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SOURCE BOOK FOR FORTRAN COMPUTER
PROGRAMS USED ON THE UNIVAC 1108
IN ENGINEERING CALCULATIONS
FOR HEAT TRANSFER, SOLVENT EXTRACTION,
ION EXCHANGE, FUEL DISSOLUTION
AND ECONOMIC CALCULATIONS

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

MASTER

NOVEMBER 1974

Prepared for the U.S. Atomic Energy
Commission under Contract AT(45-1):1830

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BNWL-B-381

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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
U.S. ATOMIC ENERGY COMMISSION
Under Contract AT(45-1)-1830

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy \$7.60; Microfiche \$0.95

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by

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Nuclear Waste Technology Department

November 1974

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INTRODUCTION

During the past few years a number of special purpose computer programs have been written for use on local computers by members of the Chemical Technology Department and the Nuclear Waste Technology Department.

In the course of changing over from the UNIVAC 1108 to the CYBER, attempts were made to get sample inputs, listings, card decks, and sample outputs for two dozen FORTRAN computer programs before the local UNIVAC 1108 was decommissioned. These programs have been used for engineering calculations in the fields of heat transfer, induction heating, ion exchange, solvent extraction, fuel dissolution, and economics.

Some of these programs have been converted to the CYBER, some have been converted to conversational BASIC for use on the INFONET system, and all of them have been put on magnetic tape for UNIVAC 1108 use at the INFONET center in Los Angeles. Not all of the programs are in good working order, so that sample runs could not be made for some of them, but they are close enough to running so that only minor modifications are needed. Program listings are given here and compilations are available on request.

The documentation here does not conform to ANSI standards.* To achieve such standards for all of these programs would require several man years of effort and would not be justified because of the uncertainty of their frequent future use. It is hoped that partial documentation will lead to their use where appropriate.

USES FOR COMPUTER PROGRAMS

The programs are presented in alphabetical order. This discussion deals with their purposes and uses in the past grouped by field of application with the approximate working-order status of the programs.

* A "Proposed American National Standard Guidelines for the Documentation of Digital Computer Programs," ANSI Project, N413, ANS 10.3 sponsored by the American Nuclear Society, March 15, 1974.

CINCOM was written to match induction heating coils to cylindrical charges in the Salt Cycle process development of the Plutonium Recycle Program and was used routinely for this purpose in the Waste Solidification Engineering Program.

FINITE, LINK, and PROFIL were used to estimate transient temperatures in heat generating cylinders, slabs, and annuli, respectively. FURFAT and TIFU estimate transient temperatures in forced-air-cooled furnaces containing heat generating sources with radiation shields. GULP estimates temperatures in and around hemispheroidal leaks from underground waste tanks. HETING is a general-purpose, finite-difference, arbitrary-geometry heat transfer program. Among its uses have been estimating temperatures in alternating layers in waste canisters. HEX estimates temperatures in arrays of long cylinders with heat transfer by radiation only. HOTANK is a finite difference heat transfer program that estimates steady-state temperatures in underground waste tanks with cylindrically symmetric geometry. SLUCE estimates temperatures in air-cooled underground waste tanks, including tanks with heat generators beneath bulged bottoms. SPHERE estimates temperatures in growing and shrinking hot spots in sludge in waste tanks. TEMP, THERM, and THRM estimate transient temperatures in walls of underground waste tanks and in the soil around tanks. UTTA and UTTANK estimate steady-state temperatures in underground tanks with solidified wastes by approximate models. TIESOC estimates steady-state temperatures in encapsulated, double-walled waste packages of SrF_2 , Sr_2TiO_4 and CsCl . DIBUW and TALUS estimate temperatures in arrays of direct-buried cylindrical waste canisters.

QUATEX estimates performance of ion exchange columns during loading, scrubbing, and elution cycles.

SEPHIS estimates transient and steady-state performance of Purex-type solvent extraction columns and combinations of columns.

BARD estimates dissolution times as a function of flow configuration for recirculating dissolvers with critically safe reservoirs. ZIRKOV estimates dissolution times in Zirflex dissolvers for zirconium cladding.

INTRST defines cash flows in project economics.

PROGRAM LISTINGS

Following is a listing of each program with the information in the following order, if available:

1. Brief Description or Abstract.
2. Detailed Program Description.
3. Sample Program Input Suitable for Compilation and Running on the UNIVAC 1108, using Source Program on Magnetic Tape.
4. Sample Program Output.
5. Listing and Compilation of All Subroutines.

A status chart for the computer programs is given in Table 1.

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TABLE 1. Status Chart for Conversion of FORTRAN Programs

Name	Purpose	UNIVAC 1108			CYBER	
		Card Deck	Sample Run	On Tape	Converted*	Number of Subroutines
1. BARD	Recirculating Dissolver	✓	YES	✓	NO	10
2. CINCOM	Induction Heating	✓	YES	✓	YES	7
3. DIBUW	Direct Buried Waste	✓	YES	✓	NO	6
4. FINITE	Cylindrical Heat Source	✓	YES	✓	YES	3
5. FURFAT-TIFU	Furnace Cooling	✓	YES	✓	NO	18
6. GULP	Underground Tank Leak	✓	YES	✓	NO	3
7. HETING	General Heat Transfer	ABS	YES	✓	YES	24
8. HEX	Radiant Arrays	NO	NO	NO	YES	5
9. HOTANK	Underground Tank Solid Waste	✓	TOO LARGE	✓	YES	3
10. INTRST	Cash Flow	✓	NO	✓	NO	1
11. LINK	Slab Heat Source	✓	YES	✓	NO	2
12. PROFIL	Annular Heat Source	NO	NO	NO	NO	10
13. QUATEX	Ion Exchange	✓	YES	✓	YES	19
14. SEPHIS	Solvent Extraction	✓	YES	✓	YES	5
15. SLUCE	Underground Tank with Bulge	✓	YES	✓	NO	5
16. SPHERE	Hot Spot in Waste Tank	✓	YES	✓	NO	4
17. TALUS	Direct Buried Waste	✓	YES	✓	YES	8
18. TEMP	Underground Tank Wall Temperature	✓	YES	✓	NO	2
19. THERM	Underground Tank Wall Temperature	✓	YES	✓	NO	11
20. THRM	Underground Tank Wall Temperature	✓	YES	✓	NO	2
21. TIESOC	Sr-Cs Capsule Heat Transfer	✓	YES	✓	YES	19
22. UTTA	Underground Tank Solid Waste	✓	YES	✓	NO	1
23. UTTANK	Air Cooled Underground Tank Solidified Waste	✓	YES	✓	NO	1
24. ZIRKOV	Zirflex Dissolver	✓	FATAL ERROR	✓	NO	11

* Programs converted to CYBER have CYBER card decks and CYBER tapes.

PROGRAM NAME: BARD

Descriptive Title: Batch and Recirculating Dissolver

Program Author: DeMier, Warren V.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: 24530B

Average Execution Time: 35 CP sec

Keywords: Chemical Dissolver, Nuclear Fuel Processing

Program Description: Estimates dissolution times in recirculating dissolvers with combinations of plug flow and stirred dissolvers, and the recirculation reservoirs needed because of nuclear criticality. Calculation is finite difference in time and position in the dissolver. Any chemical reaction may be used but usually used for nuclear fuel cladding. Nine subroutines. Namelist input.

Users of Program: G Jansen
WV DeMier

Documentation: Results of the plug flow reservoir-stirred dissolver problem are described in HW62902.

Condition of Program: Debugging was completed with no error messages. Numerical results have been lacking because the starting points for the finite difference time steps in subroutine NUPINT are not correct. A modified Newton-Raphson method should be used here.

SAMPLE INPUT: BARD

BARD 12:11 02/23/74

100 @S RUN PUN008,CUB928,GEORGE,150,6000/3000 G JANSEN 3760 BLD.
B 9423576

105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFO00

115 @PRL TEL INFO00

120 @PRL TEL CUB928

125 @X ASG A=00231

130 @N XQT CUR

150 FIND A,BARD/SIFS

160 TRD A

170 FIND A,SPILIT/SIFS

180 TRD A

190 FIND A,DBIS/SIFS

200 TRD A

210 FIND A,DCON/SIFS

220 TRD A

230 FIND A,BATCH/SIFS

240 TRD A

250 FIND A,RF/SIFS

260 TRD A

270 FIND A,NUPINT/SIFS

280 TRD A

290 FIND A,DISINP/SIFS

300 TRD A

310 FIND A,RECON/SIFS

320 TRD A

330 FIND A,REISS/SISU

340 TRD A

350 TRI A

1000 PCH BARD/SIFS

1005 PCH REDISS/SISU

1010 PCH DISINP/SIFS

1020 PCH BATCH/SIFS

1030 PCH SPILIT/SIFS

1040 PCH DCON/SIFS

1050 PCH RF/SIFS

1060 PCH RECON/SIFS

1070 PCH NUPINT/SIFS

1075 PCH DBIS/SIFS

1080 @IM FFS,* BARD/SIFS,BARD/SIFS,BARD/RIFS

1085 @IM PDP,* REDISS/SISU,REISS/SISU

1090 @IM FFS,* DISINP/SIFS,DISINP/SIFS,DISINP/RIFS

2000 @IM FFS,* BATCH/SIFS,BATCH/SIFS,BATCH/RIFS

2010 @IM FFS,* SPILIT/RIFS,SPILIT/SIFS,SPILIT/RIFS

2020 @IM FFS,* DCON/SIFS,DCON/SIFS,DCON/RIFS

2030 @IM FFS,* RF/SIFS,RF/SIFS,RF/RIFS

2040 @IM FFS,* RECON/SIFS,RECON/SIFS,RECON/RIFS

2050 @IM FFS,* DBIS/SIFS,DBIS/SIFS,DBIS/RIFS

2055 @IM FFS,* NUPINT/SIFS,NUPINT/SIFS,NUPINT/RIFS

2060 @N XQT HAND/RIFS

2070 BARD SAMPLE RUN 29 JUN 71 TEST CASE NO 1

2080 \$DATA1 R=4.,A=1000.,FL=10.,VD=30.,NZ=.01,PC=1.8E-4,PHI=2.5

2090 XTS=1,CZ=6.,VSS=150.,VSP=0.,VHA=0.,VHB=0.,NDRUG=20*05

READY

SAMPLE OUTPUT: BARD

ON XGT BARD/RIFB

DRUM LENGTH 024530

THIS ALLOCATION WAS DONE ON 23 FEB 74 AT 12:21:31

BARD CALLING DISINP

BARD SAMPLE RUN 29 JUN 71 TEST CASE NO 1 PROGRAM BARD RUN 23 FEB 74 AT 12:21:31

CONFIGURATION: DISSOLVER S RESERVOIR S
 ORDER OF REACTION 1.0000
 VD= 5.00000+01 LITERS
 VSS= 1.50000+02 LITERS
 VSP= 0.00000 LITERS
 VHA= 0.00000
 VHG= 0.00000
 CONSTANTS IN RATE EQU: A1= 1.0000+00, A2= 0.0000, A3= 1.0000+00
 NUMBER OF DISSOLVERS: 1
 C00= 6.00000+00 G MOLES/LITER
 CSC= 6.00000+00 G MOLES/LITER
 FL= 1.00000+01 LITERS/MINUTE
 R= 4.00000+01 MOLES/MOLE
 AF= 1.00000+03 S2 CM/KG METAL
 K= 1.20000-04 RATE CONSTANT
 KAR/VD= 1.80000+00
 VS/VD= 5.00000+00
 RC= 1.00000-02
 NRE= 1
 RHO= 2.50000+00 KG METAL/LITER OF DISSOLVER

* * *
 FRACT*TIME TO*METHOD*EXCESS DISSOLV TIME * NO OF*CONC AT DISSOLVER *
 REACT*DISOLVE* OF *COMPARED* *PASSES* CD/CO CS/CO *
 LEFT *MINUTES*SOLN * TO * MINS * PCT * *(L EAVING)(ENTERING)*
 * * *
 .00 5.553-04 BATCH

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00241 OF DISINP

DISINP CALLED AT SEQUENCE NUMBER 00206 OF MAIN PROGRAM

LISTING AND SUBROUTINE COMPILATION: BARD P. 1

```

DS   PUN FLDRA-CUP#28.      .010.FPCH/TEC     E JANSEN 3760 BLOC 92355
A   CLT 3ACD/SIFB.1-700713. 40195
B   LOF A
C   MAIN PROGRAM FOR BATCH AND RECIRCULATING DISSOLVER CALCULATIONS.
C   IN FOLLOWING COMMENTS TWO STANDS FOR TIME TO DISSOLVE.
C   THE FOLLOWING EXTERNAL ROUTINES ARE REQUIRED:
C
C   DISINF READS INPUT
C   RE SOLVES RATE EQUATION
C   RECON FINDS CONCENTRATIONS IN THE RESERVOIR SYSTEM FOR RECDTC. DIS.
C   RECN FINDS CONCENTRATIONS IN THE DISSOLVER SYSTEM FOR RECDTC. DIS.
C   NUNIT INTERPOLATION ROUTINE
C   SFILIT OUTPUT ROUTINE
C   BATCH FINDS TIME TO DISSOLVE BY BATCH DISSOLUTION.
C   REISS A PROCESSOR PROG CONTAINING SHARED STATEMENTS
C
C   DEFINITION OF FORMAL ARGUMENTS IS GIVEN IN ROUTINE SOURCE LISTING.
C   INCLUDE REISS.LIST
C   NAMELIST /CPH6/ TMULT,CLO,.THETA,THETA(1),THETA(2),THETA(3),
C   2THETA(1),THETA(11),THETA(12)
C   NAMELIST /DBNL7/ FC,FRC(1),FMR(1)
C   NAMELIST /CBNL8/ TS,FMR(1),FMR(2),FINIS,KOK(1),KOK(2),KOK(3),JAP
C   ZKEY
C   IF(INDBG(9).NE.0) WRITE(CFT,9375) AAU,AAZ
900 CALL DISINF READ INPUT
    IF(INDBG(9).NE.0) WRITE(CFT, 6789) AAZ,AAU
    JND=JND
    FMR(JND)=Z.O
    JAF=C
    KMOLO=2
1000 JAF=JAF + 1 &JAF IS SUBSCRIPT FOR KOK. STEPS OFF SOLUTION METHODS.
    KK=1001
1001 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    IF(JAF.GT.3) GO TO 900 CALL SOLUTION METHODS HAVE BEEN CONSIDERED.
    KK=1002
1002 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    IF(JAF.EG.1) GO TO 1200 FIRST CASE FOR THIS INPUT DATA.
    KK=1003
1003 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    IF(KOK(JAF).EQ.0) GO TO 1000 ASKIF THIS SOLUTION.
1004 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    KK=1004
    GO TO 2000 APPROXIED TO DESIRED SOLUTION METHOD.
1300 IF(INDBG(9).NE.0) WRITE(CFT,9975) AAC,AA3
    CALL BATCH (FFAC(FRAC),TBATCH)BTCH TTC BY BATCH TO LAST FRAC
    IF(INDBG(9).NE.0) WRITE(CFT,6789) AA3,AAO
C   SET UP TIME STEPS BASED ON TBATCH AND TMULT.
    DELO=TMULT * TBATCH
    VSFL=VRS/FLL
    NFEB=VSFL/DELO
    DELO=(VSFL/NFEB) * 1.CCCCCI
    THETA(1)=0.0
    NTHETA=1./TMULT * 1
    OTOTN=DELO/24.
    NTHM=NTHETA-1
    DO 1010 K=1,NTHM
        KP1=K + 1
        THETAKP1TH=DELO
1010 CONTINUE
    IF(INDBG(6).NE.0) WRITE(CFT,DBNL6)
1000 DO 800 I=1,NFRAC
    KK=2001
1001 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    FCR=FRAC(I)
    IF(INDBG(7).NE.0) WRITE(CFT,DBNL7)
    IF(INDBG(9).NE.0) WRITE(CFT,9975) AAO,AA3
    CALL BATCH (FCRTYE 1 BTCH TTC BY BATCH TC FCR=FRAC(I))
    IF(INDBG(9).NE.0) WRITE(CFT,6789) AA3,AAO
    TST=8 STORE TIME IN COMMON FOR SFILIT
    IF(INDBG(9).NE.0) WHILE (TST>.0001)
    IF(INDBG(9).NE.0) WRITE(CFT,9876) AAC,SFI
    CALL SFILIT(1)
    IF(INDBG(9).NE.0) WRITE(CFT,6789) SFI,AAO
    IF (FMR(JND),LE.FINIS)GT99903DIOLN DONE. READ NEW INPUT
    KK=2002
2002 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    KEY=KOK(JAF)
    IF(KEY.EQ.0) GOTO1000 ASKIF SOLUTION.ADVANCE JAP
    IF(INDBG(9).NE.0) WRITE(CFT,9876) AAO,AA3
    CALL DECKMYT. IN UNITIME TO PEACH FROM NEARLY FCR,AAO
    IF(INDBG(9).NE.0) WRITE(CFT,6789) AA3,AAO
    CDOCE=CMHLC/GC
    CDCEZ=CMHLC/GC
    PASSZ=TF+FL/VPL
    IF(INDBG(9).NE.0) WRITE(CFT,9876) AAC,SFI
    CALL SFILIT(5)
    IF(INDBG(9).NE.0) WRITE(CFT,6789) SFI,AAO
    WRITE(KEY = 1)
    IF(KEY.EQ.1) GO TO 1000
C   BRANCH FOR COMPARING APPROXIMATE SOLUTION TO EXACT SOLUTION.
    KK=2003
2003 IF(INDBG(9).NE.0) WRITE(CFT,5432) KK &AAD
    XSMEN=TN-TS
    XSPT=(TN-TS)/100./(EXACT-TS)
    TSN STORE TIME IN COMMON FOR USE BY TRILT.
    IF(INDBG(7).NE.0) WRITE(CFT,9876) AAO,SFI
    CALL SFILIT(TRITT)
    IF(INDBG(9).NE.0) WRITE(CFT,6789) SFI,AAO
    GO TO 8000

```

LISTING AND SUBROUTINE COMPILATION: BARD P. 2

```

1400 TXACT=IN BRANCH FOR COMPARING EXACT TO BATCH.
      KK=1404
1404 IF (IN+BUG(9),NE,0) WRITE(OUT,5431) KK ,AAC
      T=IN-80000 TIME IN COMMON FOR USE BY SFILIT.
      FOR=FORN
      IF (IN+BUG(9),NE,0) WRITE(OUT,5476) AAL,DEF
      CALL SFILIT(1) 3.0117 BATCH ANSWERS
      IF (IN+BUG(9),NE,0) WRITE(OUT,5478) SFI,AAC
      XSMIN=IN-17
      XSFCT=IN*100/17
      T=IN
      IF (IN+BUG(9),NE,0) WRITE(OUT,5476) AAL,DEF
      CALL SFILIT(KRITE)
      IF (IN+BUG(9),NE,0) WRITE(OUT,5478) SFI,AAC
8000 CONTINUE
      KK=8001
8001 IF (IN+BUG(9),NE,0) WRITE(OUT,5433) KK ,AAC
      GO TO 1000
      END

```

2 ELY REDISS/SISU.7.740221. 46276.
 3 EOF 3
 REDISS. FCOFY
 C THE STATEMENTS BETWEEN THIS AND THE FIRST END CARD ARE INCLUDED IN
 C MAIN PROGRAM BARD. FUNCTION SUBPROGRAM RF, AND SUBROUTINES DISINF.
 C DCON, RECON, SFILIT, NUPINT, AND BATCH
 C

```

      LOGICAL NTRY
      REAL NZ
      INTEGER OFT,TT,TM1,TM2,TM3,TM4,TNOM
      COMMON A,F,R,T
      COMMON A1,A2,A3,CD,CF,CS,FL,NZ,RC,TF,VJ,VJ,CZ,DC,SC,TS
      COMMON CHA,CHG,CSS,CSF, IFT,JNC,KC,NRE,OPT,RHO,RRP,TM1,
      2TM2,TM3,TM4,VHA,VH2,VPS,VSF,VSS,XTS,FM1,FMD,FDP,FMP
      COMMON AFMD,DATE,DELO,FRAC,KDIS,KORE,KRES,LINE,NTRY,TIME,VTOT,
      2 WFFC,LOFI,TNOM ,FORN
      COMMON CDOCZ,CSCCZ,DYDZ4,FLOWC,JFCRF,KHOLD,NFCRF,NFRAC,THETA,
      2 TMULT,TITLE,XSMIN,XSFCT,NFPEJ,WFFNR,FINIS,NDBUG,CZPM1,FLOWJ
      COMMON APRRGH,COHOLD,CSHOLD,FDRATE,FMDATF,FNRATF,NTHETA,PASSES,
      2 VRSOVD,TBATCH,RECIF,DCSSDT
      DIMENSION FMD(20,5), CF(20,5)
      2,DCSSDT(1001)
      3
      DIMENSION JFCRF(6), AFMD(20), WFFC(6), THETA(1001),
      2 CSF(1001), CSS(1001), CHA(1001), CHG(1001), CC(1001), DATE(2),
      2 TIME(2), KDK(3), WFFNR(5),NDBUG(20),DC(2),SC(3),CS(1001)
      4 ,FRAC(20),FMD(20),TITLE(12)
      5
      DATA NDBUG/20*1/
      DATA DM1,DM2,DM3,DM4,DM5,DM6,DM7,DM8,DM9,DM10/10*0.0/
      DATA I1,I2,I3,I4,I5,I6,I7,I8,I9,I10,I11,I12,I13,I14,I15,I16,I17
      2 I18,I19,I20/20*0.0/
8776 FORMAT (1H ,A6,9H CALLING ,A6)
6789 FORMAT (1H ,A6,14H RETURNING TO , A6)
5432 FORMAT(1H ,24HCONTROLD IS AT STATEMENT ,I5,4H IN ,A6)
      DATA AAC,AA2,AA3,AA4,AA5,SFI,AA7,AA8/ 48H BARD DISINF BATCH RF
      ZDCON SFILITNUPINT DB***/,AA6/64H RECON/
      END

```

```

      SUBROUTINE DISINF
C
C ***** A SUBROUTINE TO READ INPUT AND PERFORM SOME ONE-TIME-PER-RUN CAL-
C CULATIONS. A 72 COLUMN PAGE HEADING IS READ FIRST. REMAINING DATA
C ARE READ BY NAMELIST. A PAGE HEADING MUST PRECEDE EACH SET OF
C NAMELIST CARDS. IT MAY BE BLANK. NAMELIST NAME IS /DATA1/
C VARIABLES RECOGNIZED BY NAMELIST ARE SHOWN BELOW. *STERIKS IND-
C ICATE VARIABLES WHICH MAY BE LEFT UNDEFINED IF VALUES ASSIGNED
C INTERNALLY BY DATA STATEMENT ARE ACCEPTABLE. THE VALUES ASSIGNED
C BY DATA STATEMENT ARE SHOWN IN PARENTHESES UNDER DEFINITION COL.
C
C NAME DIMENS TYPE D E F I N I T I O N
C =====
C
C* F R ORDER OF REACTION (1.0)
C* R R MOLES DISSOLVENT TO DISSOLVE ONE MOLE OF METAL
C* A R AREA, SQ CM/KG METAL
C* FL R FLOW RATE, LITER/MIN, OUT OF DISSOLVER
C* VD P VOLUME OF DISSOLVENT, LITERS
C* NZ R FRACTION OF DISSOLVENT LEFT WHEN ALL METAL IS DIS-
C SOLVED.
C* A1 R PARAMETER IN RATE EQUATION (1.0)
C* A2 R PARAMETER IN RATE EQU. (0.0)
C* A3 R PARAMETER IN RATE EQU. (1.0)
C* RC R RATE CONSTANT
C* JN1 I NUMBER OF DISSOLVERS (1)
C* RHO P DENSITY KG METAL/LITER OF DISSOLVER
C* NRE I CONTROL VARIABLE TO SELECT RATE EQUATION TO BE USED
C IN FUNCTION SUBPROGRAM RF. (1)
C IF NRE=1 REFC=AA1C+R/AT * A2
C* XTS R FRACTION OF FLOW WHICH GOES TO STOPPED RESERVOIR
C* CZ R INITIAL CONCENTRATION OF DISSOLVENT, MOLES PER LITER

```

LISTING AND SUBROUTINE COMPILATION: BARD P. 3

```

C VSS R VOLUME OF STIRRED RESERVOIR, LITERS (0.0)AA2
C VSF R VOLUME OF PLUG FLOW DISSOLVER, LITERS (0.0)AA2
C VHA R VOLUME OF HOLDUP AFTER STIRRED RESERVOIR, LITERS(0.0)AA2
C VHB R VOLUME OF HOLDUP BEFORE STIRRED RESERVOIR, LITERS(0.0)AA2
C JFCRF (0) I DISSOLVERS FOR WHICH INTERMEDIATE OUTPUT IS DESIRED AA2
C NFCRF I NUMBER OF VALUES OF JFCRF (0) AA2
C NFREQ I FREQUENCY AT WHICH INTERMEDIATE OUTPUT IS DESIRED. AA2
C OUTPUT WILL BE WRITTEN AT THE FIRST VALUE OF THETA AA2
C AND EVERY NPERATH VALUE OF THETA. (0) AA2
C FINIS R THE FRACTION OF METAL DISSOLVED WHICH CAN BE CONSID- AA2
C ERED COMPLETE DISSOLUTION. (0.999) AA2
C FRAC (20) R VALUES OF FRACTION OF DISSOLVENT REMAINING WHEN OUT- AA2
C PUT IS TO BE PRINTED. MUST BE IN DESCENDING ORDER. AA2
C (0.99..0.9..7..6..5..4..3..2..1..001) AA2
C NFRAC I NUMBER OF VALUES OF FRAC (11) AA2
C TMULT R A CONTROL VARIABLE TO SET UP THE TIME INCREMENT DELTA AA2
C DELTA=TMULT*BATCH, WHERE BATCH IS THE TIME REQUIRED FOR AA2
C TO BATCH-DISSOLVE TO FRAC(FRAC). (0.075) AA2
C OR 1./TMULT = NUMBER OF TIME STEPS TO BE USED. AA2
C IF INPUT TMULT LESS THAN 0.001 IS ATTEMPTED, A VALUE AA2
C OF 0.001 WILL BE USED. AA2
C KKK (3) I CONTROL VARIABLE TO SELECT SOLUTION METHODS AND AA2
C SEQUENCE AFTER BATCH CALCULATION. (1,2,3) AA2
C KKK(1) DETERMINES WITH SOLUTION METHOD AFTER BATCH. AA2
C KKK=0 TO SKIP SOLN AA2
C =1 TO SOLVE BY EXACT METHOD AA2
C =2 TO SOLVE BY APPROXIMATION 1 AA2
C =3 TO SOLVE BY APPROXIMATION 2 AA2
C *** CONTROL OF DEBUG OUTPUT *** AA2
C NDBG(1)=1+20 CONTROLS DEBUG OUTPUT. NDBG IS IN NAMELIST DATA1. AA2
C TO SUPPRESS ALL DEBUG OUTPUT SET ALL NDBG=0. AA2
C (ALL NDBG(1) = 1 UNLESS DEFINED OTHERWISE BY INPUT) AA2
C FOR NDBG(1)=K (K=NE,0) THE FOLLOWING ACTION WILL BE TAKEN: AA2
C C IF PRINT AFFIXIMATE LOCATION AA2
C C I= FROM WHEN SEE SOURCE LISTING FOR NAMES OF VARIABLES OUT AA2
C C 1 NUPINT MOD(TNOW,K)=0 FIRST DSLVR. NO METAL. (7301,7302,7303) AA2
C C 2 NUPINT MOD(TNOW,K)=0 OTHER DSLVRS. NO METAL. (7304,7305,7306) AA2
C C 3 NUPINT MOD(TNOW,K)=0 ALL DSLVRS. METAL REMAINING. (7307,7308,7309, AA2
C 7310,7311,7312) AA2
C C 4 NUPINT MOD(TNOW,K)=0 FRAC METAL DISSOLVED IN JPTH DSLVR(7313, AA2
C 7314) AA2
C C 5 RECON MOD(TNOW,K)=0 FF AND STIRRED RSVR CONC(6001,6002,6003, AA2
C 6004,6005,6006) AA2
C C 6 -NOT USED AA2
C C 7 -NOT USED AA2
C C 8 -NOT USED AA2
C C 9 THIS CONTROLS TRACER OUTPUT. A NON-ZERO VALUE FOR NDBG(9) GETS A AA2
C MESSAGE PRINTED AT EACH CALL TO AND RETURN FROM A SUBROUTINE. ALSO AA2
C A MESSAGE SHOWING ROUTE TAKEN AFTER EACH MAJOR DECISION BRANCH AA2
C INCLUDE REDISS.LIST AA2
C DATA FINIS/0.999/.F/1.E/ AA2
C DATA DC/12H S FF / AA2
C DATA SC/18H S FF S=FF/ AA2
C DATA EACH,EXACT,OVER,AFROX1,AFROX2,AFROX3/36H BATCH EXACT OVER APRAA AA2
C 20X1AFROX2AFROX3/ AA2
C DATA TMULT,41.A2,A3,IFT,OFI/.005,1.0,0.0,1.5,E/ AA2
C DATA NFRAC,FPAC/11,0.999,.9,.8,.7,.6,.5,.4,.3,.2,.1,.001,.9,0.0/ AA2
C DATA FINIS/.999/.JND/1/ AA2
C NAMELIST/DATA1/F,R,A,FL,V,D,NZ,A1,A2,A3,RC,JND,NRE,XTS,VSS,VSP,CZ, AA2
C ZVHA,VHB,JFCRF,NFCRF,NFREQ,FINIS,FRAC,NFRAC,TMULT,NDBG,RHO,KKK AA2
C 1 FORMAT(12A6) AA2
C VSS=0.0 AA2
C VHA=0.0 AA2
C VSF=0.0 AA2
C VHB=0.0 AA2
C NRE=1 AA2
C READ(IFT,1) TITLE AA2
C LINE=70 AA2
C KHCOLD=1 AA2
C NTPY=.FALSE. AA2
C CALL FOT(1DATE) AA2
C CALL TOD(TIME) AA2
C READ(IFT,DATA1) AA2
C VRS=VSS+VHA+VHB+VSF AA2
C VTOT=VRS+VD AA2
C VRSOVD=VRS/VD AA2
C VJ=VD/JND AA2
C FLOVJ=FL/VJ AA2
C KPES=3 AA2
C KOIS=1 AA2
C FLOVD=FL/VD AA2
C TEST=ABS(XTS-1.) AA2
C DETERMINE KIND RESERVOIR AA2
C IF(XTS.LT.1.E-15) KRES=2 RESVR IS PLUG FLOW ONLY AA2
C IF(ABS(XTS-1.E-15)) KRES=1 RESVR IS STIRRED ONLY AA2
C IF(JND.NE.1) KOIS=2 DISSOLVER IS PLUG FLOW ONLY AA2
C RRF=1./(RC+A*P*PHO) AA2
C RECIF=1./RRF AA2

```

LISTING AND SUBROUTINE COMPILATION: BARD P. 4

```

C SET SIGNAL FOR ORDER OF REACTION, SET IMUL, SET STARTING CONC.
TCST = ARG1F-1.0)
KORDE=1
IF (TCST.GT.1.E-6) KORDE=2 REACTION IS NOT FIRST ORDER
IF (TMULT.LT..0001)MULT=.005
CHAI(1)=C2
CHB(1)=C2
CSS(1)=C2
CSF(1)=C2
CDZ=C2
CSZ=C2
FM1=F-1.
CZFM1=CZ*(F-1.)
ARRRGH=ENO*A*VD*R/ICZ*VTOT*(1.-NZ))
RETURN
END

```

```

100  ELT BATCH/S1F5.1.700710. 40201
101  B EOF 3
102  SUBROUTINE BATCH(FDL,TTD)
103  C A ROUTINE TO CALCULATE TIME, TTD, TO DISSOLVE BY BATCH PROCESS TO
104  C FDL FRACTION OF DISSOLVENT REMAINING, USING RATE EQUATION ARE.
105  INCLUDE PDISS.LIST
106  IF(INPE.NE.1) GO TO 200
107  KK=130
108  130 IF(INCBUG(9).NE.0) WRITE(OUT,5432) KK,AA3
109  GO TO (150,180),WORD 3 $150 FOR FIRST ORDER, $250 FOR OTHER.
110  150 TTD= -RRF*ALOG(FDL)
111  KK=160
112  160 IF(INCBUG(9).NE.0) WRITE(OUT,5432) KK,AA3
113  RETURN
114  180 T1=RRF/CZFM1
115  T2=1./FM1
116  T3=1./((1.-FDL)*FM1
117  TTD= T1 *(T2*(T3-1))
118  KK=190
119  190 IF(INCBUG(9).NE.0) WRITE(OUT,5432) KK,AA3
120  RETURN
121  200 CONTINUE
122  KK=201
123  201 IF(INCBUG(9).NE.0) WRITE(OUT,5432) KK,AA3
124  C RESERVED FOR SPECIAL RATE EQUATION
125  RETURN
126  END

```

```

0 ELT SFILIT/SIFS=17/00/10. 0019/
0 EOF 0
SUBROUTINE SFILIT(KOF)
C A SUBROUTINE TO WRITE OUTPUT FOR PROGRAM BARD
INCLUDE 'EDISS.LIST'
CDZ=CDZ
CSZ=CDZ
DATA BACH,EXACT ,AFROX2,AFROX1/24H BATCH,EXACT,APROX2,APROX1/
DATA DC/12H S FF /
DATA SC/18H S FF S+FF/
1 FOPMAT(140)
2 FOPMAT(11H,1246,11X,17HFPROGRAM BARD FUN ,246,3MAT ,2AE)
3 FOPMAT(11H,24HCCNFIGURATION: DISSOLVER,16,10X, 94RESERVOIR,16)
4 FOPMAT(11H+.57X,44WITH,F4,2+26H FLOW TO STIPRED RESERVOIR)
5 FOPMAT(11H ,17HORDER OF REACTION,F3,4)
6 FOPMAT(11H -.8X,34VDC=1FE11.5,7H LITERS,15X,4HCSO=,E11.5,14H 6 MOLES/SP
2/LITER,10X,24K=,E11.5,14H RATE CONSTANT)
7 FOPMAT(11H ,3X,4HVS=,IFE11.5,7H LITERS,15X,4HCSO=,E11.5,14H 6 MOLES/SP
25/LITER,6X,7H4AP/VD=,E11.5)
8 FOPMAT(11H ,3X,4HVSF=,IFE11.5,7H LITERS,15X,34FL=,E11.5,14H LITERS/SP
2MINUTE,6X,6HVC/VD=,E11.5)
9 FOPMAT(11H ,3X,4HVM=,IFE11.5,16X,2HR=,E11.5,11H MOLES/HOLE,12X,
23HND=,E11.5)
10 FOPMAT(11H ,3X,4HVM=,IFE11.5,16X,2HA=,E11.5,15H SQ CM/KG METAL,7X,SP
24HMR=,I3)
11 FOPMAT(11H ,5X,1H+.7X,1H+.5X,1H+.22X,1H+.26X,1H+)
12 FOPMAT(11H ,70HFRAC*TIME TO METHD*EXCESS DISSOLN TIME + NO OF*CSPI
20NC AT DISSOLVER *)
13 FOPMAT(11H+.70X, 55HFRAC METAL REMAINING AND (CONCENTRATION OF DISSP
25SOLVENT))
14 FOPMAT(11H ,70HREACT*DISSOLVE* OF *COMPARED* *PASSES* CSPI
2D/CO. CS/CO *)
15 FOPMAT(11H+.70X,38HJTH POSITION OF FLUG FLOW DISSOLVER)
16 FOPMAT(11H ,70HLEFT *MINUTES*50LN + TO + MINS + PCT + *EL SPI
2EAVING)ENTERING*)
17 FOPMAT(11H ,5X,1H+.7X,1H+.5X,1H+.8X,1H+.6X,1H+.6X,1H+.6X,1H+.19X,1HSP
2+)
18 FOPMAT(11H+.72X,12HJ=.I3,5X ,2HJ=.I3)
19 FOPMAT(11H ,F4,3,1X,1FE8,3,46)
20 FOPMAT(11H ,F4,2,1X,1FE8,3,46,46,1X,E9,3,OFF8,3,5F5,1,17,1P2(10,4)
21 FOPMAT(11H ,70X,1FE9,3,1FE(10,3)
22 FOPMAT(11H ,70X,6(1H,1FE8,3,1H))
23 FOPMAT(11H,70X, 6H(META,F8,3,1X,5HCS/CZ=,1PE10,4,1X,5HAFMO=,NP
2F8,4,2X,4HAFCS,1FE8,2)
24 FOPMAT(11H ,26HCONSTANTS IN RATE EQU: A1=,1PE10,4,64, A2=,C10,4,
26H, A3=,E10,4,8X,4HAFMO=,E11.5,29H KG METAL/LITER OF DISSOLVER )
25 FOPMAT(11H ,21HNUMBER OF DISSOLVCS=.I3)
IF(11H,LT,4E) GO TO 40
WRITE(10F,2) TITLE,DATE,TIME
WRITE(10F,1)
WRITE(10F,3) DC(KDIS),SC(KRES)

```


LISTING AND SUBROUTINE COMPILATION: BARD P. 5

```

      IF(KK=1,50,7) WRITE(OUT,4) XT
      WRITE(OUT,4) 1
      WRITE(OUT,4) V0,CS02,SC
      WRITE(OUT,4) V0,CS02,SC02
      WRITE(OUT,4) V0,FL,V0,SC0V
      WRITE(OUT,4) V0,0,0,0
      WRITE(OUT,10) V0,0,0,0
      WRITE(OUT,24) A1,A2,A3,040
      WRITE(OUT,25) JND
      WRITE(OUT,1)
      WRITE(OUT,11)
      WRITE(OUT,12)
      IF(KFCS.NE.1) WRITE(OUT,13)
      WRITE(OUT,14)
      IF(KFCS.NE.1) WRITE(OUT,15)
      WRITE(OUT,16)
      WRITE(OUT,17)
      IF(NFCRF.NE.0) WRITE(OUT,13) (JFCRF(I),I=1,NF,0P)
      LINE=17
      90 GO TO (100,200,300,400,500,600),KOF
      C $100 WRITES PATCH RESULTS
      100 WRITE(OUT,19) F0R,T,BACH
      GO TO 9999
      C $200 WRITES RESULTS OF EXACT SOLUTION
      200 WRITE(OUT,20) F0R,T,EXACT,BACH,XSMIN,ASFC,FASSES,CS0CZ,CS0CZ
      GO TO 9999
      C $300 WRITES RESULTS OF APPROXIMATION NUMBER 1.
      300 WRITE(OUT,20) F0R,T,APPOX1,EXACT,XSMIN,ASFC,FASSES,CS0CZ,CS0CZ
      GO TO 9999
      C $400 WRITES RESULTS OF APPROXIMATION NUMBER 2.
      400 WRITE(OUT,20) F0R,T,APPOX2,EXACT,XSMIN,ASFC,FASSES,CS0CZ,CS0CZ
      GO TO 9999
      C $500 WRITES METAL DISSOLVED AND DISSOLVENT CONCENTRATIONS AT JTH
      C POSITION IN FLUX FLOW DISSOLVER
      500 CONTINUE
      WRITE(OUT,23) T,CS0CZ,AFND(JND),FASSES
      600 WRITE(OUT,21)(WFFC(JJJ),JJJ=1,NFCRF)
      WRITE(OUT,22)(JFFMR(JJJ),JJJ=1,NFCRF)
      LINE=LINE + 2
      GO TO 9999
      9999 LINE=LINE + 1
      RETURN
      END

```

```

      @ ELT DCON/SIFS,1,700710, 40199
      @ EOF
      SUBROUTINE DCONKEY(TN)
      C KEY SELECTS PROPER ROUTE FOR SOLUTION METHOD BEING CONSIDERED.
      C FDR IS THE DESIRED VALUE OF FRACTION OF DISSOLVENT REMAINING.
      C FDRN IS THE NEAREST MATCH TO FDR OBTAINABLE WITH TIME STEP SIZE USED.
      C TN IS TIME REQUIRED TO REACH FDR NEARLY FDR.
      C NRE IS THE NUMBER OF RATE EQUATION TO BE USED.
      INCLUDE REDISS.LIST
      GO TO (1000,2000,3000), KEY
      2000 CONTINUE
      KK=2001
      2001 IF(NDEBUG(9).NE.0) WRITE(OUT,5432) KK,AA5
      C RESERVED FOR APPROXIMATION 1 ROUTINE
      RETURN
      3000 CONTINUE
      KK=3001
      3001 IF(NDEBUG(9).NE.0) WRITE(OUT,5432) KK,AA5
      C RESERVED FOR APPROXIMATION 2 ROUTINE
      RETURN
      1000 CONTINUE @ ROUTE FOR EXACT SOLUTION
      KK=1001
      1001 IF(NDEBUG(9).NE.0) WRITE(OUT,5432) KK,AA5
      LOFI=KHOLD @ START DO LOCF AT ONE INCREMENT PAST THE LAST ONE USED.
      DO 6000 KTIME=LOFI,NTHETA
      IF(NDEBUG(9).NE.0) WRITE(OUT,6789) AA5,AA7
      CALL NUFINT( FDRN )
      IF(NDEBUG(9).NE.0) WRITE(OUT,6789) AA7,AA7
      IF(NDEBUG(9).NE.0) WRITE(OUT,6789) AA5,AA5
      CALL BATCH (FDRN,YB )
      IF(NDEBUG(9).NE.0) WRITE(OUT,6789) AA3,AA5
      KHOLD=KTIME+1
      INTHETA(KTIME)
      IF(FDRN.LE.FDR) GOTO7000 @ TIME FOR FDR NEARLY FDR IS FOUND
      C FDRN IS STILL LESS THAN FDR. TAKE ANOTHER TIME STEP
      6000 CONTINUE
      7000 CMHOLD=CS(KHOLD-1)
      KK=6001
      6001 IF(NDEBUG(9).NE.0) WRITE(OUT,5432) KK,AA5
      CMHOLD=CD(KHOLD-1)
      RETURN
      END

```

LISTING AND SUBROUTINE COMPILATION: BARD P. 6

```

0 ELT RF/SIF5.1.700710. 40.02
0 EOF 0
  FUNCTION 9F(NFG,C)
C SURFPROGRAM TO SOLVE RATE EQUATIONS
  INCLUDE REDISS.LIST
C NEO IS CONTROL VARIABLE (NRE ON INPUT) TO SELECT EQUATION TO USE.
C C IS CONCENTRATION
  GO TO (100,200,300), NE0
100 CONTINUE
  KK=101
101 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  RF=RC *A1+C**F/A? + A2
  RETURN
200 CONTINUE
  KK=201
201 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
C RESERVED FOR ADDITIONAL EQUATION.
  RETURN
300 CONTINUE
  KK=301
301 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
C RESERVED FOR ADDITIONAL EQUATION.
  RETURN
END

0 ELT RECON/SIF5.1.700710. 40210
0 EOF 0
  SUBROUTINE RECON(KT)
C A ROUTINE TO CALCULATE CONCENTRATIONS IN THE RESERVOIR
  INCLUDE REDISS.LIST
  DT(C1-C2)=XTS*FL*(C1-C2)/VSS
  KK=900
900 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  GO TO(2000,1000,2000) , KRES
1000 CONTINUE=3FLUG FLOW CALCULATIONS
  KK=1001
1001 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  TNEW=THETA(KT)-VSF/((1.-XTS)*FL)
  K=1.+(TNEW+.51*DELO)/DELO
  IF(K.LT.1) K=1
  CSF(KT)=CD(K)
  IF(NDEBUG(5),EQ,0) GO TO 1012
  IF(MOD( KT,NDEBUG(5)),NE,0) GO TO 1012
6001 CALL DBIS (6001,2,KT,K,I3,I4,I5)
6002 CALL DBRS(6002,3,CSF(KT),TNEW,THETA(KT),DM0,DM5)
1012 GO TO (2000,0000,2000),KRES
2000 CONTINUE = STOPPED RESERVOIR CALCULATIONS
  KK=2001
2001 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  CHB(2)=CD(2)
  DCSSDT(1)=0.0
  IF(KT.GT.2) GO TO 1111
  DCSSDT(2)=FL*(CHB(2)-CSS(2))/VSS
  CSS(2)=CSS(1)+DT024*9.*DCSSDT(2)
  GOT06665
1111 IF (KT.GT.3) GOT02222
  KK=1112
1112 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  CSS(3)=CSS(2) + DT024* 55. * DCSSDT(2)
  DCSSDT(3)= FL*(CHB(3)-CSS(3))/VSS
  CSS(3)=CSS(2) + DT024*(9.*DCSSDT(3) + 19. * DCSSDT(2))
  GOT06666
2222 IF (KT.GT.4) GO TO 3333
  CSS(4)=CSS(3)+DT024*(55.*DCSSDT(3)-59.*DCSSDT(2))
  DCSSDT(4)=FL*(CHB(4)-CSS(4))/VSS
  CSS(4)=CSS(3)+DT024*(9.*DCSSDT(4)+19.*DCSSDT(3)-5.*DCSSDT(2))
  KK=2223
2223 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  GO TO 6666
3333 KTH1=KT-1
  KTH2=KT-2
  KTH3=KT-3
  KTH4=KT-4
  CSS(KT)=CSS(KTH1)+DT024*(55.*DCSSDT(KTH1)-59.*DCSSDT(KTH2)+37.*
2 DCSSDT(KTH3) -9.*DCSSDT(KTH4))
  DCSSDT(KT)=FL*(CHB(KT)-CSS(KT))/VSS
  CSS(KT)=CSS(KTH1) +DT024*(9.*DCSSDT(KT)+19.*DCSSDT(KTH1)
2 -5.*DCSSDT(KTH2) + DCSSDT(KTH3))
  KK=3337
3337 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
6666 CONTINUE
  TNEW=THETA(KT)-VHB/XTS*FL)
  K=1.+(TNEW+.51*DELO)/DELO
  IF(K.LT.1) K=1
  CHB(KT)=CD(K)
  IF(NDEBUG(5),EQ,0) GO TO 3000
  IF(MOD(KT,NDEBUG(5)),NE,0) GO TO 3000
6003 CALL DBIS(6003,2,KT,K,I3,I4,I5)
6004 CALL DBRS(6004,3,CHB(KT),TNEW,THETA(KT),DM0)
3000 CONTINUE
  KK=3001
3001 IF(NDEBUG(9),NE,0) WRITE(0FT,5432) KK ,AA0
  TNEW=THETA(KT)-VHA/XTS*FL)
  K=1.+(TNEW+.51*DELO)/DELO

```

LISTING AND SUBROUTINE COMPILATION: BARD P. 7

```

      IF(K.LT.1) KK=1
      CHA(KT)=CSS(K)
      CHA(KT)=CSS(K)
4000 CS(KT)=XTS*CHA(KT)+11-XTS)*CSS(KT)
      KK=K+1
4001 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
      IF(INDBUS(15).EQ.0) RETURN
      IF(INDBUS(15).NE.0) RETURN
6105 CALL DBS(ED(15,2),KT,K,17,14,15)
6006 CALL DBS(ED(15,2),CHA(KT),TNEW,THETA(KT),CS(KT),DMA)
      RETURN
      END

```

@ ELT NUFINT/SIFS*.1700710. 40006
 @ EOF @

```

      SUBROUTINE NUFINT(TFDR)
      TNOW IS INTEGER TO DESIGNATE TIME STEP
      TFDR IS FRACTION OF DISSOLVENT REMAINING
      NPE IS NUMBER OF RATE EQUATION TO BE USED
      INCLUDE REDISS.LIST

```

C
 C ARITHMETIC STATEMENT FUNCTIONS
 C
 SDCD(ILJ,LT)=FLOVJ*(CF(ILJ-1,LT-1)-CF(ILJ,LT))
 FDCD(TKK)=FLOVJ*(CS(KK)-CF(1,KK))
 FDCD(ILJ,LT)=FLOVJ*(CF(ILJ-1,LT)-CF(ILJ,LT))
 2 -LJ=FLOVJ*(CF(ILJ,LT))
 3 -LJ=FLOVJ*(CF(ILJ,LT))
 DFM(TILJ,LT)=ARRR64*F(INFL,CF(ILJ,LT))
 FDCD(TILJ,LT)=FLOVJ*(CS(LT)-CF(1,LT))-LJ*A*RHO*G*F(INRE,CF(ILJ,LT))
 FDCD(TILJ,LT)=FLOVJ*(CF(ILJ-1,LT-1)-CF(ILJ,LT))-LJ*A*RHO*G*F(INRE,CF(ILJ,LT))
 2
 TNOW=KHCLO
 IF(INTRY) GO TO 200
 C SET INITIAL VALUES IN ARRAYS FIRST TIME NUFINT IS CALLED
 NTRY=.TRUE.
 DO 40 K=1,1001
 CS(K)=CZ
 CD(K)=CZ
 CSS(K)=CZ
 40 CONTINUE
 DO 45 K=1,5
 DO 50 M=1,20
 FMD(M,K)=0.0
 CF(M,K)=CZ
 50 CONTINUE
 45 CONTINUE
 200 DO 7777 JS=1,JND
 KK=200
 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 IF (TNOW.LE.4) GO TO 400
 TM1=0
 TM2=3
 TM3=2
 TM4=1
 TT=5
 KK=207
 207 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 GO TO 260
 400 IF (TNOW.NE.2) GO TO 410
 TM1=1
 TM2=1
 TM3=1
 TM4=1
 TT=2
 KK=407
 407 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 GO TO 260
 410 IF (TNOW.NE.3) GO TO 420
 TM1=2
 TM2=1
 TM3=1
 TM4=1
 TT=3
 KK=417
 417 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 GO TO 260
 420 TM1=3
 TM2=2
 TM3=1
 TM4=1
 TT=4
 KK=427
 427 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 260 JF=JS
 KK=261
 261 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 FMRM1=1.-FMD(JS,TM1)
 IF(FMRM1.GT.FINIC) GO TO 467
 C METAL IN DISLVG JS WAS USED UP IN PREVIOUS TIME STEP. USE EQUA-
 C TIONS FOR A STIRRED RESEPOVOR FOR CURRENT TIME STEP.
 KK=262
 262 IF(INDBUS(9).NE.0) WRITE(IFT,5432) KK,AA7
 IF(JF.NE.1) GO TO 300 @ FOR DISLVRS OTHER THAN FIRST (NO METAL).

LISTING AND SUBROUTINE COMPILATION: BARD P. 8

```

C      USE FOLLOWING FOR FIRST DISSOLVER
      KK=261
163 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      CF(JF,TT)=CF(JF,TH1) + DT024*(55.*FDCOT(TH1)-59.*FDCOT(TH2)
      + 37.*FDCOT(TH3)-5.*FDCOT(TH4))
      V1=FDCOT(TH1)
      V2=FDCOT(TH2)
      V3=FDCOT(TH3)
      V4=FDCOT(TH4)
      IF(INDBUG(1).EQ.0) GO TO 230
      IF(MOD(TNOW,NCBUS(1)).NE.0) GO TO 280
7301 CALL DBR10(7301.7,TNOW,JF,TT,TH1,TH2,TH3,TH4,I8,I9,I10)
7302 CALL DBR10(7302.6,V1,V2,V3,V4,CF(JF,TT),THETA(TNOW),DM7,DM8,DM9,
      2 DM10)
      280 V4=FDCOT(TH1)
      CF(JF,TT)=CF(JF,TH1)+DT024*(9.*V4+19.*V1-5.*V2+V3)
      IF(INDBUG(1).EQ.0) GO TO 7777
      IF(MOD(TNOW,NCBUS(1)).NE.0) GO TO 7777
7303 CALL DBR5(7303.2,V4,CF(JF,TT),DM3,DM4,DM5)
      GO TO 7777
300 CONTINUE & FOR OTHER THAN FIRST DISSOLVERS (NO METAL LEFT)
      KK=301
301 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      V1=SDCOT(JF,TH1)
      KK=468
468 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      V2=SDCOT(JF,TH2)
      V3=SDCOT(JF,TH3)
      V4=SDCOT(JF,TH4)
      CF(JF,TT)=CF(JF,TH1)+DT024*(55.*V1-59.*V2+37.*V3-9.*V4)
      IF(INDBUG(2).EQ.0) GO TO 380
      IF(MOD(TNOW,NCBUS(2)).NE.0) GO TO 380
7304 CALL DBR10(7304.7,TNOW,JF,TT,TH1,TH2,TH3,TH4,I8,I9,I10)
7305 CALL DBR10(7305.6,V1,V2,V3,V4,CF(JF,TT),THETA(TNOW),DM7,DM8,DM9,
      2 DM10)
      380 V4=SDCOT(JF,TH1)
      CF(JF,TT)=CF(JF,TH1)+DT024*(9.*V4+19.*V1-5.*V2+V3)
      IF(INDBUG(2).EQ.0) GO TO 7777
      IF(MOD(TNOW,NCBUS(2)).NE.0) GO TO 7777
7306 CALL DBR5(7306.2,V4,CF(JF,TT),DM3,DM4,DM5)
      GO TO 7777
467 IF(JF.EQ.1) GO TO 500
C      THIS SECTION FOR CONC IN DSLVRS AFTER FIRST (METAL REMAINING)
      V1=OFDCOT(JF,TH1)
      V2=OFDCOT(JF,TH2)
      V3=OFDCOT(JF,TH3)
      V4=OFDCOT(JF,TH4)
      IF(TNOW.GT.4) GO TO 459
      CF(JF,TT)=CF(JF,TH1) + DELO * V1
      GO TO 600
459 CF(JF,TT)= CF(JF,TH1)+DT024*(55.*V1-59.*V2+37.*V3-9.*V4)
      KK=451
461 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      IF(INDBUG(3).EQ.0) GO TO 480
      IF(MOD(TNOW,NCBUS(3)).NE.0) GO TO 480
7307 CALL DBR10(7307.7,TNOW,JF,TT,TH1,TH2,TH3,TH4,I8,I9,I10)
7308 CALL DBR10(7308.6,V1,V2,V3,V4,CF(JF,TT),THETA(TNOW),DM7,DM8,DM9,
      2 DM10)
      480 V4=OFDCOT(JF,TH1)
      KK=481
481 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      CF(JF,TT)=CF(JF,TH1)+DT024*(9.*V4+19.*V1-5.*V2+V3)
      IF(INDBUG(3).EQ.0) GO TO 600
      IF(MOD(TNOW,NCBUS(3)).NE.0) GO TO 600
7309 CALL DBR5(7309.2,V4,CF(JF,TT),DM3,DM4,DM5)
      GO TO 600
500 CONTINUE & THIS SECTION FOR CONC IN FIRST DSLVR (METAL REMAINING)
      KK=501
501 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      V1=FFDCOT(JF,TH1)
      V2=FFDCOT(JF,TH2)
      V3=FFDCOT(JF,TH3)
      V4=FFDCOT(JF,TH4)
      IF(TNOW.GT.4) GO TO 520
      CF(JF,TT)=CF(JF,TH1) + DELO * V1
      GO TO 600
520 CF(JF,TT)= CF(JF,TH1)+DT024*(55.*V1-59.*V2+37.*V3-9.*V4)
      KK=521
521 IF(INDBUG(9).NE.0) WRITE(OUT,5432) KK,AA7
      IF(INDBUG(3).EQ.0) GO TO 580
      IF(MOD(TNOW,NCBUS(3)).NE.0) GO TO 580
7310 CALL DBR10(7310.7,TNOW,JF,TT,TH1,TH2,TH3,TH4,I8,I9,I10)
7311 CALL DBR10(7311.6,V1,V2,V3,V4,CF(JF,TT),THETA(TNOW),DM7,DM8,DM9,
      2 DM10)
      580 V4=FFDCOT(JF,TH1)
      CF(JF,TT)=CF(JF,TH1)+DT024*(9.*V4+19.*V1-5.*V2+V3)
      IF(INDBUG(3).EQ.0) GO TO 600
      IF(MOD(TNOW,NCBUS(3)).NE.0) GO TO 600
7312 CALL DBR5(7312.2,V4,CF(JF,TT),DM3,DM4,DM5)
      600 CONTINUE & THIS SECTION TO FIND FRACTION METAL DISSOLVED IN JPTH
      DISSOLVER

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LISTING AND SUBROUTINE COMPILATION: BARD P. 9

```

      KK=801
      601 IF(NCBUG(9).NE.0) WRITE(CFT,5432) KK ,AA7
      V1=JFMD(J,TM1)
      V2=JFMD(J,TM2)
      V3=JFMD(J,TM3)
      V4=JFMD(J,TM4)
      FMD(J,T1)=FMD(J,TM1)+G124*(55.*V1-53.*V2+37.*V3-9.*V4)
      IF(NCBUG(9).EQ.0) GO TO 7666
      IF(MOD(TNOW,NCBUS(4)).NE.0) GO TO 7666
      7313 CALL DBR10(7313,7,TNOW,J,T1,TM1,TM2,TM3,TM4,T8,T9,T10)
      7314 CALL DBR10(7314,7,V1,V2,V3,V4,FMD(J,T1),THETA(TNOW),CP(J,T1),
      2 DM9, CM10)
      7666 CO(TNOW)=CP(J,T1)
      7777 CONTINUE SEND OF DC INITIATED AT CARD L2900
      KK=7778
      7778 IF(NCBUG(9).NE.0) WRITE(CFT,5432) KK ,AA7
      AFMD(1)=FMD(1,T1)/JND 300VALL FRACT METAL DISLVD IN DSSLVR 1.
      FMR(1)=1-FMD(1,T1) 6FRACT METAL LEFT IN DISSOLVER 1
      IF(JND.E3.1) GO TO 8899
      DO 8888 J=2,JND
      KK=7779
      7779 IF(NCBUG(9).NE.0) WRITE(CFT,5432) KK ,AA7
      AFMD(J)=AFMD(J-1)+ FMD(J,T1)/JND
      FMR(J)=1-FMD(J,T1)
      8888 CONTINUE
      KK=8889
      8899 IF(NCBUG(9).NE.0) WRITE(CFT,5432) KK ,AA7
      8900 TFCR=1-(1-KK)*AFMD(JND)
      IF(TT.LC.4) GO TO 3330
      DO 3373 J=1,JND 3SHIFT ARRAYS
      DO 3373 KT=1,4
      CF(J,KT)=CF(J,KT+1)
      FMD(J,KT)=FMD(J,KT+1)
      3373 CONTINUE
      KK=3374
      3374 IF(NCBUG(9).NE.0) WRITE(CFT,5432) KK ,AA7
      3380 CONTINUE
      IF(NCBUG(9).NE.0) WRITE(CFT,9876) AA7,AA6
      CALL RECON(TNOW) 3CALCULATE CONCS IN RSV01R FOR THIS TIME STEP
      IF(NCBUG(9).NE.0) WRITE(CFT,6789) AA6,AA7
      IF(TNOW.E3.2) GO TO 9000 3PRINT CONCS IN EACH DSSLVR FIRST TIME.
      IF(NFREQ.E0.0) GO TO 9500
      IF(MOD(TNOW,NFREQ).NE.0) GO TO 9500
      9000 LIM=MAXC(1,NFCRF)
      KK=9001
      9001 IF(NCBUG(9).NE.0) WRITE(CFT,5432) KK ,AA7
      DO 9040 J=1,LIM
      KS=JFCRF(J)
      WFFC(J)=CF(KS,T1-1)
      WFFMR(J)=FMR(KS)
      9040 CONTINUE
      T=THETA(TNOW)
      9500 CONTINUE
      RETURN
      END

      0 ELT DBI5/SIF5.1.700710. 40198
      0 EOF 0
      SUBROUTINE DBI5(NS,NK,I1,I2,I3,I4,I5)
      1 FORMAT (1H0,24HOUTPUT FROM DEBUG ROUTINE AT POINT,I5)
      2 FORMAT (1H ,20(I5,1X))
      3 FORMAT (1H ,1F10E13.6)
      GO TO 200
      ENTRY DBI5(NS,NK,V1,V2,V3,V4,V5)
      GO TO 300
      ENTRY DBI10(NS,NK,I1,I2,I3,I4,I5,I6,I7,I8,I9,I10)
      GO TO 200
      ENTRY DBR10(NS,NK,V1,V2,V3,V4,V5,V6,V7,V8,V9,V10)
      GO TO 300
      200 WRITE (6,1) NS
      WRITE (6,7) NK,I1,I2,I3,I4,I5,I6,I7,I8,I9,I10
      RETURN
      300 WRITE (6,1) NS
      WRITE (6,3) V1,V2,V3,V4,V5,V6,V7,V8,V9,V10
      RETURN
      END
      06230274 CUB928FUNC08 100 3449 52 814 1597122051.1 00000

```

PROGRAM NAME: CINCOM

Descriptive Title: Design of Induction Heating Coils

Program Author: Block, E. Z.

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 2

Central Memory Words: 65000B

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Induction Heating

Program Description: Matches induction heating coils to power sources and work pieces by trial and error estimation of the number of turns in the coil and the power into the load. Program has several empirical form factor tables. Six subroutines. Formatted input.

Users of Program: G Jansen
WV DeMier
JR Nance
RB Dakan
RL Engel

Documentation: Equations and Results are reported in HW74093.

Condition of Program: It has been used extensively as a standard. The program as it stands is set up with the motor generator power as input. Lines must be modified by the input deck each time it is run to use power into the loaded coil as input. The CYBER version has corrections in the table lookup; these errors still remain in the UNIVAC version but have so far not affected the utility of the answers.

SAMPLE INPUT: CINCOM

CINCOM 10:22 02/15/74

```

100 @S RUN PUNCO5,CUR928,GEORGE,150,6000/3000 G JANSEN 3760 RLD
      G 9423576
110 @N MSG KEEP AT FED,DLDO FOR PICKUP AT 5:00PM BY G.JANSEN
115 @PUL TEL INFO00
120 @PUL TEL INFO00
130 @PRI TEL CUR928
140 @X ASG A=U1145(GJ1145)
150 @N XQT CUR
160 FIND A,CINCOM/SIFS
170 TRD A
180 FIND A,GJ11/SIFS
190 TRD A
200 FIND A,REP1/SIFS
210 TRD A
220 FIND A,REP2/SIFS
230 TRD A
240 FIND A,DINT/SIFS
250 TRD A
260 FIND A,SINT/SIFS
270 TRD A
280 FIND A,CBLK/SIFS
290 TRD A
300 TRI A
310 PCH CINCOM/SIFS
320 PCH GJ11/SIFS
330 PCH REP1/SIFS
340 PCH REP2/SIFS
350 PCH DINT/SIFS
360 PCH SINT/SIFS
370 PCH CBLK/SIFS
380 @IM FR5,* CINCOM/SIFS,CINCOM/SIFS,CINCOM/RIFS
390 @IM FR5,* GJ11/SIFS,GJ11/SIFS,GJ11/RIFS
400 @IM FR5,* REP1/SIFS,REP1/SIFS,REP1/RIFS
410 @IM FR5,* REP2/SIFS,REP2/SIFS,REP2/RIFS
420 @IM FR5,* DINT/SIFS,DINT/SIFS,DINT/RIFS
430 @IM FR5,* SINT/SIFS,SINT/SIFS,SINT/RIFS
440 @IM FR5,* CBLK/SIFS,CBLK/SIFS,CBLK/RIFS
450 @N XQT CINCOM/RIFS
460 2 1 1 20 0
470 4 1 1 1 1 1 1 1 5 4 1 0
480 MATCH OF 3 KC, 5 KW MOTOR GENERATOR TO CHINA SYNDROME CHARGE
490 0.005
500 0.060 0.120 0.250 0.500
510 0.032
520 0.5
530 7.000E-05 1.0
540 1.754E-06 1.0
550 220.
560 5.
570 3000.
580 .5 1. 1.5 2. 2.5 3. 3
590 4.
600 9. 12. 15. 18.
610 4.5
620 @ FIN
READY

```

SAMPLE INPUT: CINCOM

LIST

CINCOM 16:19 03/15/74

```

100 #S RUN PUN005,CUB928,GEORGE,150,6000/3000 G JANSEN 3760 BLD
    G 9423576
110 #N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
115 #PUL TEL INFO00
120 #PRL TEL INFO00
130 #PRL TEL CUB928
140 #X ASG A=U1145(JJ1145)
150 #N XQT CLR
160 FIND A,CINCOM/SIFS
170 TRD A
180 FIND A,GJJ1/SIFS
190 TRD A
200 FIND A,BER1/SIFS
210 TRD A
220 FIND A,BER2/SIFS
230 TRD A
240 FIND A,DINT/SIFS
250 TRD A
260 FIND A,SINT/SIFS
270 TRD A
280 FIND A,CBLK/SIFS
290 TRD A
300 TRI A
380 #IM FR5,* CINCOM/SIFS,CINCOM/SIFS,CINCOM/RIFS
390 #IM FR5,* GJJ1/SIFS,GJJ1/SIFS,GJJ1/RIFS
400 #IM FR5,* BER1/SIFS,BER1/SIFS,BER1/RIFS
410 #IM FR5,* BER2/SIFS,BER2/SIFS,BER2/RIFS
420 #IM FR5,* DINT/SIFS,DINT/SIFS,DINT/RIFS
430 #IM FR5,* SINT/SIFS,SINT/SIFS,SINT/RIFS
440 #IM FR5,* CBLK/SIFS,CBLK/SIFS,CBLK/RIFS
500 #A UPD,* CINCOM/SIFS,CINCOM/SIFS
510 -158,158
520 3200 FORMAT (1H,28HPower INTO LOAD + COIL PMG =,F7.3,3H KW)
530 -178,178
540 1 27H ITERATIONS. PIMG=,IPE10.3,OPF10.1,2X,3H 15)
550 #A UPD,* GJJ1/SIFS,GJJ1/SIFS
560 -135,135
570 174 IF(ABS((PIMG-PMG)/PMG)-DELPMG)260,260,176
580 -139,139
590 180 EN=EN*SQR(PIMG/PMG)
600 -143,143
610 1 IF(ABS((PIMG-PMG)/PMG)-DELPMG)240,240,200
620 -144,144
630 200 EN=EN*SQR(PIMG/PMG)
640 #IM FR5,* CINCOM/SIFS,CINCOM/SIFS,CINCOM/RIFS
650 #IM FR5,* GJJ1/SIFS,GJJ1/SIFS,GJJ1/RIFS
1000 #N XQT CINCOM/RIFS
1010 2 1 1 20 0
1020 4 1 1 1 1 1 1 1 8 4 1 0
1030 MATCH OF 3 KC, 5 KW MOTOR GENERATOR TO CHINA SYNDROME CHARGE
1040 0.005
1050 0.060 0.120 0.250 0.500
1060 0.032
1070 0.5
1080 7.000E-05 1.0
1090 1.754E-06 1.0
1100 220.
1110 5.
1120 3000.
1130 .5 1. 1.5 2. 2.5 3.
    3.5
1140 4.
1150 9. 12. 15. 18.
1160 4.5
1170 # FIN
READY

```

SAMPLE OUTPUT: CINCOM P. 1

AN APT CINCOM/115

DRUM LENGTH 015744

THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 14:03:39

THESE ARE THE RESULTS OF AN INDUCTION HEATING COIL CALCULATION

SYSTEM DEFINITION

MODE = 2 CONVERGENCE WILL BE TRIED WITH SPECIFIED TUBING O.D.
 NTK = 4 LOAD IS A CHARGE WALL
 NTAUK = 1 COIL WALL THICKNESS IS SPECIFIED
 KWHICH = 1 VALUES OF CHARGE LENGTH ARE GIVEN
 KGAP = 1 VALUES OF COIL INNER RADIUS ARE GIVEN
 KTUBE = 0 COIL TUBING IS CIRCULAR

MATCH OF 3 KC 5 KW MOTOR GENERATOR TO CHINA SYNDROME CHARGE

COIL PERMEABILITY	MUB = 1.000+00	ORIGINAL TUBING O.D.	H = .500 IN.
CHARGE PERMEABILITY	MUA = 1.000+00	CHARGE WALL	T = .060 IN.
COIL RESISTIVITY	RHOB = 1.754-06 OHM CM	CHARGE LENGTH	L = 9.000 IN.
CHARGE RESISTIVITY	RHOA = 7.060-05 OHM CM	CHARGE RADIUS	A = .500 IN.
POWER INTO LOAD	PMS*ETA = 5.000 KW	CHARGE LENGTH/DIAM.	L/2A = 9.000
TUBING WALL THICKNESS	TAU = .032 IN.	WINDING FRACTION	= 1.000

FREQ	EMG	GAP	TUBING	COIL	COIL	CHARGE	LOADED	COIL	GENERATOR	CAPACITOR	ETA	
CPS	VOLTS	IN.	O.D.	TURNS	RESISTANCE	RESISTANCE	REACTANCE	CURRENT	CURRENT	POWER	PERCENT	
			IN.		OHMS	OHMS	OHMS	AMPS	AMPS	KVAR		
3000	220.00	4.000	.500	3.05	1.773-13	7.728-05	2.734-02	8028.51	542.21	1762.2	4.2	6
3000	220.00	4.000	.500	3.34	1.753-13	7.306-05	2.658-02	8256.19	565.85	1812.1	4.0	6
3000	220.00	4.000	.500	3.60	1.760-13	7.073-05	2.616-02	8390.37	585.73	1841.4	3.9	6
3000	220.00	4.000	.500	3.85	1.774-13	6.889-05	2.582-02	8500.19	605.19	1865.3	3.7	6
3000	220.00	3.500	.500	6.36	5.323-13	1.394-13	1.161-01	1892.50	109.34	415.7	20.7	6
3000	220.00	3.500	.500	7.15	5.498-13	1.475-13	1.194-01	1839.52	107.25	404.0	21.1	6
3000	220.00	3.500	.500	7.79	5.591-13	1.477-13	1.195-01	1838.10	108.54	403.7	20.9	6
3000	220.00	3.500	.500	8.36	5.681-13	1.469-13	1.192-01	1842.95	110.38	404.7	20.5	6
3000	220.00	3.000	.500	8.86	8.761-13	5.115-13	2.222-01	988.00	61.57	216.9	36.9	6
3000	220.00	3.000	.500	10.21	9.386-13	5.864-13	2.379-01	922.71	59.01	202.6	38.5	6
3000	220.00	3.000	.500	11.60	1.016-12	6.848-13	2.571-01	853.74	56.36	187.4	40.3	6
3000	220.00	3.000	.500	12.63	1.054-12	7.153-13	2.628-01	835.26	56.10	183.3	40.4	6
3000	220.00	2.500	.500	11.29	1.260-12	1.428-12	3.710-01	591.38	42.73	129.8	53.1	6
3000	220.00	2.500	.500	12.43	1.260-12	1.232-12	3.446-01	636.72	45.91	139.7	49.4	6
3000	220.00	2.500	.500	16.22	1.680-12	2.386-12	4.792-01	457.47	38.66	100.3	58.7	6
3000	220.00	2.500	.500	17.93	1.783-12	2.615-12	5.016-01	436.90	38.15	95.7	59.5	6

SAMPLE OUTPUT: CINCOM P. 2

MATCH OF 3 KC. 5 KW MOTOR GENERATOR TO CHINA SYNDROME CHARGE

COIL PERMEABILITY	MUB =	1.000+00	ORIGINAL TUNING C.O.D.	H =	.500 IN.
CHARGE PERMEABILITY	MUA =	1.000+00	CHARGE WALL	T =	.000 IN.
COIL RESISTIVITY	RHOB =	1.754-06 JHM CM	CHARGE LENGTH	L =	9.000 IN.
CHARGE RESISTIVITY	RHOA =	7.000-05 JHM CM	CHARGE RADIUS	A =	2.500 IN.
POWER INFO LOAD	PMG+ETA =	5.000 KW	CHARGE LENGTH/DIAM.	L/2A =	1.800
TUBING WALL (INPUT)	TAU =	.032 IN.	WINDING FRACTION	=	1.000

FREQ	EMG	GAP	TUBING	COIL	COIL	CHARGE	LOADED	COIL	GENERATOR	CAPACITOR	ETA	
CPS	VOLTS	IN.	IN.	TURNS	RESISTANCE	RESISTANCE	REACTANCE	CURRENT	CURRENT	POWER	PERCENT	
					OHMS	OHMS	OHMS	AMPS	AMPS	KVAR		
3000	220.00	2.000	.500	17.16	2.362-02	7.933-02	3.703-01	251.03	29.49	54.8	77.1	9
3000	220.00	2.000	.500	12.72	1.304-02	1.467-02	3.760-01	583.46	42.88	128.0	52.9	10
3000	220.00	2.000	.500	16.96	1.797-02	2.800-02	5.190-01	422.27	37.26	92.5	60.9	11
3000	220.00	2.000	.500	19.74	2.059-02	3.656-02	5.926-01	369.52	35.47	80.9	64.0	12
3000	220.00	1.500	.500	CONVERGING WITH H = 1.897+01 GREATER THAN HMAX = 1.800+01							30.9	12
3000	220.00	1.500	.500	21.88	2.943-02	1.401-01	1.152+00	188.90	27.49	41.1	82.6	6
3000	220.00	1.500	.500	15.09	1.567-02	1.929-02	4.311-01	508.72	40.42	111.6	56.1	12
3000	220.00	1.500	.500	22.43	2.495-02	5.724-02	7.404-01	295.34	32.58	64.6	69.6	6
3000	220.00	1.000	.500	CONVERGING WITH H = 2.034+01 GREATER THAN HMAX = 1.800+01							33.0	12
3000	220.00	1.000	.500	23.62	3.301-02	1.915-01	1.343+00	161.59	26.64	35.1	85.3	7
3000	220.00	1.000	.500	24.66	3.150-02	1.493-01	1.189+00	182.95	27.50	39.8	82.6	12
3000	220.00	1.000	.500	21.58	2.355-02	5.297-02	7.125-01	307.00	32.78	67.2	69.2	6
3000	220.00	.500	.500	CONVERGING WITH H = 2.183+01 GREATER THAN HMAX = 1.800+01							85.0	12
3000	220.00	.500	.500	CONVERGING WITH H = 2.479+01 GREATER THAN HMAX = 2.400+01							86.6	7
3000	220.00	.500	.500	29.28	4.076-02	3.272-01	1.741+00	123.61	25.56	26.6	98.9	12
3000	220.00	.500	.500	30.52	3.959-02	2.271-01	1.459+00	148.33	26.67	32.1	85.2	6

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 06165 OF MAIN PROGRAM

CSCX RL6838 14 FEB 74 14: 3:10 USER CUB928 PUN005

CARDS III 53 OUT 760 LINES 1398 PROCESSING TIME 36.88 SECONDS

LISTING AND SUBROUTINE COMPILATION: CINCOM P. 1

```

DS RUN FLNCOM, CUP925, 150, FUDH/1000 C JANSEN 3760 BLOC 9423576
3 ELT CINCOM/SIF5.1.701124. 60591
2 OF 2
C INPUT DATA INFORMATION FOR CINCOM
C
C FORMATS FOR DATA CARDS:
C CARDS A,AF FORMAT(11X15)
C CARD B FORMAT(11X16)
C CARDS F,G FORMAT(13X10,3,F10.4)
C CARDS N FORMAT(11X15)
C CARDS C,D,DF,E,H,I,J,K,L,M FORMAT(10X10,1)
C
C CARD A IS A CONTROL CARD. MODE, KWHICH, KCAF, LINFAS, KTUBE
C MODE = 0: CASES ARE ALL DONE (SIGNIFIED BY BLANK CARD AFTER LAST
C DATA CARD OF LAST EXECUTED CASE.)
C MODE = 1: CONVERGENCE WILL TAKE PLACE BY ALLOWING TUNING C.D.
C TO VARY.
C MODE = 2: CONVERGENCE WILL BE TRIED WITH SPECIFIED C.D.
C MODE = 3: CALCULATE POWER DIRECTLY FROM GIVEN NUMBER OF TURNS
C KWHICH = 0: CELDIA VALUES ON L-CARDS ARE LENGTH-TO-DIAMETER RATIOS
C KWHICH = 1: CELDIA VALUES ON L-CARDS ARE CHARGE LENGTHS
C KCAF = 0: CGAFK VALUES ON N-CARDS ARE TRULY GAPS
C KCAF = 1: CGAFK VALUES ON N-CARDS ARE COIL INNER RADIUS
C LINFAS LIMIT ON NUMBER OF ITERATIONS WHEN MODE=1. VALUE
C OF 20 ASSUMED IF NOT SPECIFIED.
C KTUBE = 0: COIL TUNING IS CIRCULAR
C KTUBE = 1: COIL TUNING IS SQUARE, AND CHK VALUES ON E-CARDS
C REPRESENT DIMENSION OF SIDE, RATHER THAN C.D.
C
C CARD AF IS A CONTROL CARD. NTK, NTAUK, NRM, NRMOA, NRMOB, NRMG,
C NFMG, NAK, NELDIA, NGAFA, NICEP
C
C FIELD
C 1 NTK = NUMBER OF VALUES OF CTK ON D-CARDS MAXIMUM=100
C WHEN NTK IS POSITIVE, LOAD IS CHARGE WALL (HOLLOW CHARGE)
C WHEN NTK=0, LOAD IS A SOLID CHARGE AND THERE MUST BE
C NO D-CARD.
C 2 NTAUK NUMBER OF VALUES OF CTAUK ON DF-CARDS MAXIMUM=100
C IF NTAUK=0, THERE MUST BE NO DF-CARD AND THE OPTIMUM WALL
C THICKNESS IS USED, UP TO RADIUS.
C 3 NRM = NUMBER OF VALUES OF CRM ON E-CARDS MAXIMUM=100
C NRMOA = NUMBER OF VALUES OF CRMOA ON F-CARDS MAXIMUM=50
C NRMOB = NUMBER OF VALUES OF CRMOB ON G-CARDS MAXIMUM=50
C NRMG = NUMBER OF VALUES OF CPMG ON H-CARDS MAXIMUM=100
C NFMG = NUMBER OF VALUES OF CPMG ON I-CARDS MAXIMUM=100
C NF = NUMBER OF VALUES OF CF ON J-CARDS MAXIMUM=100
C NAK = NUMBER OF VALUES OF CAX ON K-CARDS MAXIMUM=100
C NELDIA = NUMBER OF VALUES OF CELDIA ON L-CARDS MAXIMUM=100
C NGAFA = NUMBER OF VALUES OF CGAFK ON N-CARDS MAXIMUM=100
C NICEP = COIL CONNECTIONS AND NO N-LOAD CAN BE SUPPLIED.
C = POSITIVE INTEGER NO. OF PAIRS OF LLD AND LAK ON N-CARDS.
C MAX=50
C
C CARD B
C 72 COLUMNS OF DESCRIPTION B-CARD REQUIRED EVEN IF ALL BLANK
C
C CARD C
C FIELD 1 DELFPG CONVERGENCE CRITERION, EXPRESSED AS
C A FRACTION TO COMPARE TO
C 1 FINT-KYA-FMO-ETA1/FMO-ETA
C DELFPG MUST BE ENTERED AS A POSITIVE QUANTITY.
C OTHERWISE, A VALUE OF 0.005 IS ASSUMED
C
C FIELD 2 FPAC COIL/CHARGE LENGTH WHEN MODE=1
C ASSUMES A VALUE = 0.9 IF BLANK
C ASSUMES A VALUE = 1.0 IF MODE=2
C C-CARD (THOUGH BLANK) STILL REQUIRED FOR MODE=2
C
C CARD D CTK VALUES OF CHARGE WALL THICKNESS INCHES 7 PER CARD
C
C CARD DF CTAUK VALUES OF COIL TUNING THICKNESS INCHES 7 PER CARD
C
C CARD E CHK VALUES OF COIL TUNING C.D. INCHES 7 PER CARD
C IF MODE=1, THESE WILL BE STARTING VALUES IF
C SPECIFIED, OR WHEN NOT SPECIFIED,
C STARTING VALUE = 0.5 IS ASSUMED.
C
C CARD F PAIRS OF VALUES OF 3 PAIRS PER CARD
C CRMOA CHARGE RESISTIVITY OHM CM
C CAPU CHARGE PERMEABILITY
C
C CARD G PAIRS OF VALUES OF 3 PAIRS PER CARD
C CRMOB COIL RESISTIVITY OHM CM
C CBPU COIL PERMEABILITY
C
C CARD H CPMG VALUES OF GENERATOR OUTPUT VOLTAGE VOLTS 7 PER CARD
C CARD I CPMG VALUES OF GENERATOR POWER * ETA KW 7 PER CARD
C = POWER INTO LOAD
C WHERE ETA = EFFICIENCY OF INDUCT. HEATING.
C IF MODE = 1 OR 2
C CPMG VALUES OF NUMBER OF TURNS, IF MODE = 1
C
C CARD J CF VALUES OF GENERATOR FREQUENCY CYCLES/SEC 7 PER CARD
C
C CARD K CAX VALUES OF CHARGE OUTER RADIUS INCHES 7 PER CARD
C
C CARD L CELDIA LENGTH-TO-DIAMETER IF KWHICH=0 7 PER CARD
C CHARGE LENGTH IF KWHICH=1 INCHES 7 PER CARD
C CARD M CGAFK VALUES OF AIR GAP IF KCAF=0 INCHES 7 PER CARD
C VALUES OF COIL I.P. IF KCAF=1

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LISTING AND SUBROUTINE COMPILATION: CINCOM P. 3

```

74 FORMAT (1, RNDNTAUK =:11.54M  OPTIMUM COIL TUBING WALL THICKNESS IS
1 USED UP TO FACTOR.999.1M 74)
80 FORMAT (1, RNDNTAUK =:11.54M  COIL WALL THICKNESS IS SPECIFIED.
111X.1M 80)
82 FORMAT (1, RNDKWHICH =:12.42M  LENGTH-TO-DIAMETER RATIOS ARE OF
1VEN.14X.1M 82)
84 FORMAT (1, RNDKWHICH =:12.42M  VALUES OF CHARGE LENGTH ARE OF
1VEN.14X.1M 84)
86 FORMAT (1, 7HNGAF =:12.24M  GAP VALUES ARE GIVEN.999.1M 86)
88 FORMAT (1, 7HNGAF =:12.24M  VALUES OF COIL INNER RADIUS ARE GIVEN
1.67X.1M 88)
90 FORMAT (1, RNDKTUBE =:12.27M  COIL TUBING IS CIRCULAR.11X.1M 90)
91 FORMAT (1, RNDKTUBE =:12.27M  COIL TUBING CROSS-SECTION IS SQUARE
1.67X.1M 91)
95 CONTINUE
READ (ALOG10.16)MOCE,KWHICH,KGAF,LIMFAS,KTUBE
IF(MOCE)100.100.120
100 CALL EXCT
120 WRITE (ALOG11.96)
READ (ALOG10.16)INTAUK,KWK,NFNOA,NFNOB,NENG,NPFS,NF,NAM,NELOTA
1.4GAFK,NXCE
GO TO (1121.1122.1123).MOCE
1200 WRITE (ALOG11.73)MOCE
DATA 000000/6-CHARGE /
HEAD1=000000
DATA 000010/CHARGE /
HEAD2=000010
DATA 000020/64 FCH /
HEAD3=000020
DATA 000030/CHARGE /
HEAD4=000030
DATA 000040/64 KW /
HEAD5=000040
GO TO 1205
1201 WRITE (ALOG11.70)MOCE
GO TO 1203
1202 WRITE (ALOG11.72)MOCE
DATA 000050/64 COIL /
HEAD1=000050
DATA 000060/64 /
HEAD2=000060
DATA 000070/CHARGE /
HEAD3=000070
DATA 000080/64 CHARGE /
HEAD4=000080
DATA 000090/64 CHARGE /
HEAD5=000090
1205 IF(INTK)1206.1206.1207
1206 WRITE (ALOG11.74)INTK
GO TO 1210
1207 WRITE (ALOG11.76)INTK
1210 IF(INTAUK) 1211.1211.1212
1211 WRITE (ALOG11.73)INTAUK
GO TO 1215
1212 WRITE (ALOG11.80)INTAUK
1215 IF(KWHICH)1216.1216.1217
1216 WRITE (ALOG11.82)KWHICH
GO TO 1220
1217 WRITE (ALOG11.84)KWHICH
1220 IF(KGAF)1221.1221.1222
1221 WRITE (ALOG11.86)KGAF
GO TO 1225
1222 WRITE (ALOG11.88)KGAF
1225 CONTINUE
IF(KTUBE)1226.1226.1227
1226 WRITE (ALOG11.90)KTUBE
DATA 000100/64O.D. /
HEAD6=000100
GO TO 1228
1227 WRITE (ALOG11.91)KTUBE
DATA 000110/64HSIDE /
HEAD7=000110
1228 CONTINUE
READ (ALOG10.20)TEYT
READ (ALOG10.22)CELFNO,FPAC
KCEOM=1
IF(INTK)123.123.122
122 KCEOM=1
KCEOM = 1.123 IS CHARGE WALL (HOLLOW)
KCEOM = 2.123 IS SOLID CHARGE
READ (ALOG10.22)(CTM(I),I=1,INTK)
123 CONTINUE
IF(INTAUK)124.124.125
124 CONTINUE
READ (ALOG10.22)(CTAUK(I),I=1,INTAUK)
125 CONTINUE
KJALL=INTAUK
READ (ALOG10.22)(CCK(I),I=1,NKF)
READ (ALOG10.24)(CPHKA(I),I=1,NRMTA)
READ (ALOG10.24)(CPHKB(I),I=1,NRMSB)
READ (ALOG10.22)(CCK(I),I=1,NKF)
READ (ALOG10.24)(CPHKA(I),I=1,NRMTA)
READ (ALOG10.22)(CCK(I),I=1,NKF)
READ (ALOG10.24)(CPHKB(I),I=1,NRMSB)
READ (ALOG10.22)(CCK(I),I=1,NKF)
READ (ALOG10.24)(CPHKA(I),I=1,NRMTA)
READ (ALOG10.22)(CCK(I),I=1,NKF)
READ (ALOG10.24)(CPHKB(I),I=1,NRMSB)
IF(NKF)140.140.145
145 READ (ALOG10.26)(LLD(I),I=1,NCLP)
140 IF(LIMFAS)142.142.143
142 LIMFAS=1
143 IF(CELFNO)144.144.147
144 CELFNO=1
145 CELFNO=1

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LISTING AND SUBROUTINE COMPILATION: CINCOM P. 4

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147 IF (FAC=157.157.158
148 FAC=0.9
149 GO TO (151.154.155).MODE
150 FAC=1.
161 CONTINUE
NEG=NEG*(NCAF+1)
NF=37/NEG
DO 500 J1=1,NFMA
RHOA=CRHOA(J1)
AMU=CAMU(J1)
DO 500 J2=1,NFMO
RHOB=CRHOB(J2)
BMU=CBMU(J2)
DO 500 J3=1,NFK
TK=CTK(J3)
DO 500 J4=1,NTAK
TAUK=CTAK(J4)
DO 500 J5=1,NHK
HK=CHK(J5)
IF (HK) 155.155.156
155 HK=0.5
156 CONTINUE
DO 500 J2=1,NAK
AK=CAK(J2)
DO 500 J3=1,NFMS
FMS=CFMS(J3)
DO 500 J4=1,NELDIA
IF (NWHICH) 167.160.170
160 ELDIAM=CELDIA(J4)
ELK=Z.AK*ELDIAM
GO TO 130
170 ELK=CELDIA(J4)
ELDIAM=ELK/Z.AK
180 IF (NICEF) 230.230.190
190 DO 210 LL=1,NICEF
IF (LLOILL)-J3) 210.200.210
200 IF (LAKILL)-J3) 210.500.210
210 CONTINUE
230 CONTINUE
238 DO 470 J5=1,NF
F=CF(J5)
MF=.01
KOUNT=KOUNT+1
IF (KOUNT-1) 239.239.240
239 CONTINUE
WRITE (ALOG11,30)TEXT
WRITE (ALOG11,32)8*U,HEAD6,HK,AMU,TK,RHOB,ELK,RHOA,AK,ELDIAM
GO TO (239C,239C,239I).MODE
2390 WRITE (ALOG11,3200)FMS
GO TO 4394
2391 ZN=FMG
FAC=EN*HK/ELK
2392 CONTINUE
WRITE (ALOG11,33)FAC
IF (NTAK) 2394.2394.2393
2393 WRITE (ALOG11,3300)TAUK
2394 CONTINUE
WRITE (ALOG11,36)
WRITE (ALOG11,36)
WRITE (ALOG11,36)HEAD1,HEAD2,HEAD6,HEAD3,HEAD4,HEAD5
240 IF (KOUNT-MF) 242.241.241
241 KOUNT=0
242 CONTINUE
DO 470 J6=1,NEMS
ENG=CEMG(J6)
WRITE (ALOG11,36)
DO 470 J7=1,NCAFK
GAPK=CGAPK(J7)
IF (KCAP) 246.246.245
245 GAPK=KAPK*AK
246 CONTINUE
CALL GJJI
248 KPESUL=KRESUL
GO TO (260.250.255.252.270).KPESUL
250 WRITE (ALOG11,40)M,ENG,GAPK,HKF,EN,ENMAX,ETA
GO TO 400
252 WRITE (ALOG11,50)M,ENG,GAPK,HKF,LIMPAS,P2NG,ETA
GO TO 400
255 WRITE (ALOG11,42)M,ENG,GAPK,HKF,EN,ENMAX
260 WRITE (ALOG11,44)M,ENG,GAPK,HKF,EN,RS,RA,XL,CURRL,CURRWG,CC,ETA
GO TO 400
270 WRITE (ALOG11,44)M,ENG,GAPK,HKF,EN,FING,RA,XL,CURRL,CURRWG,CC,ETA
270 CONTINUE
470 CONTINUE
500 CONTINUE
60 TO 95
END

```

LISTING AND SUBROUTINE COMPILATION: CINCOM P. 5

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A 11 C 0011/2F*+1.70112N* 1F000
A C0F A
C0J11 SUPPLEMENT 0011-00117-CALES TURNS FOR INDUCTION HEATING COIL C0J
SUBROUTINE 0011
FAPAPLEIF NAYE11N, NYLAF11, NYDLF11
COMMON ENG , ENG , F , RMOD , GNU , RM2A
COMMON AMU , HK , TAUH , AK , ELCLAM , CAPK
COMMON IA , ENH , Q1 , RA , XL , CUGRL
COMMON CURRPC , ETA , GC , KWALL , KCEOM , KRESUL
COMMON DELFMC , ENMAX , ELK , F3 , PA , HPR1
COMMON EM , SP , FL , ZL , FIMP , CUPRC
COMMON AMDA , AMDA1 , DELTA , CAYR , CAYX , FR
COMMON THEIA , YP , YX , MODL , FRAC , LIPPAS
COMMON HAF , F3MG , KTUSE
COMMON/CELK/ , TKXCL(NKX),TKX(NKX),TCAP(NYCAP),
1TOL(NYOL),TYR(NYCAR,NYOL),TYX(NYGF,NYOL)
COMMON ENG,FMC,F3MG,EMU,FHSA,AMU,HK,TAUH,AK,ELCLAM,CAPK,TK,EN,
C 1R3,SA,XL,CUGRL,CURRPC,ETA,GC,KWALL,KSTGN,KRESUL,DELPM,ENMAX,ELCUG
C 1CAYX,FP,THETA,EN,YP,TK,F3MG,CUFAC,AMDA,AMDA1,DELTA,CAYR,
C 1CAYX,FP,THETA,EN,YP,TK,F3MG,CUFAC,AMDA,AMDA1,DELTA,CAYR,
C 1COMMON NKX,NYCAP,NYOL,TK,NYOL,TKX,TCAP,TOL,TYR,TYX,KTUSE
C 1DIMENSION TKXCL(500),TKX(500),TCAF(20),TOL(20),TYR(20,20),TYX(20,
C 120)
C 1S2HAI70C0FL1=100CFL*(.997333979+700CFL**2+1.166667359+700CFL**2+160J
C 1.87258312E-07* 700CFL**3+2.0225531E-07)))
C 1A0VE COEFFICIENTS FROM CHEBYCHEV ECONIMIZATION BY P.A. EKSTROM
C 1M =2.54*HK
C 1A2=2.54*AK
C 1GAF=2.54*GAFH
C 1T=2.54*TK
C 1EL=2.54*ELK
C 1TAUH=2.54*TAUH
C 1COIL CALCULATIONS
C 1F9=3560.*SQRT((403/B**2)/F)
C 1TAUZ=2.22*F9
C 1NFAS=0
C 1GO TO (54,60,6C),MODE
C 150 ENGFPAC=EL/4
C 160 CONTINUE
C 1B=A*GAF
C 1BFRI=B*F9/1.*112
C 1COILD=2.*BFRI/EL
C 1CALL SINT(TKXCL,TKX,NXX,COILD,CAYX)
C 1CHARGE CALCULATIONS
C 1FA=3560.*SQRT((404/AMU/F)
C 1RAT3A=B/A
C 1RAT9A=B*F9/A
C 1DELTA=A/FA
C 1AMDA=1.*112*7/FA
C 1IF(DELTA-10.)AC.80.85
C 1CALL DELTA=1.1A*ENH*1.1*ENH*DELTA
C 1GO TO 95
C 185 IF(DELTA-50.)AC.90.107
C 190 CALL BERZ(DELTA,BEY,BEY*BERF*2EIF)
C 195 DENCM=BEF**2+2EIF**2
C 1F9=(9ER*BERF*BEY*BEY)/DENCM
C 1THEIA=(BER*BEY-BEY*BERF)/DENCM
C 1GO TO 110
C 107 FP=0.7071
C 1THEIA=0.7071
C 110 CHARCL=1./ELCLAM
C 1KOUT=1
C 1IF(RAT9A -1.111102*111*112
C 1102 KOUT=2
C 111 RUT9A =1.1
C 1GO TO 9114
C 112 IF(RAT9A -3.C1113*113*114
C 112 RUT9A =79AT9A
C 1GO TO 9114
C 114 RUT9A =3.0
C 114 CALL LINTYCAF,TCL,TYR,TYX,NYCAF,NYOL,RUT9A ,CHARCL ,YP,YX)
C 1GO TO (1196,1115),KOUT
C 115 YP=(1.*YP)/2.
C 1YX=(1.*YX)/2.
C 116 CONTINUE
C 1GO TO (115,120),KCEOM
C 115 FK=2.*7/IA-7/AMDA
C 1FK1=7.*(FK**2)
C 1EXARDA=EXF(AMDA)
C 1IF(AMDA-1.1115*116*117
C 116 HGINAHGINAH(AMDA)
C 1GO TO 117
C 117 HGINAH=0.*EXAH*7A-1./FXAHDA)
C 118 HCO3A=0.*EXAH*DA-1./THAMDA)
C 1SNA=CSINA(AMDA)
C 1CSA=CSINA(AMDA)
C 1EN=(HGINAH*SNA)*FK1+(HSTHA-SNA)*2.*FK*(HCO3A-CSA)/
C 1(HCO3A-SNA)*FK1+(HCO3A-CSA)*2.*FK*(HGINAH-SNA)
C 1CONPA=1.*112*2.1916*DA*DELTA*EM*YP/EL
C 1GO TO 120
C 120 CONPA=6.7812*EM*7A*DELTA*FP*YP/EL
C 1SETUP THE REMAINING CONSTANTS FOR THE TURN LOOP
C 122 C2=8.*31.006*F/EL*(BFPI**2+CAYX-A**2*YX1/1.019
C 1C3=THEIA/FR*YXYP
C 1THIS IS THE COMPILED ENH LOOP FOR MODE 1

```

CINCOM P. 6

27

○ ○

789
889
989
PER
PER

LT BCP2/SIF 5.1.7C11:4. 6199
OF 3

ELT DINT/EIFS.1.7C1124. 5C59T
E0F 2

ELT SINT/SIF 5.1.701120. EC59
EAF 3.

LISTING AND SUBROUTINE COMPILATION: CINCOM P. 8

```

1 NLARGE=NX
  NSMALL=1
10 N=(NSMALL+NLARGE)/2
  IF (ARG-X(N))140,20,70
20 VAL=Y(N)
  GO TO 80
30 IF (ARG-X(N+1))34,32,36
32 VAL=Y(N+1)
  GO TO 80
34 NV=N
  GO TO 70
36 NSMALL=N
  GO TO 10
40 IF (ARG-X(N-1))46,42,44
42 VAL=Y(N-1)
  GO TO 80
44 NV=N-1
  GO TO 70
46 NLARGE=N
  GO TO 10
70 VAL=Y(NV)+(Y(NV+1)-Y(NV))*(ARG-X(NV))/(X(NV+1)-X(NV))
80 RETURN
  END

```

```

2 ELT CLK/SIFS,1,70,1129, F0600
3 EOF 2

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```

      BLOCK DATA
C BLOCK DATA FOR INPUT ON CINCOM INDUCTION HEATING PROGRAM
C INPUT OF NKX,NYGAF,NYDL,TKYDL,TKX,TGAF,TCL,TYP,TYX
  PARAMETER NKX=114, NYGAF=11, NYDL=10
  COMMON/CBLK/ TKXDL(NKX),TKX(NKX),TGAF(NYGAF),
  1TCL(NYDL),TYP(NYGAF,NYDL),TYX(NYGAF,NYDL)
  DATA NKX/114/,NYGAF/11/,NYDL/10/
  DATA (TKXDL(I),I=1,NKX)/
  2.00, .05, .10, .15, .20, .25, .30, .35, .40, .45, .50, .55, .60,
  3.65, .70, .75, .80, .85, .90, .95, 1.00, 1.05, 1.10, 1.15, 1.20,
  41.25, 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60, 1.65, 1.70, 1.75,
  51.80, 1.85, 1.90, 1.95, 2.00, 2.10, 2.20, 2.30, 2.40, 2.50, 2.60,
  62.70, 2.80, 2.90, 3.00, 3.10, 3.20, 3.30, 3.40, 3.50, 3.6, 3.7,
  7 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0,
  8 5.2, 5.4, 5.6, 5.8, 6.0, 6.2, 6.4, 6.6, 6.8, 7.0, 7.2, 7.4, 7.6,
  9 7.8, 8.0, 8.5, 9.0, 9.5, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0,
  1 18.0, 19.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0,
  1 70.0, 80.0, 90.0, 100.0/
  DATA (TKX(I), I=1,NKX)/
  11.0, .9791, .9588, .9391, .9201, .9016, .8834, .8655, .8499, .8337, .8181,
  2.8031, .7885, .7745, .7600, .7478, .7351, .7228, .7110, .6995, .6884, .6777,
  3.6673, .6573, .6475, .6381, .6290, .6201, .6115, .6031, .5950, .5871, .5795,
  4.5721, .5649, .5579, .5511, .5444, .5379, .5316, .5255, .5197, .5137, .5075, .4913,
  5.4816, .4719, .4626, .4537, .4452, .4370, .4292, .4217, .4145, .4075, .4003,
  6.3944, .3882, .3822, .3764, .3708, .3654, .3602, .3551, .3502, .3455, .3409,
  7.3369, .3321, .3279, .3238, .3198, .3122, .3050, .2991, .2935, .2884, .2835,
  8.2739, .2685, .2632, .2584, .2537, .2491, .2448, .2406, .2366, .2322, .2285,
  9.2105, .2033, .1903, .1790, .1692, .1605, .1527, .1457, .1394, .1335, .1284,
  1.1236, .1151, .1078, .1015, .0959, .0910, .0862, .0823, .0783, .0744, .0705,
  1.0467, .0419, .0391, .0350/
  DATA (TGAF(I), I=1,NYGAF)/
  11.1, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6, 2.8, 3.0/
  DATA (TCL(I), I=1,NYDL)/1.0, 1.2, 1.5, 1.8, 2.2, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0/
  DATA (TYP(I,J), J=1,NYDL, I=1,NYGAF)/
  11.0, .955, .905, .87, .82, .81, .775, .75, .72, .70, 1.0, .95, .895,
  2.85, .805, .775, .73, .64, .65, .54, 1.0, .91, .86, .82, .775, .73,
  3.675, .62, .52, .41, 1.0, .92, .845, .80, .74, .70, .64, .57, .46,
  4.5, 1.0, .915, .81, .785, .72, .68, .61, .545, .43, .305, 1.0, .91,
  5.425, .775, .70, .66, .60, .53, .40, .28, 1.0, .90, .815, .77, .60,
  6.55, .59, .52, .39, .26, 1.0, .90, .81, .75, .635, .64, .58, .51,
  7.38, .25, 1.0, .90, .81, .775, .68, .63, .575, .50, .375, .24, 1.0,
  8.90, .81, .75, .68, .63, .57, .50, .375, .27, 1.0, .90, .81, .75,
  9.68, .625, .57, .495, .375, .23/
  DATA (TYX(I,J), J=1,NYDL, I=1,NYGAF)/
  11.0, .915, .87, .79, .73, .685, .63, .57, .51, .35, 1.0, .905, .82,
  2.77, .70, .65, .60, .53, .45, .39, 1.0, .815, .795, .74, .67, .63,
  3.56, .47, .37, .27, 1.0, .885, .78, .72, .64, .60, .53, .44, .32,
  4.77, 1.0, .885, .775, .705, .62, .58, .50, .42, .29, .15, 1.0, .875,
  5.170, .70, .61, .56, .48, .40, .275, .135, 1.0, .870, .76, .695,
  6.50, .55, .47, .395, .27, .13, 1.0, .870, .75, .69, .695, .54,
  7.465, .39, .26, .125, 1.0, .885, .74, .685, .59, .535, .46, .385,
  8.245, .125, 1.0, .855, .715, .58, .53, .57, .45, .385, .250, .12,
  91.0, .855, .73, .68, .585, .525, .45, .385, .250, .12/
  END

```

6614C274 CV892AFUNCUS 100 3688 53 760 138214 310 1 00000

6 5

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PROGRAM NAME: DIBUW

Descriptive Title: Direct Buried Waste Heat Transfer

Program Author: Niccoli, Lino G.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Radioactive Wastes, Geothermal

Program Description: Estimates the transient temperatures in arrays of direct buried long cylindrical heat sources. Cylinders are simulated by long line sources that may be dissimilar in any orientation with respect to each other or with respect to grade. Each cylinder may contain up to ten exponentially decaying heat generators. Solution is by dimensionless table lookup followed by superposition. Five subroutines.

Calculates maximum temperatures achieved from buried wastes in a series of tunnels in basalt or salt caverns. DIBUW uses generalized correlation in tabular form from the TALUS program. Specific numerical results are produced that show the effects of line sources containing mixtures of fission products with varying half-lives, finite numbers of adjacent tunnels with arbitrary spacings and filling times, and the nearness of the ground surface upon the maximum temperature achieved in the caverns.

Input Description - Suitable for teletype

Input is formatted, and more than one case per run is allowed. The following data is required once per case: KS = thermal conducting of the

medium (Btu/(hr)(ft²)(°F/ft), α (ALFA) = thermal diffusivity of medium (ft²/hr), X_0 = coordinates of observation point. For each case, as many as 22 "source packets" are allowed (as long as no more than 22 "B" cards are needed. See below.). Each represents a group of 1 to 10 isotopes at a source. Source packets may be specified in any order.

Arrangements of data input on cards: Each case requires an "A" card (card or teletype line) followed by 1 to 22 "B" cards. The "A" card format is 4F15.8 and contains KS, α , X_0 . The B card format is (10X,5E10.4) (i.e., skip first 10 positions). Each source requires at least one card and must begin on a new card. The first field for a source is X-AXIS position of source (ft). The second field is Y axis position of source (ft). The third field is the heat generation rate (Btu/hr-ft len) for the first isotope. The fourth field is the decay constant for the first isotope (hr⁻¹). If there are further isotopes for this source, the next field and more cards are used to specify heat generation rate and decay constant for each. End of a source is indicated by a blank or zero field. End of a case is indicated by "END" in columns 1-3 of the last card. Each source may be introduced into the system at a time relative to zero. If non-zero start times are desired, a START card is used immediately preceding the other "B" cards for the source. Format is "START" in cols. 1-5 and the start time (in hrs) in E10.4 format starting in column 11.

Output Description - Not Well Suited for Teletype

Output Contains:

- (1) Recap of input data
- (2) Dimensionless quantities calculated for use in table look-up.

DIFUS = $\lambda \cdot r^2 / \alpha$	(r = distance from source to point)
QISO = q/KS	λ = decay constant
AOVRAD = α / r^2	q = heat generation rate)
DTMAX = max. temp. rise expected	
- (3) The temperature rises (DELTA TEMP) for selected times (computed by the program), printed in hours and years. This data is first printed as if the sole contribution was due to the single source giving the largest contribution. It is reprinted, repeatedly adding in the effects to the next most important source. The last data printed will be the total temperature rises as a function of time.

Users of Program:

G Jansen
LG Niccoli (JCGS)
WV DeMier
JR Nance

Documentation:

Results reported in letter from G. Jansen to A. L. Boldt, ARHCO, "A Parametric Study of Temperature Rises in Horizontal Buried Long Pipes Containing Decaying Heat Generators," April 12, 1972. Letter from G. Jansen to G. L. Ritter, ARHCO, "Burial of Radioactive Wastes in Salt," April 7, 1970, and letter from G. Jansen to G. L. Ritter, ARHCO, "Transient Heat Transfer Correlations," February 18, 1970.

Condition of Program:

It has been used extensively, although the feature of nonsimultaneous burial times has not been used since it was incorporated in the program. With many heat sources present, single point singularities sometimes appear in the thermal history diagrams. These are obvious and are disregarded because they give temperatures in billions of degrees. The difficulty has been traced to interpolation problems at the edge of the table during table lookup. The dimensionless table should be expanded to include the affect of finite length of heat source.

SAMPLE INPUT: DIBUW

DIBUW 10:10 02/18/74

100 NS RUN PUN015,CUR928,GEORGE,150,6000/3000 G JANSEN 3760 BLD

G 9423576

105 ON MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFC00

115 @PRL TEL INFC00

120 @PRL TEL CURS28

125 @X ASG A=10918

130 @X XQT CUR

150 FIND A,TB2DIM/SI

160 TRD A

170 FIND A,DELTAT/SIFS

180 TRD A

190 FIND A,TTABL/SIFS

200 TRD A

210 FIND A,TABINT/SIFS

220 TRD A

330 FIND A,DIBUW/SIFS

340 TRD A

342 FIND A,TEEPEE/SIFS

344 TRD A

350 TRI A

352 PCH DIBUW/SIFS

353 PCH TB2DIM/SI

354 PCH DELTAT/SIFS

355 PCH TABINT/SIFS

356 PCH TTABL/SIFS

357 PCH TEEPEE/SIFS

360 @IM FR5,* DIBUW/SIFS,DIBUW/SIFS,DIBUW/RIFS

370 @IM FR5,* TB2DIM/SI,TB2DIM/SIFS,TB2DIM/RIFS

380 @IM FR5,* DELTAT/SIFS,DELTAT/SIFS,DELTAT/RIFS

390 @IM FR5,* TABINT/SIFS,TABINT/SIFS,TABINT/RIFS

400 @IM FR5,* TTABL/SIFS,TTABL/SIFS,TTABL/RIFS

410 @IM FR5,* TEEPEE/SIFS,TEEPEE/SIFS,TEEPEE/RIFS

1000 ON XQT DIBUW/RIFS

1010	.30	.008333	1.5	0.0
1020	-100.	0.	853.	.2637E-05
1030	.1015E-03	1000.	.4428E-03	853.
1040	-80.	0.	853.	.2637E-05
1050	.1015E-03	1000.	.4428E-03	853.
1060	-60.	0.	853.	.2637E-05
1070	.1015E-03	1000.	.4428E-03	853.
1080	-40.	0.	853.	.2637E-05
1090	.1015E-03	1000.	.4428E-03	853.
1100	-20.	0.	853.	.2637E-05
1110	.1015E-03	1000.	.4428E-03	853.
1120	0.	0.	853.	.2637E-05
1130	.1015E-03	1000.	.4428E-03	853.
1140	20.	0.	853.	.2637E-05
1150	.1015E-03	1000.	.4428E-03	853.
1160	40.	0.	853.	.2637E-05
1170	.1015E-03	1000.	.4428E-03	853.
1180	60.	0.	853.	.2637E-05
1190	.1015E-03	1000.	.4428E-03	853.
1200	80.	0.	853.	.2637E-05
1210	.1015E-03	1000.	.4428E-03	853.
1220	100.	0.	853.	.2637E-05
1230	.1015E-03	1000.	.4428E-03	853.
1240	-100.	28.	-853.	.2637E-05
1250	.1015E-03	1000.	.4428E-03	-853.
1260	-80.	28.	-853.	.2637E-05
1270	.1015E-03	1000.	.4428E-03	-853.
1280	-60.	28.	-853.	.2637E-05
1290	.1015E-03	1000.	.4428E-03	-853.
1300	-40.	28.	-853.	.2637E-05
1310	.1015E-03	1000.	.4428E-03	-853.
1320	-20.	28.	-853.	.2637E-05
1330	.1015E-03	1000.	.4428E-03	-853.
1340	0.	28.	-853.	.2637E-05
1350	.1015E-03	1000.	.4428E-03	-853.
1360	20.	28.	-853.	.2637E-05
1370	.1015E-03	1000.	.4428E-03	-853.
1380	40.	28.	-853.	.2637E-05
1390	.1015E-03	1000.	.4428E-03	-853.
1400	60.	28.	-853.	.2637E-05
1410	.1015E-03	1000.	.4428E-03	-853.
1420	80.	28.	-853.	.2637E-05
1430	.1015E-03	1000.	.4428E-03	-853.
1440	100.	28.	-853.	.2637E-05
1450	.1015E-03	1000.	.4428E-03	-853.

1460 END

1470 * FIN

READY

SAMPLE OUTPUT: DIBUW P. 1

ON XGT DIBUW/RTS

DRUM LENGTH 014064

THIS ALLOCATION WAS DONE ON 15 FEB 79 AT 09:25:33

RECAP OF INPUT DATA

.30000000	.00000000	1.50000000	.00000000
-.1000+03	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.3000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.6000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.4000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.2000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.0000	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.2000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.4000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.6000+02	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.1000+03	.0000	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.1000+03	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.6000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.6000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.4000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.2000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
-.2000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.4000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.6000+02	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000
.1000+03	.2000+02	.0530+03	.2037-05
.1015-03	.1000+04	.4420-03	-.0000

CALCULATED DIMENSIONLESS QUANTITIES

DIFUS

3.26017	2.10196	1.19696	.54501	.14028	.00071	.10331	.46906	1.08298	1.95006
3.07030	3.50827	2.35006	1.44500	.79311	.39438	.24381	.35640	.71716	1.33108
2.19016	3.31840	.00000	125.48642	89.90584	46.05555	20.97784	5.63043	.02741	4.16877
.8.75453	41.68457	75.05921	116.17613	135.03592	30.45534	55.61915	30.52735	15.17993	9.57591
13.71827	27.60403	51.23417	84.66871	127.72763	.00000	547.44225	352.95672	200.90168	91.51714
24.56319	.11956	16.18652	72.76399	161.35195	327.45042	515.55938	589.10254	394.61701	242.64196
133.17743	66.22339	41.77985	59.84681	120.42427	223.51223	369.11076	557.21965	.00000	

QISO

2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333
2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333
2843.333	2843.333	.000	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333
2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333	2843.333
2843.333	2843.333	2843.333	2843.333	2843.333	.000	3333.333	3333.333	3333.333	3333.333
3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	3333.333
3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	3333.333	.000	

ANVIRAO

.80845-06	.12545-05	.22032-05	.46784-05	.18027-04	.37036-02	.24348-04	.56219-05	.24349-05	.13523-05
.85097-06	.75155-06	.11221-05	.18249-05	.33249-05	.66635-05	.10598-04	.73989-05	.36770-05	.19811-05
.11996-05	.79436-06	.00000	.12695+04	.68713+06	.60000				

UTMAX

.63528+03	.54673+03	.42309+03	.23151+03	.13792+03	.22616+04	.23096+03	.19247+03	.39995+03	.50091+03
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UTMAX

.62357+03	.12872+03	.17135+03	.22509+03	.29440+03	.37932+03	.43778+03	.39200+03	.30635+03	.23438+03
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UTMAX

.17860+03	.13455+03	.00000							
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SAMPLE OUTPUT: DIBUW P. 2

OUTPUT: TIME (HRS.YRS).TEMPERATURE RISE ABOVE AMBIENT (DEG F)

SOURCE NO	6	TIME: HRS	YRS	DELTA TEMP
		1.2695056+11	.0145	0.0000000
		2.1698030+11	.0247	8.0862553+00
		3.6933349+11	.0422	4.4736250+01
		6.3123640+11	.0720	1.4045072+02
		1.0774022+12	.1229	3.0687065+02
		1.8389235+12	.2098	5.3740463+02
		3.1386975+12	.3581	8.0898535+02
		5.3571679+12	.6111	1.0940179+03
		9.1436810+12	1.0431	1.3558956+03
		1.5636549+13	1.7894	1.5566198+03
		2.6637452+13	3.0387	1.6631569+03
		4.5465135+13	5.1805	1.6554231+03
		7.7633459+13	8.0524	1.5715735+03
		1.3244943+14	15.1094	1.4477190+03
		2.2636634+14	25.7890	1.3616403+03
		3.8535285+14	44.0170	8.2953945+03
		6.5857845+14	75.1237	1.9430040+03
		1.1243699+15	128.2307	1.2254298+03
		1.9183765+15	218.0657	1.0953725+03
		3.2746504+15	373.5627	8.6163885+02
		5.5892140+15	637.6014	5.4901157+02
		9.5397402+15	1089.2600	2.4191203+02
		1.6232547+16	1857.4660	5.0164000+01
		2.7791254+16	3170.3462	3.2865989+01
		4.7434460+16	5411.1803	4.2529426+00
		8.0961726+16	9235.8802	6.7563332+00
		1.3818648+17	15763.9150	4.7772197+00
		2.3535841+17	26936.0430	0.0000000
		4.0256608+17	45923.5770	0.0000000
		6.8710479+17	78382.9320	0.0000000
SOURCE NO	1	TIME: HRS	YRS	DELTA TEMP
		1.2695056+11	.0145	0.0000000
		2.1698030+11	.0247	8.0862553+00
		3.6933349+11	.0422	4.4736250+01
		6.3123640+11	.0720	1.4045072+02
		1.0774022+12	.1229	3.0687065+02
		1.8389235+12	.2098	5.3740463+02
		3.1386975+12	.3581	8.0898535+02
		5.3571679+12	.6111	1.0940179+03
		9.1436810+12	1.0431	1.3558956+03
		1.5636549+13	1.7894	1.5566198+03
		2.6637452+13	3.0387	1.6631569+03
		4.5465135+13	5.1805	1.6554231+03
		7.7633459+13	8.0524	1.5715735+03
		1.3244943+14	15.1094	1.4477190+03
		2.2636634+14	25.7890	1.3616403+03
		3.8535285+14	44.0170	8.2953945+03
		6.5857845+14	75.1237	1.9430040+03
		1.1243699+15	128.2307	1.2254298+03
		1.9183765+15	218.0657	1.0953725+03
		3.2746504+15	373.5627	8.6163885+02
		5.5892140+15	637.6014	5.4901157+02
		9.5397402+15	1089.2600	2.4191203+02
		1.6232547+16	1857.4660	5.0164000+01
		2.7791254+16	3170.3462	3.2865989+01
		4.7434460+16	5411.1803	4.2529426+00
		8.0961726+16	9235.8802	6.7563332+00
		1.3818648+17	15763.9150	4.7772197+00
		2.3535841+17	26936.0430	0.0000000
		4.0256608+17	45923.5770	0.0000000
		6.8710479+17	78382.9320	0.0000000

SAMPLE OUTPUT: DIBUW P. 3

SOURCE NO	11	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0020000
			2.1668060+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4645072+02
			1.0774022+02	.1229	3.0687065+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0828535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.6637452+03	3.0387	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7600459+03	8.8524	1.5715735+03
			1.3244943+04	15.1094	1.4477190+03
			2.2606634+04	25.7890	1.3616403+03
			3.8585265+04	44.0170	8.2953945+03
			6.5857845+04	75.1287	1.9441216+03
			1.1240699+05	128.2307	1.2354335+03
			1.9185765+05	218.0657	1.1730710+03
			3.2745504+05	373.5627	1.0596563+03
			5.5892140+05	637.6014	8.861541+02
			9.5397402+05	1088.2600	6.7045600+02
			1.6282547+06	1857.4600	4.5530229+02
			2.7791254+06	3170.3402	2.9188361+02
			4.7434400+06	5411.1803	1.7865669+02
			8.0961726+06	9235.8892	1.0039284+02
			1.3818648+07	15763.9150	1.2038971+04
			2.3585841+07	26900.0480	4.7727529+04
			4.0256608+07	45923.5770	2.7927149+04
			6.8710479+07	78382.9320	8.3626169+00

SOURCE NO	2	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0020000
			2.1668060+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4645072+02
			1.0774022+02	.1229	3.0687065+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0828535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.6637452+03	3.0387	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7600459+03	8.8524	1.5715735+03
			1.3244943+04	15.1094	1.4477190+03
			2.2606634+04	25.7890	1.3616403+03
			3.8585265+04	44.0170	8.2953945+03
			6.5857845+04	75.1287	1.9441216+03
			1.1240699+05	128.2307	1.2354335+03
			1.9185765+05	218.0657	1.1730710+03
			3.2745504+05	373.5627	1.0596563+03
			5.5892140+05	637.6014	8.861541+02
			9.5397402+05	1088.2600	6.7045600+02
			1.6282547+06	1857.4600	4.5530229+02
			2.7791254+06	3170.3402	2.9188361+02
			4.7434400+06	5411.1803	1.7865669+02
			8.0961726+06	9235.8892	1.0039284+02
			1.3818648+07	15763.9150	1.2038971+04
			2.3585841+07	26900.0480	4.7727529+04
			4.0256608+07	45923.5770	2.7927149+04
			6.8710479+07	78382.9320	8.3626169+00

SOURCE NO	10	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0020000
			2.1668060+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4645072+02
			1.0774022+02	.1229	3.0687065+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0828535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.6637452+03	3.0387	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7600459+03	8.8524	1.5715735+03
			1.3244943+04	15.1094	1.4477190+03
			2.2606634+04	25.7890	1.3616403+03
			3.8585265+04	44.0170	8.2953945+03
			6.5857845+04	75.1287	1.9441216+03
			1.1240699+05	128.2307	1.2354335+03
			1.9185765+05	218.0657	1.1730710+03
			3.2745504+05	373.5627	1.0596563+03
			5.5892140+05	637.6014	8.861541+02
			9.5397402+05	1088.2600	6.7045600+02
			1.6282547+06	1857.4600	4.5530229+02
			2.7791254+06	3170.3402	2.9188361+02
			4.7434400+06	5411.1803	1.7865669+02
			8.0961726+06	9235.8892	1.0039284+02
			1.3818648+07	15763.9150	1.2038971+04
			2.3585841+07	26900.0480	4.7727529+04
			4.0256608+07	45923.5770	2.7927149+04
			6.8710479+07	78382.9320	8.3626169+00

SAMPLE OUTPUT: DIBUW P. 4

SOURCE NO	17	TIME:	HRS	YRS	DELTA TEMP
		1.2695056+01	.0145	0.0000000	
		2.1668080+01	.0247	8.0462553+00	
		3.6983349+01	.0422	4.4736256+01	
		6.3123640+01	.0720	1.4045072+02	
		1.0774022+02	.1229	3.0687665+02	
		1.8349235+02	.2098	5.3740463+02	
		3.136975+02	.3581	8.0898535+02	
		5.3571679+02	.6111	1.0940179+03	
		9.1436810+02	1.0431	1.3558956+03	
		1.5626549+03	1.7804	1.5566198+03	
		2.6637452+03	3.0387	1.6631569+03	
		4.5465135+03	5.1805	1.6554231+03	
		7.7623459+03	8.8524	1.5682656+03	
		1.3244943+04	15.1094	1.4278377+03	
		2.2626634+04	25.7890	1.2992866+03	
		3.8535285+04	44.0170	8.1743190+03	
		6.5857045+04	75.1287	1.7715225+03	
		1.1247699+05	128.2307	1.0428353+03	
		1.9185765+05	218.8657	1.0195105+03	
		3.2746504+05	373.5627	1.0100128+03	
		5.5852140+05	637.6014	9.5710083+02	
		9.5357402+05	1090.2600	8.2155152+02	
		1.6222547+06	1857.4660	6.0179711+02	
		2.7791254+06	3170.3402	-5.6939504+02	
		4.7434400+06	5411.1803	2.3542465+02	
		8.0961726+06	9235.8802	2.1393055+03	
		1.3818648+07	15763.9150	1.5255672+05	
		2.3525841+07	26950.6480	5.4715794+04	
		4.0256608+07	45923.5770	2.7932045+04	
		6.8710479+07	78382.9320	1.0040027+01	

SOURCE NO	3	TIME:	HRS	YRS	DELTA TEMP
		1.2695056+01	.0145	0.0000000	
		2.1668080+01	.0247	8.0462553+00	
		3.6983349+01	.0422	4.4736256+01	
		6.3123640+01	.0720	1.4045072+02	
		1.0774022+02	.1229	3.0687665+02	
		1.8349235+02	.2098	5.3740463+02	
		3.136975+02	.3581	8.0898535+02	
		5.3571679+02	.6111	1.0940179+03	
		9.1436810+02	1.0431	1.3558956+03	
		1.5626549+03	1.7804	1.5566198+03	
		2.6637452+03	3.0387	1.6631569+03	
		4.5465135+03	5.1805	1.6554231+03	
		7.7623459+03	8.8524	1.5682656+03	
		1.3244943+04	15.1094	1.4278377+03	
		2.2626634+04	25.7890	1.2992866+03	
		3.8535285+04	44.0170	8.1810111+03	
		6.5857045+04	75.1287	1.0014336+03	
		1.1247699+05	128.2307	1.1207662+03	
		1.9185765+05	218.8657	1.1636625+03	
		3.2746504+05	373.5627	1.2148943+03	
		5.5852140+05	637.6014	1.1820991+03	
		9.5357402+05	1090.2600	1.0043638+03	
		1.6222547+06	1857.4660	7.1122394+02	
		2.7791254+06	3170.3402	-5.1313640+02	
		4.7434400+06	5411.1803	3.3356438+02	
		8.0961726+06	9235.8802	1.1048318+04	
		1.3818648+07	15763.9150	1.5277784+05	
		2.3525841+07	26950.6480	5.4721709+04	
		4.0256608+07	45923.5770	2.7935443+04	
		6.8710479+07	78382.9320	1.0117386+01	

SOURCE NO	9	TIME:	HRS	YRS	DELTA TEMP
		1.2695056+01	.0145	0.0000000	
		2.1668080+01	.0247	8.0462553+00	
		3.6983349+01	.0422	4.4736256+01	
		6.3123640+01	.0720	1.4045072+02	
		1.0774022+02	.1229	3.0687665+02	
		1.8349235+02	.2098	5.3740463+02	
		3.136975+02	.3581	8.0898535+02	
		5.3571679+02	.6111	1.0940179+03	
		9.1436810+02	1.0431	1.3558956+03	
		1.5626549+03	1.7804	1.5566198+03	
		2.6637452+03	3.0387	1.6631569+03	
		4.5465135+03	5.1805	1.6554231+03	
		7.7623459+03	8.8524	1.5682656+03	
		1.3244943+04	15.1094	1.4278377+03	
		2.2626634+04	25.7890	1.3024241+03	
		3.8535285+04	44.0170	8.1927678+03	
		6.5857045+04	75.1287	1.8401370+03	
		1.1247699+05	128.2307	1.2140907+03	
		1.9185765+05	218.8657	1.3270208+03	
		3.2746504+05	373.5627	1.4408727+03	
		5.5852140+05	637.6014	1.4223926+03	
		9.5357402+05	1090.2600	1.1910425+03	
		1.6222547+06	1857.4660	8.2457652+02	
		2.7791254+06	3170.3402	-4.5487716+02	
		4.7434400+06	5411.1803	5.8172034+02	
		8.0961726+06	9235.8802	1.1708937+04	
		1.3818648+07	15763.9150	1.5333382+05	
		2.3525841+07	26950.6480	5.4727708+04	
		4.0256608+07	45923.5770	2.7916329+04	
		6.8710479+07	78382.9320	1.2348014+01	

SAMPLE OUTPUT: DIBUW .P. 5

SOURCE NO	10	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668080+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4045072+02
			1.0774022+02	.1229	3.0687065+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0898535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.6637452+03	3.0387	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7630459+03	8.8524	-8.0549222+16
			1.3244943+04	15.1094	1.4210695+03
			2.2636634+04	25.7890	1.2706812+03
			3.8585285+04	44.0170	8.1186776+03
			6.5857845+04	75.1287	1.7157233+03
			1.1240699+05	128.2307	1.0308296+03
			1.9185765+05	218.8657	1.0936588+03
			3.2746504+05	373.5627	1.1883271+03
			5.5892140+05	637.6014	1.2050361+03
			9.5397402+05	1088.2600	1.0571200+03
			1.6282547+06	1857.4600	7.7239162+02
			2.7791254+06	3170.3462	-4.6017157+02
			4.7434460+06	5411.1803	5.7901398+02
			8.0961726+06	9235.8802	1.1705015+04
			1.3818648+07	15763.9150	1.5333039+05
			2.3585841+07	26906.0480	5.4725716+04
			4.0256608+07	45923.5770	2.7935631+04
			6.8715479+07	78382.9320	1.2010921+01

SOURCE NO	16	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668080+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4045072+02
			1.0774022+02	.1229	3.0687065+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0898535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.6637452+03	3.0387	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7630459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.4163899+03
			2.2636634+04	25.7890	1.2473330+03
			3.8585285+04	44.0170	8.0578741+03
			6.5857845+04	75.1287	1.6071969+03
			1.1240699+05	128.2307	8.6475859+02
			1.9185765+05	218.8657	8.7591209+02
			3.2746504+05	373.5627	9.4605023+02
			5.5892140+05	637.6014	9.9523723+02
			9.5397402+05	1088.2600	9.2278609+02
			1.6282547+06	1857.4600	7.1792825+02
			2.7791254+06	3170.3462	-4.6867828+02
			4.7434460+06	5411.1803	5.7942576+02
			8.0961726+06	9235.8802	1.1701596+04
			1.3818648+07	15763.9150	1.5332709+05
			2.3585841+07	26906.0480	5.4723605+04
			4.0256608+07	45923.5770	2.7934655+04
			6.8715479+07	78382.9320	1.1717514+01

SOURCE NO	19	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668080+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4045072+02
			1.0774022+02	.1229	3.0687065+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0898535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.6637452+03	3.0387	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7630459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.4163899+03
			2.2636634+04	25.7890	1.2452406+03
			3.8585285+04	44.0170	8.0502737+03
			6.5857845+04	75.1287	1.5942602+03
			1.1240699+05	128.2307	8.4952743+02
			1.9185765+05	218.8657	8.5464012+02
			3.2746504+05	373.5627	9.1262239+02
			5.5892140+05	637.6014	9.5071531+02
			9.5397402+05	1088.2600	8.8231207+02
			1.6282547+06	1857.4600	7.0209370+02
			2.7791254+06	3170.3462	-4.6404190+02
			4.7434460+06	5411.1803	5.9296171+02
			8.0961726+06	9235.8802	1.1594536+04
			1.3818648+07	15763.9150	1.5332673+05
			2.3585841+07	26906.0480	5.4723109+04
			4.0256608+07	45923.5770	2.7934083+04
			6.8715479+07	78382.9320	1.1376425+01

SAMPLE OUTPUT: DIBUW P. 6

SOURCE NO	15	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668000+01	.0247	8.0862553+00
			3.6993349+01	.0422	4.4736256+01
			6.3123640+01	.0720	1.4045672+02
			1.0774022+02	.1229	3.0687065+02
			1.8399235+02	.2098	5.3740463+02
			3.1366975+02	.3581	8.0898335+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5561198+03
			2.6637452+03	3.6337	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7603459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.4163699+03
			2.2606634+04	25.7890	1.2436338+03
			3.8505285+04	44.6170	8.0431643+03
			6.5057845+04	75.1287	1.5739411+03
			1.1246699+05	128.2307	8.2998084+02
			1.9165765+05	218.0657	8.2755120+02
			3.2746504+05	373.5627	8.7520707+02
			5.5092140+05	627.0014	9.0652713+02
			9.5397402+05	1044.2600	8.4482690+02
			1.6282547+06	1857.4600	6.8668933+02
			2.7731254+06	3170.3402	-4.6223372+02
			4.7434460+06	5411.1803	6.0637626+02
			8.0961726+06	9235.0802	1.0610651+04
			1.3818648+07	15761.9150	1.5332600+05
			2.3555841+07	26930.0480	5.4723106+04
			4.0256608+07	45923.5770	2.7934658+04
			6.8715479+07	78382.9320	1.1012188+01
SOURCE NO	20	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668000+01	.0247	8.0862553+00
			3.6993349+01	.0422	4.4736256+01
			6.3123640+01	.0720	1.4045672+02
			1.0774022+02	.1229	3.0687065+02
			1.8399235+02	.2098	5.3740463+02
			3.1366975+02	.3581	8.0898335+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5561198+03
			2.6637452+03	3.6337	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7603459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.4163699+03
			2.2606634+04	25.7890	1.2436338+03
			3.8505285+04	44.6170	8.0431643+03
			6.5057845+04	75.1287	1.5739411+03
			1.1246699+05	128.2307	8.0626850+02
			1.9165765+05	218.0657	7.8663037+02
			3.2746504+05	373.5627	8.2132125+02
			5.5092140+05	627.0014	8.5456622+02
			9.5397402+05	1044.2600	8.1243671+02
			1.6282547+06	1857.4600	6.7649218+02
			2.7731254+06	3170.3402	-4.6223370+02
			4.7434460+06	5411.1803	6.0612635+02
			8.0961726+06	9235.0802	-0.7244044+03
			1.3818648+07	15761.9150	1.5333135+05
			2.3555841+07	26930.0480	5.4722553+04
			4.0256608+07	45923.5770	2.7934658+04
			6.8715479+07	78382.9320	1.1012188+01
SOURCE NO	5	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668000+01	.0247	8.0862553+00
			3.6993349+01	.0422	4.4736256+01
			6.3123640+01	.0720	1.4045672+02
			1.0774022+02	.1229	3.0687065+02
			1.8399235+02	.2098	5.3740463+02
			3.1366975+02	.3581	8.0898335+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5561198+03
			2.6637452+03	3.6337	1.6631569+03
			4.5465135+03	5.1805	1.6554231+03
			7.7603459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.4163699+03
			2.2606634+04	25.7890	1.2583168+03
			3.8505285+04	44.6170	8.0867501+03
			6.5057845+04	75.1287	1.6634724+03
			1.1246699+05	128.2307	9.5196465+02
			1.9165765+05	218.0657	9.7756629+02
			3.2746504+05	373.5627	1.0351369+03
			5.5092140+05	627.0014	1.0448194+03
			9.5397402+05	1044.2600	9.4649861+02
			1.6282547+06	1857.4600	7.4758286+02
			2.7731254+06	3170.3402	-4.5838174+02
			4.7434460+06	5411.1803	7.6911917+02
			8.0961726+06	9235.0802	-4.7244044+03
			1.3818648+07	15761.9150	1.5333689+05
			2.3555841+07	26930.0480	5.4725663+04
			4.0256608+07	45923.5770	2.7936094+04
			6.8715479+07	78382.9320	1.1012188+01

SAMPLE OUTPUT: DIBUW P. 7

SOURCE NO 7

TIME: HRS

YRS

DELTA TEMP

1.2695056+01	.0145	0.0000000
2.1668080+01	.0247	8.0862553+00
3.6983349+01	.0422	4.4736250+01
6.3123640+01	.0720	1.4045072+02
1.0774022+02	.1229	3.0687065+02
1.8369235+02	.2098	5.3740463+02
3.1369775+02	.3581	8.0898535+02
5.3571679+02	.6111	1.0940179+03
9.1436810+02	1.0431	1.3558956+03
1.5665549+03	1.7804	1.5566198+03
2.6637452+03	3.0387	1.6661600+03
4.5465135+03	5.1865	1.6763985+03
7.7600459+03	8.8524	-1.3590782+17
1.3244943+04	15.1094	1.5590567+03
2.2606634+04	25.7890	1.4712637+03
3.8585285+04	44.0170	8.3612428+03
6.5857845+04	75.1287	1.9920984+03
1.1245699+05	128.2337	1.3252879+03
1.9185765+05	218.8657	1.3773087+03
3.2746504+05	373.5627	1.4109096+03
5.5892140+05	637.6014	2.3156223+04
9.5397402+05	1083.2600	1.1147833+03
1.6282547+06	1857.4660	2.5895481+03
2.7791254+06	3170.3462	-4.2469222+62
4.7434460+06	5411.1863	7.8928177+02
8.0961726+06	9235.8602	-8.7136964+03
1.3818648+07	15763.9150	1.5334313+05
2.3585841+07	26906.0480	5.4729186+04
4.0256606+07	45923.5770	2.7936566+04
6.8710479+07	78382.9320	1.2302294+01

SOURCE NO 14

TIME: HRS

YRS

DELTA TEMP

1.2695056+01	.0145	0.0000000
2.1668080+01	.0247	8.0862553+00
3.6983349+01	.0422	4.4736250+01
6.3123640+01	.0720	1.4045072+02
1.0774022+02	.1229	3.0687065+02
1.8369235+02	.2098	5.3740463+02
3.1369775+02	.3581	8.0898535+02
5.3571679+02	.6111	1.0940179+03
9.1436810+02	1.0431	1.3558956+03
1.5665549+03	1.7804	1.5566198+03
2.6637452+03	3.0387	1.6661600+03
4.5465135+03	5.1865	1.6763985+03
7.7600459+03	8.8524	-1.3590782+17
1.3244943+04	15.1094	1.5590567+03
2.2606634+04	25.7890	1.4712637+03
3.8585285+04	44.0170	8.3596309+03
6.5857845+04	75.1287	1.3029712+03
1.1245699+05	128.2337	1.3360263+03
1.9185765+05	218.8657	1.3542628+03
3.2746504+05	373.5627	2.3101356+04
5.5892140+05	637.6014	1.0894264+03
9.5397402+05	1083.2600	2.5807333+03
1.6282547+06	1857.4660	-4.2367464+02
2.7791254+06	3170.3462	7.9024998+02
4.7434460+06	5411.1863	-3.1423606+04
8.0961726+06	9235.8602	1.5334786+05
1.3818648+07	15763.9150	5.4728764+04
2.3585841+07	26906.0480	2.7936676+04
4.0256608+07	45923.5770	1.2302294+01
6.8710479+07	78382.9320	

SOURCE NO 8

TIME: HRS

YRS

DELTA TEMP

1.2695056+01	.0145	0.0000000
2.1668080+01	.0247	8.0862553+00
3.6983349+01	.0422	4.4736250+01
6.3123640+01	.0720	1.4045072+02
1.0774022+02	.1229	3.0687065+02
1.8369235+02	.2098	5.3740463+02
3.1369775+02	.3581	8.0898535+02
5.3571679+02	.6111	1.0940179+03
9.1436810+02	1.0431	1.3558956+03
1.5665549+03	1.7804	1.5566198+03
2.6637452+03	3.0387	1.6661600+03
4.5465135+03	5.1865	1.6763985+03
7.7600459+03	8.8524	-1.3590782+17
1.3244943+04	15.1094	1.5634719+03
2.2606634+04	25.7890	1.4936195+03
3.8585285+04	44.0170	8.4208144+03
6.5857845+04	75.1287	2.0963058+03
1.1245699+05	128.2337	1.4693169+03
1.9185765+05	218.8657	1.5472323+03
3.2746504+05	373.5627	1.5827440+03
5.5892140+05	637.6014	2.3304342+04
9.5397402+05	1083.2600	1.2224172+03
1.6282547+06	1857.4660	2.6488066+03
2.7791254+06	3170.3462	-3.9741234+02
4.7434460+06	5411.1863	8.0323746+02
8.0961726+06	9235.8602	-3.1396296+04
1.3818648+07	15763.9150	1.5335234+05
2.3585841+07	26906.0480	5.4731831+04
4.0256608+07	45923.5770	2.7938379+04
6.8710479+07	78382.9320	1.2302294+01

SAMPLE OUTPUT: DIBUW P. 8

SOURCE NO	21	TIME: HRS	YRS	DELTA TEMP
		1.2695056+01	.0145	0.000000
		2.1668060+01	.0247	8.086253+00
		3.6983349+01	.0422	4.473625+01
		6.3123640+01	.0720	1.404507+02
		1.0774022+02	.1229	3.068765+02
		1.8389235+02	.2098	5.374063+02
		3.1386975+02	.3581	8.089635+02
		5.3571679+02	.6111	1.094017+03
		9.1436610+02	1.0431	1.355895+03
		1.5636549+03	1.7804	1.556619+03
		2.6637452+03	3.0387	1.666160+03
		4.5465135+03	5.1805	1.676385+03
		7.7637459+03	8.8524	-1.359078+17
		1.3244943+04	15.1094	1.563471+03
		2.2626034+04	25.7890	1.493619+03
		3.8585285+04	44.0170	8.429414+03
		6.5857845+04	75.1287	2.093760+03
		1.1240699+05	128.2307	1.857574+03
		1.9185765+05	218.8657	1.515553+03
		3.2746504+05	373.5627	1.527033+03
		5.5892140+05	637.6014	2.324236+04
		9.5397402+05	1088.2600	1.177133+03
		1.6282547+06	1857.4400	2.632666+03
		2.7791254+06	3170.3402	-3.012710+04
		4.7434460+06	5411.1803	7.964446+02
		8.0961726+06	9235.8802	-3.139626+04
		1.3818648+07	15763.9150	5.806305+04
		2.3585841+07	26906.0480	5.473487+04
		4.0256608+07	45923.5770	2.793791+04
		6.8715479+07	78382.9320	1.329942+01

SOURCE NO	13	TIME: HRS	YRS	DELTA TEMP
		1.2695056+01	.0145	0.000000
		2.1668060+01	.0247	8.086253+00
		3.6983349+01	.0422	4.473625+01
		6.3123640+01	.0720	1.404507+02
		1.0774022+02	.1229	3.068765+02
		1.8389235+02	.2098	5.374063+02
		3.1386975+02	.3581	8.089635+02
		5.3571679+02	.6111	1.094017+03
		9.1436610+02	1.0431	1.355895+03
		1.5636549+03	1.7804	1.556619+03
		2.6637452+03	3.0387	1.666160+03
		4.5465135+03	5.1805	1.676385+03
		7.7637459+03	8.8524	-1.359078+17
		1.3244943+04	15.1094	1.563471+03
		2.2626034+04	25.7890	1.493619+03
		3.8585285+04	44.0170	8.429414+03
		6.5857845+04	75.1287	2.093760+03
		1.1240699+05	128.2307	1.447430+03
		1.9185765+05	218.8657	1.487338+03
		3.2746504+05	373.5627	1.475237+03
		5.5892140+05	637.6014	2.318363+04
		9.5397402+05	1088.2600	1.132636+03
		1.6282547+06	1857.4400	2.617252+03
		2.7791254+06	3170.3402	-3.021137+02
		4.7434460+06	5411.1803	7.926372+02
		8.0961726+06	9235.8802	-3.139959+04
		1.3818648+07	15763.9150	3.589414+04
		2.3585841+07	26906.0480	5.473716+04
		4.0256608+07	45923.5770	2.793754+04
		6.8715479+07	78382.9320	1.400820+01

SOURCE NO	5	TIME: HRS	YRS	DELTA TEMP
		1.2695056+01	.0145	0.000000
		2.1668060+01	.0247	8.086253+00
		3.6983349+01	.0422	4.473625+01
		6.3123640+01	.0720	1.404507+02
		1.0774022+02	.1229	3.068765+02
		1.8389235+02	.2098	5.374063+02
		3.1386975+02	.3581	8.089635+02
		5.3571679+02	.6111	1.094017+03
		9.1436610+02	1.0431	1.355895+03
		1.5636549+03	1.7804	1.556619+03
		2.6637452+03	3.0387	1.666160+03
		4.5465135+03	5.1805	1.684606+03
		7.7637459+03	8.8524	-1.359078+17
		1.3244943+04	15.1094	1.454048+03
		2.2626034+04	25.7890	1.651168+03
		3.8585285+04	44.0170	8.642174+03
		6.5857845+04	75.1287	2.371367+03
		1.1240699+05	128.2307	1.780099+03
		1.9185765+05	218.8657	1.851252+03
		3.2746504+05	373.5627	1.821668+03
		5.5892140+05	637.6014	2.363123+04
		9.5397402+05	1088.2600	1.289559+03
		1.6282547+06	1857.4400	4.875890+03
		2.7791254+06	3170.3402	-3.636406+02
		4.7434460+06	5411.1803	8.037160+02
		8.0961726+06	9235.8802	-3.139124+04
		1.3818648+07	15763.9150	-3.588910+04
		2.3585841+07	26906.0480	5.474018+04
		4.0256608+07	45923.5770	2.793875+04
		6.8715479+07	78382.9320	1.400820+01

SAMPLE OUTPUT: DIBUW P. 9

SOURCE NO	22	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668080+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4045072+02
			1.0774022+02	.1229	3.0687665+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0898535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.0637452+03	3.0307	1.6661600+03
			4.5465135+03	5.1805	1.6840408+03
			7.7603459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.6548980+03
			2.2606634+04	25.7890	1.6511686+03
			3.8585285+04	44.0170	8.6421745+03
			6.5857845+04	75.1287	2.3708277+03
			1.1243699+05	128.2307	1.7749389+03
			1.9185765+05	218.8657	1.8248643+03
			3.2746504+05	373.5627	1.7525553+03
			5.5892140+05	637.6014	2.3332666+04
			9.5397402+05	1083.2600	1.1433886+03
			1.6282547+06	1857.4660	4.7437795+03
			2.7791254+06	3170.3402	-4.7416647+02
			4.7434460+06	5411.1863	7.5131692+02
			8.0961726+06	9235.8802	-3.1429335+04
			1.3018648+07	15763.9150	-3.8204940+04
			2.3585841+07	26906.0480	-4.7634473+03
			4.0256608+07	45923.5770	1.9438461+04
			6.8710479+07	78382.9320	1.1595358+01

SOURCE NO	12	TIME:	HRS	YRS	DELTA TEMP
			1.2695056+01	.0145	0.0000000
			2.1668080+01	.0247	8.0862553+00
			3.6983349+01	.0422	4.4736250+01
			6.3123640+01	.0720	1.4045072+02
			1.0774022+02	.1229	3.0687665+02
			1.8389235+02	.2098	5.3740463+02
			3.1386975+02	.3581	8.0898535+02
			5.3571679+02	.6111	1.0940179+03
			9.1436810+02	1.0431	1.3558956+03
			1.5636549+03	1.7804	1.5566198+03
			2.0637452+03	3.0307	1.6661600+03
			4.5465135+03	5.1805	1.6840408+03
			7.7603459+03	8.8524	-1.3590782+17
			1.3244943+04	15.1094	1.6548980+03
			2.2606634+04	25.7890	1.6511686+03
			3.8585285+04	44.0170	8.6421745+03
			6.5857845+04	75.1287	2.3708277+03
			1.1243699+05	128.2307	1.7703346+03
			1.9185765+05	218.8657	1.8022135+03
			3.2746504+05	373.5627	1.6906450+03
			5.5892140+05	637.6014	2.3223580+04
			9.5397402+05	1083.2600	1.0054605+03
			1.6282547+06	1857.4660	4.6164730+03
			2.7791254+06	3170.3402	-5.6340794+02
			4.7434460+06	5411.1863	6.9944607+02
			8.0961726+06	9235.8802	-3.1449167+04
			1.3018648+07	15763.9150	-3.8695037+04
			2.3585841+07	26906.0480	-8.4152874+04
			4.0256608+07	45923.5770	1.8361159+04
			6.8710479+07	78382.9320	8.8930308+00

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00152 OF MAIN PROGRAM

CSCX RL683J 15 FEB 74 9:25:14 USER CUB928 PUN024

CARDS IN .61 OUT 1 LINES 1483 PROCESSING TIME 21.41 SECONDS

LISTING AND SUBROUTINE COMPILATION: DIBUW P. 1

