS	52	125					
3317	BVI	REAL			REFS	389	DEFINED	363				
3307	BVIBT	REAL			REFS	355	357	DEFINED	354			
3316	BVISP	REAL			REFS	363	DEFINED	362				
3312	BVJK	REAL			REFS	389	DEFINED	358				
0	BVS	REAL	ARRAY	F.P.	REFS	62	DEFINED	7	419			
3313	BVSB	REAL			REFS	389	398	DEFINED	359			
3223	BVSBJ	REAL			REFS	398	412	416	419	421		
					DEFINED	101	398	416				
3225	BVSEJ	REAL			REFS	400	412	418	419	421		
					DEFINED	103	400	418				
3314	BVSG	REAL			REFS	389	399	DEFINED	360			
3224	BVSGJ	REAL			REFS	399	412	417	419	421		
					DEFINED	102	399	417				
3337	BVSJ	REAL			REFS	413	415	421	DEFINED	412	415	
0	BVST	REAL		F.P.	REFS	413	429	433	DEFINED	7	93	413
					429							
17	CPOW	REAL		BDGR	REFS	52	109					

VARIABLES SN TYPE RELOCATION

0	CO	REAL	ARRAY	F.P.	REFS	62	184	DEFINED	7			
14	CO1	REAL		BDGR	REFS	52	425	427	DEFINED	79	424	
0	DEL	REAL		F.P.	REFS	71	86	DEFINED	7			
12	DELT	REAL		GR0A2	REFS	45	88	157	272	300		
					DEFINED	86						
3260	DPRF	REAL			REFS	241	245	DEFINED	238	240		
3334	DR	REAL			REFS	386	DEFINED	385				
0	DSLC	REAL	ARRAY	F.P.	REFS	62	150	184	193	277	287	307
					312	DEFINED	7	150	222			
3251	DT	REAL			REFS	208	209	253	254	274		
					DEFINED	207						
3264	DTI	REAL			REFS	260	266	DEFINED	254			
3323	EDGEFR	REAL			REFS	389	DEFINED	368				
3253	EGRE	REAL			REFS	228	234	389	DEFINED	214	228	
3261	EPRF	REAL			REFS	242	245	389	DEFINED	241		
2	EPSI	REAL		BDG02D	REFS	49	287					
3342	ERROR	REAL			REFS	433	DEFINED	430				
3254	ESWE	REAL			REFS	229	246	389	DEFINED	215	229	
10	FBDEN	REAL		GR0A2	REFS	45	226					
11	FBSAT	REAL		GR0A2	REFS	45	226					
3310	FCBGED	REAL			REFS	356	357	DEFINED	355			
0	FDP	REAL	ARRAY	F.P.	REFS	61	164	182	184	DEFINED	7	
3344	FGGB	REAL			REFS	433	DEFINED	432				
3343	FGGP	REAL			REFS	433	DEFINED	431				
21	FGPF	REAL		BDGR	REFS	52	165					
3341	FGRDT	REAL			REFS	433	DEFINED	428				
3236	FK	REAL			REFS	139	DEFINED	132				
3237	FKM	REAL			REFS	134	137	DEFINED	133			
0	FL	REAL		F.P.	REFS	155	DEFINED	7				
0	FODSLC	REAL	ARRAY	F.P.	REFS	62	184	DEFINED	7			
0	FOGBDY	REAL	ARRAY	F.P.	REFS	62	184	DEFINED	7			
3256	FP	REAL			REFS	280	DEFINED	233				
2	FPWS	REAL		BDGR	REFS	52	110					
3326	FTGR	REAL			REFS	433	DEFINED	373				
3333	FTGRJK	REAL			REFS	389	DEFINED	384				
0	GASGEN	REAL	ARRAY	F.P.	REFS	62	211	382	DEFINED	7	145	211
1	GASIN	REAL		GR0235	REFS	43	209	DEFINED	165			
3227	GASINJ	REAL			REFS	420	DEFINED	105	420			
3252	GASINK	REAL			REFS	210	211	212	DEFINED	209		
3265	GASMGO	REAL			REFS	261	267	269	270	271		
					DEFINED	255	261	267				
3243	GASOUT	REAL			REFS	250	269	407	408	DEFINED	159	250
					269							
0	GBDY	REAL	ARRAY	F.P.	REFS	62	151	184	197	279	287	308
					313	DEFINED	7	151	231			
3322	GBDYFR	REAL			REFS	389	DEFINED	367				
0	GBYMGO	REAL	ARRAY	F.P.	REFS	62	204	DEFINED	7	153	259	266
3234	GESFP	REAL			REFS	125	DEFINED	124				
3233	GESFPD	REAL			REFS	124	DEFINED	123				
0	GESW	REAL		GR0A3	REFS	47	248	389	DEFINED	236		
0	GESWF	REAL	ARRAY	F.P.	REFS	62	125	182	233	245	246	248
					356	357	389	400	DEFINED	7	112	245
					246	248						

VARIABLES	SN	TYPE	RELOCATION									
3215	GGDT	REAL			REFS	210	427	428	DEFINED	94	210	427
3325	GGT	REAL			REFS	2*430	431	432	433	DEFINED	372	
3331	GGTJK	REAL			REFS	384	389	DEFINED	382			
0	GIP	REAL	ARRAY	F.P.	REFS	62	184	241	243	249	365	368
					403	DEFINED	7	249				
3257	GKIN	REAL			REFS	242	243	249	389	DEFINED	234	
3262	GKOUT	REAL			REFS	244	249	250	251	252		
					DEFINED	242	244					
0	GOUT	REAL	ARRAY	F.P.	REFS	62	251	271	383	DEFINED	7	144
					251	271						
3332	GOUTJK	REAL			REFS	384	389	DEFINED	383			
0	GR	REAL	ARRAY	F.P.	REFS	62	184	411	421	DEFINED	7	408
5	GRD	REAL		GR0A2	REFS	45	DEFINED	175				
3216	GRD[illegible]	REAL			REFS	407	428	DEFINED	95	407		
3327	GRF[illegible]	REAL			REFS	425	430	433	DEFINED	374		
23	GRF[illegible]	REAL		BDGR	REFS	52	425	DEFINED	80			
0	GRS[illegible]Z	REAL	ARRAY	F.P.	REFS	61	175	280	DEFINED	7		
0	GR[illegible]	REAL		F.P.	REFS	411	433	DEFINED	7	411		
0	GS	REAL	ARRAY	F.P.	REFS	62	371	389	DEFINED	7	370	
3324	GSJK	REAL			REFS	370	377	DEFINED	369			
124	H	REAL		GR0A4	REFS	48	182	184	203	274	3*285	300
					DEFINED	299	300					
0	HH	REAL	ARRAY	F.P.	REFS	62	184	274	285	299		
					DEFINED	7	285					
3242	HITEI	REAL			REFS	162	163	DEFINED	155			
0	HOLD	REAL	ARRAY	F.P.	REFS	62	DEFINED	7	140	208		
3250	HT	REAL			REFS	285	296	299	DEFINED	203	295	
3	HY	REAL		GR0A2	REFS	45	DEFINED	174				
3246	I	INTEGER			REFS	188	189	192	193	196	197	198
					217	218	221	222	225	227	2*230	231
					232	234	235	236	258	260	261	264
					266	267	DEFINED	186	188	192	196	213
					217	221	225	232	235	258	264	
0	IMAXI	INTEGER		GR0A4	REFS	48	199	274	DEFINED	198		
0	IRSTAR	INTEGER		F.P.	REFS	78	89	90	112	127	129	184
					424	427	DEFINED	7				
26	J	INTEGER		GR0235	REFS	43	109	112	4*114	116	4*118	4*120
					123	125	2*128	2*129	139	140	141	143
					144	145	2*146	147	2*149	2*150	2*151	2*154
					4*162	163	2*164	3*168	171	172	173	175
					176	178	181	6*182	189	193	197	208
					2*211	218	222	231	2*233	237	2*238	241
					243	2*245	4*246	2*248	2*249	2*251	2*271	274
					275	277	279	2*280	283	2*285	3*287	289
					299	2*307	308	2*312	313	356	2*357	358
					365	368	370	371	377	382	383	2*385
					2*386	4*389	2*393	394	400	403	408	409
					410	411	419	2*421	DEFINED	99		
4	JFIRST	INTEGER		BDG02D	REFS	49	72	112	127	129		
					DEFINED	435						
1	JKF	INTEGER		GR0A3	REFS	47	DEFINED	167	170			
33	JNCDI	INTEGER		GR0235	REFS	43	190	219				
34	JNCGBI	INTEGER		GR0235	REFS	43	194	223	256	262		

VARIABLES	SN	TYPE		RELOCATION								
27	K	INTEGER		GR0235	REFS	43	112	113	6*114	117	5*118	5*120
					2*121	123	125	126	2*128	2*129	132	139
					140	143	144	145	2*146	2*147	2*149	2*150
					2*151	152	153	2*154	161	2*162	163	164
					166	2*168	171	172	173	175	176	177
					178	181	8*182	189	193	197	201	202
					206	208	2*211	218	222	231	2*233	237
					3*238	241	242	243	2*245	5*246	3*248	2*249
					2*251	259	260	265	266	268	2*271	2*272
					2*274	2*275	2*277	2*279	3*280	283	2*285	3*287
					289	2*291	292	293	2*295	297	299	2*307
					308	2*312	313	356	2*357	358	365	368
					370	371	377	382	383	2*385	386	4*389
					2*393	2*394	400	403	DEFINED	111	158	293
					297							
0	KF	INTEGER		F.P.	REFS	3*61	25*62	83	106	111	133	158
					166	184	204	DEFINED	7			
5	KFIRST	INTEGER		BDG02D	REFS	49						
0	KFI	INTEGER		F.P.	REFS	2*61	62	157	2*164	291	386	
					DEFINED	7	83					
125	KK	INTEGER		GR0A4	REFS	48	205	274	281	392	406	437
6	KPRINT	INTEGER		BDG02D	REFS	49	DEFINED	107	179	405		
3230	KTBF	INTEGER			REFS	272	291	402	405	406		
					DEFINED	106	402					
2	KI	INTEGER		GR0A3	REFS	47	2*162	168	DEFINED	161		
45	LGRASS	INTEGER		GRSPTR	REFS	54						
3212	N	INTEGER			REFS	2*77	2*149	2*150	2*151	152	153	189
					193	197	218	222	228	229	231	259
					260	261	265	266	267	275	277	279
					311	2*312	313	314	315	DEFINED	76	148
					187	191	195	216	220	224	257	263
					275	277	279	309				
3	NAME	INTEGER	ARRAY	BDGR	REFS	52	275	277	279	280		
31	NCDI	INTEGER		GR0235	REFS	43	191	200	220	276	277	
32	NCGBI	INTEGER		GR0235	REFS	43	195	224	263	278	279	
0	NF	INTEGER		F.P.	REFS	4*61	24*62	99	155	184	204	
					DEFINED	7						
3266	NFLAG	INTEGER			REFS	301	DEFINED	286	290	294		
7	NMAX	INTEGER		BDG02D	REFS	49	76	148	287			
30	NMAXB	INTEGER		GR0235	REFS	43	187	200	216	257	275	5*287
					289	309	DEFINED	171				
0	NMAXBK	INTEGER	ARRAY	F.P.	REFS	62	2*168	171	DEFINED	7	133	143
					168	289						
35	NMAXG	INTEGER		GR0235	REFS	43	257					
0	NPRINT	INTEGER		F.P.	REFS	84	89	90	107	179	180	2*272
					397	405	421	433	438	DEFINED	7	205
					282	437						
9	NVAR1	INTEGER		GRSPTR	REFS	54						
11	NVAR10	INTEGER		GRSPTR	REFS	54						
12	NVAR11	INTEGER		GRSPTR	REFS	54						
13	NVAR12	INTEGER		GRSPTR	REFS	54						
14	NVAR13	INTEGER		GRSPTR	REFS	54						
15	NVAR14	INTEGER		GRSPTR	REFS	54						

VARIABLES	SN	TYPE		RELOCATION								
16	NVAR15	INTEGER		GRSPTR	REFS	54						
17	NVAR16	INTEGER		GRSPTR	REFS	54						
20	NVAR17	INTEGER		GRSPTR	REFS	54						
21	NVAR18	INTEGER		GRSPTR	REFS	54						
22	NVAR19	INTEGER		GRSPTR	REFS	54						
1	NVAR2	INTEGER		GRSPTR	REFS	54						
23	NVAR20	INTEGER		GRSPTR	REFS	54						
24	NVAR21	INTEGER		GRSPTR	REFS	54						
25	NVAR22	INTEGER		GRSPTR	REFS	54						
26	NVAR23	INTEGER		GRSPTR	REFS	54						
27	NVAR24	INTEGER		GRSPTR	REFS	54						
30	NVAR25	INTEGER		GRSPTR	REFS	54						
31	NVAR26	INTEGER		GRSPTR	REFS	54						
32	NVAR27	INTEGER		GRSPTR	REFS	54						
33	NVAR28	INTEGER		GRSPTR	REFS	54						
34	NVAR29	INTEGER		GRSPTR	REFS	54						
2	NVAR3	INTEGER		GRSPTR	REFS	54						
35	NVAR30	INTEGER		GRSPTR	REFS	54						
36	NVAR31	INTEGER		GRSPTR	REFS	54						
37	NVAR32	INTEGER		GRSPTR	REFS	54						
40	NVAR33	INTEGER		GRSPTR	REFS	54						
41	NVAR34	INTEGER		GRSPTR	REFS	54						
42	NVAR35	INTEGER		GRSPTR	REFS	54						
43	NVAR36	INTEGER		GRSPTR	REFS	54						
44	NVAR37	INTEGER		GRSPTR	REFS	54						
3	NVAR4	INTEGER		GRSPTR	REFS	54						
4	NVAR5	INTEGER		GRSPTR	REFS	54						
5	NVAR6	INTEGER		GRSPTR	REFS	54						
6	NVAR7	INTEGER		GRSPTR	REFS	54						
7	NVAR8	INTEGER		GRSPTR	REFS	54						
10	NVAR9	INTEGER		GRSPTR	REFS	54						
36	NXBD	INTEGER		GR0235	REFS	43	DEFINED	200				
37	NXBDG	INTEGER		GR0235	REFS	43	DEFINED	199				
11	PDSC	REAL		BDGR	REFS	52	174					
3330	PG	REAL			REFS	378	389	396	DEFINED	377	378	380
						396						
3	PI	REAL		BDG02D	REFS	49	162	163	164			
12	PI43	REAL		BDGR	REFS	52	229	248	353	354	359	360
						362						
0	PLENP	REAL		F.P.	REFS	2*173	DEFINED	7				
0	POROS	REAL	ARRAY	F.P.	REFS	61	123	233	280	DEFINED	7	
0	POW	REAL	ARRAY	F.P.	REFS	62	109	116	184	DEFINED	7	
3231	POWERL	REAL			REFS	110	DEFINED	109				
0	PRF	REAL	ARRAY	F.P.	REFS	62	147	182	238	242	246	248
						394	DEFINED	7	126			
3235	PRFC	REAL			REFS	126	DEFINED	125				
0	PRFOLD	REAL	ARRAY	F.P.	REFS	62	182	237	2*238	DEFINED	7	147
						394						
3244	PRSG	REAL			REFS	174	377	389	DEFINED	172	173	
0	PRSO	REAL	ARRAY	F.P.	REFS	62	172	173	DEFINED	7		
24	PTPL	REAL		BDGR	REFS	52	123					
40	RAD	REAL	ARRAY	GR0235	REFS	43	62	229	302	311		
3276	RAD2C	REAL			REFS	317	318	319	320	DEFINED	311	318

VARIABLES SN TYPE RELOCATION

3335	RATIO	REAL			REFS	389	DEFINED	386					
3221	RGG	REAL			REFS	404	432	DEFINED	98	404			
3220	RGP	REAL			REFS	403	431	DEFINED	97	403			
3217	RGT	REAL			REFS	410	430	433	DEFINED	96	410		
0	RGTJ	REAL	ARRAY	F.P.	REFS	62	184	410	421	DEFINED	7	409	
0	RH	REAL	ARRAY	F.P.	REFS	62	128	154	DEFINED	7			
0	RHODSL	REAL	ARRAY	F.P.	REFS	62	184	DEFINED	7				
0	RHOLD	REAL	ARRAY	F.P.	REFS	62	128	DEFINED	7	154			
7	RHOOLD	REAL		BDGR	REFS	52	149	150	151	182			
					DEFINED	128							
3270	RIC	REAL			REFS	310	317	318	DEFINED	303	310		
3267	RICO	REAL			REFS	303	354	359	360	362			
					DEFINED	302							
11	RM	REAL		BDG02D	REFS	49	77	310					
3320	RP	REAL			REFS	376	377	389	397	DEFINED	364	376	
					397								
0	RS	REAL	ARRAY	F.P.	REFS	61	2*114	2*118	2*120	4*162	163	2*164	
					2*182	2*385	2*386	DEFINED	7				
3226	RTGAS	REAL			REFS	371	409	DEFINED	104	371			
1	R9	REAL		BDGR	REFS	52	377						
3273	SATMC	REAL			REFS	321	364	DEFINED	306	321			
2	SAVG	REAL	ARRAY	GR0235	REFS	43	62	77	228	261	267	287	
					307	308	314	315	DEFINED	75	77		
3304	SBRC	REAL			REFS	353	DEFINED	324					
3271	SBRCB	REAL			REFS	319	324	359	DEFINED	304	319		
3272	SBRCG	REAL			REFS	320	324	360	DEFINED	305	320		
20	SIGPI	REAL		BDGR	REFS	52	125						
13	SPT	REAL		GR0A2	REFS	45	389						
3303	SUMA	REAL			REFS	321	DEFINED	316					
3301	SUMAB	REAL			REFS	316	322	DEFINED	314				
3302	SUMAG	REAL			REFS	316	323	DEFINED	315				
3274	SUMATB	REAL			REFS	322	325	359	366	DEFINED	307	322	
3275	SUMATG	REAL			REFS	323	325	360	367	404			
					DEFINED	308	323						
3305	SUMATM	REAL			REFS	354	364	365	366	367	368	369	
					389	DEFINED	325	365					
3277	SUMB	REAL			REFS	314	319	DEFINED	312				
3300	SUMG	REAL			REFS	315	320	DEFINED	313				
0	TAUA	REAL	ARRAY	F.P.	REFS	62	201	202	272	274	2*291	2*295	
					DEFINED	7	113	157	206				
10	TCONV	REAL		BDGR	REFS	52	86	87					
3340	TFGR	REAL			REFS	426	433	DEFINED	425	426			
1	TFPV	REAL		GR0A2	REFS	45	165	DEFINED	164				
0	TFO	REAL	ARRAY	F.P.	REFS	62	184	DEFINED	7				
0	TGASIN	REAL		BDG02D	REFS	49	79	212	372	373	424		
					DEFINED	212							
1	TGASR	REAL		BDG02D	REFS	49	79	80	252	270	373	374	
					DEFINED	252	270						
3263	TGIP	REAL			REFS	2*244	DEFINED	243					
0	TGRAD	REAL	ARRAY	F.P.	REFS	62	114	121	177	DEFINED	7	118	
					120	121							
2	TGRADI	REAL		GR0A2	REFS	45	DEFINED	177					
0	TIT	REAL		F.P.	REFS	87	DEFINED	7					

VARIABLES	SN	TYPE	RELOCATION									
0	TK	REAL	ARRAY	F.P.	REFS	62	129	146	176	246	377	393
					DEFINED	7						
0	TKI	REAL		GROA2	REFS	45	DEFINED	176				
3245	TKOJK	REAL			REFS	184	DEFINED	178				
0	TKOLD	REAL	ARRAY	F.P.	REFS	62	178	246	389	DEFINED	7	129
					146	393						
3213	TMAX	REAL			REFS	300	DEFINED	88				
3232	TOTFIS	REAL			REFS	164	DEFINED	110				
1	TPASS	REAL		GROA4	REFS	48	206	207	DEFINED	202		
0	TS	REAL	ARRAY	F.P.	REFS	61	2*114	2*118	2*120	2*182		
					DEFINED	7						
3247	TSAVE	REAL			REFS	207	DEFINED	201				
12	TS0	REAL		BDG02D	REFS	49	DEFINED	81	436			
10	TS02	REAL		BDG02D	REFS	49	DEFINED	82				
6	T2	REAL		GROA2	REFS	45	89	90	436	DEFINED	87	
3222	VOLJ	REAL			REFS	401	414	415	416	417	418	
					DEFINED	100	401					
3214	VOLT	REAL			REFS	414	429	DEFINED	92	414		
65	VOLUME	REAL		GRO235	REFS	43	209	227	234	246	353	354
					356	357	365	368	370	389	398	399
					400	401	404	DEFINED	162			
2	Y	REAL	ARRAY	GROA4	REFS	48	62	218	222	227	230	231
					234	236	260	261	266	267		
					DEFINED	189	193	197	230			
3255	YVB	REAL			REFS	228	229	DEFINED	227			

FILE NAMES	MODE									
OUTPUT	FMT	WRITES	274	275	277	279	280	283	388	389
		421								
TAPE6	FMT	WRITES	84	89	90	114	181	182	433	438

EXTERNALS	TYPE	ARGS		REFERENCES	
ALOG	REAL	1	LIBRARY	137	
ERF	REAL	1	LIBRARY	126	
EXP	REAL	1	LIBRARY	138	139
GRASS2		19		184	
GRASS4		4		204	

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
ABS	REAL	1	INTRIN		430	
AMAX1	REAL	0	INTRIN		124	241
AMIN1	REAL	0	INTRIN		299	
FLOAT	REAL	1	INTRIN		132	133
MAX0	INTEGER	0	INTRIN		168	

STATEMENT LABELS		DEF LINE	REFERENCES	
0	100	77	76	
46	110	83	72	78
224	120	120	116	117
234	130	121	119	
310	140	132	127	
354	150	143	134	
363	160	144	141	142

STATEMENT LABELS			DEF LINE	REFERENCES			
404	170		148	130			
0	180		153	148			
0	190		154	111			
466	200		161	301			
536	210		170	166			
540	220		171	169			
636	230		184	180			
0	240		189	187			
0	250		193	191			
721	260		194	190			
0	270		197	195			
741	280		198	194			
751	290		201	301			
0	300		218	216			
0	310		222	220			
1065	320		223	219			
1120	330		231	224	226		
1132	340		232	223			
1170	350		240	237			
1172	360		241	239			
1305	370		257	3*256			
0	380		261	257			
1342	390		263	256	3*262		
0	400		267	263			
1403	410		272	253	262	268	
1467	420		278	276			
1522	430		281	272	278		
1532	440		285	281			
1567	450		291	287			
1575	460		292	406			
1602	470		294	160	298		
1604	480		295	292			
0	490	INACTIVE	297	2*296			
1615	500		299	296			
1637	510		302	291			
1746	520		323	309	317		
2140	530		380	375			
2143	540		381	379			
2176	550		387	284			
0	560	INACTIVE	388	2*387			
2216	570		393	387			
0	580		423	99			
2440	590		437	392			
2451	600		439	71			
2736	610	FMT	442	114			
2741	620	FMT	443	84			
2751	630	FMT	445	89			
2755	640	FMT	446	90			
2762	650	FMT	447	181			
2771	660	FMT	448	182			
3015	670	FMT	452	388			
3026	680	FMT	454	274			
3043	690	FMT	456	275	277	279	

STATEMENT LABELS			DEF LINE	REFERENCES
3050	700	FMT	457	280
3064	710	FMT	459	283
3073	720	FMT	460	421
3106	730	FMT	462	389
3145	740	FMT	467	433
3166	750	FMT	470	438

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
24	100	N	76 77	5B	INSTACK			
125	580	J	99 423	2240B		EXT REFS	EXITS	NOT INNER
157	190	K	111 154	273B		EXT REFS	NOT INNER	
405	180	N	148 153	37B	OPT			
665	240	N	187 189	13B	OPT			
705	250	N	191 193	13B	OPT			
725	270	N	195 197	13B	OPT			
1031	300	N	216 218	13B	OPT			
1051	310	N	220 222	13B	OPT			
1071	330	N	224 231	40B	OPT			
1307	380	N	257 261	21B	OPT			
1343	400	N	263 267	21B	OPT			
1427		N	275 275	13B		EXT REFS		
1451		N	277 277	13B		EXT REFS		
1474		N	279 279	13B		EXT REFS		
1666	520	N	309 323	65B	OPT			