```

35 RUN FUNG15,CUR923, .150,6000/3000 G JANSEN 3760 BLOC 9423576
8 ELT DIBUW/SIF5.1.720512, 24513
8 EOF 8
C ****INPUT NEEDED FOR PROGRAM DIBUW***
C
C
C ADDITIONS TO PROGRAM DIBUW MADE JULY 1971 BY DEBBIE CAHN
C -- 'START' CARD TO ALLOW SOURCES TO INCLUDED AT
C TIMES OTHER THAN ZERO
C -- OUTPUT AND INTERNAL DOCUMENTATION EXPANDED AND CLARIFIED
C
C A CARD FORMAT (4F15.8)
C KS --- THERMAL CONDUCTIVITY OF MEDIUM
C BTU/(HR)(FT**2)(DEG F/FT)
C
C ALFA - THERMAL DIFFUSIVITY OF MEDIUM FT**2/(HR)
35 RUN FUNG15,CUR923, .150,6000/3000 G JANSEN 3760 BLOC 9423576
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C
C A CARD FORMAT (4F15.8)
C KS --- THERMAL CONDUCTIVITY OF MEDIUM
C BTU/(HR)(FT**2)(DEG F/FT)
C
C ALFA - THERMAL DIFFUSIVITY OF MEDIUM FT**2/(HR)
C
C XO --- RADIAL DISTANCE FROM THE LINE SOURCE FT
C
C ONE OF THESE CARDS IS NEEDED AT THE START OF EACH CASE.
C
C 3 CARDS -- FORMAT (2A3.9X,5E10.4)
C MAXIMUM OF 10 ISOTOPES PER SOURCE; MAX OF 100 SOURCES.
C MAXIMUM OF 100 ISOTOPES TOTAL
C
C ALPHA -- COLUMNS 1-6 MAY CONTAIN ALPHABETIC INFORMATION
C 'END' IN COLUMNS 1-3 INDICATES THE END OF A CASE
C 'START' IN COLUMNS 1-5 INDICATES THAT THE CARD CONTAINS THE
C START TIME (HRS) OF THE SOURCE WHICH FOLLOWS. IF NON-ZERO
C START TIME APPEARS IN BUFF (1) FIELD.
C
C BUFF(1-5) -- 5 NUMERIC FIELDS OF LENGTH 10 BEGINNING IN COLUMN 11
C DESCRIPTION OF SOURCES
C BUFF(1) X AXIS POSITION OF SOURCE, FT
C BUFF(2) Y AXIS POSITION OF SOURCE, FT
C BUFF(3) HEAT GENERATION RATE S OF 1ST ISOTOPE
C IN SOURCE, BTU/(HR)(FT LEN)
C BUFF(4) DECAY CONSTANT FOR 1ST ISOTOPE, (1/HR)
C BUFF(5) 0 FOR 2ND ISOTOPE (IF NEEDED)
C
C ADDITIONAL CARDS ARE USED AS NEEDED, 5 NUMBERS PER CARD, UNTIL
C 0 AND DECAY CONSTANT HAVE BEEN ENTERED FOR EACH ISOTOPE IN THE SOUR
C A BLANK FIELD SIGNALS THE END OF A SOURCE
C THE NEXT SOURCE MUST BEGIN ON A NEW CARD ( A 'START' CARD, IF
C ANY, PRECEDES THE FIRST CARD).
C THE 'END' CARD TERMINATES THE CASE.
C
C
C NOTE ON DIMENSIONS OF VARIABLES ----
C MAX NO OF TIMES = 500
C MAX NO OF ISOTOPES TOTAL = 100
C MAX NO OF SOURCES = 100
C MAX NO OF ISOTOPES PER SOURCE = 10
C
C DIMENSION ALPHA(2),BUFF(5),DIFU(100,10),ACVRAD(100),
C 2XO(2),QISO(100,10),P(100),DTMAX(100),FTIM(100),STIME(100)
C EQUIVALENCE (FTIM,STIME)
C INTEGER ISTART
C DIMENSION ANS(500)
C
C REAL KS
C INTEGER END,ALL,TIME ,ALPHA,ELT,P,FIRST
C DATA END/3HEND//,ALL/3HALL//,TIME/3HTIM//
C DATA START/3HSTA//
C LOGICAL NOOUT
C
C INITIALIZE POINTER ARRAY
C DO 5 J=1,100
C 5 P(J)=0
C DO 555 J=1,100
C 555 STIME(J)=0.0
C FIRST=1
C THIN =1.E+10
C TMAX =0.
C DO 6 I=1,100
C DO 6 J=1,10
C 6 QISO(I,J)=0.

```

LISTING AND SUBROUTINE COMPILATION: DIBUW P. 2

```

C INITIALIZE INPUT BUFFER
DO 3 I=1,5
  8 BUFF(I)=0.
  READ(5,9) KS,ALFA,X0
  9 FORMAT(4F15.8)
  WRITE(6,10) KS,ALFA,X0
  10 FORMAT('RECAP OF INPUT DATA'//4F15.8)
  ELT=0
C OVER-PIKE INTERNAL TIME INTERVAL CONTROL
  13 THINN=BUFF(1)
  14 TMAX=BUFF(2)
  15 DELTA=BUFF(3)
  16 ELT=ELT+1
  17 K=1
C INPUT ONE ELEMENT
  DO 50 I=1,22
    J=MOD(I-1,5)+1
    IF(J.NE.1) GOTO 35
    READ(5,30) ALFA,BUFF
    30 FORMAT(243,4X,5F10.3)
    31 FORMAT(14,243,4X,5E10.4)
    IF(ALFA(1).EQ.END) GOTO 52
    IF(ALFA(1).EQ.ALL) GOTO 61
    WRITE(6,31) ALFA,BUFF
    IF(ALFA(1).NE.START) GO TO 35
    STIME(ELT)=BUFF(1)
    GO TO 17
  35 CONTINUE
C TEST FOR CONTROL CARD
  IF(ALFA(1).EQ.TIME) GOTO 13
  GOTO(100,200,100),V
  100 RAD=SQR((X0(1)-BUFF(1))**2+(X0(2)-BUFF(2))**2)
  ACVRAD(ELT)=ALFA/RAD**2
  ISO =1
  K=2
  GOTO 50
  200 IF(I.EQ.2) GOTO 50
  IF(ABS(BUFF(J)).LE.1.E-9) GOTO 55
  QISO (ELT,ISO)= BUFF(J)/KS
  K=3
  GOTO 50
  300 DIFUS(ELT,ISO)=BUFF(J)*RAD**2/ALFA
  ISO= ISO +1
  K=2
  50 CONTINUE
  WRITE(6,52) ELT
  52 FORMAT(32H TEN COMPONENTS IN ARRAY ELEMENT,15)
  ** CONTINUE
CALC THINN,TMAX,DTMAX(ELT)
  DTMAX(ELT)=0.
  ISO=ISO-1
  DO 60 I=1,ISO
    IF(DIFUS(ELT,I).LE.1.E-20 ) GO TO 60
    T=1.1308438*DIFFUS(ELT,I)**(1.375755E-2*ALOG(DIFUS(ELT,I))-0.641664
    23)/ACVRAD(ELT)
    DFLG=ALOG(DIFUS(ELT,I))
    DTMAX(ELT)=DTMAX(ELT)+(0.04647954-D.03814864*DFLG+0.0019695*DFLG
    2**2)*QISO(ELT,I)
    TMIN =AMIN1(TMIN,T)
    TMAX =AMAX1(TMAX,T)
  60 CONTINUE
  DTMAX(ELT)=ABS(DTMAX(ELT))
  602 IF(ELT.EQ.1) GOTO 16
  IF(DTMAX(ELT).LE.DTMAX(FIRST)) GOTO 603
  F(ELT)=FIRST
  FIRST=ELT
  GOTO 16
  603 J=FIRST
  GOTO 605
  604 J=F(J)
  605 K=F(J)
  IF (DTMAX(ELT).GT.DTMAX(J)) GO TO 604
  IF(K.EQ.0) GO TO 606
  IF (DTMAX(ELT).LT.DTMAX(K)) GO TO 604
  F(ELT)=K
  606 F(J)=ELT
  GOTO 16
  61 NOCUT=.TRUE.
  62 CONTINUE
  WRITE(6,68)
  68 FORMAT('0 CALCULATED DIMENSIONLESS QUANTITIES')
  69 WRITE(6,70)((DIFUS(I,I).L=1,ELT),I=1,ISO)
  70 FORMAT(6H DIFUS(10F12.5))
  WRITE(6,75)((QISO(I,I).L=1,ELT),I=1,ISO)
  75 FORMAT(6H QISO(10F12.2))
  WRITE(6,80)((ACVRAD(I,I).L=1,ELT),TMIN,TMAX,DELTA)
  80 FORMAT(7H ACVRAD(10E12.5))
  WRITE(6,85)(DTMAX(I),I=1,ELT)
  85 FORMAT(6H DTMAX(10E12.5))
  WRITE(6,91)
  91 FORMAT('OUTPUT: TIME (HRS-YRS),TEMPERATURE RISE ABOVE AMBIENT
  (DEG F)')
  IF(TMINN.LT. 1.E-8) GO TO 109
  TMINN=101*TMIN
  TMAXX=100*TMAX
  109 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: DIBUW P. 3

```

DO 110 J=1,500
110 ANS(J)=0.
TIM=LOG10(ITPAXX)-ALOG10(ITMINN)
NTIM=TIM
NTIM=5*NTIM
RATIO=EXP(TIM/FLOAT(NTIM-1)*2.30258)
IELT=FIPT
DO 182 L=1,ELT
HRTIM=TMINN
WRITE(6,1180)IELT
1180 FORMAT('SOURCE NO ',I4,1X,'TIME: ',F10.4,1X,'WPS',F10.4,1X,'VRS',F10.4,1X,'
      'DELTA TEMP',F10.4)
DO 180 J=1,NTIM
RELTIM=HRTIM - STIME(L)
IF (RELTIM.LE.0.0) GO TO 173
C 10 = MAX NO OF ISOTOPES PER SOURCE
DO 170 I=1,10
IF (ABS(QISO(IELT,I)).LT.1.E-20) GO TO 178
ANS(J)=ANS(J)+DELTA(RELTIM*ACVPAD(IELT),DIFUS(IELT,I),
      QISO(IELT,I))
170 CONTINUE
178 CONTINUE
VRTIM=HRTIM/8766.
WRITE(6,1178) HRTIM,VRTIM,ANS(J)
1178 FORMAT(33X,1F16.7,4X,F10.4,1X,1F16.7)
HRTIM=HRTIM+RATIO
180 CONTINUE
IELT=F(IELT)
IF(IELT.EQ.0)GO TO 185
182 CONTINUE
185 CONTINUE
190 FORMAT(15X,9HTIME,12X,10HDELTA TEMP/(16X,2E16.8))
GO TO 3
END

a ELT TP2DIM/S1,1,710628, 9513R
a EOF a
C TWO DIMENSIONAL TABLE SEARCH-CALLS LAGRANGIAN INTERPOLATION
SUBROUTINE TP2DIM(X,Y,FX,FBT)
C YTB MUST INCREASE WITH INCREASING INDEX
C XTB MAY EITHER INCREASE OR DECREASE WITH INCREASING INDEX
C DIMENSION A(4),B(4),C(4),D(4)
PARAMETER KX=24,KY=64
PARAMETER KXY=KX*KY
COMMON /ITABL/ FXYTB(KXY),XTB(KX),YTB(KY)
FXY=-100.
N9I=1
SGN=SIGN(1.,YTB(KX)-XTB(1))
IF((X-XTB(1))*SGN.LT.0.) RETURN
2 IF(Y-YTB(1).LT.0.) RETURN
IF(Y-YTB(KY).GT.0.) RETURN
C LOCATE X IN XTB
DO 5 I=2,KX
IF((X-XTB(I))*SGN) 11,11,5
5 CONTINUE
C X GREATER THAN XTB(KX)
RETURN
11 L=I
C LOCATE Y IN YTB
N1=0
N2=64
DO 300 I=1,6
N2=N2/2
N1=N1+N2
IF(N1.GT.KY) GO TO 200
IF(Y-YTB(N1)) 200,300,300
200 N1=N1-N2
300 CONTINUE
NOLTA=-3
IF(N1.EQ.2) NOLTA=-N1
IF(N1.EQ.KY) NOLTA=-4
N1=N1+NOLTA
LOLTA=-3
IF(L.EQ.2) LOLTA=-L
IF(L.EQ.KY) LOLTA=-4
L=L+LOLTA
18 DO 26 I=1,4
I1=L+I
A(I)=XTB(I1)
I2=N1+I
26 B(I)=YTB(I2)
DO 28 J=1,4
I3=N1+J
I3=KX+(I3-1)*L
DO 27 I=1,4
C(I)=FXYTB(I3+I)
IF(C(I).GE.0.) GO TO 27
NBI=2
C(I)=0.
27 CONTINUE
CALL TABINT(A,C,X,D(J))
28 CONTINUE
285 CALL TABINT(B,D,Y,FX)
RETURN
END

```

LISTING AND SUBROUTINE COMPILATION: DIBUW P. 4

A ELT DELTAT/SIFS=1.720E19, 57001

B ECF B

```

FUNCTION DELTAT(TEMP,DIFF,DIFF0)
INTEGER F9
IF(DIFF-1E-10) GO TO 40
DIFF0 = 100.* DIFF/DIFF
DIFF = 99.9999
DIFF0 = 0.999999
40 CALL T82CIM(DIFF,DIFF0,TEMP,F9)
IF (TEMP.LT. 1.E-5).GO TO 100
DELTAT= TEMP*DIFF0
IF (F9.EQ. 2) GO TO 101
RETURN
100 DELTAT=0.
101 CONTINUE
RETURN
END

```

B ELT TABINT/SIFS=1.720E12, 24516

B ECF B

```

C FOUR-POINT TABLE INTERPOLATION SUBROUTINE
SUBROUTINE TABINT (X,Y,XUNK,YUNK)
DIMENSION X(4),Y(4)
YOVERR=0.0
DO2 J=1,4
R=1.0
FOFX=1.0
DO3 I=1,4
IF(I-J)4,3,4
4 R=(X(I)-X(J))/R
FOFX=FOFX*(XUNK-X(I))
3 CONTINUE
2 YOVERR=YOVERR+Y(I)/R*FOFX
YUNK =YOVERR
RETURN
END

```

B ELT TTABL/SIFS=1.720E29, 51448

B ECF B

```

BLOCK DATA
COMMON /TTABL/TEMP(1E36)*DIFF(24)*TIME(64)
DATA (TEMP(I),I=1,156)/
212* .91375E-4 ,
2.91363E-4,.91345E-4,.91315E-4,.91255E-4,.91074E-4,.90774E-4,
2.90140E-4,.88435E-4,.85650E-4,.80499E-4,.67822E-4,.53119E-4,
212* .24591E-3 ,
2.24587E-3,.24580E-3,.24559E-3,.24547E-3,.24481E-3,.24372E-3,
2.24156E-3,.23526E-3,.22534E-3,.20746E-3,.16597E-3,.12236E-3,
212* .50781E-3 ,
2.50770E-3,.50752E-3,.50735E-3,.50684E-3,.50489E-3,.50430E-3,
2.49626E-3,.47970E-3,.45402E-3,.40894E-3,.31049E-3,.21646E-3,
212* .39628E-3 ,
2.39622E-3,.39564E-3,.39501E-3,.38373E-3,.37994E-3,.37367E-3,
2.36133E-3,.32594E-3,.27190E-3,.26796E-3,.24897E-3,.23246E-3,
212* .13803E-2 ,
2.13798E-2,.13791E-2,.13779E-2,.13755E-2,.13684E-2,.13566E-2,
2.13336E-2,.12680E-2,.11645E-2,.10659E-2,.68963E-3,.47767E-3,
212* .19827E-2 ,
2.19819E-2,.19807E-2,.19726E-2,.19746E-2,.19625E-2,.19426E-2,
2.19038E-2,.17942E-2,.16372E-2,.13711E-2,.89569E-3,.54714E-3,
212* .62336E-2 /
DATA (TEMP(I),I=157,306)/
2.62288E-2,.62217E-2,.62098E-2,.61861E-2,.61158E-2,.60013E-2,
2.57816E-2,.51904E-2,.43915E-2,.32803E-2,.17513E-2,.94808E-3,
211* .11651E-1 ,.11544E-1,
2.11638E-1,.11617E-1,.11543E-1,.11516E-1,.11317E-1,.10996E-1,
2.10392E-1,.89482E-2,.69490E-2,.46660E-2,.21782E-2,.11209E-2,
211* .23281E-1 ,.23257E-1,
2.23232E-1,.23160E-1,.23040E-1,.22802E-1,.22109E-1,.21017E-1,
2.19050E-1,.14520E-1,.99100E-2,.56503E-2,.23214E-2,.11582E-2,
210* .34398E-1 ,.34371E-1,.34344E-1,
2.34291E-1,.34133E-1,.33871E-1,.33355E-1,.31870E-1,.29589E-1,
2.25659E-1,.17525E-1,.10626E-1,.55111E-2,.21683E-2,.10748E-2,
29* .44454E-1 ,.44527E-1,.44499E-1,.44453E-1,
2.44360E-1,.44065E-1,.43630E-1,.42740E-1,.40210E-1,.36422E-1,
2.30190E-1,.14583E-1,.10272E-1,.50656E-2,.19699E-2,.97510E-3,
29* .53734E-1 ,.53706E-1,.53663E-1,.53552E-1,
2.53451E-1,.53030E-1,.52378E-1,.50990E-1,.47208E-1,.41694E-1,
2.33032E-1,.12477E-1,.95402E-2,.45968E-2,.17836E-2,.00000E-0,
29* .62073E-1 ,.62033E-1,.61973E-1,.61873E-1,
2.61675E-1,.61003E-1,.60114E-1,.58235E-1,.53030E-1,.45655E-1/
DATA (TEMP(I),I=307,432)/
2.34590E-1,.17741E-1,.87399E-2,.41741E-2,.16209E-2,.00000E-0,
29* .69680E-1 ,.69627E-1,.69547E-1,.69415E-1,
2.69151E-1,.68366E-1,.67045E-1,.64612E-1,.67867E-1,.48544E-1,
2.35204E-1,.16724E-1,.79248E-2,.34081E-2,.14813E-2,.00000E-0,
29* .70660E-1 ,.70522E-1,.70491E-1,.70322E-1,
2.70596E-1,.70443E-1,.70342E-1,.70242E-1,.61851E-1,.50562E-1,
2.35141E-1,.15614E-1,.73217E-2,.34941E-2,.13616E-2,.00000E-0,
25* .83101E-1 ,.83077E-1,
2.83093E-1,.83061E-1,.83040E-1,.83010E-1,.82892E-1,.82684E-1,
2.82267E-1,.81039E-1,.79041E-1,.75228E-1,.55115E-1,.51476E-1,
2.34601E-1,.14725E-1,.67353E-2,.32240E-2,.17586E-2,.00000E-0,
25* .10938E-0 ,.10917E-0,
2.10936E-0,.10934E-0,.10929E-0,.10920E-0,.10893E-0,.10848E-0,
2.10759E-0,.10497E-0,.10074E-0,.73010E-1,.71404E-1,.51470E-1,
2.28907E-1,.10277E-1,.67724E-2,.23114E-2,.40834E-3,.00000E-0,
25* .12913E-0 ,.12917E-0,
2.12916E-0,.12911E-0,.12909E-0,.12889E-0,.12844E-0,.12770E-0,

```

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LISTING AND SUBROUTINE COMPILATION: DIBUW P. 5

```

2.12675E-00..12144E-00..11517E-00..10297E-00..78914E-10..65490E-10
2.21464E-10..17648E-10..17648E-10..17648E-10..17648E-10..17648E-10
DATA (TEMP(1),I=1,10000)
250 .17648E-10..17648E-10
2.15497E-00..15497E-00..15497E-00..15497E-00..15497E-00..15497E-00
2.15497E-00..15497E-00..15497E-00..15497E-00..15497E-00..15497E-00
2.14993E-10..52795E-20..25201E-20..12195E-20..100000
260 .17648E-10
2.17995E-00..17995E-00..17995E-00..17995E-00..17995E-00..17995E-00
2.17995E-00..17995E-00..17995E-00..17995E-00..17995E-00..17995E-00
2.10857E-10..19723E-20..19723E-20..99567E-30..0
250 .19723E-20..19723E-20
2.19625E-00..19625E-00..19625E-00..19625E-00..19625E-00..19625E-00
2.19625E-00..19625E-00..19625E-00..19625E-00..19625E-00..19625E-00
2.19395E-00..16671E-00..16671E-00..16671E-00..16671E-00..16671E-00
2.84927E-20..21528E-20..15497E-20..0
250 .21528E-20..21528E-20
2.21003E-00..20320E-00..20320E-00..20320E-00..20320E-00..20320E-00
2.19395E-00..17648E-00..17648E-00..17648E-00..17648E-00..17648E-00
2.69949E-20..26314E-20..12332E-20..0
250 .26314E-20..26314E-20
2.22134E-00..22134E-00..22134E-00..22134E-00..22134E-00..22134E-00
2.22134E-00..22134E-00..22134E-00..22134E-00..22134E-00..22134E-00
DATA (TEMP(1),I=1,10000)
2.59300E-20..22580E-20..11127E-20..0
250 .22580E-20..22580E-20
2.2327E-00..2327E-00..2327E-00..2327E-00..2327E-00..2327E-00
2.20793E-00..17667E-00..17667E-00..17667E-00..17667E-00..17667E-00
2.46667E-20..19774E-20..97609E-30..0
250 .19774E-20..19774E-20
2.24112E-00..24112E-00..24112E-00..24112E-00..24112E-00..24112E-00
2.24112E-00..24112E-00..24112E-00..24112E-00..24112E-00..24112E-00
2.45625E-20..17588E-20..0
250 .17588E-20..17588E-20
2.24992E-00..24992E-00..24992E-00..24992E-00..24992E-00..24992E-00
2.21669E-00..17626E-00..17626E-00..17626E-00..17626E-00..17626E-00
2.40917E-20..15638E-20..0
250 .15638E-20..15638E-20
2.23117E-00..23117E-00..23117E-00..23117E-00..23117E-00..23117E-00
2.24058E-00..27965E-00..27965E-00..27965E-00..27965E-00..27965E-00
2.22605E-00..16501E-00..16501E-00..16501E-00..16501E-00..16501E-00
2.27005E-20..10576E-20..0
250 .10576E-20..10576E-20
2.30377E-00..30377E-00..30377E-00..30377E-00..30377E-00..30377E-00
2.30285E-00..30149E-00..29923E-00..29923E-00..29923E-00..29923E-00
DATA (TEMP(1),I=1,10000)
2.2255E-00..14636E-00..76499E-10..30587E-10..88763E-20..41067E-20
2.20153E-20..17933E-20..0
250 .17933E-20..17933E-20
2.2357E-00..2357E-00..2357E-00..2357E-00..2357E-00..2357E-00
2.33915E-00..32183E-00..32183E-00..32183E-00..32183E-00..32183E-00
2.7147E-00..7347E-00..84633E-10..17114E-10..56681E-20..27240E-20
2.13378E-20..0
250 .27240E-20..27240E-20
2.25843E-00..25843E-00..25843E-00..25843E-00..25843E-00..25843E-00
2.35618E-00..35283E-00..34736E-00..34736E-00..34736E-00..34736E-00
2.1951E-00..97244E-10..21525E-10..21710E-10..91719E-20..20289E-20
2.10012E-20..0
250 .21525E-10..21525E-10
2.27608E-00..27608E-00..27608E-00..27608E-00..27608E-00..27608E-00
2.37311E-00..35870E-00..36147E-00..36147E-00..36147E-00..36147E-00
2.17601E-00..66685E-10..22706E-10..89581E-20..33040E-20..16165E-20
2.79938E-30..0
250 .33040E-20..33040E-20
2.39055E-00..39055E-00..39055E-00..39055E-00..39055E-00..39055E-00
2.38691E-00..38128E-00..72262E-00..35491E-00..30799E-00..24438E-00
2.16716E-00..51728E-10..17349E-10..72811E-20..27367E-20..13434E-20
260 .0
250 .40277E-00..40277E-00..40277E-00..40277E-00..40277E-00..40277E-00
DATA (TEMP(1),I=1,10000)
2.39825E-00..39825E-00..39825E-00..39825E-00..39825E-00..39825E-00
2.13972E-00..40929E-10..14009E-10..51427E-20..20354E-20..10043E-20
260 .0
250 .41336E-00..41336E-00..41336E-00..41336E-00..41336E-00..41336E-00
2.40803E-00..40803E-00..40803E-00..40803E-00..40803E-00..40803E-00
2.12397E-00..33113E-10..11776E-10..53154E-20..20354E-20..10043E-20
260 .0
250 .42271E-00..42271E-00..42271E-00..42271E-00..42271E-00..42271E-00
2.41655E-00..40751E-00..39290E-00..36529E-00..29480E-00..20444E-00
2.10995E-00..27403E-10..10183E-10..46839E-20..18044E-20..89172E-30
260 .0
250 .43107E-00..43107E-00..43107E-00..43107E-00..43107E-00..43107E-00
2.42404E-00..43027E-00..29737E-00..36643E-00..28457E-00..19665E-00
2.97594E-00..23172E-10..89955E-20..41904E-20..16204E-20..0
250 .16204E-20..16204E-20
2.46377E-00..46377E-00..46377E-00..46377E-00..46377E-00..46377E-00
2.45139E-00..45537E-00..40929E-00..16210E-00..25299E-00..14419E-00
2.55591E-10..12800E-10..7041E-20..27247E-20..10737E-20..0
250 .10737E-20..10737E-20
2.48613E-00..48605E-00..45577E-00..48572E-00..48208E-00..47806E-00
2.47013E-00..44719E-00..41161E-00..34934E-00..21714E-00..10523E-00
DATA (TEMP(1),I=1,10000)
2.34549E-10..9023E-20..41940E-20..20353E-20..20294E-20..0
250 .20353E-20..20353E-20
2.4147E-00..51827E-00..51771E-00..51705E-00..51182E-00..50537E-00
2.49272E-00..45477E-00..40301E-00..31504E-00..15664E-00..54423E-10
2.1775E-10..5714E-20..27452E-20..13410E-20..0
250 .13410E-20..13410E-20
2.49124E-00..49124E-00..49124E-00..49124E-00..49124E-00..49124E-00
2.40500E-00..45577E-00..46755E-00..27457E-00..11280E-00..35616E-10
2.11807E-10..91984E-20..70405E-20..10079E-20..0
250 .10079E-20..10079E-20
2.55379E-00..55379E-00..55379E-00..55379E-00..55379E-00..55379E-00
2.41314E-00..41314E-00..41314E-00..41314E-00..41314E-00..41314E-00
2.40174E-20..17201E-20..16270E-20..90172E-30..0
250 .90172E-30..90172E-30
2.47249E-00..47249E-00..47249E-00..47249E-00..47249E-00..47249E-00
2.51715E-00..44190E-00..34570E-00..21275E-00..61215E-10..17903E-10

```

P. 6

[illegible]

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LISTING AND SUBROUTINE COMPILATION: DIBUW P. 7

```

100 CONTINUE
110 CONTINUE
    WRITE (6,3) (HONGS(K),K=1,9)
    N=2*I
    DO 186 K1=1,M @ INDEX N (I,9) TIMES VERTICALLY PER SECTION.
    DO 185 K2=1,10 @ SUB-INDEX 10 TIMES VERTICALLY PER SECTION.
    K=10*(K1-1)+K2
    ROWS(K)=THETA(K2)*10.0*(I-I-1)*K1-1)
195 CONTINUE
186 CONTINUE
    N=10*(I-1)
    DO 192 L2=1,M @ SUB-INDEX M TIMES VERTICALLY.
    DO 191 L1=1,9 @ SUB-INDEX 9 TIMES HORIZONTALLY.
    CALL TB2CIM(HONGS(L1),ROWS(L2),FXY(L1),NSI)
    IF (FXY(L1) .LT. 1-E-5) FXY(L1)=0.0
191 CONTINUE
    WRITE (6,2) ROWS(L2),(FXY(K),K=1,9)
192 CONTINUE
198 CONTINUE
200 CONTINUE
    STOP
    END
06190279 CUB928PUND15 100 1590 79 568 15521018 8 1 00000 6 5

```

PROGRAM NAME: FINITE

Descriptive Title: Transient Heat Transfer in Infinite Length
Cylinders

Program Author: DeMier, Warren V.

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Radioactive Wastes, Cylindrical
Sources, Newtonian Cooling

Program Description: Estimates the transient temperatures in a heat
generating cylinder with constant internal
uniform heat generation rate and constant external
heat transfer coefficient to a constant temperature
external sink. Cylinder is infinite length.
Initial conditions may be constant temperature or
parabolic profile. Analytical solution with Bessel
functions. Two subroutines.

Users of Program: G Jansen
JR Nance
WV DeMier
RL Engel

Documentation: Equations, Results, and Listing of earlier version
reported in BNWL-157. Revisions appear in memo from
G. Jansen to R. J. Thompson, "Transient Temperatures
in Heat-Generating Materials," August 14, 1968.

Condition of Program: It works fine over the entire region of interest.

SAMPLE INPUT: FINITE

```

FINITE      09:23      02/14/74

100 AS RUN PIN009,CUR928,GEORGE,150,4000/3000      G JANSEN 3760 BLD
      G 9423576
105 ON MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INF000
115 @PRL TEL INF000
120 @PRL TEL CUR928
125 @X ASG A=U1145(JJ1145)
130 ON XGT CUR
150 FIND A,BLKS
160 TRD A
170 FIND A,BESMMM/SIFS
180 TRD A
190 FIND A,FINITE/SIFS
200 TRD A
210 FIND A,BFIND/SIFS
220 TRD A
350 TRI A
360 PCH FINITE/SIFS
370 PCH BFIND/SIFS
380 PCH BESMMM/SIFS
390 PCH BLKS
1000 @IM FR5,* FINITE/SIFS,FINITE/SIFS,FINITE/RIFS
1010 @IM FR5,* BFIND/SIFS,BFIND/SIFS,BFIND/RIFS
1020 @IM FR5,* BESMMM/SIFS,BESMMM/SIFS,BESMMM/RIFS
1030 @IM FR5,* BLKS,BLKS/SIFS,BLKS/RIFS
1040 @LI XGT FINITE/RIFS
1050      9 150
1060      0.5 1.0 2.0 4.0 6.0 12.0 20.0 40.0 100.0
1070      0.0 0.6 0.25 178.5 0.33 1.86 70. 0. 8163.
1080      70. 8163. 10.45 0.6
1090      1.0 0.6 0.25 178.5 0.33 1.86 70. 0. 8163. 1
1100      70. 8163. 10.45 0.6
1110 -1.0
1120 @ FIN
READY

```

SAMPLE INPUT: FINITE

FINITE 16:16 04/29/71

```

100 GO RUN FANCOR,CUE554,,60,2000
110 GPPL TEL CUE500
120 EX ASG A=USC00(GJ3000)
130 BN XOT CLR
140 IN A
150 TRI A
160 9A UPD,* BFINO/SIFS,BFINO/SIFS
163 -10,10
164 ETA(1)=APAXI(1.2,186)
170 -15
*181 SE=.81056
185 -16,16
186 T=X-(X*BJI-C*BJC)/(X*BJP+C*BJI)/2.
197 -16
198 IF(T.LE,ZJ1(ND))T=(X+ZJ1(ND))/2.
199 IF(ZJ1(ND).LE,T)T=(X+ZJ1(ND))/2.
220 @WITH PFS,* FFINITE/SIFS,FFINITE/SIFS,FFINITE/PIFS
230 @WITH PFS,* BFINO/SIFS,BFINO/SIFS,BFINO/PIFS
240 @WITH PFS,* DESMMH/SIFS,DESMMH/SIFS,DESMMH/PIFS
250 @WITH PFS,* BLKS,BLKS/SIFS,BLKS/PIFS
260 @L XOT FFINITE/PIFS
270 13 150
280 0.01 .05 .10 .20 .30 .40 .50 .60 .75 1.0 2.0
    5.0
290 100.0
300 0.0 0.17 0.14 344..09375 1.47 90.0 1200.19900.
305 70.19900. 1.47 0.17
310 0.2 0.17 0.14 344..09375 1.47 90.0 1200. 19900.
315 70.19900. 1.47 0.17
320 0.4 0.17 0.14 344..09375 1.47 90.0 1200. 19900.
325 70.19900. 1.47 0.17
330 0.6 0.17 0.14 344..09375 1.47 90.0 1200. 19900.
335 70.19900. 1.47 0.17
340 0.8 0.17 0.14 344..09375 1.47 90.0 1200.19900.
345 70.19900. 1.47 0.17
350 1.0 0.17 0.14 344..09375 1.47 90.0 1200.19900.
355 70.19900. 1.47 0.17
360 -1.0
370 @ FIN

```

* To avoid this, COMMON and DIM of items in COMMON in the main program and in BFINO must be matched.

SAMPLE OUTPUT: FINITE P. 1

WLI X01 FINITE/HIPS

THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 15:23:19

NON UNIFORM TEMP.

RUN ON 14 FEB 74 AT 15:23:19

S	K	DIFFUSIVITY	SPECIFIC HT	DENSITY	RADIUS	H	AMBIENT TEMP	INITIAL TEMP
8163.0000	.6000	.0134	.2500	178.5000	.3300	1.860n	70.0000	.0000

	S	K	H	AMB TEMP	WALL TEMP	CNTR TEMP	T AT R/A
INITIAL CONDITIONS:	8163.000	.600	10.450	70.000	198.889	569.286	569.286
FINAL CONDITIONS:	8163.000	.600	1.860	70.000	794.137	1164.533	1164.533

R/A= .0000

DMLST	TIME (HOURS)	TEMP AT R/A
-1.0692+01	.500	1.2384+03
-1.6082+01	1.000	1.1957+03
-1.5719+01	2.000	1.1697+03
-1.5638+01	4.000	1.1647+03
-1.5636+01	5.000	1.1645+03
-1.5636+01	12.000	1.1645+03
-1.5636+01	20.000	1.1645+03
-1.5636+01	40.000	1.1645+03
-1.5636+01	100.000	1.1645+03

NON UNIFORM TEMP.

RUN ON 14 FEB 74 AT 15:23:20

DEBUG OUTPUT --- VALUES OF B(N)

1 -2.112551+02	2 3.831706+00	3 7.015587+00	4 1.017347+01	5 1.332369+01	6 1.647063+01
7 1.901586+01	8 2.276008+01	9 2.590367+01	10 2.904683+01	11 3.218968+01	12 3.533231+01
13 3.847477+01	14 4.161709+01	15 4.475932+01	16 4.799146+01	17 5.104354+01	18 5.418555+01
19 5.732753+01	20 6.046940+01	21 6.361136+01	22 6.675323+01	23 6.989507+01	24 7.303690+01
25 7.617870+01	26 7.932049+01	27 8.246226+01	28 8.560402+01	29 8.874577+01	30 9.188750+01
31 9.502923+01	32 9.817095+01	33 1.013127+02	34 1.044544+02	35 1.075961+02	36 1.107376+02
37 1.138794+02	38 1.170211+02	39 1.201628+02	40 1.233045+02	41 1.264461+02	42 1.295876+02
43 1.390128+02	44 1.358711+02	45 1.390128+02	46 1.421544+02	47 1.452961+02	48 1.484377+02
49 1.515794+02	50 1.547210+02	51 1.578627+02	52 1.610043+02	53 1.641459+02	54 1.672876+02
55 1.704292+02	56 1.735708+02	57 1.767125+02	58 1.798541+02	59 1.829957+02	60 1.861373+02
61 1.892790+02	62 1.924206+02	63 1.955622+02	64 1.987038+02	65 2.018455+02	66 2.049871+02
67 2.081247+02	68 2.112703+02	69 2.144119+02	70 2.175536+02	71 2.206952+02	72 2.238368+02
73 2.269784+02	74 2.301200+02	75 2.332616+02	76 2.364033+02	77 2.395449+02	78 2.426865+02
79 2.458281+02	80 2.489697+02	81 2.521113+02	82 2.552529+02	83 2.583945+02	84 2.615362+02
85 2.646778+02	86 2.678194+02	87 2.709610+02	88 2.741026+02	89 2.772442+02	90 2.803858+02
91 2.835274+02	92 2.866690+02	93 2.898106+02	94 2.929522+02	95 2.960938+02	96 2.992354+02
97 3.023771+02	98 3.055187+02	99 3.086603+02	100 3.118019+02	101 3.149435+02	102 3.180851+02
103 3.212267+02	104 3.243683+02	105 3.275099+02	106 3.306515+02	107 3.337931+02	108 3.369347+02
109 3.400763+02	110 3.432179+02	111 3.463595+02	112 3.495011+02	113 3.526427+02	114 3.557843+02
115 3.589259+02	116 3.620675+02	117 3.652091+02	118 3.683507+02	119 3.714923+02	120 3.746339+02
121 3.777755+02	122 3.809171+02	123 3.840587+02	124 3.872003+02	125 3.903419+02	126 3.934835+02
127 3.966251+02	128 3.997667+02	129 4.029083+02	130 4.060499+02	131 4.091915+02	132 4.123331+02
133 4.154747+02	134 4.186163+02	135 4.217579+02	136 4.248995+02	137 4.280411+02	138 4.311827+02
139 4.343243+02	140 4.374659+02	141 4.406075+02	142 4.437491+02	143 4.468907+02	144 4.500323+02
145 4.531739+02	146 4.563155+02	147 4.594571+02	148 4.625987+02	149 4.657403+02	150 4.688819+02

W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTI= 0.00000	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=1
W(L)=-1.56408+01	COCQBQ= 6.50412-02	EBQTI= 4.03993-01	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=2
W(L)=-5.80434-01	COCQBQ= 2.03521-02	EBQTI= 4.79121-02	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=3
W(L)=-9.78202-03	COCQBQ= 9.78517-03	EBQTI= 1.67943-03	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=4
W(L)=-5.93486-05	COCQBQ= 5.72893-03	EBQTI= 1.74036-05	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=5
W(L)=-1.19227-07	COCQBQ= 3.75650-03	EBQTI= 5.33206-08	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=6
W(L)=-7.62278-11	COCQBQ= 2.65144-03	EBQTI= 4.82986-11	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=7
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTI= 0.00000	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=1
W(L)=-6.31879+00	COCQBQ= 6.50412-02	EBQTI= 1.63210-01	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=2
W(L)=-2.78098-02	COCQBQ= 2.03521-02	EBQTI= 2.29557-03	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=3
W(L)=-1.64283-05	COCQBQ= 9.78517-03	EBQTI= 2.82050-06	BYTOBB= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L=4

SAMPLE OUTPUT: FINITE P. 2

W(L)=-1.03208-09	COCQBQ= 5.72093-03	EBQTJ= 3.02886-10	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 5
W(L)=-0.35720-15	COCQBQ= 3.75653-03	EBQTJ= 2.84308-15	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 6
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1
W(L)=-1.03129+00	COCQBQ= 6.50412-02	EBQTJ= 2.66377-02	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 2
W(L)=-6.38393-05	COCQBQ= 2.03521-02	EBQTJ= 5.26964-06	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 3
W(L)=-4.63358-11	COCQBQ= 9.78517-03	EBQTJ= 7.95520-12	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 4
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1
W(L)=-2.74712-02	COCQBQ= 6.50412-02	EBQTJ= 7.09565-04	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 2
W(L)=-3.36410-10	COCQBQ= 2.03521-02	EBQTJ= 2.77691-11	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 3
W(L)=-3.68611-22	COCQBQ= 9.78517-03	EBQTJ= 6.32852-23	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 4
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1
W(L)=-7.31769-04	COCQBQ= 6.50412-02	EBQTJ= 1.89011-05	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 2
W(L)=-1.77276-15	COCQBQ= 2.03521-02	EBQTJ= 1.46333-16	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 3
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1
W(L)=-1.38313-08	COCQBQ= 6.50412-02	EBQTJ= 3.57253-10	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 2
W(L)=-2.59413-31	COCQBQ= 2.03521-02	EBQTJ= 2.14133-32	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 3
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1
W(L)= 0.00000	COCQBQ= 2.29219-05	EBQTJ= 0.00700	BYTQBE= 1.00000+00	BIGUN=-5.95248+02	SMALUN= 0.00000 L= 1

	S	K	H	DIFFUSIVITY	SPECIFIC HT	DENSITY	RADIUS	H	AMBIENT TEMP	INITIAL TEMP
	8163.0000	.6000	.0134	.2500	178.5050	.3300	1.8600	70.0000	.0000	
INITIAL CONDITIONS:	8163.000	.600	10.450		75.000	198.889	569.286	198.889		
FINAL CONDITIONS	8163.000	.600	1.860		75.000	794.137	1164.533	794.137		

	R/A= 1.0000	DMLST	TIME (HOURS)	TEMP AT R/A
		-9.8811+00	.500	7.6167+02
		-1.0163+01	1.000	7.8144+02
		-1.0315+01	2.000	7.9207+02
		-1.0344+01	4.000	7.9408+02
		-1.0345+01	6.000	7.9414+02
		-1.0345+01	12.000	7.9414+02
		-1.0345+01	20.000	7.9414+02
		-1.0345+01	40.000	7.9414+02
		-1.0345+01	100.000	7.9414+02

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00141 OF MAIN PROGRAM

CSCX HL683J 14 FEB 74 15:22:45 USER CUR928 RUN009

CARDS IN 32 OUT 370 LINES 772 PROCESSING TIME 33.11 SECONDS

LISTING AND SUBROUTINE COMPILATION: FINITE P. 1

```

05 RUN FUND09.CUB02A. .150.0000/3000 5 JANSEN 3760 BLDG 9433576
0 ELY FINITE/21F5.1.701223. 34999
0 EOF 0
C PROGRAM FINITE
C TRANSIENT CENTERLINE TEMPERATURE IN CYLINDER WITH INTERNAL HEAT GEN -
C CRATION, UNIFORM INITIAL TEMPERATURE, FINITE CONVECTIVE HEAT TRANSFER
C COEFFICIENT.
C
C INPUT -
C COND = THERMAL CONDUCTIVITY, (BTU FT/HR SQFT DEGREE F)
C BLANK IF DIFFUSIVITY VALUE IS ENTERED
C DIFUS = DIFFUSIVITY, SQFT PER HR
C BLANK IF CONDUCTIVITY VALUE IS ENTERED
C H = CONVECTION COEFFICIENT, BTU/HR SQFT DEGREE F)
C HRIJ1 = TIME, HOURS
C RAD = RADIUS OF CYLINDER, FEET
C RHO = DENSITY, LB/ CUFT
C ROA = R/RAD, RADIUS OF INTEREST DIVIDED BY TOTAL RADIUS OF CYLIN-
C DER (ZERO FOR CENTERLINE, UNITY FOR WALL)
C S = VOLUMETRIC HEAT GENERATION RATE, BTU/HR CUFT)
C SFHT = HEAT CAPACITY, BTU/LB DEG F)
C TO = AMBIENT TEMPERATURE, DEGREES F
C TUNI = INITIAL UNIFORM TEMPERATURE, DEGREES F
C LL = LIMITING NUMBER OF TERMS IN SERIES SUMMATION (150 MAX)
C JJ = NUMBER OF HRIJ1 TO BE ENTERED (50 MAX)
C TOO = PRESTARTUP AMBIENT TEMPERATURE, DEGREE F
C SO = PRESTARTUP VOLUMETRIC HEAT GENERATION RATE BTU/HR(CUFT)
C HO = PRESTARTUP CONVECTION COEFFICIENT, BTU/HR SQFT DEGREE F)
C CONDO = PRESTARTUP THERMAL CONDUCTIVITY, (BTU FT/HR SQFT DEG F)
C SET 1 (215) JJ,LL, SINGLE CARD
C
C SET 2 (12F6.3) HRIJ1, 5 CARD MAXIMUM
C
C SET 3 (9F6.3,F8.0) ROA,COND,DIFUS,SFHT,RHO,RAD,H,TO,TUNI,S, ANY
C NUMBER OF CARDS
C
C SET 4 (9F6.3) TOO,SO,HO,CONDO SAME NUMBER OF CARDS AS SET 3
C
C LAST CARD -1.0 IN COLUMNS 1-4
C DIMENSION BETA(151),W(150),ETA(21),THETA(60),H(60),TCL(60),ZJ0(15
C 20),ZJ1(150),TFR(60),T(2),Y(2),WORD(2)
C COMMON RAD,H,COND,TUNI,TO,DIFUS,SFHT,S,RHO,HR,LL,JJ,
C ZBETA,ETA,THETA,SUM,W,TCL,TWO,THREE,C
C COMMON/BLOA/ ZJ0,ZJ1
C DATA WORD /12H NON U U/
C READ(5,1)JJ,LL
C 1 FOPMAT (215)
C READ(5,2)(HRIJ1,1,50,1,50)
C 2 FOPMAT (12F6.3)
C 13 READ(5,3) CASE,COND,DIFUS,SFHT,RHO,RAD,H,TO,TUNI,S,NDEUG
C 3 FOPMAT (9F6.3,F8.0,2)
C READ (5,15) TOO,SO,HO,CONDO
C 15 FOPMAT (9F6.3)
C CALL B0Y(1)
C CALL T00(1)
C IF (TUNI .LT. 1.E-20) GO TO 222
C KEY = 2
C GO TO 333
C 222 KEY = 1
C 333 CONTINUE
C WRITE(6,12) WORD(KEY),Y,T
C 12 FOPMAT(1H1,10X,AE,12HNI FORM TEMP.,20X,6H RUN CN ,2A6.4H AT ,2A6.7/)
C IF(CASE) 80,86,86
C 80 STOP
C 85 IF (COND) 92,92,93
C 92 COND = DIFUS*RHO * SFHT
C 93 IF(DIFUS) 98,99,95
C 94 DIFUS = COND/RHO/SFHT
C ROA = CASE
C 95 TWO = RAD*S/(2.*H)
C THREE = S*RAD**2/(4.*COND)
C FOUR = THREE * (1.-ROA**2)
C C=PAD* H/COND
C CALL SFIND
C IF(INDBUG.EQ.0) GO TO 96
C WRITE(6,20)
C 20 FOPMAT (1H0, 31HDEBUC OUTPUT --- VALUES OF BETA )
C WRITE(6,21) (N,BETA(N),N=1,LL)
C 21 FOPMAT (1H ,G(3X,I3-1FC13.6))
C 96 DO 78 J=1,JJ
C IMFTAJ1= DIFUS*HRIJ1/RAD**2
C TSUM=C.C
C DO 77 L=1,LL
C B = BETA(L)
C YT = B* ROA
C BYT088= BESMMPL(YT,1)/BESMMIR(1)
C E01TJ= EXP(-B**2*THETA(J))
C COC080= C/(C**2+F**2)
C GO TO (777,889),KEY
C 888 SHALUN= TUNI-TO-THREE*4./R**2
C WLL= COC080 * F01TJ * BYT088 * SHALUN
C GO TO 500

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LISTING AND SUBROUTINE COMPILATION: FINITE P. 2

```

777 CONTINUE
    FIVE=SQ-RAT+.27/14.*CONDD1
    TWINIT=T00+.10.*RAD/12.*H01
    BRATIO=1/6.*1-1.7C
789 BIGUNE=TWINIT-T0-THREE*.4/8*.2+.FIVE*.2.*BRATIO
    WIL)=COC680.*ERGTJ.*BYTOP6+.FICUN
500 CONTINUE
    IF(L.LT.7).GO TO 550
    IF(ABS(WIL)).LT.1.E-10.AND.ABS(WIL-1)).LT.1.E-10) GO TO 76
550 CONTINUE
    TSUM=TSUM+WIL)
    IF(INBUS.E2.F) GO TO 77
    WRITE(6,22)
    WRITE(6,23) WIL),COC680,ERGTJ,BYTOP6,BIGUN,SPAL UN,L
22 FORMAT(1H)
23 FORMAT(1H,5H WIL)=,1FE11.5,9H COC680=,E11.5,6H ERGTJ=,F11.5,
    2 9H BYTOP6=,E11.5,8H BIGUNE=,E11.5,9H SPALUNE=,E11.5,9H L=,I0)
77 CONTINUE
76 CONTINUE
    TCL(J)=T0+TWO+FOUR+.2.*TSUM
    TFR(J)=(TCL(J)-T0)/(TUNI-T0)
    TSUM=C.0
78 CONTINUE
    WRITE(6,4)
    WRITE(6,5) S.COND,DIFUS,SPHT,RHO,RAD,H.TO,TUNI
    4 FORMAT(1H,4X,4H S,10X,14H,7X,11HDIFFUSIVITY,2X,11HSPHTIC HT,
    25X,7H DENSITY,5X,5H RHO,10X,14H,3X,12H RADIANT TEMP,1X,12H INITIAL
    3TEMP/)
    5 FORMAT(19F13.4)
    WRITE(6,16)
16 FORMAT(1H,27X,14H,12X,14H,11X,14H,6X,8HAMB TEMP,5X,9H WALL TEMP,
    2 3X,5H CNTR TEMP,3X,8H AT R/A)
    TWFINL=T0+.TWO
    TCINIT=TWINIT+.FIVE
    TCFINL=T0+.TWO+.THREE
    TRINIT=TWINIT+.FIVE*(1.-ROA**2)
    TRFINL=T0+.TWO+.FOUR
    IF(TUNI.LT..FC1) GO TO 165
    TCINIT=TUNI
    TRINIT=TUNI
    TWINIT=TUNI
165 CONTINUE
    WRITE(6,17)
17 FORMAT(1H,19H INITIAL CONDITIONS:)
    WRITE(6,18) S.COND,RHO,T00,TWINIT,TCINIT,TRINIT
18 FORMAT(1H,22X,F10.3,F11.3,5F12.3)
    WRITE(6,19)
19 FORMAT(1H,19H FINAL CONDITIONS)
    WRITE(6,10) S.COND,H.TO,TWFINL,TCFINL,TRFINL
    WRITE(6,10) CASE
10 FORMAT(1H,23H----- R/A=.F3.4)
    WRITE(6,8)
    WRITE(6,9) (TFR(I),H0(I),TCL(I),I=1,JJ)
    8 FORMAT(1H,7CX,5H CNTR,5X,12H TIME(HOURS),10X,11H TEMP AT R/A)
    9 FORMAT(1H,67X,1FE12.4,CFF12.3,1FE12.4)
    GO TO 13
    END

```

8 ELT BFIND/SIF5.1.7C1223. 35000

8 EOF 8

```

SUBROUTINE BFIND
COMMON RAD,H,COND,TUNI,T0,DIFUS,SPHT,S,RHO,HR,LL,JJ,
2BETA,ETA,THETA,SUM,W,TCL,TWO,THREE,C,X,T,B
COMMON/BLOA/ ZJO,ZJ1
DIMENSION BETA(151),W(150),ETA(41),THETA(6C),HR(6C),TCL(6C),
2 ZJO(150),ZJ1(150)
N=1
100 CONTINUE
    ARG=(ZJ1(N)+ZJO(N))/2
    ETA(1)=ANAL(2,9,ARG)
10 DO 22 K=1,40
    KP1=K+1
    X=ETA(K)
    BJ1=BESMM(X,3)
    BJ0=BESMM(X,1)
    T=X-(1X-BJ1-C*BJ0)/(X*BJ0+C*BJ1)
    IF(ABS((T-X)/T)-C.OCD1)19,19,17
17 ETA(KP1)=T
22 CONTINUE
15 WRITE(6,1) N,T,X
19 BETA(N)=T
12 N=N+1
    IF(N-LL)100,100,16
16 RETURN
1 FORMAT(1H,23H NOT CONVERGED FOR BETA(,I=,1H),5X,11H LAST VALUE=,
    21FE12.4,10X,15H PREVIOUS VALUE=,E12.4)
    END

```

LISTING AND SUBROUTINE COMPILATION: FINITE P. 3

```

B ELT BESMMH/GIF5.1.701216. 55905
B EOF B
      FUNCTION BESMMH(X,M)
C----- M=1. JZERO(X)
C----- M=2. IZERO(X)
C----- M=3. JONE(X)
C----- M=4. IONE(X)
      DIMENSION FMT(4)
      DIMENSION TERM(2),T(2),X(2),BESSL(2)
      EQUIVALENCE (FNF2,FNF2)
      DATA TWOM26,TWOM30/0.147400000000,0.147400000000/
      DATA TWOF1,FIFFS,FIHALF,FIPTH/6.2831853,2.3561945,1.5707963,
10.78539816/
      DATA (FMT(I),I=1,4)/54H(48H)---- ARC OF ZERO FUNCTION IS GREATER
1 THAN 89.01/
      DATA HZERO,HONE,SHZERO,SHZONE/
      X=ABS(X)
      IF(X.GT.6.C) GO TO 400
      Z=0.5*X
      ZSQ=Z*Z
      GO TO (10,110,210,310),M
C----- JZERO. NORMAL SERIES INITIALIZATION
10 ZSQ=ZSQ
   TEST=TWOM30
20 TEPH=ZSQ
   BESMMH=1.0+TEPH
   BESSL=BESMMH
   C=4.0
   FNF1=2.0
30 FNF2=2.0
C----- SUM NORMAL SERIES
   DO 40 NC N=1,100
   TERM=ZSQ*TERM/C
   BESMMH=BESMMH+TERM
C----- TEST TO CUT OFF SERIES
   IF ((ABS(TERM).LT.TEST).OR.(BESSL.EQ.BESMMH)) GO TO 999
   BESSL=BESMMH
   FNF1=FNF1+1.0
   FNF2=FNF2+1.0
   C=FNF1*FNF2
40 CONTINUE
C----- IZERO. NORMAL SERIES INITIALIZATION
110 TEST=TWOM26
   GO TO 20
C----- JONE. NORMAL SERIES INITIALIZATION
210 TEST=TWOM30
   ZSQ=ZSQ
300 C=4.0
   FNF1=1.0
   TEPH=Z
   BESMMH=TERM
   GO TO 30
C----- IONE. NORMAL SERIES INITIALIZATION
310 TEST=TWOM26
   GO TO 220
C----- ASYMPTOTIC SERIES INITIALIZATION
400 X(1)=1.0/(8.0*X)
   I1=1
   I2=2
   GO TO (410,510,610,710),M
C----- JZERO. ASYMPTOTIC SERIES INITIALIZATION
410 X(2)=-X(1)
   TEST=TWOM30
420 T(1)=4.5*X(1)*X(2)
   T(2)=-X(1)
   C=-25.0/3.0
   FNF1=3.0
   F2NF=5.0
   FM2N=-5.0
430 BESSL(1)=1.0
   BESSL(2)=0.0
C----- SUM ASYMPTOTIC SERIES
440 DO 450 N=1,100
   TERM(1)=T(I2)
   BESSL(1)=BESSL(1)+TERM(1)
   T(I2)=C*X(I1)*T(I1)
C----- TEST TO CUT OFF SERIES
   IF ((ABS(T(I2)).GE.ABS(T(I1))) .OR. (ABS(T(I2)).LT.TEST)) GO TO 460
   FNF1=FNF1+1.0
   F2NF=F2NF+2.0
   FM2N=FM2N-2.0
   C=F2NF*FM2N/FNF1
   I1=I2
450 I2=3-I1
460 BESSL(I1)=BESSL(I1)+0.5*T(I1)
   IF (ABS(TEPH(I2)).GE.ABS(T(I2))) GO TO 470
   T(I2)=-TERM(I2)
470 BESSL(I2)=BESSL(I2)+0.5*T(I2)
   GO TO (480,420,430,420),M
C----- IZERO. ASYMPTOTIC SERIES INITIALIZATION
510 X(2)=X(1)
   TEST=TWOM26
   IF(X.LE.44.0) GO TO 420
   FMT(4)=HZERO
   GO TO 900

```

LISTING AND SUBROUTINE COMPILATION: FINITE P. 4

```

C---- JONE, ASYMPTOTIC SERIES INITIALIZATION
610 X(121)=X(11)
TEST=TWOPI
620 T(11)=7.5*X(11)+X(12)
T(21)=3.0*X(11)
C=7.0
FNF1=3.0
FNF2=3.0
FNF3=7.0
GO TO 430

C---- JONE, ASYMPTOTIC SERIES INITIALIZATION
710 X(122)=X(11)
TEST=TWOPI
IF(X-LE.89.C) GO TO 620
FNF(1)=HIONE
GO TO 900

800 XNF=X-FIFTH
810 BESMNH=(1.0/SORT(FINALF*X))*(BESSL(1)+COS(XMP)-BESSL(2)+SIN(XMP))
GO TO 999
820 BESMNP=(XNF(X)/SORT(TWOPI*X))*(BESSL(1)-BESSL(2))
GO TO 999
830 XNF=X-FIFTH
GO TO 810
900 WRITE (6,FMT)
999 RETURN
END

B ELT BLKS=1.690517. 30220
B EOF 3

BLOCK DATA
C BLOCK DATA FOR ZJ0,ZJ1
COMMON/BLD0/ZJ0,ZJ1
DIMENSION ZJ0(150),ZJ1(150)
DATA (ZJ0(I),I=1,150)/
1 2.404930, 5.520080, 9.657370, 11.791570, 14.930920, ZJ0 5
2 18.071060, 21.211640, 24.352470, 27.493880, 30.634610, ZJ0 10
3 33.775920, 36.917000, 40.058430, 43.199790, 46.341190, ZJ0 15
4 49.482610, 52.624090, 55.765510, 58.906970, 62.048460, ZJ0 20
5 65.189950, 68.331470, 71.472770, 74.614990, 77.756220, ZJ0 25
6 80.997550, 84.039080, 87.180620, 90.322160, 93.463710, ZJ0 30
7 95.605260, 98.746820, 101.888370, 105.029920, 108.171490, ZJ0 35
8 112.313090, 115.454610, 118.596160, 121.737730, 124.879310, ZJ0 40
9 128.020380, 131.162450, 134.304020, 137.445590, 140.587160, ZJ0 45
10 143.728730, 146.870210, 150.011880, 153.153460, 156.295020, ZJ0 50
11 159.436510, 162.578190, 165.719770, 168.861350, 172.002920, ZJ0 55
12 175.144500, 178.286080, 181.427660, 184.569250, 187.710830, ZJ0 60
13 190.852410, 193.993990, 197.135570, 200.277160, 203.418740, ZJ0 65
14 206.560320, 209.701910, 212.843490, 215.985070, 219.126660, ZJ0 70
15 222.269240, 225.410830, 228.552410, 231.693990, 234.835580, ZJ0 75
16 237.378170, 240.519760, 243.661350, 246.802920, 249.944510, ZJ0 80
17 253.684100, 256.825690, 259.967270, 263.108860, 266.250450, ZJ0 85
DATA (ZJ0(I),I=86,150)/
1 269.392030, 272.533620, 275.675210, 278.816800, 281.958390, ZJ0 90
2 285.099970, 288.241560, 291.383150, 294.524740, 297.666330, ZJ0 95
3 300.807910, 303.949500, 307.091090, 310.232680, 313.374270, ZJ0 100
4 316.515850, 319.657440, 322.799030, 325.940620, 329.082210, ZJ0 105
5 332.223900, 335.365490, 338.507080, 341.648670, 344.790260, ZJ0 110
6 347.931950, 351.073540, 354.215130, 357.356720, 360.498310, ZJ0 115
7 363.639900, 366.781490, 369.923080, 373.064670, 376.206260, ZJ0 120
8 379.347940, 382.489530, 385.631120, 388.772710, 391.914300, ZJ0 125
9 395.055900, 398.197490, 401.339080, 404.480670, 407.622260, ZJ0 130
10 410.763940, 413.905530, 417.047120, 420.188710, 423.330300, ZJ0 135
11 426.471990, 429.613580, 432.755170, 435.896760, 439.038350, ZJ0 140
12 442.179450, 445.321040, 448.462630, 451.604220, 454.745810, ZJ0 145
13 457.887400, 461.028990, 464.170580, 467.312170, 470.453760, ZJ0 150
DATA (ZJ1(I),I=1,150)/
1 .000000, 3.931706, 7.015587, 10.173470, 13.323590, ZJ1 5
2 16.471630, 19.615800, 22.760080, 25.903870, 29.047660, ZJ1 10
3 32.189540, 35.333300, 38.477170, 41.617090, 44.759290, ZJ1 15
4 47.901460, 51.045230, 54.185540, 57.327510, 60.469470, ZJ1 20
5 63.611350, 66.753220, 69.895090, 73.036970, 76.178890, ZJ1 25
6 79.320490, 82.462250, 85.604010, 88.745760, 91.887490, ZJ1 30
7 95.029220, 98.170950, 101.312680, 104.454360, 107.596050, ZJ1 35
8 110.737740, 113.879470, 117.021110, 120.162790, 123.304460, ZJ1 40
9 126.446130, 129.587860, 132.729460, 135.871120, 139.012780, ZJ1 45
10 142.154530, 145.296080, 148.437720, 151.579270, 154.720810, ZJ1 50
11 157.862660, 161.004290, 164.145930, 167.287570, 170.429200, ZJ1 55
12 173.570830, 176.712460, 179.854090, 182.995720, 186.137350, ZJ1 60
13 189.278940, 192.420570, 195.562200, 198.703830, 201.845460, ZJ1 65
14 204.987090, 208.128720, 211.270350, 214.411980, 217.553610, ZJ1 70
15 220.695180, 223.836810, 226.978440, 230.120070, 233.261690, ZJ1 75
16 236.403260, 239.544890, 242.686520, 245.828150, 248.969780, ZJ1 80
17 252.111320, 255.252950, 258.394580, 261.536210, 264.677840, ZJ1 85
DATA (ZJ1(I),I=86,150)/
1 267.819370, 270.960900, 274.102430, 277.243960, 280.385490, ZJ1 90
2 283.527410, 286.668940, 289.810470, 292.952000, 296.093530, ZJ1 95
3 299.235450, 302.376980, 305.518510, 308.660040, 311.801570, ZJ1 100
4 314.943470, 318.085000, 321.226530, 324.368060, 327.509590, ZJ1 105
5 330.651490, 333.793020, 336.934550, 340.076080, 343.217610, ZJ1 110
6 348.359510, 351.501040, 354.642570, 357.784100, 360.925630, ZJ1 115
7 362.067520, 365.209050, 368.350580, 371.492110, 374.633640, ZJ1 120
8 377.775570, 380.917100, 384.058630, 387.200160, 390.341690, ZJ1 125
9 393.441520, 396.583050, 399.724580, 402.866110, 406.007640, ZJ1 130
10 409.191570, 412.333100, 415.474630, 418.616160, 421.757690, ZJ1 135
11 424.897620, 428.039150, 431.180680, 434.322210, 437.463740, ZJ1 140
12 440.603670, 443.745200, 446.886730, 450.028260, 453.169790, ZJ1 145
13 456.315710, 459.457240, 462.598770, 465.740300, 468.881830, ZJ1 150
END

```

06100274 CU9928F04N09 100 3111 32 170 764152244 1 00000 0 5

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PROGRAM NAME: FURFAT-TIFU

Descriptive Title: Forced Air-Cooled Furnace with Heat Generators

Program Author: Cahn, Deborah U.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Radioactive Wastes, Furnaces

Program Description: Estimates steady-state temperatures in a system containing a heat generating cylinder, a heat shield, and a furnace with forced air convection between the shield and the furnace. Outer wall of furnace cooled by natural convection. Seven equations with log mean air temp. Radiation + convection solved by trial and error loops. TIFU does not have shield in place. Both programs use same 17 subroutines.

Users of Program: G Jansen
JD Kaser
WV DeMier
DU Cahn (L.L.L.)

Documentation: Results undocumented. Equations and results can be found in notes of J. D. Kaser and G. Jansen.

Condition of Program: The iterative simultaneous solution of the seven equations does not converge for physically impossible situations.

PROGRAM NAMES: TIFU AND FURFAT

LANGUAGE: FORTRAN V

Both programs use an iterative technique to solve J. D. Kaser's heat balance equations for furnace-cooling problem. TIFU, the original program, solves $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5$ for the variables UTWO, UTWI, UTAO, UTS, UTP (same as variables TWO, TWI, TAO, TS, TP of setup, OUT, etc., but dimensioned 200). FURFAT solves an additional equation for UTBO. In TIFU, $TBO = (TS+TP)/2$. Either program can be run for either the 5A or 6A furnace. For the 5A furnace, TWO is a constant (TR=560). Both programs contain logic to bypass loop to calculate TWO when TYPE=5.

Use of TIFU:

The main program TIFU/R1F5 and the two subroutines PHI/R1F5, RLOGMN/R1F5 are not needed for program FURFAT.

- (1) GCALC/R6F5
- (2) SETUP/R5F5
- (3) HCALC/R1F5
- (4) WCALC/R1F5
- (5) OUT/R5F5

PDP element TAGG (APT) is included in all these programs. Whenever APT is recompiled, all tape routines must be recompiled; TIFU, RLOGMN, PHI must be recompiled and new relocatable decks punched. To avoid ambiguity when running from a tape containing all the relocatables, the following two CUR cards must be included in a TIFU deck before XQT/R1F5:

- (1) DEL PHI/R3F5
- (2) DEL RLOGMN/R2F5

TIFU Data Deck:

1st card - 72 character alphanumeric heading

2nd card - \$FURN TYPE = 5\$

3rd card, etc - \$INLIST

always to be included or remembered from previous case -

- (1) DP = (pot diameter)
- (2) NDBUG(10) = (to avoid printout appropriate only for FASAFT)
- (3) S =
- (4) WB =

- optional:
- (5) MOT = 2 (for S.R. PHI solution verification printout and convergence printout showing values at end of each N-loop)
 - (6) MIT = 2 (changes pot area (AP) in setup)

to start temperatures at 600 (approx.), include following in INLIST:

NTAOG=2, NTWIG=2, NTSG=2, NTPG=2, NTCLG=2, NTWOG=2,
TWOG=600,600, TAOG=600,01, 600,01, TWIG=600,02 600,02,
TSG=600,03, 600,03, TPG=600,04, 600,04, TCLG=600,05,
600,05.

This was usually used for each case changing anything but S alone. To start temperatures at final answers for previous case, include the following in INLIST:

TWOG=500, NTAOG=1, NTWIG=1, NTWOG=1, NTSG=1, NTPG=1,
NTCLG=1

This was usually used for all cases in which S was the only parameter being changed.

Use of FURFAT

The following routines needed to XQT FURFAT are all available on tape:

- 1) FURFAT/R1F5
- 2) PHI/R3F5
- 3) RLOGMN/R2F5
- 4) TAGG/CODE
- 5) OUT/R5F5
- 6) WCALC/R1F5
- 7) CALTA0/R1F5
- 8) CALTB0/R1F5
- 9) CALTWO/R1F5
- 10) CALTWI/R1F5
- 11) CALTP/R1F5
- 12) CALTS/R1F5
- 13) HCALC/R1F5
- 14) SETUP/R5F5
- 15) GCALC/R6F5

FURFAT Data Deck:

Same as for TIFU with the following additions:

- 1) IF $WB \neq 0$, WB must be included in INLIST for every case because the main program resets $WB=0.0$ after each case.
- 2) HP can be entered as an input value and not calculated through arithmetic stmt. funct. HPF or S.R. H_CALC. (Peace logic in setup, Furfat, GCalc)
- 3) Value for WEE (difference between last two values allowable at convergence of loop) must be entered thru INLIST. usually=.001 (which is the value always used by TIFU)

The following cases have been run for J. D. Kaser.

- TIFU: 1) 5A FURN, DP=8in., WB=190.8, S=10000,20000,....120000
2) 5A FURN, DP=12 in., WB=190.8, S=10000,20000,....120000
3) 5A FURN, DP=8 in., WB=0.0, S=10000,20000,....120000
4) 5A FURN, DP=12 in., WB=0.0, S=10000,20000,....120000
5-8) Same as 1-4 for 6A FURN

FURFAT: Cases 1, 2, 5, 6 ran (WB=190.8) with HP not input
Debug test case has been run successfully with HP=.3
(6A FURN, DP=12 in., WB=190.8, S=30000)

SAMPLE INPUT: FURFAT

```

FURFAT      CR:23      02/08/74

100 QS RUN PUN029,CURS28,GEORGE,300,6000      G JANSEN 3760 RLD
      G 9423576
105 QN MSG KEEP AT FED,BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFO00
115 @POL TEL INFO00
120 @FPL TEL CUR928
125 @X ASG :=00231
130 @X XOT CUR
150 FIND A,TAT1/SISU
160 TPD A
170 FIND A,TAGG/SISU
180 TPD A
190 FIND A,FURFAT/SIF5
200 TPD A
210 FIND A,TIFU/SIF5
220 TPD A
230 FIND A,SETUP/S5F5
240 TPD A
250 FIND A,GCALC/S6F5
260 TPD A
270 FIND A,PHI/S3F5
280 TPD A
290 FIND A,WCALC/SIF5
300 TPD A
310 FIND A,WCALC/SIF5
320 TPD A
330 FIND A,PLUGMN/SIF5
340 TPD A
350 FIND A,PLUGMN/S2F5
360 TPD A
370 FIND A,OUT/S5F5
380 TPD A
390 FIND A,CALTWU/SIF5
400 TPD A
410 FIND A,CALTWI/SIF5
420 TPD A
430 FIND A,CALTP/SIF5
440 TPD A
450 FIND A,CALTS/SIF5
460 TPD A
470 FIND A,CALTAU/SIF5
480 TPD A
490 FIND A,CALTBW/SIF5
500 TPD A
530 TFI A
560 LIST,7
980 @IM FR5 BKDAT1/SIF5,BKDAT1/SIF5,BKDAT1/RIF5
982      BLOCK DATA
984 C      BLOCK DATA FOR PROGRAMS FURFAT AND TIFU
986      INCLUDE APT1,LIST
988      INCLUDE APT2,LIST
990      END
1000 @IM FR5,* FURFAT/SIF5,FURFAT/SIF5,FURFAT/RIF5
1004 @IM PDP TAGG/SISU,TAGG/SISU,TAGG/RI5U
1010 @IM FP5,* TIFU/SIF5,TIFU/SIF5,TIFU/RI5F5
1020 @IM FP5,* SETUP/S5F5,SETUP/S5F5,SETUP/R5F5
1030 @IM FP5,* GCALC/S6F5,GCALC/S6F5,GCALC/R6F5
1040 @IM FP5,* PHI/S3F5,PHI/S3F5,PHI/R3F5
1050 @IM FR5,* WCALC/SIF5,WCALC/SIF5,WCALC/RIF5
1060 @IM FP5,* WCALC/SIF5,WCALC/SIF5,WCALC/RIF5
1080 @IM FP5,* PLUGMN/S2F5,PLUGMN/S2F5,PLUGMN/R2F5(F)
1090 @IM FP5,* OUT/S5F5,OUT/S5F5,OUT/R2F5
1100 @IM FP5,* CALTWU/SIF5,CALTWU/SIF5,CALTWU/RIF5
1110 @IM FP5,* CALTWI/SIF5,CALTWI/SIF5,CALTWI/RIF5
1120 @IM FP5,* CALTP/SIF5,CALTP/SIF5,CALTP/RIF5
1130 @IM FP5,* CALTS/SIF5,CALTS/SIF5,CALTS/RIF5
1140 @IM FP5,* CALTAU/SIF5,CALTAU/SIF5,CALTAU/RIF5
1150 @IM FP5,* CALTBW/SIF5,CALTBW/SIF5,CALTBW/RIF5
2000 @LI XOT FURFAT/RIF5
2010 FURFAT TEST CASE FOR 6A FURNACE
2020 $FURN TYPE=4,NDRUG(10)=14
2030 $INLIST S=200000$
2040 FURFAT TEST CASE FOR 5A FURNACE
2050 $FURN TYPE=5,NDRUG(10)=1,MIT=14
2060 $INLIST S=200000$
2100 * FIN
READY

```

SAMPLE INPUT: TIFU

```

TIFU      08:37      02/28/74

100 @S RUN PUIN028,CUR92F,GEORGE,200,5020.      G JANSEN 3760 RLD
      G 8423576
105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFO00
115 @PPL TEL INFO00
120 @PRL TEL CUR928
125 @X ASG A=00231
130 @N XGT CUR
150 FIND A,DATI/SISU
160 TRD A
170 FIND A,TAGG/SISU
180 TRD A
190 FIND A,FURFAT/SIFS
200 TRD A
210 FIND A,TIFU/SIFS
220 TRD A
230 FIND A,SETUP/S5F5
240 TRD A
250 FIND A,GCALC/S6F5
260 TRD A
270 FIND A,PHI/S3F5
280 TRD A
290 FIND A,WCALC/SIFS
300 TRD A
310 FIND A,WCALC/SIFS
320 TRD A
330 FIND A,PLUGMN/SIFS
340 TRD A
350 FIND A,PLUGMN/S2F5
360 TRD A
370 FIND A,OUT/S5F5
380 TRD A
390 FIND A,CALTWO/SIFS
400 TRD A
410 FIND A,CALTWI/SIFS
420 TRD A
430 FIND A,CALTP/SIFS
440 TRD A
450 FIND A,CALTS/SIFS
460 TRD A
470 FIND A,CALTAU/SIFS
480 TRD A
490 FIND A,CALTRU/SIFS
500 TRD A
530 TRI A
540 LIST,7
980 @IM FRS - BKDATI/SIFS,BKDATI/SIFS,BKDATI/PIFS
982      BLOCK DATA
984 C      BLOCK DATA FOR PROGRAMS FURFAT AND TIFU
986      INCLUDE APT1,LIST
988      INCLUDE APT2,LIST
990      END
1004 @IM PDP TAGG/SISU,TAGG/SISU,TAGG/PIFS
1010 @IM FRS,* TIFU/SIFS,TIFU/SIFS,TIFU/PIFS
1020 @IM FRS,* SETUP/S5F5,SETUP/S5F5,SETUP/PIFS
1030 @IM FRS,* GCALC/S6F5,GCALC/S6F5,GCALC/PIFS
1040 @IM FRS,* PHI/S3F5,PHI/S3F5,PHI/PIFS
1050 @IM FRS,* WCALC/SIFS,WCALC/SIFS,WCALC/PIFS
1060 @IM FRS,* WCALC/SIFS,WCALC/SIFS,WCALC/PIFS
1070 @IM FRS,* PLUGMN/SIFS,PLUGMN/SIFS,PLUGMN/PIFS(T)
1080 @IM FRS,* OUT/S5F5,OUT/S5F5,OUT/PIFS
1090 @IM FRS,* CALTWO/SIFS,CALTWO/SIFS,CALTWO/PIFS
1100 @IM FRS,* CALTWI/SIFS,CALTWI/SIFS,CALTWI/PIFS
1110 @IM FRS,* CALTP/SIFS,CALTP/SIFS,CALTP/PIFS
1120 @IM FRS,* CALTS/SIFS,CALTS/SIFS,CALTS/PIFS
1130 @IM FRS,* CALTAU/SIFS,CALTAU/SIFS,CALTAU/PIFS
1140 @IM FRS,* CALTRU/SIFS,CALTRU/SIFS,CALTRU/PIFS
1150 @IM FRS,* CALTRU/SIFS,CALTRU/SIFS,CALTRU/PIFS
2100 @LI XGT TIFU/PIFS
2110 TIFU TEST CASE FOR 6A FURNACE
2120 $FURN TYPE=6,NDFUG(10)=15
2130 $INLIST S=200000
2140 TIFU TEST CASE FOR 5A FURNACE
2150 $FURN TYPE=5,NDFUG(10)=1,MIT=15
2160 $INLIST S=200000
2170 @FIN
READY

```

Q1: XGT FURFAT/R115

RUN ON 28 FEB 74 AT 08:25:12

67

SAMPLE OUTPUT: FURFAT P. 2

X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC
X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC
X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC
X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC
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X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC
X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC
X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC

DERIVED TERMS

S BTU/HOUR	TEMPERATURE			DEGREES RANKINE				CONVECTION COEFFICIENTS			RADIANT INTERCHG		G= 8.7623+
	TAO	TBO	TP	TS	TWI	TWO	TCL	HP	HW	HS	RIPS	RISI	
2.00200+04	565.0	1235.0	1635.0	835.0	825.0	700.0	2200.0	2.150-01	4.501-01	7.137-01	9.580-01	9.217-01	

1.8147800+01 SECONDS HAD ELAPSED UPON RETURN FROM S.R. SETUP

ROUTINE TERMINATED AT MERRS

RUN TERMINATED FOR MAX TIME AT 022362

CSCX RLH83J 28 FEB 74 8:24:12 USER CUB928 PUN029
CARDS IN 74 OUT 1 LINES 2735 PROCESSING TIME 301.67 SECONDS

TEST CASE FOR 6A FURNACE

RUN N 28 FEB 74 AT 08:23:42

INPUT SUMMARY
FURN 6A

DP= 2.0000E-01 FT	POT DIAMETER	AS= 2.70300+01 SQ FT	SUSCEPTOR WALL AREA
WB= 1.89800+01 LB/HR	INNER AIR FLOW	AP= 0.30000 SQ FT	FILLED POT WALL AREA
WA= 2.47500+03 LB/HR	OUTER AIR FLOW	AW= 4.39800+01 SQ FT	INNER AREA FURN INSULATION
TA= 5.60000+02 DEG R	INLET AIR TEMP	AWO= 5.86+00+01 SQ FT	OUTER AREA FURN INSULATION
		AWM= .52950+02 SQ FT	LOG. MEAN AREA FURN INSUL.
TR= 5.60000+02 DEG R	ROOM TEMP	DWI= 2.00000+00 FT	I.O. OF FURN INSULATION
KW= 1.70000-01 BTU/HR FT DEG F	COND. OF FURNACE WALL	DSO= 1.25000+00 FT	O.D. OF FURN SUSCEPTOR
KS= 4.30000-01 BTU/HR FT DEG F	COND. OF SOLID WASTE	EP= 9.50000-01	SUSCEPTOR EMISSIVITY
CP= 2.41000-01 BTU/LB DEG R	HEAT CAPACITY OF AIR	EW= 9.50000-01	INSULATION EMISSIVITY
US= 1.21000+00 FT	SUSCEPTOR DIA.	EWQ= 3.30000-01	FURNACE SHELL EMISSIVITY
XW= 2.50000-01 FT	FURN INSULATION THKNS	ZL= 1.17000+00 FT	ZONE LENGTH

DERIVED TERMS

S BTU/HOUR	TEMPERATURE TAO TBO TP			DEGREES RANKINE TS TWI TWO TCL			CONVECTION COEFFICIENTS HP HW HS			RADIANT INTERCHG RIPS RISI		
2.00000+04	565.0	933.0	1285.0	581.0	575.0	570.0	1850.0	9.021-01	4.501-01	7.137-01	9.500-01	2.217-01 G= 2.1710+07
1.6406600+01 SECONDS HAD ELAPSED UPON RETURN FROM S.R. SETUP												

DERIVED TERMS

S BTU/HOUR	TEMPERATURE TAO TBO TP			DEGREES RANKINE TS TWI TWO TCL			CONVECTION COEFFICIENTS HP HW HS			RADIANT INTERCHG RIPS RISI		
2.00000+04	561.2	570.2	570.2	570.2	564.5	562.3	1187.1	1.162-01	2.253-01	5.954-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.5	566.6	570.2	563.0	561.9	562.3	1187.1	1.162-01	2.253-01	5.960-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.2	561.3	561.3	561.3	560.6	560.3	1178.2	1.161-01	1.375-01	5.965-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.1	560.6	561.3	560.4	560.3	560.3	1178.2	1.161-01	1.374-01	5.967-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.2	560.2	560.2	560.1	560.0	1177.0	1.161-01	8.456-02	5.967-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.1	560.2	560.1	560.0	560.0	1177.0	1.161-01	8.423-02	5.967-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.161-01	5.408-02	5.968-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.161-01	5.315-02	5.968-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.161-01	4.518-02	5.968-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.161-01	4.202-02	5.968-01	9.500-01	2.217-01 G= 2.1710+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.161-01	3.906-02	5.968-01	9.500-01	2.217-01 G= 2.1710+07

VALUES OF ENERGY BALANCE EQUATIONS FOR SOLUTION TEMPERATURES

PHI1	PHI2	PHI3	PHI4	PHI5
.038	-.013	-.021	-.228-20000.000	

DERIVED TERMS

S BTU/HOUR	TEMPERATURE TAO TBO TP			DEGREES RANKINE TS TWI TWO TCL			CONVECTION COEFFICIENTS HP HW HS			RADIANT INTERCHG RIPS RISI		
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.161-01	3.906-02	5.968-01	9.500-01	2.217-01 G= 2.1710+07

RUN TIME FOR THIS CASE WAS 1.6685200+01 SECONDS.

SAMPLE OUTPUT: TIFU P. 2

TIFU TEST CASE FOR 5A FURNACE

RUN ON 28 FEB 74 AT 08:24:00

INPUT SUMMARY FURN 5A

DP= 0.00000 FT	POT DIAMETER	AS= 2.40000+01 SQ FT	SUSCEPTOR WALL AREA
WE= 1.99300+02 LB/HR	INNER AIR FLOW	AP= 0.00000 SQ FT	FILLED POT WALL AREA
WA= 2.47500+03 LB/HR	OUTER AIR FLOW	AW= 2.55300+01 SQ FT	INNER AREA FURN INSULATION
TA= 5.60000+02 DEG R	INLET AIR TEMP	AWO= 3.27000+01 SQ FT	OUTER AREA FURN INSULATION
		AWM= .28000+02 SQ FT	LOG MEAN AREA FURN INSUL.
IR= 5.60000+02 DEG R	ROOM TEMP	DWI= 1.25000+00 FT	I.D. OF FURN INSULATION
KE= 3.00000-01 BTU/HR FT DEG F	COND. OF FURNACE WALL	DSO= 1.20000+00 FT	O.D. OF FURN SUSCEPTOR
KS= 4.30000-01 BTU/HR FT DEG F	COND. OF SOLID WASTE	EP= 9.50000-01	SUSCEPTOR EMISSIVITY
CP= 2.41000-01 BTU/LB DEG R	HEAT CAPACITY OF AIR	EA= 9.50000-01	INSULATION EMISSIVITY
JS= 1.15000+00 FT	SUSCEPTOR DIA.	EW= 0.00000	FURNACE SHELL EMISSIVITY
AW= 1.25000-01 FT	FURN INSULATION THKNS	ZL= 1.00000+00 FT	ZONE LENGTH

DERIVED TERMS

S BTU/HOUR	TEMPERATURE			DEGREES RANKINE				CONVECTION COEFFICIENTS			RADIANT INTERCHG		G
	TAO	TBO	TP	TS	TWI	TWO	TCL	HP	HW	HS	RIPS	RISI	
2.00000+04	565.0	972.5	1285.0	660.0	575.0	570.0	1850.0	1.161-01	3.906-02	5.593-01	9.500-01	9.073-01	G= 2.2149+07

9.0051999+00 SECONDS HAD ELAPSED UPON RETURN FROM S.R. SETUP

DERIVED TERMS

S BTU/HOUR	TEMPERATURE			DEGREES RANKINE				CONVECTION COEFFICIENTS			RADIANT INTERCHG		G
	TAO	TBO	TP	TS	TWI	TWO	TCL	HP	HW	HS	RIPS	RISI	
2.00000+04	562.5	570.7	570.7	570.6	562.8	560.0	1187.5	1.209-01	3.906-02	5.437-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.3	566.3	570.7	561.9	560.5	560.0	1187.5	1.209-01	3.906-02	5.504-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.1	560.3	563.3	560.3	560.1	560.0	1177.2	1.208-01	3.906-02	5.509-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.0	560.2	562.3	560.1	560.0	560.0	1177.2	1.208-01	3.906-02	5.510-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.208-01	3.906-02	5.510-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.208-01	3.906-02	5.510-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.208-01	3.906-02	5.510-01	9.500-01	9.073-01	G= 2.2149+07
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.208-01	3.906-02	5.510-01	9.500-01	9.073-01	G= 2.2149+07

VALUES OF ENERGY BALANCE EQUATIONS FOR SOLUTION TEMPERATURES

PHI1	PHI2	PHI3	PHI4	PHI5
-.016	.001	-.007	-.152-20000.000	

DERIVED TERMS

S BTU/HOUR	TEMPERATURE			DEGREES RANKINE				CONVECTION COEFFICIENTS			RADIANT INTERCHG		G
	TAO	TBO	TP	TS	TWI	TWO	TCL	HP	HW	HS	RIPS	RISI	
2.00000+04	560.0	560.0	560.0	560.0	560.0	560.0	1176.9	1.208-01	3.906-02	5.510-01	9.500-01	9.073-01	G= 2.2149+07

RUN TIME FOR THIS CASE WAS 9.2384000+00 SECONDS.

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00173 OF SETUP

SETUP CALLED AT SEQUENCE NUMBER 00126 OF MAIN PROGRAM

CSCx RLH83J 28 FEB 74 8:22:46 USER CIB928 PUN028

CARDS IN 74 OUT 1 LINES 2178 PROCESSING TIME 77.00 SECONDS

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 2

```

C WA      1      R =MASS FLOW RATE OF OUTER COOLING AIR, LB/HR.
C          ASSUMED 2475
C
C WB      1      R =MASS FLOW RATE OF INNER COOLING AIR, LB/HR.
C          ASSUMED 190.8, MAY BE DESIRED TO ENTER WB=C
C
C EF      1      R =EMISSIVITY OF FOT, ASSUMED 0.95
C
C ES      1      R =EMISSIVITY OF SUSCEPTOR, ASSUMED 0.95
C
C EN      1      R =EMISSIVITY OF INSULATION, ASSUMED 0.95
C
C ZL      1      R =ZONE LENGTH, FT. ASSUMED 1.04/5A, 1.17/6A
C
C S       1      R =TOTAL HEAT GENERATION RATE, BTU/HR. MUST BE
C          ENTERED AS INPUT. USUAL RANGE 10000-120000
C
C EVO     1      P =EMISSIVITY OF FURNACE SHELL. ASSUMED 0.3/6A
C
C DWI     1      R =INSIDE DIAMETER OF FURNACE INSULATION, FT.
C          ASSUMED 1.25/5A, 2.0/6A
C
C DSO     1      R =OUTSIDE DIAMETER OF SUSCEPTOR, FT. ASSUMED
C          1.209/5A, 1.25/6A
C
C AWT     1      R =INNER WALL AREA OF FURNACE INSULATION, SQ FT.
C          ASSUMED 25.53/5A, 43.98/6A
C
C AWO     1      R =OUTER WALL AREA OF FURNACE INSULATION, SQ FT.
C          ASSUMED 32.76/5A, 58.64/6A
C
C AMW     1      R =LOGMEAN INSULATION AREA, SQ FT. ASSUMED 28.99/
C          5A, 52.95/6A
C
C FIT     1      R =FURNACE INSULATION THICKNESS, FT. LABELLED XM
C          IN OUTPUT. ASSUMED 0.25/5A, 0.25/6A
C
C TFG     10     P =TABLE POSSIBLE INITIAL TP
C TSG     10     R =TABLE POSSIBLE INITIAL TS
C TCLG    10     P =TABLE POSSIBLE INITIAL TCL
C TAOG    10     R =TABLE POSSIBLE INITIAL TAO
C TWIG    10     P =TABLE POSSIBLE INITIAL TWI
C TWOG    10     P =TABLE POSSIBLE INITIAL TWO
C
C NTFG    1      I =NUMBER ITERATIONS IN SETUP SEARCH LOOP
C NTSG    1      I =NUMBER ITERATIONS IN SETUP SEARCH LOOP
C NTCIG    1      I =NUMBER ITERATIONS IN SETUP SEARCH LOOP
C NTAOG    1      I =NUMBER ITERATIONS IN SETUP SEARCH LOOP
C NTWIG    1      I =NUMBER ITERATIONS IN SETUP SEARCH LOOP
C NTWOG    1      I =NUMBER ITERATIONS IN SETUP SEARCH LOOP
C
C TAI     1      R =ENTERING TEMPERATURE OF COOLING AIR, DEG R.
C          ASSUMED 560
C
C NDBUG   10     I =CONTROL VARIABLE, MUST ENTER NDBUG(10)=1 TO
C          AVOID IRRELEVANT PRINTOUT
C
C KS      1      R =THERMAL CONDUCTIVITY OF SOLID WASTE, BTU/HQ FT
C          DEG F. ASSUMED 0.43
C
C KW      1      R =THERMAL CONDUCTIVITY OF FURNACE WALL, BTU/HR FT
C          DEG F. ASSUMED 0.31/5A, 0.17/6A
C
C TR      1      R =ROOM TEMP. ASSUMED 560
C
C MIT     1      I =CONTROL VARIABLE, ASSUMED=20, ENTER MIT=1 TO SET
C
C          HS, HF=1000 (CASE FOR 5A FURNACE ONLY)
C
C MOT     1      I =CONTROL VARIABLE, ASSUMED=2, ENTER MOT=1 TO SKIP
C          S.P. FMI SOLUTION VERIFICATION PRINTOUT AND
C          CONVERGENCE PRINTOUT
C
C
C *OTHER VARIABLES ARE CONTAINED IN INLIST, BUT ARE NOT USED BY THIS
C PROGRAM
C **TO SKIP S.R. SETUP SEARCH AND ENTER INITIAL VALUES THRU INLIST--
C PROGRAM
C **TO SKIP S.R. SETUP SEARCH AND ENTER INITIAL VALUES THRU INLIST--
C ASSIGN DESCENDING VALUES TO-- TCLG, TFG, TSG, TWIG, TAOG, TWOG. (FIRST
C 4 MAY BE EQUAL, LAST 2 MAY BE EQUAL, THE FOLLOWING MUST NOT BE
C TRUE-- TS>TF< 2*TAI, TS<TAI, TWI<TAI, TWI=TAI,
C
C TWO<TR. ALSO ENTER NTCIG=2, NTFG=2, ETC.
C ***TO SKIP S.R. SETUP SEARCH AND START WITH ANSWERS FOR PREVIOUS CASE
C -ENTER TWO=500, NTAOG=1, NTCIG=1, ETC.
C
C *SETUP ASSIGNS TAO=(TS+TF)/2
C INCLUDE APT1.LIST
C INCLUDE APT3.LIST
C HFF(VTF, VTE0)=.108*VTF*((-0.865)*(VTP0+TAI))+.21*((DSO-OP)+(-.21)
C 2*(1+.2*3*(DSO-OP)/ZL)
C HSF(VTS, VTA0)=.108*VTS*((-0.865)*(VIA0+TAI))+.21*((DWI-DSO)+(-FF
C 2*.21)*(1+.2*3*(DWI-DSO)/ZL)

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LISTING AND SUBROUTINE COMPILATION: FURFAT P. 3

```

1000 CALL ETIME                      FF
      W9=0.0                          FF
      HF=0.0                          FF
1002 CALL SETUP                      FF
      CALL ETIMEF(SEC)                FF
      WRITE(6,2) SEC                  FF
      2 FORMAT(1H0.1F12.7,48H SECONDS HAD ELAPSED UPON RETURN FROM S.R. SFF
      2ETUF)                          FF
910  RIFS=RIF(CF,ES,AF,AS)           FF
      RISI=RIF(ES,EW,AS,AWI)         FF
      UTAO(1)=TAC                     FF
      UTBO(1)=TBO                     FF
      UTWI(1)=TWI                     FF
      UTWO(1)=TWO                     FF
      UTS(1)=TS                       FF
      UTF(1)=TF                       FF
C   FOR SA FURNACE. SET TWO=TR       FF
      IF(ITYPE.EQ.5) GO TO 707        FF
      GO TO 80                        FF
707  TWO=TR                          FF
      DO 19 LF=1,200                  FF
      UTWO(LF)=TWO                    FF
19  CONTINUE                          FF
      DO 20 8000 N=2,200              FF
C   ABBREVIATE SUBSCRIPTS            FF
      TAON1=UTAO(N-1)                 FF
      TBON1=UTBO(N-1)                 FF
      TFN1=UTF(N-1)                   FF
      TSN1=UTS(N-1)                   FF
      TWIN1=UTWI(N-1)                 FF
      TWON1=UTWO(N-1)                FF
C   FIND HS                           FF
      HS=HCF(TSN1,TAON1)              FF
C   TEMPORARY STORAGE FOR VARIABLES TO BE USED TO TEST CONVERGENCE OF L   FF
C   LOOP                              FF
      TEMP1=TAON1                     FF
      TEMP2=TSN1                      FF
      TEMP3=TWIN1                     FF
C   CALCULATE UTAO(1)                 FF
      CALL CALTAO(N)                  FF
      DO 100 IA=2,200                 FF
C   CALCULATE UTAO(IA)                FF
      CALL UTAOIA(N,IA)               FF
C   TEST UTAO(IA) FOR CONVERGENCE     FF
      TEST=ABS(UTAO(IA)-UTAO(IA-1))  FF
      IF(TEST.LT.WEE) GO TO 11        FF
100  CONTINUE                          FF
      UTAO(N)=UTAO(IA)                FF
      UTBO(N)=TBO(N)                  FF
      UTWI(N)=TWIN1                   FF
      UTWO(N)=TWON1                   FF
      UTF(N)=TFN1                     FF
      UTS(N)=TSN1                     FF
      DO 20 200 IB=2,200              FF
C   TEMPORARY STORAGE FOR VARIABLES TO BE USED TO TEST CONVERGENCE OF IB  FF
C   LOOP                              FF
      TEMP4=UTS(IB-1)                 FF
      TEMP5=UTWI(IB-1)                 FF
      UTBO(1)=UTBO(IB-1)              FF
      UTF(1)=UTF(IB-1)                FF
      UTS(1)=UTS(IB-1)                FF
      DO 30 300 IJ=2,200              FF
C   FIND HF                           FF
      GO TO (17,13,19),FFACF          FF
12  HF=HFF(UTF(IJ-1),UTBO(IJ-1))      FF
      IF (HF.GT.5. AND.WB.LT.200.)HF=5. FF
      GO TO 19                          FF
13  CALL HCALC(UTF(IJ-1),UTS(IJ-1),HF) FF
19  CONTINUE                          FF
C   TEMPORARY STORAGE FOR VARIABLES TO BE USED TO TEST CONVERGENCE OF IJ  FF
C   LOOP                              FF
      TEMP6=UTF(IJ-1)                 FF
      TEMP7=UTS(IJ-1)                 FF
      UTBO(1)=UTBO(IJ-1)              FF
      UTF(1)=UTF(IJ-1)                FF
      DO 40 400 J1=2,200              FF
C   TEMPORARY STORAGE FOR VARIABLES TO BE USED TO TEST CONVERGENCE OF J1  FF
C   LOOP                              FF
      TEMP8=UTBO(J1-1)                FF
      TEMP9=UTF(J1-1)                 FF
C   CALCULATE UTBO(1)                 FF
      CALL CALT90(IJ,J1)              FF
      DO 50 500 K1=2,200              FF
C   CALCULATE UT90(K1)                FF
      CALL UTBCK1(K1)                 FF
C   TEST UTBO(K1) FOR CONVERGENCE     FF
      TEST=ABS(UTBO(K1)-UTBO(K1-1))  FF
      IF(TEST.LT.WCF) GO TO 51        FF
500  CONTINUE                          FF
      UTBO(J1)=UTBO(K1)               FF
      UTF(1)=UTF(J1-1)                FF
      DO 55 550 K2=2,200              FF
C   CALCULATE UTF(K2)                 FF
      UTF(K2)=CALTF(UTF(K2-1),UTBO(J1),UTS(IJ-1))

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 4

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C TEST UTRK(2) FOR CONVERGENCE
TEST=ABS(UTRK(2)-UTRK(1))
IF (TEST.LT.WEE) GO TO 551
550 CONTINUE
551 UTRK(1)=UTRK(2)
C TEST UTRC(J1) FOR CONVERGENCE
UTR0(J1)=TEMP8
UTR1(J1)=TEMP9
TEST1=ABS(UTR0(J1)-UTR1(J1))
TEST2=ABS(UTR1(J1)-UTR1(J1))
IF (TEST1.LT.WEE .AND. TEST2.LT.WEE) GO TO 41
400 CONTINUE
41 UTR0(J1)=UTR1(J1)
UTR1(J1)=UTR1(J1)
UTR1(J1)=UTR1(J1)
60 DO 600 J2=2,200
C CALCULATE UTS(J2)
UTS(J2)=CALTS(UTR1(J2),UTR1(J2),UTS(J2-1),UTW1(29-1),UTAO(1))
C TEST UTS(J2) FOR CONVERGENCE
TEST=ABS(UTS(J2)-UTS(J2-1))
IF (TEST.LT.WEE) GO TO 61
600 CONTINUE
61 UTS(J2)=UTS(J2)
C TEST UTR(IJ), UTS(IJ) FOR CONVERGENCE
UTR(IJ)=TEMP6
UTS(IJ)=TEMP7
TEST1=ABS(UTR(IJ)-UTR(IJ-1))
TEST2=ABS(UTS(IJ)-UTS(IJ-1))
IF (TEST1.LT.WEE .AND. TEST2.LT.WEE) GO TO 31
300 CONTINUE
31 UTR0(IJ)=UTR(IJ)
UTR(IJ)=UTR(IJ)
UTS(IJ)=UTS(IJ)
UTW0(IJ)=UTW0(IJ-1)
UTW1(IJ)=UTW1(IJ-1)
70 DO 700 IL=2,200
C BYPASS CALCULATION OF UTRC FOR SA FURNACE
IF (TYPE.EQ.5) GO TO 92
C FIND MW
CALL WCALC(UTW0(IL-1),MW)
C TEMPORARY STORAGE FOR VARIABLES TO BE USED TO TEST CONVERGENCE OF IL
C LOOP
TEMPIC=UTW0(IL-1)
TEMPIL=UTW1(IL-1)
UTW0(IL)=UTW0(IL-1)
90 DO 900 LI=2,200
C CALCULATE UTRC(IL)
UTW0(LI)=CALTM(UTW1(IL-1),UTW0(LI-1))
C TEST UTRC(IL) FOR CONVERGENCE
TEST=ABS(UTW0(LI)-UTW0(LI-1))
IF (TEST.LT.WEE) GO TO 91
900 CONTINUE
91 UTR0(IL)=UTW0(LI)
92 UTR1(IL)=UTW1(IL-1)
95 DO 950 L2=2,200
C CALCULATE UTR1(L2)
UTW1(L2)=CALTM(UTAO(1),UTW1(L2-1),UTW0(LI),UTS(IJ))
C TEST UTR1(L2) FOR CONVERGENCE
TEST=ABS(UTW1(L2)-UTW1(L2-1))
IF (TEST.LT.WEE) GO TO 951
950 CONTINUE
951 UTR1(L2)=UTW1(L2)
C TEST UTRC(IL), UTR1(L2) FOR CONVERGENCE
IF (TYPE.EQ.5) TEMP12=UTW0
UTW0(IL-1)=TEMPIC
UTW1(IL-1)=TEMPIL
TEST1=ABS(UTW0(IL)-UTW0(IL-1))
TEST2=ABS(UTW1(IL)-UTW1(IL-1))
IF (TEST1.LT.WEE .AND. TEST2.LT.WEE) GO TO 71
700 CONTINUE
71 UTR0(IJ)=UTW0(IL)
UTW1(IJ)=UTW1(IL)
C TEST UTS(IJ), UTR(IJ) FOR CONVERGENCE
UTS(IJ)=TEMP8
UTW1(IJ)=TEMP9
TEST1=ABS(UTS(IJ)-UTS(IJ-1))
TEST2=ABS(UTW1(IJ)-UTW1(IJ-1))
IF (TEST1.LT.WEE .AND. TEST2.LT.WEE) GO TO 21
200 CONTINUE
21 UTR0(IJ)=UTR(IJ)
UTR(IJ)=UTR(IJ)
UTS(IJ)=UTS(IJ)
UTW0(IJ)=UTW0(IJ)
UTW1(IJ)=UTW1(IJ)
C CONVERGENCE PRINTOUT ENTER NOT=1 TO CRIT
TAO=UTAO(1)
TBO=UTBO(1)
TP=UTP(1)
TS=UTS(1)
TMO=UTMO(1)
TMI=UTMI(1)
TCL=15+75.6*KG*TE1/(15.4*MS)
IF (IN.EQ.2 .AND. NOT.EQ.2) CALL OUT2
IF (IN.EQ.2 .AND. NOT.EQ.2) CALL OUT1
C TEST UTR(IJ), UTS(IJ), UTR1(IJ) FOR CONVERGENCE
TAMI=TEMP1
TSMI=TEMP2
TMINI=TEMP3

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 5

```

TEST1=ABS(UTAO(N)-TAON1)
TEST2=ABS(UTS(N)-TSN1)
TEST3=ABS(UTWI(N)-TWIN1)
IF (TEST1.LT..001.AND.TEST2.LT..001.AND.TEST3.LT..001) GO TO 3010
8000 CONTINUE
9010 TAO=UTAO(N)
TBO=UTBO(N)
TF=UTF(N)
TS=UTS(N)
TWO=UTWO(N)
TWI=UTWI(N)
TCL=(S+75.4*KS*TF)/(75.4*KS)
C ENTER MOT=1 TO SKIP S.R. FMI SOLUTION VERIFICATION PRINTOUT
IF (MOT.EQ.2) CALL FMI
CALL OUT2
CALL ETIMEF(SEC)
WRITE(6,1) SEC
1 FORMAT(1H0, 27H9UN TIME FOR THIS CASE WAS .1PE13.7,10H SECONDS. 1
GO TO 1000
END
0 ELT TIFU/SIF5.1.740222. 99953
3 EOF 3
INCLUDE AFT1.LIST
INCLUDE AFT3.LIST
HSF(VTS,VTA0)=.108*VTS**(-.0965)*(VTAC+TAI)**.21*((D50-CP)**(-.2))
2.21) * (1.+2.3*(D50-D50)/ZL)**(WA/2475.1)**.3
HFF(VF,V9)=.108*VF**(-.0865)*(V9+TAI)**.21*((D50-CP)**(-.2))
2 * (1.+2.3*(D50-D50)/ZL)*(WA/2475.1)**.8
1000 CALL ETIME
1002 CALL SETUP
CALL ETIMEF(SEC)
WRITE(6,2) SEC
2 FORMAT(1H0,1PE13.7,98H SECONDS HAD ELAPSED UPON RETURN FROM S.R.
2SETUP)
UTAO(1)=TAO
UTWI(1)=TWI
UTWO(1)=TWO
UTS(1)=TS
UTF(1)=TF
C FOR 54 FURNACE, SET TWO=TR
IF (TYPE.EQ.5) GO TO 707
GO TO 80
707 TWO=TR
DO 19 LF=1,200
UTWO(LF)=TWO
19 CONTINUE
80 DO 8000 N=2,200
C ABBREVIATE SUBSCRIPTS
TAON1=UTAO(N-1)
TWIN1=UTWI(N-1)
TWO1=UTWO(N-1)
TSN1=UTS(N-1)
TFN1=UTF(N-1)
C FIND HS
HS=HSF(TSN1,TAON1)
TEMP1=TAON1
TEMP6=TSN1
TEMP7=TWIN1
C CALCULATE UTAO(I)
Q1=.5*HS*AS*(2.*TSN1-TAI)
Q2=.5*HS*AWI*(2.*TWIN1-TAI)
Q3=WA*CF+.5*HS*AS+.5*HS*AWI
UTAO(I)=(Q1+Q2+WA*CF+TAI)/Q3
10 DO 100 I=2,200
C CALCULATE UTAO(I)
CALLRLOGMNI(UTAO(I-1),TSN1,AWI1)
CALLRLOGMNI(UTAO(I-1),TWIN1,AWI2)
Q4=(HS*AS)/(WA*CF)
Q5=(HS*AWI)/(WA*CF)
UTAO(I)=Q4*AWI1+Q5*AWI2+TAI
C TEST VALUE OF UTAO(I) FOR CONVERGENCE
IF (ABS(UTAO(I)-UTAO(I-1)).LT..001) GO TO 11
100 CONTINUE
11 UTAO(N)=UTAO(I)
UTS(1)=TSN1
UTF(1)=TFN1
20 DO 200 L=2,200
C FIND HF
HF=HFF(UTF(L-1),UTS(L-1))
IF (WB.LT.1.001E-5) CALL HCALLC(UTF(L-1),UTS(L-1),HPS)
IF (HFS.GT.HF) HF=HFS
TEMP2=UTF(L-1)
TEMP3=UTS(L-1)
UTF(1)=UTF(L-1)
30 DO 300 JA=2,200
C CALCULATE UTF(JA)
RIFS=RIF(ES,AF,AS)
RISI=RIF(ES,FW,AS,AWI)
R1=AF*RIFS+.5BC
R2=(UTS(L-1))*.01
R3=WB*CF+.5*(UTS(L-1)+UTF(JA-1)-2.*TAI)
R4=HF*(UTF(JA-1)-UTS(L-1))*AF
UTF4=(1.0E8)*(P2*R2+R2+R2+IS-R3-P4)/P1)
IF (UTF4.LT.0.0) UTF4=0.0
UTFA=UTF4**25
UTPI(JA)=.25*UTFA+.75*UTF(JA-1)

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 6

```

C TEST UTF(JA) FOR CONVERGENCE
  IF (ABS(UTF(JA)-UTF(JA-1)).LT..001) GO TO 11
200 CONTINUE
  11 UTF(L)=UTF(JA)
  UTS(L)=UTS(L-1)
  40 DO 400 KA=2,200
C CALCULATE UTS(KA)
  RS=1.0/(AF*RIFS+SBC+AT*RISI+SBC)
  RB=(1.0E-8)*AF*RIFS*UTF(L)*UTF(L)+UTF(L)*UTF(L)*SBC
  RB=(1.0E-8)*AS*RISI*TWIN1*TWIN1*TWIN1*TWIN1*SBC
  R7=HF*AF*(UTF(L)-UTS(KA-1))
  CALL PLOEMN(UTAO(N),UTS(KA-1),AWS)
  UTSN=(1.0E8)*RS*(RB+R7-HS*AS*AWS3+R8)
  IF (UTSN.LT.0.0) UTSN=0.0
  UTSA=(UTSN)**.25
  UTS(KA) = .25*UTSA + .75*UTS(KA-1)
C TEST UTS(KA) FOR CONVERGENCE
  IF (ABS(UTS(KA)-UTS(KA-1)).LT..001) GO TO 41
400 CONTINUE
  41 UTS(L)=UTS(KA)
C TEST UTF(L) FOR CONVERGENCE
  UTF(L-1)=TEMP2
  UTS(L-1)=TEMP3
  IF (ABS(UTF(L)-UTF(L-1)).LT..001) GO TO 21
200 CONTINUE
  21 UTS(N)=UTS(L)
  UTF(N)=UTF(L)
  UTWO(1)=TWIN1
  UTWI(1)=TWIN1
  50 DO 500 M=2,200
C BYPASS CALCULATION OF UTWO FOR 5A FURNACE
  IF (TYPE.EQ.5) GO TO 62
C FIND MW
  CALL MCALC(UTWO(M-1),MW)
  TEMF4 = UTWO(M-1)
  UTWO(1)=UTWO(M-1)
  60 DO 600 JB=2,200
C CALCULATE UTWO(JB)
  S1=KW*AWM
  S2=FIT*AWO*EWO+SBC
  S3=UTWI(M-1)-UTWO(JB-1)
  S4=(HW*(UTWO(JB-1)-TR))/(EWO*SBC)
  UTM04=(1.0E8)*(S1+S3)/S2-S4*(1.0E-8)*TF*TR*TR*TR
  IF (UTM04.LT.TR**4) UTM04=TR**4
  UTM0A= UTM04**.25
  UTWO(JB) = .25*UTM0A +.75*UTWO(JB-1)
C TEST UTWO(JB) FOR CONVERGENCE
  IF (ABS(UTWO(JB)-UTWO(JB-1)).LT..001) GO TO 61
600 CONTINUE
  61 UTWO(M)=UTWO(JB)
  62 TEMF5= UTWI(M-1)
  UTWI(1)=UTWI(M-1)
  70 DO 700 KB=2,200
C CALCULATE UTWI(KB)
  CALL PLOEMN(UTAO(N),UTWI(KB-1),AWS4)
  S5=(HS*AWT)/(AS*RTST+SBC)
  S6=KW*AWM*(UTWI(KB-1)-UTWO(M))/(AS*RISI*FIT+SBC)
  UTM4=UTS(N)-UTS(N)-UTS(N)*UTS(N)-(1.0E7)*(S5-AWS4*30)
  IF (UTM4.LT.0.0) UTM4=0.0
  UTM4A = UTM4**.25
  UTWI(KB) = .25*UTM4A +.75*UTWI(KB-1)
C TEST UTWI(KB) FOR CONVERGENCE
  IF (ABS(UTWI(KB)-UTWI(KB-1)).LT..001) GO TO 71
700 CONTINUE
  71 UTWI(M)= UTWI(KB)
C TEST UTWO(M) FOR CONVERGENCE
  IF (TYPE.EQ.5) TEMF4=TW0
  UTW(M-1)= TEMF4
  UTWI(M-1)= TEMF5
  IF (ABS(UTWO(M)-UTWO(M-1)).LT..001) GO TO 51
500 CONTINUE
  51 UTWO(N)=UTWO(M)
  UTWI(N)=UTWI(M)
C TEST UTAO(N) FOR CONVERGENCE
C CONVERGENCE PRINTOUT
  TAO=UTAO(N)
  TWI = UTWI (N)
  TW0 = UTWO (N)
  TS = UTS(N)
  TF = UTF(N)
  TCL= (S+75.4*KS*TF)/(75.4*KS)
  TBO= (TF+TS)*.5
C ENTER NOT=1 TO SKIP CONVERGENCE PRINTOUT
  IF (N.EQ.2.AND.NOT.EQ.2) CALL OUT2
  IF (N.EQ.2.AND.NOT.EQ.2) CALL OUT3
C TEST UTAO(N),UTS(N),UTWI(N) FOR CONVERGENCE
  TAO1=TEMP1
  TS1 =TEMP6
  TWIN1=TEMP7
  IF (ABS(UTAO(N)-TAO1).LT..001.AND.ABS(UTS(N)-TS1).LT..001.AND.
  2ABS(UTWI(N)-TWIN1).LT..001) GO TO 8010
8000 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 7

```

      BUILD TAO = UTADIN)
      TWI = UTWI (N)
      TWO = UTWO (N)
      TS = UTS(N)
      TF = UTFIN)
      TCL = TS+75.4+NS+TF1/(75.4+KS)
      TBC = (TF+TS)*.5
      C ENTER MOT=1 TO SKIP G.R. FMC SOLUTION VERIFICATION PRINTOUT
      IF (MOT.EQ.2) CALL FMI
      CALL OUT2
      CALL ETIMEF(SEC)
      WRITE(6,1) SEC
      1 FORMAT (1H0, 27H RUN TIME FOR THIS CASE WAS ,1PE13.7,10H SECONDS.
      GO TO 1000
      ENO

```

```

      2 ELT SETUP /55F5.1.740222. 44955
      3 EOF 2
      SUBROUTINE SETUP
      INCLUDE AFT1.LIST
      INCLUDE AFT3.LIST
      DIMENSION VDF(2)/.56667,1./
      2 VDS(2)/1.15,1.21/
      3 VAS(2)/24.04,27.03/
      4 VAWI(2)/25.53,43.99/
      5 VAWO(2)/32.76,58.64/
      6 VAWM(2)/23.93,52.95/
      7 VKW(2)/.3,.17/
      8 VFIT(2)/.125,.25/
      9 VDWI(2)/1.25,2.0/
      1 VDSO(2)/1.20,1.25/
      2 VZL(2)/1.08,1.17/
      3 VEWO(2)/0.0,0.3/
      DIMENSION TAO(10)/ 1600.,1400.,1300.,1200.,1100.,1000.,900.,750.,
      2650.,565./
      DIMENSION TCLG(10)/ 2200.,2025.,1850.,1675.,1500.,1325.,1150.,
      2975.,800.,625./
      DIMENSION TFG(10)/2160.,1985.,1810.,1635.,1460.,1285.,1110.,935.,
      2760.,600./
      DIMENSION TS(10)/ 2060.,1885.,1710.,1535.,1360.,1185.,1010.,835.,
      2660.,531./
      DIMENSION TWIG(10)/2050.,1875.,1700.,1525.,1350.,1175.,1000.,825.,
      2650.,575./
      DIMENSION TWO(10)/1800.,1775.,1675.,1500.,1300.,1100.,900.,
      2800.,700.,570./
      DATA NTAOG,NTCLG,NTFG,NTSG,NTWIG,NTWOG/10,10,10,10,10,10/
      NAMELIST /FURN/TYPE
      NAMELIST /INLIST/ 3F,DS,AS,CF,WA,WB,EP,ES,EW,ZL,S,KS,KW,TR,
      2S,EWO,DWI,CSC,AWZ,AWO,AWM,FIT,TWO,TFG,ISG,TCLG,TAOG,TWIG,TWOG,
      3NTCLG,NTFG,NTSG,NTWIG,NTWOG,NTAOG,TAI,NDBJG,DELX,CRIT,FACTOR,MIT,
      4GCRT,TRUN,MOT,DEC,WEE,4F
      1 FORMAT (12A6)
      2 FORMAT(1H1,12A6, 3H RUN ON ,2A6,4H AT ,2A6/16H STARTING VALUES/)
      4 FORMAT(1H , 9H START: 6=.1PE13.7,6H TAO=.0PF6.1,5H TP=.F6.1,
      25H TS=.F6.1,6H TWI=.F6.1,6H TWO=.F6.1,5H TCL=.F6.1
      3,6H SUM=.F8.0/)
      CALL COY(DATE)
      CALL TOD(TIME)
      READ (IFU,1) FMOG
      READ (IFU,FURN)
      TYPE=TYPE
      KIN=TYPE-4
      2 OS = VDS(KIN)
      AS = VAS(KIN)
      AWI=VAWI(KIN)
      AWO=VAWO(KIN)
      AWM=VAWM(KIN)
      KW = VKW(KIN)
      FIT=VFIT(KIN)
      DWI=VDWI(KIN)
      OSO=VDSO(KIN)
      ZL =VZL (KIN)
      EWO=VEWO(KIN)
      READ (IFU,INLIST)
      AF=18.44954*OF
      TESTA=ABS(CF-1.0)
      TESTB=ABS(CF-.666667)
      IF (MIT.EQ.2.AND.TESTA.LE.1.E-8) AF=25.1325
      IF (MIT.EQ.2.AND.TESTB.LE.1.E-8) AF=16.7550
      FEACE=3
      IF (MF.GT.1.E-20) GO TO 15
      FEACE=1
      IF (W3.LE.1.E-20) FEACE=2
      15 CONTINUE
      IF (W3.GT.1.E-20) GO TO 16
      WB=1.E-5
      16 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 8

```

CALL PUT
TRUN=TRUN+60.
ENTRY NEWS
BIG=1.F+Y0
SATAC=TAO
SATCL=TCL
SATF=TF
SATS=TS
SATWI=TWI
SUM=0
SATWO=TWO
DO 6000 I=1,NTAOC
  TAC=TAOC(I)
  DO 5000 J=1,NTCLG
    TCL=TCLG(J)
    DO 4000 K=1,NTFG
      TF=TFG(K)
      IF(TCL.LT.TF) GO TO 4000
    DO 3000 L=1,NTIS
      TS=TSGL(L)
      IF(TF.LT.TS) GO TO 3000
      IF(TS+TF.LT.2+TAT) GO TO 3000
      IF(TS.LT.TAO) GO TO 3000
      IF(TS.LT.TAISO) GO TO 3000
      DO 2000 M=1,NTWIG
        TWI=TWIG(M)
        IF(TWI.LL.TAT) GO TO 2000
        IF(TWI.LL.TAC) GO TO 2000
        IF(TS.LT.TWI) GO TO 2000
        DO 1000 N=1,NTWOG
          TWO=TWOG(N)
          IF(TWI.LT.TWO) GO TO 1000
          IF(TWC.LT.TF) GO TO 1000
          CALL GCALC
          IF (G.ST.BIG) GO TO 1000
          SUM=SUM+1
          BIG=6
          SATAO = TAO
          SATCL = TCL
          SATF = TF
          SATS = TS
          SATWI = TWI
          SATWO = TWO
1000      CONTINUE
2000      CONTINUE
3000      CONTINUE
4000      CONTINUE
5000      CONTINUE
6000      CONTINUE
      TAO=SATAO
      TCL=SATCL
      TF=SATF
      TS=SATS
      TWI=SATWI
      TWO=SATWO
      TBO=(TS+TF)*.5
      G=BIG
      CALL OUT2
      IF (NCBLS(10).NE.0) WRITE(OFU,4) BIG,TAO,TF,TS,TWI,TWO,TCL,SUM
      RETURN
END
B CLY GCALC/55F5,1+7ND222, 99557
B EOF 3
SUBROUTINE GCALC
C A ROUTINE TO CALCULATE GCF(X1=2 *X2=2 ...*X6=2)
INCLUDE APT1.LIST
INCLUDE APT3.LIST
MFF=VTF.VTBOI=.103+VTF*(1-.0865)*(VTBO+TAT)*.21*(1050-OP)*(1-.21)
2 *E1+.2.3*(1050-OP)/ZL*(WA/2475.)*.2
1 FORMAT(1H, 3HF1=.1FE11.5,3HF2=.E11.5,3HF3=.E11.5,
23HF5=.E11.5,3HF6=.E11.5)
C FIND MF
TBO=(TS+TF)/2.
GO TO (12,13,14).PEACE
12 MF=MFF*(TF+TBO)
GO TO 14
13 CALL MCALC(TF,TS,MF)
14 CONTINUE
MS=0.0
IF(WA.GT.1.E-12)MS=.104+TS*(1-.0865)*(TAC+TAT)*.21*(1050-OP)*.
2 *(1-.21)*(1+.2.3*(1050-OP)/ZL*(WA/2475.)*.2)
110 JA=WA*CP*(TAT-TAT)
QB=MP*CP*(TS+TF-2*TAT)/2.-5
KUNICH=TYPE=1
GO TO (170,150).KUNICH 05HIF CALC. OF MF AND F6 FOR FURNACE TA.
120 F6=0.0
GO TO 170
150 CALL MCALC(TWO,MW)
F6=AWO*(TWO+OPC*FTDI(TWO,TP)+MW*(TWO-TP))*CP+QA
170 F1=KV*AW*(TWC-TWC)/FTT*TA*QB
F2=TS*.4*PS*(TCL-TF)*S
F3=AF*PI*FIEF(CS,AF,AS)*CHC*RTD(TF,TS)*MF*AP*(TP+TS)*QB
F4=MS*IAS*ATD(TAC,TS,TAT)*AW*ATD(TAT,TWC,TAC)*TA
F5=AS*PI*FIEF(MW,AS,AWI)*TBO*RTD(TS,TWI)*.4*AS*ATD(TAT,TS,TAO)*QB
GCF1=.2*.F2+.2*.F3+.2*.F4+.2*.F5+.2*.F6
IF(INCBUS(15).NE.0) WRITE(OFU,1) F1,F2,F3,F4,F5,F6
ENTRY FCC
RFS=PI*FIEF(FS,AF,AG)
PISI=PI*FIEF(MW,AS,AWI)
RETURN
END

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 9

```

@ ELT FHI/SIFS.1.740222. 44960
@ EOF @
SUBROUTINE FHI
  INCLUDE APT1.LIST
  INCLUDE APT3.LIST
  RIFS=RIF(FF,FS,AF,AS)
  RISI=RIF(ES,EW,AS,AW)
C  CALCULATE FHI1(TWI,TWO)
  Z1=1.E-3*TWO*TWO*TWO*TWO-1.E-8*TR*TR*TR*TR
  Z2=ALQ*(TWO*SBC*Z1+HW*(TWO-TR))
  Z3=KW*AW*(TWI-TQ0)/FTT
  FHI1=Z2-Z3
C  CALCULATE FHI2(TS,TAO,TWI,TWO)
  Z4=AS*RISI*(1.E-9*TS*TS*TS*TS-1.E-8*TWI*TWI*TWI*TWI)*SBC
  Z5=HS*AW*ATD(TAI,TWI,TAO)
  FHI2=Z4-Z5-Z3
C  CALCULATE FHI3(TS,TAO,TWI)
  Z6=HS*AS*ATD(TAI,TS,TAO)
  Z7=WA*CF*(TAO-TAI)
  FHI3=Z6-Z5-Z7
C  CALCULATE FHI4(TF,TS,TBO,TAO,TWI)
  Z8=AF*RIFS*SBC*((TF-.C1)*.4-(TS*.01)*.4)
  Z9=WB*CF*(TBO-TAI)
  Z10=WF*AF*ATD(TAI,TF,TBO)
  FHI4=Z8-Z9-Z10-Z6-Z4
C  CALCULATE FHI5(TF,TS,TBO)
  FHI5=Z8-Z10-Z5
  CALL OUT4
  RETURN
END
@ ELT HCALC/SIFS.1.740222. 44961
@ EOF @
SUBROUTINE HCALC (VTF,VTS,VHF)
C  SUBROUTINE FOR CALCULATING A VALUE OF COEFF. FOR FREE CONV. HEAT
C  TRANSFER, FOT-SUSCEPTOR.
  INCLUDE APT1.LIST
  INCLUDE APT3.LIST
  2C FORMAT (51H X VALUE DIDN'T MEET CONDITIONS IN SUBROUTINE HCALC)
  C=0
  EN=0
  AA=CS-DF
  BB=VTF-VTS
  CC=VTF+VTS
  DD=CC*.694
  RR=1.736E-4*DD/AA*.89
C  TEST TO FIND WHICH VALUES OF C AND EN TO USE.
  SS=0.0875*AA*.3+BB
  TT=EXP(45.18-4.386*ALOG(CC))
  X=SS+TT
  IF (X.LT.1.E+3) GO TO 1000
  IF (X.GT.1.E+3.AND.X.LT.1.E+4) GO TO 2000
  IF (X.GT.1.E+4.AND.X.LT.1.E+7) GO TO 3000
  WRITE(6,20)
1000 VHF=2.33E-4*DD/AA
  RETURN
2000 C=0.2
  EN=0.25
  VHF=RR*C*X*EN
  RETURN
3000 C=0.071
  EN=0.33
  VHF=RR*C*X*EN
  RETURN
END
@ ELT HCALC/SIFS.1.740222. 44963
@ EOF @
SUBROUTINE HCALC (VTWO,VHW)
C  FOR CALCULATION OF COEFF. FOR FREE CONVECTIVE HEAT TRANSFER,
C  GA FURNACE.
  INCLUDE APT1.LIST
  INCLUDE APT3.LIST
  3C FORMAT (52H X VALUE DID NOT MEET CONDITIONS IN SUBROUTINE HCALC )
  TAF=VTWO-TR
  TSF=VTWO+TR
  WT=240*TAF
  WS=EXP(45.18-4.386*ALOG(TSF))
  Y=WT*WS
C  TEST TO FIND WHICH VALUES OF C AND EN TO USE TO CALCULATE HW
  IF (Y.LT.1.E+4) GO TO 500
  IF (Y.GT.1.E+4.AND.Y.LT.1.E+9) GO TO 600
  IF (Y.GT.1.E+9.AND.Y.LT.1.E+12) GO TO 700
  WRITE(6,30)
C  CALCULATION OF HW VALUE
500 C=1.15
  EN=0.18
  VHW=1.66E-05*(TSF*.694)*C*(Y*EN)
  RETURN
600 C=.59
  EN=.25
  VHW=1.66E-05*(TSF*.694)*C*(Y*EN)
  RETURN
700 C=.13
  EN=.333
  VHW=1.66E-05*(TSF*.694)*C*(Y*EN)
  RETURN
END

```


LISTING AND SUBROUTINE COMPILATION: FURFAT P. 10

```

8 ELT RLOGMN/S1F5.1.740222. 44964
8 EOF 8
SUBROUTINE RLOGMN(X,Y,ANS)
INCLUDE AFT1.LIST
INCLUDE AFT3.LIST
XYS=1A1
IF((Y-XY)/(Y-X).GT.0.0) GO TO 101
ANS=(2.*Y-XY-X)*.5
RETURN
101 ANS=(X-XY)/(ALOG((Y-XY)/(Y-X)))
RETURN
END
8 ELT RLOGMN/S2F5.1.740222. 44965
8 EOF 8
SUBROUTINE RLOGMN(X,Y,ZZ,ANS)
INCLUDE AFT1.LIST
INCLUDE AFT3.LIST
IF((X-Y)/(X-ZZ).GT.0.0) GO TO 101
ANS=(2.*X-Y-ZZ)*.5
RETURN
101 ANS=(ZZ-Y)/ALOG((X-Y)/(X-ZZ))
RETURN
END
8 ELT OUT/SSF5.1.740222. 44967
8 EOF 8
SUBROUTINE OUT
INCLUDE AFT1.LIST
INCLUDE AFT3.LIST
1 FORMAT(1H,12A6.8H PUN ON ,2A6.4H AT ,2A6/)
2 FORMAT(1H ,13HINPUT SUMMARY)
3 FORMAT(1H ,5HFURN ,11.1HA)
4 FORMAT(1HC)
5 FORMAT(1H ,5X,3HOP=,1FE11.5,45H FT ,POT DIAMETER
2 AS=E11.5,27H SQ FT SUSCEPTOR WALL AREA)
6 FORMAT(1H ,5X,3HW=,1FE11.5,45H LB/HR INNER AIR FLOW
2 AF=E11.5,28H SQ FT FILLED POT WALL AREA)
7 FORMAT(1H ,5X,3HW=,1FE11.5,45H LB/HR OUTER AIR FLOW
2 AW=E11.5,34H SQ FT INNER AREA FURN INSULATION)
8 FORMAT(1H ,4X,4HTAY=,1FE11.5,45H DEG P INLET AIR TEMP
2 AW=,E11.5,34H SQ FT OUTER AREA FURN INSULATION)
9 FORMAT(1H ,5DX
2 4HAWM=E11.5,33H SQ FT LOG MEAN AREA FURN INSUL.)
10 FORMAT(1H ,5X,3HTP=,1FE11.5,45H DEG R ROOM TEMP
2 DMI=E11.5,31H FT I.D. OF FURN INSULATION)
11 FORMAT(1H ,5X,3HK=,1FE11.5,45H BTU/HR FT DEG F COND. OF FURNACE WOU
2 ZALL DSO=E11.5,31H FT O.D. OF FURN SUSCEPTOR )
12 FORMAT(1H ,5X,3K=,1FE11.5,45H BTU/HR FT DEG F COND. OF SOLID WASOU
2 EF=E11.5,8X,20HSUSCEPTOR EMISSIVITY)
13 FORMAT(1H ,5X,3HT=,1FE11.5,45H BTU/HR DEG F HEAT CAPACITY OF
2 EW=E11.5,8X,21HINSULATION EMISSIVITY)
14 FORMAT(1H ,5X,3HDS=,1FE11.5,45H FT SUSCEPTOR DIA.
2 EWO=E11.5,8X,24HFURNACE SHELL EMISSIVITY)
15 FORMAT(1H ,5X,3HX=,1FE11.5,45H FT FURN INSULATION THOU
2 ZKNS ZL=E11.5,19H FT ZONE LENGTH)
16 FORMAT(1H,13HDEPIVED TERMS//)
17 FORMAT(1H ,5X,14S,9X,52HT E M F E P A T U R E D E G R E E S R A D
2 N X I N E,5X,23HCONVECTION COEFFICIENTS,6X,16HRADIANT INTERCHG/
31H BTU/HOUR TAO TBO TF TS TWT TWO TCL HP HW HS RIPS RISI //)
4 TCL HP HW HS RIPS RISI //)
18 FORMAT(1H ,1FE12.5,0F7F8.1,1FE10.3,3H G=E10.4)
19 FORMAT(1H,60HVALUES OF ENERGY BALANCE EQUATIONS FOR SOLUTION TEMP
2ERATURES)
20 FORMAT(1H ,5X,4HFI1,6X,4HFI2,6X,4HFI3,6X,4HFI4,6X,4HFI5)
21 FORMAT(1H ,5F10.3)
WRITE(OFU, 1)FMC9, DATE,TIME
WRITE(OFU,2)
WRITE(OFU, 3) TYPE
WRITE(OFU, 4)
WRITE(OFU, 5) CP,AS
WRITE(OFU, 6) WR,AF
WRITE(OFU, 7) VA,AWI
WRITE(OFU, 8) TAI,AWO
WRITE(OFU, 9) AWM
WRITE(OFU,10) TR,DWI
WRITE(OFU,11)
WRITE(OFU,12) KS,EF
WRITE(OFU,13) CF,EW
WRITE(OFU,14) DS,EWO
WRITE(OFU,15) FIT,ZL
WRITE(OFU, 4)
RETURN
ENTRY OUT2
WRITE(OFU,16)
WRITE(OFU,17)
ENTRY OUT3
WRITE(OFU,18) S,TAO,TBO,TF,TS,TWT,TWO,TCL,HP,HW,HS,RIPS,RISI,C
RETURN
ENTRY OUT4
WRITE(OFU,19)
WRITE(OFU,20)
WRITE(OFU,21) FHI1,FHI2,FHI3,FHI4,FHI5
RETURN
END

```

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 11

B	ELT	CALTS/SIF5.1.740222. 99969	
B	EOF	B	
		FUNCTION CALTWI(DTWI,DTWC)	TWO
C	THIS	FUNCTION SUBPROGRAM CALCULATES DTWO(1) FROM P411	TWO
		INCLUDE APT1.LIST	
		INCLUDE APT3.LIST	
		S1=K1*ANM	TWO
		S2=FIT+AWC+END+SAC	TWO
		S3=DTWI-DTWO	TWO
		S4=(S2*(DTWO-TR1)/(END+SAC)	TWO
		UTWO=(1.0E8)/(S1+S3)/(S2-S4*(1.0E-8)*TR**4)	TWO
		IF(UTWO*.LT.0.0) UTWO=TR**4	TWO
		UTWO=UTWO**0.25	TWO
		CALT=0.25*UTWO + .75*DTWO	TWO
		RETURN	TWO
		END	TWO
B	ELT	CALTWI/SIF5.1.740222. 99969	
B	EOF	B	
		FUNCTION CALTWI(DTAO,DTWI,DTWO,OTS)	TWI
C	THIS	FUNCTION SUBPROGRAM CALCULATES OTWI(12) FROM PH12	TWI
		INCLUDE APT1.LIST	
		INCLUDE APT3.LIST	
		CALL RLOGMN(DTWI,TAI,DTAO,ANS4)	TWI
		S5=(AS+AWI)/(AS+RISI+SBC)	TWI
		S6=KW*ANM*(DTWI-DTWO)/(AS+RISI*FIT+SBC)	TWI
		UTWI=OTS**0-(1.0E8)*(S5+ANS4*S6)	TWI
		IF(UTWI*.LT.0.0) UTWI=0.0	TWI
		UTWI=UTWI**0.25	TWI
		CALT=0.25*UTWI + .75*DTWI	TWI
		RETURN	TWI
		END	TWI
B	ELT	CALTF/SIF5.1.740222. 99970	
B	EOF	B	
		FUNCTION CALTF(OTF,DTBO,OTS)	TP
C	THIS	FUNCTION SUBPROGRAM CALCULATES UTF(K2) FROM PH15	TP
		INCLUDE APT1.LIST	
		INCLUDE APT3.LIST	
		T1=S/(AF+RIFS+SBC)	TP
		CALL PLOGMN(OTF,TAI,DTBO,ANS6)	TP
		T2=HF+ANS6/(RIFS+SBC)	TP
		T3=(OTS*.01)**4	TP
		UTF=1.0E8*(T3+T1-T2)	TP
		IF(UTF*.LT.0.0) UTF=0.0	TP
		UTF=UTF**0.25	TP
		CALTF=.75*OTF +.25*UTF	TP
		RETURN	TP
		END	TP
B	ELT	CALTS/SIF5.1.740222. 99971	
B	EOF	B	
		FUNCTION CALTS(OTF,DTBO,OTS,DTWI,DTAO)	TS
C	THIS	FUNCTION SUBPROGRAM CALCULATES UTS(11) FROM PH14	TS
		INCLUDE APT1.LIST	
		INCLUDE APT3.LIST	
		T4=1.0E8/(AF+RIFS+SBC+AS+RISI+SBC)	TS
		T5=AF+RIFS+SBC*(OTF*.01)**4	TS
		T6=W9*CF*(CTBO-TAI)	TS
		CALL RLOGMN(OTS,TAI,DTAO,ANS3)	TS
		CALL RLOGMN(OTF,TAI,DTBO,ANS5)	TS
		T7=HS+AS+ANS3	TS
		UTS=T4*(TS+T8-T6-T9-T7)	TS
		IF(UTS*.LT.0.0) UTS=0.0	TS
		UTS=UTS**0.25	TS
		CALTS=.75*OTS + .25*UTS	TS
		RETURN	TS
		END	TS
B	ELT	CALTAO/SIF5.1.740222. 99973	
B	EOF	B	
		SUBROUTINE CALTAO(SS1)	TAO
C	THIS	ENTRY TO S.F. CALTAO CALCULATES UTAO(1), THE APPROXIMATE VALUE	TAO
C	USED	FOR IA=2, FROM THE ARITHMETIC MEAN	TAO
		INCLUDE APT1.LIST	
		INCLUDE APT3.LIST	
		INTEGER SS1,SS2,SS3	
		Q1=.5*HS+AS*(2.0*UTS(SS1-1)-TAI)	TAO
		Q2=.5*HS+AS*(2.0*UTW(SS1-1)-TAI)	TAO
		Q3=WA*CF+.5*HS+AS+.5*HS+AWI	TAO
		UTAO(1)=(Q1+Q2+WA*CF+TAI)/Q3	TAO
		RETURN	TAO
C	THIS	ENTRY CALCULATES THE EXACT VALUE OF UTAO(1), USING LOGMEAN	TAO
C	FROM	PH13	TAO
		ENTRY UTAO(1,SS2,SS3)	TAO
		CALL RLOGMN(UTS(SS2-1),TAI,UTAO(SS3-1),ANS1)	TAO
		CALL RLOGMN(UTW(SS2-1),TAI,UTAO(SS3-1),ANS2)	TAO
		Q4=(HS+AS)/(WA*CF)	TAO
		Q5=(HS+AWI)/(WA*CF)	TAO
		UTAOA=Q4*ANS1+.75*ANS2+TAI	TAO
		UTAO(SS3)=.25*UTAOA+.75*UTAO(SS3-1)	TAO
		RETURN	TAO
		END	TAO

LISTING AND SUBROUTINE COMPILATION: FURFAT P. 12

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E

PROGRAM NAME: GULP

Descriptive Title: Generalized Underground Leak Program Heat Transfer from Buried Waste Tanks

Program Author: DeMier, Warren V.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Radioactive Wastes, Underground Tanks, Leaks, Heat Transfer

Program Description: Estimates steady-state temperatures in heat generating, dried-up leaks from underground tanks through a concrete wall into soil. Leak shapes are hemispherical, prolate hemispheroidal, oblate hemispheroidal leaks. Location of maximum temperature a function of leak shape and adsorption on soil. Analytical solutions on leak axis derived by A. G. Gibbs. Two subroutines.

Input: Input is formatted, and suitable for teletype input. Shape of the leak is specified by giving its eccentricity and volume. The points at which temperatures are to be calculated are specified by giving from 1 to 40 coordinates representing distance from the concrete-soil interface and from 1 to 20 coordinates representing distance from centerline of leak.

For detailed list and description of input variables, see internal program documentation.

Output: Output is designed for line printer, not teletype. Output for each case includes an input summary and a table of temperature increases for each point of interest. F1, F2, F3, F4 may be printed also.

Users of Program:

G Jansen
WV DeMier

Documentation:

Equations and results appear in BNWL-181.

Condition of Program:

It does not run when the wall thickness is reduced to zero.

SAMPLE INPUT: GULP

GULP 09:04 02/14/74

100 PS RUN PUN007,CUR923,GEORGE,119,4999/999 G JANSEN 3760 BLDG

9423576

105 ON MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 OPUL TEL INFO00

115 OPRL TEL INFO00

120 OPRL TEL CUR928

125 PX ASG A=11145(JJ1145)

130 ON XQT CUP

150 FIND A,GULP/SIFS

160 TRD A

170 FIND A,PHI/SIFS

180 TRD A

190 FIND A,CLINE/SIFS

200 TRD A

350 TRI A

351 PCH GULP/SIFS

352 PCH PHI/SIFS

353 PCH CLINE/SIFS

1000 @IM FR5,* GULP/SIFS,GULP/SIFS,GULP/RIFS

1010 @IM FR5,* PHI/SIFS,PHI/SIFS,PHI/RIFS

1020 @IM FR5,* CLINE/SIFS,CLINE/SIFS,CLINE/RIFS

1030 ON XQT GULP/RIFS

1040 CASE NO. 1

1050 1000. 1 0 .35 .15 .5 2

1055 11

1060 0 1 2 4.4 5 6.95 8 10 15

1070 20 30

1080 9

1090 0 2 4 6 6.9 10 15 20 30

1100 CASE NO. 2

1110

1120 0

1125 0

1130 @ FIN

READY

SAMPLE OUTPUT: GULP P. 1

BU NOT GULP/RIE5

DRUM LENGTH 013914

THIS ALLOCATION WAS DONE ON 24 FEB 74 AT 13:20:19

ALL TEMPS COMPUTED BY 10 INTERVAL INTEGRATION EXCEPT THOSE LISTED BELOW.

CASE NO. 1

TABLE B-1 BWL-181

PAGE 2

M=CONCRETE THICKNESS FEET= 2.0 K SOIL BTU/(HR SQFT DEG F/FT)= .150 V=LEAK VOLUME (GAL)= 1.0000+03
 E=VOID FRACTION IN SOIL = .350 K CONCRETE = .500 A=LEAK RADIUS (FT)= 5.67
 D=DISTRIBUTION COEFFICIENT= .000 R = 1/(D+E) = 2.357 S=HT GEN RT INITIAL SOLN BTU/HR CUFT = 1.0000+00
 ECCENTRICITY= 1.0000+00

LEAK VOL	LEAK LENGTH	DISTANCE FROM	DELTA T	M*K	K*DELTA T	F(1)	F(2)	F(3)	F(4)
GALLONS	FEET	CONCRETE	LEAK CTRLN	DEGREES F	-----	-----	-----	-----	-----
V	A	FEET	FEET	T - T0	A*KM	S*A*A			
1.0000+03	5.67	.00	.00	1.9	1.058-01	0.000	PSI1=	1.000+00	PSI2= 0.000
1.0000+03	5.67	.00	2.00	3.2	1.058-01	4.312-02	1.555+01	9.042+00	1.159+01 8.120+00
1.0000+03	5.67	.00	4.00	2.6	1.058-01	3.471-02	3.835-01	4.284-01	6.889-01 4.016-01
1.0000+03	5.67	.00	6.00	1.2	1.058-01	1.583-02	5.543-01	3.399-01	5.598-01 3.260-01
1.0000+03	5.67	.00	8.93	.7	1.058-01	9.700-03	5.537-01	3.103-01	4.966-01 2.993-01
1.0000+03	5.67	.00	10.00	.2	1.058-01	2.764-03	3.582-01	2.372-01	3.426-01 2.323-01
1.0000+03	5.67	.00	15.00	.0	1.058-01	6.390-04	2.200-01	1.768-01	2.219-01 1.690-01
1.0000+03	5.67	.00	20.00	.0	1.058-01	1.740-04	1.645-01	1.331-01	1.329-01 1.323-01
1.0000+03	5.67	.00	30.00	-0.0	1.058-01	-2.780-05	1.062-01	9.219-02	1.058-01 9.190-02
1.0000+03	5.67	1.00	.00	7.0	1.058-01	0.000	PSI1=	1.138+00	PSI2= 0.000
1.0000+03	5.67	1.00	2.00	7.7	1.058-01	1.029-01	7.554-01	5.179-01	6.066-01 4.589-01
1.0000+03	5.67	1.00	4.00	6.1	1.058-01	8.168-02	7.191-01	4.065-01	5.761-01 3.761-01
1.0000+03	5.67	1.00	6.00	2.9	1.058-01	3.906-02	5.748-01	3.286-01	4.919-01 3.119-01
1.0000+03	5.67	1.00	6.90	1.9	1.058-01	2.519-02	5.698-01	3.015-01	4.484-01 2.854-01
1.0000+03	5.67	1.00	10.00	.6	1.058-01	7.402-03	3.455-01	2.333-01	3.263-01 2.270-01
1.0000+03	5.67	1.00	15.00	.2	1.058-01	2.163-03	2.227-01	1.693-01	2.174-01 1.669-01
1.0000+03	5.67	1.00	20.00	.1	1.058-01	8.198-04	1.632-01	1.324-01	1.311-01 1.313-01
1.0000+03	5.67	1.00	30.00	.0	1.058-01	1.637-04	1.659-01	9.195-02	1.053-01 9.156-02
1.0000+03	5.67	2.00	.00	10.1	1.058-01	0.000	PSI1=	1.198+00	PSI2= 0.000
1.0000+03	5.67	2.00	2.00	10.4	1.058-01	1.381-01	5.225-01	4.685-01	5.090-01 4.137-01
1.0000+03	5.67	2.00	4.00	8.0	1.058-01	1.068-01	5.900-01	3.813-01	4.922-01 3.590-01
1.0000+03	5.67	2.00	6.00	3.9	1.058-01	5.201-02	5.645-01	3.148-01	4.353-01 2.965-01
1.0000+03	5.67	2.00	6.90	2.7	1.058-01	3.563-02	4.578-01	2.908-01	4.045-01 2.761-01
1.0000+03	5.67	2.00	10.00	.9	1.058-01	1.229-02	3.297-01	2.281-01	3.987-01 2.208-01
1.0000+03	5.67	2.00	15.00	.3	1.058-01	3.599-03	2.184-01	1.674-01	2.121-01 1.644-01

CASE NO. 1

TABLE B-1 BWL-181

PAGE 3

M=CONCRETE THICKNESS FEET= 2.0 K SOIL BTU/(HR SQFT DEG F/FT)= .150 V=LEAK VOLUME (GAL)= 1.0000+03
 E=VOID FRACTION IN SOIL = .350 K CONCRETE = .500 A=LEAK RADIUS (FT)= 5.67
 D=DISTRIBUTION COEFFICIENT= .000 R = 1/(D+E) = 2.857 S=HT GEN RT INITIAL SOLN BTU/HR CUFT = 1.0000+00
 ECCENTRICITY= 1.0000+00

LEAK VOL	LEAK LENGTH	DISTANCE FROM	DELTA T	M*K	K*DELTA T	F(1)	F(2)	F(3)	F(4)
GALLONS	FEET	CONCRETE	LEAK CTRLN	DEGREES F	-----	-----	-----	-----	-----
V	A	FEET	FEET	T - T0	A*KM	S*A*A			
1.0000+03	5.67	2.00	20.00	.1	1.058-01	1.443-03	1.615-01	1.315-01	1.589-01 1.300-01
1.0000+03	5.67	2.00	30.00	.0	1.058-01	3.523-04	1.654-01	9.163-02	1.046-01 9.114-02
1.0000+03	5.67	4.40	.00	11.2	1.058-01	0.000	PSI1=	1.080+00	PSI2= 0.000
1.0000+03	5.67	4.40	2.00	10.6	1.058-01	1.419-01	4.280-01	3.664-01	3.601-01 3.266-01
1.0000+03	5.67	4.40	4.00	7.3	1.058-01	5.666-02	4.170-01	3.199-01	3.606-01 2.923-01
1.0000+03	5.67	4.40	6.00	4.1	1.058-01	5.483-02	3.799-01	2.775-01	3.354-01 2.607-01
1.0000+03	5.67	4.40	6.90	3.2	1.058-01	4.238-02	3.589-01	2.600-01	3.266-01 2.450-01
1.0000+03	5.67	4.40	10.00	1.4	1.058-01	1.869-03	2.872-01	2.120-01	2.444-01 2.079-01
1.0000+03	5.67	4.40	15.00	.5	1.058-01	6.373-03	2.648-01	1.609-01	1.970-01 1.570-01
1.0000+03	5.67	4.40	20.00	.2	1.058-01	2.772-03	1.557-01	1.283-01	1.522-01 1.263-01
1.0000+03	5.67	4.40	30.00	.1	1.058-01	7.826-04	1.637-01	9.053-02	1.027-01 8.962-02
1.0000+03	5.67	5.00	.00	10.3	1.058-01	0.000	PSI1=	9.999-01	PSI2= 0.000
1.0000+03	5.67	5.00	2.00	9.6	1.058-01	1.278-01	3.959-01	3.456-01	3.437-01 3.072-01
1.0000+03	5.67	5.00	4.00	6.5	1.058-01	8.673-02	3.869-01	3.054-01	3.375-01 2.796-01
1.0000+03	5.67	5.00	6.00	3.9	1.058-01	5.247-02	3.505-01	2.681-01	3.165-01 2.499-01
1.0000+03	5.67	5.00	6.90	3.1	1.058-01	4.153-02	3.389-01	2.527-01	3.039-01 2.373-01
1.0000+03	5.67	5.00	10.00	1.4	1.058-01	1.428-02	2.767-01	2.003-01	2.567-01 1.994-01
1.0000+03	5.67	5.00	15.00	.5	1.058-01	6.892-03	2.609-01	1.590-01	1.929-01 1.550-01
1.0000+03	5.67	5.00	20.00	.2	1.058-01	3.637-03	1.746-01	1.273-01	1.553-01 1.252-01
1.0000+03	5.67	5.00	30.00	.1	1.058-01	8.833-04	1.632-01	9.019-02	1.021-01 8.943-02
1.0000+03	5.67	6.95	.00	6.1	1.058-01	0.000	PSI1=	6.061-01	PSI2= 6.954-01
1.0000+03	5.67	6.95	2.00	5.9	1.058-01	7.813-02	3.173-01	2.895-01	2.823-01 2.622-01
1.0000+03	5.67	6.95	4.00	4.6	1.058-01	6.678-02	3.121-01	2.648-01	2.767-01 2.434-01
1.0000+03	5.67	6.95	6.00	3.2	1.058-01	4.294-02	2.953-01	2.392-01	2.663-01 2.230-01

SAMPLE OUTPUT: GULP P. 2

CASE NO. 1

TABLE B-1 DNAL-181

PAGE 4

H=CONCRETE THICKNESS FEET= 2.0
E=VOID FRACTION IN SOIL = .350
D=DISTRIBUTION COEFFICIENT= .000
ECCENTRICITY= 1.0000+00

K SOIL BTU/HR SOFT DEG F/FT)= .150 V=LEAK VOLUME (GAL)= 1.0000+03
K CONCRETE = .500 A=LEAK RADIUS (FT)= 5.67
R = 1/(0.01) = 2.857 SENT GEN RT INITIAL SOLN BTU/HR CUFF = 1.0000+00

LEAK VOL GALLONS V	LEAK LENGTH FEET A	DISTANCE FROM CONCRETE FEET B	LEAK CTRLN FEET C	DELTA T DEGREES F T - T0	MASK A=KM	K*DELTA T S=A*A	F(1)	F(2)	F(3)	F(4)
1.0000+03	5.67	6.95	6.90	2.7	1.158-01	3.618-02	2.850-01	2.281-01	2.506-01	2.139-01
1.0000+03	5.67	6.95	10.00	1.5	1.158-01	1.973-02	2.450-01	1.938-01	2.278-01	1.849-01
1.0000+03	5.67	6.95	15.00	.6	1.158-01	8.082-03	1.870-01	1.523-01	1.797-01	1.478-01
1.0000+03	5.67	6.95	20.00	.3	1.158-01	3.829-03	1.479-01	1.238-01	1.436-01	1.214-01
1.0000+03	5.67	6.95	30.00	.1	1.158-01	1.186-03	1.013-01	8.891-02	9.999-02	3.799-02
1.0000+03	5.67	8.00	.00	4.7	1.158-01	0.000	PS11=	3.173-01	PS12=	5.692-01
1.0000+03	5.67	8.00	2.00	4.7	1.158-01	6.189-02	2.863-01	2.654-01	2.573-01	2.410-01
1.0000+03	5.67	8.00	4.00	3.9	1.158-01	5.063-02	2.825-01	2.486-01	2.545-01	2.269-01
1.0000+03	5.67	8.00	6.00	2.8	1.158-01	3.790-02	2.696-01	2.250-01	2.449-01	2.101-01
1.0000+03	5.67	8.00	6.90	2.5	1.158-01	3.273-02	2.616-01	2.157-01	2.309-01	2.024-01
1.0000+03	5.67	8.00	10.00	1.4	1.158-01	1.920-02	2.297-01	1.860-01	2.138-01	1.773-01
1.0000+03	5.67	8.00	15.00	.6	1.158-01	8.436-03	1.807-01	1.484-01	1.727-01	1.439-01
1.0000+03	5.67	8.00	20.00	.3	1.158-01	4.145-03	1.444-01	1.217-01	1.402-01	1.191-01
1.0000+03	5.67	8.00	30.00	.1	1.158-01	1.332-03	1.002-01	8.811-02	9.874-02	3.713-02
1.0000+03	5.67	10.00	.00	3.1	1.153-01	0.000	PS11=	-3.747-01	PS12=	4.546-01
1.0000+03	5.67	10.00	2.00	3.2	1.153-01	4.224-02	2.410-01	2.201-01	2.200-01	2.101-01
1.0000+03	5.67	10.00	4.00	2.8	1.153-01	3.650-02	2.386-01	2.154-01	2.162-01	2.000-01
1.0000+03	5.67	10.00	6.00	2.2	1.153-01	2.971-02	2.306-01	2.009-01	2.120-01	1.852-01
1.0000+03	5.67	10.00	6.90	2.0	1.153-01	2.660-02	2.256-01	1.942-01	2.006-01	1.827-01
1.0000+03	5.67	10.00	10.00	1.3	1.153-01	1.746-02	2.041-01	1.717-01	1.930-01	1.636-01
1.0000+03	5.67	10.00	15.00	.7	1.153-01	8.658-03	1.674-01	1.468-01	1.599-01	1.362-01
1.0000+03	5.67	10.00	20.00	.3	1.153-01	4.585-03	1.373-01	1.174-01	1.331-01	1.147-01
1.0000+03	5.67	10.00	30.00	.1	1.153-01	1.574-03	9.774-02	8.644-02	9.617-02	3.534-02
1.0000+03	5.67	15.00	.00	1.4	1.058-01	0.000	PS11=	-2.882+00	PS12=	2.870-01

CASE NO. 1

TABLE B-1 DNWL-181

PAGE 5

H=CONCRETE THICKNESS FEET= 2.0
E=VOID FRACTION IN SOIL = .350
D=DISTRIBUTION COEFFICIENT= .000
ECCENTRICITY= 1.0000+00

K SOIL BTU/HR SOFT DEG F/FT)= .150 V=LEAK VOLUME (GAL)= 1.0000+03
K CONCRETE = .500 A=LEAK RADIUS (FT)= 5.67
R = 1/(0.01) = 2.857 SENT GEN RT INITIAL SOLN BTU/HR CUFF = 1.0000+00

LEAK VOL GALLONS V	LEAK LENGTH FEET A	DISTANCE FROM CONCRETE FEET B	LEAK CTRLN FEET C	DELTA T DEGREES F T - T0	MASK A=KM	K*DELTA T S=A*A	F(1)	F(2)	F(3)	F(4)
1.0000+03	5.67	15.00	2.00	1.5	1.058-01	2.021-02	1.722-01	1.674-01	1.611-01	1.571-01
1.0000+03	5.67	15.00	4.00	1.4	1.058-01	1.885-02	1.713-01	1.621-01	1.604-01	1.528-01
1.0000+03	5.67	15.00	6.00	1.3	1.058-01	1.889-02	1.682-01	1.557-01	1.573-01	1.473-01
1.0000+03	5.67	15.00	6.90	1.2	1.058-01	1.590-02	1.662-01	1.525-01	1.562-01	1.446-01
1.0000+03	5.67	15.00	10.00	.9	1.058-01	1.242-02	1.572-01	1.408-01	1.484-01	1.345-01
1.0000+03	5.67	15.00	15.00	.6	1.058-01	7.772-03	1.384-01	1.222-01	1.324-01	1.180-01
1.0000+03	5.67	15.00	20.00	.4	1.058-01	4.769-03	1.199-01	1.059-01	1.160-01	1.032-01
1.0000+03	5.67	15.00	30.00	.1	1.058-01	1.966-03	9.084-02	8.155-02	8.909-02	8.027-02
1.0000+03	5.67	20.00	.00	.8	1.058-01	0.000	PS11=	-6.462+00	PS12=	2.089-01
1.0000+03	5.67	20.00	2.00	.9	1.058-01	1.172-02	1.338-01	1.315-01	1.279-01	1.250-01
1.0000+03	5.67	20.00	4.00	.8	1.058-01	1.128-02	1.331-01	1.289-01	1.266-01	1.220-01
1.0000+03	5.67	20.00	6.00	.6	1.058-01	1.053-02	1.319-01	1.256-01	1.253-01	1.199-01
1.0000+03	5.67	20.00	6.90	.8	1.058-01	1.014-02	1.309-01	1.239-01	1.245-01	1.184-01
1.0000+03	5.67	20.00	10.00	.6	1.058-01	8.356-03	1.262-01	1.174-01	1.205-01	1.127-01
1.0000+03	5.67	20.00	15.00	.5	1.058-01	6.266-03	1.159-01	1.059-01	1.114-01	1.024-01
1.0000+03	5.67	20.00	20.00	.3	1.058-01	4.356-03	1.044-01	9.479-02	1.011-01	9.227-02
1.0000+03	5.67	20.00	30.00	.2	1.058-01	2.097-03	8.352-02	7.612-02	8.178-02	7.480-02
1.0000+03	5.67	30.00	.00	.4	1.058-01	0.000	PS11=	-1.678+01	PS12=	1.349-01
1.0000+03	5.67	30.00	2.00	.4	1.058-01	5.331-03	9.242-02	9.163-02	8.909-02	8.840-02
1.0000+03	5.67	30.00	4.00	.4	1.058-01	5.229-03	9.225-02	9.075-02	8.895-02	8.761-02
1.0000+03	5.67	30.00	6.00	.4	1.058-01	5.067-03	9.175-02	8.956-02	8.851-02	8.654-02
1.0000+03	5.67	30.00	6.90	.4	1.058-01	4.977-03	9.142-02	8.894-02	8.821-02	8.590-02
1.0000+03	5.67	30.00	10.00	.3	1.058-01	4.607-03	8.979-02	8.644-02	8.674-02	8.371-02
1.0000+03	5.67	30.00	15.00	.3	1.058-01	3.868-03	8.584-02	8.155-02	8.316-02	7.924-02
1.0000+03	5.67	30.00	20.00	.2	1.058-01	3.121-03	8.084-02	7.612-02	7.859-02	7.424-02

SAMPLE OUTPUT: GULP P. 3

CASE NO. 1

TABLE D-1 BWL-161

PAGE 6

M=CONCRETE THICKNESS FEET= 2.0 K SOIL BTU/(HR SQFT DEG F/FT)= .150 V=LEAK VOLUME (GAL)= 1.0000+03
 E=VOID FRACTION IN SOIL = .350 K CONCRETE = .500 A=LEAK RADIUS (FT)= 5.67
 D=DISTRIBUTION COEFFICIENT= .000 R = 1/(D+E) = 2.857 SEHT GEN RT INITIAL SOLN BTU/HR CUFT = 1.0000+00
 ECCENTRICITY= 1.0000+00

LEAK VOL GALLONS V	LEAK LENGTH FEET A	DISTANCE FROM CONCRETE FEET B	LEAK FROM LEAK CTN LN FEET C	DELTA T DEGREES F T - T0	M+K A+KM	K*DELTA T S+A*4	F(1)	F(2)	F(3)	F(4)
1.0000+03	5.67	30.00	30.00	.1	1.058-01	1.912-03	6.990-02	6.539-02	6.844-02	6.419-02

CASE NO. 1

TABLE A-1 BWL-101

PAGE 7

M=CONCRETE THICKNESS FEET= 2.0 K SOIL BTU/(HR SQFT DEG F/FT)= .150 V=LEAK VOLUME (GAL)= 1.0000+03
 E=VOID FRACTION IN SOIL = .350 K CONCRETE = .500 A=LEAK RADIUS (FT)= 5.67
 D=DISTRIBUTION COEFFICIENT= .000 R = 1/(D+E) = 2.857 SEHT GEN RT INITIAL SOLN BTU/HR CUFT = 1.0000+00
 ECCENTRICITY= 1.0000+00

C ACROSS B DOWN	.0	2.0	4.0	6.0	6.9	10.0	15.0	20.0	30.0
.00	1.9	3.2	2.6	1.2	.7	.2	.0	.0	-.0
1.00	7.0	7.7	6.1	2.9	1.9	.6	.2	.1	.0
2.00	10.1	10.4	8.0	3.9	2.7	.9	.3	.1	.0
4.00	11.2	10.6	7.3	4.1	3.2	1.4	.5	.2	.1
5.00	10.3	9.6	6.5	3.9	3.1	1.4	.5	.2	.1
6.95	6.1	5.9	4.6	3.2	2.7	1.5	.6	.3	.1
8.00	4.7	4.7	3.8	2.8	2.5	1.4	.6	.3	.1
10.00	3.1	3.2	2.8	2.2	2.0	1.3	.7	.3	.1
15.00	1.4	1.5	1.4	1.3	1.2	.9	.6	.4	.1
20.00	.8	.9	.8	.8	.8	.6	.5	.3	.2
30.00	.4	.4	.4	.4	.4	.3	.3	.2	.1

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE.

I/O CALLED AT SEQUENCE NUMBER 00133 OF MAIN PROGRAM

CSCX PL083J 14 FEB 74 13:19:50 USER CUB928 PU1007

CARDS IN 32 OUT 462 LINES 1016 PROCESSING TIME 36.35 SECONDS

LISTING AND SUBROUTINE COMPILATION: GULP P. 2

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17 FORMAT(1H1, 21HALL TEMPS COMPUTED BY 14.43M INTERVAL INTEGRATION &
  EXCEPT THOSE LISTED BELOW.)
  INTEGER FREQN, FREQNC
  REAL TX(41), TY(41), HX(101), HY(101), TITLE(12), K, KN, M, MCCA,
  ZT(40,18), CELT(40,18), P(40), C(16), Z(10), VI(10), FUM1(40,16), FUM2(40,
  16), FJN3(40,16), FJN4(40,16), X0A0
  DATA DL1,DL2/6HESI= .545,12= /
  ARSINH(R)= ALOG(R+SQRT(R**2+1.))
  CALL SETIO (2,1)
  CALL SETIO (3,2)
C READ INPUT AND CALCULATE CERTVED VARIABLES
2222 READ (2,1) TITLE
  LINE=0
  NPS =1
  CALL SLITE(0)
  READ (2,3) (Z(I),I=1,10),MAF
  DO 140 I=1,10
    IF(Z(I).LT.-0.0) VI(I)=0.0
    IF(Z(I).GT.-0.0) VI(I)=Z(I)
140 CONTINUE
    IF(VI(8).GT.40.) VI(8)=40.
    IF(VI(8).LE.0.0) VI(8)=10.
    IF(VI(9).GT.100.) VI(9)=100.
    IF(VI(9).LE.0.0) VI(9)= 40.
    V=VI(1)
    S=VI(2)
    O=VI(3)
    E=VI(4)
    H=VI(5)
    K=VI(6)
    M=VI(7)
    ECC= VI(10)
    ECCQ=ECC**2
    IF(ECC) 110,110,111
110 ECC = 1.E-13
C LEAK IS PROLATE ELLIPSOID
  ASSIGN 7000 TO JUMP
  ASSIGN 7100 TO KIND
  LSHAPE = 3
  ECCQ=1.E-26
  ECCQH=0.5*ECCQ/SQRT(1.-ECCQ)
  GO TO 117
111 IF (0.000001 - ABS(ECC-1.)) 113,113,112
112 ASSIGN 3000 TO JUMP
  LSHAPE = 2
C LEAK IS HEMISPHERICAL
  GO TO 117
113 IF (ECC-1.0) 113,112,111
114 CONTINUE
  LSHAPE = 3
C LEAK IS PROLATE ELLIPSOID
  ASSIGN 7000 TO JUMP
  ASSIGN 7100 TO KIND
  ECCQH=0.5*ECCQ/SQRT(1.-ECCQ)
  GO TO 117
115 CONTINUE
  LEAK IS OBLATE ELLIPSOID
  LSHAPE = 1
  ASSIGN 7600 TO KIND
  ASSIGN 7000 TO JUMP
  ECCQH= 0.5*ECCQ/SQRT(ECC-1.)
117 CONTINUE
  IF(Z(8) + Z(9) + Z(10) -1.E-5) 142,142,141
C SKIP SET-UP OF INTEGRATION INCREMENTS IF UNCHANGED FROM PREVIOUS CASE.
141 NTX= VI(8)+0.01
  NTY=NTX
  NMX= VI(9)+0.01
  NMV=NMX
  TDY=1./VI(8)
  TDY02=TDY*ECC
  TDY02=TDY/2.
  TDY02=TDY/2.
  HDX=1./VI(9)
  HDY=HDX*ECC
  HDY02=HDX/2.
  HDY02=HDY/2.
C SET UP INTERVALS FOR COARSE INTEGRATION
  TX(1)=TDY02
  TY(1)=TDY02
  DO 30 I=2,NTX
    F=I-1
    TX(I)=F*TDY+TDY02
    TY(I)=F*TDY+TDY02
  30 CONTINUE
C SET UP INTERVALS FOR FINE INTEGRATION
  HX(1)=HDX02
  HY(1)=HDY02
  DO 33 I=2,NMX
    F=I-1
    HX(I)=F*HDX+HDX02
    HY(I)=F*HDY+HDY02
  33 CONTINUE
142 CONTINUE
  READ (2,4) NB
  IF(NB.LE.0) GO TO 200
  READ (2,5) (IBN),N=1,NB)

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LISTING AND SUBROUTINE COMPILATION: GULP P. 3

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200 IF(ND.LE.0) NF=PREVNS
   READ (2,*) NC
   IF(ND.LE.0) GO TO 700
   READ (2,*) (CIN),NFI,NCI
300 IF(ND.LE.0) NCF=PREVNC
   IF(ND.GT.1) GO TO 301
   IF(C(1) - 2.E-10) 301,301,302
301 NF6=F
   GO TO 303
302 WRITE(3,17) NTX
303 CONTINUE
   R=1./(E+C)
   VGS=V/P/7.481
C STORE HT GEN RATE OF SOLN FOR OUTPUT
   SLI3=S
C CONVERT HT GEN RATE IN SOLN TO HT GEN RT IN SOIL
   S=S/P
   A=(0.47746+VGS/ECC0)**0.3333333
   DWT=M/K/(A+KM)
   CONV=S*A**2/K
   PREVNS=N3
   PREVNC=NC
   DO 1400 NN=1,NB
     BNN=P(NN)
     IF(BNN.LE.0.) BNN=1.E-10
C CHECK FOR INVALID B VALUE
     IF(BNN + DWT) 408,408,412
408 WRITE (3,12) TITLE,BNN,NN
     GO TO 2222
412 BOA=BNN/A
     BOAQ=BOA**2
     ODBALL=EOA+2.*DWT
     DO 1300 JJ=1,NC
       CJJ=C(JJ)
       IF(CJJ-2.E-10) 460,480,430
460 CONTINUE
       BETA=BNN*M/K/KM
       BETAQ=BETA/A
       BETAQ=BETAQ**2
       CALL CLINE (SETOA,SETOAG,BOA,BOAQ,OMEGA,FSI1,PSI2,LSHAPE,ECC,
2      ECCQ,BNN,A)
       FUN1(NN,JJ)=CL1
       FUN2(NN,JJ)=FSI1
       FUN3(NN,JJ)=CL2
       FUN4(NN,JJ)=PSI2
       T(NN,JJ)=C.C
       IF(PSI2-FSI1) 6200,6400,6400
6200 IS ROUTE FOR A POINT INSIDE OF LEAK. 6400 IS FOR POINT OUTSIDE.
       DELT(NN,JJ) = CONV* 0.25*(FSI1-OMEGA)
       GO TO 1300
6400 DELT(NN,JJ) = CONV* 0.25*(PSI2-OMEGA)
       GO TO 1300
480 COA=CJJ/A
       COAQ= COA**2
       ROAQ=BOAQ + COAQ/ECCQ
       ROA=SQRT(ROAQ)
       BETA = 90AQ +COAQ -ECCQ -1.
       BETAQ=BETA**2
       GAMMA = COAQ +ECCQ + (93AQ-1.)
       MCOA=-COA
       GO TO JUMP + (3000,7000)
3000 IF (ROA-1.) 410,410,405
410 FSIROA=0.3333333+0.1666667*(1.-ROA**2)
       GO TO 420
405 FSIROA=0.3333333/ROA
       GO TO 420
7000 IF(ROA-1.) 7005,7005,7010
C7005 POINT OF INTEREST IS INTERNAL POINT
7005 KOAQ= 0.0
       GO TO 7050
7010 SIGNOP = SIGN(1.,BETA)
       KOAQ=C.5*BETA*(1.+SIGNCR*SQRT(1.+9.*GAMMA/BETAQ))
C7010 POINT OF INTEREST IS EXTERNAL POINT
7050 GO TO KIND,(7100,7600)
7600 FT1= ECCQH*(1.-( COAQ-2.*BOAQ)/(2.*(ECCQ-1.)))
       ANG= SORT1(ECCQ-1.)/(ECCQ+KOAQ)
       FT2=ASIN(ANG)
       FT3= (.25+ECCQ*SQRT(1.+KOAQ)/(ECCQ-1.))*COAQ/(ECCQ+KOAQ)
       FT4= 0.5+ECCQ*BOAQ/(ECCQ-1.)*(SQRT(1.+KOAQ)))
       FSIROA = FT1+FT2+FT3+FT4
       GO TO 420
7100 FT5= ECCQH*(1.+(COAQ-2.*BOAQ)/(2.*(1.-ECCQ)))
       ANG=SQRT((1.-ECCQ)/(ECCQ+KOAQ))
       FT6= APSINH(ANG)
       FT7=(.25+ECCQ*SQRT(1.+KOAQ)/(1.-ECCQ))*COAQ/(ECCQ+KOAQ)
       FT8= .5+ECCQ*BOAQ/(1.-ECCQ)*(SQRT(1.+KOAQ)))
       FSIROA =FT5+FT6+FT7+FT8
420 F1=0.0
     F2=0.0
     F3=0.0
     F4=0.0

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LISTING AND SUBROUTINE COMPILATION: GULP P. 4

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C DOUBLE INTEGRATION, LIMITS 0 TO 1 AND 0 TO ECC*SQRT(1-X**2) COARSE
600 DO 644 I=1,NX
  XI=X(I)
500 DO 544 J=1,NY
  YJ=Y(J)
  IF(YJ-ECC*SQRT(1-XI**2)) 510,510,600
530 F1=FHI(XI,YJ,COA,COA,TOX,TOY,ECC) + F1
  F2=FHI(XI,YJ,COA,COA,TOX,TOY,ECC) + F2
  F3=FHI(XI,YJ,CORALL,COA,TOX,TOY,ECC) + F3
  F4=FHI(XI,YJ,CORALL,COA,TOX,TOY,ECC) + F4
549 CONTINUE
644 CONTINUE
  TBT=FSIPCA-C.1591549*(F1+F2+F3+F4)
C IF COARSE INTERVALS SUFFICE, SKIP FINE INTERVAL INTEGRATION.
  CALL SLITET(2,L2)
  GO TO (340,350),L2
350 CONTINUE
  CALL SLITET(1,L1)
  GO TO (900,900),L1
800 F1=0.0
  F2=0.0
  F3=0.0
  F4=0.0
C DOUBLE INTEGRATION, LIMITS 0 TO 1 AND 0 TO ECC*SQRT(1-X**2) FINE
DO 866 I=1,NMX
  XI=X(I)
700 DO 780 J=1,NMY
  YJ=Y(J)
  IF(YJ-ECC*SQRT(1-XI**2)) 710,710,866
730 F1=FHI(XI,YJ,COA,COA,TOX,TOY,ECC) + F1
  F2=FHI(XI,YJ,COA,COA,TOX,TOY,ECC) + F2
  F3=FHI(XI,YJ,CORALL,COA,TOX,TOY,ECC) + F3
  F4=FHI(XI,YJ,CORALL,COA,TOX,TOY,ECC) + F4
749 CONTINUE
866 CONTINUE
  TBM=FSIRTA-C.1591549*(F1+F2+F3+F4)
C IF TBT IS SUFFICIENTLY NEAR TBM, THE COARSE INTEGRATION MAY BE USED FOR
C CALCULATING TEMPERATURES UNTIL BNN TAKES ON A NEW VALUE.
  IF(ABS(TBT-TBM)/TBM) .COL) 900,900,877
877 TNN=JJ+TBM
  DELT(NN,JJ)=TBM*CONV
  WRITE (3,16) NN,JJ,BNN,CJJ,TBT,NTX,TBM,NMX
  GO TO 920
340 CONTINUE
341 CALL SLITET(2)
C TURN SENSELIGHT 1 ON TO SKIP FINE INTEGRATION FOR REMAINING CJS.
900 CALL SLITET(1)
  TNN=JJ+TBT
  DELT(NN,JJ)=TBT*CONV
C TURN SENSELIGHT 2 ON TO SKIP FINE INTEGRATION FOR REMAINING BNNS.
  IF( JJ-1) 910,910,920
910 CALL SLITET(2)
920 CONTINUE
C DO NOT STORE FUNCTIONS IF NOT REQUIRED FOR OUTPUT.
  IF(MAF.EQ.1) GO TO 1300
  FUN1(NN,JJ)= F1
  FUN2(NN,JJ)= F2
  FUN3(NN,JJ)= F3
  FUN4(NN,JJ)= F4
1300 CONTINUE
1400 CONTINUE
  LINE=55
  IF(MAF.EQ.1) GO TO 4000
DO 2700 KB=1,NB
DO 2500 KC=1,NC
  IF(LINE.LE.38) GO TO 2300
  NPG=NPG+1
  WRITE(3,2) TITLE,NPG
  WRITE(3,8) M,P,V,E,KH,A,O,R,SLIT,ECC
  WRITE (3,6)
  LINE=12
C PRINT COLUMN OUTPUT AND FUNCTION TABLE
2300 CONTINUE
  IF(KC) 2,2,10) 2330,2340,2370
2350 WRITE(3,15) V,A,B(KB),C(KC),DELT(KB,KC),OUT,(K,KC),FUN1(KB,KC),
  2FUN2(KB,KC),FUN3(KB,KC),FUN4(KB,KC)
  LINE=LINE+1
  GO TO 2500
2370 WRITE(3, 7) V,A,B(KB),C(KC),DELT(KB,KC),OUT,(K,KC),FUN1(KB,KC),
  2FUN2(KB,KC),FUN3(KB,KC),FUN4(KB,KC)
  LINE=LINE + 1
2500 CONTINUE
  WRITE (3,14)
  LINE=LINE + 1
2700 CONTINUE
4000 LINE=55
  IF (MAF-1) 4100,5000,4100
C PRINT TEMPERATURES IN 9 BY C ARRAY
4100 NPG=NPG + 1
  WRITE(3,2) TITLE,NPG
  WRITE(3,8) M,P,V,E,KH,A,O,R,SLIT,ECC
  WRITE (3,9) (C I),I=1,NC)
  WRITE (3,13)
DO 4200 KB=1,NB
  WRITE (3,16) (FNB),DELT(KB,KC),KC=1,NLC)
4200 CONTINUE
5000 GO TO 2222
END

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LISTING AND SUBROUTINE COMPILATION: GULP P. 5

```

0 ELT FHI/SIFS,1.671031, 66550
0 EOF 0
FUNCTION FHI(X,Y,E,C,DELX,DELY,ECC)
ECC=ECC**2
T1=ECC*SQRT(1.-X**2-Y**2/ECC)
T2=SQRT((X*0)**2 + (Y-C)**2 + ECC*ECC*(1.-X**2-Y**2/ECC))
T3=SQRT((X*0)**2 + (Y-C)**2)
FHI=DELX*DELY*ALOG((T1+T2)/T3)
RETURN
END

0 ELT CLINE/SIFS,1.671104, 2723
0 EOF 0
SUBROUTINE CLINE (BETOA,BETCAQ,BOA,BOAG,OMEGA,PSI1,PSI2,LSHAPF,
2ECC,ECCQ,B ,A)
GO TO (1000,2000,3000),LSHAPF
1000 CONTINUE
C
SHAPE IS OBLATE
OT1=BETOA*(BETOA+1.)/(1.-ECCQ)
OT2=BETOA*SQRT(ECCQ*BETCAQ)/(1.-ECCQ)
OT3=(ECCQ-BETOA)*ECCQ/(1.-ECCQ)/SQRT(ECCQ-1.)
DENQ= SQRT( BETOA + (ECCQ-1.)*(ECCQ+BETOA))
SA1 = (-BETOA)/DENQ
SA2 = (1.-ECCQ*BETOA)/DENQ
OMEGA=OT1-OT2-BETCA-OT3*(ASIN(SA1)+ASIN(SA2))
C S.P. WILL RETURN A VALUE OF 0.0 FOR PSI2 IF POINT IS INSIDE OF LEAK
PSI2=0.0
T1F1=BOA-2.*BOAG-BOA*(1.-BOA)/(1.-ECCQ) + BOA*SQRT(ECCQ
2 + BOAG)/(1.-ECCQ)
T2F1=(ECCQ + BOAG*(ECCQ/(ECCQ-1.)))/SQRT(ECCQ-1.)
DENQ=SQRT(BOAG*(ECCQ-1.)*(ECCQ+BOAG))
PSI1=T1F1 + T2F1*(ASIN(-BOA/DENQ) - ASIN((1.-ECCQ-BOA)/DENQ))
IF(B-A) 1200,1400,1400
1200 RETURN
C RETURN TO MAIN PROGRAM IF POINT IS INSIDE OF LEAK
C CONTINUE IF POINT IS OUTSIDE OF LEAK
1400 CONTINUE
Z1F1=(-BOA)- BOA*(BOA-1.)/(1.-ECCQ)+BOA*SQRT(ECCQ+BOAG)/(1.-ECCQ)
PSI2=PSI1-T1F1+Z1F1
RETURN
2000 CONTINUE
C
SHAPE IS HEMISPHERICAL
TUMF= (1.+BOAG)**1.5
TUMQ= (1.+BETCAQ)**1.5
OMEGA=1.+0.66666667*BETCAQ-(TUMQ-1.)/BETOA /1.5
PSI2 = 0.0
C S.P. WILL RETURN A VALUE OF 0.0 FOR PSI2 IF POINT IS INSIDE OF LEAK
PSI1=1.-1.33333333*BOAG*(TUMF-1.)/BOA/1.5
IF (B-A) 2200,2400,2400
2200 RETURN
C RETURN TO MAIN PROGRAM IF POINT IS INSIDE OF LEAK
2400 CONTINUE
PSI2=(-1.)-0.66666667*BOAG*(TUMF+1.)/BOA/1.5
RETURN
3000 CONTINUE
C
SHAPE IS PROLATE
OT1= BETOA*(BETOA + 1.)/(1.-ECCQ)
OT2= BETOA*SQRT(ECCQ*BETCAQ)/(1.-ECCQ)
OT3=(ECCQ-BETOA)*(ECCQ/(1.-ECCQ))/SQRT(1.-ECCQ)
TOF= BETOA+1.-ECCQ*(1.+BETCA)*SQRT(1.-ECCQ)
BOT= BETOA*SQRT((1.-ECCQ)*(ECCQ+BETCAQ))
OT4= LOG(TOF/BOT)
OMEGA=OT1-OT2-BETOA+OT3+OT4
C S.P. WILL RETURN A VALUE OF 0.0 FOR PSI2 IF POINT IS INSIDE OF LEAK
PSI2=0.0
T1F2=BOA-2.*BOAG-BOA*(1.-BOA)/(1.-ECCQ) + BOA*SQRT(ECCQ
2+BOAG)/(1.-ECCQ)
T2F2= (ECCQ-BOAG*(ECCQ/(1.-ECCQ)))/SQRT(1.-ECCQ)
TOF2=1.-ECCQ-BOA*(1.-BOA)*SQRT(1.-ECCQ)
BOT2= (-BOA)*SQRT((1.-ECCQ)*(ECCQ+BOAG))
IF(ABS(T2F2+TOF2+BOT2)-1.E-6) 3101,3101,3121
3101 PSI1=T1F2
GO TO 3191
3121 PSI1=T1F2+T2F2*ALOG(TOF2/BOT2)
3191 CONTINUE
IF(B-A) 3200,3400,3400
3200 RETURN
C RETURN TO MAIN PROGRAM IF POINT IS INSIDE OF LEAK
3400 Z1F2=(-BOA)- BOA*(BOA-1.)/(1.-ECCQ)+BOA*SQRT(ECCQ+BOAG)/(1.-ECCQ)
ZOF2=1.-ECCQ-BOA*(1.-BOA)*SQRT(1.-ECCQ)
PSI2=Z1F2+T2F2*ALOG(ZOF2/BOT2)
RETURN
END
06140274 CUB928FUNC07 100 3635 32 462 1016131950 1 0099 8 5

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PROGRAM NAME: HETING

Descriptive Title: General Purpose Transient and Steady-State Heat Transfer Program

Program Author: Creer, James R.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 4

Central Memory Words:

Average Execution Time:

Keywords: Heat Transfer, Conduction

Program Description: A generalized heat transfer program for estimating steady-state and transient temperatures in arbitrary, finite geometries. This program was originally written by Astra, Inc, as HETING 3, and rewritten by Chevreton-Turner at ORNL. J. R. Creer created the HETING 4 version (which this is an absolute version of, for use only on the UNIVAC 1108). See J. R. Creer for the latest CYBER 74 version.

Users of Program: G Jansen
JR Creer
JD McCormack (HEDL)

Documentation: IBM 360 Version documented in ORNL-TM-3208. Results of one application appear in BNWL-SA-4753.

Condition of Program: For some geometries convergence is not achieved within reasonable running times. Lack of convergence is not evident in the output to the user.

SAMPLE INPUT: HETING

HETING 12:58 02/17/74

100 RT RUN PUNDIO,QUDDCE,GEORGE,150,6000/3000 6 JANSEN 3760 BID

G 9423576

105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFO00

115 @PRL TEL INFO00

120 @PRL TEL CUB928

125 @X ASG A=U1145(JJ1145)

130 @N XQT CUR

342 FIND A,HETING

344 TRD A

350 TRI A

1030 @LI XQT HETING

1040 CONDUCTION IN COMPOSITE METAL-WASTE LAYERED CYLINDRICAL SYSTEM

	3	2	2	1	2	1	0
1050	0						
1060	2	0	3	1			
1070	1	500	10	5			
1080	0.01	1.0					
1090	1	1	0.0	1.0	0.0	0.0	0.0
1100	0.125						
1110	2	2	0.0	1.0	0.0	0.0	0.125 0.
1120	13750	1	0	1	0	0	0
1130	1	50.	0.2	0.500	0.500	0.500	
1140	2	50.	0.2	2.5	2.5	2.5	
1150	1	0	0	0	0		
1160	1	1	0	0			
1170	1	0.					
1180	2	1000.					
1190	1	2	0.	10000.			
1200	0.0	1.0					
1210	20						
1220	0.0	0.125	0.13750				
1230	20	5					
1232							
1234							

1240 @ FIN

READY

SAMPLE OUTPUT: HETING P. 1

JCL FOR HETING

HEATING PROGRAM

INPUT RETURN

JOB DESCRIPTION-- CONDUCTION IN COMPOSITE METAL-WASTE LAYERED CYLINDRICAL SYSTEM

GEOMETRY TYPE NO. 3

NUMBER OF REGIONS 2

NUMBER OF MATERIALS 2

NUMBER OF INITIAL TEMPERATURE FUNCTIONS 1

NUMBER OF GENERAL POSITION DEPENDENT FUNCTIONS 2

NUMBER OF HEAT GENERATION FUNCTIONS 1

NUMBER OF TIME DEPENDENT FUNCTIONS 0

TYPE OF OUTPUT DESIRED 0

NUMBER OF POINTS IN GROSS X OR R LATTICE 2

NUMBER OF POINTS IN GROSS Y OR THETA LATTICE 0

NUMBER OF POINTS IN GROSS Z LATTICE 3

NUMBER OF DIFFERENT KINDS OF BOUNDARIES 1

PROBLEM TYPE NUMBER 1

MAXIMUM NUMBER OF STEADY-STATE ITERATIONS 500

NUMBER OF S-S ITERATIONS BEFORE CALC BETA 10

NUMBER OF S-S ITERATIONS BEFORE EXTRAPOLATION 5

NUMBER OF DELTATS PER MONITOR PRINT -0

CONVERGENCE CRITERION .01000000

INITIAL BETA 1.00000000

TIME INCREMENT (DELTAT) -.00000000

TOTAL TIME -.00000000

REGION DATA

1	1	.0000	1.0000	.0000	.0000	.0000	.1250
1	1	0	1	0	0	0	0
2	2	.0000	1.0000	.0000	.0000	.1250	.1375
1	0	0	1	0	0	0	0

MATERIAL DESCRIPTION DATA

MATERIAL	RHO	C SUB P	KX	KY	KZ
1	.50000000+02	.20000000-30	.50000000-00	.50000000-00	.50000000-00
2	.50000000+02	.20000000-30	.25000000+01	.25000000+01	.25000000+01

HEAT GENERATION FUNCTION DATA

1	0	2	0	0
---	---	---	---	---

INITIAL TEMPERATURE FUNCTION DATA

1	1	0	0
---	---	---	---

GENERAL POSITION DEPENDENT FUNCTION COEFFICIENTS

1	.00000000	-.00000000	-.00000000	-.00000000	-.00000000	-.00000000
2	.10000000+04	-.00000000	-.00000000	-.00000000	-.00000000	-.00000000

BOUNDARY DATA

1	2	.00000000	10000.00000000	-0
---	---	-----------	----------------	----

GROSS LATTICES AND NUMBERS OF INCREMENTS

R OR X	
.000000	1.000000
20	
Z	
.000000	.125000
30	5

SAMPLE OUTPUT: HETING P. 2

FINE LATTICE: X OR R, Y OR THETA, Z

2	.050000	3	.102000	4	.150000	5	.200000
6	.250000	7	.302000	8	.350000	9	.400000
10	.450000	11	.502000	12	.550000	13	.600000
14	.650000	15	.702000	16	.750000	17	.800000
18	.850000	19	.900000	20	.950000	21	1.000000
1	.000000	2	.002500	3	.012500	4	.016750
5	.025000	6	.031250	7	.037500	8	.043750
9	.050000	10	.056250	11	.062500	12	.068750
13	.075000	14	.081250	15	.087500	16	.093750
17	.100000	18	.106250	19	.112500	20	.118750
21	.125000	22	.127500	23	.130000	24	.132500
25	.135000	26	.137500				

RESULTS FROM STEADY STATE CALCULATION

TIME= .030050

ITERATIONS COMPLETED = 116

LATTICE POINT TEMPERATURES

POINT NUMBER	I	J	K	POINT TEMPERATURE	POINT NUMBER	I	J	K	POINT TEMPERATURE
1	2	1	1	55.8763540	2	3	1	1	56.8440000
3	4	1	1	56.2244160	4	5	1	1	56.3475730
5	6	1	1	56.4312250	6	7	1	1	56.4625920
7	8	1	1	56.4219730	8	9	1	1	56.2783670
9	10	1	1	55.9662260	10	11	1	1	55.4781750
11	12	1	1	56.6641570	12	13	1	1	55.4184330
13	14	1	1	51.5345130	14	15	1	1	48.9694970
15	16	1	1	45.3407790	16	17	1	1	40.4272930
17	18	1	1	33.9365350	18	19	1	1	25.3804570
19	20	1	1	14.3242565	20	21	1	1	.0000000
21	2	1	2	56.6904580	22	3	1	2	56.2803080
23	4	1	2	56.4392070	24	5	1	2	56.5609780
25	6	1	2	56.6138750	26	7	1	2	56.6741650
27	8	1	2	56.6315360	28	9	1	2	56.4833510
29	10	1	2	56.1666530	30	11	1	2	55.6721910
31	12	1	2	54.8478840	32	13	1	2	53.5897470
33	14	1	2	51.7405190	34	15	1	2	49.1066430
35	16	1	2	45.4576110	36	17	1	2	40.5209260
37	18	1	2	33.9752740	38	19	1	2	25.4244020
39	20	1	2	14.3440334	40	21	1	2	.0000000
41	2	1	3	56.2462830	42	3	1	3	56.4356920
43	4	1	3	56.5932390	44	5	1	3	56.7160950
45	6	1	3	56.7984970	46	7	1	3	56.8275150
47	8	1	3	56.7323780	48	9	1	3	56.6321580
49	10	1	3	56.3304330	50	11	1	3	55.8092710
51	12	1	3	54.9773200	52	13	1	3	56.7085770
53	14	1	3	51.8463130	54	15	1	3	49.1972240
55	16	1	3	45.5304620	56	17	1	3	40.5747390
57	18	1	3	34.0794590	58	19	1	3	25.4415110
59	20	1	3	14.3500364	60	21	1	3	.0000000
61	2	1	4	56.3432200	62	3	1	4	56.5326190
63	4	1	4	56.6901150	64	5	1	4	56.8129190
65	6	1	4	56.8944930	66	7	1	4	56.9226720
67	8	1	4	56.8756770	68	9	1	4	56.7230430
69	10	1	4	56.4170460	70	11	1	4	55.8919910
71	12	1	4	55.0525780	72	13	1	4	53.7756570
73	14	1	4	51.9225770	74	15	1	4	49.2403710
75	16	1	4	45.5594220	76	17	1	4	40.5886630
77	18	1	4	34.0603440	78	19	1	4	25.4317500
79	20	1	4	14.3376103	80	21	1	4	.0000000
81	2	1	5	56.3819140	82	3	1	5	56.5712300
83	4	1	5	56.7287350	84	5	1	5	56.8518490
85	6	1	5	56.9431770	86	7	1	5	56.9601770
87	8	1	5	56.9117670	88	9	1	5	56.7568760
89	10	1	5	56.4495990	90	11	1	5	55.9187500
91	12	1	5	55.0739210	92	13	1	5	53.7894440
93	14	1	5	51.9595950	94	15	1	5	49.2365430
95	16	1	5	45.5446690	96	17	1	5	40.5629170
97	18	1	5	33.9749610	98	19	1	5	25.3752170
99	20	1	5	14.3130211	100	21	1	5	.0000000

SAMPLE OUTPUT: HETING P. 3

101	2	1	0	56.3621930	102	3	1	0	56.5514020
103	4	1	0	56.7094550	104	5	1	0	56.5314010
105	0	1	0	56.4132740	106	7	1	0	56.4392260
107	0	1	0	56.6899950	108	9	1	0	56.7334990
109	10	1	0	56.4219820	110	11	1	0	56.7144000
111	12	1	0	55.0413590	112	13	1	0	53.7515750
113	14	1	0	51.3643040	114	15	1	0	49.1854470
115	16	1	0	45.4661240	116	17	1	0	40.4474730
117	18	1	0	33.4661990	118	19	1	0	25.3315750
119	20	1	0	14.2715731	120	21	1	0	.0000000
121	4	1	7	56.2845390	122	3	1	7	56.4733270
123	4	1	7	56.6315850	124	5	1	7	56.7541000
125	0	1	7	56.6352110	126	7	1	7	56.5503950
127	0	1	7	56.3130040	128	9	1	7	56.6531310
129	10	1	7	56.3411330	130	11	1	7	55.8064510
131	12	1	7	54.9550740	132	13	1	7	53.6623480
133	14	1	7	51.7739770	134	15	1	7	49.0754480
135	16	1	7	45.3633850	136	17	1	7	40.2924010
137	18	1	7	33.5623130	138	19	1	7	25.2405140
139	20	1	7	14.2132357	140	21	1	7	.0000000
141	4	1	8	56.1474760	142	3	1	8	56.3362480
143	4	1	8	56.4948190	144	5	1	8	56.6162040
145	6	1	8	56.6989830	146	7	1	8	56.7243110
147	8	1	8	56.6730200	148	9	1	8	56.5155710
149	10	1	8	56.2633320	150	11	1	8	55.2674930
151	12	1	8	54.6149620	152	13	1	8	53.5234920
153	14	1	8	51.6279870	154	15	1	8	48.9431040
155	16	1	8	45.2360390	156	17	1	8	40.2476900
157	18	1	8	33.6647710	158	19	1	8	25.1215040
159	20	1	8	14.1331933	160	21	1	8	.0000000
161	4	1	9	55.9525190	162	3	1	9	56.1423250
163	4	1	9	56.3602690	164	5	1	9	56.4233490
165	6	1	9	56.5046020	166	7	1	9	56.5285080
167	8	1	9	56.4791780	168	9	1	9	56.3212340
169	10	1	9	56.3687430	170	11	1	9	55.4734600
171	12	1	9	54.6213370	172	13	1	9	53.3275850
173	14	1	9	51.4354650	174	15	1	9	46.7515460
175	16	1	9	45.3486490	176	17	1	9	40.652410
177	18	1	9	33.4918920	178	19	1	9	24.9754790
179	20	1	9	14.0459418	180	21	1	9	.0000000
181	2	1	19	55.6991930	182	3	1	10	55.6283990
183	4	1	19	56.3074540	184	5	1	10	56.1711700
185	6	1	19	56.2521120	186	7	1	10	56.2774430
187	8	1	19	56.2271350	188	9	1	10	56.0633720
189	10	1	19	55.7533450	190	11	1	10	55.2244660
191	12	1	19	54.3742260	192	13	1	10	53.0931070
193	14	1	19	51.1935210	194	15	1	10	46.5132450
195	16	1	19	44.8157710	196	17	1	10	39.8361380
197	18	1	19	33.2440330	198	19	1	10	24.7992210
199	20	1	19	13.9358523	200	21	1	10	.0000000
201	2	1	11	55.3575140	202	3	1	11	55.2774520
203	4	1	11	55.7363550	204	5	1	11	55.6602570
205	6	1	11	55.9415060	206	7	1	11	55.9572130
207	8	1	11	55.9176420	208	9	1	11	55.7616280
209	10	1	11	55.4518950	210	11	1	11	54.5295730
211	12	1	11	54.9736960	212	13	1	11	52.7257160
213	14	1	11	50.9621730	214	15	1	11	48.2231770
215	16	1	11	44.5393930	216	17	1	11	39.5752150
217	18	1	11	33.3409740	218	19	1	11	24.5950600
219	20	1	11	13.8671696	220	21	1	11	.0000000
221	2	1	12	55.0174890	222	3	1	12	55.2076940
223	4	1	12	55.3609770	224	5	1	12	55.4912090
225	6	1	12	55.5728040	226	7	1	12	55.5931630
227	8	1	12	55.5507540	228	9	1	12	55.2953470
229	10	1	12	55.0894620	230	11	1	12	54.5615450
231	12	1	12	53.7197920	232	13	1	12	52.4337610
233	14	1	12	50.5615440	234	15	1	12	47.6265760
235	16	1	12	44.2195170	236	17	1	12	39.2714560
237	18	1	12	32.7624430	238	19	1	12	24.3582170
239	20	1	12	13.6569766	240	21	1	12	.0000000
241	2	1	13	54.5891320	242	3	1	13	54.7794400
243	4	1	13	54.9393220	244	5	1	13	55.6333350
245	6	1	13	55.1465290	246	7	1	13	55.1733790
247	8	1	13	55.1264840	248	9	1	13	54.9746770
249	10	1	13	54.6711120	250	11	1	13	54.1453520
251	12	1	13	53.3125550	252	13	1	13	52.6393190
253	14	1	13	50.1717930	254	15	1	13	47.5194190
255	16	1	13	43.6561670	256	17	1	13	38.9277760
257	18	1	13	32.4461840	258	19	1	13	24.0235520
259	20	1	13	13.4922290	260	21	1	13	.0000000
261	2	1	14	54.1024550	262	3	1	14	54.2932930
263	4	1	14	54.4533830	264	5	1	14	54.5744460
265	6	1	14	54.6611970	266	7	1	14	54.6996420
267	8	1	14	54.4448510	268	9	1	14	54.4924480
269	10	1	14	54.1968930	270	11	1	14	53.6601320
271	12	1	14	52.6525470	272	13	1	14	51.5384470
273	14	1	14	49.7327180	274	15	1	14	47.0702390
275	16	1	14	43.4493500	276	17	1	14	38.5444470
277	18	1	14	32.0978620	278	19	1	14	23.8136310
279	20	1	14	13.2996905	280	21	1	14	.0000000
281	2	1	15	53.5575020	282	3	1	15	53.7436900
283	4	1	15	53.9092150	284	5	1	15	54.0344110
285	6	1	15	54.1184760	286	7	1	15	54.1433390
287	8	1	15	54.1659780	288	9	1	15	53.9606390
289	10	1	15	53.6669430	290	11	1	15	53.1572200
291	12	1	15	52.3384930	292	13	1	15	51.0465130
293	14	1	15	49.2446430	294	15	1	15	46.6232460
295	16	1	15	42.7791600	296	17	1	15	38.1273440
297	18	1	15	31.7113130	298	19	1	15	23.6773300
299	20	1	15	13.0463074	300	21	1	15	.0000000

SAMPLE OUTPUT: HETING P. 4

301	2	1	10	52.9542300	302	3	1	10	53.1454270
303	4	1	10	53.3067400	304	5	1	10	53.4330000
305	6	1	10	53.5176330	306	7	1	10	53.5453700
307	8	1	10	53.5890370	308	9	1	10	53.6580000
309	10	1	10	53.6412440	310	11	1	10	53.7787600
311	12	1	10	51.7710130	312	13	1	10	50.5324010
313	14	1	10	49.7376480	314	15	1	10	40.1054710
315	16	1	10	42.5055170	316	17	1	10	37.6584310
317	18	1	10	31.2892040	318	19	1	10	23.1185240
319	20	1	10	12.8473265	320	21	1	10	.0000000
321	2	1	17	52.2426350	322	3	1	17	52.4846960
323	4	1	17	52.6461470	324	5	1	17	52.7733260
325	6	1	17	52.6544740	326	7	1	17	52.8927210
327	8	1	17	52.6564590	328	9	1	17	52.7235350
329	10	1	17	52.4396140	330	11	1	17	51.9474490
331	12	1	17	51.1517390	332	13	1	17	49.9252690
333	14	1	17	43.1215450	334	15	1	17	45.5420870
335	16	1	17	41.9684130	336	17	1	17	37.1521710
337	18	1	17	30.8277380	338	19	1	17	22.7252300
339	20	1	17	12.5817409	340	21	1	17	.0000000
341	2	1	18	51.5732770	342	3	1	18	51.7653140
343	4	1	18	51.9272510	344	5	1	18	52.0540300
345	6	1	18	52.1421340	346	7	1	18	52.1784080
347	8	1	18	52.1458750	348	9	1	18	52.0155360
349	10	1	18	51.7426750	350	11	1	18	51.2612650
351	12	1	18	50.4786110	352	13	1	18	49.2724520
353	14	1	18	47.4865310	354	15	1	18	44.9314290
355	16	1	18	41.3117400	356	17	1	18	36.6074520
357	18	1	18	36.3301360	358	19	1	18	22.2095550
359	20	1	18	12.2644219	360	21	1	18	.0000000
361	2	1	19	50.7959460	362	3	1	19	50.9976740
363	4	1	19	51.1501255	364	5	1	19	51.2787040
365	6	1	19	51.3675660	366	7	1	19	51.4064710
367	8	1	19	51.3781125	368	9	1	19	51.2539930
369	10	1	19	50.9893540	370	11	1	19	50.5201650
371	12	1	19	49.7528510	372	13	1	19	46.5654860
373	14	1	19	46.6026360	374	15	1	19	40.2754140
375	16	1	19	40.7636170	376	17	1	19	36.0221140
377	18	1	19	29.7945360	378	19	1	19	21.8374950
379	20	1	19	11.9601369	380	21	1	19	.0000000
381	2	1	20	49.9585490	382	3	1	20	50.1517400
383	4	1	20	50.3147770	384	5	1	20	50.4442520
385	6	1	20	50.5349140	386	7	1	20	50.5757770
387	8	1	20	50.5535240	388	9	1	20	50.4357420
389	10	1	20	50.1812760	390	11	1	20	46.7243700
391	12	1	20	48.9737470	392	13	1	20	47.8371920
393	14	1	20	46.0695800	394	15	1	20	43.5723360
395	16	1	20	40.0956240	396	17	1	20	35.3958350
397	18	1	20	29.2297320	398	19	1	20	21.3238250
399	20	1	20	11.5981743	400	21	1	20	.0000000
401	2	1	21	49.0642320	402	3	1	21	49.2574570
403	4	1	21	49.4209990	404	5	1	21	49.5510040
405	6	1	21	49.6443140	406	7	1	21	49.6274400
407	8	1	21	49.6707430	408	9	1	21	49.5639370
409	10	1	21	49.3168530	410	11	1	21	48.8740510
411	12	1	21	48.1415970	412	13	1	21	46.9977230
413	14	1	21	45.2875720	414	15	1	21	42.8228000
415	16	1	21	39.3839460	416	17	1	21	34.7236350
417	18	1	21	28.6083530	418	19	1	21	20.8026970
419	20	1	21	11.1975320	420	21	1	21	.0000000
421	2	1	22	49.2236740	422	3	1	22	49.4169220
423	4	1	22	49.5803490	424	5	1	22	49.7107600
425	6	1	22	49.8029310	426	7	1	22	49.8671360
427	8	1	22	49.6266900	428	9	1	22	49.7144400
429	10	1	22	49.4664520	430	11	1	22	49.0178930
431	12	1	22	48.2774480	432	13	1	22	47.1230570
433	14	1	22	45.3996330	434	15	1	22	42.9139670
435	16	1	22	39.4616400	436	17	1	22	34.7857990
437	18	1	22	28.6437740	438	19	1	22	20.8156960
439	20	1	22	11.1936672	440	21	1	22	.0000000
441	2	1	23	49.4019970	442	3	1	23	49.5950510
443	4	1	23	49.7583450	444	5	1	23	49.8684850
445	6	1	23	49.9801720	446	7	1	23	50.0233000
447	8	1	23	50.0613170	448	9	1	23	49.8661660
449	10	1	23	49.6336490	450	11	1	23	49.1731620
451	12	1	23	48.4302250	452	13	1	23	47.2446970
453	14	1	23	45.5273570	454	15	1	23	43.0298560
455	16	1	23	39.5535660	456	17	1	23	34.8555700
457	18	1	23	28.6905300	458	19	1	23	20.8403430
459	20	1	23	11.1973398	460	21	1	23	.0000000
461	2	1	24	49.5986560	462	3	1	24	49.7918370
463	4	1	24	49.9549780	464	5	1	24	50.0848070
465	6	1	24	50.1764330	466	7	1	24	50.2179150
467	8	1	24	50.1945640	468	9	1	24	50.0759270
469	10	1	24	49.8191740	470	11	1	24	49.3578260
471	12	1	24	48.5998940	472	13	1	24	47.4226070
473	14	1	24	45.6705450	474	15	1	24	43.1554080
475	16	1	24	39.6581760	476	17	1	24	34.9379340
477	18	1	24	28.7485520	478	19	1	24	20.8737430
479	20	1	24	11.2087772	480	21	1	24	.0000000
481	2	1	25	49.8143970	482	3	1	25	50.0672940
483	4	1	25	50.1704510	484	5	1	25	50.2777520
485	6	1	25	50.3902770	486	7	1	25	50.4309920
487	8	1	25	50.4051190	488	9	1	25	50.2937730
489	10	1	25	50.0221750	490	11	1	25	49.5538700
491	12	1	25	48.7864400	492	13	1	25	47.5467750
493	14	1	25	45.8294170	494	15	1	25	43.2756170
495	16	1	25	37.7767750	496	17	1	25	35.0228450
497	18	1	25	28.8177270	498	19	1	25	20.4167820
499	20	1	25	11.2258935	500	21	1	25	.0000000

SAMPLE OUTPUT: HETING P. 5

501	2	1	26	50.0461895	502	3	1	26	50.2413990
503	4	1	26	50.4461841	504	5	1	26	50.5432950
505	6	1	26	50.6229172	506	7	1	26	50.6524940
507	8	1	26	50.6994960	508	9	1	26	50.7396660
509	10	1	26	50.7426681	510	11	1	26	49.7572590
511	12	1	26	48.9595100	512	13	1	26	47.7871350
513	14	1	26	46.9835100	514	15	1	26	43.4504290
515	16	1	26	39.9894780	516	17	1	26	35.1403540
517	18	1	26	28.9985220	518	19	1	26	20.9694516
519	20	1	26	11.2507749	520	21	1	26	.0000000

RESULTS FROM STEADY STATE CALCULATION

TIME= .000000

ITERATIONS COMPLETED = 115

TEMPERATURES ON NUMBERED BOUNDARIES

BOUNDARY NUMBER	TEMPERATURE
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1	.0000000
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EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 06117 OF LINK1

LINK1 CALLED AT SEQUENCE NUMBER 06114 OF MAIN PROGRAM

CSCA RL68JJ 17 FEB 74 13: 5: 6 USER CUB928 PUN019

CARD5 IN 33 OUT 1 LINES 371 PROCESSING TIME 56.03 SECONDS

LISTING AND SUBROUTINE COMPILATION: HETING P. 1

PROGRAM HEAT4

74/74

OPT=2

FTN 4.1+HEL

03/26/74 10.17.28.

```

PROGRAM HEAT4(INPUT,TAPE5=INPUT,
1          OUTPUT,TAPE6=OUTPUT,
3          TAPE7=200)
C***** THE HEATING CODE WITH TEMPERATURE-DEPENDENT THERMAL PROPERTIES
C***** AND NON-LINEAR AND SURFACE-TO-SURFACE BOUNDARY CONDITIONS.
C*****
C*      LET MAXPTS = MAXIMUM NUMBER OF LATTICE POINTS.
C*      IF ONE WISHES TO CHANGE THE MAXIMUM NUMBER OF LATTICE POINTS,
C*      THEN THE FOLLOWING TWO STATEMENTS MUST BE MODIFIED AS
C*      INDICATED.
C*****
      DIMENSION ICOPE(1)
      EQUIVALENCE (CORE(1),ICORE(1))
      COMMON /MNINCA/ JORDES(16)
      COMMON /INTHCG/SLTH(5),SLHM(5),MATSL
      COMMON /INPOCA/IT,JT,KT,NGEOM
      COMMON CORE(1)
      DATA IOLANK/111 /
C*
      DATA MAXPTS/2120/
      GO TO 1
900 DO 300 J=1,1000
      READ (5,100) (JOBDES(I),I=1,18)
100 FORMAT(18A4)
      DO 310 K=1,18
      IF (JOBDES(K).NE.IBLANK) GO TO 300
310 CONTINUE
      GO TO 1
300 CONTINUE
      JOBSKP=1
      CALL INPUT(MAXPTS,JOBSKP),*RETURNS(900)
      N=IT*JT*KT
      GO TO (66,44,44,22,22,66,44,44,22) NGEOM
22 NX=2
      GO TO 99
44 NX=4
      GO TO 99
66 NX=6
99 CONTINUE
      I1=1
      I2=I1+N
      I3=I2+N
      I4=I3+N
      I5=I4+N
      I6=I5+N
      I7=I6+N*NX
      I8=I7+2*N
      I9=J8*MATSL*N
      J10=J9*MATSL*N
      I8=J10+N
      I9=I8+6*N
      I10=I9+N
      I11=I10+N
      I12=I11+N
      I13=I12+N
      I14=I13+N
      I15=I14+N
      I16=I15+N
      I17=I16+N
      I18=I17+N
      I19=I18+N
      I20=I19+N
      I21=I20+N
      I22=I21+N
      I23=I22+N
      I24=I23+N*NX
      I25=I24+2*N
      IALLCC=I25+N
      PRINT 9999,IALLCC

```

```

HEAT4      2
HEAT4      3
HEAT4      4
HEAT4      5
HEAT4      6
HEAT4      7
HEAT4      8
HEAT4      9
HEAT4     10
HEAT4     11
HEAT4     12
HEAT4     13
HEAT4     14
HEAT4     15
HEAT4     16
HEAT4     17
HEAT4     18
HEAT4     19
HEAT4     20
HEAT4     21
HEAT4     22
HEAT4     23
HEAT4     24
HEAT4     25
HEAT4     26
HEAT4     27
HEAT4     28
HEAT4     29
HEAT4     30
HEAT4     31
HEAT4     32
HEAT4     33
HEAT4     34
HEAT4     35
HEAT4     36
HEAT4     37
HEAT4     38
HEAT4     39
HEAT4     40
HEAT4     41
HEAT4     42
HEAT4     43
HEAT4     44
HEAT4     45
HEAT4     46
HEAT4     47
HEAT4     48
HEAT4     49
HEAT4     50
HEAT4     51
HEAT4     52
HEAT4     53
HEAT4     54
HEAT4     55
HEAT4     56
HEAT4     57
HEAT4     58
HEAT4     59
HEAT4     60
HEAT4     61
HEAT4     62
HEAT4     63
HEAT4     64
HEAT4     65
HEAT4     66
HEAT4     67
HEAT4     68
HEAT4     69
HEAT4     70

```

LISTING AND SUBROUTINE COMPILATION: HETING P. 2

```

9999 FORMAT(1H0, * VARIABLE STORAGE ALLOCATED= * ,1,0) HEAT4 71
C HEAT4 72
C ***** HEAT4 73
C HEAT4 74
C IALLOC IS THE AMMOUNT OF CORE NEEDED FOR COMMON ON THE BASIS OF HEAT4 75
C THE INPUT DATA. HEAT4 76
C EXFL IS A SUBROUTINE TO EXTEND FIELD LENGTH--DYNAMICALLY ALLOCATE HEAT4 77
C COMMON. IF THIS PROGRAM IS TO BE RUN ON A COMPUTER THAT HEAT4 78
C CAN NOT DYNAMICALLY ALLOCATE COMMON, CHANGE THE CARD NEAR THE HEAT4 79
C FRONT OF THE DECK---COMMON CORE(1) ---TO THE SIZE HEAT4 80
C REQUIRED AND DELETE THE FOLLOWING STATEMENT--CALL EXFL. HEAT4 81
C ***** HEAT4 82
C HEAT4 83
C HEAT4 84
C CALL EXFL(CORE,IALLOC) HEAT4 85
C DO 999 I=1,IALLOC HEAT4 86
C ICORE(I)=0 HEAT4 87
999 CONTINUE HEAT4 88
CALL POINTS HEAT4 89
1 ( CORE(I1 ), CORE(I2 ), CORE(I3 ), CORE(I4 ), CORE(I5 ) HEAT4 90
2 , CORE(I6 ), CORE(I7 ), CORE(I8 ), CORE(I9 ), CORE(I10) HEAT4 91
3 , ICORE(I8 ), ICORE(I9 ), ICORE(I10), ICORE(I11) HEAT4 92
4 , ICORE(I12), ICORE(I13), ICORE(I14), ICORE(I15), ICORE(I16) HEAT4 93
5 , ICORE(I17), ICORE(I18), ICORE(I19), ICORE(I20), ICORE(I21) HEAT4 94
6 , ICORE(I22), ICORE(I23), ICORE(I24), ICORE(I25), MAXPTS ) HEAT4 95
CALL CALGLT HEAT4 96
1 ( CORE(I1 ), CORE(I2 ), CORE(I3 ), CORE(I4 ), CORE(I5 ) HEAT4 97
2 , CORE(I6 ), CORE(I7 ), CORE(I8 ), CORE(I9 ), CORE(I10) HEAT4 98
3 , ICORE(I8 ), ICORE(I9 ), ICORE(I10), ICORE(I11) HEAT4 99
4 , ICORE(I12), ICORE(I13), ICORE(I14), ICORE(I15), ICORE(I16) HEAT4 100
5 , ICORE(I17), ICORE(I18), ICORE(I19), ICORE(I20), ICORE(I21) HEAT4 101
6 , ICORE(I22), ICORE(I23), ICORE(I24), ICORE(I25), MAXPTS ) HEAT4 102
C** 1 (T1 , T2 , T3 , SMVG , SMRCV HEAT4 103
C** 2 , CDLIST , VGLIST , X1 , X2 , SLCAP HEAT4 104
C** 3 , NB , NNA , NPT , NVG , NTPI HEAT4 105
C** 4 , NTPJ , NTPK , NILBR , NILFR , NIRBR HEAT4 106
C** 5 , NIRFR , NOLBR , NOLFR , NORBR , NORFR HEAT4 107
C** 6 , NBLIST , NGLIST , MELMAT , MAXPTS ) HEAT4 108
HEAD (5,100)(JOBDES(I),I=1,18) HEAT4 109
DO 320 K = 1,18 HEAT4 110
IF (JOBDES(K).EQ.IBLANK) GO TO 320 HEAT4 111
JORSKP = 2 HEAT4 112
WRITE (6,200) HEAT4 113
200 FORMAT(1H0,10("XXXXXXXXX")/1H0,"YOU ARE SUPPOSED TO PUT A BLANK CAR HEAT4 114
1D BETWEEN JOBS."/1H ,"I HAVE NOT FOUND IT. I SHALL GO AHEAD AND W HEAT4 115
RITE THE" /1H ,"CARD I HAVE JUST READ AS THE JOB DESCRIPTION FOR T HEAT4 116
HE NEXT JOB." ) HEAT4 117
GO TO 2 HEAT4 118
320 CONTINUE HEAT4 119
GO TO 1 HEAT4 120
END HEAT4 121

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LISTING AND SUBROUTINE COMPILATION: HETING P. 3

SUBROUTINE INPUT

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.18.02.

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SUBROUTINE INPUT(MAXPTS,JUMSKP,RETURNS(X900)
COMMON /ECPU/ ICPU0,MAXCPU,MAXCPU
COMMON /INTHRM/ G1M(100) , G1P(100) , G2M(100) , G2P(100)
1 , G3M(100) , G3P(100) , G4M(100) , G4P(100) , G5M(100)
2 , G5P(100) , INTM(100) , ITMTM(25) , NGNTH(20) , NGNTH(20)
3 , ITMR(25) , ITMZ(25) , NGEN(100) , NGNR(20) , NGNZ(20)
4 , INITEM , JIN , NGG
COMMON /INTHCO/ SLTM(5) , SLHM(5) , MATSL
COMMON /INCALQ/ PRTIME(100) , DELTAT , BETA , FTIME
1 , EPI , MAXPRT , NPRINT , NOITX , IQUT
2 , JOUT , NDTA , NEX1 , NEX , KTHFCT
COMMON /INPOCA/ IT,JT,KT,NGEGM
COMMON /PTCSEN/ NGGR,NT
COMMON /ITCSPC/ BYTEMP(50) , TDUM(50) , TH(100) , R(100)
1 , Z(100) , NGYTFN(50) , NBDTPT , NTYPE
COMMON /MNINGA/ JORDFS(18)
COMMON /INASHC/ BHCONV(50) , BHEXP(50) , BMNAT(50) , BHRAD(50)
1 , BFLUX(50)
COMMON /INBCTB/ NBYTYP(50)
COMMON /ITPG/ POSFN(50,9) , VAR(3) , NFNX(3)
COMMON /ITCTIM/ TIMEFN(20,50) , TFN(20) , TIM , NTIMFP(20)
1 , NTDFN
COMMON /IPSECS/ NRRIN(100) , NRROT(100) , NTHLT(100) , NTHRT(100)
1 , NZZBK(100) , NZZFR(100) , MAXREG
COMMON /IPTSSB/ NBDHK(100) , NBDFR(100) , NBDIN(100) , NBDLT(100)
1 , NBDOT(100) , NBDPT(100) , MATL(100) , NOREGT , NGXP1
2 , NGYP1 , NGZP1 , NGX , NGY , NGZ
COMMON /ERROR/ IERPOR
COMMON /ITCCHD/ TABS(2) , JABS , IRAD , TDCDHC
DIMENSION RRIN(100) , RROT(100) , THLT(100) , THRT(100) , ZZBK(100)
1 ZZFR(100)
DIMENSION RG(50) , ZG(50) , THG(50) , DUMMY(9)
DIMENSION NORG(50) , NOZG(50) , NDTG(50) , NOPARM(9)
1 , NVA,UE(26)
DIMENSION MATNAM(100)
LOGICAL TDCDHC
DATA ZERO/0.0,COOR/6HX OR W,XORR/6HX OR R,YORT/6HY OR T/,
127/3H 7/
DATA MAXBUC/50/,MAXFGL/100/,MAXGFN/20/,MAXGPT/50/
1 , MAXITF /25/ , MAXMNT /50/ , MAXPAR /9/ , MAXPDF /50/
2 , MAXTDF /20/ , MAXTWT /25/
ICPU0=ICLOCK(0)
CALL TIME(CURTIM)
CALL IDAY(DATE)
MAXCPU=100000000
TDCDHC=.FALSE.
MAXPRT=100
MAXREG=100
C FOR PROBLEMS INVOLVING RADIATION
C TABS(1) CONTAINS CONVERSION TERM FOR FARENHEIT TO RANKINE
C TABS(2) CONTAINS CONVERSION TERM FOR CENTIGRADE TO KELVIN.
TABS(1)=459.69
TABS(2)=273.16
DO 55 I=1,MAXREG
NRRIN(I)=1
NRROT(I)=1
NTHLT(I)=1
NTHRT(I)=1
NZZBK(I)=1
NZZFR(I)=1
55 CONTINUE
WRITE(6,10000)
3000 FORMAT(' ','9X','THE HEATING CODE WITH TEMPERATURE-DEPENDENT THERMAL
1 PROPERTIES AND','0','9X','NON-LINEAR AND SURFACE-TO-SURFACE BOUNDAR
2Y CONDITIONS AND CHANGE OF PHASE CAPABILITIES.')
IF (JOBSP.NE.2) READ (5,5000)(JOBDES(I),I=1,18)
IF (EOF(5)) 999*888
999 CALL EXIT

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LISTING AND SUBROUTINE COMPILATION: HETING P. 4

888	CONTINUE	HEAT4	224
5000	FORMAT(18A4)	HEAT4	225
	READ(5,5001)NGEOM,NOREGT,MATLT,NINTFN,NPDFN,NGENFN,NTDFN,IOUT	HEAT4	226
5001	FORMAT(8I9)	HEAT4	227
	READ(5,5001)IGT,JGT,KGT,NHUTPT,INITEM,JIN,JOUT,IERROR	HEAT4	228
	WRITE(6,3004)MAXPTS	HEAT4	229
3004	FORMAT("0",9X,"THIS VERSION OF HEATING CAN HANDLE A MAXIMUM OF "	HEAT4	230
	1 16," LATTICE POINTS.")	HEAT4	231
	WRITE(6,3010)	HEAT4	232
3010	FORMAT(1H0,9X,12HINPUT RETURN)	HEAT4	233
	WRITE(6,3001)DATE,CURTIM	HEAT4	234
3001	FORMAT("0",11X,"DATE ",A10/"0",11X,"TIME ",A8)	HEAT4	235
	READ(5,5001)NTYPE,NOITX,NEA1,NEX,NOTA,NPRINT,IDEGRE,MATSL	HEAT4	236
C	FOR PROBLEMS INVOLVING RADIATION	HEAT4	237
C	IDEGRE = 0 IMPLIES DEGREES FAHRENHEIT	HEAT4	238
C	IDEGRE = 1 IMPLIES DEGREES CENTIGRADE.	HEAT4	239
	JARS=IDEGRE+1	HEAT4	240
	WRITE(6,3012)(JORDES(I),I=1,18)	HEAT4	241
	IF(IERROR.GT.0)WRITE(IERROR,3012)(JORDES(I),I=1,18)	HEAT4	242
3012	FORMAT(1H0,11X,18HJOB DESCRIPTION-- 18A4)	HEAT4	243
	READ(5,5006)EPI,BETA,DELTAI,KTHFCT,TIM,FTIME,MXCPU	HEAT4	244
5006	FORMAT(3E9.8,19,2E9.8,19)	HEAT4	245
	IF(MXCPU.GT.0)MAXCPU=100*MXCPU-500	HEAT4	246
	IF(MXCPU.LT.0)MAXCPU=0	HEAT4	247
5002	FORMAT(HE9.8)	HEAT4	248
	IF(BETA.EQ.0.0)BETA=1.9	HEAT4	249
	WRITE(6,3014)NGEOM	HEAT4	250
3014	FORMAT(1H0,11X,17HGEOMETRY TYPE NO.16)	HEAT4	251
	IF(NGEOM.LT.10 .AND. NGEOM.GT.0)GO TO 15	HEAT4	252
	IF(IERROR.GT.0)WRITE(IERROR,9001)	HEAT4	253
	WRITE(6,9001)	HEAT4	254
9001	FORMAT("0THE SPECIFIED GEOMETRY TYPE IS UNACCEPTABLE. PLEASE SEE	HEAT4	255
	1WRITE-UP.")	HEAT4	256
	STOP 11001	HEAT4	257
15	IF(NGEOM-5)202,203,204	HEAT4	258
C*	NGG=0 FOR RECTANGULAR COORDINATES.	HEAT4	259
C*	NGG=1 FOR CYLINDRICAL COORDINATES.	HEAT4	260
0202	NGG=1	HEAT4	261
	NGX=1	HEAT4	262
	GO TO (1,2,3,4),NGEOM	HEAT4	263
0203	NGG=1	HEAT4	264
	NGZ=1	HEAT4	265
	NGX=0	HEAT4	266
	NGY=0	HEAT4	267
	IT=1	HEAT4	268
	JT=1	HEAT4	269
	GO TO 205	HEAT4	270
0204	NGG=0	HEAT4	271
	NGX=1	HEAT4	272
	NERR = 99	HEAT4	273
	GO TO (10,10,10,10,10,6,7,8,9),NGEOM	HEAT4	274
0001	NGY=1	HEAT4	275
	NGZ=1	HEAT4	276
	GO TO 205	HEAT4	277
0002	NGY=1	HEAT4	278
	NGZ=0	HEAT4	279
	KT=1	HEAT4	280
	GOTO205	HEAT4	281
0003	NGY=0	HEAT4	282
	NGZ=1	HEAT4	283
	JT=1	HEAT4	284
	GO TO 205	HEAT4	285
0004	NGY=0	HEAT4	286
	NGZ=0	HEAT4	287
	JT=1	HEAT4	288
	KT=1	HEAT4	289
	GO TO 205	HEAT4	290
0006	NGY=1	HEAT4	291
	NGZ=1	HEAT4	292
	GO TO 205	HEAT4	293
0007	NGY=1	HEAT4	294
	NGZ=0	HEAT4	295
	KT=1	HEAT4	296
	GO TO 205	HEAT4	297

LISTING AND SUBROUTINE COMPILATION: HETING P. 5

0008	NGY=0	HEAT4	298
	NG7=1	HEAT4	299
	JT=1	HEAT4	300
	GO TO 205	HEAT4	301
0009	NGY=0	HEAT4	302
	NG7=0	HEAT4	303
	JT=1	HEAT4	304
	KT=1	HEAT4	305
205	WRITE (6,3016) NOREGT	HEAT4	306
3016	FORMAT(1H0,11X,18HNUMBER OF REGIONS I6)	HEAT4	307
	IF (NOREGT.GT.MAXREG) GO TO 11	HEAT4	308
	DO 206 M=1,NOREGT	HEAT4	309
	READ (5,5004) NOREG, (MATL(NOREG),RRIN(NOREG),RROT(NOREG),THLT(NOREG),THRT(NOREG),ZZBK(NOREG),ZZFR(NOREG))	HEAT4	310
	16)	HEAT4	311
5004	FORMAT(2I9,6E9,8)	HEAT4	312
	IF (NOREG.GT.MAXREG) GO TO 20	HEAT4	313
0206	READ (5,5001) ITEM(NOREG),NGEN(NOREG),NBDIN(NOREG),NBDOT(NOREG),NBDLT(NOREG),NBDRT(NOREG),NBDDBK(NOREG),NBDDBR(NOREG)	HEAT4	314
	18)	HEAT4	315
	WRITE (6,3018) MATLT	HEAT4	316
3018	FORMAT(1H0,11X,20HNUMBER OF MATERIALS I6)	HEAT4	317
	IF (MATLT.GT.MAXMAT) GO TO 11	HEAT4	318
	WRITE(6,3019) MATSL	HEAT4	319
3019	FORMAT(1H0,11X,54HNUMBER OF MATERIALS WITH CHANGE OF PHASE CAPABILITIES, I6)	HEAT4	320
	IF (MATSL.GT.0) TDCDHC=.TRUE.	HEAT4	321
	IF (MATSL.GT.5) GO TO 11	HEAT4	322
	IR=0	HEAT4	323
	DO 207 M=1,MATLT	HEAT4	324
	READ(5,5010) MAT, MATNAM(MAT),CONDY,DENSTY,SPHEAT,NCON,NDEN,NSHT	HEAT4	325
	10)	HEAT4	326
5010	FORMAT(19,1X,A8,3E9,8,3I9)	HEAT4	327
	IF (M.LE.MATSL) READ(5,5020) SLTM(MAT),SLHM(MAT)	HEAT4	328
5020	FORMAT(8E9,8)	HEAT4	329
	IF (MAT.GT.MAXMAT) GO TO 20	HEAT4	330
	CALL RCOND(CONDY,NCON,MAT,IR)	HEAT4	331
	IF (IR.EQ.20) GO TO 20	HEAT4	332
	IF (NTYPE.NE.1) CALL RDNEN(DENSTY,NDEN,MAT,IR)	HEAT4	333
	IF (IR.EQ.20) GO TO 20	HEAT4	334
	IF (NTYPE.NE.1) CALL RHTCP(SPHEAT,NSHT,MAT,IR)	HEAT4	335
	IF (IR.EQ.20) GO TO 20	HEAT4	336
207	CONTINUE	HEAT4	337
	WRITE(6,3020) NINTFN	HEAT4	338
3020	FORMAT(1H0,11X,40HNUMBER OF INITIAL TEMPERATURE FUNCTIONS I6)	HEAT4	339
	IF (NINTFN.GT.MAXITF) GO TO 11	HEAT4	340
	WRITE(6,3022) NPDFN	HEAT4	341
3022	FORMAT(1H0,11X,36HNUMBER OF GENERAL POSITION DEPENDENT, 11X,11HFUNCTIONS I6)	HEAT4	342
	IF (NPDFN.GT.MAXPDF) GO TO 11	HEAT4	343
	WRITE (6,3024) NGENFN	HEAT4	344
3024	FORMAT(1H0,11X,35HNUMBER OF HEAT GENERATION FUNCTIONS I6)	HEAT4	345
	IF (NGENFN.GT.MAXGFN) GO TO 11	HEAT4	346
	IF (NGENFN.LE.0) GO TO 7209	HEAT4	347
	DO 208 M=1,NGENFN	HEAT4	348
	READ (5,5001) NGN, (NGNTM(NGN),NGNR(NGN),NGNTH(NGN),NGNZ(NGN))	HEAT4	349
	IF (NGN.GT.MAXGFN) GO TO 20	HEAT4	350
0208	CONTINUE	HEAT4	351
7209	IF (NINTFN.LE.0) GO TO 7211	HEAT4	352
	DO 209 M=1,NINTFN	HEAT4	353
	READ (5,5001) INTM, (ITMR(INTM),ITMTH(INTM),ITMZ(INTM))	HEAT4	354
	IF (INTM.GT.MAXITF) GO TO 20	HEAT4	355
0209	CONTINUE	HEAT4	356
7211	IF (NPDFN.LE.0) GO TO 7213	HEAT4	357
	DO 7212 I=1,MAXPDF	HEAT4	358
	DO 7212 J=1,MAXPAR	HEAT4	359
7212	POSFN(I,J)=ZERO	HEAT4	360
	DO 210 M=1,NPDFN	HEAT4	361
	READ(5,5001) NFN,NPAR	HEAT4	362
	IF (NFN.GT.MAXPDF) GO TO 20	HEAT4	363
	IF (NPAR.GT.MAXPAR) GO TO 20	HEAT4	364
	READ(5,5003) (NOPARM(I),DUMMY(I),I=1,NPAR)	HEAT4	365
5003	FORMAT(4(I9,E9,0))	HEAT4	366
	DO 350 I=1,NPAR	HEAT4	367
	IF (NOPARM(I).GT.MAXPAR) GO TO 20	HEAT4	368
350	POSFN(NFN,NOPARM(I))=DUMMY(I)	HEAT4	369
210	CONTINUE	HEAT4	370
7213	WRITE (6,3026) NTOFN	HEAT4	371
		HEAT4	372

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3026	FORMAT(1H0,11X,34HNUMBER OF TIME DEPENDENT FUNCTIONS I6)	HEAT4	373
	IF (NTDFN.GT.MAXTDF)GO TO 11	HEAT4	374
	IF (NTDFN)7214,7216,7214	HEAT4	375
7214	DO 211 L=1,NTDFN	HEAT4	376
	READ(5,5004) NTM,NTMFP(NTM),(TIMFN(NTM,I),I=1,6)	HEAT4	377
	IF (NTM.GT.MAXTDF)GO TO 20	HEAT4	378
	IF (NTMFP(NTM).GT.MAXTDF)GO TO 20	HEAT4	379
	K=NTMFP(NTM)*2	HEAT4	380
	IF (K-6) 211,211,7215	HEAT4	381
7215	READ (5,5002) (TIMFN(NTM,I),I=7,K)	HEAT4	382
0211	CONTINUE	HEAT4	383
7216	WRITE(6,3028)IOUT	HEAT4	384
3028	FORMAT(1H0,11X,22HTYPE OF OUTPUT DESIRED I6)	HEAT4	385
	WRITE(6,3030)IGT	HEAT4	386
3030	FORMAT(1H0,11X,40HNUMBER OF POINTS IN GROSS X OR R LATTICE I6)	HEAT4	387
	IF (IGT.GT.MAXGPT)GO TO 11	HEAT4	388
	WRITE (6,3032)JGT	HEAT4	389
3032	FORMAT(1H0,11X,44HNUMBER OF POINTS IN GROSS Y OR THETA LATTICE I6)	HEAT4	390
	IF (JGT.GT.MAXGPT)GO TO 11	HEAT4	391
	WRITE (6,3034)KGT	HEAT4	392
3034	FORMAT(1H0,11X,35HNUMBER OF POINTS IN GROSS Z LATTICE I6)	HEAT4	393
	IF (KGT.GT.MAXGPT)GO TO 11	HEAT4	394
C	IRAD = 1 IMPLIES NO RADIATION FOR THE PROBLEM.	HEAT4	395
C	IRAD = 2 IMPLIES THE PROBLEM INVOLVES RADIATION.	HEAT4	396
	IRAD = 1	HEAT4	397
C	INCONV = 1 IMPLIES NO NATURAL CONVECTION FOR THE PROBLEM	HEAT4	398
C	INCONV = 2 IMPLIES THE PROBLEM INVOLVES NATURAL CONVECTION.	HEAT4	399
	INCONV=1	HEAT4	400
	WRITE(6,3036)NBDTPT	HEAT4	401
3036	FORMAT(1H0,11X,39HNUMBER OF DIFFERENT KINDS OF BOUNDARIES I6)	HEAT4	402
	IF (NBDTPT.GT.MAXBDC)GO TO 11	HEAT4	403
	IF (NBDTPT.LE.0)GO TO 7217	HEAT4	404
	DO 212 M=1,NBDTPT	HEAT4	405
	READ (5,5005)NBDTP,(NBTTYP(NBDTP),BYTEMP(NBDTP),NBTFN(NBDTP),	HEAT4	406
	1BHCONV(NBDTP),BHRAD(NBDTP),BHNAT(NBDTP),BHEXP(NBDTP),BFLUX(NBDTP))	HEAT4	407
5005	FORMAT(2I9,E9.3,I9/5E9.8)	HEAT4	408
	IF (NBDTP.GT.MAXBDC)GO TO 20	HEAT4	409
	IF (BHRAD(NBDTP).GT.0)IRAD=2	HEAT4	410
	IF (BHNAT(NBDTP).GT.0)INCONV=2	HEAT4	411
0212	CONTINUE	HEAT4	412
C	IF TDCDHC IS TRUE, THE CODE WILL UPDATE THE FILM COEFFICIENT	HEAT4	413
C	AT EACH ITERATION OR TIME STEP.	HEAT4	414
7217	IF (IRAD.EQ.2 .OR. INCONV.EQ.2)TDCDHC=.TRUE.	HEAT4	415
	WRITE(6,3006)INITEM	HEAT4	416
3006	FORMAT("0",11X,"NUMBER OF LATTICE POINTS FOR WHICH THE INITIAL TEM	HEAT4	417
	PERATURES ARE ENTERED",I6)	HEAT4	418
	IF (INITEM.GT.0 .AND. JIN.EQ.0)WRITE(6,3003)	HEAT4	419
	IF (INITEM.GT.0 .AND. JIN.EW.0 .AND. IERROR.GT.0)WRITE IERROR,3003)	HEAT4	420
3003	FORMAT("0***** PLEASE SPECIFY ON INPUT CARD 3 THE UNIT FROM WHICH	HEAT4	421
	THE INITIAL TEMPERATURE DISTRIBUTION IS TO BE READ. *****")	HEAT4	422
	IF (JIN.GT.0)WRITE(6,3005)JIN	HEAT4	423
3005	FORMAT("0",11X,"THE INITIAL TEMPERATURE DISTRIBUTION IS ON UNIT "	HEAT4	424
	1 I6)	HEAT4	425
	IF (JOUT.GT.0)WRITE(6,3007)JOUT	HEAT4	426
3007	FORMAT("0",11X,"THE FINAL TEMPERATURE DISTRIBUTION WILL BE WRITTEN	HEAT4	427
	1 ON UNIT ",I6)	HEAT4	428
	IF (INITEM.GT.MAXPTS)GO TO 11	HEAT4	429
	IF (IGX-1)271,213,413	HEAT4	430
0213	READ (5,5002) (RG(IG),IG=1,IGT)	HEAT4	431
	IGTM1=IGT-1	HEAT4	432
	READ (5,5001) (NDRG(IG),IG=1,IGTM1)	HEAT4	433
	R(1)=RG(1)	HEAT4	434
	I=1	HEAT4	435
	DO 215 IG=1,IGTM1	HEAT4	436
	DELTAR=(RG(IG+1)-RG(IG))/FLOAT(NDRG(IG))	HEAT4	437
	IXX=NDRG(IG)	HEAT4	438
	DO 214 IX=1,IXX	HEAT4	439
	R(I+1)=R(I)+DELTAR	HEAT4	440
	I=I+1	HEAT4	441
	IF (I.LE.MAXFGL)GO TO 214	HEAT4	442
	COOR=XORR	HEAT4	443
	WRITE(6,9005)MAXFGL,COOR	HEAT4	444
	IF (IERROR.GT.0)WRITE(IERROR,9005)MAXFGL,COOR	HEAT4	445

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9005	FORMAT("0***** YOU HAVE GENERATED MORE THAN THE",I6," ALLOWABLE FI	HEAT4	446
	NE GRID LINES IN THE "A6." DIRECTION. *****")	HEAT4	447
	STOP 214	HEAT4	448
0214	CONTINUE	HEAT4	449
	R(I)=RG(I*1)	HEAT4	450
0215	CONTINUE	HEAT4	451
	IT=1	HEAT4	452
0271	IF(NGY-1)272,216,216	HEAT4	453
0216	READ (5,5002)(THG(JG),JG=1,JGT)	HEAT4	454
	JGTM1=JGT-1	HEAT4	455
	READ (5,5001)(NOTHG(JG),JG=1,JGTM1)	HEAT4	456
	TH(1)=THG(1)	HEAT4	457
	J=1	HEAT4	458
	DO 218 JG=1,JGTM1	HEAT4	459
	DELTTH=(THG(JG+1)-THG(JG))/FLOAT(NOTHG(JG))	HEAT4	460
	JXX=NOTHG(JG)	HEAT4	461
	DO 217 JX=1,JXX	HEAT4	462
	TH(J+1)=TH(J)+DELTTH	HEAT4	463
	J=J+1	HEAT4	464
	IF(J.LE.MAXFGL)GO TO 217	HEAT4	465
	COOR=YORT	HEAT4	466
	WRITE(6,9005)MAXFGL,COOR	HEAT4	467
	IF(IERROR.GT.0)WRITE(IEHRON,9005)MAXFGL,COOR	HEAT4	468
	STOP 217	HEAT4	469
0217	CONTINUE	HEAT4	470
	TH(J)=THG(JG+1)	HEAT4	471
0218	CONTINUE	HEAT4	472
	JT=J	HEAT4	473
0272	IF(NGZ-1)273,219,219	HEAT4	474
0219	READ (5,5002)(ZG(KG),KG=1,KGT)	HEAT4	475
	KGTM1=KGT-1	HEAT4	476
	READ (5,5001)(NDZG(KG),KG=1,KGTM1)	HEAT4	477
	Z(1)=ZG(1)	HEAT4	478
	K=1	HEAT4	479
	DO 221 KG=1,KGTM1	HEAT4	480
	DELTZ=(ZG(KG+1)-ZG(KG))/FLOAT(NDZG(KG))	HEAT4	481
	KXX=NDZG(KG)	HEAT4	482
	DO 220 KX=1,KXX	HEAT4	483
	Z(K+1)=Z(K)+DELTZ	HEAT4	484
	K=K+1	HEAT4	485
	IF(K.LE.MAXFGL)GO TO 220	HEAT4	486
	COOR=ZZ	HEAT4	487
	WRITE(6,9005)MAXFGL,COOR	HEAT4	488
	IF(IERROR.GT.0)WRITE(IEHRON,9005)MAXFGL,COOR	HEAT4	489
	STOP 220	HEAT4	490
0220	CONTINUE	HEAT4	491
	Z(K)=ZG(KG+1)	HEAT4	492
0221	CONTINUE	HEAT4	493
	KT=K	HEAT4	494
C*	FOR RZT. IF R(1)=0. LET R(1)=-R(2) AND NGGR=1.	HEAT4	495
C*	OTHERWISE. LET NGGR=0.	HEAT4	496
0273	NGGR=0	HEAT4	497
	IF(NGG-1)224,222,222	HEAT4	498
0222	IF(NGX-1)224,270,270	HEAT4	499
0270	IF(R(1))224,223,224	HEAT4	500
223	R(1)=-R(2)	HEAT4	501
	NGGR=1	HEAT4	502
C	*****WRITE REST OF INPUT DATA*****	HEAT4	503
224	WRITE(6,3038)NTYPE	HEAT4	504
3038	FORMAT(1H0,11X,20HPROBLEM TYPE NUMBER I6)	HEAT4	505
	WRITE (6,3040)NOITX	HEAT4	506
3040	FORMAT(1H0,11X,41HMAXIMUM NUMBER OF STEADY-STATE ITERATIONS I6)	HEAT4	507
	WRITE (6,3042)NFX1	HEAT4	508
3042	FORMAT(1H0,11X,41HNUMBER OF S-S ITERATIONS BEFORE CALC BETA I6)	HEAT4	509
	WRITE (6,3044)NEX	HEAT4	510
3044	FORMAT(1H0,11X,45HNUMBER OF S-S ITERATIONS BEFORE EXTRAPOLATION I6)	HEAT4	511
	WRITE (6,3046)NATA	HEAT4	512
3046	FORMAT(1H0,11X,35HNUMBER OF DELTATS PER MONITOR PRINT I6)	HEAT4	513
	IF(NPRINT.LE.0)GO TO 150	HEAT4	514
	WRITE(6,3045)NPRINT	HEAT4	515
3045	FORMAT("0",11X,"NUMBER OF TRANSIENT PRINTOUTS SPECIFIED",I6)	HEAT4	516
	IF(NPRINT.GT.MAXPRT)GO TO 11	HEAT4	517
	READ(5,5002)(PRTIME(I),I=1,NPRINT)	HEAT4	518
150	IF(TDCDHC)GO TO 155	HEAT4	519
	WRITE(6,3049)	HEAT4	520

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3049 FORMAT("0",11X,"THE CONDUCTIVITY, DENSITY, AND HEAT CAPACITY ARE I HEAT4 521
      INDEPENDENT OF TEMPERATURE.") HEAT4 522
      GO TO 160 HEAT4 523
155 WRITE(6,3051) HEAT4 524
3051 FORMAT("0",11X,"THE CONDUCTIVITY, DENSITY, AND HEAT CAPACITY ARE T HEAT4 525
      TEMPERATURE DEPENDENT.") HEAT4 526
160 CONTINUE HEAT4 527
      WRITE(6,3048)EPI HEAT4 528
3048 FORMAT(*0*,11X,"CONVERGENCE CRITERION*,E15.7) HEAT4 529
      WRITE(6,3050)HETA HEAT4 530
3050 FORMAT(1H0,11X,12HINITIAL HETA F12.8) HEAT4 531
      WRITE(6,3052)DELTA T HEAT4 532
3052 FORMAT(*0*,11X,"TIME INCREMENT*,E15.7) HEAT4 533
      WRITE(6,3055)KTMFCT HEAT4 534
3055 FORMAT("0",11X,"NUMBER OF STABLE TIME STEPS UNTIL MODIFIED EXPLICI HEAT4 535
      T METHOD IS ACTIVATED",15) HEAT4 536
      WRITE(6,3053)TIM HEAT4 537
3053 FORMAT(*0*,11X,"INITIAL TIME *,E15.7) HEAT4 538
      WRITE(6,3054)FTIME HEAT4 539
3054 FORMAT(*0*,11X,"FINAL TIME*,E15.7) HEAT4 540
      IF(MXCPU.GT.0)WRITE(6,3057)MXCPU HEAT4 541
3057 FORMAT("0",11X,"THE PROBLEM WILL BE TERMINATED AFTER",110," SECOND HEAT4 542
      15") HEAT4 543
      WRITE(6,3056) HEAT4 544
3056 FORMAT(1H1,50X,"SUMMARY OF REGION DATA" /1H,"NUMBERS AND FCN NU HEAT4 545
      MBFR",3X,7("*****"), " DIMENSIONS *", 7("*****"), 2X, 2("----"), HEAT4 546
      2" BOUNDARY NUMBERS " , 2("----") / " REG. MATL INIT HEAT", 3X, HEAT4 547
      3"LEFT-X-OR RIGHT-X-OR LOWER-Y-OR UPPER-Y-OR", 4X, "REAR-Z", 5X, HEAT4 548
      4"FRONT-Z", 4X, "LF-X RT-X LO-Y UP-Y RR-Z FT-Z" / " NO. NO. HEAT4 549
      5 TEMP GEN", 4X, "INNER-R OUTER-R LEFT-THETA RIGHT-THETA" HEAT4 550
      6 25X, "IN-R OT-R LF-O RT-O" ) HEAT4 551
      WRITE(6,3058)(I,MATL(I),INTEM(I),NGEN(I),RRIN(I),RROT(I),THLT(I), HEAT4 552
      1THRT(I),ZZBK(I),ZZFR(I),NBDIN(I),NBDOT(I),NBDLT(I),NBDRT(I),NBD8K( HEAT4 553
      2I),NBD8R(I),I=1,NOREGT) HEAT4 554
-----3058 FORMAT(1H ,14,316,6F12.4,616) HEAT4 555
      WRITE(6,3062) HEAT4 556
3062 FORMAT(1H ,11X,25H MATERIAL DESCRIPTION DATA) HEAT4 557
      CALL WCOND(MATNAM,MATLT) HEAT4 558
      IF(NTYPE.NE.1)CALL WDEN (MATNAM,MATLT) HEAT4 559
      IF(NTYPE.NE.1)CALL WHTCP(MATNAM,MATLT) HEAT4 560
      IF(MATSL.EQ.0) GO TO 92007 HEAT4 561
      WRITE(6,2004) HEAT4 562
2004 FORMAT("0",18X,"MATERIAL MATERIAL MELTING LATENT", HEAT4 563
      1 " ",19X, "NUMBER NAME POINT HEAT") HEAT4 564
      DO 2007 MAT=1,MATSL HEAT4 565
      WRITE(6,2005) MAT,MATNAM(MAT),SLTM(MAT),SLHM(MAT) HEAT4 566
2005 FORMAT(" ",18X,15,6X,A8,2X,1PE14.5,2X,1PE14.5) HEAT4 567
2007 CONTINUE HEAT4 568
92007 CONTINUE HEAT4 569
      IF(NGENFN)3011,3011,3009 HEAT4 570
3009 WRITE(6,3068) HEAT4 571
3068 FORMAT(1H0,11X,29HHEAT GENERATION FUNCTION DATA) HEAT4 572
      WRITE(6,3070)(I,NGNTM(I),NGNR(I),NGNTH(I),NGNZ(I),I=1,NGENFN) HEAT4 573
3070 FORMAT(1H ,9X,5I10) HEAT4 574
3011 IF(NINTFN)3130,3130,3029 HEAT4 575
3029 WRITE(6,3072) HEAT4 576
3072 FORMAT(1H0,11X,33HINITIAL TEMPERATURE FUNCTION DATA) HEAT4 577
      WPTTE(6,3074)(I,ITMR(I),ITMTH(I),ITMZ(I),I=1,NINTFN) HEAT4 578
3074 FORMAT(1H ,9X,4I10) HEAT4 579
3130 IF(NPDFN)3031,3031,3131 HEAT4 580
3131 WRITE(6,3076) HEAT4 581
3076 FORMAT(1H0,11X,36HGENERAL POSITION DEPENDENT FUNCTION , HEAT4 582
      112HCOEFFICIENTS) HEAT4 583
C***** PRINTOUT CHANGED 4-22-69. HEAT4 584
      WRITE(6,3078)((J,(POSFN(J,1),I=1,9)),J=1,NPDFN) HEAT4 585
3078 FORMAT(1H ,7X,15,1PE13.5) HEAT4 586
3031 IF(NTDFN)3143,3143,3039 HEAT4 587
3039 WRITE(6,3080) HEAT4 588
3080 FORMAT(1H0,11X,28HTIME DEPENDENT FUNCTION DATA) HEAT4 589
      DO 3041 J=1,NTDFN HEAT4 590
      K=2*NTIMFP(J) HEAT4 591
      WRITE(6,3082)(J,NTIMFP(J),(TIMFN(J,I),I=1,K)) HEAT4 592
3082 FORMAT("0",9X,21,4,6E14.5/(* ,9X,8E14.5)) HEAT4 593

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3041	CONTINUE	HEAT4	594
3143	IF (NBDTPT) 3150, 3150, 3043	HEAT4	595
3043	WRITE (6, 3086)	HEAT4	596
3086	FORMAT(1H, 11X, 13HBOUNDARY DATA)	HEAT4	597
	WRITE(6, 3088) (I, NBYTYP(I), BYTEMP(I), NBYTFN(I), BHCONV(I), BHRAD(I),	HEAT4	598
	1 BHNAT(I), BHEXP(I), BFLUX(I), I=1, NBDTPT)	HEAT4	599
3088	FORMAT(10X, 2I10, E14.5, I10, 5E14.5)	HEAT4	600
C	IF RADIATION IS PRESENT, CONVERT TO ABSOLUTE TEMPERATURES.	HEAT4	601
	IF (IRAD, LT, 2) GO TO 3150	HEAT4	602
	DO 3145 I=1, NBDTPT	HEAT4	603
3145	BYTEMP(I)=BYTEMP(I)+TABS(JABS)	HEAT4	604
	DO 3147 I=1, MATSL	HEAT4	605
3147	SLTM(I)=SLTM(I)+TABS(JABS)	HEAT4	606
3150	WRITE (6, 3090)	HEAT4	607
3090	FORMAT(1H0, 11X, 40HGROSS LATTICES AND NUMBERS OF INCREMENTS)	HEAT4	608
	IF (NGX, LE, 0) GO TO 3160	HEAT4	609
	WRITE (6, 3091)	HEAT4	610
3091	FORMAT(1H0, 15X, 6HR OR X)	HEAT4	611
	WRITE (6, 3092) (RG(I), I=1, IGT)	HEAT4	612
3092	FORMAT(1H, 9X, 8F13.6)	HEAT4	613
	WRITE (6, 3093) (NDNG(I), I=1, IGTM1)	HEAT4	614
3093	FORMAT(1H, 4X, 8I11)	HEAT4	615
3160	IF (NGY) 3170, 3170, 3065	HEAT4	616
3065	WRITE (6, 3094)	HEAT4	617
3094	FORMAT(1H0, 15X, 10HTHETA OR Y)	HEAT4	618
	WRITE (6, 3092) (THG(J), J=1, JGT)	HEAT4	619
	WRITE (6, 3093) (NDTHG(J), J=1, JGTM1)	HEAT4	620
3170	IF (NGZ) 3180, 3180, 3075	HEAT4	621
3075	WRITE (6, 3095)	HEAT4	622
3095	FORMAT(1H0, 15X, 1HZ)	HEAT4	623
	WRITE (6, 3092) (ZG(K), K=1, KGT)	HEAT4	624
	WRITE (6, 3093) (NDZG(K), K=1, KGTM1)	HEAT4	625
3180	WRITE (6, 3098)	HEAT4	626
3098	FORMAT(1H1, 5X, "FINE LATTICE, X OR R, Y OR THETA, AND Z")	HEAT4	627
	IF (NGX) 3184, 3184, 3182	HEAT4	628
3182	I=1+NGGP	HEAT4	629
	WRITE (6, 3099) (I, R(I), I=1, IT)	HEAT4	630
3099	FORMAT(11H, 5X, 15F13.6, 11F13.6, 11F13.6, 11F13.6, 11F13.6)	HEAT4	631
1		HEAT4	632
3184	IF (NGY) 3188, 3188, 3186	HEAT4	633
3186	WRITE (6, 3099) (J, TH(J), J=1, JGT)	HEAT4	634
3188	IF (NGZ) 225, 225, 3190	HEAT4	635
3190	WRITE (6, 3099) (K, Z(K), K=1, KGT)	HEAT4	636
C	THE SIX G ARRAYS FORMED BELOW ARE USED LATER TO SET UP THE	HEAT4	637
C	DIFFERENCING.	HEAT4	638
0225	DO 226 I=1, IT	HEAT4	639
	G1P(I)=1.0	HEAT4	640
	G1M(I)=1.0	HEAT4	641
	G3P(I)=1.0	HEAT4	642
	G2P(I)=1.0	HEAT4	643
	G2M(I)=1.0	HEAT4	644
0226	G3M(I)=1.0	HEAT4	645
C	FOR THE X OR R GRID.	HEAT4	646
	IF (NGX-1) 229, 227, 227	HEAT4	647
0227	G1M(I)=0.0	HEAT4	648
	G2M(I)=0.0	HEAT4	649
	G3M(I)=0.0	HEAT4	650
	DO 228 I=2, IT	HEAT4	651
	G1P(I-1)=(R(I)-R(I-1))/2.0	HEAT4	652
	G1M(I)=G1P(I-1)	HEAT4	653
	IF (NGG) 7228, 228, 7228	HEAT4	654
7228	G2P(I-1)=(3.0*R(I-1)+R(I))/4.0	HEAT4	655
	G2M(I)=(3.0*R(I)+R(I-1))/4.0	HEAT4	656
	G3P(I-1)=(R(I)+R(I-1))/2.0	HEAT4	657
	G3M(I)=G3P(I-1)	HEAT4	658
0228	CONTINUE	HEAT4	659
	G1P(IT)=0.0	HEAT4	660
	G2P(IT)=0.0	HEAT4	661
	G3P(IT)=0.0	HEAT4	662
C	FOR THE Y OR T GRID.	HEAT4	663
0229	IF (NGY-1) 230, 232, 232	HEAT4	664
0230	IF (NGG-1) 231, 234, 234	HEAT4	665
0231	G4P(I)=1.0	HEAT4	666
	G4M(I)=1.0	HEAT4	667
	GO TO 237	HEAT4	668

LISTING AND SUBROUTINE COMPILATION: HETING P. 10

0234	G4P(1)=6.2831853	HEAT4	669
	G4M(1)=G4P(1)	HEAT4	670
	GO TO 237	HEAT4	671
0232	G4M(1)=0.0	HEAT4	672
	DO 236 J=2,JT	HEAT4	673
	G4P(J)=(TH(J)-TH(J-1))/2.0	HEAT4	674
	G4M(J)=G4P(J-1)	HEAT4	675
0236	CONTINUE	HEAT4	676
	G4P(JT)=0.0	HEAT4	677
C*	FOR THE Z GRID.	HEAT4	678
0237	IF (NGZ-1) 238,240,240	HEAT4	679
0238	G5P(1)=1.0	HEAT4	680
	G5M(1)=G5P(1)	HEAT4	681
	GO TO 242	HEAT4	682
0240	G5M(1)=0.0	HEAT4	683
	DO 241 K=2,KT	HEAT4	684
	G5P(K)=(Z(K)-Z(K-1))/2.0	HEAT4	685
	G5M(K)=G5P(K-1)	HEAT4	686
0241	CONTINUE	HEAT4	687
	G5P(KT)=0.0	HEAT4	688
C*	DETERMINE THE FINE LATTICE LINE WHICH BOUNDS REGION NOREG	HEAT4	689
0242	IF (NGX-1) 241,243,243	HEAT4	690
C*	ON THE LEFT (X) OR INSIDE (R), NRRIN(NOREG).	HEAT4	691
0243	DO 249 NOREG=1,NOREGT	HEAT4	692
	IF (RRIN(NOREG)) 246,244,246	HEAT4	693
0244	IF (NGG-1) 246,245,246	HEAT4	694
0245	NRRIN(NOREG)=1	HEAT4	695
	GO TO 249	HEAT4	696
0246	DO 248 I=1,IT	HEAT4	697
	IF (RRIN(NOREG)-R(I)) 248,247,248	HEAT4	698
0247	NRRIN(NOREG)=I	HEAT4	699
	GO TO 249	HEAT4	700
0248	CONTINUE	HEAT4	701
	NERR = 1	HEAT4	702
	CALL REGION(RRIN(NOREG),R,IT,NRRIN(NOREG),NOREG,NERR)	HEAT4	703
0249	CONTINUE	HEAT4	704
C*	ON THE RIGHT (X) OR OUTSIDE (R), NRROT(NOREG).	HEAT4	705
	DO 252 NOREG=1,NOREGT	HEAT4	706
	DO 250 I=1,IT	HEAT4	707
	IF (RROT(NOREG)-R(I)) 250,251,250	HEAT4	708
0250	CONTINUE	HEAT4	709
	NERR = 2	HEAT4	710
	CALL REGION(RROT(NOREG),R,IT,NRROT(NOREG),NOREG,NERR)	HEAT4	711
	GO TO 252	HEAT4	712
0251	NRROT(NOREG)=I	HEAT4	713
0252	CONTINUE	HEAT4	714
0261	IF (NGY-1) 260,253,253	HEAT4	715
C*	ON THE BOTTOM (Y) OR LEFT (T), NTHLT(NOREG).	HEAT4	716
0253	DO 256 NOREG=1,NOREGT	HEAT4	717
	DO 254 J=1,JT	HEAT4	718
	IF (THLT(NOREG)-TH(J)) 254,255,254	HEAT4	719
0254	CONTINUE	HEAT4	720
	NERR = 3	HEAT4	721
	CALL REGION(THLT(NOREG),TH,JT,NTHLT(NOREG),NOREG,NERR)	HEAT4	722
	GO TO 256	HEAT4	723
0255	NTHLT(NOREG)=J	HEAT4	724
0256	CONTINUE	HEAT4	725
C*	ON THE TOP (Y) OR RIGHT (T), NTHRT(NOREG).	HEAT4	726
	DO 259 NOREG=1,NOREGT	HEAT4	727
	DO 257 J=1,JT	HEAT4	728
	IF (THRT(NOREG)-TH(J)) 257,258,257	HEAT4	729
0257	CONTINUE	HEAT4	730
	NERR = 4	HEAT4	731
	CALL REGION(THRT(NOREG),TH,JT,NTHRT(NOREG),NOREG,NERR)	HEAT4	732
	GO TO 259	HEAT4	733
0258	NTHRT(NOREG)=J	HEAT4	734
0259	CONTINUE	HEAT4	735
0260	IF (NGZ-1) 280,262,262	HEAT4	736
C*	ON THE BACK (Z), NZZBK(NOREG).	HEAT4	737
0262	DO 266 NOREG=1,NOREGT	HEAT4	738
	DO 264 K=1,KT	HEAT4	739
	IF (ZZBK(NOREG)-Z(K)) 264,265,264	HEAT4	740
0264	CONTINUE	HEAT4	741

LISTING AND SUBROUTINE COMPILATION: HETING P. 11

NERR = 5	HEAT4	742
CALL REGION(ZZBK(NOREG),Z,KT,NZZBK(NOREG),NOREG,NERR)	HEAT4	743
GO TO 260	HEAT4	744
NZZBK(NOREG)=K	HEAT4	745
0265 CONTINUE	HEAT4	746
C ON THE FRONT (Z), NZZFN(NOREG).	HEAT4	747
DO 269 NOREG=1,NOREG	HEAT4	748
DO 267 K=1,KT	HEAT4	749
IF(ZZFR(NOREG)-Z(K))267,268,267	HEAT4	750
0267 CONTINUE	HEAT4	751
NERR = 6	HEAT4	752
CALL REGION(ZZFR(NOREG),Z,AT,NZZFR(NOREG),NOREG,NERR)	HEAT4	753
GO TO 269	HEAT4	754
0269 NZZFR(NOREG)=K	HEAT4	755
0269 CONTINUE	HEAT4	756
280 RETURN	HEAT4	757
C ERROR MESSAGES.	HEAT4	758
M=NOREG	HEAT4	759
10 WRITE (6,100) M,NERR	HEAT4	760
IF(IERROR.GT.0) WRITE(IERROR,100)M,NERR	HEAT4	761
100 FORMAT(1H0,9X,"INPUT ERROR FOUND IN BOUNDARIES FOR REGION", I4 /	HEAT4	762
1 1X,"BOUNDARY IN ERROR IS ",I3," ON REGION DATA CARD.")	HEAT4	763
GO TO 12	HEAT4	764
11 WRITE (6,101)	HEAT4	765
IF(IERROR.GT.0)WRITE(IERRON,101)	HEAT4	766
101 FORMAT(1H0,11X,"THE FOREGOING VALUE IS TOO LARGE FOR THE ARRAY SIZE	HEAT4	767
1 WHICH ARE SPECIFIED" / 12X,"IN THE PROGRAM. PLEASE SEE PROGRAM	HEAT4	768
2 DESCRIPTION FOR LIMITATIONS." / 1H0,11X,"THIS JOB IS SKIPPED AND A	HEAT4	769
3 SEARCH WILL BE MADE FOR ANOTHER CASE.")	HEAT4	770
12 JOBSKIP = 1	HEAT4	771
RETURN X900	HEAT4	772
20 WRITE (6,102)	HEAT4	773
IF(IERROR.GT.0)WRITE(IERRON,102)	HEAT4	774
102 FORMAT(1H0,11X,"A VALUE HAS BEEN READ INTO AN ARRAY FOR A SUBSCRIPT	HEAT4	775
1 OUTSIDE THE ASSIGNED RANGE." / 12X,"SINCE A PROGRAM INSTRUCTION	HEAT4	776
2 MAY HAVE BEEN OVERWRITTEN. ALL CALCULATIONS WILL BE TERMINATED."/	HEAT4	777
3 1H0, 6X,"THE CARDS NOT READ INTO THE PROGRAM ARE AS LISTED AS FOL	HEAT4	778
4 LLOWS."/7X,"LOOK FOR ERROR IN CARD PRECEDING THIS GROUP."/1H0,6X,9	HEAT4	779
5" COLUMNS " / 8X, "1",8X,"9 10",5X,"18 19",5X,"27 28",5X,	HEAT4	780
6"36 37",5X,"45 46",5X,"54 55",5X,"63 64",5X,"72 73",4X,	HEAT4	781
7"60", 8X, 8("-----",3X), "-----")	HEAT4	782
DO 30 J=1,1000	HEAT4	783
READ (5,103) (NVALUE(I),I=1,26)	HEAT4	784
IF(IERROR.GT.0)WRITE(IERRON,104) (NVALUE(I),I=1,26)	HEAT4	785
WRITE(6,104) (NVALUE(I),I=1,26)	HEAT4	786
30 CONTINUE	HEAT4	787
103 FORMAT(8(3A3),2A4)	HEAT4	788
104 FORMAT(8X,8(3A3,3X),2A4)	HEAT4	789
STOP	HEAT4	790
END	HEAT4	791

SUBROUTINE REGION 74/74 OPT=2

FTN 4.1-REL

03/26/74 10.16.58.

SUBROUTINE REGION(REGDIM,X,ITOT,IGL,NOREG,NERR)	HEAT4	792
C IF THE FINE GRID LINE WHICH BOUNDS A REGION CANNOT BE LOCATED,	HEAT4	793
C THEN THIS ROUTINE IS USED TO LOCATE THE FINE GRID LINE WHICH	HEAT4	794
C IS NEAREST THE REGION BOUNDARY. (ADDED BY WOT ON 9-11-79)	HEAT4	795
COMMON /EPROM/ IERROR	HEAT4	796
DIMENSION X(1)	HEAT4	797
IF(REGDIM.GT.X(1))GO TO 10	HEAT4	798
IGL=1	HEAT4	799
GO TO 30	HEAT4	800
10 DO 20 I=2,ITOT	HEAT4	801
IF(REGDIM.GT.X(I)) GO TO 20	HEAT4	802
IGL=I	HEAT4	803
IF(REGDIM.LT.(0.5*(X(I)+X(I-1)))) IGL=I-1	HEAT4	804
GO TO 30	HEAT4	805
20 CONTINUE	HEAT4	806

LISTING AND SUBROUTINE COMPILATION: HETING P. 12

```

      IGL=ITOT
      30 WRITE(6,2001) IERR, NOREG, REGDIM, IGL, X(IGL)
      IF (IERR.GT.0) WRITE(1,ERRFMT,2001) IERR, NOREG, REGDIM, IGL, X(IGL)
2001 FORMAT("0***** AN ERROR HAS OCCURRED WHICH IS DUE TO EITHER AN INP
      1UT ERROR OR A ROUNDOFF ERROR *****"/" ",6X,"THE FINE GRID LINE WHI
      2CH MATCHES BOUNDARY",I2," FOR REGION",I4," CANNOT BE LOCATED."/
      3 * *,6X,"THIS REGION BOUNDARY*,IPE23.15,* HAS BEEN MOVED TO FINE G
      4RID LINE*,I3,* (*,E23.15,*))
      RETURN
      END

```

```

      PLAT4      807
      PLAT4      808
      PLAT4      809
      PLAT4      810
      PLAT4      811
      PLAT4      812
      PLAT4      813
      PLAT4      814
      PLAT4      815
      PLAT4      816

```

SUBROUTINE RCOND 74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.01.

```

      SUBROUTINE RCOND(VALUE,MPTS,MAT,IR)
C***** THIS SUBROUTINE READS THE THERMAL CONDUCTIVITY AS A FUNCTION
C      OF TEMPERATURE.
      COMMON /ITCCHD/ TABS(2) , JABS , IRAD , TDCDHC
      DIMENSION MATNAM(1)
      COMMON/LOGCOND/LOVAL(50),HIVAL(50)
      COMMON/CONDUCT/T(25,50),V(25,50),NPTS(50)
      LOGICAL LOVAL,HIVAL,TDCDHC
      DATA MAXPT/25/
      LOVAL(MAT)=.FALSE.
      HIVAL(MAT)=.FALSE.
      IF(VALUE.EQ.0.0)GO TO 200
C      IF THE THERMAL PROPERTY IS CONSTANT, INITILIZE T, V, I NPTS.
      T(1,MAT)=0.0
      V(1,MAT)=VALUE
      NPTS(MAT)=1
      GO TO 210
C      READ THE THERMAL PROPERTY VS TEMPERATURE TABLE.
200 TDCDHC=.TRUE.
      IF(MPTS.GT.MAXPT)GO TO 220
      READ(5,1002) (T(J,MAT),V(J,MAT),J=1,MPTS)
1002 FORMAT(6E9.0)
      NPTS(MAT)=MPTS
210 IF(MPTS(MAT).GT.1)RETURN
      LOVAL(MAT)=.TRUE.
      HIVAL(MAT)=.TRUE.
      RETURN
220 IR=20
      RETURN
      END

```

```

      HEAT4      817
      HEAT4      818
      HEAT4      819
      HEAT4      820
      HEAT4      821
      HEAT4      822
      HEAT4      823
      HEAT4      824
      HEAT4      825
      HEAT4      826
      HEAT4      827
      HEAT4      828
      HEAT4      829
      HEAT4      830
      HEAT4      831
      HEAT4      832
      HEAT4      833
      HEAT4      834
      HEAT4      835
      HEAT4      836
      HEAT4      837
      HEAT4      838
      HEAT4      839
      HEAT4      840
      HEAT4      841
      HEAT4      842
      HEAT4      843
      HEAT4      844
      HEAT4      845
      HEAT4      846

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SUBROUTINE WCOND 74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.04.

```

      SUBROUTINE WCOND(MATNAM,MATLT)
      COMMON/CONDUCT/T(25,50),V(25,50),NPTS(50)
      COMMON/LOGCOND/LOVAL(50),HIVAL(50)
      COMMON/ITCCHD/TABS(2),JABS,IRAD,TDCDHC
      LOGICAL LOVAL,HIVAL,TDCDHC
      DIMENSION MATNAM(1)
      DATA MAXPT/25/
C      WRITE THE THERMAL PROPERTIES.
      WRITE(6,2001)
2001 FORMAT("0",15X,"CONDUCTIVITY AS A FUNCTION OF TEMPERATURE."/
      1 "0",18X,"MATERIAL MATERIAL NUMBER TEMPERATURE",8X,"K"/
      2 " ",19X,"NUMBER NAME")
      DO 10 MAT=1,MATLT
      J=1
      WRITE(6,2002) MAT,MATNAM(MAT),J,T(J,MAT),V(J,MAT)
2002 FORMAT(" ",18X,I5,6X,A8,I7,2X,1P2E14.5)
      MPTS=NPTS(MAT)
      IF(MPTS.LE.1)GO TO 3
      WRITE(6,2003) (J,T(J,MAT),V(J,MAT),J=2,MPTS)
2003 FORMAT(" ",37X,I7,2X,1P2E14.5)
      3 IF(IRAD.LT.2)GO TO 10
C      IF RADIATION IS PRESENT, CONVERT TO ABSOLUTE TEMPERATURES.
      DO 5 J=1,MPTS
      5 T(J,MAT)=T(J,MAT)+TABS(JABS)
      10 CONTINUE
      RETURN
      END

```

```

      HEAT4      847
      HEAT4      848
      HEAT4      849
      HEAT4      850
      HEAT4      851
      HEAT4      852
      HEAT4      853
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      HEAT4      855
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      HEAT4      859
      HEAT4      860
      HEAT4      861
      HEAT4      862
      HEAT4      863
      HEAT4      864
      HEAT4      865
      HEAT4      866
      HEAT4      867
      HEAT4      868
      HEAT4      869
      HEAT4      870
      HEAT4      871
      HEAT4      872
      HEAT4      873

```

LISTING AND SUBROUTINE COMPILATION: HETING P. 13

FUNCTION COND

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.07.

```

FUNCTION COND(MAT,TEMP)
COMMON/CONDUCT/T(25,50),V(25,50),NPTS(50)
COMMON/LOGCOND/LOVAL(50),HIVAL(50)
COMMON/ITCCHD/TABS(2),JABS,IRAD,TDCHC
LOGICAL LOVAL,HIVAL,TDCHC
DIMENSION MATNAM(1)
DATA MAXPT/25/
C***** THE CONDUCTIVITY AT TEMPERATURE TEMP IS DETERMINED BY LINEAR
C INTERPOLATION AND IS RETURNED IN COND.
C
IF(TEMP.GE.T(1,MAT))GO TO 50
IF(LOVAL(MAT))GO TO 40
LOVAL(MAT)=.TRUE.
IF(IRAD.NE.2)GO TO 25
TEMP1=TEMP-TABS(JABS)
TEMP2=T(1,MAT)-TABS(JABS)
GO TO 30
25 TEMP1=TEMP
TEMP2=T(1,MAT)
30 WRITE(6,9910)MAT,TEMP1,TEMP2
9910 FORMAT("0***** FOR MATERIAL",I4," THE CONDUCTIVITY MUST BE EVALUAT
1ED AT",1PE12.4," DEGREES."/7X,"IT IS ASSUMED THAT THE CONDUCTIVITY
2 IS CONSTANT FOR ALL TEMPERATURES LESS THAN OR EQUAL TO",1PE12.4)
40 COND=V(1,MAT)
RETURN
50 MPTS=NPTS(MAT)
IF(MPTS.EQ.1)GO TO 65
DO 60 I=2,MPTS
M=I
IF(TEMP.LE.T(I,MAT))GO TO 100
60 CONTINUE
65 IF(HIVAL(MAT))GO TO 90
HIVAL(MAT)=.TRUE.
IF(IRAD.NE.2)GO TO 70
TEMP1=TEMP-TABS(JABS)
TEMP2=T(MPTS,MAT)-TABS(JABS)
GO TO 80
70 TEMP1=TEMP
TEMP2=T(MPTS,MAT)
80 WRITE(6,9920)MAT,TEMP1,TEMP2
9920 FORMAT("0***** FOR MATERIAL",I4," THE CONDUCTIVITY MUST BE EVALUAT
1ED AT",1PE12.4," DEGREES."/7X,"IT IS ASSUMED THAT THE CONDUCTIVITY
2 IS CONSTANT FOR ALL TEMPERATURES GREATER THAN OR EQUAL TO",E13.5)
90 COND=V(MPTS,MAT)
RETURN
100 COND=V(M,MAT)+((V(M-1,MAT)-V(M,MAT))*(TEMP-T(M,MAT)))/
1 (T(M-1,MAT)-T(M,MAT))
RETURN
END

```

SUBROUTINE RDEN

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.11.

```

SUBROUTINE RDEN(VALUE,MPTS,MAT,IR)
C***** THIS SUBROUTINE READS THE DENSITY AS A FUNCTION OF TEMPERATURE.
COMMON /ITCCHD/ TABS(2) , JABS , IRAD , TDCHC
DIMENSION MATNAM(1)
COMMON/LOGDEN /LOVAL(50),HIVAL(50)
COMMON/DENSITY/T(25,50),V(25,50),NPTS(50)
LOGICAL LOVAL,HIVAL,TDCHC
DATA MAXPT/25/
LOVAL(MAT)=.FALSE.
HIVAL(MAT)=.FALSE.
IF(VALUE.EQ.0.0)GO TO 200
C IF THE THERMAL PROPERTY IS CONSTANT, INITILIZE T, V, I NPTS.
T(1,MAT)=0.0
V(1,MAT)=VALUE
NPTS(MAT)=1
GO TO 210

```

LISTING AND SUBROUTINE COMPILATION: HETING P. 14

C	READ THE THERMAL PROPERTY VS TEMPERATURE TABLE.	HEAT4	939
200	TDCDHC=.TRUE.	HEAT4	940
	IF (MPTS.GT.MAXPT)GO TO 220	HEAT4	941
	READ(5,1002) (T(J,MAT),V(J,MAT),J=1,MPTS)	HEAT4	942
1002	FORMAT(8E9.0)	HEAT4	943
	NPTS (MAT)=MPTS	HEAT4	944
210	IF (NPTS (MAT).GT.1)RETURN	HEAT4	945
	LOVAL (MAT)=.TRUE.	HEAT4	946
	HIVAL (MAT)=.TRUE.	HEAT4	947
	RETURN	HEAT4	948
220	IR=20	HEAT4	949
	RETURN	HEAT4	950
	END	HEAT4	951

SUBROUTINE WDEN

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.15.

	SUBROUTINE WDEN(MATNAM,MATLT)	HEAT4	952
	COMMON/DENSITY/T(25,50),V(25,50),NPTS(50)	HEAT4	953
	COMMON/LOGDEN /LOVAL(50),HIVAL(50)	HEAT4	954
	COMMON/ITCCHD/TABS(2),JABS,IRAD,TDCDHC	HEAT4	955
	LOGICAL LOVAL,HIVAL,TDCDHC	HEAT4	956
	DIMENSION MATNAM(1)	HEAT4	957
	DATA MAXPT/25/	HEAT4	958
C	WRITE THE THERMAL PROPERTIES.	HEAT4	959
	WRITE(6,2001)	HEAT4	960
2001	FORMAT("0",15X,"DENSITY AS A FUNCTION OF TEMPERATURE."/	HEAT4	961
	1 "0",19X,"MATERIAL MATERIAL NUMBER TEMPERATURE",7X,"RHO"/	HEAT4	962
	2 " ",19X,"NUMBER NAME")	HEAT4	963
	DO 10 MAT=1,MATLT	HEAT4	964
	J=1	HEAT4	965
	WRITE(6,2002)MAT,MATNAM(MAT),J,T(J,MAT),V(J,MAT)	HEAT4	966
2002	FORMAT(" ",15X,15,6X,A8,17,2X,1P2E14.5)	HEAT4	967
	MPTS=NPTS(MAT)	HEAT4	968
	IF (MPTS.LT.1)GO TO 3	HEAT4	969
	WRITE(6,2003) (J,T(J,MAT),V(J,MAT),J=2,MPTS)	HEAT4	970
2003	FORMAT(" ",37X,17,2X,1P2E14.5)	HEAT4	971
3	IF (IRAD.T.2)GO TO 10	HEAT4	972
C	IF RADIATION IS PRESENT, CONVERT TO ABSOLUTE TEMPERATURES.	HEAT4	973
	DO 5 J=1,MPTS	HEAT4	974
5	T(J,MAT)=T(J,MAT)+TABS(JABS)	HEAT4	975
10	CONTINUE	HEAT4	976
	RETURN	HEAT4	977
	END	HEAT4	978

FUNCTION RHO

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.18.

	FUNCTION RHO(MAT,TEMP)	HEAT4	979
	COMMON/DENSITY/T(25,50),V(25,50),NPTS(50)	HEAT4	980
	COMMON/LOGDEN /LOVAL(50),HIVAL(50)	HEAT4	981
	COMMON/ITCCHD/TABS(2),JABS,IRAD,TDCDHC	HEAT4	982
	LOGICAL LOVAL,HIVAL,TDCDHC	HEAT4	983
	DATA MAXPT/25/	HEAT4	984
C*****	THE DENSITY AT TEMPERATURE TEMP IS DETERMINED BY LINEAR	HEAT4	985
C	INTERPOLATION AND IS RETURNED IN RHO.	HEAT4	986
C		HEAT4	987
	IF (TEMP.GE.T(1,MAT))GO TO 50	HEAT4	988
	IF (LOVAL (MAT))GO TO 40	HEAT4	989
	LOVAL (MAT)=.TRUE.	HEAT4	990
	IF (IRAD.NE.2)GO TO 25	HEAT4	991
	TEMP1=TEMP-TABS(JABS)	HEAT4	992
	TEMP2=T(1,MAT)-TABS(JABS)	HEAT4	993
	GO TO 30	HEAT4	994
25	TEMP1=TEMP	HEAT4	995
	TEMP2=T(1,MAT)	HEAT4	996
30	WRITE(6,9910)MAT,TEMP1,TEMP2	HEAT4	997
9910	FORMAT("***** FOR MATERIAL",I4," THE DENSITY MUST BE EVALUATED AT	HEAT4	998
	1",1P12.4," DEGREES.",7X,"IT IS ASSUMED THAT THE DENSITY IS CONSTA	HEAT4	999
	2NT FOR ALL TEMPERATURES LESS THAN OR EQUAL TO",1P12.4)	HEAT4	1000

LISTING AND SUBROUTINE COMPILATION: HETING P. 15

40	RHO=V(1,MAT)	HEAT4	1001
	RETURN	HEAT4	1002
50	MPTS=NPTS(MAT)	HEAT4	1003
	IF(MPTS.EQ.1)GO TO 65	HEAT4	1004
	DO 60 I=2,MPTS	HEAT4	1005
	M=I	HEAT4	1006
	IF(TEMP.LE.T(I,MAT))GO TO 100	HEAT4	1007
60	CONTINUE	HEAT4	1008
65	IF(HIVAL(MAT))GO TO 90	HEAT4	1009
	HIVAL(MAT)=.TRUE.	HEAT4	1010
	IF(IRAD.NE.2)GO TO 70	HEAT4	1011
	TEMP1=TEMP-TABS(JABS)	HEAT4	1012
	TEMP2=T(MPTS,MAT)-TABS(JABS)	HEAT4	1013
	GO TO 90	HEAT4	1014
70	TEMP1=TEMP	HEAT4	1015
	TEMP2=T(MPTS,MAT)	HEAT4	1016
80	WRITE(6,9920)MAT,TEMP1,TEMP2	HEAT4	1017
9920	FORMAT("***** FOR MATERIAL",I4," THE DENSITY MUST BE EVALUATED AT	HEAT4	1018
	1",IPE12.4," DEGREES,"/7X,"IT IS ASSUMED THAT THE DENSITY IS CONSTA	HEAT4	1019
	2NT FOR ALL TEMPERATURES GREATER THAN OR EQUAL TO",IPE12.4)	HEAT4	1020
90	RHO=V(MPTS,MAT)	HEAT4	1021
	RETURN	HEAT4	1022
100	RHO=V(M,MAT)+((V(M-1,MAT)-V(M,MAT))*(TEMP-T(M,MAT)))/	HEAT4	1023
	1 (T(M-1,MAT)-T(M,MAT))	HEAT4	1024
	RETURN	HEAT4	1025
	END	HEAT4	1026

SUBROUTINE RHTCP

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.21.

	SUBROUTINE RHTCP(VALUE,MPTS,MAT,IR)	HEAT4	1027
C*****	THIS SUBROUTINE READS THE HEAT CAPACITY AS A FUNCTION OF	HEAT4	1028
C	TEMPERATURE.	HEAT4	1029
	COMMON /ITCCHD/ TABS(2) , JABS , IRAD , TDCDHC	HEAT4	1030
	DIMENSION MATNAM(1)	HEAT4	1031
	COMMON/LOGHEAT/LOVAL(50),HIVAL(50)	HEAT4	1032
	COMMON/SPHEAT /T(25,50),V(25,50),NPTS(50)	HEAT4	1033
	LOGICAL LOVAL,HIVAL,TDCDHC	HEAT4	1034
	DATA MAXPT/25/	HEAT4	1035
	LOVAL(MAT)=.FALSE.	HEAT4	1036
	HIVAL(MAT)=.FALSE.	HEAT4	1037
	IF(VALUE.EQ.0.0)GO TO 200	HEAT4	1038
G	IF THE THERMAL PROPERTY IS CONSTANT, INITILIZE T, V, I NPTS.	HEAT4	1039
	T(1,MAT)=0.0	HEAT4	1040
	V(1,MAT)=VALUE	HEAT4	1041
	NPTS(MAT)=1	HEAT4	1042
	GO TO 210	HEAT4	1043
C	READ THE THERMAL PROPERTY VS TEMPERATURE TABLE.	HEAT4	1044
200	TDCDHC=.TRUE.	HEAT4	1045
	IF(MPTS.GT.MAXPT)GO TO 220	HEAT4	1046
	READ(5,1002)(T(J,MAT),V(J,MAT),J=1,MPTS)	HEAT4	1047
1002	FORMAT(HE9.0)	HEAT4	1048
	NPTS(MAT)=MPTS	HEAT4	1049
210	IF(NPTS(MAT).GT.1)RETURN	HEAT4	1050
	LOVAL(MAT)=.TRUE.	HEAT4	1051
	HIVAL(MAT)=.TRUE.	HEAT4	1052
	RETURN	HEAT4	1053
220	IR=20	HEAT4	1054
	RETURN	HEAT4	1055
	END	HEAT4	1056

SUBROUTINE WHTCP

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.19.54.

	SUBROUTINE WHTCP(MATNAM,MAILT)	HEAT4	1057
	COMMON/SPHEAT /T(25,50),V(25,50),NPTS(50)	HEAT4	1058
	COMMON/LOGHEAT/LOVAL(50),HIVAL(50)	HEAT4	1059
	COMMON/ITCCHD/ TABS(2) , JABS , IRAD , TDCDHC	HEAT4	1060
	DIMENSION MATNAM(1)	HEAT4	1061
	LOGICAL LOVAL,HIVAL,TDCDHC	HEAT4	1062
	DATA MAXPT/25/	HEAT4	1063

LISTING AND SUBROUTINE COMPILATION: HETING P. 16

C	WRITE THE THERMAL PROPERTIES.	HEAT4	1064
	WRITE(6,2001)	HEAT4	1065
2001	FORMAT("0",15X,"HEAT CAPACITY AS A FUNCTION OF TEMPERATURE."/	HEAT4	1066
1	"0",18X,"MATERIAL MATERIAL NUMBER TEMPERATURE",5X,"C SUB P"	HEAT4	1067
2	" "19X,"NUMBER NAME")	HEAT4	1068
	DO 10 MAT=1,MATLT	HEAT4	1069
	J=1	HEAT4	1070
	WRITE(6,2002)MAT,MATNAM(MAT),J,T(J,MAT),V(J,MAT)	HEAT4	1071
2002	FORMAT(" ",18X,15,6X,A8,17,2X,1P2E14,5)	HEAT4	1072
	MPTS=NPTS(MAT)	HEAT4	1073
	IF(MPTS.LE.1)GO TO 3	HEAT4	1074
	WRITE(6,2003)J,T(J,MAT),V(J,MAT),J=2,MPTS)	HEAT4	1075
2003	FORMAT(" ",37X,17,2X,1P2E14,5)	HEAT4	1076
3	IF(IRAD.LT.2)GO TO 10	HEAT4	1077
C	IF RADIATION IS PRESENT, CONVERT TO ABSOLUTE TEMPERATURES.	HEAT4	1078
	DO 5 J=1,MPTS	HEAT4	1079
5	T(J,MAT)=T(J,MAT)+TABS(JABS)	HEAT4	1080
10	CONTINUE	HEAT4	1081
	RETURN	HEAT4	1082
C****	THE HEAT CAPACITY AT TEMPERATURE TEMP IS DETERMINED BY LINEAR	HEAT4	1083
C	INTERPOLATION AND IS RETURNED IN CSUBP.	HEAT4	1084
C		HEAT4	1085
	END	HEAT4	1086

FUNCTION CSUBP 74/74 OPT=2 FTN 4.1+REL 03/26/74 10.19.57.