COMMON BLOCKS	LENGTH
GR0235	54
GR0A2	12
GR0A3	3
GR0A4	86
BDG02D	11
BDGR	21
GRSPTR	38

STATISTICS

PROGRAM LENGTH	3657B	1967
SCM LABELED COMMON LENGTH	341B	225

140000B SCM USED

```
      1              SUBROUTINE GRASS1 (SUM,S)                          GRASS1      2
                     IF (S.EQ.0.) RETURN                                GRASS1      3
                     IF (S-SUM) 100,100,110                             GRASS1      4
                100  SUM = SUM-S                                        GRASS1      5
      5              S = 0.                                             GRASS1      6
                     RETURN                                             GRASS1      7
                110  S = S-SUM                                          GRASS1      8
                     SUM = 0.                                           GRASS1      9
                     RETURN                                             GRASS1     10
     10              END                                                GRASS1     11
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES		
4	GRASS1	1	2	6	9

VARIABLES	SN	TYPE	RELOCATION								
0	S	REAL	F.P.	REFS	2	3	4	7	DEFINED	1	5
				7							
0	SUM	REAL	F.P.	REFS	3	4	7	DEFINED	1	4	8

STATEMENT LABELS			DEF LINE	REFERENCES
0	100	INACTIVE	4	2*3
23	110		7	3

STATISTICS
PROGRAM LENGTH 30B 24
140000B SCM USED

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      SUBROUTINE GRASS2 (H,TKOLD,IRSTAR,GR,POW,RGTJ,FDP,FODSLC,FOGBDY,RH  GRASS2      2
     +ODSL,CO,GIP,HH,TFO,BULK,DSLC,GBDY,NF,KF)                            GRASS2      3
      COMMON/GR0A2/TK,TFPV,TGRAD,HS,AREA,GRD,T2,AGBY,FBDEN,FBSAT,DELT     GRASS2      4
     +,SPT                                                                GRASS2      5
      COMMON/BDG02D/                                                      GRASS2      6
     +TGASIN,TGASR,EPSI,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02,                GRASS2      7
     +RM,TS0                                                              GRASS2      8
      COMMON/GR2A4/EPS,YA,IMAX2,D4LIM                                     GRASS2      9
      COMMON/GTWOLC/SQN,DELHVN,YY,XX,XLAMDA,CONS,FC,FCEC,FCSD,DCEC,DCSD,  GRASS2     10
     +DCECN                                                               GRASS2     11
      COMMON/GR0235/AVN,GASIN,SAVG,J,K,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,     GRASS2     12
     +NMAXG,NXBD,NXBDG,RAD,VOLUME                                         GRASS2     13
      COMMON/GR2A3/PBK,PGBDY,PBKDS,PDSL,PBKGBY,PBKDLC,FLXGB2,GBRF,        GRASS2     14
     +RRGBIP,RTRS,BLKMOR,GBYMOR,NMAXD,NMAXB2,NMAXD2,NMAXG2                GRASS2     15
      COMMON/BDGR2/FFDSLC,ATMVOL,BOLTZ,G1,G2,                             GRASS2     16
     +AVNUM,FG,DELHV,TPG,GBSQ2P,SIG,WM1,WM2,XK,XKP,GBR,                   GRASS2     17
     +QSSTAR,QS,DZERO,PZERO,FN,ACON,DELTA,REDIS,RESCON,DVOL,EVL,          GRASS2     18
     +DVOG,EVG,ALFA,BEVK,BADC1,BADC2,BADC3,BADC4,BADC5,BADC6,             GRASS2     19
     +GBADC1,GBADC2,FAWGE,ASTAR,NOYES(2),GBADC3,A(9),DLIM                 GRASS2     20
      DIMENSION PBK(20,20),PDSL(20,20),PGBDY(20,20),PBKDS(20,20),         GRASS2     21
     +PBKGBY(20),PBKDLC(20),RRGBIP(20),SAVG(20),EPS(82)                   GRASS2     22
     +,YA(60),RAD(21),DSLCA(20),GBDYA(20),                                GRASS2     23
     +RTRS(20),BLKMOR(20),GBYMOR(20),BVBULK(20),BVDSLC(20),DCECN(20),     GRASS2     24
     +BULKA(20),BVGBDY(20),BDBULK(20),BDDSLC(20),BDGBDY(20)               GRASS2     25
     +,GR(NF),POW(NF),RGTJ(NF),FDP(KF),FODSLC(KF),FOGBDY(KF),             GRASS2     26
     +RHODSL(KF),CO(NF,KF),GIP(NF,KF),HH(NF,KF),TFO(NF,KF),BULK(NF,       GRASS2     27
     +KF,20),DSLC(NF,KF,20),GBDY(NF,KF,20)                                GRASS2     28
C                                                                         GRASS2     29
      IF (KFIRST.NE.0) GO TO 110                                          GRASS2     30
      GBRF = GBR                                                          GRASS2     31
      SQN = SQRT(FAWGE)                                                   GRASS2     32
      AVN = AVNUM                                                         GRASS2     33
      DELHVN = DELHV/AVNUM                                                GRASS2     34
      YY = 1./(RM-1.)                                                     GRASS2     35
      XX = RM*YY                                                          GRASS2     36
      XLAMDA = ATMVOL**(1./3.)                                            GRASS2     37
      CONS = 3.*XK/(2.*XK+XKP)                                            GRASS2     38
      FC = 4.*PI/(3.*ATMVOL)*CONS                                         GRASS2     39
      FCEC = FC*DELHVN                                                    GRASS2     40
      FCSD = FC*QSSTAR                                                    GRASS2     41
      DCEC = 3.*ATMVOL*ATMVOL/(8.*BOLTZ*PI*SIG*SIG)*SQRT((WM1+WM2)/(WM1*  GRASS2     42
     +WM2)*.5*PI*RG)*PZERO                                                GRASS2     43
      DCSD = 3.*XLAMDA*ATMVOL*DZERO/(2.*PI)                               GRASS2     44
          DO 100 N=1,NMAX                                                 GRASS2     45
  100     DCECN(N) = DCEC/SAVG(N)                                         GRASS2     46
      KFIRST = 1                                                          GRASS2     47
      D4LIM = DLIM                                                        GRASS2     48
  110 CONTINUE                                                            GRASS2     49
      GAMMA = G1-G2*(TK-273.14)                                           GRASS2     50
      NY = NOYES(1)                                                       GRASS2     51
      RHODIS = RHODSL(K)                                                  GRASS2     52
      AGBY = ACON/GRD                                                     GRASS2     53
      RB = GRD/SQN                                                        GRASS2     54
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                RINFY = 1./SQRT(RHODSL(K)*PI)                                    GRAS52     55
55              TKS = TK                                                         GRAS52     56
                IF (TKS.LE.1773.0) TKS = 1773.0                                  GRAS52     57
                VKT = BEVK*TKS                                                   GRAS52     58
                DVCVL = DVOL*EXP(-EVL/VKT)                                       GRAS52     59
                DVCVG = DVOG*EXP(-EVG/VKT)                                       GRAS52     60
60              D = GRD*1.E4                                                     GRAS52     61
                IF (D.LE.2.0) D = 2.0                                            GRAS52     62
                IF (D.GE.14.5) D = 14.5                                          GRAS52     63
                A0 = A(1)+A(2)*D+A(3)*D**2                                       GRAS52     64
                A1 = A(4)+A(5)*D+A(6)*D*D                                        GRAS52     65
65              A2 = A(7)+A(8)*D+A(9)*D*D                                        GRAS52     66
                IF (TKS.GE.2350.0) TKS = 2350.0                                  GRAS52     67
                SIGF = EXP(A0+A1/TKS+A2/TKS/TKS)*9.8E05                          GRAS52     68
                DTDT = (TK-TKOLD)/DELT                                           GRAS52     69
                DCIE = BADC3*TFPV*EXP(BADC4/TK)                                  GRAS52     70
70              CALL GRAS55 (TK,GAMMA,HS,NF,KF)                                  GRAS52     71
                OKT = 1.0/(BOLTZ*TK)                                             GRAS52     72
                CONST = TGRAD/TK                                                 GRAS52     73
                FCSDT = FCSD*CONST                                               GRAS52     74
                FCECT = FCEC*CONST                                               GRAS52     75
75              EVCDTD = EXP(-DELHV/(RG*TK))/SQRT(TK)                            GRAS52     76
                DCSDT = DCSD*EXP(-QS/(RG*TK))                                    GRAS52     77
                FBSAT = ASTAR*AGBY                                               GRAS52     78
                FBDEN = 0.0                                                      GRAS52     79
                    DO 120 N=1,NMAXB                                             GRAS52     80
80          120     FBDEN = FBDEN+PI*RAD(N)*RAD(N)*GBDY(J,K,N)                   GRAS52     81
                IF (FBDEN.GE.FBSAT) NY = NOYES(2)                                GRAS52     82
                IF (KPRINT.LT.2) GO TO 130                                       GRAS52     83
                PRINT 630, TK,TGRAD,TFPV,GASIN                                   GRAS52     84
                PRINT 640                                                        GRAS52     85
85          130 NGBI = 0                                                         GRAS52     86
                NDI = 0                                                          GRAS52     87
                G = 0.0                                                          GRAS52     88
                BSPT = 0.0                                                       GRAS52     89
                Z = 1.0                                                          GRAS52     90
90              IF (BULK(J,K,1).GT.GBDY(J,K,1)) Z = (1.-GBDY(J,K,1)/BULK(J,K,1)) GRAS52     91
                    DO 350 N=1,NMAXB                                             GRAS52     92
                    RTRS(N) = TFPV*RESCON*(1.-RAD(N)/(RAD(N)+REDIS))*SAVG(N)     GRAS52     93
                    RADC = RAD(N)**3                                             GRAS52     94
            C   -----DRIVING FORCE ON BUBBLE IN TEMPERATURE GRADIENT             GRAS52     95
95                  FSURF = -FCSDT*RADC                                          GRAS52     96
                    FEVCD = -FCECT*RADC                                          GRAS52     97
                    FATOM = -FCSDT*RADC                                          GRAS52     98
                    TAUB = RAD(N)*RAD(N)/(DVCVL)                                 GRAS52     99
                    TAUG = RAD(N)*RAD(N)/(DVCVG)                                 GRAS52    100
100                 IF (DTDT.LE.0) GO TO 140                                     GRAS52    101
                    TPD = TKOLD*RAD(N)*SIGF/(3.*GAMMA*DTDT)                      GRAS52    102
                    IF (TPD.LE.0.0) TPD = 0.0                                    GRAS52    103
                    GO TO 150                                                    GRAS52    104
            140     TPD = 20.*TAUB                                               GRAS52    105
105         C   -----BUBBLE DIFFUSION COEFFICIENTS                               GRAS52    106
            150     BDSURF = DCSDT/(RADC*RAD(N))                                 GRAS52    107
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                      BDEVCD = EVCDTD*DCECN(N)                                          GRASS2   108
                      IF (TPD.LE.0.) GO TO 160                                          GRASS2   109
                      BETAB = 1.0-EXP(-TAUB/TPD)                                        GRASS2   110
110                   BETAG = 1.0-EXP(-TAUG/TPD)                                        GRASS2   111
                      GO TO 170                                                         GRASS2   112
                160   BETAB = 1.0                                                       GRASS2   113
                      BETAG = 1.0                                                       GRASS2   114
                170   BADC7 = BADC5+(4.0-BADC5)*BETAB                                   GRASS2   115
115                   GBADC4 = BADC5+(4.0-BADC5)*BETAG                                  GRASS2   116
                      BADC8 = BADC2+(108000.-BADC2)*BETAB                               GRASS2   117
                      GBADC5 = GBADC2+(108000.-GBADC2)*BETAG                            GRASS2   118
                      BDATOM = BADC1*EXP(-BADC8/(1.986*TK))/((RAD(N)*BADC6)**BADC7)     GRASS2   119
                      BDGATM = GBADC1*EXP(-GBADC5/(1.986*TK))/((RAD(N)*GBADC3)**GBAD    GRASS2   120
120                 +     C4)                                                         GRASS2   121
                      DCIEB = DCIE*(RAD(1)/RAD(N))**BADC7                               GRASS2   122
                      DCIEG = DCIE*(RAD(1)/RAD(N))**GBADC4                              GRASS2   123
                      BDATOM = AMAX1(BDATOM,DCIEB)                                      GRASS2   124
                      BDGATM = AMAX1(BDGATM,DCIEG)                                      GRASS2   125
125                 C   -----BUBBLE VELOCITIES                                          GRASS2   126
                      BVSURF = FSURF*BDSURF*OKT                                         GRASS2   127
                      BVEVCD = FEVCD*BDEVCD*OKT                                         GRASS2   128
                      BVATOM = FATOM*BDATOM*OKT                                         GRASS2   129
                      BVGATM = FATOM*BDGATM*OKT                                         GRASS2   130
130                   BVBULK(N) = -AMAX1(BVEVCD,AMIN1(BVSURF,BVATOM))                   GRASS2   131
                      BDBULK(N) = AMAX1(BDEVCD,AMIN1(BDSURF,BDATOM))                    GRASS2   132
                      FORCE = AMAX1(FSURF,FEVCD,FATOM)                                  GRASS2   133
                      BVGBDY(N) = -FOGBDY(K)*AMAX1(BVEVCD,AMIN1(BVSURF,BVGATM))         GRASS2   134
                      BDGBDY(N) = AMAX1(BDEVCD,AMIN1(BDSURF,BDGATM))                    GRASS2   135
135                   BVDSLC(N) = -FODSLC(K)*AMAX1(BVEVCD,AMIN1(BVSURF,FFDSLC*BVATOM    GRASS2   136
                    +     ))                                                          GRASS2   137
                      BDDSLC(N) = AMAX1(BDEVCD,AMIN1(BDSURF,FFDSLC*BDATOM))           GRASS2   138
                      BLKMOR(N) = -BVBULK(N)*AREA                                       GRASS2   139
                      GBYMOR(N) = -BVGBDY(N)*AREA                                       GRASS2   140
140                 C   CALCULATE COALESCENCE PROBABILITIES IN BULK                     GRASS2   141
                      M = 0                                                             GRASS2   142
                180   M = M+1                                                           GRASS2   143
                      RADNM = RAD(N)+RAD(M)                                             GRASS2   144
                      PR = 4.*PI*(BDBULK(N)+BDBULK(M))*RADNM                            GRASS2   145
145                   PB = PI*ABS(BVBULK(N)-BVBULK(M))*RADNM*RADNM                      GRASS2   146
                      TAUB = RADNM*RADNM/(DVCVL)                                        GRASS2   147
                      HOTAUB = -TPD/TAUB                                                GRASS2   148
                      FACTOR = 0.0                                                      GRASS2   149
                      IF (HOTAUB.GT.DLIM) FACTOR = EXP(HOTAUB)                          GRASS2   150
150                   RATEB = (1.0-(1.0-ALFA)*FACTOR)                                   GRASS2   151
                      PBK(N,M) = (PR+PB)*RATEB                                          GRASS2   152
                      IF (M.EQ.N) GO TO 190                                             GRASS2   153
                      PBK(M,N) = PBK(N,M)*SAVG(M)                                       GRASS2   154
                      GO TO 180                                                         GRASS2   155
155                 190   PBK(N,N) = .5*PBK(N,N)                                       GRASS2   156
                      IF (N.EQ.1) PBK(N,M) = FN*PBK(N,N)                                GRASS2   157
                      BULKA(N) = PBK(N,N)*XX                                            GRASS2   158
                      PBK(N,N) = PBK(N,N)*YY                                            GRASS2   159
                      FGBDY = TPG*RAD(N)                                                GRASS2   160
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                      IF (FORCE.GT.FGBDY) GO TO 260                                    GRA552  161
                C   TPG=2*PI*GBDY ENERGY                                               GRA552  162
                      NCGBI = N                                                        GRA552  163
                C   CALCULATE RATE OF DIFFUSION OF GRAIN  BOUNDARY BUBBLES TO GRAIN EDGE GRA552  164
                      IF (N.GT.1) GO TO 220                                            GRA552  165
                      IF (IRSTAR.NE.13) GO TO 200                                      GRA552  166
                      BPRIM = SQRT(2.0/DELTA/BDGBDY(N))*(BDBULK(N)*PI/H)**.25*RB       GRA552  167
                      BMPRIM = -BPRIM                                                  GRA552  168
                      EB = 0.0                                                         GRA552  169
                      IF (BMPRIM.GT.DLIM) EB = EXP(BMPRIM)                             GRA552  170
                      FLUXED = .25*((1.0-EB)/BPRIM-EB)/H                               GRA552  171
                      IF (FLUXED.LE.0) FLUXED = 0.                                     GRA552  172
                      GO TO 210                                                        GRA552  173
                200   FLUXED = 4.0*BDGBDY(N)*FAWGE/(GRD*GRD)                           GRA552  174
                210   XE = FLUXED                                                      GRA552  175
                      GO TO 230                                                        GRA552  176
                220   FLUXED = 0.                                                      GRA552  177
                      G = G+4.*PI*RAD(N)*RAD(N)*BDBULK(N)*BULK(J,K,N)/REDIS            GRA552  178
                      BSPT = BSPT+RTRS(N)/SAVG(N)                                      GRA552  179
                230   RRGBIP(N) = ABS(BVGBDY(N))/RB+FLUXED                             GRA552  180
                C   CALCULATE COALESCENCE PROBABILITIES ON GRAIN BOUNDARIES           GRA552  181
                      M = 0                                                            GRA552  182
                240   M = M+1                                                          GRA552  183
                      PR = (BDGBDY(N)+BDGBDY(M))/AGBY                                  GRA552  184
                      RADNM = RAD(N)+RAD(M)                                            GRA552  185
                      PB = ABS(BVGBDY(N)-BVGBDY(M))*RADNM*2./AGBY                      GRA552  186
                      TAUG = RADNM*RADNM/(DVCVG)                                       GRA552  187
                      HOTAUG = -TPD/TAUG                                               GRA552  188
                      FACTOR = 0.0                                                     GRA552  189
                      IF (HOTAUG.GT.DLIM) FACTOR = EXP(HOTAUG)                         GRA552  190
                      RATEG = (1.0-(1.0-ALFA)*FACTOR)                                  GRA552  191
                      PGBDY(N,M) = (PR+PB)*RATEG                                       GRA552  192
                      IF (M.EQ.N) GO TO 250                                            GRA552  193
                      PGBDY(M,N) = PGBDY(N,M)*SAVG(M)                                  GRA552  194
                      GO TO 240                                                        GRA552  195
                250   PGBDY(N,N) = .5*PGBDY(N,N)                                       GRA552  196
                      IF (N.EQ.1) PGBDY(N,N) = PGBDY(N,N)*FN                           GRA552  197
                      GBDYA(N) = PGBDY(N,N)*XX                                         GRA552  198
                      PGBDY(N,N) = PGBDY(N,N)*YY                                       GRA552  199
                      PBKGBY(N) = ABS(BVBULK(N))*AGBY                                  GRA552  200
                260   TRADPO = RAD(N)*2.584E7-1.                                       GRA552  201
                      IF (TRADPO.LT.1.) GO TO 270                                      GRA552  202
                      FDSLC = GBSO2P*ALOG(TRADPO)*0.5                                  GRA552  203
                      IF (FORCE.GT.FDSLC) GO TO 320                                    GRA552  204
                270   NCDI = N                                                         GRA552  205
                C   -----CALCULATE COALESCENCE PROBABILITIES ON DISLOCATIONS           GRA552  206
                      M = 0                                                            GRA552  207
                280   M = M+1                                                          GRA552  208
                      PR = (BDDSLC(N)+BDDSLC(M))/SQRT(RHODSL(K))                       GRA552  209
                      PB = ABS(BVDSLC(N)-BVDSLC(M))/RHODSL(K)                          GRA552  210
                      RADNM = RAD(N)+RAD(M)                                            GRA552  211
                      TAUD = RADNM*RADNM/(DVCVL)                                       GRA552  212
                      HOTAUD = -TPD/TAUD                                               GRA552  213
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                      FACTOR = 0.0                                                      GRASS2   214
                      IF (HOTAUD.GT.DLIM) FACTOR = EXP(HOTAUD)                          GRASS2   215
215                   RATED = (1.0-(1.0-ALFA)*FACTOR)                                   GRASS2   216
                      PDSL(N,M) = (PR+PB)*RATED                                         GRASS2   217
                      IF (M.EQ.N) GO TO 290                                             GRASS2   218
                      PDSL(M,N) = PDSL(N,M)*SAVG(M)                                     GRASS2   219
                      GO TO 280                                                         GRASS2   220
220         290       PDSL(N,N) = 0.5*PDSL(N,N)                                         GRASS2   221
                      IF (N.EQ.1) PDSL(N,N) = PDSL(N,N)*FN                              GRASS2   222
                      DSLCA(N) = PDSL(N,N)*XX                                           GRASS2   223
                      PDSL(N,N) = PDSL(N,N)*YY                                          GRASS2   224
                      M = 0                                                             GRASS2   225
225         300       M = M+1                                                           GRASS2   226
                      RADNM = RAD(N)+RAD(M)                                             GRASS2   227
                      PR = 4.*PI*BDBULK(M)*RADNM                                        GRASS2   228
                      PB = PI*ABS(BVBULK(M))*RADNM*RADNM                                GRASS2   229
                      TAUD = RADNM*RADNM/(DVCVL)                                        GRASS2   230
230                   HOTAUD = -TPD/TAUD                                                GRASS2   231
                      FACTOR = 0.0                                                      GRASS2   232
                      IF (HOTAUD.GT.DLIM) FACTOR = EXP(HOTAUD)                          GRASS2   233
                      RATED = (1.0-(1.0-ALFA)*FACTOR)                                   GRASS2   234
                      PBKDS(N,M) = (PR+PB)*RATED                                        GRASS2   235
235                   IF (M.EQ.N) GO TO 310                                             GRASS2   236
                      PBKDS(M,N) = PBKDS(N,M)*SAVG(M)                                   GRASS2   237
            C   -----THE SMALLER INDEX REFERS TO BULK ; THE LARGER TO DSLC BUBBLES      GRASS2   238
                      GO TO 300                                                         GRASS2   239
            310       CONTINUE                                                          GRASS2   240
240                   PBKDLC(N) = 2.*(RHODIS*RAD(N)*(-BVBULK(N))+PI*BDBULK(N)/ALOG(R    GRASS2   241
                +     INFY/RAD(N)))                                                     GRASS2   242
                      GO TO 330                                                         GRASS2   243
            320       IF (NCDI.EQ.0) GO TO 340                                          GRASS2   244
                        DO 330 M=1,NCDI                                                 GRASS2   245
245                     RADNM = RAD(N)+RAD(M)                                           GRASS2   246
                        PR = 4.*PI*BDBULK(N)*RADNM                                      GRASS2   247
                        PB = PI*ABS(BVBULK(N))*RADNM*RADNM                              GRASS2   248
                        TAUD = RADNM*RADNM/(DVCVL)                                      GRASS2   249
                        HOTAUD = -TPD/TAUD                                              GRASS2   250
250                     FACTOR = 0.0                                                    GRASS2   251
                        IF (HOTAUD.GT.DLIM) FACTOR = EXP(HOTAUD)                        GRASS2   252
                        RATED = (1.0-(1.0-ALFA)*FACTOR)                                 GRASS2   253
                        PBKDS(N,M) = (PR+PB)*RATED                                      GRASS2   254
            330         PBKDS(M,N) = PBKDS(N,M)*SAVG(M)                                 GRASS2   255
255         C   -----THE INDEX > NCDI REFERS TO BULK;   < TO DISLOCATION                GRASS2   256
            340       IF (KPRINT.LT.2) GO TO 350                                        GRASS2   257
                      PRINT 610, SAVG(N),RAD(N),BDSURF,BDEVCD,BDATOM,BVSURF,BVEVCD,B    GRASS2   258
                +     VATOM,BDGATM,BVGATM                                               GRASS2   259
            350       CONTINUE                                                          GRASS2   260
260         C   REMOVE THIS                                                            GRASS2   261
                  WRITE (6,600) SPT,BSPT,G                                            GRASS2   262
            C   DOWN TO HERE                                                          GRASS2   263
                  SPT = BSPT/(BSPT+G)                                                 GRASS2   264
                  IF (TFPV.LE.0.0) SPT = 1.0                                          GRASS2   265
265         C   CALCULATE  DIFFUSION RATE OF LATTICE GAS TO GRAIN FACES               GRASS2   266
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                  DPRIM = BDBULK(I)*SPT*4.0/(GRD*GRD)                                  GRASS2   267
                  AMI = AMAX1(TFPV,TFO(J,K))                                           GRASS2   268
                  DTF = ABS(TFO(J,K)-TFPV)/AMAX1(AMI,1.0)                              GRASS2   269
                  IF (DTF.LE..01) GO TO 360                                            GRASS2   270
270               CO(J,K) = BULK(J,K,I)                                                GRASS2   271
                  TSO2 = TSO                                                           GRASS2   272
            360   T = T2-TSO2                                                          GRASS2   273
                  DPRIMT = DPRIM*T                                                     GRASS2   274
                  FLXGB2 = GASIN*(6.0*SQRT(DPRIMT/PI)-3.*DPRIMT)                       GRASS2   275
275               DPT = DPRIMT*PI*PI                                                   GRASS2   276
                  IF (DPT.GT.1.0) FLXGB2 = GASIN*(1.0-6.0*EXP(-DPT)/PI/PI)             GRASS2   277
                  GBI = 3.0*(SQRT(DPRIM/PI/T)-DPRIM)                                   GRASS2   278
                  IF (DPT.GT.1.0) GBI = 6.0*DPRIM*EXP(-DPT)                            GRASS2   279
                  GBI = GBI*Z                                                          GRASS2   280
280               IF (GBI.LE.0.0) GBI = 0.0                                            GRASS2   281
                  IF (BULK(J,K,I).LE.1.E-20) GO TO 370                                 GRASS2   282
                  XGBI = GBI*CO(J,K)/BULK(J,K,I)                                       GRASS2   283
                  FLXGB2 = FLXGB2/BULK(J,K,I)+XGBI                                     GRASS2   284
                  GO TO 380                                                            GRASS2   285
285         370   FLXGB2 = 0.0                                                         GRASS2   286
                  XGBI = 0.0                                                           GRASS2   287
            380   NMAXB2 = NMAXB-1                                                     GRASS2   288
                  I = 0                                                                GRASS2   289
                  N = 0                                                                GRASS2   290
290         390   N = N+1                                                              GRASS2   291
                  I = I+1                                                              GRASS2   292
                  EPS(I) = EPSI/SAVG(N)                                                GRASS2   293
                  IF (N.EQ.NMAXB) GO TO 400                                            GRASS2   294
                  YA(I) = BULKA(N)                                                     GRASS2   295
295               GO TO 390                                                            GRASS2   296
            400   YA(I) = 0.                                                           GRASS2   297
                  IF (NCDI.EQ.NMAXB) GO TO 420                                         GRASS2   298
                  JNCDI = 2                                                            GRASS2   299
                  NMAXD = NCDI+1                                                       GRASS2   300
300               IF (NMAXD.EQ.NMAXB) JNCDI = 3                                        GRASS2   301
                      DO 410 N=NMAXD,NMAXB                                             GRASS2   302
                      BULK(J,K,N) = BULK(J,K,N)+DSLC(J,K,N)                            GRASS2   303
            410       DSLC(J,K,N) = 0.                                                 GRASS2   304
                  IF (NCDI.EQ.0) GO TO 460                                             GRASS2   305
305               GO TO 430                                                            GRASS2   306
            420   JNCDI = 4                                                            GRASS2   307
                  NMAXD = NMAXB                                                        GRASS2   308
            430   NMAXD2 = NMAXD-1                                                     GRASS2   309
                      DO 440 N=1,NMAXD2                                                GRASS2   310
310                   I = I+1                                                          GRASS2   311
                      EPS(I) = EPSI/SAVG(N)                                            GRASS2   312
            440       YA(I) = DSLCA(N)                                                 GRASS2   313
                  GO TO (460,470,470,450), JNCDI                                       GRASS2   314
            450   I = I+1                                                              GRASS2   315
315               YA(I) = 0                                                            GRASS2   316
                  EPS(I) = EPSI/SAVG(NMAXB)                                            GRASS2   317
                  GO TO 470                                                            GRASS2   318
            460   JNCDI = 1                                                            GRASS2   319
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                NMAXD2 = 0                                                                  GRASS2   320
320         470 IF (NCGBI.EQ.NMAXB) GO TO 490                                               GRASS2   321
                JNCGBI = 2                                                                  GRASS2   322
                NMAXG = NCGBI+1                                                             GRASS2   323
                IF (NMAXG.EQ.NMAXB) JNCGBI = 3                                              GRASS2   324
                    DO 480 N=NMAXG,NMAXB                                                    GRASS2   325
325                 BULK(J,K,N) = BULK(J,K,N)+GBDY(J,K,N)                                   GRASS2   326
            480     GBDY(J,K,N) = 0.                                                        GRASS2   327
                IF (NCGBI.EQ.0) GO TO 530                                                   GRASS2   328
                GO TO 500                                                                   GRASS2   329
            490 JNCGBI = 4                                                                  GRASS2   330
330             NMAXG = NMAXB                                                               GRASS2   331
            500 NMAXG2 = NMAXG-1                                                            GRASS2   332
                    DO 510 N=1,NMAXG2                                                       GRASS2   333
                    I = I+1                                                                 GRASS2   334
                    EPS(I) = EPSI/SAVG(N)                                                   GRASS2   335
335         510     YA(I) = GBDYA(N)                                                        GRASS2   336
                GO TO (530,540,540,520), JNCGBI                                             GRASS2   337
            520 I = I+1                                                                     GRASS2   338
                YA(I) = 0.                                                                  GRASS2   339
                EPS(I) = EPSI/SAVG(NMAXB)                                                   GRASS2   340
340             GO TO 540                                                                   GRASS2   341
            530 JNCGBI = 1                                                                  GRASS2   342
                NMAXG2 = 0                                                                  GRASS2   343
            540 I = I+1                                                                     GRASS2   344
                EPS(I) = EPSI*1.E-2                                                         GRASS2   345
345             I = I+1                                                                     GRASS2   346
                EPS(I) = EPSI*1.E-2                                                         GRASS2   347
                GO TO (550,550,550,570), JNCGBI                                             GRASS2   348
            550     DO 560 N=NMAXG,NMAXB                                                    GRASS2   349
                    I = I+1                                                                 GRASS2   350
350         560     EPS(I) = EPSI/SAVG(N)                                                   GRASS2   351
                GO TO (590,570,570,570), JNCGBI                                             GRASS2   352
            570     DO 580 N=1,NCGBI                                                        GRASS2   353
                    I = I+1                                                                 GRASS2   354
            580     EPS(I) = EPSI/SAVG(N)                                                   GRASS2   355
355         590 IMAX2 = I                                                                   GRASS2   356
                TFO(J,K) = TFPV                                                             GRASS2   357
                IF (KPRINT.GE.2) PRINT 620, NMAXB,NMAXD,NCDI,NMAXG,NCGBI,IMAX2,XGB          GRASS2   358
               +I,FLXGB2,XE,FBDEN,FBSAT,NY                                                  GRASS2   359
                RETURN                                                                      GRASS2   360
360             C                                                                           GRASS2   361
            600 FORMAT (1X,"SPT",E12.4,5X,"BSPT",E12.4,5X,"G",E12.4)                        GRASS2   362
            610 FORMAT (10E13.5)                                                            GRASS2   363
            620 FORMAT (/114H NMAXB NMAXD  NCDI NMAXG NCGBI IMAX2     FLXGBI               GRASS2   364
               + FLXGB2      FLUXED        FBDEN        FBSAT       NEW CHANNELS/616,     GRASS2   365
365            +5E12.4,9X,A4)                                                               GRASS2   366
            630 FORMAT (//4H TK=,E14.7,7H TGRAD=,E12.4,16H(DEG-C/CM) TFPV=,E12.4,7          GRASS2   367
               +H GASIN=,E12.4)                                                             GRASS2   368
            640 FORMAT (//52H          SAVG           RAD        BDSURF        BDEVCD,     GRASS2   369
               +52H       BDATOM        BVSURF        BVEVCD        BVATOM,26H            GRASS2   370
370            +BDGATM       BVGATM)                                                       GRASS2   371
                END                                                                         GRASS2   372
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GRASS2 1 359

VARIABLES	SN	TYPE		RELOCATION								
54	A	REAL	ARRAY	BDGR2	REFS	15	3*63	3*64	3*65			
25	ACON	REAL		BDGR2	REFS	15	52					
7	AGBY	REAL		GR0A2	REFS	3	77	183	185	199		
					DEFINED	52						
35	ALFA	REAL		BDGR2	REFS	15	150	190	215	233	252	
2667	AMI	REAL			REFS	268	DEFINED	267				
4	AREA	REAL		GR0A2	REFS	3	138	139				
50	ASTAR	REAL		BDGR2	REFS	15	77					
1	ATMVOL	REAL		BDGR2	REFS	15	36	38	2*41	43		
0	AVN	REAL		GR0235	REFS	11	DEFINED	32				
5	AVNUM	REAL		BDGR2	REFS	15	32	33				
2573	A0	REAL			REFS	67	DEFINED	63				
2574	A1	REAL			REFS	67	DEFINED	64				
2575	A2	REAL			REFS	67	DEFINED	65				
37	BADC1	REAL		BDGR2	REFS	15	118					
40	BADC2	REAL		BDGR2	REFS	15	2*116					
41	BADC3	REAL		BDGR2	REFS	15	69					
42	BADC4	REAL		BDGR2	REFS	15	69					
43	BADC5	REAL		BDGR2	REFS	15	2*114	2*115				
44	BADC6	REAL		BDGR2	REFS	15	118					
2625	BADC7	REAL			REFS	118	121	DEFINED	114			
2627	BADC8	REAL			REFS	118	DEFINED	116				
2631	BDATOM	REAL			REFS	123	128	131	137	257		
					DEFINED	118	123					
3067	BDBULK	REAL	ARRAY		REFS	20	2*144	166	177	227	240	246
					266	DEFINED	131					
3113	BDDSLC	REAL	ARRAY		REFS	20	2*208	DEFINED	137			
2622	BDEVCD	REAL			REFS	127	131	134	137	257		
					DEFINED	107						
2632	BDGATM	REAL			REFS	124	129	134	257	DEFINED	119	124
3137	BDGBDY	REAL	ARRAY		REFS	20	166	173	2*183	DEFINED	134	
2621	BDSURF	REAL			REFS	126	131	134	137	257		
					DEFINED	106						
2623	BETAB	REAL			REFS	114	116	DEFINED	109	112		
2624	BETAG	REAL			REFS	115	117	DEFINED	110	113		
36	BEVK	REAL		BDGR2	REFS	15	57					
3222	BLKMOR	REAL	ARRAY	GR2A3	REFS	13	20	DEFINED	138			
2653	BMPRIM	REAL			REFS	2*169	DEFINED	167				
2	BOLTZ	REAL		BDGR2	REFS	15	41	71				
2652	BPRIM	REAL			REFS	167	170	DEFINED	166			
2610	BSPT	REAL			REFS	178	261	2*263	DEFINED	88	178	
0	BULK	REAL	ARRAY	F.P.	REFS	20	2*90	177	270	281	282	283
					302	325	DEFINED	1	302	325		
3017	BULKA	REAL	ARRAY		REFS	20	294	DEFINED	157			
2637	BVATOM	REAL			REFS	130	135	257	DEFINED	128		
2747	BVBULK	REAL	ARRAY		REFS	20	138	2*145	199	228	240	247

VARIABLES	SN	TYPE	RELOCATION										
					DEFINED	130							
2773	BVDSLC	REAL	ARRAY		REFS	20	2*209	DEFINED	135				
2636	BVEVCD	REAL			REFS	130	133	135	257	DEFINED	127		
2640	BVGATM	REAL			REFS	133	257	DEFINED	129				
3043	BVGBDY	REAL	ARRAY		REFS	20	139	179	2*185	DEFINED	133		
2635	BVSURF	REAL			REFS	130	133	135	257	DEFINED	126		
5	CONS	REAL		GTWOLC	REFS	9	38	DEFINED	37				
2602	CONST	REAL			REFS	73	74	DEFINED	72				
0	CO	REAL	ARRAY	F.P.	REFS	20	282	DEFINED	1	270			
2572	D	REAL			REFS	61	62	3*63	3*64	3*65			
					DEFINED	60	61	62					
11	DCEC	REAL		GTWOLC	REFS	9	45	DEFINED	41				
13	DCECN	REAL	ARRAY	GTWOLC	REFS	9	20	107	DEFINED	45			
2600	DCIE	REAL			REFS	121	122	DEFINED	69				
2633	DCIEB	REAL			REFS	123	DEFINED	121					
2634	DCIEG	REAL			REFS	124	DEFINED	122					
12	DCSD	REAL		GTWOLC	REFS	9	76	DEFINED	43				
2606	DCSDT	REAL			REFS	106	DEFINED	76					
7	DELHV	REAL		BDGR2	REFS	15	33	75					
1	DELHVN	REAL		GTWOLC	REFS	9	39	DEFINED	33				
12	DELT	REAL		GR0A2	REFS	3	68						
26	DELTA	REAL		BDGR2	REFS	15	166						
65	DLIM	REAL		BDGR2	REFS	15	47	149	169	189	214	232	
					251								
2666	DPRIM	REAL			REFS	273	2*277	278	DEFINED	266			
2672	DPRIMT	REAL			REFS	2*274	275	DEFINED	273				
2673	DPT	REAL			REFS	2*276	2*278	DEFINED	275				
0	DSLC	REAL	ARRAY	F.P.	REFS	20	302	DEFINED	1	303			
2677	DSLCA	REAL	ARRAY		REFS	20	312	DEFINED	222				
2577	DTDT	REAL			REFS	100	101	DEFINED	68				
2670	DTF	REAL			REFS	269	DEFINED	268					
2571	DVCVG	REAL			REFS	99	186	DEFINED	59				
2570	DVCVL	REAL			REFS	98	196	211	229	248			
					DEFINED	58							
33	DVOG	REAL		BDGR2	REFS	15	59						
31	DVOL	REAL		BDGR2	REFS	15	58						
22	DZERO	REAL		BDGR2	REFS	15	43						
217	D4LIM	REAL		GR2A4	REFS	8	DEFINED	47					
2654	EB	REAL			REFS	2*170	DEFINED	168	169				
0	EPS	REAL	ARRAY	GR2A4	REFS	8	20	DEFINED	292	311	316	334	
					339	344	346	350	354				
2	EPSI	REAL		BDG02D	REFS	5	292	311	316	334	339	344	
					346	350	354						
2605	EVCDTD	REAL			REFS	107	DEFINED	75					
34	EVG	REAL		BDGR2	REFS	15	59						
32	EVL	REAL		BDGR2	REFS	15	58						
2647	FACTOR	REAL			REFS	150	190	215	233	252			
					DEFINED	148	149	188	189	213	214	231	
					232	250	251						
2615	FATOM	REAL			REFS	128	129	132	DEFINED	97			
47	FAWGE	REAL		BDGR2	REFS	15	31	173					
10	FBDEN	REAL		GR0A2	REFS	3	80	81	357	DEFINED	78	80	
11	FBSAT	REAL		GR0A2	REFS	3	81	357	DEFINED	77			

VARIABLES	SN	TYPE		RELOCATION								
6	FC	REAL		GTWOLC	REFS	9	39	40	DEFINED	38		
7	FCEC	REAL		GTWOLC	REFS	9	74	DEFINED	39			
2604	FCECT	REAL			REFS	96	DEFINED	74				
10	FCSD	REAL		GTWOLC	REFS	9	73	DEFINED	40			
2603	FCSDT	REAL			REFS	95	97	DEFINED	73			
0	FDP	REAL	ARRAY	F.P.	REFS	20	DEFINED	1				
2662	FDSLC	REAL			REFS	203	DEFINED	202				
2614	FEVCD	REAL			REFS	127	132	DEFINED	96			
0	FFDSLC	REAL		BDGR2	REFS	15	135	137				
2651	FGBDY	REAL			REFS	160	DEFINED	159				
2655	FLUXED	REAL			REFS	171	174	179	DEFINED	170	171	173
					176							
3150	FLXGB2	REAL		GR2A3	REFS	13	283	357	DEFINED	274	276	283
					285							
24	FN	REAL		BDGR2	REFS	15	156	196	221			
0	FODSLC	REAL	ARRAY	F.P.	REFS	20	135	DEFINED	1			
0	FOGBDY	REAL	ARRAY	F.P.	REFS	20	133	DEFINED	1			
2641	FORCE	REAL			REFS	160	203	DEFINED	132			
2613	FSURF	REAL			REFS	126	132	DEFINED	95			
2607	G	REAL			REFS	177	261	263	DEFINED	87	177	
2561	GAMMA	REAL			REFS	70	101	DEFINED	49			
1	GASIN	REAL		GR0235	REFS	11	83	274	276			
45	GBADC1	REAL		BDGR2	REFS	15	119					
46	GBADC2	REAL		BDGR2	REFS	15	2*117					
53	GBADC3	REAL		BDGR2	REFS	15	119					
2626	GBADC4	REAL			REFS	119	122	DEFINED	115			
2630	GBADC5	REAL			REFS	119	DEFINED	117				
0	GBDY	REAL	ARRAY	F.P.	REFS	20	80	2*90	325	DEFINED	1	326
2723	GBDYA	REAL	ARRAY		REFS	20	335	DEFINED	197			
17	GBR	REAL		BDGR2	REFS	15	30					
3151	GBRF	REAL		GR2A3	REFS	13	DEFINED	30				
11	GBSO2P	REAL		BDGR2	REFS	15	202					
3246	GBYMOR	REAL	ARRAY	GR2A3	REFS	13	20	DEFINED	139			
2674	GBI	REAL			REFS	279	280	282	DEFINED	277	278	279
					280							
0	GIP	REAL	ARRAY	F.P.	REFS	20	DEFINED	1				
0	GR	REAL	ARRAY	F.P.	REFS	20	DEFINED	1				
5	GRD	REAL		GR0A2	REFS	3	52	53	60	2*173	2*266	
3	GI	REAL		BDGR2	REFS	15	49					
4	G2	REAL		BDGR2	REFS	15	49					
0	H	REAL		F.P.	REFS	166	170	DEFINED	1			
0	HH	REAL	ARRAY	F.P.	REFS	20	DEFINED	1				
2646	HOTAUB	REAL			REFS	2*149	DEFINED	147				
2664	HOTAUD	REAL			REFS	2*214	2*232	2*251	DEFINED	212	230	249
2657	HOTAUG	REAL			REFS	2*189	DEFINED	187				
3	HS	REAL		GR0A2	REFS	3	70					
2676	I	INTEGER			REFS	291	292	294	296	310	311	312
					314	315	316	333	334	335	337	338
					339	343	344	345	346	349	350	353
					354	355	DEFINED	288	291	310	314	333
					337	343	345	349	353			
216	IMAX2	INTEGER		GR2A4	REFS	8	357	DEFINED	355			
0	IRSTAR	INTEGER		F.P.	REFS	165	DEFINED	1				

VARIABLES	SN	TYPE		RELOCATION								
26	J	INTEGER		GR0235	REFS	11	80	4*90	177	267	268	2*270
						281	2*282	283	3*302	303	3*325	326	356
4	JFIRST	INTEGER		BDG02D	REFS	5						
33	JNCDI	INTEGER		GR0235	REFS	11	313	DEFINED	298	300	306	318
34	JNCGBI	INTEGER		GR0235	REFS	11	336	347	351	DEFINED	321	323
						329	341					
27	K	INTEGER		GR0235	REFS	11	51	54	80	4*90	133	135
						177	208	209	267	268	2*270	281	2*282
						283	3*302	303	3*325	326	356		
0	KF	INTEGER		F.P.	REFS	11*20	70	DEFINED	1			
5	KFIRST	INTEGER		BDG02D	REFS	5	29	DEFINED	46			
6	KPRINT	INTEGER		BDG02D	REFS	5	82	256	357			
2642	M	INTEGER			REFS	142	143	144	145	151	152	3*153
						182	183	184	185	191	192	3*193	207
						208	209	210	216	217	3*218	225	226
						227	228	234	235	3*236	245	253	3*254
					DEFINED	141	142	181	182	206	207	224	
						225	244						
2560	N	INTEGER			REFS	2*45	3*80	4*92	93	2*98	2*99	101
						106	107	118	119	121	122	130	131
						133	134	135	137	2*138	2*139	143	144
						145	151	152	2*153	4*155	5*156	3*157	4*158
						159	162	164	2*166	173	4*177	2*178	2*179
						183	184	185	191	192	2*193	4*195	5*196
						3*197	4*198	2*199	200	204	208	209	210
						216	217	2*218	4*220	5*221	3*222	4*223	226
						234	235	2*236	5*240	245	246	247	253
						2*254	2*257	290	292	293	294	3*302	303
						311	312	3*325	326	334	335	350	354
					DEFINED	44	79	91	289	290	301	309	
						324	332	348	352				
31	NCDI	INTEGER		GR0235	REFS	11	243	244	297	299	304	357
					DEFINED	86	204					
32	NCGBI	INTEGER		GR0235	REFS	11	320	322	327	352	357	
					DEFINED	85	162					
0	NF	INTEGER		F.P.	REFS	10*20	70	DEFINED	1			
7	NMAX	INTEGER		BDG02D	REFS	5	44					
30	NMAXB	INTEGER		GR0235	REFS	11	79	91	287	293	297	300
						301	307	316	320	323	324	330	339
						348	357						
3273	NMAXB2	INTEGER		GR2A3	REFS	13	DEFINED	287				
3272	NMAXD	INTEGER		GR2A3	REFS	13	300	301	308	357		
					DEFINED	299	307					
3274	NMAXD2	INTEGER		GR2A3	REFS	13	309	DEFINED	308	319		
35	NMAXG	INTEGER		GR0235	REFS	11	323	324	331	348	357	
					DEFINED	322	330					
3275	NMAXG2	INTEGER		GR2A3	REFS	13	332	DEFINED	331	342		
51	NOYES	INTEGER	ARRAY	BDGR2	REFS	15	50	81				
36	NXBD	INTEGER		GR0235	REFS	11						
37	NXBDG	INTEGER		GR0235	REFS	11						
2562	NY	INTEGER			REFS	357	DEFINED	50	81			
2601	OKT	REAL			REFS	126	127	128	129	DEFINED	71	
2645	PB	REAL			REFS	151	191	216	234	253		

VARIABLES	SN	TYPE	RELOCATION									
					DEFINED	145	185	209	228	247		
0	PBK	REAL	ARRAY	GR2A3	REFS	13	20	153	155	156	157	158
					DEFINED	151	153	155	156	158		
3124	PBKDLC	REAL	ARRAY	GR2A3	REFS	13	20	DEFINED	240			
1440	PBKDS	REAL	ARRAY	GR2A3	REFS	13	20	236	254	DEFINED	234	236
					253	254						
3100	PBKGBY	REAL	ARRAY	GR2A3	REFS	13	20	DEFINED	199			
2260	PDSL	REAL	ARRAY	GR2A3	REFS	13	20	218	220	221	222	223
					DEFINED	216	218	220	221	223		
620	PGBDY	REAL	ARRAY	GR2A3	REFS	13	20	193	195	196	197	198
					DEFINED	191	193	195	196	198		
3	PI	REAL		BDG02D	REFS	5	38	2*41	43	54	80	144
					145	166	177	227	228	240	246	247
					274	2*275	2*276	277				
0	POW	REAL	ARRAY	F.P.	REFS	20	DEFINED	1				
2644	PR	REAL			REFS	151	191	216	234	253		
					DEFINED	144	183	208	227	246		
23	PZERO	REAL		BDGR2	REFS	15	41					
21	QS	REAL		BDGR2	REFS	15	76					
20	QSSTAR	REAL		BDGR2	REFS	15	40					
40	RAD	REAL	ARRAY	GR0235	REFS	11	20	2*80	2*92	93	2*98	2*99
					101	106	118	119	2*121	2*122	2*143	159
					2*177	2*184	200	2*210	2*226	2*240	2*245	257
2612	RADC	REAL			REFS	95	96	97	106	DEFINED	93	
2643	RADNM	REAL			REFS	144	2*145	2*146	185	2*186	2*211	227
					2*228	2*229	246	2*247	2*248	DEFINED	143	184
					210	226	245					
2650	RATEB	REAL			REFS	151	DEFINED	150				
2665	RATED	REAL			REFS	216	234	253	DEFINED	215	233	252
2660	RATEG	REAL			REFS	191	DEFINED	190				
2564	RB	REAL			REFS	166	179	DEFINED	53			
27	REDIS	REAL		BDGR2	REFS	15	92	177				
30	RESCON	REAL		BDGR2	REFS	15	92					
6	RG	REAL		BDGR2	REFS	15	41	75	76			
0	RGTJ	REAL	ARRAY	F.P.	REFS	20	DEFINED	1				
2563	RHODIS	REAL			REFS	240	DEFINED	51				
0	RHODSL	REAL	ARRAY	F.P.	REFS	20	51	54	208	209		
					DEFINED	1						
2565	RINFY	REAL			REFS	240	DEFINED	54				
11	RM	REAL		BDG02D	REFS	5	34	35				
3152	RRGBIP	REAL	ARRAY	GR2A3	REFS	13	20	DEFINED	179			
3176	RTRS	REAL	ARRAY	GR2A3	REFS	13	20	178	DEFINED	92		
2	SAVG	REAL	ARRAY	GR0235	REFS	11	20	45	92	153	178	193
					218	236	254	257	292	311	316	334
					339	350	354					
12	SIG	REAL		BDGR2	REFS	15	2*41					
2576	SIGF	REAL			REFS	101	DEFINED	67				
13	SIT	REAL		GR0A2	REFS	3	261	266	DEFINED	263	264	
0	SQN	REAL		GTWOLC	REFS	9	53	DEFINED	31			
2671	T	REAL			REFS	273	277	DEFINED	272			
2616	TAUB	REAL			REFS	104	109	147	DEFINED	98	146	
2663	TAUD	REAL			REFS	212	230	249	DEFINED	211	229	248
2617	TAUG	REAL			REFS	110	187	DEFINED	99	186		

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VARIABLES     SN  TYPE          RELOCATION
    1  TFPV       REAL          GR0A2     REFS      3      69      83      92     264     267     268
                                                    356
    0  TF0        REAL    ARRAY   F.P.      REFS     20     267     268  DEFINED       1     356
    0  TGASIN     REAL          BDG02D    REFS      5
    1  TGASR      REAL          BDG02D    REFS      5
    2  TGRAD      REAL          GR0A2     REFS      3      72      83
    0  TK         REAL          GR0A2     REFS      3      49      55      66      69      70      71
                                                     72    2*75      76      83     118     119
    0  TKOLD      REAL            F.P.    REFS     68     101  DEFINED       1
 2566  TKS        REAL                    REFS     56      57      66    3*67  DEFINED      55      56
                                                     66
 2620  TPD        REAL                    REFS    102     108     109     110     147     187     212
                                                    230     249  DEFINED     101     102     104
   10  TPG        REAL          BDGR2     REFS     15     159
 2661  TRADP0     REAL                    REFS    201     202  DEFINED     200
   12  TS0        REAL          BDG02D    REFS      5     271
   10  TS02       REAL          BDG02D    REFS      5     272  DEFINED     271
    6  T2         REAL          GR0A2     REFS      3     272
 2567  VKT        REAL                    REFS     58      59  DEFINED      57
   65  VOLUME     REAL          GR0235    REFS     11
   13  WM1        REAL          BDGR2     REFS     15    2*41
   14  WM2        REAL          BDGR2     REFS     15    2*41
 2656  XE         REAL                    REFS    357  DEFINED     174
 2675  XGB1       REAL                    REFS    283     357  DEFINED     282     286
   15  XK         REAL          BDGR2     REFS     15    2*37
   16  XKP        REAL          BDGR2     REFS     15      37
    4  XLAMDA     REAL          GTWOLC    REFS      9      43  DEFINED      36
    3  XX         REAL          GTWOLC    REFS      9     157     197     222  DEFINED      35
  122  YA         REAL    ARRAY GR2A4     REFS      8      20  DEFINED     294     296     312     315
                                                    335     338
    2  YY         REAL          GTWOLC    REFS      9      35     158     198     223
                                           DEFINED     34
 2611  Z          REAL                      REFS    279  DEFINED      89      90

FILE NAMES      MODE
      OUTPUT    FMT                 WRITES     83      84     257     357
      TAPE6     FMT                 WRITES    261

EXTERNALS       TYPE   ARGS       REFERENCES
      ALOG      REAL     1 LIBRARY    202     240
      EXP       REAL     1 LIBRARY     58      59      67      69      75      76     109     110     118
                                       119     149     169     189     214     232     251     276     278
      GRAS55             5             70
      SQRT      REAL     1 LIBRARY     31      41      54      75     166     208     274     277

INLINE FUNCTIONS  TYPE   ARGS       DEF LINE  REFERENCES
      ABS       REAL     1  INTRIN              145     179     185     199     209     228     247     268
      AMAX1     REAL     0  INTRIN              123     124     130     131     132     133     134     135
                                                137     267     268
      AMIN1     REAL     0  INTRIN              130     131     133     134     135     137
```

STATEMENT LABELS			DEF LINE	REFERENCES	
0	100		45	44	
116	110		48	29	
0	120		80	79	
350	130		85	82	
442	140		104	100	
445	150		106	103	
473	160		112	108	
500	170		114	111	
676	180		142	154	
762	190		155	152	
1061	200		173	165	
1066	210		174	172	
1072	220		176	164	
1113	230		179	175	
1122	240		182	194	
1206	250		195	192	
1233	260		200	160	
1252	270		204	201	
1257	280		207	219	
1345	290		220	217	
1370	300		225	238	
1452	310		239	235	
1467	320		243	203	
0	330		254	244	
1550	340		256	242	243
1561	350		259	91	256
1635	360		272	269	
1737	370		285	281	
1743	380		287	284	
1752	390		290	295	
1772	400		296	293	
0	410		303	301	
2035	420		306	297	
2041	430		308	305	
0	440		312	309	
2072	450		314	313	
2104	460		318	304	313
2110	470		320	2*313	317
0	480		326	324	
2150	490		329	320	
2154	500		331	328	
0	510		335	332	
2205	520		337	336	
2217	530		341	327	336
2223	540		343	2*336	340
2247	550		348	3*347	
0	560		350	348	
2273	570		352	347	3*351
0	580		354	352	
2305	590		355	351	
2454	600	FMT	361	261	
2462	610	FMT	362	257	

```
STATEMENT LABELS                DEF LINE   REFERENCES
 2464  620      FMT                363        357
 2503  630      FMT                366         83
 2513  640      FMT                368         84

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  104  100      N           44 45        5B     INSTACK
  321  120      N           79 80       13B        OPT
  374  350      N           91 259    1170B                EXT REFS  NOT INNER
 1472  330      M          244 254      55B                EXT REFS
 2012  410      N          301 303      17B        OPT
 2045  440      N          309 312      13B        OPT
 2125  480      N          324 326      17B        OPT
 2160  510      N          332 335      13B        OPT
 2251  560      N          348 350      10B     INSTACK
 2274  580      N          352 354      10B     INSTACK

COMMON BLOCKS   LENGTH
       GR0A2        12
       BDG02D       11
       GR2A4       144
       GTWOLC       31
       GR0235       54
       GR2A3      1726
       BDGR2        54

STATISTICS
  PROGRAM LENGTH                  3204B    1668
  SCM LABELED COMMON LENGTH       3760B    2032
       140000B SCM USED
```

```
      SUBROUTINE GRASS3 (Y,YB,YC,BLKMO,GBYMO,NF,KF)                          GRASS3     2
      COMMON/GR0235/AVN,GASIN,SAVG,J,K,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,        GRASS3     3
     +NMAXG,NXBD,NXBDG,RAD,VOLUME                                            GRASS3     4
      COMMON/GR0A3/GESW,JKMAX,KI                                             GRASS3     5
      COMMON/GR2A3/PBK,PGBDY,PBKDS,PDSL,PBKGBY,PBKDLC,FLXGB2,GBRF,           GRASS3     6
     +RRGBIP,RTRS,BLKMOR,GBYMOR,NMAXD,NMAXB2,NMAXD2,NMAXG2                   GRASS3     7
      DIMENSION PBK(20,20),PDSL(20,20),PBKDS(20,20),PGBDY(20,20),            GRASS3     8
     +PBKGBY(20),PBKDLC(20),SAVG(20),RTRS(20),RRGBIP(20),                    GRASS3     9
     +Y(82),YB(60),YC(82),GBYMO(KF,20),BLKMO(KF,20),BLKMOR(20),              GRASS3    10
     +GBYMOR(20),BULKB(20),DSLCB(20),GBDYB(20),BULKC(20),DSLCC(20),          GRASS3    11
     +GBDYC(20),ARDB(20),ARDD(20),ARDG(20),RAD(21),YO(82)                    GRASS3    12
      TARB = 0.                                                              GRASS3    13
          DO 120 N=1,NMAXB                                                   GRASS3    14
          IF (N.EQ.1) GO TO 100                                              GRASS3    15
          ARDB(N) = RTRS(N)                                                  GRASS3    16
          TARB = TARB+ARDB(N)*Y(N)                                           GRASS3    17
  100     IF (N.GT.NCDI) GO TO 110                                           GRASS3    18
          ARDD(N) = RTRS(N)                                                  GRASS3    19
          TARB = TARB+ARDD(N)*Y(NMAXB+N)                                     GRASS3    20
  110     IF (N.GT.NCGBI) GO TO 120                                          GRASS3    21
          ARDG(N) = RTRS(N)*GBRF                                             GRASS3    22
          TARB = TARB+ARDG(N)*Y(NXBD+N)                                      GRASS3    23
  120     CONTINUE                                                           GRASS3    24
      JQ = NXBDG                                                             GRASS3    25
      GR = 0.                                                                GRASS3    26
C   -----COALESCENCE IN BULK                                                 GRASS3    27
      N = 1                                                                  GRASS3    28
      NI = 2                                                                 GRASS3    29
      GROW = 0.                                                              GRASS3    30
      BULKC(N) = GASIN/SAVG(1)                                               GRASS3    31
      GO TO 160                                                              GRASS3    32
  130 DISAP = 0.                                                             GRASS3    33
          DO 140 M=NI,NMAXB2                                                 GRASS3    34
  140     DISAP = DISAP+Y(M)*PBK(M,N)                                        GRASS3    35
      BULKB(N) = DISAP+GROW                                                  GRASS3    36
      BULKC(NI) = (GROW+PBK(N,N)*Y(N))*Y(N)                                  GRASS3    37
      SUM = 0.                                                               GRASS3    38
          DO 150 M=1,N                                                       GRASS3    39
C   THE RATE NI BUBBLES BECOME NI+1 BUBBLES IS REDUCED BY RESOLUTION         GRASS3    40
  150     SUM = SUM+Y(M)*PBK(M,NI)                                           GRASS3    41
      CALL GRASS1 (SUM,ARDB(NI))                                             GRASS3    42
      N = NI                                                                 GRASS3    43
      NI = N+1                                                               GRASS3    44
      GROW = SUM/(SAVG(NI)-SAVG(N))                                          GRASS3    45
  160 IF (N-NMAXB2) 130,170,180                                              GRASS3    46
  170 BULKB(N) = GROW                                                        GRASS3    47
      BULKC(NI) = (GROW+PBK(N,N)*Y(N))*Y(N)                                  GRASS3    48
      N = NI                                                                 GRASS3    49
  180 BULKB(N) = 0.                                                          GRASS3    50
C   -----COALESCENCE ON DISLOCATIONS                                         GRASS3    51
      N = 1                                                                  GRASS3    52
      NI = 2                                                                 GRASS3    53
      GROW = 0.                                                              GRASS3    54
```

```
                DSLCC(N) = 0.                                                    GRASS3     55
55              GO TO 220                                                        GRASS3     56
          190   DISAP = 0.                                                       GRASS3     57
                    DO 200 M=N1,NMAXD2                                           GRASS3     58
          200       DISAP = DISAP+Y(NMAXB+M)*PDSL(M,N)                           GRASS3     59
                DSLCB(N) = DISAP+GROW                                            GRASS3     60
60              NBN = NMAXB+N                                                    GRASS3     61
                DSLCC(N1) = (GROW+PDSL(N,N)*Y(NBN))*Y(NBN)                       GRASS3     62
                SUM = 0.                                                         GRASS3     63
                    DO 210 M=1,N                                                 GRASS3     64
          210       SUM = SUM+Y(NMAXB+M)*PDSL(M,N1)                              GRASS3     65
65              CALL GRASS1 (SUM,ARDD(N1))                                       GRASS3     66
                N = N1                                                           GRASS3     67
                N1 = N+1                                                         GRASS3     68
                GROW = SUM/(SAVG(N1)-SAVG(N))                                    GRASS3     69
          220   IF (N-NMAXD2) 190,230,240                                        GRASS3     70
70        230   DSLCB(N) = GROW                                                  GRASS3     71
                NBN = NMAXB+N                                                    GRASS3     72
                DSLCC(N1) = (GROW+PDSL(N,N)*Y(NBN))*Y(NBN)                       GRASS3     73
                N = N1                                                           GRASS3     74
          240   DSLCB(N) = 0.                                                    GRASS3     75
75        C   -----COALESCENCE ON GRAIN BOUNDARIES                               GRASS3     76
                N = 1                                                            GRASS3     77
                N1 = 2                                                           GRASS3     78
                GROW = 0.                                                        GRASS3     79
                GBDYC(N) = 0.                                                    GRASS3     80
80              GO TO 280                                                        GRASS3     81
          250   DISAP = 0.                                                       GRASS3     82
                    DO 260 M=N1,NMAXG2                                           GRASS3     83
          260       DISAP = DISAP+Y(NXBD+M)*PGBDY(M,N)                           GRASS3     84
                GBDYB(N) = DISAP+GROW                                            GRASS3     85
85              NBN = NXBD+N                                                     GRASS3     86
                GBDYC(N1) = (GROW+PGBDY(N,N)*Y(NBN))*Y(NBN)                      GRASS3     87
                SUM = 0.                                                         GRASS3     88
                    DO 270 M=1,N                                                 GRASS3     89
          270       SUM = SUM+Y(NXBD+M)*PGBDY(M,N1)                              GRASS3     90
90              CALL GRASS1 (SUM,ARDG(N1))                                       GRASS3     91
                N = N1                                                           GRASS3     92
                N1 = N+1                                                         GRASS3     93
                GROW = SUM/(SAVG(N1)-SAVG(N))                                    GRASS3     94
          280   IF (N-NMAXG2) 250,290,300                                        GRASS3     95
95        290   GBDYB(N) = GROW                                                  GRASS3     96
                NBN = NXBD+N                                                     GRASS3     97
                GBDYC(N1) = (GROW+PGBDY(N,N)*Y(NBN))*Y(NBN)                      GRASS3     98
                N = N1                                                           GRASS3     99
          300   GBDYB(N) = 0.                                                    GRASS3    100
100       C   -----BULK BUBBLES COALESCE WITH LARGER DISLCATION BUBBLES           GRASS3    101
                IF (JNCDI.EQ.1) GO TO 340                                        GRASS3    102
                N = 1                                                            GRASS3    103
                SUM = 0.                                                         GRASS3    104
          310   N1 = N+1                                                         GRASS3    105
105             GROW = (SUM+Y(N)*SAVG(N)*PBKDS(N,N))/(SAVG(N1)-SAVG(N))          GRASS3    106
                DSLCB(N) = DSLCB(N)+GROW                                         GRASS3    107
```

```
                      DSLCC(NI) = DSLCC(NI)+GROW*Y(NMAXB+N)                    GRASS3   108
                      DISAP = 0.                                               GRASS3   109
                          DO 320 M=N,NMAXD2                                    GRASS3   110
110                320    DISAP = DISAP+Y(NMAXB+M)*PBKDS(M,N)                  GRASS3   111
                      BULKB(N) = BULKB(N)+DISAP                                GRASS3   112
                      IF (NI.EQ.NMAXD) GO TO 340                               GRASS3   113
                      SUM = 0.                                                 GRASS3   114
                          DO 330 M=1,N                                         GRASS3   115
115                330    SUM = SUM+Y(M)*PBKDS(M,NI)                           GRASS3   116
                      CALL GRASS1 (SUM,ARDD(NI))                               GRASS3   117
                      N = NI                                                   GRASS3   118
                      GO TO 310                                                GRASS3   119
                340   CONTINUE                                                 GRASS3   120
120                   C   -----DISLOCATION BUBBLES COALESCE WITH BULK BUBBLES > NCDI  GRASS3   121
                      GO TO (400,350,400,400), JNCDI                           GRASS3   122
                350   N = 1                                                    GRASS3   123
                360   DISAP = 0.                                               GRASS3   124
                          DO 370 M=NMAXD,NMAXB2                                GRASS3   125
125                370    DISAP = DISAP+Y(M)*PBKDS(M,N)                        GRASS3   126
                      DSLCB(N) = DSLCB(N)+DISAP                                GRASS3   127
                      N = N+1                                                  GRASS3   128
                      IF (N.LE.NCDI) GO TO 360                                 GRASS3   129
                380   SUM = 0.                                                 GRASS3   130
130                       DO 390 M=1,NCDI                                      GRASS3   131
                390       SUM = SUM+Y(NMAXB+M)*PBKDS(M,N)                      GRASS3   132
                      CALL GRASS1 (SUM,ARDB(N))                                GRASS3   133
                      NI = N                                                   GRASS3   134
                      N = N+1                                                  GRASS3   135
135                   GROW = SUM/(SAVG(N)-SAVG(NI))                            GRASS3   136
                      BULKB(NI) = BULKB(NI)+GROW                               GRASS3   137
                      BULKC(N) = BULKC(N)+GROW*Y(NI)                           GRASS3   138
                      IF (N.LT.NMAXB) GO TO 380                                GRASS3   139
                400   CONTINUE                                                 GRASS3   140
140                   C   -----BULK BUBBLES MIGRATE/DIFFUSE TO DISLOCATIONS    GRASS3   141
                      GO TO (440,410,410,420), JNCDI                           GRASS3   142
                410   BULKC(NMAXD) = BULKC(NMAXD)+DSLCC(NMAXD)                 GRASS3   143
                420       DO 430 N=1,NCDI                                      GRASS3   144
                          X = PBKDLC(N)                                        GRASS3   145
145                       BULKB(N) = BULKB(N)+X                                GRASS3   146
                430       DSLCC(N) = DSLCC(N)+X*Y(N)                           GRASS3   147
                440   CONTINUE                                                 GRASS3   148
                      C   -----BULK BUBBLES MIGRATE/DIFFUSE TO GRAIN BOUNDARIES  GRASS3   149
                      GO TO (480,450,450,460), JNCGBI                          GRASS3   150
150                   450   BULKC(NMAXG) = BULKC(NMAXG)+GBDYC(NMAXG)           GRASS3   151
                      460       DO 470 N=1,NCGBI                             GRASS3   152
                                X = PBKGBY(N)                                  GRASS3   153
                                BULKB(N) = BULKB(N)+X                          GRASS3   154
                                IF (N.GT.1) GO TO 470                          GRASS3   155
155                             BULKB(N) = BULKB(N)+FLXGB2                     GRASS3   156
                                GBDYC(N) = GBDYC(N)+FLXGB2*Y(N)                GRASS3   157
                      470       GBDYC(N) = GBDYC(N)+X*Y(N)                     GRASS3   158
                      480   CONTINUE                                           GRASS3   159
                      C   -----BUBBLES MIGRATE IN & OUT OF RADIAL SECTION AND  GRASS3   160
```

```
      C   -----GRAIN BOUNDARY BUBBLES RELEASE TO INTER CONNECTED POROSITY
        GO TO (490,490,490,540), JNCGBI
  490       DO 500 N=NMAXG,NMAXB
  500       BULKB(N) = BULKB(N)+BLKMOR(N)/VOLUME
        GO TO (530,510), JKMAX
  510       DO 520 N=NMAXG,NMAXB
  520       BULKC(N) = BULKC(N)+(GBYMO(K1,N)+BLKMO(K1,N))/VOLUME
  530   GO TO (580,540,540,540), JNCGBI
  540   GR = 0.
        GESW = 0.0
            DO 550 N=1,NCGBI
            NXBDN = NXBD+N
            GR = GR+RRGBIP(N)*SAVG(N)*Y(NXBDN)
            GESW = GESW+RAD(N)**3*RRGBIP(N)*Y(NXBDN)
  550       GBDYB(N) = GBDYB(N)+GBYMOR(N)/VOLUME+RRGBIP(N)
        GO TO (580,560), JKMAX
  560       DO 570 N=1,NCGBI
            BULKC(N) = BULKC(N)+BLKMO(K1,N)/VOLUME
  570       GBDYC(N) = GBDYC(N)+GBYMO(K1,N)/VOLUME
  580   CONTINUE
      C   -----CALCULATE COEFFICIENTS YB AND YC
      C   ----- & INCLUDE EFFECT OF RESOLUTION
        JZ = JQ+1
        IF (JNCGBI.EQ.1) GO TO 610
        GDO = 0.
        N = NCGBI
  590   JZ = JZ-1
        YC(JZ) = GBDYC(N)+GDO
        IF (N.EQ.1) GO TO 600
        N1 = N-1
        GDO = ARDG(N)/(SAVG(N)-SAVG(N1))
        YB(JZ) = GBDYB(N)+GDO
        GDO = GDO*Y(NXBD+N)
        N = N1
        GO TO 590
  600   YB(JZ) = GBDYB(N):ARDG(N)
  610   IF (JNCDI.EQ.1) GO TO 640
        GDO = 0.
        N = NCDI
  620   JZ = JZ-1
        YC(JZ) = DSLCC(N)+GDO
        IF (N.EQ.1) GO TO 630
        N1 = N-1
        GDO = ARDD(N)/(SAVG(N)-SAVG(N1))
        YB(JZ) = DSLCB(N)+GDO
        GDO = GDO*Y(NMAXB+N)
        N = N1
        GO TO 620
  630   YB(JZ) = DSLCB(N)+ARDD(N)
  640   GDO = 0.
        N = NMAXB
  650   JZ = JZ-1
        YC(JZ) = BULKC(N)+GDO
```

```
                NI = N-1                                                    GRASS3   214
                GDO = ARDB(N)/(SAVG(N)-SAVG(NI))                            GRASS3   215
215             YB(JZ) = BULKB(N)+GDO                                       GRASS3   216
                GDO = GDO*Y(N)                                              GRASS3   217
                N = NI                                                      GRASS3   218
                IF (N.GT.1) GO TO 650                                       GRASS3   219
                JZ = JZ-1                                                   GRASS3   220
220             YB(JZ) = BULKB(N)                                           GRASS3   221
                YC(JZ) = BULKC(N)+GDO+TARB                                  GRASS3   222
                JQ = JQ+1                                                   GRASS3   223
                YC(JQ) = GR                                                 GRASS3   224
                JQ = JQ+1                                                   GRASS3   225
225             YC(JQ) = GESW                                               GRASS3   226
          C   -----MIGRATION OUT                                            GRASS3   227
                GO TO (660,660,660,680), JNCGBI                             GRASS3   228
          660       DO 670 N=NMAXG,NMAXB                                    GRASS3   229
                    JQ = JQ+1                                               GRASS3   230
230       670       YC(JQ) = BLKMOR(N)*Y(N)                                 GRASS3   231
          680   IF (JNCGBI.EQ.1) GO TO 700                                  GRASS3   232
                    DO 690 N=1,NCGBI                                        GRASS3   233
                    JQ = JQ+1                                               GRASS3   234
          690       YC(JQ) = GBYMOR(N)*Y(NXBD+N)                            GRASS3   235
235       700   CONTINUE                                                    GRASS3   236
                RETURN                                                      GRASS3   237
                END                                                         GRASS3   238
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

```
     164    1            AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
     175    1            AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES

```
    4  GRASS3            1   236
```

VARIABLES SN TYPE RELOCATION

```
 1623  ARDB      REAL    ARRAY                REFS      7    16    41   132   214
                                             DEFINED  15
 1647  ARDD      REAL    ARRAY                REFS      7    19    65   116   203   208
                                             DEFINED  18
 1673  ARDG      REAL    ARRAY                REFS      7    22    90   190   195
                                             DEFINED  21
    0  AVN       REAL                 GR0235  REFS      2
    0  BLKMO     REAL    ARRAY         F.P.   REFS      7   166   177   DEFINED   1
 3222  BLKMOR    REAL    ARRAY        GR2A3   REFS      5     7   163       230
```

VARIABLES	SN	TYPE	RELOCATION									
1433	BULKB	REAL	ARRAY		REFS	7	111	136	145	153	155	163
						215	220	DEFINED	35	46	49	111	136
						145	153	155	163			
1527	BULKC	REAL	ARRAY		REFS	7	137	142	150	166	177	212
						221	DEFINED	30	36	47	137	142	150
						166	177					
1423	DISAP	REAL			REFS	34	35	58	59	83	84	110
						111	125	126	DEFINED	32	34	56	58
						81	83	108	110	123	125		
1457	DSLCB	REAL	ARRAY		REFS	7	106	126	204	208		
					DEFINED	59	70	74	106	126		
1553	DSLCC	REAL	ARRAY		REFS	7	107	142	146	200		
					DEFINED	54	61	72	107	146		
3150	FLXGB2	REAL		GR2A3	REFS	5	155	156				
1	GASIN	REAL		GR0235	REFS	2	30					
1503	GBDYB	REAL	ARRAY		REFS	7	174	191	195	DEFINED	84	95
						99	174					
1577	GBDYC	REAL	ARRAY		REFS	7	150	156	157	178	187	
					DEFINED	79	86	97	156	157	178	
3151	GBRF	REAL		GR2A3	REFS	5	21					
0	GBYMO	REAL	ARRAY	F.P.	REFS	7	166	178	DEFINED	1		
3246	GBYMOR	REAL	ARRAY	GR2A3	REFS	5	7	174	234			
1432	GDO	REAL			REFS	187	191	192	200	204	205	212
						215	216	221	DEFINED	184	190	192	197
						203	205	209	214	216		
0	GESW	REAL		GR0A3	REFS	4	173	225	DEFINED	169	173	
1420	GR	REAL			REFS	172	223	DEFINED	25	168	172	
1422	GROW	REAL			REFS	35	36	46	47	59	61	70
						72	84	86	95	97	106	107	136
						137	DEFINED	29	44	53	68	78	93
						105	135					
26	J	INTEGER		GR0235	REFS	2						
1	JKMAX	INTEGER		GR0A3	REFS	4	164	175				
33	JNCDI	INTEGER		GR0235	REFS	2	101	121	141	196		
34	JNCGBI	INTEGER		GR0235	REFS	2	149	161	167	183	227	231
1417	JQ	INTEGER			REFS	182	222	223	224	225	229	230
						233	234	DEFINED	24	222	224	229	233
1431	JZ	INTEGER			REFS	186	187	191	195	199	200	204
						208	211	212	215	219	220	221	
					DEFINED	182	186	199	211	219		
27	K	INTEGER		GR0235	REFS	2						
0	KF	INTEGER		F.P.	REFS	2*7	DEFINED	1				
2	KI	INTEGER		GR0A3	REFS	4	2*165	177	178			
1424	M	INTEGER			REFS	2*34	2*40	2*58	2*64	2*83	2*89	2*110
						2*115	2*125	2*131	DEFINED	33	38	57	63
						82	88	109	114	124	130		
1416	N	INTEGER			REFS	14	2*15	2*16	17	2*18	2*19	20
						2*21	2*22	30	34	35	4*36	38	43
						44	45	46	4*47	49	54	58	59
						60	2*61	63	67	68	69	70	71
						2*72	74	79	83	84	85	2*86	88
						92	93	94	95	96	2*97	99	104
						5*105	2*106	107	109	110	2*111	114	125