	FUNCTION CSUBP(MAT,TEMP)	HEAT4	1087
	COMMON/SPHEAT /T(25,50),V(25,50),NPTS(50)	HEAT4	1088
	COMMON/LOGHEAT/LOVAL(50),HIVAL(50)	HEAT4	1089
	COMMON/ITCCHD/TABS(2),JABS,IRAD,TDCHD	HEAT4	1090
	LOGICAL LOVAL,HIVAL,TDCHD	HEAT4	1091
	DATA MAXPT/25/	HEAT4	1092
	IF(TEMP.GE.T(1,MAT))GO TO 50	HEAT4	1093
	IF(LOVAL(MAT))GO TO 40	HEAT4	1094
	LOVAL(MAT)=.TRUE.	HEAT4	1095
	IF(IRAD.NE.2)GO TO 25	HEAT4	1096
	TEMP1=TEMP-TABS(JABS)	HEAT4	1097
	TEMP2=T(1,MAT)-TABS(JABS)	HEAT4	1098
	GO TO 30	HEAT4	1099
25	TEMP1=TEMP	HEAT4	1100
	TEMP2=T(1,MAT)	HEAT4	1101
30	WRITE(6,9910)MAT,TEMP1,TEMP2	HEAT4	1102
9910	FORMAT("0**** FOR MATERIAL",I4," THE HEAT CAPACITY MUST BE EVALUA	HEAT4	1103
	TED AT",1PE12.4," DEGREES."/7X,"IT IS ASSUMED THAT THE HEAT CAPACI	HEAT4	1104
	2TY IS CONSTANT FOR ALL TEMPERATURES LESS THAN OR EQUAL TO",1PE12.4	HEAT4	1105
3)		HEAT4	1106
40	CSUBP=V(1,MAT)	HEAT4	1107
	RETURN	HEAT4	1108
50	MPTS=NPTS(MAT)	HEAT4	1109
	IF(MPTS.EQ.1)GO TO 65	HEAT4	1110
DO 60	I=2,MPTS	HEAT4	1111
	M=I	HEAT4	1112
	IF(TEMP.LE.T(I,MAT))GO TO 100	HEAT4	1113
60	CONTINUE	HEAT4	1114
65	IF(HIVAL(MAT))GO TO 90	HEAT4	1115
	HIVAL(MAT)=.TRUE.	HEAT4	1116
	IF(IRAD.NE.2)GO TO 70	HEAT4	1117
	TEMP1=TEMP-TABS(JABS)	HEAT4	1118
	TEMP2=T(MPTS,MAT)-TABS(JABS)	HEAT4	1119
	GO TO 80	HEAT4	1120
70	TEMP1=TEMP	HEAT4	1121
	TEMP2=T(MPTS,MAT)	HEAT4	1122
80	WRITE(6,9920)MAT,TEMP1,TEMP2	HEAT4	1123
9920	FORMAT("0**** FOR MATERIAL",I4," THE HEAT CAPACITY MUST BE EVALUA	HEAT4	1124
	TED AT",1PE12.4," DEGREES."/7X,"IT IS ASSUMED THAT THE HEAT CAPACI	HEAT4	1125
	2TY IS CONSTANT FOR ALL TEMPERATURES GREATER THAN OR EQUAL TO",	HEAT4	1126
3	1PE12.4)	HEAT4	1127
90	CSUBP=V(MPTS,MAT)	HEAT4	1128
	RETURN	HEAT4	1129
100	CSUBP=V(M,MAT)+((V(M-1,MAT)-V(M,MAT))*(TEMP-T(M,MAT)))/	HEAT4	1130
1	(T(M-1,MAT)-T(M,MAT))	HEAT4	1131
	RETURN	HEAT4	1132
	END	HEAT4	1133

LISTING AND SUBROUTINE COMPILATION: HETING P. 17

SUBROUTINE POINTS

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.20.26.

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SUBROUTINE POINTS
1      (T1      ,T2      ,T3      ,SMVG      ,SMRCV      ,HEAT4      1134
2      ,CDLIST  ,VGLIST  ,X1      ,X2      ,SLCAP      ,HEAT4      1135
3      ,NB      ,NNR      ,NPT      ,NVG      ,NPI      ,HEAT4      1136
4      ,NTPJ     ,NTPK     ,NILBR    ,NILFR    ,NIRRR    ,HEAT4      1137
5      ,NIRFR    ,NOLBR    ,NOLFR    ,NORRR    ,NORFR    ,HEAT4      1138
6      ,NHLIST   ,NGLIST   ,MELMAT   ,MAXPTS   ,          ,HEAT4      1139
COMMON /INPOCA/ IT,JT,KT,NGEOM      ,          ,HEAT4      1140
COMMON /IPSCS/  NRHIN(100) , NRROT(100) , NTHLT(100) , NTHRT(100) ,HEAT4      1141
1      , NZZBK(100) , NZZFR(100) , MAXREG      ,          ,HEAT4      1142
COMMON /IPTSSB/ NDBRK(100) , NDOFR(100) , NBDIN(100) , NBDLT(100) ,HEAT4      1143
1      , NBUOT(100) , NBDRT(100) , MATL(100) , NOREGT      , NGXP1      ,HEAT4      1144
2      , NGYP1      , NGZP1      , NGX      , NGY      , NGZ      ,HEAT4      1145
COMMON /PTCSSM/ NGGR,NT              ,          ,HEAT4      1146
COMMON /ERROR/ IERROR                ,          ,HEAT4      1147
DIMENSION T1(1) ,          , SMRCV(1) , CDLIST(1) , VGLIST(1) ,HEAT4      1148
1      , NR(6,1) , NNB(1) , NPT(1) , NVG(1) , NTP1(1) ,HEAT4      1149
2      , NTPJ(1) , NTPK(1) , NILBR(1) , NILFR(1) , NIRRR(1) ,HEAT4      1150
3      , NIRFR(1) , NOLBR(1) , NOLFR(1) , NORRR(1) , NORFR(1) ,HEAT4      1151
4      , NBLIST(1) , NGLIST(1) , X1(MAXPTS,1) , SLCAP(1) , MELMAT(1) ,HEAT4      1152
DIMENSION NRAC2(100) , NRAC3(100) ,          ,          ,HEAT4      1153
C*      IT = NUMBER OF X OR R FINE LATTICE LINES.      ,HEAT4      1154
C*      JT = NUMBER OF Y OR T FINE LATTICE LINES.      ,HEAT4      1155
C*      KT = NUMBER OF Z FINE LATTICE LINES.      ,HEAT4      1156
N=1      ,HEAT4      1157
I1=1+NGGP      ,HEAT4      1158
FOR LATTICE POINT N, THE NUMBER OF THE REGION WHICH APPEARS      ,HEAT4      1159
C*      ON LEFT OR INSIDE, BOTTOM OR LEFT, AND FRONT = NILFR(N),      ,HEAT4      1160
C*      ON LEFT OR INSIDE, BOTTOM OR LEFT, AND BACK  = NILBR(N),      ,HEAT4      1161
C*      ON LEFT OR INSIDE, TOP OR RIGHT, AND FRONT  = NIRFR(N),      ,HEAT4      1162
C*      ON LEFT OR INSIDE, TOP OR RIGHT, AND BACK   = NIRBR(N),      ,HEAT4      1163
C*      ON RIGHT OR OUTSIDE, BOTTOM OR LEFT, AND FRONT = NOLFR(N),      ,HEAT4      1164
C*      ON RIGHT OR OUTSIDE, BOTTOM OR LEFT, AND BACK = NOLBR(N),      ,HEAT4      1165
C*      ON RIGHT OR OUTSIDE, TOP OR RIGHT, AND FRONT = NORFR(N),      ,HEAT4      1166
C*      ON RIGHT OR OUTSIDE, TOP OR RIGHT, AND BACK  = NORBR(N),      ,HEAT4      1167
DO 313 K=1,KT      ,HEAT4      1168
NAC3=0      ,HEAT4      1169
DO 285 NOREG=1,NOREG1      ,HEAT4      1170
IF (NGZ) 283,283,281      ,HEAT4      1171
0281 IF (K-NZZFR(NOREG)) 284,283,282      ,HEAT4      1172
0282 IF (K-NZZFR(NOREG)) 283,283,284      ,HEAT4      1173
0283 NAC3=NAC3+1      ,HEAT4      1174
NRAC3(NAC3)=NOREG      ,HEAT4      1175
0284 CONTINUE      ,HEAT4      1176
0285 CONTINUE      ,HEAT4      1177
IF (NAC3) 313,313,286      ,HEAT4      1178
286 DO 312 J=1,JT      ,HEAT4      1179
NAC2=0      ,HEAT4      1180
DO 291 NOREG=1,NAC3      ,HEAT4      1181
JJ=NRAC3(NOREG)      ,HEAT4      1182
IF (NGY) 289,289,287      ,HEAT4      1183
0287 IF (J-NTHLT(JJ)) 290,289,288      ,HEAT4      1184
0288 IF (J-NTHRT(JJ)) 289,289,290      ,HEAT4      1185
0289 NAC2=NAC2+1      ,HEAT4      1186
NRAC2(NAC2)=JJ      ,HEAT4      1187
0290 CONTINUE      ,HEAT4      1188
0291 CONTINUE      ,HEAT4      1189

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SUBROUTINE POINTS

74/74 OPT=2

FTN 4.1+REL

03/26/74 10.20.26.

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IF (NAC2) 312,312,292      ,HEAT4      1191
292 DO 311 I=1,IT      ,HEAT4      1192
NPT(N)=0      ,HEAT4      1193
NILBR(N)=0      ,HEAT4      1194
NILFR(N)=0      ,HEAT4      1195
NIRBR(N)=0      ,HEAT4      1196
NIRFR(N)=0      ,HEAT4      1197
NOLBR(N)=0      ,HEAT4      1198
NOLFR(N)=0      ,HEAT4      1199
NORBR(N)=0      ,HEAT4      1200

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LISTING AND SUBROUTINE COMPILATION: HETING P. 18

NORFR(N)=0	HEAT4	1201
DO 310 NOREG=1,NAC2	HEAT4	1202
NSUM=0	HEAT4	1203
IT=NRAC2(NOREG)	HEAT4	1204
IF(NGX)297,297,293	HEAT4	1205
0293 IF(I-NRRIN(II))310,294,295	HEAT4	1206
0294 NSUM=NSUM+1	HEAT4	1207
GO TO 297	HEAT4	1208
0295 IF(I-NRR0T(II))297,296,310	HEAT4	1209
0296 NSUM=NSUM+2	HEAT4	1210
0297 IF(NGY)302,302,298	HEAT4	1211
0298 IF(J-NTHLT(II))310,299,300	HEAT4	1212
0299 NSUM=NSUM+4	HEAT4	1213
GO TO 302	HEAT4	1214
0300 IF(J-NTHRT(II))302,301,310	HEAT4	1215
0301 NSUM=NSUM+8	HEAT4	1216
0302 IF(NGZ)307,307,303	HEAT4	1217
0303 IF(K-NZZRK(II))310,304,305	HEAT4	1218
0304 NSUM=NSUM+16	HEAT4	1219
GO TO 307	HEAT4	1220
0305 IF(K-NZZFR(II))307,306,310	HEAT4	1221
0306 NSUM=NSUM+32	HEAT4	1222
0307 CONTINUE	HEAT4	1223
NPT(N)=(K-1)*(IT-NGGR)*JT+(J-1)*(IT-NGGR)*I-NGGR	HEAT4	1224
NTP(N)=I	HEAT4	1225
NTPJ(N)=J	HEAT4	1226
NTPK(N)=K	HEAT4	1227
IF(NSUM)2043,2000,308	HEAT4	1228
0308 GO TO (2001,2002,2043,2004,2005,2006,2043,	HEAT4	1229
12008,2009,2010,2043,2043,2043,2043,2016,	HEAT4	1230
22017,2018,2043,2020,2021,2022,2043,2024,2025,	HEAT4	1231
32026,2043,2043,2043,2043,2032,2033,2034,	HEAT4	1232
42043,2036,2037,2038,2043,2040,2041,2042),NSUM	HEAT4	1233
2000 NILFR(N)=II	HEAT4	1234
NILBR(N)=II	HEAT4	1235
NIRFR(N)=II	HEAT4	1236
NIRBR(N)=II	HEAT4	1237
NOLFR(N)=II	HEAT4	1238
NOLBR(N)=II	HEAT4	1239
NOPFR(N)=II	HEAT4	1240
NOPBR(N)=II	HEAT4	1241
GO TO 310	HEAT4	1242
2001 NOLFR(N)=II	HEAT4	1243
NOLBR(N)=II	HEAT4	1244
NOPFR(N)=II	HEAT4	1245
NOPBR(N)=II	HEAT4	1246
GO TO 310	HEAT4	1247
2002 NILFR(N)=II	HEAT4	1248
NILBR(N)=II	HEAT4	1249
NIRFR(N)=II	HEAT4	1250
NIRBR(N)=II	HEAT4	1251
GO TO 310	HEAT4	1252
2004 NIRFR(N)=II	HEAT4	1253
NIRBR(N)=II	HEAT4	1254
NOPFR(N)=II	HEAT4	1255
NOPBR(N)=II	HEAT4	1256
GO TO 310	HEAT4	1257
2005 NOPFR(N)=II	HEAT4	1258
NOPBR(N)=II	HEAT4	1259
GO TO 310	HEAT4	1260
2006 NIRFR(N)=II	HEAT4	1261
NIRBR(N)=II	HEAT4	1262
GO TO 310	HEAT4	1263
2008 NILFR(N)=II	HEAT4	1264
NILBR(N)=II	HEAT4	1265
NOLFR(N)=II	HEAT4	1266
NOLBR(N)=II	HEAT4	1267
GO TO 310	HEAT4	1268
2009 NOLFR(N)=II	HEAT4	1269
NOLBR(N)=II	HEAT4	1270
GO TO 310	HEAT4	1271
2010 NILFR(N)=II	HEAT4	1272
NILBR(N)=II	HEAT4	1273
GO TO 310	HEAT4	1274

LISTING AND SUBROUTINE COMPILATION: HETING P. 19

2016	NILFR(N)=II	HEAT4	1275
	NIRFR(N)=II	HEAT4	1276
	NOLFR(N)=II	HEAT4	1277
	NORFR(N)=II	HEAT4	1278
	GO TO 310	HEAT4	1279
2017	NOLFR(N)=II	HEAT4	1280
	NORFR(N)=II	HEAT4	1281
	GO TO 310	HEAT4	1282
2018	NILFR(N)=II	HEAT4	1283
	NIRFR(N)=II	HEAT4	1284
	GO TO 310	HEAT4	1285
2020	NIRFR(N)=II	HEAT4	1286
	NORFR(N)=II	HEAT4	1287
	GO TO 310	HEAT4	1288
2021	NORFR(N)=II	HEAT4	1289
	GO TO 310	HEAT4	1290
2022	NIRFR(N)=II	HEAT4	1291
	GO TO 310	HEAT4	1292
2024	NILFR(N)=II	HEAT4	1293
	NOLFR(N)=II	HEAT4	1294
	GO TO 310	HEAT4	1295
2025	NOLFR(N)=II	HEAT4	1296
	GO TO 310	HEAT4	1297
2026	NILFR(N)=II	HEAT4	1298
	GO TO 310	HEAT4	1299
2032	NILBR(N)=II	HEAT4	1300
	NIRBR(N)=II	HEAT4	1301
	NOLBR(N)=II	HEAT4	1302
	NORBR(N)=II	HEAT4	1303
	GO TO 310	HEAT4	1304
2033	NOLBR(N)=II	HEAT4	1305
	NORBR(N)=II	HEAT4	1306
	GO TO 310	HEAT4	1307
2034	NILBR(N)=II	HEAT4	1308
	NIRBR(N)=II	HEAT4	1309
	GO TO 310	HEAT4	1310
2036	NIRBR(N)=II	HEAT4	1311
	NORBR(N)=II	HEAT4	1312
	GO TO 310	HEAT4	1313
2037	NORBR(N)=II	HEAT4	1314
	GO TO 310	HEAT4	1315
2038	NIRBR(N)=II	HEAT4	1316
	GO TO 310	HEAT4	1317
2040	NILBR(N)=II	HEAT4	1318
	NOLBR(N)=II	HEAT4	1319
	GO TO 310	HEAT4	1320
2041	NOLBR(N)=II	HEAT4	1321
	GO TO 310	HEAT4	1322
2042	NILBR(N)=II	HEAT4	1323
	GO TO 310	HEAT4	1324
2043	NORGG = II	HEAT4	1325
	GO TO 5006	HEAT4	1326
0310	CONTINUE	HEAT4	1327
	IF (NDT(N)) 311,311,7311	HEAT4	1328
7311	NOREG=NILBR(N)	HEAT4	1329
	IF (NOREG.LE.0) GO TO 5	HEAT4	1330
	IF (MATL(NOREG).GT.0) GO TO 40	HEAT4	1331
5	NOREG=NILFR(N)	HEAT4	1332
	IF (NOREG.LE.0) GO TO 10	HEAT4	1333
	IF (MATL(NOREG).GT.0) GO TO 40	HEAT4	1334
10	NOREG=NIRBR(N)	HEAT4	1335
	IF (NOREG.LE.0) GO TO 15	HEAT4	1336
	IF (MATL(NOREG).GT.0) GO TO 40	HEAT4	1337
15	NOREG=NIRFR(N)	HEAT4	1338
	IF (NOREG.LE.0) GO TO 20	HEAT4	1339
	IF (MATL(NOREG).GT.0) GO TO 40	HEAT4	1340
20	NOREG=NOLBR(N)	HEAT4	1341
	IF (NOREG.LE.0) GO TO 25	HEAT4	1342
	IF (MATL(NOREG).GT.0) GO TO 40	HEAT4	1343
25	NOREG=NOLFR(N)	HEAT4	1344
	IF (NOREG.LE.0) GO TO 30	HEAT4	1345
	IF (MATL(NOREG).GT.0) GO TO 40	HEAT4	1346

LISTING AND SUBROUTINE COMPILATION: HETING P. 20

30	NOPEG=NORBR(N)	HEAT4	1347
	IF(NOREG.LE.0)GO TO 35	HEAT4	1348
	IF(MATL(NOREG).GT.0)GO TO 40	HEAT4	1349
35	NOPEG=NORFR(N)	HEAT4	1350
	IF(NOREG.LE.0)GO TO 311	HEAT4	1351
	IF(MATL(NOREG).GT.0)GO TO 40	HEAT4	1352
	GO TO 311	HEAT4	1353
40	N=N+1	HEAT4	1354
311	CONTINUE	HEAT4	1355
312	CONTINUE	HEAT4	1356
313	CONTINUE	HEAT4	1357
	NT=N-1	HEAT4	1358
	WRITE(6,3000)NT	HEAT4	1359
	IF(IEERROR.GT.0)WRITE(IEERROR,3000)NT	HEAT4	1360
3000	FORMAT("0",5X,"THIS PROBLEM CONTAINS",I5," NODES.")	HEAT4	1361
	IF(NT.LE.MAXPTS)GO TO 7321	HEAT4	1362
7322	WRITE(6,7323)NT	HEAT4	1363
	IF(IEERROR.GT.0)WRITE(IEERROR,7323)NT	HEAT4	1364
7323	FORMAT(1H1,9X,12HJOB SKIPPED,I6,7H POINTS)	HEAT4	1365
	CALL EXIT	HEAT4	1366
C*	THE ARRAY NR(I,J) CONTAINS THE NEIGHBORS OF NODE J.	HEAT4	1367
7321	DO 570 NTP=1,NT	HEAT4	1368
	DO 7320 M=1,6	HEAT4	1369
7320	NR(M,NTP)=0	HEAT4	1370
	IF(NGX)330,330,320	HEAT4	1371
0320	NINI=NTP1(NTP)-1	HEAT4	1372
	NOTI=NTP1(NTP)+1	HEAT4	1373
0330	IF(NGY)350,350,340	HEAT4	1374
0340	NLTJ=NTPJ(NTP)-1	HEAT4	1375
	NRTJ=NTPJ(NTP)+1	HEAT4	1376
0350	IF(NGZ)369,369,360	HEAT4	1377
0360	NKK=NTPK(NTP)-1	HEAT4	1378
	NFRK=NTPK(NTP)+1	HEAT4	1379
0369	IF(NGX)420,420,370	HEAT4	1380
0370	IF(NINI-NGGR)400,400,380	HEAT4	1381
0380	NR(1,NTP)=(NTPK(NTP)-1)*(IT-NGGR)*JT	HEAT4	1382
	1*(NTPJ(NTP)-1)*(IT-NGGR)+NINI-NGGR	HEAT4	1383
0400	IF(NOTI-IT)410,410,420	HEAT4	1384
0410	NR(2,NTP)=(NTPK(NTP)-1)*(IT-NGGR)*JT	HEAT4	1385
	1*(NTPJ(NTP)-1)*(IT-NGGR)+NOTI-NGGR	HEAT4	1386
0420	IF(NGY)470,470,430	HEAT4	1387
0430	IF(NLTJ)450,450,440	HEAT4	1388
0440	NR(3,NTP)=(NTPK(NTP)-1)*(IT-NGGR)*JT	HEAT4	1389
	1*(NLTJ-1)*(IT-NGGR)+NTP1(NTP)-NGGR	HEAT4	1390
0450	IF(NRTJ-JT)460,460,470	HEAT4	1391
0460	NR(4,NTP)=(NTPK(NTP)-1)*(IT-NGGR)*JT	HEAT4	1392
	1*(NRTJ-1)*(IT-NGGR)+NTP1(NTP)-NGGR	HEAT4	1393
0470	IF(NGZ)520,520,480	HEAT4	1394
0480	IF(NKK)500,500,490	HEAT4	1395
0490	NR(5,NTP)=(NKK-1)*(IT-NGGR)*JT	HEAT4	1396
	1*(NTPJ(NTP)-1)*(IT-NGGR)+NTP1(NTP)-NGGR	HEAT4	1397
0500	IF(NFRK-KT)510,510,520	HEAT4	1398
0510	NR(6,NTP)=(NFRK-1)*(IT-NGGR)*JT	HEAT4	1399
	1*(NTPJ(NTP)-1)*(IT-NGGR)+NTP1(NTP)-NGGR	HEAT4	1400
0520	DO 560 M=1,6	HEAT4	1401
	DO 550 N=1,NT	HEAT4	1402
	IF(NR(M,NTP))560,560,530	HEAT4	1403
0530	IF(NR(M,NTP)-NPT(N))550,540,550	HEAT4	1404
0540	NR(M,NTP)=N	HEAT4	1405
	GO TO 560	HEAT4	1406
0550	CONTINUE	HEAT4	1407
	NR(M,NTP)=0	HEAT4	1408
0560	CONTINUE	HEAT4	1409
0570	CONTINUE	HEAT4	1410
C***	LOCATE THE NODES WHICH REQUIRE SURFACE-TO-SURFACE HEAT TRANSFER.	HEAT4	1411
	CALL SSBOCN(NTP1,NTPJ,NTPK)	HEAT4	1412
	NGXP1=NGX+1	HEAT4	1413
	NGYP1=NGY+1	HEAT4	1414
	NGZP1=NGZ+1	HEAT4	1415
	CALL THRMPR	HEAT4	1416
1	(T1 ,T2 ,T3 ,SMVG ,SMRCV	HEAT4	1417
2	,COLIST ,VGLIST ,X1 ,X2 ,SLCAP	HEAT4	1418
3	,NB ,NNB ,NPT ,NVG ,NTP1	HEAT4	1419
4	,NTPJ ,NTPK ,NILBR ,NILFR ,NIRBR	HEAT4	1420
5	,NIRFR ,NOLBR ,NOLFR ,NORBR ,NORFR	HEAT4	1421
6	,NBLIST ,NGLIST ,MELMAT ,MAXPTS ,0	HEAT4	1422
	RETURN	HEAT4	1423

LISTING AND SUBROUTINE COMPILATION: HETING P. 21

5006	M = NORGG	HEAT4	1424
	WRITE (6,5007)M	HEAT4	1425
	IF (IERHOR.GT.0) WRITE (IERHOR,5007)M	HEAT4	1426
5007	FORMAT(1H0,9X,32HINPUT ERROR DETECTED, REGION NO. 16)	HEAT4	1427
295	STOP	HEAT4	1428
	END	HEAT4	1429

--PASS 2 MEMORY OVERFLOW AT SOURCE LINE 193-- IN DOPRE--

SUBROUTINE SSBOCN 74/74 OPT=2

FTN 4.1*REL

03/26/74 10.20.40.

.....	SUBROUTINE SSBOCN (NTPJ, NTPJ, NTPK)	HEAT4	1430
C	***** THESE ROUTINES LOCATE THE BOUNDARIES WHICH REQUIRE SURFACE-TO-	HEAT4	1431
C	SURFACE HEAT TRANSFER. THEN, EACH NODE ON ONE SURFACE IS	HEAT4	1432
C	CONNECTED WITH THE CORRESPONDING NODE ON THE OPPOSING SURFACE.	HEAT4	1433
	COMMON /IPSHCS/ NRRIN(100), NRROT(100), NTHLT(100), NTHRT(100)	HEAT4	1434
	1, NZZBK(100), NZZFR(100), MAXREG	HEAT4	1435
	COMMON /IPTSSB/ NDBBK(100), NDBFR(100), NBDIN(100), NBDLT(100)	HEAT4	1436
	1, NBDOT(100), NBDPT(100), MATL(100), NOREGT, NGXP1	HEAT4	1437
	2, NGYP1, NGZP1, NGX, NGY, NGZ	HEAT4	1438
	COMMON /TSBCSS/ MAXSUR, ISUR, KSUR(2*3,100), NSUR(2*500)	HEAT4	1439
	COMMON /ERROR/ IERPOR	HEAT4	1440
	DIMENSION BOUND(3), NTPJ(1), NTPJ(1), NTPK(1)	HEAT4	1441
	DATA BOUND/0H X OR R, 0H Y OR T, 0H Z	HEAT4	1442
C	IGRID = 1 --- ALONG X OR R AXIS.	HEAT4	1443
C	= 2 --- ALONG Y OR THETA AXIS.	HEAT4	1444
C	= 3 --- ALONG Z AXIS.	HEAT4	1445
	ISTOP=0	HEAT4	1446
	ISUR=1	HEAT4	1447
	MAXSUR=500	HEAT4	1448
	DO 10 I=1,2	HEAT4	1449
	DO 10 J=1,3	HEAT4	1450
	DO 10 K=1,MAXREG	HEAT4	1451
10	KSUR(I,J,K)=0	HEAT4	1452
	DO 20 I=1,2	HEAT4	1453
	DO 20 J=1,MAXSUR	HEAT4	1454
20	NSUR(I,J)=0	HEAT4	1455
C	FOR EACH REGION	HEAT4	1456
	DO 100 NOREG=1,NOREGT	HEAT4	1457
C	IS THE X OR R AXIS PRESENT.	HEAT4	1458
	IF (NGX.EQ.0) GO TO 30	HEAT4	1459
C	IF 50* IS THERE ANY SURFACE TO SURFACE-TO-SURFACE HEAT TRANSFER	HEAT4	1460
C	BETWEEN THE OPPOSING X OR R BOUNDARIES.	HEAT4	1461
	IGRID=1	HEAT4	1462
	CALL TYPEHC (NBDIN(NOREG), NBDOT(NOREG), RETURNS (30,900))	HEAT4	1463
C	BOTH X OR R DIMENSIONS HAVE SURFACE-TO-SURFACE BOUNDARY	HEAT4	1464
C	CONDITIONS.	HEAT4	1465
C	LOCATE EACH PAIR OF SURFACE NODES WHICH HAVE SURFACE-TO-SURFACE	HEAT4	1466
C	HEAT TRANSFER BETWEEN THEM.	HEAT4	1467
	CALL SSNODE (NTPJ, NTPJ, NTPK, NRRIN(NOREG), NRROT(NOREG), NTHLT(NOREG),	HEAT4	1468
	1 NTHRT(NOREG), NZZBK(NOREG), NZZFR(NOREG), IGRID, NOREG, ISTOP)	HEAT4	1469
C	IS THE Y OR THETA AXIS PRESENT.	HEAT4	1470
	30 IF (NGY.EQ.0) GO TO 40	HEAT4	1471
C	IF 50* IS THERE ANY SURFACE-TO-SURFACE HEAT TRANSFER	HEAT4	1472
C	BETWEEN THE OPPOSING Y OR THETA BOUNDARIES.	HEAT4	1473
	IGRID=2	HEAT4	1474
	CALL TYPEHC (NBDLT(NOREG), NBDRT(NOREG), RETURNS (60,900))	HEAT4	1475
C	BOTH Y OR THETA DIMENSIONS HAVE SURFACE-TO-SURFACE BOUNDARY	HEAT4	1476
C	CONDITIONS. LOCATE EACH PAIR OF SURFACE NODES WHICH HAVE	HEAT4	1477
C	SURFACE-TO-SURFACE HEAT TRANSFER BETWEEN THEM.	HEAT4	1478
	CALL SSNODE (NTPJ, NTPJ, NTPK, NTHLT(NOREG), NTHRT(NOREG), NRRIN(NOREG),	HEAT4	1479
	1 NRROT(NOREG), NZZBK(NOREG), NZZFR(NOREG), IGRID, NOREG, ISTOP)	HEAT4	1480
C	IS THE Z AXIS PRESENT.	HEAT4	1481
	60 IF (NGZ.EQ.0) GO TO 100	HEAT4	1482
C	IF 50* IS THERE ANY SURFACE-TO-SURFACE HEAT TRANSFER	HEAT4	1483
C	BETWEEN THE OPPOSING Z BOUNDARIES.	HEAT4	1484
	IGRID=3	HEAT4	1485
	CALL TYPEHC (NDBBK(NOREG), NDBFR(NOREG), RETURNS (100,900))	HEAT4	1486
C	BOTH Z DIMENSIONS HAVE SURFACE-TO-SURFACE BOUNDARY CONDITIONS.	HEAT4	1487
C	LOCATE EACH PAIR OF SURFACE NODES WHICH HAVE SURFACE-TO-SURFACE	HEAT4	1488
C	HEAT TRANSFER BETWEEN THEM.	HEAT4	1489
	CALL SSNODE (NTPK, NTPJ, NTPJ, NZZBK(NOREG), NZZFR(NOREG), NRRIN(NOREG),	HEAT4	1490
	1 NRROT(NOREG), NTHLT(NOREG), NTHRT(NOREG), IGRID, NOREG, ISTOP)	HEAT4	1491
	GO TO 100	HEAT4	1492

LISTING AND SUBROUTINE COMPILATION: HETING P. 22

900	WRITE(6,9060)BOUND(IGRID),NOREG	HEAT4	1493
	IF(IEERROR.GT.0)WRITE(IEERROR,9060)BOUND(IGRID),NOREG	HEAT4	1494
9060	FORMAT("THERE IS AN ERROR IN THE BOUNDARY CONDITION FOR ONE OF THE	HEAT4	1495
	1E"AX,"DIMENSIONS OF REGION",I4)	HEAT4	1496
	ISTOP=1	HEAT4	1497
C	CONTINUE THE PROBLEM BUT STOP BEFORE RETURNING TO POINTS.	HEAT4	1498
	GO TO (30,60,100),IGRID	HEAT4	1499
100	CONTINUE	HEAT4	1500
	ISUR=ISUR-1	HEAT4	1501
	IF(ISUR.EQ.0)GO TO 175	HEAT4	1502
	WRITE(6,2000)	HEAT4	1503
2000	FORMAT("1",11X,"SURFACE-TO-SURFACE CONNECTIONS"/	HEAT4	1504
	1 "0",13X,"NUMBER NODE TO NODE")	HEAT4	1505
	DO 200 I=1,ISUR	HEAT4	1506
200	WRITE(6,2001) I,(NSUR(J,I),J=1,2)	HEAT4	1507
2001	FORMAT(" ",13X,I4,2I10)	HEAT4	1508
C	IF A DATA ERROR WAS LOCATED IN ONE OF THE REGIONS, TERMINATE	HEAT4	1509
C	THE PROBLEM.	HEAT4	1510
175	IF(ISTOP.EQ.1)STOP 175	HEAT4	1511
	RETURN	HEAT4	1512
	END	HEAT4	1513

SUBROUTINE TYPEBC 74/74 OPT=2 FTN 4.1+REL 03/26/74 10.20.46.

	SUBROUTINE TYPEBC(NB1,NB2),RETURNS(A1,A2)	HEAT4	1514
C	THIS ROUTINE DETERMINES IF THERE ARE ANY SURFACE-TO-SURFACE	HEAT4	1515
C	BOUNDARY CONDITIONS IN THE REGION ALONG THE AXIS INVOLVED.	HEAT4	1516
	COMMON /INBCTB/ NB2TYP(50)	HEAT4	1517
C	ISS IS THE BOUNDARY CONDITION TYPE FOR SURFACE-TO-SURFACE HEAT	HEAT4	1518
C	TRANSFER.	HEAT4	1519
	DATA ISS/3/	HEAT4	1520
	NB1T=0	HEAT4	1521
	NB2T=0	HEAT4	1522
C	IF THE SMALLER DIMENSION HAS A BOUNDARY CONDITION, RECORD ITS	HEAT4	1523
C	TYPE.	HEAT4	1524
	IF(NB1.GT.0)NB1T=NB2TYP(NB1)	HEAT4	1525
C	IF THE LARGER DIMENSION HAS A BOUNDARY CONDITION, RECORD ITS	HEAT4	1526
C	TYPE.	HEAT4	1527
	IF(NB2.GT.0)NB2T=NB2TYP(NB2)	HEAT4	1528
C	DOES NEITHER BOUNDARY POSSESS A SURFACE-TO-SURFACE BOUNDARY	HEAT4	1529
C	CONDITION.	HEAT4	1530
	IF(NB1T.NE.ISS.AND.NB2T.NE.ISS) RETURN A1	HEAT4	1531
C	IF NOT, DOES BOTH BOUNDARIES POSSESS A SURFACE-TO-SURFACE	HEAT4	1532
C	BOUNDARY CONDITION.	HEAT4	1533
	IF(NB1T.EQ.ISS.AND.NB2T.EQ.ISS)RETURN	HEAT4	1534
C	SINCE ONE BOUNDARY CONDITION IS SURFACE-TO-SURFACE AND THE	HEAT4	1535
C	OTHER IS NOT, THERE MUST BE AN ERROR IN THE INPUT DATA.	HEAT4	1536
	RETURN A2	HEAT4	1537
	END	HEAT4	1538

SUBROUTINE SSNODE 74/74 OPT=2 FTN 4.1+REL 03/26/74 10.20.49.

	SUBROUTINE SSNODE(NI,NJ,NK,I1,I2,J1,J2,K1,K2,IGRID,NOREG,ISTOP)	HEAT4	1539
	COMMON /TSBCSS/ MAXSUR , ISUR , KSUR(2*3*100),NSUR(2*500)	HEAT4	1540
	COMMON /PTCSS/ NGGR,NT	HEAT4	1541
	COMMON /ERROR/ IEERROR	HEAT4	1542
	DIMENSION NI(1),NJ(1),NK(1),BOUND(3)	HEAT4	1543
	DATA BOUND/8H X OR R ,8H Y OR T ,2H Z/,SMALL/5HSMALL/,LARGE/5HLLARGE	HEAT4	1544
	1E/	HEAT4	1545
C	KSUR(1,IGRID,NOREG) INDICATES THE LOCATION IN ARRAY NSUR FOR	HEAT4	1546
C	THE FIRST SURFACE-TO-SURFACE CONNECTOR ALONG THE IGRID AXIS	HEAT4	1547
C	OF REGION NOREG.	HEAT4	1548
	KSUR(1,IGRID,NOREG)=ISUR	HEAT4	1549
C	FOR EACH K PLANE,	HEAT4	1550
	DO 100 K=K1,K2	HEAT4	1551
C	AND EACH J PLANE,	HEAT4	1552
	DO 90 J=J1,J2	HEAT4	1553
C	LOCATE THE NODE, NS ₁ , AT THE INTERSECTION OF THE I ₁ , J, AND K	HEAT4	1554
C	PLANES.	HEAT4	1555
	DO 30 N=1,NT	HEAT4	1556
	NS ₁ =N	HEAT4	1557
	IF(I1.EQ.NI(N).AND.J.EQ.NJ(N).AND.K.EQ.NK(N))GO TO 40	HEAT4	1558
30	CONTINUE	HEAT4	1559

LISTING AND SUBROUTINE COMPILATION: HETING P. 23

C	IF GEOMETRY TYPE IS LESS THAN 5 AND R(1)=0.0, THEN THERE	HEAT4	1560
C	CAN BE NO SURFACE-TO-SURFACE CONNECTORS INVOLVING R(1).	HEAT4	1561
	IF (NGGR.NE.1) GO TO 38	HEAT4	1562
	GO TO (32,34,34), IGRID	HEAT4	1563
32	IF (I1.EQ.1) GO TO 90	HEAT4	1564
	GO TO 38	HEAT4	1565
34	IF (J.EQ.1) GO TO 90	HEAT4	1566
38	CONTINUE	HEAT4	1567
C	THE NODE CANNOT BE FOUND.	HEAT4	1568
	WRITE(6,9070) NOREG, SMALL, BOUND(IGRID), J, K	HEAT4	1569
	IF (IERROR.GT.0) WRITE(IERRON,9070) NOREG, SMALL, BOUND(IGRID), J, K	HEAT4	1570
9070	FORMAT('FOR REGION', I4, ' THE NODE AT THE INTERSECTION OF THE "AS	HEAT4	1571
	'AB, "GRID LINE AND THE "I4, " AND "I4, " GRID LINES CANNOT BE FOUND	HEAT4	1572
	1 D.")	HEAT4	1573
	2 D.")	HEAT4	1574
C	ISTOP=1	HEAT4	1575
C	LOCATE THE NODE, NS2, AT THE INTERSECTION OF THE I2, J, AND K	HEAT4	1576
	PLANES.	HEAT4	1577
40	DO 50 N=NS1, NT	HEAT4	1578
	NS2=N	HEAT4	1579
	IF (I2.EQ.NI(N) .AND. J.EQ.NJ(N) .AND. K.EQ.NK(N)) GO TO 60	HEAT4	1580
50	CONTINUE	HEAT4	1581
C	THE NODE CANNOT BE LOCATED.	HEAT4	1582
	WRITE(6,9070) NOREG, LARGE, BOUND(IGRID), J, K	HEAT4	1583
	IF (IERROR.GT.0) WRITE(IERRON,9070) NOREG, LARGE, BOUND(IGRID), J, K	HEAT4	1584
	ISTOP=1	HEAT4	1585
C	STORE THE NUMBERS OF THE OPPOSING NODES.	HEAT4	1586
60	NSUR(1, ISUR)=NS1	HEAT4	1587
	NSUR(2, ISUR)=NS2	HEAT4	1588
	ISUR=ISUR+1	HEAT4	1589
	IF (ISUR.LE.MAXSUR) GO TO 90	HEAT4	1590
	WRITE(6,9080) MAXSUR	HEAT4	1591
	IF (IERROR.GT.0) WRITE(IERRON,9080) MAXSUR	HEAT4	1592
9080	FORMAT('THE NUMBER OF SURFACE-TO-SURFACE CONNECTIONS EXCEEDS', I5,	HEAT4	1593
	1 " , EXECUTION OF THE PROGRAM IS TERMINATED.")	HEAT4	1594
	STOP 11010	HEAT4	1595
90	CONTINUE	HEAT4	1596
100	CONTINUE	HEAT4	1597
C	KSUR(2, IGRID, NOREG) INDICATES THE LOCATION IN ARRAY NSUR FOR	HEAT4	1598
C	THE LAST SURFACE-TO-SURFACE CONNECTOR ALONG THE IGRID AXIS	HEAT4	1599
C	OF REGION NOREG.	HEAT4	1600
	KSUR(2, IGRID, NOREG)=ISUR-1	HEAT4	1601
	RETURN	HEAT4	1602
	END	HEAT4	1602

SUBROUTINE THRMPR

74/74

OPT=2

FTN 4.1+REL

03/26/74

10.20.55.

SUBROUTINE THRMPR										HEAT4	1603
1	IT1	IT2	IT3	SMVG	SMRCV	HEAT4	1604				
2	CDLIST	VGLIST	X1	X2	SLCAP	HEAT4	1605				
3	NR	NNB	NPT	NVG	NTPI	HEAT4	1606				
4	NTPI	NTPK	NTLPR	NTLFR	NIPRR	HEAT4	1607				
5	NIRFR	NOLBR	NOLFR	NORBR	NORFR	HEAT4	1608				
6	NBLIST	NGLIST	MELMAT	MAXPTS	NSET	HEAT4	1609				
C	THIS ROUTINE EVALUATES THE THERMAL PROPERTIES CORRESPONDING					HEAT4	1610				
C	TO EACH NODE.					HEAT4	1611				
C	Q IS A FUNCTION OF POSITION.					HEAT4	1612				
	COMMON /INTHRM/	G1M(100)	G1P(100)	G2M(100)	G2P(100)	HEAT4	1613				
1	G3M(100)	G3P(100)	G4M(100)	G4P(100)	G5M(100)	HEAT4	1614				
2	G5P(100)	INTEN(100)	ITMTH(25)	NGNTH(20)	NGNTH(20)	HEAT4	1615				
3	ITMTH(25)	ITWZ(25)	NGEN(100)	NGNR(20)	NGNZ(20)	HEAT4	1616				
4	INITEM	JIN	HGG			HEAT4	1617				
	COMMON /ITCSRC/	BTTEMP(50)	TDUM(50)	TH(100)	R(100)	HEAT4	1618				
1	Z(100)	ABYTFN(50)	NEOTPT	NTYPE		HEAT4	1619				
	COMMON /THHSRC/	NBDTP	NDIR			HEAT4	1620				
	COMMON /THMRBC/	CDTY(24)	NDMNO(24)	NDUM		HEAT4	1621				
	COMMON /THSRC/	CONDTY(24)	G1(2)	G2(2)	G4(2)	HEAT4	1622				
1	G5(2)	NSMODE(24)	NSCONN			HEAT4	1623				
	COMMON /ITPG/	POSFN(50,4)	VAR(3)	NFNX(3)		HEAT4	1624				
	COMMON /INTHCR/	SLTM(5)	SLHM(5)	MATSL		HEAT4	1625				
	COMMON /ITCTIM/	TFN(20,50)	TFN(20)	TIM	NTIMFP(20)	HEAT4	1626				

LISTING AND SUBROUTINE COMPILATION: HETING P. 24

1 . NTDFN	HEAT4	1627
COMMON /IPTSS/ NDBRK(100) , NBDFR(100) , NBDIN(100) , NBDLT(100)	HEAT4	1628
1 . NBDRT(100) , NBDRT(100) , MATL(100) , NOREGT , NGXP1	HEAT4	1629
2 . NGYP1 , NGZP1 , NGX , NGY , NGZ	HEAT4	1630
COMMON /TSCSS/ MAXSUR , ISUR , KSUR(2*3*100) , NSUR(2*500)	HEAT4	1631
COMMON /PTCSS/ NGGR,NT	HEAT4	1632
COMMON /ITCCHD/ IARS(2) , JABS , IRAD , TDCDHC	HEAT4	1633
COMMON /ERROR/ IERROR	HEAT4	1634
DIMENSION T1(1) , SMRCV(1) , COLIST(1) , VGLIST(1)	HEAT4	1635
1 . NR(6,1) , NNU(1) , NVG(1) , NTP1(1) , NTPJ(1)	HEAT4	1636
2 . NTPK(1) , NILBR(1) , NILFR(1) , NIRBR(1) , NIRFR(1)	HEAT4	1637
3 . NOLBR(1) , NOLFR(1) , NORBR(1) , NORFR(1) , NBLIST(1)	HEAT4	1638
4 . NGLIST(1) , X1(1,1) , SLCAP(1) , MELMAT(1)	HEAT4	1639
LOGICAL TDCDHC	HEAT4	1640
DIMENSION VG(8) , MREG(2,2,2) , NGNTML(8)	HEAT4	1641
DIMENSION G3(2)	HEAT4	1642
MPTST2=2*MAXPTS	HEAT4	1643
IF(NTDFN.GT.0)CALL TIMEDF	HEAT4	1644
IF(NBDTPT)490,490,410	HEAT4	1645
C* CALCULATE THE CURRENT TEMPERATURE FOR EACH BOUNDARY POINT.	HEAT4	1646
0410 DO 480 I=1,NBDTPT	HEAT4	1647
IF(NBYTFN(I))420,420,430	HEAT4	1648
0420 TDUM(I)=BYTEMP(I)	HEAT4	1649
GO TO 480	HEAT4	1650
0430 II=NBYTFN(I)	HEAT4	1651
TDUM(I)=BYTEMP(I)*TFN(II)	HEAT4	1652
0480 CONTINUE	HEAT4	1653
490 MOUNT=6*MAXPTS	HEAT4	1654
MOUNT=2*MAXPTS	HEAT4	1655
NSET=-1	HEAT4	1656
IF(NTYPE.EQ.1)NSET=1	HEAT4	1657
IKOUNT=0	HEAT4	1658
DO 550 N=1,NT	HEAT4	1659
550 NVG(N)=0	HEAT4	1660
C* CALCULATE THE INITIAL TEMPERATURE DISTRIBUTION.	HEAT4	1661
DO 500 N=1,NT	HEAT4	1662
NFT=0	HEAT4	1663
IX=NTP1(N)	HEAT4	1664
JY=NTPJ(N)	HEAT4	1665
KZ=NTPK(N)	HEAT4	1666
G1(1)=G1M(IX)	HEAT4	1667
G1(2)=G1P(IX)	HEAT4	1668
G2(1)=G2M(IX)	HEAT4	1669
G2(2)=G2P(IX)	HEAT4	1670
G3(1)=G3M(IX)	HEAT4	1671
G3(2)=G3P(IX)	HEAT4	1672
G4(1)=G4M(JY)	HEAT4	1673
G4(2)=G4P(JY)	HEAT4	1674
G5(1)=G5M(KZ)	HEAT4	1675
G5(2)=G5P(KZ)	HEAT4	1676
MREG(1,1,2)=NILFR(N)	HEAT4	1677
MREG(1,1,1)=NILBR(N)	HEAT4	1678
MREG(1,2,2)=NIRFR(N)	HEAT4	1679
MREG(1,2,1)=NIRBR(N)	HEAT4	1680
MREG(2,1,2)=NOLFR(N)	HEAT4	1681
MREG(2,1,1)=NOLBR(N)	HEAT4	1682
MREG(2,2,2)=NORFR(N)	HEAT4	1683
MREG(2,2,1)=NORBR(N)	HEAT4	1684
C* SMV = SUM OVER ALL SECTIONS OF A NODE OF (THE INITIAL	HEAT4	1685
C* TEMPERATURE OF A SECTION TIMES THE VOLUME OF THE SECTION).	HEAT4	1686
C* SMV = VOLUME OF THE NODE.	HEAT4	1687
SMV=0.0	HEAT4	1688
SMV=0.0	HEAT4	1689
VAP(1)=R(IX)	HEAT4	1690
VAP(2)=TH(JY)	HEAT4	1691
VAP(3)=Z(KZ)	HEAT4	1692
DO 980 I=1,NGXP1	HEAT4	1693
DO 980 J=1,NGYP1	HEAT4	1694
DO 980 K=1,NGZP1	HEAT4	1695
NOREG=MREG(I,J,K)	HEAT4	1696
IF(NOREG.LE.0)GO TO 980	HEAT4	1697
IF(MATL(NOREG).LE.0)GO TO 980	HEAT4	1698
V=G1(I)*G2(J)*G4(K)*G5(K)	HEAT4	1699

LISTING AND SUBROUTINE COMPILATION: HETING P. 25

C*	CALCULATE THE HEAT GENERATION RATE OF EACH NODE.	HEAT4	1700
	NGN=NGEN(NGREG)	HEAT4	1701
	IF (NGN.LE.0) GO TO 100	HEAT4	1702
	NFNX(1)=NGNR(NGN)	HEAT4	1703
	NFNX(2)=NGNT(NGN)	HEAT4	1704
	NFNX(3)=NGNZ(NGN)	HEAT4	1705
C*	CALCULATE THE POSITION DEPENDENT FACTOR FOR THE HEAT GENERATION	HEAT4	1706
C*	RATE FOR A SECTION OF A NODE.	HEAT4	1707
	CALL GENFN(TSN,TIM,GEN)	HEAT4	1708
	IF (NFT.LT.1) GO TO 60	HEAT4	1709
	DO 50 NFT=1,NFT	HEAT4	1710
	IF (NGNTM(NGN).NE.NGNTML(NFTL)) GO TO 50	HEAT4	1711
	VG(NFTL)=VG(NFTL)*V*GEN	HEAT4	1712
	GO TO 100	HEAT4	1713
50	CONTINUE	HEAT4	1714
60	NFT=NFT+1	HEAT4	1715
	VG(NFT)=V*GEN	HEAT4	1716
	NGNTML(NFT)=NGNTM(NGN)	HEAT4	1717
100	CONTINUE	HEAT4	1718
	INTM=INTEN(NGREG)	HEAT4	1719
	IF (INTM.GT.0) GO TO 973	HEAT4	1720
	TEMP=0.0	HEAT4	1721
	GO TO 974	HEAT4	1722
973	NFNX(1)=ITMR(INTM)	HEAT4	1723
	NFNX(2)=ITMT(INTM)	HEAT4	1724
	NFNX(3)=ITMZ(INTM)	HEAT4	1725
C*	CALCULATE THE POSITION DEPENDENT FACTOR FOR THE INITIAL	HEAT4	1726
C*	TEMPERATURE FOR A SECTION OF A NODE.	HEAT4	1727
	CALL POSDFN(TEMP)	HEAT4	1728
974	SMTV=SMTV+TEMP*V	HEAT4	1729
	SMV=SMV+V	HEAT4	1730
980	CONTINUE	HEAT4	1731
	IF (NFT.LE.0) GO TO 990	HEAT4	1732
C*	STORE THE HEAT GENERATIONS FOR EACH SECTION OF NODE N.	HEAT4	1733
	DO 130 NFTL=1,NFT	HEAT4	1734
	NTAH=130	HEAT4	1735
	IKOUNT=IKOUNT+1	HEAT4	1736
	IF (IKOUNT.GT.MKOUNT) GO TO 9999	HEAT4	1737
	NGLIST(IKOUNT)=NGNTML(NFTL)	HEAT4	1738
	VGLIST(IKOUNT)=VG(NFTL)	HEAT4	1739
130	CONTINUE	HEAT4	1740
	NVG(N)=NFT	HEAT4	1741
C*	CALCULATE THE INITIAL TEMPERATURE OF NODE N.	HEAT4	1742
990	T1(N)=SMTV/SMV	HEAT4	1743
	DO 500 I=1,MATSL	HEAT4	1744
	X1(N,I)=0.0	HEAT4	1745
500	CONTINUE	HEAT4	1746
C*	READ THE INITIAL TEMPERATURES OF SELECTED NODES, IF ANY.	HEAT4	1747
	IF (JIN.LE.0) GO TO 505	HEAT4	1748
	READ(JIN,3001) INITEM,INITV	HEAT4	1749
3001	FORMAT(/,2I5)	HEAT4	1750
	IF (INITEM.GT.0) READ(JIN,3002) (N,T1(N),I=1,INITEM)	HEAT4	1751
3002	FORMAT(5I5,E10.0)	HEAT4	1752
	IF (INITX1.LT.1) GO TO 505	HEAT4	1753
	DO 503 J=1,INITX1	HEAT4	1754
503	READ(JIN,3003) N, (X1(N,I),I=1,MATSL)	HEAT4	1755
3003	FORMAT(15I5,E10.0)	HEAT4	1756
505	CONTINUE	HEAT4	1757
C*		HEAT4	1758
	IF (IRAD.LT.2) GO TO 520	HEAT4	1759
C	IF RADIATION IS PRESENT, CONVERT TO ABSOLUTE TEMPERATURES.	HEAT4	1760
	DO 510 N=1,NT	HEAT4	1761
510	T1(N)=T1(N)+TABS(JABS)	HEAT4	1762
520	CONTINUE	HEAT4	1763
	ENTRY THRM	HEAT4	1764
C*		HEAT4	1765
	ICOUNT=0	HEAT4	1766
	DO 575 N=1,NT	HEAT4	1767
575	NNR(N)=0	HEAT4	1768
	DO 1000 N=1,NT	HEAT4	1769
	TSN = T1(N)	HEAT4	1770
	NDIUM=0	HEAT4	1771
	NSCONN=0	HEAT4	1772
	IX=NTPI(N)	HEAT4	1773

LISTING AND SUBROUTINE COMPILATION: HETING P. 26

JY=NTPJ(N)	HEAT4	1774
KZ=NTPK(N)	HEAT4	1775
G1(1)=G1M(IX)	HEAT4	1776
G1(2)=G1P(IX)	HEAT4	1777
G2(1)=G2M(IX)	HEAT4	1778
G2(2)=G2P(IX)	HEAT4	1779
G3(1)=G3M(IX)	HEAT4	1780
G3(2)=G3P(IX)	HEAT4	1781
G4(1)=G4M(JY)	HEAT4	1782
G4(2)=G4P(JY)	HEAT4	1783
G5(1)=G5M(KZ)	HEAT4	1784
G5(2)=G5P(KZ)	HEAT4	1785
MREG(1,1,2)=NILFR(N)	HEAT4	1786
MREG(1,1,1)=NILBR(N)	HEAT4	1787
MREG(1,2,2)=NIRFR(N)	HEAT4	1788
MREG(1,2,1)=NIRBR(N)	HEAT4	1789
MREG(2,1,2)=NOLFR(N)	HEAT4	1790
MREG(2,1,1)=NOLBR(N)	HEAT4	1791
MREG(2,2,2)=NORFR(N)	HEAT4	1792
MREG(2,2,1)=NORBR(N)	HEAT4	1793
IF(NGX.LE.0)GO TO 703	HEAT4	1794
C* CALCULATE THE THERMAL CONDUCTANCE IN NODE N ALONG	HEAT4	1795
C* THE X OR R AXIS.	HEAT4	1796
NDIR=1	HEAT4	1797
DO 690 I=1,2	HEAT4	1798
NBD=NB(I,N)	HEAT4	1799
IF(NBD.GT.0)GO TO 610	HEAT4	1800
TEMP=T1(N)	HEAT4	1801
GO TO 615	HEAT4	1802
610 TEMP=(T1(N)+T1(NBD))/2.0	HEAT4	1803
615 SMKK=0.0	HEAT4	1804
DO 651 J=1,NGYP1	HEAT4	1805
DO 651 K=1,NGZP1	HEAT4	1806
C IS A REGION DEFINED ADJACENT TO NODE N.	HEAT4	1807
NOREG=MREG(I,J,K)	HEAT4	1808
IF(NOREG.LE.0)GO TO 630	HEAT4	1809
C IF SO, DOES IT CONTAIN A MATERIAL.	HEAT4	1810
MAT=MATL(NOREG)	HEAT4	1811
IF(MAT.LE.0)GO TO 620	HEAT4	1812
C IF SO, CALCULATE THE EFFECTIVE CONDUCTANCE BETWEEN NODE N AND	HEAT4	1813
C ITS NEIGHBORING INTERIOR NODE	HEAT4	1814
DELK=G3(I)*G4(J)*G5(K)/(2.0*G1(I))	HEAT4	1815
SMKK=SMKK+DELK*COND(MAT,TEMP)	HEAT4	1816
C IS HEAT TO BE TRANSFERRED BETWEEN THE OPPOSING SURFACES OF THE	HEAT4	1817
C REGION (THOSE PERPENDICULAR TO THE X OR R AXIS).	HEAT4	1818
620 IF(KSUR(1,NDIR,NOREG).LE.0)GO TO 628	HEAT4	1819
GO TO (623,625),I	HEAT4	1820
623 NBDTP=NBDOT(NOREG)	HEAT4	1821
GO TO 627	HEAT4	1822
625 NBDTP=NBDIN(NOREG)	HEAT4	1823
627 CALL SURRC(NOREG,I,J,K,N,T1,IX,NTP1,NTPJ,NTPK,MPTST2)	HEAT4	1824
628 IF(MAT.GT.0)GO TO 651	HEAT4	1825
C* TOWARDS BOUNDARY POINT NEIGHBORS.	HEAT4	1826
630 M3MI=3-I	HEAT4	1827
NOREG=MREG(M3MI,J,K)	HEAT4	1828
IF(NOREG.LE.0)GO TO 651	HEAT4	1829
IF(I.GT.1)GO TO 643	HEAT4	1830
NBDTP=NBDIN(NOREG)	HEAT4	1831
GO TO 645	HEAT4	1832
643 NBDTP=NBDOT(NOREG)	HEAT4	1833
645 IF(NBDTP.GT.0) CALL BDCOND(G1(I),G2(I),G4(J),G5(K),R(IX),MAXPTS,	HEAT4	1834
1 TSN,TOUM(NBDTP))	HEAT4	1835
651 CONTINUE	HEAT4	1836
IF(SMKK.EQ.0.0)GO TO 690	HEAT4	1837
ICOUNT=ICOUNT+1	HEAT4	1838
NTAR=690	HEAT4	1839
IF(ICOUNT.GT.MCOUNT)GO TO 9999	HEAT4	1840
NNR(N)=NNH(N)+1	HEAT4	1841
NBLIST(ICOUNT)=NB(I,N)	HEAT4	1842
CDLIST(ICOUNT)=SMKK	HEAT4	1843
690 CONTINUE	HEAT4	1844
703 IF(NGY.LE.0)GO TO 804	HEAT4	1845

LISTING AND SUBROUTINE COMPILATION: HETING P. 27

C*	CALCULATE THE THERMAL CONDUCTANCE IN NODE N ALONG	HEAT4	1846
C*	THE Y OR T AXIS.	HEAT4	1847
	NDIR=2	HEAT4	1848
	DO 790 J=1,2	HEAT4	1849
	NBD=NH(J,2,N)	HEAT4	1850
	IF(NBD.GT.0)GO TO 710	HEAT4	1851
	TEMP=T1(N)	HEAT4	1852
	GO TO 715	HEAT4	1853
710	TEMP=(T1(N)+T1(NBD))/2.0	HEAT4	1854
715	SMKK=0.0	HEAT4	1855
	DO 751 I=1,NGXP1	HEAT4	1856
	DO 751 K=1,NGZP1	HEAT4	1857
C	IS A REGION DEFINED ADJACENT TO NODE N.	HEAT4	1858
	NOREG=HREG(I,J,K)	HEAT4	1859
	IF(NOREG.LE.0)GO TO 730	HEAT4	1860
C	IF SO, DOES IT CONTAIN A MATERIAL.	HEAT4	1861
	MAT=MATL(NOREG)	HEAT4	1862
	IF(MAT.LE.0)GO TO 720	HEAT4	1863
C	IF SO, CALCULATE THE EFFECTIVE CONDUCTANCE BETWEEN NODE N AND	HEAT4	1864
C	ITS NEIGHBORING INTERIOR NODE	HEAT4	1865
	DELK=G1(I)*G5(K)/(2.0*G4(J))	HEAT4	1866
	IF(NGG.EQ.1)DELK=DELK/R(IX)	HEAT4	1867
	SMKK=SMKK+DELK*COND(MAT,TEMP)	HEAT4	1868
C	IS HEAT TO BE TRANSFERRED BETWEEN THE OPPOSING SURFACES OF THE	HEAT4	1869
C	REGION (THOSE PERPENDICULAR TO THE Y OR THETA AXIS).	HEAT4	1870
720	IF(KSUR(1,NDIR,NOREG).LE.0)GO TO 728	HEAT4	1871
	GO TO (72J,725),J	HEAT4	1872
723	NBDTP=NBDRT(NOREG)	HEAT4	1873
	GO TO 727	HEAT4	1874
725	NBDTP=NBDLT(NOREG)	HEAT4	1875
727	CALL SUBBC(NOREG,I,J,K,N,T1,IX,NTPJ,NTPK,MPTST2)	HEAT4	1876
728	IF(MAT.GT.0)GO TO 751	HEAT4	1877
C*	TOWARDS BOUNDARY POINT NEIGHBORS.	HEAT4	1878
0730	M3MJ=3-J	HEAT4	1879
	NOREG=HREG(I,M3MJ,K)	HEAT4	1880
	IF(NOREG.LE.0)GO TO 751	HEAT4	1881
	IF(J.GT.1)GO TO 743	HEAT4	1882
	NBDTP=NBDLT(NOREG)	HEAT4	1883
	GO TO 745	HEAT4	1884
0743	NBDTP=NBDRT(NOREG)	HEAT4	1885
745	IF(NBDTP.GT.0) CALL 90CONU(G1(I),G2(I),G4(J),G5(K),R(IX),MAXPTS,	HEAT4	1886
	1 TSN,TDM(NBDTP))	HEAT4	1887
0751	CONTINUE	HEAT4	1888
	IF(SMKK.EQ.0.0)GO TO 790	HEAT4	1889
	ICOUNT=ICOUNT+1	HEAT4	1890
	NTAR=790	HEAT4	1891
	IF(ICOUNT.GT.MCOUNT)GO TO 9999	HEAT4	1892
	NNH(N)=NNH(N)+1	HEAT4	1893
	NH1,IST(ICOUNT)=NH(J,2,N)	HEAT4	1894
	COLIST(ICOUNT)=SMKK	HEAT4	1895
0790	CONTINUE	HEAT4	1896
804	IF(NGZ.LE.0)GO TO 900	HEAT4	1897
C*	CALCULATE THE THERMAL CONDUCTANCE IN NODE N ALONG	HEAT4	1898
C*	THE Z AXIS.	HEAT4	1899
	NDIR=3	HEAT4	1900
	DO 890 K=1,2	HEAT4	1901
	NBD=NH(K,4,N)	HEAT4	1902
	IF(NBD.GT.0)GO TO 810	HEAT4	1903
	TEMP=T1(N)	HEAT4	1904
	GO TO 815	HEAT4	1905
810	TEMP=(T1(N)+T1(NBD))/2.0	HEAT4	1906
815	SMKK=0.0	HEAT4	1907
	DO 851 I=1,NGXP1	HEAT4	1908
	DO 851 J=1,NGYP1	HEAT4	1909
C	IS A REGION DEFINED ADJACENT TO NODE N.	HEAT4	1910
	NOREG=HREG(I,J,K)	HEAT4	1911
	IF(NOREG.LE.0)GO TO 830	HEAT4	1912
C	IF SO, DOES IT CONTAIN A MATERIAL.	HEAT4	1913
	MAT=MATL(NOREG)	HEAT4	1914
	IF(MAT.LE.0)GO TO 820	HEAT4	1915
C	IF SO, CALCULATE THE EFFECTIVE CONDUCTANCE BETWEEN NODE N AND	HEAT4	1916
C	ITS NEIGHBORING INTERIOR NODE	HEAT4	1917
	DELK=G1(I)*G2(I)*G4(J)/(2.0*G5(K))	HEAT4	1918
	SMKK=SMKK+DELK*COND(MAT,TEMP)	HEAT4	1919

LISTING AND SUBROUTINE COMPILATION: HETING P. 28

C	IS HEAT TO BE TRANSFERRED BETWEEN THE OPPOSING SURFACES OF THE	HEAT4	1920
C	REGION (THOSE PERPENDICULAR TO THE Z AXIS).	HEAT4	1921
820	IF (K SUR (1,NDIR,NOREG).LE.0) GO TO 823	HEAT4	1922
	GO TO (823,825).K	HEAT4	1923
823	NBUTP=NBDFR(NOREG)	HEAT4	1924
	GO TO 827	HEAT4	1925
825	NBUTP=NRDBK(NOREG)	HEAT4	1926
827	CALL SUBFC(NOREG,I,J,K,N,1,IX,NTP1,NTPJ,NTPK,MPTST2)	HEAT4	1927
828	IF (MAT.GT.0) GO TO 851	HEAT4	1928
C	TOWARDS BOUNDARY POINT NEIGHBORS.	HEAT4	1929
0830	M3MK=3-K	HEAT4	1930
	NOREG=MREG(I,J,M3MK)	HEAT4	1931
	IF (NOREG.LE.0) GO TO 851	HEAT4	1932
	IF (K.GT.1) GO TO 843	HEAT4	1933
	NBUTP=NRDBK(NOREG)	HEAT4	1934
	GO TO 845	HEAT4	1935
0843	NBUTP=NBDFR(NOREG)	HEAT4	1936
845	IF (NBUTP.GT.0) CALL RDCOND(G1(I),G2(I),G4(J),G5(K),R(IX),MAXPTS,	HEAT4	1937
	1 TSN,TDUM(NBUTP))	HEAT4	1938
0851	CONTINUE	HEAT4	1939
	IF (SMKK.EQ.0.0) GO TO 890	HEAT4	1940
	ICOUNT=ICOUNT+1	HEAT4	1941
	NTAB=890	HEAT4	1942
	IF (ICOUNT.GT.MCOUNT) GO TO 9999	HEAT4	1943
	NNB(N)=NNB(N)+1	HEAT4	1944
	NRLIST(ICOUNT)=NB(K+4,N)	HEAT4	1945
	COLIST(ICOUNT)=SMKK	HEAT4	1946
0890	CONTINUE	HEAT4	1947
900	IF (NDUM.LE.0) GO TO 918	HEAT4	1948
C	STORE THE THERMAL CONDUCTANCE FROM NODE N TO ITS BOUNDARY	HEAT4	1949
C	POINTS.	HEAT4	1950
	DO 915 NDML=1,NDUM	HEAT4	1951
	ICOUNT=ICOUNT+1	HEAT4	1952
	NTAB=915	HEAT4	1953
	IF (ICOUNT.GT.MCOUNT) GO TO 9999	HEAT4	1954
	NNB(N)=NNB(N)+1	HEAT4	1955
	NRLIST(ICOUNT)=NDMNO(NDML)	HEAT4	1956
	COLIST(ICOUNT)=CDTY(NDML)	HEAT4	1957
0915	CONTINUE	HEAT4	1958
918	IF (NSCONN.LE.0) GO TO 150	HEAT4	1959
C	STORE THE EFFECTIVE CONDUCTANCE FOR SURFACE-TO-SURFACE HEAT	HEAT4	1960
C	TRANSFER FROM NODE N TO EACH OF ITS OPPOSING NODES.	HEAT4	1961
	DO 917 NDML=1,NSCONN	HEAT4	1962
	ICOUNT=ICOUNT+1	HEAT4	1963
	NTAB=917	HEAT4	1964
	IF (ICOUNT.GT.MCOUNT) GO TO 9999	HEAT4	1965
	NNB(N)=NNB(N)+1	HEAT4	1966
	NRLIST(ICOUNT)=NSNODE(NDML)	HEAT4	1967
	COLIST(ICOUNT)=CONDY(NDML)	HEAT4	1968
917	CONTINUE	HEAT4	1969
150	MELMAT(N)=0	HEAT4	1970
	IF (MSET.GT.0) GO TO 1000	HEAT4	1971
C	SMRCV(N) = THERMAL CAPACITANCE FOR NODE N.	HEAT4	1972
	TEMP=T1(N)	HEAT4	1973
	SLCAP(N)=0.0	HEAT4	1974
	SMRCV(N)=0.0	HEAT4	1975
	DO 930 I=1,N6XP1	HEAT4	1976
	DO 930 J=1,N6YP1	HEAT4	1977
	DO 930 K=1,N6ZP1	HEAT4	1978
	NOREG=MREG(I,J,K)	HEAT4	1979
	IF (NOREG.LE.0) GO TO 930	HEAT4	1980
	V=G1(I)+G2(J)+G4(J)+G5(K)	HEAT4	1981
	MAT=MATL(NOREG)	HEAT4	1982
	IF (MAT.LE.0) GO TO 930	HEAT4	1983
	IF (MAT.GT.MATSL) GO TO 929	HEAT4	1984
	QTTY = X1(N,MAT)	HEAT4	1985
	IF (TEMP.GT.SLTM(MAT).AND.QTTY.GE.1.0.OR.TEMP.LT.SLTM(MAT).AND.	HEAT4	1986
	1 QTTY.LE.0.0.OR.SLHM(MAT).LT.1.0E-10) GO TO 929	HEAT4	1987
	IF (MELMAT(N).NE.0.AND.MAT.NE.MELMAT(N)) GO TO 929	HEAT4	1988
	MELMAT(N)=MAT	HEAT4	1989
	SLCAP(N) = SLCAP(N) + RHO(MAT,TEMP) * SLHM(MAT) * V	HEAT4	1990
929	SMRCV(N)=SMRCV(N)+RHO(MAT,TEMP)*CSUBP(MAT,TEMP)*V	HEAT4	1991
930	CONTINUE	HEAT4	1992
1000	CONTINUE	HEAT4	1993
	RETURN	HEAT4	1994
9999	WRITE(6,4848)NTAB	HEAT4	1995
	IF (IERRON.GT.0) WRITE(IERRON,4848)NTAB	HEAT4	1996
4848	FORMAT('NO ARRAY OVERFLOW OCCURRED IN SUBROUTINE POINTS NEAR STATEME	HEAT4	1997
	INT NUMBER "I5"/"0" * 5X "INCREASE DIMENSIONS OF CORE AND ICORE AND	HEAT4	1999
	2THE VALUE OF N AS INDICATED IN THE MAIN PROGRAM.")	HEAT4	1999
	STOP 11111	HEAT4	2000
	END	HEAT4	2001

LISTING AND SUBROUTINE COMPILATION: HETING P. 29

SUBROUTINE BDCOND

74/74

OPT=2

FTN 4.1+REL

03/26/74

10.21.19.

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SUBROUTINE BDCOND(G1,G2,G4,G5,R,MAXPTS,TSN,TBN)
C* CALCULATE THE THERMAL CONDUCTANCE FROM A NODE TO A
C* BOUNDARY POINT.
COMMON /INBSBC/ BHCONV(50) , BHEXP(50) , BHNAT(50) , BHRAD(50)
1 , BFLUX(50)
COMMON /INPOCA/ IT,JT,KT,NGEOM
COMMON /INBCTR/ NRYTYP(50)
COMMON /THBSBC/ NBDTP , NDIR
COMMON /THMBC/ CDTY(24) , NDMNO(24) , NDUH
LOGICAL FLUX
NRYTYP=NRYTYP(NBDTP)
IF(NBTYPE.EQ.0 .CR. NBTYPE.EQ.3)RETURN
FLUX=.TRUE.
GO TO (20,10),NBTYPE
C* IF THE BOUNDARY TYPE IS 2, SET THE FILM COEFFICIENT TO 25.0025.
10 DELAH=25.0E25
GO TO 90
20 GO TO (30,60,70),NDIR
30 IF(NGEOM.LT.6)GO TO 40
DELA=G4*G5
GO TO 80
40 DELA=R*G4*G5
GO TO 80
60 DELA=G1*G5
GO TO 80
70 DELA=G1*G2*G4
80 FACTOR=ABS(TSN-TBN)
IF(FACTOR.EQ.0.0)GO TO 85
FACTOR=FACTOR**BHEXP(NBDTP)
85 DELA=DELA*(BHCONV(NBDTP)
1 * BHRAD(NBDTP)*(TSN**2+TBN**2)*(TSN+TBN)
2 * BHNAT(NBDTP)*FACTOR)
90 NPMPTS=NBDTP+MAXPTS
IF(DELA.EQ.0.0)GO TO 120
IF(NDUM.LE.0)GO TO 110
DO 100 NDM=1,NDUM
IF(NDMNO(NDM).NE.NPMPTS)GO TO 100
CDTY(NDM)=CDTY(NDM)*DELA
IF(FLUX)GO TO 120
RETURN
100 CONTINUE
110 NDUM=NDUM+1
CDTY(NDUM)=DELA
NDMNO(NDUM)=NPMPTS
IF(FLUX)GO TO 120
RETURN
C CHECK FOR CONSTANT HEAT FLUX ACROSS THE BOUNDARY.
120 IF(BFLUX(NBDTP).EQ.0.0)RETURN
FLUX=.FALSE.
DELA=BFLUX(NBDTP)*DELA
NPMPTS=0
GO TO 95
END

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SUBROUTINE SURRC

74/74

OPT=2

FTN 4.1+REL

03/26/74

10.22.37.

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SUBROUTINE SURRC(NOREG,I,J,K,N1,T1,IX,NTPJ,NTPK,MPTST2)
C THIS ROUTINE CALCULATES THE EFFECTIVE CONDUCTANCE FOR SURFACE=
C TO-SURFACE HEAT TRANSFER BETWEEN NODES N1 AND N2.
COMMON /ITCSHC/ BYTEMP(50) , TDUM(50) , TH(100) , R(100)
1 , Z(100) , NRYTYP(50) , NBDTP , NTYPE
COMMON /INBSBC/ BHCONV(50) , BHEXP(50) , BHNAT(50) , BHRAD(50)
1 , BFLUX(50)
COMMON /INPOCA/ IT,JT,KT,NGEOM
COMMON /THBSBC/ NBDTP , NDIR
COMMON /THMBC/ CDTY(24) , G1(2) , G2(2) , G4(2)
1 , G5(2) , NSNODE(24) , NSCONN
COMMON /IPSBCS/ NRRIN(100) , NRRUT(100) , NTHLT(100) , NTHRT(100)
1 , NZZHK(100) , NZZFR(100) , MAXREG
COMMON /TSRCS/ MAXSUR , ISUR , KSUR(2,3,100) , NSUR(2,500)
COMMON /ERROR/ IERROR

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LISTING AND SUBROUTINE COMPILATION: HETING P. 30

DIMENSION NTPJ(1),NTPK(1),DIRECT(3),T1(1)	HEAT4	2070
LOGICAL FLUX	HEAT4	2071
DATA DIRECT/8H X OR R ,8H Y OR T ,8H Z /	HEAT4	2072
LO=NSUR(1,NDIR,NOREG)	HEAT4	2073
LUP=NSUR(2,NDIR,NOREG)	HEAT4	2074
C DETERMINE WHICH SIDE OF THE DEFINED REGION NODE N1 IS ON.	HEAT4	2075
IR=1	HEAT4	2076
IF(NDIR.EQ.1 .AND. I.EQ.1 .OR. NDIR.EQ.2 .AND. J.EQ.1 .OR.	HEAT4	2077
1 NDIR.EQ.3 .AND. K.EQ.1) IR=2	HEAT4	2078
C DETERMINE THE NODE WHICH OPPOSES N1.	HEAT4	2079
DO 10 II=LO,LUP	HEAT4	2080
IF(N1.EQ.NSUR(IR,II))GO TO 20	HEAT4	2081
10 CONTINUE	HEAT4	2082
C IF NODE N1 CANNOT BE LOCATED IN ARRAY NSUR, SEE IF IT APPEARS	HEAT4	2083
C ON ONE OF THE REGION BOUNDARIES WHICH REQUIRES SURFACE-TO-	HEAT4	2084
C SURFACE HEAT TRANSFER.	HEAT4	2085
GO TO (11,14,17),NDIR	HEAT4	2086
C FOR HEAT TRANSFER IN THE X OR R DIRECTION.	HEAT4	2087
11 IF(NTPJ(N1).EQ.NRRIN(NOREG) .OR. NTPJ(N1).EQ.NRROT(NOREG))GO TO 18	HEAT4	2088
RETURN	HEAT4	2089
C FOR HEAT TRANSFER IN THE Y OR THETA DIRECTION.	HEAT4	2090
14 IF(NTPJ(N1).EQ.NTHLT(NOREG) .OR. NTPJ(N1).EQ.NTHRT(NOREG))GO TO 18	HEAT4	2091
RETURN	HEAT4	2092
C FOR HEAT TRANSFER IN THE Z DIRECTION.	HEAT4	2093
17 IF(NTPK(N1).EQ.NZZBK(NOREG) .OR. NTPK(N1).EQ.NZZFR(NOREG))GO TO 18	HEAT4	2094
RETURN	HEAT4	2095
18 WRITE(6,9060)DIRECT(NDIR),N1,I,J,K,IR,LO,IR,LUP	HEAT4	2096
IF(IEERROR.GT.0)WRITE(IEERROR,9060)DIRECT(NDIR),N1,I,J,K,IR,LO,IR,LU	HEAT4	2097
1 P	HEAT4	2098
9060 FORMAT("1FOR THE",A8,"DIRECTION, THE NODE WHICH OPPOSES NODE ",I5,	HEAT4	2099
1 " FOR I =",I4," , J =",I4," , AND K =",I4," CANNOT BE FOUND IN THE	HEAT4	2100
2NSUR ARRAY."/	HEAT4	2101
3 "0IT SHOULD BE BETWEEN (" ,I1," ,",I4,") AND (" ,I1," ,",I4,")"	HEAT4	2102
STOP 11060	HEAT4	2103
20 N2=NSUR(3-IR,II)	HEAT4	2104
N2PMPT=N2*MPST2	HEAT4	2105
FLUX=.TRUE.	HEAT4	2106
C RECORD THE TEMPERATURES OF THE OPPOSING SURFACES.	HEAT4	2107
TS1=T1(N1)	HEAT4	2108
TS2=T1(N2)	HEAT4	2109
C DETERMINE THE CROSS-SECTIONAL AREA.	HEAT4	2110
GO TO (30,60,70),NDIR	HEAT4	2111
30 IF(NGEOM.LT.6)GO TO 40	HEAT4	2112
C ALONG X-AXIS.	HEAT4	2113
DELA=G4(J)*G5(K)	HEAT4	2114
GO TO 80	HEAT4	2115
C ALONG R-AXIS.	HEAT4	2116
40 IF(I.EQ.1)GO TO 50	HEAT4	2117
DELA=R(IX)*G4(J)*G5(K)	HEAT4	2118
GO TO 80	HEAT4	2119
50 DELA=R(NTPJ(N2))*G4(J)*G5(K)	HEAT4	2120
GO TO 80	HEAT4	2121
C ALONG Y- OR T- AXIS.	HEAT4	2122
60 DELA=G1(I)*G5(K)	HEAT4	2123
GO TO 80	HEAT4	2124
C ALONG Z-AXIS.	HEAT4	2125
70 DELA=G1(I)*G2(I)*G4(J)	HEAT4	2126
C CALCULATE THE EFFECTIVE CONDUCTANCE.	HEAT4	2127
80 FACTOR = ABS(TS1-TS2)	HEAT4	2128
IF(FACTOR.EQ.0)GO TO 90	HEAT4	2129
FACTOR=FACTOR**RHEXP(NBDTP)	HEAT4	2130
90 DELAH=DELA*(BHCONV(NBDTP)	HEAT4	2131
1 + BHRAD(NBDTP)*(TS1**2+TS2**2)*(TS1+TS2)	HEAT4	2132
2 + BHNT(NBDTP)*FACTOR)	HEAT4	2133
IF(DELAH.EQ.0.0)GO TO 120	HEAT4	2134
95 IF(NSCONN.LE.0)GO TO 110	HEAT4	2135
DO 100 NSC=1,NSCONN	HEAT4	2136
IF(NSNODE(NSC).NE.N2PMPT)GO TO 100	HEAT4	2137
CONDTY(NSC)=CONDTY(NSC)+DELAH	HEAT4	2138
IF(FLUX)GO TO 120	HEAT4	2139
RETURN	HEAT4	2140
100 CONTINUE	HEAT4	2141

LISTING AND SUBROUTINE COMPILATION: HETING P. 31

110	NSCONN=NSCONN+1	HEAT4	2142
	CONDY(NSCONN)=DELAH	HEAT4	2143
	NSNODE(NSCONN)=N2PMPT	HEAT4	2144
	IF(FLUX)GO TO 120	HEAT4	2145
	RETURN	HEAT4	2146
C	CHECK FOR CONSTANT HEAT FLUX ACROSS THE BOUNDARY.	HEAT4	2147
120	IF (BFLUX(NBDTP).EQ.0.0)RETURN	HEAT4	2148
	FLUX=.FALSE.	HEAT4	2149
	DELAH=BFLUX(NBDTP)*DELA	HEAT4	2150
	N2PMPT=0	HEAT4	2151
	GO TO 95	HEAT4	2152
	END	HEAT4	2153

SUBROUTINE TIMEDF 74/74 OPT=2 FTN 4.1+REL 03/26/74 10.22.43.

	SUBROUTINE TIMEDF	HEAT4	2154
C*	CALCULATE THE CURRENT VALUE FOR EACH TIME DEPENDENT FUNCTION.	HEAT4	2155
	COMMON /ITCIM/ TIMFN(20,50),TFN(20) , TIM , NTIMFP(20)	HEAT4	2156
	1 , NTDFN	HEAT4	2157
	DO 390 I=1,NTDFN	HEAT4	2158
	IF (TIM-TIMFN(I,1))280,280,290	HEAT4	2159
0280	TFN(I)=TIMFN(I,2)	HEAT4	2160
	GO TO 390	HEAT4	2161
0290	JJ=NTIMFP(I)	HEAT4	2162
	IF (JJ-1)340,340,300	HEAT4	2163
0300	DO 320 J=2,JJ	HEAT4	2164
	II=2*J-1	HEAT4	2165
	IF (TIMFN(I,II)-TIM)320,330,330	HEAT4	2166
0320	CONTINUE	HEAT4	2167
	JJ=II	HEAT4	2168
0340	TFN(I)=TIMFN(I,JJ+1)	HEAT4	2169
	GO TO 390	HEAT4	2170
0330	TFN(I)=TIMFN(I,II-1)+(TIMFN(I,II+1)-TIMFN(I,II-1))*(TIM-TIMFN(I,II-2))/(TIMFN(I,II)-TIMFN(I,II-2))	HEAT4	2171
0390	CONTINUE	HEAT4	2172
	RETURN	HEAT4	2173
	END	HEAT4	2174
		HEAT4	2175

SUBROUTINE GENFN 74/74 OPT=2 FTN 4.1+REL 03/26/74 10.22.52.

	SUBROUTINE GENFN(T,TIM,FUNC)	HEAT4	2176
C*	DEVELOPMENT OF HEAT GENERATION FUNCTIONS.	HEAT4	2177
	COMMON /ITPG/ POSFN(50,9), VAR(3) , NFNX(3)	HEAT4	2178
	FUNC=1.0	HEAT4	2179
	DO 100 I=1,3	HEAT4	2180
	NFN=NFNX(I)	HEAT4	2181
	IF (NFN.LE.0)GO TO 100	HEAT4	2182
	FUNCX=POSFN(NFN,1)+POSFN(NFN,2)*VAR(I)+POSFN(NFN,3)*(VAR(I)**2)	HEAT4	2183
	IF (POSFN(NFN,4).EQ.0.0EU)GO TO 20	HEAT4	2184
	FUNCX=FUNCX+POSFN(NFN,4)*(VAR(I)**3)+POSFN(NFN,5)*(VAR(I)**4)	HEAT4	2185
20	IF (POSFN(NFN,6).EQ.0.0EU)GO TO 40	HEAT4	2186
	FUNCX=FUNCX+POSFN(NFN,6)*(VAR(I)**5)+POSFN(NFN,7)*(VAR(I)**6)	HEAT4	2187
40	IF (POSFN(NFN,8).EQ.0.0EU)GO TO 80	HEAT4	2188
	FUNCX=FUNCX+POSFN(NFN,8)*(VAR(I)**POSFN(NFN,9))	HEAT4	2189
80	FUNC=FUNC*FUNCX	HEAT4	2190
100	CONTINUE	HEAT4	2191
	RETURN	HEAT4	2192
	END	HEAT4	2193

SUBROUTINE POSDFN 74/74 OPT=2 FTN 4.1+REL 03/26/74 10.22.56.

	SUBROUTINE POSDFN(FUNC)	HEAT4	2194
C*	DEVELOPMENT OF POSITION DEPENDENT FUNCTIONS.	HEAT4	2195
	COMMON /ITPG/ POSFN(50,9), VAR(3) , NFNX(3)	HEAT4	2196
	FUNC=1.0	HEAT4	2197
	DO 100 I=1,3	HEAT4	2198
	NFN=NFNX(I)	HEAT4	2199
	IF (NFN.LE.0)GO TO 100	HEAT4	2200
	FUNCX=POSFN(NFN,1)+POSFN(NFN,2)*VAR(I)+POSFN(NFN,3)*(VAR(I)**2)	HEAT4	2201

LISTING AND SUBROUTINE COMPILATION: HETING P. 32

IF (POSFN(NFN,4).EQ.0.0E0)GO TO 20	HEAT4	2202
FUNCX=FUNCX+POSFN(NFN,4)*(VAR(I)**3)+POSFN(NFN,5)*(VAR(I)**4)	HEAT4	2203
20 IF (POSFN(NFN,6).EQ.0.0E0)GO TO 40	HEAT4	2204
FUNCX=FUNCX+POSFN(NFN,6)*(VAR(I)**5)+POSFN(NFN,7)*(VAR(I)**6)	HEAT4	2205
40 IF (POSFN(NFN,8).EQ.0.0E0)GO TO 80	HEAT4	2206
FUNCX=FUNCX+POSFN(NFN,8)*(VAR(I)**POSFN(NFN,9))	HEAT4	2207
80 FUNC=FUNC*FUNCX	HEAT4	2208
100 CONTINUE	HEAT4	2209
RETURN	HEAT4	2210
END	HEAT4	2211

SUBROUTINE CALQLT 74/74 OPT=2

FTN 4.1+REL

03/26/74 10.23.01.

SUBROUTINE CALQLT	HEAT4	2212
1 (T1 ,T2 ,T3 ,SMVG ,SMRCV	HEAT4	2213
2 ,CDLIST ,VGLIST ,X1 ,X2 ,SLCAP	HEAT4	2214
3 ,NR ,NNH ,NPT ,NVG ,NTPI	HEAT4	2215
4 ,NTPJ ,NTPK ,NILBR ,NILFR ,NIRBR	HEAT4	2216
5 ,NIRFR ,NOLHR ,NOLFR ,NORRR ,NORFR	HEAT4	2217
6 ,NBLIST ,NGLIST ,MELMAT ,MAXPTS	HEAT4	2218
COMMON /ECPU/ ICPU0,MAXCPU,MAXCPU	HEAT4	2219
COMMON /INCALQ/ PRTIME(100), DELTAT , BETA , FTIME	HEAT4	2220
1 , EPI , MAXPRT , NPRINT , NOITX , IOUT	HEAT4	2221
2 , JOUT , NDTA , NEX , KTMFCT	HEAT4	2222
COMMON /INPOCA/ IT,JT,KT,NGEOM	HEAT4	2223
COMMON /ITCSBC/ BYTEMP(50) , TDUM(50) , TH(100) , R(100)	HEAT4	2224
1 , Z(100) , NBYTFN(50) , NBDTPT , NTYPE	HEAT4	2225
COMMON /MNINCA/ JOHDES(18)	HEAT4	2226
COMMON /ITCTIM/ TIMFN(20,50),TFN(20) , TIM , NTIMFP(20)	HEAT4	2227
1 , NTUEN	HEAT4	2228
COMMON /PTCSSN/ NGGR,NT	HEAT4	2229
COMMON /ITCCHO/ TABS(2) , JABS , IRAD , TDCDHC	HEAT4	2230
COMMON /INTHCO/ SLTM(5) , SLHM(5) , MATSL	HEAT4	2231
COMMON /ERROP/ IERROR	HEAT4	2232
DIMENSION T1(1) , T2(1) , SMVG(1) , SMRCV(1) ,	HEAT4	2233
1 CDLIST(1) , VGLIST(1) , NNH(1) , NVG(1) , NTPI(1) ,	HEAT4	2234
2 NTPJ(1) , NTPK(1) , NBLIST(1) , NGLIST(1) , T3(1)	HEAT4	2235
3 ,X1(1,1),X2(1,1),SLCAP(1),MELMAT(1)	HEAT4	2236
DIMENSION TBOUND(50) , PRATIO(10) , IND(4)	HEAT4	2237
C* NNH(N) = NUMBER OF CONDUCTANCES FOR NODE N IN CDLIST.	HEAT4	2238
C* NVG(N) = NUMBER OF HEAT GENERATIONS FOR NODE N IN VGLIST.	HEAT4	2239
DIMENSION XMELT(4)	HEAT4	2240
LOGICAL TDCDHC	HEAT4	2241
DATA ITAPE/R/	HEAT4	2242
ISTAB=10	HEAT4	2243
IF (KTMFCT.GT.1)KTMFCT=KTMFCT+ISTAB	HEAT4	2244
IMOUFY=0	HEAT4	2245
ISTARM=ISTAB-1	HEAT4	2246
NOIT=0	HEAT4	2247
KOTEST=0	HEAT4	2248
DELTAS=DELTAT	HEAT4	2249
IEXTRR=0	HEAT4	2250
IPR=1	HEAT4	2251
VRG1 = 1.0	HEAT4	2252
VERGF = 1.0	HEAT4	2253
NIIT=0	HEAT4	2254
EXFAC = 1.0	HEAT4	2255
TIMX=FTIME-TIM	HEAT4	2256
NIIT=0	HEAT4	2257
LASTIT = 0	HEAT4	2258
MPST2=2*MAXPTS	HEAT4	2259
C***** FLAG TO CONTROL FLOW OF CODE PRIOR TO COMPLETION OF	HEAT4	2260
C FIRST ITERATION.	HEAT4	2261
ITER00=0	HEAT4	2262
IF (NTYPE.EQ.1)GO TO 205	HEAT4	2263
IF (NPRINT.GT.0)GO TO 170	HEAT4	2264
I=0	HEAT4	2265
DELT=NDTA*DELTAT	HEAT4	2266
162 I=I+1	HEAT4	2267
IF (I.GE.MAXPRT)GO TO 183	HEAT4	2268

LISTING AND SUBROUTINE COMPILATION: HETING P. 33

PRIME(I)=I*DELT*TIM	HEAT4	2269
IF(PRTIME(I).LT.FTIME)GO TO 182	HEAT4	2270
183 NPRINT=MIN0(I,MAXPRT)	HEAT4	2271
PRIME(NPRINT)=FTIME	HEAT4	2272
170 IF(NTYPE.LT.0)GO TO 178	HEAT4	2273
DO 173 I=1,NPRINT	HEAT4	2274
173 PRTIME(I)=PRTIME(I)-TIMX	HEAT4	2275
GO TO 178	HEAT4	2276
260 IF(NTDFN.GT.0)CALL TIMEOF	HEAT4	2277
IF(NBOTPT.LE.0)GO TO 175	HEAT4	2278
C* CALCULATE THE CURRENT TEMPERATURE FOR EACH BOUNDARY POINT.	HEAT4	2279
0410 DO 480 I=1,NBOTPT	HEAT4	2280
IF(NBYTFN(I).420.420.430	HEAT4	2281
0420 TDUM(I)=BYTEMP(I)	HEAT4	2282
GO TO 480	HEAT4	2283
0430 II=NBYTFN(I)	HEAT4	2284
TDUM(I)=BYTEMP(I)*TFN(II)	HEAT4	2285
0480 CONTINUE	HEAT4	2286
175 IF(.NOT.TDCOMC)GO TO 490	HEAT4	2287
CALL THRM1	HEAT4	2288
1 (T1 T2 T3 SMVG SMRCV	HEAT4	2289
2 CDLIST VGLIST X1 X2 SLCAP	HEAT4	2290
3 NB NNH NPT NVG NTPI	HEAT4	2291
4 NTPJ NTPA NILBR NILFR NIRBR	HEAT4	2292
5 NIRFR NOLHR NOLFR NORBR NCORR	HEAT4	2293
6 NMLIST NGLIST HELMAT MAXPTS NSET	HEAT4	2294
C* FOR TRANSIENT PROBLEMS -- CHECK TIME STEP. IF IT IS TOO LARGE	HEAT4	2295
C* EITHER TERMINATE JOB OR CALCULATE AN ACCEPTABLE TIME STEP.	HEAT4	2296
IF(NSET.GT.0 .OR. IMODFY.EQ.1)GO TO 490	HEAT4	2297
178 DELMIN=1.0E25	HEAT4	2298
NXM=0	HEAT4	2299
DELM=2.0*DELTAT	HEAT4	2300
M=0	HEAT4	2301
DO 190 N=1,NT	HEAT4	2302
T2(N)=0.0	HEAT4	2303
SMK=0.0	HEAT4	2304
IF(NNB(N),190,190,185	HEAT4	2305
0185 NRX=NNB(N)	HEAT4	2306
DO 196 I=1,NHX	HEAT4	2307
M=M+1	HEAT4	2308
IF(NRLIST(M).EQ.0)GO TO 186	HEAT4	2309
SMK=SMK+CDLIST(M)	HEAT4	2310
0186 CONTINUE	HEAT4	2311
IF(SMK.GT.1.0E25)GO TO 190	HEAT4	2312
DELMN=SMRCV(N)/SMK	HEAT4	2313
T2(N)=DELMN	HEAT4	2314
IF(DELMIN.LT.DELMN)GO TO 190	HEAT4	2315
DELMN=DELMN	HEAT4	2316
NXM=M	HEAT4	2317
IF(DELM.LE.DELMN)GO TO 190	HEAT4	2318
DELM=DELMN	HEAT4	2319
0190 CONTINUE	HEAT4	2320
IF(ITER00.GT.0)GO TO 194	HEAT4	2321
C* PRINT OUT THE STABILITY CRITERION FOR EACH NODE.	HEAT4	2322
WRITE(6,4000)	HEAT4	2323
IF(ITER00.GT.0)WRITE(ITER00,4000)	HEAT4	2324
4000 FORMAT("1",44A,"STABILITY CRITERION FOR EACH NODE"/)	HEAT4	2325
WRITE(6,4005) (N,T2(N),N=1,NT)	HEAT4	2326
IF(ITER00.GT.0)WRITE(ITER00,4005) (N,T2(N),N=1,NT)	HEAT4	2327
4005 FORMAT("1",14,1PE13.4,19,E13.4,19,E13.4,19,E13.4,19,E13.4	HEAT4	2328
1)	HEAT4	2329
WRITE(6,3001)DELMIN,NXM	HEAT4	2330
IF(ITER00.GT.0)WRITE(ITER00,3001)DELMIN,NXM	HEAT4	2331
3001 FORMAT("1",25X,"THE STABILITY CRITERION IS",1PE15.7," FOR POINT"	HEAT4	2332
1,14)	HEAT4	2333
IF(DELTAT.GT.DELEM)GO TO 191	HEAT4	2334
WRITE(6,3002)	HEAT4	2335
IF(ITER00.GT.0)WRITE(ITER00,3002)	HEAT4	2336
3002 FORMAT("0",25X,"THE INPUT TIME INCREMENT SATISFIES THE STABILITY C	HEAT4	2337
1RITERION.")	HEAT4	2338
GO TO 200	HEAT4	2339
191 IF(DELTAT/DELM.GT.10.0.AND.KTHFCT.LT.1) GO TO 199	HEAT4	2340
DELTAT=DELM	HEAT4	2341
DELTAS=DELTAT	HEAT4	2342

LISTING AND SUBROUTINE COMPILATION: HETING P. 34

WRITE(6,193)DELTAT	HEAT4	2343
IF(IERROR.GT.0)WRITE(IERRON,193)DELTAT	HEAT4	2344
193 FORMAT('0*,25X,*THE INPUT TIME INCREMENT DOES NOT SATISFY THE STAB	HEAT4	2345
ILITY CRITERION.*/26X,*THE TIME INCREMENT IS NOW =*,1PE15.7)	HEAT4	2346
GO TO 200	HEAT4	2347
199 WRITE(6,198)	HEAT4	2348
IF(IERROR.GT.0)WRITE(IERRON,198)	HEAT4	2349
198 FORMAT('0*,25X,*CASE DELETED -- INPUT TIME INCREMENT EXCEEDS THE S	HEAT4	2350
TABILITY CRITERION BY MORE THAN A FACTOR OF 10.')	HEAT4	2351
RETURN	HEAT4	2352
194 IF(DELTA.LE.DELM .AND. KTMFCT.LT.2,GO TO 200	HEAT4	2353
IF(DELTA/DELM.GT.10.0.AND.KTMFCT.LT.1) GO TO 199	HEAT4	2354
DELTA=DELM	HEAT4	2355
DELTA=DELTAT	HEAT4	2356
200 HDELT=0.5E0*DELTAT	HEAT4	2357
STOPTM=FTIME-HDELT	HEAT4	2358
PRTIM=PRTIME(IPR)-HDELT	HEAT4	2359
IF(ITER00.EQ.1)GO TO 495	HEAT4	2360
C* NSET=1 FOR STEADY STATE PROBLEMS.	HEAT4	2361
C* NSET=-1 FOR TRANSIENT PROBLEMS.	HEAT4	2362
205 IF(NTYPE)210,1500,230	HEAT4	2363
0210 NSET=-1	HEAT4	2364
GO TO 250	HEAT4	2365
0230 NSET=1	HEAT4	2366
250 NTYPE=NTYPE-NSET	HEAT4	2367
C***** IF IOUT = 2, THEN TEMPERATURE DISTRIBUTION WILL ALSO BE	HEAT4	2368
C***** WRITTEN ON TAPE AT EACH PRINTOUT. AT THIS POINT,	HEAT4	2369
C***** IDENTIFICATION FOR THE PROBLEM IS WRITTEN ON TAPE. WDT,4-11-69	HEAT4	2370
IF(IOUT.NE.2)GO TO 490	HEAT4	2371
WRITE(ITAPE)JOBDES,DELTAT,NT,NBDTPT,NGEOM	HEAT4	2372
WRITE(ITAPE)IT,(R(I),I=1,IT)	HEAT4	2373
WRITE(ITAPE)JT,(TH(I),I=1,JT)	HEAT4	2374
WRITE(ITAPE)KT,(Z(I),I=1,KT)	HEAT4	2375
WRITE(ITAPE)(I,NTPI(I),NTPJ(I),NTPK(I),I=1,NT)	HEAT4	2376
C***** ADDED TO ALLOW PRINTOUT OF TEMPERATURES PRIOR TO FIRST	HEAT4	2377
C***** ITERATION.	HEAT4	2378
490 IF(ITER00.EQ.1)GO TO 495	HEAT4	2379
ITER00=1	HEAT4	2380
ASSIGN 495 TO K02000	HEAT4	2381
GO TO 2000	HEAT4	2382
495 IF(NSET.LT.0)GO TO 1000	HEAT4	2383
C* PERFORM THE STEADY STATE CALCULATIONS.	HEAT4	2384
WRITE(6,9501)	HEAT4	2385
9501 FORMAT('11",,NUMBER OF",48X,"EXTRAPO LATION"/	HEAT4	2386
1 " ",,ITERATIONS CONVERGENCE --- NODE --- TEMPERATURE",8X,	HEAT4	2387
2 "FACTOR"/)	HEAT4	2388
L=0	HEAT4	2389
DO 575 N=1,NT	HEAT4	2390
SMVG(N)=0.	HEAT4	2391
II=NVG(N)	HEAT4	2392
IF(II.LE.0)GO TO 575	HEAT4	2393
DO 570 I=1,II	HEAT4	2394
L=L+1	HEAT4	2395
TEMP=VGLIST(L)	HEAT4	2396
JJ=VGLIST(L)	HEAT4	2397
IF(JJ.LE.0)GO TO 565	HEAT4	2398
TEMP=TEMP*TFN(JJ)	HEAT4	2399
565 SMVG(N)=SMVG(N)+TEMP	HEAT4	2400
570 CONTINUE	HEAT4	2401
575 CONTINUE	HEAT4	2402
C* T2(N) = OLD TEMPERATURES.	HEAT4	2403
C* T1(N) = NEW TEMPERATURES.	HEAT4	2404
11502 DO510N=1,NT	HEAT4	2405
T2(N)=T1(N)	HEAT4	2406
0510 CONTINUE	HEAT4	2407
XRX=0.0	HEAT4	2408
XRN=10000.0	HEAT4	2409
NMX=0	HEAT4	2410
NMN=0	HEAT4	2411
M=0	HEAT4	2412
DO 600 N=1,NT	HEAT4	2413
C* SMKT = SUM OVER ALL NEIGHBORS OF (THE THERMAL CONDUCTANCE	HEAT4	2414
C* FROM NODE N TO A NEIGHBOR TIMES THE CURRENT TEMPERATURE OF	HEAT4	2415
C* THAT NEIGHBOR).	HEAT4	2416
SMKT=0.0	HEAT4	2417
C* SMK = SUM OVER ALL NEIGHBORS OF (THE THERMAL CONDUCTANCE	HEAT4	2418
C* FROM NODE N TO A NEIGHBOR).	HEAT4	2419

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SMK=0.0	HEAT4	2420
Q=0.0	HEAT4	2421
IJ=NNB(N)	HEAT4	2422
IF(IJ)600,600,520	HEAT4	2423
C* CALCULATE SMK AND SMKT.	HEAT4	2424
0520 DO 550 I=1,IJ	HEAT4	2425
M=M+1	HEAT4	2426
JJ=NBLIST(M)	HEAT4	2427
IF(JJ.GT.0)GO TO 525	HEAT4	2428
Q=Q+CDLIST(M)	HEAT4	2429
GO TO 550	HEAT4	2430
525 SMK=SMK+CDLIST(M)	HEAT4	2431
IF(JJ.LE.MAXPTS)GO TO 530	HEAT4	2432
IF(JJ.LE.MPTST2)GO TO 540	HEAT4	2433
SMKT=SMKT+CDLIST(M)*T2(JJ-MPTST2)	HEAT4	2434
GO TO 550	HEAT4	2435
0530 SMKT=SMKT+CDLIST(M)*T1(JJ)	HEAT4	2436
GO TO 550	HEAT4	2437
0540 IF(CDLIST(M)-1.0E25)544,544,546	HEAT4	2438
544 SMKT=SMKT+CDLIST(M)*TDUM(JJ-MAXPTS)	HEAT4	2439
GO TO 550	HEAT4	2440
546 JJJ=JJ-MAXPTS	HEAT4	2441
0550 CONTINUE	HEAT4	2442
C* CALCULATE THE NEW TEMPERATURE OF NODE N.	HEAT4	2443
IF(SMK-1.0E25)560,560,580	HEAT4	2444
C* SINCE BETA IS INITIALLY 1.0, THE EXTRAPOLATED IIFMANN METHOD	HEAT4	2445
C* CAN EASILY DIVERGE UNLESS CERTAIN BOUNDS ARE PLACED ON THE	HEAT4	2446
C* NEW TEMPERATURE AT EACH ITERATION. APPARENTLY, THE CODING IN	HEAT4	2447
C* THE NEXT 15 STATEMENTS IS DESIGNED TO PREVENT DIVERGENCE.	HEAT4	2448
560 A1=(SMKT-SMVG(N)+Q)/SMK	HEAT4	2449
IF(T2(N).NE.0.0)GO TO 562	HEAT4	2450
A4=BETA*A1	HEAT4	2451
GO TO 11179	HEAT4	2452
562 A2=BETA*(A1/T2(N)-1.0)	HEAT4	2453
A3=-ABS(A2)	HEAT4	2454
IF(0.001+A3)11173,11176,11176	HEAT4	2455
11173 IF(0.1+A3)11174,11175,11175	HEAT4	2456
11174 A4=EXP(A3)*T2(N)	HEAT4	2457
GO TO 11177	HEAT4	2458
11175 A5=A3/2.0	HEAT4	2459
A4=T2(N)*(1.0+A5)/(1.0-A5)	HEAT4	2460
GOTO11177	HEAT4	2461
11176 A4=T2(N)*(1.0+A3)	HEAT4	2462
11177 IF(A2)11179,11178,11178	HEAT4	2463
11178 T1(N)=2.0*T2(N)-A4	HEAT4	2464
GOTO11180	HEAT4	2465
11179 T1(N)=A4	HEAT4	2466
GOTO11180	HEAT4	2467
C* CALCULATE NEW TEMPERATURE OF INTERNAL NODE WHICH IS CONNECTED	HEAT4	2468
C* TO A TYPE 2 BOUNDARY.	HEAT4	2469
580 T1(N)=TDUM(JJJ)	HEAT4	2470
11180 IF(T2(N))11181,600,11181	HEAT4	2471
11181 A1=T1(N)/T2(N)	HEAT4	2472
IF(A1.GT.XRX)NMN=N	HEAT4	2473
XXR=AMAX1(XXR,A1)	HEAT4	2474
IF(A1.LT.XRN)NMN=N	HEAT4	2475
XRN=AMIN1(XRN,A1)	HEAT4	2476
600 CONTINUE	HEAT4	2477
C* THE CODING FROM HERE THRU STATEMENT 12250 IS APPARENTLY AN	HEAT4	2478
C* APPROXIMATION TO THE AYKEN-DELTA-SQUARED EXTRAPOLATION.	HEAT4	2479
XN01=ABS(XRX-1.0)	HEAT4	2480
XN02=ABS(XRN-1.0)	HEAT4	2481
NOIT=NOIT+1	HEAT4	2482
NIIT=NIIT+1	HEAT4	2483
LASTIT=LASTIT+1	HEAT4	2484
VERGF0=VERGF	HEAT4	2485
VRG2=VRG1	HEAT4	2486
EXFC=EXFAC	HEAT4	2487
VERGF=AMAX1(XN01,XN02)	HEAT4	2488
IF(XN01-XN02)11221,11221,11222	HEAT4	2489
11221 VRG1=XRN-1.0	HEAT4	2490
NODECV=NMN	HEAT4	2491
GOTO11223	HEAT4	2492
11222 VRG1=XRX-1.0	HEAT4	2493
NODECV=NMN	HEAT4	2494
11223 CONTINUE	HEAT4	2495
XXMU=(VRG1/VRG2)*(1.0+VRG2)	HEAT4	2496

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EXFAC=XXMU/(1.0-XXMU)	HEAT4	2497
C* CONTROLS WRITE-OUT OF EXTRAPOLATION FACTOR AND	HEAT4	2498
C* CONVERGENCE STATUS.	HEAT4	2499
IF(LASTIT-5,32,31,31)	HEAT4	2500
31 CONTINUE	HEAT4	2501
LASTIT = 0	HEAT4	2502
WRITE(6,11124)NOIT,VRG1,NOUECV,T1(NOUECV),EXFAC	HEAT4	2503
11124 FORMAT(" ",I8,4X,IPE14.5,I9,2E17.5)	HEAT4	2504
32 CONTINUE	HEAT4	2505
C* IF EXTRAPOLATION HAS BEEN UNSUCCESSFULLY ATTEMPTED, THEN SKIP	HEAT4	2506
C* THE FOLLOWING TESTS AND TRY AGAIN.	HEAT4	2507
IF(IEXTRP)11127,11127,11126	HEAT4	2508
11126 NIIT=0	HEAT4	2509
NIIT=0	HEAT4	2510
GOTO11244	HEAT4	2511
C***** THE FIRST BRANCH IN THE IF TEST WAS CHANGED FROM 11226 TO	HEAT4	2512
C***** 11254 BY WDT ON 3-6-69.	HEAT4	2513
11127 IF(NIIT-10)11254,11227,11228	HEAT4	2514
11227 VFERG=VERGF	HEAT4	2515
C***** GO TO 11254 ADDED BY WDT 3-6-69.	HEAT4	2516
GO TO 11254	HEAT4	2517
11228 PRO1=VERGF/VERGFO	HEAT4	2518
PROUT=PRO1*(1.0+VRG2)	HEAT4	2519
PROUT=AMAX1(PRO1, ABS(PROUT))	HEAT4	2520
IF(NIIT-10)11254,11254,11232	HEAT4	2521
11232 NIIT=NIIT+1	HEAT4	2522
PRATIO(NIIT)=PROUT	HEAT4	2523
C* CONTROLS EXTRAPOLATION. IF 20 ITERATIONS HAVE ELAPSED	HEAT4	2524
C* SINCE THE LAST EXTRAPOLATION OR ATTEMPTED BETA REDUCTION, THEN	HEAT4	2525
C* ATTEMPT EITHER TO EXTRAPOLATE OR TO REDUCE BETA.	HEAT4	2526
IF(NIIT-20)11254,11233,11233	HEAT4	2527
11233 NIIT=0	HEAT4	2528
NIIT=0	HEAT4	2529
RNOW=VERGF/VERGF	HEAT4	2530
III=0	HEAT4	2531
DO11237IIII=1,10	HEAT4	2532
IF(PRATIO(IIII)-1.0)11237,11236,11236	HEAT4	2533
11236 III=III+1	HEAT4	2534
11237 CONTINUE	HEAT4	2535
IF(III-2)11244,11249,11249	HEAT4	2536
C* TRY TO EXTRAPOLATE.	HEAT4	2537
11244 IF(ABS(XXMU)-1.0)11245,11246,11246	HEAT4	2538
11245 IF(ABS(EXFAC/EXFC-1.0)-0.05)11247,11247,11246	HEAT4	2539
C* EXTRAPOLATION ATTEMPT UNSUCCESSFUL.	HEAT4	2540
11246 IEXTR=1	HEAT4	2541
GOTO11254	HEAT4	2542
C* EXTRAPOLATE.	HEAT4	2543
11247 IEXTR=0	HEAT4	2544
WRITE(6,12247)	HEAT4	2545
12247 FORMAT(53H EXTRAPOLATION)	HEAT4	2546
DO12250N=1,NT	HEAT4	2547
CRON=T1(N)*(T1(N)-T2(N))*EXFAC	HEAT4	2548
IF(CRON)12248,12249,12249	HEAT4	2549
12248 CRON=T1(N)	HEAT4	2550
12249 T1(N)=CRON	HEAT4	2551
12250 CONTINUE	HEAT4	2552
GOTO11254	HEAT4	2553
C* ATTEMPT A BETA REDUCTION.	HEAT4	2554
11249 IF(RNOW-1.5)11250,11254,11254	HEAT4	2555
11250 BETA=BETA-0.1	HEAT4	2556
C***** LOWER LIMIT FOR BETA CHANGED FROM 0.1 TO 1.0 BY WDT ON 3-6-69.	HEAT4	2557
IF(BETA-1.0)11251,11248,11248	HEAT4	2558
11251 BETA=1.0	HEAT4	2559
11248 WRITE(6,12228)BETA	HEAT4	2560
12228 FORMAT(39H	HEAT4	2561
117H BETA REDUCED TO F6.3)	HEAT4	2562
C***** STATEMENT (11254 XLUM1=0.0) REMOVED BY WDT ON 3-6-69.	HEAT4	2563
C* CHECK TO SEE IF TOTAL NUMBER OF STEADY STATE ITERATIONS HAS	HEAT4	2564
C* BEEN REACHED.	HEAT4	2565
11254 IF(NOIT.GE.NOITX)GO TO 1501	HEAT4	2566
C* CHECK TO SEE IF THE CONVERGENCE CRITERION HAS BEEN MET.	HEAT4	2567
IF(VERGF.LE.EPI)GO TO 1500	HEAT4	2568

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C*	HAS THE SPECIFIED CPU TIME BEEN EXCEEDED.	HEAT4	2569
	IF (ICLOCK(0)-ICPU0.GE.MAXCPU) GO TO 1490	HEAT4	2570
	IF (TOCDHC)	HEAT4	2571
	*CALL THRM1	HEAT4	2572
1	(T1 ,T2 ,T3 ,SMVG ,SMRCV	HEAT4	2573
2	,CDLIST ,VGLIST ,X1 ,X2 ,SLCAP	HEAT4	2574
3	,NB ,NNH ,NPT ,NVG ,NTP1	HEAT4	2575
4	,NTPJ ,NTPK ,NILBR ,NILFR ,NIRBR	HEAT4	2576
5	,NIRFR ,NOLBR ,NOLFR ,NORBR ,NORFR	HEAT4	2577
6	,NBLIST ,NGLIST ,MELMAT ,MAXPTS ,NSET	HEAT4	2578
	GO TO 11502	HEAT4	2579
C*	PERFORM THE TRANSIENT CALCULATIONS.	HEAT4	2580
1000	DO 1005 N=1,NT	HEAT4	2581
	T2(N)=T1(N)	HEAT4	2582
	DO 1005 I=1,MATSL	HEAT4	2583
	X2(N,I) = X1(N,I)	HEAT4	2584
1005	CONTINUE	HEAT4	2585
	M=0	HEAT4	2586
	L=0	HEAT4	2587
	DO 1090 N=1,NT	HEAT4	2588
	Q=0.0	HEAT4	2589
	SMK1=0.0	HEAT4	2590
	SMK=0.0	HEAT4	2591
	SMTVG=0.0	HEAT4	2592
	II=NNH(N)	HEAT4	2593
	IF (II) 1050,1050,1010	HEAT4	2594
1010	DO 1040 I=1,II	HEAT4	2595
	M=M+1	HEAT4	2596
	JJ=NBLIST(M)	HEAT4	2597
	IF (JJ.GT.0) GO TO 1015	HEAT4	2598
	Q=Q+CDLIST(M)	HEAT4	2599
	GO TO 1040	HEAT4	2600
1015	SMK=SMK+CDLIST(M)	HEAT4	2601
	IF (JJ.LE.MAXPTS) GO TO 1020	HEAT4	2602
	IF (JJ.LE.MPTST2) GO TO 1030	HEAT4	2603
	SMKT=SMKT+CDLIST(M)*(T2(JJ-MPTST2)-T2(N))	HEAT4	2604
	GO TO 1040	HEAT4	2605
1020	SMKT=SMKT+CDLIST(M)*(T2(JJ)-T2(N))	HEAT4	2606
	GO TO 1040	HEAT4	2607
1030	IF (CDLIST(M)-1.0E25) 1032,1032,1035	HEAT4	2608
1032	SMKT=SMKT+CDLIST(M)*(TDOM(JJ-MAXPTS)-T2(N))	HEAT4	2609
	GO TO 1040	HEAT4	2610
1035	JJJ=JJ-MAXPTS	HEAT4	2611
1040	CONTINUE	HEAT4	2612
1050	II=NVG(N)	HEAT4	2613
	IF (II) 1080,1080,1060	HEAT4	2614
1060	DO 1070 I=1,II	HEAT4	2615
	L=L+1	HEAT4	2616
	TEMP=VGLIST(L)	HEAT4	2617
	JJ=NGLIST(L)	HEAT4	2618
	IF (JJ) 1065,1065,1062	HEAT4	2619
1062	TEMP=TEMP*TFN(JJ)	HEAT4	2620
1065	SMTVG=SMTVG+TEMP	HEAT4	2621
1070	CONTINUE	HEAT4	2622
1080	IF (SMK-1.0E25) 1300,1300,1087	HEAT4	2623
1300	THEAT = DELTAT*(SMTVG+Q+SMKT)	HEAT4	2624
	IF (MELMAT(N).EQ.0) GO TO 1085	HEAT4	2625
	X1(N,MELMAT(N)) = X2(N,MELMAT(N)) + THEAT/SLCAP(N)	HEAT4	2626
	IF (NOIT.EQ.1STABM) T3(N)=T2(N)	HEAT4	2627
	IF (X1(N,MELMAT(N)).LT.0.0) GO TO 1305	HEAT4	2628
	IF (X1(N,MELMAT(N)).GT.1.0) GO TO 1310	HEAT4	2629
	GO TO 1090	HEAT4	2630
1305	THEAT = X1(N,MELMAT(N)) *SLCAP(N)	HEAT4	2631
	X1(N,MELMAT(N))=0.0	HEAT4	2632
	GO TO 1085	HEAT4	2633
1310	THEAT = (X1(N,MELMAT(N))-1.0)*SLCAP(N)	HEAT4	2634
	X1(N,MELMAT(N))=1.0	HEAT4	2635
1085	IF (KTMFCT.LT.2 .OR. NOIT.LT.KTMFCT) GO TO 1086	HEAT4	2636
	D1=DELTAT/SMRCV(N)	HEAT4	2637
	D=D1*SMK	HEAT4	2638
	IF (D.GT.1.0) GO TO 1088	HEAT4	2639
	TMFCT=0.0	HEAT4	2640
	GO TO 1089	HEAT4	2641

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1088	TMFCT=0.5*(D-1.0)	HEAT4	2642
1089	T1(N)=T2(N)+(THEAT/SMRCV(N) *TMFCT*(T2(N)-T3(N)))/(1.0+TMFCT)	HEAT4	2643
	T3(N)=T2(N)	HEAT4	2644
	GO TO 1090	HEAT4	2645
1086	T1(N) = T2(N) + THEAT/SMRCV(N)	HEAT4	2646
	IF(NOIT.EQ.1STABM)T3(N)=T2(N)	HEAT4	2647
	GO TO 1090	HEAT4	2648
1087	T1(N)=IDUM(JJJ)	HEAT4	2649
1090	CONTINUE	HEAT4	2650
	TIM=TIM+DELTAT	HEAT4	2651
	NOIT=NOIT+1	HEAT4	2652
	IF(NOIT-1STAB)1100,1093,1095	HEAT4	2653
1093	TIME0=TIM	HEAT4	2654
	GO TO 1100	HEAT4	2655
1095	IF(NOIT.NE.KTMFCT)GO TO 1100	HEAT4	2656
	IMODFY=1	HEAT4	2657
	DELTAS=DELTAT	HEAT4	2658
	DELTAT=TIM-TIME0	HEAT4	2659
	HDELT=0.5*DELTAT	HEAT4	2660
	STOPTM=FTIME-HDELT	HEAT4	2661
	PRTIM=PRTIME(IPR)-HDELT	HEAT4	2662
	WRITE(6,195)DELTAT,NOIT,TIM	HEAT4	2663
195	FORMAT(*0*,25X,*THE MODIFIED EXPLICIT METHOD WITH A CONSTANT TIME	HEAT4	2664
	1 INCREMENT EQUAL* / 26X,*TO*,1PE15.7,* WILL NOW BE USED.* / 26X,	HEAT4	2665
	2*NUMBER OF STABLE TIME INCKEMENTS COMPLETED =*,I6/ 26X,	HEAT4	2666
	3*CURRENT TIME =*,1PE15.7)	HEAT4	2667
C****	PRINTOUT OF TRANSIENT TEMPERATURES CHANGED ON 4-18-69,	HEAT4	2668
C*	HAS SPECIFIED CPU TIME BEEN EXCEEDED.	HEAT4	2669
1100	IF(ICLOCK(0)-ICPU0.GE.MAXCPU)GO TO 1490	HEAT4	2670
	IF(TIM.GE.STOPTM)GO TO 1500	HEAT4	2671
	IF(TIM.LT.PRTIM)GO TO 260	HEAT4	2672
	IPR=IPR+1	HEAT4	2673
	PRTIM=PRTIME(IPR)-HDELT	HEAT4	2674
	ASSIGN 260 TO K02000	HEAT4	2675
	GO TO 2000	HEAT4	2676
1490	WRITE(6,5005)MXCPU	HEAT4	2677
	IF(IERROR.GT.0)WRITE(IERROR,5005)MXCPU	HEAT4	2678
5005	FORMAT("1",10X,"THE SPECIFIED CPU TIME OF",I10," SECONDS HAS BEEN	HEAT4	2679
	1 EXCEEDED.")	HEAT4	2680
	IF(NSET.EQ.1)WRITE(6,1502)	HEAT4	2681
	IF(NSET.EQ.1 .AND. IERROR.GT.0)WRITE(IERROR,1502)	HEAT4	2682
	NTYPE=0	HEAT4	2683
1500	ASSIGN 1510 TO K02000	HEAT4	2684
	GO TO 2000	HEAT4	2685
1501	WRITE (6,1502)	HEAT4	2686
	IF(IERROR.GT.0)WRITE(IERROR,1502)	HEAT4	2687
1502	FORMAT(1H1,10X,30HEND STEADY STATE CALCULATION,	HEAT4	2688
	125HCONVERGENCE NOT SATISFIED)	HEAT4	2689
	NTYPE=0	HEAT4	2690
	GO TO 1500	HEAT4	2691
C****	MODIFIED FOR TAPE OUTPUT.	HEAT4	2692
1510	IF(IERROR.LE.0)GO TO 1515	HEAT4	2693
	IF(NSET.GT.0)WRITE(IERROR,9005)NOIT	HEAT4	2694
9005	FORMAT("1",10X,"THE STEADY STATE CALCULATIONS HAVE BEEN COMPLETED.	HEAT4	2695
	1"/"0",10X,"NUMBER OF ITERATIONS COMPLETED =",I6)	HEAT4	2696
	IF(NSET.LT.0)WRITE(IERROR,9010)TIM,NOIT	HEAT4	2697
9010	FORMAT("1",10X,"THE TRANSIENT CALCULATIONS HAVE BEEN COMPLETED."/	HEAT4	2698
	1,1H1,10X,14HFINAL TIME IS ,E15.5/	HEAT4	2699
	2"0",10X,"NUMBER OF TIME STEPS COMPLETED =",I6)	HEAT4	2700
1515	IF(NTYPE.NE.0)GO TO 1520	HEAT4	2701
	IF(IERROR.GT.0)WRITE(IERROR,5000)XCPU	HEAT4	2702
	IF(JOUT.EQ.0)GO TO 1505	HEAT4	2703
	WRITE(JOUT,3050)(JOBDES(I),I=1,18)	HEAT4	2704
3050	FORMAT(18A4)	HEAT4	2705
C*	DETERMINE HOW MANY NODES ARE CURRENTLY UNDERGOING PHASE CHANGE.	HEAT4	2706
	J=0	HEAT4	2707
	DO 1615 N=1,NT	HEAT4	2708
	DO 1605 I=1,MATSL	HEAT4	2709
	IF(X1(N,I).NE.0.0)GO TO 1610	HEAT4	2710
1605	CONTINUE	HEAT4	2711
	GO TO 1615	HEAT4	2712
1610	J=J+1	HEAT4	2713
1615	CONTINUE	HEAT4	2714
	WRITE(JOUT,3065)NT,J	HEAT4	2715
3065	FORMAT(2I5)	HEAT4	2716
	GO TO (3052,3053),IRAD	HEAT4	2717

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3052	WRITE(JOUT,3055)(I,T1(I),I=1,NT)	HEAT4	2718
	GO TO 1503	HEAT4	2719
3053	WRITE(JOUT,3055)(I,T2(I),I=1,NT)	HEAT4	2720
3055	FORMAT(5(15,1PE10.3))	HEAT4	2721
1503	DO 1504 I=1,NT	HEAT4	2722
	DO 1504 I=1,MATSL	HEAT4	2723
	IF(X1(N,I).NE.0.0)GO TO 1506	HEAT4	2724
1504	CONTINUE	HEAT4	2725
	GO TO 1507	HEAT4	2726
1506	WRITE(JOUT,3060)N,(X1(N,I),I=1,MATSL)	HEAT4	2727
1507	CONTINUE	HEAT4	2728
3060	FORMAT(15,5E10.3)	HEAT4	2729
1505	IF(IOUT.EQ.2)END FILE ITAPE	HEAT4	2730
	RETURN	HEAT4	2731
1520	NTYPE=IABS(NTYPE)-1	HEAT4	2732
	NSET=-NSET	HEAT4	2733
	NOIT=0	HEAT4	2734
	IF(NSET.GT.0)GO TO 1530	HEAT4	2735
	DELTAT=DELTAS	HEAT4	2736
	IMODFY=0	HEAT4	2737
	HDELT=0.5*DELTAT	HEAT4	2738
	FTIME=TIM*TIMX	HEAT4	2739
	DO 1540 I=1,NPRINT	HEAT4	2740
1540	PRTIME(I)=PRTIME(I)+TIMX	HEAT4	2741
	IPR=1	HEAT4	2742
	PRTIM=PRTIME(IPR)-HDELT	HEAT4	2743
	STOPIM=FTIME-HDELT	HEAT4	2744
	GO TO 175	HEAT4	2745
1530	IEXTRR=0	HEAT4	2746
	GO TO 260	HEAT4	2747
C*	START PRINT-OUTS	HEAT4	2748
2000	IF(IRAD.LT.2)GO TO 1930	HEAT4	2749
C	IF RADIATION IS PRESENT, CONVERT TEMPERATURES FROM ABSOLUTE.	HEAT4	2750
	DO 1900 N=1,NT	HEAT4	2751
1900	T2(N)=T1(N)-TABS(JABS)	HEAT4	2752
	IF(NBDTPT.EQ.0)GO TO 1930	HEAT4	2753
	DO 1910 N=1,NBDTPT	HEAT4	2754
1910	TROUND(N)=TDUM(N)-TABS(JABS)	HEAT4	2755
1930	NTT=NT	HEAT4	2756
	NF=1	HEAT4	2757
2005	IF(NSET)2010,2010,2020	HEAT4	2758
2010	WRITE(6,2011)	HEAT4	2759
2011	FORMAT(1H1,45X,"RESULTS FROM TRANSIENT CALCULATIONS")	HEAT4	2760
	GO TO 2030	HEAT4	2761
2020	WRITE(6,2021)	HEAT4	2762
2021	FORMAT(1H1,45X,"RESULTS FROM STEADY STATE CALCULATIONS")	HEAT4	2763
2030	IF (NTT-200) 2040,2040,2050	HEAT4	2764
2040	NPX=NTT	HEAT4	2765
	NTT=0	HEAT4	2766
	GO TO 2052	HEAT4	2767
2050	NPX = 200	HEAT4	2768
	NTT = NTT - 200	HEAT4	2769
2052	IF(NSET.EQ.1)WRITE(6,2055)TIM,NOIT	HEAT4	2770
2055	FORMAT(*,35X,*TIME=*,1P13.5,15X,*ITERATIONS COMPLETED=*,16)	HEAT4	2771
	IF(NSET.EQ.-1)WRITE(6,2056)TIM,NOIT	HEAT4	2772
	WRITE(6,2065)	HEAT4	2773
2065	FORMAT(1H0,2X,3("LATTICE POINT TEMPERATURES",7X),"LATTICE POINT TE	HEAT4	2774
	MPERATURES")	HEAT4	2775
	WRITE(6,2070)	HEAT4	2776
2070	FORMAT(1H,3("POINT INDICIES POINT",8X),"POINT INDICIES	HEAT4	2777
	POINT"/2X,3("NO. I J K TEMPERAT.(QLTY)",2X),"NO. I J K	HEAT4	2778
	TEMPERAT.(QLTY)")	HEAT4	2779
	NPY=NPX+NF-1	HEAT4	2780
	IF (NPX.LE.50) NCOL = 1	HEAT4	2781
	IF (NPX.GT.50) NCOL = 2	HEAT4	2782
	IF (NPX.GT.100) NCOL = 3	HEAT4	2783
	IF (NPX.GT.150) NCOL = 4	HEAT4	2784
	NUMCOL = NCOL	HEAT4	2785
	NLINES = NPX - (NCOL - 1)*50	HEAT4	2786
	IF (NCOL.GT.1) NTOTAL = 49 + NF	HEAT4	2787
	IF (NCOL.LE.1) NTOTAL = NLINES + NF - 1	HEAT4	2788
	DO 2090 N = NF,NTOTAL	HEAT4	2789
	IND(1) = N	HEAT4	2790
	IND(2) = N + 50	HEAT4	2791

LISTING AND SUBROUTINE COMPILATION: HETING P. 40

IND(3) = N + 100	HEAT4	2792
IND(4) = N + 150	HEAT4	2793
IF (IND(NCOL).GT.NT) NUMCOL = NCOL - 1	HEAT4	2794
IF (NUMCOL.GT.1) GO TO 72	HEAT4	2795
XMFLT(1)=1.0E 10	HEAT4	2796
IF (MELMAT(N).GT.0) XMELT(1)=X1(N,MELMAT(N))	HEAT4	2797
GO TO (70,75),IRAD	HEAT4	2798
70 WRITE(6,2091) N,NTP1(N),NTPJ(N),NTPK(N),T1(N),XMELT(1)	HEAT4	2799
GO TO 90	HEAT4	2800
75 WRITE(6,2091) N,NTP1(N),NTPJ(N),NTPK(N),T2(N),XMELT(1)	HEAT4	2801
GO TO 90	HEAT4	2802
92 DO 98 J=1,NUMCOL	HEAT4	2803
XMELT(J)=1.0E 10	HEAT4	2804
IF (MELMAT(IND(J)).GT.0) XMELT(J)=X1(IND(J),MELMAT(IND(J)))	HEAT4	2805
98 CONTINUE	HEAT4	2806
GO TO (80,85),IRAD	HEAT4	2807
80 WRITE(6,2092) (IND(J),NTP1(IND(J)),NTPJ(IND(J)),NTPK(IND(J)),	HEAT4	2808
1 T1(IND(J)),XMELT(J),J=1,NUMCOL)	HEAT4	2809
GO TO 90	HEAT4	2810
85 WRITE(6,2092) (IND(J),NTP1(IND(J)),NTPJ(IND(J)),NTPK(IND(J)),	HEAT4	2811
1 T2(IND(J)),XMELT(J),J=1,NUMCOL)	HEAT4	2812
90 CONTINUE	HEAT4	2813
2090 CONTINUE	HEAT4	2814
2091 FORMAT(1H,15,1X,3I3, F11.3,1H,(F4.2,1H))	HEAT4	2815
2092 FORMAT(1H,3(15,1X,3I3,F11.3,1H,(F4.2,1H)),15,1X,3I3,F11.3,1H,	HEAT4	2816
1 F4.2,1H))	HEAT4	2817
IF (NTT) 2100,2100,2095	HEAT4	2818
2095 NF = NF + 200	HEAT4	2819
GO TO 2005	HEAT4	2820
2100 IF (NBDTPT) 2150,2150,2110	HEAT4	2821
2110 WRITE (6,2145)	HEAT4	2822
2145 FORMAT(1H0,30X,35HTEMPERATURES ON NUMBERED BOUNDARIES)	HEAT4	2823
WRITE (6,2146)	HEAT4	2824
2146 FORMAT(1H0,27X,15HBOUNDARY NUMBER ,5X,11HTEMPERATURE)	HEAT4	2825
GO TO (2200,2210),IRAD	HEAT4	2826
2200 WRITE(6,2147) (N,TDUM(N),N=1,NBDTPT)	HEAT4	2827
GO TO 2220	HEAT4	2828
2210 WRITE(6,2147) (N,TBOUND(N),N=1,NBDTPT)	HEAT4	2829
2147 FORMAT(1H,31X,13,14X,F12.0)	HEAT4	2830
2220 IF (INSET.EQ.-1) WRITE(5,2148) DELTAT	HEAT4	2831
2056 FORMAT(1H,35X,TIME =,1PE13.5,15X,TIME STEPS COMPLETED =,16)	HEAT4	2832
2148 FORMAT(1H,25X,THE CURRENT TIME STEP (DELTAT) =,1PE15.8)	HEAT4	2833
2150 XCPU=FLOAT(ICLOCK(0)-ICPU0)/100.0	HEAT4	2834
WRITE(6,5000) XCPU	HEAT4	2835
5000 FORMAT(1H,25X,"ELAPSED CPU TIME IS",F8.2," SECONDS")	HEAT4	2836
C*** WRITE TEMPERATURES ON TAPE	HEAT4	2837
IF (IOUT.EQ.2) GO TO 2165	HEAT4	2838
2160 GO TO K02000, (260,1510,445)	HEAT4	2839
2165 IF (KOTEST.EQ.1) GO TO (2170,2180),IRAD	HEAT4	2840
KOTEST=1	HEAT4	2841
GO TO 495	HEAT4	2842
2170 WRITE(1TAPE) NSET,TIM,NOIT,(T1(I),I=1,NT),(TDUM(N),N=1,NBDTPT)	HEAT4	2843
GO TO 2160	HEAT4	2844
2180 WRITE(1TAPE) NSET,TIM,NOIT,(T2(I),I=1,NT),(TBOUND(N),N=1,NBDTPT)	HEAT4	2845
GO TO 2160	HEAT4	2846
END	HEAT4	2847

REGISTER ALLOCATION

1 REGISTERS ASSIGNED OVER THE LOOP BEGINNING AT LINE 63.

1 REGISTERS ASSIGNED OVER THE LOOP BEGINNING AT LINE 529.

SUBROUTINE IDAY 74/74 OPT=2 FTN 4.1.REL 03/26/74 10.23.31.

SUBROUTINE IDAY(X)

CALL DATE(X)

RETURN

END

HEAT4 2848
HEAT4 2849
HEAT4 2850
HEAT4 2851

FUNCTION ICLOCK 74/74 OPT=2

FTN 4.1.REL

03/26/74 10.23.34.

FUNCTION ICLOCK(ETIME)

CALL SECOND(CLOCK)

ICLOCK=CLOCK*100

RETURN

END

HEAT4 2852
HEAT4 2853
HEAT4 2854
HEAT4 2855
HEAT4 2856

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PROGRAM NAME: HEX

Descriptive Title: Radiant Heat Transfer in Arrays of Cylinders

Program Author: R. L. Cox (ORNL)

Computer: CYBER 74

Operating System: SCOPE 3.4

Language: FORTRAN 4

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Radiant, Heat Transfer, Cylinders

Program Description: Estimates steady-state temperatures in finite size arrays of cylinders for which radiant heat transfer is controlling. Originally written by ORNL for LMFBR fuel element heat transfer, modified by Skorpik for CYBER 74. Four sub-routines. Radiant interchange equations solved by matrix inversion. No UNIVAC 1108 version.

Users of Program: JR Sheff
PJ Skorpik

Documentation: Original version appears in ORNL-TM-3773.

Condition of Program: A test case has been run successfully on the CYBER.

SAMPLE OUTPUT: HEX

SCOPE 3.4 - CONTROL-CARD-INITIATED LOAD LOADER L357 01/25/74 19.15.27.

FWO OF THE LOAD 121
LW+1 OF THE LOAD 164522

401558 WORDS WERE REQUIRED FOR LOADING

TRANSFER ADDRESS -- HEX -211

NO. TABLE MOVES 13

.798 CP SECONDS LOAD TIME

HEXAGONAL ARRAY OF 3 ROWS OF 10 RODS ON A TRIANGULAR PITCH
RATIO OF AREA OF SURFACE 1 TO SURFACE N IS .163200
PITCH TO DIAMETER RATIO OF RODS= 1.200
BLACK BODY VIEW FACTOR A24 F12= .1477415798 F13= .0236565287
F15= .000102375 F19= .0000269968

SURFACE	EMISSIVITY	DIMENSIONLESS HEAT FLUX	DIMENSIONLESS TEMPERATURE
1	.600	1.000E+00	6.924E+00
2	.590	2.800E-01	5.375E+00
3	.580	4.400E-01	5.461E+00
4	.570	8.500E-01	6.179E+00
5	.560	8.900E-01	6.317E+00
6	.550	2.900E-01	5.512E+00
7	.540	7.000E-01	6.249E+00
8	.530	9.400E-01	5.735E+00
9	.520	6.500E-01	4.793E+00
10	.510	3.200E-01	4.459E+00
11	.500	4.800E-01	4.289E+00
12	.490	1.300E-01	4.049E+00
13	.480	1.400E-01	3.749E+00
14	.470	5.400E-01	4.973E+00
15	.460	1.500E-01	3.033E+00
16	.450	4.700E-01	5.015E+00
17	.440	6.700E-01	5.107E+00
18	.430	7.400E-01	5.789E+00
19	.420	5.100E-01	4.909E+00
20	.410	-1.600E+00	0.

01/25/74 SCOPE 3.4.0 PL08.01 LEVEL 357 01/14/74
18.01.29.HEX20IM FROM 13
18.01.29.IP 00002563 WORDS - FILE INPUT , DC 10
18.01.30.HEX,T200,P2,CH200000 PJ SKORPIK
18.01.30.PO-II
18.01.33.ACCOUNT(112574.300023, Z1.
18.02.05.SY3BULL (BATCH)
18.02.06.PFL1200000
18.02.06.FTN(K=2,CPT=0)
18.15.24. 6.928 CP SECONDS COMPIATION TIME
18.15.24.LGO.
18.15.27. 2.628 RT SECONDS LOAD TIME
18.15.28.FTN - FATAL ERROR 0065
18.15.28. 2.218 CP SECONDS EXECUTION TIME
18.15.28.OP 00013184 WORDS - FILE OUTPUT , DC 43
18.15.28.MS 16000 WORDS (400.0 MAX USED)
18.15.28.CPA 8.462 SEC. 8.462 ADJ.
18.15.28.T0 4.442 SEC. 2.221 ADJ.
18.15.28.CH 691.640 KWS. 2.765 ADJ.
18.15.28.SS 13.450
18.15.28.PP 13.236 SEC. DATE 01/25/74
18.15.28.RMS 224 ACC.
18.15.28.EJ END OF JOB, A9

LISTING AND SUBROUTINE COMPILATION: HEX P. 1

 18.11.32 01/25/74 PJ SKM:PIK RD-II 11 *****

PROGRAM HEX 74/74 OPT=J TRACE

FTN 4.1+REL

01/25/74 18.14.54.

```

PROGRAM HEX(INPUT,OUTPUT,TYPE=INPUT,TYPE=OUTPUT)
COMMON B(218,218),E(218),X(218)
C
PROGRAM IS DIMENSIONED FOR 217 ROD ARRAY
DIMENSION C(218),D(218),Y(218)
NMAX=218
C
READ IN GEOMETRIC PARAMETERS FOR ARRAY
1 CALL LCAID(ROWS,NRODS,POR,AR,N,M),RETURNS(8)
RODS=NRODS
ROWS=ROWS
10 C
CALCULATE DIMENSIONLESS HEAT FLUX FOR SURFACE N
X(N)=0.0
DO 2 J=1,M
2 X(N)=X(N)-X(J)
X(N)=AR*X(N)
15 C
CALCULATE CONFIGURATION FACTORS
CALL BLACK(POR,F12,F13,F15,F18)
C
SET UP MATRIX OF VIEW FACTORS
CALL MATRIX(ROWS,N,NMAX,AR,F12,F13,F15,F18)
C
CALCULATE COEFFICIENTS IN EQS. (9)
20 DO 3 I=1,N
3 B(I,I)=B(I,I)-1.0
DO 4 J=1,N
4 B(J)=(1.0-E(J))/E(J)
DO 7 I=1,N
25 C(I)=0.0
DO 5 J=1,N
5 C(I)=C(I)+B(I,J)*D(J)*X(J)
C(I)=C(I)-X(I)
C
MAKE INITIAL ESTIMATE OF Y(I) VALUES
30 7 Y(I)=C(I)/B(I,I)
C
SOLVE FOR DIMENSIONLESS TEMPERATURES
CALL SIMEQ(C,Y,M,NMAX)
Y(N)=0.0
C
PRINT RESULTS
35 WRITE(6,200) ROWS,NRODS
WRITE(6,201) AR
WRITE(6,202) POR
WRITE(6,203) F12,F13,F15,F18
WRITE(6,204)
40 WRITE(6,205) (I,E(I),X(I),Y(I),I=1,N)
GO TO 1
1 CONTINUE
200 FORMAT('1 HEXAGONAL ARRAY OF',I3,' RODS OF',I4,
1 ' RODS ON A TRIANGULAR PITCH')
45 201 FORMAT('X',I3,' RATIO OF AREA OF SURFACE 1 TO SURFACE N IS',
1 F9.6)
202 FORMAT('X',I3,' PITCH TO DIAMETER RATIO OF RODS=',F6.3)
203 FORMAT('X',I3,' BLACK BODY VIEW FACTORS ARE F12=',F13.10,
1 2X,'F13=',F13.10,76X,'F15=',F13.10,2X,'F16=',F13.10,/)
50 204 FORMAT('X',I3,' SURFACE EMISSIVITY DIMENSIONLESS',
1 ' DIMENSIONLESS',729X,'HEAT FLUX TEMPERATURE',/)
205 FORMAT('X',I3,OPF13.3,1P2E16.3)
STOP
END
  
```

SUBROUTINE LOAD 74/74 OPT=0 TRACE

FTN 4.1+REL

01/25/74 18.14.57.

```

SUBROUTINE LOAD(ROWS,NRODS,POR,AR,N,M),RETURNS(8)
COMMON B(218,218),E(218),X(218)
NAMELIST/SPX/ROWS,NRODS,POR,AR,E,X
READ(5,SPX)
5 IF(EOF(5).NE.0) GO TO 100
IF(NRODS.EQ.0) GO TO 100
N=NRODS
N=M+1
RETURN
10 100 RETURN A
END
  
```

SUBROUTINE SIMEQ 74/74 OPT=0 TRACE

FTN 4.1+REL

01/25/74 18.15.01.

```

SUBROUTINE SIMEQ(C,Y,M,NMAX)
COMMON B(218,218),E(218),X(218)
C
EQUATIONS (9) ARE SOLVED BY GAUSS-SEIDEL METHOD
C
ITERATION CONTINUED UNTIL RELATIVE ERROR IS
5 C
LESS THAN 1.0E-5
DIMENSION C(NMAX),Y(NMAX)
1 EROR=0.0
DO 7 I=1,M
7 J=0.0
SJ=0.0
10 IF (I.EQ. 1) GO TO 4
J1=I-1
DO 1 J=1,J1
3 SUM=SUM+B(I,J)*Y(J)
IF (I.EQ. M) GO TO 5
  
```

LISTING AND SUBROUTINE COMPILATION: HEX P. 2

```

15      4 J2=I+1
        03 5 J=J2,M
        5 S14=SUM+B(I,J)*Y(J)
        6 Z=(C(I)-SUM)/B(I,I)
        ERR=ABS(1-Z-Y(I)/Z)
23      IF (ERR.GT. ERROR) ERROR=ERR
        7 Y(I)=Z
        IF (ERROR.LT. 0.5E-5) RETURN
        GO TO 1
      END

```

SUBROUTINE BLACK

74/74

OPT=0

TRACE

FTN 4.1*REL

01/25/74 18.15.03.

```

SUBROUTINE BLACK(PDR,F12,F13,F15,F18)
C      THIS SUBROUTINE CALCULATES VIEW FACTORS-ROD TO ROD
      PI=3.14159265358979
      P0=PI*PI
      P2=PI/2.0
      P3=PI/3.0
      P6=PI/6.0
      R1=2.0/SQRT(3.0)
      R3=2.0*SQRT(21.0)/3.0
13      C1=SQRT(3.0)
      C2=SQRT(13.0)/9.0
      C3=ATAN(C2)
      S1=SQRT(7.0)
15      S1=SQRT(1.0*PDR*PDR-1.0)
      S3=SQRT(3.0*PDR*PDR-1.0)
      S7=SQRT(7.0*PDR*PDR-1.0)
      T1=ATAN(S1)
      T3=ATAN(S3)
      T7=ATAN(S7)
20      IF (PDR.GT. R1) GO TO 1
      F12=(P0-T1-S1)/PI
      GO TO 2
1      F12=(P2-PDR-T1+S1)/PI
2      IF (PDR.GT. F1) GO TO 3
23      F13=(S1-T1)/PI
      GO TO 5
3      IF (PDR.GT. 2.0) GO TO 4
      F13=(S3-T3-2.0*(S1-T1)-P6)/PI
      GO TO 5
33      4 F13=(P2-PDR*C1-T3+S3)/PI
      5 IF (PDR.GT. R1) GO TO 5
      F15=0.0
      GO TO 9
6      IF (PDR.GT. 3.0) GO TO 7
35      F15=(S7-T7-2.0*(S3-T3)+S1-T1+C3+P6)/P0
      GO TO 9
7      IF (PDR.GT. R3) GO TO 4
      F15=(S7-T7-S3+T3-S1+T1-P3)/PI
      GO TO 9
43      8 F15=(P2-PDR*C4-T7+S7)/PI
      9 F15=6.0*(F12+F13)+12.0*F15
13 F18=(1.0-F15)/12.0
      RETURN
      END

```

SUBROUTINE MATRIX

74/74

OPT=0

TRACE

FTN 4.1*REL

01/25/74 18.15.07.

```

SUBROUTINE MATRIX(NROWS,N,NMAX,AF,F12,F13,F15,F18)
C      COMMON 3(21A,21B),F(21A),Y(21B)
      MATRIX CONSTRUCTS THE ARRAY OF FIJ VALUES
      DIMENSION F(21A,21B),M(20)
      EQUIVALENCE(F(1,1),B(1,1))
      NROWS=N-1
      K1=NROWS
13      K1=NROWS-1
      K2=NROWS-2
      K3=NROWS-3
      K4=NROWS-4
      M(1)=1
      DO 1 I=2,NROWS
15      1 M(I)=M(I-1)+6*(I-1)
      DO 2 I=1,N
      DO 2 J=1,N
2      F(I,J)=1.0
      IF (NROWS.LT. 2) GO TO 43
20      F(1,2)=12
      F(1,3)=12
      F(1,4)=F12
      F(1,5)=F12
      F(1,6)=F12
      F(1,7)=F12
25      F(2,4)=F13
      F(3,5)=F13
      F(3,7)=F13
      F(4,6)=F13
      F(5,7)=F13

```

LISTING AND SUBROUTINE COMPILATION: HEX P. 3

```

30      DO 3 K=2,K1
        I1=N(K-1)+1
        I2=N(K)-1
        DO 3 I=I1,I2
          J=I+1
35      3 F(I,J)=F12
        DO 4 K=2,K1
          I=N(K-1)+1
          J=N(K)
        4 F(I,J)=F12
40      DO 5 K=2,K1
          I=N(K-1)+1
          J=N(K)-1
        5 F(I,J)=F13
        IF (NRDMS .LT. 3) GO TO 93
45      F(1, 9)=F13
        F(1,10)=F13
        F(1,12)=F13
        F(1,14)=F13
        F(1,16)=F13
50      F(1,18)=F13
        F(2,13)=F15
        F(2,14)=F15
        F(2,16)=F15
        F(3,15)=F15
55      F(3,16)=F15
        F(3,18)=F15
        F(4, 9)=F15
        F(4, 9)=F15
        F(4,17)=F15
        F(4,18)=F15
60      F(5, 8)=F15
        F(5,10)=F15
        F(5,11)=F15
        F(5, 9)=F15
        F(5,10)=F15
65      F(5,12)=F15
        F(5,13)=F15
        F(5,11)=F15
        F(7,11)=F15
        F(7,12)=F15
70      F(7,14)=F15
        F(7,15)=F15
        F(8,11)=F15
        F(8,12)=F15
        F(10,13)=F15
        F(13,19)=F15
75      F(11,14)=F15
        F(12,15)=F15
        F(13,16)=F15
        F(14,17)=F15
        F(15,18)=F15
80      F(15,19)=F15
        F(9,13)=F18
        F(9,15)=F18
        F(9,14)=F18
        F(9,16)=F18
85      F(10,15)=F18
        F(10,17)=F18
        F(11,16)=F18
        F(11,19)=F18
90      F(12,17)=F18
        F(12,19)=F18
        F(13,18)=F18
        F(14,19)=F18
95      DO 6 K=2,K1
          I=N(K)
          J=I+1
        6 F(I,J)=F12
        DO 7 K=2,K1
          I1=N(K-1)+1
100      I2=N(K)-2
          I4=6*K-5
          DO 7 I=I1,I2
            J=I+I4
        7 F(I,J)=F12
105      DO 8 K=2,K1
          I1=N(K-1)+1
          I2=I1+2*K-3
          I4=6*K-5
          DO 8 I=I1,I2
            J=I+I4
110      8 F(I,J)=F12
        DO 9 K=2,K1
          L1=N(K-1)+K-1
          L2=N(K)-2*K+2
115      L3=K-1
          L4=2*K-2
          I4=6*K-5
          DO 9 L=L1,L2,L3
            I1=L
            I2=I1+L4
            I4=I4+1
            DO 9 I=I1,I2
              J=I+I4
120      9 F(I,J)=F12

```

LISTING AND SUBROUTINE COMPILATION: HEX P. 4

125	DO 10 K=2,K1
	I1=M(K)-K+1
	I2=M(K)
	I4=6*K
130	DO 11 I=I1,I2
	J=I+I4
	10 F(I,J)=F12
	DO 11 K=2,K1
	I4=M(K)
	J=I+2
133	11 F(I,J)=F13
	DO 12 K=2,K1
	L1=M(K)-1+K
	L2=M(K)-K+2
	L3=K-1
140	I4=6*K-7
	DO 12 L=L1,L2,L3
	I1=L
	I2=I1+K-2
	I4=I4+1
145	DO 12 I=I1,I2
	J=I+I4
	12 F(I,J)=F13
	DO 13 K=2,K1
	L1=M(K)-1+K-1
150	L2=M(K)-K
	L3=K-1
	I4=6*K-4
	DO 13 L=L1,L2,L3
	I1=L
	I2=I1+K-2
	I4=I4+1
155	DO 13 I=I1,I2
	J=I+I4
	13 F(I,J)=F13
160	DO 14 K=2,K1
	I1=M(K)-K+1
	I2=M(K)-1
	I4=6*K+1
	DO 14 I=I1,I2
165	J=I+I4
	14 F(I,J)=F13
	DO 15 K=2,K1
	I1=M(K)-1+1
	J=M(K+1)
170	15 F(I,J)=F13
	DO 16 K=3,K0
	I1=M(K)-1+K-2
	I2=M(K)-K
	I3=K-2
175	DO 16 I=I1,I2,I3
	J=I+2
	16 F(I,J)=F13
	DO 17 K=2,K1
	I1=M(K)-K
180	I2=I1+K-2
	I4=6*K+2
	DO 17 I=I1,I2
	J=I+I4
185	17 F(I,J)=F15
	DO 18 K=2,K1
	I1=M(K)-1+1
	I2=I1+1
	I4=I2+K-10
	DO 18 I=I1,I2
190	I4=I4+1
	J=I+I4
	18 F(I,J)=F15
	DO 19 K=3,K0
	I1=M(K)-1+1+1
195	I2=I1+1
	I4=6*K-3
	DO 19 I=I1,I2
	J=I+I4
200	19 F(I,J)=F15
	IF (NRO45 .LT. 5) GO TO 83
	F(2,21)=F13
	F(3,24)=F13
	F(4,27)=F13
205	F(5,30)=F13
	F(6,33)=F13
	F(7,36)=F13
	F(1,23)=F15
	F(1,21)=F15
210	F(1,23)=F15
	F(1,24)=F15
	F(1,26)=F15
	F(1,27)=F15
	F(1,29)=F15
	F(1,30)=F15
215	F(1,32)=F15
	F(1,33)=F15
	F(1,35)=F15
	F(1,36)=F15
	F(2,25)=F15

LISTING AND SUBROUTINE COMPILATION: HEX P. 5

```

220      F(2,26)=F18
      F(3,28)=F18
      F(3,29)=F18
      F(4,31)=F18
      F(4,32)=F18
225      F(5,34)=F18
      F(5,35)=F18
      F(5,37)=F18
      F(7,23)=F18
      F(2,28)=F18
230      F(2,30)=F18
      F(2,32)=F18
      F(2,34)=F18
      F(3,31)=F18
      F(3,33)=F18
      F(3,35)=F18
235      F(3,37)=F18
      F(4,20)=F18
      F(4,22)=F18
      F(4,34)=F18
      F(4,36)=F18
240      F(5,21)=F18
      F(5,23)=F18
      F(5,25)=F18
      F(5,37)=F18
245      F(5,24)=F18
      F(6,26)=F18
      F(6,29)=F18
      F(7,25)=F18
      F(7,27)=F18
250      F(7,29)=F18
      F(7,31)=F18
      F(3,26)=F18
      F(3,33)=F18
      F(9,27)=F18
255      F(9,35)=F18
      F(10,29)=F18
      F(10,36)=F18
      F(11,26)=F18
      F(11,30)=F18
260      F(12,21)=F18
      F(12,32)=F18
      F(13,23)=F18
      F(13,33)=F18
      F(14,24)=F18
265      F(14,35)=F18
      F(15,26)=F18
      F(15,36)=F18
      F(16,24)=F18
      F(16,27)=F18
270      F(17,21)=F18
      F(17,29)=F18
      F(18,23)=F18
      F(18,30)=F18
      F(19,24)=F18
275      F(19,32)=F18
      F(21,25)=F18
      F(22,26)=F18
      F(23,37)=F18
      F(24,28)=F18
280      F(25,29)=F18
      F(27,31)=F18
      F(28,32)=F18
      F(30,34)=F18
      F(31,35)=F18
285      F(33,37)=F18
      DO 20 K=2,K2
      I=M(K)
      J=M(K)+1
290      F(I,J)=F13
      DO 21 K=2,K2
      I1=M(K-1)+K-1
      I2=M(K)-K+1
      I3=K-1
      I4=12*K-5
295      DO 21 I=I1,I2,I3
      I4=I+2
      J=I+I4
      F(I,J)=F13
300      DO 22 K=3,K1
      I1=M(K-1)+2
      I2=I1+K-3
      I4=6*K-7
      DO 22 I=I1,I2
      J=I+I4
      F(I,J)=F13
305      DO 23 K=3,K1
      I1=M(K-1)+1
      I2=I1+K-3
      I4=6*K-6
      DO 23 I=I1,I2
      J=I+I4
310      F(I,J)=F13
      DO 24 K=2,K2
      I=M(K)
      J=M(K)+3
315

```

LISTING AND SUBROUTINE COMPILATION: HEX P. 6

	24	F(I,J)=F15
		DO 25 K=2,K2
		I1=M(K-1)+K
		I2=M(K)-K+2
320		I3=K-1
		I4=12*K-4
		DO 25 I=I1,I2,I3
		I4=I4+2
		J=I+I4
325	25	F(I,J)=F15
		DO 26 K=2,K2
		I1=M(K-1)+K
		I2=M(K)-K+2
		I3=K-1
330		I4=12*K-7
		DO 26 I=I1,I2,I3
		I4=I4+2
		J=I+I4
335	26	F(I,J)=F15
		DO 27 K=2,K2
		I=M(K-1)+1
		J=M(K+2)-1
	27	F(I,J)=F15
		DO 28 K=2,K2
340		I=M(K-1)+1
		J=M(K+2)
	28	F(I,J)=F15
		DO 29 K=2,K2
		I=M(K)-1
345		J=M(K+1)+1
	29	F(I,J)=F15
		DO 30 K=3,K1
		I1=M(K)-1
		I2=M(K)
350		DO 30 I=I1,I2
		J=I+3
	30	F(I,J)=F15
		DO 31 K=3,K1
		L1=M(K-1)+K+1
355		L2=M(K)-2*K+1
		L3=K-1
		I4=6*K-8
		DO 31 L=L1,L2,L3
360		I1=L
		I2=I1+K-2
		I4=I4+1
		DO 31 I=I1,I2
		J=I+I4
365	31	F(I,J)=F15
		DO 32 K=3,K1
		I1=M(K)-K+3
		I2=M(K)
		I4=6*K-3
370		DO 32 I=I1,I2
		J=I+I4
	32	F(I,J)=F15
		DO 33 K=3,K1
		I1=M(K-1)+3
		I2=I1+K-3
375		I4=6*K-8
		DO 33 I=I1,I2
		J=I+I4
	33	F(I,J)=F15
		DO 34 K=3,K1
380		L1=M(K-1)+K-2
		L2=L1+3*K-3
		L3=K-1
		I4=6*K-3
385		DO 34 L=L1,L2,L3
		I1=L
		I2=I1+K-2
		I4=I4+1
		DO 34 I=I1,I2
		J=I+I4
390	34	F(I,J)=F15
		DO 35 K=4,K0
		L1=M(K-1)+K-3
		L2=M(K)-K-1
		L3=K-1
395		DO 35 L=L1,L2,L3
		I1=L
		I2=I1+1
		DO 35 I=I1,I2
		J=I+3
400	35	F(I,J)=F15
		DO 36 K=2,K2
		I=M(K)-1
		J=M(K+1)+3
405	36	F(I,J)=F15
		DO 37 K=4,K0
		I1=M(K-1)+1
		I2=I1+2
		I4=6*K-10
		DO 37 I=I1,I2,2
410		J=I+I4
	37	F(I,J)=F15
		IF (NROWS .LT. 5) GO TO 43

LISTING AND SUBROUTINE COMPILATION: HEX P. 7

415	F(2,42)=F15
	F(2,43)=F15
	F(3,43)=F15
	F(3,44)=F15
	F(3,46)=F15
	F(3,47)=F15
420	F(4,47)=F15
	F(4,48)=F15
	F(4,50)=F15
	F(4,51)=F15
	F(5,51)=F15
425	F(5,52)=F15
	F(5,54)=F15
	F(5,55)=F15
	F(6,55)=F15
	F(6,56)=F15
	F(6,58)=F15
430	F(6,59)=F15
	F(7,59)=F15
	F(7,63)=F15
	F(1,38)=F18
	F(1,4)=F18
435	F(1,42)=F18
	F(1,44)=F18
	F(1,46)=F18
	F(1,43)=F18
	F(1,50)=F18
440	F(1,52)=F18
	F(1,54)=F18
	F(1,56)=F18
	F(1,58)=F18
	F(1,63)=F18
445	F(2,45)=F18
	F(2,47)=F18
	F(3,41)=F18
	F(3,49)=F18
	F(3,51)=F18
450	F(4,5)=F18
	F(4,53)=F18
	F(4,55)=F18
	F(5,49)=F18
	F(5,57)=F18
455	F(5,59)=F18
	F(6,53)=F18
	F(6,51)=F18
	F(7,43)=F18
	F(7,57)=F18
460	F(8,44)=F18
	F(9,46)=F18
	F(10,48)=F18
	F(11,50)=F18
465	F(12,52)=F18
	F(13,54)=F18
	F(14,56)=F18
	F(15,58)=F18
	F(16,60)=F18
	F(19,42)=F18
470	DO 38 K=3,K2
	L1=M(K-1)+1
	L2=M(K)-K+2
	L3=K-1
	I4=I2*K-7
475	DO 38 L=L1,L2,L3
	I1=L
	I2=I1+K-2
	I4=I4+2
	DO 38 I=I1,I2
480	J=I+I4
	38 F(I,J)=F13
	DO 39 K=2,K3
	I=M(K)
	J=M(K+2)+1
485	39 F(I,J)=F15
	DO 40 K=2,K3
	I=M(K)
	J=M(K+2)+2
	40 F(I,J)=F15
490	DO 41 K=2,K3
	I1=M(K-1)+1
	I2=I1+K-2
	I4=I8*K+1
	DO 41 I=I1,I2
495	J=I+I4
	41 F(I,J)=F15
	DO 42 K=2,K3
	I1=M(K-1)+1
	I2=I1+K-2
500	I4=I8*K+2
	DO 42 I=I1,I2
	J=I+I4
	42 F(I,J)=F15
505	DO 43 K=3,K2
	L1=M(K-1)+2
	L2=M(K)-K+3
	L3=K-1
	I4=I2*K-9

LISTING AND SUBROUTINE COMPILATION: HEX P. 8

511	DO 43 L=L1,L2,L3 I1=L I2=I1+K-3 I4=I4+2 DO 43 I=I1,I2 J=I+I4
515	43 F(I,J)=F15 DO 44 K=3,K2 L1=M(K-1)+K-1 L2=M(K)-K+1 L3=K-1 I4=12*K-3 DO 44 L=L1,L2,L3 I1=L I2=I1+K-2 I4=I4+2
523	DO 44 I=I1,I2 J=I+I4
525	44 F(I,J)=F15 DO 45 K=3,K2 I1=M(K-1)+1 I2=I1+K-3 I4=12*K-3 DO 45 I=I1,I2 J=I+I4
530	45 F(I,J)=F15 DO 46 K=3,K2 I1=M(K-1)+K-2 I2=M(K)-K I3=K-1 I4=12*K-4 DO 46 I=I1,I2,I3 I4=I4+2 J=I+I4
535	46 F(I,J)=F15 DO 47 K=4,K1 I1=M(K-1)+1 I2=I1+K-4 I4=5*K-3 DO 47 I=I1,I2 J=I+I4
540	47 F(I,J)=F15 DO 48 K=2,K3 I1=M(K)-1 I2=M(K) I4=12*K+8 DO 48 I=I1,I2 I4=I4+1 J=I+I4
545	48 F(I,J)=F18 DO 49 K=2,K3 I1=M(K-1)+K I2=M(K)-K+2 I3=K-1 I4=13*K-5 DO 49 I=I1,I2,I3 I4=I4+3 J=I+I4
550	49 F(I,J)=F18 DO 50 K=2,K3 I=M(K-1)+1 J=M(K+3)+2
555	50 F(I,J)=F18 DO 51 K=2,K3 I=M(K-1)+1 J=M(K+3)
560	51 F(I,J)=F18 DO 52 K=3,K2 L1=M(K-1)+K L2=L1+4*K-4 L3=K-1 L4=12*K-11 DO 52 L=L1,L2,L3 I1=L I2=I1+1 L4=L4+2 I4=J DO 52 I=I1,I2 I4=I4+1 J=I+L4+I4
565	52 F(I,J)=F18 DO 53 K=3,K2 I1=M(K-1)+1 I2=I1+1 I4=14*K-5 DO 53 I=I1,I2 I4=I4+1 J=I+I4
570	53 F(I,J)=F18 DO 54 K=3,K2 I=M(K)-2 J=M(K+1)+1 F(I,J)=F13 DO 54 K=3,K1 I1=M(K)-2 I2=M(K)
575	54 F(I,J)=F13 DO 55 K=3,K1 I1=M(K)-2 I2=M(K)
580	
585	
590	
595	
600	

LISTING AND SUBROUTINE COMPILATION: HEX P. 9

```

605      DO 51 I=I1,I2,2
          J=I+4
          55 F(I,J)=F18
          DO 56 K=4,K1
              L1=M(K-1)*K+2
610              L2=M(K)-K+4
              L3=K-1
              I4=6*K-9
          DO 56 L=L1,L2,L3
              I1=L
615              I2=I1+K-4
              I4=I4+1
              DO 56 I=I1,I2
                  J=I+I4
          55 F(I,J)=F18
          DO 57 K=4,K1
              I1=M(K-1)*K+1
              I2=M(K)-K+3
              I3=K-1
              I4=6*K-11
620              DO 57 I=I1,I2,I3
                  I4=I4+1
                  J=I+I4
          57 F(I,J)=F18
          DO 58 K=4,K1
              L1=M(K-1)*K-1
              L2=M(K)-2*K+2
              L3=K-1
              I4=6*K-2
630              DO 58 L=L1,L2,L3
                  I1=L
                  I2=I1+K-4
                  I4=I4+1
                  DO 58 I=I1,I2
                      J=I+I4
          58 F(I,J)=F18
          DO 59 K=4,K1
              I1=M(K)-K+1
              I2=I1+K-4
              I4=5*K+3
640              DO 59 I=I1,I2
                  J=I+I4
          59 F(I,J)=F18
          DO 60 K=4,K1
              I1=M(K-1)*K-3
              I2=I1+4*K-4
              I3=K-1
              I4=6*K-2
          DO 60 I=I1,I2,I3
              I4=I4+1
              J=I+I4
650              60 F(I,J)=F18
          DO 61 K=4,K1
              I1=M(K-1)+2
              I2=I1+1
              I4=12*K-11
          DO 61 I=I1,I2
              I4=I4+1
              J=I+I4
          61 F(I,J)=F18
          DO 62 K=5,K0
              L1=M(K-1)*K-4
              L2=M(K)-K-2
              L3=K-1
          DO 62 L=L1,L2,L3
              I1=L
660              I2=I1+2
              DO 62 I=I1,I2,2
                  J=I+4
          62 F(I,J)=F18
          IF (NRC4S,LT,5) GO TO 83
              F(1,58)=F18
              F(10,73)=F18
              F(12,78)=F18
              F(14,83)=F18
              F(15,88)=F18
680              DO 63 K=3,K3
                  L1=M(K-1)*K-1
                  L2=M(K)-K+1
                  L3=K-1
                  I4=13*K+1
          DO 63 L=L1,L2,L3
              I1=L
              I2=I1+2
              I4=I4+3
          DO 63 I=I1,I2
              J=I+I4
          63 F(I,J)=F18
          DO 64 K=3,K3
              L1=M(K-1)*K-1
              L2=M(K)-K+1
              L3=K-1
              I4=14*K+2
          DO 64 L=L1,L2,L3
              I1=L
          64 F(I,J)=F18
          DO 65 K=3,K3
              L1=M(K-1)*K-1
              L2=M(K)-K+1
              L3=K-1
              I4=15*K+2
          DO 65 L=L1,L2,L3
              I1=L
          65 F(I,J)=F18

```

LISTING AND SUBROUTINE COMPILATION: HEX P. 10

[illegible]

LISTING AND SUBROUTINE COMPILATION: HEX P. 11

```

      DO 75 I=I1,I2
      J=I+1
      75 F(I,J)=F18
      DO 76 K=3,K3
      800 I1=4(K-1)+2
      I2=I1+K-3
      I4=18*K-1
      DO 76 I=I1,I2
      J=I+1
      805 76 F(I,J)=F18
      DO 77 K=3,K3
      I1=4(K-1)+1
      I2=I1+K-3
      I4=18*K+4
      810 DO 77 I=I1,I2
      J=I+1
      77 F(I,J)=F18
      DO 78 K=3,K3
      L1=4(K-1)+K-1
      815 L2=4(K)-K+1
      L3=K-1
      I4=18*K+4
      DO 78 L=L1,L2,L3
      I1=L
      820 I2=I1+K-2
      I4=I4+3
      DO 78 I=I1,I2
      J=I+1
      78 F(I,J)=F18
      DO 79 K=4,K2
      L1=4(K-1)+K-3
      L2=4(K)-K-1
      L3=K-1
      L4=12*K+4
      825 DO 79 L=L1,L2,L3
      I1=L
      I2=I1+1
      L4=L4+2
      I4=0
      830 DO 79 I=I1,I2
      I4=I4+1
      J=I+1
      79 F(I,J)=F18
      DO 80 K=5,K1
      I1=4(K-1)+4
      840 I2=I1+K-5
      I4=5*K-3
      DO 80 I=I1,I2
      J=I+1
      845 80 F(I,J)=F18
      DO 81 K=5,K1
      I1=4(K-1)+2
      I2=I1+K-5
      I4=5*K-2
      850 DO 81 I=I1,I2
      J=I+1
      81 F(I,J)=F18
      IF (NR045 .LT. 7) GO TO 83
      DO 82 K=4,K3
      I1=4(K-1)+K-2
      855 I2=4(K)-K
      I3=K-1
      I4=18*K+3
      DO 82 I=I1,I2,I3
      I4=I4+3
      860 J=I+1
      82 F(I,J)=F18
      DO 84 I=1,NR005
      DO 84 J=1,I
      865 84 F(I,J)=F(J,I)
      TOTAL=C.0
      DO 85 I=1,NR005
      SUM=0.0
      DO 85 J=1,NR005
      870 85 SUM=SUM+F(I,J)
      F(I,N)=1.0-SUM
      F(N,I)=4.0-F(I,N)
      86 TOTAL=TOTAL+F(N,I)
      F(N,N)=1.0-TOTAL
      875 RETURN
      END

```

COMMON BLOCKS LENGTH
 / / 47960

STATISTICS
 PROGRAM LENGTH 29353 29353
 BLANK COMMON 1355303 47951

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PROGRAM NAME: HOTANK

Descriptive Title: Heat Transfer in Hot Underground Waste Tanks
Containing Underground Waste

Program Author: Willingham, W. E.

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 4

Central Memory Words: 210000B

Average Execution Time: 120 CP sec

Keywords:

Program Description: Estimates steady-state temperatures in underground waste tanks of arbitrary geometry containing liquid or solidified wastes, air spaces and concrete walls. Also estimates soil temperatures. Axially symmetric, up to 1000 nodes, material properties in regions defined by material type. Originally written for Hanford fuel elements but modified by W. E. Willingham for waste tanks. Two subroutines.

Users of Program: G Jansen
WE Willingham (Vitro)
WV DeMier
JR Nance
RL Engel

Documentation: Program description appears in BNWL-616. Results are given in BNWL-181 and BNWL-262.

Condition of Program: Stability and convergence are highly dependent on choice of starting values. Nonsensical outputs are usually produced when convergence is not achieved.

SAMPLE INPUT: HOTANK P. 1

HOTANK 10:04 02/15/74

100 @S RUN PUN022,CURSZE,FL0H3E,150,6000/3000 G JANSEN 3/80 BLD
G 9423576

105 @N MSG KEEP AT FED.SLTS FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFOCO

115 @PRL TEL INFOCO

120 @PRL TEL CUB92R

125 @X ASG A=U1145(JU1145)

130 @N XGT CUR

150 FIND A,HOTANK/SIFS

160 TRD A

170 FIND A,DATAIN/SIFS

180 TRD A

190 FIND A,DATABL/SIFS

200 TRD A

350 TRI A

351 PCN HOTANK/SIFS

352 PCN DATAIN/SIFS

353 PCN DATABL/SIFS

360 @IM FRS,* HOTANK/SIFS,HOTANK/SIFS,HOTANK/RIFS

380 @IM FRS,* DATAIN/SIFS,DATAIN/SIFS,DATAIN/RIFS

390 @IM FRS,* DATABL/SIFS,DATABL/SIFS,DATABL/RIFS

1070 @N XGT HOTANK/RIFS

1080 036 290 2 1

1090 1 290 2 280 3 280 4 280 5 286

NSN

1100 6 285 7 284 8 283 9 282 10 281

NSN

1110 11 280 12 279 13 278 14 277 15 276

NSN

1120 16 275 17 274 18 273 19 272 20 271

NSN

1130 21 270 22 269 23 268 24 267 25 266

NSN

1140 26 265 27 264 28 263 29 262 30 261

NSN

1150 31 260 32 259 33 258 34 257 35 256

NSN

1160 36 255 37 254 38 253 39 252 40 251

NSN

1170 41 250 42 249 43 248 44 247 45 246

NSN

1180 46 245 47 244 48 243 49 242 50 241

NSN

1190 51 240 52 239 53 238 54 237 55 236

NSN

1200 56 235 57 234 58 233 59 232 60 231

NSN

1210 61 230 62 229 63 228 64 227 65 226

NSN

1220 66 225 67 224 68 223 69 222 70 221

NSN

1230 71 220 72 219 73 218 74 217 75 216

NSN

1240 76 215 77 214 78 213 79 212 80 211

NSN

1250 81 210 82 209 83 208 84 207 85 206

NSN

1260 86 205 87 204 88 203 89 202 90 201

NSN

SAMPLE INPUT: HOTANK P. 2

1270	91	200	92	199	93	198	94	197	95	196
	NS N									
1280	96	195	97	194	98	193	99	192	100	191
	NS N									
1290	101	190	102	189	103	188	104	187	105	186
	NS N									
1300	106	185	107	184	108	183	109	182	110	181
	NS N									
1310	111	180	112	179	113	178	114	177	115	176
	NS N									
1320	116	175	117	174	118	173	119	172	120	171
	NS N									
1330	121	170	122	169	123	168	124	167	125	166
	NS N									
1340	126	165	127	164	128	163	129	162	130	161
	NS N									
1350	131	160	132	159	133	158	134	157	135	156
	NS N									
1360	136	155	137	154	138	153	139	152	140	151
	NS N									
1370	141	150	142	149	143	148	144	147	145	146
	NS N									
1380	1000									
1390	700+1700+1									
1400	3	3	3	3	3	3	3	3	3	3
1410	4	4	4	4	4	4	4	4	4	4
1420	4	4	4	4	4	4	4	4	4	4
1430	4	4	4	4	4	4	4	4	4	4
1440	4	4	4	4	4	4	4	4	4	4
1450	5	5	5	5	5	5	5	5	5	5
1460	5	5	5	5	5	5	5	5	5	5
1470	3	3	3	3	3	3	3	3	3	3
1480	3	3	3	3	3	3	3	3	3	3
1490	3	3	3	3	3	3	3	3	3	3
1500	3	3	3	3	3	3	3	3	3	3
1510	3	3	3	3	3	3	3	3	3	3
1520	3	3	3	3	3	3	3	3	3	3
1530	3	3	3	3	3	3	3	3	3	3
1540	3	3	3	3	3	3	3	3	3	3
1550	3	3	3	3	3	3	3	3	3	3
1560	1	1	1	1	1	1	1	1	1	3
1570	1	1	1	1	1	1	1	1	1	3
1580	1	1	1	1	1	1	1	1	1	3
1590	1	1	1	1	1	1	1	1	1	3
1600	1	1	1	1	1	1	1	1	1	3
1610	1	1	1	1	1	1	1	1	1	3
1620	1	1	1	1	1	1	1	1	1	3
1630	1	1	1	1	1	1	1	1	1	3
1640	1	1	1	1	1	1	1	1	1	3
1650	1	1	1	1	1	1	1	1	1	3
1660	2	2	2	2	2	2	2	2	2	3
1670	2	2	2	2	2	2	2	2	2	3
1680	2	2	2	2	2	2	2	2	2	3
1690	045+0	055+0	100+2	134+0	070+0					
1700		2006-05								
1710	00+0	01+01								
1720	10									
1730	0.10									
1740	1				1.5					
1750	2				1.5					
1760	3				1.5					

SAMPLE INPUT: HOTANK P. 3

1770	4		1.5
1780	5		1.5
1790	6		1.5
1800	7		1.5
1810	8		1.5
1820	9		1.5
1830	10		1.5
1840	11	1.5	
1850	12	1.5	
1860	13	1.5	
1870	14	1.5	
1880	15	1.5	
1890	16	1.5	
1900	17	1.5	
1910	18	1.5	
1920	19	1.5	
1930	20	1.5	
1940	61		1.5
1950	62		1.5
1960	63		1.5
1970	64		1.5
1980	65		1.5
1990	66		1.5
2000	67		1.5
2010	68		1.5
2020	69		1.5
2030	70		1.5
2040	71	1.5	
2050	72	1.5	
2060	73	1.5	
2070	74	1.5	
2080	75	1.5	
2090	76	1.5	
2100	77	1.5	
2110	78	1.5	
2120	79	.75	1.5
2130	80	.75	.75
2140	81		.75
2150	82		.75
2160	83		.75
2170	84		.75
2180	85		.75
2190	86		.75
2200	87		.75
2210	88		.75
2220	89	.75	.75
2230	90	.75	
2240	91		.75
2250	92		.75
2260	93		.75
2270	94		.75
2280	95		.75
2290	96		.75
2300	97		.75
2310	98		.75
2320	99	.75	.75
2330	100	.75	
2340	109	.75	
2350	110	.75	
2360	119	.75	

SAMPLE INPUT: HOTANK P. 4

[illegible]

SAMPLE INPUT: HOTANK P. 5

2950 12. 12. 12. 12. 12. 12.
 2960 12.
 2970 C0000
 2980 S9999
 2990 @ FIN
 READY

HOTANK 13:11 02/23/74

100 @S RUN PUN022,CURS28,GEORGE,150,6000/3000 G JANSEN 3760 BLD
 G 9423576
 105 @N PLS KEEP AT FED.DLDO FOR PICKUP AT 5:00PM BY G.JANSEN
 110 @PUL TEL INFO00
 115 @PFL TEL INFO00
 120 @PFL TEL CUR9928
 125 @X ASG A=00231
 130 @N XQT CUR
 150 FIND A,HOTANK/S2F5
 160 TRD A
 170 FIND A,DATAIN/S2F5
 180 TRD A
 190 FIND A,DATABL/S2F5
 200 TRD A
 350 TRI A
 351 PCF HOTANK/S2F5
 352 PCF DATAIN/S2F5
 353 PCF DATABL/S2F5
 360 @I FR5,* HOTANK/S2F5,HOTANK/S2F5,HOTANK/R2F5
 380 @I FR5,* DATAIN/S2F5,DATAIN/S2F5,DATAIN/R2F5
 390 @I FR5,* DATABL/S2F5,DATABL/S2F5,DATABL/R2F5
 1070 @N XQT HOTANK/R2F5
 READY

SAMPLE OUTPUT: HOTANK P. 1

1. HOT TANK

THIS CALCULATION WAS DONE ON 01 AUG 73 AT 14:45:27

CALCULATION OF STEADY STATE TEMPERATURES

PROGRAM HOTANK

CASE NO. 6666

HEAT BALANCE ERROR = -.191649 PERCENT

MAX TEMP = 5.551+02 DEG F AT NODE 231

1.392E+02 BTU/HR TO SINK 1 2.774-05 BTU/HR TO SINK 2 0.000 BTU/HR TO SINK 3

HEAT FROM NODES TO SINK 1

HEAT= 5.113-01 FROM NODE 1	HEAT= 7.646-01 FROM NODE 2	HEAT= 2.036+00 FROM NODE 3
HEAT= 8.305+00 FROM NODE 4	HEAT= 1.225+01 FROM NODE 5	HEAT= 1.538+01 FROM NODE 6
HEAT= 1.347+01 FROM NODE 7	HEAT= 2.347+01 FROM NODE 8	HEAT= 2.719+01 FROM NODE 9
HEAT= 3.078+01 FROM NODE 10		

HEAT FROM NODES TO SINK 2

HEAT= 1.392E+02 FROM NODE 281	HEAT= 1.573-07 FROM NODE 282	HEAT= 4.220-07 FROM NODE 283
HEAT= 1.709-01 FROM NODE 284	HEAT= 2.946-06 FROM NODE 285	HEAT= 4.128-06 FROM NODE 286
HEAT= 5.106-01 FROM NODE 287	HEAT= 6.497-06 FROM NODE 288	HEAT= 7.667-06 FROM NODE 289
HEAT= 8.846-01 FROM NODE 290		

NODE TEMPERATURES, DEG F

	1	2	3	4	5	6	7	8	9	10
1X	7.001+01	7.001+01	7.001+01	7.001+01	7.001+01	7.001+01	7.001+01	7.001+01	7.001+01	7.001+01
11X	1.196+02	1.195+02	1.190+02	1.176+02	1.121+02	1.076+02	1.056+02	1.059+02	1.053+02	1.046+02
21X	1.975+02	1.951+02	1.950+02	1.924+02	1.777+02	1.656+02	1.500+02	1.601+02	1.587+02	1.471+02
31X	2.750+02	2.742+02	2.726+02	2.675+02	2.427+02	2.230+02	2.125+02	2.111+02	2.088+02	2.063+02
41X	3.515+02	3.511+02	3.496+02	3.442+02	3.071+02	2.789+02	2.629+02	2.582+02	2.546+02	2.415+02
51X	4.284+02	4.271+02	4.274+02	4.230+02	3.713+02	3.339+02	3.111+02	3.007+02	2.956+02	2.818+02
61X	4.700+02	4.703+02	4.726+02	4.708+02	4.357+02	3.883+02	3.576+02	3.386+02	3.314+02	3.271+02
71X	4.737+02	4.700+02	4.710+02	4.712+02	4.719+02	4.431+02	4.039+02	3.718+02	3.619+02	3.572+02
81X	4.712+02	4.715+02	4.719+02	4.725+02	4.730+02	4.746+02	4.511+02	4.005+02	3.874+02	3.824+02
91X	4.775+02	4.700+02	4.717+02	4.720+02	4.751+02	4.762+02	4.721+02	4.240+02	4.004+02	4.033+02
101X	4.749+02	4.757+02	4.757+02	4.773+02	4.762+02	4.790+02	4.810+02	4.426+02	4.256+02	4.193+02
111X	4.717+02	4.765+02	4.804+02	4.815+02	4.810+02	4.824+02	4.836+02	4.561+02	4.397+02	4.335+02
121X	4.834+02	4.842+02	4.845+02	4.853+02	4.855+02	4.860+02	4.867+02	4.667+02	4.516+02	4.451+02
131X	4.882+02	4.883+02	4.884+02	4.888+02	4.890+02	4.893+02	4.896+02	4.751+02	4.617+02	4.554+02
141X	4.925+02	4.925+02	4.923+02	4.917+02	4.917+02	4.915+02	4.918+02	4.818+02	4.702+02	4.645+02
151X	4.934+02	4.930+02	4.932+02	4.939+02	4.935+02	4.936+02	4.935+02	4.872+02	4.776+02	4.728+02
161X	4.936+02	4.932+02	4.934+02	4.954+02	4.944+02	4.947+02	4.946+02	4.919+02	4.840+02	4.800+02
171X	5.016+02	5.020+02	4.997+02	4.964+02	4.955+02	4.955+02	4.953+02	4.963+02	4.896+02	4.862+02
181X	5.025+02	5.012+02	4.984+02	4.970+02	4.961+02	4.959+02	4.957+02	5.008+02	4.947+02	4.914+02
191X	5.023+02	5.011+02	4.924+02	4.922+02	4.961+02	4.961+02	4.959+02	5.058+02	4.994+02	4.959+02
201X	5.225+02	5.214+02	5.199+02	5.177+02	5.169+02	5.161+02	5.150+02	5.120+02	5.038+02	4.993+02
211X	5.363+02	5.362+02	5.367+02	5.347+02	5.335+02	5.324+02	5.306+02	5.179+02	5.076+02	5.033+02
221X	5.502+02	5.491+02	5.476+02	5.455+02	5.444+02	5.420+02	5.405+02	5.224+02	5.110+02	5.066+02
231X	5.551+02	5.549+02	5.524+02	5.504+02	5.491+02	5.475+02	5.447+02	5.251+02	5.139+02	5.096+02
241X	5.531+02	5.520+02	5.509+02	5.471+02	5.472+02	5.444+02	5.393+02	5.277+02	5.196+02	5.153+02
251X	5.465+02	5.460+02	5.460+02	5.443+02	5.431+02	5.403+02	5.359+02	5.296+02	5.246+02	5.220+02
261X	5.361+02	5.358+02	5.374+02	5.377+02	5.371+02	5.357+02	5.336+02	5.316+02	5.298+02	5.287+02
271X	5.314+02	5.310+02	5.324+02	5.320+02	5.332+02	5.330+02	5.326+02	5.320+02	5.314+02	5.311+02
281X	4.706+02	4.707+02	4.708+02	4.708+02	4.708+02	4.708+02	4.708+02	4.708+02	4.708+02	4.708+02

SUPPLEMENTAL PROGRAM *** ERROR FIGURES FOR CASE NO. 6666

2.66286E+01 BTU/HR = ERROR IN HEAT BALANCE BETWEEN HEAT IN AND HEAT OUT OF THE SYSTEM
1.59073+02 BTU/HR = TOTAL HEAT ADDED TO THE SYSTEM (AND REMOVED FROM THE SYSTEM)

2.64243E+01 BTU/HR = ERROR IN HEAT BALANCE AMONG ALL INDIVIDUAL NODES
2.15754E+04 BTU/HR = SUM OF HEAT TRANSFERRED ACROSS ALL NODE FACES
1.57256E+02 BTU/HR = ALGEBRAIC SUM OF THE HEAT FLOWS OVER ALL NODE FACES

SAMPLE OUTPUT: HOTANK P. 2

*** SUMMARY OF INPUT DATA FOR CASE NO. 0006 ***

THERMAL CONDUCTIVITY (BTU/HR SQ FT DEG F/FT)	SINK TEMPERATURES (DEGREES FAHRENHEIT)	VOLUMETRIC HEAT GEN RATE (BTU/HR CU FT) = 1.415
		TOTAL HEAT LOAD IN TANK (BTU/HR) = 5.00184E+04

MATERIAL 1 0.1500	SINK 1 70.00	SLOPE OR CAKE THICKNESS (FEET) =
MATERIAL 2 1.2000		
MATERIAL 3 200.0000	SINK 2 70.00	SOIL COVER DEPTH (FEET) =
MATERIAL 4 -0.0000		
MATERIAL 5 200.0000		LIQUID LAYER DEPTH (FEET) =
MATERIAL 6 -0.0000		

MATERIAL TYPE	FILM COEFFICIENTS (BTU/HR SQ FT DEG F)	TANK DIAMETER (FEET) =
1		
2	NODE H	TANK HEIGHT (FEET) =
3		
4		
5		
6		

TIME SPENT ON CALCULATION = 4.678-01 SECS

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00230 OF MAIN PROGRAM

CSCX RLG300 03 AUG 7 14:45:16 USER RCC304 AP0031

CARDS IN 756 OUT 0 LINES 930 PROCESSING TIME 10.33 SECONDS

LISTING AND SUBROUTINE COMPILATION: HOTANK P. 1

```

3  ELT HOTANK/SEFS.1.710.70. 73571
3  EOF 3
C
C      NAME OF PROGRAM IS HOTANK
C
C  INCLUDES HEAT TRANSFER BY CONDUCTION AND CONVECTION
C  SPECIAL PRINTOUT FORMAT INCLUDED
C  SYSTEM IS LIMITED TO NODES WITH A MAXIMUM OF 6 SIDES
C
C  INPUT INFORMATION REQUIRED
C  EACH GROUP TO BE LISTED ON SEPARATE CARDS
C  (1) CASE IDENTIFICATION NOT BLANK OR ZERO
C      NUMBER OF NODES (1000 MAXIMUM)
C      MAXIMUM NUMBER OF MINUTES TO CALCULATE BEFORE
C      PRINTING RESULTS
C      METHOD OF CALCULATION
C      FORMAT(4ES)
C  (2) NODE SEQUENCE NUMBER (NSN)
C      ORDER IN WHICH THE NODES ARE TO BE CALCULATED
C      FORMAT(11IS)
C  (3) INITIAL TEMPERATURE GUESS
C      FORMAT(1F5.0) OR 41GF5.0) OR (12F5.0)
C  (4) TEMPERATURES (NOT ZERO) OF SINKS 1 TO 6. IF
C      THERE IS NO SINK LEAVE BLANK (DEG F)
C      FORMAT(6F5.2)
C  (5) MATERIAL TYPE FOR EACH NODE (INTEGERS FROM 1 TO 12)
C      FORMAT(12IS)
C  (6) THERMAL CONDUCTIVITY OF EACH MATERIAL TYPE
C      TWO FIELDS FOR EACH TYPE (A1,B1,A2,B2,----)
C      WHEN A FUNCTION OF TEMPERATURE (A+BT)
C      (BTU/HR SFT DEG F/FT)
C      FORMAT(12ES.2)
C  (7) HEAT GENERATION BY MATERIAL TYPE. ONE VALUE OR
C      BLANK FOR EACH TYPE. NOT ZERO (BTU/HR CU IN)
C      FORMAT(12ES.2)
C  (8) ALLOWABLE ERROR FOR CONDUCTANCE CALCULATIONS (DEG F)
C      AND ALLOWABLE ERROR IN THE TEMPERATURE CALCULATIONS
C      (DEG F)
C      -OR-
C      ALLOWABLE HEAT BALANCE ERROR (OVERALL) (IN PERCENT)
C      FORMAT(2ES.2)
C  (9) NUMBER OF ITERATIONS PER CYCLE BEFORE GOING TO
C      THE EXTRAPOLATION SECTION OF THE PROGRAM (NIT)
C      FORMAT(1IS)
C  (10) ACCELERATION FACTOR IN THE EXTRAPOLATION SECTION (ACF)
C      FORMAT(1F5.0)
C  (11) NODE NUMBER AND FILM OR CONTACT COEFFICIENT AT
C      EACH FACE. MUST BE DUPLICATED FOR ADJACENT FACES
C      USE A BLANK OR ZERO FOR A HOMOGENEOUS INTERFACE
C      FORMAT(12F5.0)
C  (12) LAST CARD OF EACH CASE (IN ADDITION TO DATA CARDS) IS
C      BLANK
C
C  ALTERNATE INPUT FOR ADDITIONAL CASES ON THE SAME RUN
C  (1) CASE IDENTIFICATION (NOT BLANK OR ZERO)
C      NUMBER OF NODES
C      TIME LIMIT ON CALCULATIONS
C      CHANGE CASE (NEW)
C      FORMAT (4IS)
C  (2) NUMBER OF CARDS TO BE READ (NCC),(NCR)
C      NCC REFERS TO A NODE MATERIAL TYPE CHANGE (IF ANY)
C      NCR REFERS TO ANY ADDITIONAL CHANGES
C      FORMAT (2IS)
C  (3) NODE NUMBER
C      MATERIAL TYPE
C      FORMAT (3IS)
C  (4) MATERIAL TYPE
C      THERMAL CONDUCTIVITY (2 FIELDS)
C      HEAT GENERATION BY MATERIAL TYPE
C      FORMAT (15.3ES.2)
C
1  FORMAT (4IS)
2  FORMAT (1F5.0)
3  FORMAT (5ES.2)
4  FORMAT (14IS)
5  FORMAT (12ES.2)
6  FORMAT (12F5.0)
7  FORMAT (12F5.0)
8  FORMAT (46H)  CALCULATION OF STEADY STATE TEMPERATURES.48X.
115HPROGRAM HOTANK ///
214H  CASE NO.16. 744
3  HEAT BALANCE ERROR = F12.6.9H PERCENT //
480X. 1CHMAX TME =1F12.3.19H DEG F AT NODE 15///
514X. 1F11.3.17H BTU/HR TO SINK 11F13.3.17H BTU/HR TO SINK 2
61F13.3.17H BTU/HR TO SINK 3/
714X. 1F11.3.17H BTU/HR TO SINK 41F13.3.17H BTU/HR TO SINK 5
81F13.3.17H BTU/HR TO SINK 6/
9  FORMAT ( 3CHD  HEAT FROM NODES TO SINK 111/)
10 FORMAT 16X. 5HHEAT=1F11.3.10H FROM NODE 15)
11 FORMAT (1H+.4CX 5HHEAT=1F11.3.10H FROM NODE 15)
12 FORMAT (1H+.7CX 5HHEAT=1F11.3.10H FROM NODE 15)
13 FORMAT (1HC/1H 47.244NODE TEMPERATURES, DEG F)

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LISTING AND SUBROUTINE COMPILATION: HOTANK P. 2

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14 FORMAT (15,3E5.2)
15 FORMAT (1H 13,1X,1X,1F10F11.3)
16 FORMAT (1H1,31X, 5H SUPPLEMENTAL PROGRAM *** ERROR FIGURES FOR CA
1ASE NO. 115///5X, 1F12.5, 744 BTU/HR = ERROR IN HEAT BALANCE
2C BETWEEN HEAT IN AND HEAT OUT OF THE SYSTEM / 5X, 1F12.5,
370H BTU/HR = TOTAL HEAT ADDED TO THE SYSTEM (AND REMOVED FROM THE
4SYSTEM)
5///5X, 1F12.5, 554 BTU/HR = ERROR IN HEAT BALANCE AMONG ALL
6 INDIVIDUAL NODES / 5X, 1F12.5, 55H BTU/HR = SUM OF HEAT TRA
7NSFERRED ACROSS ALL NODE FACES / 5X, 1F12.5, 60H BTU/HR = ALGEBRA
8IC SUM OF THE HEAT FLOW OVER ALL NODE FACES )
17 FORMAT (1H1 10X,141,10X,142,10X,143,10X,144,10X,145,10X,10X,
11H7,10X,148,10X,149,9X,1410/1H )
18 FORMAT (12F5.0)
19 FORMAT (1H1,31X, 36HTHERE IS AN ERROR IN THE INPUT DATA )
20 FORMAT (1H0,1X,77+TIME SPENT ON CALCULATION =1PE11.3,7H SECS )
21 FORMAT (6E10.0)
DIMENSION X(750,6),A(750,6),U(750,6),C(750,6),THERM(750,6),
1ADJ(750,6),Z(750),D(750),VOL(750),FRET(750),SEGT(750),
2OLDT(750),MAT(750),SINKS(750),TC(24),TGUSS(750),NSN(750),
3HEAT(24),TMAT(12),SINK(1)
COMMON X,C,E,D,Z,S,A,J,N,L,N,Z,R,S,IO,IZ,M,O,TC,KA,BTU,ALL,ADJ,I,
4MAT,NON,VOL,HEAT,SEGT,OLDT,FRET,SINK,NLIN,TEMP,THERM,SINKQ,
5ZDELTA,NTIME,CERROR,TERROR,ANGLE
INTEGER ADJ
C
C IF STORAGE SPACE IS REQUIRED SET TGUSS EQUIVALENT TO SEGT
C
CALL SETIO(2,1)
CALL SETIO(3,2)
DO 30 I=1,750
DO 30 J=1,6
C(I,J)=0.0
30 CONTINUE
31 READ (2,1) IO,NON,NLIN,METHOD
IF (IO .EQ. 0) GO TO 999
IF (NON .EQ. 0) GO TO 999
READ (2,4) (NSN(I),I=1,NON)
DO 40 J=1,NON
N=NSN(J)
40 CONTINUE
GO TO (42,41,43), METHOD
C METHOD 1= UNIFORM TEMPERATURE GUESS
C METHOD 2= NODAL TEMPERATURE GUESS
C METHOD 3= MATERIAL TYPE TEMPERATURE GUESS
41 READ (2,7) (TGUSS(I),I=1,NON)
C SETTING UP TEMPERATURES FOR EACH NODE
DO 50 N=1,NON
SEGT(N)=TGUSS(N)
OLDT(N)=SEGT(N)
50 CONTINUE
GO TO 43
42 READ (2,2) TEMP
C SETTING ALL TEMPERATURES EQUAL
DO 60 I=1,NON
SEGT(I)=TEMP
OLDT(I)=SEGT(I)
60 CONTINUE
61 IF (NON .NE. 0) GO TO 43
GO TO 999
C THIS IS TO TAKE CARE OF CHANGE CASES
63 READ (2,1) IO,NON,NLIN,NEW
IF (IO .EQ. 0) GO TO 999
IF (IO .EQ. 99999) GO TO 888
CALL ETIME
IF (NEW .EQ. 0) GO TO 64
GO TO 999
C NCC= NUMBER OF CARDS TO BE READ
64 READ (2,1) NCC,NCR
IF (NCC .LE. 0) GO TO 65
DO 70 J=1,NCC
C NEW INPUT DATA
READ (2,1) N,MAT(N)
70 CONTINUE
65 IF (NCR .LE. 0) GO TO 95
DO 71 N=1,NCR
C NEW INPUT DATA
READ (2,14) I,TC(2-I-1),TC(2-I),HEAT(I)
71 CONTINUE
66 GO TO 95
43 READ (2,3) (SINK(I),I=1,6)
READ (2,4) (MAT(I),I=1,NON)
READ (2,5) TC
READ (2,21) (HEAT(I),I=1,12)
READ (2,3) CERROR,TERROR
READ (2,1) NIT
READ (2,2) ACF
CERROR=CERROR*(1.0-CERROR/CERROR)+1.0E+30
44 CONTINUE
READ (2,6) N,(C(N),I=1,6)
IF (N .EQ. 1000) GO TO 95
C WHEN N=1000 IT INDICATES END OF DATA SET
GO TO 44
45 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: HOTANK P. 3

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      IF (METHOD .EQ. 3) GO TO 46
      GO TO 90
46  READ (2,14) (TMAT(I),I=1,17)
      SETTING OF TEMPERATURES BY MATERIAL TYPE
      DO 80 N=1,NON
      MT=TMAT(N)
      GO TO 131,33,35,39,36,47,39,49,41,42,43, MT
81  SEQT(N)=TMAT(1)
      GO TO 80
92  SEQT(N)=TMAT(2)
      GO TO 80
83  SEQT(N)=TMAT(3)
      GO TO 80
84  SEQT(N)=TMAT(4)
      GO TO 80
95  SEQT(N)=TMAT(5)
      GO TO 80
86  SEQT(N)=TMAT(6)
      GO TO 80
97  SEQT(N)=TMAT(7)
      GO TO 80
88  SEQT(N)=TMAT(8)
      GO TO 80
89  SEQT(N)=TMAT(9)
      GO TO 80
91  SEQT(N)=TMAT(10)
      GO TO 80
92  SEQT(N)=TMAT(11)
      GO TO 80
93  SEQT(N)=TMAT(12)
80  CONTINUE
90  CONTINUE
      CALL DATAIN
      SUBROUTINE DATAIN WILL CALCULATE THE NODE DIMENSIONS,FACE AREAS,
      VOLUMES,AND ADJACENT NODE NUMBERS FOR THE SYSTEM
C
C
C
      CONTINUE
95  HG=0.0
      CALL ETIME
      NLIM=NLIM*(1-NLIM/NLIM)+500
      NTIME=XLFTIM*2.0
      DO 100 N=1,NON
      CALCULATION OF HEAT FLOW (BTU/HR)
      MO=MT(N)
96  Q(N)=VOL(N)*HEAT(MO)
97  HG=HG+Q(N)
100  CONTINUE
      DO 110 N=1,NON
      MESS=1
      DO 120 I=1,6
      IF (ADJ(N,I)) 122,121,122
121  U(N,I)=0.0
      GO TO 141
122  K=MT(N)
      IF ((TC(2*I-1)+TC(2*K))*(SEQT(N)-460.0)) 123,999,123
C
C
C
      CHECKING TO SEE IF THERE IS A THERMAL CONDUCTIVITY VALUE
      FOR NODE (N)
123  R=X(N,I)/(12.0*(TC(2*K-1)+TC(2*K))*(SEQT(N)-460.0))
      IF (ADJ(N,I)) 124,121,125
125  L=ADJ(N,I)
      KA=MT(L)
      IF ((TC(2*KA-1)+TC(2*KA))*(SEQT(N)-460.0)) .GT. 0.0) GO TO 126
      GO TO 999
126  GO TO (131,132,133,134), MESS
C
C
C
      CALCULATING THE CONDUCTANCE ACROSS EACH FACE I R ORIGINALLY
      HAS THE UNITS OF HR-FT**2-DEG F/BTU, THEN FINALLY
      THE RECIPROCAL OF THIS, BTU/HR-FT**2-DEG F.
C
C
C
1 1  R=R*X(L,2)/(12.0*(TC(2*KA-1)+TC(2*KA))*(SEQT(L)-460.0))
      GO TO 130
132  R=R*X(L,1)/(12.0*(TC(2*KA-1)+TC(2*KA))*(SEQT(L)-460.0))
      GO TO 130
133  R=R*X(L,4)/(12.0*(TC(2*KA-1)+TC(2*KA))*(SEQT(L)-460.0))
      GO TO 130
134  R=R*X(L,2)/(12.0*(TC(2*KA-1)+TC(2*KA))*(SEQT(L)-460.0))
130  CONTINUE
124  IF (C(N,2)) .LT. 1.0E-4) GO TO 135
      GO TO 136
135  IF (R) 137,138,137
138  Q=1.0E-30
137  R=1.0/R
      GO TO 139
136  R=1.0/(P*1.0/455(C(N,1)))
139  U(N,I)=P*(A(N,I)/144.0)
C
C
C
      U HAS THE UNITS OF BTU/HR-DEG F
141  MESS=MESS+1
120  CONTINUE
110  CONTINUE
      IF (NIT .NE. 0) GO TO 142
      NIT=5
C
C
C
      NIT = NUMBER OF ITERATIONS BEFORE GOING TO THE NEXT STEP
      START OF THE ACTUAL TEMPERATURE CALCULATIONS (ITERATIVE TYPE)
142  DO 150 K=1,NIT
      DO 150 N=1,NON

```


LISTING AND SUBROUTINE COMPILATION: HOTANK P. 4

```

C      SEQT = SEQUENTIAL TEMPERATURE
C      OLOT = OLD TEMPERATURE
151 D(1)=SEQT(1)-OLOT(1)
      OLOT(1)=SEQT(1)
      TOP=0.0
      BOTTOM=0.0
      HOLD=0.0
      DO 160 I=1,6
        L=ADJIN(I)
        IF (L) 161,163,163
161 MO=-1*L
162 TOP=TOP+(460.0+SINK(MO))*UIN(I)
      GO TO 160
163 TOP=TOP+SEQT(L)*UIN(I)
160 BOTTOM=BOTTOM+UIN(I)
      IF (BOTTOM.GT. 0.0) GO TO 164
      BOTTOM=1.0E-04
164 SEQT(N)=(D(1)+TOP)/BOTTOM
150 CONTINUE
C      START OF THE HEAT BALANCE CALCULATIONS
C      ERROR = ALGEBRAIC SUM OF THE HEAT FLOW FROM EACH NODE + THE
C      HEAT GENERATED IN THE NODE
C      ALL = ABSOLUTE SUM OF THE HEAT FLOW BETWEEN THE SYSTEM AND
C      THE SINKS
C      FLAME = BTU INTERCHANGE BETWEEN FACES OR BETWEEN A FACE AND
C      A SINK
C      DELTA = ALGEBRAIC SUM OF THE HEAT FLOW + THE HEAT GENERATED,
C      OVER ALL THE NODES
C      BTU = SUM OF THE HEAT FLOW ACROSS ALL THE NODES
C      THF = ALGEBRAIC SUM OF THE HEAT FLUX OVER ALL THE NODE FACES
C      HS=SUM OF THE HEAT TO THE SINKS
      ERROR=0.0
      ALL=0.0
      DELTA=0.0
      BTU=0.0
      THF=0.0
      HS=0.0
      DO 170 N=1,NON
        ERROR=ERROR+Q(N)
        ALL=ALL+Q(N)
        DELTA=DELTA+Q(N)
        DO 170 I=1,6
          K=ADJIN(I)
          IF (K) 171,170,170
171 MO=-1*K
          FLAME=UIN(I)*(SEQT(N)-(460.0+SINK(MO)))
          ERROR=ERROR-FLAME
          DELTA=DELTA-FLAME
172 THF=THF+FLAME
          HS=HS+FLAME
          ALL=ALL+ABS(FLAME)
173 BTU=BTU+ABS(FLAME)
          GO TO 170
174 FLAME=UIN(I)*(SEQT(K)-SEQT(N))
          DELTA=DELTA+FLAME
175 THF=THF+FLAME
176 BTU=BTU+0.5*ABS(FLAME)
170 CONTINUE
      ALL=0.5*ALL
      IF (MG.LE.0.0) GO TO 771
      IF (ABS((MG-HS)/MG).GT. 100 .LE. ABS(TERROR)) GO TO 191
      GO TO 177
C      CHECKING THE ELAPSED TIME
771 DO 770 J=1,NON
      TO = ABS((SEQT(J)-OLOT(J))/OLOT(J))
      IF (TO.GT.TERROR) GO TO 177
770 CONTINUE
177 CALL STIMEF(XLFTIM)
      NTIME=XLFTIM+2.0
      IF ((NTIME/120-NLIM).GT. 0) GO TO 191
      DO 180 N=1,NON
C      THIS IS THE EXTRAPOLATION SECTION OF THE PROGRAM (FOR
C      TEMPERATURE ADJUSTMENTS)
        HOLD=SEQT(N)
        DIFF=(SEQT(N)-OLOT(N))
        FACS=SIGN(1.0,DIFF)
        CH=ACF*SEQT(N)+ABS((MG-HS)/MG)
C      CH=CHANGE
C      ACF = ACCELERATION FACTOR
        IF (25.0>CH) 181,183,182
182 IF (25.0>CH) 184,183,183
181 CH=-25.0
        GO TO 185
183 CH=CH
        GO TO 185
184 CH=+25.0
185 IF ((SEQT(N)-OLOT(N))/C(N)) 187,187,186
186 IF ((SEQT(N)-OLOT(N))/C(N)-0.85) 189,189,188
188 SEQT(N)=(SEQT(N)+(SEQT(N)-OLOT(N))*ACF)+(CH*FACS)
        GO TO 180
189 SEQT(N)=(SEQT(N)-(SEQT(N)-OLOT(N))/(1.0-(D(N)/(SEQT(N)-OLOT(N)))))*
        1+(CH*FACS)
187 OLOT(N)=HOLD
180 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: HOTANK P. 5

```

      GO TO 192
191 DO 190 I=1,NCN
      DO 190 J=1,6
      K=ADJ(I,I)
      IF (K.CE. 0) GO TO 190
      MO=-1*K
      C THERM = THE HEAT FLOW FROM A NODE TO A SINK
192 THERM(I,I)=UCL(I)*(SEGT(I)-(460.0+SINK(MO)))
190 CONTINUE
      Z=-460.0
      DO 200 I=1,NCN
      SEGT(I)=SEGT(I)-460.0
      IF (SEGT(I)-Z) 100,200,193
193 Z=SEGT(I)
      C PICKING OUT THE NODE WITH THE MAXIMUM TEMPERATURE
      IZ=I
200 CONTINUE
      DO 210 K=1,6
210 SINK(K)=0.0
      DO 220 N=1,NCN
      DO 220 J=1,6
      IF (ADJ(N,I)) 211,220,220
211 L=-1*ADJ(N,I)
      C SINK = THE SUM OF THE HEAT FLOW TO A SINK
      SINK(L)=SINK(L)+THERM(N,I)
220 CONTINUE
      C ERRIS = HEAT BALANCE ERROR IN PERCENT. ((HEAT GENERATED-HEAT TO
      C THE SINKS)/HEAT GENERATED)*100
      EPRIS=((HG-HS)/HS)*100
      NSK=3
      C IF (FIX(SINK(4)+SINK(5)+SINK(6)) .GT. 0) NSK=6
      C SETTING UP THE PRINTOUT INSTRUCTIONS
      WRITE(3,8) ID,EPRIS,Z,IZ,(SINK(I),I=1,NSK)
      DO 240 J=1,6
      IF (SINK(J)) 241,240,241
241 WRITE(3,9) J
      K=1
      DO 230 N=1,NCN
      DO 230 I=1,6
      IF (ADJ(N,I)+J) 230,231,230
231 GO TO (232,233,234), K
232 WRITE(3,10) THERM(N,I),N
      K=2
      GO TO 230
233 WRITE(3,11) THERM(N,I),N
      K=3
      GO TO 230
234 WRITE(3,12) THERM(N,I),N
      K=1
230 CONTINUE
240 CONTINUE
      WRITE(3,13)
      WRITE(3,17)
      NN=1
      DO 300 J=1,92
242 NNN=NN+9
      WRITE(3,15) NN,(SEGT(I),I=NN,NNN)
      NN=NN+19
300 CONTINUE
      MM=11
      DO 330 K=1,92
      MMM=MM+3
      WRITE(3,16) MM,(SEGT(I),I=MM,MMM)
      MM=MM+19
330 CONTINUE
244 WRITE(3,16) ID,ERROR,ALL,DELTA,BTU,THF
      CALL DATBL
      DO 245 I=1,NCN
      SEGT(I)=SEGT(I)+460.0
245 CONTINUE
      WRITE(3,20) XLFTIM
      GO TO 63
999 WRITE(3,19)
998 CALL EXIT
      END

```

B ELT DATABL/S2F5.1.710320. 72572

B EOF a

 SUBROUTINE DATBL

C THIS SUBROUTINE PROVIDES A PRINTOUT OF PRESELECTED INPUT DATA

 DIMENSION X(750,6),A(750,6),U(750,6),C(750,6),THERM(750,6),

 1ADJ(750,6),Q(750),D(750),VCL(750),FRET(750),SEGT(750),

 ZOLDT(750),MAT(750),SINK(750),TC(24),HEAT(24),SINK(6)

 COMMON X,C,E,Q,U,A,J,K,L,N,Z,P,S,IO,IZ,MO,TC,KA,BTU,ALL,ADJ,I,

 1MAT,NN,VCL,HEAT,SEGT,ZOLDT,FRET,SINK,NLIM,TEMP,THERM,SINK2,

 ZDELTA,NTIME,CEPROP,TEPROP,ANGLE

LISTING AND SUBROUTINE COMPILATION: HOTANK P. 6

```

1 FORMAT (1H0,7X,1A40... SUMMARY OF INPUT DATA FOR CASE NO.15,4H ..)
1.722X,23H THERMAL CONDUCTIVITIES,10X,17H MAX TEMPERATURES,10X,4H NO
2 LUMETRIC HEAT-GEN RATE (BTU/HR CU FT) 1.67,3.772X,22H BTU/HR SQ FT
3 DEG F/11,10X,18H CEEFEE FAHNHEIT,9X,4H TOTAL HEAT LOAD IN TANK
4 (BTU/HR) 1.0E12,7.772X,11H MATERIAL 1 FPR,4.15X,7H SINK 1
5 7.2,17X,23H CLUDE OF CANK THICKNESS (FEET) 2ZX,11H MATERIAL 1 FR
6 6X/2X,11H MATERIAL 3 FR,4.15X,7H SINK 2 67.3,12X,13H OIL COVER DEPTH
7 (FEET) 2ZX,11H MATERIAL 4 FR,4/2X,11H MATERIAL 5 FR,4.41X,
8 833H LIQUID LAYER DEPTH (FEET) 2ZX,11H MATERIAL 6 FR,9.772X,11
9 H MATERIAL TYPE,17X,17H FILM COEFFICIENTS,17X,33H TANK DIAMETER
A (FEET) 2/27X,19H BTU/HR SQ FT DEG F/13X,1H1,6X,13H TANK HEIGHT
BT (FEET) 2/2X,142.24X,4H NODE,10X,1H H/3X,1H 1/7X,1H 4/7X
C,1H5/3X,1H6/1)
BTU=0.0
DO 11 I=1,NOM
BTU=BTU+Q(I)
11 CONTINUE
BTU=BTU*.360.C/ANGLE
S=HEAT(1)*.179
WRITE(3,1) I,S,BTU,TC(1),SINK(1),TC(3),TC(5),SINK(2),TC(7),
1TC(9),TC(11)
RETURN
END

```

Q FLY DATAIN/S2F5.1.710370. 72°74
Q EOF Q

```

SUBROUTINE TADTAN
PROVIDES INPUT DATA FOR HEAT TRANSFER PROGRAM ** HOTANK **
TWO DIMENSIONAL STEADY-STATE HEAT TRANSFER IN CYLINDRICAL COOR-
DINATES
SINGLE NODE THICKNESS MODEL CONCENTRIC CYLINDERS
CALCULATES ADJACENT NODE NUMBER, DISTANCE FROM CENTROID TO NODE
FACE (PROPORTIONAL TO THE LOG MEAN AREA), FACE AREA, AND VOLUMES
FOR INDIVIDUAL NODES, WITH A WEDGE SHAPED (CENTER TO CIRCUMFERENCE)
GRID
NECESSARY INPUT DATA FOR EACH CASE
  NUMBER OF CONCENTRIC CYLINDERS OR HORIZONTAL COLUMNS (LEFT TO
  RIGHT)
  NUMBER OF AXIAL LAYERS OR VERTICAL ROWS (TOP TO BOTTOM)
  1 IF NUMBERED VERTICALLY (TOP TO BOTTOM), (N+1), 0 IF NUMBER-
  ED HORIZONTALLY (LEFT TO RIGHT), (N+1)
  ANGLE OF THE WEDGE IN DEGREES (NOT 0, MAX. 90)
  NEGATIVE SINK NUMBER AT LEFT (AXIS), RIGHT (CIRCUMFERENCE),
  TOP, BOTTOM, FRONT, BACK, OR 0 AT NOFLOW INTERFACES
  FORMAT (3I5,1E10,0.6I5)
  ACTUAL THICKNESS OF EACH CONCENTRIC LAYER, CENTERLINE TO OUTER
  EDGE IN INCHES
  FORMAT (7E10,0)
  THICKNESS OF EACH AXIAL LAYER OR NODE ROW, TOP TO BOTTOM IN
  INCHES
  FORMAT (7E10,0)

  DIMENSION X(750,6),A(750,6),U(750,6),C(750,6),THERM(750,6),
  143J(750,6),Q(750),E(750),VOL(750),FRET(750),SEGT(750),
  2OLDU(750),PAT(750),SINKO(750),TC(24),HEAT(750),SINK(6),
  3RADIUS(750),THICK(750),NXT(16)
  COMMON X,C,E,D,S,U,A,J,K,L,N,Z,R,S,10,12,30,TC,KA,BTU,ALL,ADJ,T,
  1MAT,NON,VOL,HEAT,SEGT,CLDT,FRET,SINK,NLIN,TEMP,THERM,SINKQ,
  2DELTA,NTIME,CEPPOR,TEPRO,ANGLE
  INTEGER WRITE,ADJ

  RADIUS=THICKNESS OF EACH CONCENTRIC LAYER (HORIZONTAL)
  THICK=THICKNESS OF EACH AXIAL LAYER (VERTICAL)
  NEXT =SINK OR NOFLOW INTERFACE LOCATION
  ADJ =ADJACENT NODE NUMBER
  X =DIMENSIONS OF EACH NODE
  A =FACE AREA OF EACH NODE
  VOL =VOLUME OF EACH NODE
1 FORMAT (3I5,1E10,0.6I5)
2 FORMAT (7E10,0)
3 FORMAT (16H1E10,0.6I5)
PI=3.14159
4 READ (2,1) NC,NR,NC,ANGLE,(NXT(1:16), 7=1,16)
  NC =NUMBER OF COLUMNS (LEFT TO RIGHT)
  NR =NUMBER OF LAYERS (TOP TO BOTTOM)
  NS =NUMBERING SEQUENCE (HORIZONTALLY OR VERTICALLY)
  ANGLE =ANGLE OF WEDGE USED

5 READ (2,2) (RADIUS(I), I=1,NC)
6 READ (2,2) (THICK(I), I=1,NR)
7 IF (ANGLE .GT. 0.6) GO TO 8
  WRITE (3,3)
  CALL EXIT
8 INTC=NC*NC*(1-NS)
  INTR=(1-NS)*NR*NS
  TO START THE PROGRAM AT THE FIRST NODE OF THE FIRST COLUMN AND ROW
  NB=1-INTC
9 DO 20 IR=1,NR
  RO=0.0
  NB=NR+INTC
  N =NB-INTR

```

```

10 DO 20 IC=1,N
   RC=RO+RADIUS(IC)
   NN=INTR
   CALCULATION OF ADJACENT NODE NUMBERS
11 NF=1
   ADJ(N,NF)=(N-1)*(1-NC)+(N-NP)*NS
   ADJ(N,NF+1)=(N-1)*(1-NS)+(N-NR)*NG
   ADJ(N,NF+2)=(N-NC)*(1-S)+(N-1)*ND
   ADJ(N,NF+3)=(N-NC)*(1-NS)+(N-1)*NS
   ADJ(N,NF+4)=NEXT(5)
   ADJ(N,NF+5)=NEXT(6)
12 IF ((IC-1).NE.0) GO TO 13
   ADJ(N,NF)=NEXT(1)
13 IF ((IC-NC).NE.0) GO TO 14
   ADJ(N,NF+1)=NEXT(3)
14 IF ((IR-1).NE.1) GO TO 15
   ADJ(N,NF+2)=NEXT(3)
15 IF ((IR-NP).NE.0) GO TO 16
   ADJ(N,NF+3)=NEXT(4)
16 CONTINUE
   CALCULATION OF NODE DIMENSIONS
17 ND=1
   RC=SQRT(0.5*(RO**2+(RC-RADIUS(IC))**2))
   IF (RC-RADIUS(IC)) 29,19,20
29 X(N,ND)=(2.0*RADIUS(IC)*SIN(ANGLE*0.01745))/13.0*ANGLE*0.01745)
   X(N,ND+1)=FO-X(N,ND)
   GO TO 31
30 X(N,ND)=(RC-RADIUS(IC))*ALOG(RC/(RC-RADIUS(IC)))
   X(N,ND+1)=RO*ALOG(RO/RC)
31 X(N,ND+2)=0.5*THICK(IR)
   X(N,ND+3)=X(N,ND+2)
   X(N,ND+4)=RC*SIN(ANGLE/360.0*PI)
   X(N,ND+5)=X(N,ND+4)
   CONTINUE
   CALCULATION OF FACE AREAS
18 NA=1
   A(N,NA)=(ANGLE/180.0*PI*THICK(IR))*(RO-RADIUS(IC))
   A(N,NA+1)=(ANGLE/180.0*PI*THICK(IR))*RO
   A(N,NA+2)=(ANGLE/360.0*PI*(RO**2-(RO-RADIUS(IC))**2))
   A(N,NA+3)=A(N,NA+2)
   A(N,NA+4)=RADIUS(IC)*THICK(IR)
   A(N,NA+5)=A(N,NA+4)
   CONTINUE
   CALCULATION OF NODE VOLUME
   VOLA=A(N,NA+2)
19 VOL(N)=VOLA*THICK(IR)
20 CONTINUE
   TO PRINTOUT ADJACENT NODE NUMBERS,AREAS,DIMENSIONS,VOLUMES
   READ (10,2) NRITE
   IF (NRITE.EG. 3333) GO TO 21
   GO TO 23
22 FORMAT (1HG,50X,28H TITLE OF PROGRAM IS CATAIN )
23 FORMAT (1HG,10X,7HNODE NO,10X,11HADJ NODE NO,10X,10HDIMENSIONS,10X
   1,8HAREA,10X,6HVOLUME)
24 FORMAT (1H ,10X,15,10X,15,10X,1PE10,2,7X,1E10,2,5X,1E10,2)
25 FORMAT (1HG)
21 WRITE (3,22)
   WRITE (3,23)
   DO 26 N=1,NON
   DO 27 J=1,6
   WRITE (3,24) N,ADJ(N,J),X(N,J),A(N,J),VOL(N)
27 CONTINUE
   WRITE (3,25)
26 CONTINUE
28 RETURN
   END

```

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PROGRAM NAME: INTRST

Descriptive Title: Cash Flow for Projects Under Annually Varying Economic Conditions

Program Author: Hammons, G. L.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 4

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Cash Flow, Economics

Program Description: Estimates cash flows for projects or corporations under annually varying economic conditions. Originally written by G. L. Hammons of CSC for ARHCO. Made available to others in FORTRAN course. Name changed from "IN" by G. Jansen to avoid confusion with CUR commands in CSCX. No subroutines. Requires annual series of data for input, includes escalation, variable payout period, three depreciation methods.

Users of Program: GL Hammons
G Jansen

Documentation: None

Condition of Program: Unknown

SAMPLE INPUT: INTRST

```

INTRST      09:21      02/26/74

100 @S RUN PUN018,CURS2R,GEORGE,150,6000/3000      G JANSEN 3760 RLD
      C 9403576
105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PIN TPI INFO000
115 @PRL TEL INFO000
120 @PRL TEL CURS2R
125 @X ASG A=00231
130 @N XOT CUP
150 FIND A,INTRST/SIF5
155 TPD A
160 TPI A
230 FCH INTRST/SIF5
410 @IM FR5,* INTRST/SIF5,INTRST/SIF5,INTRST/RIF5
1000 @LI XOT INTRST/RIF5
1010 1 TEST INVESTMENT RUN FUP UNIVAC1108
1020 2 111111 3.1 6.3 12.0 18.0196819741997 6.0 15.0 3.00010100
1030 3 1968 555555 222222 121222 333555 123556 12355 98756 35567
1040 3 1969 444444 333333 111333 330044 130056 13005 88756 00567
1050 3 1970 444444 222222 111222 330044 122006 12200 98756 20067
1060 3 1971 555555 222222 121222 333555 123556 12355 88756 35567
1080 3 1972 444444 235334 111234 330044 120056 12005 98756 00567
1090 3 1973 555555 234234 111234 333555 123556 12355 88756 35567
1100 3 1974 444444 234234 111234 330044 120056 12005 98756 00567
1120 3 1976 666666 234234 111234 333666 123666 12366 98766 36667
1130 3 1976 444444 333333 111333 330044 130056 13005 88756 00567
1140 3 1977 444444 234234 111234 330044 120056 12005 98756 00567
1150 3 1978 555555 234234 121234 333555 123556 12355 98756 35567
1160 3 1979 444444 333333 111333 330044 130056 13005 98756 00567
1170 3 1980 444444 234234 111234 330044 122006 12200 88756 20067
1180 3 1981 555555 234234 111234 333555 123556 12355 98756 35567
1190 3 1982 444444 333333 121333 330044 130056 13005 98756 00567
1200 9
1210 9 FIN
READY

```

LISTING AND SUBROUTINE COMPILATION: INTRST P. 1

```

DIM FRS INTRST/CIFFS,INTRST/CIFFS,INTRST/RIFFS
REAL INCAP
REAL ICEFS
REAL ICEFR
DIMENSION ARRAY(101,15)
DIMENSION POF(100)
DIMENSION TDF(15)
DIMENSION NF(15)
DIMENSION NAW(15)
DIMENSION SFR(15)
COMMON ICEFR(100)
COMMON IA(F)
COMMON XINT(5)
COMMON TITLE(12,3)
COMMON IDEFS(100)
COMMON IPRAY(101,15)
EQUIVALENCE (IPRAY,ARRAY)
EQUIVALENCE (I01,IO1)
DATA ELANK/6H /
1 FORMAT(I1)
2 FORMAT(1X,12A6)
3 FORMAT(1X,F41.0FF5.0,779.3FF5.0,7A1)
4 FORMAT(I1,I9)
5 FORMAT(1X,I9,817)
6 FORMAT(1H1,13X,15-- STUDY TITLE - / )
7 FORMAT(1H ,13X,12A6)
8 FORMAT(1H0,11X,20-- STUDY CONDITIONS - / )
9 FORMAT(1H ,16X,25-CASH FLOW DISCOUNTED TO ,I9)
10 FORMAT(1H ,16X,31-FEDERAL INCOME TAX NOT INCLUDED )
11 FORMAT(1H ,16X,27-FEDERAL INCOME TAX INCLUDED )
12 FORMAT(1H ,16X,27-INCOME TAX SCHEDULE READ IN )
13 FORMAT(1H ,16X,29-INCOME TAX LOSSES WRITTEN OFF )
14 FORMAT(1H ,16X,24-5T PAIGHT LINE DEFR. USED )
15 FORMAT(1H ,16X,34-SUM OF THE YEARS DIGITS DEPR. USED )
16 FORMAT(1H0,10X,22-- SUMMARY OF RESULTS - )
17 FORMAT(1H0,13X,41-CASH FLOW ANALYSIS - THOUSANDS OF DOLLARS / )
18 FORMAT(1H ,55X,13-INTEREST RATE )
19 FORMAT(1H ,15X,5F10.1)
20 FORMAT(1H ,10X,5(1X,7HPERCENT)/)
21 FORMAT(1H ,13X,26-NET PRESENT WORTH ,5(1X,16))
22 FORMAT(1H ,13X,25-NET ANNUAL WORTH ,5(1X,15))
23 FORMAT(1H ,13X,26-PAYOUT PERIOD,YEARS ,5(5X,F5.1))
24 FORMAT(1H ,13X,26-RATE OF RETURN,PERCENT )
25 FORMAT(1H ,16X,24-INTERVAL ,5(1X,F7.2))
26 FORMAT(1H ,16X,24-5 SINKING FUND ,5(1X,F7.2))
27 FORMAT(1H ,16X,24-5N CASH OUTSTANDING ,5(1X,F7.2))
28 FORMAT(1H ,10X,54-INCOME,2X,74-FEDERAL,1X,64-INCOME,4X,3HNET,5X,3HNET
1.1X,4HCASH,2X,9HFLOW,1X,10HDISCOUNTED,1X,2HAT)
29 FORMAT(1H ,7X,7HINCOME,1X,7HCAPITAL,1X,7HWORKING,2X,6HTOTAL,2X,
16HBEFORE,2X,6HINCOME,2X,5HAFTER,2X,4HCASH,4F8.1)
30 FORMAT(1H ,1X,4HYEAR,2X,7H(SALES),2X,5H(COSTS),2X,7H(CAPITAL),1X,7H(EXP
ENSE),2X,5H TAX ,4,3HTAX,5X,3HTAX,4X,6H FLOW ,418H PERCENT)/)
31 FORMAT(1H ,15,12I3)
32 FORMAT(1H0,5HTOTAL,12I8)
33 FORMAT(1H ,36X,21-INVESTMENT CREDIT OF ,F4.1,10H PERCENT )
34 FORMAT(1H0,33X,41HCASH FLOW ANALYSIS - DOLLARS / )
35 FORMAT(1H0,33X,41HCASH FLOW ANALYSIS - TENS OF DOLLARS / )
36 FORMAT(1H0,33X,41HCASH FLOW ANALYSIS - HUNDREDS OF DOLLARS / )
37 FORMAT(1H ,36X,15-5URTAX RATE OF ,F4.1,104 PERCENT )
38 FORMAT(1H ,36X,35-5CHEDULE DECLINING BALANCE DEFR. USED)
39 FORMAT(1H ,36X,27-FEDERAL INCOME TAX RATE OF ,F4.1,10H PERCENT )
C
C PROGRAM WILL READ DATA DECK UNTIL OUT OF CARDS. WHEN IT FINDS
C AN EOF MARK IT WILL DIRECT ITSELF TO STATEMENT 9000
C TO EXIT PROGRAM.
C
C CALL SETEOF(49000)
C L=1
C
C DESIGNATING LOGICAL TAPE UNITS
C INPUT=5
C NFUT=5
C BUFFERING=4
C IUNIT=4
C OUTPUT=6
C IOI = 6
C
C 49 CONTINUE
C INITIALIZE PARAMETERS AND VARIABLES
N = 0
FIRR1 = 0
INFW = 0
INAW = 0
IPOP = 0
IIRR = 0
ISF = 0
IRONC = 0
ISTLM = 0
ISOYS = 0
IDCB = 0
IIOUC = 0
IIOO = 0
IIO = 0
II = 0
DO471=1,5

```


LISTING AND SUBROUTINE COMPILATION: INSTR P. 2

```

FOFI(1) = 0
NFNI(1) = 0
NAFNI(1) = 0
SFOR(1) = 0
RONC(1) = 0
47 CONTINUE
C
C SET ALL ELEMENTS IN COMMON STORAGE TO ZERO
DO 48 I=1,1754
  IDEPS(I) = 0.
48 CONTINUE
C
C READ DATA CARD INTO BUFFER AND TEST TO DETERMINE
C WHAT SORT OF DATA THE CARD CONTAINS.
C I=1, TITLE CARD
C I=2, PARAMETER CARD
C I=3, CASH FLOW DATA
C I=9, LAST CARD IN CASE
C
50 READ(UNIT,1)Z
  IF(Z.EQ.9)IF=9
  GO TO(200,210,400,400),I
200 CONTINUE
  N=4+1
  READ(UNIT,2)(TITLE(J,N),J=1,12)
  GO TO 50
210 CONTINUE
  READ(UNIT,3)IAPL,ANNU,ACCR,ATPR,ASF,ARDHCO,(XINTI,102,5),IYRST,
  IYPRZO,ILIFE,TPAT,TPRT,IRATE,ASTLN,ASOYD,ADDB,A1,A1U,A1UUA,A1UUD
  JVF1 = IYPRZO
C
C SHOULD NET PRESENT WORTH BE CALCULATED
  IF(IAPL.NE.BLANK)IFN = 1
C
C SHOULD NET ANNUAL WORTH BE CALCULATED
  IF(ANNU.NE.BLANK)IFNA = 1
C
C SHOULD PAYOUT PERIOD BE CALCULATED
  IF(ATPR.NE.BLANK)IFP = 1
C
C SHOULD INTERNAL RATE OF RETURN BE CALCULATED
  IF(ATPR.NE.BLANK)IFR = 1
C
C SHOULD SINKING FUND RATE OF RETURN BE CALCULATED
  IF(ASF.NE.BLANK)ISF = 1
C
C SHOULD RETURN ON NET CASH OUTSTANDING BE CALCULATED
  IF(ARDHCO.NE.BLANK)IRONCO = 1
C
C SHOULD STRAIGHT LINE DEPRECIATION BE USED
  IF(ASTLN.NE.BLANK)ISLN = 1
C
C SHOULD SUM OF THE YEARS DIGITS DEPRECIATION BE USED
  IF(ASOYD.NE.BLANK)ISYD = 1
C
C SHOULD DOUBLE DECLINING BALANCE DEPRECIATION BE USED
  IF(ADDB.NE.BLANK)IDDB = 1
C
C IF THE FIRST YEAR OF THE PROJECT IS NOT SPECIFIED
C THEN USE 1968 AS THE FIRST YEAR
C
  IF(IYRST.EQ.0)IYRST = 1968
C
C ARE FIGURES IN THOUSANDS OF DOLLARS
  IF(A1000.NE.BLANK)I1000 = 1
C
C ARE FIGURES IN HUNDREDS OF DOLLARS
  IF(A100.NE.BLANK)I100 = 1
C
C ARE FIGURES IN TENS OF DOLLARS
  IF(A10.NE.BLANK)I10 = 1
C
C ARE FIGURES IN DOLLARS
  IF(A1.NE.BLANK)I1 = 1
C
C ESTABLISH THE INTEGER NUMBER OF THE YEAR TO WHICH
C CASH FLOWS WILL BE DISCOUNTED
C
  IYPRZO = IYRST - IYRST + 1
C
C IF NO LAST YEAR IS SPECIFIED THE PROJECT
C WILL BE SET AT A 25 YEAR LIFE
C
  IF(ILIFE.EQ.0)ILIFE = IYRST + 25
C
C ESTABLISH THE INTEGER NUMBER OF THE LAST YEAR OF THE PROJECT
  ILIFE = ILIFE - IYRST + 1
  GO TO 50
C
C READ CASH FLOW DATA
C
300 CONTINUE
  READ(UNIT,5)Y,(CASH),L=1,8)
  IF(K.LT.IYPRZO)GO TO 40
  L = IYRST + ILIFE - 1
  IF(K.GT.L)GO TO 50
  K = K - IYRST + 1
C
C SAVE TAX FROM SCHEDULE IN IDEPS(YEAR)
  IDEPS(K) = IAPL
  DO 350 L=1,8
    IOPAY(K,L) = CASH
  350 CONTINUE
C
C IOPAY(1,1) = SALDO
C IOPAY(1,2) = CAPITAL COSTS
C IOPAY(1,3) = WORKING CAPITAL
C IOPAY(1,4) = TOTAL EXPENSES
C IOPAY(1,5) = INCOME BEFORE TAX
C IOPAY(1,6) = INCOME TAX
C IOPAY(1,7) = INCOME AFTER TAX

```

LISTING AND SUBROUTINE COMPILATION: INTRST P. 3

```

C      IRRAY(I,4) = NET CASH FLOW
C      IRRAY(I,9) = NET CASH FLOW AT 1ST INTEREST RATE
C      IRRAY(I,10) = NET CASH FLOW AT 2ND INTEREST RATE
C      IRRAY(I,11) = NET CASH FLOW AT 3RD INTEREST RATE
C      IRRAY(I,12) = NET CASH FLOW AT 4TH INTEREST RATE
C
C      GO TO 50
400 CONTINUE
      DO 301 I=1,N
        IF(IN.OF.I)GO TO 301
        DO 302 J=1,12
          TITLE(J,I) = PLANK
        302 CONTINUE
      301 CONTINUE
C
C      RECOVER WORKING CAPITAL IN LAST YEAR
C
      LLIFE=ILIFE-1
      DO 431 I=1,LLIFE
        IRRAY(ILIFE,I)=IRRAY(ILIFE,I)-IRRAY(I,I)
      431 CONTINUE
C
C      IF NO INCOME BEFORE TAX IS FURNISHED THEN INCOME BEFORE
C      TAX EQUALS SALES LESS TOTAL EXPENSES
C
      DO 430 I=1,ILIFE
        IF(IRRAY(I,5).EQ.0)IRRAY(I,5) = IRRAY(I,1) - IRRAY(I,4)
      430 CONTINUE
C
C      TO CALCULATE OR NOT TO CALCULATE TAX IS THE QUESTION
C      IF NO TAX RATE IS SPECIFIED THEN SKIP ALL
C      TAX AND DEPRECIATION CALCULATIONS
C
      IF(1TRATE.LE.0) GO TO 410
C
C      FIND FIRST YEAR OF SALES
C
      K=0
      451 CONTINUE
      K = K + 1
      IF(IRRAY(K,1).LE.0)GO TO 451
C
C      SET UP TAXABLE INCOME BEFORE FIRST SALES
C
      K = FIRST YEAR OF SALES
C
      KK = K - 1
      DO 452 I=1,KK
        IDEFS(I) = IRRAY(I,5)
      452 CONTINUE
C
C      INCAP IS INITIAL CAPITAL
C      INITIAL CAPITAL IS ALL CAPITAL SPENT BEFORE FIRST YEAR OF SALES
C
      SUM INITIAL CAPITAL
C
      INCAP= 0
      DO 453 I=1,K
        INCAP= INCAP+ IRRAY(I,2)
      453 CONTINUE
C
C      WHICH DEPRECIATION SCHEME SHALL WE USE
C
      IF(1STLN.NE.1)GO TO 401
C
C      CALCULATE STRAIGHT LINE DEPRECIATION
C
      DEPRECIATE INITIAL CAPITAL FIRST
C
      BOT IS THE NUMBER OF YEARS OVER WHICH INITIAL
      CAPITAL WILL BE DEPRECIATED
C
      BOT= ILIFE-K+1
      DO 454 I=K,ILIFE
C
C      ANNUAL TAXABLE INCOME EQUALS INCOME BEFORE TAX LESS
C      DEPRECIATION CHARGES FOR INITIAL CAPITAL
C
      IDEFS(I)= IRRAY(I,5)- INCAP/ BOT
      454 CONTINUE
C
C      DEPRECIATE ALL SUSEQUENT CAPITAL
C
      K=K+1
      DO 456 L=K,ILIFE
C
C      NOW BOT IS THE NUMBER OF YEARS OVER WHICH CAPITAL PURCHASED
C      AFTER THE FIRST YEAR OF SALES WILL BE DEPRECIATED
C
      BOT=ILIFE-L+1
      DO 455 I=L,ILIFE
C
C      THE NEW ANNUAL TAXABLE INCOME EQUALS INCOME AFTER
C      ALL DEPRECIATION CHARGES

```

LISTING AND SUBROUTINE COMPILATION: INTRST. P. 4

```

C      IDEFS(1) = IDEFS(1) - IRPAY(1.2) / POT
455 CONTINUE
456 CONTINUE
C
C      TAXABLE INCOME AFTER DEPRECIATION HAS BEEN CALCULATED ON A
C      STRAIGHT LINE BASIS. SKIP TO TAX CALCULATION.
C
C      GO TO 409
C
C      CALCULATE SUM OF DIGITS DEPRECIATION
C
C      CALCULATE SUM OF DIGITS FOR EACH YEAR
C
401 CONTINUE
IF (ISODS.NE.1) GO TO 408
DO 402 I=1,ILIFE
  IDEFS(I) = I
402 CONTINUE
C      DETERMINE THE DENOMINATOR FOR DEPRECIATION FACTORS
DO 404 I=1,ILIFE
  DO 403 L=1,ILIFE
    IDEFS(I) = IDEFS(I) + ILIFE + 1 - L
403 CONTINUE
404 CONTINUE
C      DEPRECIATE INITIAL CAPITAL FIRST
DO 405 I=1,ILIFE
  C      ESTABLISH THE NUMERATOR FOR DEPRECIATION FACTOR
  TOF = ILIFE - I + 1
C
C      SUBTRACT INITIAL CAPITAL DEPRECIATION CHARGES
C      FROM INCOME BEFORE TAXES
C
  IDEFS(I) = IRPAY(I.5) - INCAP + TOF / IDEFS(I)
405 CONTINUE
C
C      DEPRECIATE ALL SUBSEQUENT CAPITAL
C
C      FIND NEXT YEAR AFTER THE FIRST YEAR OF SALES
  K=K+1
DO 407 L=K,ILIFE
  DO 406 I=L,ILIFE
    C      ESTABLISH NUMERATOR FOR DEPRECIATION FACTOR
    TOF = ILIFE - I + 1
    C      TAXABLE INCOME EQUALS INCOME AFTER ALL DEPRECIATION CHARGES
    IDEFS(I) = IDEFS(I) - IRPAY(I.2) * TOF / IDEFS(I)
406 CONTINUE
407 CONTINUE
C
C      TAXABLE INCOME AFTER DEPRECIATION HAS BEEN CALCULATED BY THE SUM
C      OF THE YEARS DIGITS METHOD. SKIP TO TAX CALCULATION.
C
C      GO TO 409
408 CONTINUE
IF (ISODS.NE.1) GO TO 409
C
C      CALCULATE DOUBLE DECLINING BALANCE
C
C      WITH THE DOUBLE DECLINING BALANCE METHOD, CAPITAL WILL BE
C      DEPRECIATED AT TWICE THE STRAIGHT LINE RATE FOR THE FIRST HALF
C      OF THE LIFE. THE REMAINING BOOK VALUE WILL THEN BE DEPRECIATED
C      ON A STRAIGHT LINE BASIS OVER THE SECOND HALF OF THE LIFE.
C
C      DEPRECIATE INITIAL CAPITAL FIRST
C
C      FIND THE LIFE OF THE INITIAL CAPITAL
  BOT = ILIFE - K + 1
  IBOT = BOT + 1
C      FIND THE DOUBLE DECLINING RATE FOR THE FIRST HALF OF THE LIFE
  BOT = 2 / BOT
C      FIND THE HALFWAY POINT OF PROJECT LIFE IN YEARS
  IBOT = IBOT / 2
C      ESTABLISH THE SPECIFIC YEAR WHICH IS HALF THE LIFE
  IBOT = IBOT + K - 1
C
C      NOW DEPRECIATE THE INITIAL CAPITAL OVER
C      THE FIRST HALF OF THE LIFE
C
  DO 630 I=K,IBOT
    C      TAXABLE INCOME EQUALS INCOME BEFORE TAX LESS DEPRECIATION
    IDEFS(I) = IRPAY(I.5) - INCAP + BOT
    C      FIND NEW BOOK VALUE OF INCAP
    INCAP = INCAP - INCAP * BOT
  630 CONTINUE
  C      FIND NUMBER OF YEARS IN SECOND HALF OF LIFE
  KBOT = IBOT + 1
  COT = ILIFE - KBOT + 1
C      ESTABLISH THE STRAIGHT LINE RATE FOR THE REMAINING YEARS
  COT = 1 / COT
C      NOW DEPRECIATE FOR THE SECOND HALF OF LIFE
  DO 631 I=KBOT,ILIFE
    C      TAXABLE INCOME EQUALS INCOME BEFORE TAX LESS DEPRECIATION
    IDEFS(I) = IRPAY(I.5) - INCAP + COT
  631 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: INTRST P. 5

```

C   DEPRECIATE SUBSEQUENT CAPITAL
C   K = K + 1
C   DO 631 J=1,ILIFE
C
C   INCAF NOW BECOMES CAPITAL EXPENDITURES IN THE
C   SUBSEQUENT INDIVIDUAL YEARS
C
C   INCAF = TRRAY(J,2)
C   IF NO CAPITAL IS SPENT GO TO THE NEXT YEAR
C   IF INCAF.EQ.0 GO TO 631
C   FIND THE LIFE OF THIS CAPITAL
C   BOT = ILIFE - J + 1
C   FIND THE HALFWAY POINT OF PROJECT LIFE IN YEARS
C   IBOT = (BOT + 1) / 2
C   ESTABLISH THE SPECIFIC YEAR WHICH IS HALF THE LIFE
C   IBOT = IBOT + J - 1
C   FIND THE DOUBLE DECLINING RATE FOR THE FIRST HALF LIFE
C   BOT = 2 / BOT
C   FIND THE NUMBER OF YEARS IN THE SECOND HALF OF LIFE
C   KBOT = IBOT + 1
C   COT = ILIFE - KBOT + 1
C   ESTABLISH THE STRAIGHT LINE RATE FOR THE REMAINING YEARS
C   COT = 1 / COT
C   DEPRECIATE CAPITAL FOR THE FIRST HALF OF THE LIFE
C   DO 632 J=1,IBOT
C   TAXABLE INCOME IS INCOME BEFORE TAX LESS ALL DEPRECIATION CHARGES
C   IDEFS(I) = IDEFS(I) - INCAF * BOT
C   FIND NEW BOOK VALUE OF CAPITAL
C   INCAF = INCAF - INCAF * BOT
C 633 CONTINUE
C   DEPRECIATE CAPITAL FOR SECOND HALF OF LIFE
C   DO 632 J=KBOT,ILIFE
C   TAXABLE INCOME IS INCOME BEFORE TAX LESS ALL DEPRECIATION CHARGES
C   IDEFS(I) = IDEFS(I) - INCAF * COT
C 634 CONTINUE
C 632 CONTINUE
C
C   TAXABLE INCOME HAS BEEN CALCULATED BY THE DOUBLE
C   DECLINING BALANCE METHOD. GO ON TO TAX CALCULATION
C
C 409 CONTINUE
C   DO 411 I=1,ILIFE
C
C   WE HAVE FINALLY ARRIVED AT THE TAX CALCULATION
C   AND IDEFS IS TAXABLE INCOME
C
C   TAX PAYMENT EQUALS INCOME BEFORE TAXES AND AFTER
C   DEPRECIATION TIMES THE TAX RATE
C
C   IDEFS(I) = IDEFS(I) * (TRATE / 100)
C 411 CONTINUE
C 410 CONTINUE
C 412 CONTINUE
C   DO 450 I=1,ILIFE
C
C   IF THERE IS AN INVESTMENT CREDIT, THE TAX PAYMENT IS
C   REDUCED BY THE AMOUNT OF THE INVESTMENT CREDIT
C
C   IF (CORT.GT.0) IDEFS(I) = IDEFS(I) - TRRAY(I,2) * (CORT/100)
C
C   IF THERE IS A SURTAX, THE TAX PAYMENT IS INCREASED
C   BY THE AMOUNT OF THE SURTAX
C
C   IF (SPATE.GT.0) IDEFS(I) = IDEFS(I) * (1+SRATE/100)
C   SET UP TAX PAYMENT
C   IRRAY(I,6) = IDEFS(I) * .5
C
C   INCOME AFTER TAX EQUALS INCOME BEFORE TAX LESS TAX PAYMENT
C
C   IF (TRAY(I,7).EQ.0) IRRAY(I,7) = IRRAY(I,5) - IRRAY(I,6)
C
C   NET CASH FLOW EQUALS INCOME AFTER TAX LESS CAPITAL
C   COSTS LESS WORKING CAPITAL
C
C   IF (IPRAY(I,8).EQ.0) IPRAY(I,8) = IRRAY(I,7) - IRRAY(I,2) - IPRAY(I,3)
C 449 CONTINUE
C   DO 450 I=1,8
C   DO 450 J=1,ILIFE
C
C   SUM ALL THE INPUT COLUMNS
C
C   IPRAY(101,I) = IRRAY(101,I) + IPRAY(J,I)
C 450 CONTINUE
C
C   ALL INPUT ARRAYS ARE NOW IN PLACE.
C
C 501 CONTINUE
C 505 CONTINUE
C 506 CONTINUE
C
C   START CALCULATIONS
C
C 1000 CONTINUE
C
C   CALCULATE NET PRESENT WORTH
C
C   DO 1120 I=2,9

```

LISTING AND SUBROUTINE COMPILATION: INTRST .P. 6

```

C      SET UP THE DISCOUNT RATE
V = XINT(1) / 100
DO 1111 J=1, ILIFE
C      ESTABLISH THE CURRENT YEAR
Z = J - IYF2R0
K = I + 7
C
C      ANNUAL NET PRESENT WORTH EQUALS NET CASH FLOW
C      TIMES THE PRESENT WORTH FACTOR
C
ARRAY(J,K) = IPAY(J,K) / (1. + V) ** Z
C
C      ROUND NET PRESENT WORTH TO THE NEAREST INTEGER
C
IF (ARRAY(J,K).LE.C) IPAY(J,K) = ARRAY(J,K) - .5
IF (ARRAY(J,K).GT.C) IPAY(J,K) = ARRAY(J,K) + .5
1121 CONTINUE
1120 CONTINUE
C
C      CALCULATE INTERNAL RATE OF RETURN
C
C      IF NET CASH FLOW IS NOT POSITIVE, OMIT CALCULATION
C      OF INTERNAL RATE OF RETURN
IF (IPAY(111,3).LE.C) GO TO 1192
IF (IPAY(111,3).GT.C) GO TO 1192
V = 0.
C
C      THE PROGRAM WILL CONDUCT A SEARCH TO DETERMINE THE RATE WHICH
C      DISCOUNTS NET CASH FLOW TO ZERO. THE SEARCH WILL BEGIN AT
C      1000 PERCENT AND THE RATE WILL BE CALCULATED TO EIGHT DECIMAL
C      PLACES.
C
F1 = 10.
DO 1111 J=1, ILIFE
DO 1111 I=1, 10
V1 = V + I * F1
F1 = C.
DO 1111 J=1, ILIFE
Z = J - IYF2R0
F1 = (IPAY(J,8) / ((1+V1)**Z) + F1
1114 CONTINUE
IF (F1.LT.0) GO TO 1115
1113 CONTINUE
1115 CONTINUE
V = V1 - F1
F1 = F1 / 10
1112 CONTINUE
FIR1 = V * 100.
1192 CONTINUE
C
C      SUM APAYS NINE THRU TWELVE TO GET TOTAL NET PRESENT WORTH AT
C      ALL DISCOUNT RATES.
C
DO 3003 J=1, ILIFE
IPAY(101,9) = IPAY(101,9) + IPAY(J,9)
IPAY(101,10) = IPAY(101,10) + IPAY(J,10)
IPAY(101,11) = IPAY(101,11) + IPAY(J,11)
IPAY(101,12) = IPAY(101,12) + IPAY(J,12)
3003 CONTINUE
C
C      SET UP NET PRESENT WORTH
C
N = 101
DO 223 I=1,5
K = I + 7
NPM(I) = IPAY(N,K)
223 CONTINUE
C
C      CALCULATE NET ANNUAL WORTH
C
C      ESTABLISH THE NUMBER OF YEARS OVER WHICH
C      CASH FLOWS WERE DISCOUNTED
Z = ILIFE - IYF2R0
C      CALCULATE THE UNDISCOUNTED NET ANNUAL WORTH
NAW(1) = NPM(1)/Z
C      NOW CALCULATE NET ANNUAL WORTH AT THE SPECIFIED DISCOUNT RATES
DO 224 I=2,5
C
C      IF A NET PRESENT WORTH IS NOT POSITIVE DO NOT CALCULATE
C      NET ANNUAL WORTH FOR THAT DISCOUNT RATE AND THOSE AFTER IT
C
IF (NPM(I).LE.C) GO TO 224
C
C      NET ANNUAL WORTH EQUALS NET PRESENT WORTH TIMES
C      THE CAPITAL RECOVERY FACTOR
C
NAW(I) = NPM(I) * (XINT(1) / (1 - 1 / ((1 + XINT(1) / 100) ** Z)))
C      EXPRESS NET ANNUAL WORTH AS A PERCENT
NAW(I) = NAW(I) / 100
224 CONTINUE
C
C      CALCULATE PAYOUT PERIODS
C
DO 220 I=1,5
POP(I) = 1 / (NAW(I) / 100)
220 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: INTRST P. 7

```

DO 222 J=1,12
N = J - 7
C
C IF A NET PRESENT WORTH IS NOT POSITIVE DO NOT CALCULATE
C THE PAYOUT PERIOD FOR THAT DISCOUNT RATE AND THOSE AFTER IT
C
IF (NPW(K).LE.0) GO TO 222
SUM=0.
C
C SUM THE YEARLY NET CASH FLOWS TO DETERMINE THE FIRST YEAR THAT
C THE CUMULATIVE NET PRESENT WORTH IS POSITIVE. THEN CALCULATE
C THE PAYOUT PERIOD
C
DO 221 I=1,ILIFE
SUM=SUM + IPAY(I,J)
IF (SUM.LE.0) GO TO 221
FOR(I)=(IPAY(I,J)-SUM)/(IPAY(I,J)+1)
GO TO 222
221 CONTINUE
222 CONTINUE
C
C CALCULATE EQUIVALENT RATE OF RETURN
C
C DETERMINE THE ANNUALIZED SAVINGS X1, THE ANNUALIZED SINKING FUND
C PAYMENT X2, AND THE ANNUALIZED INVESTMENT OUTSTANDING X3.
C EQUIVALENT RATE OF RETURN THEN EQUALS (X1 - X2) / X3
C
DO 1130 I=1,5
X1 = 0.
X2 = 0.
X3 = 0.
Y = XINT(I)/100.
DO 1131 J=2,ILIFE
Z = J - IYR2R0
X1 = IPAY(J,7) / ((1. + Y)**Z) + X1
X2 = 0.
JJ = J - 1
DO 1132 K=1,JJ
X2 = IPAY(K,2) + IPAY(K,3)*X2
1132 CONTINUE
X3 = X2 / ((1. + Y)**Z) + X3
1131 CONTINUE
DO 1133 K=1,ILIFE
X4 = IPAY(K,2) + IPAY(K,3)*X4
1133 CONTINUE
X4 = X4 / ((1+Y)**Z)
SFRR(I) = ((X1 - X2) / X3) * 100.
1130 CONTINUE
C
C CALCULATE RETURN ON NET CASH OUTSTANDING
C
C AT EACH DISCOUNT RATE, DETERMINE THE NET PRESENT WORTH, WHICH IS
C THE ANNUALIZED NET SAVINGS. THEN CALCULATE DENOM, WHICH IS THE
C ANNUALIZED INVESTMENT. RONCO THEN EQUALS THE SUM OF THE DISCOUNT
C RATE AND THE RATIO OF ANNUALIZED NET SAVINGS TO ANNUALIZED
C INVESTMENT.
C
DO 227 J=1,5
RONCO(J) = 10000.
C
C IF A NET PRESENT WORTH IS NOT POSITIVE DO NOT CALCULATE
C RETURN ON NET CASH OUTSTANDING FOR THAT DISCOUNT RATE
C AND THOSE AFTER IT
C
IF (NPW(J).LE.0) GO TO 227
DENOM = 0.
I = 0
Z = 1. - IYR2R0
YIMS = FOR(J)
225 IIMS = IIMS - 1.
IF (IIMS.LE.0) GO TO 226
Z = Z * 1.
I = I + 1
DENOM = DENOM - IIMS * IPAY(I,8) / ((1. + XINT(I))/100.)**Z)
GO TO 225
226 CONTINUE
RONCO(J) = NPW(J)/DENOM * 100. + XINT(I)
227 CONTINUE
2200 CONTINUE
C
C ALL CALCULATIONS HAVE BEEN MADE. THE REMAINING PROGRAM STATEMENTS
C ARE INSTRUCTIONS FOR PRINTING THE TWO OUTPUT FORMS.
C
C LMT2 = ILIFE + 1
C WRITE SUMMARY
C WRITE(I01,6)
C WRITE TITLE
C WRITE(I01,7) ((TITLE(I,J),I=1,12),J=1,3)
C WRITE CONDITIONS
C WRITE(I01,8)
C WRITE(I01,9) JYPR
C IF (IPAY(1,7).GT.0) GO TO 232
C IF (IPAY(1,6).GT.0) GO TO 231
C WRITE(I01,10)
C GO TO 235

```

LISTING AND SUBROUTINE COMPILATION: INTRST P. 8

```

231 CONTINUE
WRITE(IOL,11)
WRITE(IOL,12)
GO TO 235
232 CONTINUE
WRITE(IOL,13)
WRITE(IOL,13)
IF(IESTLN.EQ.1)WRITE(IOL,14)
IF(ISSCYD.EQ.1)WRITE(IOL,15)
IF(ISSCB .EQ.1)WRITE(IOL,16)
IF(ISSPATE.GT.0)WRITE(IOL,17)
IF(ISSPATE.GT.0)WRITE(IOL,18)
233 CONTINUE
C WRITE SUMMARY REPORT
I = INFW + INAW + IPOF + IIRR + ISF + IRONCO
IF(I.EQ.1)GO TO 343
WRITE(IOL,19)
WRITE(IOL,19)
WRITE(IOL,20)
WRITE(IOL,20)
IF(INFW.EQ.1)WRITE(IOL,21)INFW(I,I=1,5)
IF(INAW.EQ.1)WRITE(IOL,22)INAW(I,I=1,5)
IF(IPOF.EQ.1)WRITE(IOL,23)IPOF(I,I=1,5)
I = IIRR + ISF + IRONCO
IF(I.EQ.1)GO TO 343
WRITE(IOL,24)
IF(IIRR.EQ.1)WRITE(IOL,25)IIRR(I,I=1,5)
IF(ISF.EQ.1)WRITE(IOL,26)ISF(I,I=1,5)
IF(IRONCO.EQ.1)WRITE(IOL,27)IRONCO(I,I=1,5)
234 CONTINUE
C WRITE TITLE
IYP = 0
IYEAR = IYRST - 1
235 CONTINUE
LNCNT = 0
WRITE(IOL,6)
WRITE(IOL,7)
C WRITE CONDITIONS
WRITE(IOL,8)
WRITE(IOL,9)
IF(IYRST.GT.0) GO TO 332
IF(IYRST.GT.0) GO TO 331
GO TO 335
331 CONTINUE
WRITE(IOL,11)
WRITE(IOL,12)
GO TO 335
332 CONTINUE
WRITE(IOL,13)
WRITE(IOL,13)
IF(IESTLN.EQ.1)WRITE(IOL,14)
IF(ISSCYD.EQ.1)WRITE(IOL,15)
IF(ISSCB .EQ.1)WRITE(IOL,16)
IF(ISSPATE.GT.0)WRITE(IOL,17)
IF(ISSPATE.GT.0)WRITE(IOL,18)
233 CONTINUE
IF(I.ISSCB.ISSCYD.ISSPATE)
336 CONTINUE
WRITE(IOL,36)
GO TO 342
337 CONTINUE
IF(I.ISSCB.ISSCYD.ISSPATE)
338 CONTINUE
WRITE(IOL,37)
GO TO 342
339 CONTINUE
IF(I.ISSCB.ISSCYD.ISSPATE)
340 CONTINUE
WRITE(IOL,38)
GO TO 342
341 CONTINUE
WRITE(IOL,39)
342 CONTINUE
WRITE(IOL,40)
WRITE(IOL,41)
WRITE(IOL,42)
376 CONTINUE
LNCNT = LNCNT + 1
IYP = IYR - 1
IYEAR = IYEAR + 1
NOT IF(IOL,33)IF IYR .EQ. 1
IF(IYR.EQ.1)IF IYR .EQ. 1
IF(LNCNT.LT.25)GO TO 376
GO TO 375
377 CONTINUE
N = 101
WRITE(IOL,34) (IPAY(N,J),J=1,12)
GO TO 49
9000 CONTINUE
END

```

PROGRAM NAME: LINK

Descriptive Title: Transient Temperatures in Heat Generating Slabs with Convective Cooling

Program Author: Stouffer, J. C.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 4

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Conduction, Slabs, Radioactive Waste

Program Description: Estimates transient temperatures within a uniform heat generating slab with equal or unequal constant heat transfer coefficients to constant temperature sinks on either side of slab. Initial temperature is uniform. Analytical solution with Bessel functions. Variables have no dimensions (units). One subroutine for finding roots of eigenvalue equation.

Users of Program: G Jansen
WV DeMier

Documentation: Results and listing appear in BNWL-157.

Condition of Program: Only a sample run exists for the UNIVAC 1108. The output is not self-explanatory.

SAMPLE INPUT: LINK

```

LINK      10:00      02/14/74
100 @S RUN PUN012,CUPS28,GEORGE,60,3000/1000      G.JANSEN.3760 BLD
      G 9423575
105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFOCO
115 @PRL TEL INFOCO
120 @PRL TEL CUB928
125 @X ASG A=U1145(JJ1145)
130 @N XQT CUR
150 FIND A,LINK/SIFA
160 TRD A
170 FIND A,ROOT/SIFA
180 TRD A
350 TRI A
355 PCH LINK/SIFA
357 PCH ROOT/SIFA
360 @IM FR5,* LINK/SIFA,LINK/SIFA,LINK/RIFA
380 @IM FR5,* ROOT/SIFA,ROOT/SIFA,ROOT/RIFA
1000 @LI XQT LINK/RIFA
1010 500 1.00000E-05
1020 5.0000E-01 1.500E+02 2.200E-01
1030 1.0000E+03 5.000E+02 1.000E+01
1040 1.0000E+01 2.000E+01 8.000E+01 2.500E-01
1050 13 2.50000E-02
1060 5.000E-01 1.000E+00 2.000E+00 5.000E+00 1.000E+01 2.000E+01 5.000E+
01
1070 1.000E+02 2.000E+02 5.000E+02 1.000E+03 2.000E+03 5.000E+03
1080 @ FIN
READY

```

SAMPLE OUTPUT: LINK P. 1

BLT XOT LINK/11P-
DRUM LENGTH 010274

END OF ALLOCATION
THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 13:20:45

T0 = 1.00000+03
T1 = 5.00000+02
T2 = 1.00000+01
H1 = 1.00000+01
H2 = 2.00000+01
A = 8.00000+01
L = 2.50000-01
K = 5.00000-01
R = 1.50000+02
C = 2.20000-01
INTERM = 500
EPS = 1.00000-05

X	TIME	SS-TEMP	TEMP
.000	.00000	-2.41500-01	3.79250+02
.025	.00000	-2.55000-01	3.49013+02
.050	.00000	-2.71712-01	3.18675+02
.075	.00000	-2.86837-01	2.88238+02
.100	.00000	-3.01975-01	2.57700+02
.125	.00000	-3.17125-01	2.27063+02
.150	.00000	-3.32267-01	1.96325+02
.175	.00000	-3.47462-01	1.65488+02
.200	.00000	-3.62650-01	1.34550+02
.225	.00000	-3.77850-01	1.03513+02
.250	.00000	-3.93062-01	7.23750+01
.000	1.00000	-2.41500-01	3.79250+02
.025	1.00000	-2.55000-01	3.49013+02
.050	1.00000	-2.71712-01	3.18675+02
.075	1.00000	-2.86837-01	2.88238+02
.100	1.00000	-3.01975-01	2.57700+02
.125	1.00000	-3.17125-01	2.27063+02
.150	1.00000	-3.32267-01	1.96325+02
.175	1.00000	-3.47462-01	1.65488+02
.200	1.00000	-3.62650-01	1.34550+02
.225	1.00000	-3.77850-01	1.03513+02
.250	1.00000	-3.93062-01	7.23750+01
.000	2.00000	-2.41500-01	3.79250+02
.025	2.00000	-2.55000-01	3.49013+02
.050	2.00000	-2.71712-01	3.18675+02
.075	2.00000	-2.86837-01	2.88238+02
.100	2.00000	-3.01975-01	2.57700+02
.125	2.00000	-3.17125-01	2.27063+02
.150	2.00000	-3.32267-01	1.96325+02
.175	2.00000	-3.47462-01	1.65488+02
.200	2.00000	-3.62650-01	1.34550+02
.225	2.00000	-3.77850-01	1.03513+02
.250	2.00000	-3.93062-01	7.23750+01

X	TIME	SS-TEMP	TEMP
.000	5.00000	-2.41500-01	3.79250+02
.025	5.00000	-2.55000-01	3.49013+02
.050	5.00000	-2.71712-01	3.18675+02
.075	5.00000	-2.86837-01	2.88238+02
.100	5.00000	-3.01975-01	2.57700+02
.125	5.00000	-3.17125-01	2.27063+02
.150	5.00000	-3.32267-01	1.96325+02
.175	5.00000	-3.47462-01	1.65488+02
.200	5.00000	-3.62650-01	1.34550+02
.225	5.00000	-3.77850-01	1.03513+02
.250	5.00000	-3.93062-01	7.23750+01

SAMPLE OUTPUT: LINK P. 2

.000*****	-2.41500-01	3.79250+02
.025*****	-2.56500-01	3.49013+02
.050*****	-2.71712-01	3.18675+02
.075*****	-2.86337-01	2.88238+02
.100*****	-3.01975-01	2.57700+02
.125*****	-3.17125-01	2.27063+02
.150*****	-3.32287-01	1.96325+02
.175*****	-3.47462-01	1.65488+02
.200*****	-3.62550-01	1.34550+02
.225*****	-3.77350-01	1.03513+02
.250*****	-3.93062-01	7.23750+01
.000*****	-2.41500-01	3.79250+02
.025*****	-2.56500-01	3.49013+02
.050*****	-2.71712-01	3.18675+02
.075*****	-2.86337-01	2.88238+02
.100*****	-3.01975-01	2.57700+02
.125*****	-3.17125-01	2.27063+02
.150*****	-3.32287-01	1.96325+02
.175*****	-3.47462-01	1.65488+02
.200*****	-3.62550-01	1.34550+02
.225*****	-3.77350-01	1.03513+02
.250*****	-3.93062-01	7.23750+01

X	TIME	SS-TEMP	TEMP
.000*****	-2.41500-01	3.79250+02	
.025*****	-2.56500-01	3.49013+02	
.050*****	-2.71712-01	3.18675+02	
.075*****	-2.86337-01	2.88238+02	
.100*****	-3.01975-01	2.57700+02	
.125*****	-3.17125-01	2.27063+02	
.150*****	-3.32287-01	1.96325+02	
.175*****	-3.47462-01	1.65488+02	
.200*****	-3.62550-01	1.34550+02	
.225*****	-3.77350-01	1.03513+02	
.250*****	-3.93062-01	7.23750+01	
.000*****	-2.41500-01	3.79250+02	
.025*****	-2.56500-01	3.49013+02	
.050*****	-2.71712-01	3.18675+02	
.075*****	-2.86337-01	2.88238+02	
.100*****	-3.01975-01	2.57700+02	
.125*****	-3.17125-01	2.27063+02	
.150*****	-3.32287-01	1.96325+02	
.175*****	-3.47462-01	1.65488+02	
.200*****	-3.62550-01	1.34550+02	
.225*****	-3.77350-01	1.03513+02	
.250*****	-3.93062-01	7.23750+01	
.000*****	-2.41500-01	3.79250+02	
.025*****	-2.56500-01	3.49013+02	
.050*****	-2.71712-01	3.18675+02	
.075*****	-2.86337-01	2.88238+02	
.100*****	-3.01975-01	2.57700+02	
.125*****	-3.17125-01	2.27063+02	
.150*****	-3.32287-01	1.96325+02	
.175*****	-3.47462-01	1.65488+02	
.200*****	-3.62550-01	1.34550+02	
.225*****	-3.77350-01	1.03513+02	
.250*****	-3.93062-01	7.23750+01	

X	TIME	SS-TEMP	TEMP
.000*****	-2.41500-01	3.79250+02	
.025*****	-2.56500-01	3.49013+02	
.050*****	-2.71712-01	3.18675+02	
.075*****	-2.86337-01	2.88238+02	
.100*****	-3.01975-01	2.57700+02	
.125*****	-3.17125-01	2.27063+02	
.150*****	-3.32287-01	1.96325+02	
.175*****	-3.47462-01	1.65488+02	
.200*****	-3.62550-01	1.34550+02	
.225*****	-3.77350-01	1.03513+02	
.250*****	-3.93062-01	7.23750+01	
.000*****	-2.41500-01	3.79250+02	
.025*****	-2.56500-01	3.49013+02	
.050*****	-2.71712-01	3.18675+02	
.075*****	-2.86337-01	2.88238+02	
.100*****	-3.01975-01	2.57700+02	
.125*****	-3.17125-01	2.27063+02	
.150*****	-3.32287-01	1.96325+02	
.175*****	-3.47462-01	1.65488+02	
.200*****	-3.62550-01	1.34550+02	
.225*****	-3.77350-01	1.03513+02	
.250*****	-3.93062-01	7.23750+01	

SAMPLE OUTPUT: LINK P. 3

.000*****	-2.41500-01	3.79250+02
.025*****	-2.56000-01	3.49013+02
.050*****	-2.71712-01	3.18675+02
.075*****	-2.86937-01	2.88233+02
.100*****	-3.01975-01	2.57700+02
.125*****	-3.17125-01	2.27063+02
.150*****	-3.32207-01	1.96325+02
.175*****	-3.47462-01	1.65488+02
.200*****	-3.62650-01	1.34550+02
.225*****	-3.77850-01	1.03513+02
.250*****	-3.93062-01	7.23750+01

X	TIME	SS-TEMP	TEMP
.000*****	-2.41500-01	3.79250+02	
.025*****	-2.56000-01	3.49013+02	
.050*****	-2.71712-01	3.18675+02	
.075*****	-2.86937-01	2.88233+02	
.100*****	-3.01975-01	2.57700+02	
.125*****	-3.17125-01	2.27063+02	
.150*****	-3.32207-01	1.96325+02	
.175*****	-3.47462-01	1.65488+02	
.200*****	-3.62650-01	1.34550+02	
.225*****	-3.77850-01	1.03513+02	
.250*****	-3.93062-01	7.23750+01	

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00131 OF MAIN PROGRAM

CSCX RL683J 14 FEB 74 13:20:33 USER CU6928 PUN012

CARDS IN 24 OUT 168 LINES 569 PROCESSING TIME 12.10 SECONDS

LISTING AND SUBROUTINE COMPILATION: LINK P. 1

```

25  RUN  F0H012.CUP923.      .C00.3000/1000      C JANSEN 3700 BLOC 943357.
8  CLY LINK/SIFN+1.670*10.  7975
8  EOF 8
C      THIS PROGRAM CALCULATES TEMPERATURES IN AN INFINITE
C      SLAB AT SPECIFIED POSITION INCREMENTS AND TIMES.
C
C      INPUT DATA
C
C      T0=INITIAL TEMP OF SLAB
C      T1=TEMP OF MEDIUM TO LEFT OF SLAB
C      T2=TEMP OF MEDIUM TO RIGHT OF SLAB
C      H1=HEAT TRANSFER COEFFICIENT AT LEFT SURFACE OF SLAB
C      H2=HEAT TRANSFER COEFFICIENT AT RIGHT SURFACE OF SLAB
C      A=HEAT GENERATION RATE IN SLAB
C      L=SLAB WIDTH
C      K=THERMAL CONDUCTIVITY OF SLAB
C      R=DENSITY OF SLAB MATERIAL
C      C=SPECIFIC HEAT OF SLAB MATERIAL
C      NTERM=MAX NO OF TERMS IN INFINITE SERIES TO BE CONSIDERED
C      EPS=CONVERGENCE CRITERION FOR INFINITE SERIES
C      NT=NO OF SPECIFIC TIMES CONSIDERED IN THIS CASE
C      DELX=X INCREMENT FOR TEMP EVALUATION
C      TIME(I)=TIMES AT WHICH TEMP IS TO BE EVALUATED
C
C      COMMON/INT/ML;110
C      COMMON/MOUNT/KOUNT
C      DIMENSION TTAU(100),TIME(100)
C      DOUBLE PRECISION PI,STINT
C
99  FORMAT(1H1)
93  FORMAT(122X#PAGE13//5Y1X#X04TIME6XTH53-T0M93X#TEMP//)
97  FORMAT(122X#PAGE13//17X#T0 D1E13.5//17X#T1 D13.5//17X#T2 D
1  E13.5//17X#H1 D13.5//17X#H2 D13.5//13X#A D13.5//13X#L D
2  E13.5//18X#K D13.5//14X#R D13.5//18X#C D13.5//14X#NTERM D
3  15//16X#EPS D13.5)
96  FORMAT(1H1)
94  FORMAT(11X#7.3-F10.5+1E2E14.5+2I5)
92  FORMAT(7E10.4)
91  FORMAT(12X#G12.4)
C      REAL K,L
C      FCN(I)=-A+Y**2+89*(Y+1./ML)
C      CALL SETIC (2,1)
C      CALL SETIC (3,2)
C      KOUNT=1
C      PI=3.1415926535897932
C      NPAGE=0
C      XS=0.
C      READ(2,51) N1,N2,N3
C      3  READ(2,92) K,P,C
C      IF(A=5(K)-ABS(P)+ABS(C)) 1110,1110,5
C      5  READ(2,92) T0,T1,T2
C      READ(2,92) H1,H2,A,L
C      READ(2,91)INT,DELX
C      READ(2,92)(TIME(I),I=1,NT)
C      DELT=T0-T1
C      ALKT=A*L**2/(K*DELT)
C      H3=H2/H1
C      T0=(T2-T1)/DELT
C      HL=H1*L
C      DX=DELX/L
C      AAA=(1/C+L**2)
C      DO 2 I=1,NT
C      2  TTAU(I)=AAA*TIME(I)
C      HL50=HL**2
C      KX= INT(1./DX)+1
C      103  AA=ALKT/2.
C      NPAGE=NPAGE+1
C      WRITE(3,99)
C      WRITE(3,97) NPAGE,T0,T1,T2,H1,H2,A,L,K,P,C,NTERM,EPS
C      BB=(AA*(2.-H3*HL)+H3*HL+T0)/(1.-H3*(1.-HL))
C      DO 1010 I=1,NT
C      TAU=TTAU(I)+TAU
C      WRITE(3,96)
C      11=INT(TAU/3)
C      IF(11.NE.1) GO TO 303
C      WRITE(3,99)
C      NPAGE=NPAGE+1
C      WRITE(3,98) NPAGE
C      303  CONTINUE
C      DO 810 I=1,NX
C      X=XS+FLCAT(I)-1+DX
C      QUADZ=FCN(I)
C      XX=X*L
C      SST=FCN(XX)
C      FOSL=QU.
C      SUM=0.
C      EVALUATE TEMP AT X
C      DO 210 I=1,NTERM
C      STINT=FLCAT(I)-1+PI
C      BETA=POCT(STINT,PI)
C      IF(BETA)105,105,205
C      105  BETA=FLCAT(I)-1+PI
C      205  DFAS=BETA**2

```

LISTING AND SUBROUTINE COMPILATION: LINK P. 2

```

GAM=2./((PTASQ+HLSQ)*.1+.HQ*ML/PTASQ+HLSQ*HL*.2)*HL
SINB=SIN(PTA)
COSB=COS(PTA)
HLB=HL/BETA
FSN=SIN-HLB*COSB
HFFB=HL+FSN
CNEF=GAM*(HFFB*(1.-ALMT/PTASQ)-TO*FSN)
BX=BETA*X
TERM=COEF*(BETA*COS(BX)+ML*STN(BX))*EXP(-BTAG*TAU)
SUM=SUM+TERM
IF (AES(SUM-FRESUM)-EPS) 110,110,110
110 FRESUM=SUM
210 CONTINUE
310 V=QUAD*SUM
TEMP=V*DELT+1
WRITE(3,99) XX,TIME(ITAU),SST,TEMP
810 CONTINUE
1010 CONTINUE
GO TO 3
1110 CONTINUE
STOP
END

```

```

8 ELT ROOT/SIF*.1*670910. 7979
8 EOF 3
FUNCTION ROOT(A,B)
COMMON/RT/HL,HQ
FCN(Z)=SIN(Z)*(Z*.2-HQ*HL*.2)-COS(Z)*(Z*(1.+HQ)*HL)
ZL=A+B/2.
ZZR=ZL
FL=FCN(ZL)
FR=FL
DELZ=B/2.
DO 135 I=1,10
DELZ=DELZ/2.
ZL=ZZL-DELZ
GL=FCN(ZL)
IF (GL-SIGN(GL,FL)) 5,15,85
15 ZR=ZZR+DELZ
GR=FCN(ZR)
IF (GR-SIGN(GR,FR)) 55,35,25
35 ZZL=ZL
ZZR=ZR
FL=GL
FR=GR
135 CONTINUE
ROOT=0.
GO TO 610
45 XX=1.
GO TO 105
5 XX=-1.
105 ZLS=ZL
ZRS=ZZL
GO TO 10
55 XX=1.
GO TO 125
25 XX=-1.
125 ZLS=ZZR
ZRS=ZR
10 Z=(ZRS+ZLS)/2.
DELZ=DELZ/2.
DO 410 J=1,30
DELZ=DELZ/2.
IF (DELZ-5.E-8) 510,110,110
110 F=FCN(Z)
IF (F) 210,510,310
210 Z=Z-SIGN(DELZ,XX)
GO TO 410
310 Z=Z+SIGN(DELZ,XX)
410 CONTINUE
ROOT=0.
GO TO 610
510 ROOT=Z
610 RETURN
END
06140274 CUE928FUNC12 100 1210 29 168 569132033 1 0000 6 5

```

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PROGRAM NAME: PROFIL

Descriptive Title: Transient Temperatures in Heat Generating Annuli with Convective Cooling

Program Author: DeMier, W. V.

Computer: UNIVAC 1108, IBM 7090

Operating System: CSCX, EXEC 8

Language: FORTRAN 2

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Conduction, Annuli, Radioactive Waste

Program Description: Estimates transient temperatures within a uniform heat generating annulus with equal or unequal constant heat transfer coefficients to constant temperature sinks. Initial temperature is uniform. Analytical solution with Bessel functions. Uses a double Fibonacci search routine to find multiple roots of a complex Bessel function eigenvalue equation. Nine sub-routines.

Users of Program: G Jansen
WV DeMier

Documentation: Results, equations and listing appear in BNWL-157.

Condition of Program: Does not run for certain mysterious combinations of whole number input variables. This problem can be eliminated by changing these values a fraction of a percent. This is believed to be related to multiplicity of poles in the root finding subroutine.

FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES IN ANNULAR VESSELS: PROFIL P. 1

FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES IN ANNULAR VESSELS
PROFIL

SOURCE PROGRAM LISTINGS HAVE BEEN OMITTED FOR THE FOLLOWING ROUTINES
WHICH WERE OBTAINED IN OBJECT DECK FORM FROM THE FORTRAN LIBRARY.

BESYF(X,N) -A ROUTINE TO FIND NTH ORDER BESSEL FUNCTION Y OF X.
BESJF(X,N) -A ROUTINE TO FIND NTH ORDER BESSEL FUNCTION J OF X.
SAVE(N) -A ROUTINE TO SAVE CORE ON PUNCHED CARDS FOR RESTART.

N214-

A FORTRAN II PROGRAM FOR CALCULATING TRANSIENT TEMPERATURES IN HEAT-
GENERATING,HOLLOW,RIGHT CYLINDERS.

PROGRAM COMPUTES INSTANTANEOUS TEMPERATURES FOR A MAXIMUM OF 12 RAD-
IAL POSITIONS (R/E) AT A MAXIMUM OF 27 POINTS IN TIME (THRS).

* * INPUT DESCRIPTION * *

CARD TYPE	F O R M A T	FIELD	CONTENTS OF CARD
A1	(15,13F5.0)	1	TOTAL NUMBER OF THRS(J) VALUES ON THIS CARD AND TYPE A2 CARD. (27 MAX)
		2-14	THRS(J) FOR J=1,13 -POINTS IN TIME AT WHICH TEMPERATURES ARE TO BE COMPUTED. HOURS.
A2	(14F5.0)	1-14	CONTINUATION OF THRS(J) FOR J=14-27. OMIT A2-CARD IF ALL FIELDS ARE BLANK.
B	(14,13F5.0)	1	NUMBER OF ROOTS TO BE COMPUTED FOR AUXIL- IARY EQUATIONS. (149 MAXIMUM)
		2	PROBLEM NUMBER -NEVER BLANK OR ZERO.
		3	GENT =VOLUMETRIC HEAT GENERATION RATE, BTU/(HR CU FT)
		4	TO =OUTER AMBIENT TEMPERATURE, DEGREES F
		5	TA =INNER AMBIENT TEMPERATURE, DEGREES F
		6	T1 =INITIAL UNIFORM TEMP, DEGREES F
		7	B =OUTER RADIUS OF HOLLOW CYLINDER, FT.
		8	A =INNER RADIUS OF HOLLOW CYLINDER, FT.
		9	COND =THERMAL CONDUCTIVITY OF MATERIAL, BTU/(HR SQ FT DEGREE F/FT) BLANK IF ALPHA IS ENTERED.
		10	H1 =HEAT TRANSFER COEFFICIENT AT INNER WALL, BTU/(HR SQ FT DEGREE F).

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C
C
C      11  H2  =HEAT TRANSFER COEFFICIENT AT OUTER
C              WALL, BTU/(HR SQ FT DEGREE F).
C
C      12  ALPHA=THERMAL DIFFUSIVITY, SQ FT/(HR DEG F)
C
C      13  RHO  =DENSITY, POUNDS/CU FT.
C
C      14  SPHT =SPECIFIC HEAT CAPACITY,BTU/(LB DEG F)
C
C      C (15)      1  NRG  =NUMBER OF ROOTS APPEARING ON D-CARDS
C                      DO NOT OMIT C-CARD EVEN IF BLANK.
C
C      D (1P7E10.0) 1-7 BGR(1)=ROOTS OF COMPOSITE EQUATION. ANY
C                      NUMBER OF CARDS. OMIT D-CARDS IF
C                      C-CARD IS BLANK OR ZERO.
C
C      E (15,13F5.0) 1  NVR  =NUMBER OF VALUES OF R/B ON THIS CARD
C
C      2-14 VR(L)=VALUES OF R/B AT WHICH TEMPERATURE
C              IS TO BE CALCULATED. IF E-CARD CONTAINS
C              SOME VR(L) VALUES WHICH ARE LESS THAN A/B
C              FOR A PARTICULAR CASE THESE WILL BE IG-
C              NORED. THUS A MASTER LIST OF VR(L) ENTER-
C              ED WITH FIRST CASE IS USED FOR ALL CASES.

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TERMINATE DATA DECK WITH TWO BLANK CARDS.

NOTE- A UNIQUE SET OF ROOTS IS REQUIRED FOR EACH DIFFERENT SET OF THE
FOLLOWING VARIABLES-

H1/H2	H2*B/COND	A/B
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IF ROOTS ARE NOT SUPPLIED AS INPUT, THE PROGRAM WILL REQUIRE ABOUT
4 MINUTES TO COMPUTE EACH SET. OUTPUT WILL THEN INCLUDE PUNCHED CARDS
(TYPE C AND TYPE D) IN PROPER FORMAT FOR FUTURE INPUT OF ROOTS. ALSO
A TABLE OF THE ROOTS WILL BE PRINTED. IN MULTIPLE CASE RUNS, USE THE
FOLLOWING HINTS TO MINIMIZE TIME REQUIRED FOR EXECUTION-

1. 50 TO 100 ROOTS FOR AUXILIARY EQUATIONS (B-CARD, FIELD 1) ARE USU-
ALLY ADEQUATE.
2. ALWAYS SUPPLY COMPOSITE EQUATION ROOTS (C- AND D-CARDS) WHEN POS-
SIBLE.
3. ON CHANGE CASES ALWAYS USE BLANK FIELD (ON B-CARDS) FOR VALUE RE-
MAINING UNCHANGED FROM PRECEDING CASE.
4. ARRANGE DATA CARDS FOR CHANGE CASES SO THAT VALUES OF GENT, TO, TA,
AND T1 VARY MORE RAPIDLY THAN ANY OF THE OTHER VARIABLES ON B-CARD.
5. TO CHANGE A VARIABLE TO ZERO AFTER IT HAS HAD A POSITIVE VALUE IN
THE PRECEDING CASE ENTER -0.001 IN THE FIELD FOR THAT VARIABLE.

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COMMON DLM,ZY0,ZY1,ZJ0,ZJ1,CA,CB,CM,THETA,CGR,NREG,NTHEM,CASE,PAB,
2PH,FK,PS,WW,WWW,PNC4,STD,STQ,SH1,SH2,SH3,SH4,SH5,SH6,SH7,DP,DR,DT,
3TAG,ADO,TTR,ALPHA,GENT,SOOT,TJN1,T2,TA,THRS
DIMENSION DLM(7986),ZY0(150),ZY1(150),ZJ0(150),ZJ1(150),Y(13),CA(1
251),CB(151),CM(151),BGR(151),THETA(26),X(13),PSM(26),RAD(28),TM(28
31),TDS(28),TGM(23),R(60),E(101),SG(151),PNC4(151)
4,NXT(151),THRS(28)
1 FORMAT(1H,4HCASE,F12.4,26H CONVERGENCE TEST FAILURE RI,I3,6H) IN
2F,12,14H NTH VALUE = ,E14.7,15H (N-1)TH VALUE=,E14.7)
2 FORMAT(1H,12HWORK ON CASE F8.2, 73H WAS DISCONTINUED BECAUSE N
20 ROOTS WERE FOUND FOR THE COMPOSITE EQUATION. /)
3 FORMAT(1H,5X,45HTABLE OF ROOTS OF COMPOSITE EQUATION FOR CASE F12
2.4//)
5 FORMAT(1H,116HENTER CONDUCTIVITY OR DIFFUSIVITY, NOT BOTH. INPUT
2DIFFUSIVITY HAS BEEN DISCARDED AND A NEW VALUE CALCULATED FROM K.)
6 FORMAT (14,13F5.0)
7 FORMAT (1H1//////////1H0,5HCASE ,F12.5,21H DELETED BECAUSE NL=
2, 15//)
18 FORMAT(1H,20HINPUT DATA FOR CASE ,F12.4,45HSHOW OUTER RADIUS SMAL
2LER THAN INNER RADIUS/1H , 91HPROGRAM PROCEEDING UNDER ASSUMPTION
3THAT RADII WERE INADVERTENTLY INTERCHANGED ON DATA CARD/)
19 FORMAT(1H,61HCANNOT PROCEED WITH INNER RADIUS EQUAL TO OUTER RADI
2US. CASE ,F12.4, 9H DELETED.//)
22 FORMAT(1E,13F5.0/14F5.0)
24 FORMAT(1H,9JPF7.3,F9.3,F7.3,2F9.3,1P2E14.5,0P2F8.5,1P2E14.5)
25 FORMAT(1H,59HLESS THAN 5-PLACE CONVERGENCE ACCEPTED FOR FOLLOWING
2 ROOTS-//)
26 FORMAT(1H,15,1PE17.7//)
30 FORMAT(1H,14HDATA FOR CASE ,F11.4,16H HAVE BEEN READ.//)
31 FORMAT(1H1////////1H HEAT TRANSFER COEFFICIENT INNER WALL H1=,F9.4,6X
2,9HCASE NO. ,F11.4,14X,15HOUTER RADIUS B=,F9.4/41H HEAT TRANSFER C
3OEFFICIENT OUTER WALL H2=,F9.4,40X,16HINNER RADIUS A =,F9.4//14X,2
46HTHERMAL DIFFUSIVITY ALPHA=,F9.4,33X,3HS =,E14.7/14X,26HTHERMAL C
5ONDUCTIVITY COND=,0PF9.4/21X,19HSPECIFIC HEAT SPHT=,F9.4,33X,23HOU
6TER AMBIENT TEMP T2 =,F7.1/26X,12HDENSITY RHG=,F9.4,33X,23HINNER A
7MBIENT TEMP T2 =,F7.1/37X,3HNL=,14,36X,25HINITIAL UNIFORM TEMP T1=
8,F7.1//)
42 FORMAT (15)
44 FORMAT(1P7E10.4)
1999 READ INPJT TAPE 2,22,NTHEM,(THRS(J),J=1,NTHEM)
KAUS=0
IF(SENSELIGHT 1) 2000,2000
2000 READ INPJT TAPE 2,6,K,(X(I),I=1,13)
IF (X(1)) 7005,20,7005
20 CALL EXIT
7005 IF (K) 7010,7010,7023
7010 K=NL
GO TO 7030
7020 NL=K
7030 READ INPUT TAPE 2,42,NBG
IF(NBG) 173,173,103
103 READ INPJT TAPE 2,44,(BGR(I),I=1,NBG)
KPNCH=1
NL=NBG

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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
IN ANNULAR VESSELS: PROFIL P. 4

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      NTERMS=NEG
      GO TO 101
      173 KPACh = 2
      101 WRITE OUTPUT TAPE 3,30,X(1)
      IF (NL) 7011,7011,7035
      7011 WRITE OUTPUT TAPE 3,7,X(1),NL
      GO TO 2000
      7035 DO 7040 I=2,13
      IF (X(I)) 7032,7040,7036
      7032 Y(I)=1.E-15
      GO TO 7040
      7036 Y(I)=X(I)
      7040 CONTINUE
      CASE=X(1)
      GENT=Y(2)
      TZ =Y(3)
      TA =Y(4)
      TUNI=Y(5)
      BOUT=Y(6)
      A =Y(7)
      IF(BOUT-A) 4300,4400,4500
      4300 CONTINUE
      WRITE OUTPUT TAPE 3,18,CASE
      BOUT=Y(7)
      A=Y(6)
      GO TO 4500
      4400 CONTINUE
      WRITE OUTPUT TAPE 3,19,CASE
      GO TO 2000
      4500 CONTINUE
      COND=Y(8)
      H1 =Y(9)
      H2 =Y(10)
      RHO =Y(12)
      SPHT=Y(13)
      NEXT=2
      DO 7141 I=6,13
      IF (ABS(X(I))-0.00001) 7141,7141,7137
      7137 NEXT=1
      GO TO 7143
      7141 CONTINUE
      7143 IF(X(8)*X(11))56,56,55
      55 WRITE OUTPUT TAPE 3,5
      GO TO 57
      56 IF(Y(8)) 57,59,57
      57 ALPHA= COND/RHO/SPHT
      GO TO 23
      59 ALPHA=Y(11)
      COND=ALPHA*RHO*SPHT
      23 PS=GENT * BOUT**2/(4.*COND*(TUNI-TZ))
      DO 7042 I=1,NTERMS
      7042 THETA(I)=ALPHA*THRS(I)/BOUT**2
      STD=(TA-TZ)/(TUNI-TZ)
      PAD=A/BOUT
      PH=H1/H2

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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES IN ANNULAR VESSELS: PROFIL P. 5

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      PK=H2*BCUT/COND
      WRITE OUTPUT TAPE 3,31,N1,CASE,BCUT,N2,A,ALPHA,GEHT,COND,SPHT,TZ,
      ZRHO,TA,NL,TUNI
35  ASQ=PAB**2
      BLOG=LOGF(PAB)
      W=P/PK
      WAW=P/PK*PAB
37  PPH=1./PH
39  RPK=1./PK
      IF (3-NEXT*KPNCH) 703,703,36
36  DO 306 I=1,601
306  R(I)=0.0
      DO 307 I=1,151
307  BGR(I)=0.0
      MCP=1
      IF(SENSESWITCH 1) 396,397
396  CONTINUE
      CALL SAVE(C)
397  CONTINUE
      FIND NL ROOTS OF AUX EQUATION F1.      STORE IN R(2) TO R(NL+1)
100  DO 180 NB=1,NL
105  NEP=NB+1
110  E(1)=(Z-G(NB)+ZJ1(N6P))/2.
120  DO 160 K=1,100
125  KPI=K+1
130  X=E(K)
135  BJ1=BES.F(X,1)
140  BJ2=BES.F(X,0)
145  T=X-((X*BJ1+WWW*BJ2)/(X*BJ2-WWW*BJ1))
150  IF(ABSF(T-X)-0.0001) 170,170,155
      DIVIDE BY A/3 TO GET ACTUAL ROOT
170  T=T/PAB
      GO TO 175
155  E(KPI)=T
160  CONTINUE
162  KP=1
      MOP=MOP+1
163  T=T/PAB
164  X=X/PAB
165  WRITE OUTPUT TAPE 3,1,CASE,KPI,KF,T,X
175  MCP=MOP+1
      R(MOP)=T
180  CCNTINUE
190  IF(SENSESWITCH 1) 761, 199
761  CCNTINUE
      CALL SAVE(O)
199  TTTT=R(MOP)
      SENSELIGHT 4 MUST BE ON TO ESTABLISH PROPER INTERVAL FOR FIRST ROOT SEARCH.
185  SENSELIGHT 4
      FIND NL ROOTS OF AUX EQUATION F2.      STORE IN R(NL+2) TO R(2*NL+1)
200  DO 205 NS=1,NL
      NEV=NS-1
      DIRECT CONTROL TO 210 FOR ALL ROOTS AFTER FIRST ONE.
205  IF(SENSELIGHT 4) 201,210
201  E(1)=0.446788

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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
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202 SENSELIGHT 4
C TURN SL4 ON TO SET UP TEST IN STATEMENT 261 FOR FIRST ROOT ONLY.
GO TO 220
210 E(1)=(ZY1(NB)+ZYU(NB))/2.
220 DO 260 K=1,100
225 KP1=K+1
230 X=E(K)
235 BY1=BESYF(X,1)
240 BYZ=BESYF(X,2)
245 T=X-((X*BY1-FK*BYZ)/(X*BYZ+PK*BY1))
246 IF(K-5) 250,247,250
247 CALL TEST(X,T,KSIN)
GO TO (285,250),KSIN
250 IF(ABSF(T-X)-0.0001) 272,272,255
255 E(KP1)=T
260 CONTINUE
IF(SENSELIGHT 4) 261,262
C STATEMENTS 261,262 TEST FIRST ROOT TO MAKE SURE IT IS WITHIN INTERVAL.
261 IF(T) 255,263,261
2611 IF(T-.893577) 275,275,285
262 KF=2.
MP1=MOP+1
265 WRITE CPUTAP TAPE 3,1,CASE,MP1,KF,T,X
C TURN SL4 OFF AFTER FIRST INTERVAL ROOT TEST IS FINISHED.
272 IF(SENSELIGHT 4) 275,275
275 MOP=MOP+1
R(MOP)=T
285 CONTINUE
290 IF(SENSESWITCH 1) 762, 299
762 CONTINUE
CALL S-VE(0)
299 TT=R(MOP)
C FIND NL ROOTS OF AUX EQUATION F3. STORE IN R(2*NL+2) TO R(3*NL+1)
300 DO 380 NB=1,NL
310 E(1)=(ZYU(NB)+ZY1(NB))/2.
320 DO 360 K=1,100
325 KP1=K+1
330 X=E(K)
335 BY1=BESYF(X,1)
340 BYZ=BESYF(X,2)
345 T=X-((X*BY1+ WWW*BYZ)/(X*BYZ- WWW*BY1))
350 IF(ABSF(T-X)-0.0001) 370,370,355
C DIVIDE ANSWER BY A/3 TO GET ACTUAL ROOT
370 T=T/PAE
GO TO 371
355 E(KP1)=T
360 CONTINUE
362 KF=3
363 T=T/PAE
MP1=MOP+1
364 X=X/PAE
365 WRITE CPUTAP TAPE 3,1,CASE,MP1,KF,T,X
371 MOP=MOP+1
R(MOP)=T
380 CONTINUE

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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
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399 IF(SENSESWITCH 1) 763, 399
763 CONTINUE
CALL SAVE(0)
399 TTT=R(MOP)
C FIND NL ROOTS OF AUX EQUATION F4. STORE IN R(3*NL+2) TO R(4*NL+1)
400 DO 430 NB=1,NL
405 NBP=NB+1
410 E(1)=(ZJC(NB)+ZJ1(NB))/2.
420 DO 450 K=1,100
425 KP1=K+1
430 X=E(K)
435 BJ1=3ESJF(X,1)
440 BJZ=3ESJF(X,0)
445 T=X-((A*BJ1-PK*BJZ)/(A*BJZ+PK*BJ1))
450 IF(ABS(T-X)-0.0001) 470,470,455
455 E(KP1)=T
460 CONTINUE
462 KF=4
MP1=MOP+1
465 WRITE OUTPUT TAPE 3,1,CASE,MP1,KF,T,X
470 MOP=MOP+1
R(MOP)=T
480 CONTINUE
490 IF(SENSESWITCH 1) 764, 499
764 CONTINUE
CALL SAVE(0)
499 QUIT=MIN(QUIT,T,TTT)
CALL ORDRP(R,MOP)
DO 530 LL=1,151
LLP=LL+1
IF(R(LLP)-QUIT) 520,520,94
520 BB(LL)=(R(LL)+R(LLP))/2.
530 NBI=LL
580 CONTINUE
94 NBI=0
95 DO 565 K1=1,NBI
95 BOR=K(K1)
97 TOR=K(K1+1)
98 B=BB(K1)
99 BAB=3*PAB
905 AJ1=3ESJF(BAB,1)
910 AJZ=3ESJF(BAB,0)
915 F1=B*AJ1+WW*AJZ
920 LY1=3ESYF(B,1)
925 BYZ=3ESYF(B,0)
930 F4=B*BY1-PK*BYZ
935 AY1=3ESYF(BAB,1)
940 AYZ=3ESYF(BAB,0)
945 F2=B*AY1+WW*AYZ
950 BJ1=3ESJF(B,1)
955 BJZ=3ESJF(B,0)
960 F2=B*BJ1-PK*BJZ
965 S=F1+F2*F3*F4
970 IF(S) 565,565,600
600 E(1)=B

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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
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      SENSELIGHT 4
605 DO 535 NN=1,100
610 NNP=NN+1
612 X=E(NN)
      IF(SENSELIGHT 4) 660,615
615 BAB=X*PAB
620 BJ1=BESJF(X,1)
625 BYZ=BESYF(X,J)
630 BY1=BESYF(X,1)
635 BJZ=BESJF(X,J)
640 AJ1=BESJF(BA3,1)
645 AJZ=BESJF(BA3,C)
650 AY1=BESYF(BA3,1)
655 AYZ=BESYF(BA3,C)
660 F1=X*AJ1+WW*AJZ
665 F4=X*BY1-PK*BYZ
670 F3=X*AY1+WW*AYZ
675 F2=X*BJ1-PK*BJZ
680 D1=PAB*X*AJZ-WW*AJ1
685 D4=X*BYZ+PK*BY1
690 D3=PAB*X*AYZ-WW*AY1
695 D2=X*BJZ+PK*BJ1
500 F=F1+F4-F3+F2
505 DERIV=F1+D4+F4*D1-F3*D2-F2*D3
510 T=X-(F/DERIV)
515 IF(ABSF(1-X)-1.E-1) 1349,1349,1348
525 E(NNP)=T
535 CONTINUE
1346 IF(ABSF(T-X)-1.E-5) 1349,1349,1348
1348 KAUS=1
      GO TO 565
1349 IF (T) 1350,1350,1351
1350 KAUS=2
      GO TO 565
1351 IF(T-BOR) 1353,1352,1352
1352 IF(TOR-T) 1353,550,550
1353 KAUS=3
      GO TO 565
550 NRG=NRG+1
555 BGR(NRG)=T
556 IF(KAUS-1) 565,557,565
557 NIX(NRG)=NRG
559 KAUS=C
565 CONTINUE
572 NTERMS=NRG
5070 IF(NRG) 696,696,697
696 WRITE OUTPUT TAPE 3,2,CASE
      GO TO 2000
697 WRITE OUTPUT TAPE 3,3,CASE
700 CALL ROOT(BGR,NTERMS)
      PUNCH 42,NRG
      PUNCH 44,(BGR(I),I=1,NRG)
      WRITE OUTPUT TAPE 3,25
      DO 560 IJ=1,NRG
      IF(NIX(IJ)) 560,560,558

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558 WRITE OUTPUT TAPE 3,26,NIX(IJ),BGR(IJ)
560 CONTINUE
701 CALL CSOUP(PK,PH,PAB,NTERMS)
703 CALL PROFIL(PAB,NTERMS)
1702 IF(SENSESWITCH 1) 765,1704
765 CONTINUE
      CALL SAVE(U)
1704 GO TO 2000
      END

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CN207-
      SUBROUTINE PROFIL(CRIT,NTERMS)
      COMMON DUM,ZY,ZY1,ZJC,ZJ1,CA,CB,CM,THETA,BGR,NREG,NTHEM,CASE,PAB,
      2PH,PK,PS,WWW,PNCA,STD,STG,SM1,SM2,SM3,SM4,SM5,SM6,SM7,DP,DR,DT,
      3TAG,ADD,TTR,ALPHA,GENT,BCUT,TUNI,TZ,TA,THRS
      DIMENSION DUM(7936),ZY(150),ZY1(150),ZJC(150),ZJ1(150),CA(151),CB
      2(151),CM(151),THETA(26),BGR(151),VR(11),VTH(42),TRAN(11,-2),PNCA(1
      351),THRS(26)
      ISUM=1
      IF(SENSELIGHT 1) 12,20
20 CONTINUE
      READ INPUT TAPE 2,6,NVR,(VR(N),N=1,NVR)
12 CONTINUE
      SENSELIGHT=
      DO 90 I=1,NVR
      RR=VR(I)
      IF(RR+2.E-5-CRIT) 76,17,17
76 ISUM=ISUM + 1
      GO TO 90
17 DO 80 K=1,NTHEM
      TH=THETA(K)
      TRAN(I,K)=TFR(RR,PS,TH,NTERMS)
      TRAN(I,K)=TRAN(I,K)*(TUNI-TZ)+TZ
      IF(SENSESWITCH 1) 222, 60
222 CONTINUE
      CALL SAVE(U)
80 CONTINUE
90 CONTINUE
      WRITE OUTPUT TAPE 3,1,CASE,PS
      DO 110 L=ISUM,NVR
      WRITE OUTPUT TAPE 3,2,VR(L)
      DO 100 M=1,NTHEM
      WRITE OUTPUT TAPE 3,3,THRS(M),TRAN(L,M)
100 CONTINUE
      IF(SENSESWITCH 1) 333, 110
333 CONTINUE
      CALL SAVE(U)
110 CONTINUE
      RETURN
      1 FORMAT(1H1,17X,32HTEMPERATURE VERSUS TIME FOR CASE F9.4,4X,3HPS= F
      210.4//1H0,79X,3H2/8.9X,5H TIME,6X,5H TEMP/)
      2 FORMAT(1H0,76X,F7.4)
      3 FORMAT(1H0,69X,2PF6.4,1PE17.5)

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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
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6 FORMAT(15,13F5.0)
END
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SUBROUTINE TEST (X,T,KSIN)
  AX=XFIXF(X)
  NT=XFIXF(T)
  NX=XSIGNF(1,NX)
  NT=XSIGNF(1,NT)
  IF(NX+NT) 10,20,20
10 KSIN=1
  RETURN
20 KSIN=2
  RETURN
END
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CN216-
SUBROUTINE RCJT (A,I)
  DIMENSION A(151)
10 FORMAT(1H0,13)
12 FORMAT(1H+,3X,1P5E15.4)
  NN=1
  NNN=5
120 WRITE OUTPUT TAPE 3,10,NN
  WRITE OUTPUT TAPE 3,12,(A(N),N=NN,NNN)
  IF(NNN-I) 320,350,350
320 NN=NN+5
  NNN=NN+4
  GO TO 120
350 RETURN
END
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```
FUNCTION TFR(ROB,PV,ETA,NTERMS)
  COMMON DUM,ZY,ZY1,ZJ0,ZJ1,CA,CB,CM,THETA,BGR,NREG,NTHEN,CASE,PAB,
  2P1,P2,P3,WWW,PNCA,STD,STG,SM1,SM2,SM3,SM4,SM5,SM6,SM7,DP,DR,DT,
  3,TAG,ADD
  DIMENSION DUM(7986),ZY0(150),ZY1(150),ZJ0(150),ZJ1(150),CA(151),CB
  2(151),CM(151),THETA(26),BGR(151),PNCA(151)
610 SM4=0.0
620 SM5=0.0
630 DO 800 N=1,NTERMS
640 B=BGR(N)
650 DT=B**2
660 X=B*ROB
670 BJZ=BESJF(X,0)
680 BYZ=BESYF(X,0)
690 C4=CA(N)*BJZ-CB(N)*BYZ
700 P=CM(N)*CN
710 EBQT=EXP(-BQ*ETA)
720 ST4=P*(EBQT+PV*(4./EQ)*(1.-EBQT))
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FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
IN ANNULAR VESSELS: PROFIL P. 11

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725 SM4=SM4+ST4
730 IF(ABSF(ST4)-1.E-7) 310,810,740
740 IF(ABSF(STD)-1.E-7) 300,800,750
750 ST5=PNCA(N)*CN*((1.-ESGT)/30)*STD
760 SM5=SM5+ST5
800 CONTINUE
810 TFR=SM4+SM5
820 DT=TFR
830 DR=ROB
1850 RETURN
      END

```

```

      SUBROUTINE ORDUP (A,N)
C A SUBROUTINE FOR ARRANGING N ELEMENTS OF A SINGLE DIMENSIONAL ARRAY,A,
C IN ASCENDING ORDER. N MAY NOT EXCEED 601
      DIMENSION A(601)
      NM1=N-1
      DO 20 I=1,NM1
      IP1=I+1
      DO 10 J=IP1,N
      IF (A(I)-A(J)) 10,10,17
17  T=A(I)
      A(I)=A(J)
      A(J)=T
19  CONTINUE
20  CONTINUE
      L=0
      DO 40 K=1,NM1
      IF(SENSELIGHT 4) 40,30
30  IF(ABSF(A(K)-A(K+1)) -1.E-5) 31,31,35
35  L=L+1
      A(L)=A(K)
      GO TO 40
1  SENSELIGHT 4
40  CONTINUE
16  RETURN
      END

```

```

      SUBROUTINE CSOUP(PK,PH,PAB,INTERMS)
      COMMON DUM,ZY0,ZY1,ZJ0,ZJ1,CA,CB,CM,THETA,BGR,NREG,NTHEX,CASE,PAB,
      ZPH,PX,PS,WW,WWW,PNCA,STD,STC
      DIMENSION DUM(7986),ZY0(150),ZY1(150),ZJ0(150),ZJ1(150),CA(151),CB
      2(151),CM(151),THETA(28),BGR(151),PNCA(151)
10  WW=PK*PH
15  WQ=WW**2
20  PKQ=PK**2
25  DO 120 I=1,INTERMS
30  X=BGR(I)*PAB
40  AY1=SESYF(X,1)
45  AY2=SESYF(X,0)
50  AJ1=SESYF(X,1)

```

FORTRAN LISTING FOR PROGRAM TO FIND TEMPERATURES
IN ANNULAR VESSELS: PROFIL P. 12

```

55 AJZ=BESJF(X,0)
60 X=SGR(I)
35 XC=X**2
65 BJ1=BESJF(X,1)
70 BJZ=BESJF(X,0)
75 BY1=BESYF(X,1)
76 BYZ=BESYF(X,0)
80 AN=X*AY1+WW*AYZ
85 BN=X*AJ1+WW*AJZ
86 CNB=AN*BJZ-BN*BYZ
87 CNA= AN*AJZ-BN*AYZ
88 CF2=(XQ+PKQ)*(CNB**2)-(XQ+WQ)*(PA6*CNA)**2
100 CG=2.*XQ/CF2
102 CZ=(AN*(SJ1-PA6*AJ1)-BN*(BY1-PA6*AY1))/X
104 PNCA(I)=CG*WW*CNA
105 CM(I)=CG*CZ
110 CA(I)=AN
115 CB(I)=BN
120 CONTINUE
    RETURN
    END

```

Zeros of Bessel functions are entered by F&P as follows:

$J_0(X)$: 150th zero at 57777₆, 1st zero at 57552₃

$J_1(X)$: 150th zero at 57551₆, 1st zero at 57324₆

$Y_0(X)$: 150th zero at 57323₆, 1st zero at 57076₃

$Y_1(X)$: 150th zero at 57075₆, 1st zero at 56650₈

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PROGRAM NAME: QUATEX

Descriptive Title: Cation Exchange Column Operation with Four Ions,
Loading, Scrubbing, Elution

Program Author: DeMier, W. V., Cahn, D. U.