VARIABLES	SN	TYPE		RELOCATION								
					2*126	127	128	131	132	133	134	135
					2*137	138	144	2*145	3*146	152	2*153	154
					2*155	3*156	3*157	3*163	4*166	171	2*172	2*173
					4*174	3*177	3*178	187	188	189	2*190	191
					192	2*195	200	201	202	2*203	204	205
					2*208	212	213	2*214	215	216	218	220
					221	2*230	2*234	DEFINED	13	27	42	48
					51	66	73	76	91	98	102	117
					122	127	134	143	151	162	165	170
					176	185	193	198	206	210	217	228
					232							
1426	NBN	INTEGER			REFS	2*61	2*72	2*86	2*97	DEFINED	60	71
					85	96						
31	NCDI	INTEGER		GR0235	REFS	2	17	128	130	143	198	
32	NCGBI	INTEGER		GR0235	REFS	2	20	151	170	176	165	232
0	NF	INTEGER	*UNUSED	F.P.	DEFINED	1						
30	NMAXB	INTEGER		GR0235	REFS	2	13	19	58	60	64	71
					107	110	131	138	162	165	205	210
					228							
3273	NMAXB2	INTEGER		GR2A3	REFS	5	33	45	124			
3272	NMAXD	INTEGER		GR2A3	REFS	5	112	124	3*142			
3274	NMAXD2	INTEGER		GR2A3	REFS	5	57	69	109			
35	NMAXG	INTEGER		GR0235	REFS	2	3*150	162	165	228		
3275	NMAXG2	INTEGER		GR2A3	REFS	5	82	94				
36	NXBD	INTEGER		GR0235	REFS	2	22	83	85	89	96	171
					192	234						
37	NXBDG	INTEGER		GR0235	REFS	2	24					
1430	NXBDN	INTEGER			REFS	172	173	DEFINED	171			
1421	NI	INTEGER			REFS	33	36	40	41	42	44	47
					48	57	61	64	65	66	68	72
					73	82	86	89	90	91	93	97
					98	105	2*107	112	115	116	117	135
					2*136	137	190	193	203	206	214	217
					DEFINED	28	43	52	67	77	92	104
					133	189	202	213				
0	PBK	REAL	ARRAY	GR2A3	REFS	5	7	34	36	40	47	
3124	PBKDLC	REAL	ARRAY	GR2A3	REFS	5	7	144				
1440	PBKDS	REAL	ARRAY	GR2A3	REFS	5	7	105	110	115	125	131
3100	PBKGBY	REAL	ARRAY	GR2A3	REFS	5	7	152				
2260	PDSL	REAL	ARRAY	GR2A3	REFS	5	7	50	61	64	72	
620	PGBDY	REAL	ARRAY	GR2A3	REFS	5	7	83	86	89	97	
40	RAD	REAL	ARRAY	GR0235	REFS	2	7	173				
3152	RRGBIP	REAL	ARRAY	GR2A3	REFS	5	7	172	173	174		
3176	RTRS	REAL	ARRAY	GR2A3	REFS	5	7	15	18	21		
2	SAVG	REAL	ARRAY	GR0235	REFS	2	7	30	2*44	2*68	2*93	3*105
					2*135	172	2*190	2*203	2*214			
1425	SUM	REAL			REFS	40	41	44	64	65	68	89
					90	93	105	115	116	131	132	135
					DEFINED	37	40	62	64	87	89	103
					113	115	129	131				
1415	TARB	REAL			REFS	16	19	22	221	DEFINED	12	16
					19	22						
65	VOLUME	REAL		GR0235	REFS	2	163	166	174	177	178	

VARIABLES	SN	TYPE	RELOCATION									
1427	X	REAL			REFS	145	146	153	157	DEFINED	144	152
0	Y	REAL	ARRAY	F.P.	REFS	7	16	19	22	34	2*36	40
					2*47	58	2*61	64	2*72	83	2*86	89
					2*97	105	107	110	115	125	131	137
					146	156	157	172	173	192	205	216
					230	234	DEFINED	1				
0	YB	REAL	ARRAY	F.P.	REFS	7	DEFINED	1	191	195	204	208
					215	220						
0	YC	REAL	ARRAY	F.P.	REFS	7	DEFINED	1	187	200	212	221
					223	225	230	234				
1717	YO	REAL	*UNDEF		REFS	7						

EXTERNALS	TYPE	ARGS	REFERENCES				
GRASS1		2	41	65	90	116	132

STATEMENT LABELS			DEF LINE	REFERENCES	
30	100		17	14	
44	110		20	17	
60	120		23	13	20
102	130		32	45	
0	140		34	33	
0	150		40	38	
161	160		45	31	
0	170	INACTIVE	46	45	
200	180		49	45	
214	190		56	69	
0	200		58	57	
0	210		64	63	
277	220		69	55	
0	230	INACTIVE	70	69	
322	240		74	69	
336	250		81	94	
0	260		83	82	
0	270		89	88	
421	280		94	80	
0	290	INACTIVE	95	94	
444	300		99	94	
456	310		104	118	
0	320		110	109	
0	330		115	114	
547	340		119	101	112
561	350		122	121	
563	360		123	128	
0	370		125	124	
607	380		129	138	
0	390		131	130	
653	400		139	3*121	
665	410		142	2*141	
671	420		143	141	
0	430		146	143	
707	440		147	141	
721	450		150	2*149	
725	460		151	149	

STATEMENT LABELS		DEF LINE	REFERENCES	
747	470	157	151	154
755	480	158	149	
767	490	162	3*161	
0	500	163	162	
1007	510	165	164	
0	520	166	165	
1023	530	167	164	
1035	540	168	161	3*167
0	550	174	170	
1077	560	176	175	
0	570	178	176	
1117	580	179	167	175
1132	590	186	194	
1171	600	195	188	
1176	610	196	183	
1205	620	199	207	
1244	630	208	201	
1251	640	209	196	
1255	650	211	218	
1351	660	228	3*227	
0	670	230	228	
1364	680	231	227	
0	690	234	232	
1402	700	235	231	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
15	120	N	13 23	46B	OPT
105	140	M	33 34	10B	INSTACK
132	150	M	38 40	10B	INSTACK
217	200	M	57 58	10B	INSTACK
250	210	M	63 64	10B	INSTACK
341	260	M	82 83	10B	INSTACK
372	270	M	88 89	10B	INSTACK
505	320	M	109 110	10B	INSTACK
527	330	M	114 115	10B	INSTACK
566	370	M	124 125	10B	INSTACK
612	390	M	130 131	10B	INSTACK
672	430	N	143 146	14B	OPT
726	470	N	157 157	26B	OPT
771	500	N	162 163	6B	INSTACK
1011	520	N	165 166	11B	INSTACK
1042	550	N	170 174	25B	OPT
1100	570	N	176 178	16B	OPT
1353	670	N	228 230	10B	INSTACK
1370	690	N	232 234	11B	INSTACK

COMMON BLOCKS	LENGTH
GR0235	54
GR0A3	3
GR2A3	1726

STATISTICS
PROGRAM LENGTH 2074B 1084
SCM LABELED COMMON LENGTH 3367B 1783
140000B SCM USED

```
      SUBROUTINE GRASS4 (BLKMO,GBYMO,NF,KF)                                  GRASS4      2
      COMMON/GROA4/IMAX1,X,Y,H,KK                                            GRASS4      3
      COMMON/BDGR4/DT(81,13),D(13),HMIN,CRT,JM                               GRASS4      4
      COMMON/GR2A4/EPS,YA,IMAX2,DLIM                                         GRASS4      5
      DIMENSION Y0(82),YB0(60),YC0(82),YA(60),YB(60),YC(82),Y(82),YL(82)     GRASS4      6
     +,YM(82),EPS(82),BLKMO(KF,20),GBYMO(KF,20)                              GRASS4      7
      DATA JFLAG/1/                                                          GRASS4      8
      DATA E/.9536E-6/                                                       GRASS4      9
      JMAX = JM+4                                                            GRASS4     10
          DO 100 I=1,IMAX1                                                   GRASS4     11
          IF (Y(I).LT.10.0E-60) Y(I) = 0.0                                   GRASS4     12
  100     Y0(I) = Y(I)                                                       GRASS4     13
      CALL GRASS3 (Y0,YB0,YC0,BLKMO,GBYMO,NF,KF)                             GRASS4     14
      KK = +1                                                                GRASS4     15
  110 JB0 = -1                                                               GRASS4     16
      M = 1                                                                  GRASS4     17
      JR = 2                                                                 GRASS4     18
      JS = 3                                                                 GRASS4     19
      JJ = 0                                                                 GRASS4     20
          DO 520 J=1,JMAX                                                    GRASS4     21
          IF (JB0) 130,120,120                                               GRASS4     22
  120     D(2) = 16./9.                                                      GRASS4     23
          D(4) = 64./9.                                                      GRASS4     24
          D(6) = 256./9.                                                     GRASS4     25
          D(8) = 1024./9.                                                    GRASS4     26
          D(10) = 4096./9.                                                   GRASS4     27
          D(12) = 16384./9.                                                  GRASS4     28
          GO TO 140                                                          GRASS4     29
  130     D(2) = 2.25                                                        GRASS4     30
          D(4) = 9.                                                          GRASS4     31
          D(6) = 36.                                                         GRASS4     32
          D(8) = 144.                                                        GRASS4     33
          D(10) = 576.                                                       GRASS4     34
          D(12) = 2304.                                                      GRASS4     35
  140     KONV = +1                                                          GRASS4     36
          IF (J-1) 150,150,160                                               GRASS4     37
  150     KONV = -1                                                          GRASS4     38
  160     IF (J-(JM+1)) 180,180,170                                          GRASS4     39
  170     L = JM+1                                                           GRASS4     40
          D(L) = 4.*D(L-2)                                                   GRASS4     41
          FC = 0.7071068*FC                                                  GRASS4     42
          GO TO 190                                                          GRASS4     43
  180     L = J                                                              GRASS4     44
          D(L) = FLOAT(M*M)                                                  GRASS4     45
          FC = 1.+FLOAT(JM+1-J)/6.                                           GRASS4     46
  190     M = M+M                                                            GRASS4     47
          G = H/FLOAT(M)                                                     GRASS4     48
          B = G+G                                                            GRASS4     49
              DO 260 I=1,IMAX2                                               GRASS4     50
              IF (I-IMAX1) 200,200,250                                       GRASS4     51
  200         YL(I) = Y0(I)                                                  GRASS4     52
              IF (YA(I).LT.0..OR.YB0(I).LT.0..OR.YC0(I).LT.0..OR.YL(I).L     GRASS4     53
     +        T.0.) GO TO 230                                                GRASS4     54
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```
                      AYL = YA(I)*YL(I)                                                  GRASS4    55
55                    DD = AYL+YBO(I)                                                    GRASS4    56
                      CD = YCO(I)-DD*YL(I)                                               GRASS4    57
                      ACD = ABS(CD)                                                      GRASS4    58
                      IF ((ACD.LE.E*YCO(I)).OR.(ACD*G.LT.E*YL(I))) GO TO 210             GRASS4    59
                      BCA = SQRT(YBO(I)*YBO(I)+4.*YA(I)*YCO(I))                          GRASS4    60
60                    DTBCA = G*BCA                                                      GRASS4    61
                      IF (DTBCA.LT..001) GO TO 220                                       GRASS4    62
                      BCAB = BCA+YBO(I)                                                  GRASS4    63
                      P = 2.*YCO(I)/BCAB                                                 GRASS4    64
                      Z = 0.0                                                            GRASS4    65
65                    IF (-DTBCA.GT.DLIM) Z = EXP(-DTBCA)                                GRASS4    66
                      ZZ = (1.+Z)*TANH(DTBCA*.5)                                         GRASS4    67
                      AYPZZB = YA(I)*(YL(I)-P)*ZZ/BCA                                    GRASS4    68
                      YM(I) = (YL(I)*Z+P*(ZZ+AYPZZB))/(1.+AYPZZB)                        GRASS4    69
                      GO TO 240                                                          GRASS4    70
70          210       YM(I) = YL(I)                                                      GRASS4    71
                      GO TO 240                                                          GRASS4    72
            220       YM(I) = YL(I)+CD*(1.-G*.5*(DD+AYL))*G                              GRASS4    73
                      GO TO 240                                                          GRASS4    74
            230       WRITE (6,560) YA(I),YBO(I),YCO(I),YL(I),I                          GRASS4    75
75                    KK = -1                                                            GRASS4    76
                      GO TO 540                                                          GRASS4    77
            240       CONTINUE                                                           GRASS4    78
                      GO TO 260                                                          GRASS4    79
            250       YL(I) = 0.                                                         GRASS4    80
80                    YM(I) = YCO(I)*G                                                   GRASS4    81
            260       CONTINUE                                                           GRASS4    82
                      DO 350 K=2,M                                                       GRASS4    83
                      CALL GRASS3 (YM,YB,YC,BLKMO,GBYMO,NF,KF)                           GRASS4    84
                          DO 340 I=1,IMAX2                                               GRASS4    85
85                        IF (I-IMAX1) 270,270,320                                       GRASS4    86
            270           IF (YA(I).LT.0..OR.YB(I).LT.0..OR.YC(I).LT.0..OR.YL(I)       GRASS4    87
                     +    .LT.0.) GO TO 300                                            GRASS4    88
                          AYL = YA(I)*YL(I)                                              GRASS4    89
                          DD = AYL+YB(I)                                                 GRASS4    90
90                        CD = YC(I)-DD*YL(I)                                            GRASS4    91
                          ACD = ABS(CD)                                                  GRASS4    92
                          IF ((ACD.LE.E*YC(I)).OR.(ACD*B.LT.E*YL(I))) GO TO 280          GRASS4    93
                          BCA = SQRT(YB(I)*YB(I)+4.*YA(I)*YC(I))                         GRASS4    94
                          DTBCA = B*BCA                                                  GRASS4    95
95                        IF (DTBCA.LT..001) GO TO 290                                   GRASS4    96
                          BCAB = BCA+YB(I)                                               GRASS4    97
                          P = 2.*YC(I)/BCAB                                              GRASS4    98
                          Z = 0.0                                                        GRASS4    99
                          IF (-DTBCA.GT.DLIM) Z = EXP(-DTBCA)                            GRASS4   100
100                       ZZ = (1.+Z)*TANH(DTBCA*.5)                                     GRASS4   101
                          AYPZZB = YA(I)*(YL(I)-P)*ZZ/BCA                                GRASS4   102
                          U = (YL(I)*Z+P*(ZZ+AYPZZB))/(1.+AYPZZB)                        GRASS4   103
                          GO TO 310                                                      GRASS4   104
            280           U = YL(I)                                                      GRASS4   105
105                       GO TO 310                                                      GRASS4   106
            290           U = YL(I)+CD*(1.-B*.5*(DD+AYL))*B                              GRASS4   107
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```
                      GO TO 310                                                  GRA554   108
              300     WRITE (6,560) YA(I),YB(I),YC(I),YL(I),I                    GRA554   109
                      KK = -1                                                    GRA554   110
110                   GO TO 540                                                  GRA554   111
              310     CONTINUE                                                   GRA554   112
                      GO TO 330                                                  GRA554   113
              320     U = YL(I)+YC(I)*B                                          GRA554   114
              330     YL(I) = YM(I)                                              GRA554   115
115                   YM(I) = U                                                  GRA554   116
              340     CONTINUE                                                   GRA554   117
              350   CONTINUE                                                     GRA554   118
                  CALL GRA553 (YM,YB,YC,BLKMO,GBYMO,NF,KF)                       GRA554   119
                    DO 500 I=1,IMAX2                                             GRA554   120
120                 V = DT(I,1)                                                  GRA554   121
                    IF (I-IMAX1) 360,360,410                                     GRA554   122
              360   IF (YA(I).LT.0..OR.YB(I).LT.0..OR.YC(I).LT.0..OR.YL(I).LT.   GRA554   123
                  +   0.) GO TO 390                                              GRA554   124
                    AYL = YA(I)*YL(I)                                            GRA554   125
125                 DD = AYL+YB(I)                                               GRA554   126
                    CD = YC(I)-DD*YL(I)                                          GRA554   127
                    ACD = ABS(CD)                                                GRA554   128
                    IF ((ACD.LE.E*YC(I)).OR.(ACD*G.LT.E*YL(I))) GO TO 370        GRA554   129
                    BCA = SQRT(YB(I)*YB(I)+4.*YA(I)*YC(I))                       GRA554   130
130                 DTBCA = G*BCA                                                GRA554   131
                    IF (DTBCA.LT..001) GO TO 380                                 GRA554   132
                    BCAB = BCA+YB(I)                                             GRA554   133
                    P = 2.*YC(I)/BCAB                                            GRA554   134
                    Z = 0.0                                                      GRA554   135
135                 IF (-DTBCA.GT.DLIM) Z = EXP(-DTBCA)                          GRA554   136
                    ZZ = (1.+Z)*TANH(DTBCA*.5)                                   GRA554   137
                    AYPZZB = YA(I)*(YL(I)-P)*ZZ/BCA                              GRA554   138
                    DT2 = (YL(I)*Z+P*(ZZ+AYPZZB))/(1.+AYPZZB)                    GRA554   139
                    GO TO 400                                                    GRA554   140
140           370   DT2 = YL(I)                                                  GRA554   141
                    GO TO 400                                                    GRA554   142
              380   DT2 = YL(I)+CD*(1.-G*.5*(DD+AYL))*G                          GRA554   143
                    GO TO 400                                                    GRA554   144
              390   WRITE (6,560) YA(I),YB(I),YC(I),YL(I),I                      GRA554   145
145                 KK = -1                                                      GRA554   146
                    GO TO 540                                                    GRA554   147
              400   CONTINUE                                                     GRA554   148
                    GO TO 420                                                    GRA554   149
              410   DT2 = YL(I)+YC(I)*G                                          GRA554   150
150           420   DT(I,1) = (DT2+YM(I))*0.5                                    GRA554   151
                    C = DT(I,1)                                                  GRA554   152
                    TA = C                                                       GRA554   153
                    IF (C.LT.0.) GO TO 490                                       GRA554   154
                    IF (L.LT.2) GO TO 500                                        GRA554   155
155                 IF (JFLAG.LT.0) GO TO 470                                    GRA554   156
                    IF (V*65536.0.LT.C) GO TO 490                                GRA554   157
                      DO 450 K=2,L                                               GRA554   158
                      B1 = D(K)*V                                                GRA554   159
                      B = B1-C                                                   GRA554   160
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                      IF (B.LT.1.E-60) B = 0.0                                  GRASS4   161
                      U = V                                                     GRASS4   162
                      IF (B) 430,440,430                                        GRASS4   163
          430         B = (C-V)/B                                               GRASS4   164
                      U = C*B                                                   GRASS4   165
                      C = BI*B                                                  GRASS4   166
          440         V = DT(I,K)                                               GRASS4   167
                      DT(I,K) = U                                               GRASS4   168
                      TA = U+TA                                                 GRASS4   169
          450         CONTINUE                                                  GRASS4   170
          460       IF (TA.LT.0.) GO TO  90                                     GRASS4   171
                    IF (ABS(Y(I)-TA).LT.(ERT*TA+EPS(I))) GO TO 500              GRASS4   172
                    GO TO 490                                                   GRASS4   173
          470         DO 480 K=2,L                                              GRASS4   174
                      TA = TA+(TA-V)/(D(K)-1.)                                  GRASS4   175
                      V = DT(I,K)                                               GRASS4   176
          480         DT(I,K) = TA                                              GRASS4   177
                    GO TO 460                                                   GRASS4   178
          490       KONV = -1                                                   GRASS4   179
          500       Y(I) = TA                                                   GRASS4   180
                IF (KONV) 510,550,550                                           GRASS4   181
          510   D(3) = 4.                                                       GRASS4   182
                D(5) = 16.                                                      GRASS4   183
                JBO = -JBO                                                      GRASS4   184
                M = JR                                                          GRASS4   185
                JR = JS                                                         GRASS4   186
                JS = M+M                                                        GRASS4   187
                D(7) = 64.                                                      GRASS4   188
                D(9) = 256.                                                     GRASS4   189
                D(11) = 1024.                                                   GRASS4   190
          520     CONTINUE                                                      GRASS4   191
                IF (H.LE.HMIN) GO TO 540                                        GRASS4   192
                H = H/2.                                                        GRASS4   193
                IF (ABS(H)-HMIN) 530,110,110                                    GRASS4   194
          530   H = SIGN(HMIN,H)                                              GRASS4   195
                GO TO 110                                                       GRASS4   196
          540   KK = -1                                                       GRASS4   197
          550   X = X+H                                                       GRASS4   198
                H = FC*H                                                        GRASS4   199
                RETURN                                                          GRASS4   200
                C                                                               GRASS4   201
          560   FORMAT (12H A,B,C,Y,I= ,4E12.4,I3)                            GRASS4   202
                END                                                             GRASS4   203
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 GRASS4	1	199

VARIABLES SN TYPE RELOCATION

1307	ACD		REAL			REFS	2*58	2*92	2*128	DEFINED	57	91	127
1304	AYL		REAL			REFS	55	72	89	106	125	142	
						DEFINED	54	88	124				
1316	AYPZZB		REAL			REFS	2*68	2*102	2*138	DEFINED	67	101	137
1303	B		REAL			REFS	92	94	2*106	113	160	162	163
						164	165	DEFINED	48	159	160	163	
1310	BCA		REAL			REFS	60	62	67	94	96	101	130
						132	137	DEFINED	59	93	129		
1312	BCAB		REAL			REFS	63	97	133	DEFINED	62	96	132
0	BLKMO		REAL	ARRAY	F.P.	REFS	5	13	83	118	DEFINED	1	
1325	BI		REAL			REFS	159	165	DEFINED	158			
1323	C		REAL			REFS	152	153	156	159	163	164	
						DEFINED	151	165					
1306	CD		REAL			REFS	57	72	91	106	127	142	
						DEFINED	56	90	126				
2053	CRT		REAL		BDGR4	REFS	3	171					
2035	D		REAL	ARRAY	BDGR4	REFS	3	40	158	174	DEFINED	22	23
						24	25	26	27	29	30	31	32
						33	34	40	44	181	182	187	188
						189							
1305	DD		REAL			REFS	56	72	90	106	126	142	
						DEFINED	55	89	125				
217	DLIM		REAL		GR2A4	REFS	4	65	99	135			
0	DT		REAL	ARRAY	BDGR4	REFS	3	120	151	166	175		
						DEFINED	150	167	176				
1311	DTBCA		REAL			REFS	61	2*65	66	95	2*99	100	131
						2*135	136	DEFINED	60	94	130		
1322	DT2		REAL			REFS	150	DEFINED	138	140	142	149	
1176	E		REAL			REFS	2*58	2*92	2*128	DEFINED	8		
0	EPS		REAL	ARRAY	GR2A4	REFS	4	5	171				
1301	FC		REAL			REFS	41	198	DEFINED	41	45		
1302	G		REAL			REFS	2*48	58	60	2*72	80	128	130
						2*142	149	DEFINED	47				
0	GBYMO		REAL	ARRAY	F.P.	REFS	5	13	83	118	DEFINED	1	
124	H		REAL		GR0A4	REFS	2	47	191	192	193	194	197
						198	DEFINED	192	194	198			
2052	HMIN		REAL		BDGR4	REFS	3	191	193	194			
1270	I		INTEGER			REFS	2*11	2*12	50	2*51	4*52	2*54	55
						2*56	2*58	4*59	62	63	2*67	2*68	2*70
						2*72	5*74	79	2*80	85	4*86	2*88	89
						2*90	2*92	4*93	96	97	2*101	102	104
						106	5*108	2*113	2*114	115	120	121	4*122
						2*124	125	2*126	2*128	4*129	132	133	2*137
						138	140	142	5*144	2*149	2*150	151	166
						167	2*171	175	176	179	DEFINED	10	49
						84	119						
0	IMAX1		INTEGER		GR0A4	REFS	2	10	50	85	121		
216	IMAX2		INTEGER		GR2A4	REFS	4	49	84	119			
1276	J		INTEGER			REFS	36	38	43	45	DEFINED	20	
1271	JBO		INTEGER			REFS	21	183	DEFINED	15	183		
1175	JFLAG		INTEGER			REFS	155	DEFINED	7				
1275	JJ	*	INTEGER			DEFINED	15						

VARIABLES	SN	TYPE		RELOCATION								
2054	JM	INTEGER		BDGR4	REFS	3	9	38	39	45		
1267	JMAX	INTEGER			REFS	20	DEFINED	9				
1273	JR	INTEGER			REFS	184	DEFINED	17	185			
1274	JS	INTEGER			REFS	185	DEFINED	18	186			
1317	K	INTEGER			REFS	158	166	167	174	175	176	
					DEFINED	82	157	173				
0	KF	INTEGER		F.P.	REFS	2*5	13	83	118	DEFINED	1	
125	KK	INTEGER		GR0A4	REFS	2	DEFINED	14	75	109	145	196
1277	KONV	INTEGER			REFS	180	DEFINED	35	37	178		
1300	L	INTEGER			REFS	2*40	44	154	157	173		
					DEFINED	39	43					
1272	M	INTEGER			REFS	2*44	2*46	47	82	2*186		
					DEFINED	16	46	184				
0	NF	INTEGER		F.P.	REFS	13	83	118	DEFINED	1		
1313	P	REAL			REFS	67	68	101	102	137	138	
					DEFINED	63	97	133				
1324	TA	REAL			REFS	168	170	2*171	2*174	176	179	
					DEFINED	152	168	174				
1320	U	REAL			REFS	115	167	168	DEFINED	102	104	106
						113	161	164				
1321	V	REAL			REFS	156	158	161	163	174		
					DEFINED	120	166	175				
1	X	REAL		GRUA4	REFS	2	197	DEFINED	197			
2	Y	REAL	ARRAY	GR0A4	REFS	2	5	11	12	171		
					DEFINED	11	179					
122	YA	REAL	ARRAY	GR2A4	REFS	4	5	52	54	59	67	74
						86	88	93	101	108	122	124
						137	144					129
1666	YB	REAL	ARRAY		REFS	5	83	86	89	2*93	96	108
						118	122	125	2*129	132	144	
1450	YB0	REAL	ARRAY		REFS	5	13	52	55	2*59	62	74
1762	YC	REAL	ARRAY		REFS	5	83	86	90	92	93	97
						108	113	118	122	126	128	129
						144	149					133
1544	YC0	REAL	ARRAY		REFS	5	13	52	56	58	59	63
						74	80					
2104	YL	REAL	ARRAY		REFS	5	52	54	56	58	67	68
						70	72	74	86	88	90	92
						102	104	106	108	113	122	124
						128	137	138	140	142	144	149
					DEFINED	51	79	114				126
2226	YM	REAL	ARRAY		REFS	5	83	114	118	150		
					DEFINED	68	70	72	80	115		
1326	Y0	REAL	ARRAY		REFS	5	13	51	DEFINED	12		
1314	Z	REAL			REFS	66	68	100	102	136	138	
					DEFINED	64	65	98	99	134	135	
1315	ZZ	REAL			REFS	67	68	101	102	137	138	
					DEFINED	66	100	136				

FILE NAMES	MODE					
TAPE6	FMT	WRITES	74	108	144	

EXTERNALS	TYPE	ARGS		REFERENCES		
EXP	REAL	1	LIBRARY	65	99	135
GRASS3		7		13	83	118
SQRT	REAL	1	LIBRARY	59	93	129
TANH	REAL	1	LIBRARY	66	100	136

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES				
ABS	REAL	1	INTRIN		57	91	127	171	193
FLOAT	REAL	1	INTRIN		44	45	47		
SIGN	REAL	2	INTRIN		194				

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		12	10			
37	110		15	2*193	195		
0	120	INACTIVE	22	2*21			
72	130		29	21			
107	140		35	28			
0	150	INACTIVE	37	2*36			
116	160		38	36			
0	170	INACTIVE	39	38			
133	180		43	2*38			
147	190		46	42			
0	200	INACTIVE	51	2*50			
300	210		70	58			
304	220		72	61			
315	230		74	52			
331	240		77	69	71	73	
333	250		79	50			
341	260		81	49	78		
0	270	INACTIVE	86	2*85			
474	280		104	92			
500	290		106	95			
511	300		108	86			
525	310		111	103	105	107	
527	320		113	85			
534	330		114	112			
0	340		116	84			
0	350		117	82			
0	360	INACTIVE	122	2*121			
700	370		140	128			
704	380		142	131			
715	390		144	122			
731	400		147	139	141	143	
733	410		149	121			
740	420		150	118			
0	430	INACTIVE	163	2*162			
1015	440		166	162			
0	450		169	157			
1034	460		170	177			
1046	470		173	155			
0	480		176	173			
1070	490		178	153	156	170	172
1072	500		179	119	154	171	

STATEMENT LABELS			DEF LINE	REFERENCES			
0	510	INACTIVE	181	180			
0	520		190	20			
0	530	INACTIVE	194	193			
1143	540		196	76	110	146	191
1145	550		197	2*180			
1227	560	FMT	201	74	108	144	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
14	100	I	10 12	11B	INSTACK			
52	520	J	20 190	1053B		EXT REFS	EXITS	NOT INNER
157	260	I	49 81	165B		EXT REFS	EXITS	
346	350	K	82 117	201B		EXT REFS	EXITS	NOT INNER
356	340	I	84 116	166B		EXT REFS	EXITS	
557	500	I	119 179	317B		EXT REFS	EXITS	NOT INNER
766	450	K	157 169	45B	OPT			
1047	480	K	173 176	17B	OPT			

COMMON BLOCKS	LENGTH
GR0A4	86
BDGR4	1069
GR2A4	144

STATISTICS

PROGRAM LENGTH	2361B	1265
SCM LABELED COMMON LENGTH	2423B	1299

140000B SCM USED

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      SUBROUTINE GRASS5 (TEMP,GAMMA,HS,NF,KF)                                  GRASS5     2
      COMMON/BDGR5/DLI,D(10),DI(10),SL(10),BI(10),NOPT                         GRASS5     3
      COMMON/GR0235/AVN,GASIN,SAVG,J5,K5,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,        GRASS5     4
     +NMAXG,NXBD,NXBDG,RAD,VOLUME                                              GRASS5     5
      DIMENSION SAVG(20),RAD(21),PT(10)                                        GRASS5     6
      IF (NOPT.EQ.1) GO TO 130                                                 GRASS5     7
      N0 = 1                                                                   GRASS5     8
      GO TO 110                                                                GRASS5     9
  100 N0 = N                                                                   GRASS5    10
  110     DO 120 N=N0,NMAXB                                                    GRASS5    11
          C = SAVG(N)                                                          GRASS5    12
  120     RAD(N) = SQRT((3.0*TEMP*1.38E-16)/(8.0*GAMMA*3.1416)*C)              GRASS5    13
      GO TO 300                                                                GRASS5    14
  130 TR = TEMP/289.74                                                         GRASS5    15
          DO 140 J=1,10                                                        GRASS5    16
          PT(J) = SL(J)*TR+BI(J)                                               GRASS5    17
  140     CONTINUE                                                             GRASS5    18
      M = -1                                                                   GRASS5    19
      N = 1                                                                    GRASS5    20
      J = 10                                                                   GRASS5    21
      C = SAVG(1)                                                              GRASS5    22
      DLM = DLI                                                                GRASS5    23
      AT = PT(10)*(DI(10)-DLM)                                                 GRASS5    24
      GO TO 180                                                                GRASS5    25
  150 CONTINUE                                                                 GRASS5    26
      M = 0                                                                    GRASS5    27
  160 CONTINUE                                                                 GRASS5    28
      K = DD*DI(1)                                                             GRASS5    29
      IF (K.LT.1) GO TO 170                                                    GRASS5    30
      IF (K.GE.J) GO TO 280                                                    GRASS5    31
      J = K                                                                    GRASS5    32
      DLM = (PT(J+1)*DI(J+1)-PT(J)*DI(J))/(PT(J+1)-PT(J))                      GRASS5    33
      AT = PT(J)*(DI(J)-DLM)                                                   GRASS5    34
      GO TO 180                                                                GRASS5    35
  170 CONTINUE                                                                 GRASS5    36
      M = 1                                                                    GRASS5    37
      AT = 8.314E7*TEMP                                                        GRASS5    38
      DLM = 51.                                                                GRASS5    39
  180 CONTINUE                                                                 GRASS5    40
      IF (HS.EQ.0.0) HS = .001                                                 GRASS5    41
      A3 = GAMMA*2.0E4/HS                                                      GRASS5    42
      A3 = 0.6*A3                                                              GRASS5    43
      A0 = -3.964E-13*DLM*A3*C                                                 GRASS5    44
      A1 = -3.964E-13*(DLM+AT/HS)*C                                            GRASS5    45
      B0 = -A1*A1-A0*A3*A3                                                     GRASS5    46
      B1 = A1*A3-4.*A0                                                         GRASS5    47
      RR = -B0/2.                                                              GRASS5    48
      T = B1*B1*B1/27.                                                         GRASS5    49
      B = RR*RR+T                                                              GRASS5    50
      IF (B) 210,200,190                                                       GRASS5    51
  190 XN = 1./3.                                                               GRASS5    52
      YN = 2.*XN                                                               GRASS5    53
      B = SQRT(B)                                                              GRASS5    54
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```
                U = -B0/((ABS(RR+B))**YN+(ABS(RR-B))**YN+B1/3.)                    GRASS5    55
55              GO TO 220                                                          GRASS5    56
          200   XN = 1./3.                                                         GRASS5    57
                RRA = ABS(RR)                                                      GRASS5    58
                U = RR/RRA*RRA**XN                                                 GRASS5    59
                U = 2.*U                                                           GRASS5    60
60              GO TO 220                                                          GRASS5    61
          210   SA = SQRT(-B1/3.)                                                  GRASS5    62
                U = 2*SA*COS(ACOS(RR/SA**3)/3.)                                    GRASS5    63
          220   CONTINUE                                                           GRASS5    64
                THING = A3/2.*U/2.-A1/2.                                           GRASS5    65
65              IF (A3.LT.0.) GO TO 250                                            GRASS5    66
                IF (THING.LT.0.) GO TO 240                                         GRASS5    67
                IF (U.LT.0.) GO TO 230                                             GRASS5    68
                C1 = U/(A3+SQRT(A3*A3+4.*U))                                       GRASS5    69
                C0 = 2.*A0/(U+SQRT(U*U-4.*A0))                                     GRASS5    70
70              DDD = C1*C1-C0                                                     GRASS5    71
                IF (DDD.LT.0.) GO TO 290                                           GRASS5    72
                R = C1+SQRT(DDD)                                                   GRASS5    73
                GO TO 260                                                          GRASS5    74
          230   CONTINUE                                                           GRASS5    75
75              C1 = U/(A3+SQRT(A3*A3+4.*U))                                       GRASS5    76
                C0 = U/2.-SQRT(U*U/4.-A0)                                          GRASS5    77
                DDD = C1*C1-C0                                                     GRASS5    78
                IF (DDD.LT.0.) GO TO 290                                           GRASS5    79
                R = C0/(C1-SQRT(DDD))                                              GRASS5    80
80              GO TO 260                                                          GRASS5    81
          240   CONTINUE                                                           GRASS5    82
                IF (U.GT.0.) GO TO 290                                             GRASS5    83
                C1 = A3/2.+SQRT(A3*A3/4.+U)                                        GRASS5    84
                C0 = U/2.-SQRT(U*U/4.-A0)                                          GRASS5    85
85              DDD = C1*C1-C0*4.                                                  GRASS5    86
                IF (DDD.LT.0.) GO TO 290                                           GRASS5    87
                R = -2.*C0/(C1+SQRT(DDD))                                          GRASS5    88
                GO TO 260                                                          GRASS5    89
          250   CONTINUE                                                           GRASS5    90
90              IF (THING.GT.0..OR.U.LT.0.) GO TO 290                              GRASS5    91
                C1 = A3/2.-SQRT(A3*A3/4.+U)                                        GRASS5    92
                C0 = U/2.+SQRT(U*U/4.-A0)                                          GRASS5    93
                DDD = C1*C1-C0*4.                                                  GRASS5    94
                IF (DDD.LT.0.) GO TO 100                                           GRASS5    95
95              R = -2.*C0/(C1-SQRT(DDD))                                          GRASS5    96
          260   CONTINUE                                                           GRASS5    97
                DD = 3.964E-13*C/R**3                                              GRASS5    98
                IF (M) 270,160,280                                                 GRASS5    99
          270   CONTINUE                                                           GRASS5   100
100             IF (DD.LT.D(10)) GO TO 150                                         GRASS5   101
          280   RAD(N) = R*1.E-4                                                   GRASS5   102
                IF (RAD(N).LE.0.0) RAD(N) = 2.5E-08                                GRASS5   103
                IF (N.EQ.NMAXB) GO TO 300                                          GRASS5   104
                N = N+1                                                            GRASS5   105
105             C = SAVG(N)                                                        GRASS5   106
                GO TO 180                                                          GRASS5   107
```

```
                290   CONTINUE                                                                  GRASS5   108
                      WRITE (6,310) C,HS,TEMP                                                   GRASS5   109
                300   CONTINUE                                                                  GRASS5   110
    110               RETURN                                                                    GRASS5   111
                C                                                                               GRASS5   112
                310   FORMAT (66H THIS CONDITION NOT EXPECTED OR ACCOUNTED FOR IN SUBROU        GRASS5   113
                     +TINE GRASS5,/39H THE NUMBER OF GAS ATOMS IN A BUBBLE IS,E12.4,/38H       GRASS5   114
                     + THE HYDROSTATIC STRESS IN THE FUEL IS,E12.4,/19H THE TEMPERATURE        GRASS5   115
    115              +IS,E12.4,/)                                                              GRASS5   116
                      END                                                                       GRASS5   117
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GRASS5 1 110

VARIABLES	SN	TYPE		RELOCATION								
644	AT	REAL			REFS	44	DEFINED	23	33	37		
0	AVN	REAL		GR0235	REFS	3						
650	A0	REAL			REFS	45	46	2*69	76	84	92	
					DEFINED	43						
651	A1	REAL			REFS	2*45	46	64	DEFINED	44		
647	A3	REAL			REFS	42	43	2*45	46	64	65	3*68
					3*75	3*83	3*91	DEFINED	41	42		
656	B	REAL			REFS	50	53	2*54	DEFINED	49	53	
37	B1	REAL	ARRAY	BDGR5	REFS	2	16					
652	B0	REAL			REFS	47	54	DEFINED	45			
653	B1	REAL			REFS	3*48	54	61	DEFINED	46		
637	C	REAL			REFS	12	43	44	97	108		
					DEFINED	11	21	105				
666	C0	REAL			REFS	70	77	79	85	87	93	95
					DEFINED	69	76	84	92			
665	C1	REAL			REFS	2*70	72	2*77	79	2*85	87	2*93
					95	DEFINED	68	75	83	91		
1	D	REAL	ARRAY	BDGR5	REFS	2	100					
646	DD	REAL			REFS	28	100	DEFINED	97			
667	DDD	REAL			REFS	71	72	78	79	86	87	94
					95	DEFINED	70	77	85	93		
13	D1	REAL	ARRAY	BDGR5	REFS	2	23	28	2*32	33		
0	DL1	REAL		BDGR5	REFS	2	22					
643	DLM	REAL			REFS	23	33	43	44	DEFINED	22	32
					38							
0	GAMMA	REAL		F.P.	REFS	12	41	DEFINED	1			
1	GASIN	REAL		GR0235	REFS	3						
0	HS	REAL		F.P.	REFS	40	41	44	108	DEFINED	1	40
641	J	INTEGER			REFS	3*16	30	6*32	2*33	DEFINED	15	20
					31							
33	JNCDI	INTEGER		GR0235	REFS	3						
34	JNCGBI	INTEGER		GR0235	REFS	3						

```
VARIABLES     SN  TYPE          RELOCATION
   26  J5         INTEGER       GR0235    REFS        3
  645  K          INTEGER                 REFS       29      30      31   DEFINED      28
    0  KF         INTEGER   *UNUSED   F.P.  DEFINED    -1
   27  K5         INTEGER       GR0235    REFS        3
  642  M          INTEGER                 REFS       98  DEFINED      18      26      36
  636  N          INTEGER                 REFS        9      11      12     101  2*102     103     104
                                          105  DEFINED      10      19     104
   31  NCDI       INTEGER       GR0235    REFS        3
   32  NCGBI      INTEGER       GR0235    REFS        3
    0  NF         INTEGER   *UNUSED   F.P.  DEFINED    -1
   30  NMAXB      INTEGER       GR0235    REFS        3      10     103
   35  NMAXG      INTEGER       GR0235    REFS        3
   51  NOPT       INTEGER       BDGR5     REFS        2       6
   36  NXBD       INTEGER       GR0235    REFS        3
   37  NXBDG      INTEGER       GR0235    REFS        3
  635  NO         INTEGER                 REFS       10  DEFINED       7       9
  671  PT         REAL      ARRAY         REFS        5      23    4*32      33  DEFINED      16
  670  R          REAL                    REFS       97     101  DEFINED      72      79      87      95
   40  RAD        REAL      ARRAY   GR0235  REFS        3       5     102  DEFINED      12     101     102
  654  RR         REAL                    REFS     2*49    2*54      57      58      62
                                       DEFINED       47
  662  RRA        REAL                    REFS     2*58  DEFINED      57
  663  SA         REAL                    REFS     2*62  DEFINED      61
    2  SAVG       REAL      ARRAY   GR0235  REFS        3       5      11      21     105
   25  SL         REAL      ARRAY   BDGR5   REFS        2      16
  655  T          REAL                    REFS       49  DEFINED      48
    0  TEMP       REAL              F.P.  REFS       12      14      37     108  DEFINED       1
  664  THING      REAL                    REFS       66      90  DEFINED      64
  640  TR         REAL                    REFS       16  DEFINED      14
  661  U          REAL                    REFS       59      64      67    2*68    3*69    2*75    3*76
                                          82      83    3*84      90      91    3*92
                                       DEFINED       54      58      59      62
   65  VOLUME     REAL            GR0235    REFS        3
  657  XN         REAL                    REFS       52      58  DEFINED      51      56
  660  YN         REAL                    REFS     2*54  DEFINED      52

FILE NAMES       MODE
     TAPE6       FMT                 WRITES      108

EXTERNALS          TYPE   ARGS       REFERENCES
     ACOS          REAL     1 LIBRARY     62
     COS           REAL     1 LIBRARY     62
     SQRT          REAL     1 LIBRARY     12      53      61      68      69      72      75      76      79
                                          83      84      87      91      92      95

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE  REFERENCES
     ABS           REAL     1  INTRIN             2*54      57

STATEMENT LABELS              DEF LINE   REFERENCES
   16  100                        9         94
   21  110                       10          8
    0  120                       12         10
   43  130                       14          6
```

STATEMENT LABELS			DEF LINE	REFERENCES			
0	140		17	15			
76	150		25	100			
101	160		27	98			
130	170		35	29			
140	180		39	24	34	106	
0	190	INACTIVE	51	50			
236	200		56	50			
253	210		61	50			
273	220		63	55	60		
341	230		74	67			
375	240		81	66			
434	250		89	65			
473	260		96	73	80	88	
0	270	INACTIVE	99	98			
505	280		101	30	98		
526	290		107	71	78	82	86	90
531	300		109	13	103		
564	310	FMT	112	108			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
23	120	N	10 12	16B	EXT REFS
47	140	J	15 17	7B	INSTACK

COMMON BLOCKS	LENGTH
BDGR5	42
GR0235	54

STATISTICS

PROGRAM LENGTH	706B	454
SCM LABELED COMMON LENGTH	140B	96

140000B SCM USED

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      SUBROUTINE GRASS6 (AGRASS,NWORDS)                                  GRASS6     2
      DIMENSION AGRASS(NWORDS)                                           GRASS6     3
      COMMON/GRSPTR/IAGRASS(38)                                          GRASS6     4
      COMMON/GRHOLD/TIT,GRT                                              GRASS6     5
      COMMON /BDG02D/ Z1(11)                                             GRASS6     6
      COMMON /BDGR/   Z2(21)                                             GRASS6     7
      COMMON /BDGR2/  Z3(54)                                             GRASS6     8
      COMMON /BDGR4/  Z4(1069)                                           GRASS6     9
      COMMON /BDGR5/  Z5(42)                                             GRASS6    10
      COMMON /GR0235/ Z6(54)                                             GRASS6    11
      COMMON /GTWOLC/ Z7(31)                                             GRASS6    12
      COMMON /GR2A3/ Z8(1726)                                            GRASS6    13
      COMMON /GR2A4/ Z9(144)                                             GRASS6    14
      READ (3) IAGRASS,AGRASS,TIT,GRT                                    GRASS6    15
      READ (3) Z1                                                        GRASS6    16
      READ (3) Z2                                                        GRASS6    17
      READ (3) Z3                                                        GRASS6    18
      READ (3) Z4                                                        GRASS6    19
      READ (3) Z5                                                        GRASS6    20
      READ (3) Z6                                                        GRASS6    21
      READ (3) Z7                                                        GRASS6    22
      READ (3) Z8                                                        GRASS6    23
      READ (3) Z9                                                        GRASS6    24
      WRITE (6,100) TIT,GRT                                              GRASS6    25
      IF (TIT.NE.20.5E05) RETURN                                         GRASS6    26
      WRITE (6,110) Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9                           GRASS6    27
      RETURN                                                             GRASS6    28
C                                                                        GRASS6    29
100   FORMAT (1X,"WRITEOUT",2E13.4)                                      GRASS6    30
110   FORMAT (1X,5E13.4)                                                 GRASS6    31
      END                                                                GRASS6    32
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

	DEF LINE	REFERENCES
4 GRASS6	1	25 27

VARIABLES

	SN	TYPE		RELOCATION							
0	AGRASS	REAL	ARRAY	F.P.	REFS	2	DEFINED	1	14		
1	GRT	REAL		GRHOLD	REFS	4	24	DEFINED	14		
0	IAGRASS	INTEGER	ARRAY	GRSPTR	REFS	3	DEFINED	14			
0	NWORDS	INTEGER		F.P.	REFS	2	DEFINED	1			
0	TIT	REAL		GRHOLD	REFS	4	24	25	DEFINED	14	
0	Z1	REAL	ARRAY	BDG02D	REFS	5	26	DEFINED	15		
0	Z2	REAL	ARRAY	BDGR	REFS	6	26	DEFINED	16		
0	Z3	REAL	ARRAY	BDGR2	REFS	7	26	DEFINED	17		
0	Z4	REAL	ARRAY	BDGR4	REFS	8	26	DEFINED	18		
0	Z5	REAL	ARRAY	BDGR5	REFS	9	26	DEFINED	19		
0	Z6	REAL	ARRAY	GR0235	REFS	10	26	DEFINED	20		

```
VARIABLES     SN  TYPE          RELOCATION
    0  Z7         REAL      ARRAY    GTWOLC      REFS      11      26    DEFINED      21
    0  Z8         REAL      ARRAY    GR2A3       REFS      12      26    DEFINED      22
    0  Z9         REAL      ARRAY    GR2A4       REFS      13      26    DEFINED      23

FILE NAMES        MODE
       TAPE3      UNFMT                    READS      14      15      16      17      18      19      20      21
                                             22      23
       TAPE6      FMT                      WRITES     24      26

STATEMENT LABELS              DEF LINE   REFERENCES
  142  100      FMT               29         24
  146  110      FMT               30         26

COMMON BLOCKS   LENGTH
       GRSPTR       38
       GRHOLD        2
       BDG02D       11
       BDGR         21
       BDGR2        54
       BDGR4      1069
       BDGR5        42
       GR0235       54
       GTWOLC       31
       GR2A3      1726
       GR2A4       144

STATISTICS
  PROGRAM LENGTH                  1518     105
  SCM LABELED COMMON LENGTH       6170B   3192
        140000B SCM USED
```

```
      SUBROUTINE GRASS7 (AGRASS,NWORDS)                                  GRASS7     2
      DIMENSION AGRASS(NWORDS)                                           GRASS7     3
      COMMON /GRSPTR/IAGRASS(38)                                         GRASS7     4
      COMMON/GRHOLD/TIT,GRT                                              GRASS7     5
      COMMON /BDG02D/ Z1(11)                                             GRASS7     6
      COMMON /BDGR/   Z2(21)                                             GRASS7     7
      COMMON /BDGR2/  Z3(54)                                             GRASS7     8
      COMMON /BDGR4/  Z4(1069)                                           GRASS7     9
      COMMON /BDGR5/  Z5(42)                                             GRASS7    10
      COMMON /GR0235/ Z6(54)                                             GRASS7    11
      COMMON /GTWOLC/ Z7(31)                                             GRASS7    12
      COMMON /GR2A3/ Z8(1726)                                            GRASS7    13
      COMMON /GR2A4/ Z9(144)                                             GRASS7    14
      WRITE (2) IAGRASS,AGRASS,TIT,GRT                                   GRASS7    15
      WRITE (2) Z1                                                       GRASS7    16
      WRITE (2) Z2                                                       GRASS7    17
      WRITE (2) Z3                                                       GRASS7    18
      WRITE (2) Z4                                                       GRASS7    19
      WRITE (2) Z5                                                       GRASS7    20
      WRITE (2) Z6                                                       GRASS7    21
      WRITE (2) Z7                                                       GRASS7    22
      WRITE (2) Z8                                                       GRASS7    23
      WRITE (2) Z9                                                       GRASS7    24
      WRITE (6,100) TIT,GRT                                              GRASS7    25
      IF (TIT.EQ.20.5E05) WRITE (6,110) Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9       GRASS7    26
      RETURN                                                             GRASS7    27
C                                                                        GRASS7    28
100   FORMAT (1X,"WRITEOUT",2E13.4)                                      GRASS7    29
110   FORMAT (1X,5E13.4)                                                 GRASS7    30
      END                                                                GRASS7    31
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	GRASS7	1	26

VARIABLES	SN	TYPE		RELOCATION						
0	AGRASS	REAL	ARRAY	F.P.	REFS	2	14	DEFINED	1	
1	GRT	REAL		GRHOLD	REFS	4	14	24		
0	IAGRASS	INTEGER	ARRAY	GRSPTR	REFS	3	14			
0	NWORDS	INTEGER		F.P.	REFS	2	DEFINED	1		
0	TIT	REAL		GRHOLD	REFS	4	14	24	25	
0	Z1	REAL	ARRAY	BDG02D	REFS	5	15	25		
0	Z2	REAL	ARRAY	BDGR	REFS	6	16	25		
0	Z3	REAL	ARRAY	BDGR2	REFS	7	17	25		
0	Z4	REAL	ARRAY	BDGR4	REFS	8	16	25		
0	Z5	REAL	ARRAY	BDGR5	REFS	9	19	25		
0	Z6	REAL	ARRAY	GR0235	REFS	10	20	25		
0	Z7	REAL	ARRAY	GTWOLC	REFS	11	21	25		

VARIABLES	SN	TYPE	RELOCATION					
0	Z8	REAL	ARRAY	GR2A3	REFS	12	22	25
0	Z9	REAL	ARRAY	GR2A4	REFS	13	23	25

FILE NAMES	MODE							
TAPE2	UNFMT	WRITES	14	15	16	17	18	19	20	21
		22	23							
TAPE6	FMT	WRITES	24	25						

STATEMENT LABELS			DEF LINE	REFERENCES
127	100	FMT	28	24
133	110	FMT	29	25

COMMON BLOCKS	LENGTH
GRSPTR	38
GRHOLD	2
BDG02D	11
BDGR	21
BDGR2	54
BDGR4	1069
BDGR5	42
GR0235	54
GTWOLC	31
GR2A3	1726
GR2A4	144

STATISTICS

PROGRAM LENGTH	136B	94
SCM LABELED COMMON LENGTH	6170B	3192

140000B SCM USED

```
      C   GRASS8 -COMMON DATA                                                  GRASS8      2
            BLOCK DATA                                                         GRASS8      3
            COMMON/BDG02D/                                                     GRASS8      4
           +TGASIN.TGASR,EPSI,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02,               GRASS8      5
      5    +RM,TS0                                                            GRASS8      6
            COMMON/BDGR/A1,R9,FPWS,NAME(4),RHOOLD,TCONV,PDSC,PI43,BCF,C01,     GRASS8      7
           +BKLO,BKHI,CPOW,SIGPI,FGPF,BVCRIT,GRF0,PTPL                         GRASS8      8
            COMMON/BDGR2/FFDSLC,ATMVOL,BOLTZ,G1,G2,                            GRASS8      9
           +AVNUM,RG,DELHV,TPG,GBS02P,SIG,WM1,WM2,XK,XKF,GBR,                  GRASS8     10
     10    +QSSTAR,QS,DZERO,PZERO,FN,ACON,DELTA,REDIS,RESCON.DVOL,EVL,         GRASS8     11
           +DVOG,EVG,ALFA,BEVK,BADC1,BADC2,BADC3,BADC4,BADC5,BADC6,            GRASS8     12
           +GBADC1,GBADC2,FAWGE,ASTAR,NOYES(2),GBADC3,A(9),DLIM                GRASS8     13
            COMMON/BDGR4/DT(81,13),DD(13),HMIN,CRT,JM                          GRASS8     14
            COMMON/BDGR5/DLI,D(10),DI(10),SL(10),BI(10),NOPT                   GRASS8     15
     15     COMMON /VER/ VERS                                                  GRASS8     16
      C                                                                        GRASS8     17
            DATA A/-57.364866,-7.0264645,.52281105,                            GRASS8     18
           +1.9840863E5,2.9969484E4,-2.07175E3,                                GRASS8     19
           +-1.4947535E8,-3.0994649E7,2.0330.26E6/                             GRASS8     20
     20     DATA A1/2.09E7/                                                    GRASS8     21
            DATA ACON/2.37/                                                    GRASS8     22
            DATA ALFA/0.0/                                                     GRASS8     23
            DATA ASTAR/0.907/                                                  GRASS8     24
            DATA ATMVOL/4.09E-23/                                              GRASS8     25
     25     DATA AVNUM/6.024E23/                                               GRASS8     26
            DATA BADC1/6.732E-11/                                              GRASS8     27
            DATA BADC2/91000./                                                 GRASS8     28
            DATA BADC3/2.00E-29/                                               GRASS8     29
            DATA BADC4/0.0/                                                    GRASS8     30
     30     DATA BADC5/1.62/                                                   GRASS8     31
            DATA BADC6/4084./                                                  GRASS8     32
            DATA BCF/.20/                                                      GRASS8     33
            DATA BEVK/8.625E-05/                                               GRASS8     34
            DATA BI/-1.203475E07,-4.687770E07,-1.032119E08,-1.807985E08,       GRASS8     35
     35    +-2.782098E08,-3.936497E08,-5.213507E08,-6.494966E08,-7.642163E08,  GRASS8     36
           +-8.330086E08/                                                      GRASS8     37
            DATA BKHI/5.0/                                                     GRASS8     38
            DATA BKLO/2.0/                                                     GRASS8     39
            DATA BOLTZ/1.38E-16/                                               GRASS8     40
     40     DATA BVCRIT/.05/                                                   GRASS8     41
            DATA C01/0.0/                                                      GRASS8     42
            DATA CPOW/32.8084/                                                 GRASS8     43
            DATA CRT/.01/                                                      GRASS8     44
            DATA D/1.709134E-3,3.418267E-3,5.127398E-3,0.683653E-2,            GRASS8     45
     45    +8.545665E-3,1.025480E-2,1.196394E-2,1.367307E-2,1.538220E-2,       GRASS8     46
           +1.709134E-2/                                                       GRASS8     47
            DATA DD/13*0./                                                     GRASS8     48
            DATA DI/585.0918,292.5457,195.0307,146.2730,117.0184,97.51531,     GRASS8     49
           +83.58456,73.13648,65.01020,58.50918/                               GRASS8     50
     50     DATA DELTA/50.E-08/                                                GRASS8     51
            DATA DELHV/5.96E12/                                                GRASS8     52
            DATA DLI/32.95967/                                                 GRASS8     53
            DATA DLIM/-180.0/                                                  GRASS8     54
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```
                      DATA DT/1053*0./                                          GRASS8     55
55                    DATA DVOG/.001/                                           GRASS8     56
                      DATA DVOL/.01/                                            GRASS8     57
                      DATA DZERO/57.E4/                                         GRASS8     58
                      DATA EPSI/1.E14/                                          GRASS8     59
                      DATA EVG/1.2/                                             GRASS8     60
60                    DATA EVL/4.8/                                             GRASS8     61
                      DATA FAWGE/14.0/                                          GRASS8     62
                      DATA FFDSLC/10./                                          GRASS8     63
                      DATA FGPF/.310/                                           GRASS8     64
                      DATA FN/.90E-05/                                          GRASS8     65
65                    DATA FPWS/3.1E10/                                         GRASS8     66
                      DATA G1/1509./                                            GRASS8     67
                      DATA G2/.3459/                                            GRASS8     68
                      DATA GBADC1/4.43E-18/                                     GRASS8     69
                      DATA GBADC2/32000./                                       GRASS8     70
70                    DATA GBADC3/65.42/                                        GRASS8     71
                      DATA GBR/.002/                                            GRASS8     72
                      DATA GRF0/0.0/                                            GRASS8     73
                      DATA GBSO2P/1.43E-4/                                      GRASS8     74
                      DATA HMIN/.0001/                                          GRASS8     75
75                    DATA JFIRST/0/                                            GRASS8     76
                      DATA JM/6/                                                GRASS8     77
                      DATA KFIRST/0/                                            GRASS8     78
                      DATA KPRINT/2/                                            GRASS8     79
                      DATA NAME/4HBULK,4HDSLC,4HGBDY,4HMCRO/                    GRASS8     80
80                    DATA NMAX/20/                                             GRASS8     81
                      DATA NOPT/1/                                              GRASS8     82
                      DATA NOYES/4H  NO,4H YES/                                 GRASS8     83
                      DATA PDSC/68948.06/                                       GRASS8     84
                      DATA PI/3.141593/                                         GRASS8     85
85                    DATA PI43/4.188791/                                       GRASS8     86
                      DATA PTPL/.08/                                            GRASS8     87
                      DATA PZERO/1.64E14/                                       GRASS8     88
                      DATA Q5/4.52E12/                                          GRASS8     89
                      DATA Q5STAR/.69466E-11/                                   GRASS8     90
90                    DATA R9/73.592/                                           GRASS8     91
                      DATA REDIS/50.E-8/                                        GRASS8     92
                      DATA RESCON/1.0E-18/                                      GRASS8     93
                      DATA RG/8.31E7/                                           GRASS8     94
                      DATA RHOOLD/1.000/                                        GRASS8     95
95                    DATA RM/10./                                              GRASS8     96
                      DATA SIG/3.E-8/                                           GRASS8     97
                      DATA SIGPI/.03/                                           GRASS8     98
                      DATA SL/4.608549E07,1.023236E08,1.703004E08,2.526030E08,  GRASS8     99
                     +3.521856E08,4.731108E08,6.194947E08,7.952701E08,1.006582E09,GRASS8    100
100                  +1.255744E09/                                             GRASS8    101
                      DATA TCONV/1.000/                                         GRASS8    102
                      DATA TGASIN/0./                                           GRASS8    103
                      DATA TGASR/0./                                            GRASS8    104
                      DATA TPG/8.57024E06/                                      GRASS8    105
105                   DATA TS0/0.0/                                             GRASS8    106
                      DATA TS02/0./                                             GRASS8    107
```

```
                    DATA  VERS / 4HGRA5 /                                    GRA558    108
                    DATA WM1/270./                                           GRA558    109
                    DATA WM2/132./                                           GRA558    110
110                 DATA XK/1./                                              GRA558    111
                    DATA XKP/1./                                             GRA558    112
                    END                                                      GRA558    113
```

SYMBOLIC REFERENCE MAP (R=2)

VARIABLES	SN	TYPE	RELOCATION						
54	A	REAL	ARRAY	BDGR2	REFS	8	DEFINED	17	
25	ACON	REAL		BDGR2	REFS	8	DEFINED	21	
35	ALFA	REAL		BDGR2	REFS	8	DEFINED	22	
50	ASTAR	REAL		BDGR2	REFS	8	DEFINED	23	
1	ATMVOL	REAL		BDGR2	REFS	8	DEFINED	24	
5	AVNUM	REAL		BDGR2	REFS	8	DEFINED	25	
0	A1	REAL		BDGR	REFS	6	DEFINED	20	
37	BADC1	REAL		BDGR2	REFS	8	DEFINED	26	
40	BADC2	REAL		BDGR2	REFS	8	DEFINED	27	
41	BADC3	REAL		BDGR2	REFS	8	DEFINED	28	
42	BADC4	REAL		BDGR2	REFS	8	DEFINED	29	
43	BADC5	REAL		BDGR2	REFS	8	DEFINED	30	
44	BADC6	REAL		BDGR2	REFS	8	DEFINED	31	
13	BCF	REAL		BDGR	REFS	6	DEFINED	32	
36	BEVK	REAL		BDGR2	REFS	8	DEFINED	33	
37	BI	REAL	ARRAY	BDGR5	REFS	14	DEFINED	34	
16	BKHI	REAL		BDGR	REFS	6	DEFINED	37	
15	BKLO	REAL		BDGR	REFS	6	DEFINED	38	
2	BOLTZ	REAL		BDGR2	REFS	8	DEFINED	39	
22	BVCRIT	REAL		BDGR	REFS	6	DEFINED	40	
17	CPOW	REAL		BDGR	REFS	6	DEFINED	42	
2053	CRT	REAL		BDGR4	REFS	13	DEFINED	43	
14	CO1	REAL		BDGR	REFS	6	DEFINED	41	
1	D	REAL	ARRAY	BDGR5	REFS	14	DEFINED	44	
2035	DD	REAL	ARRAY	BDGR4	REFS	13	DEFINED	47	
7	DELHV	REAL		BDGR2	REFS	8	DEFINED	51	
26	DELTA	REAL		BDGR2	REFS	8	DEFINED	50	
13	DI	REAL	ARRAY	BDGR5	REFS	14	DEFINED	48	
0	DLI	REAL		BDGR5	REFS	14	DEFINED	52	
65	DLIM	REAL		BDGR2	REFS	8	DEFINED	53	
0	DT	REAL	ARRAY	BDGR4	REFS	13	DEFINED	54	
33	DVDS	REAL		BDGR2	REFS	8	DEFINED	55	
31	DVOL	REAL		BDGR2	REFS	8	DEFINED	56	
22	DZERO	REAL		BDGR2	REFS	8	DEFINED	57	
2	EPSI	REAL		BDG02D	REFS	3	DEFINED	58	
34	EVG	REAL		BDGR2	REFS	8	DEFINED	59	
32	EVL	REAL		BDGR2	REFS	8	DEFINED	60	
47	FAWGE	REAL		BDGR2	REFS	8	DEFINED	61	
0	FFDSLC	REAL		BDGR2	REFS	8	DEFINED	62	

VARIABLES	SN	TYPE		RELOCATION				
21	FGPF	REAL		BDGR	REFS	6	DEFINED	63
24	FN	REAL		BDGR2	REFS	8	DEFINED	64
2	FPWS	REAL		BDGR	REFS	6	DEFINED	65
45	GBADC1	REAL		BDGR2	REFS	8	DEFINED	68
46	GBADC2	REAL		BDGR2	REFS	8	DEFINED	69
53	GBADC3	REAL		BDGR2	REFS	8	DEFINED	70
17	GBR	REAL		BDGR2	REFS	8	DEFINED	71
11	GBSO2P	REAL		BDGR2	REFS	8	DEFINED	73
23	GRF0	REAL		BDGR	REFS	6	DEFINED	72
3	G1	REAL		BDGR2	REFS	8	DEFINED	66
4	G2	REAL		BDGR2	REFS	8	DEFINED	67
2052	HMIN	REAL		BDGR4	REFS	13	DEFINED	74
4	JFIRST	INTEGER		BDG02D	REFS	3	DEFINED	75
2054	JM	INTEGER		BDGR4	REFS	13	DEFINED	76
5	KFIRST	INTEGER		BDG02D	REFS	3	DEFINED	77
6	KPRINT	INTEGER		BDG02D	REFS	3	DEFINED	78
3	NAME	INTEGER	ARRAY	BDGR	REFS	6	DEFINED	79
7	NMAX	INTEGER		BDG02D	REFS	3	DEFINED	80
51	NOPT	INTEGER		BDGR5	REFS	14	DEFINED	81
51	NOYES	INTEGER	ARRAY	BDGR2	REFS	8	DEFINED	82
11	PDSC	REAL		BDGR	REFS	6	DEFINED	83
3	PI	REAL		BDG02D	REFS	3	DEFINED	84
12	PI43	REAL		BDGR	REFS	6	DEFINED	85
24	PTPL	REAL		BDGR	REFS	6	DEFINED	86
23	PZERO	REAL		BDGR2	REFS	8	DEFINED	87
21	QS	REAL		BDGR2	REFS	8	DEFINED	88
20	QSSTAR	REAL		BDGR2	REFS	8	DEFINED	89
27	REDIS	REAL		BDGR2	REFS	8	DEFINED	91
30	RESCON	REAL		BDGR2	REFS	8	DEFINED	92
6	RG	REAL		BDGR2	REFS	8	DEFINED	93
7	RHOOLD	REAL		BDGR	REFS	6	DEFINED	94
11	RM	REAL		BDG02D	REFS	3	DEFINED	95
1	R9	REAL		BDGR	REFS	6	DEFINED	90
12	SIG	REAL		BDGR2	REFS	8	DEFINED	96
20	SIGPI	REAL		BDGR	REFS	6	DEFINED	97
25	SL	REAL	ARRAY	BDGR5	REFS	14	DEFINED	98
10	TCONV	REAL		BDGR	REFS	6	DEFINED	101
0	TGASIN	REAL		BDG02D	REFS	3	DEFINED	102
1	TGASR	REAL		BDG02D	REFS	3	DEFINED	103
10	TPG	REAL		BDGR2	REFS	8	DEFINED	104
12	TSO	REAL		BDG02D	REFS	3	DEFINED	105
10	TSO2	REAL		BDG02D	REFS	3	DEFINED	106
0	VERS	REAL		VER	REFS	15	DEFINED	107
13	WM1	REAL		BDGR2	REFS	8	DEFINED	108
14	WM2	REAL		BDGR2	REFS	8	DEFINED	109
15	XK	REAL		BDGR2	REFS	8	DEFINED	110
16	XKP	REAL		BDGR2	REFS	8	DEFINED	111

COMMON BLOCKS	LENGTH
BDG02D	11
BDGR	21
BDGR2	54
BDGR4	1069

```
COMMON BLOCKS   LENGTH
       BDGRS        42
       VER           1

STATISTICS
  PROGRAM LENGTH                    0B      0
  SCM LABELED COMMON LENGTH      2256B   1198
        1400008 SCM USED
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```
      SUBROUTINE GRASS9 (NF,KF,NWORDS,LENGTH)                                  GRASS9     2
C                                                                              GRASS9     3
C     *******                                                                  GRASS9     4
C     GRASS9 IS CALLED FROM SUBROUTINE POINTR                                  GRASS9     5
C     SUBROUTINE TO COMPUTE LOCATION OF NODALLY DEPENDENT VARIABLES            GRASS9     6
C     USED IN GRASS                                                            GRASS9     7
C                                                                              GRASS9     8
C     LENGTH = LENGTH OF FROCON A ARRAY                                        GRASS9     9
C     NF = NUMBER OF AXIAL NODES  --  INPUT                                    GRASS9    10
C     KF = NUMBER OF RADIAL RINGS  --  INPUT                                   GRASS9    11
C     NJ = NUMBER OF AXIAL VARIABLES                                           GRASS9    12
C     NK = NUMBER OF RADIAL VARIABLES                                          GRASS9    13
C     NJK = NUMBER OF AXIAL,RADIAL VARIABLES                                   GRASS9    14
C     NKN = NUMBER OF RADIAL,BUBBLE VARIABLES                                  GRASS9    15
C     NJKN = NUMBER OF AXIAL,RADIAL,BUBBLE VARIABLES                           GRASS9    16
C     NVAR = TOTAL NUMBER OF VARIABLES IN AGRASS                               GRASS9    17
C     NWORDS = TOTAL NUMBER OF WORDS NEEDED FOR AGRASS ARRAY  --  OUTPUT       GRASS9    18
C                                                                              GRASS9    19
C     THE FOLLOWING VARIABLES ARE IN THE AGRASS ARRAY                          GRASS9    20
C     NVAR1=BVS(NF)      NVAR14=GASGEN(NF,KF)     NVAR28=RS(NF,KF)            GRASS9    21
C     NVAR2=GR(NF)       NVAR15=GESWF(NF,KF)      NVAR29=TFO(NF,KF)           GRASS9    22
C     NVAR3=POW(NF)      NVAR16=GIP(NF,KF)        NVAR30=TK(NF,KF)            GRASS9    23
C     NVAR4=RGTJ(NF)     NVAR17=GOUT(NF,KF)       NVAR31=TKOLD(NF,KF)         GRASS9    24
C     NVAR5=FDP(KF)      NVAR18=GRSIZ(NF,KF)      NVAR32=TS(NF,KF1)           GRASS9    25
C     NVAR6=FODSLC(KF)   NVAR19=GS(NF,KF)         NVAR33=BLKMGO(KF,20)        GRASS9    26
C     NVAR7=FOGBDY(KF)   NVAR20=HH(NF,KF)         NVAR34=GBYMGO(KF,20)        GRASS9    27
C     NVAR8=PRF(KF)      NVAR21=HOLD(NF,KF)       NVAR35=BULK(NF,KF,20)       GRASS9    28
C     NVAR9=RHODSL(KF)   NVAR22=NMAXBK(NF,KF)     NVAR36=DSLC(NF,KF,20)       GRASS9    29
C     NVAR10=TAUA(KF1)   NVAR23=POROS(NF,KF)      NVAR37=GBDY(NF,KF,20)       GRASS9    30
C     NVAR11=TGRAD(KF)   NVAR24=PRFOLD(NF,KF)                                  GRASS9    31
C     NVAR12=BV(NF,KF)   NVAR25=FRSO(NF,KF)                                    GRASS9    32
C     NVAR13=CO(NF,KF)   NVAR26=RH(NF,KF)                                      GRASS9    33
C     NVAR27=RHOLD(NF,KF)                                                      GRASS9    34
C     *******                                                                  GRASS9    35
C                                                                              GRASS9    36
      COMMON /GRSPTR/ IAGRAS(38)                                               GRASS9    37
C                                                                              GRASS9    38
      NJ = 4                                                                   GRASS9    39
      NK = 7                                                                   GRASS9    40
      NJK = 21                                                                 GRASS9    41
      NKN = 2                                                                  GRASS9    42
      NJKN = 3                                                                 GRASS9    43
      NBBLE = 20                                                               GRASS9    44
C                                                                              GRASS9    45
C     CALCULATIONS INVOLVING RS, TS, AND TAUA REQUIRE AN ADDITIONAL            GRASS9    46
C     RADIAL ELEMENT IN EACH ARRAY                                             GRASS9    47
C                                                                              GRASS9    48
      NWORDS = NJ*NF+NK*KF+1+NJK*NF*KF+(2*NF)+NKN*KF*NBBLE+NJKN*NF*KF*NB       GRASS9    49
     +BLE                                                                      GRASS9    50
      NVAR = NJ+NK+NJK+NKN+NJKN                                                GRASS9    51
C                                                                              GRASS9    52
      IAGRAS(1) = 1                                                            GRASS9    53
      NBEG = 2                                                                 GRASS9    54
```

```
      NEND = NJ+1                                                        GRASS9     55
      DO 100 I=NBEG,NEND                                                 GRASS9     56
100   IAGRAS(I) = IAGRAS(I-1)+NF                                         GRASS9     57
      NBEG = NEND+1                                                      GRASS9     58
      NEND = NEND+NK                                                     GRASS9     59
C                                                                        GRASS9     60
C     INCREASE NUMBER OF RADIAL ELEMENTS IN TAUA BY ONE                  GRASS9     61
C                                                                        GRASS9     62
      DO 110 I=NBEG,NEND                                                 GRASS9     63
      IAGRAS(I) = IAGRAS(I-1)+KF                                         GRASS9     64
110   IF (I.EQ.11) IAGRAS(I) = IAGRAS(I)+1                               GRASS9     65
      NBEG = NEND+1                                                      GRASS9     66
      NEND = NEND+NJK                                                    GRASS9     67
C                                                                        GRASS9     68
C     INCREASE NUMBER OF RADIAL ELEMENTS IN TS AND RS BY ONE FOR EACH    GRASS9     69
C     AXIAL NODE                                                         GRASS9     70
C                                                                        GRASS9     71
      DO 120 I=NBEG,NEND                                                 GRASS9     72
      IAGRAS(I) = IAGRAS(I-1)+NF*KF                                      GRASS9     73
      IF (I.EQ.29.OR.I.EQ.33) IAGRAS(I) = IAGRAS(I)+NF                   GRASS9     74
120   CONTINUE                                                           GRASS9     75
      NBEG = NEND+1                                                      GRASS9     76
      NEND = NEND+NKN                                                    GRASS9     77
      DO 130 I=NBEG,NEND                                                 GRASS9     78
130   IAGRAS(I) = IAGRAS(I-1)+KF*NBBLE                                   GRASS9     79
      NBEG = NEND+1                                                      GRASS9     80
      NEND = NVAR                                                        GRASS9     81
      DO 140 I=NBEG,NVAR                                                 GRASS9     82
140   IAGRAS(I) = IAGRAS(I-1)+NF*KF*NBBLE                                GRASS9     83
C                                                                        GRASS9     84
C     POSITION AGRASS ARRAY AT END OF FRPCON A ARRAY                     GRASS9     85
C                                                                        GRASS9     86
      DO 150 I=1,NVAR                                                    GRASS9     87
150   AGRAS(I) = IAGRAS(I)+LENGTH                                        GRASS9     88
      WRITE (6,160) (I,IAGRAS(I),I=1,NVAR)                               GRASS9     89
      WRITE (6,170) NWORDS                                               GRASS9     90
      RETURN                                                             GRASS9     91
C                                                                        GRASS9     92
160   FORMAT (1X,I5,1X,I5)                                               GRASS9     93
170   FORMAT (1X,"NWORDS I5",I10)                                        GRASS9     94
      END                                                                GRASS9     95
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 GRASS9	1	90

VARIABLES	SN	TYPE	RELOCATION									
241	I	INTEGER			REFS	2*56	2*63	3*64	2*72	4*73	2*78	2*82
						2*87	2*88	DEFINED	55	62	71	77	81
						86	88					
0	IAGRAS	INTEGER	ARRAY	GRSPTR	REFS	36	56	63	64	72	73	78
						82	87	88	DEFINED	52	58	63	64
						72	73	78	82	87		
0	KF	INTEGER		F.P.	REFS	4*48	63	72	78	82		
					DEFINED	1						
0	LENGTH	INTEGER		F.P.	REFS	87	DEFINED	1				
235	NBBLE	INTEGER			REFS	2*[illegible]	78	82	DEFINED	43		
237	NBEG	INTEGER			REFS	55	62	71	77	81		
					DEFINED	53	57	65	75	79		
240	NEND	INTEGER			REFS	55	57	58	62	65	66	71
						75	76	77	79	DEFINED	54	58	66
						76	80					
0	NF	INTEGER		F.P.	REFS	4*48	56	72	73	82		
					DEFINED	1						
230	NJ	INTEGER			REFS	48	50	54	DEFINED	38		
232	NJK	INTEGER			REFS	48	50	66	DEFINED	40		
234	NJKN	INTEGER			REFS	48	50	DEFINED	42			
231	NK	INTEGER			REFS	48	50	58	DEFINED	39		
233	NKN	INTEGER			REFS	48	50	76	DEFINED	41		
236	NVAR	INTEGER			REFS	80	81	86	88	DEFINED	50	
0	NWORDS	INTEGER		F.P.	REFS	89	DEFINED	1	48			

FILE NAMES	MODE			
TAPE6	FMT	WRITES	68	89

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		56	55
0	110		64	62
0	120		74	71
0	130		78	77
0	140		82	81
0	150		87	86
222	160	FMT	92	88
225	170	FMT	93	89

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
54	100	I	55 56	5B	INSTACK
70	110	I	62 64	12B	INSTACK
111	120	I	71 74	15B	OPT
135	130	I	77 78	6B	INSTACK
152	140	I	81 82	7B	INSTACK
163	150	I	86 87	5B	INSTACK
173		I	88 88	7B	EXT REFS

COMMON BLOCKS	LENGTH
GRSPTR	38

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STATISTICS
  PROGRAM LENGTH                254B     172
  SCM LABELED COMMON LENGTH      46B      38
        140000B SCM USED
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CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

TIDY GRASS0 GRASS1 GRASS2 GRASS3 GRASS4 GRASS5 GRASS6
GRASS7 GRASS8 GRASS9 CALLGR

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$ TIDY GRASS0 GRASS1 GRASS2 GRASS3 GRASS4 GRASS5
GRASS6 GRASS7 GRASS8 GRASS9 CALLGR

DECK LIST AS WRITTEN TO SEQUENTIAL NEWPL

YANK$$$ TIDY GRASS0 GRASS1 GRASS2 GRASS3 GRASS4 GRASS5
GRASS6 GRASS7 GRASS8 GRASS9 CALLGR

DECKS WRITTEN TO COMPILE FILE

TIDY GRASS0 GRASS1 GRASS2 GRASS3 GRASS4 GRASS5 GRASS6
GRASS7 GRASS8 GRASS9 CALLGR

THIS UPDATE REQUIRED 34300B WORDS OF CORE.

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      C   FASTGRASS-MOD2          SEPTEMBER,1980                                  GRASS0      2
      C   GRASS1:  FASTGRASS MAIN PROGRAM                                         GRASS0      3
      C   BY J.REST                                                               GRASS0      4
      C   TELEPHONE NUMBER: 312-972-5026                                          GRASS0      5
      C                                                                           GRASS0      6
      C   WITH STEADY-STATE AND TRANSIENT CAPABILITIES                            GRASS0      7
      C   ARGONNE NATIONAL LABORATORY                                             GRASS0      8
            SUBROUTINE GRASS (DEL,NF,KF,FL,TIT,PLENP,IRSTAR,NPRINT,GRT,BVST,KF GRASS0      9
           +1,BVS,GR,POW,RGTJ,FDP,FODSLC,FOGBDY,PRF,RHODSL,TMIA,TGRAD,BV,C0,GA GRASS0     10
           +SGEN,GESWF,GIP,GOUT,GRSIZ,GS,HH,HOLD,NMAXBK,POROS,PRFOLD,PRSO,RH,R GRASS0     11
           +HOLD,RS,TFO,TK,TKOLD,TS,BLKMGO,GBYMGO,BULK,DIST,SAVG)              GRASS0     12
      C                                                                           GRASS0     13
      C   INPUT QUANTITIES                                                       GRASS0     14
      C   DEL=TIME STEP(S)                                                       GRASS0     15
      C   NF=TOTAL NUMBER OF AXIAL FUEL SECTIONS                                 GRASS0     16
      C   KF=TOTAL NUMBER OF RADIAL RINGS                                        GRASS0     17
      C   FL=LENGTH OF FUEL ROD(CM)                                              GRASS0     18
      C   RH(J,K)=FUEL DENSITY IN ZONE (J,K) (GM/CM**3)                          GRASS0     19
      C   TK(J,K)=AVERAGE TEMPERATURE IN ZONE (J,K) (K)                          GRASS0     20
      C   PRSO(J,K)=HYDROSTATIC PRESSURE IN ZONE (J,K) (PSI)                     GRASS0     21
      C   POW(J)=LINEAR POWER IN AXIAL SECTION J (KW/FT)                        GRASS0     22
      C   RS(J,K)=INNER RADIUS OF ZONE (J,K) (CM)                               GRASS0     23
      C   TS(J,K)=TEMPERATURE AT RS(J,K) (C)                                    GRASS0     24
      C   GRSIZ(J,K)=GRAIN DIAMETER IN REGION (J,K) (CM)                        GRASS0     25
      C   POROS(J,K)=FRACTIONAL POROSITY IN REGION (J,K)                        GRASS0     26
      C   FDP(K)=RADIAL FLUX DEPRESSION FACTOR IN REGION K                       GRASS0     27
      C   TIT=IRRADIATION TIME (S)                                               GRASS0     28
      C   PLENP=PLENUM PRESSURE (PSI)                                            GRASS0     29
      C   IRSTAR=RESTART INDICATOR (1=RESTART,2=DUMP,3=TRANSIENT,                GRASS0     30
      C   0=STEADY-POWER IRRADIATION)                                            GRASS0     31
      C   NPRINT=LEVEL OF FASTGRASS PRINTOUT (1-4)                               GRASS0     32
      C   GRT=TOTAL FISSION-GAS RELEASE (MOLES)--INITIAL AMOUNT IN PLENUM        GRASS0     33
      C   MUST BE SPECIFIED                                                      GRASS0     34
      C                                                                           GRASS0     35
      C   OUTPUT QUANTITIES                                                      GRASS0     36
      C   GS(J,K)=AMOUNT OF RETAINED GAS IN REGION (J,K) (MOLES)                 GRASS0     37
      C   GR(J)=AMOUNT OF GAS RELEASED FROM AXIAL SECTION (J) (MOLES)            GRASS0     38
      C   DURING DEL(SECONDS)                                                    GRASS0     39
      C   GRT=TOTAL FISSION GAS RELEASED (MOLES)                                 GRASS0     40
      C   BV(J,K)=FISSION-GAS SWELLING/VOLUME IN REGION (J,K)                    GRASS0     41
      C   BVS(J)=FISSION-GAS SWELLING/VOLUME IN AXIAL SECTION (J)                GRASS0     42
      C   BVST=TOTAL FISSION-GAS SWELLING/VOLUME                                 GRASS0     43
      C                                                                           GRASS0     44
            COMMON/GR0235/AVN,GASIN,SAVGI,J,K,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,     GRASS0     45
           +NMAXG,NXBD,NXBDG,RAD,VOLUME                                         GRASS0     46
            COMMON/GR0A2/TKI,TFPV,TGRADI,HY,AREA,GRD,T2,AGBY,FBDEN,FBSAT,DELT   GRASS0     47
           +,SPT,SRNK(3),GROW(3)                                                GRASS0     48
            COMMON/GR0A3/GESW,JKF,KI,EGRE,EPRF                                  GRASS0     49
            COMMON/GR0A4/IMAXI,TPASS,Y,H,KK                                     GRASS0     50
            COMMON/BDG02D/                                                      GRASS0     51
           +TGASIN,TGASR,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02                      GRASS0     52
           +,TS0,IRSTRD,VERS                                                    GRASS0     53
            COMMON/BDGR/A1,R9,FPWS,NAME(3),RHOOLD,TCONV,PDSC,PI43,BCF,C01,      GRASS0     54
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                     +BKLO,BKHI,CPOW,SIGPI,FGPF,BVCRIT,GRFO,PTPL,PG,SBCF,FLXPT,RM          GRASSO     55
55                    COMMON/GRSPTR/NVAR1,NVAR2,NVAR3,NVAR4,NVAR5,NVAR6,NVAR7,NVAR8,      GRASSO     56
                     +NVAR9,NVAR10,NVAR11,NVAR12,NVAR13,NVAR14,NVAR15,NVAR16,NVAR17,     GRASSO     57
                     +NVAR18,NVAR19,NVAR20,NVAR21,NVAR22,NVAR23,NVAR24,NVAR25,NVAR26,    GRASSO     58
                     +NVAR27,NVAR28,NVAR29,NVAR30,NVAR31,NVAR32,NVAR33,NVAR34,NVAR35,    GRASSO     59
                     +NVAR36,NVAR37,LGRASS                                               GRASSO     60
60                    DIMENSION RS(NF,KF1),TS(NF,KF1),GRSIZ(NF,KF),POROS(NF,KF),FDP(KF)  GRASSO     61
                      DIMENSION TK(NF,KF),BLKMGO(1,1),GS(NF,KF),BV(NF,KF),BVS(NF)       GRASSO     62
                     +,GBYMGO(KF,20),PRSO(NF,20),RH(NF,20),Y(6),SAVG(NF,KF,4),           GRASSO     63
                     +RAD(2,2),TAUA(KF1),TGRAD(KF),GR(NF),POW(NF),RGTJ(NF),PRF(KF)       GRASSO     64
                     +,CO(NF,KF),GASGEN(NF,KF),GESWF(NF,KF),GIP(1,1),GOUT(NF,KF),        GRASSO     65
65                   +HH(NF,KF),HOLD(1,1),NMAXBK(1,1),DIST(NF,KF,4),                     GRASSO     66
                     +PRFOLD(NF,KF),RHOLD(NF,KF),TFO(NF,KF),                             GRASSO     67
                     +TKOLD(NF,KF),BULK(1,1,1)                                           GRASSO     68
                     +,FODSLC(1),FOGBDY(KF),RHODSL(1)                                    GRASSO     69
                      IF (DEL.LE.0.) GO TO 430                                           GRASSO     70
70                    IF (IRSTAR.EQ.13.AND.IRSTAR.NE.IRSTRO) JFIRST = 0                  GRASSO     71
                      IF (JFIRST.NE.0) GO TO 100                                         GRASSO     72
                C    -----INITIALIZATION OF GRASS                                       GRASSO     73
                      IF (IRSTAR.NE.13) GO TO 100                                        GRASSO     74
                      CO1 = TGASIN-TGASR                                                 GRASSO     75
75                    GRFO = TGASR                                                       GRASSO     76
                      IF (TIT.GE.TSO) GO TO 100                                          GRASSO     77
                      IRSTRO = IRSTAR                                                    GRASSO     78
                      TSO = 0.0                                                          GRASSO     79
                      TSO2 = 0.0                                                         GRASSO     80
80              100   KF1 = KF+1                                                         GRASSO     81
                      IF (NPRINT.GT.1) WRITE (6,440)                                     GRASSO     82
                      DELT = DEL                                                         GRASSO     83
                      T2 = TIT                                                           GRASSO     84
                      TMAX = .90*DELT                                                    GRASSO     85
85                    IF (NPRINT.GT.1.AND.IRSTAR.NE.13) WRITE (6,450) T2                 GRASSO     86
                      IF (NPRINT.GT.1.AND.IRSTAR.EQ.13) WRITE (6,460) T2                 GRASSO     87
                C    -----DO AXIAL SECTIONS ONE BY ONE                                  GRASSO     88
                      RGT = 0.                                                           GRASSO     89
                      RGP = 0.                                                           GRASSO     90
90                    RGG = 0.                                                           GRASSO     91
                          DO 410 J=1,NF                                                  GRASSO     92
                          VOLJ = 0.                                                      GRASSO     93
                          BVSBJ = 0.                                                     GRASSO     94
                          BVSGJ = 0.                                                     GRASSO     95
95                        BVSEJ = 0.                                                     GRASSO     96
                          RTGAS = 0.                                                     GRASSO     97
                          KTBF = KF                                                      GRASSO     98
                          IF (NPRINT.GE.3) KPRINT = 2                                    GRASSO     99
                C    -----CONVERT KW/FT TO W/CM                                         GRASSO    100
100                       POWERL = POW(J)*CPOW                                          GRASSO    101
                          TOTFIS = FPWS*POWERL                                          GRASSO    102
                              DO 160 K=1,KF                                             GRASSO    103
                              IF (JFIRST.EQ.0.AND.IRSTAR.EQ.0) GESWF(J,K) = 0.          GRASSO    104
                              TAUA(K) = 0.                                              GRASSO    105
105                           IF (POW(J).GT.0) GO TO 110                                GRASSO    106
                              IF (K.EQ.1) GO TO 110                                     GRASSO    107
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                      TGRAD(K) = (TS(J,K+1)-TS(J,K-1))/(RS(J,K+1)-RS(J,K-1))      GRASSO    108
                      GO TO 120                                                   GRASSO    109
              110     TGRAD(K) = (TS(J,K+1)-TS(J,K))/(RS(J,K+1)-RS(J,K))          GRASSO    110
110           120     IF (TGRAD(K).GT.0) TGRAD(K) = 0                             GRASSO    111
              C   ** COMPUTE PERCOLATION PROBABILITY, PRF(K) *****                GRASSO    112
                      GESFPD = POROS(J,K)-PTPL                                    GRASSO    113
                      GESFP = AMAX1(0.0,GESFPD)                                   GRASSO    114
                      PRFC = (BVCRIT-GESFP-GESWF(J,K))/(1.1417*SIGPI)             GRASSO    115
115                   PRF(K) = (1.0-ERF(PRFC))*.50                                GRASSO    116
                      IF (JFIRST.EQ.0.AND.IRSTAR.EQ.0) GO TO 130                  GRASSO    117
                      RHOOLD = RH(J,K)/RHOLD(J,K)                                 GRASSO    118
                      IF (JFIRST.EQ.0.AND.IRSTAR.EQ.13) TKOLD(J,K) = TK(J,K)      GRASSO    119
                      GO TO 140                                                   GRASSO    120
120           130     GOUT(J,K) = 0.0                                             GRASSO    121
                      GASGEN(J,K) = 0.0                                           GRASSO    122
                      TKOLD(J,K) = TK(J,K)                                        GRASSO    123
                      PRFOLD(J,K) = PRF(K)                                        GRASSO    124
              140         DO 150 N=1,4                                            GRASSO    125
125           150         DIST(J,K,N) = DIST(J,K,N)*RHOOLD                        GRASSO    126
                      GBYMGO(K) = 0.                                              GRASSO    127
              160     RHOLD(J,K) = RH(J,K)                                        GRASSO    128
                  HITEI = FL/NF                                                   GRASSO    129
              C   ----- DO RADIAL SECTIONS                                        GRASSO    130
130                   TAUA(KF1) = DELT                                            GRASSO    131
                      K = KF                                                      GRASSO    132
                      GASOUT = 0.                                                 GRASSO    133
                      GO TO 320                                                   GRASSO    134
              170     K1 = K+1                                                    GRASSO    135
135                   VOLUME = PI*HITEI*(RS(J,K1)*RS(J,K1)-RS(J,K)*RS(J,K))       GRASSO    136
                      AREA = 2.*PI*RS(J,K)*HITEI                                  GRASSO    137
                      TFPV = TOTFIS*FDP(K)/(PI*(RS(J,KF1)*RS(J,KF1)-RS(J,1)*RS(J,1)) GRASSO    138
                  +   )                                                           GRASSO    139
                      GASIN = TFPV*FGPF                                           GRASSO    140
140                   IF (K.EQ.KF) GO TO 180                                      GRASSO    141
                      JKF = 2                                                     GRASSO    142
                      GO TO 190                                                   GRASSO    143
              180     JKF = 1                                                     GRASSO    144
              190     HPRS = PRSO(J,K)                                            GRASSO    145
145                   IF (PRSO(J,K).LE.PLENP) HPRS = PLENP                        GRASSO    146
                      HY = HPRS*PDSC                                              GRASSO    147
                      GRD = GRSIZ(J,K)                                            GRASSO    148
                      TKI = TK(J,K)                                               GRASSO    149
                      TGRADI = TGRAD(K)                                           GRASSO    150
150                   TKOJK = TKOLD(J,K)                                          GRASSO    151
                      IF (NPRINT.LT.3) KPRINT = 1                                 GRASSO    152
                      IF (NPRINT.NE.4) GO TO 200                                  GRASSO    153
                      WRITE (6,470) J,K                                           GRASSO    154
                      RHOOLD = RH(J,K)/RHOLD(J,K)                                 GRASSO    155
155                   WRITE (6,480) RS(J,K),RS(J,K+1),TS(J,K),TS(J,K+1),FDP(K),H,PRF GRASSO    156
                  +   (K),PRFOLD(J,K),GESWF(J,K),RHOOLD                           GRASSO    157
              200     CALL GRASS2 (H,TKOJK,IRSTAR,FOGBDY,CO,HH,TFO,SAVG,DIST,NF,KF) GRASSO    158
                      GBCF = -(FBDEN/FBSAT-1.)/(1.4147*SBCF)                      GRASSO    159
                      EGRE = (1.-ERF(GBCF))*.5/DELT                               GRASSO    160
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                      IF (PRFOLD(J,K).GE.1.0.OR.PRFOLD(J,K).GE.PRF(K)) GO TO 210      GRASS0   161
                      EPRF = (PRF(K)-PRFOLD(J,K))/(1.0-PRFOLD(J,K))/DELT              GRASS0   162
                      GO TO 220                                                       GRASS0   163
              210     EPRF = 0.0                                                      GRASS0   164
              220     I = 0                                                           GRASS0   165
                          DO 230 N=1,4                                                GRASS0   166
                          I = I+1                                                     GRASS0   167
              230         Y(I) = DIST(J,K,N)                                          GRASS0   168
              240     TSAVE = TAUA(K)                                                 GRASS0   169
                      TPASS = TAUA(K)                                                 GRASS0   170
                      HT = H                                                          GRASS0   171
                      CALL GRASS4 (SAVG,DIST,PRF,GBYMGO,NF,KF)                        GRASS0   172
                      IF (KK.LT.0) NPRINT = 4                                         GRASS0   173
                      TAUA(K) = TPASS                                                 GRASS0   174
                      DT = TPASS-TSAVE                                                GRASS0   175
                      GASINK = GASIN*DT*VOLUME                                        GRASS0   176
                      GASGEN(J,K) = GASGEN(J,K)+GASINK                                GRASS0   177
                      TGASIN = TGASIN+GASINK                                          GRASS0   178
                      I = 0                                                           GRASS0   179
                          DO 250 N=1,4                                                GRASS0   180
                          I = I+1                                                     GRASS0   181
              250         DIST(J,K,N) = Y(I)                                          GRASS0   182
                      I = I+1                                                         GRASS0   183
                      GKOUT = Y(I)                                                    GRASS0   184
                      GASOUT = GASOUT+GKOUT                                           GRASS0   185
                      GOUT(J,K) = GOUT(J,K)+GKOUT                                     GRASS0   186
                      TGASR = TGASR+GKOUT                                             GRASS0   187
                      IF (DT.EQ.0.) GO TO 260                                         GRASS0   188
                      I = I+1                                                         GRASS0   189
                      GBYMGO(K) = Y(I)/DT                                             GRASS0   190
                      GASMGO = Y(I)*SAVG(J,K,3)                                       GRASS0   191
                      IF (K.NE.1) GO TO 260                                           GRASS0   192
                      GASOUT = GASOUT+GASMGO                                          GRASS0   193
                      TGASR = TGASR+GASMGO                                            GRASS0   194
                      GOUT(J,K) = GOUT(J,K)+GASMGO                                    GRASS0   195
              260     IF (.NOT.(NPRINT.EQ.4.OR.(NPRINT.EQ.3.AND.K.EQ.KTBF.AND.TAUA(K  GRASS0   196
                +     ).GE.DELT))) GO TO 270                                          GRASS0   197
                      PRINT 510, NAME(1),K,(DIST(J,K,N),N=1,2)                        GRASS0   198
                      PRINT 520, NAME(2),K,DIST(J,K,3)                                GRASS0   199
                      PRINT 530, NAME(3),K,DIST(J,K,4)                                GRASS0   200
                      PRINT 500, TAUA(K),DT,H,GRSIZ(J,K),POROS(J,K)                   GRASS0   201
              270     IF (KK.GT.0) GO TO 280                                          GRASS0   202
                      NPRINT = 4                                                      GRASS0   203
                      PRINT 540, J,K                                                  GRASS0   204
                      GO TO 380                                                       GRASS0   205
              280     IF (H.GT.HH(J,K).OR.H.LT.HT) HH(J,K) = H                        GRASS0   206
                      NFLAG = 1                                                       GRASS0   207
                      M = 1                                                           GRASS0   208
                          DO 300 N=1,3                                                GRASS0   209
                          M = M+1                                                     GRASS0   210
                          SAVGRM = SAVG(J,K,M)/RM                                     GRASS0   211
                          FLX = FLXPT*DIST(J,K,M)                                     GRASS0   212
                          IF (SRNK(N).LE.FLX.OR.SAVGRM.LT.2.0) GO TO 290              GRASS0   213
```

```
                        SAVG(J,K,M) = SAVGRM                                    GRASS0   214
                        DIST(J,K,M) = RM*DIST(J,K,M)                            GRASS0   215
215                     NFLAG = 2                                               GRASS0   216
              290       IF (GROW(N).LE.FLX) GO TO 300                           GRASS0   217
                        SAVG(J,K,M) = RM*SAVG(J,K,M)                            GRASS0   218
                        DIST(J,K,M) = DIST(J,K,M)/RM                            GRASS0   219
                        NFLAG = 2                                               GRASS0   220
220           300       CONTINUE                                                GRASS0   221
                      IF (K.EQ.KTBF.AND.TAUA(K).GE.TAUA(KF1)) GO TO 360         GRASS0   222
              310     IF (K.EQ.1) GO TO 330                                     GRASS0   223
                      K = K-1                                                   GRASS0   224
              320     NFLAG = 2                                                 GRASS0   225
225           330     HT = TAUA(K+1)-TAUA(K)                                    GRASS0   226
                      IF (HT) 340,340,350                                       GRASS0   227
              340     K = K+1                                                   GRASS0   228
                      GO TO 320                                                 GRASS0   229
              350     H = AMIN1(HT,HH(J,K))                                     GRASS0   230
230                   IF (H.GT.TMAX) H = DELT                                   GRASS0   231
                      GO TO (240,170), NFLAG                                    GRASS0   232
              360     SUMAB = DIST(J,K,2)*SAVG(J,K,2)+DIST(J,K,1)*SAVG(J,K,1)   GRASS0   233
                      SUMAG = DIST(J,K,3)*SAVG(J,K,3)                           GRASS0   234
                      SUMAE = SAVG(J,K,4)*DIST(J,K,4)                           GRASS0   235
235                   SUMA = SUMAB+SUMAG+SUMAE                                  GRASS0   236
                      BRICO = RAD(1,1)**3                                       GRASS0   237
                C   CALCULATE OUTPUT QUANTITIES                                 GRASS0   238
                C                                                               GRASS0   239
                C   IN ANNULAR REGION (J,K):                                    GRASS0   240
240             C   BVC=COMPRESSIBLE FISSION GAS VOLUME (CM**3)                  GRASS0   241
                C   RP=FRACTION OF RETAINED FISSION GAS RESIDING IN BUBBLES     GRASS0   242
                C   PG=EFFECTIVE SURFACE TENSION INDUCED PRESSURE (PSI)         GRASS0   243
                C   BVI=VOLUME PER MOLE OF DISSOLVED FISSION GAS (INCHES**3)    GRASS0   244
                C   GOUTJK=AMOUNT OF FISSION GAS RELEASED (MOLES)               GRASS0   245
245             C   BULKFR=FRACTION OF FISSION GAS RETAINED IN BULK             GRASS0   246
                C   GBDYFR=FRACTION OF FISSION GAS RETAINED ON GRAIN BOUNDARIES GRASS0   247
                C   EDGEFR=FRACTION OF FISSION GAS RETAINED IN EDGE TUNNELS     GRASS0   248
                C   FTGRJK=FRACTION OF FISSION GAS RELEASED FROM REGION         GRASS0   249
                C   GGTJK=AMOUNT OF FISSION GAS GENERATED IN REGION (MOLES)     GRASS0   250
250             C                                                               GRASS0   251
                C   BVSBJ=STRAIN IN SECTION J DUE TO BULK BUBBLES               GRASS0   252
                C   BVSGJ=STRAIN IN SECTION J DUE TO GRAIN BOUNDARY BUBBLES     GRASS0   253
                C   BVSEJ=STRAIN IN SECTION J DUE TO GRAIN EDGE SWELLING        GRASS0   254
                C                                                               GRASS0   255
255             C   GGT=TOTAL AMOUNT OF GAS PRODUCED BY FISSION IN FUEL         GRASS0   256
                C   RTGAS=TOTAL AMOUNT OF RETAINED GAS IN FUEL (MOLES)         GRASS0   257
                C   GRFT=TOTAL AMOUNT OF FISSION GAS RELEASED FROM FUEL (MOLES) GRASS0   258
                C   FTGR=FRACTION OF FISSION GAS RELEASED FROM FUEL             GRASS0   259
                C   TFGR=FRACTION OF FISSION GAS RELEASED DURING TRANSIENT(IRSTAR=13) GRASS0   260
260             C   RGGE=FRACTION OF GENERATED GAS TRAPPED IN CLOSED POROSITY   GRASS0   261
                C   RGGF=FRACTION OF GENERATED GAS TRAPPED ON GRAIN BOUNDARIES GRASS0   262
                C   RGTJ(J)=AMOUNT OF RETAINED FISSION GAS IN AXIAL SECTION J (MOLES) GRASS0   263
                C                                                               GRASS0   264
                      BVSB = PI43*(DIST(J,K,1)*BRICO+DIST(J,K,2)*RAD(2,1)**3)   GRASS0   265
265                   BVSG = PI43*(DIST(J,K,3)*RAD(1,2)**3)                     GRASS0   266
```

```
                      GESWF(J,K) = PI43*(DIST(J,K,4)*RAD(2,2)**3)                                GRASS0    267
                      BV(J,K) = BVSB+BVSG+GESWF(J,K)                                             GRASS0    268
                      BVCO = 0.0                                                                 GRASS0    269
                          DO 370 N=1,4                                                           GRASS0    270
270         370           BVCO = BVCO+DIST(J,K,N)*SAVG(J,K,N)                                    GRASS0    271
                      BVC = BV(J,K)-BVCO*PI43*BRICO                                              GRASS0    272
                      RP = (SUMA-DIST(J,K,1)*SAVG(J,K,1))/SUMA                                   GRASS0    273
                      BULKFR = SUMAB/SUMA                                                        GRASS0    274
                      GBDYFR = SUMAG/SUMA                                                        GRASS0    275
275                   EDGEFR = SUMAE/SUMA                                                        GRASS0    276
                      GSJK = SUMA/AVN                                                            GRASS0    277
                      GS(J,K) = GSJK*VOLUME                                                      GRASS0    278
                      RTGAS = RTGAS+GS(J,K)                                                      GRASS0    279
                      GGT = TGASIN/AVN                                                           GRASS0    280
280                   FTGR = TGASR/TGASIN                                                        GRASS0    281
                      GRFT = TGASR/AVN                                                           GRASS0    282
                      IF (BVC.LE.1.E-20) GO TO 380                                               GRASS0    283
                      PG = GSJK*R9/BVC/16.387*TK(J,K)**RP-HPRS                                   GRASS0    284
                      IF (PG.LE.0.0) PG = 0.0                                                    GRASS0    285
285         380       GGTJK = GASGEN(J,K)/AVN                                                    GRASS0    286
                      GOUTJK = GOUT(J,K)/AVN                                                     GRASS0    287
                      FTGRJK = GOUTJK/GGTJK                                                      GRASS0    288
                      RATIO = (RS(J,K)+RS(J,K+1))/RS(J,KF1)/2.                                   GRASS0    289
                      IF (NPRINT-2) 400,390,390                                                  GRASS0    290
290         390       PRINT 490                                                                  GRASS0    291
                      PRINT 560, J,K,PG,RP,BV(J,K),BVC,GS(J,K),HPRS,VOLUME,SUMA,FTGR             GRASS0    292
                    + JK,GOUTJK,GGTJK,BULKFR,GKOUT,RATIO,BVSB,BVSG,GESWF(J,K),GBDYFR             GRASS0    293
                    + ,GROW(1),EGRE,EPRF,TK(J,K),TKOLD(J,K),EDGEFR,SRNK(1)                       GRASS0    294
                      IF (KK.LT.0) GO TO 420                                                     GRASS0    295
295         400       TKOLD(J,K) = TK(J,K)                                                       GRASS0    296
                      PRFOLD(J,K) = PRF(K)                                                       GRASS0    297
                      BVSBJ = BVSBJ+BVSB*VOLUME                                                  GRASS0    298
                      BVSGJ = BVSGJ+BVSG*VOLUME                                                  GRASS0    299
                      BVSEJ = BVSEJ+GESWF(J,K)*VOLUME                                            GRASS0    300
300                   VOLJ = VOLJ+VOLUME                                                         GRASS0    301
                      KTBF = KTBF-1                                                              GRASS0    302
                      RGP = RGP+SUMAE*VOLUME/AVN                                                 GRASS0    303
                      RGG = RGG+SUMAG*VOLUME/AVN                                                 GRASS0    304
                      IF (NPRINT.GE.3.AND.KTBF.NE.0) KPRINT = 2                                  GRASS0    305
305                   IF (KTBF.GT.0.AND.KK.GE.0) GO TO 310                                       GRASS0    306
                      GR(J) = GASOUT/AVN                                                         GRASS0    307
                      RGTJ(J) = RTGAS                                                            GRASS0    308
                      RGT = RGT+RGTJ(J)                                                          GRASS0    309
                      GRT = GRT+GASOUT/AVN                                                       GRASS0    310
310                   BVSBJ = BVSBJ/VOLJ                                                         GRASS0    311
                      BVSGJ = BVSGJ/VOLJ                                                         GRASS0    312
                      BVSEJ = BVSEJ/VOLJ                                                         GRASS0    313
                      BVS(J) = BVSBJ+BVSGJ+BVSEJ                                                 GRASS0    314
                      IF (NPRINT.GT.2.AND.NF.GT.1) PRINT 550, GR(J),RGTJ(J),BVS(J),B             GRASS0    315
315                 + VSBJ,BVSGJ,BVSEJ                                                           GRASS0    316
              410     CONTINUE                                                                   GRASS0    317
                    IF (IRSTAR.NE.13) CO1 = TGASIN                                             GRASS0    318
                    TFGR = (GRFT*AVN-GRF0)/CO1                                                 GRASS0    319
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                IF (TFGR.LE.0.OR.IRSTAR.NE.13) TFGR = 0.0                                GRASS0    320
320             ERROR = ABS((RGT+GRFT-GGT)/GGT)                                          GRASS0    321
                RGGL = (RGT-RGP-RGG)/GGT                                                 GRASS0    322
                RGGE = RGP/GGT                                                           GRASS0    323
                RGGF = RGG/GGT                                                           GRASS0    324
                IF (NPRINT.GE.2) WRITE (6,570) GRT,GRFT,GGT,RGT,ERROR,FTGR,TFGR,RG       GRASS0    325
325            +GL,RGGF,RGGE                                                             GRASS0    326
                JFIRST = 1                                                               GRASS0    327
                TSO = T2                                                                 GRASS0    328
          420   IF (KK.LT.0) NPRINT = -9                                                 GRASS0    329
                IF (NPRINT.GT.1) WRITE (6,580)                                           GRASS0    330
330       430   CONTINUE                                                                 GRASS0    331
                RETURN                                                                   GRASS0    332
          C                                                                              GRASS0    333
          440   FORMAT (//36X,54H********** GRASS OUTPUT **********                     GRASS0    334
               +*****,/)                                                                 GRASS0    335
335       450   FORMAT (50X,6HTIME= ,1E16.9,//)                                          GRASS0    336
          460   FORMAT (45X,16HTRANSIENT TIME= ,1E16.9,//)                               GRASS0    337
          470   FORMAT (//22H ------ AXIAL SECTION=,I3,16H RADIAL SECTION=,I3,//)        GRASS0    338
          480   FORMAT (9H RS(J,K)=,D14.6,11H RS(J,K+1)=,D14.6,9H TS(J,K)=,D14.6,1       GRASS0    339
               +1H TS(J,K+1)=,D12.6,9H FDP(K) =,D14.6,/10H H(INPUT)=,E13.6,11H PRF       GRASS0    340
340            +(K)   =,E14.6,9H PRFOLD =,E14.6,12H SESWF(J,K)=E11.5,9H RHOOLD =,E       GRASS0    341
               +14.6)                                                                    GRASS0    342
          490   FORMAT (//3X,1HJ,2X,1HK,13X,2HPG,13X,2HRP,13X,2HBV,12X,3HBVC,12X,2       GRASS0    343
               +HGS,11X,4HHPRS,12X,3HVOL)                                                GRASS0    344
          500   FORMAT (/5H TAU=,E14.6,11H H(ACTUAL)=,E14 6,9H H(SUGG)=,E14.6,7H G       GRASS0    345
345            +RSIZ=,E12.4,7H POROS=,E12.4)                                             GRASS0    346
          510   FORMAT (/1X,A4,2X,6HREGION,I2,2E12.4)                                    GRASS0    347
          520   FORMAT (1X,A4,2X,6HREGION,I2,1E12.4)                                     GRASS0    348
          530   FORMAT (1X,A4,2X,6HREGION,I2,1E12.4)                                     GRASS0    349
          540   FORMAT (32H GRASS NOT CONVERGING, AXL SECT#,I3,12HRADIAL SCT #,I3)       GRASS0    350
350       550   FORMAT (/7H GR(J)=,D14.7,9H RGTJ(J)=,E12.5,8H BVS(J)=,E15.7,7H BVS       GRASS0    351
               +BJ=,E14.7,7H BVSGJ=,E14.7,8H  BVSEJ=,E14.7)                              GRASS0    352
          560   FORMAT (1X,2I3,7D15.6,//8H SUMATM=,E13.6,8H FTGRJK=,E13.6,8H GOUTJ        GRASS0    353
               +K=,E13.6,7H GGTJK=,E14.7,8H BULKFR=,E13.6,7H GKOUT=,E14.7/,7H RATI       GRASS0    354
               +O=,E14.7,6H BVSB=,E15.7,6H BVSG=,E15.7,6H BVSE=,E15.7,8H GBDYFR=,E       GRASS0    355
355            +13.6,7H GROWL=,E14.7,/7H EGRE =,E14.7,7H EPRF =,E14.7,7H TKJK =,E1       GRASS0    356
               +4.6,7H TKOLD=,E14.7,8H EDGEFR=,E13.6,7H SRNKL=,E14.7)                    GRASS0    357
          570   FORMAT (/6H GRT= ,E15.7,6H GRFT=,E15.7,6H GGT= ,E15.7,6H RGT= ,E15       GRASS0    358
               +.7,7H ERROR=,E14.7,/6H FTGR=,E15.7,6H TFGR=,E15.7,6H RGGL=,E15.7,6       GRASS0    359
               +H RGGF=,E15.7,6H RGGE=,E15.7)                                            GRASS0    360
360       580   FORMAT (//27X,80H********** END OF GRASS OUTPUT FOR THIS                 GRASS0    361
               + TIME STEP **********,//)                                                GRASS0    362
                END                                                                      GRASS0    363
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
91	1		CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
102	1		CONTROL VARIABLE IN COMMON OR EQUIVALENCED, OPTIMIZATION MAY BE INHIBITED.
231	1		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GRASS 8 331

VARIABLES	SN	TYPE		RELOCATION								
7	AGBY	REAL		GR0A2	REFS	46						
4	AREA	REAL		GR0A2	REFS	46	DEFINED	136				
0	AVN	REAL		GR0235	REFS	44	276	279	261	285	286	302
						303	306	309	318			
0	AI	REAL		BDGR	REFS	53						
12	BCF	REAL		BDGR	REFS	53						
15	BKHI	REAL		BDGR	REFS	53						
14	BKLO	REAL		BDGR	REFS	53						
0	BLKMGO	REAL	ARRAY	F.P.	REFS	61	DEFINED	8				
2376	BRICO	REAL			REFS	264	271	DEFINED	236			
0	BULK	REAL	ARRAY	F.P.	REFS	61	DEFINED	8				
2404	BULKFR	REAL			REFS	291	DEFINED	273				
0	BV	REAL	ARRAY	F.P.	REFS	61	271	291	DEFINED	8	267	
2402	BVC	REAL			REFS	282	283	291	DEFINED	271		
21	BVCRIT	REAL		BDGR	REFS	53	114					
2401	BVCO	REAL			REFS	270	271	DEFINED	268	270		
0	BVS	REAL	ARRAY	F.P.	REFS	61	314	DEFINED	8	313		
2377	BVSB	REAL			REFS	267	291	297	DEFINED	264		
2337	BVSBJ	REAL			REFS	297	310	313	314	DEFINED	93	297
						310						
2341	BVSEJ	REAL			REFS	299	312	313	314	DEFINED	95	299
						312						
2400	BVSG	REAL			REFS	267	291	298	DEFINED	265		
2340	BVSGJ	REAL			REFS	298	311	313	314	DEFINED	94	298
						311						
0	BVST	REAL	*UNUSED	F.P.	DEFINED	8						
16	CPOW	REAL		BDGR	REFS	53	100					
0	CO	REAL	ARRAY	F.P.	REFS	61	157	DEFINED	8			
13	CO1	REAL		BDGR	REFS	53	318	DEFINED	74	317		
0	DEL	REAL		F.P.	REFS	69	82	DEFINED	8			
12	DELT	REAL		GR0A2	REFS	46	84	130	159	161	195	230
					DEFINED	82						
0	DIST	REAL	ARRAY	F.P.	REFS	61	125	157	167	171	197	198
					199	211	214	218	2*232	233	234	2*264
					265	266	270	272	DEFINED	8	125	181
					214	218						
2362	DT	REAL			REFS	175	187	189	200	DEFINED	174	
2406	EDGEFR	REAL			REFS	291	DEFINED	275				
3	EGRE	REAL		GR0A3	REFS	48	291	DEFINED	159			
4	EPRF	REAL		GR0A3	REFS	48	291	DEFINED	161	163		
2420	ERROR	REAL			REFS	324	DEFINED	320				
10	FBDEN	REAL		GR0A2	REFS	46	158					
11	FBSAT	REAL		GR0A2	REFS	46	158					
0	FDP	REAL	ARRAY	F.P.	REFS	60	137	155	DEFINED	8		
20	FGPF	REAL		BDGR	REFS	53	139					
0	FL	REAL		F.P.	REFS	128	DEFINED	8				

VARIABLES	SN	TYPE	RELOCATION									
2371	FLX	REAL			REFS	212	213	DEFINED	211			
26	FLXPT	REAL		BDGR	REFS	53	211					
0	FQDSLC	REAL	ARRAY	F.P.	REFS	61	DEFINED	8				
0	FQGBDY	REAL	ARRAY	F.P.	REFS	61	157	DEFINED	8			
2	FPWS	REAL		BDGR	REFS	53	101					
2411	FTGR	REAL			REFS	324	DEFINED	280				
2415	FTGRJK	REAL			REFS	291	DEFINED	287				
0	GASGEN	REAL	ARRAY	F.P.	REFS	61	176	285	DEFINED	8	121	176
1	GASIN	REAL		GR0235	REFS	44	175	DEFINED	139			
2363	GASINK	REAL			REFS	176	177	DEFINED	175			
[illegible]	GASMGO	REAL			REFS	192	193	194	DEFINED	190		
2353	GBCOUT	REAL			REFS	184	192	306	309	DEFINED	132	184
					192							
2356	GBCF	REAL			REFS	159	DEFINED	158				
2405	GBDYFR	REAL			REFS	271	DEFINED	274				
0	GBYMGO	REAL	ARRAY	F.P.	REFS	61	171	DEFINED	8	126	189	
2347	GESFP	REAL			REFS	114	DEFINED	113				
2346	GESFPD	REAL			REFS	113	DEFINED	112				
0	GESW	REAL		GR0A3	REFS	48						
0	GESWF	REAL	ARRAY	F.P.	REFS	61	114	155	267	291	299	
					DEFINED	8	103	266				
2410	GGT	REAL			REFS	2*320	321	322	323	324		
					DEFINED	279						
2413	GGTJK	REAL			REFS	287	291	DEFINED	285			
0	GIP	REAL	ARRAY	F.P.	REFS	61	DEFINED	8				
2364	GKOUT	REAL			REFS	184	185	186	291	DEFINED	183	
0	GOUT	REAL	ARRAY	F.P.	REFS	61	185	194	236	DEFINED	8	120
					185		194					
2414	GOUTJK	REAL			REFS	287	291	DEFINED	236			
0	GR	REAL	ARRAY	F.P.	REFS	61	314	DEFINED	8	306		
5	GRD	REAL		GR0A2	REFS	46	DEFINED	147				
2412	GRFT	REAL			REFS	318	320	324	DEFINED	281		
22	GRFO	REAL		BDGR	REFS	53	318	DEFINED	75			
17	GROW	REAL	ARRAY	GR0A2	REFS	46	216	291				
0	GRSIZ	REAL	ARRAY	F.P.	REFS	60	147	200	DEFINED	8		
0	GRT	REAL		F.P.	REFS	309	324	DEFINED	8	309		
0	GS	REAL	ARRAY	F.P.	REFS	61	278	291	DEFINED	8	277	
2407	GSJK	REAL			REFS	277	283	DEFINED	276			
10	H	REAL		GR0A4	REFS	49	155	157	170	200	3*205	230
					DEFINED	229	230					
0	HH	REAL	ARRAY	F.P.	REFS	61	157	205	229	DEFINED	8	205
2352	HITEI	REAL			REFS	135	136	DEFINED	128			
0	HOLD	REAL	ARRAY	F.P.	REFS	61	DEFINED	8				
2354	HPRS	REAL			REFS	146	283	291	DEFINED	144	145	
2361	HT	REAL			REFS	205	226	229	DEFINED	170	225	
3	HY	REAL		GR0A2	REFS	46	DEFINED	146				
2357	I	INTEGER			REFS	166	167	180	181	182	183	188
					189	190	DEFINED	164	166	178	180	182
					188							
0	IMAXI	INTEGER		GR0A4	REFS	49						
0	IRSTAR	INTEGER		F.P.	REFS	2*70	73	77	85	86	103	116
					118	157	317	319	DEFINED	8		
11	IRSTRO	INTEGER		BDG02D	REFS	50	70	DEFINED	77			

VARIABLES	SN	TYPE		RELOCATION								
3	J	INTEGER		GR0235	REFS	44	100	103	105	4*107	4*109	112
						114	2*117	2*118	120	121	2*122	123	2*125
						2*127	4*135	136	4*137	144	145	147	148
						150	153	2*154	6*155	2*160	2*161	167	2*176
						181	2*185	190	2*194	197	198	199	2*200
						203	2*205	210	211	213	2*214	2*217	2*218
						229	4*232	2*233	2*234	2*264	265	2*266	2*267
						2*270	271	2*272	277	278	283	285	286
						3*288	6*291	2*295	296	299	306	307	308
						313	3*314	DEFINED	91				
3	JFIRST	INTEGER		BDG02D	REFS	50	71	103	116	118			
					DEFINED	70	326						
1	JKF	INTEGER		GR0A3	REFS	48	DEFINED	141	143				
10	JNCDI	INTEGER		GR0235	REFS	44							
11	JNCGBI	INTEGER		GR0235	REFS	44							
4	K	INTEGER		GR0235	REFS	44	103	104	106	5*107	5*109	2*110	
						112	114	115	2*117	2*118	120	121	2*122
						2*123	2*125	126	2*127	134	2*135	136	137
						140	144	145	147	148	149	150	153
						2*154	8*155	3*160	3*161	167	168	169	173
						2*176	181	2*185	189	190	191	2*194	2*195
						2*197	2*198	2*199	3*200	203	2*205	210	211
						213	2*214	2*217	2*218	2*221	222	223	2*225
						227	229	4*232	2*233	2*234	2*264	265	2*266
						2*267	2*270	271	2*272	277	278	283	285
						286	2*288	6*291	2*295	2*296	299		
					DEFINED	102	131	223	227				
0	KF	INTEGER		F.P.	REFS	3*60	18*61	80	97	102	131	140	
						157	171	DEFINED	8				
4	KFIRST	INTEGER		BDG02D	REFS	50							
0	KFI	INTEGER		F.P.	REFS	2*60	61	130	2*137	221	288		
					DEFINED	8	80						
11	KK	INTEGER		GR0A4	REFS	49	172	201	294	305	328		
5	KPRINT	INTEGER		BDG02D	REFS	50	DEFINED	98	151	304			
2343	KTBF	INTEGER			REFS	195	221	301	304	305			
					DEFINED	97	301						
2	KI	INTEGER		GR0A3	REFS	48	2*135	DEFINED	134				
45	LGRASS	INTEGER		GRSPTR	REFS	55							
2367	M	INTEGER			REFS	209	210	211	213	2*214	2*217	2*218	
					DEFINED	207	209						
2351	N	INTEGER			REFS	2*125	167	181	197	212	216	2*270	
					DEFINED	124	165	179	197	208	269		
3	NAME	INTEGER	ARRAY	BDGR	REFS	53	197	198	199				
6	NCDI	INTEGER		GR0235	REFS	44							
7	NCGBI	INTEGER		GR0235	REFS	44							
0	NF	INTEGER		F.P.	REFS	4*60	20*61	91	128	157	171	314	
					DEFINED	8							
2366	NFLAG	INTEGER			REFS	231	DEFINED	206	215	219	224		
6	NMAX	INTEGER		BDG02D	REFS	50							
5	NMAXB	INTEGER		GR0235	REFS	44							
0	NMAXBK	INTEGER	ARRAY	F.P.	REFS	61	DEFINED	8					
12	NMAXG	INTEGER		GR0235	REFS	44							
0	NPRINT	INTEGER		F.P.	REFS	81	85	86	98	151	152	2*195	

VARIABLES	SN	TYPE		RELOCATION								
						289	304	314	324	329	DEFINED	8	172
						202	328						
0	NVAR1	INTEGER		GRSPTR	REFS	55							
11	NVAR10	INTEGER		GRSPTR	REFS	55							
12	NVAR11	INTEGER		GRSPTR	REFS	55							
13	NVAR12	INTEGER		GRSPTR	REFS	55							
14	NVAR13	INTEGER		GRSPTR	REFS	55							
15	NVAR14	INTEGER		GRSPTR	REFS	55							
16	NVAR15	INTEGER		GRSPTR	REFS	55							
17	NVAR16	INTEGER		GRSPTR	REFS	55							
20	NVAR17	INTEGER		GRSPTR	REFS	55							
21	NVAR18	INTEGER		GRSPTR	REFS	55							
22	NVAR19	INTEGER		GRSPTR	REFS	55							
1	NVAR2	INTEGER		GRSPTR	REFS	55							
23	NVAR20	INTEGER		GRSPTR	REFS	55							
24	NVAR21	INTEGER		GRSPTR	REFS	55							
25	NVAR22	INTEGER		GRSPTR	REFS	55							
26	NVAR23	INTEGER		GRSPTR	REFS	55							
27	NVAR24	INTEGER		GRSPTR	REFS	55							
30	NVAR25	INTEGER		GRSPTR	REFS	55							
31	NVAR26	INTEGER		GRSPTR	REFS	55							
32	NVAR27	INTEGER		GRSPTR	REFS	55							
33	NVAR28	INTEGER		GRSPTR	REFS	55							
34	NVAR29	INTEGER		GRSPTR	REFS	55							
2	NVAR3	INTEGER		GRSPTR	REFS	55							
35	NVAR30	INTEGER		GRSPTR	REFS	55							
36	NVAR31	INTEGER		GRSPTR	REFS	55							
37	NVAR32	INTEGER		GRSPTR	REFS	55							
40	NVAR33	INTEGER		GRSPTR	REFS	55							
41	NVAR34	INTEGER		GRSPTR	REFS	55							
42	NVAR35	INTEGER		GRSPTR	REFS	55							
43	NVAR36	INTEGER		GRSPTR	REFS	55							
44	NVAR37	INTEGER		GRSPTR	REFS	55							
3	NVAR4	INTEGER		GRSPTR	REFS	55							
4	NVAR5	INTEGER		GRSPTR	REFS	55							
5	NVAR6	INTEGER		GRSPTR	REFS	55							
6	NVAR7	INTEGER		GRSPTR	REFS	55							
7	NVAR8	INTEGER		GRSPTR	REFS	55							
10	NVAR9	INTEGER		GRSPTR	REFS	55							
13	NXBD	INTEGER		GR0235	REFS	44							
14	NXBDG	INTEGER		GR0235	REFS	44							
10	PDSC	REAL		BDGR	REFS	53	146						
24	PG	REAL		BDGR	REFS	53	284	291	DEFINED	283	284		
2	PI	REAL		BDG02D	REFS	50	135	136	137				
11	PI43	REAL		BDGR	REFS	53	264	265	266	271			
0	PLENP	REAL		F.P.	REFS	2*145	DEFINED	8					
0	POROS	REAL	ARRAY	F.P.	REFS	60	112	200	DEFINED	8			
0	POW	REAL	ARRAY	F.P.	REFS	61	100	105	DEFINED	8			
2344	POWERL	REAL			REFS	101	DEFINED	100					
0	PRF	REAL	ARRAY	F.P.	REFS	61	123	155	160	161	171	296	
					DEFINED	8	115						
2350	PRFC	REAL			REFS	115	DEFINED	114					
0	PRFOLD	REAL	ARRAY	F.P.	REFS	61	155	2*160	2*161	DEFINED	8	123	

VARIABLES SN TYPE RELOCATION

					296							
0	PRSO	REAL	ARRAY	F.P.	REFS	61	144	145	DEFINED	8		
23	PTPL	REAL		BDGR	REFS	53	112					
15	RAD	REAL	ARRAY	GR0235	REFS	44	61	236	264	265	266	
2416	RATIO	REAL			REFS	291	DEFINED	288				
2335	RGG	REAL			REFS	303	321	323	DEFINED	90	303	
2422	RGGE	REAL			REFS	324	DEFINED	322				
2423	RGGF	REAL			REFS	324	DEFINED	323				
2421	RGGL	REAL			REFS	324	DEFINED	321				
2334	RGP	REAL			REFS	302	321	322	DEFINED	89	302	
2333	RGT	REAL			REFS	308	320	321	324	DEFINED	88	308
0	RGTJ	REAL	ARRAY	F.P.	REFS	61	308	314	DEFINED	8	307	
0	RH	REAL	ARRAY	F.P.	REFS	61	117	127	154	DEFINED	8	
0	RHODSL	REAL	ARRAY	F.P.	REFS	61	DEFINED	8				
0	RHOLD	REAL	ARRAY	F.P.	REFS	61	117	154	DEFINED	8	127	
6	RHOOLD	REAL		BDGR	REFS	53	125	155	DEFINED	117	154	
27	RM	REAL		BDGR	REFS	53	210	214	217	218		
2403	RP	REAL			REFS	283	291	DEFINED	272			
0	RS	REAL	ARRAY	F.P.	REFS	60	2*107	2*109	4*135	136	4*137	2*155
					3:28A	DEFINED	8					
2342	RTGAS	REAL			REFS	278	307	DEFINED	96	278		
1	R9	REAL		BDGR	REFS	53	283					
0	SAVG	REAL	ARRAY	F.P.	REFS	61	157	171	190	210	217	2*232
					233	234	270	272	DEFINED	8	213	217
2370	SAVGRM	REAL			REFS	212	213	DEFINED	210			
2	SAVGI	REAL		GR0235	REFS	44						
25	SBCF	REAL		BDGR	REFS	53	158					
17	SIGPI	REAL		BDGR	REFS	53	114					
13	SPT	REAL		GR0A2	REFS	46						
14	SRNK	REAL	ARRAY	GR0A2	REFS	46	212	291				
2375	SUMA	REAL			REFS	2*272	273	274	275	276	291	
					DEFINED	235						
2372	SUMAB	REAL			REFS	235	273	DEFINED	232			
2374	SUMAE	REAL			REFS	235	275	302	DEFINED	234		
2373	SUMAG	REAL			REFS	235	274	303	DEFINED	233		
0	TAUA	REAL	ARRAY	F.P.	REFS	61	168	169	195	200	2*221	2*225
					DEFINED	8	104	130	173			
7	TCONV	REAL		BDGR	REFS	53						
2417	TFGR	REAL			REFS	319	324	DEFINED	318	319		
1	TFPV	REAL		GR0A2	REFS	46	139	DEFINED	137			
0	TFO	REAL	ARRAY	F.P.	REFS	61	157	DEFINED	8			
0	TGASIN	REAL		BDG02D	REFS	50	74	177	279	280	317	
					DEFINED	177						
1	TGASR	REAL		BDG02D	REFS	50	74	75	186	193	280	281
					DEFINED	186	193					
0	TGRAD	REAL	ARRAY	F.P.	REFS	61	110	149	DEFINED	8	107	109
					110							
2	TGRADI	REAL		GR0A2	REFS	46	DEFINED	149				
0	TIT	REAL		F.P.	REFS	76	83	DEFINED	8			
0	TK	REAL	ARRAY	F.P.	REFS	61	118	122	148	283	291	295
					DEFINED	8						
0	TKI	REAL		GR0A2	REFS	46	DEFINED	148				
2355	TKOJK	REAL			REFS	157	DEFINED	150				