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 5

Central Memory Words: 150000B

Average Execution Time: 60 CP sec

Keywords: Ion Exchange, Cesium Recovery, Adsorption

Program Description: Estimates local loadings and effluent concentrations for transient operation of a cation exchange column during loading, scrubbing and elution for four monovalent cations with arbitrary initial loading. One cation may complex as a function of pH and complexant concentration. Finite difference in time and one space dimension uses bilinear isotherms and bilinear ion exchange kinetics with constant mass transfer coefficients. Eighteen subroutines.

Users of Program: G Jansen
WV DeMier
WJ Van Slyke (ARHCO)
KB Stewart
DU Cahn (LLL)
RL Engel

Documentation: Uses of program and equations were described in
BNWL-SA-4106.

Condition of Program: It works okay but the running time is very long and
the output is voluminous.

SAMPLE INPUT: QUATEX

QUATEX 12:18 02/23/74
 100 @S PUN PUN023,CUB928,GEORGE,150,6000 G JANSEN 3760 BLD
 G 9423576
 105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
 110 @PUL TEL INFO00
 115 @PRL TEL INFO00
 120 @PRL TEL CUB928
 125 @X ASG A=U44RR
 130 @N XNI CUN
 150 IN A
 350 TRI A
 1000 @I ASM,* TCHEK/S2SU,TCHEK/S2SU,TCHEK/R2SU
 1010 @IM PDP,* SHARE/S2FS,SHARE/S2FS
 1020 @IM FR5,* QUATEX/COFS,QUATEX/COFS,QUATEX/R2FS
 1030 @IM FR5,* DRIVER/S2FS,DRIVER/S2FS,DRIVER/R2FS
 1040 @IM FR5,* QINPUT/S2FS,QINPUT/S2FS,QINPUT/R2FS
 1050 @IM FR5,* QOUTPT/S2FS,QOUTPT/S2FS,QOUTPT/R2FS
 1060 @IM FR5,* LOAD1/S2FS,LOAD1/S2FS,LOAD1/R2FS
 1070 @IM FR5,* LOAD2/S2FS,LOAD2/S2FS,LOAD2/R2FS
 1080 @IM FR5,* LODE/S2FS,LODE/S2FS,LODE/R2FS
 1090 @IM FR5,* ADJU/S2FS,ADJU/S2FS,ADJU/R2FS
 1100 @IM FR5,* DAYWUN/S2FS,DAYWUN/S2FS,DAYWUN/R2FS
 1110 @IM FR5,* NIUFID/S2FS,NIUFID/S2FS,NIUFID/R2FS
 1120 @IM FR5,* SETINC/S2FS,SETINC/S2FS,SETINC/R2FS
 1130 @IM FR5,* AMCAR/S2FS,AMCAR/S2FS,AMCAR/R2FS
 1140 @IM FR5,* CONSUL/S2FS,CONSUL/S2FS,CONSUL/R2FS
 1150 @IM FR5,* SRFLIP/S2FS,SRFLIP/S2FS,SRFLIP/R2FS
 1160 @IM FR5,* SHOT/S2FS,SHOT/S2FS,SHOT/R2FS
 1170 @IM FR5,* COLINV/S2FS,COLINV/S2FS,COLINV/R2FS
 1180 @IM FR5,* FRONT/S2FS,FRONT/S2FS,FRONT/R2FS
 1270 @N XOT QUATEX/R2FS
 1280 SDIN E=.33,VOL=.04,QZ=3*2.56,F=3*.12,NFC=3,CHV=3*0.40,CZF=.1004,
 1290 .40,8.0,CZI=0.1,0.0,CCAF=.00015,.15,3.0,CBUN=.0001,.10,2.0,PK14
 =3*24,
 1300 S14=3*.25,D=1.9,LEAVE=3,KWICK=0,KIN=0,JT=3*100,JX=3*1,DX=.004
 1310 LIT=0,KDUMP=0,INVT=3*1005
 1320 @ PTN
 READY

SAMPLE OUTPUT: QUATEX P. 1

IN LOT QUATEX/R2F5

FROM LENGTH P22154

THIS ALLOCATION WAS DONE ON 15 FEB 74 AT 09:20:22

PRINT FROM PROGRAM QUATEX RUN AT 09:20:23 15 FEB 74

***** BED DATA AND INITIAL CONDITIONS

VOLUME= 4.000-02 LITERS
VOID FRACTION= 3.300-01
DIAMETER= 1.900+00 CM.
DISSOC. CONST. FOR NH4+H (PK1)= 1.8000-05
1ST DISSOC. CONST. FOR H2CO3 (PK1A)= 4.3100-07
2ND DISSOC. CONST. FOR H2CO3 (PK2A)= 5.6900-11
IONIZ. CONST. FOR WATER (KW)= .1000-13

***** FEED CONDITIONS:

FEED NUMBER:	1	2	3
FLOW RATE (L/HR):	1.2000-01	1.2000-01	1.2000-01
FEED VOLUME (LITERS):	4.0000-01	4.0000-01	4.0000-01
CONCENTRATIONS IN			
C21:	1.0000-01	4.0000-01	8.0000+00
C22:	0.0000	0.0000	0.0000
C23:	0.0000	0.0000	0.0000
CCAR:	1.5000-04	1.5000-01	3.0000+00
C60H:	1.0000-04	1.0000-01	2.0000+00
RATE CONSTANTS IN			
RK12:	0.0000	0.0000	0.0000
RK13:	0.0000	0.0000	0.0000
RK14:	2.4000+01	2.4000+01	2.4000+01
RK23:	0.0000	0.0000	0.0000
RK24:	0.0000	0.0000	0.0000
RK34:	0.0000	0.0000	0.0000
SELECTIVITY			
S12:	0.0000	0.0000	0.0000
S13:	0.0000	0.0000	0.0000
S14:	2.5000-01	2.5000-01	2.5000-01
S23:	0.0000	0.0000	0.0000
S24:	0.0000	0.0000	0.0000
S34:	0.0000	0.0000	0.0000

NT= 494 DELTA T= 2.02+0-02 HRS. IX= 11 DELTA X= 4.0000-03

CONCENTRATIONS FOR TIME STEP 1. 2.0240-02 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION-1	ION-2	ION-3	ION-4	CT4	PH	ION-1	ION-2	ION-3	ION-4
FEED	1.200-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	1.789-03	0.000	0.000	9.832-02	9.851-02	6.733	5.959-02	0.000	0.000	2.530+00
3	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
4	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
5	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
6	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
7	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
8	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
9	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
10	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
11	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
11	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	0.000

CONCENTRATIONS FOR TIME STEP 2. 4.0480-02 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION-1	ION-2	ION-3	ION-4	CT4	PH	ION-1	ION-2	ION-3	ION-4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	5.110-03	0.000	0.000	9.500-02	9.529-02	6.746	1.171-01	0.000	0.000	2.443+00
3	1.684-03	0.000	0.000	9.842-02	9.872-02	6.732	1.028-03	0.000	0.000	2.559+00
4	0.109-04	0.000	0.000	9.969-02	9.999-02	6.727	2.508-04	0.000	0.000	2.560+00
5	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
6	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.070
7	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.000
8	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.000
9	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.000
10	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.000
11	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	3.000
11	0.000	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	0.000

SAMPLE OUTPUT: QUATEX P. 2

CONCENTRATIONS FOR TIME STEP 3. 0.0720-02 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.661-04	4.000-04	9.316+00				
2	0.000-03	0.000	0.000	0.000-02	0.001-02	0.763	1.710-01	0.000	0.000	2.364+00
3	1.740-01	0.000	0.000	0.000-02	0.000-02	0.733	0.000-03	0.000	0.000	2.554+00
4	4.243-04	0.000	0.000	0.000-02	0.000-02	0.727	1.004-03	0.000	0.000	2.554+00
5	2.000-04	0.000	0.000	0.000-02	1.000-01	0.726	1.249-04	0.000	0.000	2.560+00
6	4.975-05	0.000	0.000	1.001-01	1.000-01	0.726	1.000-05	0.000	0.000	2.560+00
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CONCENTRATIONS FOR TIME STEP 4. 0.0960-02 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.661-04	4.000-04	9.316+00				
2	1.471-02	0.000	0.000	0.000-02	0.000-02	0.733	2.230-01	0.000	0.000	2.334+00
3	1.902-03	0.000	0.000	0.000-02	0.000-02	0.733	1.000-02	0.000	0.000	2.540+00
4	4.303-04	0.000	0.000	0.000-02	0.000-02	0.727	1.874-03	0.000	0.000	2.554+00
5	2.000-04	0.000	0.000	0.000-02	1.000-01	0.726	2.634-04	0.000	0.000	2.560+00
6	5.127-05	0.000	0.000	1.001-01	1.000-01	0.726	1.227-04	0.000	0.000	2.560+00
7	2.465-05	0.000	0.000	1.001-01	1.000-01	0.726	1.595-05	0.000	0.000	2.560+00
8	4.017-06	0.000	0.000	1.001-01	1.000-01	0.726	3.673-06	0.000	0.000	2.560+00
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CONCENTRATIONS FOR TIME STEP 5. 1.0120-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.661-04	4.000-04	9.316+00				
2	1.993-02	0.000	0.000	0.000-02	0.000-02	0.813	2.720-01	0.000	0.000	2.234+00
3	2.172-03	0.000	0.000	0.000-02	0.000-02	0.734	1.933-02	0.000	0.000	2.540+00
4	4.540-04	0.000	0.000	0.000-02	0.000-02	0.727	2.633-03	0.000	0.000	2.554+00
5	2.000-04	0.000	0.000	0.000-02	1.000-01	0.726	4.130-04	0.000	0.000	2.560+00
6	8.375-05	0.000	0.000	1.001-01	1.000-01	0.726	2.136-04	0.000	0.000	2.560+00
7	2.464-05	0.000	0.000	1.001-01	1.000-01	0.726	3.173-05	0.000	0.000	2.560+00
8	6.262-06	0.000	0.000	1.001-01	1.000-01	0.726	1.484-05	0.000	0.000	2.560+00
9	2.962-06	0.000	0.000	1.001-01	1.000-01	0.726	1.620-06	0.000	0.000	2.560+00
10	7.278-07	0.000	0.000	1.001-01	1.000-01	0.726	4.442-07	0.000	0.000	2.560+00
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CONCENTRATIONS FOR TIME STEP 6. 1.2144-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.661-04	4.000-04	9.316+00				
2	2.431-02	0.000	0.000	0.000-02	0.000-02	0.834	3.176-01	0.000	0.000	2.242+00
3	2.540-03	0.000	0.000	0.000-02	0.000-02	0.734	3.184-02	0.000	0.000	2.324+00
4	4.627-04	0.000	0.000	0.000-02	0.000-02	0.726	3.982-03	0.000	0.000	2.554+00
5	2.000-04	0.000	0.000	0.000-02	1.000-01	0.726	5.759-04	0.000	0.000	2.554+00
6	5.418-05	0.000	0.000	1.001-01	1.000-01	0.726	3.035-04	0.000	0.000	2.560+00
7	2.446-05	0.000	0.000	1.001-01	1.000-01	0.726	4.935-05	0.000	0.000	2.560+00
8	6.379-06	0.000	0.000	1.001-01	1.000-01	0.726	2.543-05	0.000	0.000	2.560+00
9	2.968-06	0.000	0.000	1.001-01	1.000-01	0.726	3.838-06	0.000	0.000	2.560+00
10	7.551-07	0.000	0.000	1.001-01	1.000-01	0.726	1.775-06	0.000	0.000	2.560+00
11	3.677-07	0.000	0.000	1.001-01	1.000-01	0.726	2.202-07	0.000	0.000	2.560+00
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

SAMPLE OUTPUT: QUATEX P. 3

CONCENTRATIONS FOR TIME STEP 7. 1.4160-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	2.907-02	0.000	0.000	7.105-02	7.153-02	6.861	3.605-01	0.000	0.000	2.199+00
3	3.144-03	0.000	0.000	9.606-02	9.726-02	6.733	4.627-02	0.000	0.000	2.514+00
4	5.161-04	0.000	0.000	9.959-02	9.988-02	6.723	5.435-03	0.000	0.000	2.555+00
5	2.027-04	0.000	0.000	4.990-02	1.002-01	6.726	7.559-04	0.000	0.000	2.559+00
6	5.557-05	0.000	0.000	1.000-01	1.003-01	6.726	3.927-04	0.000	0.000	2.560+00
7	2.441-05	0.000	0.000	1.001-01	1.004-01	6.726	6.785-05	0.000	0.000	2.560+00
8	6.551-06	0.000	0.000	1.001-01	1.004-01	6.726	3.009-05	0.000	0.000	2.560+00
9	2.958-06	0.000	0.000	1.001-01	1.004-01	6.726	5.908-06	0.000	0.000	2.560+00
10	7.716-07	0.000	0.000	1.001-01	1.004-01	6.726	3.125-06	0.000	0.000	2.560+00
11	3.592-07	0.000	0.000	1.001-01	1.004-01	6.726	4.642-07	0.000	0.000	2.560+00
11	3.592-07	0.000	0.000	1.001-01	1.004-01	6.726	4.642-07	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 8. 1.6192-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	3.258-02	0.000	0.000	6.753-02	6.782-02	6.881	4.014-01	0.000	0.000	2.159+00
3	3.870-03	0.000	0.000	9.624-02	9.653-02	6.741	6.262-02	0.000	0.000	2.497+00
4	5.615-04	0.000	0.000	9.954-02	9.984-02	6.726	7.193-03	0.000	0.000	2.553+00
5	2.039-04	0.000	0.000	9.990-02	1.002-01	6.726	9.593-04	0.000	0.000	2.559+00
6	5.694-05	0.000	0.000	1.000-01	1.003-01	6.726	4.815-04	0.000	0.000	2.560+00
7	2.439-05	0.000	0.000	1.001-01	1.004-01	6.726	8.719-05	0.000	0.000	2.560+00
8	6.717-06	0.000	0.000	1.001-01	1.004-01	6.726	4.742-05	0.000	0.000	2.560+00
9	2.952-06	0.000	0.000	1.001-01	1.004-01	6.726	8.204-06	0.000	0.000	2.560+00
10	7.924-07	0.000	0.000	1.001-01	1.004-01	6.726	4.437-06	0.000	0.000	2.560+00
11	3.578-07	0.000	0.000	1.001-01	1.004-01	6.726	7.218-07	0.000	0.000	2.560+00
11	3.578-07	0.000	0.000	1.001-01	1.004-01	6.726	7.218-07	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 9. 1.8210-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	3.537-02	0.000	0.000	6.475-02	6.503-02	6.897	4.405-01	0.000	0.000	2.119+00
3	4.754-03	0.000	0.000	9.535-02	9.565-02	6.745	8.034-02	0.000	0.000	2.480+00
4	6.222-04	0.000	0.000	9.948-02	9.978-02	6.723	9.431-03	0.000	0.000	2.551+00
5	2.060-04	0.000	0.000	9.990-02	1.002-01	6.726	1.193-03	0.000	0.000	2.559+00
6	5.830-05	0.000	0.000	1.000-01	1.003-01	6.726	5.705-04	0.000	0.000	2.559+00
7	2.440-05	0.000	0.000	1.001-01	1.004-01	6.726	1.074-04	0.000	0.000	2.560+00
8	6.879-06	0.000	0.000	1.001-01	1.004-01	6.726	5.805-05	0.000	0.000	2.560+00
9	2.950-06	0.000	0.000	1.001-01	1.004-01	6.726	1.054-05	0.000	0.000	2.560+00
10	8.125-07	0.000	0.000	1.001-01	1.004-01	6.726	5.736-06	0.000	0.000	2.560+00
11	3.571-07	0.000	0.000	1.001-01	1.004-01	6.726	9.922-07	0.000	0.000	2.560+00
11	3.571-07	0.000	0.000	1.001-01	1.004-01	6.726	9.922-07	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 10. 2.0240-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	3.751-02	0.000	0.000	6.261-02	6.289-02	6.911	4.784-01	0.000	0.000	2.082+00
3	5.775-03	0.000	0.000	9.433-02	9.463-02	6.749	9.893-02	0.000	0.000	2.461+00
4	7.019-04	0.000	0.000	9.940-02	9.976-02	6.724	1.220-02	0.000	0.000	2.548+00
5	2.094-04	0.000	0.000	9.989-02	1.002-01	6.726	1.468-03	0.000	0.000	2.559+00
6	5.968-05	0.000	0.000	1.000-01	1.003-01	6.726	6.604-04	0.000	0.000	2.559+00
7	2.445-05	0.000	0.000	1.001-01	1.004-01	6.726	1.243-04	0.000	0.000	2.560+00
8	7.037-06	0.000	0.000	1.001-01	1.004-01	6.726	6.861-05	0.000	0.000	2.560+00
9	2.951-06	0.000	0.000	1.001-01	1.004-01	6.726	1.297-05	0.000	0.000	2.560+00
10	8.320-07	0.000	0.000	1.001-01	1.004-01	6.726	7.022-06	0.000	0.000	2.560+00
11	3.568-07	0.000	0.000	1.001-01	1.004-01	6.726	1.275-06	0.000	0.000	2.560+00
11	3.568-07	0.000	0.000	1.001-01	1.004-01	6.726	1.275-06	0.000	0.000	2.560+00

SAMPLE OUTPUT: QUATEX P. 4

CONCENTRATIONS FOR TIME STEP 11. 2.2664-01 HRS SI CE START OF FEED 1. CURRENT FEED NO.= 1

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-00	9.316+90				
2	4.036-02	0.000	0.000	5.972-02	5.100-02	6.929	5.515-01	0.000	0.000	2.009+00
3	6.036-03	0.000	0.000	9.202-02	9.231-02	6.759	1.372-01	0.000	0.000	2.523+00
4	9.313-04	0.000	0.000	9.917-02	9.647-02	6.729	1.954-02	0.000	0.000	2.530+00
5	2.214-04	0.000	0.000	9.988-02	1.000-01	6.726	2.187-03	0.000	0.000	2.552+00
6	6.459-05	0.000	0.000	1.000-01	1.000-01	6.726	8.462-04	0.000	0.000	2.559+00
7	2.452-05	0.000	0.000	1.001-01	1.004-01	6.726	1.727-04	0.000	0.000	2.561+00
8	7.192-06	0.000	0.000	1.001-01	1.004-01	6.726	8.955-05	0.000	0.000	2.561+00
9	2.964-06	0.000	0.000	1.001-01	1.004-01	6.726	1.811-05	0.000	0.000	2.567+00
10	8.696-07	0.000	0.000	1.001-01	1.004-01	6.726	9.567-06	0.000	0.000	2.567+00
11	3.576-07	0.000	0.000	1.001-01	1.004-01	6.726	1.874-06	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 12. 2.2683-01 HRS SI CE START OF FEED 1. CURRENT FEED NO.= 1

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-00	9.316+90				
2	4.036-02	0.000	0.000	5.972-02	5.100-02	6.929	5.515-01	0.000	0.000	2.009+00
3	6.036-03	0.000	0.000	9.202-02	9.231-02	6.759	1.372-01	0.000	0.000	2.523+00
4	9.313-04	0.000	0.000	9.917-02	9.647-02	6.729	1.954-02	0.000	0.000	2.530+00
5	2.214-04	0.000	0.000	9.988-02	1.000-01	6.726	2.187-03	0.000	0.000	2.552+00
6	6.459-05	0.000	0.000	1.000-01	1.000-01	6.726	8.462-04	0.000	0.000	2.559+00
7	2.451-05	0.000	0.000	1.001-01	1.004-01	6.726	1.727-04	0.000	0.000	2.561+00
8	7.344-06	0.000	0.000	1.001-01	1.004-01	6.726	8.955-05	0.000	0.000	2.561+00
9	2.964-06	0.000	0.000	1.001-01	1.004-01	6.726	1.811-05	0.000	0.000	2.567+00
10	8.696-07	0.000	0.000	1.001-01	1.004-01	6.726	9.567-06	0.000	0.000	2.567+00
11	3.576-07	0.000	0.000	1.001-01	1.004-01	6.726	1.874-06	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 13. 2.2702-01 HRS SI CE START OF FEED 1. CURRENT FEED NO.= 1

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-00	9.316+90				
2	4.136-02	0.000	0.000	5.875-02	5.900-02	6.936	5.671-01	0.000	0.000	1.973+00
3	9.296-03	0.000	0.000	9.081-02	9.110-02	6.764	1.563-01	0.000	0.000	2.401+00
4	1.087-03	0.000	0.000	9.002-02	9.931-02	6.736	2.415-02	0.000	0.000	2.536+00
5	2.308-04	0.000	0.000	9.987-02	1.000-01	6.727	2.660-03	0.000	0.000	2.557+00
6	6.416-05	0.000	0.000	1.000-01	1.000-01	6.726	9.444-04	0.000	0.000	2.559+00
7	2.474-05	0.000	0.000	1.001-01	1.004-01	6.726	1.962-04	0.000	0.000	2.561+00
8	7.495-06	0.000	0.000	1.001-01	1.004-01	6.726	9.998-05	0.000	0.000	2.561+00
9	2.975-06	0.000	0.000	1.001-01	1.004-01	6.726	2.081-05	0.000	0.000	2.563+00
10	8.632-07	0.000	0.000	1.001-01	1.004-01	6.726	1.063-05	0.000	0.000	2.567+00
11	3.535-07	0.000	0.000	1.001-01	1.004-01	6.726	2.191-06	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 14. 2.8336-01 HRS SI CE START OF FEED 1. CURRENT FEED NO.= 1

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-00	9.316+90				
2	4.817-02	0.000	0.000	5.795-02	5.921-02	6.940	6.222-01	0.000	0.000	1.939+00
3	1.249-02	0.000	0.000	8.961-02	9.090-02	6.769	1.753-01	0.000	0.000	2.355+00
4	1.272-03	0.000	0.000	9.893-02	9.910-02	6.731	2.938-02	0.000	0.000	2.522+00
5	2.431-04	0.000	0.000	9.985-02	1.000-01	6.727	3.222-03	0.000	0.000	2.557+00
6	6.574-05	0.000	0.000	1.001-01	1.001-01	6.726	1.042-03	0.000	0.000	2.559+00
7	2.490-05	0.000	0.000	1.001-01	1.004-01	6.726	2.204-04	0.000	0.000	2.561+00
8	7.644-06	0.000	0.000	1.001-01	1.004-01	6.726	1.104-04	0.000	0.000	2.561+00
9	2.989-06	0.000	0.000	1.001-01	1.004-01	6.726	2.359-05	0.000	0.000	2.566+00
10	9.063-07	0.000	0.000	1.001-01	1.004-01	6.726	1.207-05	0.000	0.000	2.567+00
11	3.598-07	0.000	0.000	1.001-01	1.004-01	6.726	2.517-06	0.000	0.000	2.561+00

SAMPLE OUTPUT: QUATEX P. 5

CONCENTRATIONS FOR TIME STEP 15. 3.3360-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	4.247-02	0.000	0.000	5.725-02	5.753-02	6.946	6.568-01	0.000	0.000	1.903+03
3	1.165-02	0.000	0.000	8.846-02	8.875-02	6.774	1.940-01	0.000	0.000	2.366+00
4	1.448-03	0.000	0.000	9.862-02	9.891-02	6.732	3.519-02	0.000	0.000	2.525+00
5	2.589-04	0.000	0.000	9.945-02	1.001-01	6.727	3.908-03	0.000	0.000	2.556+03
6	6.789-05	0.000	0.000	1.000-01	1.003-01	6.726	1.159-03	0.000	0.000	2.559+03
7	2.509-05	0.000	0.000	1.001-01	1.004-01	6.726	2.466-04	0.000	0.000	2.560+03
8	7.792-06	0.000	0.000	1.001-01	1.004-01	6.726	1.208-04	0.000	0.000	2.560+03
9	3.005-06	0.000	0.000	1.001-01	1.004-01	6.726	2.045-05	0.000	0.000	2.560+03
10	9.243-07	0.000	0.000	1.001-01	1.004-01	6.726	1.335-05	0.000	0.000	2.560+03
11	3.615-07	0.000	0.000	1.001-01	1.004-01	6.726	2.853-06	0.000	0.000	2.560+03
11	3.615-07	0.000	0.000	1.001-01	1.004-01	6.726	2.853-06	0.000	0.000	2.560+03

CONCENTRATIONS FOR TIME STEP 16. 3.2384-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	4.351-02	0.000	0.000	5.661-02	5.689-02	6.951	6.911-01	0.000	0.000	1.869+00
3	1.274-02	0.000	0.000	8.737-02	8.766-02	6.779	2.125-01	0.000	0.000	2.348+00
4	1.735-03	0.000	0.000	9.837-02	9.866-02	6.733	4.154-02	0.000	0.000	2.518+00
5	2.787-04	0.000	0.000	9.933-02	1.001-01	6.727	4.717-03	0.000	0.000	2.555+03
6	7.022-05	0.000	0.000	1.000-01	1.003-01	6.726	1.230-03	0.000	0.000	2.559+03
7	2.531-05	0.000	0.000	1.001-01	1.004-01	6.726	2.725-04	0.000	0.000	2.560+03
8	7.940-06	0.000	0.000	1.001-01	1.004-01	6.726	1.313-04	0.000	0.000	2.560+03
9	3.024-06	0.000	0.000	1.001-01	1.004-01	6.726	2.939-05	0.000	0.000	2.560+03
10	9.421-07	0.000	0.000	1.001-01	1.004-01	6.726	1.461-05	0.000	0.000	2.560+03
11	3.635-07	0.000	0.000	1.001-01	1.004-01	6.726	3.199-06	0.000	0.000	2.560+03
11	3.635-07	0.000	0.000	1.001-01	1.004-01	6.726	3.199-06	0.000	0.000	2.560+03

CONCENTRATIONS FOR TIME STEP 17. 3.4408-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	4.412-02	0.000	0.000	5.600-02	5.628-02	6.955	7.250-01	0.000	0.000	1.835+00
3	1.375-02	0.000	0.000	8.636-02	8.665-02	6.784	2.307-01	0.000	0.000	2.329+00
4	2.013-03	0.000	0.000	9.809-02	9.839-02	6.734	4.835-02	0.000	0.000	2.512+00
5	3.030-04	0.000	0.000	9.980-02	1.001-01	6.727	5.670-03	0.000	0.000	2.554+03
6	7.268-05	0.000	0.000	1.000-01	1.003-01	6.726	1.412-03	0.000	0.000	2.559+03
7	2.558-05	0.000	0.000	1.001-01	1.004-01	6.726	3.003-04	0.000	0.000	2.560+03
8	8.069-06	0.000	0.000	1.001-01	1.004-01	6.726	1.419-04	0.000	0.000	2.560+03
9	3.066-06	0.000	0.000	1.001-01	1.004-01	6.726	3.241-05	0.000	0.000	2.560+03
10	9.598-07	0.000	0.000	1.001-01	1.004-01	6.726	1.597-05	0.000	0.000	2.560+03
11	3.658-07	0.000	0.000	1.001-01	1.004-01	6.726	3.554-06	0.000	0.000	2.560+03
11	3.658-07	0.000	0.000	1.001-01	1.004-01	6.726	3.554-06	0.000	0.000	2.560+03

CONCENTRATIONS FOR TIME STEP 18. 3.6432-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	4.472-02	0.000	0.000	5.540-02	5.568-02	6.959	7.546-01	0.000	0.000	1.801+00
3	1.468-02	0.000	0.000	8.543-02	8.572-02	6.788	2.487-01	0.000	0.000	2.311+00
4	2.318-03	0.000	0.000	9.779-02	9.808-02	6.735	5.556-02	0.000	0.000	2.504+00
5	3.324-04	0.000	0.000	9.977-02	1.001-01	6.727	6.732-03	0.000	0.000	2.553+03
6	7.567-05	0.000	0.000	1.000-01	1.003-01	6.726	1.599-03	0.000	0.000	2.558+03
7	2.569-05	0.000	0.000	1.001-01	1.004-01	6.726	3.296-04	0.000	0.000	2.560+03
8	8.240-06	0.000	0.000	1.001-01	1.004-01	6.726	1.525-04	0.000	0.000	2.560+03
9	3.070-06	0.000	0.000	1.001-01	1.004-01	6.726	3.590-05	0.000	0.000	2.560+03
10	9.774-07	0.000	0.000	1.001-01	1.004-01	6.726	1.713-05	0.000	0.000	2.560+03
11	3.684-07	0.000	0.000	1.001-01	1.004-01	6.726	3.919-06	0.000	0.000	2.560+03
11	3.684-07	0.000	0.000	1.001-01	1.004-01	6.726	3.919-06	0.000	0.000	2.560+03

SAMPLE OUTPUT: QUATEX P. 6

CONCENTRATIONS FOR TIME STEP 19. 4.050-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.001-04	4.000-04	9.316+04				
2	4.531-02	0.000	0.000	5.451-02	5.451-02	6.963	7.918-01	0.000	0.000	1.763+00
3	1.353-02	0.000	0.000	8.459-02	8.459-02	6.792	2.000-01	0.000	0.000	2.793+00
4	2.049-03	0.000	0.000	9.740-02	9.775-02	6.733	6.312-02	0.000	0.000	2.497+00
5	3.075-04	0.000	0.000	9.974-02	1.000-01	6.727	8.000-03	0.000	0.000	2.552+00
6	7.915-05	0.000	0.000	1.000-01	1.000-01	6.726	1.724-03	0.000	0.000	2.559+00
7	2.025-05	0.000	0.000	1.001-01	1.000-01	6.726	3.607-04	0.000	0.000	2.560+00
8	8.302-06	0.000	0.000	1.001-01	1.000-01	6.726	1.032-04	0.000	0.000	2.560+00
9	3.297-06	0.000	0.000	1.001-01	1.000-01	6.726	3.867-05	0.000	0.000	2.560+00
10	9.951-07	0.000	0.000	1.001-01	1.000-01	6.726	1.800-05	0.000	0.000	2.560+00
11	3.713-07	0.000	0.000	1.001-01	1.000-01	6.726	4.292-06	0.000	0.000	2.560+00
11	3.713-07	0.000	0.000	1.001-01	1.000-01	6.726	4.292-06	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 20. 4.080-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.001-04	4.000-04	9.316+04				
2	4.590-02	0.000	0.000	5.423-02	5.451-02	6.963	8.266-01	0.000	0.000	1.735+00
3	1.030-02	0.000	0.000	8.351-02	8.410-02	6.793	2.844-01	0.000	0.000	2.276+00
4	3.703-03	0.000	0.000	9.710-02	9.740-02	6.733	7.095-02	0.000	0.000	2.489+00
5	4.786-04	0.000	0.000	9.970-02	9.999-02	6.727	9.533-03	0.000	0.000	2.552+00
6	8.322-05	0.000	0.000	1.000-01	1.000-01	6.726	1.939-03	0.000	0.000	2.559+00
7	2.067-05	0.000	0.000	1.001-01	1.000-01	6.726	3.938-04	0.000	0.000	2.560+00
8	8.543-06	0.000	0.000	1.001-01	1.000-01	6.726	1.741-04	0.000	0.000	2.560+00
9	3.125-06	0.000	0.000	1.001-01	1.000-01	6.726	4.191-05	0.000	0.000	2.560+00
10	1.713-06	0.000	0.000	1.001-01	1.000-01	6.726	1.967-05	0.000	0.000	2.560+00
11	3.744-07	0.000	0.000	1.001-01	1.000-01	6.726	4.674-06	0.000	0.000	2.560+00
11	3.744-07	0.000	0.000	1.001-01	1.000-01	6.726	4.674-06	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 21. 4.204-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.001-04	4.000-04	9.316+04				
2	4.649-02	0.000	0.000	5.363-02	5.451-02	6.972	8.571-01	0.000	0.000	1.703+00
3	1.701-02	0.000	0.000	8.310-02	8.339-02	6.799	3.021-01	0.000	0.000	2.253+00
4	3.374-03	0.000	0.000	9.673-02	9.703-02	6.739	7.900-02	0.000	0.000	2.481+00
5	4.564-04	0.000	0.000	9.965-02	9.999-02	6.727	1.119-02	0.000	0.000	2.549+00
6	8.800-05	0.000	0.000	1.000-01	1.000-01	6.726	2.118-03	0.000	0.000	2.558+00
7	2.717-05	0.000	0.000	1.001-01	1.000-01	6.726	4.272-04	0.000	0.000	2.560+00
8	8.707-06	0.000	0.000	1.001-01	1.000-01	6.726	1.851-04	0.000	0.000	2.560+00
9	3.157-06	0.000	0.000	1.001-01	1.000-01	6.726	4.524-05	0.000	0.000	2.560+00
10	1.231-06	0.000	0.000	1.001-01	1.000-01	6.726	2.075-05	0.000	0.000	2.560+00
11	3.779-07	0.000	0.000	1.001-01	1.000-01	6.726	5.065-06	0.000	0.000	2.560+00
11	3.779-07	0.000	0.000	1.001-01	1.000-01	6.726	5.065-06	0.000	0.000	2.560+00

CONCENTRATIONS FOR TIME STEP 22. 4.528-01 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.001-04	4.000-04	9.316+04				
2	4.708-02	0.000	0.000	5.304-02	5.312-02	6.977	8.872-01	0.000	0.000	1.671+00
3	1.765-02	0.000	0.000	8.246-02	8.275-02	6.802	3.178-01	0.000	0.000	2.247+00
4	3.760-03	0.000	0.000	9.635-02	9.644-02	6.741	8.723-02	0.000	0.000	2.472+00
5	5.111-04	0.000	0.000	9.959-02	9.999-02	6.728	1.305-02	0.000	0.000	2.547+00
6	9.357-05	0.000	0.000	1.000-01	1.000-01	6.726	2.354-03	0.000	0.000	2.549+00
7	2.774-05	0.000	0.000	1.001-01	1.000-01	6.726	4.675-04	0.000	0.000	2.560+00
8	8.872-06	0.000	0.000	1.001-01	1.000-01	6.726	1.964-04	0.000	0.000	2.547+00
9	3.191-06	0.000	0.000	1.001-01	1.000-01	6.726	4.863-05	0.000	0.000	2.547+00
10	1.040-06	0.000	0.000	1.001-01	1.000-01	6.726	2.274-05	0.000	0.000	2.547+00
11	3.816-07	0.000	0.000	1.001-01	1.000-01	6.726	5.444-06	0.000	0.000	2.547+00
11	3.816-07	0.000	0.000	1.001-01	1.000-01	6.726	5.444-06	0.000	0.000	2.547+00

SAMPLE OUTPUT: QUATEX P. 7

CONCENTRATIONS FOR TIME STEP 150. 2.024000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	8.811-02	0.000	0.000	1.000-02	1.000-02	7.583	2.316+00	0.000	0.000	2.000-01
3	6.297-02	0.000	0.000	3.000-02	3.000-02	7.111	1.700+00	0.000	0.000	7.514-01
4	3.440-02	0.000	0.000	6.000-02	6.000-02	6.890	1.000+00	0.000	0.000	1.000-01
5	1.014-02	0.000	0.000	8.307-02	8.307-02	6.795	5.217-01	0.000	0.000	2.000-01
6	6.650-03	0.000	0.000	9.345-02	9.375-02	6.753	2.203-01	0.000	0.000	2.340+00
7	2.303-03	0.000	0.000	9.780-02	9.800-02	6.730	8.000-02	0.000	0.000	2.000-01
8	6.228-04	0.000	0.000	9.949-02	9.978-02	6.726	2.370-02	0.000	0.000	2.530+00
9	1.331-04	0.000	0.000	9.967-02	1.000-01	6.726	5.557-03	0.000	0.000	2.550+00
10	2.789-05	0.000	0.000	1.001-01	1.000-01	6.726	1.147-03	0.000	0.000	2.550+00
11	5.520-06	0.000	0.000	1.001-01	1.000-01	6.726	2.304-04	0.000	0.000	2.560+00
11	5.520-06	0.000	0.000	1.001-01	1.000-01	6.726	2.304-04	0.000	0.000	2.560+00

COLUMN INVENTORIES COLUMN EXIT INVENTORIES AT TIME STEP 100

ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4
2.42850-02	0.00000	0.00000	7.94403-02	2.83035-07	0.00000	0.00000	2.31656-02

SUPPLY OF FEED NUMBER 1 DEPLETED

CONCENTRATIONS FOR TIME STEP 164. 3.319400 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 1

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	1.000-01	0.000	0.000	1.861-04	4.000-04	9.316+00				
2	9.817-02	0.000	0.000	1.983-03	2.230-03	8.351	2.524+00	0.000	0.000	3.579-02
3	9.042-02	0.000	0.000	9.726-03	9.983-03	7.576	2.399+00	0.000	0.000	1.702-01
4	7.161-02	0.000	0.000	2.852-02	2.879-02	7.220	2.033+00	0.000	0.000	5.273-01
5	4.360-02	0.000	0.000	5.447-02	5.475-02	6.360	1.430+00	0.000	0.000	1.130+00
6	2.401-02	0.000	0.000	7.610-02	7.639-02	6.333	8.440-01	0.000	0.000	1.700+00
7	1.105-02	0.000	0.000	8.906-02	8.935-02	6.771	3.922-01	0.000	0.000	2.167+00
8	4.554-03	0.000	0.000	9.555-02	9.585-02	6.744	1.679-01	0.000	0.000	2.392+00
9	1.626-03	0.000	0.000	9.848-02	9.877-02	6.732	6.333-02	0.000	0.000	2.497+00
10	4.868-04	0.000	0.000	9.962-02	9.991-02	6.726	2.022-02	0.000	0.000	2.540+00
11	1.276-04	0.000	0.000	9.998-02	1.003-01	6.726	5.471-03	0.000	0.000	2.555+00
11	1.276-04	0.000	0.000	9.998-02	1.003-01	6.726	5.471-03	0.000	0.000	2.555+00

COLUMN INVENTORIES COLUMN EXIT INVENTORIES AT TIME STEP 164

ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4
3.98226-02	0.00000	0.00000	6.39026-02	7.10313-06	0.00000	0.00000	3.87653-02

WT= 494 DELTA T= 2.0240-02 HRS. X= 11 DELTA Y= 4.0400-03

CONCENTRATIONS FOR TIME STEP 165. 3.339600 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.393+00				
2	5.109-02	0.000	0.000	1.224-01	3.469-01	9.522	2.502+00	0.000	0.000	5.783-02
3	1.004-01	0.000	0.000	0.000	0.000	7.676	2.376+00	0.000	0.000	1.639-01
4	7.446-02	0.000	0.000	2.518-02	2.544-02	7.279	2.045+00	0.000	0.000	5.150-01
5	4.681-02	0.000	0.000	5.331-02	5.359-02	6.975	1.446+00	0.000	0.000	1.114+00
6	2.449-02	0.000	0.000	7.563-02	7.591-02	6.836	8.275-01	0.000	0.000	1.732+00
7	1.128-02	0.000	0.000	8.883-02	8.912-02	6.772	4.067-01	0.000	0.000	2.159+00
8	4.662-03	0.000	0.000	9.544-02	9.574-02	6.744	1.718-01	0.000	0.000	2.388+00
9	1.673-03	0.000	0.000	9.843-02	9.873-02	6.732	6.511-02	0.000	0.000	2.495+00
10	5.339-04	0.000	0.000	9.960-02	9.990-02	6.726	2.072-02	0.000	0.000	2.539+00
11	1.327-04	0.000	0.000	9.997-02	1.003-01	6.726	5.631-03	0.000	0.000	2.554+00
11	1.327-04	0.000	0.000	9.997-02	1.003-01	6.726	5.631-03	0.000	0.000	2.554+00

SAMPLE OUTPUT: QUATEX P. 8

CONCENTRATIONS FOR TIME STEP 166. 3.360000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.600-01	9.395+02	2.471+00	0.000	0.000	8.720-02
2	5.793-02	0.000	0.000	1.105-01	3.420-01	9.542	2.401+00	0.000	0.000	1.501-01
3	1.345-01	0.000	0.000	5.635-02	3.055-01	9.820	2.051+00	0.000	0.000	5.394-01
4	5.875-03	0.000	0.000	4.138-02	4.134-02	7.077	1.400+00	0.000	0.000	1.101-00
5	4.450-02	0.000	0.000	5.556-02	5.554-02	6.950	3.403-01	0.000	0.000	1.721+00
6	2.465-02	0.000	0.000	7.546-02	7.575-02	6.837				
7	1.149-02	0.000	0.000	8.867-02	8.891-02	6.773	4.056-01	0.000	0.000	2.151+00
8	4.771-03	0.000	0.000	9.533-02	9.503-02	6.745	1.758-01	0.000	0.000	2.384+00
9	1.721-03	0.000	0.000	9.838-02	9.804-02	6.732	6.033-02	0.000	0.000	2.493+00
10	5.213-04	0.000	0.000	9.958-02	9.928-02	6.720	2.103-02	0.000	0.000	2.531+00
11	1.593-04	0.000	0.000	9.997-02	1.003-01	6.726	5.918-03	0.000	0.000	2.554+00
11	1.383-04	0.000	0.000	9.997-02	1.003-01	6.726	5.918-03	0.000	0.000	2.554+00

CONCENTRATIONS FOR TIME STEP 167. 3.380100 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.600-01	9.395+02	2.438+00	0.000	0.000	1.214-01
2	5.359-02	0.000	0.000	1.203-01	3.468-01	9.536	2.335+00	0.000	0.000	1.749-01
3	8.463-02	0.000	0.000	9.454-02	3.157-01	9.625	2.061+00	0.000	0.000	4.982-01
4	9.023-02	0.000	0.000	8.319-02	3.014-01	9.575	1.436+00	0.000	0.000	1.064+00
5	1.953-01	0.000	0.000	7.445-02	2.805-01	9.718	8.486-01	0.000	0.000	1.711+00
6	2.239-02	0.000	0.000	7.772-02	7.801-02	6.825				
7	1.152-02	0.000	0.000	8.858-02	8.883-02	6.774	4.159-01	0.000	0.000	2.144+00
8	4.873-03	0.000	0.000	9.523-02	9.493-02	6.745	1.790-01	0.000	0.000	2.353+00
9	1.773-03	0.000	0.000	9.833-02	9.803-02	6.733	6.878-02	0.000	0.000	2.461+00
10	5.392-04	0.000	0.000	9.957-02	9.927-02	6.728	2.237-02	0.000	0.000	2.523+00
11	1.434-04	0.000	0.000	9.996-02	1.003-01	6.726	6.153-03	0.000	0.000	2.554+00
11	1.434-04	0.000	0.000	9.996-02	1.003-01	6.726	6.153-03	0.000	0.000	2.554+00

CONCENTRATIONS FOR TIME STEP 168. 3.400000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.600-01	9.395+02	2.407+00	0.000	0.000	1.534-01
2	5.244-02	0.000	0.000	1.212-01	3.475-01	9.526	2.366+00	0.000	0.000	1.943-01
3	8.463-02	0.000	0.000	9.396-02	3.151-01	9.627	2.060+00	0.000	0.000	5.002-01
4	8.672-02	0.000	0.000	9.238-02	3.133-01	9.634	1.510+00	0.000	0.000	1.057+00
5	7.133-02	0.000	0.000	1.651-01	3.787-01	9.593	8.718-01	0.000	0.000	1.823+00
6	5.374-02	0.000	0.000	1.201-01	3.463-01	9.530				
7	4.212-02	0.000	0.000	1.303-01	3.579-01	9.493	4.338-01	0.000	0.000	2.124+00
8	4.935-03	0.000	0.000	9.517-02	9.486-02	6.745	1.836-01	0.000	0.000	2.374+00
9	1.619-03	0.000	0.000	9.829-02	9.798-02	6.733	7.065-02	0.000	0.000	2.483+00
10	5.577-04	0.000	0.000	9.955-02	9.924-02	6.728	2.312-02	0.000	0.000	2.537+00
11	1.493-04	0.000	0.000	9.996-02	1.003-01	6.726	6.396-03	0.000	0.000	2.554+00
11	1.493-04	0.000	0.000	9.996-02	1.003-01	6.726	6.396-03	0.000	0.000	2.554+00

CONCENTRATIONS FOR TIME STEP 169. 3.420000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER CONCENTRATIONS IN SOLUTION CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.600-01	9.395+02	2.376+00	0.000	0.000	1.804-01
2	5.196-02	0.000	0.000	1.224-01	3.489-01	9.522	2.347+00	0.000	0.000	2.121+00
3	8.275-02	0.000	0.000	9.461-02	3.172-01	9.620	2.058+00	0.000	0.000	5.021-01
4	8.693-02	0.000	0.000	9.223-02	3.131-01	9.634	1.522+00	0.000	0.000	1.057+00
5	6.616-02	0.000	0.000	1.645-01	3.738-01	9.547	8.866-01	0.000	0.000	1.823+00
6	4.477-02	0.000	0.000	1.279-01	3.552-01	9.505				
7	2.787-02	0.000	0.000	1.429-01	3.721-01	9.460	4.472-01	0.000	0.000	2.113+00
8	1.964-02	0.000	0.000	1.503-01	3.803-01	9.440	1.929-01	0.000	0.000	2.367+00
9	1.866-03	0.000	0.000	9.824-02	9.793-02	6.733	7.252-02	0.000	0.000	2.487+00
10	5.764-04	0.000	0.000	9.951-02	9.920-02	6.726	2.338-02	0.000	0.000	2.534+00
11	1.548-04	0.000	0.000	9.995-02	1.002-01	6.726	6.646-03	0.000	0.000	2.553+00
11	1.548-04	0.000	0.000	9.995-02	1.002-01	6.726	6.646-03	0.000	0.000	2.553+00

SAMPLE OUTPUT: QUATEX P. 9

CONCENTRATIONS FOR TIME STEP 171. 4.4403+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.980-02	0.000	0.000	1.235-01	3.502-01	9.519	2.345+00	0.000	0.000	2.146-01
3	8.091-02	0.000	0.000	9.713-02	3.191-01	9.614	2.328+00	0.000	0.000	2.315-01
4	8.557-02	0.000	0.000	9.332-02	3.144-01	9.630	2.056+00	0.000	0.000	5.744-01
5	6.594-02	0.000	0.000	1.097-01	3.341-01	9.560	1.535+00	0.000	0.000	1.125+00
6	4.105-02	0.000	0.000	1.312-01	3.509-01	9.485	9.019-01	0.000	0.000	1.258+00
7	2.552-02	0.000	0.000	1.450-01	3.745-01	9.455	4.578-01	0.000	0.000	2.102+00
8	1.480-02	0.000	0.000	1.547-01	3.852-01	9.429	2.002-01	0.000	0.000	2.360+00
9	7.855-03	0.000	0.000	1.610-01	3.921-01	9.412	7.820-02	0.000	0.000	2.482+00
10	2.513-03	0.000	0.000	1.659-01	3.975-01	9.400	2.699-02	0.000	0.000	2.533+00
11	1.611-04	0.000	0.000	9.094-02	1.002-01	6.720	6.914-03	0.000	0.000	2.553+00
11	1.611-04	0.000	0.000	9.994-02	1.002-01	6.720	6.914-03	0.000	0.000	2.553+00

CONCENTRATIONS FOR TIME STEP 171. 3.4610+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.860-02	0.000	0.000	1.246-01	3.514-01	9.515	2.316+00	0.000	0.000	2.441-01
3	7.915-02	0.000	0.000	9.858-02	3.208-01	9.638	2.310+00	0.000	0.000	2.497-01
4	8.442-02	0.000	0.000	9.425-02	3.156-01	9.626	2.053+00	0.000	0.000	5.976-01
5	6.575-02	0.000	0.000	1.098-01	3.342-01	9.566	1.547+00	0.000	0.000	1.113+00
6	3.991-02	0.000	0.000	1.322-01	3.601-01	9.492	9.177-01	0.000	0.000	1.642+00
7	2.374-02	0.000	0.000	1.466-01	3.763-01	9.450	4.680-01	0.000	0.000	2.092+00
8	1.416-02	0.000	0.000	1.553-01	3.858-01	9.427	2.066-01	0.000	0.000	2.353+00
9	7.736-03	0.000	0.000	1.611-01	3.923-01	9.412	8.230-02	0.000	0.000	2.476+00
10	2.584-03	0.000	0.000	1.658-01	3.974-01	9.400	3.016-02	0.000	0.000	2.530+00
11	7.106-04	0.000	0.000	1.675-01	3.993-01	9.396	8.029-03	0.000	0.000	2.552+00
11	7.106-04	0.000	0.000	1.675-01	3.993-01	9.396	8.029-03	0.000	0.000	2.552+00

CONCENTRATIONS FOR TIME STEP 172. 3.4613+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.745-02	0.000	0.000	1.256-01	3.526-01	9.512	2.287+00	0.000	0.000	2.729-01
3	7.748-02	0.000	0.000	9.997-02	3.225-01	9.603	2.293+00	0.000	0.000	2.505-01
4	8.329-02	0.000	0.000	9.517-02	3.167-01	9.622	2.050+00	0.000	0.000	5.100-01
5	6.559-02	0.000	0.000	1.099-01	3.344-01	9.565	1.558+00	0.000	0.000	1.302+00
6	3.971-02	0.000	0.000	1.324-01	3.603-01	9.491	9.334-01	0.000	0.000	1.527+00
7	2.258-02	0.000	0.000	1.477-01	3.774-01	9.447	4.785-01	0.000	0.000	2.001+00
8	1.353-02	0.000	0.000	1.558-01	3.865-01	9.426	2.125-01	0.000	0.000	2.348+00
9	7.599-03	0.000	0.000	1.612-01	3.924-01	9.412	8.609-02	0.000	0.000	2.474+00
10	2.650-03	0.000	0.000	1.658-01	3.973-01	9.401	3.320-02	0.000	0.000	2.527+00
11	7.370-04	0.000	0.000	1.675-01	3.993-01	9.396	9.170-03	0.000	0.000	2.551+00
11	7.370-04	0.000	0.000	1.675-01	3.993-01	9.396	9.170-03	0.000	0.000	2.551+00

CONCENTRATIONS FOR TIME STEP 173. 3.5015+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.635-02	0.000	0.000	1.266-01	3.537-01	9.509	2.259+00	0.000	0.000	3.310-01
3	7.597-02	0.000	0.000	1.013-01	3.241-01	9.598	2.275+00	0.000	0.000	2.350-01
4	8.220-02	0.000	0.000	9.608-02	3.178-01	9.618	2.047+00	0.000	0.000	5.133-01
5	6.543-02	0.000	0.000	1.101-01	3.346-01	9.565	1.568+00	0.000	0.000	9.710-01
6	3.983-02	0.000	0.000	1.323-01	3.602-01	9.492	9.490-01	0.000	0.000	1.611+00
7	2.193-02	0.000	0.000	1.483-01	3.781-01	9.446	4.804-01	0.000	0.000	2.171+00
8	1.295-02	0.000	0.000	1.564-01	3.870-01	9.424	2.181-01	0.000	0.000	2.342+00
9	7.449-03	0.000	0.000	1.614-01	3.926-01	9.411	8.961-02	0.000	0.000	2.470+00
10	2.711-03	0.000	0.000	1.657-01	3.973-01	9.401	3.612-02	0.000	0.000	2.524+00
11	7.642-04	0.000	0.000	1.675-01	3.992-01	9.396	1.033-02	0.000	0.000	2.551+00
11	7.642-04	0.000	0.000	1.675-01	3.992-01	9.396	1.033-02	0.000	0.000	2.551+00

SAMPLE OUTPUT: QUATEX P. 10

CONCENTRATIONS FOR TIME STEP 174. 3.510000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.533-02	0.000	0.000	1.275-01	3.507-01	9.530	2.232+00	0.000	0.000	3.553-01
3	7.434-02	0.000	0.000	1.026-01	3.257-01	9.593	2.258+00	0.000	0.000	3.023-01
4	8.113-02	0.000	0.000	9.496-02	3.163-01	9.615	2.043+00	0.000	0.000	2.166-01
5	6.528-02	0.000	0.000	1.107-01	3.367-01	9.584	1.578+00	0.000	0.000	9.418-01
6	4.207-02	0.000	0.000	1.321-01	3.564-01	9.492	9.644-01	0.000	0.000	1.566+00
7	2.162-02	0.000	0.000	1.485-01	3.764-01	9.445	5.075-01	0.000	0.000	2.057+00
8	1.240-02	0.000	0.000	1.508-01	3.835-01	9.423	2.236-01	0.000	0.000	2.333+00
9	7.290-03	0.000	0.000	1.615-01	3.927-01	9.411	4.291-02	0.000	0.000	2.467+00
10	2.766-03	0.000	0.000	1.656-01	3.972-01	9.421	3.692-02	0.000	0.000	2.521+00
11	7.922-04	0.000	0.000	1.675-01	3.982-01	9.396	1.151-02	0.000	0.000	2.543+00
11	7.922-04	0.000	0.000	1.675-01	3.982-01	9.396	1.151-02	0.000	0.000	2.543+00

CONCENTRATIONS FOR TIME STEP 175. 3.542000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.429-02	0.000	0.000	1.284-01	3.557-01	9.534	2.205+00	0.000	0.000	3.553-01
3	7.237-02	0.000	0.000	1.038-01	3.271-01	9.536	2.241+00	0.000	0.000	3.151-01
4	8.003-02	0.000	0.000	9.781-02	3.139-01	9.611	2.030+00	0.000	0.000	2.273-01
5	6.508-02	0.000	0.000	1.104-01	3.349-01	9.564	1.568+00	0.000	0.000	9.723-01
6	4.234-02	0.000	0.000	1.313-01	3.537-01	9.493	9.794-01	0.000	0.000	1.552+00
7	2.166-02	0.000	0.000	1.486-01	3.754-01	9.445	5.116-01	0.000	0.000	2.049+00
8	1.207-02	0.000	0.000	1.572-01	3.840-01	9.420	2.204-01	0.000	0.000	2.333+00
9	7.126-03	0.000	0.000	1.617-01	3.929-01	9.411	4.603-02	0.000	0.000	2.464+00
10	2.614-03	0.000	0.000	1.658-01	3.972-01	9.401	4.158-02	0.000	0.000	2.513+00
11	8.208-04	0.000	0.000	1.674-01	3.992-01	9.396	1.271-02	0.000	0.000	2.547+00
11	8.208-04	0.000	0.000	1.674-01	3.992-01	9.396	1.271-02	0.000	0.000	2.547+00

CONCENTRATIONS FOR TIME STEP 176. 3.562000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.332-02	0.000	0.000	1.292-01	3.557-01	9.531	2.178+00	0.000	0.000	3.616-01
3	7.148-02	0.000	0.000	1.050-01	3.255-01	9.583	2.224+00	0.000	0.000	3.151-01
4	7.997-02	0.000	0.000	9.865-02	3.259-01	9.608	2.035+00	0.000	0.000	2.255-01
5	6.490-02	0.000	0.000	1.105-01	3.351-01	9.563	1.596+00	0.000	0.000	9.636-01
6	4.261-02	0.000	0.000	1.316-01	3.594-01	9.494	9.942-01	0.000	0.000	1.556+00
7	2.163-02	0.000	0.000	1.485-01	3.754-01	9.445	5.233-01	0.000	0.000	2.037+00
8	1.176-02	0.000	0.000	1.574-01	3.862-01	9.421	2.356-01	0.000	0.000	2.324+00
9	6.964-03	0.000	0.000	1.618-01	3.930-01	9.410	4.905-02	0.000	0.000	2.461+00
10	2.657-03	0.000	0.000	1.656-01	3.971-01	9.401	4.412-02	0.000	0.000	2.516+00
11	8.497-04	0.000	0.000	1.674-01	3.992-01	9.397	1.391-02	0.000	0.000	2.546+00
11	8.497-04	0.000	0.000	1.674-01	3.992-01	9.397	1.391-02	0.000	0.000	2.546+00

CONCENTRATIONS FOR TIME STEP 177. 3.582500 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.240-02	0.000	0.000	1.300-01	3.576-01	9.498	2.173+00	0.000	0.000	3.673-01
3	7.010-02	0.000	0.000	1.061-01	3.270-01	9.579	2.207+00	0.000	0.000	3.125-01
4	7.808-02	0.000	0.000	9.947-02	3.219-01	9.605	2.031+00	0.000	0.000	2.298-01
5	6.471-02	0.000	0.000	1.107-01	3.373-01	9.562	1.605+00	0.000	0.000	9.551-01
6	4.288-02	0.000	0.000	1.318-01	3.591-01	9.494	1.009+00	0.000	0.000	1.551+00
7	2.180-02	0.000	0.000	1.488-01	3.722-01	9.445	5.349-01	0.000	0.000	2.025+00
8	1.155-02	0.000	0.000	1.576-01	3.835-01	9.421	2.417-01	0.000	0.000	2.313+00
9	6.808-03	0.000	0.000	1.619-01	3.937-01	9.410	1.626-01	0.000	0.000	2.454+00
10	2.693-03	0.000	0.000	1.653-01	3.971-01	9.401	4.605-02	0.000	0.000	2.513+00
11	8.790-04	0.000	0.000	1.674-01	3.991-01	9.397	1.512-02	0.000	0.000	2.545+00
11	8.790-04	0.000	0.000	1.674-01	3.991-01	9.397	1.512-02	0.000	0.000	2.545+00

SAMPLE OUTPUT: QUATEX P. 11

CONCENTRATIONS FOR TIME STEP 178. 3.627+00 MRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					PH	CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4		ION 1	ION 2	ION 3	ION 4
FEED	0.700	0.000	0.000	1.642-01	4.000-01	9.395+00				
2	4.151-02	0.000	0.000	1.308-01	3.565-01	9.489	2.127+00	0.000	0.000	4.325-01
3	0.063-02	0.000	0.000	1.072-01	3.312-01	9.575	2.171+00	0.000	0.000	3.689-01
4	7.711-02	0.000	0.000	1.003-01	3.229-01	9.632	2.076+00	0.000	0.000	5.346-01
5	0.451-02	0.000	0.000	1.109-01	3.358-01	9.562	1.613+00	0.000	0.000	9.472-01
6	4.114-02	0.000	0.000	1.311-01	3.589-01	9.495	1.023+00	0.000	0.000	1.537-00
7	2.203-02	0.000	0.000	1.482-01	3.700-01	9.440	5.463-01	0.000	0.000	2.014-00
8	1.141-02	0.000	0.000	1.578-01	3.886-01	9.421	2.481-01	0.000	0.000	2.312-00
9	6.001-03	0.000	0.000	1.821-01	3.933-01	9.410	1.049-01	0.000	0.000	2.455-00
10	2.923-03	0.000	0.000	1.855-01	3.971-01	9.401	4.886-02	0.000	0.000	2.511-00
11	9.784-04	0.000	0.000	1.674-01	3.991-01	9.397	1.634-02	0.000	0.000	2.544-00
11	9.084-04	0.000	0.000	1.674-01	3.991-01	9.397	1.634-02	0.000	0.000	2.544-00

CONCENTRATIONS FOR TIME STEP 179. 3.6230+00 MRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					PH	CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4		ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	4.266-02	0.000	0.000	1.315-01	3.593-01	9.494	2.103+00	0.000	0.000	4.572-01
3	0.754-02	0.000	0.000	1.043-01	3.325-01	9.571	2.175+00	0.000	0.000	3.689-01
4	7.617-02	0.000	0.000	1.011-01	3.238-01	9.599	2.021+00	0.000	0.000	5.389-01
5	6.431-02	0.000	0.000	1.110-01	3.357-01	9.561	1.620+00	0.000	0.000	9.397-01
6	4.140-02	0.000	0.000	1.309-01	3.586-01	9.495	1.037+00	0.000	0.000	1.523-00
7	2.228-02	0.000	0.000	1.479-01	3.777-01	9.447	5.578-01	0.000	0.000	2.002-00
8	1.134-02	0.000	0.000	1.578-01	3.887-01	9.420	2.547-01	0.000	0.000	2.305-00
9	6.527-03	0.000	0.000	1.622-01	3.935-01	9.409	1.079-01	0.000	0.000	2.452-00
10	2.948-03	0.000	0.000	1.655-01	3.971-01	9.401	5.107-02	0.000	0.000	2.509-00
11	9.378-04	0.000	0.000	1.673-01	3.991-01	9.397	1.755-02	0.000	0.000	2.542-00
11	9.378-04	0.000	0.000	1.673-01	3.991-01	9.397	1.755-02	0.000	0.000	2.542-00

CONCENTRATIONS FOR TIME STEP 180. 3.6432+00 MRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					PH	CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4		ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	3.998-02	0.000	0.000	1.323-01	3.602-01	9.492	2.079+00	0.000	0.000	4.813-01
3	6.633-02	0.000	0.000	1.093-01	3.337-01	9.568	2.159+00	0.000	0.000	4.007-01
4	7.524-02	0.000	0.000	1.018-01	3.248-01	9.596	2.016+00	0.000	0.000	5.430-01
5	6.410-02	0.000	0.000	1.112-01	3.359-01	9.561	1.627+00	0.000	0.000	9.327-01
6	4.165-02	0.000	0.000	1.307-01	3.584-01	9.496	1.051+00	0.000	0.000	1.509-00
7	2.256-02	0.000	0.000	1.477-01	3.774-01	9.447	5.693-01	0.000	0.000	1.991+00
8	1.133-02	0.000	0.000	1.576-01	3.887-01	9.420	2.614-01	0.000	0.000	2.296+00
9	6.407-03	0.000	0.000	1.623-01	3.936-01	9.409	1.109-01	0.000	0.000	2.446+00
10	2.969-03	0.000	0.000	1.655-01	3.970-01	9.401	5.320-02	0.000	0.000	2.507+00
11	9.670-04	0.000	0.000	1.673-01	3.990-01	9.397	1.876-02	0.000	0.000	2.541+00
11	9.670-04	0.000	0.000	1.673-01	3.990-01	9.397	1.876-02	0.000	0.000	2.541+00

CONCENTRATIONS FOR TIME STEP 181. 3.663+00 MRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					PH	CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4		ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	3.995-02	0.000	0.000	1.330-01	3.609-01	9.489	2.055+00	0.000	0.000	5.050-01
3	6.517-02	0.000	0.000	1.103-01	3.348-01	9.564	2.144+00	0.000	0.000	4.163-01
4	7.434-02	0.000	0.000	1.026-01	3.257-01	9.593	2.011+00	0.000	0.000	5.491-01
5	6.349-02	0.000	0.000	1.114-01	3.361-01	9.566	1.634+00	0.000	0.000	9.260-01
6	4.149-02	0.000	0.000	1.305-01	3.581-01	9.497	1.064+00	0.000	0.000	1.496+00
7	2.264-02	0.000	0.000	1.474-01	3.772-01	9.440	5.808-01	0.000	0.000	1.975+00
8	1.137-02	0.000	0.000	1.578-01	3.886-01	9.420	2.683-01	0.000	0.000	2.292+00
9	6.398-03	0.000	0.000	1.624-01	3.937-01	9.409	1.130-01	0.000	0.000	2.444+00
10	2.985-03	0.000	0.000	1.655-01	3.970-01	9.401	5.524-02	0.000	0.000	2.505+00
11	9.960-04	0.000	0.000	1.673-01	3.990-01	9.397	1.996-02	0.000	0.000	2.541+00
11	9.960-04	0.000	0.000	1.673-01	3.990-01	9.397	1.996-02	0.000	0.000	2.541+00

SAMPLE OUTPUT: QUATEX P. 12

CONCENTRATIONS FOR TIME STEP 152.

3.033+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	3.029-02	0.000	0.000	1.336-01	3.617-01	9.487	2.032+00	0.000	0.000	5.283-01
3	6.404-02	0.000	0.000	1.113-01	3.365-01	9.505	2.120+00	0.000	0.000	4.316-01
4	7.340-02	0.000	0.000	1.033-01	3.205-01	9.500	2.036+00	0.000	0.000	5.544-01
5	6.307-02	0.000	0.000	1.116-01	3.303-01	9.569	1.640+00	0.000	0.000	9.163-01
6	4.212-02	0.000	0.000	1.303-01	3.970-01	9.495	1.077+00	0.000	0.000	1.483+01
7	2.313-02	0.000	0.000	1.472-01	3.769-01	9.449	5.923-01	0.000	0.000	1.963+01
8	1.144-02	0.000	0.000	1.577-01	3.886-01	9.421	2.753-01	0.000	0.000	2.265+01
9	6.218-03	0.000	0.000	1.625-01	3.928-01	9.409	1.171-01	0.000	0.000	2.443+01
10	2.998-03	0.000	0.000	1.654-01	3.970-01	9.401	5.732-02	0.000	0.000	2.503+01
11	1.725-03	0.000	0.000	1.672-01	3.989-01	9.397	2.116-02	0.000	0.000	2.530+01

CONCENTRATIONS FOR TIME STEP 153.

3.703+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	3.756-02	0.000	0.000	1.343-01	3.624-01	9.445	2.009+00	0.000	0.000	5.510-01
3	6.295-02	0.000	0.000	1.122-01	3.379-01	9.557	2.113+00	0.000	0.000	4.468-01
4	7.259-02	0.000	0.000	1.040-01	3.274-01	9.527	2.099+00	0.000	0.000	5.509-01
5	6.345-02	0.000	0.000	1.118-01	3.368-01	9.559	1.646+00	0.000	0.000	9.163-01
6	4.235-02	0.000	0.000	1.301-01	3.976-01	9.493	1.070+00	0.000	0.000	1.473+01
7	2.342-02	0.000	0.000	1.469-01	3.766-01	9.448	6.637-01	0.000	0.000	1.995+01
8	1.155-02	0.000	0.000	1.576-01	3.835-01	9.421	2.824-01	0.000	0.000	2.273+01
9	6.150-03	0.000	0.000	1.626-01	3.938-01	9.405	1.203-01	0.000	0.000	2.445+01
10	3.099-03	0.000	0.000	1.654-01	3.970-01	9.401	5.915-02	0.000	0.000	2.501+01
11	1.753-03	0.000	0.000	1.672-01	3.989-01	9.397	2.234-02	0.000	0.000	2.538+01

CONCENTRATIONS FOR TIME STEP 154.

3.724+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	3.695-02	0.000	0.000	1.349-01	3.632-01	9.434	1.987+00	0.000	0.000	5.738-01
3	6.190-02	0.000	0.000	1.131-01	3.381-01	9.554	2.098+00	0.000	0.000	4.618-01
4	7.175-02	0.000	0.000	1.046-01	3.283-01	9.584	1.994+00	0.000	0.000	5.658-01
5	6.322-02	0.000	0.000	1.125-01	3.369-01	9.550	1.651+00	0.000	0.000	9.096-01
6	4.257-02	0.000	0.000	1.299-01	3.974-01	9.494	1.071+00	0.000	0.000	1.457+01
7	2.371-02	0.000	0.000	1.467-01	3.763-01	9.450	6.151-01	0.000	0.000	1.945+01
8	1.168-02	0.000	0.000	1.575-01	3.863-01	9.421	2.896-01	0.000	0.000	2.270+01
9	6.100-03	0.000	0.000	1.626-01	3.939-01	9.408	1.237-01	0.000	0.000	2.436+01
10	3.218-03	0.000	0.000	1.654-01	3.970-01	9.401	6.104-02	0.000	0.000	2.499+01
11	1.781-03	0.000	0.000	1.672-01	3.989-01	9.397	2.351-02	0.000	0.000	2.536+01

CONCENTRATIONS FOR TIME STEP 155.

3.744+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+00				
2	3.616-02	0.000	0.000	1.355-01	3.638-01	9.482	1.965+00	0.000	0.000	5.753-01
3	6.288-02	0.000	0.000	1.140-01	3.391-01	9.551	2.083+00	0.000	0.000	4.746-01
4	7.292-02	0.000	0.000	1.054-01	3.291-01	9.582	1.999+00	0.000	0.000	5.713-01
5	6.299-02	0.000	0.000	1.122-01	3.370-01	9.557	1.657+00	0.000	0.000	9.135-01
6	4.278-02	0.000	0.000	1.297-01	3.972-01	9.499	1.115+00	0.000	0.000	1.445+01
7	2.400-02	0.000	0.000	1.464-01	3.760-01	9.451	6.264-01	0.000	0.000	1.734+01
8	1.103-02	0.000	0.000	1.574-01	3.882-01	9.422	2.969-01	0.000	0.000	2.263+01
9	6.267-03	0.000	0.000	1.626-01	3.939-01	9.408	1.271-01	0.000	0.000	2.433+01
10	3.226-03	0.000	0.000	1.654-01	3.970-01	9.401	6.280-02	0.000	0.000	2.507+01
11	1.108-03	0.000	0.000	1.672-01	3.989-01	9.397	2.467-02	0.000	0.000	2.535+01

SAMPLE OUTPUT: QUATEX P. 13

CONCENTRATIONS FOR TIME STEP 100. 1.7700+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+01				
2	3.550-02	0.000	0.000	1.361-01	3.645-01	9.483	1.943+00	0.000	0.000	6.169-01
3	5.990-02	0.000	0.000	1.148-01	3.461-01	9.543	2.009+00	0.000	0.000	4.912-01
4	7.211-02	0.000	0.000	1.061-01	3.299-01	9.574	1.943+00	0.000	0.000	5.772-01
5	6.275-02	0.000	0.000	1.124-01	3.373-01	9.557	1.681+00	0.000	0.000	8.985-01
6	4.299-02	0.000	0.000	1.205-01	3.576-01	9.506	1.127+00	0.000	0.000	1.433+00
7	2.428-02	0.000	0.000	1.461-01	3.757-01	9.451	6.377-01	0.000	0.000	1.922+00
8	1.293-02	0.000	0.000	1.572-01	3.880-01	9.422	3.643-01	0.000	0.000	2.255+00
9	6.250-03	0.000	0.000	1.626-01	3.939-01	9.403	1.397-01	0.000	0.000	2.429+00
10	3.233-03	0.000	0.000	1.654-01	3.970-01	9.401	6.473-02	0.000	0.000	2.495+00
11	1.135-03	0.000	0.000	1.671-01	3.989-01	9.397	2.532-02	0.000	0.000	2.534+00
11	1.135-03	0.000	0.000	1.671-01	3.989-01	9.397	2.582-02	0.000	0.000	2.534+00

CONCENTRATIONS FOR TIME STEP 200. 4.0480+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+01				
2	2.808-02	0.000	0.000	1.427-01	3.719-01	9.461	1.677+00	0.000	0.000	8.825-01
3	4.375-02	0.000	0.000	1.245-01	3.513-01	9.516	1.832+00	0.000	0.000	6.781-01
4	6.326-02	0.000	0.000	1.145-01	3.397-01	9.549	1.892+00	0.000	0.000	6.675-01
5	5.903-02	0.000	0.000	1.156-01	3.415-01	9.545	1.697+00	0.000	0.000	8.633-01
6	4.510-02	0.000	0.000	1.276-01	3.549-01	9.506	1.269+00	0.000	0.000	1.291+00
7	2.803-02	0.000	0.000	1.428-01	3.725-01	9.461	7.892-01	0.000	0.000	1.771+00
8	1.489-02	0.000	0.000	1.546-01	3.851-01	9.429	4.121-01	0.000	0.000	2.142+00
9	7.279-03	0.000	0.000	1.617-01	3.929-01	9.411	1.839-01	0.000	0.000	2.370+00
10	3.352-03	0.000	0.000	1.651-01	3.966-01	9.402	9.239-02	0.000	0.000	2.468+00
11	1.475-03	0.000	0.000	1.668-01	3.985-01	9.398	4.134-02	0.000	0.000	2.519+00
11	1.475-03	0.000	0.000	1.668-01	3.985-01	9.398	4.134-02	0.000	0.000	2.519+00

COLUMN INVENTORIES				COLUMN EXIT INVENTORIES				AT TIME STEP 200	
ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4		
4.11603-02	0.00000	0.00000	6.75197-02	8.99479-05	0.00000	0.00000	6.92911-02		

CONCENTRATIONS FOR TIME STEP 300. 6.0720+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.682-01	4.000-01	9.395+01				
2	9.100-03	0.000	0.000	1.599-01	3.909-01	9.415	7.093-01	0.000	0.000	1.851+01
3	1.855-02	0.000	0.000	1.513-01	3.814-01	9.437	1.052+00	0.000	0.000	1.505+01
4	2.713-02	0.000	0.000	1.436-01	3.729-01	9.459	1.271+00	0.000	0.000	1.289+01
5	3.391-02	0.000	0.000	1.375-01	3.661-01	9.476	1.393+00	0.000	0.000	1.167+01
6	3.747-02	0.000	0.000	1.344-01	3.625-01	9.485	1.411+00	0.000	0.000	1.149+01
7	3.627-02	0.000	0.000	1.354-01	3.637-01	9.482	1.301+00	0.000	0.000	1.259+01
8	3.016-02	0.000	0.000	1.409-01	3.698-01	9.466	1.063+00	0.000	0.000	1.497+01
9	2.155-02	0.000	0.000	1.436-01	3.764-01	9.445	7.561-01	0.000	0.000	1.804+01
10	1.365-02	0.000	0.000	1.557-01	3.863-01	9.426	4.748-01	0.000	0.000	2.021+01
11	7.892-03	0.000	0.000	1.610-01	3.921-01	9.412	2.758-01	0.000	0.000	2.284+01
11	7.892-03	0.000	0.000	1.610-01	3.921-01	9.412	2.758-01	0.000	0.000	2.284+01

COLUMN INVENTORIES				COLUMN EXIT INVENTORIES				AT TIME STEP 300	
ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4		
3.91506-02	0.00000	0.00000	6.85294-02	1.10744-03	0.00000	0.00000	1.65426-01		

SUPPLY OF FEED NUMBER 2 DEPLETED

SAMPLE OUTPUT: QUATEX P. 14

CONCENTRATIONS FOR TIME STEP 328.

6.659000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 2

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	1.662-01	6.666+00	9.395+00	5.736-01	0.000	0.000	1.747+00
2	7.113-03	0.000	0.000	1.617-01	1.726+01	9.411	9.051-01	0.000	0.000	1.655+00
3	1.500-02	0.000	0.000	1.500-01	1.500+01	9.404	1.135+00	0.000	0.000	1.425+00
4	2.271-02	0.000	0.000	1.475-01	1.777+01	9.404	1.282+00	0.000	0.000	1.275+00
5	2.922-02	0.000	0.000	1.417-01	1.708+01	9.404	1.343+00	0.000	0.000	1.217+00
6	3.361-02	0.000	0.000	1.378-01	1.604+01	9.473	1.302+00	0.000	0.000	1.253+00
7	3.457-02	0.000	0.000	1.369-01	1.599-01	9.469	1.142+00	0.000	0.000	1.413+00
8	3.121-02	0.000	0.000	1.400-01	1.706+01	9.452	8.865-01	0.000	0.000	1.674+00
9	2.443-02	0.000	0.000	1.529-01	1.532-01	9.413	5.195-01	0.000	0.000	1.945+00
10	1.663-02	0.000	0.000	1.586-01	1.505-01	9.413	3.736-01	0.000	0.000	2.181+00
11	1.746-02	0.000	0.000	1.546-01	1.605-01	9.413	3.786-01	0.000	0.000	2.181+00

COLUMN INVENTORIES

COLUMN EXIT INVENTORIES

AT TIME STEP 328

ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4
3.65273-02	0.00000	0.00000	6.71027-02	1.73385-03	0.00000	0.00000	1.92002-01

NT= 494 DELTA TE 2.02+0-02 HRS. ---NKE 11 - DELTA TE 2.000-03

CONCENTRATIONS FOR TIME STEP 329.

6.659000 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	6.666+00	9.395+00	5.033-01	0.000	0.000	2.057+00
2	1.159-01	0.000	0.000	3.257+00	7.834+00	9.413	9.527-01	0.000	0.000	1.607+00
3	4.928-02	0.000	0.000	1.240-01	1.507-01	9.517	1.137+00	0.000	0.000	1.423+00
4	2.842-02	0.000	0.000	1.428-01	1.714-01	9.462	1.279+00	0.000	0.000	1.281+00
5	3.219-02	0.000	0.000	1.408-01	1.658-01	9.466	1.341+00	0.000	0.000	1.219+00
6	3.370-02	0.000	0.000	1.377-01	1.663-01	9.475	1.302+00	0.000	0.000	1.253+00
7	3.454-02	0.000	0.000	1.370-01	1.655-01	9.473	1.144+00	0.000	0.000	1.415+00
8	3.123-02	0.000	0.000	1.399-01	1.668-01	9.469	8.906-01	0.000	0.000	1.669+00
9	2.452-02	0.000	0.000	1.459-01	1.755-01	9.452	5.151-01	0.000	0.000	1.945+00
10	1.664-02	0.000	0.000	1.527-01	1.501-01	9.419	3.824-01	0.000	0.000	2.173+00
11	1.256-02	0.000	0.000	1.585-01	1.694-01	9.419	3.824-01	0.000	0.000	2.173+00

CONCENTRATIONS FOR TIME STEP 330.

6.6792+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	6.666+00	9.395+00	4.664-01	0.000	0.000	2.094+00
2	1.569-01	0.000	0.000	3.222+00	7.845+00	9.412	9.649-01	0.000	0.000	1.539+00
3	4.273-02	0.000	0.000	1.303-01	1.568-01	9.497	1.143+00	0.000	0.000	1.417+00
4	3.434-02	0.000	0.000	1.371-01	1.657-01	9.477	1.278+00	0.000	0.000	1.232+00
5	3.251-02	0.000	0.000	1.388-01	1.675-01	9.472	1.339+00	0.000	0.000	1.221+00
6	3.432-02	0.000	0.000	1.372-01	1.657-01	9.477	1.301+00	0.000	0.000	1.255+00
7	3.467-02	0.000	0.000	1.369-01	1.651-01	9.478	1.146+00	0.000	0.000	1.411+00
8	3.129-02	0.000	0.000	1.399-01	1.667-01	9.469	8.946-01	0.000	0.000	1.665+00
9	2.461-02	0.000	0.000	1.454-01	1.754-01	9.452	5.197-01	0.000	0.000	1.950+00
10	1.735-02	0.000	0.000	1.527-01	1.430-01	9.434	3.863-01	0.000	0.000	2.174+00
11	1.265-02	0.000	0.000	1.584-01	1.693-01	9.419	3.863-01	0.000	0.000	2.174+00

CONCENTRATIONS FOR TIME STEP 331.

6.6994+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION
INCREMENT
NUMBER

CONCENTRATIONS IN SOLUTION

CONCENTRATIONS ON EXCHANGER

	ION 1	ION 2	ION 3	ION 4	CTA	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	6.666+00	9.395+00	3.838-01	0.000	0.000	2.171+00
2	1.290-01	0.000	0.000	3.245+00	7.871+00	9.404	9.535-01	0.000	0.000	1.607+00
3	1.671-01	0.000	0.000	3.191+00	7.811+00	9.416	1.142+00	0.000	0.000	1.401+00
4	2.690-02	0.000	0.000	1.425-01	1.711-01	9.463	1.277+00	0.000	0.000	1.243+00
5	3.295-02	0.000	0.000	1.384-01	1.671-01	9.473	1.338+00	0.000	0.000	1.222+00
6	3.492-02	0.000	0.000	1.364-01	1.651-01	9.476	1.301+00	0.000	0.000	1.256+00
7	3.491-02	0.000	0.000	1.364-01	1.651-01	9.476	1.146+00	0.000	0.000	1.412+00
8	3.140-02	0.000	0.000	1.392-01	1.664-01	9.463	8.946-01	0.000	0.000	1.661+00
9	2.472-02	0.000	0.000	1.447-01	1.753-01	9.453	5.197-01	0.000	0.000	1.950+00
10	1.716-02	0.000	0.000	1.525-01	1.422-01	9.434	3.901-01	0.000	0.000	2.170+00
11	1.275-02	0.000	0.000	1.584-01	1.693-01	9.419	3.901-01	0.000	0.000	2.170+00

SAMPLE OUTPUT: QUATEX P. 15

CONCENTRATIONS FOR TIME STEP 332. 6.7197+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	1.102-01	0.000	0.000	3.262+00	7.890+00	9.407	3.224-01	0.000	0.000	2.238+00
3	1.813-01	0.000	0.000	3.197+00	7.810+00	9.415	9.162-01	0.000	0.000	1.844+00
4	3.763-01	0.000	0.000	3.021+00	7.624+00	9.435	1.031+00	0.000	0.000	1.529+00
5	7.037-01	0.000	0.000	2.727+00	7.296+00	9.479	1.139+00	0.000	0.000	1.421+00
6	3.550-02	0.000	0.000	1.361-01	3.645-01	9.480	1.337+00	0.000	0.000	1.223+00
7	3.517-02	0.000	0.000	1.364-01	3.648-01	9.479	1.301+00	0.000	0.000	1.259+00
8	3.155-02	0.000	0.000	1.396-01	3.685-01	9.470	1.150+00	0.000	0.000	1.410+00
9	2.484-02	0.000	0.000	1.456-01	3.732-01	9.453	9.026-01	0.000	0.000	1.657+00
10	1.727-02	0.000	0.000	1.525-01	3.827-01	9.434	6.268-01	0.000	0.000	1.931+00
11	1.084-02	0.000	0.000	1.583-01	3.892-01	9.419	3.940-01	0.000	0.000	2.166+00
11	1.084-02	0.000	0.000	1.583-01	3.892-01	9.419	3.940-01	0.000	0.000	2.166+00

CONCENTRATIONS FOR TIME STEP 333. 6.7399+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	9.085-02	0.000	0.000	3.275+00	7.893+00	9.406	2.639-01	0.000	0.000	2.296+00
3	1.690-01	0.000	0.000	3.209+00	7.831+00	9.414	8.768-01	0.000	0.000	1.663+00
4	3.220-01	0.000	0.000	3.070+00	7.678+00	9.432	9.431-01	0.000	0.000	1.617+00
5	5.707-01	0.000	0.000	2.846+00	7.429+00	9.462	1.008+00	0.000	0.000	1.552+00
6	8.722-01	0.000	0.000	2.579+00	7.128+00	9.502	1.190+00	0.000	0.000	1.370+00
7	9.316-01	0.000	0.000	2.527+00	7.068+00	9.510	1.210+00	0.000	0.000	1.350+00
8	3.364-02	0.000	0.000	1.378-01	3.664-01	9.475	1.155+00	0.000	0.000	1.405+00
9	2.524-02	0.000	0.000	1.453-01	3.748-01	9.454	9.071-01	0.000	0.000	1.653+00
10	1.742-02	0.000	0.000	1.523-01	3.826-01	9.435	6.334-01	0.000	0.000	1.927+00
11	1.094-02	0.000	0.000	1.582-01	3.891-01	9.419	3.979-01	0.000	0.000	2.162+00
11	1.094-02	0.000	0.000	1.582-01	3.891-01	9.419	3.979-01	0.000	0.000	2.162+00

CONCENTRATIONS FOR TIME STEP 334. 6.7602+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	8.771-02	0.000	0.000	3.283+00	7.912+00	9.405	2.109-01	0.000	0.000	2.349+00
3	1.547-01	0.000	0.000	3.222+00	7.845+00	9.412	8.392-01	0.000	0.000	1.721+00
4	2.815-01	0.000	0.000	3.106+00	7.719+00	9.427	8.715-01	0.000	0.000	1.688+00
5	4.832-01	0.000	0.000	2.924+00	7.517+00	9.451	8.995-01	0.000	0.000	1.660+00
6	7.271-01	0.000	0.000	2.707+00	7.273+00	9.482	1.072+00	0.000	0.000	1.488+00
7	8.657-01	0.000	0.000	2.504+00	7.134+00	9.501	1.114+00	0.000	0.000	1.389+00
8	9.327-01	0.000	0.000	2.526+00	7.067+00	9.510	1.127+00	0.000	0.000	1.433+00
9	7.633-01	0.000	0.000	2.675+00	7.237+00	9.487	9.242-01	0.000	0.000	1.636+00
10	1.885-02	0.000	0.000	1.513-01	3.811-01	9.436	6.412-01	0.000	0.000	1.919+00
11	1.113-02	0.000	0.000	1.580-01	3.889-01	9.420	4.021-01	0.000	0.000	2.158+00
11	1.113-02	0.000	0.000	1.580-01	3.889-01	9.420	4.021-01	0.000	0.000	2.158+00

CONCENTRATIONS FOR TIME STEP 335. 6.7804+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	6.436-02	0.000	0.000	3.304+00	7.936+00	9.402	1.724-01	0.000	0.000	2.348+00
3	1.383-01	0.000	0.000	3.237+00	7.862+00	9.410	8.018-01	0.000	0.000	1.758+00
4	2.484-01	0.000	0.000	3.136+00	7.752+00	9.423	8.106-01	0.000	0.000	1.749+00
5	4.212-01	0.000	0.000	2.983+00	7.579+00	9.444	8.063-01	0.000	0.000	1.754+00
6	6.254-01	0.000	0.000	2.797+00	7.375+00	9.469	9.697-01	0.000	0.000	1.590+00
7	7.820-01	0.000	0.000	2.653+00	7.218+00	9.499	1.109+00	0.000	0.000	1.451+00
8	8.015-01	0.000	0.000	2.570+00	7.119+00	9.503	1.053+00	0.000	0.000	1.467+00
9	8.141-01	0.000	0.000	2.630+00	7.186+00	9.494	9.794-01	0.000	0.000	1.541+00
10	6.174-01	0.000	0.000	2.804+00	7.383+00	9.460	7.388-01	0.000	0.000	1.821+00
11	3.775-01	0.000	0.000	3.020+00	7.622+00	9.433	4.707-01	0.000	0.000	2.089+00
11	3.775-01	0.000	0.000	3.020+00	7.622+00	9.433	4.707-01	0.000	0.000	2.089+00

SAMPLE OUTPUT: QUATEX P. 16

CONCENTRATIONS FOR TIME STEP 336. 6.000+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	5.978-02	0.000	0.000	3.312+00	7.954+00	9.471	1.349-01	0.000	0.000	2.421+00
3	1.293-01	0.000	0.000	3.293+00	7.850+00	9.453	7.657-01	0.000	0.000	1.751+00
4	2.195-01	0.000	0.000	3.163+00	7.781+00	9.449	7.506-01	0.000	0.000	1.893+00
5	3.749-01	0.000	0.000	3.122+00	7.675+00	9.475	7.220-01	0.000	0.000	1.833+00
6	5.518-01	0.000	0.000	2.853+00	7.448+00	9.465	6.733-01	0.000	0.000	1.582+00
7	7.041-01	0.000	0.000	2.727+00	7.296+00	9.479	6.041+00	0.000	0.000	1.513+00
8	8.226-01	0.000	0.000	2.622+00	7.177+00	9.489	5.047+00	0.000	0.000	1.513+00
9	8.274-01	0.000	0.000	2.618+00	7.173+00	9.485	5.940-01	0.000	0.000	1.562+00
10	6.991-01	0.000	0.000	2.739+00	7.310+00	9.475	5.163-01	0.000	0.000	1.744+00
11	4.361-01	0.000	0.000	2.949+00	7.544+00	9.443	5.857-01	0.000	0.000	1.971+00
11	4.561-01	0.000	0.000	2.949+00	7.544+00	9.448	5.837-01	0.000	0.000	1.971+00

CONCENTRATIONS FOR TIME STEP 337. 6.020+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	4.253-02	0.000	0.000	3.324+00	7.957+00	9.399	1.133-01	0.000	0.000	2.447+00
3	1.723-01	0.000	0.000	3.279+00	7.858+00	9.455	7.339-01	0.000	0.000	1.823+00
4	1.932-01	0.000	0.000	3.187+00	7.697+00	9.417	7.076-01	0.000	0.000	1.852+00
5	3.391-01	0.000	0.000	3.054+00	7.651+00	9.434	6.423-01	0.000	0.000	1.913+00
6	4.973-01	0.000	0.000	2.912+00	7.503+00	9.453	7.945-01	0.000	0.000	1.765+00
7	6.384-01	0.000	0.000	2.786+00	7.362+00	9.471	9.739-01	0.000	0.000	1.563+00
8	7.643-01	0.000	0.000	2.674+00	7.236+00	9.467	9.919-01	0.000	0.000	1.563+00
9	8.153-01	0.000	0.000	2.629+00	7.155+00	9.494	9.811-01	0.000	0.000	1.573+00
10	7.916-01	0.000	0.000	2.694+00	7.253+00	9.464	9.632-01	0.000	0.000	1.657+00
11	5.352-01	0.000	0.000	2.878+00	7.465+00	9.456	9.964-01	0.000	0.000	1.564+00
11	5.352-01	0.000	0.000	2.878+00	7.465+00	9.458	9.964-01	0.000	0.000	1.564+00

CONCENTRATIONS FOR TIME STEP 338. 6.041+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	3.604-02	0.000	0.000	3.330+00	7.964+00	9.399	9.157-02	0.000	0.000	2.468+00
3	8.445-02	0.000	0.000	3.286+00	7.916+00	9.414	7.070-01	0.000	0.000	1.853+00
4	1.685-01	0.000	0.000	3.209+00	7.831+00	9.414	6.626-01	0.000	0.000	1.957+00
5	3.115-01	0.000	0.000	3.079+00	7.680+00	9.430	5.637-01	0.000	0.000	1.956+00
6	4.568-01	0.000	0.000	2.948+00	7.543+00	9.448	7.158-01	0.000	0.000	1.844+00
7	5.850-01	0.000	0.000	2.833+00	7.415+00	9.464	9.038-01	0.000	0.000	1.650+00
8	7.159-01	0.000	0.000	2.721+00	7.289+00	9.460	9.331-01	0.000	0.000	1.627+00
9	7.858-01	0.000	0.000	2.657+00	7.211+00	9.491	9.507-01	0.000	0.000	1.659+00
10	7.764-01	0.000	0.000	2.668+00	7.250+00	9.468	9.816-01	0.000	0.000	1.673+00
11	6.268-01	0.000	0.000	2.814+00	7.393+00	9.467	7.851-01	0.000	0.000	1.775+00
11	6.068-01	0.000	0.000	2.814+00	7.393+00	9.467	7.051-01	0.000	0.000	1.775+00

CONCENTRATIONS FOR TIME STEP 339. 6.061+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	2.816-02	0.000	0.000	3.338+00	7.972+00	9.399	7.460-02	0.000	0.000	2.485+00
3	6.723-02	0.000	0.000	3.312+00	7.933+00	9.472	5.861-01	0.000	0.000	1.874+00
4	1.449-01	0.000	0.000	3.231+00	7.855+00	9.411	4.213-01	0.000	0.000	1.959+00
5	2.912-01	0.000	0.000	3.090+00	7.707+00	9.428	4.826-01	0.000	0.000	2.077+00
6	4.279-01	0.000	0.000	2.974+00	7.572+00	9.444	4.397-01	0.000	0.000	1.923+00
7	5.477-01	0.000	0.000	2.871+00	7.457+00	9.459	4.498-01	0.000	0.000	1.710+00
8	6.655-01	0.000	0.000	2.761+00	7.334+00	9.474	3.726-01	0.000	0.000	1.627+00
9	7.570-01	0.000	0.000	2.686+00	7.247+00	9.446	3.092-01	0.000	0.000	1.651+00
10	7.077-01	0.000	0.000	2.655+00	7.215+00	9.444	4.768-01	0.000	0.000	1.633+00
11	6.011-01	0.000	0.000	2.762+00	7.335+00	9.474	2.506-01	0.000	0.000	1.769+00
11	6.051-01	0.000	0.000	2.762+00	7.335+00	9.474	8.506-01	0.000	0.000	1.769+00

SAMPLE OUTPUT: QUATEX P. 17

CONCENTRATIONS FOR TIME STEP 341. 6.0810+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					CONCENTRATIONS ON EXCHANGER				
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	2.352-02	0.000	0.000	3.342+00	7.970+00	9.397	6.052-02	0.000	0.000	2.490+00
3	9.068-02	0.000	0.000	3.317+00	7.949+00	9.400	6.715-01	0.000	0.000	1.580+00
4	1.220-01	0.000	0.000	3.252+00	7.878+00	9.408	5.836-01	0.000	0.000	1.970+00
5	2.450-01	0.000	0.000	3.137+00	7.750+00	9.423	4.142-01	0.000	0.000	2.140+00
6	4.062-01	0.000	0.000	2.994+00	7.590+00	9.442	5.572-01	0.000	0.000	2.702+00
7	5.105-01	0.000	0.000	2.900+00	7.493+00	9.455	7.939-01	0.000	0.000	1.766+00
8	6.293-01	0.000	0.000	2.794+00	7.371+00	9.473	8.112-01	0.000	0.000	1.744+00
9	7.260-01	0.000	0.000	2.706+00	7.272+00	9.483	8.611-01	0.000	0.000	1.690+00
10	7.793-01	0.000	0.000	2.660+00	7.221+00	9.489	8.547-01	0.000	0.000	1.705+00
11	7.959-01	0.000	0.000	2.724+00	7.293+00	9.480	8.932-01	0.000	0.000	1.666+00
11	7.959-01	0.000	0.000	2.724+00	7.293+00	9.480	8.939-01	0.000	0.000	1.566+00

CONCENTRATIONS FOR TIME STEP 341. 6.9018+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					CONCENTRATIONS ON EXCHANGER				
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	1.864-02	0.000	0.000	3.346+00	7.921+00	9.397	4.931-02	0.000	0.000	2.511+00
3	3.599-02	0.000	0.000	3.331+00	7.965+00	9.399	6.634-01	0.000	0.000	1.597+00
4	9.936-02	0.000	0.000	3.272+00	7.931+00	9.406	5.499-01	0.000	0.000	2.310+00
5	2.066-01	0.000	0.000	3.175+00	7.793+00	9.416	3.571-01	0.000	0.000	2.203+00
6	3.361-01	0.000	0.000	3.057+00	7.664+00	9.433	4.931-01	0.000	0.000	2.267+00
7	4.790-01	0.000	0.000	2.928+00	7.521+00	9.451	7.232-01	0.000	0.000	1.331+00
8	6.009-01	0.000	0.000	2.819+00	7.393+00	9.466	7.475-01	0.000	0.000	1.312+00
9	7.030-01	0.000	0.000	2.728+00	7.297+00	9.479	8.064-01	0.000	0.000	1.752+00
10	7.729-01	0.000	0.000	2.666+00	7.227+00	9.483	8.201-01	0.000	0.000	1.740+00
11	7.336-01	0.000	0.000	2.701+00	7.266+00	9.483	9.197-01	0.000	0.000	1.541+00
11	7.336-01	0.000	0.000	2.701+00	7.266+00	9.483	9.193-01	0.000	0.000	1.541+00

CONCENTRATIONS FOR TIME STEP 342. 6.9221+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					CONCENTRATIONS ON EXCHANGER				
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	1.543-02	0.000	0.000	3.349+00	7.965+00	9.396	4.005-02	0.000	0.000	2.520+00
3	2.257-02	0.000	0.000	3.344+00	7.973+00	9.397	6.616-01	0.000	0.000	1.898+00
4	7.677-02	0.000	0.000	3.293+00	7.923+00	9.403	5.258-01	0.000	0.000	2.039+00
5	1.717-01	0.000	0.000	3.206+00	7.828+00	9.414	3.072-01	0.000	0.000	2.253+00
6	2.898-01	0.000	0.000	3.099+00	7.710+00	9.428	4.332-01	0.000	0.000	2.127+00
7	4.468-01	0.000	0.000	2.957+00	7.553+00	9.447	6.468-01	0.000	0.000	1.911+00
8	5.794-01	0.000	0.000	2.838+00	7.421+00	9.463	6.774-01	0.000	0.000	1.883+00
9	6.847-01	0.000	0.000	2.744+00	7.315+00	9.477	7.515-01	0.000	0.000	1.308+00
10	7.668-01	0.000	0.000	2.672+00	7.233+00	9.488	7.759-01	0.000	0.000	1.784+00
11	7.487-01	0.000	0.000	2.687+00	7.251+00	9.485	9.314-01	0.000	0.000	1.629+00
11	7.487-01	0.000	0.000	2.687+00	7.251+00	9.485	9.314-01	0.000	0.000	1.629+00

CONCENTRATIONS FOR TIME STEP 343. 6.9423+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					CONCENTRATIONS ON EXCHANGER				
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	1.234-02	0.000	0.000	3.352+00	7.968+00	9.396	3.264-02	0.000	0.000	2.527+00
3	7.439-03	0.000	0.000	3.356+00	7.993+00	9.396	6.659-01	0.000	0.000	1.894+00
4	5.393-02	0.000	0.000	3.314+00	7.946+00	9.401	4.972-01	0.000	0.000	2.063+00
5	1.386-01	0.000	0.000	3.237+00	7.861+00	9.410	2.635-01	0.000	0.000	2.296+00
6	2.426-01	0.000	0.000	3.142+00	7.757+00	9.422	3.814-01	0.000	0.000	2.170+00
7	4.100-01	0.000	0.000	2.970+00	7.590+00	9.442	5.625-01	0.000	0.000	1.990+00
8	5.401-01	0.000	0.000	2.873+00	7.460+00	9.458	6.156-01	0.000	0.000	1.749+00
9	6.712-01	0.000	0.000	2.756+00	7.329+00	9.475	6.842-01	0.000	0.000	1.876+00
10	7.652-01	0.000	0.000	2.673+00	7.235+00	9.487	7.227-01	0.000	0.000	1.837+00
11	7.573-01	0.000	0.000	2.680+00	7.243+00	9.486	9.365-01	0.000	0.000	1.623+00
11	7.573-01	0.000	0.000	2.680+00	7.243+00	9.486	9.365-01	0.000	0.000	1.623+00

SAMPLE OUTPUT: QUATEX P. 18

CONCENTRATIONS FOR TIME STEP 344. 6.9626+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	1.817-02	0.000	0.000	3.354+00	7.992+00	9.395	2.652-02	0.000	0.000	2.533+00
3	0.000	0.000	0.000	3.363+00	8.000+00	9.395	6.754-01	0.000	0.000	1.865+00
4	3.284-02	0.000	0.000	3.335+00	7.949+00	9.394	4.813-01	0.000	0.000	2.079+00
5	1.285-01	0.000	0.000	3.264+00	7.891+00	9.407	2.242-01	0.000	0.000	2.339+00
6	2.935-01	0.000	0.000	3.177+00	7.796+00	9.416	3.330-01	0.000	0.000	2.226+00
7	3.335-01	0.000	0.000	3.059+00	7.666+00	9.433	4.974-01	0.000	0.000	2.063+00
8	4.001-01	0.000	0.000	2.945+00	7.550+00	9.448	5.590-01	0.000	0.000	2.001+00
9	5.873-01	0.000	0.000	2.831+00	7.413+00	9.464	6.335-01	0.000	0.000	1.927+00
10	7.096-01	0.000	0.000	2.722+00	7.290+00	9.480	6.786-01	0.000	0.000	1.98+00
11	7.535-01	0.000	0.000	2.683+00	7.246+00	9.486	9.269-01	0.000	0.000	1.633+00
11	7.535-01	0.000	0.000	2.683+00	7.246+00	9.486	9.269-01	0.000	0.000	1.633+00

CONCENTRATIONS FOR TIME STEP 345. 6.9826+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	6.177-03	0.000	0.000	3.356+00	7.992+00	9.395	2.101-02	0.000	0.000	2.533+00
3	0.000	0.000	0.000	3.353+00	7.990+00	9.395	6.873-01	0.000	0.000	1.873+00
4	7.893-03	0.000	0.000	3.356+00	7.992+00	9.396	4.771-01	0.000	0.000	2.093+00
5	7.987-02	0.000	0.000	3.295+00	7.920+00	9.404	1.882-01	0.000	0.000	2.372+00
6	1.665-01	0.000	0.000	3.211+00	7.834+00	9.413	2.909-01	0.000	0.000	2.269+00
7	2.892-01	0.000	0.000	3.099+00	7.711+00	9.428	4.353-01	0.000	0.000	2.125+00
8	3.991-01	0.000	0.000	3.004+00	7.591+00	9.441	5.073-01	0.000	0.000	2.053+00
9	5.144-01	0.000	0.000	2.995+00	7.486+00	9.455	5.840-01	0.000	0.000	1.975+00
10	6.211-01	0.000	0.000	2.801+00	7.379+00	9.469	6.352-01	0.000	0.000	1.925+00
11	7.266-01	0.000	0.000	2.705+00	7.271+00	9.483	8.891-01	0.000	0.000	1.671+00
11	7.266-01	0.000	0.000	2.705+00	7.271+00	9.483	8.891-01	0.000	0.000	1.671+00

CONCENTRATIONS FOR TIME STEP 346. 7.0036+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	6.711-03	0.000	0.000	3.357+00	7.993+00	9.395	1.757-02	0.000	0.000	2.562+00
3	0.000	0.000	0.000	3.363+00	8.000+00	9.395	6.976-01	0.000	0.000	1.862+00
4	0.000	0.000	0.000	3.363+00	8.000+00	9.395	4.867-01	0.000	0.000	2.073+00
5	6.211-02	0.000	0.000	3.305+00	7.940+00	9.401	1.844-01	0.000	0.000	2.445+00
6	1.368-01	0.000	0.000	3.238+00	7.863+00	9.410	2.511-01	0.000	0.000	2.309+00
7	2.426-01	0.000	0.000	3.144+00	7.759+00	9.422	3.826-01	0.000	0.000	2.177+00
8	3.471-01	0.000	0.000	3.047+00	7.653+00	9.435	4.568-01	0.000	0.000	2.101+00
9	4.546-01	0.000	0.000	2.950+00	7.545+00	9.446	5.361-01	0.000	0.000	2.024+00
10	5.553-01	0.000	0.000	2.857+00	7.442+00	9.461	5.921-01	0.000	0.000	1.963+00
11	6.917-01	0.000	0.000	2.738+00	7.308+00	9.478	8.282-01	0.000	0.000	1.732+00
11	6.917-01	0.000	0.000	2.738+00	7.308+00	9.478	8.282-01	0.000	0.000	1.732+00

CONCENTRATIONS FOR TIME STEP 347. 7.0233+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	5.420-03	0.000	0.000	3.358+00	7.995+00	9.395	1.432-02	0.000	0.000	2.586+00
3	0.000	0.000	0.000	3.367+00	8.000+00	9.395	7.066-01	0.000	0.000	1.851+00
4	0.000	0.000	0.000	3.363+00	8.000+00	9.395	5.002-01	0.000	0.000	2.079+00
5	4.042-02	0.000	0.000	3.319+00	7.951+00	9.406	1.254-01	0.000	0.000	2.435+00
6	1.143-01	0.000	0.000	3.259+00	7.886+00	9.408	2.153-01	0.000	0.000	2.345+00
7	2.069-01	0.000	0.000	3.174+00	7.793+00	9.418	3.341-01	0.000	0.000	2.226+00
8	3.051-01	0.000	0.000	3.070+00	7.700+00	9.427	4.137-01	0.000	0.000	2.184+00
9	4.000-01	0.000	0.000	2.999+00	7.600+00	9.441	4.911-01	0.000	0.000	2.069+00
10	4.975-01	0.000	0.000	2.911+00	7.502+00	9.453	5.510-01	0.000	0.000	2.003+00
11	6.548-01	0.000	0.000	2.771+00	7.345+00	9.473	7.521-01	0.000	0.000	1.809+00
11	6.548-01	0.000	0.000	2.771+00	7.345+00	9.473	7.521-01	0.000	0.000	1.809+00

SAMPLE OUTPUT: QUATEX P. 19

CONCENTRATIONS FOR TIME STEP 349. 7.0435+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTC	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.600+00	9.395+00				
2	4.437-03	0.000	0.000	3.363+00	7.999+00	9.395	1.185-02	0.000	0.000	2.548+00
3	0.000	0.000	0.000	3.363+00	8.600+00	9.395	7.105-01	0.000	0.000	1.844+00
4	0.000	0.000	0.000	3.363+00	8.600+00	9.395	5.146-01	0.000	0.000	2.045+00
5	3.924-02	0.000	0.000	3.327+00	7.981+00	9.395	1.018-01	0.000	0.000	2.458+00
6	9.002-02	0.000	0.000	3.275+00	7.984+00	9.405	1.842-01	0.000	0.000	2.376+00
7	1.757-01	0.000	0.000	3.203+00	7.824+00	9.415	2.921-01	0.000	0.000	2.268+00
8	2.025-01	0.000	0.000	3.124+00	7.737+00	9.425	3.714-01	0.000	0.000	2.189+00
9	3.636-01	0.000	0.000	3.041+00	7.644+00	9.435	4.434-01	0.000	0.000	2.112+00
10	4.452-01	0.000	0.000	2.959+00	7.555+00	9.447	5.109-01	0.000	0.000	2.049+00
11	6.024-01	0.000	0.000	2.818+00	7.398+00	9.460	6.739-01	0.000	0.000	1.886+00

CONCENTRATIONS FOR TIME STEP 349. 7.0635+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTC	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.600+00	9.395+00				
2	3.593-03	0.000	0.000	3.360+00	7.996+00	9.395	9.487-03	0.000	0.000	2.551+00
3	0.000	0.000	0.000	3.363+00	8.600+00	9.395	7.215-01	0.000	0.000	1.338+00
4	0.000	0.000	0.000	3.363+00	8.600+00	9.395	5.281-01	0.000	0.000	2.032+00
5	3.181-02	0.000	0.000	3.334+00	7.958+00	9.396	8.269-02	0.000	0.000	2.777+00
6	8.502-02	0.000	0.000	3.290+00	7.920+00	9.404	1.573-01	0.000	0.000	2.403+00
7	1.508-01	0.000	0.000	3.225+00	7.849+00	9.412	2.548-01	0.000	0.000	2.305+00
8	2.279-01	0.000	0.000	3.155+00	7.772+00	9.421	3.330-01	0.000	0.000	2.227+00
9	3.126-01	0.000	0.000	3.078+00	7.687+00	9.431	4.086-01	0.000	0.000	2.151+00
10	3.934-01	0.000	0.000	3.001+00	7.602+00	9.441	4.725-01	0.000	0.000	2.087+00
11	5.252-01	0.000	0.000	2.887+00	7.475+00	9.457	6.131-01	0.000	0.000	1.947+00
11	5.252-01	0.000	0.000	2.887+00	7.475+00	9.457	6.131-01	0.000	0.000	1.947+00

CONCENTRATIONS FOR TIME STEP 350. 7.0845+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTC	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.600+00	9.395+00				
2	2.937-03	0.000	0.000	3.361+00	7.997+00	9.395	7.721-03	0.000	0.000	2.552+00
3	0.000	0.000	0.000	3.363+00	8.600+00	9.395	7.277-01	0.000	0.000	1.332+00
4	0.000	0.000	0.000	3.363+00	8.600+00	9.395	5.413-01	0.000	0.000	2.019+00
5	2.756-02	0.000	0.000	3.341+00	7.974+00	9.396	6.721-02	0.000	0.000	2.493+00
6	6.755-02	0.000	0.000	3.301+00	7.932+00	9.402	1.341-01	0.000	0.000	2.426+00
7	1.226-01	0.000	0.000	3.246+00	7.871+00	9.409	2.222-01	0.000	0.000	2.338+00
8	1.992-01	0.000	0.000	3.181+00	7.801+00	9.417	2.977-01	0.000	0.000	2.262+00
9	3.762-01	0.000	0.000	3.111+00	7.724+00	9.426	3.715-01	0.000	0.000	2.184+00
10	3.565-01	0.000	0.000	3.039+00	7.643+00	9.436	4.359-01	0.000	0.000	2.124+00
11	4.716-01	0.000	0.000	2.935+00	7.528+00	9.450	5.574-01	0.000	0.000	2.003+00
11	4.716-01	0.000	0.000	2.935+00	7.528+00	9.450	5.574-01	0.000	0.000	2.003+00

CONCENTRATIONS FOR TIME STEP 400. 8.0965+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION						CONCENTRATIONS ON EXCHANGER			
	ION 1	ION 2	ION 3	ION 4	CTC	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.600+00	9.395+00				
2	1.018-07	0.000	0.000	3.361+00	8.000+00	9.395	2.687-07	0.000	0.000	2.560+00
3	0.000	0.000	0.000	3.363+00	8.600+00	9.395	7.857-01	0.000	0.000	1.774+00
4	0.000	0.000	0.000	3.363+00	8.600+00	9.395	7.795-01	0.000	0.000	1.780+00
5	8.742-07	0.000	0.000	3.363+00	8.600+00	9.395	2.313-06	0.000	0.000	2.560+00
6	6.698-06	0.000	0.000	3.363+00	8.600+00	9.395	1.600-05	0.000	0.000	2.560+00
7	2.812-05	0.000	0.000	3.363+00	8.600+00	9.395	6.457-05	0.000	0.000	2.560+00
8	8.496-05	0.000	0.000	3.363+00	8.600+00	9.395	1.437-04	0.000	0.000	2.560+00
9	2.337-04	0.000	0.000	3.363+00	8.600+00	9.395	4.813-04	0.000	0.000	2.560+00
10	5.376-04	0.000	0.000	3.363+00	7.798+00	9.395	1.041-03	0.000	0.000	2.559+00
11	1.075-03	0.000	0.000	3.363+00	7.600+00	9.395	2.024-03	0.000	0.000	2.558+00
11	1.075-03	0.000	0.000	3.363+00	7.600+00	9.395	2.024-03	0.000	0.000	2.558+00

COLUMN INVENTORIES

COLUMN EXIT INVENTORIES

AT TIME STEP 400

ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4	
6.28107-03	0.00000	0.00000	2.1719-01	225	3.59018-02	0.00000	0.00000	1.44547+00

SAMPLE OUTPUT: QUATEX P. 20

CONCENTRATIONS FOR TIME STEP 492. 9.9581+00 HRS SINCE START OF FEED 1. CURRENT FEED NO.= 3.