```
VARIABLES     SN  TYPE          RELOCATION
     0  TKOLD      REAL      ARRAY     F.P.      REFS      61     150     291  DEFINED       8     118     122
                                                  295
  2332  TMAX       REAL                          REFS     230  DEFINED      84
  2345  TOTFIS     REAL                          REFS     137  DEFINED     101
     1  TPASS      REAL                GR0A4     REFS      49     173     174  DEFINED     169
     0  TS         REAL      ARRAY     F.P.      REFS      60    2*107    2*109    2*155  DEFINED       8
  2360  TSAVE      REAL                          REFS     174  DEFINED     168
    10  TS0        REAL                BDG02D    REFS      50      76  DEFINED      78     327
     7  TS02       REAL                BDG02D    REFS      50  DEFINED      79
     6  T2         REAL                GR0A2     REFS      46      85      86     327  DEFINED      83
    12  VERS       REAL                BDG02D    REFS      50
  2336  VOLJ       REAL                          REFS     300     310     311     312  DEFINED      92     300
    21  VOLUME     REAL                GR0235    REFS      44     175     277     291      297     298     299
                                                  300     302     303  DEFINED     135
     2  Y          REAL      ARRAY     GR0A4     REFS      49      61     181     183      189     190
                                                DEFINED     167

FILE NAMES       MODE
     OUTPUT      FMT                   WRITES    197     198     199     200     203      290     291     314
     TAPE6       FMT                   WRITES     81      85      86     153     155      324     329

EXTERNALS          TYPE    ARGS        REFERENCES
     ERF           REAL       1 LIBRARY    115      159
     GRASS2                  11           157
     GRASS4                   6           171

INLINE FUNCTIONS   TYPE    ARGS        DEF LINE  REFERENCES
     ABS           REAL       1  INTRIN              320
     AMAX1         REAL       0  INTRIN              113
     AMIN1         REAL       0  INTRIN              229

STATEMENT LABELS          DEF LINE   REFERENCES
    47   100                  80        71        73        76
   175   110                 109       105       106
   205   120                 110       108
   261   130                 120       116
   302   140                 124       119
     0   150                 125       124
     0   160                 127       102
   337   170                 134       231
   401   180                 143       140
   403   190                 144       142
   501   200                 157       152
   546   210                 163       160
   550   220                 164       162
     0   230                 167       165
   567   240                 168       231
     0   250                 181       179
   727   260                 195       187       191
  1012   270                 201       195
  1022   280                 205       201
  1104   290                 216       212
  1130   300                 220       208       216
```

STATEMENT LABELS			DEF LINE	REFERENCES	
1142	310		222	305	
1147	320		224	133	228
1151	330		225	222	
0	340	INACTIVE	227	2*226	
1162	350		229	226	
1204	360		232	221	
0	370		270	269	
1405	380		285	204	282
0	390	INACTIVE	290	2*289	
1456	400		295	289	
0	410		316	91	
1642	420		328	294	
1653	430		330	69	
2075	440	FMT	333	81	
2105	450	FMT	335	85	
2111	460	FMT	336	86	
2116	470	FMT	337	153	
2125	480	FMT	338	155	
2151	490	FMT	342	290	
2161	500	FMT	344	200	
2173	510	FMT	346	197	
2177	520	FMT	347	198	
2203	530	FMT	348	199	
2207	540	FMT	349	203	
2216	550	FMT	350	314	
2231	560	FMT	352	291	
2267	570	FMT	357	324	
2307	580	FMT	360	329	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
114	410	J	91 316	1460B		EXT REFS	EXITS	NOT INNER
144	160	K	102 127	157B		EXT REFS	NOT INNER	
303	150	N	124 125	10B	INSTACK			
553	230	N	165 167	13B	OPT			
636	250	N	179 181	13B	OPT			
743		N	197 197	13B		EXT REFS		
1037	300	N	208 220	74B	OPT			
1300	370	N	269 270	11B	INSTACK			

COMMON BLOCKS	LENGTH
GR0235	18
GR0A2	18
GR0A3	5
GR0A4	10
BDG02D	11
BDGR	24
GR5PTR	38

STATISTICS

PROGRAM LENGTH	2702B	1474
SCM LABELED COMMON LENGTH	174B	124

140000B SCM USED

```
      1              SUBROUTINE GRASSI (SUM,S)                                  GRASSI      2
                     IF (S.EQ.0.) RETURN                                        GRASSI      3
                     IF (S-SUM) 100,100,110                                     GRASSI      4
                100  SUM = SUM-S                                               GRASSI      5
      5              S = 0.                                                     GRASSI      6
                     RETURN                                                     GRASSI      7
                110  S = S-SUM                                                  GRASSI      8
                     SUM = 0.                                                   GRASSI      9
                     RETURN                                                     GRASSI     10
     10              END                                                        GRASSI     11
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
    4  GRASSI          1        2        6        9

VARIABLES     SN  TYPE           RELOCATION
    0  S          REAL                F.P.       REFS        2        3        4        7    DEFINED        1        5
                                                                                      7
    0  SUM        REAL                F.P.       REFS        3        4        7    DEFINED        1        4        8

STATEMENT LABELS              DEF LINE   REFERENCES
    0  100          INACTIVE       4        2*3
   23  110                         7         3
```

STATISTICS

```
  PROGRAM LENGTH                  30B      24
        140000B SCM USED
```

```
      SUBROUTINE GRASS2 (H,TKOLD,IRSTAR,FOGBDY,CO,HH,TFO,SAVG,DIST,NF,KF GRASS2      2
     +)                                                                  GRASS2      3
      COMMON/GR0A2/TK,TFPV,TGRAD,HS,AREA,GRD,T2,AGBY,FBDEN,FBSAT,DELT    GRASS2      4
     +,SPT,SRNK(3),GROW(3)                                               GRASS2      5
      COMMON/BDG02D/                                                     GRASS2      6
     +TGASIN,TGASR,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02,                    GRASS2      7
     +TSC,IRSTRO,VERS                                                    GRASS2      8
      COMMON/GR2A4/EPS,YA,IMAX2,D4LIM                                    GRASS2      9
      COMMON/GTWOLC/SQN,DELHVN,YY,XX,XLAMDA,CONS,FC,FCEC,FCSD,DCEC,DCSD, GRASS2     10
     +DCECN                                                              GRASS2     11
      COMMON/GR0235/AVN,GASIN,SAVGI,J,K,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,   GRASS2     12
     +NMAXG,NXBD,NXBDG,RAD,VOLUME                                        GRASS2     13
      COMMON/GR2A3/PBK,PGBDY,PBKDS,PDSL,PBKGBY,PBKDLC,FLXGB2,GBRF,       GRASS2     14
     +RRGBIP,RTRS,BLKMOR,GBYMOP,NMAXD,NMAXB2,NMAXD2,NMAXG2,GBYMR,S12,   GRASS2     15
     +S13,S34                                                            GRASS2     16
      COMMON/BDGR2/FFDSLC,ATMVOL,BOLTZ,G1,G2,EPSI,                       GRASS2     17
     +AVNUM,RG,DELHV,TPG,GBSO2P,SIG,WM1,WM2,XK,XKP,GBR,                  GRASS2     18
     +QSSTAR,QS,DZERO,PZERO,FN,ACON,DELTA,REDIS,RESCON,DVOL,EVL,         GRASS2     19
     +DVOG,EVG,ALFA,BEVK,BADC1,BADC2,BADC3,BADC4,BADC5,BADC6,            GRASS2     20
     +GBADC1,GBADC2,FAWGE,ASTAR,NOYES(2),GBADC3,A(9),DLIM,B              GRASS2     21
      DIMENSION PBK(2,2),PGBDY(2),                                       GRASS2     22
     +PBKGBY(2),EPS(6),SAVG(NF,KF,4),DIST(NF,KF,4)                       GRASS2     23
     +,YA(4),RAD(2,2),                                                   GRASS2     24
     +RTRS(2),BVBULK(2),                                                 GRASS2     25
     +BULKA(2),BVGBDY(2),BDBULK(2),BDGBDY(2),FOGBDY(KF),                 GRASS2     26
     +CO(NF,KF),HH(NF,KF),TFO(NF,KF)                                     GRASS2     27
C                                                                        GRASS2     28
      IF (KFIRST.NE.0) GO TO 100                                         GRASS2     29
      AVN = AVNUM                                                        GRASS2     30
      DELHVN = DELHV/AVNUM                                               GRASS2     31
      XLAMDA = ATMVOL**(1./3.)                                           GRASS2     32
      CONS = 3.*XK/(2.*XK+XKP)                                           GRASS2     33
      FC = 4.*PI/(3.*ATMVOL)*CONS                                        GRASS2     34
      FCEC = FC*DELHVN                                                   GRASS2     35
      FCSD = FC*QSSTAR                                                   GRASS2     36
      DCEC = 3.*ATMVOL*ATMVOL/(8.*BOLTZ*PI*SIG*SIG)*SQRT((WM1+WM2)/(WM1* GRASS2     37
     +WM2)*.5*PI*RG)*PZERO                                               GRASS2     38
      DCSD = 3.*XLAMDA*ATMVOL*DZERO/(2.*PI)                              GRASS2     39
      KFIRST = 1                                                         GRASS2     40
      D4LIM = DLIM                                                       GRASS2     41
  100 CONTINUE                                                           GRASS2     42
      GAMMA = G1-G2*(TK-273.14)                                          GRASS2     43
      AGBY = ACON/GRD                                                    GRASS2     44
      TKS = TK                                                           GRASS2     45
      IF (TKS.LE.1773.0) TKS = 1773.0                                    GRASS2     46
      VKT = BEVK*TKS                                                     GRASS2     47
      DVCVL = DVOL*EXP(-EVL/VKT)                                         GRASS2     48
      DVCVG = DVOG*EXP(-EVG/VKT)                                         GRASS2     49
      D = GRD*1.E4                                                       GRASS2     50
      IF (D.LE.2.0) D = 2.0                                              GRASS2     51
      IF (D.GE.14.5) D = 14.5                                            GRASS2     52
      A0 = A(1)+A(2)*D+A(3)*D*D                                          GRASS2     53
      A1 = A(4)+A(5)*D+A(6)*D*D                                          GRASS2     54
```

```
      A2 = A(7)+A(8)*D+A(9)*D*D                                          GRASS2     55
   55 IF (TKS.GE.2350.0) TKS = 2350.0                                    GRASS2     56
      SIGF = EXP(A0+A1/TKS+A2/TKS/TKS)*9.8E05                            GRASS2     57
      DTDT = (TK-TKOLD)/DELT                                             GRASS2     58
      DCIE = BADC3*TFPV*EXP(BADC4/TK)                                    GRASS2     59
      CALL GRASS5 (TK,GAMMA,HS,SAVG,NF,KF)                               GRASS2     60
   60 OKT = 1.0/(BOLTZ*TK)                                               GRASS2     61
      CONST = TGRAD/TK                                                   GRASS2     62
      FCSDT = FCSD*CONST                                                 GRASS2     63
      FCECT = FCEC*CONST                                                 GRASS2     64
      EVCDTD = EXP(-DELHV/(RG*TK))/SQRT(TK)                              GRASS2     65
   65 DCSDT = DCSD*EXP(-QS/(RG*TK))                                      GRASS2     66
      FBSAT = ASTAR*AGBY                                                 GRASS2     67
      FBDEN = +PI*RAD(1,2)*RAD(1,2)*DIST(J,K,3)                          GRASS2     68
      RTRS(1) = TFPV*RESCON*(1.0-RAD(2,1)/(RAD(2,1)+REDIS))              GRASS2     69
      RTRS(2) = TFPV*RESCON*(1.0-RAD(1,2)/(RAD(1,2)+REDIS))*GBR          GRASS2     70
   70 S12 = SAVG(J,K,1)/SAVG(J,K,2)                                      GRASS2     71
      S13 = SAVG(J,K,1)/SAVG(J,K,3)                                      GRASS2     72
      S23 = SAVG(J,K,2)/SAVG(J,K,3)                                      GRASS2     73
      S34 = SAVG(J,K,3)/SAVG(J,K,4)                                      GRASS2     74
      IF (KPRINT.LT.2) GO TO 110                                         GRASS2     75
   75 PRINT 360, TK,TGRAD,DTDT,TFPV,GASIN                                GRASS2     76
      PRINT 370                                                          GRASS2     77
      PRINT 400                                                          GRASS2     78
      PRINT 410                                                          GRASS2     79
  110 LN = 0                                                             GRASS2     80
   80 L = 0                                                              GRASS2     81
  120 L = L+1                                                            GRASS2     82
      N = 0                                                              GRASS2     83
  130 N = N+1                                                            GRASS2     84
      IF (.NOT.(L.EQ.2.AND.KPRINT.GE.2)) GO TO 140                       GRASS2     85
   85 IF (N.EQ.1) PRINT 380                                              GRASS2     86
      IF (N.EQ.2) PRINT 390                                              GRASS2     87
      PRINT 400                                                          GRASS2     88
  140 LN = LN+1                                                          GRASS2     89
      RADC = RAD(N,L)**3                                                 GRASS2     90
   90 C  -----DRIVING FORCE ON BUBBLE IN TEMPERATURE GRADIENT            GRASS2     91
      FSURF = -FCSDT*RADC                                                GRASS2     92
      FEVCD = -FCECT*RADC                                                GRASS2     93
      FATOM = -FCSDT*RADC                                                GRASS2     94
      TAUB = RAD(N,L)*RAD(N,L)/(DVCVL)                                   GRASS2     95
   95 IF (DTDT.LE.0.0) GO TO 150                                         GRASS2     96
      TPD = TKOLD*RAD(N,L)*SIGF/(3.*GAMMA*DTDT)                          GRASS2     97
      GO TO 160                                                          GRASS2     98
  150 TPD = 20.0*TAUB                                                    GRASS2     99
      C  -----LATTICE BUBBLE DIFFUSION COEFFICIENTS AND VELOCITIES       GRASS2    100
  100 160 BDSURF = DCSDT/(RADC*RAD(N,L))                                 GRASS2    101
      BDEVCD = EVCDTD*DCEC/SAVG(J,K,LN)                                  GRASS2    102
      BVSURF = FSURF*BDSURF*OKT                                          GRASS2    103
      BVEVCD = FEVCD*BDEVCD*OKT                                          GRASS2    104
      IF (L.EQ.2) GO TO 200                                              GRASS2    105
  105 BETAB = 1.0-EXP(-TAUB/TPD)                                         GRASS2    106
      BADC7 = BADC5+(4.0-BADC5)*BETAB                                    GRASS2    107
```

```
                BADC8 = BADC2+(108000.-BADC2)*BETAB                                  GRASS2   108
                BDATOM = BADC1*EXP(-BADC8/(1.986*TK))/((RAD(N,L)*BADC6)**BADC7)      GRASS2   109
                IF (N.EQ.1) BDATOM = AMAX1(BDATOM,DCIE)                              GRASS2   110
110             BVATOM = FATOM*BDATOM*OKT                                            GRASS2   111
                BVBULK(N) = -AMAX1(BVEVCD,AMIN1(BVSURF,BVATOM))                      GRASS2   112
                BDBULK(N) = AMAX1(BDEVCD,AMIN1(BDSURF,BDATOM))                       GRASS2   113
      C   CALCULATE COALESCENCE PROBABILITIES IN BULK                                GRASS2   114
                M = 0                                                                GRASS2   115
115   170       M = M+1                                                              GRASS2   116
                RADNM = RAD(N,L)+RAD(M,L)                                            GRASS2   117
                PR = 4.*PI*(BDBULK(N)+BDBULK(M))*RADNM                               GRASS2   118
                PB = PI*ABS(BVBULK(N)-BVBULK(M))*RADNM*RADNM                         GRASS2   119
                TAUB = RADNM*RADNM/(DVCVL)                                           GRASS2   120
120             HOTAUG = -TPD/TAUB                                                   GRASS2   121
                FACTOR = 0.0                                                         GRASS2   122
                IF (HOTAUG.GT.DLIM) FACTOR = EXP(HOTAUG)                             GRASS2   123
                RATEB = (1.0-(1.0-ALFA)*FACTOR)                                      GRASS2   124
                PBK(N,M) = (PR+PB)*RATEB                                             GRASS2   125
125             IF (M.EQ.N) GO TO 180                                                GRASS2   126
                PBK(M,N) = PBK(N,M)                                                  GRASS2   127
                GO TO 170                                                            GRASS2   128
          180   IF (N.NE.1) GO TO 190                                                GRASS2   129
                PBK(N,N) = FN*PBK(N,N)                                               GRASS2   130
130       190   BULKA(N) = PBK(N,N)                                                  GRASS2   131
                GO TO 220                                                            GRASS2   132
      C   -----BOUNDARY AND EDGE BUBBLE DIFFUSION COEFFICIENTS AND VELOCITIES       GRASS2   133
          200   TAUG = RAD(N,L)*RAD(N,L)/(DVCVG)                                     GRASS2   134
                BETAG = 1.0-EXP(-TAUG/TPD)                                           GRASS2   135
135             GBADC4 = BADC5+(4.0-BADC5)*BETAG                                     GRASS2   136
                GBADC5 = GBADC2+(108000.-GBADC2)*BETAG                               GRASS2   137
                BDGATM = GBADC1*EXP(-GBADC5/(1.986*TK))/((RAD(N,L)*GBADC3)**GBADC4   GRASS2   138
               +)                                                                    GRASS2   139
                BVGATM = FATOM*BDGATM*OKT                                            GRASS2   140
140             BVGBDY(N) = -FOGBDY(K)*AMAX1(BVEVCD,AMIN1(BVSURF,BVGATM))            GRASS2   141
                BDGBDY(N) = AMAX1(BDEVCD,AMIN1(BDSURF,BDGATM))                       GRASS2   142
                GBYMR = -BVGBDY(N)*AREA                                              GRASS2   143
      C   CALCULATE RATE OF DIFFUSION OF GRAIN  BOUNDARY BUBBLES TO GRAIN EDGE      GRASS2   144
                IF (N.GT.1) GO TO 210                                                GRASS2   145
145             TKS = TK                                                             GRASS2   146
                IF (TK.LE.477.0) TKS = 477.0                                         GRASS2   147
                BDATOM = BADC1*EXP(-BADC8/(1.986*TKS))/((RAD(N,L)*BADC6)**BADC7)     GRASS2   148
                DCIEB = DCIE*(RAD(1,L)/RAD(N,L))**BADC7                              GRASS2   149
                BDATOM = AMAX1(BDATOM,DCIEB)                                         GRASS2   150
150             BDLTCE = AMAX1(BDEVCD,AMIN1(BDSURF,BDATOM))                          GRASS2   151
                BPRIM = SQRT(2.0/DELTA/BDGBDY(N))*(BDLTCE*PI/H)**.25*(GRD*.26726)    GRASS2   152
                BMPRIM = -BPRIM                                                      GRASS2   153
                EB = 0.0                                                             GRASS2   154
                IF (BPRIM.GT.DLIM) EB = EXP(BMPRIM)                                  GRASS2   155
155             FLUXED = .25*((1.0-EB)/BPRIM-EB)/H                                   GRASS2   156
                IF (FLUXED.LE.0) FLUXED = 0.                                         GRASS2   157
                RRGBIP = ABS(BVGBDY(1))/(GRD/3.742)+FLUXED                           GRASS2   158
      C   CALCULATE COALESCENCE PROBABILITIES ON GRAIN BOUNDARIES AND EDGES        GRASS2   159
          210   PR = 2.0*BDGBDY(N)/AGBY                                              GRASS2   160
```

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                  RADNM = 2.0*RAD(N,L)                                                GRASS2   161
                  TAUG = RADNM*RADNM/(DVCVG)                                          GRASS2   162
                  HOTAUG = -TPD/TAUB                                                  GRASS2   163
                  FACTOR = 0.0                                                        GRASS2   164
                  IF (HOTAUG.GT.DLIM) FACTOR = EXP(HOTAUG)                            GRASS2   165
                  RATEG = (1.0-(1.0-ALFA)*FACTOR)                                     GRASS2   166
                  PGBDY(N) = PR*RATEG                                                 GRASS2   167
                  GO TO 280                                                           GRASS2   168
            C   CALCULATE  DIFFUSION RATE OF LATTICE GAS TO GRAIN FACES               GRASS2   169
            220   DPRIM = BDBULK(N)*4.0/(GRD*GRD)                                     GRASS2   170
                  IF (N.GT.1) GO TO 240                                               GRASS2   171
                  AMI = AMAX1(TFPV,TFO(J,K))                                          GRASS2   172
                  DTF = ABS(TFO(J,K)-TFPV)/AMAX1(AMI,1.0)                             GRASS2   173
                  IF (DTF.LE..01) GO TO 230                                           GRASS2   174
                  CO(J,K) = DIST(J,K,N)                                               GRASS2   175
                  TS02 = TS0                                                          GRASS2   176
            230   T = T2-TS02                                                         GRASS2   177
            240   IF (N.GT.1) T = H                                                   GRASS2   178
                  DPRIMT = DPRIM*T                                                    GRASS2   179
                  DPT = DPRIMT*PI*PI                                                  GRASS2   180
                  IF (N.GT.1) GO TO 250                                               GRASS2   181
                  FLXGB2 = GASIN*(6.0*SQRT(DPRIMT/PI)-3.*DPRIMT)                      GRASS2   182
                  IF (DPT.GT.1.0) FLXGB2 = GASIN*(1.0-6.0*EXP(-DPT)/PI/PI)            GRASS2   183
            250   GBI = 3.0*(SQRT(DPRIM/PI/T)-DPRIM)                                  GRASS2   184
                  IF (DPT.GT.1.0) GBI = 6.0*DPRIM*EXP(-DPT)                           GRASS2   185
                  IF (N.GT.1) GO TO 270                                               GRASS2   186
                  IF (DIST(J,K,N).LE.1.E-20) GO TO 260                                GRASS2   187
                  XGBI = GBI*CO(J,K)/DIST(J,K,N)                                      GRASS2   188
                  FLXGB2 = FLXGB2/DIST(J,K,N)+XGBI                                    GRASS2   189
                  GO TO 270                                                           GRASS2   190
            260   FLXGB2 = 0.0                                                        GRASS2   191
                  XGBI = 0.0                                                          GRASS2   192
            270   IF (N.EQ.1) GBI = 0.0                                               GRASS2   193
                  PBKGBY(N) = ABS(BVBULK(N))*AGBY+GBI                                 GRASS2   194
                  IF (KPRINT.LT.2) GO TO 290                                          GRASS2   195
                  PRINT 350, SAVG(J,K,LN),RAD(N,L),BDSURF,BDEVCD,BDATOM,BVSURF,BVEVC  GRASS2   196
                 +D,BVATOM,PBKGBY(N)                                                  GRASS2   197
                  GO TO 290                                                           GRASS2   198
            280   IF (KPRINT.LT.2) GO TO 290                                          GRASS2   199
                  PRINT 350, SAVG(J,K,LN),RAD(N,L),BDSURF,BDEVCD,BDGATM,BVSURF,BVEVC  GRASS2   200
                 +D,BVGATM,RRGBIP                                                     GRASS2   201
            290   CONTINUE                                                            GRASS2   202
                  IF (N.EQ.1) GO TO 130                                               GRASS2   203
                  IF (L.EQ.1) GO TO 120                                               GRASS2   204
                  GRL112 = 2.0*PBK(1,1)*DIST(J,K,1)*DIST(J,K,1)*S12                   GRASS2   205
                  GRL122 = PBK(1,2)*S12*DIST(J,K,1)*DIST(J,K,2)                       GRASS2   206
                  GRL223 = PBK(2,2)*DIST(J,K,2)*DIST(J,K,2)                           GRASS2   207
                  SRNL21 = RTRS(1)*DIST(J,K,2)*S12                                    GRASS2   208
                  GRLG2 = PBKGBY(2)*DIST(J,K,2)*S23                                   GRASS2   209
                  IF (S23.GT.1.0) GRLG2 = -GRLG2                                      GRASS2   210
                  GRG223 = PGBDY(1)*DIST(J,K,3)*DIST(J,K,3)                           GRASS2   211
                  GRE223 = PGBDY(2)*DIST(J,K,4)*DIST(J,K,4)                           GRASS2   212
                  IF (S34.GT.1.0) GRGE2 = -GRGE2                                      GRASS2   213
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                SRNG21 = RTRS(2)*DIST(J,K,3)*S13                                  GRASS2   214
                FLUXL = GRL223-SRNL21                                             GRASS2   215
215             STABL = GRL112+GRL122                                             GRASS2   216
                STABG = (FLXGB2+PBKGBY(1)*DIST(J,K,1))*S13                        GRASS2   217
                IF (FLUXL.GE.0.0) GO TO 300                                       GRASS2   218
                FLUXL = -FLUXL                                                    GRASS2   219
                SRNK(1) = (FLUXL-STABL)*H                                         GRASS2   220
220             GROW(1) = 0.0                                                     GRASS2   221
                GO TO 310                                                         GRASS2   222
            300 GROW(1) = (FLUXL-STABL)*H                                         GRASS2   223
                SRNK(1) = 0.0                                                     GRASS2   224
            310 FLUXG = GRG223-SRNG21-GRLG2                                       GRASS2   225
225             IF (FLUXG.GE.0.0) GO TO 320                                       GRASS2   226
                FLUXG = -FLUXG                                                    GRASS2   227
                SRNK(2) = (FLUXG-STABG)*H                                         GRASS2   228
                GROW(2) = 0.0                                                     GRASS2   229
                GO TO 330                                                         GRASS2   230
230         320 GROW(2) = (FLUXG-STABG)*H                                         GRASS2   231
                SRNK(2) = 0.0                                                     GRASS2   232
            330 GROW(3) = GRE223*H                                                GRASS2   233
                SRNK(3) = 0.0                                                     GRASS2   234
                YA(1) = BULKA(1)                                                  GRASS2   235
235             YA(2) = 0.0                                                       GRASS2   236
                YA(3) = 0.0                                                       GRASS2   237
                YA(4) = 0.0                                                       GRASS2   238
                    DO 340 N=1,4                                                  GRASS2   239
            340     EPS(N) = EPSI/SAVG(J,K,N)                                     GRASS2   240
240             EPS(5) = EPSI                                                     GRASS2   241
                EPS(6) = EPS(3)                                                   GRASS2   242
                TFO(J,K) = TFPV                                                   GRASS2   243
                RETURN                                                            GRASS2   244
            C                                                                     GRASS2   245
245         350 FORMAT (10E13.5)                                                  GRASS2   246
            360 FORMAT (//4H TK=,E12.4,7H TGRAD=,E12.4,6H DTDT=,E12.4,6H TFPV=,E12 GRASS2   247
               +.4,7H GASIN=,E12.4)                                               GRASS2   248
            370 FORMAT (/21H LATTICE SIZE CLASSES)                                GRASS2   249
            380 FORMAT (/20H BOUNDARY SIZE CLASS)                                 GRASS2   250
250         390 FORMAT (/16H EDGE SIZE CLASS)                                     GRASS2   251
            400 FORMAT (//52H          SAVG          RAD       BDSURF       BDEVCD, GRASS2   252
               +52H       BDATOM       BVSURF       BVEVCD       BVATOM,13H     GRASS2   253
               +FLUXGB)                                                           GRASS2   254
            410 FORMAT (1H0)                                                      GRASS2   255
255             END                                                               GRASS2   256
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SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4 GRASS2	1	243

VARIABLES	SN	TYPE		RELOCATION							
55	A	REAL	ARRAY	BDGR2	REFS	16	3*52	3*53	3*54		
26	ACON	REAL		BDGR2	REFS	16	43				
7	AGBY	REAL		GR0A2	REFS	3	66	159	193	DEFINED	43
36	ALFA	REAL		BDGR2	REFS	16	123	165			
2126	AMI	REAL			REFS	172	DEFINED	171			
4	AREA	REAL		GR0A2	REFS	3	142				
51	ASTAR	REAL		BDGR2	REFS	16	66				
1	ATMVOL	REAL		BDGR2	REFS	16	31	33	2*36	38	
0	AVN	REAL		GR0235	REFS	11	DEFINED	29			
6	AVNUM	REAL		BDGR2	REFS	16	29	30			
2042	A0	REAL			REFS	56	DEFINED	52			
2043	A1	REAL			REFS	56	DEFINED	53			
2044	A2	REAL			REFS	56	DEFINED	54			
67	B	REAL		BDGR2	REFS	16					
40	BADC1	REAL		BDGR2	REFS	16	108	147			
41	BADC2	REAL		BDGR2	REFS	16	2*107				
42	BADC3	REAL		BDGR2	REFS	16	58				
43	BADC4	REAL		BDGR2	REFS	16	58				
44	BADC5	REAL		BDGR2	REFS	16	2*106	2*135			
45	BADC6	REAL		BDGR2	REFS	16	108	147			
2075	BADC7	REAL			REFS	108	147	148	DEFINED	106	
2076	BADC8	REAL			REFS	108	147	DEFINED	107		
2077	BDATOM	REAL			REFS	109	110	112	149	150	195
					DEFINED	108	109	147	149		
2160	BDBULK	REAL	ARRAY		REFS	21	2*117	169	DEFINED	112	
2071	BDEVCD	REAL			REFS	103	112	141	150	195	199
					DEFINED	101					
2111	BDGATM	REAL			REFS	139	141	199	DEFINED	137	
2162	BDGBDY	REAL	ARRAY		REFS	21	151	159	DEFINED	141	
2117	BDLTCE	REAL			REFS	151	DEFINED	150			
2070	BDSURF	REAL			REFS	102	112	141	150	195	199
					DEFINED	100					
2074	BETAB	REAL			REFS	106	107	DEFINED	105		
2111	BETAG	REAL			REFS	135	136	DEFINED	134		
37	BEVK	REAL		BDGR2	REFS	16	46				
20	BLKMOR	REAL		GR2A3	REFS	13					
2121	BMPRIM	REAL			REFS	154	DEFINED	152			
2	BOLTZ	REAL		BDGR2	REFS	16	36	60			
2120	BPRIM	REAL			REFS	152	154	155	DEFINED	151	
2154	BULKA	REAL	ARRAY		REFS	21	234	DEFINED	130		
2100	BVATOM	REAL			REFS	111	195	DEFINED	110		
2152	BVBULK	REAL	ARRAY		REFS	21	2*118	193	DEFINED	111	
2073	BVEVCD	REAL			REFS	111	140	195	199	DEFINED	103
2115	BVGATM	REAL			REFS	140	199	DEFINED	139		
2156	BVGBDY	REAL	ARRAY		REFS	21	142	157	DEFINED	140	
2072	BVSURF	REAL			REFS	111	140	195	199	DEFINED	102
5	CONS	REAL		GTWOLC	REFS	9	33	DEFINED	32		
2051	CONST	REAL			REFS	62	63	DEFINED	61		
0	C0	REAL	ARRAY	F.P.	REFS	21	187	DEFINED	1	174	
2041	D	REAL			REFS	50	51	3*52	3*53	3*54	
					DEFINED	49	50	51			
11	DCEC	REAL		GTWOLC	REFS	9	101	DEFINED	36		

VARIABLES	SN	TYPE	RELOCATION									
13	DCECN	REAL	GTWOLC	REFS	9							
2047	DCIE	REAL		REFS	109	148	DEFINED	58				
2116	DCIEB	REAL		REFS	149	DEFINED	148					
12	DCSD	REAL	GTWOLC	REFS	9	65	DEFINED	38				
2055	DCSDT	REAL		REFS	100	DEFINED	65					
10	DELHV	REAL	BDGR2	REFS	16	30	64					
1	DELHVN	REAL	GTWOLC	REFS	9	34	DEFINED	30				
12	DELT	REAL	GR0A2	REFS	3	57						
27	DELTA	REAL	BDGR2	REFS	16	151						
0	DIST	REAL	ARRAY F.P.	REFS	21	67	174	186	187	188	2*204	
				2*205	2*206	207	208	2*210	2*211	213	216	
				DEFINED	1							
66	DLIM	REAL	BDGR2	REFS	16	40	122	154	164			
2125	DPRIM	REAL		REFS	178	2*183	184	DEFINED	169			
2131	DPRIMT	REAL		REFS	179	2*181	DEFINED	178				
2132	DPT	REAL		REFS	2*182	2*184	DEFINED	179				
2046	DTDT	REAL		REFS	75	95	96	DEFINED	57			
2127	DTF	REAL		REFS	173	DEFINED	172					
2040	DVCVG	REAL		REFS	133	151	DEFINED	48				
2037	DVCVL	REAL		REFS	94	119	DEFINED	47				
34	DVOG	REAL	BDGR2	REFS	16	48						
32	DVOL	REAL	BDGR2	REFS	16	47						
23	DZERO	REAL	BDGR2	REFS	16	38						
13	D4LIM	REAL	GR2A4	REFS	8	DEFINED	40					
2122	EB	REAL		REFS	2*155	DEFINED	153	154				
0	EPS	REAL	ARRAY GR2A4	REFS	8	21	241	DEFINED	239	240	241	
5	EPSI	REAL	BDGR2	REFS	16	239	240					
2054	EVCDTD	REAL		REFS	101	DEFINED	64					
35	EVG	REAL	BDGR2	REFS	16	48						
33	EVL	REAL	BDGR2	REFS	16	47						
2106	FACTOR	REAL		REFS	123	165	DEFINED	121	122	163	164	
2065	FATOM	REAL		REFS	110	139	DEFINED	93				
50	FAWGE	REAL	BDGR2	REFS	16							
10	FBDEN	REAL	GR0A2	REFS	3	DEFINED	67					
11	FBSAT	REAL	GR0A2	REFS	3	DEFINED	66					
6	FC	REAL	GTWOLC	REFS	9	34	35	DEFINED	33			
7	FCEC	REAL	GTWOLC	REFS	9	63	DEFINED	34				
2053	FCECT	REAL		REFS	92	DEFINED	63					
10	FCSD	REAL	GTWOLC	REFS	9	62	DEFINED	35				
2052	FCSDT	REAL		REFS	91	93	DEFINED	62				
2064	FEVCD	REAL		REFS	103	DEFINED	92					
0	FFDSLC	REAL	BDGR2	REFS	16							
2123	FLUXED	REAL		REFS	156	157	DEFINED	155	156			
2151	FLUXG	REAL		REFS	225	226	227	230	DEFINED	224	226	
2146	FLUXL	REAL		REFS	217	218	219	222	DEFINED	214	218	
13	FLXGB2	REAL	GR2A3	REFS	13	188	216	DEFINED	181	182	188	
				190								
25	FN	REAL	BDGR2	REFS	16	129						
0	FOGBDY	REAL	ARRAY F.P.	REFS	21	140	DEFINED	1				
2063	FSURF	REAL		REFS	102	DEFINED	91					
2034	GAMMA	REAL		REFS	59	96	DEFINED	42				
1	GASIN	REAL	GR0235	REFS	11	75	181	182				
46	GBADC1	REAL	BDGR2	REFS	16	137						

VARIABLES	SN	TYPE		RELOCATION								
47	GBADC2	REAL		BDGR2	REFS	16	2*136					
54	GBADC3	REAL		BDGR2	REFS	16	137					
2112	GBADC4	REAL			REFS	137	DEFINED	135				
2113	GBADC5	REAL			REFS	137	DEFINED	136				
20	GBR	REAL		BDGR2	REFS	16	69					
14	GBRF	REAL		GR2A3	REFS	13						
12	GBSO2P	REAL		BDGR2	REFS	16						
21	GBYMOR	REAL		GR2A3	REFS	13						
26	GBYMR	REAL		GR2A3	REFS	13	DEFINED	142				
2133	GBI	REAL			REFS	187	193	DEFINED	183	184	192	
5	GRD	REAL		GR0A2	REFS	3	43	49	151	157	2*169	
2143	GRE223	REAL			REFS	232	DEFINED	211				
2144	GRGE2	REAL			REFS	212	DEFINED	212				
2142	GRG223	REAL			REFS	224	DEFINED	210				
2141	GRLG2	REAL			REFS	209	224	DEFINED	208	209		
2135	GRL112	REAL			REFS	215	DEFINED	204				
2136	GRL122	REAL			REFS	215	DEFINED	205				
2137	GRL223	REAL			REFS	214	DEFINED	206				
17	GROW	REAL	ARRAY	GR0A2	REFS	3	DEFINED	220	222	228	230	232
3	G1	REAL		BDGR2	REFS	16	42					
4	G2	REAL		BDGR2	REFS	16	42					
0	H	REAL		F.P.	REFS	151	155	177	219	222	227	230
						232	DEFINED	1				
0	HH	REAL	ARRAY	F.P.	REFS	21	DEFINED	1				
2105	HOTAUG	REAL			REFS	2*122	2*164	DEFINED	120	162		
3	HS	REAL		GR0A2	REFS	3	59					
12	IMAX2	INTEGER		GR2A4	REFS	8						
0	IRSTAR	INTEGER	*UNUSED	F.P.	DEFINED	1						
11	IRSTRO	INTEGER		BDG02D	REFS	5						
3	J	INTEGER		GR0235	REFS	11	67	2*70	2*71	2*72	2*73	101
						171	172	2*174	186	2*187	188	195	199
						2*204	2*205	2*206	207	208	2*210	2*211	213
						216	239	242				
3	JFIRST	INTEGER		BDG02D	REFS	5						
10	JNCDI	INTEGER		GR0235	REFS	11						
11	JNCGBI	INTEGER		GR0235	REFS	11						
4	K	INTEGER		GR0235	REFS	11	67	2*70	2*71	2*72	2*73	101
						140	171	172	2*174	186	2*187	188	195
						199	2*204	2*205	2*206	207	208	2*210	2*211
						213	216	239	242				
0	KF	INTEGER		F.P.	REFS	6*21	59	DEFINED	1			
4	KFIRST	INTEGER		BDG02D	REFS	5	28	DEFINED	39			
5	KPRINT	INTEGER		BDG02D	REFS	5	74	84	194	198		
2060	L	INTEGER			REFS	81	84	89	2*94	96	100	104
						108	2*116	2*133	137	147	2*148	160	195
						199	203	DEFINED	80	81		
2057	LN	INTEGER			REFS	88	101	195	199	DEFINED	79	88
2101	M	INTEGER			REFS	115	116	117	118	124	125	2*126
					DEFINED	114	115					
2061	N	INTEGER			REFS	83	85	86	89	2*94	96	100
						108	109	111	112	116	117	118	124
						125	2*126	128	4*129	3*130	2*133	137	140
						141	142	144	147	148	151	159	160

VARIABLES	SN	TYPE		RELOCATION								
						166	169	170	174	177	180	185	186
						187	188	192	2*193	2*195	199	202	2*239
						DEFINED	82	83	238				
6	NCDI	INTEGER		GR0235		REFS	11						
7	NCGBI	INTEGER		GR0235		REFS	11						
0	NF	INTEGER		F.P.		REFS	5*21	59	DEFINED	1			
6	NMAX	INTEGER		BDG02D		REFS	5						
5	NMAXB	INTEGER		GR0235		REFS	11						
23	NMAXB2	INTEGER		GR2A3		REFS	13						
22	NMAXD	INTEGER		GR2A3		REFS	13						
24	NMAXD2	INTEGER		GR2A3		REFS	13						
12	NMAXG	INTEGER		GR0235		REFS	11						
25	NMAXG2	INTEGER		GR2A3		REFS	13						
52	NOYES	INTEGER	ARRAY	BDGR2		REFS	16						
13	NXRD	INTEGER		GR0235		REFS	11						
14	NXBDG	INTEGER		GR0235		REFS	11						
2050	OKT	REAL				REFS	102	103	110	1[illegible]	DEFINED	60	
2104	PB	REAL				REFS	124	DEFINED	118				
0	PBK	REAL	ARRAY	GR2A3		REFS	13	21	126	129	130	204	205
						206	DEFINED	124	126	129			
12	PBKDLC	REAL		GR2A3		REFS	13						
6	PBKDS	REAL		GR2A3		REFS	13						
10	PBKGBY	REAL	ARRAY	GR2A3		REFS	13	21	195	208	216		
						DEFINED	193						
7	PDSL	REAL		GR2A3		REFS	13						
4	PGBDY	REAL	ARRAY	GR2A3		REFS	13	21	210	211	DEFINED	166	
2	PI	REAL		BDG02D		REFS	5	33	2*36	38	67	117	118
						151	2*179	181	2*182	183			
2103	PR	REAL				REFS	124	166	DEFINED	117	159		
24	PZERO	REAL		BDGR2		REFS	16	36					
22	QS	REAL		BDGR2		REFS	16	65					
21	QSSTAR	REAL		BDGR2		REFS	16	35					
15	RAD	REAL	ARRAY	GR0235		REFS	11	21	2*67	2*68	2*69	89	2*94
						96	100	108	2*116	2*133	137	147	2*148
						160	195	199					
2062	RADC	REAL				REFS	91	92	93	100	DEFINED	89	
2102	RADNM	REAL				REFS	117	2*118	2*119	2*161	DEFINED	116	160
2107	RATEB	REAL				REFS	124	DEFINED	123				
2124	RATEG	REAL				REFS	166	DEFINED	165				
30	REDIS	REAL		BDGR2		REFS	16	68	69				
31	RESCON	REAL		BDGR2		REFS	16	68	69				
7	RG	REAL		BDGR2		REFS	16	36	64	65			
15	RRGBIP	REAL		GR2A3		REFS	13	199	DEFINED	157			
16	RTRS	REAL	ARRAY	GR2A3		REFS	13	21	207	213	DEFINED	68	69
0	SAVG	REAL	ARRAY	F.P.		REFS	21	55	2*70	2*71	2*72	2*73	101
						195	199	239	DEFINED	1			
2	SAVG1	REAL		GR0235		REFS	11						
13	SIG	REAL		BDGR2		REFS	16	2*36					
2045	SIGF	REAL				REFS	96	DEFINED	56				
13	SPT	REAL		GR0A2		REFS	3						
0	SQN	REAL		GTWOLC		REFS	9						
2145	SRNG21	REAL				REFS	224	DEFINED	213				
14	SRNK	REAL	ARRAY	GR0A2		REFS	3	DEFINED	219	223	227	231	233

```
VARIABLES      SN  TYPE          RELOCATION
 2140  SRNL21      REAL                      REFS      214   DEFINED      207
 2150  STABG       REAL                      REFS      227       230   DEFINED      216
 2147  STABL       REAL                      REFS      219       222   DEFINED      215
   27  S12         REAL            GR2A3     REFS       13       204       205      207   DEFINED       70
   30  S13         REAL            GR2A3     REFS       13       213       216   DEFINED       71
 2056  S23         REAL                      REFS      208       209   DEFINED       72
   31  S34         REAL            GR2A3     REFS       13       212   DEFINED       73
 2130  T           REAL                      REFS      178       183   DEFINED      176      177
 2066  TAUB        REAL                      REFS       98       105       120      162   DEFINED       94       119
 2110  TAUG        REAL                      REFS      134   DEFINED      133      161
    1  TFPV        REAL            GR0A2     REFS        3        58        68       69        75       171       172
                                               242
    0  TF0         REAL      ARRAY   F.P.    REFS       21       171       172   DEFINED         1       242
    0  TGASIN      REAL            BDG02D    REFS        5
    1  TGASR       REAL            BDG02D    REFS        5
    2  TGRAD       REAL            GR0A2     REFS        3        61        75
    0  TK          REAL            GR0A2     REFS        3        42        44       57        58       59        60
                                               61      2*64        65        75      108       137      145       146
    0  TKOLD       REAL              F.P.    REFS       57        96   DEFINED         1
 2035  TKS         REAL                      REFS       45        46        55     3*56       147
                                             DEFINED      44        45        55      145       146
 2067  TPD         REAL                      REFS      105       120       134      162   DEFINED       96        98
   11  TPG         REAL            BDGR2     REFS       16
   10  TS0         REAL            BDG02D    REFS        5       175
    7  TS02        REAL            BDG02D    REFS        5       176   DEFINED      175
    6  T2          REAL            GR0A2     REFS        3       176
   12  VERS        REAL            BDG02D    REFS        5
 2036  VKT         REAL                      REFS       47        48   DEFINED       46
   21  VOLUME      REAL            GR0235    REFS       11
   14  WM1         REAL            BDGR2     REFS       16      2*36
   15  WM2         REAL            BDGR2     REFS       16      2*36
 2134  XGB1        REAL                      REFS      188   DEFINED      187      191
   16  XK          REAL            BDGR2     REFS       16      2*32
   17  XKP         REAL            BDGR2     REFS       16        32
    4  XLAMDA      REAL            GTWOLC    REFS        9        38   DEFINED       31
    3  XX          REAL            GTWOLC    REFS        9
    6  YA          REAL      ARRAY GR2A4     REFS        8        21   DEFINED      234       235       236       237
    2  YY          REAL            GTWOLC    REFS        9

FILE NAMES        MODE
      OUTPUT      FMT                   WRITES      75        76        77        78        85        86        87       195
                                               199

EXTERNALS           TYPE    ARGS        REFERENCES
      EXP         REAL        1 LIBRARY      47        48        56        58        64        65       105       108       122
                                              134       137       147       154       164       182       184
      GRASS5                  6              59
      SQRT        REAL        1 LIBRARY      36        64       151       181       183

INLINE FUNCTIONS    TYPE    ARGS        DEF LINE  REFERENCES
      ABS         REAL        1  INTRIN             118       157       172       193
      AMAX1       REAL        0  INTRIN             109       111       112       140       141       149       150       171
                                                    172
```

INLINE FUNCTIONS	TYPE	ARGS	DEF LINE	REFERENCES				
AMINI	REAL	0	INTRIN	111	112	140	141	150

STATEMENT LABELS			DEF LINE	REFERENCES			
74	100		41	28			
353	110		79	74			
357	120		81	203			
364	130		83	202			
405	140		88	84			
444	150		98	95			
447	160		100	97			
557	170		115	127			
641	180		128	125			
650	190		130	128			
655	200		133	104			
1053	210		159	144			
1110	220		169	131			
1156	230		176	173			
1161	240		177	170			
1220	250		183	180			
1276	260		190	186			
1302	270		192	185	189		
1335	280		198	167			
1354	290		201	194	197	198	
1515	300		222	217			
1523	310		224	221			
1542	320		230	225			
1550	330		232	229			
0	340		239	238			
1736	350	FMT	245	195	199		
1740	360	FMT	246	75			
1751	370	FMT	248	76			
1755	380	FMT	249	85			
1761	390	FMT	250	86			
1765	400	FMT	251	77	87		
2003	410	FMT	254	78			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
1566	340	N	238 239	11B	INSTACK

COMMON BLOCKS	LENGTH
GR0A2	18
BDG02D	11
GR2A4	12
GTWOLC	12
GR0235	18
GR243	26
BDGRC	56

STATISTICS

PROGRAM LENGTH	2166B	1142
SCM LABELED COMMON LENGTH	231B	153

140000B SCM USED

```
      SUBROUTINE GRASS3 (Y,YB,YC,GBYMO,PRF,SAVG,DIST,NF,KF)                    GRASS3     2
      COMMON/GR0235/AVN,GASIN,SAVGI,J,K,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,         GRASS3     3
     +NMAXG,NXBD,NXBDG,RAD,VOLUME                                              GRASS3     4
      COMMON/GR0A3/GESW,JKMAX,KI,EGRE,EPRF                                     GRASS3     5
      COMMON/GR2A3/PBK,PGBDY,PBKDS,PDSL,PBKGBY,PBKDLC,FLXGB2,CRF,              GRASS3     6
     +RRGBIP,RTRS,BLKMOR,GBYMOR,NMAXD,NMAXB2,NMAXD2,NMAXG2,GBYMR,S12,         GRASS3     7
     +S13,S34                                                                  GRASS3     8
      DIMENSION PBK(2,2),PGBDY(2),                                             GRASS3     9
     +PBKGBY(2),SAVG(NF,KF,4),DIST(NF,KF,4),RTRS(2),                           GRASS3    10
     +Y(6),YB(4),YC(6),GBYMO(KF),PRF(KF),                                      GRASS3    11
     +BULKB(2),BULKC(2),                                                       GRASS3    12
     +RAD(2,2)                                                                 GRASS3    13
      TARB = RTRS(1)*Y(2)*SAVG(J,K,2)+RTRS(2)*Y(3)*SAVG(J,K,3)                 GRASS3    14
C     -----COALESCENCE IN BULK                                                 GRASS3    15
      BULKC(1) = GASIN                                                         GRASS3    16
      DISAP = Y(2)*PBK(1,2)                                                    GRASS3    17
      BULKB(1) = DISAP                                                         GRASS3    18
      BULKB(2) = 0.0                                                           GRASS3    19
      BULKC(2) = (DISAP+PBK(1,1)*Y(1))*Y(1)*S12                                GRASS3    20
C     -----BULK BUBBLES MIGRATE/DIFFUSE TO GRAIN BOUNDARIES                    GRASS3    21
      DO 100 N=1,2                                                             GRASS3    22
      BULKB(N) = BULKB(N)+PBKGBY(N)                                            GRASS3    23
      IF (N.GT.1) GO TO 100                                                    GRASS3    24
      BULKB(N) = BULKB(N)+FLXGB2                                               GRASS3    25
      GADYC = FLXGB2*S13*Y(N)                                                  GRASS3    26
100   GBDYC = GBDYC+PBKGBY(N)*Y(N)*SAVG(J,K,N)/SAVG(J,K,3)                     GRASS3    27
C     -----BUBBLES MIGRATE IN & OUT OF RADIAL SECTION AND                      GRASS3    28
C     -----GRAIN BOUNDARY BUBBLES RELEASE TO INTER CONNECTED POROSITY          GRASS3    29
C     AND GRAIN-EDGE GAS ESCAPES TO EXTERIOR OF FUEL                           GRASS3    30
      EDGECO = (RRGBIP+EGRE)*Y(3)*S34                                          GRASS3    31
      EDGEC = EDGECO*(1.0-PRF(K))                                              GRASS3    32
      GR = (EDGECO*PRF(K)+EPRF*Y(4))*SAVG(J,K,4)*VOLUME                        GRASS3    33
      GBDYB = GBYMR/VOLUME+(RRGBIP+EGRE)                                       GRASS3    34
      GO TO (120,110), JKMAX                                                   GRASS3    35
110   CONTINUE                                                                 GRASS3    36
      IF (K.LT.KF) GBDYC = GBDYC+GBYMO(KI)/VOLUME*SAVG(J,KI,3)/SAVG(J,K,       GRASS3    37
     +3)                                                                       GRASS3    38
120   CONTINUE                                                                 GRASS3    39
C     -----CALCULATE COEFFICIENTS YB AND YC                                    GRASS3    40
C     ----- & INCLUDE EFFECT OF RESOLUTION                                     GRASS3    41
      YC(4) = EDGEC                                                            GRASS3    42
      YB(4) = EPRF                                                             GRASS3    43
      YB(3) = GBDYB+RTRS(2)                                                    GRASS3    44
      YC(3) = GBDYC                                                            GRASS3    45
      YC(2) = BULKC(2)                                                         GRASS3    46
      YB(2) = BULKB(2)+RTRS(1)                                                 GRASS3    47
      YB(1) = BULKB(1)                                                         GRASS3    48
      YC(1) = BULKC(1)+TARB                                                    GRASS3    49
      YC(5) = GR                                                               GRASS3    50
C     -----MIGRATION OUT                                                       GRASS3    51
      YC(6) = GBYMR*Y(3)                                                       GRASS3    52
      RETURN                                                                   GRASS3    53
      END                                                                      GRASS3    54
```

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

34 I AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GRASS3 1 52

VARIABLES	SN	TYPE		RELOCATION								
0	AUN	REAL		GR0235	REFS	2						
20	BLKMOR	REAL		GR2A3	REFS	5						
233	BULKB	REAL	ARRAY		REFS	8	22	24	46	47		
					DEFINED	17	18	22	24			
235	BULKC	REAL	ARRAY		REFS	8	45	48	DEFINED	[illegible]	19	
224	DISAP	REAL			REFS	17	19	DEFINED	16			
0	DIST	REAL	ARRAY	F.P.	REFS	8	DEFINED	1				
230	EDGEC	REAL			REFS	41	DEFINED	31				
227	EDGECO	REAL			REFS	31	32	DEFINED	30			
3	EGRE	REAL		GR0A3	REFS	4	30	33				
4	EPRF	REAL		GR0A3	REFS	44	32	42				
13	FLXGB2	REAL		GR2A3	REFS	5	24	25				
1	GASIN	REAL		GR0235	REFS	2	15					
232	GBDYB	REAL			REFS	43	DEFINED	33				
226	GBDYC	REAL			REFS	26	36	44	DEFINED	25	26	36
14	GBRF	REAL		GR2A3	REFS	5						
0	GBYMQ	REAL	ARRAY	F.P.	REFS	8	36	DEFINED	1			
21	GBYMQR	REAL		GR2A3	REFS	5						
26	GBYMR	REAL		GR2A3	REFS	5	33	51				
0	GESW	REAL		GR0A3	REFS	4						
231	GR	REAL			REFS	49	DEFINED	32				
3	J	INTEGER		GR0235	REFS	2	2*13	2*26	32	2*36		
1	JKMAX	INTEGER		GR0A3	REFS	4	34					
10	JNCDI	INTEGER		GR0235	REFS	2						
11	JNCGBI	INTEGER		GR0235	REFS	2						
4	K	INTEGER		GR0235	REFS	2	2*13	2*26	31	2*32	2*36	
0	KF	INTEGER		F.P.	REFS	4*8	36	DEFINED	1			
2	KI	INTEGER		GR0A3	REFS	4	2*36					
225	N	INTEGER			REFS	3*22	23	2*24	25	3*26		
					DEFINED	21						
6	NCDI	INTEGER		GR0235	REFS	2						
7	NCGBI	INTEGER		GR0235	REFS	2						
0	NF	INTEGER		F.P.	REFS	2*8	DEFINED	1				
5	NMAXB	INTEGER		GR0235	REFS	2						
23	NMAXB2	INTEGER		GR2A3	REFS	5						
22	NMAXD	INTEGER		GR2A3	REFS	5						
24	NMAXD2	INTEGER		GR2A3	REFS	5						
12	NMAXG	INTEGER		GR0235	REFS	2						
25	NMAXG2	INTEGER		GR2A3	REFS	5						

VARIABLES	SN	TYPE		RELOCATION							
13	NXBD	INTEGER		GR0235	REFS	2					
14	NXBDG	INTEGER		GR0235	REFS	2					
0	PBK	REAL	ARRAY	GR2A3	REFS	5	8	16	19		
12	PBKDLC	REAL		GR2A3	REFS	5					
6	PBKDS	REAL		GR2A3	REFS	5					
10	PBKGBY	REAL	ARRAY	GR2A3	REFS	5	8	22	26		
7	PDSL	REAL		GR2A3	REFS	5					
4	PGBDY	REAL	ARRAY	GR2A3	REFS	5	8				
0	PRF	REAL	ARRAY	F.P.	REFS	8	31	32	DEFINED	1	
15	RAD	REAL	ARRAY	GR0235	REFS	2	8				
15	RRGBIP	REAL		GR2A3	REFS	5	30	33			
16	RTRS	REAL	ARRAY	GR2A3	REFS	5	8	2*13	43	46	
0	SAVG	REAL	ARRAY	F.P.	REFS	8	2*13	2*26	32	2*36	
					DEFINED	1					
2	SAVG1	REAL		GR0235	REFS	2					
27	S12	REAL		GR2A3	REFS	5	19				
30	S13	REAL		GR2A3	REFS	5	25				
31	S34	REAL		GR2A3	REFS	5	30				
223	TARB	REAL			REFS	48	DEFINED	13			
21	VOLUME	REAL		GR0235	REFS	2	32	33	36		
0	Y	REAL	ARRAY	F.P.	REFS	8	2*13	16	2*19	25	26	30
					32	51	DEFINED	1				
0	YB	REAL	ARRAY	F.P.	REFS	8	DEFINED	1	42	43	46	47
0	YC	REAL	ARRAY	F.P.	REFS	8	DEFINED	1	41	44	45	48
					49	51						

STATEMENT LABELS		DEF LINE	REFERENCED	
65	100	26	21	23
143	110	35	34	
161	120	38	34	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
47	100	N	21 26	318	OPT

COMMON BLOCKS	LENGTH
GR0235	18
GR0A3	5
GR2A3	26

STATISTICS

PROGRAM LENGTH	244B	164
SCM LABELED COMMON LENGTH	61B	49

140000B SCM USED

```
      SUBROUTINE GRASS4 (SAVG,DIST,PRF,GBYMO,NF,KF)                                    GRASS4      2
      COMMON/GR0A4/IMAX1,X,Y,H,KK                                                      GRASS4      3
      COMMON/BDGR4/DT(7,13),D(13),HMIN,CRT,JM                                          GRASS4      4
      COMMON/GR2A4/EPS,YA,IMAX2,DLIM                                                   GRASS4      5
      DIMENSION Y0(6),YB0(4),YC0(6),YA(4),YB(4),YC(6),Y(6),YL(6)                       GRASS4      6
     +,YM(6),EPS(6),SAVG(NF,KF,4),DIST(NF,KF,4),PRF(KF),GBYMO(KF)                      GRASS4      7
      DATA JFLAG/1/                                                                    GRASS4      8
      DATA E/.9536E-6/                                                                 GRASS4      9
      JMAX = JM+4                                                                      GRASS4     10
          DO 100 I=1,4                                                                 GRASS4     11
          IF (Y(I).LT.10.0E-60) Y(I) = 0.0                                             GRASS4     12
  100     Y0(I) = Y(I)                                                                 GRASS4     13
      CALL GRASS3 (Y0,YB0,YC0,GBYMO,PRF,SAVG,DIST,NF,KF)                               GRASS4     14
      KK = +1                                                                          GRASS4     15
  110 JBO = -1                                                                         GRASS4     16
      M = 1                                                                            GRASS4     17
      JR = 2                                                                           GRASS4     18
      JS = 3                                                                           GRASS4     19
          DO 520 J=1,JMAX                                                              GRASS4     20
          IF (JBO) 130,120,120                                                         GRASS4     21
  120     D(2) = 16./9.                                                                GRASS4     22
          D(4) = 64./9.                                                                GRASS4     23
          D(6) = 256./9.                                                               GRASS4     24
          D(8) = 1024./9.                                                              GRASS4     25
          D(10) = 4096./9.                                                             GRASS4     26
          D(12) = 16384./9.                                                            GRASS4     27
          GO TO 140                                                                    GRASS4     28
  130     D(2) = 2.25                                                                  GRASS4     29
          D(4) = 9.                                                                    GRASS4     30
          D(6) = 36.                                                                   GRASS4     31
          D(8) = 144.                                                                  GRASS4     32
          D(10) = 576.                                                                 GRASS4     33
          D(12) = 2304.                                                                GRASS4     34
  140     KONV = +1                                                                    GRASS4     35
          IF (J-1) 150,150,160                                                         GRASS4     36
  150     KONV = -1                                                                    GRASS4     37
  160     IF (J-(JM+1)) 180,180,170                                                    GRASS4     38
  170     L = JM+1                                                                     GRASS4     39
          D(L) = 4.*D(L-2)                                                             GRASS4     40
          FC = 0.7071068*FC                                                            GRASS4     41
          GO TO 190                                                                    GRASS4     42
  180     L = J                                                                        GRASS4     43
          D(L) = FLOAT(M*M)                                                            GRASS4     44
          FC = 1.+FLOAT(JM+1-J)/6.                                                     GRASS4     45
  190     M = M+M                                                                      GRASS4     46
          G = H/FLOAT(M)                                                               GRASS4     47
          B = G+G                                                                      GRASS4     48
              DO 260 I=1,6                                                             GRASS4     49
              IF (I-4) 200,200,250                                                     GRASS4     50
  200         YL(I) = Y0(I)                                                            GRASS4     51
              IF (YA(I).LT.0..OR.YB0(I).LT.0..OR.YC0(I).LT.0..OR.YL(I).L               GRASS4     52
             +T.0.) GO TO 230                                                          GRASS4     53
              AYL = YA(I)*YL(I)                                                        GRASS4     54
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```
                      DD = AYL+YB0(I)                                                  GRASS4    55
55                    CD = YC0(I)-DD*YL(I)                                             GRASS4    56
                      ACD = ABS(CD)                                                    GRASS4    57
                      IF ((ACD.LE.E*YC0(I)).OR.(ACD*G.LT.E*YL(I))) GO TO 210           GRASS4    58
                      BCA = SQRT(YB0(I)*YB0(I)+4.*YA(I)*YC0(I))                        GRASS4    59
                      DTBCA = G*BCA                                                    GRASS4    60
60                    IF (DTBCA.LT..001) GO TO 220                                     GRASS4    61
                      BCAB = BCA+YB0(I)                                                GRASS4    62
                      P = 2.*YC0(I)/BCAB                                               GRASS4    63
                      Z = 0.0                                                          GRASS4    64
                      IF (DTBCA.GT.DLIM) Z = EXP(-DTBCA)                               GRASS4    65
65                    ZZ = (1.+Z)*TANH(DTBCA*.5)                                       GRASS4    66
                      AYPZZB = YA(I)*(YL(I)-P)*ZZ/BCA                                  GRASS4    67
                      YM(I) = (YL(I)*Z+P*(ZZ+AYPZZB))/(1.+AYPZZB)                      GRASS4    68
                      GO TO 240                                                        GRASS4    69
            210       YM(I) = YL(I)                                                    GRASS4    70
70                    GO TO 240                                                        GRASS4    71
            220       YM(I) = YL(I)+CD*(1.-G*.5*(DD+AYL))*G                            GRASS4    72
                      GO TO 240                                                        GRASS4    73
            230       WRITE (6,560) YA(I),YB0(I),YC0(I),YL(I),I                        GRASS4    74
                      KK = -1                                                          GRASS4    75
75                    GO TO 540                                                        GRASS4    76
            240       CONTINUE                                                         GRASS4    77
                      GO TO 260                                                        GRASS4    78
            250       YL(I) = 0.                                                       GRASS4    79
                      YM(I) = YC0(I)*G                                                 GRASS4    80
80          260       CONTINUE                                                         GRASS4    81
                      DO 350 K=2,M                                                     GRASS4    82
                      CALL GRASS3 (YM,YB,YC,GBYM0,PRF,SAVG,DIST,NF,KF)                 GRASS4    83
                          DO 340 I=1,6                                                 GRASS4    84
                          IF (I-4) 270,270,320                                         GRASS4    85
85          270       +       IF (YA(I).LT.0..OR.YB(I).LT.0..OR.YC(I).LT.0..OR.YL(I)  GRASS4    86
                              .LT.0.) GO TO 300                                        GRASS4    87
                              AYL = YA(I)*YL(I)                                        GRASS4    88
                              DD = AYL+YB(I)                                           GRASS4    89
                              CD = YC(I)-DD*YL(I)                                      GRASS4    90
90                            ACD = ABS(CD)                                            GRASS4    91
                              IF ((ACD.LE.E*YC(I)).OR.(ACD*D.LT.E*YL(I))) GO TO 280    GRASS4    92
                              BCA = SQRT(YB(I)*YB(I)+4.*YA(I)*YC(I))                   GRASS4    93
                              DTBCA = B*BCA                                            GRASS4    94
                              IF (DTBCA.LT..001) GO TO 290                             GRASS4    95
95                            BCAB = BCA+YB(I)                                         GRASS4    96
                              P = 2.*YC(I)/BCAB                                        GRASS4    97
                              Z = 0.0                                                  GRASS4    98
                              IF (DTBCA.GT.DLIM) Z = EXP(-DTBCA)                       GRASS4    99
                              ZZ = (1.+Z)*TANH(DTBCA*.5)                               GRASS4   100
100                           AYPZZB = YA(I)*(YL(I)-P)*ZZ/BCA                          GRASS4   101
                              U = (YL(I)*Z+P*(ZZ+AYPZZB))/(1.+AYPZZB)                  GRASS4   102
                              GO TO 310                                                GRASS4   103
            280               U = YL(I)                                                GRASS4   104
                              GO TO 310                                                GRASS4   105
105         290               U = YL(I)+CD*(1.-B*.5*(DD+AYL))*B                        GRASS4   106
                              GO TO 310                                                GRASS4   107
```

```
      300          WRITE (6,560) YA(I),YB(I),YC(I),YL(I),I                    GRASS4   108
                   KK = -1                                                    GRASS4   109
                   GO TO 540                                                  GRASS4   110
110   310          CONTINUE                                                   GRASS4   111
                   GO TO 330                                                  GRASS4   112
      320          U = YL(I)+YC(I)*B                                          GRASS4   113
      330          YL(I) = YM(I)                                              GRASS4   114
                   YM(I) = U                                                  GRASS4   115
115   340          CONTINUE                                                   GRASS4   116
      350       CONTINUE                                                      GRASS4   117
             CALL GRASS3 (YM,YB,YC,GBYMO,PRF,SAVG,DIST,NF,KF)                 GRASS4   118
                DO 500 I=1,6                                                  GRASS4   119
                V = DT(I,1)                                                   GRASS4   120
120             IF (I-4) 360,360,410                                          GRASS4   121
      360       IF (YA(I).LT.0..OR.YB(I).LT.0..OR.YC(I).LT.0..OR.YL(I .LT.    GRASS4   122
              + 0.) GO TO 390                                                 GRASS4   123
                AYL = YA(I)*YL(I)                                             GRASS4   124
                DD = AYL+YB(I)                                                GRASS4   125
125             CD = YC(I)-DD*YL(I)                                           GRASS4   126
                ACD = ABS(CD)                                                 GRASS4   127
                IF ((ACD.LE.E*YC(I)).OR.(ACD*G.LT.E*YL(I))) GO TO 370         GRASS4   128
                BCA = SQRT(YB(I)*YB(I)+4.*YA(I)*YC(I))                        GRASS4   129
                DTBCA = G*BCA                                                 GRASS4   130
130             IF (DTBCA.LT..001) GO TO 380                                  GRASS4   131
                BCAB = BCA+YB(I)                                              GRASS4   132
                P = 2.*YC(I)/BCAB                                             GRASS4   133
                Z = 0.0                                                       GRASS4   134
                IF (DTBCA.GT.DLIM) Z = EXP(-DTBCA)                            GRASS4   135
135             ZZ = (1.+Z)*TANH(DTBCA*.5)                                    GRASS4   136
                AYPZZB = YA(I)*(YL(I)-P)*ZZ/BCA                               GRASS4   137
                DT2 = (YL(I)*Z+P*(ZZ+AYPZZB))/(1.+AYPZZB)                     GRASS4   138
                GO TO 400                                                     GRASS4   139
      370       DT2 = YL(I)                                                   GRASS4   140
140             GO TO 400                                                     GRASS4   141
      380       DT2 = YL(I)+CD*(1.-G*.5*(DD+AYL))*G                           GRASS4   142
                GO TO 400                                                     GRASS4   143
      390       WRITE (6,560) YA(I),YB(I),YC(I),YL(I),I                       GRASS4   144
                KK = -1                                                       GRASS4   145
145             GO TO 540                                                     GRASS4   146
      400       CONTINUE                                                      GRASS4   147
                GO TO 420                                                     GRASS4   148
      410       DT2 = YL(I)+YC(I)*G                                           GRASS4   149
      420       DT(I,1) = (DT2+YM(I))*0.5                                     GRASS4   150
150             C = DT(I,1)                                                   GRASS4   151
                TA = C                                                        GRASS4   152
                IF (C.LT.0.) GO TO 490                                        GRASS4   153
                IF (L.LT.2) GO TO 500                                         GRASS4   154
                IF (JFLAG.LT.0) GO TO 470                                     GRASS4   155
155             IF (V*65536.0.LT.C) GO TO 490                                 GRASS4   156
                   DO 450 K=2,L                                               GRASS4   157
                   BI = D(K)*V                                                GRASS4   158
                   B = BI-C                                                   GRASS4   159
                   IF (B.LT.1.E-60) B = 0.0                                   GRASS4   160
```

```
                      U = V                                                    GRASS4   161
                      IF (B) 430,440,430                                       GRASS4   162
          430         B = (C-V)/B                                              GRASS4   163
                      U = C*B                                                  GRASS4   164
                      C = B1*B                                                 GRASS4   165
          440         V = DT(I,K)                                              GRASS4   166
                      DT(I,K) = U                                              GRASS4   167
                      TA = U+TA                                                GRASS4   168
          450         CONTINUE                                                 GRASS4   169
          460       IF (TA.LT.0.) GO TO 490                                    GRASS4   170
                    IF (ABS(Y(I)-TA).LT.(CRT*TA+EPS(I))) GO TO 500             GRASS4   171
                    GO TO 490                                                  GRASS4   172
          470         DO 480 K=2,L                                             GRASS4   173
                      TA = TA+(TA-V)/(D(K)-1.)                                 GRASS4   174
                      V = DT(I,K)                                              GRASS4   175
          480         DT(I,K) = TA                                             GRASS4   176
                    GO TO 460                                                  GRASS4   177
          490       KONV = -1                                                  GRASS4   178
          500       Y(I) = TA                                                  GRASS4   179
                IF (KONV) 510,550,550                                          GRASS4   180
          510   D(3) = 4.                                                      GRASS4   181
                D(5) = 16.                                                     GRASS4   182
                JBO = -JBO                                                     GRASS4   183
                M = JR                                                         GRASS4   184
                JR = JS                                                        GRASS4   185
                JS = M+M                                                       GRASS4   186
                D(7) = 64.                                                     GRASS4   187
                D(9) = 256.                                                    GRASS4   188
                D(11) = 1024.                                                  GRASS4   189
          520   CONTINUE                                                       GRASS4   190
              IF (H.LE.HMIN) GO TO 540                                         GRASS4   191
              H = H/2.                                                         GRASS4   192
              IF (ABS(H)-HMIN) 530,110,110                                     GRASS4   193
          530 H = SIGN(HMIN,H)                                                 GRASS4   194
              GO TO 110                                                        GRASS4   195
          540 KK = -1                                                          GRASS4   196
          550 X = X+H                                                          GRASS4   197
              H = FC*H                                                         GRASS4   198
              RETURN                                                           GRASS4   199
              C                                                                GRASS4   200
          560 FORMAT (12H A,B,C,Y,I= ,4E12.4,I3)                               GRASS4   201
              END                                                              GRASS4   202
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	GRASS4	1	198

VARIABLES	SN	TYPE		RELOCATION										
1316	ACD	REAL			REFS	2*57	2*91	2*127	DEFINED	56	90	126		
1313	AYL	REAL			REFS	54	71	88	105	124	141			
					DEFINED	53	87	123						
1325	AYPZZB	REAL			REFS	2*67	2*101	2*137	DEFINED	66	100	136		
1312	B	REAL			REFS	91	93	2*105	112	159	161	162		
					163	164	DEFINED	47	158	159	162			
1317	BCA	REAL			REFS	59	61	66	93	95	100	129		
					131	136	DEFINED	58	92	128				
1321	BCAB	REAL			REFS	62	96	132	DEFINED	61	95	131		
1334	BI	REAL			REFS	158	164	DEFINED	157					
1332	C	REAL			REFS	151	152	155	158	162	163			
					DEFINED	150	164							
1315	CD	REAL			REFS	56	71	90	105	126	141			
					DEFINED	55	89	125						
151	CRT	REAL		BDGR4	REFS	3	170							
133	D	REAL	ARRAY	BDGR4	REFS	3	39	157	173	DEFINED	21	22		
					23	24	25	26	28	29	30	31		
					32	33	39	43	180	181	186	187		
					188									
1314	DD	REAL			REFS	55	71	89	105	125	141			
					DEFINED	54	88	124						
0	DIST	REAL	ARRAY	F.P.	REFS	5	13	82	117	DEFINED	1			
13	DLIM	REAL		GR2A4	REFS	4	64	98	134					
0	DT	REAL	ARRAY	BDGR4	REFS	3	119	150	165	174				
					DEFINED	149	166	175						
1320	DTBCA	REAL			REFS	60	2*64	65	94	2*96	99	130		
					2*134	135	DEFINED	59	93	129				
1331	DT2	REAL			REFS	149	DEFINED	137	139	141	148			
1206	E	REAL			REFS	2*57	2*91	2*127	DEFINED	8				
0	EPS	REAL	ARRAY	GR2A4	REFS	4	5	170						
1310	FC	REAL			REFS	40	197	DEFINED	40	44				
1311	G	REAL			REFS	2*47	57	59	2*71	79	127	129		
					2*141	148	DEFINED	46						
0	GBYMO	REAL	ARRAY	F.P.	REFS	5	13	82	117	DEFINED	1			
10	H	REAL		GR0A4	REFS	2	46	190	191	192	193	196		
					197	DEFINED	191	193	197					
150	HMIN	REAL		BDGR4	REFS	3	190	192	193					
1300	I	INTEGER			REFS	2*11	2*12	49	2*50	4*51	2*53	54		
					2*55	2*57	4*58	61	62	2*66	2*67	2*69		
					2*71	5*73	78	2*79	84	4*85	2*87	88		
					2*89	2*91	4*92	95	96	2*100	101	103		
					105	5*107	2*112	2*113	114	119	120	4*121		
					2*123	124	2*125	2*127	4*128	131	132	2*136		
					137	139	141	5*143	2*148	2*149	150	165		
					166	2*170	174	175	178	DEFINED	10	48		
					83	118								
0	IMAX1	INTEGER		GR0A4	REFS	2								
12	IMAX2	INTEGER		GR2A4	REFS	4								
1305	J	INTEGER			REFS	35	37	42	44	DEFINED	19			
1301	JBO	INTEGER			REFS	20	182	DEFINED	15	182				
1205	JFLAG	INTEGER			REFS	154	DEFINED	7						
152	JM	INTEGER		BDGR4	REFS	3	9	37	38	44				