POSITION INCREMENT NUMBER	CONCENTRATIONS IN SOLUTION					CONCENTRATIONS ON EXCHANGER				
	ION 1	ION 2	ION 3	ION 4	CT4	PH	ION 1	ION 2	ION 3	ION 4
FEED	0.000	0.000	0.000	3.363+00	8.000+00	9.395+00				
2	6.353-16	0.000	0.000	3.363+00	8.000+00	9.395	1.684-15	0.000	0.000	2.560+00
3	0.000	0.000	0.000	3.363+00	8.000+00	9.395	7.860-01	0.000	0.000	1.773+00
4	0.000	0.000	0.000	3.363+00	8.000+00	9.395	7.860-01	0.000	0.000	1.773+00
5	5.510-15	0.000	0.000	3.363+00	8.000+00	9.395	1.454-14	0.000	0.000	2.560+00
6	9.197-14	0.000	0.000	3.363+00	8.000+00	9.395	2.341-13	0.000	0.000	2.560+00
7	3.158-13	0.000	0.000	3.363+00	8.000+00	9.395	2.011-12	0.000	0.000	2.560+00
8	5.099-12	0.000	0.000	3.363+00	8.000+00	9.395	1.221-11	0.000	0.000	2.560+00
9	2.515-11	0.000	0.000	3.363+00	8.000+00	9.395	5.853-11	0.000	0.000	2.560+00
10	1.041-10	0.000	0.000	3.363+00	8.000+00	9.395	2.350-10	0.000	0.000	2.560+00
11	3.750-10	0.000	0.000	3.363+00	8.000+00	9.395	8.296-10	0.000	0.000	2.560+00
11	3.750-10	0.000	0.000	3.363+00	8.000+00	9.395	8.296-10	0.000	0.000	2.560+00

COLUMN INVENTORIES				COLUMN EXIT INVENTORIES		AT TIME STEP 492	
ION 1	ION 2	ION 3	ION 4	ION 1	ION 2	ION 3	ION 4
6.29547-03	0.00000	0.00000	2.91705-11	3.69004-02	0.00000	0.00000	3.23357+00
END OF RUN							

CSCX RL083J 15 FEB 74 9:25:43 USER CUE908 PUN023

CARDS IN 33 OUT 1 LINES 3643 PROCESSING TIME 94.71 SECONDS

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 1

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@S RUN FUNN01,CUR742, .60,5000/100 G JANSEN 3760 BLOC 9421576
@ ELT SHARE.1.711024. 47183
@ EOF @
SHARE=FCOFY
C THIS FILE SAVED 19 AUG 71
PARAMETER MXL=601,NTL=2,IFU=5,IFU5=OFJER
C MXL IS MAXIMUM ALLOWABLE VALUE FOR POSITION SUBSCRIPTS
C NTL IS MAXIMUM ALLOWABLE VALUE FOR TIME SUBSCRIPTS
C IFL IS MAXIMUM ALLOWABLE NUMBER OF DIFFERENT FEEDS
C IFU IS LOGICAL UNIT DESIGNATION FOR READ STATEMENTS
C GFL IS LOGICAL UNIT DESIGNATION FOR WRITE STATEMENTS
REAL QZ(IFL),QZ(MXL),CZF(IFL),CZ1(IFL),CZ2(IFL),CZ3(IFL),CZ4(IFL),
2 CCAR(IFL),RK12(IFL),RK13(IFL),RK14(IFL),RK15(IFL),RK24(IFL),
3 RK34(IFL),S124(IFL),S134(IFL),S144(IFL),S234(IFL),S244(IFL),
4 S34(IFL),CHV(IFL),F(IFL),CBCH(IFL),BLURF(IFL),G1N(IFL),
5 G2N(IFL),G1N2(IFL)
REAL CX1(MXL),CX2(MXL),CX3(MXL),CX4(MXL),CX5(MXL),CX6(MXL),
1 CX7(MXL),CX8(MXL),CX9(MXL),CX10(MXL),CX11(MXL),CX12(MXL),
2 CX13(MXL),CX14(MXL),CX15(MXL),CX16(MXL)
REAL Q1(MXL,NTL),Q2(MXL,NTL),Q3(MXL,NTL),Q4(MXL,NTL),
2 Q5(MXL,NTL),Q6(MXL,NTL),Q7(MXL,NTL),Q8(MXL,NTL)
EQUIVALENCE (CX1,Q1),(CX2,Q2),(CX3,Q3),(CX4,Q4),(CX5,Q5),(CX6,Q6),
2 (CX7,Q7),(CX8,Q8),(CX9,Q9),(CX10,Q10),(CX11,Q11),(CX12,Q12),
3 (CX13,Q13),(CX14,Q14),(CX15,Q15),(CX16,Q16),(CX17,Q17),
4 (CX18,Q18),(CX19,Q19),(CX20,Q20),(CX21,Q21),(CX22,Q22),
5 (CX23,Q23),(CX24,Q24),(CX25,Q25),(CX26,Q26),(CX27,Q27),
6 (CX28,Q28),(CX29,Q29),(CX30,Q30),(CX31,Q31),(CX32,Q32),
7 (CX33,Q33),(CX34,Q34),(CX35,Q35),(CX36,Q36),(CX37,Q37),
8 (CX38,Q38),(CX39,Q39),(CX40,Q40),(CX41,Q41),(CX42,Q42),
9 (CX43,Q43),(CX44,Q44),(CX45,Q45),(CX46,Q46),(CX47,Q47),
10 (CX48,Q48),(CX49,Q49),(CX50,Q50),(CX51,Q51),(CX52,Q52),
11 (CX53,Q53),(CX54,Q54),(CX55,Q55),(CX56,Q56),(CX57,Q57),
12 (CX58,Q58),(CX59,Q59),(CX60,Q60)
INTEGER KIN(IFL),NS(IFL),N2(IFL),K1B(IFL),NIF(IFL),
2 JX(IFL),JT(IFL)
COMMON/IN/ QZ,CZ,CZ1,CZ2,CZ3,CCAR,C1,C2,C3,KIN,F,F,RK12,RK13,
2 RK14,RK23,RK24,RK34,S12,S13,S14,S23,S24,S34,FKW,KMB,DK1A,
3 DK2A,DT,DX,NT,XX,CHV,JX,JT,G1N,G2N,G3N,VOL,NFC,CROH,K1B,
4 NTF,HRO,D,BLURF,LEAVE,NBOH,VWICK,NNN,ADUMP,
5 RK14A,RK24A,RK34A,RK13A,RK23A,RK12A,S12A,S13A,S14A,
6 S23A,S24A,S34A
INTEGER MCRIT(IFL),MCRITX(IFL)
REAL ADF(IFL),AN(MXL)
REAL CT9(MXL)
LOGICAL FLIF(IFL)
REAL FH(MXL),CARB(MXL),CSOHY(MXL)
INTEGER INVT(IFL)
COMMON/OUT/ CZ4,C4,Q1,Q2,Q3,Q4,WPS
2,MCRIT,MCRITX,AC,ADF,CZF
3,CT9,INVT
4,FH,FLIF,CARB,CSOHY
COMMON/CALC/NS,NQ
END

```

```

@ ELT TCHEK/S2SU.1.711109. 31160
@ EOF @
CALL TCHEK(I,N)
IF TIME REMAINING FOR EXECUTION IS LE I (SEC). TRANSFER TO IN
NBRF .
MCR1B EQU 07320
TCHEK L AD,MCR1B+12
L A1,MCR1B
DSL A1,36
DI,M A1,5000
TZ AD
AN AD,A1
AN AD,0.811
TG AD,(0)
J 3,811
J 1,811
END

```

```

@ ELT QUATEX/S2F5.1.711109. 31162
@ EOF @
CALL DRIVER
STOP
END

```

```

@ ELT DRIVER/S2F5.1.711109. 31164
@ EOF @
SUBROUTINE DRIVER
1 FORMAT('CSUFFLY OF FEED NUMBER *.12.* DEPLETED'////)
C THIS FILE SAVED 24 AUG 71
2 FORMAT(1H0,'END OF RUN')
INCLUDE SHARE
3 FORMAT('ALLOWABLE EXECUTION TIME NEARLY USED UP. *')
2 *CALCULATIONS STOPPED TO ALLOW TIME FOR PRINTING ANSWERS.*
4 FORMAT('NNN=*.14')
DATA NNF/22/ 3 NNF= NO. OF TIMES OUTPUT TO BE PRINTED EVERY STEP
FOLLOWING FEED CHANGE
NF=0 3 INITIALIZE FEED NUMBER
NNN=0 3 INITIALIZE VIRTUAL TIME SUBSCRIPT
CALL DAYWUN
CALL INFUT
CALL GETINC
CALL FRONT 3 COMPUTE THE THAY (I)
100 NF=NF+1 3 START NEXT FEED
IF (KRAF.NE.0) CALL PFT1(JX(NF-1)) 3 PRINT OUTPUT AT EOF
IF (MPAR.NE.0) CALL COLIN(NNN)
IF (FLIF(NF)) CALL SRFLIF
IF (NF.LE.NFC) GO TO 200 3 NEXT FEED EXISTS
WRITE(OFU,2)
STOP 3 NO FEED REMAINS

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 2

```

700 CALL NUFID (NF) TO SET UP CONCENTRATIONS AT FEED CHANGE
    CALL OUTPUT(NF)
    NF=0
210 NNN=NNN+1 INCREMENT THE VIRTUAL TIME SUBSCRIPT
    WRITE(OFU,4) NNN
    CHV(NF)=CHV(NF)-DT*F(NF) DECREMENT FEED SUPPLY
    IF(CHV(NF).GT.0.0) GOTO 400 FEED IS AVAILABLE
    WRITE(OFU,1) NF 3 FEED(NF) IS EXHAUSTED
    NNN=NNN-1 BECAUSE WE DIDN'T HAVE FEED FOR THIS TIME STEP
    GOTO 100
300 IF(NNN.EQ.1) GOTO 400 ASKIF SHIFT FIRST TIME THRU
C
C SHIFT TIME2 CONCENTRATIONS INTO TIME1 STORAGE SLOTS
    DO 350 M=1,NK
        O1(M)=O1(M,2)
        O2(M)=O2(M,2)
        O3(M)=O3(M,2)
        O4(M)=O4(M,2)
        C1(M)=C1(M,2)
        C2(M)=C2(M,2)
        C3(M)=C3(M,2)
        C4(M)=C4(M,2)
350 CONTINUE
400 HRS=NNN*DT+HRO DELAYED TIME CALCULATION
    CALL FRONTL(NF)
    MU=MINO(NK)*CRIT(1)
C HANDLE M=1 BY SETTING CONC. TO FEED
    C1X2(1)=C21(NF)
    C2X2(1)=C22(NF)
    C3X2(1)=C23(NF)
    DO 500 M=2,MU
        CALL LOAD1(M,2,NF)
        CALL CONSOL(M,2,NF)
    IF (NNN.EQ.1) GO TO 500
    CALL LOAD2(M,2,NF)
    CALL CONSOL(M,2,NF)
500 CONTINUE
    CALL EXINV(NF)
    CALL TCHEK (LEAVE,8699)
    NF=NF+1
    IF(NF.LE.NNF) GO TO 700
    KRAF=MOD(NNN,JT(NF))
    IF(KRAF.EQ.0) GOTO 700
505 CONTINUE
    KRAF2=MOD(NNN,INVT(NF))
    IF(KRAF2.EQ.0) CALL COLINV(NNN)
    GOTO 210
699 WRITE(OFU,3)
    CALL PFT1(JX(NF))
    CALL COLINV(NNN)
    STOP
700 CALL PFT1 (JX(NF))
    GO TO 505
END

789
8 ELT QINPUT/S2F5-1-711109- 31165
9 EOF 0
    SUBROUTINE INPUT
C THIS FILE SAVED 24 AUG 71
    INCLUDE QUATEX.LIST
    NAMELIST/DT/GT,CZF,CZ1,CZ2,CZ3,CCAR,C1,C2,C3,KIN,E,F,PV12,
    2 RK13,RK14,RK23,RK24,RK34,S12,S13,S14,S23,S24,DKW,DKS,KI3,D,
    3 DK13,DK24,DT,DX,HT,NK,CHV,JY,JT,GIN,G2N,G3N,VOL,NFC,NECM
    4 ,NMF,LEAVE,LIT,S34,C30H,KWICK,KDURF
    5 , INVT,FLIP
    REAL PDAY(2),FTIME(2)
    1 FORMAT(12A6)
    3 FORMAT(1H1)
    4 FORMAT(1H ,12A6)
    5 FORMAT(1H1,69X,'OUTPUT FROM PROGRAM QUATEX RUN AT ',
    2 9A6//)
    CALL TND (FTIME)
    CALL DOY (PDAY)
    WRITE(OFU,5) FTIME,PDAY
    READ (IFU,210)
    IF(11.11) RETURN
    WRITE(OFU,3)
    DO 2 I=1 , LIT
        READ(IFU,1) (BLURB(I,K),K=1 , 12)
        WRITE(OFU,4)(SLJ09(I,K),K=1,12)
    2 CONTINUE
    RETURN
END

8 ELT QOUTFT/S2F5-1-711109- 31164
9 EOF 0
    SUBROUTINE OUTPUT(NF)
C ARGUMENT NF REPRESENTS THE CURRENT FEED NUMBER
C THIS FILE SAVED 24 AUG 71
    INTEGER NMH1,STAP2(10)
    DATA NMH1 /1,1,51/1,7,1,9,7,KALL/0,2,2,10,6H*****
    INCLUDE SHARP

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 3

```

1 FORMAT(' ***** BED DATA AND INITIAL CONDITIONS: ')
2 FORMAT('          VOLUME=.1FE9.3.' LITER.          DISSOC. CONST. FOR H
2H40H (DK1)=.7E10.4)
3 FORMAT(' VOID FRACTION=.1FE9.3.'          ISI DISSOC. CONST. FOR H
2H20H (DK14)=.5E10.4)
4 FORMAT('          DIAMETER=.1FE9.3.' CM.          2ND DISSOC. CONST. FOR H
2H20H (DK24)=.5E10.4)
5 FORMAT('          IONIZ. CONST. FOR W
2ATER (DKW)=.7E10.4)
7 FORMAT(1H 1)
8 FORMAT(' ***** FEED CONDITIONS: ')
9 FORMAT(4EX. '          FEED NUMBER:'.5(2X.7))
10 FORMAT(4EX. '          FLOW RATE (L/HR):'.5(2X.1FE10.4))
11 FORMAT(4EX. '          FEED VOLUME (LITERS):'.5(2X.1FE10.4))
12 FORMAT(4EX. '          CONCENTRATIONS . C21:'.5(2X.1FE10.4))
13 FORMAT(4EX. '          IN . C21:'.5(2X.1FE10.4))
14 FORMAT(4EX. '          EQUIVS/LITER . C22:'.5(2X.1FE10.4))
15 FORMAT(4EX. '          . C23:'.5(2X.1FE10.4))
16 FORMAT(4EX. '          . CCAR:'.5(2X.1FE10.4))
17 FORMAT(4EX. '          . CPGH:'.5(2X.1FE10.4))
18 FORMAT(4EX. '          RATE CONSTANTS . RK12:'.5(2X.1FE10.4))
19 FORMAT(4EX. '          IN . RK13:'.5(2X.1FE10.4))
20 FORMAT(4EX. '          LITERS/EG HR . RK14:'.5(2X.1FE10.4))
21 FORMAT(4EX. '          . RK23:'.5(2X.1FE10.4))
22 FORMAT(4EX. '          . RK24:'.5(2X.1FE10.4))
23 FORMAT(4EX. '          . RK24:'.5(2X.1FE10.4))
24 FORMAT(4EX. '          SELECTIVITY . S12:'.5(2X.1FE10.4))
25 FORMAT(4EX. '          . S13:'.5(2X.1FE10.4))
26 FORMAT(4EX. '          . S14:'.5(2X.1FE10.4))
27 FORMAT(4EX. '          . S23:'.5(2X.1FE10.4))
28 FORMAT(4EX. '          . S24:'.5(2X.1FE10.4))
29 FORMAT(4EX. '          . S24:'.5(2X.1FE10.4))
30 FORMAT(' FOR FEED NO. '.11. ' KIN IS 0. THUS: C1(M.1)=C2(M.1)=C3(M
2.1)=C1(M.1)=C2(M.1)=C3(M.1)=0.0 FOR 1(M.1)=14)
31 FORMAT(39X. 'C1:'.11. '=.1FE9.3.10X. '22(1.11. '=.E9.3)
32 FORMAT(' FOR FEED NO. '.11. ' KIN IS 1. THUS FOR ALL M: C1(M.1)=C2
21(M.1)=.1FE9.3. ' Q1(M.1)=Q14(NF)=.E9.3)
33 FORMAT('          C2(M.1)=C2 ' C2(M.1)=C2
22(M.1)=.1FE9.3. ' Q2(M.1)=Q24(NF)=.E9.3)
34 FORMAT('          C3(M.1)=C3 ' C3(M.1)=C3
23(M.1)=.1FE9.3. ' Q3(M.1)=Q34(NF)=.E9.3)
35 FORMAT(' FOR FEED NO. '.11. ' KIN IS 2. THUS INPUT VALUES OF C1(M.
21. C2(M.1). C3(M.1). Q1(M.1). Q2(M.1). Q3(M.1) ARE AS FOLLOWS: ')
36 FORMAT('          C1(M.1)          C2(M.1)          C3(M.1)
2          Q1(M.1)          Q2(M.1)          Q3(M.1)
37 FORMAT(1H 16.5X.6(1FE10.3.2X))
38 FORMAT(1H1)
39 FORMAT(' CONCENTRATIONS FOR TIME STEP '.16. ' .5X.1FE10.4.
2. HAS SINCE START OF FEED 1. CURRENT FEED NO. '.11. '
40 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
41 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
42 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
43 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
44 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
45 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
46 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
47 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
48 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
49 FORMAT(1H 16.5X.6(1FE10.3.2X))
2 31X. 'CONCENTRATIONS ON EXCHANGER')
50 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 4

```

NEXTKININ(1)=1
WRITE(OFU,48) NF,DT,NF,DT
RETURN 4 54EF KIN PRINTOUT, MEANINGFUL ONLY IF NF=1
GO TO (1100,1000,1200),NEXT
1100 MDEF=NX+1
WRITE(OFU,70) KF,MDF
WRITE(OFU,11) KF,C2F(KF),KF,C2(KF)
RETURN
1200 WRITE(OFU,12) KF,C2(KF),C3(KF)
WRITE(OFU,13) C2(KF),C3(KF)
WRITE(OFU,14) C3(KF),C3(KF)
RETURN
1300 WRITE(OFU,16)
WRITE(OFU,34) NF
WRITE(OFU,7)
WRITE(OFU,16)
DO 1400 M=1,NX
WRITE(OFU,37) P,C1(M,1),C2(M,1),C3(M,1),C1(M,1),C2(M,1),C3(M,1)
1400 CONTINUE
RETURN
ENTRY OFI(JXP)
C ARGUMENT JXP REPRESENTS THE SPACE-INCREMENT REPORT FREQUENCY.
WRITE(OFU,33)
WRITE(OFU,39) NNN,MPS,KF
JWICK=KJWICK+1
GO TO (1449,1449,1450,2000),JWICK
1449 CONTINUE
WRITE(OFU,7)
WRITE(OFU,40)
WRITE(OFU,41)
WRITE(OFU,42)
WRITE(OFU,7)
1450 CONTINUE
WRITE(OFU,44)
WRITE(OFU,7)
WRITE(OFU,7)
LC=LC+1 8 SET LINE COUNTER
M=1
J1=2
WRITE(OFU,49)C1(K1,J1),C2(K1,J1),C3(K1,J1),C4(K1,J1),C5(K1,J1),
PH(K1)
DO 1800 N=2,NX,JXP BREFOOT CONCENTRATIONS AT JXP INCREMENTS.
WRITE(OFU,47)K,C1(K,2),C2(K,2),C3(K,2),C4(K,2),C5(K,2),PH(K)
1 01(K,2),C2(K,2)
2 03(K,2),C3(K,2)
LC=LC+1 8 ADVANCE LINE COUNTER
IF (MOD(LC,5).EQ.0) WRITE(OFU,7)
IF (LC.LT.45) GO TO 1800
LC=0
1800 CONTINUE
N=NX
WRITE(OFU,47)K,C1(K,2),C2(K,2),C3(K,2),C4(K,2),C5(K,2),PH(K)
1 01(K,2),C2(K,2)
2 03(K,2),C3(K,2)
RETURN
2000 CONTINUE
C AT 2000, JWICK = 3 OUTPUT, MOST ABBREVIATED FORM
WRITE(OFU,200)
200 FORM=11M+14X+2H21.9X+2HCR.9X+3HCT9.8X+2H21.11X+2H24
WRITE(OFU,7)
WRITE(OFU,49)C1X2(1),C2X2(1),C3X2(1),C4X2(1)
DO 2010 N=2,NX,JXP
2010 WRITE(OFU,47)K,C1X2(K),C2X2(K),C3X2(K),C4X2(K),C5X2(K)
N=NX
WRITE(OFU,47)K,C1X2(K),C2X2(K),C3X2(K),C4X2(K),C5X2(K)
RETURN
END

8 ELT LOAD1/S2F5.1.711109. 31169
8 EOF 8
SUBROUTINE LOAD1(M,N,NF)
C THIS FILE SAVED JULY 2 71 - 15135
INCLUDE SHAPE
C... M IS POSITION SUBSCRIPT, MAX VALUE IS SET BY PARAMETER NML.
C... N IS TIME SUBSCRIPT, MAX VALUE IS SET BY PARAMETER NTL.
C... NF IS THE CURRENT FEED NUMBER.
IF (MCD(M,KDUMF).EQ.0)CALL SHOT16H LOAD1(M,N)
CALL LOAD1(M,N,NF,C1X1(M),C2X1(M),C3X1(M),C4X1(M),C5X1(M))
2 C2X1(M),C3X1(M),C4X1(M)
IF (MOD(M,KDUMF).EQ.0)CALL SHOT16H LOAD1(M,N)
RETURN
END

8 ELT LOAD2/S2F5.1.711109. 31170
8 EOF 8
SUBROUTINE LOAD2(M,N,NF)
C THIS FILE SAVED 30 JUN 71 - 13152
INCLUDE SHAPE
C... M IS POSITION SUBSCRIPT, MAX VALUE IS SET BY PARAMETER NML.
C... N IS TIME SUBSCRIPT, MAX VALUE IS SET BY PARAMETER NTL.
C... NF IS THE CURRENT FEED NUMBER.
IF (MCD(M,KDUMF).EQ.0) CALL SHOT16H LOAD2(M,N)
C1=C1X2(M)+C1X1(M)*.5
C2=C2X2(M)+C2X1(M)*.5

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 5

```

C3A=(C1X2(M)+C1Y1(M)).5
C4A=(C1X2(M)+C1Y1(M)).5
C1A=(C1X2(M)+C1Y1(M)).5
Q1A=(C1X2(M)+C1Y1(M)).5
Q1A=(C1X2(M)+C1Y1(M)).5
Q1A=(C1X2(M)+C1Y1(M)).5
Q1A=(C1X2(M)+C1Y1(M)).5
CALL LODD(M,N,NF,Q1A,Q2A,Q3A,Q4A,C1A,C2A,C3A,C4A)
IF (MOD(M,KDUMF).EQ.0) CALL SHOT(16H LOAD2,M,N)
RETURN
END

```

```

3 ELT LODD/S2F5.1.711109. 31172
3 EOF 3
SUBROUTINE LODD(M,N,NF,Q01,Q02,Q03,Q04,Q01,Q02,Q03,Q04)
INCLUDE SHARE
C WHEN CALLED FROM LOAD1, Q01 = Q1(M,N-1), ETC.
C WHEN CALLED FROM LOAD2, Q01 = Q1AV, ETC.
C
J=N-1
BL1=PK17A*(DC1*Q02-S12A*Q02*Q01)
1 +PK13A*(DC1*Q03-S17A*Q03*Q01)
2 +PK14A*(DC1*Q04-S14A*Q04*Q01)
Q1X2(M)=Q1(M,J)+BL1*DT
C
BL1=-PK17A*(DC1*Q02-S12A*Q02*Q01)
1 +PK23A*(DC2*Q03-S23A*Q03*Q02)
2 +PK24A*(DC2*Q04-S24A*Q04*Q02)
Q2X2(M)=Q2(M,J)+BL1*DT
C
BL1=-PK13A*(DC1*Q03-S13A*Q03*Q01)
1 -PK23A*(DC2*Q03-S23A*Q03*Q02)
2 +PK34A*(DC3*Q04-S34A*Q04*Q03)
Q3X2(M)=Q3(M,J)+BL1*DT
C Q1,Q2,Q3 MUST BE GREATER THAN ZERO AND LESS THAN Q2(NF).
VL=Q2(NF)
VS=0.0
CALL ADJU(VL,Q1X2(M),VS)
CALL ADJU(VL,Q2X2(M),VS)
CALL ADJU(VL,Q3X2(M),VS)
FAC=Q1X2(M)+Q2X2(M)+Q3X2(M)
Q4X2(M)=VL-FAC
IF(Q4X2(M).GT.0.0) RETURN
Q4X2(M)=0.0
FAC=Q2(NF)/FAC
Q1X2(M)=Q1X2(M)*FAC
Q2X2(M)=Q2X2(M)*FAC
Q3X2(M)=Q3X2(M)*FAC
IF (MOD(M,KDUMF).EQ.0) CALL SHOT(16H LOAD1,M,N)
RETURN
END

```

```

3 ELT ADJU/S2F5.1.711109. 31172
3 EOF 3
SUBROUTINE ADJU(VMAX,V,VMIN)
C THIS FILE SAVED 21 JUN 71 - 16:13
C
C *** THIS ROUTINE TESTS FOR: VMIN < V < VMAX
C IF (V < VMIN) THEN V IS SET EQUAL TO VMIN ON RETURN
C IF (V > VMAX) THEN V IS SET EQUAL TO VMAX ON RETURN
C ELSE V IS NOT CHANGED.
C
1 FORMAT('BAD ARGUMENT IN CALL TO SUBROUTINE ADJU.')
2 'VMIN MUST BE LESS THAN VMAX'
3 'VMIN WAS *.F13.7,1LX.* VMAX WAS *.F13.7.* PROGRAM STOPPED.'
IF(VMIN.LT.VMAX) GOTO 2
WRITE(6,1) VMIN,VMAX
STOP
2 IF(V.GT.VMIN) GOTO 3
V=VMIN
RETURN
3 IF(V.LT.VMAX) RETURN
V=VMAX
RETURN
END

```

```

3 ELT DAYMUN/S2F5.1.711109. 31174
3 EOF 3
SUBROUTINE DAYMUN
C THIS FILE SAVED 29 AUG 71
INCLUDE SHARE,LIST
LEAVE=15
KDUMF=0
DKM=1.E-14
DKB=1.8E-5
DK1A=0.11E-7
DK2A=5.6E-11
HRO=0.0
DO 100 I=1,IFL
OZ(I)=0.0
CZF(I)=0.0

```


LISTING AND SUBROUTINE COMPILATION: QUATEX P. 6

```

INVT(1)=1
C21(1)=0.0
C22(1)=0.0
C23(1)=0.0
C24(1)=0.0
CCAP(1)=0.0
PK1(1)=0.0
PK11(1)=0.0
PK12(1)=0.0
PK13(1)=0.0
PK14(1)=0.0
PK2(1)=0.0
PK21(1)=0.0
PK22(1)=0.0
PK23(1)=0.0
PK24(1)=0.0
PK3(1)=0.0
S12(1)=0.0
S13(1)=0.0
S14(1)=0.0
S23(1)=0.0
S24(1)=0.0
S34(1)=0.0
CHV(1)=0.0
F(1)=0.0
CBOM(1)=0.0
J1N(1)=0.0
J2N(1)=0.0
J3N(1)=0.0
K1N(1)=0
NS(1)=0
N9(1)=0
N18(1)=0
N17(1)=0
JX(1)=1

JY(1)=1
FLIP(1)=.FALSE.
NBOC=0
J=0.0
PCRTX(1)=1
MCPY(1)=1
AOF(1)=0.0
100 CONTINUE
DO 200 I=1,MXL
DO 200 J=1,NTL
O1(I,J)=0.0
O2(I,J)=0.0
O3(I,J)=0.0
O4(I,J)=0.0
C1(I,J)=0.0
C2(I,J)=0.0
C3(I,J)=0.0
C4(I,J)=0.0
200 CONTINUE
RETURN
END

* ELT NIUFID/S2FS-1.711109. 31176
* EOF *
SUBROUTINE NIUFID(IJK)
C THIS FILE SAVED 23 AUG 71
INCLUDE SHARE
NAMELIST/CON/C2,CZ,C21,C22,C23,CCAP,C1,C2,C3,K1N,C,F,PK12,
& PK13,PK14,NK21,PK22,PK23,S12,S13,S14,S23,S24,C4,PK2,
& PK3,C24,C34,C1N,NT,NY,CHV,JX,JY,G1N,G2N,G3N,VCL,NPC,NDOH
& NTF,LEAVE,L1,S34
C THE FORMAL ARGUMENT IJK CORRESPONDS TO ACTUAL ARG AF.
C THIS ROUTINE HANDLES CONCENTRATION INPUTS AT FEED CHANGES.
KSW=KIN(IJK)+1
S24A=S24(IJK)
S34A=S34(IJK)
S23A=S23(IJK)
RK12A=RK12(IJK)
RK13A=RK13(IJK)
RK14A=RK14(IJK)
RK23A=RK23(IJK)
RK24A=RK24(IJK)
RK34A=RK34(IJK)
S12A=S12(IJK)
S13A=S13(IJK)
S14A=S14(IJK)
C1(1,2)=C21(IJK)
C2(1,2)=C22(IJK)
C3(1,2)=C23(IJK)
SUM=C12(1)+C2X2(1)+C3X7(1)
AUF(IJK)=SUM
CT(1)=CZF(IJK)-SUM
CALL AMCAR(CCAR(IJK),CZF(IJK),FNC(1),SUM,CX2(1),CBOM(IJK),
& ACF(IJK))
IF(IJK.GT.1) GOTO400
O4X1(1)=O2(IJK)-O1X1(1)-C2X1(1)-O3X1(1)
GOTO (100,200,300),KSW
100 DO 120 I=1,MX & IF KIN(I)=0 FOR FEED NO. NF.
C1(I,1)=0.0
C2(I,1)=0.0
C3(I,1)=0.0
O1(I,1)=0.0
O2(I,1)=0.0

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 7

```

0111.11=F.P
0211.11=02(IJK)
110 CONTINUE
GOTO 400
200 DO 200 I=1,NY & IF KIN(FI)=1 FOR FEED NO. NF.
C1(I)=C21(IJK)
C2(I)=C22(IJK)
C3(I)=C23(IJK)
C4(I)=C14(IJK)
C5(I)=C24(IJK)
C6(I)=C34(IJK)
C7(I)=C44(IJK)
C8(I)=C54(IJK)
C9(I)=C64(IJK)
C10(I)=C74(IJK)
C11(I)=C84(IJK)
C12(I)=C94(IJK)
C13(I)=C104(IJK)
C14(I)=C114(IJK)
C15(I)=C124(IJK)
C16(I)=C134(IJK)
C17(I)=C144(IJK)
C18(I)=C154(IJK)
C19(I)=C164(IJK)
C20(I)=C174(IJK)
C21(I)=C184(IJK)
C22(I)=C194(IJK)
C23(I)=C204(IJK)
C24(I)=C214(IJK)
C25(I)=C224(IJK)
C26(I)=C234(IJK)
C27(I)=C244(IJK)
C28(I)=C254(IJK)
C29(I)=C264(IJK)
C30(I)=C274(IJK)
C31(I)=C284(IJK)
C32(I)=C294(IJK)
C33(I)=C304(IJK)
C34(I)=C314(IJK)
C35(I)=C324(IJK)
C36(I)=C334(IJK)
C37(I)=C344(IJK)
C38(I)=C354(IJK)
C39(I)=C364(IJK)
C40(I)=C374(IJK)
C41(I)=C384(IJK)
C42(I)=C394(IJK)
C43(I)=C404(IJK)
C44(I)=C414(IJK)
C45(I)=C424(IJK)
C46(I)=C434(IJK)
C47(I)=C444(IJK)
C48(I)=C454(IJK)
C49(I)=C464(IJK)
C50(I)=C474(IJK)
C51(I)=C484(IJK)
C52(I)=C494(IJK)
C53(I)=C504(IJK)
C54(I)=C514(IJK)
C55(I)=C524(IJK)
C56(I)=C534(IJK)
C57(I)=C544(IJK)
C58(I)=C554(IJK)
C59(I)=C564(IJK)
C60(I)=C574(IJK)
C61(I)=C584(IJK)
C62(I)=C594(IJK)
C63(I)=C604(IJK)
C64(I)=C614(IJK)
C65(I)=C624(IJK)
C66(I)=C634(IJK)
C67(I)=C644(IJK)
C68(I)=C654(IJK)
C69(I)=C664(IJK)
C70(I)=C674(IJK)
C71(I)=C684(IJK)
C72(I)=C694(IJK)
C73(I)=C704(IJK)
C74(I)=C714(IJK)
C75(I)=C724(IJK)
C76(I)=C734(IJK)
C77(I)=C744(IJK)
C78(I)=C754(IJK)
C79(I)=C764(IJK)
C80(I)=C774(IJK)
C81(I)=C784(IJK)
C82(I)=C794(IJK)
C83(I)=C804(IJK)
C84(I)=C814(IJK)
C85(I)=C824(IJK)
C86(I)=C834(IJK)
C87(I)=C844(IJK)
C88(I)=C854(IJK)
C89(I)=C864(IJK)
C90(I)=C874(IJK)
C91(I)=C884(IJK)
C92(I)=C894(IJK)
C93(I)=C904(IJK)
C94(I)=C914(IJK)
C95(I)=C924(IJK)
C96(I)=C934(IJK)
C97(I)=C944(IJK)
C98(I)=C954(IJK)
C99(I)=C964(IJK)
100 CONTINUE
GOTO 500
300 WRITE(10PU,*) IJK & IF KIN(FI)=2 FOR FEED NO. NF
5 FORMAT(' READY TO READ CONCENTRATIONS AT STARTING OF FEED NO. ',
I2)
READ(10PU,*) IJK
500 CONTINUE
C INITIALIZE BY SETTING EQUAL TO FEED
C1(I)=C21(IJK)
C2(I)=C22(IJK)
C3(I)=C23(IJK)
RETURN
C INITIALIZE BY AVERAGING FEED AND INITIAL CONC IN COLUMN
END

```

```

0 ELY SETINC/S2FE.1.711109. 31177
0 ECF 0

```

```

SUBROUTINE SETINC
C TIS FILE SAVE 13 JULY 71
INCLUDE SHARE
MX=VOL/DX+1.1
SUN=0.0
VV=E-2.
DO 100 I=1,NFC
II=I
SUN=SUN+VV+DX/F(I)
100 CONTINUE
DT=.92*SUN/II
SUN=0.0
DO 200 I=1,NFC
SUN=SUN+CHV(I)/F(I)
200 CONTINUE
MT=SUN/DT
RETURN
END

```

```

0 ELY AMCAP/S2FE.1.711109. 31178
0 ECF 0

```

```

SUBROUTINE AMCAP(XCAR,XCZ,DPH,FHI,AP,XHHQCH,XAD)
C TIS FILE SAVED 23 AUG 71
INCLUDE SHARE
J=0
DATA CRIT/.0001/
XCZ=XCZ-FHI
IF (XCZ-0.0) GOTO 60
AM=0.0
RETURN
60 CONTINUE
IF (XCAR-0.0) AND (XHHQCH-0.0) GOTO 80
AM=XCT0
RETURN
80 CONTINUE
P3=0.0
P2=10.0
90 CONTINUE
J=J+1
IF (J-0.20) WRITE(16,111) NAW
111 FORMAT(' AMCAP J = 20. NAW = ',I6)
P1=(P3+P2)/2.
ND=10**(-P1)
V= -ND * DPH/HC * XCAR*(ND/DK2A+2)/11+ND/DK2A*ND*ND/DK2A/
* DK1A) - FPI *XAD
V=V - XCT0/11+DPH/DK5/ND1
IF (P2-P1).LT.CRIT GOTO 150
IF (V-LE.D.E) P2=P1
IF (V-0.0) P2=P1
GO TO 90
150 CONTINUE
IF (ND-0.0) GOTO 101
WRITE(16,150) ND,FHI,XAD,NAW
1500 FORMAT(' ERROR IN AMCAP IFN SET TO 93 ND,FHI,XAD,NAW ',
I16.6,I10)
P1=9.0
101 DPH=P1
ND=10**(-DPH)
AM=XCT0/11+DPH/DK5/ND1
RETURN
END

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 8

```

D ELY CWNOL/S2FS.1.711109. J1100
B EOF 1
SUBROUTINE CWNOL(N,NF)
C THIS FILE SAVED 21 AUG 71
LOGICAL NO FEED
INCLUDE SHARE
C*** P IS POSITION SUBSCRIPT. MAX VALUE IS SET BY PARAMETER PML.
C*** N IS TIME SUBSCRIPT. MAX VALUE IS SET BY PARAMETER NIL.
C*** NF IS THE CURRENT FEED NUMBER.
NCFRNT=.TRUE.
EDX=.0X
FDT=F(NF)*DT/7.
DENP=EDX+FDT
AA=EDX-FDT
ML=1
IF(NF.EQ.1.0)ML=NF.NCFRNT=NF/100 TO 100
NCFRNT=.FALSE.
SCALE=CZF(NF)/CZF(NF-1)
DO 50 J=1,2
C1(ML,J)=C1(ML,J)/SCALE
C2(ML,J)=C2(ML,J)/SCALE
C3(ML,J)=C3(ML,J)/SCALE
50 CONTINUE
100 CONTINUE
CT=(C1X1(M)-C1X2(M))*CX+C1X1(M)*AA
C1X2(M)=(CT*(C1X1(M)-C1X1(M))+C1X1(M))*FDT/DENP
CT=(C2X1(M)-C2X2(M))*CX+C2X1(M)*AA
C2X2(M)=(CT*(C2X1(M)-C2X1(M))+C2X1(M))*FDT/DENP
CT=(C3X1(M)-C3X2(M))*CX+C3X1(M)*AA
C3X2(M)=(CT*(C3X1(M)-C3X1(M))+C3X1(M))*FDT/DENP
CZNF=CZ(M)
CALL ADJUCZNF,C1X2(M),0.0)
CALL ADJUCZNF,C2X2(M),0.0)
CALL ADJUCZNF,C3X2(M),0.0)
SUM=C1X2(M)+C2X2(M)+C3X2(M)
CT(M)=CZNF/SUM
IF(NCFRNT) GO TO 200
DO 150 J=1,2
C1(ML,J)=C1(ML,J)*SCALE
C2(ML,J)=C2(ML,J)*SCALE
C3(ML,J)=C3(ML,J)*SCALE
150 CONTINUE
200 CONTINUE
IF(CT(M).GT.0.0) GO TO 4
CT(M)=0.0
FAC=CZNF/SUM
C1X2(M)=C1X2(M)*FAC
C2X2(M)=C2X2(M)*FAC
C3X2(M)=C3X2(M)*FAC
CZNF=0.0
RETURN
4 CONTINUE
NMT=SUM
CALL AMCARICAPB(M),CZNF,FH(M),NMT,C1X2(M),C2X2(M),C3X2(M),AD(M)
C IF(NNN.GT.409.AND.NNN.LT.920) WRITE(6,2000)NNN,M,C1X1(ML),
C C1X2(ML),C1X2(ML),C1X2(ML),FH(M),NCFRNT(NF)
2000 FORMAT(' CNSOL NNN=',I6,' M=',I6,' C1X1(ML),C1X2(ML),
2'C1X2(ML),C1X2(ML),FH(M),NCFRNT=',5E15.4,15)
RETURN
END

D ELY SPFLIF/S2FS.1.711109. J1102
B EOF 2
SUBROUTINE SPFLIF
INCLUDE SHARE
C THIS FILE SAVED 25 AUG 71
C
C THIS PROGRAM "FLIPS" THE COLUMN: EFFECTIVELY SIMULATING CHANGE IN
C DIRECTION OF FEED.
C SPFLIF CAN BE CALLED AT EACH FEED CHANGE FROM DRIVER
C
N=(NX+1)/2
DO 200 I=2,N
IX=NX-I+1
DO 100 J=1,2
T=C1(I,J)
C1(I,J)=C1(IX,J)
C1(IX,J)=T
T=C2(I,J)
C2(IX,J)=C2(I,J)
C2(I,J)=T
T=C3(I,J)
C3(IX,J)=C3(I,J)
C3(I,J)=T
T=C4(I,J)
C4(IX,J)=C4(I,J)
C4(I,J)=T
T=C5(I,J)
C5(IX,J)=C5(I,J)
C5(I,J)=T
T=C6(I,J)
C6(IX,J)=C6(I,J)
C6(I,J)=T
T=C7(I,J)
C7(IX,J)=C7(I,J)
C7(I,J)=T
T=C8(I,J)
C8(IX,J)=C8(I,J)
C8(I,J)=T
T=C9(I,J)
C9(IX,J)=C9(I,J)
C9(I,J)=T
T=C10(I,J)
C10(IX,J)=C10(I,J)
C10(I,J)=T
T=C11(I,J)
C11(IX,J)=C11(I,J)
C11(I,J)=T
T=C12(I,J)
C12(IX,J)=C12(I,J)
C12(I,J)=T
T=C13(I,J)
C13(IX,J)=C13(I,J)
C13(I,J)=T
T=C14(I,J)
C14(IX,J)=C14(I,J)
C14(I,J)=T
T=C15(I,J)
C15(IX,J)=C15(I,J)
C15(I,J)=T
T=C16(I,J)
C16(IX,J)=C16(I,J)
C16(I,J)=T
T=C17(I,J)
C17(IX,J)=C17(I,J)
C17(I,J)=T
T=C18(I,J)
C18(IX,J)=C18(I,J)
C18(I,J)=T
T=C19(I,J)
C19(IX,J)=C19(I,J)
C19(I,J)=T
T=C20(I,J)
C20(IX,J)=C20(I,J)
C20(I,J)=T
T=C21(I,J)
C21(IX,J)=C21(I,J)
C21(I,J)=T
T=C22(I,J)
C22(IX,J)=C22(I,J)
C22(I,J)=T
T=C23(I,J)
C23(IX,J)=C23(I,J)
C23(I,J)=T
T=C24(I,J)
C24(IX,J)=C24(I,J)
C24(I,J)=T
T=C25(I,J)
C25(IX,J)=C25(I,J)
C25(I,J)=T
T=C26(I,J)
C26(IX,J)=C26(I,J)
C26(I,J)=T
T=C27(I,J)
C27(IX,J)=C27(I,J)
C27(I,J)=T
T=C28(I,J)
C28(IX,J)=C28(I,J)
C28(I,J)=T
T=C29(I,J)
C29(IX,J)=C29(I,J)
C29(I,J)=T
T=C30(I,J)
C30(IX,J)=C30(I,J)
C30(I,J)=T
T=C31(I,J)
C31(IX,J)=C31(I,J)
C31(I,J)=T
T=C32(I,J)
C32(IX,J)=C32(I,J)
C32(I,J)=T
T=C33(I,J)
C33(IX,J)=C33(I,J)
C33(I,J)=T
T=C34(I,J)
C34(IX,J)=C34(I,J)
C34(I,J)=T
T=C35(I,J)
C35(IX,J)=C35(I,J)
C35(I,J)=T
T=C36(I,J)
C36(IX,J)=C36(I,J)
C36(I,J)=T
T=C37(I,J)
C37(IX,J)=C37(I,J)
C37(I,J)=T
T=C38(I,J)
C38(IX,J)=C38(I,J)
C38(I,J)=T
T=C39(I,J)
C39(IX,J)=C39(I,J)
C39(I,J)=T
T=C40(I,J)
C40(IX,J)=C40(I,J)
C40(I,J)=T
T=C41(I,J)
C41(IX,J)=C41(I,J)
C41(I,J)=T
T=C42(I,J)
C42(IX,J)=C42(I,J)
C42(I,J)=T
T=C43(I,J)
C43(IX,J)=C43(I,J)
C43(I,J)=T
T=C44(I,J)
C44(IX,J)=C44(I,J)
C44(I,J)=T
T=C45(I,J)
C45(IX,J)=C45(I,J)
C45(I,J)=T
T=C46(I,J)
C46(IX,J)=C46(I,J)
C46(I,J)=T
T=C47(I,J)
C47(IX,J)=C47(I,J)
C47(I,J)=T
T=C48(I,J)
C48(IX,J)=C48(I,J)
C48(I,J)=T
T=C49(I,J)
C49(IX,J)=C49(I,J)
C49(I,J)=T
T=C50(I,J)
C50(IX,J)=C50(I,J)
C50(I,J)=T
T=C51(I,J)
C51(IX,J)=C51(I,J)
C51(I,J)=T
T=C52(I,J)
C52(IX,J)=C52(I,J)
C52(I,J)=T
T=C53(I,J)
C53(IX,J)=C53(I,J)
C53(I,J)=T
T=C54(I,J)
C54(IX,J)=C54(I,J)
C54(I,J)=T
T=C55(I,J)
C55(IX,J)=C55(I,J)
C55(I,J)=T
T=C56(I,J)
C56(IX,J)=C56(I,J)
C56(I,J)=T
T=C57(I,J)
C57(IX,J)=C57(I,J)
C57(I,J)=T
T=C58(I,J)
C58(IX,J)=C58(I,J)
C58(I,J)=T
T=C59(I,J)
C59(IX,J)=C59(I,J)
C59(I,J)=T
T=C60(I,J)
C60(IX,J)=C60(I,J)
C60(I,J)=T
T=C61(I,J)
C61(IX,J)=C61(I,J)
C61(I,J)=T
T=C62(I,J)
C62(IX,J)=C62(I,J)
C62(I,J)=T
T=C63(I,J)
C63(IX,J)=C63(I,J)
C63(I,J)=T
T=C64(I,J)
C64(IX,J)=C64(I,J)
C64(I,J)=T
T=C65(I,J)
C65(IX,J)=C65(I,J)
C65(I,J)=T
T=C66(I,J)
C66(IX,J)=C66(I,J)
C66(I,J)=T
T=C67(I,J)
C67(IX,J)=C67(I,J)
C67(I,J)=T
 
```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 9

```

071X=J1
T=C3(I,J)
071Z=J1:11(TV,J)
071X=J1
T=C4(I,J)
071Z=J1:11(TV,J)
071X=J1
T=C5(I,J)
071Z=J1:11(TV,J)
071X=J1
T=C6(I,J)
071Z=J1:11(TV,J)
100 CONTINUE
T=C7(I)
C7(I)=C7(I)
C7(I)=T
T=C2(I)
C2(I)=C2(I)
C2(I)=T
T=AD(I)
AD(I)=AD(I)
AD(I)=T
T=CARG(I)
CARG(I)=CARG(I)
CARG(I)=T
T=CSCHV(I)
CSCHV(I)=CSCHV(I)
CSCHV(I)=T
200 CONTINUE
WRITE(10PU,3000)
3000 FORMAT('***** DIRECTION OF FEED HAS BEEN REVERSED *****')
RETURN
END

```

```

0 ELT SHOT/SIFS=1.711109. 3118Y
0 EOP 0
SUBROUTINE SHOT(SRM,N,M)
INCLUDE SHAPE
1 FORMAT(2H )
2 FORMAT(1H ,A6,' NNN=' ,I0,' C1=' ,IF9.3,' C2=' ,E9.3,' C3=' ,
3E9.3,' C4=' ,E9.3/1H ,N=' ,I2,' P=' ,I0,' Q1=' ,E9.3,' Q2=' ,
3E9.3,' Q3=' ,E9.3,' Q4=' ,E9.3)
WRITE(10PU,1)
WRITE(10PU,2)SRM,NNN,C1(M,N),C2(M,N),C3(M,N),C4(M,N),N,M
3 Q1(M,N),Q2(M,N),Q3(M,N),Q4(M,N)
RETURN
END

```

```

0 ELT COLINV/SIFS=1.711109. 3118Y
0 EOP 0
SUBROUTINE COLINV(N,M)
REAL C1,C2,C3,CT1
REAL UC1,UC2,UC3,UCT1
INCLUDE SHAPE
C
C S.R. COLINV CALCULATES AND PRINTS THE COLUMN INVENTORIES AT
C TIME STEP NMP.
C COLINV ALSO PRINTS THE COLUMN EXIT INVENTORIES.
C COLINV IS CALLED BY S.R. DRIVER AND THE FREQUENCY IS CONTROLLED
C BY INPUT VARIABLE INVT.
C
C ENTRY EXINV (NF) INCREMENTS THE COLUMN EXIT INVENTORIES AND
C IS CALLED BY S.R. DRIVER AT THE END OF EVERY TIME STEP.
C
C
C1=0.0
C2=0.0
C3=0.0
CT1=0.0
DO 100 M2,NX
C1=C1+(C1X2(M)-C-01X2(M))*DX
C2=C2+(C2X2(M)-C-02X2(M))*DX
C3=C3+(C3X2(M)-C-03X2(M))*DX
CT1=CT1+(CT1X(M)-C-04X2(M))*DX
100 CONTINUE
C PRINT COLUMN INVENTORIES AND EXIT INVENTORY
WRITE(10PU,901)C1,C2,C3,CT1,UC1,UC2,UC3,UCT1
900 FORMAT('COLUMN INVENTORIES',T61,'COLUMN EXIT INVENTORIES',
1T99,'AT TIME STEP ',I6,'/' 'ION 1',9X,' ION 2',9X,' ION 3',9X,
' ION 4',10X,' ION 1',9X,' ION 2',9X,' ION 3',9X,' ION 4',9X)
901 FORMAT(' ',I1E15.5,' ',I2E15.5,' ',I3E15.5,' ',I4E15.5)
C
C RETURN
C
C
C ENTRY EXINV(NF)
DATA UC1,UC2,UC3,UCT1/0.0,0.0,0.0,0.0/
FACT=DT*(NF)
UC1=UC1+C1X2(NX)*FACT
UC2=UC2+C2X2(NX)*FACT
UC3=UC3+C3X2(NX)*FACT
UCT1=UCT1+CT1X(NX)*FACT
C
C RETURN
END

```

LISTING AND SUBROUTINE COMPILATION: QUATEX P. 10

```

3 1LT FRONT/52F5.1.711109. 11185
3 12F 3
SUBROUTINE FRONT      3  LOCATION OF FRONTS
C
C 3.R. FRONT DOES INITIALIZATION, COMPUTES THE TMAX(I) = TIME IN
C HOURS AT THE START OF EACH FEEL
C
C ENTRY FRONTL (NF) --- IS CALLED ONCE PER TIME STEP, BEFORE CONC.
C CALCUL.
C --- COMPUTES THE MCRT(I) = FRONT LOCATIONS IN POSITION
C INCREMENT UNITS.
C --- USES MCRT TO SET CZ(I), TOTAL CONC. IN SOLN. AT
C EACH POSITION. ALSO SCALES OTHER CONC. IF NECESS.
C
C INCLUDE SHARE
REAL TMAX(1F1),THP,FACT
TMAX(1)=0.0
DO 100 J=2,NFC
JMI=J-1
100 TMAX(J)=TMAX(JMI) + CHV(JMI)/F(JMI)
RETURN
C
ENTRY FRONTL(NF)
THP=NNN*CT
FACT=F(NF)/(E*DX)
DO 225 J=1,NF      3 COMPUTE MCRT
MCRTX(J)=MCPIT(J)
IF(MCRT(J).GE.NX) GO TO 225
MCRT(J)=(THR-TMAX(J))*FACT+1
225 CONTINUE
DO 400 J=1,NF
ML=MCRTX(J)+1
MU= MIND(MCRT(J),NX)
C FUDGE ON 1ST TIME INCREMENT
IF(MU.LT.2)MU=2
CZFJ=CZF(J)
ADFJ=ADF(J)
IF(J.GT.1)GO TO 250
SCALE=1.0
GO TO 270
250 CZSAVE=CZF(J-1)
SCALE=CZFJ/CZSAVE
270 CONTINUE
IF(ML.GT.MU) GO TO 400
DO 500 M=ML,MU
CZ(M)=CZFJ
AD(M)=ADFJ
CPSB(M)=LCAPI(J)
CSCHY(M)=CBOM(J)
C1Y1(M)=C1X1(M)*SCALE
G3X1(M)=G3X1(M)*SCALE
C3Y1(M)=C3X1(M)*SCALE
500 CONTINUE
400 CONTINUE
RETURN
END
06130274 CUB792FUND01 100 951 9 873 19121601 1 0000 5 JANSE 5

```

PROGRAM NAME: SEPHIS

Descriptive Title: Solvent Extraction Between Phases in Stagewise Contactors

Program Author: Groenier, William S. (ORNL)

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 4

Central Memory Words: 311000B

Average Execution Time: 60 CP sec

Keywords: Solvent Extraction, Purex Plant, Tributyl Phosphate, Nuclear Fuel Reprocessing

Program Description: Estimates local stage conditions and effluent concentrations for steady-state and transient operation of a solvent extraction column or series of columns with an arbitrary number of stages for the system TBP-uranium-plutonium-nitric acid. This is the Richardson-Nance revised version with empirical equilibrium data and optional plutonium reduction. Finite difference in time. Four subroutines. Formatted input.

Users of Program: G Jansen
GL Richardson (HEDL)
JR Nance
LG Niccoli (JCGS)
RL Walser (ARHCO)
WV DeMier
RL Engel

Documentation: Original program is described in ORNL-4746. Revisions are described in letter from G. Jansen to G. E. Benedict, ARHCO, "Computer Program for Solvent Extraction Calculations," January 14, 1971.

Condition of Program: It is in good running order but the output is voluminous. Continual modifications and enhancements make it desirable to consult with persons running the program to get the latest version.

PROGRAM SEPHIS (Richardson-Nance Revised Version)
(Solvent Extraction Processes Having Interacting Solutes)

G. L. Richardson

The computer program is written in FORTRAN V for the CSC Univac-1108 and is a modification of the original SEPHIS program developed by W. S. Groenier at ORNL. The program can be used to predict transient and steady-state concentrations in stage-wise solvent extraction equipment. It can handle the simultaneous extraction of three solutes that interact; thus, the approach to steady state of all three solutes can be studied. Specifically, the program calculates the changes in stage-wise equilibrium concentrations for transfer of uranyl nitrate, plutonium (IV) nitrate, and nitric acid between water and TBP-hydrocarbon diluent phases as a function of operating time after a change in operating conditions.

Equilibrium relationships are mathematical and only approximate. The equations were derived from equilibrium data covering the range of 2.5 to 100% TBP for uranium and nitric acid and from 2 to 40% TBP for plutonium. The estimated maximum applicable aqueous phase concentrations are $2M$ U, $0.2M$ Pu, $6M$ HNO_3 , and $6M$ NO_3^- . Temperature correction coefficients were derived from data covering the temperature range of 0 to $70^\circ C$. The equilibrium correlation is inserted as a subroutine that can be easily changed when improved equilibrium data become available. (Additional plutonium data would be particularly welcome to resolve discrepancies between different sets of published data.) Caution should be applied in accepting the calculated plutonium concentrations, particularly at elevated temperatures, high uranium concentrations, and low acidities, until the validity of the plutonium correlation can be confirmed.

Input data include the feed stream compositions, relative flows, and temperatures; initial stage concentration and temperature profiles; the number of stages; the phase ratio within a stage (if different than the flow ratio); the volume of each stage (if set independently for each stage); and the definition of outgoing streams other than the normal end streams. Stages are numbered from the top down; Stage 1 is the stage where the first aqueous feed stream enters and the organic end stream leaves. Initially,

both phases must be present in each stage. In each time interval, the phases are mixed completely, separated cleanly (no entrainment), and sent to the proper adjacent stage. A time interval is the time required to perform the above operation.

The aqueous/organic phase ratio may be specified for each stage (or group of stages), starting at the top stage, or it may be set equal to the flow ratio. If the specified phase ratio differs from the flow ratio, the program provides that a portion of one of the phases leaving the stage be recycled back to the same stage to satisfy the phase ratio requirement.

The total stage volume is defined by the total stage flow, including that of internal recycle streams. The minimum stage volume is that required to contain the interstage flows, which are determined by the specified feed and raffinate flows. The case with minimum stage volume will be calculated if the phase ratio is set equal to the flow ratio and the stage volume is specified to vary with total flow. However, this option has little practical application except to simulate the results of a batch counter-current laboratory extraction.

Normally, the aqueous/organic (A/O) phase ratio in an actual contactor "stage" is determined by the design or mode of operation of the contactor (i.e., by interface location, pulsing conditions, etc. in a pulse column); and the stage volumes are either equal, as in a mixer-settler contactor, or set arbitrarily according to assumed stage heights, as in a pulse column. Options to simulate these operating conditions are provided in the program. If selected, they provide that a portion of one or both phases be recycled within a stage to satisfy the total stage volume and phase ratio requirements. This recycle flow volume is added to the previously defined interstage flow volumes to obtain the total stage flow volumes for a time interval. In practice, if an independent stage volume option is selected, the minimum amount of recycle flow is calculated for each stage so that the total stage flow is set in proportion (not equal) to the specified stage volume.

The first page of output prints the problem conditions (feed stream compositions, feed points, flow rates, temperatures, initial profiles and phase ratio) and defines the interstage, recycle, and total flows of each phase for each stage according to the phase ratio and stage volume options.

The time scale of a time interval can be calculated if the actual stage volumes and the flow rate of one of the interstage streams are known:

$$\frac{\text{Minutes}}{\text{Time Interval}} = \frac{(\text{Relative interstage flow rate})(\text{Actual stage volume})}{(\text{Calc. relative total stage flow})(\text{Actual interstage flow/min.})}$$

(Actual stage volumes and flows must be given in the same volume units.)

To save computer time, the phase ratios, stage volumes, and interstage, recycle, and total stage flows are calculated or specified on a solute-free volume basis. This volume basis is used in stage equilibrium calculations to correct for volume changes caused by extraction of solutes. Input feed streams are converted to the solute-free volume basis at the start of the computation by subtracting the approximate solute volumes from the feed stream volumes. At the end of the stage equilibrium calculation, new solute volumes are calculated and added to the solute-free volumes leaving each stage to give the actual output solution volumes. Solute concentrations during the stage calculations are on a solute-free volume basis, but those in the printed output are converted back to molarities. For most practical purposes the specification of actual volumes in place of solute-free volumes when defining phase ratios and total stage volumes will introduce little error, since the selection of such variables can seldom be precise.

The program provides for outgoing streams other than the normal end streams. If used, the desired flows must be specified on a solute-free volume basis. For the organic phase, this volume can be approximated by multiplying the actual volume (if known) by the factor $(1 - 0.092(\underline{M} \text{ U}) - 0.18(\underline{M} \text{ Pu}) - 0.043(\underline{M} \text{ HNO}_3))$. The corresponding aqueous volume correction factor is $1 - 0.0724(\underline{M} \text{ U}) - 0.13(\underline{M} \text{ Pu}) - 0.0309(\underline{M} \text{ HNO}_3)$. An example case where this option might be used would be to calculate the time required for an extraction battery consisting of a 1A and a 1C column to come to steady state. The total number of stages in both the 1A and 1C columns would be used as input to the computer, and the total 1CX flow would be removed as the 1CU product stream at the stage corresponding to the product stage of the 1C column. The specified exit stream flow would be that of the water in the 1CX stream.

The temperature profile in the column is calculated by a simple, stage-wise heat balance based on the temperatures and volumes of the solute-free

flows (including recycle) entering each stage. Specific heats were assumed to be 1 for the aqueous phase and about 0.5 for the organic phase. No correction is made for the heat capacity of the solutes, for any heat generated by the mass transfer reaction, or for heat losses from the system.

The program has two options for determining when the desired steady-state operation has been achieved. For shut-down calculations where the time to strip uranium and plutonium from the system is desired, the program tests each stage after each time interval to see if the uranium and plutonium concentration in each phase has decreased to less than 10^{-6} M. For the start-up case, the approach to steady-state is defined by the percent of the overall material balance of that component which is furthest from the steady-state value:

$$\% \text{ Steady State} = 100(1 - |1 - \text{moles solute out}/\text{moles solute in}|)$$

The percent material balance that terminates the program depends on the rate at which steady-state is approached. The program will terminate at 99.9% material balance if 99.5% material balance is achieved within 100 time intervals. This is usually sufficient to provide 3 to 5 throughputs of the solvent phase. If considerable reflux of one of the transferring solutes occurs, it may take several hundred time intervals to reach 99.9% of steady state. In this case, the program will be terminated at 99% of steady state if only 95% steady-state has been reached in 100 time intervals, or at 99.5% if 99% steady-state has been reached. The overall percent steady state is printed out at the end of the program and at the end of each 100 time-intervals, together with the number of the time interval at which it reaches 90, 95, 99, and 99.5% of steady state. This latter information can be a useful indication of the transient behavior if the option to print only the last time interval is chosen.

The computer calculates about 40 to 45 lines of output (stage-time intervals) per second. A typical 100 time-interval run will produce about $[(100)(\text{No. of stages}) + 40]$ lines of output. Runs involving considerable reflux will have about 2 to 4 times this many lines of output. Sufficient time and lines of output must be specified on the RUN card to permit complete computation and printout of the results.

If desired, the final "steady-state" profile concentrations and temperatures can be punched out on cards in a format suitable for use as input in later calculations. Provision is also made for using the final profile results directly as input for a second calculation where the effects of changed feed stream conditions only are being studied. With this option it is necessary to provide input cards for all feed and out streams whether changed or not; no changes in phase ratio, stage volumes, or TBP concentration are permitted.

The formats of the data cards used in this program are presented in the following table. The cards must be arranged in the order shown. Integer numbers, designated by the I prefix in the card format column, must be punched without a decimal point at the far right of the column field (unpunched spaces in the column field are treated as zeros). The F prefix designates a "real" number, which must contain a decimal point. Real numbers can be placed anywhere in the column field. The variable name is that referenced in the program compilation.

TABLE I
DATA CARD FORMATS

PROBLEM CARD

<u>Variable Name</u>	<u>Column Field</u>	<u>Description</u>	<u>Field Format</u>
TAT1,4	1-16	Problem title	4A4
NTOST	17-20	Number of stages (25 maximum)	I4
NSOLU	21-24	Number of solutes (must use 3 at present)	I4
CTBP	25-28	Volume fraction TBP in dry solvent	F4.0
IPRO	29-32	0 for a zero initial profile (25°C) 1 for a non-zero initial profile (profile cards must be provided for each stage)	I4
IRATIO	33-36	0 if phase ratio equals flow ratio 1 if phase ratio does not equal flow ratio (usually true; Phase Ratio cards required)	I4
ICALC	37-40	0 to calculate shut-down transient to zero uranium and plutonium concentrations 1 for start-up or interruptive transient calculation	I4
IOUT	41-44	0 for no outgoing streams other than end streams 1 if there are outgoing streams in addition to normal end streams	I4
IVOL	45-48	0 if all stage volumes are equal 1 if stage volumes are unequal but vary according to total flow 2 if stage volumes are unequal and not flow related (Stage Volume cards required)	I4
IPR	49-52	0 to print transient results for every time interval 1 to print only last time interval	I4
IPNCH	53-56	0 if no punched card output is desired 1 to punch final profile concentrations and temperatures according to Profile Card format	I4

FEED STREAM CARDS (One card required for each feed stream)

I	1- 4	Stage number that feed enters	I4
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FEED STREAM CARDS (Continued)

Variable Name	Column Field	Description	Field Format
JHAS	5- 8	0 (or -1) for an organic feed 1 for aqueous feed	I4
FDRT	9-16	Feed rate in relative volume units	F8.0
CON1	17-24	Uranium concentration, <u>M</u>	F8.0
CON2	25-32	Plutonium concentration, <u>M</u>	F8.0
CON3	33-40	Nitric acid concentration, <u>M</u>	F8.0
TEMP	41-48	Temperature, °C (Not needed if temperature is 25°C)	F8.0
INDEX	49-52	0 for last card 1 if more cards of this type follow	I4

PROFILE CARDS (Used only for a non-zero initial profile. One card required for each stage.)

X(1,J,1)	1- 8	<u>M</u> U, aqueous	F8.0
X(2,J,1)	9-16	<u>M</u> Pu, aqueous	F8.0
X(3,J,1)	17-24	<u>M</u> HNO ₃ , aqueous	F8.0
Y(1,J,1)	25-32	<u>M</u> U, organic	F8.0
Y(2,J,1)	33-40	<u>M</u> Pu, organic	F8.0
Y(3,J,1)	41-48	<u>M</u> HNO ₃ , organic	F8.0
Tprof(J,1)	49-56	Temperature, °C (not needed for 25°C profile.)	F8.0

OUT CARDS (Used only if there are outgoing streams in addition to the end streams. One card required for each extra out stream.)

I	1- 4	Stage number that stream leaves	I4
JHAS	5- 8	0 if an organic stream 1 if an aqueous stream	I4
OTRT	9-16	Flow rate in solute-free volume units	F8.0
INDEX	17-20	0 for last card 1 if more cards of this type follow	I4

PHASE RATIO CARDS (Used only if phase ratio and flow ratios are not equal.
One card needed for each region of constant flow ratio.)

Variable Name	Column Field	Description	Field Format
I	1- 8	Number of stages having ratio shown	I8
RATIO	9-16	Phase ratio, A/O	F8.0

STAGE VOLUME CARDS (Used only if stage volumes are unequal and independent of total flow. Two or three cards may be required to provide a value for each stage.)

STVOL(1)	1- 8	Volume of stage 1 (Card 1)	F8.0
(2)	9-16	Volume of stage 2 (Card 1)	F8.0
.	.	.	.
.	.	.	.
(10)	72-80	Volume of stage 10 (Card 1)	F8.0
(11)	1- 8	Volume of stage 11 (Card 2)	F8.0
.	.	.	.
.	.	.	.

CONTINUATION CARD

ICHNGE	1- 2	0 if a complete set of cards for a new case follow 1 if a second case follows, involving only a change in feed streams* 2 if no cases follow	I2
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* For ICHNGE = 1, the CONTINUATION CARD must be followed, in order, by FEED STREAM and OUT CARDS, one card for each feed and extra outgoing stream used in the next case, and a second CONTINUATION CARD. The profile will be that calculated for the preceding case. No changes in phase ratios, stage volumes, number of stages, or TBP concentration are permitted. The following punches are required only if ICHNGE = 1:

ICALC	3- 4	0 for shut-down calculation 1 for continuation to a new steady-state profile	I2
IOUT	5- 6	0 if no extra outgoing streams 1 for outgoing streams in addition to end streams	I2
IPNCH	7- 8	0 for no punched card output 1 to punch final profile conditions	I2

Example Problems

The following examples illustrate the use of the card format table and many of the options available in the SEPHIS program:

1. Given: A six-stage Purex 1A column with three 0.8-liter scrub stages and three 1-liter extraction stages. Feed streams:

1AS = 2M HNO_3 at 60 ml/min, 35°C

1AF = 1.5M U, 0.0045M Pu, 1.5M HNO_3 at 100 ml/min., 50°C

1AX = 30% TBP, 0.01M HNO_3 at 400 ml/min., 45°C

Calculate: The steady state profile and the time required to reach steady state. Assume the column has been filled with 1AS and 1AX prior to startup, that (for illustration purposes only) the aqueous scrub flow is removed from the column just before it enters the 1AF feed stage, and that the A/O phase ratio is 0.2 in the scrub section and 0.25 in the extraction section.

2. Given: The above column after it has reached steady state.

Calculate: The time required to strip the U and Pu from the column after the 1AF is shut off. Assume that the spent scrub is no longer removed from the column.

The coding sheet for these problems is shown in Table II. The flow shown on the OUT CARD is the solute-free water flow, given by the equation

$$1AS \text{ Water Flow} = 60 [1 - 0.0309 (2.0)] = 56.29$$

When the computer run is completed, the time scale of a time interval will be given in minutes by the ratio of an actual stage volume in milliliters to the calculated overall total stage flow (a simplification of the equation on page 3, possible because the actual interstage flows in ml/min are numerically equal to the corresponding relative interstage flows). The computer program will end naturally when no more cards are found or can be instructed to end with a final CONTINUATION CARD with a 2 punched in column 2. All time interval results are printed, and the final stage profiles for the first case only are punched out in PROFILE CARD format.

CODING SHEET FOR EXAMPLE 1A COLUMN PROBLEMS

247

SAMPLE INPUT: SEPHIS

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SEPHIS      12:42      02/14/74

100 @S RUN PUN014,CUB928,GEORGE,150,6000/3000      G JANSEN 3760 BLD
      G 9423576
105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFO00
115 @PRL TEL INFO00
117 @PRL TEL CUB928
120 @X ASG A=12296
130 @N XQT CUR
140 IN A
370 TRI A
375 PCH,1
380 TUC
390 LIST 1,7
400 @IM FR5,* SEPHIS/S2F5,SEPHIS/S2F5,SEPHIS/R2F5
410 @IM FR5,* FLOWS/S2F5,FLOWS/S2F5,FLOWS/P2F5
420 @IM FR5,* STAGES/S2F5,STAGES/S2F5,STAGES/P2F5
430 @IM FR5,* PROFIL/S2F5,PROFIL/S2F5,PROFIL/P2F5
435 @IM FR5,* UCOR/S2F5,UCOR/S2F5,UCOR/P2F5
440 @N XQT SEPHIS/R2F5
450 N-FUEL HA COLUMN      8      3      .3      0      1      1      0      0      0      0
460      1      1      3.63      0.      0.      2.0      30.      1
470      5      1      4.24      1.65 0.00235      0.39      50.      1
480      6      1      3.29      .0780.000029      8.0      50.      1
490      8      0      23.20      0.      0.      0.01      40.      0
500      8      0.2
510      1      1      0      0
520      1      1      3.63      0.      0.      2.0      30.      1
530      5      1      4.24      1.65 0.00235      0.39      50.      1
540      6      1      3.29      .0780.000029      8.0      50.      1
550      8      0      22.00      0.      0.      0.01      40.      0
560      1      0      0      0
570      1      1      3.63      0.      0.      2.0      30.      1
600      8      0      22.00      0.      0.      0.01      40.      0
610      2
620 @ FIN
READY

```

SAMPLE INPUT: SEPHIS

```

100 @D RUN SEP211,CUR686,SEDDUC,120,7000      G JANSEN X3576 3760 PD
110 @PFL TEL CUP600
120 @X ASG A=U1145(JJ1145)
130 @N XQT CLR
140 IN A
150 TRI A
160 @WITH FR5,* SEPHIS/S2F5,SEPHIS/S2F5,SEPHIS/P2F5
170 -110
180      AFDRT(10)=AFDRT(10)+25.99197
190 -187
200      AFDRT(10)=AFDRT(10)-ALVRT(7)
210 -1F8
220      AFDRT(10)=AFDRT(10)+ALVRT(7)
230 -212,212
240 -273,273
250      530 IF(K-M)531,502,502
260      531 IF(K-21)540,502,532
270      532 IF(K-41)540,502,533
280      533 IF (K-61)540,502,534
290      534 IF(K-81)540,502,535
300      535 IF(K-101)540,502,540
310 -274
320      IF(L.EQ,700)ICALC=0
330      IF(ICALC.EQ,0)YFD(1,12)=0.
332 -2F1
334      PRINT 1050
340 @WITH FR5,* STAGES/S2F5,STAGES/S2F5,STAGES/P2F5
350 -26,26
360      IF(J-10)8,6,8
370      6 AFDRT1=AFDRT(J)-ALVRT(7)
380      AIN(I)=AFDRT1*YFD(I,J)+ALVRT(7)*X(I,7,KK)+(AR(J)+RCYCA(J))*X(I,
390      1J,KK)+A(CJJ)*X(I,JJ,KY)
400      GO TO 20
410      8 IF(J-1)10,10,15
420 -51,51
430      435 TPOFF(I,Y)=25.0
440 @N XQT SEPHIS/P2F5
450 PRF CASE 1      16      3      .20      0      1      1      1      2      1      1
460      1      1      26.      0.      0.      0.01      1
470      8      1      7.2      0.      0.      2.0      1
480      10      1      3.0      0.0      0.      12.20      1
490      12      1      75.      0.0252      0.      4.2      1
500      16      0      36.      0.      0.      0.12      0
510      7      125.99197      0
520      1      1.5
530      5      4.0
540      1      14.2
550      1      .038
560      3      0.20
570      4      0.25
580      1      0.53
590      11.1      3.66      3.66      3.66      3.66      9.7      9.5      8
600      2.085      4.17      4.17      4.17      4.17      10.2
610      2
620 @ FIN

```

SAMPLE OUTPUT: SEPHIS P. 1

SEPHIS/SEPHIS

FROM LENGTH 314725

THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 13:00:22

CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS HAVING INTERACTING SOLUTES
N-FUEL HA COLUMN

8 STAGES
3 INTERACTING SOLUTES

FEED STREAM DATA - AQUEOUS	STAGE NO.	URANIUM (M)	PLUTONIUM (M)	HNO3 (M)	FLOW RATE (VOL. UNITS)	TEMP DEG C
	1	0.0000	0.0000	2.0000+00	3.630+00	30.0
	5	1.6500+00	2.3500-03	3.9800-01	4.240+00	50.0
	6	7.8000+02	2.9000-05	8.7000+00	3.290+00	50.0
30.00 X TBP ORGANIC	8	0.0000	0.0000	1.0000-02	2.320+01	40.0

PHASE RATIOS DO NOT EQUAL FLOW RATIOS - THEY ARE --- STAGE NO. A/O PHASE RATIO

1 - 8 2.00-01

STAGE FLOWS (SOLUTE-FREE VOLUMES):

STAGE NO.	FLOW RATE	FLOW OUT OF STAGE	RECYCLE 2 TO FILL STAGE	RECYCLE 1 FOR PHASE RATIO	TOTAL AQUEOUS FLOW	FLOW OUT OF STAGE	RECYCLE 2 TO FILL STAGE	RECYCLE 1 FOR PHASE RATIO	TOTAL ORGANIC FLOW	OVERALL TOTAL STAGE FLOW	STAGE VOL
1	1.480-01	3.406+00	4.944+00	1.195+00	9.545+00	2.330+01	2.472+01	0.000	4.772+01	5.727+01	0.000
2	1.480-01	3.406+00	4.944+00	1.195+00	9.545+00	2.330+01	2.472+01	0.000	4.772+01	5.727+01	0.000
3	1.480-01	3.406+00	4.944+00	1.195+00	9.545+00	2.330+01	2.472+01	0.000	4.772+01	5.727+01	0.000
4	1.480-01	3.406+00	4.944+00	1.195+00	9.545+00	2.330+01	2.472+01	0.000	4.772+01	5.727+01	0.000
5	3.581-01	7.087+00	2.456+00	0.000	9.545+00	2.330+01	1.229+01	1.243+01	4.772+01	5.727+01	0.000
6	4.149-01	9.545+00	0.000	0.000	9.545+00	2.330+01	3.600	2.472+01	4.772+01	5.727+01	0.000
7	4.149-01	9.545+00	0.000	0.000	9.545+00	2.330+01	3.600	2.472+01	4.772+01	5.727+01	0.000
8	4.149-01	9.545+00	0.000	0.000	9.545+00	2.330+01	3.600	2.472+01	4.772+01	5.727+01	0.000

TRANSIENT BEHAVIOR RESULTS

SOLUTE CONCENTRATIONS IN EFFLUENT FROM EACH STAGE

TIME INTERVAL	STAGE	URANIUM (M)	PLUTONIUM (M)	HNO3 (M)	URANIUM (M)	PLUTONIUM (M)	HNO3 (M)	ITERATIONS	FLOW OUT AQUEOUS	FLOW OUT ORGANIC	TEMP DEG C
0	1	0.000	0.000	0.000	0.000	0.000	0.000	0.	3.406+00	2.320+01	25.0
	2	0.000	0.000	0.000	0.000	0.000	0.000	0.	3.406+00	2.320+01	25.0
	3	0.000	0.000	0.000	0.000	0.000	0.000	0.	3.406+00	2.320+01	25.0
	4	0.000	0.000	0.000	0.000	0.000	0.000	0.	3.406+00	2.320+01	25.0
	5	0.000	0.000	0.000	0.000	0.000	0.000	0.	7.087+00	2.320+01	25.0
	6	0.000	0.000	0.000	0.000	0.000	0.000	0.	9.545+00	2.320+01	25.0
	7	0.000	0.000	0.000	0.000	0.000	0.000	0.	9.545+00	2.320+01	25.0
	8	0.000	0.000	0.000	0.000	0.000	0.000	0.	9.545+00	2.320+01	25.0
1	1	0.000	0.000	4.419-01	0.000	0.000	6.182-02	6.	3.453+00	2.325+01	25.6
	2	0.000	0.000	0.000	0.000	0.000	0.000	1.	3.406+00	2.320+01	25.0
	3	0.000	0.000	0.000	0.000	0.000	0.000	1.	3.406+00	2.320+01	25.0
	4	0.000	0.000	0.000	0.000	0.000	0.000	1.	3.406+00	2.320+01	25.0
	5	1.224-01	4.218-04	1.190-01	1.196-01	1.211-04	1.055-02	6.	7.177+00	2.341+01	28.3
	6	5.742-04	4.152-07	1.280+00	5.155-03	1.675-06	2.782-01	6.	9.940+00	2.354+01	27.2
	7	0.000	0.000	0.000	0.000	0.000	0.000	1.	9.545+00	2.320+01	25.0
	8	0.000	0.000	2.274-02	0.000	0.000	3.068-04	4.	9.552+00	2.320+01	29.7
2	1	0.000	0.000	6.394-01	0.000	0.000	1.102-01	6.	3.474+00	2.330+01	26.0
	2	0.000	0.000	1.840-01	0.000	0.000	6.061-03	5.	3.419+00	2.321+01	25.1
	3	0.000	0.000	0.000	0.000	0.000	0.000	1.	3.406+00	2.320+01	25.0
	4	8.278-02	1.959-04	1.517-02	4.155-02	1.979-05	1.304-03	31.	3.428+00	2.324+01	26.0
	5	2.060-02	2.598-04	5.776+01	1.933-01	2.362-04	6.208-02	7.	7.269+00	2.361+01	30.4
	6	2.121-03	1.024-05	1.653+00	2.543-02	6.272-05	3.567-01	6.	1.005+01	2.357+01	28.8
	7	2.945-05	4.829-08	6.550-01	1.121-04	7.560-08	1.242-01	7.	9.754+00	2.331+01	27.3
	8	0.000	0.000	2.346-02	0.000	0.000	3.228-04	3.	9.552+00	2.320+01	31.4
3	1	0.000	0.000	7.553-01	0.000	0.000	1.406-01	5.	3.487+00	2.333+01	26.2
	2	0.000	0.000	2.281-01	0.000	0.000	2.011-02	6.	3.430+00	2.322+01	25.2
	3	4.110-02	3.007-05	3.773-02	1.103-02	1.069-06	1.907-03	10.	3.420+00	2.321+01	25.3
	4	1.093-01	3.252-04	1.172-01	1.042-01	8.531-05	1.042-02	8.	3.446+00	2.330+01	27.3
	5	1.033-01	2.166-04	8.778-01	2.440-01	3.290-04	9.144-02	6.	7.341+00	2.373+01	32.0
	6	2.115-03	9.147-04	2.651+00	3.254-02	7.080-05	4.389-01	6.	1.311+01	2.364+01	30.5
	7	7.893-05	6.643-07	1.034+00	4.819-04	2.028-06	2.055-01	6.	9.450+00	2.337+01	29.1
	8	3.079-06	1.197-08	4.335-01	5.327-06	7.365-09	5.859-02	8.	9.674+00	2.325+01	32.7
4	1	0.000	0.000	8.341-01	0.000	0.000	1.616-01	4.	3.496+00	2.335+01	26.3
	2	3.893-03	1.721-06	3.070-01	4.946-03	5.543-07	3.385-02	7.	3.439+00	2.324+01	25.3
	3	6.859-02	1.527-04	9.703-02	4.817-02	2.079-05	7.754-03	13.	3.433+00	2.331+01	25.9
	4	1.310-01	3.916-04	2.295-01	1.631-01	1.705-04	2.177-02	6.	3.463+00	2.351+01	28.5
	5	1.038-01	2.554-04	1.185+00	2.752-01	3.902-04	1.131-01	7.	7.805+00	2.361+01	33.4
	6	2.093-03	8.468-06	2.351+00	3.725-02	7.601-05	4.945-01	4.	1.029+01	2.372+01	32.2
	7	7.645-05	5.047-07	1.333+00	6.786-04	2.845-06	2.910-01	3.	9.955+00	2.344+01	30.7
	8	5.940-06	6.902-08	6.462-01	1.765-05	1.211-07	1.095-01	7.	9.739+00	2.330+01	33.8

SAMPLE OUTPUT: SEPHIS P. 2

1	1	4.178-04	4.919-04	4.947-01	2.287-03	2.466-07	1.749-01	5.	3.563+00	2.337+01	26.5
2	2	1.361-02	1.519-05	3.732-01	2.370-02	7.494-06	4.633-02	6.	3.443+00	2.327+01	27.7
3	3	9.068-02	4.233-04	1.655-01	9.483-02	6.343-03	1.555-02	7.	3.400+00	2.337+01	26.7
4	4	1.477-01	4.256-04	3.494-01	2.106-01	2.520-04	3.287-02	8.	3.481+00	2.311+01	29.7
5	5	1.032-01	2.561-04	1.156+00	2.491-01	4.241-04	1.257-01	9.	7.457+00	2.344+01	36.6
6	6	2.028-03	7.727-06	2.019+00	3.494-02	7.432-05	5.581-01	10.	1.039+01	2.377+01	31.6
7	7	6.794-05	5.110-07	1.625+00	7.363-04	3.209-06	3.637-01	11.	1.005+01	2.353+01	32.2
8	8	5.531-06	7.433-08	4.524-01	2.372-05	1.687-07	1.629-01	12.	7.803+00	2.339+01	36.7
9	1	2.091-03	1.290-06	9.493-01	1.269-02	3.475-06	1.874-01	5.	3.509+00	2.337+01	26.6
2	2	2.775-02	4.337-05	4.153-01	5.435-02	2.374-05	5.671-02	5.	3.459+00	2.335+01	24.1
3	3	1.154-01	2.949-04	2.412-01	1.413-01	1.263-04	2.362-02	6.	3.459+00	2.349+01	27.5
4	4	1.075-01	4.427-04	4.653-01	2.449-01	3.179-04	4.274-02	5.	3.497+00	2.364+01	36.9
5	5	1.017-01	2.577-04	1.556+00	3.379-01	4.518-04	1.426-01	6.	7.593+00	2.339+01	35.7
6	6	1.945-03	7.126-06	2.819+00	4.139-02	6.162-05	5.928-01	9.	1.047+01	2.332+01	36.9
7	7	5.475-05	4.233-07	1.495+00	8.343-04	3.291-06	4.258-01	10.	1.018+01	2.359+01	33.5
8	8	4.523-06	5.513-08	1.494+00	2.542-05	1.799-07	2.132-01	5.	9.663+00	2.339+01	35.5
10	1	5.337-03	5.236-06	1.105+00	3.155-02	1.471-05	1.933-01	4.	3.516+00	2.343+01	26.9
2	2	4.143-02	6.036-05	5.129-01	9.166-02	6.544-05	4.498-02	5.	3.470+00	2.343+01	26.6
3	3	1.463-01	3.529-04	3.136-01	1.321-01	1.912-04	3.111-02	5.	3.472+00	2.356+01	28.4
4	4	1.091-01	4.494-04	5.624-01	2.705-01	3.723-04	5.156-02	6.	3.512+00	2.374+01	32.0
5	5	9.969-02	2.516-04	1.719+00	3.164-01	4.067-04	1.542-01	8.	7.542+00	2.342+01	36.8
6	6	1.475-03	6.365-06	3.511+00	4.261-02	8.298-05	6.290-01	9.	1.054+01	2.345+01	36.0
7	7	5.114-05	4.233-07	2.147-00	8.486-04	3.211-06	4.856-01	10.	1.022+01	2.364+01	34.6
8	8	3.531-06	4.270-08	1.225+00	2.467-05	1.733-07	2.603-01	5.	9.920+00	2.343+01	36.2
11	1	1.085-02	1.290-05	1.564+00	5.963-02	3.713-05	1.952-01	6.	3.524+00	2.344+01	27.2
2	2	5.594-02	1.198-04	5.687-01	1.299-01	1.129-04	7.153-02	6.	3.481+00	2.350+01	27.2
3	3	1.820-01	3.911-04	3.576-01	2.159-01	2.514-04	3.792-02	5.	3.485+00	2.363+01	29.3
4	4	1.733-01	4.457-04	6.546-01	2.391-01	4.114-04	5.959-02	6.	3.526+00	2.374+01	33.1
5	5	9.749-02	2.469-04	1.666+00	3.226-01	4.763-04	1.646-01	8.	7.576+00	2.394+01	37.7
6	6	1.811-03	5.762-06	3.227+00	4.211-02	8.346-05	6.594-01	9.	1.060+01	2.338+01	37.0
7	7	4.516-05	3.610-07	2.366+00	8.429-04	3.045-06	5.352-01	10.	1.030+01	2.369+01	35.6
8	8	2.746-06	3.756-08	1.193+00	2.293-05	1.582-07	3.031-01	5.	9.974+00	2.347+01	36.9
12	1	1.590-02	2.450-05	1.127+00	9.107-02	7.021-05	1.940-01	5.	3.533+00	2.354+01	27.5
2	2	6.965-02	1.375-04	6.396-01	1.653-01	1.648-04	7.691-02	5.	3.492+00	2.357+01	27.9
3	3	1.552-01	4.167-04	4.731-01	2.427-01	3.347-04	4.419-02	5.	3.497+00	2.369+01	30.3
4	4	1.757-01	4.421-04	8.412-01	3.228-01	4.403-04	6.712-02	6.	3.538+00	2.331+01	34.1
5	5	9.523-02	2.410-04	1.693+00	3.255-01	4.824-04	1.741+01	8.	7.606+00	2.396+01	38.5
6	6	1.753-03	5.226-06	3.381+00	4.188-02	8.317-05	1.066+01	9.	1.066+01	2.396+01	37.9
7	7	4.055-05	2.526-07	2.557+00	8.284-04	2.838-06	5.781-01	10.	1.036+01	2.372+01	36.5
8	8	2.165-06	2.336-08	1.547+00	2.095-05	1.406-07	3.417-01	5.	1.002+01	2.356+01	37.4
13	1	2.259-02	3.956-05	1.190+00	1.241-01	1.108-04	1.907-01	6.	3.542+00	2.360+01	27.9
2	2	8.263-02	1.614-04	7.133-01	1.963-01	2.163-04	8.152-02	5.	3.508+00	2.363+01	28.6
3	3	1.643-01	4.322-04	5.540-01	2.540-01	3.440-04	5.014-02	5.	3.508+00	2.373+01	31.2
4	4	1.751-01	4.330-04	5.540-01	3.125-01	4.007-04	7.030-02	6.	3.530+00	2.380+01	35.6
5	5	9.298-02	2.342-04	2.391+00	3.277-01	4.463-04	1.827-01	8.	7.631+00	2.397+01	39.3
6	6	1.763-03	4.760-06	3.515+00	4.147-02	8.223-05	7.066-01	5.	1.071+01	2.392+01	39.7
7	7	3.663-05	2.117-07	2.733+00	8.598-04	2.321-06	6.152-01	10.	1.043+01	2.376+01	37.3
8	8	1.746-06	1.812-08	1.647+00	1.968-05	1.226-07	3.762-01	4.	1.007+01	2.354+01	37.9
14	1	2.976-02	5.725-05	1.254+00	1.556-01	1.548-04	1.864-01	6.	3.551+00	2.365+01	29.4
2	2	9.249-02	2.215-04	7.540-01	2.224-01	2.632-04	8.573-02	5.	3.515+00	2.368+01	29.3
3	3	1.729-01	4.397-04	6.420-01	2.506-01	3.462-04	5.594-02	5.	3.519+00	2.376+01	32.1
4	4	1.726-01	4.218-04	1.102+00	3.260-01	4.754-04	8.142-02	7.	3.561+00	2.386+01	35.9
5	5	9.077-02	2.269-04	2.135+00	3.289-01	4.879-04	1.907-01	8.	7.654+00	2.394+01	40.0
6	6	1.656-03	4.355-06	3.433+00	4.195-02	8.079-05	7.248-01	5.	1.075+01	2.394+01	39.4
7	7	3.421-05	1.760-07	2.689+00	7.903-04	2.409-06	6.470-01	10.	1.048+01	2.379+01	37.9
8	8	1.844-06	1.423-08	1.614+00	1.746-05	1.036-07	4.069-01	4.	1.011+01	2.356+01	38.3
15	1	3.711-02	7.665-05	1.315+00	1.540-01	1.987-04	1.817-01	6.	3.560+00	2.376+01	28.9
2	2	1.019-01	2.446-04	8.643-01	2.442-01	3.053-04	3.526+00	6.	3.526+00	2.373+01	30.1
3	3	1.739-01	4.438-04	7.247-01	2.935-01	4.124-04	6.174-02	6.	3.529+00	2.379+01	33.0
4	4	1.648-01	4.642-04	1.197+00	3.252-01	4.857-04	8.639-02	7.	3.570+00	2.384+01	36.7
5	5	8.869-02	2.195-04	2.246+00	3.294-01	4.884-04	1.979-01	7.	7.674+00	2.394+01	40.6
6	6	1.619-03	4.335-06	3.734+00	4.137-02	7.894-05	7.402-01	5.	1.079+01	2.395+01	40.0
7	7	3.233-05	1.507-07	3.726+00	7.714-04	2.213-06	6.742-01	10.	1.053+01	2.381+01	38.6
8	8	1.244-06	1.131-08	1.929+00	1.611-05	9.045-06	4.341-01	4.	1.015+01	2.354+01	38.7
16	1	4.438-02	9.640-05	1.372+00	2.344-01	2.400-04	1.773-01	6.	3.568+00	2.374+01	29.4
2	2	1.042-01	2.640-04	9.396-01	2.414-01	3.405-04	9.344-02	6.	3.536+00	2.376+01	30.8
3	3	1.750-01	4.371-04	8.170-01	3.346-01	4.346-04	6.754-02	6.	3.539+00	2.382+01	32.8
4	4	1.640-01	3.435-04	1.147+00	3.289-01	4.926-04	9.532-02	7.	3.580+00	2.389+01	37.5
5	5	8.866-02	2.119-04	2.306+00	3.293-01	4.687-04	2.047-01	7.	7.691+00	2.394+01	41.2
6	6	1.545-03	3.734-06	3.823+00	3.778-02	7.694-05	7.532-01	10.	1.082+01	2.394+01	40.6
7	7	3.831-05	1.267-07	3.166+00	7.537-04	2.035-06	6.974-01	5.	1.057+01	2.393+01	39.1
8	8	1.043-06	9.671-09	2.431+00	1.500-05	7.731-06	4.580-01	3.	1.018+01	2.361+01	39.1
17	1	5.134-02	1.166-04	1.425+00	2.293-01	2.772-04	1.733-01	6.	3.577+00	2.378+01	29.9
2	2	1.144-01	4.792-04	1.113+00	2.761-01	3.708-04	9.755-02	6.	3.546+00	2.379+01	31.6
3	3	1.743-01	4.297-04	6.694-01	3.117-01	4.518-04	7.342-02	6.	3.548+00	2.384+01	34.4
4	4	1.566-01	3.720-04	1.273+00	3.313-01	4.264-04	1.022-01	7.	3.586+00	2.390+01	39.2
5	5	8.474-02	2.745-04	2.455+00	3.270-01	4.669-04	2.110-01	7.	7.707+00	2.406+01	41.7
6	6	1.554-03	3.443-06	3.706+00	3.918-02	7.476-05	7.442-01	10.	1.085+01	2.397+01	41.1
7	7	2.893-05	1.111-07	3.577+00	7.377-04	1.477-06	7.172-01	4.	1.061+01	2.395+01	39.6
8	8	9.432-07	7.342-09	2.124+00	1.410-05	6.623-06	4.791-01	3.	1.021+01	2.363+01	39.4
18	1	5.744-02	1.359-04	1.474+00	2.464-01	3.097-04	1.499-01	5.	3.544+00	2.381+01	30.5
2	2	1.190-01	4.934-04	1.435+00	2.476-01	3.954-04	1.014-01	6.	3.556+00	2.382+01	32.3
3	3	1.721-01	4.177-04	6.713-01	3.177-01	4.444-04	7.936-02	6.	3.557+00	2.385+01	35.4
4	4	1.527-01	3.624-04	1.346+00	3.308-01	4.793-04	1.072-01	7.	3.576+00	2.391+01	38.7
5	5	8.244-02	1.974-04	2.443+00	3.284-01	4.052-04	2.169-01	7.	7.721+00	2.400+01	42.2
6	6	1.526-03	3.215-06	3.707+00	3.977-02	7.251-05	7.737-01	10.	1.084+01	2.374+01	41.6
7	7	2.742-05	9.677-09	3.152+00	7.237-04	1.737-06	7.341-01	4.	1.065+01	2.387+01	40.1
8	8	8.523-07	6.679-09	2.402+00	1.134-05	5.704-06	4.976-01	3.	1.024+01	2.365+01	39.7

SAMPLE OUTPUT: SEPHIS P. 3

16	1	6.369-C2	1.533-C4	1.513+00	2.619-C1	3.379-C4	1.673-01	5.	3.501+00	2.363+01	31.3
	2	1.226-C1	2.988-C4	1.153+00	2.964-C1	4.162-C4	1.062-01	6.	3.564+00	2.354+01	31.1
	3	1.618-C1	4.210-C4	1.931+00	3.217-C1	4.746-C4	8.537-C2	6.	3.565+00	2.347+01	30.1
	4	1.476-C1	3.985-C4	1.433+00	3.330-C1	5.001-C4	1.161-01	7.	3.604+00	2.333+01	30.3
	5	0.117-C2	1.937-C4	2.513+00	3.277-C1	4.632-C4	2.274-01	7.	7.733+00	2.401+01	42.3
	6	1.536-C2	3.210-C4	4.025+00	3.802-C2	5.105-C5	7.818-01	4.	1.000+01	2.334+01	42.0
	7	2.596-C5	4.582-C3	3.435+00	7.169-C4	1.319-C6	7.384-01	4.	1.064+01	2.333+01	40.3
	8	7.426-C9	5.275-C9	2.274+00	1.290-C5	4.350-C6	5.138-01	3.	1.027+01	2.366+01	39.3
17	1	6.638-C2	1.689-C4	1.553+00	2.723-C1	3.600-C4	1.662-01	5.	3.597+00	2.345+01	31.5
	2	1.246-C1	3.243-C4	1.219+00	3.047-C1	4.327-C4	1.090-01	6.	3.572+00	2.346+01	33.4
	3	1.646-C1	3.944-C4	1.120+00	3.251-C1	4.318-C4	9.146-C2	7.	3.573+00	2.361+01	35.1
	4	1.411-C1	3.314-C4	1.511+00	3.334-C1	4.498-C4	1.236-01	8.	3.611+00	2.337+01	40.1
	5	7.455-C2	1.643-C4	2.562+00	3.264-C1	4.309-C4	2.275-01	7.	7.745+00	2.401+01	43.3
	6	1.477-C3	2.640-C5	4.077+00	3.749-C2	4.409-C5	7.089-01	4.	1.092+01	2.359+01	42.4
	7	2.614-C5	7.641-C3	3.568+00	6.950-C4	1.360-C6	7.007-01	4.	1.071+01	2.337+01	40.5
	8	7.231-C7	4.295-C9	2.337+00	1.232-C5	4.334-C6	5.280-01	3.	1.029+01	2.367+01	40.1
18	1	7.338-C2	1.624-C4	1.593+00	2.816-C1	3.802-C4	1.637-01	5.	3.602+00	2.385+01	32.1
	2	1.251-C1	3.275-C4	1.262+00	3.169-C1	4.459-C4	1.127-01	6.	3.580+00	2.357+01	34.5
	3	1.599-C1	3.613-C4	1.234+00	3.274-C1	4.568-C4	9.751-C2	7.	3.583+00	2.337+01	37.5
	4	1.354-C1	3.168-C4	1.522+00	3.325-C1	4.386-C4	1.298-01	8.	3.618+00	2.333+01	40.6
	5	7.633-C2	1.763-C4	2.603+00	3.257-C1	4.765-C4	2.324-01	7.	7.755+00	2.431+01	43.4
	6	1.555-C3	2.660-C5	4.173+00	3.665-C2	4.998-C5	7.956-01	4.	1.094+01	2.401+01	42.7
	7	2.549-C5	6.667-C3	3.572+00	6.871-C4	1.411-C6	7.712-01	4.	1.073+01	2.377+01	41.1
	8	6.649-C7	3.660-C9	2.393+00	1.193-C5	3.631-C6	5.404-01	3.	1.031+01	2.363+01	40.3
19	1	7.719-C2	1.937-C4	1.620+00	2.860-C1	3.960-C4	1.627-01	5.	3.607+00	2.363+01	32.6
	2	1.254-C1	3.263-C4	1.335+00	3.165-C1	4.363-C4	1.165-01	6.	3.587+00	2.343+01	35.1
	3	1.550-C1	3.675-C4	1.270+00	3.209-C1	4.407-C4	1.035-01	7.	3.588+00	2.337+01	38.1
	4	1.299-C1	3.223-C4	1.651+00	3.331-C1	4.467-C4	1.365-01	8.	3.625+00	2.393+01	41.1
	5	7.667-C2	1.723-C4	2.645+00	3.259-C1	4.759-C4	2.368-01	6.	7.765+00	2.401+01	43.0
	6	1.436-C3	2.549-C5	4.163+00	3.646-C2	6.394-C5	8.004-01	4.	1.096+01	2.403+01	43.7
	7	2.493-C5	6.263-C3	3.623+00	6.779-C4	1.323-C6	7.802-01	4.	1.075+01	2.397+01	41.4
	8	6.501-C7	3.234-C9	2.442+00	1.160-C5	3.419-C6	5.512-01	3.	1.032+01	2.373+01	40.5
20	1	8.036-C2	2.730-C4	1.655+00	2.949-C1	4.089-C4	1.622-01	5.	3.611+00	2.397+01	33.1
	2	1.252-C1	3.275-C4	1.393+00	3.183-C1	4.643-C4	1.202-01	6.	3.593+00	2.387+01	35.3
	3	1.596-C1	3.538-C4	1.345+00	3.262-C1	4.918-C4	1.095-01	7.	3.594+00	2.397+01	38.7
	4	1.247-C1	2.897-C4	1.715+00	3.324-C1	4.944-C4	1.431-01	8.	3.631+00	2.394+01	41.6
	5	7.537-C2	1.677-C4	2.681+00	3.249-C1	4.734-C4	2.410-01	6.	7.773+00	2.402+01	44.0
	6	1.418-C3	2.427-C5	4.199+00	3.669-C2	6.210-C5	8.052-01	4.	1.097+01	2.407+01	43.3
	7	2.445-C5	5.743-C3	3.673+00	6.677-C4	1.254-C6	7.681-01	4.	1.077+01	2.392+01	41.7
	8	6.216-C7	2.620-C9	2.465+00	1.133-C5	3.080-C6	5.607-01	3.	1.034+01	2.377+01	40.7
21	1	8.293-C2	2.132-C4	1.681+00	2.995-C1	4.192-C4	1.620-01	5.	3.615+00	2.397+01	33.5
	2	1.245-C1	3.253-C4	1.444+00	3.265-C1	4.704-C4	1.236-01	6.	3.599+00	2.397+01	36.4
	3	1.640-C1	3.944-C4	1.415+00	3.364-C1	4.925-C4	1.160-01	7.	3.611+00	2.397+01	39.2
	4	1.199-C1	2.775-C4	1.770+00	3.315-C1	4.918-C4	1.498-01	8.	3.637+00	2.397+01	42.3
	5	7.417-C2	1.630-C4	2.715+00	3.231-C1	4.710-C4	2.450-01	6.	7.781+00	2.402+01	44.3
	6	1.401-C3	2.319-C5	4.231+00	3.553-C2	6.134-C5	8.095-01	4.	1.095+01	2.401+01	43.5
	7	2.403-C5	5.335-C3	3.723+00	6.593-C4	1.189-C6	7.945-01	4.	1.079+01	2.397+01	41.9
	8	5.976-C7	2.510-C9	2.524+00	1.164-C5	2.799-C6	5.691-01	3.	1.035+01	2.371+01	40.8
22	1	8.495-C2	2.157-C4	1.765+00	3.031-C1	4.273-C4	1.622-01	5.	3.619+00	2.397+01	34.0
	2	1.235-C1	3.220-C4	1.491+00	3.225-C1	4.748-C4	1.275-01	6.	3.604+00	2.397+01	36.9
	3	1.436-C1	3.276-C4	1.472+00	3.306-C1	4.923-C4	1.212-01	7.	3.606+00	2.392+01	39.3
	4	1.155-C1	2.663-C4	1.834+00	3.305-C1	4.890-C4	1.556-01	8.	3.643+00	2.395+01	42.4
	5	7.306-C2	1.566-C4	2.746+00	3.223-C1	4.687-C4	2.487-01	6.	7.789+00	2.402+01	44.5
	6	1.386-C3	2.223-C5	4.260+00	3.513-C2	5.371-C5	8.133-01	4.	1.099+01	2.401+01	43.8
	7	2.365-C5	4.923-C3	3.762+00	6.514-C4	1.131-C6	8.009-01	4.	1.080+01	2.393+01	42.1
	8	5.779-C7	2.297-C9	2.550+00	1.069-C5	2.865-C6	6.765-01	3.	1.036+01	2.372+01	40.9
23	1	8.646-C2	2.195-C4	1.727+00	3.059-C1	4.335-C4	1.626-01	5.	3.622+00	2.397+01	34.4
	2	1.221-C1	3.221-C4	1.535+00	3.234-C1	4.778-C4	1.311-01	6.	3.609+00	2.397+01	37.5
	3	1.354-C1	3.153-C4	1.531+00	3.304-C1	4.915-C4	1.268-01	7.	3.612+00	2.397+01	40.2
	4	1.115-C1	2.560-C4	1.680+00	3.295-C1	4.861-C4	1.615-01	7.	3.648+00	2.395+01	42.7
	5	7.205-C2	1.546-C4	2.774+00	3.215-C1	4.664-C4	2.522-01	6.	7.796+00	2.402+01	44.4
	6	1.371-C3	2.137-C5	4.287+00	3.460-C2	5.719-C5	8.167-01	4.	1.100+01	2.401+01	44.0
	7	2.332-C5	4.614-C3	3.790+00	6.442-C4	1.080-C6	8.062-01	4.	1.081+01	2.394+01	42.3
	8	5.608-C7	2.249-C9	2.589+00	1.071-C5	2.367-C6	5.631-01	3.	1.037+01	2.373+01	41.0
24	1	8.757-C2	2.220-C4	1.747+00	3.090-C1	4.382-C4	1.633-01	5.	3.624+00	2.397+01	34.6
	2	1.206-C1	2.928-C4	1.577+00	3.247-C1	4.796-C4	1.346-01	6.	3.613+00	2.392+01	38.0
	3	1.309-C1	3.137-C4	1.585+00	3.300-C1	4.901-C4	1.322-01	7.	3.617+00	2.392+01	40.7
	4	1.073-C1	2.465-C4	1.939+00	3.284-C1	4.832-C4	1.671-01	7.	3.653+00	2.395+01	43.1
	5	7.114-C2	1.510-C4	2.601+00	3.267-C1	4.644-C4	2.554-01	6.	7.802+00	2.402+01	45.0
	6	1.358-C3	2.259-C5	4.311+00	3.444-C2	5.580-C5	8.195-01	4.	1.101+01	2.401+01	44.2
	7	2.302-C5	4.339-C3	3.639+00	6.375-C4	1.135-C6	8.109-01	4.	1.083+01	2.394+01	42.5
	8	5.464-C7	1.676-C9	2.617+00	1.055-C5	2.200-C6	5.896-01	3.	1.038+01	2.371+01	41.2
25	1	8.831-C2	2.234-C4	1.765+00	3.098-C1	4.416-C4	1.642-01	5.	3.627+00	2.392+01	35.2
	2	1.189-C1	2.875-C4	1.615+00	3.252-C1	4.806-C4	1.380-01	6.	3.617+00	2.397+01	38.4
	3	1.268-C1	2.928-C4	1.637+00	3.276-C1	4.863-C4	1.374-01	7.	3.622+00	2.397+01	41.1
	4	1.344-C1	2.378-C4	1.487+00	3.274-C1	4.804-C4	1.725-01	7.	3.658+00	2.396+01	43.4
	5	7.034-C2	1.478-C4	2.620+00	3.260-C1	4.624-C4	2.583-01	5.	7.809+00	2.407+01	45.2
	6	1.347-C3	1.990-C5	4.333+00	3.415-C2	5.552-C5	8.226-01	4.	1.102+01	2.402+01	44.4
	7	2.273-C5	4.171-C3	3.059+00	6.314-C4	9.940-C7	8.151-01	4.	1.084+01	2.397+01	42.7
	8	5.334-C7	1.730-C9	2.642+00	1.041-C5	2.057-C6	5.943-01	3.	1.039+01	2.377+01	41.3
26	1	8.670-C2	2.238-C4	1.782+00	3.104-C1	4.439-C4	1.651-01	5.	3.629+00	2.397+01	35.6
	2	1.171-C1	2.819-C4	1.651+00	3.253-C1	4.807-C4	1.414-01	6.	3.621+00	2.397+01	38.9
	3	1.229-C1	2.828-C4	1.655+00	3.297-C1	4.843-C4	1.424-01	7.	3.627+00	2.397+01	41.5
	4	1.014-C1	2.299-C4	2.031+00	3.264-C1	4.777-C4	1.776-01	7.	3.662+00	2.394+01	43.7
	5	6.954-C2	1.447-C4	2.849+00	3.193-C1	4.606-C4	2.611-01	5.	7.814+00	2.403+01	45.3

SAMPLE OUTPUT: SEPHIS P. 4

	6	1.331-03	1.928-06	4.354+00	3.367-02	5.330-05	9.252-01	4.	1.103+01	2.407+01	44.5
	7	2.251-05	3.693-03	3.684+00	8.258-04	9.377-17	8.189-01	4.	1.085+01	2.394+01	42.9
	8	5.221-07	1.636-09	2.684+00	1.079-05	1.939-08	5.990-01	3.	1.040+01	2.374+01	41.3
27	1	0.396-02	2.235-04	1.709+00	3.111-61	4.454-04	1.662-01	3.	3.631+00	2.392+01	36.0
	2	1.153-01	2.761-04	1.684+00	3.253-61	4.493-04	1.447-01	6.	3.625+00	2.391+01	39.3
	3	1.153-01	2.734-04	1.709+00	3.259-61	4.491-04	1.472-01	7.	3.631+00	2.391+01	41.3
	4	9.368-02	2.227-04	2.072+00	3.254-61	4.781-04	1.624-01	7.	3.667+00	2.394+01	43.9
	5	6.896-02	1.420-04	2.671+00	3.187-61	4.589-04	2.639-01	5.	7.820+00	2.403+01	45.5
	6	1.327-03	1.673-06	4.372+00	3.361-62	5.239-05	8.276-01	4.	1.104+01	2.407+01	44.7
	7	2.229-05	3.718-05	3.913+00	6.267-64	9.251-07	8.224-01	4.	1.086+01	2.385+01	42.9
	8	5.122-07	1.533-09	2.639+00	1.014-05	1.027-08	6.034-01	3.	1.041+01	2.374+01	41.4
28	1	0.830-02	2.223-04	1.813+00	3.113-61	4.461-04	1.675-01	4.	3.633+00	2.392+01	36.3
	2	1.134-01	2.713-04	1.715+00	3.251-61	4.765-04	1.478-01	6.	3.628+00	2.393+01	39.7
	3	1.166-01	2.643-04	1.771+00	3.272-61	4.819-04	1.510-01	7.	3.635+00	2.394+01	42.2
	4	9.623-02	2.163-04	2.111+00	3.245-61	4.727-04	1.869-01	7.	3.671+00	2.397+01	44.2
	5	6.628-02	1.395-04	2.692+00	3.182-61	4.574-04	2.600-01	5.	7.824+00	2.403+01	45.6
	6	1.318-03	1.923-06	4.392+00	3.334-62	5.132-05	9.297-01	4.	1.104+01	2.402+01	44.3
	7	2.210-05	3.550-03	3.932+00	6.161-64	8.963-07	8.255-01	4.	1.087+01	2.384+01	43.3
	8	5.033-07	1.439-09	2.704+00	1.004-05	1.734-08	6.073-01	3.	1.041+01	2.375+01	41.5
29	1	0.668-02	2.236-04	1.826+00	3.116-61	4.463-04	1.687-01	4.	3.634+00	2.393+01	36.6
	2	1.116-01	2.647-04	1.783+00	3.247-61	4.783-04	1.509-01	6.	3.631+00	2.393+01	40.1
	3	1.136-01	2.569-04	1.816+00	3.264-61	4.796-04	1.561-01	7.	3.639+00	2.394+01	42.5
	4	9.493-02	2.134-04	2.147+00	3.237-61	4.704-04	1.911-01	7.	3.675+00	2.397+01	44.4
	5	6.772-02	1.372-04	2.909+00	3.177-61	4.560-04	2.682-01	5.	7.829+00	2.403+01	45.3
	6	1.316-03	1.778-06	4.405+00	3.316-62	5.644-05	9.317-01	3.	1.105+01	2.402+01	44.9
	7	2.192-05	3.439-03	3.953+00	6.119-64	8.699-07	8.283-01	4.	1.087+01	2.396+01	43.2
	8	4.959-07	1.330-09	2.721+00	9.987-66	1.653-08	6.109-01	3.	1.042+01	2.375+01	41.6
30	1	0.636-02	2.189-04	1.838+00	3.115-61	4.460-04	1.700-01	4.	3.636+00	2.393+01	36.9
	2	1.099-01	2.582-04	1.775+00	3.242-61	4.768-04	1.538-01	6.	3.633+00	2.393+01	40.4
	3	1.103-01	2.497-04	1.846+00	3.257-61	4.773-04	1.602-01	7.	3.643+00	2.394+01	42.8
	4	9.211-02	2.152-04	2.150+00	3.229-61	4.633-04	1.950-01	6.	3.678+00	2.397+01	44.6
	5	6.721-02	1.352-04	2.926+00	3.173-61	4.547-04	2.702-01	5.	7.833+00	2.403+01	45.9
	6	1.303-03	1.738-06	4.420+00	3.267-62	4.963-05	8.335-01	3.	1.106+01	2.402+01	45.0
	7	2.177-05	3.264-03	3.972+00	6.082-64	8.466-07	8.309-01	4.	1.088+01	2.396+01	43.3
	8	4.684-07	1.261-09	2.737+00	9.968-66	1.581-08	6.142-01	3.	1.043+01	2.375+01	41.6
31	1	0.794-02	2.168-04	1.850+00	3.113-61	4.453-04	1.714-01	4.	3.637+00	2.393+01	37.2
	2	1.082-01	2.539-04	1.795+00	3.237-61	4.752-04	1.566-01	6.	3.636+00	2.394+01	40.7
	3	1.078-01	2.431-04	1.879+00	3.249-61	4.751-04	1.640-01	7.	3.646+00	2.394+01	43.1
	4	9.034-02	2.134-04	2.211+00	3.221-61	4.663-04	1.986-01	6.	3.681+00	2.397+01	44.8
	5	6.686-02	1.334-04	2.943+00	3.169-61	4.536-04	2.720-01	4.	7.837+00	2.403+01	46.0
	6	1.296-03	1.731-06	4.434+00	3.279-62	4.639-05	8.351-01	3.	1.106+01	2.402+01	45.1
	7	2.163-05	3.173-03	3.999+00	6.047-64	8.255-07	8.333-01	4.	1.089+01	2.396+01	43.3
	8	4.822-07	1.231-09	2.751+00	9.834-66	1.519-08	6.173-01	3.	1.043+01	2.375+01	41.7
32	1	0.747-02	2.146-04	1.861+00	3.110-61	4.444-04	1.727-01	4.	3.638+00	2.393+01	37.4
	2	1.066-01	2.489-04	1.818+00	3.231-61	4.735-04	1.593-01	6.	3.638+00	2.394+01	41.0
	3	1.056-01	2.373-04	1.917+00	3.242-61	4.732-04	1.675-01	6.	3.649+00	2.395+01	43.3
	4	8.876-02	1.960-04	2.243+00	3.215-61	4.646-04	2.020-01	6.	3.684+00	2.397+01	45.6
	5	6.639-02	1.317-04	2.957+00	3.165-61	4.525-04	2.737-01	4.	7.841+00	2.403+01	46.1
	6	1.291-03	1.688-06	4.447+00	3.264-62	4.824-05	8.366-01	3.	1.107+01	2.403+01	45.2
	7	2.150-05	3.174-03	4.005+00	6.017-64	8.066-07	8.354-01	4.	1.089+01	2.394+01	43.4
	8	4.765-07	1.148-09	2.765+00	9.769-66	1.463-08	6.200-01	3.	1.044+01	2.376+01	41.7
33	1	0.691-02	2.121-04	1.870+00	3.106-61	4.433-04	1.741-01	5.	3.639+00	2.393+01	37.7
	2	1.052-01	2.442-04	1.839+00	3.226-61	4.716-04	1.618-01	6.	3.640+00	2.394+01	41.3
	3	1.036-01	2.318-04	1.939+00	3.235-61	4.710-04	1.708-01	6.	3.652+00	2.395+01	43.6
	4	8.734-02	1.921-04	2.267+00	3.209-61	4.629-04	2.052-01	6.	3.687+00	2.398+01	45.1
	5	6.602-02	1.311-04	2.971+00	3.162-61	4.516-04	2.753-01	4.	7.845+00	2.403+01	46.2
	6	1.296-03	1.639-06	4.450+00	3.250-62	4.763-05	8.380-01	3.	1.107+01	2.403+01	45.3
	7	2.139-05	2.985-03	4.025+00	5.989-64	7.695-07	8.375-01	4.	1.090+01	2.397+01	43.5
	8	4.714-07	1.132-09	2.777+00	9.710-66	1.414-08	6.226-01	3.	1.044+01	2.376+01	41.8
34	1	0.642-02	2.199-04	1.890+00	3.102-61	4.420-04	1.753-01	4.	3.640+00	2.393+01	37.9
	2	1.038-01	2.398-04	1.853+00	3.220-61	4.730-04	1.642-01	6.	3.642+00	2.394+01	41.4
	3	1.017-01	2.269-04	1.960+00	3.228-61	4.692-04	1.740-01	6.	3.655+00	2.395+01	43.8
	4	8.607-02	1.865-04	2.292+00	3.203-61	4.614-04	2.081-01	6.	3.690+00	2.399+01	45.1
	5	6.569-02	1.267-04	2.994+00	3.159-61	4.537-04	2.768-01	4.	7.848+00	2.403+01	46.3
	6	1.281-03	1.612-06	4.469+00	3.238-62	4.739-05	8.393-01	3.	1.108+01	2.403+01	45.4
	7	2.129-05	2.936-03	4.034+00	5.965-64	7.742-07	8.393-01	4.	1.090+01	2.397+01	43.6
	8	4.669-07	1.160-09	2.789+00	9.654-66	1.370-08	6.250-01	3.	1.045+01	2.374+01	41.9
35	1	0.588-02	2.176-04	1.888+00	3.097-61	4.407-04	1.765-01	4.	3.641+00	2.393+01	38.1
	2	1.025-01	2.257-04	1.877+00	3.214-61	4.683-04	1.664-01	6.	3.644+00	2.394+01	41.6
	3	1.071-01	2.224-04	1.900+00	3.222-61	4.675-04	1.769-01	6.	3.657+00	2.395+01	44.0
	4	8.492-02	1.853-04	2.315+00	3.194-61	4.651-04	2.178-01	6.	3.693+00	2.399+01	45.4
	5	6.539-02	1.274-04	2.976+00	3.154-61	4.499-04	2.781-01	4.	7.851+00	2.404+01	46.6
	6	1.277-03	1.588-06	4.479+00	3.224-62	4.659-05	8.404-01	3.	1.108+01	2.403+01	45.4
	7	2.120-05	2.835-03	4.047+00	5.944-64	7.693-07	8.410-01	3.	1.091+01	2.397+01	43.6
	8	4.620-07	1.124-09	2.800+00	9.612-66	1.330-08	6.273-01	3.	1.045+01	2.377+01	41.3
36	1	0.535-02	2.154-04	1.896+00	3.092-61	4.393-04	1.777-01	4.	3.642+00	2.393+01	38.3
	2	1.013-01	2.329-04	1.894+00	3.209-61	4.666-04	1.684-01	6.	3.646+00	2.394+01	42.1
	3	9.850-02	2.013-04	2.013+00	3.217-61	4.654-04	1.796-01	6.	3.640+00	2.395+01	44.2
	4	8.375-02	1.825-04	2.330+00	3.194-61	4.604-04	2.133-01	5.	3.695+00	2.399+01	45.5
	5	6.512-02	1.263-04	3.007+00	3.154-61	4.472-04	2.794-01	4.	7.854+00	2.404+01	46.4
	6	1.274-03	1.586-06	4.489+00	3.216-62	4.613-05	8.415-01	3.	1.108+01	2.403+01	45.5
	7	2.112-05	2.772-03	4.054+00	5.924-64	7.478-07	8.426-01	3.	1.091+01	2.397+01	43.7
	8	4.591-07	9.911-10	2.810+00	9.571-66	1.295-08	6.293-01				

SAMPLE OUTPUT: SEPHIS P. 5

5	6.457-02	1.252-04	3.017+00	3.151-01	4.450-04	2.005-01	4.	7.556+00	2.404+01	46.5
6	1.276-03	1.346-06	4.497+00	3.200-02	4.752-05	2.675-01	3.	1.109+01	2.433+01	45.0
7	2.125-05	2.714-09	4.277+00	4.407-06	7.400-07	3.444-01	3.	1.702+01	2.307+01	45.7
8	4.550-07	9.019-10	2.019+00	4.539-06	1.204-03	6.312-01	3.	1.006+01	2.377+01	41.9
30	1	5.434-02	2.712-04	1.911+00	3.333-01	4.37-04	4.	3.643+00	2.393+01	38.6
	2	4.919-02	2.253-04	1.825+00	3.103-01	4.000-04	5.	3.649+00	2.394+01	42.5
	3	9.036-02	2.113-04	2.054+00	3.267-01	4.030-04	6.	3.664+00	2.394+01	46.5
	4	8.219-02	1.775-04	2.377+00	3.180+01	4.507-04	5.	3.609+00	2.395+01	45.4
	5	6.450-02	1.243-04	3.321+00	3.153-01	4.437-04	3.	7.859+00	2.404+01	46.6
	6	1.250-03	1.227-06	4.535+00	3.103-02	4.534-05	3.	1.109+01	2.403+01	45.0
	7	2.048-05	2.002-08	4.380+00	5.391-04	7.202-07	3.	1.702+01	2.397+01	43.5
	8	4.520-07	9.250-10	2.420+00	9.507-05	1.230-06	3.	1.046+01	2.377+01	41.9
39	1	3.357-02	1.093-04	1.911+00	3.373-01	4.354-04	4.	3.644+00	2.394+01	38.6
	2	9.820-02	2.223-04	1.935+00	3.104-01	4.012-04	5.	3.650+00	2.394+01	42.5
	3	4.495-02	2.734-04	2.377+00	3.203-01	4.017-04	6.	3.666+00	2.394+01	46.7
	4	3.144-02	1.753-04	2.391+00	3.183-01	4.557-04	5.	3.701+00	2.394+01	45.9
	5	6.449-02	1.234-04	3.330+00	3.144-01	4.474-04	3.	7.861+00	2.404+01	46.5
	6	1.260-03	1.311-06	4.513+00	3.101-02	4.531-05	3.	1.109+01	2.403+01	45.7
	7	2.093-05	2.010-08	4.390+00	5.877-04	7.199-07	3.	1.702+01	2.397+01	43.5
	8	4.531-07	9.124-10	2.430+00	9.473-05	1.210-06	3.	1.046+01	2.377+01	42.7
40	1	8.344-02	1.975-04	1.923+00	3.075-01	4.342-04	4.	3.644+00	2.393+01	38.6
	2	9.741-02	2.190-04	1.951+00	3.199-01	4.009-04	5.	3.652+00	2.394+01	42.5
	3	9.395-02	2.757-04	2.083+00	3.100-01	4.006-04	6.	3.667+00	2.394+01	46.7
	4	8.077-02	1.733-04	2.407+00	3.150-01	4.549-04	5.	3.703+00	2.394+01	46.2
	5	6.431-02	1.226-04	3.344+00	3.146-01	4.473-04	3.	7.863+00	2.404+01	46.7
	6	1.203-03	1.900-06	4.522+00	3.184-02	4.473-05	3.	1.110+01	2.403+01	45.7
	7	2.036-05	2.073-08	4.099+00	5.865-04	7.035-07	3.	1.702+01	2.397+01	43.5
	8	4.476-07	8.913-10	2.443+00	9.447-05	1.187-06	3.	1.046+01	2.377+01	42.3
41	1	8.333-02	1.959-04	1.929+00	3.071-01	4.330-04	4.	3.645+00	2.393+01	38.6
	2	9.663-02	2.172-04	1.902+00	3.186-01	4.537-04	5.	3.653+00	2.394+01	43.5
	3	9.330-02	2.732-04	2.104+00	3.195-01	4.595-04	6.	3.669+00	2.394+01	46.9
	4	8.016-02	1.715-04	2.421+00	3.177-01	4.542-04	5.	3.704+00	2.394+01	46.7
	5	6.414-02	1.219-04	3.351+00	3.145-01	4.465-04	3.	7.865+00	2.404+01	46.7
	6	1.261-03	1.823-06	4.520+00	3.178-02	4.441-05	3.	1.110+01	2.403+01	45.4
	7	2.033-05	2.335-08	4.107+00	5.854-04	7.009-07	3.	1.702+01	2.397+01	43.9
	8	4.450-07	8.722-10	2.452+00	9.424-05	1.157-06	3.	1.047+01	2.374+01	42.7
42	1	8.265-02	1.943-04	1.933+00	3.067-01	4.320-04	4.	3.645+00	2.393+01	39.2
	2	9.593-02	2.149-04	1.973+00	3.153-01	4.586-04	5.	3.650+00	2.394+01	42.1
	3	9.223-02	2.739-04	2.119+00	3.192-01	4.586-04	6.	3.671+00	2.394+01	45.7
	4	7.961-02	1.696-04	2.435+00	3.175-01	4.535-04	5.	3.706+00	2.394+01	46.1
	5	6.399-02	1.212-04	3.355+00	3.144-01	4.461-04	3.	7.867+00	2.404+01	46.3
	6	1.253-03	1.471-06	4.532+00	3.173-02	4.440-05	3.	1.110+01	2.403+01	45.3
	7	2.079-05	2.531-08	4.114+00	5.845-04	6.940-07	3.	1.702+01	2.397+01	43.9
	8	4.434-07	8.551-10	2.457+00	9.404-05	1.148-06	3.	1.047+01	2.373+01	42.1
43	1	8.230-02	1.929-04	1.938+00	3.064-01	4.317-04	4.	3.646+00	2.393+01	39.3
	2	9.528-02	2.129-04	1.993+00	3.179-01	4.576-04	5.	3.655+00	2.394+01	43.2
	3	9.149-02	1.963-04	2.132+00	3.194-01	4.577-04	6.	3.672+00	2.394+01	45.1
	4	7.915-02	1.566-04	2.447+00	3.172-01	4.526-04	5.	3.707+00	2.394+01	46.2
	5	6.386-02	1.236-04	3.365+00	3.142-01	4.458-04	3.	7.868+00	2.404+01	46.3
	6	1.257-03	1.559-06	4.538+00	3.168-02	4.392-05	3.	1.110+01	2.403+01	45.3
	7	2.076-05	2.469-08	4.121+00	5.836-04	6.877-07	3.	1.702+01	2.397+01	43.9
	8	4.410-07	8.396-10	2.463+00	9.336-05	1.131-06	3.	1.047+01	2.379+01	42.3
44	1	8.202-02	1.917-04	1.943+00	3.061-01	4.308-04	4.	3.646+00	2.393+01	39.4
	2	9.474-02	2.111-04	1.992+00	3.176-01	4.560-04	5.	3.656+00	2.394+01	43.4
	3	9.082-02	1.973-04	2.144+00	3.187-01	4.569-04	6.	3.673+00	2.394+01	45.2
	4	7.870-02	1.671-04	2.459+00	3.171-01	4.523-04	5.	3.709+00	2.394+01	46.3
	5	6.373-02	1.239-04	3.371+00	3.141-01	4.455-04	3.	7.870+00	2.404+01	46.4
	6	1.250-03	1.443-06	4.543+00	3.163-02	4.379-05	3.	1.110+01	2.403+01	45.9
	7	2.071-05	2.441-08	4.123+00	5.829-04	6.819-07	3.	1.702+01	2.397+01	43.9
	8	4.400-07	8.250-10	2.463+00	9.370-05	1.110-06	3.	1.047+01	2.374+01	42.1
45	1	8.173-02	1.935-04	1.947+00	3.058-01	4.292-04	4.	3.647+00	2.393+01	39.5
	2	9.420-02	2.104-04	2.031+00	3.174-01	4.558-04	5.	3.657+00	2.394+01	43.5
	3	9.020-02	1.950-04	2.150+00	3.184-01	4.562-04	6.	3.675+00	2.394+01	45.3
	4	7.820-02	1.653-04	2.470+00	3.169-01	4.514-04	5.	3.710+00	2.394+01	46.3
	5	6.350-02	1.195-04	3.370+00	3.140-01	4.452-04	3.	7.871+00	2.404+01	46.7
	6	1.254-03	1.439-06	4.540+00	3.159-02	4.350-05	3.	1.111+01	2.403+01	45.7
	7	2.069-05	2.415-08	4.134+00	5.822-04	6.707-07	3.	1.702+01	2.397+01	43.9
	8	4.386-07	8.129-10	2.473+00	9.356-05	1.102-06	3.	1.047+01	2.374+01	42.1
46	1	8.146-02	1.894-04	1.951+00	3.055-01	4.284-04	4.	3.647+00	2.393+01	39.5
	2	9.371-02	2.175-04	2.029+00	3.171-01	4.550-04	5.	3.656+00	2.394+01	43.5
	3	8.971-02	1.923-04	2.160+00	3.182-01	4.559-04	6.	3.676+00	2.394+01	45.4
	4	7.791-02	1.647-04	2.480+00	3.167-01	4.513-04	5.	3.711+00	2.394+01	46.4
	5	6.352-02	1.193-04	3.381+00	3.140-01	4.444-04	3.	7.873+00	2.404+01	46.7
	6	1.253-03	1.431-06	4.552+00	3.155-02	4.332-05	3.	1.111+01	2.403+01	45.7
	7	2.067-05	2.341-08	4.140+00	5.815-04	6.719-07	3.	1.702+01	2.397+01	43.9
	8	4.374-07	8.140-10	2.478+00	9.343-05	1.109-06	3.	1.048+01	2.374+01	42.1
47	1	8.121-02	1.884-04	1.954+00	3.053-01	4.277-04	4.	3.647+00	2.393+01	39.7
	2	9.327-02	2.164-04	2.016+00	3.169-01	4.543-04	5.	3.652+00	2.394+01	43.7
	3	8.920-02	1.929-04	2.170+00	3.180-01	4.550-04	6.	3.677+00	2.394+01	45.5
	4	7.757-02	1.636-04	2.489+00	3.166-01	4.504-04	5.	3.712+00	2.394+01	46.4
	5	6.342-02	1.180-04	3.390+00	3.130-01	4.440-04	3.	7.874+00	2.404+01	46.7
	6	1.252-03	1.423-06	4.550+00	3.152-02	4.313-05	3.	1.111+01	2.403+01	45.7
	7	2.064-05	2.363-08	4.145+00	5.804-04	6.707-07	3.	1.702+01	2.397+01	43.9
	8	4.360-07	7.734-10	2.482+00	9.331-05	1.170-06	3.	1.048+01	2.374+01	42.1
48	1	8.090-02	1.875-04	1.958+00	3.051-01	4.273-04	4.	3.648+00	2.393+01	39.7
	2	9.287-02	2.151-04	2.023+00	3.167-01	4.537-04	5.	3.657+00	2.394+01	43.8
	3	8.974-02	1.912-04	2.185+00	3.179-01	4.545-04	6.	3.676+00	2.394+01	45.6

SAMPLE OUTPUT: SEPHIS P. 6

49	1	7.725-02	1.020-04	2.497+00	3.185-01	4.235-04	1.318-01	4.	3.713+00	2.390+01	44.5
	2	6.334-02	1.182-04	3.001+00	3.173-01	4.244-04	1.293-01	3.	7.575+00	2.404+01	47.1
	3	1.251-03	1.416-04	4.562+00	3.180-01	4.237-04	1.293-01	3.	1.111+01	2.404+01	44.1
	4	2.062-03	2.349-04	4.115+00	3.184-01	4.234-04	1.293-01	3.	1.295+01	2.395+01	44.1
	5	4.349-07	7.014-10	2.085+00	9.321-06	1.057-06	6.440-01	3.	1.248+01	2.379+01	42.1
49	1	9.070-02	1.067-04	1.961+00	3.047-01	4.259-04	1.278-01	3.	3.448+00	2.393+01	39.9
	2	9.250-02	2.340-04	2.922+00	3.185-01	4.231-04	1.293-01	4.	3.650+00	2.395+01	43.3
	3	8.633-02	1.930-04	2.193+00	3.177-01	4.240-04	1.297-01	4.	3.679+00	2.397+01	45.3
	4	7.791-02	1.018-04	2.560+00	3.183-01	4.232-04	1.296-01	3.	3.714+00	2.390+01	46.3
	5	6.320-02	1.176-04	3.992+00	3.124-01	4.242-04	1.298-01	3.	7.376+00	2.404+01	47.3
	6	1.290-03	1.439-04	4.563+00	3.185-01	4.236-04	1.297-01	2.	1.111+01	2.404+01	46.3
	7	2.060-03	2.331-04	4.115+00	3.180-01	4.234-04	1.295-01	3.	1.295+01	2.398+01	44.1
	8	4.339-07	7.727-10	2.085+00	9.312-06	1.058-06	6.440-01	3.	1.048+01	2.378+01	42.1
50	1	8.004-02	1.061-04	1.966+00	3.047-01	4.259-04	1.282-01	2.	3.648+00	2.393+01	39.9
	2	9.222-02	2.330-04	2.933+00	3.184-01	4.230-04	1.290-01	3.	3.660+00	2.395+01	43.3
	3	8.795-02	1.089-04	2.201+00	3.176-01	4.236-04	1.296-01	4.	3.679+00	2.397+01	45.3
	4	7.675-02	1.010-04	2.513+00	3.182-01	4.235-04	1.296-01	3.	3.715+00	2.390+01	46.3
	5	6.319-02	1.175-04	3.999+00	3.127-01	4.240-04	1.292-01	3.	7.677+00	2.404+01	47.1
	6	1.249-03	1.433-04	4.563+00	3.183-01	4.237-04	1.297-01	2.	1.111+01	2.404+01	46.3
	7	2.050-03	2.315-04	4.115+00	3.180-01	4.235-04	1.295-01	3.	1.295+01	2.398+01	44.1
	8	4.329-07	7.647-10	2.085+00	9.313-06	1.059-06	6.440-01	3.	1.048+01	2.378+01	42.1
51	1	8.043-02	1.053-04	1.965+00	3.045-01	4.254-04	1.286-01	3.	3.649+00	2.393+01	39.9
	2	9.191-02	2.320-04	2.941+00	3.182-01	4.231-04	1.287-01	3.	3.661+00	2.395+01	43.3
	3	8.760-02	1.079-04	2.203+00	3.174-01	4.232-04	1.295-01	4.	3.680+00	2.397+01	45.3
	4	7.651-02	1.033-04	2.521+00	3.181-01	4.236-04	1.292-01	3.	3.716+00	2.390+01	46.3
	5	6.312-02	1.172-04	3.101+00	3.125-01	4.239-04	1.295-01	3.	7.678+00	2.404+01	47.3
	6	1.248-03	1.397-04	4.564+00	3.181-01	4.231-04	1.293-01	2.	1.112+01	2.404+01	46.3
	7	2.057-03	2.310-04	4.162+00	3.182-01	4.234-04	1.295-01	3.	1.295+01	2.398+01	44.1
	8	4.321-07	7.576-10	2.087+00	9.296-06	1.041-06	6.449-01	3.	1.048+01	2.378+01	42.1
52	1	8.032-02	1.047-04	1.963+00	3.044-01	4.249-04	1.290-01	2.	3.649+00	2.393+01	40.2
	2	9.163-02	2.311-04	2.940+00	3.181-01	4.231-04	1.273-01	3.	3.661+00	2.395+01	44.3
	3	8.733-02	1.071-04	2.215+00	3.173-01	4.232-04	1.292-01	3.	3.681+00	2.397+01	45.3
	4	7.629-02	1.046-04	2.520+00	3.180-01	4.233-04	1.293-01	3.	3.716+00	2.390+01	46.3
	5	6.306-02	1.169-04	3.125+00	3.126-01	4.237-04	1.299-01	3.	7.679+00	2.404+01	47.1
	6	1.248-03	1.392-04	4.572+00	3.129-01	4.235-04	1.296-01	2.	1.112+01	2.404+01	46.3
	7	2.055-03	2.286-04	4.165+00	3.184-01	4.236-04	1.295-01	3.	1.295+01	2.398+01	44.2
	8	4.313-07	7.510-10	2.092+00	9.283-06	1.034-06	6.475-01	3.	1.048+01	2.378+01	42.1
53	1	8.019-02	1.042-04	1.971+00	3.043-01	4.245-04	1.293-01	2.	3.649+00	2.393+01	40.1
	2	9.137-02	2.303-04	2.955+00	3.180-01	4.231-04	1.278-01	3.	3.662+00	2.395+01	44.1
	3	8.704-02	1.063-04	2.221+00	3.172-01	4.232-04	1.293-01	3.	3.682+00	2.397+01	45.3
	4	7.609-02	1.090-04	2.532+00	3.180-01	4.231-04	1.295-01	3.	3.717+00	2.390+01	46.3
	5	6.301-02	1.166-04	3.101+00	3.125-01	4.235-04	1.292-01	3.	7.680+00	2.404+01	47.1
	6	1.247-03	1.387-04	4.575+00	3.127-01	4.230-04	1.295-01	2.	1.112+01	2.404+01	46.3
	7	2.054-03	2.273-04	4.163+00	3.185-01	4.230-04	1.296-01	3.	1.296+01	2.395+01	44.2
	8	4.300-07	7.444-10	2.093+00	9.283-06	1.027-06	6.481-01	3.	1.049+01	2.379+01	42.2
54	1	8.006-02	1.037-04	1.973+00	3.042-01	4.242-04	1.296-01	2.	3.649+00	2.393+01	40.1
	2	9.114-02	1.996-04	2.054+00	3.159-01	4.239-04	1.284-01	3.	3.662+00	2.395+01	44.2
	3	8.678-02	1.056-04	2.227+00	3.171-01	4.232-04	1.245-01	3.	3.682+00	2.397+01	45.3
	4	7.590-02	1.084-04	2.537+00	3.159-01	4.239-04	1.292-01	3.	3.718+00	2.400+01	46.3
	5	6.299-02	1.165-04	3.111+00	3.125-01	4.234-04	1.290-01	1.	7.680+00	2.404+01	47.1
	6	1.247-03	1.383-04	4.577+00	3.125-01	4.230-04	1.291-01	2.	1.112+01	2.404+01	46.1
	7	2.053-03	2.261-04	4.172+00	3.185-01	4.236-04	1.297-01	3.	1.296+01	2.398+01	44.2
	8	4.299-07	7.393-10	2.095+00	9.277-06	1.021-06	6.486-01	3.	1.049+01	2.379+01	42.2
55	1	7.994-02	1.032-04	1.975+00	3.041-01	4.238-04	1.299-01	2.	3.650+00	2.393+01	40.2
	2	9.099-02	1.990-04	2.050+00	3.159-01	4.230-04	1.288-01	2.	3.663+00	2.395+01	44.2
	3	8.653-02	1.049-04	2.232+00	3.170-01	4.239-04	1.282-01	3.	3.683+00	2.397+01	45.9
	4	7.573-02	1.078-04	2.542+00	3.159-01	4.236-04	1.297-01	3.	3.718+00	2.400+01	46.7
	5	6.292-02	1.161-04	3.111+00	3.125-01	4.233-04	1.297-01	3.	7.681+00	2.404+01	47.1
	6	1.246-03	1.380-04	4.575+00	3.125-01	4.224-04	1.291-01	2.	1.112+01	2.404+01	46.1
	7	2.052-03	2.251-04	4.175+00	3.185-01	4.234-04	1.297-01	3.	1.296+01	2.398+01	44.2
	8	4.293-07	7.342-10	2.090+00	9.272-06	1.015-06	6.491-01	3.	1.049+01	2.379+01	42.2
56	1	7.983-02	1.027-04	1.970+00	3.040-01	4.238-04	1.292-01	2.	3.650+00	2.393+01	40.2
	2	9.074-02	1.983-04	2.062+00	3.157-01	4.233-04	1.293-01	3.	3.663+00	2.395+01	44.3
	3	8.630-02	1.042-04	2.237+00	3.170-01	4.237-04	1.287-01	3.	3.683+00	2.397+01	46.0
	4	7.557-02	1.074-04	2.547+00	3.159-01	4.235-04	1.292-01	3.	3.719+00	2.400+01	46.7
	5	6.290-02	1.161-04	3.110+00	3.124-01	4.232-04	1.291-01	1.	7.682+00	2.404+01	47.1
	6	1.246-03	1.376-04	4.582+00	3.132-01	4.235-04	1.291-01	2.	1.112+01	2.404+01	46.1
	7	2.051-03	2.242-04	4.177+00	3.184-01	4.235-04	1.297-01	3.	1.296+01	2.398+01	44.2
	8	4.288-07	7.296-10	2.091+00	9.267-06	1.010-06	6.495-01	3.	1.049+01	2.379+01	42.2
57	1	7.974-02	1.023-04	1.970+00	3.039-01	4.233-04	1.294-01	2.	3.650+00	2.393+01	40.2
	2	9.061-02	1.978-04	2.063+00	3.154-01	4.230-04	1.297-01	2.	3.664+00	2.395+01	44.3
	3	8.615-02	1.038-04	2.242+00	3.163-01	4.234-04	1.282-01	2.	3.684+00	2.397+01	44.0
	4	7.543-02	1.069-04	2.551+00	3.157-01	4.234-04	1.297-01	3.	3.719+00	2.400+01	46.8
	5	6.285-02	1.158-04	3.110+00	3.124-01	4.231-04	1.292-01	2.	7.682+00	2.404+01	47.1
	6	1.245-03	1.373-04	4.583+00	3.131-01	4.229-04	1.291-01	2.	1.112+01	2.404+01	46.1
	7	2.050-03	2.233-04	4.182+00	3.184-01	4.234-04	1.297-01	3.	1.296+01	2.398+01	44.2
	8	4.283-07	7.254-10	2.091+00	9.264-06	1.016-06	6.500-01	3.	1.049+01	2.379+01	42.2
58	1	7.965-02	1.020-04	1.974+00	3.037-01	4.233-04	1.296-01	2.	3.650+00	2.393+01	40.3
	2	9.045-02	1.973-04	2.060+00	3.155-01	4.230-04	1.290-01	2.	3.664+00	2.395+01	44.3
	3	8.591-02	1.031-04	2.244+00	3.164-01	4.232-04	1.287-01	3.	3.684+00	2.397+01	46.0
	4	7.533-02	1.066-04	2.555+00	3.154-01	4.231-04	1.291-01	2.	3.720+00	2.400+01	46.5
	5	6.281-02	1.157-04	3.127+00	3.124-01	4.231-04	1.291-01	1.	7.683+00	2.404+01	47.1
	6	1.245-03	1.364-04	4.585+00	3.132-01	4.224-04	1.291-01	2.	1.112+01	2.404+01	46.1
	7	2.049-03	2.225-04	4.182+00	3.184-01	4.233-04	1.297-01	3.	1.296+01	2.398+01	44.2
	8	4.279-07	7.215-10	2.091+00	9.267-06	1.011-06	6.503-01	2.	1.049+01	2.379+01	42.2
59	1	7.957-02	1.016-04	1.981+00	3.037-01	4.234-04	1.298-01	2.	3.650+00	2.393+01	40.3
	2	9.030-02	1.960-04	2.071+00	3.155-01	4.230-04	1.294-01	2.	3.664+00	2.395+01	44.4

SAMPLE OUTPUT: SEPHIS P. 7

	3	0.578-C2	1.027-C4	2.250+00	3.107-01	4.510-04	2.071-01	2.	3.650+00	2.393+01	40.1
	4	7.513-C2	1.501-C4	2.550+00	3.156-01	4.400-04	2.500-01	3.	3.770+00	2.400+01	46.0
	5	6.270-C2	1.150-C4	3.123+00	3.134-01	4.400-04	2.915-01	2.	7.003+00	2.400+01	47.1
	6	1.245-C3	1.307-C4	4.547+00	3.170-02	4.197-05	6.521-01	2.	1.112+01	2.400+01	46.1
	7	2.043-C5	2.217-C3	4.184+00	5.772-04	6.365-07	6.500-01	2.	1.096+01	2.399+01	44.2
	8	4.270-C7	7.180-10	2.910+00	9.257-06	9.370-09	6.507-01	2.	1.049+01	2.379+01	42.2
60	1	7.949-C2	1.813-C4	1.984+00	3.037-01	4.220-04	1.910-01	2.	3.650+00	2.393+01	40.3
	2	9.010-C2	1.904-C4	2.074+00	3.154-01	4.493-04	1.907-01	2.	3.665+00	2.395+01	44.4
	3	8.503-C2	1.603-C4	2.254+00	3.107-01	4.500-04	2.075-01	2.	3.605+00	2.397+01	46.1
	4	7.510-C2	1.558-C4	2.502+00	3.150-01	4.479-04	2.300-01	2.	3.721+00	2.400+01	46.3
	5	6.270-C2	1.154-C4	3.174+00	3.133-01	4.420-04	2.915-01	1.	7.884+00	2.400+01	47.2
	6	1.244-C3	1.304-C4	4.584+00	3.128-02	4.191-05	6.523-01	2.	1.112+01	2.400+01	46.1
	7	2.043-C5	2.210-C3	4.180+00	5.771-04	6.361-07	6.506-01	2.	1.096+01	2.390+01	44.2
	8	4.271-C7	7.146-10	2.917+00	9.254-06	9.339-09	6.510-01	2.	1.049+01	2.379+01	42.2
61	1	7.943-C2	1.811-C4	1.953+00	3.037-01	4.224-04	1.912-01	2.	3.650+00	2.393+01	40.4
	2	9.003-C2	1.900-C4	2.070+00	3.154-01	4.492-04	1.910-01	2.	3.665+00	2.395+01	44.4
	3	8.500-C2	1.618-C4	2.257+00	3.166-01	4.507-04	2.070-01	2.	3.606+00	2.397+01	46.1
	4	7.508-C2	1.555-C4	2.500+00	3.155-01	4.477-04	2.302-01	2.	3.721+00	2.400+01	46.5
	5	6.272-C2	1.152-C4	3.170+00	3.133-01	4.427-04	2.915-01	2.	7.884+00	2.400+01	47.2
	6	1.244-C3	1.302-C4	4.590+00	3.127-02	4.180-05	6.525-01	2.	1.112+01	2.400+01	46.1
	7	2.047-C5	2.203-C3	4.150+00	5.770-04	6.337-07	6.507-01	2.	1.096+01	2.399+01	44.2
	8	4.267-C7	7.150-10	2.910+00	9.252-06	9.304-09	6.512-01	2.	1.049+01	2.379+01	42.2
62	1	7.937-C2	1.818-C4	1.944+00	3.036-01	4.222-04	1.914-01	2.	3.651+00	2.393+01	40.4
	2	8.991-C2	1.910-C4	2.074+00	3.153-01	4.492-04	1.910-01	2.	3.665+00	2.395+01	44.5
	3	8.534-C2	1.614-C4	2.260+00	3.168-01	4.506-04	2.083-01	2.	3.606+00	2.397+01	46.1
	4	7.491-C2	1.552-C4	2.503+00	3.155-01	4.476-04	2.300-01	2.	3.721+00	2.400+01	46.9
	5	6.278-C2	1.151-C4	3.127+00	3.133-01	4.427-04	2.921-01	1.	7.885+00	2.400+01	47.2
	6	1.244-C3	1.359-C5	4.591+00	3.126-02	4.160-05	6.525-01	2.	1.112+01	2.400+01	46.1
	7	2.047-C5	2.197-C3	4.190+00	5.769-04	6.326-07	6.502-01	2.	1.096+01	2.399+01	44.2
	8	4.264-C7	7.067-10	2.920+00	9.249-06	9.375-09	6.516-01	2.	1.049+01	2.379+01	42.2
63	1	7.931-C2	1.816-C4	1.955+00	3.036-01	4.221-04	1.915-01	1.	3.651+00	2.393+01	40.4
	2	8.988-C2	1.952-C4	2.091+00	3.153-01	4.488-04	1.916-01	2.	3.665+00	2.395+01	44.5
	3	8.521-C2	1.611-C4	2.252+00	3.166-01	4.504-04	2.085-01	2.	3.606+00	2.397+01	46.2
	4	7.482-C2	1.549-C4	2.571+00	3.155-01	4.475-04	2.300-01	2.	3.722+00	2.400+01	46.9
	5	6.269-C2	1.150-C4	3.124+00	3.133-01	4.426-04	2.922-01	1.	7.885+00	2.400+01	47.2
	6	1.243-C3	1.357-C5	4.592+00	3.125-02	4.177-05	6.527-01	2.	1.112+01	2.400+01	46.1
	7	2.046-C5	2.152-C3	4.191+00	5.767-04	6.314-07	6.504-01	2.	1.096+01	2.390+01	44.2
	8	4.261-C7	7.062-10	2.922+00	9.247-06	9.346-09	6.519-01	2.	1.049+01	2.379+01	42.2
64	1	7.930-C2	1.815-C4	1.980+00	3.035-01	4.219-04	1.917-01	1.	3.651+00	2.393+01	40.4
	2	8.970-C2	1.949-C4	2.093+00	3.152-01	4.487-04	1.918-01	2.	3.665+00	2.395+01	44.5
	3	8.510-C2	1.638-C4	2.265+00	3.165-01	4.503-04	2.080-01	2.	3.606+00	2.397+01	46.2
	4	7.476-C2	1.548-C4	2.573+00	3.154-01	4.474-04	2.402-01	1.	3.722+00	2.400+01	46.9
	5	6.260-C2	1.149-C4	3.135+00	3.133-01	4.425-04	2.923-01	1.	7.885+00	2.400+01	47.2
	6	1.243-C3	1.350-C5	4.593+00	3.124-02	4.169-05	6.520-01	2.	1.113+01	2.400+01	46.1
	7	2.046-C5	2.187-C3	4.193+00	5.766-04	6.304-07	6.505-01	2.	1.097+01	2.394+01	44.3
	8	4.258-C7	7.037-10	2.923+00	9.245-06	9.620-09	6.521-01	2.	1.049+01	2.379+01	42.2
65	1	7.926-C2	1.813-C4	1.947+00	3.035-01	4.218-04	1.918-01	1.	3.651+00	2.393+01	40.4
	2	8.960-C2	1.946-C4	2.084+00	3.152-01	4.486-04	1.920-01	2.	3.666+00	2.395+01	44.5
	3	8.493-C2	1.634-C4	2.267+00	3.165-01	4.502-04	2.092-01	2.	3.607+00	2.397+01	46.2
	4	7.466-C2	1.544-C4	2.570+00	3.154-01	4.473-04	2.404-01	2.	3.722+00	2.400+01	46.9
	5	6.265-C2	1.148-C4	3.131+00	3.132-01	4.425-04	2.924-01	1.	7.886+00	2.400+01	47.2
	6	1.243-C3	1.354-C5	4.595+00	3.124-02	4.169-05	6.520-01	2.	1.113+01	2.400+01	46.2
	7	2.045-C5	2.182-C3	4.194+00	5.765-04	6.295-07	6.507-01	2.	1.097+01	2.390+01	44.3
	8	4.250-C7	7.015-10	2.924+00	9.243-06	9.795-09	6.524-01	2.	1.049+01	2.379+01	42.2
66	1	7.922-C2	1.811-C4	1.963+00	3.034-01	4.217-04	1.919-01	1.	3.651+00	2.393+01	40.5
	2	8.956-C2	1.944-C4	2.086+00	3.152-01	4.484-04	1.922-01	1.	3.666+00	2.395+01	44.6
	3	8.494-C2	1.632-C4	2.269+00	3.164-01	4.501-04	2.094-01	1.	3.607+00	2.397+01	46.2
	4	7.464-C2	1.543-C4	2.573+00	3.154-01	4.473-04	2.406-01	1.	3.722+00	2.400+01	46.9
	5	6.263-C2	1.147-C4	3.132+00	3.132-01	4.424-04	2.925-01	1.	7.886+00	2.400+01	47.2
	6	1.243-C3	1.352-C5	4.595+00	3.123-02	4.160-05	6.530-01	1.	1.113+01	2.400+01	46.2
	7	2.045-C5	2.178-C3	4.195+00	5.764-04	6.286-07	6.509-01	2.	1.097+01	2.399+01	44.3
	8	4.254-C7	6.996-10	2.925+00	9.242-06	9.774-09	6.526-01	2.	1.049+01	2.379+01	42.2
67	1	7.918-C2	1.799-C4	1.929+00	3.034-01	4.216-04	1.920-01	1.	3.651+00	2.393+01	40.5
	2	8.942-C2	1.942-C4	2.088+00	3.151-01	4.483-04	1.924-01	1.	3.666+00	2.395+01	44.6
	3	8.401-C2	1.793-C4	2.272+00	3.164-01	4.499-04	2.096-01	2.	3.607+00	2.397+01	46.2
	4	7.456-C2	1.542-C4	2.581+00	3.153-01	4.472-04	2.408-01	2.	3.723+00	2.400+01	46.9
	5	6.261-C2	1.144-C4	3.133+00	3.132-01	4.424-04	2.926-01	1.	7.886+00	2.400+01	47.2
	6	1.243-C3	1.351-C5	4.590+00	3.123-02	4.163-05	6.531-01	2.	1.113+01	2.400+01	46.2
	7	2.044-C5	2.174-C3	4.190+00	5.764-04	6.279-07	6.600-01	2.	1.097+01	2.399+01	44.3
	8	4.251-C7	6.977-10	2.926+00	9.240-06	9.754-09	6.528-01	2.	1.049+01	2.379+01	42.2
68	1	7.914-C2	1.793-C4	1.799+00	3.034-01	4.215-04	1.921-01	1.	3.651+00	2.393+01	40.5
	2	8.930-C2	1.934-C4	2.089+00	3.151-01	4.482-04	1.926-01	2.	3.666+00	2.395+01	44.6
	3	8.470-C2	1.753-C4	2.273+00	3.164-01	4.499-04	2.099-01	2.	3.607+00	2.397+01	46.2
	4	7.451-C2	1.539-C4	2.581+00	3.153-01	4.471-04	2.410-01	1.	3.723+00	2.400+01	46.9
	5	6.259-C2	1.145-C4	3.134+00	3.132-01	4.424-04	2.927-01	1.	7.886+00	2.400+01	47.2
	6	1.243-C3	1.349-C5	4.597+00	3.122-02	4.160-05	6.532-01	1.	1.113+01	2.400+01	46.2
	7	2.044-C5	2.170-C3	4.197+00	5.763-04	6.271-07	6.601-01	2.	1.097+01	2.399+01	44.3
	8	4.249-C7	6.961-10	2.927+00	9.239-06	9.735-09	6.529-01	2.	1.049+01	2.379+01	42.2
69	1	7.910-C2	1.796-C4	1.907+00	3.034-01	4.214-04	1.922-01	1.	3.651+00	2.393+01	40.5
	2	8.930-C2	1.937-C4	2.091+00	3.151-01	4.482-04	1.928-01	1.	3.666+00	2.395+01	44.6
	3	8.471-C2	1.790-C4	2.275+00	3.164-01	4.498-04	2.101-01	1.	3.608+00	2.397+01	46.3
	4	7.447-C2	1.535-C4	2.583+00	3.153-01	4.471-04	2.412-01	1.	3.723+00	2.400+01	46.9
	5	6.257-C2	1.144-C4	3.133+00	3.132-01	4.423-04	2.928-01	1.	7.887+00	2.400+01	47.2
	6	1.244-C3	1.348-C5	4.594+00	3.122-02	4.157-05	6.533-01	1.	1.113+01	2.400+01	46.2
	7	2.044-C5	2.167-C3	4.190+00	5.762-04	6.264-07	6.602-01	2.	1.097+01	2.397+01	44.3
	8	4.247-C7	6.944-10	2.928+00	9.237-06	9.717-09	6.531-01	2.	1.049+01	2.379+01	42.2