VARIABLES	SN	TYPE		RELOCATION										
1277	JMAX	INTEGER			REFS	19	DEFINED	9						
1303	JR	INTEGER			REFS	183	DEFINED	17	184					
1304	JS	INTEGER			REFS	184	DEFINED	18	185					
1326	K	INTEGER			REFS	157	165	166	173	174	175			
					DEFINED	81	156	172						
0	KF	INTEGER		F.P.	REFS	4*5	13	82	117	DEFINED	1			
11	KK	INTEGER		GR0A4	REFS	2	DEFINED	14	74	108	144	195		
1306	KONV	INTEGER			REFS	179	DEFINED	34	36	177				
1307	L	INTEGER			REFS	2*39	43	153	156	172				
					DEFINED	38	42							
1302	M	INTEGER			REFS	2*43	2*45	46	81	2*185				
					DEFINED	16	45	183						
0	NF	INTEGER		F.P.	REFS	2*5	13	82	117	DEFINED	1			
1322	P	REAL			REFS	66	67	100	101	136	137			
					DEFINED	62	96	132						
0	PRF	REAL	ARRAY	F.P.	REFS	5	13	82	117	DEFINED	1			
0	SAVG	REAL	ARRAY	F.P.	REFS	5	13	82	117	DEFINED	1			
1333	TA	REAL			REFS	167	169	2*170	2*173	175	178			
					DEFINED	151	167	173						
1327	U	REAL			REFS	114	166	167	DEFINED	101	103	105		
						112	160	163						
1330	V	REAL			REFS	155	157	160	162	173				
					DEFINED	119	165	174						
1	X	REAL		GR0A4	REFS	2	196	DEFINED	196					
2	Y	REAL	ARRAY	GR0A4	REFS	2	5	11	12	170				
					DEFINED	11	178							
6	YA	REAL	ARRAY	GR2A4	REFS	4	5	51	53	58	66	73		
						85	87	92	100	107	121	123	128	
						136	143							
1355	YB	REAL	ARRAY		REFS	5	82	85	88	2*92	95	107		
						117	121	124	2*128	131	143			
1343	YBO	REAL	ARRAY		REFS	5	13	51	54	2*58	61	73		
1361	YC	REAL	ARRAY		REFS	5	82	85	89	91	92	96		
						107	112	117	121	125	127	128	132	
						143	148							
1347	YCO	REAL	ARRAY		REFS	5	13	51	55	57	58	62		
						73	79							
1367	YL	REAL	ARRAY		REFS	5	51	53	55	57	66	67		
						69	71	73	85	87	89	91	100	
						101	103	105	107	112	121	123	125	
						127	136	137	139	141	143	148		
					DEFINED	50	78	113						
1375	YM	REAL	ARRAY		REFS	5	82	113	117	149				
					DEFINED	67	69	71	79	114				
1335	YO	REAL	ARRAY		REFS	5	13	50	DEFINED	12				
1323	Z	REAL			REFS	65	67	99	101	135	137			
					DEFINED	63	64	97	98	133	134			
1324	ZZ	REAL			REFS	66	67	100	101	136	137			
					DEFINED	65	99	135						

FILE NAMES	MODE				
TAPE6	FMT	WRITES	73	107	143

EXTERNALS	TYPE	ARGS		REFERENCES		
EXP	REAL	1	LIBRARY	64	98	134
GRASS3		9		13	82	117
SQRT	REAL	1	LIBRARY	58	92	128
TANH	REAL	1	LIBRARY	65	99	135

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES				
ABS	REAL	1	INTRIN		56	90	126	170	192
FLOAT	REAL	1	INTRIN		43	44	46		
SIGN	REAL	2	INTRIN		193				

STATEMENT LABELS			DEF LINE	REFERENCES			
0	100		12	10			
41	110		15	2*192	194		
0	120	INACTIVE	21	2*20			
72	130		28	20			
107	140		34	27			
0	150	INACTIVE	36	2*35			
116	160		37	35			
0	170	INACTIVE	38	37			
133	180		42	2*37			
147	190		45	41			
0	200	INACTIVE	50	2*49			
300	210		69	57			
304	220		71	60			
315	230		73	51			
331	240		76	68	70	72	
333	250		78	49			
341	260		80	48	77		
0	270	INACTIVE	85	2*84			
476	280		103	91			
502	290		105	94			
513	300		107	85			
527	310		110	102	04	106	
531	320		112	84			
536	330		113	111			
0	340		115	83			
0	350		116	81			
0	360	INACTIVE	121	2*120			
704	370		139	127			
710	380		141	130			
721	390		143	121			
735	400		146	138	140	142	
737	410		148	120			
744	420		149	147			
0	430	INACTIVE	162	2*161			
1021	440		165	161			
0	450		168	156			
1040	460		169	176			
1052	470		172	154			
0	480		175	172			
1074	490		177	152	155	169	171
1076	500		178	118	153	170	

STATEMENT LABELS			DEF LINE	REFERENCES			
0	510	INACTIVE	180	179			
0	520		189	19			
0	530	INACTIVE	193	192			
1147	540		195	75	109	145	190
1151	550		196	2*179			
1237	560	FMT	200	73	107	143	

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES			
14	100	I	10 12	10B	INSTACK			
52	520	J	19 189	1057B		EXT REFS	EXITS	NOT INNER
157	260	I	48 80	165B		EXT REFS	EXITS	
346	350	K	81 116	203B		EXT REFS	EXITS	NOT INNER
360	340	I	83 115	166B		EXT REFS	EXITS	
563	500	I	118 178	317B		EXT REFS	EXITS	NOT INNER
772	450	K	156 168	45B	UPT			
1053	480	K	172 175	17B	OPT			

COMMON BLOCKS	LENGTH
GR0A4	10
BDGR4	107
GR2A4	12

STATISTICS

PROGRAM LENGTH	1420B	784
SCM LABELED COMMON LENGTH	201B	129

140000B SCM USED

```
      SUBROUTINE GRASS5 (TEMP,GAMMA,HS,SAVG,NF,KF)                                    GRASS5     2
      COMMON/BDGR5/DLI,D(10),DI(10),SL(10),BI(10)                                     GRASS5     3
      COMMON/GR0235/AVN,GASIN,SAVGI,J5,K5,NMAXB,NCDI,NCGBI,JNCDI,JNCGBI,              GRASS5     4
     +NMAXG,NXBD,NXBDG,RAD,VOLUME                                                     GRASS5     5
      DIMENSION SAVG(NF,KF,4),RAD(2,2),PT(10)                                         GRASS5     6
      TR = TEMP/289.74                                                                GRASS5     7
      TR = TR/1.005                                                                   GRASS5     8
          DO 100 J=1,10                                                               GRASS5     9
          PT(J) = SL(J)*TR+BI(J)                                                      GRASS5    10
  100     CONTINUE                                                                    GRASS5    11
      M = -1                                                                          GRASS5    12
      N = 1                                                                           GRASS5    13
      L = 1                                                                           GRASS5    14
      LN = 1                                                                          GRASS5    15
      J = 10                                                                          GRASS5    16
      C = SAVG(J5,K5,1)                                                               GRASS5    17
      DLM = DLI                                                                       GRASS5    18
      AT = PT(10)*(DI(10)-DLM)                                                        GRASS5    19
      GO TO 140                                                                       GRASS5    20
  110 CONTINUE                                                                        GRASS5    21
      M = 0                                                                           GRASS5    22
  120 CONTINUE                                                                        GRASS5    23
      K = DD*DI(1)                                                                    GRASS5    24
      IF (K.LT.1) GO TO 130                                                           GRASS5    25
      IF (K.GE.J) GO TO 230                                                           GRASS5    26
      J = K                                                                           GRASS5    27
      DLM = (PT(J+1)*DI(J+1)-PT(J)*DI(J))/(PT(J+1)-PT(J))                             GRASS5    28
      AT = PT(J)*(DI(J)-DLM)                                                          GRASS5    29
      GO TO 140                                                                       GRASS5    30
  130 CONTINUE                                                                        GRASS5    31
      M = 1                                                                           GRASS5    32
      AT = 8.314E7*TEMP                                                               GRASS5    33
      DLM = 51.                                                                       GRASS5    34
  140 CONTINUE                                                                        GRASS5    35
      A3 = GAMMA*2.0E4/HS                                                             GRASS5    36
      A3 = 0.6*A3                                                                     GRASS5    37
      A0 = -3.964E-13*DLM*A3*C                                                        GRASS5    38
      A1 = -3.964E-13*(DLM+AT/HS)*C                                                   GRASS5    39
      B0 = -A1*A1-A0*A3*A3                                                            GRASS5    40
      B1 = A1*A3-4.*A0                                                                GRASS5    41
      RR = -B0/2.                                                                     GRASS5    42
      T = B1*B1*B1/27.                                                                GRASS5    43
      B = RR*RR+T                                                                     GRASS5    44
      IF (B) 170,160,150                                                              GRASS5    45
  150 XN = 1./3.                                                                      GRASS5    46
      YN = 2.*XN                                                                      GRASS5    47
      B = SQRT(B)                                                                     GRASS5    48
      U = -B0/((ABS(RR+B))**YN+(ABS(RR-B))**YN+B1/3.)                                 GRASS5    49
      GO TO 180                                                                       GRASS5    50
  160 XN = 1./3.                                                                      GRASS5    51
      RRA = ABS(RR)                                                                   GRASS5    52
      U = RR/RRA*RRA**XN                                                              GRASS5    53
      U = 2.*U                                                                        GRASS5    54
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```
                GO TO 180                                                       GRASS5     55
55          170 SA = SQRT(-B1/3.)                                               GRASS5     56
                U = 2*SA*COS(ACOS(RR/SA**3)/3.)                                 GRASS5     57
            180 CONTINUE                                                        GRASS5     58
                THING = A3/2.*U/2.-A1/2.                                        GRASS5     59
                IF (THING.LT.0.) GO TO 200                                      GRASS5     60
60              IF (U.LT.0.) GO TO 190                                          GRASS5     61
                C1 = U/(A3+SQRT(A3*A3+4.*U))                                    GRASS5     62
                C0 = 2.*A0/(U+SQRT(U*U-4.*A0))                                  GRASS5     63
                DDD = C1*C1-C0                                                  GRASS5     64
                IF (DDD.LT.0.) GO TO 250                                        GRASS5     65
65              R = C1+SQRT(DDD)                                                GRASS5     66
                GO TO 210                                                       GRASS5     67
            190 CONTINUE                                                        GRASS5     68
                C1 = U/(A3+SQRT(A3*A3+4.*U))                                    GRASS5     69
                C0 = U/2.-SQRT(U*U/4.-A0)                                       GRASS5     70
70              DDD = C1*C1-C0                                                  GRASS5     71
                IF (DDD.LT.0.) GO TO 250                                        GRASS5     72
                R = C0/(C1-SQRT(DDD))                                           GRASS5     73
                GO TO 210                                                       GRASS5     74
            200 CONTINUE                                                        GRASS5     75
75              IF (U.GT.0.) GO TO 250                                          GRASS5     76
                C1 = A3/2.+SQRT(A3*A3/4.+U)                                     GRASS5     77
                C0 = U/2.-SQRT(U*U/4.-A0)                                       GRASS5     78
                DDD = C1*C1-C0*4.                                               GRASS5     79
                IF (DDD.LT.0.) GO TO 250                                        GRASS5     80
80              R = -2.*C0/(C1+SQRT(DDD))                                       GRASS5     81
            210 CONTINUE                                                        GRASS5     82
                DD = 3.964E-13*C/R**3                                           GRASS5     83
                IF (M) 220,120,230                                              GRASS5     84
            220 CONTINUE                                                        GRASS5     85
85              IF (DD.LT.D(10)) GO TO 110                                      GRASS5     86
            230 RAD(N,L) = R*1.E-4                                              GRASS5     87
                IF (RAD(N,L).LE.0.0) RAD(N,L) = 2.5E-08                         GRASS5     88
                IF (N.EQ.2.AND.L.EQ.1) GO TO 240                                GRASS5     89
                IF (N.EQ.2.AND.L.EQ.2) GO TO 260                                GRASS5     90
90              LN = LN+1                                                       GRASS5     91
                N = N+1                                                         GRASS5     92
                C = SAVG(J5,K5,LN)                                              GRASS5     93
                GO TO 140                                                       GRASS5     94
            240 N = 1                                                           GRASS5     95
95              L = 2                                                           GRASS5     96
                LN = LN+1                                                       GRASS5     97
                C = SAVG(J5,K5,LN)                                              GRASS5     98
                GO TO 140                                                       GRASS5     99
            250 CONTINUE                                                        GRASS5    100
100             WRITE (6,270) C,H5,TEMP                                         GRASS5    101
            260 CONTINUE                                                        GRASS5    102
                RETURN                                                          GRASS5    103
            C                                                                   GRASS5    104
            270  FORMAT (66H THIS CONDITION NOT EXPECTED OR ACCOUNTED FOR IN SUBROU GRASS5    105
105            +TINE GRASS5,/39H THE NUMBER OF GAS ATOMS IN A BUBBLE IS,E12.4,/38H GRASS5    106
               + THE HYDROSTATIC STRESS IN THE FUEL IS,E12.4,/19H THE TEMPERATURE  GRASS5    107
```

```
     +15,E12.4,/)                                                    GRASS5   108
      END                                                            GRASS5   109
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS DEF LINE REFERENCES
4 GRASS5 1 102

VARIABLES	SN	TYPE		RELOCATION								
617	AT	REAL			REFS	38	DEFINED	18	28	32		
0	AVN	REAL		GR0235	REFS	3						
623	AJ	REAL			REFS	39	40	2*62	69	77		
					DEFINED	37						
624	AI	REAL			REFS	2*39	40	58	DEFINED	38		
622	A3	REAL			REFS	36	37	2*39	40	58	3*61	3*68
					3*76	DEFINED	35	36				
631	B	REAL			REFS	44	47	2*48	DEFINED	43	47	
37	BI	REAL	ARRAY	BDGR5	REFS	2	9					
625	BO	REAL			REFS	41	48	DEFINED	39			
626	BI	REAL			REFS	3*42	48	55	DEFINED	40		
615	C	REAL			REFS	37	38	82	100	DEFINED	16	92
					97							
641	CO	REAL			REFS	63	70	72	78	80		
					DEFINED	62	69	77				
640	CI	REAL			REFS	2*63	65	2*70	72	2*78	80	
					DEFINED	61	68	76				
1	D	REAL	ARRAY	BDGR5	REFS	2	85					
621	DD	REAL			REFS	23	85	DEFINED	82			
642	DDD	REAL			REFS	64	65	71	72	79	80	
					DEFINED	63	70	78				
13	DI	REAL	ARRAY	BDGR5	REFS	2	18	23	2*27	28		
0	DLI	REAL		BDGR5	REFS	2	17					
616	DLM	REAL			REFS	18	28	37	38	DEFINED	17	27
					33							
0	GAMMA	REAL		F.P.	REFS	35	DEFINED	1				
1	GASIN	REAL		GR0235	REFS	3						
0	HS	REAL		F.P.	REFS	35	36	100	DEFINED	1		
619	J	INTEGER			REFS	3*9	25	6*27	2*28	DEFINED	8	15
					26							
10	JNCDI	INTEGER		GR0235	REFS	3						
11	JNCGBI	INTEGER		GR0235	REFS							
3	J5	INTEGER		GR0235	REFS	3	16	92	97			
620	K	INTEGER			REFS	24	25	26	DEFINED	23		
0	KF	INTEGER		F.P.	REFS	5	DEFINED	1				
4	K5	INTEGER		GR0235	REFS	3	16	92	97			
613	L	INTEGER			REFS	86	2*87	88	89	DEFINED	13	95
614	LN	INTEGER			REFS	90	92	96	97	DEFINED	14	90
					96							
611	M	INTEGER			REFS	83	DEFINED	11	21	31		

VARIABLES	SN	TYPE		RELOCATION								
612	N	INTEGER			REFS	86	2*87	88	89	91		
					DEFINED	12	91	94				
6	NCDI	INTEGER		GR0235	REFS	3						
7	NCGBI	INTEGER		GR0235	REFS	3						
0	NF	INTEGER		F.P.	REFS	5	DEFINED	1				
5	NMAXB	INTEGER		GR0235	REFS	3						
12	NMAXG	INTEGER		GR0235	REFS	3						
13	NXBD	INTEGER		GR0235	REFS	3						
14	NXBDG	INTEGER		GR0235	REFS	3						
64[illegible]	PT	REAL	ARRAY		REFS	5	18	4*27	28	DEFINED	9	
6[illegible]3	R	REAL			REFS	82	86	DEFINED	65	72	80	
5	RAD	REAL	ARRAY	GR0235	REFS	3	5	87	DEFINED	86	87	
6[illegible]7	RR	REAL			REFS	2*43	2*48	51	52	56		
					DEFINED	41						
635	RRA	REAL			REFS	2*52	DEFINED	51				
636	SA	REAL			REFS	2*56	DEFINED	55				
0	SAVG	REAL	ARRAY	F.P.	REFS	5	16	92	97	DEFINED	1	
2	SAVG1	REAL		GR0235	REFS	3						
25	SL	REAL	ARRAY	BDGR5	REFS	2	9					
630	T	REAL			REFS	43	DEFINED	42				
0	TEMP	REAL		F.P.	REFS	6	32	100	DEFINED	1		
637	THING	REAL			REFS	59	DEFINED	58				
607	TR	REAL			REFS	7	9	DEFINED	6	7		
634	U	REAL			REFS	53	58	60	2*61	3*62	2*68	3*69
					75	76	3*77	DEFINED	48	52	53	56
21	VOLUME	REAL		GR0235	REFS	3						
632	XN	REAL			REFS	46	52	DEFINED	45	50		
633	YN	REAL			REFS	2*48	DEFINED	46				

FILE NAMES	MODE		
TAPE6	FMT	WRITES	100

EXTERNALS	TYPE	ARGS		REFERENCES							
ACOS	REAL	1	LIBRARY	56							
COS	REAL	1	LIBRARY	56							
SQRT	REAL	1	LIBRARY	47	55	61	62	65	68	69	72	76
				77	80							

INLINE FUNCTIONS	TYPE	ARGS		DEF LINE	REFERENCES	
ABS	REAL	1	INTRIN		2*48	51

STATEMENT LABELS			DEF LINE	REFERENCES				
0	100		10	8				
57	110		20	85				
62	120		22	83				
111	130		30	24				
121	140		34	19	29	93	98	
0	150	INACTIVE	45	44				
214	160		50	44				
231	170		55	44				
251	180		57	49	54			
315	190		67	60				
351	200		74	59				

STATEMENT LABELS			DEF LINE	REFERENCES			
407	210		81	66	73		
0	220	INACTIVE	84	83			
421	230		86	25	83		
462	240		94	88			
501	250		99	64	71	75	79
504	260		101	89			
541	270	FMT	104	100			

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
2	100	J	8 10	7B	INSTACK

COMMON BLOCKS	LENGTH
BDGR5	41
GR0235	18

STATISTICS

PROGRAM LENGTH	656B	430
SCM LABELED COMMON LENGTH	73B	59

140000B SCM USED

```
      SUBROUTINE GRAS56 (AGRASS,NWORDS)                                  GRAS56     2
      DIMENSION AGRASS(NWORDS)                                           GRAS56     3
      COMMON/GRSPTR/IAGRAS(38)                                           GRAS56     4
      COMMON/GRHOLD/TIT,GRT                                              GRAS56     5
      COMMON /BDG02D/ Z1(11)                                             GRAS56     6
      COMMON /BDGR/   Z2(24)                                             GRAS56     7
      COMMON /BDGR2/  Z3(56)                                             GRAS56     8
      COMMON /BDGR4/  Z4(107)                                            GRAS56     9
      COMMON /BDGR5/  Z5(41)                                             GRAS56    10
      COMMON /GR0235/ Z6(18)                                             GRAS56    11
      COMMON /GTWOLC/ Z7(12)                                             GRAS56    12
      COMMON /GR2A3/ Z8(26)                                              GRAS56    13
      COMMON /GR2A4/ Z9(12)                                              GRAS56    14
      READ (3) IAGRAS,AGRASS,TIT,GRT                                     GRAS56    15
      READ (3) Z1                                                        GRAS56    16
      READ (3) Z2                                                        GRAS56    17
      READ (3) Z3                                                        GRAS56    18
      READ (3) Z4                                                        GRAS56    19
      READ (3) Z5                                                        GRAS56    20
      READ (3) Z6                                                        GRAS56    21
      READ (3) Z7                                                        GRAS56    22
      READ (3) Z8                                                        GRAS56    23
      READ (3) Z9                                                        GRAS56    24
      RETURN                                                             GRAS56    25
      END                                                                GRAS56    26
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	GRAS56	1	24

VARIABLES	SN	TYPE		RELOCATION					
0	AGRASS	REAL	ARRAY	F.P.	REFS	2	DEFINED	1	14
1	GRT	REAL		GRHOLD	REFS	4	DEFINED	14	
0	IAGRAS	INTEGER	ARRAY	GRSPTR	REFS	3	DEFINED	14	
0	NWORDS	INTEGER		F.P.	REFS	2	DEFINED	1	
0	TIT	REAL		GRHOLD	REFS	4	DEFINED	14	
0	Z1	REAL	ARRAY	BDG02D	REFS	5	DEFINED	15	
0	Z2	REAL	ARRAY	BDGR	REFS	6	DEFINED	16	
0	Z3	REAL	ARRAY	BDGR2	REFS	7	DEFINED	17	
0	Z4	REAL	ARRAY	BDGR4	REFS	8	DEFINED	18	
0	Z5	REAL	ARRAY	BDGR5	REFS	9	DEFINED	19	
0	Z6	REAL	ARRAY	GR0235	REFS	10	DEFINED	20	
0	Z7	REAL	ARRAY	GTWOLC	REFS	11	DEFINED	21	
0	Z8	REAL	ARRAY	GR2A3	REFS	12	DEFINED	22	
0	Z9	REAL	ARRAY	GR2A4	REFS	13	DEFINED	23	

```
FILE NAMES        MODE
      TAPE3       UNFMT                READS      14        15        16        17        18        19        20        21
                                                   22        23

COMMON BLOCKS   LENGTH
      GRSPTR        38
      GRHOLD         2
      BDG02D        11
      BDGR          24
      BDGR2         56
      BDGR4        107
      BDGR5         41
      GR0235        18
      GTWOLC        12
      GR2A3         26
      GR2A4         12

STATISTICS
  PROGRAM LENGTH                  112B       74
  SCM LABELED COMMON LENGTH       533B      347
        140000B SCM USED
```

```
      SUBROUTINE GRASS7 (AGRASS,NWORDS)                                 GRASS7     2
      DIMENSION AGRASS(NWORDS)                                          GRASS7     3
      COMMON /GRSPTR/IAGRAS(38)                                         GRASS7     4
      COMMON/GRHOLD/TIT,GRT                                             GRASS7     5
      COMMON /BDG02D/ Z1(11)                                            GRASS7     6
      COMMON /BDGR/   Z2(24)                                            GRASS7     7
      COMMON /BDGR2/  Z3(56)                                            GRASS7     8
      COMMON /BDGR4/  Z4(107)                                           GRASS7     9
      COMMON /BDGR5/  Z5(41)                                            GRASS7    10
      COMMON /GR0235/ Z6(16)                                            GRASS7    11
      COMMON /GTWOLC/ Z7(12)                                            GRASS7    12
      COMMON /GR2A3/ Z8(26)                                             GRASS7    13
      COMMON /GR2A4/ Z9(12)                                             GRASS7    14
      WRITE (2) IAGRAS,AGRASS,TIT,GRT                                   GRASS7    15
      WRITE (2) Z1                                                      GRASS7    16
      WRITE (2) Z2                                                      GRASS7    17
      WRITE (2) Z3                                                      GRASS7    18
      WRITE (2) Z4                                                      GRASS7    19
      WRITE (2) Z5                                                      GRASS7    20
      WRITE (2) Z6                                                      GRASS7    21
      WRITE (2) Z7                                                      GRASS7    22
      WRITE (2) Z8                                                      GRASS7    23
      WRITE (2) Z9                                                      GRASS7    24
      RETURN                                                            GRASS7    25
      END                                                               GRASS7    26
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	GRASS7	1	24

VARIABLES	SN	TYPE		RELOCATION					
0	AGRASS	REAL	ARRAY	F.P.	REFS	2	14	DEFINED	1
1	GRT	REAL		GRHOLD	REFS	4	14		
0	IAGRAS	INTEGER	ARRAY	GRSPTR	REFS	3	14		
0	NWORDS	INTEGER		F.P.	REFS	2	DEFINED	1	
0	TIT	REAL		GRHOLD	REFS	4	14		
0	Z1	REAL	ARRAY	BDG02D	REFS	5	15		
0	Z2	REAL	ARRAY	BDGR	REFS	6	16		
0	Z3	REAL	ARRAY	BDGR2	REFS	7	17		
0	Z4	REAL	ARRAY	BDGR4	REFS	8	18		
0	Z5	REAL	ARRAY	BDGR5	REFS	9	19		
0	Z6	REAL	ARRAY	GR0235	REFS	10	20		
0	Z7	REAL	ARRAY	GTWOLC	REFS	11	21		
0	Z8	REAL	ARRAY	GR2A3	REFS	12	22		
0	Z9	REAL	ARRAY	GR2A4	REFS	13	23		

```
FILE NAMES        MODE
      TAPE2       UNFMT                WRITES      14        15        16        17        18        19        20        21
                                                    22        23

COMMON BLOCKS    LENGTH
      GRSPTR         38
      GRHOLD          2
      BDG02D         11
      BDGR           24
      BDGR2          56
      BDGR4         107
      BDGR5          41
      GR0235         18
      GTWOLC         12
      GR2A3          26
      GR2A4          12

STATISTICS
  PROGRAM LENGTH                  100B      64
  SCM LABELED COMMON LENGTH       533B     347
        140000B SCM USED
```

```
      C   GRASS8 -COMMON DATA                                                  GRASS8      2
            BLOCK DATA                                                         GRASS8      3
            COMMON/BDG02D/                                                     GRASS8      4
           +TGASIN,TGASR,PI,JFIRST,KFIRST,KPRINT,NMAX,TS02                     GRASS8      5
     5     +,TS0,IRSTRO,DUM                                                    GRASS8      6
            COMMON/BDGR/A1,R9,FPWS,NAME(3),RHOOLD,TCONV,PDSC,PI43,BCF,C01,     GRASS8      7
           +BKLO,BKHI,CPOW,SIGPI,FGPF,BVCRIT,GRFO,PTPL,PG,SBCF,FLXPT,RM        GRASS8      8
            COMMON/BDGR2/FFDSLC,ATMVOL,BOLTZ,G1,G2,EPSI,                       GRASS8      9
           +AVNUM,RG,DELHV,TPG,GBSO2P,SIG,WM1,WM2,XK,XKP,GBR,                  GRASS8     10
    10     +QSSTAR,QS,DZERO,PZERO,FN,ACON,DELTA,REDIS,RESCON,DVOL,EVL,         GRASS8     11
           +DVOG,EVG,ALFA,BEVK,BADC1,BADC2,BADC3,BADC4,BADC5,BADC6,            GRASS8     12
           +GBADC1,GBADC2,FAWGE,ASTAR,NOYES(2),GBADC3,A(9),DLIM,B              GRASS8     13
            COMMON/BDGR4/DT(7,13),DD(13),HMIN,CRT,JM                           GRASS8     14
            COMMON /VER/ VERS                                                  GRASS8     15
    15      COMMON/BDGR5/DLI,D(10),DI(10),SL(10),BI(10)                        GRASS8     16
      C                                                                        GRASS8     17
            DATA A/-57.364866,-7.0264645,.52281105,                            GRASS8     18
           +1.9840863E5,2.9969484E4,-2.07175E3,                                GRASS8     19
           +-1.4947535E8,-3.0994649E7,2.0330226E6/                             GRASS8     20
    20      DATA ACON/2.37/                                                    GRASS8     21
            DATA ALFA/0.0/                                                     GRASS8     22
            DATA ASTAR/0.50/                                                   GRASS8     23
            DATA ATMVOL/4.09E-23/                                              GRASS8     24
            DATA AVNUM/6.024E23/                                               GRASS8     25
    25      DATA B/8.3E-23/                                                    GRASS8     26
            DATA BADC1/4.9202E-11/                                             GRASS8     27
            DATA BADC2/91000./                                                 GRASS8     28
            DATA BADC3/2.00E-29/                                               GRASS8     29
            DATA BADC4/0.0/                                                    GRASS8     30
    30      DATA BADC5/1.62/                                                   GRASS8     31
            DATA BADC6/3365.51/                                                GRASS8     32
            DATA SBCF/.20/                                                     GRASS8     33
            DATA BEVK/8.625E-05/                                               GRASS8     34
            DATA BI/-1.203475E07,-4.687770E07,-1.032119E08,-1.807985E08,       GRASS8     35
    35     +-2.782098E08,-3.936497E08,-5.213507E08,-6.494966E08,-7.642163E08,  GRASS8     36
           +-8.330086E08/                                                      GRASS8     37
            DATA BOLTZ/1.38E-16/                                               GRASS8     38
            DATA BVCRIT/.05/                                                   GRASS8     39
            DATA C01/0.0/                                                      GRASS8     40
    40      DATA CPOW/32.8084/                                                 GRASS8     41
            DATA CRT/.01/                                                      GRASS8     42
            DATA D/1.709134E-3,3.418267E-3,5.127398E-3,0.683653E-2,            GRASS8     43
           +8.545665E-3,1.025480E-2,1.196394E-2,1.367307E-2,1.538220E-2,       GRASS8     44
           +1.709134E-2/                                                       GRASS8     45
    45      DATA DD/13*0./                                                     GRASS8     46
            DATA DI/585.0918,292.5457,195.0307,146.2730,117.0184,97.51531,     GRASS8     47
           +83.58456,73.13648,65.01020,58.50918/                               GRASS8     48
            DATA DELTA/50.E-08/                                                GRASS8     49
            DATA DELHV/5.96E12/                                                GRASS8     50
    50      DATA DLI/32.95967/                                                 GRASS8     51
            DATA DLIM/-180.0/                                                  GRASS8     52
            DATA DT/91*0./                                                     GRASS8     53
            DATA DVOG/.001/                                                    GRASS8     54
```

```
                      DATA DVOL/.01/                                                    GRASS8     55
                      DATA DZERO/57.E4/                                                 GRASS8     56
                      DATA EPSI/1.0E14/                                                 GRASS8     57
                      DATA EVG/4.8/                                                     GRASS8     58
                      DATA EVL/4.8/                                                     GRASS8     59
                      DATA FGPF/.310/                                                   GRASS8     60
                      DATA FLXPT/.01/                                                   GRASS8     61
                      DATA FN/.90E-05/                                                  GRASS8     62
                      DATA FPWS/3.1E10/                                                 GRASS8     63
                      DATA G1/1507./                                                    GRASS8     64
                      DATA G2/.3459/                                                    GRASS8     65
                      DATA GBADC1/4.43E-18/                                             GRASS8     66
                      DATA GBADC2/32000./                                               GRASS8     67
                      DATA GBADC3/65.42/                                                GRASS8     68
                      DATA GBR/.002/                                                    GRASS8     69
                      DATA GRF0/0.0/                                                    GRASS8     70
                      DATA IRSTRO/0/                                                    GRASS8     71
                      DATA HMIN/.0001/                                                  GRASS8     72
                      DATA JFIRST/0/                                                    GRASSA     73
                      DATA JM/6/                                                        GRASS8     74
                      DATA KFIRST/0/                                                    GRASS8     75
                      DATA KPRINT/2/                                                    GRASS8     76
                      DATA NAME/4HBULK,4HGBDY,4HEDGE/                                   GRASS8     77
                      DATA PDSC/68948.06/                                               GRASS8     78
                      DATA PG/2.09E7/                                                   GRASS8     79
                      DATA PI/3.141593/                                                 GRASS8     80
                      DATA PI43/4.18879!/                                               GRASS8     81
                      DATA PTPL/.08/                                                    GRASS8     82
                      DATA PZERO/1.64E14/                                               GRASS8     83
                      DATA Q5/4.52E12/                                                  GRASS8     84
                      DATA Q5STAR/.69466E-11/                                           GRASS8     85
                      DATA R9/73.592/                                                   GRASS8     86
                      DATA REDIS/50.E-8/                                                GRASS8     87
                      DATA RESCON/1.0E-18/                                              GRASS8     88
                      DATA RG/8.31E7/                                                   GRASS8     89
                      DATA RHOOLD/1.000/                                                GRASS8     90
                      DATA RM/5.0/                                                      GRASS8     91
                      DATA SIG/3.E-8/                                                   GRASS8     92
                      DATA SIGPI/.03/                                                   GRASS8     93
                      DATA SL/4.608549E07,1.023236E08,1.703004E08,2.526030E08,          GRASS8     94
                     +3.521856E08,4.731108E08,6.194947E08,7.952701E08,1.006582E09,      GRASS8     95
                     +1.255744E09/                                                      GRASS8     96
                      DATA TGASIN/0./                                                   GRASS8     97
                      DATA TGASR/0./                                                    GRASS8     98
                      DATA T50/0.0/                                                     GRASS8     99
                      DATA T502/0./                                                     GRASS8    100
                      DATA VERS/4HFAST/                                                 GRASS8    101
                      DATA WM1/270./                                                    GRASS8    102
                      DATA WM2/132./                                                    GRASS8    103
                      DATA XK/1./                                                       GRASS8    104
                      DATA XKP/1./                                                      GRASS8    105
                      END                                                               GRASS8    106
```

SYMBOLIC REFERENCE MAP (R=2)

VARIABLES	SN	TYPE		RELOCATION					
55	A	REAL	ARRAY	BDGR2	REFS	8	DEFINED	17	
26	ACON	REAL		BDGR2	REFS	8	DEFINED	20	
36	ALFA	REAL		BDGR2	REFS	8	DEFINED	21	
51	ASTAR	REAL		BDGR2	REFS	8	DEFINED	22	
1	ATMVOL	REAL		BDGR2	REFS	8	DEFINED	23	
6	AVNUM	REAL		BDGR2	REFS	8	DEFINED	24	
0	AI	REAL		BDGR	REFS	6			
67	B	REAL		BDGR2	REFS	8	DEFINED	25	
40	BADC1	REAL		BDGR2	REFS	8	DEFINED	26	
41	BADC2	REAL		BDGR2	REFS	8	DEFINED	27	
42	BADC3	REAL		BDGR2	REFS	8	DEFINED	28	
43	BADC4	REAL		BDGR2	REFS	8	DEFINED	29	
44	BADC5	REAL		BDGR2	REFS	8	DEFINED	30	
45	BADC6	REAL		BDGR2	REFS	8	DEFINED	31	
12	BCF	REAL		BDGR	REFS	6			
37	BEVK	REAL		BDGR2	REFS	8	DEFINED	33	
37	BI	REAL	ARRAY	BDGR5	REFS	15	DEFINED	34	
15	BKHI	REAL		BDGR	REFS	6			
14	BKLO	REAL		BDGR	REFS	6			
2	BOLTZ	REAL		BDGR2	REFS	8	DEFINED	37	
21	BVCRIT	REAL		BDGR	REFS	6	DEFINED	38	
16	CPOW	REAL		BDGR	REFS	6	DEFINED	40	
151	CRT	REAL		BDGR4	REFS	13	DEFINED	41	
13	C01	REAL		BDGR	REFS	6	DEFINED	39	
1	D	REAL	ARRAY	BDGR5	REFS	15	DEFINED	42	
133	DD	REAL	ARRAY	BDGR4	REFS	13	DEFINED	45	
10	DELHV	REAL		BDGR2	REFS	8	DEFINED	49	
27	DELTA	REAL		BDGR2	REFS	8	DEFINED	48	
13	DI	REAL	ARRAY	BDGR5	REFS	15	DEFINED	46	
0	DLI	REAL		BDGR5	REFS	15	DEFINED	50	
66	DLIM	REAL		BDGR2	REFS	8	DEFINED	51	
0	DT	REAL	ARRAY	BDGR4	REFS	13	DEFINED	52	
12	DUM	REAL		BDG02D	REFS	3			
34	DVOG	REAL		BDGR2	REFS	8	DEFINED	53	
32	DVOL	REAL		BDGR2	REFS	8	DEFINED	54	
23	DZERO	REAL		BDGR2	REFS	8	DEFINED	55	
5	EPSI	REAL		BDGR2	REFS	8	DEFINED	56	
35	EVG	REAL		BDGR2	REFS	8	DEFINED	57	
33	EVL	REAL		BDGR2	REFS	8	DEFINED	58	
50	FAWGE	REAL		BDGR2	REFS	8			
0	FFDSLC	REAL		BDGR2	REFS	8			
20	FGPF	REAL		BDGR	REFS	6	DEFINED	59	
26	FLXPT	REAL		BDGR	REFS	6	DEFINED	60	
25	FN	REAL		BDGR2	REFS	8	DEFINED	61	
2	FPWS	REAL		BDGR	REFS	6	DEFINED	62	
46	GBADC1	REAL		BDGR2	REFS	8	DEFINED	65	
47	GBADC2	REAL		BDGR2	REFS	8	DEFINED	66	
54	GBADC3	REAL		BDGR2	REFS	8	DEFINED	67	
20	GBR	REAL		BDGR2	REFS	8	DEFINED	68	

VARIABLES	SN	TYPE		RELOCATION				
12	GB502P	REAL		BDGR2	REFS	8		
22	GRF0	REAL		BDGR	REFS	6	DEFINED	69
3	G1	REAL		BDGR2	REFS	8	DEFINED	63
4	G2	REAL		BDGR2	REFS	8	DEFINED	64
150	HMIN	REAL		BDGR4	REFS	13	DEFINED	71
11	IRSTRO	INTEGER		BDG02D	REFS	3	DEFINED	70
3	JFIRST	INTEGER		BDG02D	REFS	3	DEFINED	72
152	JM	INTEGER		BDGR4	REFS	13	DEFINED	73
4	KFIRST	INTEGER		BDG02D	REFS	3	DEFINED	74
5	KPRINT	INTEGER		BDG02D	REFS	3	DEFINED	75
3	NAME	INTEGER	ARRAY	BDGR	REFS	6	DEFINED	76
6	NMAX	INTEGER		BDG02D	REFS	3		
52	NOYES	INTEGER	ARRAY	BDGR2	REFS	8		
10	PDSC	REAL		BDGR	REFS	6	DEFINED	77
24	PG	REAL		BDGR	REFS	6	DEFINED	78
2	PI	REAL		BDG02D	REFS	3	DEFINED	79
11	PI43	REAL		BDGR	REFS	6	DEFINED	80
23	PTPL	REAL		BDGR	REFS	6	DEFINED	81
24	PZERO	REAL		BDGR2	REFS	8	DEFINED	82
22	QS	REAL		BDGR2	REFS	8	DEFINED	83
21	QSSTAR	REAL		BDGR2	REFS	8	DEFINED	84
30	REDIS	REAL		BDGR2	REFS	8	DEFINED	86
31	RESCON	REAL		BDGR2	REFS	8	DEFINED	87
7	RG	REAL		BDGR2	REFS	8	DEFINED	88
6	RHOOLD	REAL		BDGR	REFS	6	DEFINED	89
27	RM	REAL		BDGR	REFS	6	DEFINED	90
1	R9	REAL		BDGR	REFS	6	DEFINED	85
25	SBCF	REAL		BDGR	REFS	6	DEFINED	32
13	SIG	REAL		BDGR2	REFS	8	DEFINED	91
17	SIGPI	REAL		BDGR	REFS	6	DEFINED	92
25	SL	REAL	ARRAY	BDGR2	REFS	15	DEFINED	93
7	TCONV	REAL		BDGR	REFS	6		
0	TGASIN	REAL		BDG02D	REFS	3	DEFINED	96
1	TGASR	REAL		BDG02D	REFS	3	DEFINED	97
11	TPG	REAL		BDGR2	REFS	8		
10	TS0	REAL		BDG02D	REFS	3	DEFINED	98
7	TS02	REAL		BDG02D	REFS	3	DEFINED	99
0	VERS	REAL		VER	REFS	14	DEFINED	100
14	WM1	REAL		BDGR2	REFS	8	DEFINED	101
15	WM2	REAL		BDGR2	REFS	8	DEFINED	102
16	XK	REAL		BDGR2	REFS	8	DEFINED	103
17	XKP	REAL		BDGR2	REFS	8	DEFINED	104

COMMON BLOCKS	LENGTH
BDG02D	11
BDGR	24
BDGR2	56
BDGR4	107
VER	1
BDGR5	41

```
STATISTICS
  PROGRAM LENGTH                    0B       0
  SCM LABELED COMMON LENGTH       360B     240
        140000B SCM USED
```

```
      SUBROUTINE GRASS9 (NF,KF,NWORDS,LENGTH)                                  GRASS9     2
C                                                                              GRASS9     3
C     *******                                                                  GRASS9     4
C     GRASS9 IS CALLED FROM SUBROUTINE POINTR                                  GRASS9     5
C     SUBROUTINE TO COMPUTE LOCATION OF NODALLY DEPENDENT VARIABLES            GRASS9     6
C     USED IN GRASS                                                            GRASS9     7
C                                                                              GRASS9     8
C     LENGTH = LENGTH OF FRAPCON A ARRAY                                       GRASS9     9
C     NF = NUMBER OF AXIAL NODES  --  INPUT                                    GRASS9    10
C     KF = NUMBER OF RADIAL RINGS  --  INPUT                                   GRASS9    11
C     KF1 = KF + 1                                                             GRASS9    12
C     NJ = NUMBER OF AXIAL VARIABLES                                           GRASS9    13
C     NK = NUMBER OF RADIAL VARIABLES                                          GRASS9    14
C     NJK = NUMBER OF AXIAL,RADIAL VARIABLES                                   GRASS9    15
C     NKN = NUMBER OF RADIAL,BUBBLE VARIABLES                                  GRASS9    16
C     NJKN = NUMBER OF AXIAL,RADIAL,BUBBLE VARIABLES                           GRASS9    17
C     NVAR = TOTAL NUMBER OF VARIABLES IN AGRASS                               GRASS9    18
C     NWORDS = TOTAL NUMBER OF WORDS NEEDED FOR AGRASS ARRAY  --  OUTPUT       GRASS9    19
C                                                                              GRASS9    20
C     TO MAINTAIN COMPATIBILITY WITH GRASS-SST THE FOLLOWING VARIABLES         GRASS9    21
C     HAVE BEEN DIMENSIONED TO ONE:  FODSLC,RHODSL,GIP,HOLD,NMAXBK,            GRASS9    22
C     BLKMGO, AND BULK                                                         GRASS9    23
C     GBDY HAS BEEN REPLACED WITH SAVG AND DSLC BY DIST.                       GRASS9    24
C     THE FOLLOWING VARIABLES ARE IN THE AGRASS ARRAY                          GRASS9    25
C     NVAR1=BVS(NF)      NVAR14=GASGEN(NF,KF)     NVAR28=RS(NF,KF1)           GRASS9    26
C     NVAR2=GR(NF)       NVAR15=GESWF(NF,KF)      NVAR29=TFO(NF,KF)           GRASS9    27
C     NVAR3=POW(NF)      NVAR16=GIP(1,1)          NVAR30=TK(NF,KF)            GRASS9    28
C     NVAR4=RGTJ(NF)     NVAR17=GOUT(NF,KF)       NVAR31=TKOLD(NF,KF)         GRASS9    29
C     NVAR5=FDP(KF)      NVAR18=GRSIZ(NF,KF)      NVAR32=TS(NF,KF1)           GRASS9    30
C     NVAR6=FODSLC(1)    NVAR19=GS(NF,KF)         NVAR33=BLKMGO(1)            GRASS9    31
C     NVAR7=FOGBDY(KF)   NVAR20=HH(NF,KF)         NVAR34=GBYMGO(KF)           GRASS9    32
C     NVAR8=PRF(KF)      NVAR21=HOLD(1,1)         NVAR35=BULK(1,1)            GRASS9    33
C     NVAR9=RHODSL(1)    NVAR22=NMAXBK(1,1)       NVAR36=DIST(NF,KF,4)        GRASS9    34
C     NVAR10=TAUA(KF1)   NVAR23=POROS(NF,KF)      NVAR37=SAVG(NF,KF,4)        GRASS9    35
C     NVAR11=TGRAD(KF)   NVAR24=PRFOLD(NF,KF)                                  GRASS9    36
C     NVAR12=BV(NF,KF)   NVAR25=PRSO(NF,KF)                                    GRASS9    37
C     NVAR13=CO(NF,KF)   NVAR26=RH(NF,KF)                                      GRASS9    38
C     NVAR27=RHOLD(NF,KF)                                                      GRASS9    39
C     *******                                                                  GRASS9    40
C                                                                              GRASS9    41
      COMMON/GRSPTR/IAGRAS(38)                                                 GRASS9    42
C                                                                              GRASS9    43
      NJ = 4                                                                   GRASS9    44
      NK = 7                                                                   GRASS9    45
      NJK = 21                                                                 GRASS9    46
      NKN = 2                                                                  GRASS9    47
      NJKN = 3                                                                 GRASS9    48
C                                                                              GRASS9    49
C     CALCULATIONS INVOLVING RS, TS, AND TAUA REQUIRE AN ADDITIONAL            GRASS9    50
C     RADIAL ELEMENT IN EACH ARRAY                                             GRASS9    51
C                                                                              GRASS9    52
C     NWORDS = NJ*NF + NK*KF+1 + NJK*NF*KF+(2*NF) + NKN*KF                     GRASS9    53
C    +    + NJKN*NF*KF*4 - 3*(KF-1) - 7*(NF*KF-1)                              GRASS9    54
```

```
      NVAR = NJ+NK+NJK+NKN+NJKN                                          GRASS9     55
C                                                                        GRASS9     56
      IAGRAS(1) = 1                                                      GRASS9     57
      NBEG = 2                                                           GRASS9     58
      NEND = NJ+1                                                        GRASS9     59
          DO 100 I=NBEG,NEND                                             GRASS9     60
100       IAGRAS(I) = IAGRAS(I-1)+NF                                     GRASS9     61
      NBEG = NEND+1                                                      GRASS9     62
      NEND = NEND+NK                                                     GRASS9     63
C                                                                        GRASS9     64
C   INCREASE NUMBER OF RADIAL ELEMENTS IN TAUA BY ONE                    GRASS9     65
C                                                                        GRASS9     66
          DO 110 I=NBEG,NEND                                             GRASS9     67
          IAGRAS(I) = IAGRAS(I-1)+KF                                     GRASS9     68
          IF (I.EQ.11) IAGRAS(I) = IAGRAS(I)+1                           GRASS9     69
          IF (I.EQ.7) IAGRAS(I) = IAGRAS(I)-KF+1                         GRASS9     70
          IF (I.EQ.10) IAGRAS(I) = IAGRAS(I)-KF+1                        GRASS9     71
110       CONTINUE                                                       GRASS9     72
      NBEG = NEND+1                                                      GRASS9     73
      NEND = NEND+NJK                                                    GRASS9     74
C                                                                        GRASS9     75
C   INCREASE NUMBER OF RADIAL ELEMENTS IN TS AND RS BY ONE FOR EACH      GRASS9     76
C   AXIAL NODE                                                           GRASS9     77
C                                                                        GRASS9     78
          DO 120 I=NBEG,NEND                                             GRASS9     79
          IAGRAS(I) = IAGRAS(I-1)+NF*KF                                  GRASS9     80
          IF (I.EQ.29.OR.I.EQ.33) IAGRAS(I) = IAGRAS(I)+NF               GRASS9     81
          IF (I.EQ.17) IAGRAS(I) = IAGRAS(I)-NF*KF+1                     GRASS9     82
          IF (I.EQ.22) IAGRAS(I) = IAGRAS(I)-NF*KF+1                     GRASS9     83
          IF (I.EQ.23) IAGRAS(I) = IAGRAS(I)-NF*KF+1                     GRASS9     84
120       CONTINUE                                                       GRASS9     85
      NBEG = NEND+1                                                      GRASS9     86
      NEND = NEND+NKN                                                    GRASS9     87
          DO 130 I=NBEG,NEND                                             GRASS9     88
          IAGRAS(I) = IAGRAS(I-1)+KF                                     GRASS9     89
          IF (I.EQ.34) IAGRAS(I) = IAGRAS(I)-KF+1                        GRASS9     90
130       CONTINUE                                                       GRASS9     91
      NBEG = NEND+1                                                      GRASS9     92
      NEND = NVAR                                                        GRASS9     93
          DO 140 I=NBEG,NVAR                                             GRASS9     94
          IAGRAS(I) = IAGRAS(I-1)+NF*KF*4                                GRASS9     95
          IF (I.EQ.36) IAGRAS(I) = IAGRAS(I)-KF*NF*4+1                   GRASS9     96
140       CONTINUE                                                       GRASS9     97
C                                                                        GRASS9     98
C   POSITION AGRASS ARRAY AT END OF FRAPCON A ARRAY                      GRASS9     99
C                                                                        GRASS9    100
      NWORDS = IAGRAS(NVAR)+NF*KF*4                                      GRASS9    101
          DO 150 I=1,NVAR                                                GRASS9    102
150       IAGRAS(I) = IAGRAS(I)+LENGTH                                   GRASS9    103
      WRITE (6,160) (I,IAGRAS(I),I=1,NVAR)                               GRASS9    104
      WRITE (6,170) NWORDS                                               GRASS9    105
      RETURN                                                             GRASS9    106
C                                                                        GRASS9    107
```

```
  160   FORMAT (1X,I5,1X,I5)                                   GRASS9   108
  170   FORMAT (1X,"NWORDS IS",I10)                            GRASS9   109
        END                                                    GRASS9   110
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS		DEF LINE	REFERENCES
4	GRASS9	1	105

VARIABLES	SN	TYPE			RELOCATION								
277	I	INTEGER				REFS	2*60	2*67	3*68	3*69	3*70	2*79	4*80
						3*81	3*82	3*83	2*88	3*89	2*94	3*95	2*102
						2*103	DEFINED	59	66	78	87	93	101
						103							
0	IAGRAS	INTEGER	ARRAY		GRSPTR	REFS	41	60	67	68	69	70	79
						80	81	82	83	88	89	94	95
						100	102	103	DEFINED	56	60	67	68
						69	70	79	80	81	82	83	88
						89	94	95	102				
0	KF	INTEGER			F.P.	REFS	67	69	70	79	81	82	83
						88	89	94	95	100	DEFINED	1	
0	LENGTH	INTEGER			F.P.	REFS	102	DEFINED	1				
275	NBEG	INTEGER				REFS	59	66	78	87	93		
						DEFINED	57	61	72	85	91		
276	NEND	INTEGER				REFS	59	61	62	66	72	73	78
						85	86	87	91	DEFINED	58	62	73
						86	92						
0	NF	INTEGER			F.P.	REFS	60	79	80	81	82	83	94
						95	100	DEFINED	1				
267	NJ	INTEGER				REFS	54	58	DEFINED	43			
271	NJK	INTEGER				REFS	54	73	DEFINED	45			
273	NJKN	INTEGER				REFS	54	DEFINED	47				
270	NK	INTEGER				REFS	54	62	DEFINED	44			
272	NKN	INTEGER				REFS	54	86	DEFINED	46			
274	NVAR	INTEGER				REFS	92	93	100	101	103		
						DEFINED	54						
0	NWORDS	INTEGER			F.P.	REFS	104	DEFINED	1	100			

FILE NAMES	MODE			
TAPE6	FMT	WRITES	103	104

STATEMENT LABELS			DEF LINE	REFERENCES
0	100		60	59
0	110		71	66
0	120		84	78
0	130		90	87
0	140		96	93
0	150		102	101
261	160	FMT	107	103

```
STATEMENT LABELS                DEF LINE   REFERENCES
  264  170     FMT                 108        104

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   37  100      I           59 60        5B     INSTACK
   53  110      I           66 71       24B        OPT
  106  120      I           78 84       37B        OPT
  154  130      I           87 90       13B        OPT
  176  140      I           93 96       15B        OPT
  222  150      I          101 102       5B     INSTACK
  232           I          103 103       7B                EXT REFS

COMMON BLOCKS   LENGTH
       GRSPTR       38

STATISTICS
  PROGRAM LENGTH                  325B      213
  SCM LABELED COMMON LENGTH        46B       38
        140000B SCM USED
```

```
      SUBROUTINE CALLGR (DEL,NF,KF,FL,PLENP,TIT,GRT,IRSTAR,NPRINT,AGRASS CALLGR      2
     +,NWORDS)                                                          CALLGR      3
      COMMON/GRSPTR/NVAR1,NVAR2,NVAR3,NVAR4,NVAR5,NVAR6,NVAR7,NVAR8,    CALLGR      4
     +NVAR9,NVAR10,NVAR11,NVAR12,NVAR13,NVAR14,NVAR15,NVAR16,NVAR17,    CALLGR      5
     +NVAR18,NVAR19,NVAR20,NVAR21,NVAR22,NVAR23,NVAR24,NVAR25,NVAR26,   CALLGR      6
     +NVAR27,NVAR28,NVAR29,NVAR30,NVAR31,NVAR32,NVAR33,NVAR34,NVAR35,   CALLGR      7
     +NVAR36,NVAR37,LGRASS                                              CALLGR      8
      COMMON/BDG02D/                                                    CALLGR      9
     +TGASIN,TGASR,FI,JFIRST,KFIRST,KPRINT,NMAX,TS02                    CALLGR     10
     +,TS0,IRSTRO,VERS                                                  CALLGR     11
      DIMENSION AGRASS(NWORDS)                                          CALLGR     12
      KFI = KF+1                                                        CALLGR     13
      CALL GRASS (DEL,NF,KF,FL,TIT,PLENP,IRSTAR,NPRINT,GRT,BVST,KFI,AGRA CALLGR     14
     +SS(NVAR1),AGRASS(NVAR2),AGRASS(NVAR3),AGRASS(NVAR4),AGRASS(NVAR5), CALLGR     15
     +AGRASS(NVAR6),AGRASS(NVAR7),AGRASS(NVAR8),AGRASS(NVAR9),AGRASS(NVA CALLGR     16
     +R10),AGRASS(NVAR11),AGRASS(NVAR12),AGRASS(NVAR13),AGRASS(NVAR14),A CALLGR     17
     +GRASS(NVAR15),AGRASS(NVAR16),AGRASS(NVAR17),AGRASS(NVAR18),AGRASS( CALLGR     18
     +NVAR19),AGRASS(NVAR20),AGRASS(NVAR21),AGRASS(NVAR22),AGRASS(NVAR23 CALLGR     19
     +),AGRASS(NVAR24),AGRASS(NVAR25),AGRASS(NVAR26),AGRASS(NVAR27),AGRA CALLGR     20
     +SS(NVAR28),AGRASS(NVAR29),AGRASS(NVAR30),AGRASS(NVAR31),AGRASS(NVA CALLGR     21
     +R32),AGRASS(NVAR33),AGRASS(NVAR34),AGRASS(NVAR35),AGRASS(NVAR36),A CALLGR     22
     +GRASS(NVAR37))                                                    CALLGR     23
C     WRITE(6,30)(I,AGRASS(I),I=LGRASS,LGRSSN)                          CALLGR     24
      RETURN                                                            CALLGR     25
      END                                                               CALLGR     26
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS

		DEF LINE	REFERENCES
4	CALLGR	1	24

VARIABLES

		SN	TYPE		RELOCATION					
0	AGRASS		REAL	ARRAY	F.P.	REFS	11	37*13	DEFINED	1
222	BVST	*	REAL			REFS	13			
0	DEL		REAL		F.P.	REFS	13	DEFINED	1	
0	FL		REAL		F.P.	REFS	13	DEFINED	1	
0	GRT		REAL		F.P.	REFS	13	DEFINED	1	
0	IRSTAR		INTEGER		F.P.	REFS	13	DEFINED	1	
11	IRSTRO		INTEGER		BDG02D	REFS	8			
3	JFIRST		INTEGER		BDG02D	REFS	8			
0	KF		INTEGER		F.P.	REFS	12	13	DEFINED	1
4	KFIRST		INTEGER		BDG02D	REFS	8			
221	KFI		INTEGER			REFS	13	DEFINED	12	
5	KPRINT		INTEGER		BDG02D	REFS	8			
45	LGRASS		INTEGER		GRSPTR	REFS	3			
3	NF		INTEGER		F.P.	REFS	13	DEFINED	1	
6	NMAX		INTEGER		BDG02D	REFS	8			
0	NPRINT		INTEGER		F.P.	REFS	13	DEFINED	1	
0	NVAR1		INTEGER		GRSPTR	REFS	3	13		

VARIABLES	SN	TYPE	RELOCATION				
11	NVAR10	INTEGER	GRSPTR	REFS	13		
12	NVAR11	INTEGER	GRSPTR	REFS	13		
13	NVAR12	INTEGER	GRSPTR	REFS	13		
14	NVAR13	INTEGER	GRSPTR	REFS	13		
15	NVAR14	INTEGER	GRSPTR	REFS	13		
16	NVAR15	INTEGER	GRSPTR	REFS	13		
17	NVAR16	INTEGER	GRSPTR	REFS	13		
20	NVAR17	INTEGER	GRSPTR	REFS	13		
21	NVAR18	INTEGER	GRSPTR	REFS	13		
22	NVAR19	INTEGER	GRSPTR	REFS	13		
1	NVAR2	INTEGER	GRSPTR	REFS	13		
23	NVAR20	INTEGER	GRSPTR	REFS	13		
24	NVAR21	INTEGER	GRSPTR	REFS	13		
25	NVAR22	INTEGER	GRSPTR	REFS	13		
26	NVAR23	INTEGER	GRSPTR	REFS	13		
27	NVAR24	INTEGER	GRSPTR	REFS	13		
30	NVAR25	INTEGER	GRSPTR	REFS	13		
31	NVAR26	INTEGER	GRSPTR	REFS	13		
32	NVAR27	INTEGER	GRSPTR	REFS	13		
33	NVAR28	INTEGER	GRSPTR	REFS	13		
34	NVAR29	INTEGER	GRSPTR	REFS	13		
2	NVAR3	INTEGER	GRSPTR	REFS	13		
35	NVAR30	INTEGER	GRSPTR	REFS	13		
36	NVAR31	INTEGER	GRSPTR	REFS	13		
37	NVAR32	INTEGER	GRSPTR	REFS	13		
40	NVAR33	INTEGER	GRSPTR	REFS	13		
41	NVAR34	INTEGER	GRSPTR	REFS	13		
42	NVAR35	INTEGER	GRSPTR	REFS	13		
43	NVAR36	INTEGER	GRSPTR	REFS	13		
44	NVAR37	INTEGER	GRSPTR	REFS	13		
3	NVAR4	INTEGER	GRSPTR	REFS	13		
4	NVAR5	INTEGER	GRSPTR	REFS	13		
5	NVAR6	INTEGER	GRSPTR	REFS	13		
6	NVAR7	INTEGER	GRSPTR	REFS	13		
7	NVAR8	INTEGER	GRSPTR	REFS	13		
10	NVAR9	INTEGER	GRSPTR	REFS	13		
0	NWORDS	INTEGER	F.P.	REFS	11	DEFINED	1
2	PI	REAL	BDG02D	REFS	8		
0	PLENP	REAL	F.P.	REFS	8	DEFINED	1
0	TGASIN	REAL	BDG02D	REFS	8		
1	TGASR	REAL	BDG02D	REFS	8		
0	TIT	REAL	F.P.	REFS	13	DEFINED	1
10	TS0	REAL	BDG02D	REFS	8		
7	TS02	REAL	BDG02D	REFS	8		
12	VERS	REAL	BDG02D	REFS	8		

EXTERNALS	TYPE	ARGS	REFERENCES
GRASS		48	13

COMMON BLOCKS	LENGTH
GRSPTR	38
BDG02D	11

```
STATISTICS
  PROGRAM LENGTH                 223B     147
  SCM LABELED COMMON LENGTH       61B      49
        140000B SCM USED
```

SEGLOAD DIRECTIVES.

```
                                TREE DRIVER-(ANSWER,FRPCON-(SETUP,TMPSUB,FC
,MI,FCMI2,FAILUR,PLTOUT,VOLUME,BURNUP,PRINT2,PELET-(TEMPA,ABOUND,KREEP),
,CALLGR,CCREEP.)
ANSWER  INCLUDE READIN,DESIGN,NAMES,ECHO1
BURNUP  INCLUDE GASPRO,COOLT,FLMDRP,CORROS,CLADRP,FLUXD,CEXPAN
BURNUP  INCLUDE RPACK,CLDGRO
TMPSUB  INCLUDE FLXPAN,SWELL,RADIAL,CONDUC
VOLUME  INCLUDE FGASRE,ENERGY,ANS54
PLTOUT  INCLUDE RESTFS,PRINTM,WRITER
TEMPA   INCLUDE TEMPB,TEMPC,TEMPD
ABOUND  INCLUDE BOUND,ASOLVE,SOLVET,ALOAD,LOAD,STFAXL,STIFF
PRINT2  INCLUDE GASOLT
DRIVER GLOBAL POINT,PNTINL,REALS,INTEG,INPTR,INPTI,MATCNS
DRIVER GLOBAL PHYPRP,LACMDL,LIMITS,08.IO.,FCL.C.,IO.BUF.,BA
DRIVER GLOBAL PNTPNL,AXL,FFP,STFMAT,GEOPAR,LASTIC,CONTNT
DRIVER GLOBAL TAPES,PRSSV,  DEV,EMFLGS
DRIVER GLOBAL GRSPTR,BDGO2D,BDGR,BDGR2,BDGR4,BDGR5,GRHOLD
DRIVER GLOBAL GTWOLC,GR0235,GR2A3,GR2A4,VER
DRIVER GLOBAL GR0A2,GR0A3,GR2A4,GR0A4
DRIVER GLOBAL PFRCS2,PFCMI2
DRIVER GLOBAL DESNBL,STP.END,CON.RM,AOB.RM,JMPS.RM,MEMC.RM,OPES.FO
DRIVER GLOBAL OPEN.FO,PUT.RT,CLSF.FO,CLSV.FO,REW.FO,TERM.RM,GET.FO
DRIVER GLOBAL RPAR.XX,GET.BT,GET.RT,PUT.FO,SKFL.FO
       LEVEL
       TREE FTBNUL
FTBNUL GLOBAL FAST
       END DRIVER
```

TREE DIAGRAM.

```
*DRIVER
 ?
 ?_ANSWER
 ?
 ?_FRPCON
   ?
   ?_SETUP
   ?
   ?_TMPSUB
   ?
   ?_FCMI
   ?
   ?_FCMI2
   ?
   ?_FAILUR
   ?
   ?_PLTOUT
   ?
   ?_VOLUME
   ?
```

```
   ?_BURNUP
   ?
   ?_PRINT2
   ?
   ?_PELET
   ? ?
   ? ?_TEMPA
   ? ?
   ? ?_ABOUND
   ? ?
   ? ?_KREEP
   ?
   ?_CALLGR
   ?
   ?_CCREEP
```

==========

*FTBNUL

```
FWA OF THE LOAD          1046
LWA+1 OF THE LOAD      260073

ECS FWA                   0
ECS LWA+1               162560

WRITTEN TO FILE     FRPCAB
TRANSFER ADDRESS -- DRIVER        35431

********** ERROR SUMMARY
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - DESNBL
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - CON.RM
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - AOB.RM
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - JMPS.RM
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - MEMC.RM
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - OPES.FO
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - OPEN.FO
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - PUT.RT
     NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - CLSF.FO
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 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - CLSV.FO
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - REW.FO
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - TERM.RM
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - GET.FO
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - RPAR.XX
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - GET.BT
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - GET.RT
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - PUT.FO
 NE4420///COULD NOT FIND COMMON OR GLOBAL BLOCK - SKFL.FO
```

-------- SEGMENT - DRIVER

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
(DRIVER)		1046	15					
/FCL=ENT/	G5	1063	42					
/POINT/	G	1125	307					
/PNTINL/	G	1434	1					
/REALS/	G	1435	610					
/INTEG/	G	2245	30					
/INPTR/	G	2275	2561					
/INPTI/	G	5056	305					
/MATCNS/	G	5363	14					
/PHYPRO/	G	5377	13					
/LACMDL/	G	5412	25					
/LIMITS/	G	5437	76					
/QB.IO./	G	5535	155					
/FCL.C./	G	5712	26					
/IO.BUF./	G	5740	227					
/BA/	G	6167	126					
/PNTPNL/	G	6315	107					
/AXL/	G	6424	4					
/FEP/	G	6430	105					
/STFMAT/	G	6535	204					
/GEOPAR/	G	6741	15					
/LASTIC/	G	6756	3					
/CON[illegible]/	G	6761	1					
/TA[illegible]	G	6762	6					

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/PRSSV/	G	6770	50						
/IODEV/	G	7040	2						
/EMFLGS/	G	7042	12						
/GRSPTR/	G	7054	46						
/BDG02D/	G	7122	13						
/BDGR/	G	7135	30						
/BDGR2/	G	7165	70						
/BDGR4/	G	7255	153						
/BDGR5/	G	7430	51						
/GRHOLD/	G	7501	2						
/GTWOLC/	G	7503	14						
/GR0235/	G	7517	22						
/GR2A3/	G	7541	32						
/GR2A4/	G	7573	14						
/VER/	G	7607	1						
/GR0A2/	G	7610	22						
/GR0A3/	G	7632	5						
/GR094/	G	7637	12						
/PFRCS2/	G	7651	26						
/PFCM12/	G	7677	47						
/STP.END/	G	7746	1						
DRIVER		7747	30414	NEW	10/21/80	FTN	4.8 508	767X IL	PROGRAM OPT=0 TRACE STATIC
FLUXDP		40363	105	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
POLATE		40470	234	NEW	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
DIALOT		40724	61	NEW	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
RUNFRP		41005	520	NEW	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
STRANI		41525	7	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CREPI		41534	13	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
STRESI		41547	13	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRAINX		41562	227	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRESSX		42011	172	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CREEPX		42203	402	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TEMPS		42605	21	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
TEMPKF		42626	17	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
PSIS		42645	15	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
PSIB		42662	15	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CRAPX		42677	156	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FPRESS		43055	60	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CONVTR		43135	44	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXI2IN		43201	53	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXILOD		43254	601	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXIMDL		44055	1314	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ZCOR		45371	47	NEWAXS	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
AXI2		45440	2332	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
AXIOUT		47772	1465	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXSCRP		51457	410	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CLOSAX		52067	714	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
ELAST		53003	177	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
ELEMI		53202	535	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EOCALC		53737	440	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
FILL		54377	23	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
GAPADD	54422	124	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GAPSEM	54546	325	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
GPFORC	55073	205	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GAPTST	55300	350	NEWAXS	10/21/80	FTN	4.8 508	767X IL	FUNCTION OPT=0 TRACE STATIC
IFPRES	55650	315	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
KTIE	56165	370	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
NULOAD	56555	2137	NEWAXS	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
PASPSI	60714	15	NEWAXS	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
AXPLAS	60731	1715	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PSIPAS	62646	15	NEWAXS	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
RADFRC	62663	120	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRNAD	63003	300	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRNAV	63303	162	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRSAV	63465	57	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SIGCLC	63544	332	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TEMPFK	64076	21	NEWAXS	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
TF	64117	245	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
XGAPSM	64364	114	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
XLFRC	64500	114	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
XLLOK	64614	145	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CRIIPX	64761	144	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXDRIV	65125	44266	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CANISO	131413	544	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CBRTTL	132157	254	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CCLAPS	132433	42	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CCP	132475	125	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CCRPR	132622	205	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CELAST	133027	1676	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CELMOD	134725	274	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CFATIG	135221	67	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CHITOX	135310	114	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CHSCP	135424	131	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CHUPTK	135555	242	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CKMN	136017	504	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
COBILD	136523	1556	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CSHEAR	140301	254	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CSIGMA	140555	150	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CSTRAN	140725	66	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CSTRES	141013	64	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CSTRNI	141077	227	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CTHEXP	141326	273	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CTXTUR	141621	1623	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FCP	143444	250	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FCREEP	143714	435	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FELMOD	144351	161	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FFRACS	144532	74	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FGASRL	144626	345	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FHOTPS	145173	600	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FPOIR	145773	61	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FRESTR	146054	172	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FTHEXP	146246	172	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER	LEVEL	HARDWARE	COMMENTS
FVAPRS	146440	315	MTPLM	10/21/80	FTN	4.8	508	767X 1	SUBROUTINEOPT=0 TRACE STATIC
EMCPIR	146755	30	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMCTXP	147005	47	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMFCP	147054	75	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMFEOD	147151	41	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMFPIR	147212	14	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMFESS	147226	61	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMCCP	147307	37	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMCLEM	147346	42	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMFTXP	147410	67	MTPLM	10/21/80	FTN	4.8	508	767X 1	FUNCTION OPT=0 TRACE STATIC
EMSTRN	147477	236	MTPLM	10/21/80	FTN	4.8	508	767X 1	SUBROUTINEOPT=0 TRACE STATIC
GRASS1	147735	30	NEWFG	10/21/80	FTN	4.8	508	767X 1	SUBROUTINEOPT=0 TRACE STATIC
GRASS7	147765	100	NEWFG	10/21/80	FTN	4.8	508	767X 1	SUBROUTINEOPT=0 TRACE STATIC
BLKDAT.	150065	0	NEWFG	10/21/80	FTN	4.8	508	767X 1	BLOCKDATA OPT=0 TRACE STATIC
ALOG	150065	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CALL-BY-REFERENCE LINK TO ALOG. .
ALOG.	150075	64	SL-FORTRAN	04/29/80	COMPASS	3.6	508		COMPUTE COMMON AND NATURAL LOGARITHMS. OPT=
EXP	150161	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CALL-BY-REFERENCE LINK TO EXP. .
ITOJ.	150171	32	SL-FORTRAN	04/29/80	COMPASS	3.6	508		INTEGER TO INTEGER EXPONENTIATION. OPT=ALL
COS	150223	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		FCL4 - EVALUATE COSINE FUNCTION. CAL
SQRT.	150233	32	SL-FORTRAN	04/29/80	COMPASS	3.6	508		COMPUTE THE SQUARE ROOT OF X. OPT=ALL.
SYS=IST	150265	65	SL-FORTRAN	04/29/80	COMPASS	3.6	508		MATH LIBRARY LINK TO ERROR MESSAGE PROCESSO
XTOY*	150352	13	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CALL-BY-REFERENCE LINK TO XTOY. .
BACKSP=	150365	55	SL-FORTRAN	04/29/80	COMPASS	3.6	508		BACKSPACE LOGICAL RECORD.
COMIO=	150442	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		COMMON CODED I/O ROUTINES AND CONSTANTS.
EOF	150452	20	SL-FORTRAN	04/29/80	COMPASS	3.6	508		TEST FOR END OF FILE STATUS.
FECMSK=	150472	41	SL-FORTRAN	04/29/80	COMPASS	3.6	508		INITIALIZE CONSTANTS.
FLTIN=	150533	156	SL-FORTRAN	04/29/80	COMPASS	3.6	508		COMMON FLOATING INPUT CONVERTER.
FMTAP=	150711	377	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CRACK APLIST AND FORMAT FOR KODER/KRAKER.
FORUTL=	151310	25	SL-FORTRAN	04/29/80	COMPASS	3.6	508		FCL MISC. UTILITIES.
GETFIT=	151335	66	SL-FORTRAN	04/29/80	COMPASS	3.6	508		LOCATE A FIT GIVEN A FILE DESCRIPTOR
INPB=	151423	406	SL-FORTRAN	04/29/80	COMPASS	3.6	508		BINARY READ FORTRAN RECORD.
KRAKER=	152031	454	SL-FORTRAN	04/29/80	COMPASS	3.6	508		PROCESS FORMATTED FORTRAN INPUT.
NAMIN=	152505	527	SL-FORTRAN	04/29/80	COMPASS	3.6	508		NAMELIST INPUT ROUTINE.
OUTCOM=	153234	204	SL-FORTRAN	04/29/80	COMPASS	3.6	508		COMMON OUTPUT CODE
SPA=	153440	12	SL-FORTRAN	04/29/80	COMPASS	3.6	508		SPA= - SUBSTITUTE PARAMETER ADDRESSES.
STLBAK.	153452	13	SL-FORTRAN	04/29/80	COMPASS	3.6	508		STATIC LOAD FOR BACKSPACE.
STLOBI.	153465	15	SL-FORTRAN	04/29/80	COMPASS	3.6	508		STATIC LOAD FOR BINARY OUTPUT.
STLOCO.	153502	12	SL-FORTRAN	04/29/80	COMPASS	3.6	508		STATIC LOAD FOR CODED OUTPUT.
STLRP2=	153514	1	SL-FORTRAN	04/29/80	COMPASS	3.6	508		STATIC LOADING FTNRP2=
SYSTEMC	153515	434	SL-FORTRAN	04/29/80	COMPASS	3.6	508		EXTENDED ERROR HANDLING OPTION.
ERRCAP=	154151	324	SL-FORTRAN						
OUTC=	154475	154	SL-FORTRAN	05/09/80	COMPASS	3.6	508		FORMATTED WRITE FORTRAN RECORD.
ALOG10	154651	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CALL-BY-REFERENCE LINK TO ALOG10. .
EXP.	154661	73	SL-FORTRAN	04/29/80	COMPASS	3.6	508		EXPONENTIAL FUNCTION. E TO POWER X. OPT=ALL
EXP.MSG	154754	16	SL-FORTRAN	04/29/80	COMPASS	3.6	508		COMMON ERROR MESSAGES FOR EXPONENTIATION.
ITOJ*	154772	13	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CALL-BY-REFERENCE LINK TO ITOJ. .
ITOX*	155005	56	SL-FORTRAN	04/29/80	COMPASS	3.6	508		INTEGER BASE TO REAL POWER.
SIN	155063	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		FCL4 - EVALUATE SINE FUNCTION.CALL-BY-REFER
SINCOS.	155073	60	SL-FORTRAN	04/29/80	COMPASS	3.6	508		TRIGONOMETRIC SINE OR COSINE OF X. OPT=ALL.
SQRT	155153	10	SL-FORTRAN	04/29/80	COMPASS	3.6	508		CALL-BY-REFERENCE LINK TO SQRT. .
SYSAID=	155163	1	SL-FORTRAN	04/29/80	COMPASS	3.6	508		LINK BETWEEN SYS=AID AND INITIALIZATION COD

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
SYS=AID	155164	7	SL-FORTRAN	04/29/80	COMPASS 3.6 508		AUXILIARY MATH LIBRARY LINK FOR ERRORS.
XTOY.	155173	31	SL-FORTRAN	04/29/80	COMPASS 3.6 508		REAL BASE TO REAL POWER. OPT=ALL.
Q2NTRY=	155224	1	SL-FORTRAN	04/29/80	COMPASS 3.6 508		FCL INITIALIZATION ROUTINE.
FCL=FDL	155225	40	SL-FORTRAN	04/29/80	COMPASS 3.6 508		FCL CAPSULE LOADING
FEIFST=	155265	3	SL-FORTRAN	04/29/80	COMPASS 3.6 508		CONVERTED DATA STORAGE
FLTOUT=	155270	315	SL-FORTRAN	04/29/80	COMPASS 3.6 508		COMMON FLOATING OUTPUT CODE
FORSYS=	155605	525	SL-FORTRAN	04/29/80	COMPASS 3.6 508		FORTRAN OBJECT LIBRARY UTILITIES.
INCOM=	156332	145	SL-FORTRAN	04/29/80	COMPASS 3.6 508		COMMON INPUT FORMATTING CODE
INPC=	156477	207	SL-FORTRAN	04/29/80	COMPASS 3.6 508		FORMATTED READ FORTRAN RECORD.
KODER=	156706	476	SL-FORTRAN	04/29/80	COMPASS 3.6 508		OUTPUT FORMAT INTERPRETER.
NAMOUT=	157404	267	SL-FORTRAN	04/29/80	COMPASS 3.6 508		NAMELIST OUTPUT ROUTINE.
OUTB=	157673	265	SL-FORTRAN	04/29/80	COMPASS 3.6 508		BINARY WRITE FORTRAN RECORD.
REWIND=	160100	33	SL-FORTRAN	04/29/80	COMPASS 3.6 508		POSITION FILE AT BEGINNING-OF-INFORMATION.
STLCRM=	160133	31	SL-FORTRAN	04/29/80	COMPASS 3.6 508		STATIC LOADING OF FCL CAPSULES
STLIBI.	160164	24	SL-FORTRAN	04/29/80	COMPASS 3.6 508		STATIC LOAD FOR BINARY INPUT.
STLICO.	160210	16	SL-FORTRAN	04/29/80	COMPASS 3.6 508		STATIC LOAD FOR CODED INPUT.
STLREW.	160226	14	SL-FORTRAN	04/29/80	COMPASS 3.6 508		STATIC LOAD FOR REWIND.
FTNRP2=	160242	21	SL-FORTRAN	05/19/80	COMPASS 3.6 508		FORTRAN REPRIEVE.
CPU.SYS	160263	40	SL-SYSLIB	01/08/80	COMPASS 3.6 498		PROCESS SYSTEM REQUEST.
CMF.GSS	160323	22	SL-SYSLIB	01/08/80	COMPASS 3.6 508		CMM V1.1 - GET SUMMARY STATISTICS.
CMM.KIL	160345	12	SL-SYSLIB	01/08/80	COMPASS 3.6 508		CMM V1.1 - DEACTIVATE CMM.
CMM.MEM	160357	7	SL-SYSLIB	01/08/80	COMPASS 3.6 508		
CMM.R	160366	206	SL-SYSLIB	01/08/80	COMPASS 3.6 508		CMM V1.1 - RESIDENT SUBROUTINES.
CTL$PTL	160574	34	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM CONTROLLER - PARTIAL GET/PUT.
CTL$SKP	160630	57	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM CONTROLLER - SKIP PHYSICAL/FILE.
LIST$RM	160707	67	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM - ALLOCATE SPACE FOR LIST OF FILES
CTL$RM	160776	576	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM CONTROLLING ROUTINE.
CTL$WR	161574	44	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM CONTROLLER - WEOX, REWIND
ERR$RM	161640	25	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM ERROR PROCESSOR ENTRY.
RM$SYS=	161665	5	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM - POST RA+1 REQUEST
RBL$RM	161665	0	SL-SYSLIB	01/23/80	COMPASS 3.6 508		CRM - MANIFEST BAMLIB/AAMLIB FOR STATIC LOA
RECOVR	161672	166	SL-SYSLIB	01/24/80	COMPASS 3.6 508		REPRIEVE INTERFACE
FERCAP=	162060	230	SL-FORTRAN				
RPVCAP=	162310	160	SL-FORTRAN				
CHEK$SQ	162470	77	SL-BAMLIB				
CLSV$SQ	162567	222	SL-BAMLIB				
DF$CRM	163011	226	SL-BAMLIB				
EF$CRM	163237	445	SL-BAMLIB				
GET$W	163704	53	SL-BAMLIB				
GET$WA	163757	175	SL-BAMLIB				
PUT$SQ	164154	574	SL-BAMLIB				
PUT$W	164750	215	SL-BAMLIB				
PUT$WA	165165	172	SL-BAMLIB				
REW$SQ	165357	126	SL-BAMLIB				
SKBL$SQ	165505	765	SL-BAMLIB				
SKIP$SQ	166472	234	SL-BAMLIB				
WEOX$SQ	166726	141	SL-BAMLIB				
FCL$RM	167067	42	SL-BAMLIB	01/23/80	COMPASS 3.6 508		LINK/DELINK STATIC CAPSULES.
PLG$RM	167067	0	SL-BAMLIB	01/23/80	COMPASS 3.6 508		
CLSF$RM	167131	433	SL-BAMLIB				
COMM$WA	167564	306	SL-BAMLIB				

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
GET$SQ	170072	627	SL-BAMLIB				
GET$FU	170721	117	SL-BAMLIB				
GET$S	171040	506	SL-BAMLIB				
GET$Z	171546	164	SL-BAMLIB				
GPTM$SQ	171732	527	SL-BAMLIB				
LBUF$RM	172461	134	SL-BAMLIB				
OPEN$RM	172615	1366	SL-BAMLIB				
PUT$CI	174175	65	SL-BAMLIB				
PUT$S	174262	372	SL-BAMLIB				
PUT$Z	174654	76	SL-BAMLIB				
RPES$Q	174752	166	SL-BAMLIB				
SKFL$SQ	175140	37	SL-BAMLIB				
SKSP$SQ	175177	105	SL-BAMLIB				
WAR$SQ	175304	162	SL-BAMLIB				
CMF.SDF	175466	47	SL-SYSLIB	01/08/80	COMPASS 3.6 508		CMM V1.1 - SET DABA.
/DESNB./	40000000	11200					
/DOT/	40011200	151360					

-------- SEGMENT - ANSWER

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
(ANSWER)	175535	0					
READIN	175535	1002	NEW	10/21/80	FTN 4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
DESIGN	176537	4121	NEW	10/21/80	FTN 4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
NAMES	202660	605	NEW	10/21/80	FTN 4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
ECHOI	203465	255	NEW	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ANSWER	203742	14404	NEW	10/21/80	FTN 4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
PROD	220346	132	NEW	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
IDEA	220500	124	NEW	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/DESNBL/	40000000	11200					

-------- SEGMENT - FRPCON

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
/POINT/ S	1125	307					

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
/REALS/	1435	610					
/INTEG/	2245	30					
/INPTR/	2275	2561					
/INPTI/	5056	305					
/MATCNS/	5363	14					
/PHYPRO/	5377	13					
/LACMDL/	5412	25					
/LIMITS/	5437	76					
/Q8.IO./	5535	155					
/FCL.C./	5712	26					
/BA/	6167	126					
/PNTPNL/	6315	107					
/AXL/	6424	4					
/EMFLGS/	7042	12					
/GRSPTR/	7054	46					
/BDG02D/	7122	13					
/BDGR/	7135	30					
/BDGR2/	7165	70					
/BDGR4/	7255	153					
/BDGR5/	7430	51					
/GRHOLD/	7501	2					
/GTWOLC/	7503	14					
/GR0235/	7517	22					
/GR2A3/	7541	32					
/GR2A4/	7573	14					
/VER/	7607	1					
/PFRCS2/	7651	20					
/PFCMI2/	7677	47					
(FRPCON)	175535	40					
FRPCON	175575	7456	NEW	10/21/80 FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC
CLADF	205253	355	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CLOSE	205630	1147	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
COUPLE	206777	1106	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CRAP	210105	123	NEW	10/21/80 FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
CREEP	210230	366	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CREPR	210616	115	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EMRLOC	210733	72	NEW	10/21/80 FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FRACAS	211025	1051	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GSPRES	212076	602	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GAPT	212700	214	NEW	10/21/80 FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
GASREL	213114	647	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
MEMSET	213763	25	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
NEWGAP	214010	232	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
NEMSET	214242	24	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PGHEAD	214266	223	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PLNT	214511	640	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
RMESH	215351	74	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SIMQ	215445	336	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STORE	216003	133	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRAIN	216136	216	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRESS	216354	200	NEW	10/21/80 FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
TAPEGN		216554	734	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TERP		217510	312	NEW	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
TOTGAS		220022	537	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CRIIP		220561	141	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FCRNCH		220722	66	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
RATIO		221010	1071	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PELLET		222101	566	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CLOSEX		222667	1015	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EQUAL1		223704	31	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EQUAL2		223735	44	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GAPTX		224001	525	NEWF	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
AXRACH		224526	3114	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TRANSF		227642	4365	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXIWRT		234227	245	NEWAXS	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PROPID		234474	45	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PHYPRP		234541	207	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CANEAL		234750	430	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CTHCON		235400	102	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GTHCON		235502	455	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
GVISCO		236157	574	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
ZOTCON		236753	44	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
EMCTON		237017	34	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EMGTON		237053	713	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
ERF		237766	153	NEWP	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
GRASS6		240141	112	NEWFG	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TANH.		240253	37	SL-FORTRAN	04/29/80	COMPASS	3.6 508		HYPERBOLIC TANGENT. OPT=ALL.
XTOI*		240312	11	SL-FORTRAN	04/29/80	COMPASS	3.6 508		CALL-BY-REFERENCE LINK TO XTOI.
LDOUT=		240323	253	SL-FORTRAN	04/29/80	COMPASS	3.6 508		LIST DIRECTED OUTPUT FORMATTING
CLOCK=		240576	53	SL-FORTRAN	04/29/80	COMPASS	3.6 508		ACCESS SYSTEM CLOCKS FOR FORTRAN.
GOTOER=		240651	14	SL-FORTRAN	04/29/80	COMPASS	3.6 508		COMPUTED GO TO ERROR PROCESSOR.
TANH		240665	10	SL-FORTRAN	04/29/80	COMPASS	3.6 508		CALL-BY-REFERENCE LINK TO TANH. .
XTOI.		240675	63	SL-FORTRAN	04/29/80	COMPASS	3.6 508		REAL TO INTEGER EXPONENTIATION.
OUTF=		240760	163	SL-FORTRAN	04/29/80	COMPASS	3.6 508		LIST DIRECTED OUTPUT CONTROL
/FAST/	D	260066	1						
/DESNBL/		40000000	11200						

-------- SEGMENT - SETUP

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/POINT/	S	1125	307						
/PNTINL/	S	1434	1						
/REALS/	S	1435	610						
/INTEG/	S	2245	30						

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/INPTR/	S	2275	2561						
/INPTI/	S	5056	305						
/MATCNS/	S	5363	14						
/PHYPRO/	S	5377	13						
/LACMDL/	S	5412	25						
/LIMITS/	S	5437	76						
/PNTPNL/	S	6315	107						
/AXL/	S	6424	4						
/EMFLGS/	S	7042	12						
/GRSPTR/	S	7054	46						
/VER/	S	7607	1						
/PFRCS2/	S	7651	26						
/PFCMI2/	S	7677	47						
(SETUP)		241143	0						
SETUP		241143	547	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ASSIGN		241712	51	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AXHEF		241763	1407	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CHECK		243372	2561	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
INITAL		246153	3770	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
LACINP		252143	107	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PLTINP		252252	274	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
POINTR		252546	1637	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PRINTI		254405	2414	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FC2PTR		257021	306	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FR2PTR		257327	212	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GRASS9		257541	325	NEWFG	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/FAST/	D	260066	1						

-------- SEGMENT - TMPSUB

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/PHYPRO/	S	5377	13						
/LACMDL/	S	5412	25						
(TMPSUB)		241143	0						
FEXPAN		241143	125	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SWELL		241270	507	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
RADIAL		241777	1356	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CONDUC		243355	224	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TMPSUB		243601	541	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
DDLF		244342	2045	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EFFCON		246407	126	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EMDNSF		246535	106	NEW	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
EMFTC		246643	20	NEW	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
EMSSF2	246663	56	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GAPRS	246741	726	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CMHARD	247667	52	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FEMISS	247741	51	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
FSWELL	250012	123	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FTHCON	250135	376	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FUDENS	250533	452	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC
ZOEMIS	251205	125	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EMFTON	251332	56	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ATAN.	251410	60	SL-FORTRAN	04/29/80	COMPASS	3.6 508		COMPUTE THE INVERSE TANGENT FUNCTION. OPT=A
ATAN	251470	10	SL-FORTRAN	04/29/80	COMPASS	3.6 508		CALL-BY-REFERENCE LINK TO ATAN. .

-------- SEGMENT - FCMI

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
(FCMI)	241143	0						
FCMI	241143	1320	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

-------- SEGMENT - FCMI2

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/PFCMI2/ S	7677	47						
(FCMI2)	241143	0						
FCMI2	241143	1200	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

-------- SEGMENT - FAILUR

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/MATCNS/	S	5363	14						
/PHYPRO/	S	5377	13						
(FAILUR)		241143	0						
FAILUR		241143	1174	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
BDTR		242337	1561	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
BFRAC		244120	41	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
BURST		244161	111	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CCRAK		244272	356	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CDTR		244650	1437	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CRAKF		246307	131	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CRERUP		246440	12	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
DFRAC		246452	23	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
DLGAM		246475	301	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EUMELT		246776	26	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FBLOK		247024	37	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FLOBLK		247063	365	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FRAIL		247450	521	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FSIGT		250171	164	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FSTEMP		250355	301	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FSTRS		250656	73	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
HCFF		250751	12	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
LCFF		250763	12	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
MELT		250775	30	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
NDTR		251025	64	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SCC		251111	327	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CESIOD		251440	370	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CMLIMT		252030	472	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CSRUPT		252522	234	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
DEULER.		252756	60	SL-FORTRAN	04/29/80	COMPASS	3.6 508		COMMON CODE FOR DEXP=, DHYP=, DTANH=.
DEXP.		253036	35	SL-FORTRAN	04/29/80	COMPASS	3.6 508		DOUBLE PRECISION EXP. OPT=ALL.
DLOG.		253073	146	SL-FORTRAN	04/29/80	COMPASS	3.6 508		COMPUTE DOUBLE LOG AND DLOG10.
DSQRT.		253241	24	SL-FORTRAN	04/29/80	COMPASS	3.6 508		DOUBLE PRECISION SQUARE ROOT. OPT=ALL.
DEXP		253265	7	SL-FORTRAN	04/29/80	COMPASS	3.6 508		COMPUTE DOUBLE PRECISION EXPONENTIAL.
DLOG		253274	24	SL-FORTRAN	04/29/80	COMPASS	3.6 508		DOUBLE LOGARITHM BASE E OF X.
DSQRT		253320	11	SL-FORTRAN	04/29/80	COMPASS	3.6 508		CALL-BY-REFERENCE LINK TO DSQRT. .

-------- SEGMENT - PLTOUT

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
(PLTOUT)	241143	0						
RESTFS	241143	1565	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PRINTM	242730	315	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
WRITER	243245	553	NEW	10/21/80	FTN	4.8 508	767X IL	SUBROUTINEOPT=0 TRACE STATIC

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
PLTOUT	244020	372	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PLOTW	244412	141	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/DESNBL/	40000000	11200						

-------- SEGMENT - VOLUME

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
(VOLUME)	241143	0						
FGASRE	241143	1663	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ENERGY	243026	146	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
AN554	243174	1461	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
VOLUME	244655	367	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FENTHL	245244	142	NEW	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC

-------- SEGMENT - BURNUP

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
(BURNUP)	241143	0						
GASPRO	241143	110	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
COOLT	241253	215	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FLMDRP	241470	166	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CORROS	241656	322	MTPLM	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CLADRP	242200	64	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FLUXD	242264	346	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CEXPAN	242632	41	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
REPACK	242673	57	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CLDGRO	242752	120	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
BURNUP	243072	200	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PWRDEP	243272	732	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
CAGROW	244224	61	MTPLM	10/21/80	FTN	4.8 508	767X I	FUNCTION OPT=0 TRACE STATIC

-------- SEGMENT - PRINT2

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
/POINT/	S	1125	307					
/REALS/	S	1435	610					
/INTEG/	S	2245	30					
/INPTR/	S	2275	2561					
/INPTI/	S	5056	305					
/MATCNS/	S	5363	14					
/PHYPRO/	S	5377	13					
/LACMDL/	S	5412	25					
/LIMITS/	S	5437	76					
/BA/	S	6167	126					
/PNTPNL/	S	6315	107					
/AXL/	S	6424	4					
/EMFLGS/	S	7042	12					
/VER/	S	7607	1					
/PFRCS2/	S	7651	26					
(PRINT2)		241143	0					
GASPLT		241143	414	NEW	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
PRINT2		241557	5436	NEW	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/FAST/	D	260066	1					

-------- SEGMENT - PELET

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
/LIMITS/	S	5437	76					
/BA/	S	6167	126					
/PNTPNL/	S	6315	107					
/AXL/	S	6424	4					
/FEP/	S	6430	105					
/STFMAT/	S	6535	204					
/GEOPAR/	S	6741	15					
/LASTIC/	S	6756	3					
/CONTNT/	S	6761	1					
/TAPES/	S	6762	6					
/PRSSV/	S	6770	50					
(PELET)		241143	13					
PELET		241156	1630	NEWP	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
INPAXL		243006	576	NEWP	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
INPUT		243604	165	NEWP	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
MOVEKA		243771	25	NEWP	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/FAST/	D	260066	1					

-------- SEGMENT - CALLGR

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
/GRSPTR/	S	7054	46					
/BDG02D/	S	7122	13					
/BDGR/	S	7135	30					
/BDGR2/	S	7165	70					
/BDGR4/	S	7255	153					
/BDGR5/	S	7430	51					
/GTWOLC/	S	7503	14					
/GR0235/	S	7517	22					
/GR2A3/	S	7541	32					
/GR2A4/	S	7573	14					
/GR0A2/	S	7610	22					
/GR0A3/	S	7632	5					
/GR0A4/	S	7637	12					
(CALLGR)		241143	0					
CALLGR		241143	223	NEWFG	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GRASS		241366	2702	NEWFG	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GRASS2		244270	2166	NEWFG	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GRASS3		246456	244	NEWFG	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GRASS4		246722	1420	NEWFG	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
GRASS5		250342	656	NEWFG	10/21/80	FTN 4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ACOS		251220	10	SL-FORTRAN	04/29/80	COMPASS 3.6 508		CALL-BY-REFERENCE LINK TO ACOS.
ACOSIN.		251230	63	SL-FORTRAN	04/29/80	COMPASS 3.6 508		COMPUTE THE INVERSE SINE OR COSINE OF X.

-------- SEGMENT - CCREEP

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR VER LEVEL	HARDWARE	COMMENTS
/POINT/	S	1125	307					
/REALS/	S	1435	610					
/INTEG/	S	2245	30					
/INPTR/	S	2275	2561					
/INPTI/	S	5056	305					
/MATCNS/	S	5363	14					
/PHYPRO/	S	5377	13					
/LACMDL/	S	5412	25					
/EMFLGS/	S	7042	12					
/VER/	S	7607	1					
/PFRCS2/	S	7651	26					

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/PFCMI2/	S	7677	47						
(CCREEP)		241143	0						
CCREEP		241143	1352	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FCMI2		242515	1200	NEWF	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
FCMI		243715	1320	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/FAST/	D	260066	1						

-------- SEGMENT - TEMPA

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
(TEMPA)	244016	0						
TEMPB	244016	206	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TEMPC	244224	176	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TEMPD	244422	616	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
TEMPA	245240	32	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

-------- SEGMENT - ABOUND

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/MATCNS/	S	5363	14						
/LIMITS/	S	5437	76						
/BA/	S	6167	126						
/PNTPNL/	S	6315	107						
/AXL/	S	6424	4						
/FEP/	S	6430	105						
/STFMAT/	S	6535	204						
/GEOPAR/	S	6741	15						
/LASTIC/	S	6756	3						
/CONTNT/	S	6761	1						
/TAPES/	S	6762	6						
/PRSSV/	S	6770	50						
(ABOUND)		244016	0						
BOUND		244016	155	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ASOLVE		244173	505	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SOLVET		244700	1026	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
ALOAD		245726	1227	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
LOAD		247155	1102	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STFAXL		250257	2005	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STIFF		252264	1301	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ABOUND		253565	233	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
ASTRES		254020	217	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
DMCHB		254237	512	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
STRES		254751	760	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
/FAST/	D	260066	1						

-------- SEGMENT - KREEP

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
/MATCNS/	S	5363	14						
/LIMITS/	S	5437	76						
/BA/	S	6167	126						
/PNTPNL/	S	6315	107						
/FEP/	S	6430	105						
/GEOPAR/	S	6741	15						
/LASTIC/	S	6756	3						
/CONTNT/	S	6761	1						
/TAPES/	S	6762	6						
/IODEV/	S	7040	2						
(KREEP)		244016	0						
KREEP		244016	371	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
EFFECT		244407	61	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
RATE		244470	1415	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SORTP		246105	747	NEWP	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC
SINH		247054	10	SL-FORTRAN	04/29/80	COMPASS	3.6 508		CALL-BY-REFERENCE LINK TO SINH.
HYP.		247064	66	SL-FORTRAN	04/29/80	COMPASS	3.6 508		HYPERBOLIC SINE OR COSINE OF X. OPT=ALL.
/FAST/	D	260066	1						

-------- SEGMENT - FTBNUL

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK		ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER LEVEL	HARDWARE	COMMENTS
(FTBNUL)		260066	0						
/FAST/	G	260066	1						
FTBNUL		260067	4	NEW	10/21/80	FTN	4.8 508	767X I	SUBROUTINEOPT=0 TRACE STATIC

2.979 CP SECONDS 217600B CM STORAGE USED 33 TABLE MOVES

DMPX.

```
P   000631   A0   220000   B0   000000
RA  312000   A1   000001   B1   000001   C(A1)=  0102  2420  0000  0000  0000   C(B1)=  0102  2420  0000  0000  0000
FL  220000   A2   000135   B2   000560   C(A2)=  0000  0000  0000  0000  0000   C(B2)=  5169  0001  3301  0000  0475
EM  000600   A3   000700   B3   001236   C(A3)=  0000  0000  0000  0022  0000   C(B3)=  0015  0016  3000  0000  1046
RE  000057   A4   001237   B4   000047   C(A4)=  3426  0073  0000  0017  4467   C(B4)=  0000  0000  0000  0000  0000
FE  000163   A5   001577   B5   220000   C(A5)=  4000  0000  0000  0016  2341   C(B5)=
MA  001400   A6   000001   B6   121535   C(A6)=  0102  2420  0000  0000  0000   C(B6)=  4000  0000  0000  0000  1035
             A7   000101   B7   121535   C(A7)=  0000  0000  1625  6017  5535   C(B7)=  4000  0000  0000  0000  1035

X0  0000  0000  0000  0016  3000
X1  0000  0000  0000  0000  0000
X2  0000  0000  0000  0000  0000
X3  7777  7777  7777  7773  7677
X4  7777  7777  7777  7700  0000
X5  0000  0000  0000  0022  0000
X6  0102  2420  0000  0000  0000
X7  0000  0000  1625  6017  5535

00000   00000 00000 00000 00000        01022 42000 00000 00000        20140 00000 00000 00002        43333 33333 00000 00017
00004   00000 00000 00000 00000
00054  -56110 03110 00054 56120        63310 63410 13414 21422        03140 00057 02300 00000        13443 03040 00060 67405
00060  -56154 63310 13415 21422        61447 77776 03040 00056        07040 00060 51600 00001        04000 00063 00000 00021
00064   06222 00301 02000 00002        00000 00000 00002 60073        40000 00000 01000 00100        00000 00000 40000 00000
00070   06222 00301 02562 01454        43333 33333 57000 00000        00000 00000 00000 00000
00100  -00162 56026 00730 00733

00531   04004 00531 61000 46000        36127 50267 77772 43652        54721 11262 54771 73311
00534   12772 54171 54720 11161        12631 54610 75271 46000        71707 77757 01000 00623        04000 00531 61000 46000
00540   04000 01137 00000 00000        51100 00100 51200 00065        21122 73220 03320 00560        73110 03010 00562 37212
00544   03320 00540 61000 46000        51100 00133 54610 37116        03210 00540 51200 00135        03020 00540 72660 00103
00550   43166 21236 11616 37226        03020 00540 53060 20636        51600 00135 71601 50515        27606 20652 71100 00135
00554   12661 01000 00631 46000        51200 00115 43652 11262        74600 12662 54620 46000        04000 00540 61000 46000
00560   51600 00133 01000 00475        04000 00540 61000 46000        51100 00104 73110 37212        03020 00545 04000 00540
00564   04004 00564 61000 46000        56147 43773 20721 11771        54710 54211 73620 73170        51300 00132 37731 21774
00570   11373 15717 12773 54730        51300 00134 36716 37173        21174 15671 11313 12636        54630 20252 73320 56171
00574   03030 00564 20103 37673        03210 00577 55121 73610        21160 36661 36763 46000        51300 00122 43152 11313
00600   12663 54630 54761 73660        54671 54361 73771 11313        12773 20252 54730 15721        03170 00611 71600 00614
00604   51600 00127 71200 00121        71707 77753 01000 00623        43652 51100 00614 15616        20644 54220 12626 54620
00610   04000 00564 61000 46000        51700 00127 71200 00121        71707 77553 01000 00623        04000 00564 61000 46000
00614   00000 00000 00000 00000        01000 00650 61000 46000        43652 71100 00002 12661        53120 11161 71600 31117
00620   03270 00621 14777 27606        12717 20652 53720 12662        73220 01000 00631 46000        04000 01116 00000 00000
00624   53120 20173 03310 00616        03110 00615 53121 73610        54611 54661 02000 00623        04000 00642 00000 00000
00630   01300 00000 00000 00000        04000 01215 00000 00000        51100 00001 03110 00632        54610 04000 00630 46000
00634   51100 00066 03310 00636        51100 00627 04000 00637        71100 00130 20160 46000        13661 13161 13661 46000
00640   51600 00630 10611 46000        51100 00001 01000 00627        20652 01000 00631 46000        51100 00001 03110 00643
00644   04004 00644 61000 46000        51100 00001 03110 00644        71602 20314 04000 00642        20150 36661 01000 00631
00650   04004 00650 61000 46000        71602 20314 20652 36662        53160 20173 03310 00650        03010 00650 51100 00001
00654   03110 00652 71100 00001        04000 00647 61000 46000        71603 24616 12661 20651        01000 00631 61000 46000
00660   04000 01213 00000 00000        20630 12161 73610 20123        03210 00656 20151 13116        20636 51600 00665 74660
00664   36116 20123 04000 00656        00000 00000 00000 00000        01000 00000 00000 00003        00000 00000 00000 01236
00672  -00000 00000 00000 01237        00000 00000 00000 05723
00674  -00000 00000 00000 00000        00000 00000 00001 63000        00000 00000 00001 62560        00000 00000 00003 77700
00700   00000 00000 00002 20000        00000 00000 00000 00003        32323 23232 36340 00003        32323 23232 36350 00003
00704   00000 00000 00000 00001        40000 00000 00000 00000        55151 12323 11160 75505        30050 32524 05570 00000
00710   55031 55506 14552 41717        55231 50114 14570 00000        55050 32355 06145 52417        17552 31501 14145 70003
00714   55161 75524 22011 62306        05225 50104 04220 52323        57000 00000 00000 00000        55110 71617 22111 60755
00720   05302 42201 55141 70104        55061 11405 23570 00000        55230 50722 05235 52417        17551 40122 07055 70000
00724   55050 32355 27221 12405        55010 21722 24570 00000        55151 12323 11160 75514        17010 45700 00000 00000
00730   55020 10455 23050 71417        01045 50211 16012 23157
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