SAMPLE OUTPUT: SEPHIS P. 8

70	1	7.900-02	1.790-04	1.991+00	3.033-01	4.213-04	1.923-01	1.	3.651+00	2.393+01	40.5
	2	8.920-02	1.920-04	2.092+00	3.156-01	4.473-04	1.933-01	1.	3.667+00	2.395+01	40.7
	3	8.440-02	1.790-04	2.070+00	3.163-01	4.495-04	2.113-01	1.	3.689+00	2.397+01	46.3
	4	7.443-02	1.530-04	2.590+00	3.152-01	4.466-04	2.423-01	1.	3.724+00	2.406+01	47.0
	5	6.250-02	1.140-04	3.130+00	3.132-01	4.423-04	2.933-01	1.	7.887+00	2.404+01	47.2
	6	1.240-03	1.340-06	4.000+00	3.120-02	4.145-05	8.535-01	1.	1.113+01	2.404+01	46.2
	7	2.040-05	2.150-08	4.200+00	5.759-04	6.230-07	8.603-01	2.	1.097+01	2.399+01	44.3
	8	4.240-07	6.840-10	2.930+00	9.233-06	9.628-09	6.539-01	2.	1.050+01	2.379+01	42.2
71	1	7.900-02	1.790-04	1.991+00	3.033-01	4.213-04	1.923-01	1.	3.651+00	2.393+01	40.5
	2	8.920-02	1.920-04	2.092+00	3.156-01	4.473-04	1.933-01	1.	3.667+00	2.395+01	40.7
	3	8.440-02	1.790-04	2.070+00	3.163-01	4.495-04	2.113-01	1.	3.688+00	2.397+01	46.3
	4	7.443-02	1.530-04	2.590+00	3.152-01	4.466-04	2.418-01	1.	3.723+00	2.406+01	47.0
	5	6.250-02	1.140-04	3.130+00	3.132-01	4.423-04	2.930-01	1.	7.987+00	2.404+01	47.2
	6	1.240-03	1.340-06	4.000+00	3.120-02	4.145-05	8.535-01	1.	1.113+01	2.404+01	46.2
	7	2.040-05	2.150-08	4.200+00	5.761-04	6.230-07	8.604-01	2.	1.097+01	2.399+01	44.3
	8	4.240-07	6.840-10	2.920+00	9.235-06	9.628-09	6.534-01	2.	1.049+01	2.379+01	42.2
72	1	7.900-02	1.790-04	1.991+00	3.033-01	4.213-04	1.923-01	1.	3.651+00	2.393+01	40.5
	2	8.910-02	1.932-04	2.094+00	3.156-01	4.473-04	1.931-01	1.	3.667+00	2.395+01	40.7
	3	8.451-02	1.790-04	2.070+00	3.163-01	4.495-04	2.116-01	1.	3.688+00	2.397+01	46.3
	4	7.430-02	1.530-04	2.587+00	3.153-01	4.466-04	2.416-01	1.	3.723+00	2.406+01	47.0
	5	6.250-02	1.142-04	3.137+00	3.132-01	4.423-04	2.931-01	1.	7.887+00	2.404+01	47.2
	6	1.240-03	1.345-06	4.000+00	3.120-02	4.145-05	8.534-01	1.	1.113+01	2.404+01	46.2
	7	2.040-05	2.159-08	4.200+00	5.760-04	6.240-07	8.606-01	2.	1.097+01	2.399+01	44.3
	8	4.240-07	6.840-10	2.930+00	9.234-06	9.628-09	6.535-01	2.	1.049+01	2.379+01	42.2
73	1	7.897-02	1.791-04	1.992+00	3.033-01	4.213-04	1.925-01	1.	3.651+00	2.393+01	40.5
	2	8.910-02	1.931-04	2.095+00	3.156-01	4.473-04	1.933-01	1.	3.667+00	2.395+01	40.7
	3	8.445-02	1.789-04	2.081+00	3.163-01	4.495-04	2.117-01	1.	3.688+00	2.397+01	46.3
	4	7.430-02	1.532-04	2.589+00	3.152-01	4.466-04	2.418-01	1.	3.724+00	2.406+01	47.0
	5	6.252-02	1.142-04	3.130+00	3.132-01	4.423-04	2.931-01	1.	7.887+00	2.404+01	47.2
	6	1.242-03	1.344-06	4.000+00	3.120-02	4.147-05	8.535-01	1.	1.113+01	2.404+01	46.2
	7	2.040-05	2.156-08	4.201+00	5.760-04	6.241-07	8.606-01	2.	1.097+01	2.399+01	44.3
	8	4.240-07	6.840-10	2.930+00	9.233-06	9.628-09	6.536-01	2.	1.050+01	2.379+01	42.2
74	1	7.895-02	1.790-04	1.993+00	3.033-01	4.210-04	1.926-01	1.	3.651+00	2.393+01	40.6
	2	8.900-02	1.929-04	2.096+00	3.150-01	4.476-04	1.934-01	1.	3.667+00	2.395+01	40.7
	3	8.440-02	1.787-04	2.080+00	3.163-01	4.495-04	2.109-01	1.	3.688+00	2.397+01	46.3
	4	7.426-02	1.531-04	2.590+00	3.152-01	4.466-04	2.419-01	1.	3.724+00	2.406+01	47.0
	5	6.251-02	1.141-04	3.139+00	3.132-01	4.422-04	2.932-01	1.	7.888+00	2.404+01	47.2
	6	1.242-03	1.343-06	4.001+00	3.119-02	4.145-05	8.535-01	1.	1.113+01	2.404+01	46.2
	7	2.040-05	2.154-08	4.202+00	5.759-04	6.230-07	8.607-01	1.	1.097+01	2.399+01	44.3
	8	4.240-07	6.840-10	2.931+00	9.232-06	9.649-09	6.537-01	2.	1.050+01	2.379+01	42.2
75	1	7.893-02	1.790-04	1.993+00	3.032-01	4.210-04	1.926-01	1.	3.651+00	2.393+01	40.6
	2	8.900-02	1.928-04	2.097+00	3.150-01	4.477-04	1.935-01	1.	3.667+00	2.395+01	40.7
	3	8.430-02	1.756-04	2.093+00	3.163-01	4.495-04	2.113-01	1.	3.689+00	2.397+01	46.3
	4	7.422-02	1.530-04	2.591+00	3.152-01	4.466-04	2.420-01	1.	3.724+00	2.406+01	47.0
	5	6.250-02	1.141-04	3.139+00	3.131-01	4.422-04	2.932-01	1.	7.888+00	2.404+01	47.2
	6	1.241-03	1.342-06	4.001+00	3.119-02	4.143-05	8.536-01	1.	1.113+01	2.404+01	46.2
	7	2.042-05	2.152-08	4.202+00	5.759-04	6.231-07	8.603-01	2.	1.097+01	2.399+01	44.3
	8	4.239-07	6.873-10	2.931+00	9.231-06	9.638-09	6.538-01	2.	1.050+01	2.379+01	42.2
76	1	7.891-02	1.789-04	1.993+00	3.032-01	4.209-04	1.927-01	1.	3.652+00	2.393+01	40.6
	2	8.900-02	1.927-04	2.097+00	3.149-01	4.477-04	1.936-01	1.	3.667+00	2.395+01	40.7
	3	8.429-02	1.784-04	2.084+00	3.163-01	4.494-04	2.111-01	1.	3.689+00	2.397+01	46.3
	4	7.418-02	1.528-04	2.592+00	3.152-01	4.466-04	2.421-01	1.	3.724+00	2.406+01	47.0
	5	6.249-02	1.140-04	3.140+00	3.131-01	4.421-04	2.933-01	1.	7.888+00	2.404+01	47.2
	6	1.241-03	1.341-06	4.002+00	3.119-02	4.142-05	8.536-01	1.	1.113+01	2.404+01	46.2
	7	2.042-05	2.150-08	4.203+00	5.758-04	6.227-07	8.603-01	2.	1.097+01	2.399+01	44.3
	8	4.238-07	6.864-10	2.932+00	9.230-06	9.628-09	6.539-01	2.	1.050+01	2.379+01	42.2
77	1	7.889-02	1.788-04	1.994+00	3.032-01	4.209-04	1.927-01	1.	3.652+00	2.393+01	40.6
	2	8.896-02	1.926-04	2.098+00	3.149-01	4.477-04	1.937-01	1.	3.667+00	2.395+01	40.7
	3	8.425-02	1.783-04	2.085+00	3.162-01	4.494-04	2.112-01	1.	3.689+00	2.397+01	46.3
	4	7.415-02	1.527-04	2.593+00	3.152-01	4.467-04	2.422-01	1.	3.724+00	2.406+01	47.0
	5	6.248-02	1.140-04	3.140+00	3.131-01	4.421-04	2.933-01	1.	7.888+00	2.404+01	47.2
	6	1.241-03	1.340-06	4.002+00	3.118-02	4.140-05	8.537-01	1.	1.113+01	2.404+01	46.2
	7	2.042-05	2.148-08	4.204+00	5.757-04	6.223-07	8.609-01	1.	1.097+01	2.399+01	44.3
	8	4.237-07	6.853-10	2.932+00	9.229-06	9.619-09	6.540-01	2.	1.050+01	2.379+01	42.2
78	1	7.887-02	1.787-04	1.994+00	3.032-01	4.209-04	1.923-01	1.	3.652+00	2.393+01	40.6
	2	8.894-02	1.924-04	2.099+00	3.149-01	4.476-04	1.937-01	1.	3.667+00	2.395+01	40.7
	3	8.420-02	1.782-04	2.086+00	3.162-01	4.494-04	2.113-01	1.	3.689+00	2.397+01	46.3
	4	7.412-02	1.526-04	2.593+00	3.152-01	4.467-04	2.423-01	1.	3.724+00	2.406+01	47.0
	5	6.247-02	1.139-04	3.141+00	3.131-01	4.421-04	2.934-01	1.	7.888+00	2.404+01	47.2
	6	1.241-03	1.340-06	4.002+00	3.118-02	4.139-05	8.537-01	1.	1.113+01	2.404+01	46.2
	7	2.042-05	2.146-08	4.204+00	5.757-04	6.219-07	8.610-01	1.	1.097+01	2.399+01	44.3
	8	4.236-07	6.848-10	2.933+00	9.228-06	9.610-09	6.541-01	2.	1.050+01	2.379+01	42.2
79	1	7.880-02	1.787-04	1.994+00	3.032-01	4.208-04	1.928-01	1.	3.652+00	2.393+01	40.6
	2	8.889-02	1.923-04	2.099+00	3.149-01	4.476-04	1.938-01	1.	3.667+00	2.395+01	40.7
	3	8.416-02	1.781-04	2.087+00	3.162-01	4.493-04	2.114-01	1.	3.689+00	2.397+01	46.3
	4	7.407-02	1.526-04	2.594+00	3.152-01	4.467-04	2.424-01	1.	3.724+00	2.406+01	47.0
	5	6.246-02	1.139-04	3.141+00	3.131-01	4.421-04	2.934-01	1.	7.888+00	2.404+01	47.2
	6	1.241-03	1.339-06	4.003+00	3.118-02	4.137-05	8.537-01	1.	1.113+01	2.404+01	46.2
	7	2.041-05	2.144-08	4.205+00	5.756-04	6.210-07	8.610-01	1.	1.097+01	2.399+01	44.3
	8	4.235-07	6.839-10	2.933+00	9.227-06	9.601-09	6.542-01	2.	1.050+01	2.379+01	42.2
80	1	7.880-02	1.786-04	1.995+00	3.032-01	4.208-04	1.929-01	1.	3.652+00	2.393+01	40.6
	2	8.880-02	1.923-04	2.100+00	3.149-01	4.475-04	1.939-01	1.	3.667+00	2.395+01	40.7
	3	8.410-02	1.780-04	2.088+00	3.162-01	4.493-04	2.115-01	1.	3.689+00	2.397+01	46.3
	4	7.400-02	1.525-04	2.595+00	3.152-01	4.467-04	2.425-01	1.	3.724+00	2.406+01	47.0
	5	6.245-02	1.139-04	3.141+00	3.131-01	4.420-04	2.935-01	1.	7.888+00	2.404+01	47.2
	6	1.241-03	1.338-06	4.003+00	3.117-02	4.136-05	8.538-01	1.	1.113+01	2.404+01	46.2
	7	2.041-05	2.142-08	4.205+00	5.756-04	6.213-07	8.611-01	1.	1.097+01	2.399+01	44.3
	8	4.230-07	6.833-10	2.933+00	9.227-06	9.593-09	6.543-01	1.	1.050+01	2.379+01	42.2

SAMPLE OUTPUT: SEPHIS P. 9

81	1	7.643-C2	1.786-24	1.996+00	3.032-01	4.206-04	1.931-01	1.	3.652+00	2.393+01	40.6
	2	8.643-C2	1.921-24	2.101+00	3.149-01	4.475-04	1.941-01	1.	3.667+00	2.395+01	40.7
	3	8.430-C2	1.777-24	2.290+00	3.162-01	4.492-04	2.117-01	1.	3.669+00	2.397+01	46.4
	4	7.399-C2	1.522-24	2.596+00	3.151-01	4.465-04	2.429-01	1.	3.725+00	2.406+01	47.0
	5	6.244-C2	1.137-24	3.143+00	3.131-01	4.420-04	2.936-01	1.	7.889+00	2.405+01	47.3
	6	1.241-C3	1.336-26	4.634+00	3.116-02	4.131-05	8.539-01	1.	1.113+01	2.404+01	46.2
	7	2.041-C5	2.135-28	4.297+00	5.754-04	6.196-07	6.613-01	1.	1.097+01	2.399+01	44.3
	8	4.233-C7	6.815-10	2.935+00	9.223-06	9.567-09	6.545-01	1.	1.053+01	2.379+01	42.2
82	1	7.642-C2	1.785-24	1.995+00	3.032-01	4.207-04	1.930-01	1.	3.652+00	2.393+01	40.6
	2	8.642-C2	1.921-24	2.101+00	3.149-01	4.475-04	1.940-01	1.	3.667+00	2.395+01	40.7
	3	8.430-C2	1.776-24	2.290+00	3.162-01	4.492-04	2.117-01	1.	3.669+00	2.397+01	46.4
	4	7.398-C2	1.523-24	2.597+00	3.151-01	4.466-04	2.427-01	1.	3.725+00	2.406+01	47.0
	5	6.244-C2	1.138-24	3.142+00	3.131-01	4.420-04	2.935-01	1.	7.883+00	2.405+01	47.2
	6	1.241-C3	1.337-26	4.634+00	3.117-02	4.134-05	8.538-01	1.	1.113+01	2.404+01	46.2
	7	2.041-C5	2.140-28	4.296+00	5.755-04	6.207-07	6.612-01	1.	1.097+01	2.399+01	44.3
	8	4.233-C7	6.820-10	2.934+00	9.225-06	9.579-09	6.544-01	1.	1.053+01	2.379+01	42.2
83	1	7.660-C2	1.785-24	1.995+00	3.032-01	4.207-04	1.930-01	1.	3.652+00	2.393+01	40.6
	2	8.660-C2	1.920-24	2.101+00	3.149-01	4.475-04	1.941-01	1.	3.667+00	2.395+01	40.7
	3	8.430-C2	1.777-24	2.290+00	3.162-01	4.492-04	2.117-01	1.	3.669+00	2.397+01	46.4
	4	7.399-C2	1.523-24	2.597+00	3.151-01	4.466-04	2.427-01	1.	3.725+00	2.406+01	47.0
	5	6.244-C2	1.138-24	3.142+00	3.131-01	4.420-04	2.935-01	1.	7.883+00	2.405+01	47.2
	6	1.241-C3	1.337-26	4.634+00	3.117-02	4.133-05	8.538-01	1.	1.113+01	2.404+01	46.2
	7	2.041-C5	2.135-28	4.296+00	5.754-04	6.204-07	6.612-01	1.	1.097+01	2.399+01	44.3
	8	4.232-C7	6.815-10	2.934+00	9.224-06	9.572-09	6.545-01	1.	1.053+01	2.379+01	42.2
84	1	7.679-C2	1.784-24	1.996+00	3.032-01	4.207-04	1.931-01	1.	3.652+00	2.393+01	40.6
	2	8.679-C2	1.919-24	2.102+00	3.149-01	4.474-04	1.941-01	1.	3.663+00	2.395+01	44.6
	3	8.430-C2	1.776-24	2.290+00	3.162-01	4.492-04	2.116-01	1.	3.669+00	2.397+01	46.4
	4	7.397-C2	1.522-24	2.597+00	3.151-01	4.466-04	2.428-01	1.	3.725+00	2.406+01	47.0
	5	6.242-C2	1.138-24	3.142+00	3.131-01	4.420-04	2.936-01	1.	7.889+00	2.405+01	47.3
	6	1.241-C3	1.336-26	4.634+00	3.116-02	4.132-05	8.539-01	1.	1.113+01	2.404+01	46.2
	7	2.040-C5	2.137-28	4.296+00	5.755-04	6.202-07	6.612-01	1.	1.097+01	2.399+01	44.3
	8	4.231-C7	6.819-10	2.935+00	9.224-06	9.567-09	6.545-01	1.	1.053+01	2.379+01	42.2
85	1	7.676-C2	1.784-24	1.996+00	3.032-01	4.207-04	1.931-01	1.	3.652+00	2.393+01	40.6
	2	8.676-C2	1.919-24	2.102+00	3.149-01	4.474-04	1.941-01	1.	3.663+00	2.395+01	44.6
	3	8.397-C2	1.775-24	2.291+00	3.162-01	4.492-04	2.119-01	1.	3.669+00	2.397+01	46.4
	4	7.399-C2	1.522-24	2.596+00	3.151-01	4.465-04	2.428-01	1.	3.725+00	2.406+01	47.0
	5	6.242-C2	1.137-24	3.143+00	3.131-01	4.420-04	2.936-01	1.	7.889+00	2.405+01	47.3
	6	1.241-C3	1.336-26	4.634+00	3.116-02	4.131-05	8.539-01	1.	1.113+01	2.404+01	46.2
	7	2.040-C5	2.135-28	4.297+00	5.754-04	6.200-07	6.613-01	1.	1.097+01	2.399+01	44.3
	8	4.231-C7	6.815-10	2.935+00	9.223-06	9.561-09	6.545-01	1.	1.053+01	2.379+01	42.2
86	1	7.677-C2	1.784-24	1.996+00	3.032-01	4.206-04	1.931-01	1.	3.652+00	2.393+01	40.6
	2	8.671-C2	1.918-24	2.103+00	3.149-01	4.474-04	1.942-01	1.	3.663+00	2.395+01	44.6
	3	8.394-C2	1.775-24	2.291+00	3.162-01	4.491-04	2.119-01	1.	3.669+00	2.397+01	46.4
	4	7.399-C2	1.521-24	2.596+00	3.151-01	4.465-04	2.429-01	1.	3.725+00	2.406+01	47.0
	5	6.241-C2	1.137-24	3.143+00	3.131-01	4.420-04	2.936-01	1.	7.889+00	2.405+01	47.3
	6	1.240-C3	1.336-26	4.634+00	3.116-02	4.129-05	8.539-01	1.	1.113+01	2.404+01	46.2
	7	2.040-C5	2.135-28	4.297+00	5.754-04	6.196-07	6.613-01	1.	1.097+01	2.399+01	44.3
	8	4.230-C7	6.810-10	2.935+00	9.223-06	9.556-09	6.546-01	1.	1.053+01	2.379+01	42.2
87	1	7.676-C2	1.783-24	1.996+00	3.031-01	4.206-04	1.931-01	1.	3.652+00	2.393+01	40.6
	2	8.669-C2	1.918-24	2.103+00	3.149-01	4.474-04	1.943-01	1.	3.663+00	2.395+01	44.6
	3	8.392-C2	1.774-24	2.292+00	3.162-01	4.491-04	2.120-01	1.	3.669+00	2.397+01	46.4
	4	7.392-C2	1.521-24	2.596+00	3.151-01	4.465-04	2.429-01	1.	3.725+00	2.406+01	47.0
	5	6.241-C2	1.137-24	3.143+00	3.131-01	4.420-04	2.937-01	1.	7.889+00	2.405+01	47.3
	6	1.240-C3	1.335-26	4.635+00	3.116-02	4.129-05	8.539-01	1.	1.113+01	2.404+01	46.2
	7	2.040-C5	2.135-28	4.297+00	5.754-04	6.196-07	6.613-01	1.	1.097+01	2.399+01	44.3
	8	4.229-C7	6.796-10	2.935+00	9.222-06	9.552-09	6.546-01	1.	1.050+01	2.379+01	42.2

99.9 PERCENT OF STEADY STATE BY OVER-LL MATERIAL BALANCE

90.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 27

95.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 37

99.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 58

99.9 PERCENT OF STEADY STATE AFTER TIME INTERVAL 67

SAMPLE OUTPUT: SEPHIS P. 10

CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS INVOLVING INTERACTING SOLUTES
N-FUEL IN COLUMN 8 STAGES
3 INTERACTING SOLUTES

FEED STREAM DATA - AQUEOUS	STAGE NO.	URANIUM (M)	PLUTONIUM (M)	HN03 (M)	FLOW RATE (VOL. UNITS)	TEMP DEG C
	1	3.0000	0.0000	2.0000+00	3.000+00	30.0
	5	1.6500+00	2.5500+03	3.9800+01	4.240+00	50.0
	6	7.0000+02	2.0000+05	8.0000+00	3.240+00	50.0
30.00 % TOP ORGANIC	0	0.0000	0.0000	1.0000+02	2.200+01	40.0

NON-ZERO INITIAL PROFILE	STAGE NO. (OUTFLOW)	URANIUM (M)	AQUEOUS PHASE PLUTONIUM (M)	HN03 (M)	URANIUM (M)	ORGANIC PHASE PLUTONIUM (M)	HN03 (M)	TEMP DEG C
	1	7.8761-02	1.7832-04	1.9902+00	3.0315-01	4.2062-04	1.9338-01	40.0
	2	8.8666-02	1.9175-04	2.1030+00	3.1485-01	4.4736-04	1.9427-01	44.9
	3	8.3921-02	1.7742-04	2.2915+00	3.1015-01	4.4911-04	2.1230-01	46.4
	4	7.3920-02	1.5205-04	2.5984+00	3.1512-01	4.4650-04	2.2248-01	47.0
	5	6.2410-02	1.1370-04	3.1431+00	3.1309-01	4.4195-04	2.4355-01	47.3
	6	1.2404-03	1.3354-06	4.6046+00	3.1159-02	4.1294-05	6.5392-01	46.2
	7	2.0401-05	2.1345-08	4.2070+00	5.7535-03	6.1963-07	8.5137-01	44.3
	8	4.2293-07	6.7963-10	2.9351+00	9.2220-05	9.5519-09	6.5462-01	42.2

PHASE RATIOS DO NOT EQUAL FLOW RATIOS - THEY ARE --- STAGE NO. A/U PHASE RATIO

1 --- 8 --- 2.00+01

STAGE FLOWS (SOLUTE-FREE VOLUMES):

STAGE NO.	FLOW RATIO	FLOW OUT OF STAGE	RECYCLE 2 TO FILL STAGE	RECYCLE 1 FOR PHASE RATIO	TOTAL AQUEOUS FLOW	FLOW OUT OF STAGE	RECYCLE 2 TO FILL STAGE	RECYCLE 1 FOR PHASE RATIO	TOTAL ORGANIC FLOW	OVERALL TOTAL STAGE FLOW	STAGE VOL.
1	1.561-01	3.406+00	5.182+00	9.574-01	9.545+00	2.181+01	2.591+01	0.000	4.772+01	5.727+01	0.000
2	1.561-01	3.406+00	5.182+00	9.574-01	9.545+00	2.181+01	2.591+01	0.000	4.772+01	5.727+01	0.000
3	1.561-01	3.406+00	5.182+00	9.574-01	9.545+00	2.181+01	2.591+01	0.000	4.772+01	5.727+01	0.000
4	1.561-01	3.406+00	5.182+00	9.574-01	9.545+00	2.181+01	2.591+01	0.000	4.772+01	5.727+01	0.000
5	3.249-01	7.027+00	2.458+00	0.000	9.545+00	2.181+01	1.229+01	1.362+01	4.772+01	5.727+01	0.000
6	4.375-01	9.545+00	0.000	0.000	9.545+00	2.181+01	3.000	2.591+01	4.772+01	5.727+01	0.000
7	4.375-01	9.545+00	0.000	0.000	9.545+00	2.181+01	3.000	2.591+01	4.772+01	5.727+01	0.000
8	4.375-01	9.545+00	0.000	0.000	9.545+00	2.181+01	3.000	2.591+01	4.772+01	5.727+01	0.000

TRANSIENT BEHAVIOR RESULTS

SOLUTE CONCENTRATIONS IN EFFLUENT FROM EACH STAGE

TIME	STAGE	URANIUM (M)	PLUTONIUM (M)	HN03 (M)	URANIUM (M)	PLUTONIUM (M)	HN03 (M)	ITERATIONS	FLOW OUT AQUEOUS	FLOW OUT ORGANIC	TEMP DEG C
0	1	7.876-02	1.783-04	1.990+00	3.031-01	4.206-04	1.931-01	0	3.652+00	2.259+01	40.0
	2	8.866-02	1.917-04	2.103+00	3.148-01	4.473-04	1.943-01	0	3.668+00	2.271+01	44.9
	3	8.392-02	1.774-04	2.292+00	3.161-01	4.491-04	2.123-01	0	3.689+00	2.273+01	46.4
	4	7.392-02	1.521-04	2.598+00	3.151-01	4.465-04	2.225-01	0	3.725+00	2.276+01	47.0
	5	6.241-02	1.137-04	3.143+00	3.131-01	4.419-04	2.436-01	0	7.889+00	2.230+01	47.3
	6	1.240-03	1.335-06	4.605+00	3.115-02	4.128-05	6.537-01	0	1.113+01	2.230+01	46.2
	7	2.040-05	2.135-08	4.207+00	5.752-03	6.195-07	8.611-01	0	1.097+01	2.275+01	44.3
	8	4.229-07	6.796-10	2.935+00	9.220-05	9.550-09	6.545-01	0	1.050+01	2.257+01	42.2
1	1	7.857-02	1.780-04	1.996+00	3.029-01	4.200-04	1.931-01	2	3.652+00	2.259+01	40.6
	2	8.864-02	1.917-04	2.102+00	3.148-01	4.472-04	1.941-01	1	3.667+00	2.271+01	44.7
	3	8.390-02	1.774-04	2.290+00	3.161-01	4.491-04	2.117-01	1	3.689+00	2.273+01	46.4
	4	7.393-02	1.521-04	2.594+00	3.151-01	4.465-04	2.242-01	2	3.724+00	2.276+01	47.0
	5	6.081-02	1.221-04	3.121+00	3.191-01	4.501-04	2.845-01	9	7.886+00	2.230+01	47.3
	6	1.274-03	1.170-06	4.607+00	3.115-02	4.229-05	6.537-01	3	1.113+01	2.230+01	46.2
	7	2.086-05	2.172-08	4.221+00	5.892-04	6.345-07	8.639-01	4	1.098+01	2.275+01	44.3
	8	4.274-07	6.611-10	2.972+00	9.447-06	9.781-09	6.619-01	4	1.051+01	2.257+01	42.3
2	1	7.840-02	1.777-04	1.990+00	3.027-01	4.196-04	1.932-01	2	3.652+00	2.259+01	40.5
	2	8.861-02	1.917-04	2.101+00	3.148-01	4.472-04	1.941-01	1	3.667+00	2.271+01	44.7
	3	8.391-02	1.775-04	2.287+00	3.162-01	4.491-04	2.117-01	1	3.689+00	2.273+01	46.4
	4	7.396-02	1.502-04	2.586+00	3.175-01	4.494-04	2.395-01	7	3.724+00	2.276+01	47.0
	5	6.944-02	1.208-04	3.113+00	3.224-01	4.544-04	2.704-01	4	7.885+00	2.231+01	47.3
	6	1.324-03	1.438-06	4.603+00	3.301-02	4.414-05	8.506-01	3	1.113+01	2.230+01	46.3
	7	2.100-05	2.212-08	4.234+00	5.044-04	6.504-07	8.646-01	4	1.098+01	2.275+01	44.4
	8	4.351-07	6.685-10	2.989+00	9.677-06	9.991-09	6.654-01	3	1.052+01	2.257+01	42.3
3	1	7.833-02	1.776-04	1.995+00	3.026-01	4.194-04	1.932-01	1	3.652+00	2.259+01	40.5
	2	8.864-02	1.917-04	2.102+00	3.147-01	4.472-04	1.940-01	1	3.667+00	2.271+01	44.7
	3	8.400-02	1.792-04	2.284+00	3.171-01	4.501-04	2.106-01	5	3.689+00	2.273+01	46.4
	4	7.020-02	1.018-04	2.577+00	3.201-01	4.520-04	2.360-01	7	3.723+00	2.274+01	47.0
	5	7.125-02	1.312-04	3.106+00	3.247-01	4.575-04	2.762-01	7	7.884+00	2.231+01	47.3
	6	1.370-03	1.510-06	4.603+00	3.401-02	4.589-05	8.491-01	3	1.113+01	2.230+01	46.3
	7	2.204-05	2.288-08	4.239+00	5.236-04	6.740-07	8.650-01	3	1.098+01	2.275+01	44.4
	8	4.441-07	6.974-10	3.032+00	9.918-06	1.019-09	6.678-01	3	1.052+01	2.257+01	42.3
4	1	7.826-02	1.775-04	1.995+00	3.025-01	4.192-04	1.932-01	1	3.652+00	2.259+01	40.5
	2	8.864-02	1.922-04	2.076+00	3.151-01	4.475-04	1.938-01	3	3.667+00	2.271+01	44.7
	3	8.025-02	1.021-04	2.279+00	3.185-01	4.517-04	2.088-01	4	3.689+00	2.273+01	46.3
	4	8.043-02	1.052-04	2.569+00	3.274-01	4.555-04	2.320-01	7	3.723+00	2.274+01	47.0
	5	7.243-02	1.320-04	3.130+00	3.203-01	4.599-04	2.736-01	6	7.884+00	2.231+01	47.3
	6	1.400-03	1.554-06	4.601+00	3.485-02	4.740-05	8.476-01	3	1.113+01	2.230+01	46.3
	7	2.213-05	2.275-08	4.242+00	6.443-04	7.007-07	8.654-01	3	1.098+01	2.275+01	44.4
	8	4.559-07	7.140-10	3.027+00	1.070-05	1.047-09	6.687-01	3	1.052+01	2.257+01	42.3

SAMPLE OUTPUT: SEPHIS P. 11

5	1	7.624-C2	1.775-24	1.994+00	3.027-01	4.193-34	1.932-01	1.	3.651+00	2.270+01	40.4
	2	8.975-C2	1.837-24	2.096+00	3.154-01	4.432-34	1.938-01	4.	3.667+00	2.272+01	40.7
	3	8.790-C2	1.870-24	2.174+00	3.203-01	4.537-34	2.067-01	6.	3.688+00	2.274+01	40.3
	4	8.235-C2	1.871-24	2.302+00	3.249-01	4.597-34	2.301-01	6.	3.723+00	2.277+01	47.3
	5	7.370-C2	1.870-24	3.036+00	3.276-01	4.619-34	2.714-01	6.	7.003+00	2.281+01	47.3
	6	1.439-C3	1.870-24	4.027+00	3.562-02	4.809-35	3.463-01	3.	1.113+01	2.280+01	46.3
	7	2.353-C5	2.484-28	4.243+00	6.660-04	7.271-37	8.055-01	2.	1.099+01	2.275+01	44.5
	8	4.099-C7	7.250-10	3.011+00	1.051-05	1.081-06	6.090-01	3.	1.052+01	2.257+01	42.4
6	1	7.040-C2	1.779-24	1.993+00	3.030-01	4.195-34	1.930-01	3.	3.651+00	2.270+01	40.4
	2	9.063-C2	1.830-24	2.093+00	3.169-01	4.432-34	1.916-01	5.	3.667+00	2.272+01	40.7
	3	8.975-C2	1.871-24	2.168+00	3.211-01	4.558-34	2.044-01	6.	3.689+00	2.274+01	40.3
	4	8.404-C2	1.726-24	2.555+00	3.281-01	4.607-34	2.277-01	6.	3.722+00	2.277+01	47.3
	5	7.464-C2	1.870-24	3.022+00	3.256-01	4.635-34	2.792-01	5.	7.003+00	2.281+01	47.3
	6	1.465-C3	1.870-24	4.099+00	3.606-02	4.900-35	3.452-01	3.	1.113+01	2.280+01	46.3
	7	2.417-C5	2.485-28	4.243+00	6.017-04	7.271-37	8.055-01	2.	1.099+01	2.275+01	44.5
	8	4.333-C7	7.035-10	3.012+00	1.044-05	1.119-06	6.090-01	2.	1.052+01	2.257+01	42.4
7	1	7.040-C2	1.779-24	1.992+00	3.036-01	4.200-34	1.924-01	4.	3.651+00	2.270+01	40.4
	2	9.198-C2	1.943-24	2.092+00	3.182-01	4.505-34	1.994-01	5.	3.667+00	2.272+01	40.6
	3	9.151-C2	1.927-24	2.263+00	3.238-01	4.579-34	2.025-01	6.	3.688+00	2.274+01	40.3
	4	8.551-C2	1.757-24	2.584+00	3.276-01	4.625-34	2.258-01	6.	3.722+00	2.277+01	47.3
	5	7.548-C2	1.870-24	3.089+00	3.294-01	4.650-34	2.689-01	5.	7.003+00	2.281+01	47.4
	6	1.485-C3	1.866-26	4.596+00	3.650-02	5.043-35	8.444-01	3.	1.113+01	2.280+01	46.4
	7	2.472-C5	2.613-28	4.243+00	6.970-04	7.272-37	8.054-01	2.	1.099+01	2.275+01	44.5
	8	4.979-C7	7.000-10	3.013+00	1.115-05	1.157-06	6.708-01	2.	1.052+01	2.257+01	42.4
8	1	7.040-C2	1.779-24	1.991+00	3.045-01	4.207-34	1.916-01	4.	3.651+00	2.270+01	40.4
	2	9.238-C2	2.113-24	2.086+00	3.196-01	4.520-34	1.859-01	5.	3.667+00	2.272+01	40.6
	3	9.319-C2	1.901-24	2.250+00	3.253-01	4.600-34	2.006-01	6.	3.688+00	2.274+01	40.3
	4	8.068-C2	1.735-24	2.544+00	3.288-01	4.647-34	2.236-01	6.	3.722+00	2.277+01	47.1
	5	7.024-C2	1.870-24	3.086+00	3.300-01	4.661-34	2.678-01	5.	7.003+00	2.281+01	47.4
	6	1.502-C3	1.891-26	4.596+00	3.686-02	5.112-35	8.437-01	3.	1.113+01	2.280+01	46.4
	7	2.519-C5	2.651-28	4.242+00	7.099-04	7.912-37	8.053-01	2.	1.098+01	2.275+01	44.5
	8	5.109-C7	6.116-10	3.013+00	1.145-05	1.193-06	6.790-01	2.	1.052+01	2.257+01	42.4
9	1	8.049-C2	1.620-24	1.989+00	3.055-01	4.216-34	1.906-01	5.	3.651+00	2.270+01	40.4
	2	9.475-C2	2.741-24	2.082+00	3.210-01	4.530-34	1.674-01	5.	3.667+00	2.272+01	40.6
	3	9.477-C2	1.594-24	2.252+00	3.267-01	4.620-34	1.985-01	6.	3.688+00	2.274+01	40.3
	4	8.788-C2	1.678-24	2.533+00	3.294-01	4.665-34	2.224-01	5.	3.721+00	2.277+01	47.1
	5	7.053-C2	1.436-24	3.093+00	3.306-01	4.671-34	2.670-01	4.	7.003+00	2.281+01	47.4
	6	1.518-C3	1.713-26	4.595+00	3.716-02	5.170-35	8.438-01	3.	1.113+01	2.280+01	46.4
	7	2.558-C5	2.736-28	4.241+00	7.208-04	8.070-37	8.051-01	2.	1.098+01	2.275+01	44.5
	8	5.220-C7	6.335-10	3.012+00	1.170-05	1.220-06	6.699-01	2.	1.052+01	2.257+01	42.4
10	1	8.141-C2	1.639-24	1.997+00	3.066-01	4.226-34	1.695-01	5.	3.651+00	2.270+01	40.4
	2	9.619-C2	2.571-24	2.079+00	3.224-01	4.553-34	1.859-01	5.	3.667+00	2.272+01	40.6
	3	9.611-C2	2.723-24	2.247+00	3.280-01	4.639-34	1.973-01	5.	3.688+00	2.274+01	40.3
	4	8.265-C2	1.520-24	2.531+00	3.307-01	4.640-34	2.211-01	5.	3.721+00	2.277+01	47.1
	5	7.698-C2	1.415-24	3.066+00	3.310-01	4.680-34	2.662-01	4.	7.003+00	2.281+01	47.4
	6	1.528-C3	1.731-26	4.594+00	3.740-02	5.216-35	8.425-01	3.	1.113+01	2.280+01	46.4
	7	2.591-C5	2.763-28	4.240+00	7.299-04	8.205-37	8.050-01	2.	1.098+01	2.275+01	44.5
	8	5.329-C7	6.541-10	3.011+00	1.193-05	1.256-06	6.697-01	2.	1.052+01	2.257+01	42.4
11	1	8.239-C2	1.660-24	1.985+00	3.078-01	4.238-34	1.684-01	5.	3.652+00	2.270+01	40.4
	2	9.758-C2	2.131-24	2.070+00	3.236-01	4.570-34	1.645-01	5.	3.667+00	2.272+01	40.6
	3	9.740-C2	2.551-24	2.243+00	3.291-01	4.657-34	1.959-01	5.	3.687+00	2.274+01	40.3
	4	8.971-C2	1.648-24	2.535+00	3.314-01	4.693-34	2.193-01	5.	3.721+00	2.277+01	47.1
	5	7.731-C2	1.422-24	3.178+00	3.314-01	4.687-34	2.656-01	4.	7.003+00	2.281+01	47.4
	6	1.535-C3	1.747-26	4.593+00	3.781-02	5.239-35	8.428-01	3.	1.112+01	2.280+01	46.4
	7	2.618-C5	2.623-28	4.239+00	7.374-04	8.319-37	8.045-01	2.	1.098+01	2.275+01	44.5
	8	5.418-C7	6.723-10	3.011+00	1.212-05	1.282-06	6.695-01	2.	1.052+01	2.257+01	42.4
12	1	8.337-C2	1.581-24	1.983+00	3.089-01	4.251-34	1.873-01	5.	3.652+00	2.270+01	40.4
	2	9.890-C2	2.129-24	2.072+00	3.248-01	4.587-34	1.832-01	5.	3.667+00	2.272+01	40.6
	3	9.856-C2	2.776-24	2.233+00	3.300-01	4.673-34	1.944-01	5.	3.687+00	2.274+01	40.3
	4	9.040-C2	1.664-24	2.520+00	3.320-01	4.705-34	2.190-01	4.	3.720+00	2.277+01	47.1
	5	7.763-C2	1.429-24	3.070+00	3.317-01	4.693-34	2.659-01	3.	7.003+00	2.281+01	47.4
	6	1.545-C3	1.760-26	4.591+00	3.777-02	5.293-35	8.416-01	3.	1.112+01	2.280+01	46.4
	7	2.641-C5	2.658-28	4.237+00	7.437-04	8.415-37	8.046-01	2.	1.098+01	2.275+01	44.5
	8	5.494-C7	6.884-10	3.010+00	1.229-05	1.305-06	6.693-01	2.	1.052+01	2.257+01	42.4
13	1	8.434-C2	1.932-24	1.982+00	3.100-01	4.264-34	1.863-01	5.	3.652+00	2.270+01	40.4
	2	1.051-C1	2.156-04	2.069+00	3.259-01	4.604-34	1.620-01	5.	3.667+00	2.272+01	40.6
	3	9.961-C2	2.799-24	2.235+00	3.309-01	4.688-34	1.935-01	5.	3.687+00	2.274+01	40.3
	4	9.105-C2	1.678-04	2.522+00	3.326-01	4.715-34	2.161-01	4.	3.720+00	2.277+01	47.1
	5	7.791-C2	1.435-04	3.074+00	3.320-01	4.699-34	2.645-01	3.	7.003+00	2.281+01	47.4
	6	1.552-C3	1.771-06	4.592+00	3.791-02	5.322-05	8.413-01	2.	1.112+01	2.280+01	46.4
	7	2.661-C5	2.687-08	4.236+00	7.489-04	8.497-07	8.045-01	2.	1.098+01	2.275+01	44.5
	8	5.559-C7	9.724-10	3.039+00	1.243-05	1.325-06	6.691-01	2.	1.052+01	2.257+01	42.4
14	1	8.526-C2	1.922-24	1.980+00	3.110-01	4.278-34	1.852-01	5.	3.652+00	2.270+01	40.4
	2	1.013-C1	2.181-04	2.060+00	3.269-01	4.620-34	1.809-01	5.	3.667+00	2.272+01	40.6
	3	1.055-C1	2.120-04	2.231+00	3.316-01	4.702-34	1.925-01	5.	3.687+00	2.274+01	40.3
	4	9.162-C2	1.691-04	2.519+00	3.330-01	4.724-34	2.174-01	4.	3.720+00	2.277+01	47.1
	5	7.816-C2	1.440-04	3.072+00	3.322-01	4.703-34	2.641-01	3.	7.003+00	2.281+01	47.4
	6	1.558-C3	1.781-06	4.589+00	3.803-02	5.347-05	8.410-01	2.	1.112+01	2.280+01	46.4
	7	2.677-C5	2.713-08	4.235+00	7.532-04	8.567-07	8.043-01	2.	1.098+01	2.275+01	44.5
	8	5.614-C7	9.145-10	3.000+00	1.254-05	1.342-06	6.689-01	2.	1.052+01	2.257+01	42.4
15	1	8.612-C2	1.942-04	1.970+00	3.130-01	4.291-34	1.843-01	5.	3.652+00	2.270+01	40.4
	2	1.023-C1	2.214-04	2.063+00	3.277-01	4.634-34	1.787-01	5.	3.667+00	2.273+01	40.6
	3	1.013-C1	2.138-04	2.222+00	3.323-01	4.714-34	1.914-01	5.	3.687+00	2.274+01	40.3
	4	9.212-C2	1.713-04	2.510+00	3.334-01	4.732-34	2.167-01	4.	3.720+00	2.277+01	47.1
	5	7.037-C2	1.445-04	3.071+00	3.324-01	4.707-34	2.647-01	3.	7.003+00	2.281+01	47.4
	6	1.563-C3	1.789-06	4.580+00	3.814-02	5.370-05	8.407-01	2.	1.112+01	2.280+01	46.4
	7	2.690-C5	2.735-08	4.233+00	7.560-04	8.627-07	8.041-01	2.	1.098+01	2.275+01	44.5
	8	5.680-C7	9.651-10	3.007+00	1.264-05	1.357-06	6.687-01	2.	1.052+01	2.257+01	42.4

SAMPLE OUTPUT: SEPHIS P. 12

16	1	8.088-02	1.950-04	1.970+00	3.129-01	4.303-00	1.835-01	4.	3.652+00	2.276+01	40.4
	2	1.012-01	2.220-04	2.250+00	3.285-01	4.004-00	1.770-01	5.	3.667+00	2.273+01	40.7
	3	1.071-01	2.180-04	2.220+00	3.325-01	4.730-00	1.908-01	4.	3.686+00	2.274+01	40.4
	4	9.281-02	1.910-04	2.010+00	3.437-01	4.730-00	2.161-01	3.	3.719+00	2.277+01	47.1
	5	7.655-02	1.450-04	3.060+00	3.325-01	4.711-00	2.034-01	3.	7.879+00	2.281+01	47.4
	6	1.507-03	1.797-04	4.037+00	3.325-01	5.300-00	2.005-01	2.	1.112+01	2.280+01	46.5
17	1	8.761-02	1.976-04	1.970+00	3.130-01	4.310-00	1.827-01	4.	3.652+00	2.276+01	40.4
	2	1.048-01	2.240-04	2.250+00	3.292-01	4.001-00	1.743-01	4.	3.667+00	2.273+01	40.7
	3	1.027-01	2.169-04	2.222+00	3.333-01	4.730-00	1.901-01	4.	3.686+00	2.274+01	40.4
	4	9.289-02	1.921-04	2.010+00	3.348-01	4.730-00	2.156-01	3.	3.719+00	2.277+01	47.1
	5	7.662-02	1.450-04	3.060+00	3.327-01	4.711-00	2.031-01	3.	7.879+00	2.281+01	47.4
	6	1.571-03	1.804-04	4.030+00	3.336-01	5.400-00	2.003-01	2.	1.112+01	2.280+01	46.5
18	1	8.761-02	1.976-04	1.970+00	3.130-01	4.310-00	1.827-01	4.	3.652+00	2.276+01	40.4
	2	1.048-01	2.240-04	2.250+00	3.292-01	4.001-00	1.743-01	4.	3.667+00	2.273+01	40.7
	3	1.027-01	2.169-04	2.222+00	3.333-01	4.730-00	1.901-01	4.	3.686+00	2.274+01	40.4
	4	9.289-02	1.921-04	2.010+00	3.348-01	4.730-00	2.156-01	3.	3.719+00	2.277+01	47.1
	5	7.662-02	1.450-04	3.060+00	3.327-01	4.711-00	2.031-01	3.	7.879+00	2.281+01	47.4
	6	1.571-03	1.804-04	4.030+00	3.336-01	5.400-00	2.003-01	2.	1.112+01	2.280+01	46.5
19	1	8.869-02	2.036-04	1.972+00	3.140-01	4.337-00	1.814-01	4.	3.652+00	2.276+01	40.4
	2	1.055-01	2.277-04	2.253+00	3.303-01	4.063-00	1.769-01	4.	3.666+00	2.273+01	40.7
	3	1.033-01	2.195-04	2.210+00	3.341-01	4.750-00	1.859-01	4.	3.686+00	2.274+01	40.4
	4	9.355-02	1.936-04	2.009+00	3.345-01	4.750-00	2.146-01	3.	3.719+00	2.277+01	47.1
	5	7.853-02	1.457-04	3.065+00	3.328-01	4.715-00	2.026-01	3.	7.878+00	2.281+01	47.4
	6	1.577-03	1.814-04	4.034+00	3.342-01	5.431-00	2.009-01	2.	1.112+01	2.280+01	46.5
20	1	8.942-02	2.019-04	1.971+00	3.155-01	4.347-00	1.808-01	4.	3.652+00	2.276+01	40.4
	2	1.061-01	2.291-04	2.251+00	3.308-01	4.092-00	1.763-01	4.	3.666+00	2.273+01	40.7
	3	1.043-01	2.234-04	2.214+00	3.344-01	4.759-00	1.865-01	3.	3.686+00	2.274+01	40.4
	4	9.383-02	1.942-04	2.003+00	3.347-01	4.759-00	2.133-01	3.	3.719+00	2.277+01	47.1
	5	7.921-02	1.460-04	3.064+00	3.330-01	4.723-00	2.025-01	3.	7.878+00	2.281+01	47.4
	6	1.579-03	1.818-04	4.034+00	3.346-01	5.440-00	2.009-01	2.	1.112+01	2.280+01	46.5
21	1	8.990-02	2.031-04	1.970+00	3.159-01	4.350-00	1.803-01	4.	3.652+00	2.276+01	40.4
	2	1.066-01	2.304-04	2.254+00	3.312-01	4.700-00	1.758-01	4.	3.666+00	2.273+01	40.7
	3	1.047-01	2.213-04	2.211+00	3.347-01	4.760-00	1.820-01	3.	3.686+00	2.274+01	40.4
	4	9.404-02	1.948-04	2.001+00	3.350-01	4.760-00	2.122-01	3.	3.719+00	2.277+01	47.1
	5	7.926-02	1.461-04	3.063+00	3.330-01	4.722-00	2.023-01	3.	7.878+00	2.281+01	47.4
	6	1.581-03	1.822-04	4.038+00	3.351-01	5.451-00	2.009-01	2.	1.112+01	2.280+01	46.5
22	1	9.028-02	2.041-04	1.960+00	3.164-01	4.364-00	1.800-01	4.	3.652+00	2.276+01	40.4
	2	1.079-01	2.314-04	2.254+00	3.316-01	4.708-00	1.754-01	3.	3.666+00	2.273+01	40.7
	3	1.053-01	2.222-04	2.209+00	3.349-01	4.769-00	1.876-01	3.	3.686+00	2.274+01	40.4
	4	9.425-02	1.952-04	2.009+00	3.350-01	4.765-00	2.136-01	3.	3.718+00	2.277+01	47.1
	5	7.919-02	1.460-04	3.062+00	3.331-01	4.723-00	2.021-01	3.	7.877+00	2.281+01	47.5
	6	1.583-03	1.825-04	4.042+00	3.354-01	5.454-00	2.009-01	2.	1.112+01	2.280+01	46.5
23	1	9.066-02	2.050-04	1.960+00	3.167-01	4.372-00	1.796-01	3.	3.652+00	2.276+01	40.4
	2	1.079-01	2.324-04	2.254+00	3.319-01	4.715-00	1.750-01	3.	3.666+00	2.273+01	40.7
	3	1.054-01	2.230-04	2.200+00	3.351-01	4.774-00	1.872-01	3.	3.686+00	2.274+01	40.4
	4	9.443-02	1.956-04	2.009+00	3.351-01	4.767-00	2.144-01	3.	3.718+00	2.277+01	47.1
	5	7.924-02	1.460-04	3.061+00	3.332-01	4.724-00	2.019-01	3.	7.877+00	2.281+01	47.5
	6	1.585-03	1.823-04	4.042+00	3.354-01	5.467-00	2.009-01	2.	1.112+01	2.280+01	46.5
24	1	9.109-02	2.059-04	1.967+00	3.171-01	4.378-00	1.792-01	3.	3.652+00	2.276+01	40.4
	2	1.079-01	2.333-04	2.254+00	3.321-01	4.721-00	1.746-01	3.	3.666+00	2.273+01	40.7
	3	1.057-01	2.237-04	2.200+00	3.353-01	4.776-00	1.869-01	3.	3.686+00	2.274+01	40.4
	4	9.464-02	1.960-04	2.009+00	3.352-01	4.773-00	2.131-01	3.	3.718+00	2.277+01	47.1
	5	7.937-02	1.467-04	3.062+00	3.332-01	4.726-00	2.018-01	3.	7.877+00	2.281+01	47.5
	6	1.586-03	1.831-04	4.041+00	3.356-01	5.473-00	2.009-01	2.	1.112+01	2.280+01	46.5
25	1	9.150-02	2.073-04	1.965+00	3.174-01	4.383-00	1.796-01	3.	3.652+00	2.276+01	40.4
	2	1.079-01	2.349-04	2.254+00	3.324-01	4.731-00	1.740-01	3.	3.666+00	2.273+01	40.7
	3	1.061-01	2.240-04	2.200+00	3.350-01	4.765-00	1.863-01	3.	3.686+00	2.274+01	40.4
	4	9.486-02	1.964-04	2.009+00	3.350-01	4.774-00	2.126-01	3.	3.718+00	2.277+01	47.1
	5	7.944-02	1.469-04	3.064+00	3.333-01	4.727-00	2.017-01	3.	7.877+00	2.281+01	47.5
	6	1.587-03	1.834-04	4.040+00	3.363-01	5.479-00	2.009-01	2.	1.112+01	2.280+01	46.5
26	1	9.150-02	2.073-04	1.965+00	3.174-01	4.383-00	1.796-01	3.	3.652+00	2.276+01	40.4
	2	1.079-01	2.349-04	2.254+00	3.324-01	4.731-00	1.740-01	3.	3.666+00	2.273+01	40.7
	3	1.061-01	2.240-04	2.200+00	3.350-01	4.765-00	1.863-01	3.	3.686+00	2.274+01	40.4
	4	9.486-02	1.964-04	2.009+00	3.350-01	4.774-00	2.126-01	3.	3.718+00	2.277+01	47.1
	5	7.944-02	1.469-04	3.064+00	3.333-01	4.727-00	2.017-01	3.	7.877+00	2.281+01	47.5
	6	1.587-03	1.834-04	4.040+00	3.363-01	5.479-00	2.009-01	2.	1.112+01	2.280+01	46.5

SAMPLE OUTPUT: SEPHIS P. 13

6	1.588e-03	1.838e-04	4.582e-03	3.265e-02	5.499e-03	3.391e-01	1.	1.112e+01	2.278e+01	46.5	
7	2.750e-05	3.750e-08	4.224e-03	7.747e-04	6.942e-07	5.659e-11	2.	1.098e+01	2.275e+01	44.7	
8	5.537e-07	9.332e-10	2.995e-03	1.316e-05	1.453e-06	6.671e-11	2.	1.052e+01	2.257e+01	42.5	
21	1	9.175e-02	2.373e-04	1.964e-03	3.137e-01	4.394e-04	1.780e-01	2.	3.652e+00	2.271e+01	40.4
2	1.537e-01	2.355e-04	2.941e-03	3.330e-01	4.733e-04	1.733e-01	2.	3.666e+00	2.273e+01	44.7	
3	1.555e-01	2.351e-04	2.821e-03	3.350e-01	4.730e-04	1.653e-01	2.	3.684e+00	2.275e+01	46.5	
4	9.533e-02	1.971e-04	2.491e-03	3.350e-01	4.775e-04	2.123e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.446e-02	1.471e-04	3.050e-03	3.333e-01	4.728e-04	2.610e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.539e-01	1.334e-04	4.570e-03	3.267e-02	5.499e-03	3.391e-01	2.	1.112e+01	2.278e+01	46.5	
7	2.750e-05	3.750e-08	4.224e-03	7.747e-04	6.942e-07	5.659e-11	2.	1.098e+01	2.275e+01	44.7	
8	5.537e-07	9.332e-10	2.995e-03	1.316e-05	1.453e-06	6.671e-11	2.	1.052e+01	2.257e+01	42.5	
26	1	9.195e-02	2.363e-04	1.964e-03	3.130e-01	4.398e-04	1.782e-01	2.	3.652e+00	2.271e+01	40.4
2	1.538e-01	2.355e-04	2.939e-03	3.330e-01	4.733e-04	1.733e-01	2.	3.666e+00	2.273e+01	44.7	
3	1.555e-01	2.350e-04	2.821e-03	3.350e-01	4.730e-04	1.653e-01	2.	3.684e+00	2.275e+01	46.5	
4	9.515e-02	1.971e-04	2.491e-03	3.355e-01	4.777e-04	2.123e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.515e-02	1.472e-04	3.057e-03	3.334e-01	4.729e-04	2.610e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.539e-01	1.334e-04	4.570e-03	3.269e-02	5.499e-03	3.391e-01	1.	1.112e+01	2.278e+01	46.5	
7	2.750e-05	3.750e-08	4.224e-03	7.747e-04	6.942e-07	5.659e-11	2.	1.098e+01	2.275e+01	44.7	
8	5.537e-07	9.332e-10	2.997e-03	1.313e-05	1.453e-06	6.669e-11	2.	1.052e+01	2.257e+01	42.5	
29	1	9.214e-02	2.385e-04	1.963e-03	3.132e-01	4.402e-04	1.780e-01	2.	3.652e+00	2.271e+01	40.4
2	1.532e-01	2.364e-04	2.933e-03	3.330e-01	4.742e-04	1.733e-01	2.	3.666e+00	2.273e+01	44.7	
3	1.557e-01	2.361e-04	2.193e-03	3.350e-01	4.792e-04	1.653e-01	2.	3.684e+00	2.275e+01	46.5	
4	9.519e-02	1.974e-04	2.469e-03	3.356e-01	4.778e-04	2.121e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.559e-02	1.473e-04	3.057e-03	3.334e-01	4.727e-04	2.613e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.531e-01	1.342e-04	4.574e-03	3.267e-02	5.498e-03	3.391e-01	1.	1.112e+01	2.278e+01	46.5	
7	2.754e-05	3.178e-08	4.221e-03	7.743e-04	6.976e-07	5.627e-11	2.	1.098e+01	2.275e+01	44.5	
8	5.509e-07	9.362e-10	2.997e-03	1.314e-05	1.442e-06	6.668e-11	2.	1.052e+01	2.257e+01	42.5	
30	1	9.231e-02	2.392e-04	1.963e-03	3.133e-01	4.405e-04	1.779e-01	2.	3.652e+00	2.271e+01	40.4
2	1.534e-01	2.369e-04	2.933e-03	3.332e-01	4.744e-04	1.731e-01	2.	3.666e+00	2.273e+01	44.7	
3	1.555e-01	2.362e-04	2.197e-03	3.351e-01	4.794e-04	1.655e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.535e-02	1.977e-04	2.485e-03	3.356e-01	4.779e-04	2.120e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.559e-02	1.476e-04	3.050e-03	3.334e-01	4.730e-04	2.612e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.531e-01	1.344e-04	4.573e-03	3.272e-02	5.502e-03	3.382e-01	1.	1.112e+01	2.279e+01	46.5	
7	2.750e-05	3.174e-08	4.221e-03	7.743e-04	6.995e-07	5.626e-11	2.	1.098e+01	2.275e+01	44.5	
8	5.515e-07	9.936e-10	2.990e-03	1.315e-05	1.444e-06	6.667e-11	2.	1.052e+01	2.257e+01	42.5	
31	1	9.245e-02	2.396e-04	1.963e-03	3.134e-01	4.408e-04	1.777e-01	2.	3.652e+00	2.271e+01	40.4
2	1.536e-01	2.373e-04	2.937e-03	3.333e-01	4.747e-04	1.730e-01	2.	3.666e+00	2.273e+01	44.7	
3	1.570e-01	2.366e-04	2.190e-03	3.361e-01	4.796e-04	1.653e-01	2.	3.684e+00	2.275e+01	46.5	
4	9.541e-02	1.979e-04	2.487e-03	3.356e-01	4.783e-04	2.118e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.553e-02	1.475e-04	3.050e-03	3.334e-01	4.731e-04	2.611e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.533e-01	1.345e-04	4.573e-03	3.274e-02	5.506e-03	3.387e-01	1.	1.112e+01	2.280e+01	46.5	
7	2.756e-05	3.177e-08	4.221e-03	7.772e-04	6.994e-07	5.626e-11	2.	1.098e+01	2.275e+01	44.5	
8	5.520e-07	9.923e-10	2.990e-03	1.316e-05	1.446e-06	6.666e-11	2.	1.052e+01	2.257e+01	42.5	
32	1	9.259e-02	2.399e-04	1.962e-03	3.135e-01	4.410e-04	1.776e-01	2.	3.652e+00	2.271e+01	40.4
2	1.536e-01	2.375e-04	2.930e-03	3.334e-01	4.749e-04	1.728e-01	1.	3.665e+00	2.273e+01	44.7	
3	1.571e-01	2.368e-04	2.195e-03	3.362e-01	4.797e-04	1.652e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.546e-02	1.980e-04	2.485e-03	3.357e-01	4.781e-04	2.117e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.550e-02	1.476e-04	3.055e-03	3.334e-01	4.731e-04	2.611e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.533e-01	1.346e-04	4.577e-03	3.275e-02	5.509e-03	3.387e-01	1.	1.112e+01	2.280e+01	46.5	
7	2.759e-05	3.180e-08	4.222e-03	7.776e-04	6.993e-07	5.625e-11	1.	1.098e+01	2.275e+01	44.5	
8	5.525e-07	9.938e-10	2.995e-03	1.317e-05	1.448e-06	6.665e-11	2.	1.052e+01	2.257e+01	42.5	
33	1	9.265e-02	2.411e-04	1.962e-03	3.136e-01	4.412e-04	1.775e-01	1.	3.652e+00	2.271e+01	40.4
2	1.538e-01	2.379e-04	2.935e-03	3.334e-01	4.751e-04	1.727e-01	2.	3.665e+00	2.273e+01	44.7	
3	1.572e-01	2.370e-04	2.194e-03	3.362e-01	4.799e-04	1.650e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.555e-02	1.982e-04	2.485e-03	3.357e-01	4.782e-04	2.116e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.570e-02	1.476e-04	3.055e-03	3.335e-01	4.731e-04	2.610e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.534e-01	1.348e-04	4.577e-03	3.275e-02	5.512e-03	3.386e-01	1.	1.112e+01	2.280e+01	46.5	
7	2.771e-05	3.184e-08	4.222e-03	7.780e-04	6.991e-07	5.624e-11	2.	1.098e+01	2.275e+01	44.5	
8	5.530e-07	9.951e-10	2.995e-03	1.318e-05	1.450e-06	6.665e-11	2.	1.052e+01	2.257e+01	42.5	
34	1	9.273e-02	2.413e-04	1.961e-03	3.137e-01	4.414e-04	1.774e-01	1.	3.652e+00	2.271e+01	40.4
2	1.539e-01	2.382e-04	2.935e-03	3.335e-01	4.753e-04	1.726e-01	1.	3.665e+00	2.273e+01	44.7	
3	1.573e-01	2.372e-04	2.194e-03	3.363e-01	4.800e-04	1.649e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.562e-02	1.983e-04	2.484e-03	3.357e-01	4.782e-04	2.115e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.573e-02	1.477e-04	3.055e-03	3.335e-01	4.732e-04	2.609e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.534e-01	1.349e-04	4.577e-03	3.276e-02	5.515e-03	3.386e-01	1.	1.112e+01	2.280e+01	46.5	
7	2.772e-05	3.187e-08	4.222e-03	7.783e-04	6.998e-07	5.624e-11	1.	1.098e+01	2.275e+01	44.5	
8	5.534e-07	9.965e-10	2.995e-03	1.319e-05	1.451e-06	6.664e-11	2.	1.052e+01	2.257e+01	42.5	
35	1	9.282e-02	2.415e-04	1.961e-03	3.138e-01	4.416e-04	1.773e-01	1.	3.652e+00	2.271e+01	40.4
2	1.540e-01	2.384e-04	2.934e-03	3.336e-01	4.754e-04	1.725e-01	1.	3.665e+00	2.273e+01	44.7	
3	1.574e-01	2.374e-04	2.194e-03	3.363e-01	4.801e-04	1.648e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.568e-02	1.985e-04	2.485e-03	3.354e-01	4.783e-04	2.114e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.575e-02	1.478e-04	3.054e-03	3.335e-01	4.732e-04	2.609e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.535e-01	1.350e-04	4.576e-03	3.277e-02	5.518e-03	3.385e-01	1.	1.112e+01	2.280e+01	46.5	
7	2.773e-05	3.190e-08	4.219e-03	7.787e-04	6.992e-07	5.623e-11	1.	1.098e+01	2.275e+01	44.5	
8	5.535e-07	9.977e-10	2.795e-03	1.320e-05	1.453e-06	6.663e-11	2.	1.052e+01	2.257e+01	42.5	
36	1	9.290e-02	2.417e-04	1.961e-03	3.139e-01	4.418e-04	1.772e-01	1.	3.652e+00	2.271e+01	40.4
2	1.541e-01	2.386e-04	2.933e-03	3.334e-01	4.756e-04	1.724e-01	1.	3.665e+00	2.273e+01	44.7	
3	1.575e-01	2.376e-04	2.192e-03	3.364e-01	4.802e-04	1.647e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.574e-02	1.986e-04	2.482e-03	3.354e-01	4.783e-04	2.113e-01	1.	3.717e+00	2.277e+01	47.2	
5	7.570e-02	1.478e-04	3.054e-03	3.335e-01	4.732e-04	2.608e-01	1.	7.876e+00	2.281e+01	47.5	
6	1.535e-01	1.351e-04	4.576e-03	3.278e-02	5.521e-03	3.385e-01	1.	1.112e+01	2.280e+01	46.5	
7	2.774e-05	3.192e-08	4.219e-03	7.789e-04	6.991e-07	5.623e-11	1.	1.098e+01	2.275e+01	44.5	
8	5.541e-07	9.987e-10	2.594e-03	1.320e-05	1.454e-06	6.663e-11	1.	1.052e+01	2.257e+01	42.5	
37	1	9.297e-02	2.419e-04	1.961e-03	3.140e-01	4.419e-04	1.772e-01	1.	3.652e+00	2.271e+01	40.4
2	1.542e-01	2.388e-04	2.933e-03	3.337e-01	4.757e-04	1.723e-01	1.	3.665e+00	2.273e+01	44.7	
3	1.576e-01	2.378e-04	2.191e-03	3.364e-01	4.804e-04	1.646e-01	1.	3.684e+00	2.275e+01	46.5	
4	9.580e-02	1.990e-04	2.482e-03	3.354e-01	4.784e-04	2.112e-01	1.	3.717e+00	2.277e+01	47.2	

SAMPLE OUTPUT: SEPHIS P. 14

	5	7.930-02	1.479-04	3.353+00	3.335-01	4.733-04	2.408-01	1.	7.875+00	2.281+01	47.5
	6	1.506-03	1.852-06	4.576+00	3.881-02	5.533-05	8.385-01	1.	1.112+01	2.240+01	46.5
	7	2.776-05	3.795-08	4.214+00	7.702-04	9.437-07	6.623-01	1.	1.098+01	2.275+01	46.5
	8	5.945-07	9.999-10	2.994+00	1.321-05	1.456-05	6.662-01	2.	1.052+01	2.257+01	42.5
36	1	9.334-02	2.111-04	1.966+00	3.196-01	4.422-04	1.771-01	1.	3.652+00	2.271+01	46.4
	2	1.103-01	2.396-04	2.032+00	3.337-01	4.761-04	1.722-01	1.	3.665+00	2.273+01	46.7
	3	1.076-01	2.263-04	2.190+00	3.364-01	4.803-04	1.845-01	1.	3.684+00	2.274+01	46.5
	4	9.586-02	1.969-04	2.471+00	3.358-01	4.786-04	2.111-01	1.	3.716+00	2.277+01	47.2
	5	7.982-02	1.479-04	3.053+00	3.335-01	4.733-04	2.607-01	1.	7.875+00	2.281+01	47.5
	6	1.596-03	1.853-06	4.576+00	3.882-02	5.532-05	8.354-01	1.	1.112+01	2.280+01	46.5
	7	2.777-05	3.797-08	4.218+00	7.705-04	9.442-07	6.622-01	1.	1.098+01	2.275+01	46.5
	8	5.947-07	1.031-09	2.994+00	1.321-05	1.457-05	6.662-01	1.	1.052+01	2.257+01	42.5
39	1	9.316-02	2.112-04	1.966+00	3.196-01	4.421-04	1.770-01	1.	3.652+00	2.271+01	46.4
	2	1.104-01	2.391-04	2.032+00	3.334-01	4.758-04	1.721-01	1.	3.665+00	2.273+01	46.7
	3	1.077-01	2.261-04	2.190+00	3.365-01	4.804-04	1.844-01	1.	3.684+00	2.274+01	46.5
	4	9.591-02	1.990-04	2.466+00	3.359-01	4.785-04	2.110-01	1.	3.716+00	2.277+01	47.2
	5	7.984-02	1.480-04	3.053+00	3.336-01	4.733-04	2.607-01	1.	7.875+00	2.281+01	47.5
	6	1.597-03	1.854-06	4.575+00	3.882-02	5.527-05	8.364-01	1.	1.112+01	2.280+01	46.5
	7	2.778-05	3.799-08	4.218+00	7.707-04	9.446-07	6.622-01	1.	1.098+01	2.275+01	46.5
	8	5.950-07	1.032-09	2.994+00	1.322-05	1.458-05	6.661-01	1.	1.052+01	2.257+01	42.5
40	1	9.316-02	2.113-04	1.966+00	3.196-01	4.422-04	1.770-01	1.	3.652+00	2.271+01	46.4
	2	1.104-01	2.393-04	2.032+00	3.334-01	4.759-04	1.721-01	1.	3.665+00	2.273+01	46.7
	3	1.075-01	2.263-04	2.189+00	3.365-01	4.804-04	1.843-01	1.	3.684+00	2.274+01	46.5
	4	9.590-02	1.991-04	2.466+00	3.359-01	4.785-04	2.109-01	1.	3.716+00	2.277+01	47.2
	5	7.980-02	1.480-04	3.053+00	3.336-01	4.734-04	2.605-01	1.	7.875+00	2.281+01	47.5
	6	1.597-03	1.855-06	4.575+00	3.883-02	5.529-05	8.364-01	1.	1.112+01	2.280+01	46.5
	7	2.775-05	3.131-08	4.218+00	7.709-04	9.052-07	8.622-01	1.	1.098+01	2.275+01	46.5
	8	5.953-07	1.033-09	2.993+00	1.322-05	1.459-05	6.661-01	1.	1.052+01	2.257+01	42.5
41	1	9.321-02	2.115-04	1.966+00	3.191-01	4.422-04	1.769-01	1.	3.652+00	2.271+01	46.4
	2	1.105-01	2.394-04	2.031+00	3.334-01	4.760-04	1.720-01	1.	3.665+00	2.273+01	46.7
	3	1.079-01	2.264-04	2.189+00	3.365-01	4.805-04	1.843-01	1.	3.684+00	2.274+01	46.5
	4	9.600-02	1.992-04	2.479+00	3.359-01	4.786-04	2.109-01	1.	3.716+00	2.277+01	47.2
	5	7.986-02	1.481-04	3.052+00	3.336-01	4.734-04	2.606-01	1.	7.875+00	2.281+01	47.5
	6	1.596-03	1.856-06	4.575+00	3.884-02	5.531-05	8.383-01	1.	1.112+01	2.280+01	46.5
	7	2.779-05	3.133-08	4.218+00	7.801-04	9.057-07	8.621-01	1.	1.098+01	2.275+01	46.5
	8	5.955-07	1.033-09	2.993+00	1.323-05	1.460-05	6.660-01	1.	1.052+01	2.257+01	42.5
42	1	9.325-02	2.116-04	1.966+00	3.191-01	4.423-04	1.768-01	1.	3.652+00	2.271+01	46.4
	2	1.106-01	2.396-04	2.031+00	3.334-01	4.760-04	1.719-01	1.	3.665+00	2.273+01	46.7
	3	1.079-01	2.286-04	2.189+00	3.365-01	4.805-04	1.842-01	1.	3.684+00	2.274+01	46.5
	4	9.604-02	1.993-04	2.479+00	3.359-01	4.786-04	2.108-01	1.	3.716+00	2.277+01	47.2
	5	7.990-02	1.481-04	3.052+00	3.336-01	4.734-04	2.606-01	1.	7.875+00	2.281+01	47.5
	6	1.593-03	1.857-06	4.575+00	3.885-02	5.532-05	8.383-01	1.	1.112+01	2.280+01	46.5
	7	2.781-05	3.135-08	4.217+00	7.803-04	9.061-07	8.621-01	1.	1.098+01	2.275+01	46.5
	8	5.958-07	1.034-09	2.993+00	1.323-05	1.461-05	6.660-01	1.	1.052+01	2.257+01	42.5
43	1	9.329-02	2.117-04	1.966+00	3.191-01	4.424-04	1.768-01	1.	3.652+00	2.271+01	46.4
	2	1.106-01	2.397-04	2.031+00	3.339-01	4.761-04	1.719-01	1.	3.665+00	2.273+01	46.7
	3	1.080-01	2.287-04	2.188+00	3.365-01	4.806-04	1.841-01	1.	3.684+00	2.274+01	46.5
	4	9.606-02	1.994-04	2.479+00	3.359-01	4.786-04	2.107-01	1.	3.716+00	2.277+01	47.2
	5	7.991-02	1.482-04	3.052+00	3.336-01	4.734-04	2.605-01	1.	7.875+00	2.281+01	47.5
	6	1.593-03	1.657-06	4.575+00	3.885-02	5.534-05	8.383-01	1.	1.112+01	2.280+01	46.5
	7	2.781-05	3.137-08	4.217+00	7.805-04	9.065-07	8.621-01	1.	1.098+01	2.275+01	46.5
	8	5.960-07	1.035-09	2.993+00	1.324-05	1.462-05	6.660-01	1.	1.052+01	2.257+01	42.5
44	1	9.333-02	2.117-04	1.959+00	3.191-01	4.424-04	1.768-01	1.	3.652+00	2.271+01	46.4
	2	1.107-01	2.398-04	2.030+00	3.339-01	4.761-04	1.718-01	1.	3.665+00	2.273+01	46.7
	3	1.081-01	2.289-04	2.188+00	3.366-01	4.806-04	1.841-01	1.	3.684+00	2.274+01	46.5
	4	9.612-02	1.995-04	2.478+00	3.359-01	4.787-04	2.107-01	1.	3.716+00	2.277+01	47.2
	5	7.993-02	1.482-04	3.052+00	3.336-01	4.734-04	2.605-01	1.	7.875+00	2.281+01	47.5
	6	1.599-03	1.658-06	4.574+00	3.886-02	5.535-05	8.383-01	1.	1.112+01	2.280+01	46.5
	7	2.781-05	3.138-08	4.217+00	7.806-04	9.068-07	8.621-01	1.	1.097+01	2.275+01	46.5
	8	5.962-07	1.036-09	2.993+00	1.324-05	1.463-05	6.659-01	1.	1.052+01	2.257+01	42.5
45	1	9.336-02	2.118-04	1.959+00	3.191-01	4.424-04	1.767-01	1.	3.652+00	2.271+01	46.4
	2	1.107-01	2.399-04	2.030+00	3.339-01	4.762-04	1.718-01	1.	3.665+00	2.273+01	46.7
	3	1.081-01	2.289-04	2.187+00	3.366-01	4.806-04	1.840-01	1.	3.684+00	2.274+01	46.5
	4	9.615-02	1.996-04	2.478+00	3.360-01	4.787-04	2.106-01	1.	3.716+00	2.277+01	47.2
	5	7.994-02	1.482-04	3.052+00	3.336-01	4.735-04	2.605-01	1.	7.875+00	2.281+01	47.5
	6	1.599-03	1.658-06	4.574+00	3.886-02	5.537-05	8.382-01	1.	1.112+01	2.280+01	46.5
	7	2.784-05	3.139-08	4.217+00	7.809-04	9.071-07	8.620-01	1.	1.097+01	2.275+01	46.5
	8	5.964-07	1.036-09	2.992+00	1.324-05	1.463-05	6.659-01	1.	1.052+01	2.257+01	42.5
46	1	9.339-02	2.119-04	1.959+00	3.192-01	4.425-04	1.767-01	1.	3.652+00	2.271+01	46.4
	2	1.108-01	2.400-04	2.030+00	3.339-01	4.762-04	1.717-01	1.	3.665+00	2.273+01	46.7
	3	1.081-01	2.290-04	2.187+00	3.366-01	4.807-04	1.839-01	1.	3.684+00	2.274+01	46.5
	4	9.619-02	1.996-04	2.478+00	3.360-01	4.787-04	2.106-01	1.	3.716+00	2.277+01	47.2
	5	7.995-02	1.483-04	3.051+00	3.336-01	4.735-04	2.605-01	1.	7.875+00	2.281+01	47.5
	6	1.599-03	1.659-06	4.574+00	3.887-02	5.538-05	8.382-01	1.	1.112+01	2.280+01	46.5
	7	2.784-05	3.141-08	4.217+00	7.811-04	9.077-07	8.620-01	1.	1.097+01	2.275+01	46.5
	8	5.965-07	1.037-09	2.992+00	1.324-05	1.464-05	6.659-01	1.	1.052+01	2.257+01	42.5
47	1	9.342-02	2.120-04	1.959+00	3.192-01	4.425-04	1.767-01	1.	3.651+00	2.271+01	46.4
	2	1.108-01	2.401-04	2.030+00	3.339-01	4.763-04	1.717-01	1.	3.665+00	2.273+01	46.7
	3	1.082-01	2.291-04	2.187+00	3.366-01	4.807-04	1.839-01	1.	3.683+00	2.274+01	46.5
	4	9.621-02	1.997-04	2.477+00	3.360-01	4.787-04	2.105-01	1.	3.716+00	2.277+01	47.2
	5	7.996-02	1.483-04	3.051+00	3.336-01	4.735-04	2.604-01	1.	7.875+00	2.281+01	47.5
	6	1.599-03	1.659-06	4.574+00	3.887-02	5.539-05	8.382-01	1.	1.112+01	2.280+01	46.5
	7	2.785-05	3.142-08	4.216+00	7.811-04	9.077-07	8.620-01	1.	1.097+01	2.275+01	46.5
	8	5.967-07	1.037-09	2.992+00	1.325-05	1.465-05	6.658-01	1.	1.052+01	2.257+01	42.5

SAMPLE OUTPUT: SEPHIS P. 15

1	9.344-02	2.129-04	1.959+00	3.192-01	4.426-04	1.766-01	1.	3.851+00	2.271+01	40.5
2	1.108-01	2.402-04	2.029+00	3.350-01	4.793-04	1.716-01	1.	3.665+00	2.273+01	40.5
3	1.082-01	2.291-04	2.136+00	3.366-01	4.197-04	1.838-01	1.	3.603+00	2.274+01	40.5
4	9.624-02	1.998-04	2.477+00	3.360-01	4.766-04	2.105-01	1.	3.716+00	2.277+01	40.5
5	7.998-02	1.465-04	3.051+00	3.336-01	4.735-04	2.604-01	1.	7.875+00	2.281+01	40.5
6	1.599-03	1.860-06	4.574+00	3.889-02	5.540-05	8.382-01	1.	1.112+01	2.286+01	40.5
7	2.783-05	3.115-08	4.216+00	7.812-04	9.182-07	8.620-01	1.	1.097+01	2.275+01	40.5
8	5.968-07	1.038-09	2.992+00	1.325-05	1.465-03	6.653-01	1.	1.052+01	2.257+01	42.5

99.92 PERCENT OF STEADY STATE BY OVERALL MATERIAL BALANCE

96.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 7

95.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 9

99.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 26

99.5 PERCENT OF STEADY STATE AFTER TIME INTERVAL 32

CSCX RL683J 14 FEB 74 13:57:43 USER C11B958 PUN014

CARDS IN 32 OUT 1 LINES 2957 PROCESSING TIME 32.97 SECONDS

LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 1

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05 RUN FUNDZCOP782 .FCP=SCPD/SLUD C JANSEN TSP FLOC 962357A
J ELT SCENIS/GSIF+1/JR121. 36490
B FOR A
PROGRAM SCENIS BTRCHARJON-NANCE REVISED VERSIONI
10/02/70
CCC
C
C TRANSIENT CALCULATIONS FOR SOLVENT EXTRACTION PROCESSES HAVING INTERACTING
C SOLUTES - ASSUMES PHASE RATIO EQUAL TO FLOW RATIO UNLESS SPECIFICALLY
C NOTED - VALID FOR UP TO 3 COMPONENTS - FCP USE IN TRP SYSTEMSIG/02/70
C STAGE VOLUMES EQUAL UNLESS NOTED OTHERWISE
C COMPONENT 1 - UREANILN
C COMPONENT 2 - FLUTONIUM
C COMPONENT 3 - MNOS
10/02/70
CCC
DIMENSION X(1:25,1:11),Y(1:25,1:11),XFO(1:25),VFD(1:25),TPROF(1:25,1:1)
11,XTC(F(1:25),YTEM(F(1:25),AFDTE(I(1),OFDTE(I(1),SOLU(I(1),SOLU(I(1)
ZIO(1),ROUT(1:25,1:1),OCLT(1:25,1:1),CODUM(1:25,1:1),STVGL(1:25),CF(1:1)
10/05/70
DIMENSION AFORT(1:25),OFORT(1:25),ALVRT(1:25),OLVRT(1:25),AT(2:1),OT(2:1)
DIMENSION PA(1:25),PCYCA(1:1),RCYCD(1:1),AP(1:25),OP(1:25)
DIMENSION APY(1:1),PPY(1:1),STRY(1:1),RECY(1:1),AT(2:1),OT(2:1)
COMMON/CL121F/IFFO,IFATO,IOUT,IVOL,NSOLU,CODUM,RECT,ICHNGE
COMMON/C1135/NTOST,IPORT,OPORT,X,Y,K,L,VFD,TPROF,AFDTE,OFDTE
COMMON/CN15/A,B,ALVRT,OLVRT,RATIO,PCYCA,RCYCD,A,B,OR,AT,OT
COMMON/CF156/CTIF,ARY,CRY,STRY,TQ
09/25/70
09/01/70
09/25/70
Z READ(5,901) TAT1,TAT2,TAT3,TAT4,NTOST,NSOLU,CTBP,IPRO,
09/28/70
IIRATIO,ICALC,IOUT,IVOL,IPR,IFNMH
10/05/70
C
C TAT1 AND TAT2 REPRESENT THE PROBLEM TITLE; 16 SPACES ARE ALLOWED
C NTOST = TOTAL NUMBER OF STAGES, MUST NOT EXCEED 25
09/25/70
C NSOLU = NUMBER OF SOLUTES, MAXIMUM 3 CTBP = VOLUME FRACTION OF TBP
C IFR0 = 1 IF A NON-ZERO PROFILE
C IFR0 = 0 FOR A ZERO PROFILE
C IFRATIO = 0 IF PHASE RATIO = FLOW RATIO ICALC = 1 FOR START-UP OR INTERRUPTION
C 1 IF PHASE RATIO CARDS FOLLOW 0 FOR SMT-COMM
C IOUT = 1 IF THERE ARE OUT GOING STREAMS IN ADDITION TO END STREAMS. 10/01/70
C 0 IF THERE ARE NO EXTRA OUTGOING STREAMS
C IVOL = 0 IF STAGE VOLUMES ARE ALL EQUAL
C 1 IF STAGE VOL'S ARE UNEQUAL BUT ACCORDING TO TOTAL FLOW
C 2 IF STAGE VOL'S ARE INDEPENDENTLY UNEQUAL
C IPR = 0 TO PRINT OUT ALL TIME INTERVALS
C 1 TO PRINT ONLY LAST INTERVAL
C ICHNGE = 0 IF NEXT CASE IS NEW
10/02/70
C 1 IF NEXT CASE INVOLVES ONLY A CHANGE IN FEED FLOWS,COMP.ANCIO/01/70
C 2 STEP
10/01/70
C IFNMH = 0 IF NO PUNCHED CARD OUTPUT DESIRED
10/05/70
C 1 FOR FINAL PROFILE OUTPUT ON PUNCHED CARDS
10/05/70
C
C
DO 20 J=1,NTOST
DO 20 J=1,NTOST
CODUM(J,K) = 0.0
DO 21 I=1,NSOLU
X(I,J,K) = 0.0
Y(I,J,K) = 0.0
TPROF(J,K) = 25.0
20 CONTINUE
DO 22 J = 1,NTOST
STVGL(J) = 0.0
10/05/70
22 CONTINUE
DO 23 I = 1,NSOLU
DF(I) = 0.0
10/05/70
10/05/70
10/05/70
23 CONTINUE
ICHNGE = 0
10/05/70
25 DO 30 J=1,NTOST
AI(J) = 0.0
OI(J) = 0.0
AFORT(I) = 0.0
OFORT(I) = 0.0
ALVRT(I) = 0.0
OLVRT(I) = 0.0
AFDTE(I) = 25.0
OFDTE(I) = 25.0
10/01/70
30 CONTINUE
DO 40 I=1,NSOLU
DO 40 J=1,NTOST
XFO(I,J) = 0.0
VFD(I,J) = 0.0
40 CONTINUE
CALL PPROFIL
10/01/70
C
C PROFIL SETS INITIAL CONCENTRATIONS FOR TIME ZERO, ALSO DEFINES FEED STREAMS
C
WRITE(6,910) TAT1,TAT2,TAT3,TAT4,NTOST,NSOLU
WRITE(6,920)
DO 50 I=1,NTOST
IFIAFORT(I)=0.0
95 WRITE(6,930) I,XFO(1:I),XFO(2:I),XFO(3:I),AFDTE(I),OFDTE(I)
DENOMA = 1.0-0.0728*XFO(1:I)-0.11*XFO(2:I)-0.0309*XFO(3:I)
AFORT(I) = AFDTE(I)/DENOMA
DO 40 J=1,3
XFO(I,J) = XFO(I,J)/DENOMA
40 CONTINUE
50 CONTINUE
WRITE(6,940) CTBP
TO = 3.65145 * CTBP
C
C TO IS MOLARITY OF OPV. SOLUTE-FREE TBP

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LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 2

```

      US = 0.5*TD/(1.0+0.046*TD)
      FUS = 0.5*TD/(1.0+0.05*TD)
C
C   US, FUS, AND MS ARE MOLARITIES OF U-FU, AND HNO3 REQUIRED TO SATURATE THE TBP
C   DO 60 I=1,NTOST
C   IF (IDFRT(I).NE.0.0) GO TO 55
55  WRITE(6,95) YFDC(I),YFDC(I),YFDC(I),YFDC(I),YFDC(I),YFDC(I),YFDC(I),YFDC(I)
      MD = 12.95 - C.D19**CFDIFM(I)*CTEP**1.65
      MS = TD*(1.0-C.D0609*MD)/(1.0+C.D33*TD)
      MC = 10*(1.0-YFDC(I)*YFDC(I)/FUS-0.65*YFDC(I)*MS)
      DENOM = 1.0-C.D92*YFDC(I)-0.18*YFDC(I)-0.03*YFDC(I)-0.013*MC
      OFDR(I) = OFDR(I)+DENOM
      DO 56 J=1,3
      YFDC(J,I) = YFDC(J,I)/DENOM
56  CONTINUE
60  CONTINUE
C
C   FEED CONCENTRATIONS AND VOLUMES ARE NOW ON A SOLUTE-FREE BASIS
      CALL FLCJSCSTVOL)
C
C   FLOWS SETS ALL INTERSTAGE FLOW RATES, DEFINES OUTGOING STREAMS AND FLOW
C   RATIOS, AND CALCULATES NECESSARY RECYCLE FLOWS.
C
65  IF (ICUT) GO TO 800+800+70
70  WRITE(6,95C)
      DO 75 I=1,NTOST
      IF (ALVPT(I).GT.75.75)
72  WRITE(6,96C) I,ALVPT(I)
75  CONTINUE
      WRITE(6,96C)
      DO 80 I=1,NTOST
      IF (OLVPT(I).GT.80.80)
77  WRITE(6,96C) I,OLVPT(I)
80  CONTINUE
800  IF (IC4NCE) 91,91,92
81  IF (IFC191,91,92
82  WRITE(6,97C)
      DO 90 J=1,NTOST
      FRNT 980 J,X(1,J),X(2,J),X(3,J),Y(1,J),Y(2,J),Y(3,J),
      1,TFRCF(J)
      DENOM = 1.0-C.D72*X(1,J)-0.13*Y(2,J)-0.0309*X(3,J)
      MO = (3.95 - C.D19**TFRCF(J))*CTEP**1.65
      MS = TD*(1.0-C.D0609*MO)/(1.0+C.D33*TD)
      MC = 10*(1.0-Y(1,J)*Y(2,J)/FUS-0.65*Y(3,J)*MS)
      DENOM = 1.0-C.D32*Y(1,J)-0.18*Y(2,J)-0.043*Y(3,J)-0.017*MC
      DO 90 I=1,3
      X(I,J) = X(I,J)/DENOM
      Y(I,J) = Y(I,J)/DENOM
90  CONTINUE
C
C   PROFILE CONCENTRATIONS ARE NOW ON SOLUTE-FREE BASIS
91  IF (IPAT1) 100,100,92
92  WRITE(6,99C)
93  DO 99 I=1,NTOST
      IF (I-1) 94,94,95
94  RATIO = PACO(I)
      NST = I
      IF (I-NTOST) 99,98,98
95  TFRATIO = BATNIT(I),96,97,95
96  IV = I-1
      WRITE(6,99C) NST,IK,RATIO
      DO 97 94
97  IF (I-NTOST) 99,98,98
98  WRITE(6,99C) NST,I,PATIO
99  CONTINUE
      GO TO 101
100  WRITE(6,997)
      GO TO 93
101  WRITE(6,998)
      DO 105 I=1,NTOST
      AA = ALVPT(I) + AT(I)
      OO = OLVPT(I) + O(I)
      RATIO = AA/OO
      AR(I) = PCY(I)*PATIO/(1.0+RATIO)
      OR(I) = PCY(I)/(1.0+RATIO)
      AT(I) = AA + AR(I) + PCYCA(I)
      O(I) = OO + OR(I) + PCYCO(I)
      Y(I) = AT(I) + O(I)
      WRITE(6,999) I,RATIO,AA,AR(I),RCYCA(I),AT(I),OO,OR(I),
      1,PCYCO(I),CT(I),TI,STVOL(I)
105  CONTINUE
110  WRITE(6,100C)
      WRITE(6,105C)
      N = 101
      ICEN = 0
      DDF = 0.10
      DO 1101 I=1,NSCLU
      SOLINI(I) = C.O
      DO 1101 K=1,101
      SOLOUT(I,K)=C.O
1101  CONTINUE
      DO 1102 I=1,NSCLU
      DO 1102 J=1,NTOST
      SOLINI(I) = SOLINI(I) + AFCDT(I)*YFDC(I,J) - OFLRT(I)*YFDC(I,J)
1102  CONTINUE

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10/05/70

10/01/70

10/01/70

10/08/70

09/25/70

09/25/70

09/25/70

09/25/70

09/25/70

09/25/70

10/05/70

LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 3

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      SFH = 0.240*CTRF + 0.775*ILU - CTRF
111 DO 500 K=2, N
      CALL STAGE(I, SFH)
C
C STAGES PERFORMS STAGE CALCULATIONS FOR EACH TIME INTERVAL
C
      IF (ICEN) 170, 120, 125
120 IF (K-NTOST) 150, 175, 175
125 IF (ICALC) 130, 130, 170
C
C FOR SHUTDOWN, ICALC=0, TEST FOR COMPONENTS 1 AND 2 = 0, NOT COMPONENT 3
C
130 DO 140 J=1, NTOST
      IF (X11, J, K) - C.00000000000000000000
135 IF (Y11, J, K) - C.00000000000000000000
136 IF (X12, J, K) - C.00000000000000000000
137 IF (Y12, J, K) - C.00000000000000000000
140 CONTINUE
      GO TO 700
150 DO 170 I=1, NSOLU
      SOLOUT(I, K) = AINTOST*(X11, NTOST, K) + C(11)*Y(11, K)
      DO 165 J=1, NTOST
      SOLCUT(I, K) = SOLCUT(I, K) + ALVRT(J)*X11, J, K + CLVRT(J)*Y(11, J, K)
165 CONTINUE
      DF(1) = ARS((SOLIN(I) - SOLOUT(I, K))/SOLIN(I))
      IF (K, 50) GO TO 170
      IF (DF(1) - CDF) 170, 170, 500
170 CONTINUE
      ADF = AMAX1(CF(1), DF(1), CF(3))
      IF (ADF - GT, CDF) GO TO 500
      IF (DCF - C.10) 190, 160, 180
180 JK = K - 1 + 100*ICEN
      POF = 100. * (1.0 - DCF)
      DCF = 0.05
      GO TO 500
190 IF (DCF - 0.05) 210, 200, 200
200 JJK = K - 1 + 100*ICEN
      PPOF = 100. * (1.0 - DCF)
      DCF = 0.010
      GO TO 500
210 IF (ICEN) 220, 220, 700
220 IF (DCF - C.010) 240, 230, 230
230 JJJJK = K - 1 + 100*ICEN
      PFFF = 100. * (1.0 - DCF)
      DCF = 0.005
      GO TO 500
240 IF (ICEN) 250, 250, 700
250 IF (DCF - C.005) 260, 260, 260
260 JJJJK = K - 1 + 100*ICEN
      PFFFF = 100. * (1.0 - DCF)
      DCF = 0.001
      GO TO 500
500 CONTINUE
      DO 501 J=1, NTOST
      DO 500 I=1, NSOLU
      XTEMP(I, J) = X11, J, K
      YTEMP(I, J) = Y11, J, K
501 CONTINUE
501 DO 540 K=1, N
      IF (XPR) 502, 502, 530
502 DO 525 J=1, NTOST
      DENA = 1.0 - 0.072*(X11, J, K) + 0.13*(X12, J, K) + 0.0309*(X13, J, K)
      WDM = 14.2 - 0.015*(PPOF(J, K)) + (1.0 - 2.0*(Y11, J, K) + Y12, J, K))/TO - 0.6*(Y13, J, K)/TO) + CTRF*0.169
      DENO = 1.0 - 0.092*(Y11, J, K) + 0.18*(Y12, J, K) + 0.043*(Y13, J, K) + 0.0174*WDM
      AOUT(J, K) = (A(J) + ALVRT(J))*DENA
      QOUT(J, K) = (Q(J) + CLVRT(J))*DENO
      DO 505 I=1, NSOLU
      X(I, J, K) = X11, J, K/DENA
      Y(I, J, K) = Y11, J, K/DENO
505 CONTINUE
      IF (J - 1750 - 500) 720
506 IF (ICEN - 1) 507, 503, 508
507 L = 7 - 1
      IF (K, 50) L=0
      GO TO 515
508 L = K + 99 + 100*(ICEN - 1)
515 WRITE(16, 1100) L, J, (X11, J, K), (I=1, 3), (Y11, J, K), (I=1, 3), CDDU(J, K)
      1AOUT(J, K), QOUT(J, K), TPROF(J, K)
      GO TO 525
520 WRITE(16, 1150) J, (X11, J, K), (I=1, 3), (Y11, J, K), (I=1, 3), CDDU(J, K)
      1AOUT(J, K), QOUT(J, K), TPROF(J, K)
525 CONTINUE
      GO TO 540
530 IF (K - N) 540, 502, 502
540 CONTINUE
      IF (ICALC, C.7, 0) GO TO 541
      APOF = 100. * (1.0 - ADF)
      PRINT 1300, APOF
      IF (DCF, LT, C.1) PRINT 1400, POF, JK
      IF (DCF, LT, C.05) PRINT 1400, PPOF, JJK
      IF (DCF, LT, C.01) PRINT 1400, PFFF, JJJK
      IF (DCF, LT, C.005) PRINT 1400, PFFFF, JJJJK
541 IF (K - 101) 542, 541, 541
542 IF (CPNCH) 5501, 5501, 541

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LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 4

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243 DO 550 J=1,NTEST
  IFUNC=1250,X(I,J,M)=X(I,J,M)+Y(I,J,M),I=1,3),TPROF(J,M)
10/05/70
550 CONTINUE
5501 READ 1500, ICHNGE,ICALC,ICUT,IFRCH
10/05/70
C
C IF ICHNGE = 1, NEW FEED STREAM AND CUT CARDS ARE REQUIRED FOR EACH
10/01/70
C FEED AND EXIT STREAM, EVEN IF NO CHANGE IS MADE. NO PROFILE CARDS
10/01/70
C ARE REQUIRED.
10/01/70
C
C IF (ICHNGE-1) 600,602,601
10/01/70
600 GO TO 2
10/01/70
601 STOP
10/01/70
602 DO 605 J=1,NTEST
  TPROF(J,1)=TPROF(J,M)
10/01/70
  DO 605 I=1,NISLU
    X(I,J,1)=X(I,J,M)
10/01/70
    Y(I,J,1)=Y(I,J,M)
10/01/70
605 CONTINUE
  IFR0 = G
10/01/70
C
C INITIAL PROFILE IS SET AS THAT AT END OF LAST CALCULATION.
10/01/70
C
  GO TO 25
10/01/70
551 DO 560 J=1,NTEST
  TPROF(J,1)=TPROF(J,IC1)
C9/25/70
  DO 560 I=1,NISLU
    X(I,J,1)=XTEMP(I,J)
    Y(I,J,1)=YTEMP(I,J)
560 CONTINUE
  ICEN = ICEN + 1
  GO TO 111
700 N = K
  GO TO 501
900 FORMAT (44X,2I4,F9.0,7I4)
10/05/70
910 FORMAT (73H)CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS HAVING I
  INTERACTING SOLUTES/10X,4A3.6X,1A.3X,6HSTAGE5/32X,1A.2X,19HINTERACT
  2ING SOLUTES)
920 FORMAT (27H)FEED STREAM DATA - AQUEOUS,6X,54STAGE,3X,7HURANIUM,5X,
  19HFLUTONIUM,6X,4HMO3,6X,5HFLOW RATE,6X,4HTEMP/2X,3HMO,6X,5H
  2.6X,5H (M),6X,3H(M),6X,11HIVOL. UNITS),3X,5HDEG C/)
10/05/70
930 FORMAT (32X,1A.3(3X,1FF10.4),3X,1FE9.3,3X,UPP7.1)
10/07/70
940 FORMAT (20X,7HORGANIC)
942 FORMAT (7X,2FFE.2,1A.3,7HORGANIC)
950 FORMAT (27H)EXIT STREAM DATA - AQUEOUS)
960 FORMAT (32X,1A.4X,1FE9.3,2X,76H(SOLUTE-FREE VOLUME UNITS))
10/21/70
970 FORMAT (25H)NON-ZERO INITIAL PROFILE,2A,54STAGE,13X,17HAQUEOUS PHA
  15E,2X,13HORGANIC PHASE /3X,3HMO,6X,7HURANIUM,5X,5HPLU1E/5/70
  77HNUM,6X,4HMO3,6X,5HFLOW RATE,6X,4HTEMP/2X,3HMO,6X,5H
  10/05/70
  631X,9HOUTFLOW),3X,3H(M),1X,3H(M),1X,3H(M),1X,3H(M),1X,3H(M),1X,3H(M),1
  90X,3H(M),1X,5HDEG C/)
10/05/70
980 FORMAT (32X,1A.61X,1FE10.4),3X,UPP6.1)
10/07/70
990 FORMAT (32H)COEFFICIENTS USED FOR URANUM (4F10.5)
991 FORMAT (14C,2X,9HFLUTONIUM,6F10.5)
992 FORMAT (14C,2X,9HMO3,6F10.5)
995 FORMAT (15H)PHASE RATIOS DO NOT EQUAL FLOW RATIOS - THEY ARE ---
  13X,9HSTAGE NO.,2X,15.4/0 PHASE RATIO/)
10/08/70
996 FORMAT (15X,1A.3H ---,2X,9X,1FE10.2)
997 FORMAT (15H)PHASE RATIOS EQUAL FLOW RATIOS --- ,21X,9HSTAGE NO.,3X
  1,11HPHASE RATIO/)
998 FORMAT (15H)STAGE FLOWS (SOLUTE-FREE VOLUMES):1/3X,12HAQUEOUS PHA10/C8/70
  15E,3X,17HORGANIC PHASE,18X,7HINTERACT,13X,9HFLOW,1X,10HSTAGE,6X,5
  2HRECYCLE 1,4X,5HSTOTAL,1X,9HFLOW,9X,20HRECYCLE 2 RECYCLE 1,4X,5HSTOT
  3AL,7X,5HSTOTAL/13H STAGE FLOW,9X,6HOUT OF,9X,7HIC FILL,3X,9HFOR P
  9HASE,3X,7HAQUEOUS,6X,5HOUT OF,9X,7HIC FILL,3X,9HFOR PHASE,3X,7HOG
  9HMO,6X,5HSTAGE/2X,3HMO,6X,5HSTAGE,7X,5HSTAGE,6X,5HSTAGE,6X,7HRA
  610,6X,9HFLOW,6X,5HSTAGE,6X,5HSTAGE,6X,5HSTAGE,6X,9HFLOW,9X,9HFLOW,10/05/70
  75X,9HSTAGE VOL/)
  10/05/70
999 FORMAT (15,2X,1PE9.3,1X,4(2X,1FE9.3),1X,4(2X,1PE9.3),3X,1PE9.3,2X,10/05/70
  11FE9.3)
10/05/70
1000 FORMAT (27H)TRANSIENT BEHAVIOR RESULTS,10X,9HSCOLUTE CONCENTRATION
  15 IN EFFLUENT FROM EACH STAGE)
1050 FORMAT (14C,2X,20HAQUEOUS PHASE VALU,1X,21H ORGANIC PHASE VALU,9/28/70
  1ES/7H TIME,13X,3HURANIUM FLUTONIUM MO3,6X,3HURANIUM CS/28/70
  8 FLUTONIUM HMO,3X,9HINTERACT,6X,9HFLOW,OUT,1X,4HTEMP/9H INTER,9/28/70
  3RVAL,2X,5HSTAGE,6X,3H(M),9X,3H(M),6X,3H(M),9X,3H(M),9X,3H(M),9X,7HOG
  9HMO,4X,5HSTAGE,3X,7HAQUEOUS,1X,7HORGANIC,6X,5HDEG C)
C9/29/70
1100 FORMAT (14C,2X,1A.4X,1A.1X,6(3X,1FE9.3),2X,UPP6.0,1X,7(2X,1PE9.3),
  12X,UPP4.1)
C9/29/70
1150 FORMAT (11X,1A.1X,6(3X,1FE9.3),2X,UPP6.0,1X,2(2X,1PE9.3),
  12X,UPP6.1)
C9/29/70
1250 FORMAT (21FE.6,F8.7,FA.61,FA.4)
1C/01/70
1300 FORMAT (14C,F7.2,52H PERCENT OF STEADY STATE BY OVERALL MATERIAL BAL,10/07/70
  12ANCE)
1C/05/70
1400 FORMAT (14C,F6.1,2X,9HPERCENT OF STEADY STATE AFTER TIME INTERVAL
  3,16)
1500 FORMAT (4I2)
10/05/70
END

```

LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 5

```

8 ELT FLOWS/52F5.1.7C1021. 1N492
8 EOF 2
      SUBROUTINE FLOWSESTVOL)
      10/05/70

      DIMENSION X(17,25,101),Y(17,25,101),XFC(13,25),YFC(13,25)
      DIMENSION AF(125),CF(125),ALVRT(125),OLVRT(125),A(175),O(125)
      DIMENSION RATIO(25),RCYC(125),RCYCA(125),RCYCO(125),AT(125),OT(125)
      DIMENSION STVOL(125),CDOU(125,101)
      COMMON/CL1234/IFRC,IPATIO,ICUT,TVOL,NSOLU,COLU,RECY,ICHNGE
      COMMON/CM1235/NTOST,AFORT,CFORT,X,Y,XFC,YFC,IPROF,AFOTEM,CFOTEM
      COMMON/CN135/FA,C,ALVRT,OLVRT,RATIO,RCYCA,RCYCO,AR,GR,AT,CT
      09/01/70
      09/28/70

      C
      C
      C   DEFINE OUTGOING STREAMS OTHER THAN AQUEOUS RAFFINATE AND ORGANIC PRODUCT
      C
      C
      C   IF(IOUT)5C,5C,10
      10 READ(5,700) I,JHAS,OTPT,INDEX
      C
      C   I = STAGE NUMBER THAT STREAM LEAVES JHAS = 1 FOR AQUEOUS STREAM
      C   INDEX = 1 IF MORE CARDS FOLLOW -1 FOR ORGANIC STREAM
      C   0 FOR LAST CARD OTPT = EXIT FLOW RATE (VOL. UNITS)
      C (FLOWS GIVEN IN SOLUTE-FREE VOLUME UNITS)
      C
      C   IF(JHAS)20,2C,3C
      20 OLVRT(I) = OTPT
      60 TO 40
      30 ALVRT(I) = OTPT
      40 IF(INDEX)5C,5C,10
      C
      C   WE DO NOT PROVIDE FOR RETURNING STREAMS
      C
      C
      50 DO 100 I=1,NTOST
      IF(I-1)60,60,70
      60 A(I) = AFORT(I)-ALVRT(I)
      65 O(NTOST) = CFORT(NTOST)-OLVRT(NTOST)
      60 TO 100
      70 A(I) = A(I)-AFORT(I)-ALVRT(I)
      INST = NTOST+1-I
      O(INST) = O(INST)-CFORT(INST)-OLVRT(INST)
      100 CONTINUE
      C
      C   THE INTERSTAGE FLOWS ARE NOW SET
      C
      C   DEFINE PHASE RATIOS
      C
      C
      DO 150 I=1,NTOST
      RCYCA(I) = C.O
      RCYCO(I) = C.C
      150 CONTINUE
      FLOWAX = C.O
      K = 1
      IF(IPATIO)200,200,300
      200 DO 250 I=1,NTOST
      RATIO(I) = (ALVRT(I)-A(I))/(OLVRT(I)-O(I))
      250 CONTINUE
      60 TO 310
      300 IF(ICHNGE) 301,301,320
      301 READ(5,710) I,FATIO
      10/02/70
      10/01/70
      C
      C   I = NUMBER OF STAGES HAVING THE PHASE RATIO SHOWN
      C
      C   I = K + I - 1
      C
      C   CALCULATE NECESSARY RECYCLE FLOWS
      C   TYPE 1 IS RECYCLE OF ONE PHASE ONLY, TO SATISFY PHASE RATIO
      C   USED WHEN IPATIO = 1
      C   TYPE 2 IS RECYCLE OF BOTH PHASES WITH PHASE RATIO RATIO(I)
      C   TO ALLOW TOTAL STAGE FLOW TO EQUAL FLOWAX
      C   USED WHEN IVOL = 0.2
      C   RECYCLE VOLUMES AND RATIOS ARE SOLUTE-FREE VALUES
      C
      DO 305 J=K,I
      RATIO(J) = RATIO
      305 CONTINUE
      IF(I-NTOST)306,320,320
      306 K = I + 1
      60 TO 300
      310 IF(IVOL-1)315,360,315
      315 DO 317 I=1,NTOST
      FLOTOT = ALVRT(I) + A(I) + OLVRT(I) + O(I)
      RCYV(I) = FLOTOT
      FLOWAX = APAX/(FLOTOT-FLOWAX)
      317 CONTINUE
      IF(IVOL-1)340,360,400
      320 DO 330 I=1,NTOST
      AFL = ALVRT(I) + A(I)
      OFL = OLVRT(I) + O(I)
      FLOTOT = AFL + OFL
      RFL = AFL/OFL
      IF(RFL-RATIO(I))322,322,322
      322 FLOTOT = FLOTOT*(RATIO(I)+1.0)/(RFL+1.0)
      RCYCA(I) = FLOTOT - AFL - OFL
      60 TO 325

```

LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 6

```

323 FLOTOT = FLOTOT + RFL * (RATIO(I) + 1.0) / (RATIO(I) + (RFL + 1.0))
      RECY(I) = FLOTOT - AFL - OFL
325 RECY(I) = FLOTOT
      FLOMAX = AMAX1(FLOTOT, FLOMAX)
330 CONTINUE
C
C FLOMAX CONTAINS THE LARGEST TOTAL FLOW FROM A STAGE - STAGES HAVING A
C TOTAL FLOW LESS THAN FLOMAX MUST EXHIBIT RECYCLE
C OF TYPE 2
C
      IF (IVOL - 1) 340, 360, 400
340 DO 350 I = 1, NTOST
      RECY(I) = FLOMAX - RECY(I)
350 CONTINUE
      RETURN
360 DO 370 I = 1, NTOST
      RECY(I) = 0.0
370 CONTINUE
      RETURN
400 IF (ICHNGE) 410, 410, 415
410 READ(5, 720) (STVOL(I), I = 1, NTOST)
C
C STAGE VOLUMES ARE SOLUTE-FREE VOLUMES
C
415 TIMIN = 0.0
      DO 420 I = 1, NTOST
      RECY(I) = RECY(I) / STVOL(I)
      TIMIN = AMAX1(RECY(I), TIMIN)
420 CONTINUE
      FLOMAX = TIMIN
      DO 430 I = 1, NTOST
      RECY(I) = (FLOMAX - RECY(I)) * STVOL(I)
430 CONTINUE
      RETURN
700 FORMAT (2I9, F8.0, C, I4)
710 FORMAT (I9, F8.0)
720 FORMAT (10F8.0)
      END

a ELT STAGES/S2F5.1.701021. 34694
a EOF 2
      SUBROUTINE STAGES(K, SFM)
      DIMENSION X(3, 25, 101), Y(3, 25, 101), XFD(3, 25), YFD(3, 25), TPROF(25,
1101), AFDTEM(25), OFDTEM(25)
      DIMENSION AFDRT(25), OFDRT(25), ALVRT(25), OLVRT(25), AT(25), OT(25)
      DIMENSION RECY(25), CODUM(25, 101), AR(25), CP(25)
      DIMENSION RATIO(25), RCYCA(25), RCYCO(25)
      DIMENSION AIN(3), OIN(3), DTRY(3), ARY(3), ORY(3), AT(25), OT(25)
      COMMON /CL123/ TPROF, RATIO, DOUT, IVOL, NSOLU, CODUM, RECY, TEMNRT
      COMMON /CM123/ NTOST, AFDRT, OFDRT, X, Y, XFD, YFD, TPROF, AFDTEM, OFDTEM
      COMMON /CN135/ A, O, ALVRT, OLVRT, RATIO, RCYCA, RCYCO, AR, OR, AT, OT
      COMMON /CF156/ CTBF, ARY, ORY, DTRY, TC
C
C PERFORM STAGE CALCULATIONS FOR CURRENT TIME INTERVAL - CONSIDER
C INPUTS FROM ADJACENT STAGES, FEED STREAMS, AND MOST IMPORTANTLY
C RECYCLE WITHIN THE STAGE - RECYCLE A RESULT OF STAGE FLOW BEING
C LESS THAN FLOMAX (TYPE 2) AND PHASE RATIO NOT EQUAL TO FLOW
C RATIO (TYPE 1)
C
      DO 130 J = 1, NTOST
      KK = K - 1
      JJ = J - 1
      JJJ = J + 1
      5 DO 40 I = 1, NSOLU
      IF (J - 1) 10, 10, 15
10 AIN(I) = AFDRT(J) * XFD(I, J) + (AR(J) * RCYCA(J)) * X(I, J, KK)
      GO TO 20
15 AIN(I) = AFDRT(J) * XFD(I, J) + (AR(J) * RCYCA(J)) * X(I, J, KK) + A(JJ) * X(I, JJ,
1KK)
20 IF (J - NTOST) 25, 30, 30
25 OIN(I) = OFDRT(J) * YFD(I, J) + (OR(J) * RCYCO(J)) * Y(I, J, KK) + O(JJJ) * Y(I,
1JJJ, KK)
      GO TO 35
30 OIN(I) = OFDRT(J) * YFD(I, J) + (OR(J) * RCYCO(J)) * Y(I, J, KK)
35 AIN(I) = AIN(I) / AT(J)
      OIN(I) = OIN(I) / OT(J)
      ARY(I) = X(I, J, KK)
      IF (X(I, J, KK) .EQ. 0.0) ARY(I) = AIN(I)
40 CONTINUE
      IF (J - 1) 410, 410, 415
410 AHTIN = AFDRT(J) * AFDTEM(J) + (AR(J) * RCYCA(J)) * TPROF(J, KK)
      GO TO 420
415 AHTIN = AFDRT(J) * AFDTEM(J) + (AR(J) * RCYCA(J)) * TPROF(J, KK) + A(JJ) * TPROF
1(JJJ, KK)
420 IF (J - NTOST) 425, 430, 430
425 OHTIN = SFM * (OFDRT(J) * OFDTEM(J) + (OR(J) * RCYCO(J)) * TPROF(J, KK) + O(JJJ)
1 * TPROF(JJJ, KK))
      GO TO 435
430 OHTIN = SFM * (OFDRT(J) * OFDTEM(J) + (OR(J) * RCYCO(J)) * TPROF(J, KK))
435 TPROF(J, KK) = (AHTIN * OHTIN) / (AT(J) * SFM * OT(J))
      TEMPC = TPROF(J, KK)
      CCD = 0.001

```

LISTING AND SUBROUTINE COMPILATION: SEPHIS P. 7

```

41 NCK = 0
42 *DEX = 0
C
C NCK IS THE ITERATION COUNTER
C NOEX IS THE FIT COUNTER
C
      CALL UCOR(TEMP2)
      DO 76 I=1,NSCLU
        X(I,J,K) = (AIN(I)*ATC(IJ)+DIN(IJ)/(RAI(IJ)+APV(IJ))
        IF(X(I,J,K).LT.1.E-10) GO TO 76
44      XI = (X(I,J,K)-APV(IJ))/(APV(IJ)+X(I,J,K)/2.)
        DIF = ABS(DI)
        APV(IJ) = X(I,J,K)
        IF(DIF.LT.CC0) GO TO 76
68      NOEX = NOEX + 1
70      CONTINUE
        NCK = NCK + 1
        IF(NCK.EQ.100) GO TO 78
77      IF(NDX)78,78,42
78      DO 80 I=1,NSCLU
        VII(J,K) = X(I,J,K)+JTPY(I)
80      CONTINUE
95      CDDUM(J,K) = NCK
130     CONTINUE
140     RETURN
      END

```

10/01/70

09/28/70

09/25/70

```

8 ELT PROFIL/S2F5.1.701021. 30695
8 EOF 8
      SUBROUTINE PROFIL
      DIMENSION X(3,25,101),Y(3,25,101),XFD(3,25),YFD(3,25),TPROF(25,
1101),AFDTEM(125),CFDTEM(125)
      DIMENSION AFDRT(25),CFDRT(25),CDDUM(125,101),PCDY(125)
      COMMON/CL1235/IFRO,IRATIO,IGOUT,IVOL,NSCLU,CCDUM,REC,ICMNEE
      COMMON/CM1235/NTCST,AFDRT,CFDRT,X,Y,XFD,YFD,IFROF,AFDTEM,CFDTEM

```

10/01/70

```

C
C
C DEFINE FEED STREAMS
C
C
      10 READ(5,800)I,JHAS,FDRT,CON1,CON2,CON3,TEMP,INDEX
C
C      I = STAGE NUMBER THAT FEED ENTERS      JHAS = 1 FOR AQUEOUS FEED
C      FDRT = THE FEED FLOW RATE (VOL. UNITS)    -1 FOR ORGANIC FEED
C      CON1 = URANIUM CONTENT IN MOLARITY      INDEX = 1 IF MORE FEED CARDS FOLLOW
C      CON2 = PLUTONIUM CONTENT IN MOLARITY      0 -OR LAST CARD
C      CON3 = ALIUM MOLARITY                    TEMP = TEMP IN DEG C
C
      IF(IJHAS) 20,20,30
      20 3FDRT(I) = FDRT
      IF(TEMP.EQ.0.) GO TO 21
      3FDTE(I) = TEMP
      21 YFD(1,I) = CON1
      YFD(2,I) = CON2
      YFD(3,I) = CON3
      GO TO 40
      30 AFDRT(I) = FDRT
      IF(TEMP.EQ.0.) GO TO 31
      AFDTE(I) = TEMP
      31 XFD(1,I) = CON1
      XFD(2,I) = CON2
      XFD(3,I) = CON3
      40 IF(INDEX)50,50,10
      50 IF(IFRO)60,60,70
      60 RETURN
      70 DO 100 J=1,NTCST
C
C      FOR IFRO = 0, THE ZERO PROFILE IS ALREADY IN X AND Y ARRAYS
C      FOR A NON-ZERO INITIAL PROFILE, VALUES ARE NOW READ
C
      READ(5,810) (X(I,J,1),I=1,3),(Y(I,J,1),I=1,3),TPROF(J,1)
      IF (TPROF(J,1).EQ.0.) TPROF(J,1)=25.0
      100 CONTINUE
      GO TO 60
      800 FORMAT (2I4,5F8.0,I4)
      810 FORMAT (7F8.0)
      END

```

```

8 ELT UCOR/S2F5.1.701021. 30677
8 EOF 8
      SUBROUTINE UCOR(TEMP2)
      DIMENSION DTPY(3),ARY(3),OPV(3)
      COMMON/CF156/CTBF,ARY,OPV,DTPY,TO

```


LISTING AND SUBROUTINE COMPILATION: SÉPHIS P. 8

C
C UCOR RETURNS A VALUE OF THE DISTRIBUTION COEFFICIENT = Y/X FOR EACH
C VALUE OF X TRIED
C
C

```

DO 3 I=1,3
  IF (APY(I)) 2,2,3
2  ARY(I) = 0.0
3  CONTINUE
  UAM = ARY(1)
  FUAM = ARY(2)
  HAM = ARY(3)
  F=CTBF
  TNM = HAM + 2.*UAM+2.*FUAM
  IF (TNM.EQ.0.0) TNM = 1.0
  TEMPRK = 1000./(TEMFC + .273.16)
  DRT = TEMPRK - 3.3539
  UK = 3.7*TNM**1.57 + 1.9*TNM**3.9 + 0.011*TNM**7.3
  UK = UK*(4.*F**(-0.17) - .3.)
  IF (TEMFC.NE.25.) UK = UK*EXP(2.2*DRT)
  HK1 = 0.135*TNM**0.82 + 0.0052*TNM**3.44
  IF (F.LT.1.) HK1 = HK1*(1. - 0.59*EXP(-15.*F))
  IF (TEMFC.NE.25.) HK1 = HK1*EXP(0.34*DRT)
  HK2 = HK1
  FUK = 1.7*TNM**1.9 + 2.7*TNM**3 + .0067*TNM**9.
  IF (TEMFC.NE.25.) FUK = FUK*EXP(0.2*DRT)
  A = 2.*(UK*UAM + FUK*FUAM + HK2*HAM)
  B = HK1*HAM + 1.
  C = -T0
  TF = (-B + SQRT(B**2 - 4.*A*C))/(2.*A)
  DH1 = HK1*TF
  DH2 = HK2*TF**2
  DH = DH1 + DH2
  DU = UK*TF**2
  DFU = FUK*TF**2
  DTPY(1) = DU
  DTRY(2) = DFU
  DTPY(3) = DH
50 RETURN
END

```

09/29/70

06130279 CUB742FUN002 100 342 9 683 14121647 1 0000 G JANSE S

PROGRAM NAME: SLUCE

Descriptive Title: Steady-State Temperatures in Underground Tanks with Bulges and/or Sluicing

Program Author: Nance, James R.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Underground Waste Tanks, Tank 105A, Sluicing

Program Description: Calculates the maximum temperature of the cake in an underground waste tank as a function of air flow rate, cake thickness, and moisture present. A bulge in the tank floor may or may not be present, and water may be present above or below the cake or both. Used for heat transfer analysis of tank 105A during sluicing operations. Four subroutines.

Input Description - Suitable for teletype.

Namelist input.

Namelist \$AB - describes conditions above the bulge, or if no bulge exists.

Namelist \$BB - describes conditions below the bulge.

See reprint of program self-documentation for names and definitions of input variables.

Output Description - Suitable for line printer, not for teletype.

Output includes an input summary and the following calculated quantities for above and below the bulge: total heat generation rate Q , the temperature of the air, the maximum temperature in layers, the maximum temperature uniform, and mole fraction of water in air.

Users of Program:

G Jansen
JR Nance

Documentation:

Undocumented.

Condition of Program:

In good running order.

SAMPLE INPUT: SLUCE

```

SLUCE      OR:40      02/14/74

100 @S RUN PUN006,CUR928,GEORGE,150,6000/3000      G JANSEN 3760 RLD
      G 9423576
105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFO00
115 @PRL TEL INFO00
120 @PRL TEL CUR928
125 @X ASG A=U1145(JJ1145)
130 @N YQT CUP
150 FIND A,BENV/SIFS
160 TRD A
170 FIND A,REVIT/SIFS
180 TRD A
190 FIND A,ABVIT/SIFS
200 TRD A
210 FIND A,ABVU/SIFS
220 TRD A
230 FIND A,SLUCE/SIFS
240 TRD A
250 PCH SLUCE/SIFS
260 PCH BENV/SIFS
270 PCH REVIT/SIFS
280 PCH ABVIT/SIFS
290 PCH ABNU/SIFS
350 TRI A
360 @IM FR5,* SLUCE/SIFS,SLUCE/SIFS,SLUCE/RIFS
370 @IM FR5,* BENV/SIFS,BENV/SIFS,BENV/RIFS
380 @IM FR5,* REVIT/SIFS,REVIT/SIFS,REVIT/RIFS
390 @IM FR5,* ABVIT/SIFS,ABVIT/SIFS,ABVIT/RIFS
400 @IM FR5,* ABNU/SIFS,ABNU/SIFS,ABNU/RIFS
1000 @N XQT SLUCE/RIFS
1010 $A3 S=28.0,TAMB=70.0,TR=220.0,RHOC=0.014,RHUV=.04
1020 CPW=.5,LWV=17500.0,UU=.05,HACT=1.5,HACR=100.0
1030 R=37.5,KC=.45,LC=0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
1040 LCUA=0.,LL=2,RULGE=1,SAME=0,NCFM=7,CFM=0,100,500,
1050 1000,2000,3000,5000,0,0,0,NLC=1 $
1060 $BB SB=60.,HALN=0.,PALV=0.,HBL=1.5,HBLW=100.,HBCT=1.5,
1070 HBCR=1.5,ARUA=.5,ALUA=.67,KCR=.15
1080 LCR=.25,.5,1.,2.,4.,0.,0.,0.,0.,0.,LCBUA=1.
1090 SAMER=1.,LLR=2.,CLR=5 $
2000 @ FIN
READY

```

SAMPLE OUTPUT: SLUCE

ON XOT SLUCE/RIFS

DRUM LENGTH 015010

THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 15:18:46

	AVERAGE CAKE THICKNESS	LOCAL CAKE THICKNESS	CFM AIR	TOTAL HEAT GENERATION RATE	TEMP. OF AIR FAHRENHEIT	MAX TEMP IN LAYERS	MAX TEMP UNIFORM	MOL FRAC OF WATER IN AIR
	(LCOA)	(LC)	(CFM)	(G)	(TAIR)	(TC)	(TU)	(YW)
ABOVE	.000	.000	.000	.133+0e	TAIR IS OUTSIDE THE RANGE FOR BOILING WATER			
BELOW	1.000	.250	.000	.133+0e	TAIR IS OUTSIDE THE RANGE FOR BOILING WATER			
ABOVE	.000	.000	100.000	.133+0e	181.645	181.645	181.645	.40107-00
BELOW	1.000	.250	100.000	.133+0e	182.449	192.449	190.574	.46905-00
ABOVE	.000	.000	500.000	.133+0e	124.203	124.203	124.203	.11957+00
BELOW	1.000	.250	500.000	.133+0e	125.007	135.007	133.132	.12208+00
ABOVE	.000	.000	1000.000	.133+0e	106.404	106.404	106.404	.74454-01
BELOW	1.000	.250	1000.000	.133+0e	107.203	117.208	115.333	.76113-01
ABOVE	.000	.000	2000.000	.133+0e	93.631	93.631	93.631	.52011-01
BELOW	1.000	.250	2000.000	.133+0e	94.435	104.435	102.560	.53224-01
ABOVE	.000	.000	3000.000	.133+0e	88.353	88.353	88.353	.44026-01
BELOW	1.000	.250	3000.000	.133+0e	89.157	99.157	97.282	.45688-01
ABOVE	.000	.000	5000.000	.133+0e	83.603	83.603	83.603	.38783-01
BELOW	1.000	.250	5000.000	.133+0e	84.407	94.407	92.532	.39722-01

SUMMARY OF INPUT DATA FOR THE ABOVE CASE

SAB	=	.28000000+02,		
S	=	.70000000+02,		
TAMB	=	.22000000+03,		
TB	=	.14000000-01,		
RHOCP	=	.39999999-01,		
RHOW	=	.50000000+00,		
CPW	=	.17500000+05,		
LWV	=	.49999999-01,		
UU	=	.15000000+01,		
HACT	=	.10000000+03,		
HACB	=	.37500000+02,		
R	=	.45000000+00,		
KC	=	.00000000+00,	.00000000+00,	.10000000+00,
LC	=	.00000000+00,	.00000000+00,	.10000000+00,
.00000000+00,		.00000000+00,	.00000000+00,	.10000000+00,
.00000000+00,		.00000000+00,	.00000000+00,	.10000000+00,
LCOA	=	.00000000+00,		
LL	=	2,		
BULGE	=	.10000000+01,		
SAME	=	.30000000+00,		
NCFM	=	7,		
CFM	=	.00000000+00,	.10000000+03,	.50000000+03,
.10000000+04,		.20000000+04,	.30000000+04,	.50000000+04,
.00000000+00,		.00000000+00,	.00000000+00,	.00000000+00,
NLC	=	1,		
HALH	=	.00000000+00,		
HALW	=	.00000000+00,		
SEND				
SBB				
SB	=	.60000000+02,		
HBC	=	.15000000+01,		
HBLW	=	.10000000+03,		
HBCT	=	.15000000+01,		
HBCB	=	.15000000+01,		
ABOA	=	.50000000+00,		
ALQA	=	.66999999+00,		
KCB	=	.15000000+00,		
LCB	=	.25000000+00,	.50000000+00,	.10000000+01,
.20000000+01,		.40000000+01,	.00000000+00,	.10000000+00,
.00000000+00,		.30000000+00,	.00000000+00,	.00000000+00,
LCBOA	=	.10000000+01,		
SAMEU	=	.10000000+01,		
LLB	=	2,		
NLCB	=			
SEND				

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00122 OF MAIN PROGRAM

CSCX RL683J 14 FEB 74 15:18:16 USER CUR928 PUN006

CARDS IN 38 OUT 293 LINES 543 PROCESSING TIME 27.83 SECONDS

LISTING AND SUBROUTINE COMPILATION: SLUCE P. 1

85 RUN FUNCTION=CURRIB, .15C+FFDD/3000 G JANSEN 3760 BLOC 942327F
 8 ELT SLUCE/SIF5.1.700505. 42207

8 CCF 2

PROGRAM SLUCE

A FORTRAN V PROGRAM FOR CALCULATING THE MAXIMUM TEMPERATURE OF THE CAKE IN AN UNDERGROUND WASTE TANK AS A FUNCTION OF AIR FLOW RATE, CAKE THICKNESS, AND MOISTURE PRESENT. THE INPUT OF THE PROGRAM IS BY NAMELIST WITH A LIST FOR ABOVE A BULGE AND A LIST FOR BELOW.

INPUT NEEDED FOR NAMELIST ABOVE THE BULGE. NAMELIST AB

NAME	DIMENS	TYPE	D E F I N I T I O N
S	1	R	UNIFORM VOLUMETRIC HEAT GENERATION RATE IN THE CAKE. BTU/(HR)(FT**3)
TAMB	1	D	AMBIENT TEMPERATURE, DEGREE F
TB	1	R	NORMAL BOILING POINT OF SOLUTION IN THE TANK DEGREE F
RHOCP	1	R	VOLUMETRIC HEAT CAPACITY OF THE AIR. BTU/(FT**3)(DEGREE F)
RHOM	1	R	DENSITY OF WATER VAPOR AT ONE ATMOSPHERE AND AMBIENT TEMPERATURE. LB/FT**3
CFM	1	R	SPECIFIC HEAT CAPACITY OF WATER VAPOR. BTU/LB(DEGREE F)
LHV	1	R	LATENT HEAT OF VAPORIZATION OF WATER. BTU/LBMOLE
UU	1	R	OVERALL HEAT TRANSFER COEFFICIENT FROM THE CAKE THROUGH THE SOIL TO THE ATMOSPHERE. BTU/(HR)(FT**2 OF TANK FLOOR AREA)
HACT	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM AIR TO TOP OF CAKE. BTU/(HR)(FT**2)
HACB	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM AIR TO BOTTOM OF CAKE. BTU/(HR)(FT**2)
HALN	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM DRY AIR TO LINER ABOVE BULGE. BTU/(HR)(FT**2)
HALM	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM WET AIR TO LINER ABOVE BULGE. BTU/(HR)(FT**2)
R	1	R	RADIUS OF TANK. FT
KC	1	R	THERMAL CONDUCTIVITY OF CAKE. BTU/(HR)(FT**2)(DEGREE F/FT)
LCOA	1	R	AVERAGE CAKE THICKNESS ABOVE BULGE. FT
LC	10	R	LOCAL CAKE THICKNESS ABOVE BULGE. FT
CFM	10	R	AIR FLOW THROUGH THE TANK. CFM
LL	1	I	CONTROL VARIABLE. 1 WITH NO WATER PRESENT. 2 WITH WATER PRESENT.
NLC	1	I	NUMBER OF LC'S IN THIS CASE. 10 MAX
NCFM	1	I	NUMBER OF CFM'S IN THIS CASE. 10 MAX
BULGE	1	I	CONTROL VARIABLE. 0 IF NO BULGE. 1 IF BULGE
SAME	1	I	CONTROL VARIABLE. 0 IF AVERAGE CAKE THICKNESS IS THE SAME AS THE LOCAL. 1 IF THERE WILL BE AN AVERAGE CAKE THICKNESS THAT IS DIFFERENT.

INPUT NEEDED IF THERE IS A BULGE. NAMELIST BB

NAME	DIMENS	TYPE	D E F I N I T I O N
SB	1	R	UNIFORM VOLUMETRIC HEAT GENERATION RATE IN THE CAKE BELOW THE BULGE. BTU/(HR)(FT**3)
HBL	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM DRY VAPOR SPACE BELOW BULGE TO LINER. BTU/(HR)(FT**2)
HBLM	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM WET VAPOR SPACE BELOW BULGE TO LINER. BTU/(HR)(FT**2)
HBCY	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM TOP OF CAKE BENEATH BULGE TO VAPOR SPACE BENEATH BULGE. BTU/(HR)(FT**2)
HBCB	1	R	LOCAL HEAT TRANSFER COEFFICIENT FROM BOTTOM OF CAKE BENEATH BULGE TO VAPOR SPACE BENEATH BULGE. BTU/(HR)(FT**2)

 

LISTING AND SUBROUTINE COMPILATION: SLUCE P. 3

```

8 ELT 37ND/SIF5.1.700110. 15107
8 ECF 8
SUBROUTINE 87ND (TAUP,TCN,TUNB,Y4,J,K,TAIR)
REAL LCVOR,LCR(10),KCE,CFM(10),LWV,LNX,LCSOA
COMMON/BL1/ TAMB,CFM,PHOCF
COMMON/BL4/ ALCA,HAL,BL,ABCA,SR,LCB,KCB,LCSOA,HCLN,HDCT
YV=0
HUBA=ALCA*(1./AL+1./HAL)/AFGA
DTBA=SR-LCSOA+HUBA
CFM=CFM(1)+EC
TAUB=TAIR+DTBA
CCANB=SR*LCR(1)/HBCF
CCNB=SR*LCR(1)*7/KCB
TCNB=TAUB+CCANB+CCNB
UCNB=CCNB/2.
TUNE=TAUB+CCANB+UCNB
RETURN
END

8 ELT 8EWIT/SIF5.1.702131. 15112
8 ECF 8
SUBROUTINE 87WIT (TAUPW,TCW3,TUNW,Y4,J,K,TAIR)
REAL LWVOR,LCR(10),KCE,CFM(10),LWV,LNX,LCSOA
COMMON/BL1/ TAMB,CFM,PHOCF
COMMON/BL1/ LWVOR,TB,PHOW,OB,HBCB,UU,A,LWV,CPM
COMMON/BL4/ ALCA,HAL,BL,ABCA,SR,LCB,KCB,LCSOA,HCLN,HDCT
CFM=CFM(1)+EC
77 HUBW=ALCA*(1./AL+1./HAL)/ABCA
DTBW=SR-LCSOA+HUBW
TAUBW=TAIR+DTBW
RTB=1./RTB+EC
RTAUB=1./RTAUB+EC
LNX=-LWVOR*(RTAUB-RTB)
YVBI=EXP(LNX)
CCANB=SR*LCR(1)/HBCB
TCW3=TAUBW+CCANB
UCW3=SR*LCR(1)/(HBCB+2.)
UCW3=SR*LCR(1)*7/KCB/2.
TUNB=TAUBW+CCANB+UCW3
RETURN
END

8 ELT 83WIT/SIF5.1.702210. 16039
8 ECF 8
SUBROUTINE 83WIT (TAIPW,TCW,TUN,Y4,J,K)
REAL LWVOR,LCR(10),KCE,CFM(10),LNXCL,NYWA,NYWC,NYV2,LWV,NYV3
COMMON/BL1/ TAMB,CFM,PHOCF
COMMON/BL2/ G,S,LC,KC,HACT,HACE
COMMON/BL1/ LWVOR,TB,PHOW,OB,HBCB,UU,A,LWV,CPM
DATA YV1/.5/
YV=VW1
CFM=CFM(1)+EC
H2=KCE
RTB=1./RTB+EC
LNXCL=ALOG(YV1)/LWVOR
RTAIP=RTB-LNXCL
TAIPW=1./RTAIP+EC
NYWA=UU*(1-RTAIP-TAMB)
NYV3=CFM*PHOCF*(TAIR-TAMB)
XAMB=EXP(-LWVOR*(1/(TAMB+EC)-G.UC1881))
NYWC=CFM*XAMB*PHOW/LWV/18.
NYV2=0-NYWA-NYV3+NYWC
NYV2=0-NYWA-NYV3+NYWC
NYWC=CFM*XAMB*PHOW/LWV/18.
DYWA=CFM*PHOW*CFM*(TAIRW-TB)
DYV3=CFM*PHOW*LWV/18.
DYV2=DYWA+DYV3
YV2=NYV2/DYV2
IF(YV2.LT..00001) YV2=.00001
YV2=.33333*(2*YV1+YV2)
DYZY1=ABS(YV2-YV1)
IF(DYZY1.LT..00001) GO TO 55
YV1=YV2
55 CONTINUE
WRITE(6,1) YV2,DYZY1
1 FORMAT(1X,SEPIE DIDNOT CONVERGE. LAST VALUES ARE: YV=.E10.4, DY
ZY1=.E10.4)
55 CCAN=SR*LCR(1)/HACE
TCW=TAIPW+CCAN
UCANB=SR*LCR(1)/HACE/2.
UCN=SR*LCR(1)*7/KC/2.
TUN=TAIPW+CCAN+UCN
RETURN
END

8 ELT 89ND/SIF5.1.702210. 16039
8 ECF 8
SUBROUTINE 89ND (TAIPW,TCN,TUN,YV,I,J)
REAL LCR(10),KCE,CFM(10),LWVOR
COMMON/BL1/ TAMB,CFM,PHOCF
COMMON/BL2/ G,S,LC,KC,HACT,HACE
COMMON/BL1/ LWVOR,TB,PHOW,OB,HBCB,UU,A,LWV,CPM
YV=EXP(-LWVOR*(1/(TAMB+EC)-G.UC1881))
CFM=CFM(1)+EC
AIPP=PHOCF*CFM
TAIPW=TAMB+3/(TAIR+UU+A)
CCAN=SR*LCR(1)/HACT
CCN=SR*LCR(1)*7/KC
TCN=TAIPW+CCAN+CCN
UCN=CCN/2.
TUN=TAIPW+CCAN+UCN
RETURN
END

```


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PROGRAM NAME: SPHERE

Descriptive Title: Hot Spots in Heat Generating Sludge in Underground Waste Tanks

Program Author: Rasmussen, J. J. (CSC)

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 150 CP sec

Keywords: Heat Transfer, Radioactive Wastes, Underground Tanks

Program Description: Computes transient temperatures in a variable diameter heat generating sphere located in a perfectly conducting medium. Finite difference methods are used. The program has been applied to hot spot formation in heat generating sludge in an underground waste tank. A plotting routine gives local temperature as a function of position. Three subroutines.

Input Description - Input is formatted and is suitable for teletype input. See internal program documentation for list and description of input physical and control variables.

Output Description - Output is designed for line printer, not teletype.

Users of Program: G Jansen
WV DeMier
JJ Rasmussen (CSC)

Documentation: Undocumented.

Condition of Program: The plotting routine does not add much to the usefulness of the output and should probably be bypassed. The size of the time increments is determined by the space increment. For stability these tend to be too small to give reasonable running time and output volume.

SAMPLE INPUT: SPHERE

LIST

```

SPHERE      15:56      03/15/74

100 @S RUN PUN011,CUR928,GEORGE,150,6000/3000      G JANSEN 3760 ELD
      G 9423576
105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFO00
115 @PRL TEL INFO00
120 @PRL TEL CUR928
125 @X ASG A=02881
130 @N XQT CUR
170 FIND A,TVSR/SIFA
180 TRD A
190 FIND A,ALFPL3/SIFA
200 TRD A
210 FIND A,REPORT/SIFA
211 TRD A
212 FIND A,SPHERE/S2F5
220 TRD A
350 TPI A
360 @IM FR5,* SPHERE/S2F5,SPHERE/S2F5,SPHERE/R2F5
380 @IM FR5,* TVSR/SIFA,TVSR/SIFA,TVSR/RIFA
390 @IM FR5,* ALFPL3/SIFA,ALFPL3/SIFA,ALFPL3/RIFA
400 @IM FR5,* REPORT/SIFA,REPORT/SIFA,REPORT/RIFA
900 @IM FR5,* SPHERE/S2F5,SPHERE/S2F5,SPHERE/R2F5
910 -294
915      GO TO 3333 @ BYPASS PLOTS
920 -300
922 3333 CONTINUE
924 -358
925      GO TO 140 @ BYPASS PLOTS
930 -367
940 @IM FR5,* TVSR/SIFA,TVSR/SIFA,TVSR/RIFA
945 -52
950      GO TO 3333 @ BYPASS PLOTS
960 -59
970 3333 CONTINUE
1000 @N XQT SPHERE/R2F5
1010      1      1      1      1      1      1      100
1020      12.      .8E-2      100.      160.      3.

1030      .05
1040      300.
1050      0.
1060      .8E-3
1070      .0175
1080      150.
1090 @ FIN
READY

```

SAMPLE INPUT: SPHERE

```

SPHERE      10:14      C2/14/74
100 OS RUN PUND11,CURRGR,GEORGE,150,6000/3000      G JANSEN 3760 BLD
      G 9423576
105 ON MSG KEEP AT TEL BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 OPUL TEL INFO00
115 OPRL TEL INFO00
120 OPRL TEL CUR928
125 EX MSG A=J1145(J1145)
130 ON XQT CLR
170 FIND A,TUSR/SIF4
180 TRD A
190 FIND A,ALFPL3/SIF4
200 TRD A
210 FIND A,REPORT/SIF4
211 TRD A
212 FIND A,SPHERE/S2F5
220 TRD A
350 TRI A
351 PCM SPHERE/S2F5
352 PCM TUSR/SIF4
353 PCM ALFPL3/SIF4
354 PCM REPORT/SIF4
365 DIM FRS,1 SPHERE/S2F5,SPHERE/S2F5,SPHERE/S2F5
380 DIM FRS,* TUSR/SIF4,TUSR/SIF4,TUSR/SIF4
390 DIM FRS,* ALFPL3/SIF4,ALFPL3/SIF4,ALFPL3/SIF4
400 DIM FRS,* REPORT/SIF4,REPORT/SIF4,REPORT/SIF4
1000 ON XQT SPHERE/S2F5
1010      1      1      1      1      1      100
1020      12.      .8E-2      100.      160.      3.
1030      .05
1040      300.
1050      2.
1060      .8E-3
1070      .0175
1080      150.
1090 * FIN
READY

```

SAMPLE OUTPUT: SPHERE P. 1

ON XOT SPHERE/R2FS

DIRIM LENGTH 014033

THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 15:32:42

INPUT DATA

IDT	NHETG1	NCOND	NBETA2	NBETA1	NTIME	INC	1
1	1	1	1	1	1	100	

ALPHA	H	TZERO	RUNTIM	DTOUT
.80000-02	.10000+03	.16000+03	.30000+01	.12000+02

DT	1	2	3	4	5	6	7	8	9	10
DT-	.50000-01									
HETG1-	.30000+03									
COND-	.20000+01									
BETA2-	.00000-03									
BETA1-	.17500-01									
TIME1-	.15000+03									

THE TIME INCREMENT HAS BEEN HALVED FOR STABILITY PURPOSES

THE TIME INCREMENT HAS BEEN HALVED FOR STABILITY PURPOSES

THE TIME INCREMENT HAS BEEN HALVED FOR STABILITY PURPOSES

THE TIME INCREMENT HAS BEEN HALVED FOR STABILITY PURPOSES

TIME	CENTER TEMP.	S. S. TEMP	SPHERE RADIUS
.000	.00000	.00000	.00000

THE FOLLOWING IS PLOTTED AS A FUNCTION OF TIME. A- CENTER TEMP. B- STEADY STATE TEMP. C- SPHERE RADIUS.

SAMPLE OUTPUT: SPHERE P. 2

CURRENT TIME - .31250-02

NODE NUMBER, RADIAL DISTANCE FROM CENTER OF SPHERE, AND NODE TEMPERATURE IN THAT ORDER.

1	.0000	.1600+03	3	.0000	.1600+03	5	.0000	.0000
2	.1823-04	.1600+03	4	.5469-04	.1600+03	6	.0000	.0000

STEADY STATE TEMPERATURES CORRESPONDING TO THE ABOVE LISTED RADIAL TEMPERATURES

.1600+03
.1600+03
.1600+03

THE FOLLOWING PLOTS THE TEMPERATURE OF EACH RADIAL NODE VS. NODE DISTANCE FROM THE CENTER
A - NODE TEMPERATURE

TIME	CENTER TEMP.	S. S. TEMP	SPHERE RADIUS
2.859	.16126+03	.17006+03	.12010+01
5.718	.22095+03	.33001+03	.24017+01

SAMPLE OUTPUT: SPHERE P. 3

THE FOLLOWING IS PLOTTED AS A FUNCTION OF TIME. A- CENTER TEMP. B- STEADY STATE TEMP. C- SPHERE RADIUS.

CURRENT TIME - .14400+03

MAXIMUM TEMP. (DEG. FAR.)	TIME OF MAX TEMP. (HOURS)	MAX TEMP RADIUS (FEET)	MAX. SPHERE RADIUS (FEET)	THERM COND BTU/(HR.FT**2 (DEG. FAR.))	THERM DIFF BTU/(HR.FT**3)	HEAT GEN. RATE BTU/(HR.FT**3)	TIME COEFS NETAL DETP
.22533+03	.14400+03	.25200+01	.25200+01	.20000+01	.80000+02	.30000+03	.017 .001

TIME OF MAXIMUM RADIUS

(HOURS)

.15000+03

TEMP. AT CENTER OF SPHERE

TIME	TEMP. AT CENTER OF SPHERE
5.728	.22110+03
5.741	.22131+03
5.754	.22151+03
5.767	.22171+03
5.780	.22192+03
5.793	.22212+03

CURRENT TIME - .14400+03

MODE NUMBER, RADIAL DISTANCE FROM CENTER OF SPHERE, AND NODE TEMPERATURE IN THAT ORDER.

MODE NUMBER	RADIAL DISTANCE FROM CENTER OF SPHERE	TEMPERATURE
1	.0000	.2254+03
2	.9354-01	.2251+03
3	.1871-00	.2238+03
4	.2866-00	.2243+03
5	.3742-00	.2236+03
6	.4677-00	.2227+03
7	.5612-00	.2217+03
8	.6540-00	.2204+03
9	.7403-00	.2189+03
10	.8414-00	.2173+03

SAMPLE OUTPUT: SPHERE P. 4

STEADY STATE TEMPERATURES CORRESPONDING TO THE ABOVE LISTED RADIAL TEMPERATURES

.31870+03
 .31880+03
 .31760+03
 .31680+03
 .31520+03
 .31330+03
 .31080+03
 .30460+03
 .30470+03
 .30100+03
 .29880+03
 .29230+03
 .28720+03
 .28100+03
 .27580+03
 .26950+03
 .26270+03
 .25550+03
 .24780+03
 .23900+03
 .23120+03
 .22230+03
 .21290+03
 .20380+03
 .19270+03
 .16200+03
 .17200+03

THE FOLLOWING PLOTS THE TEMPERATURE OF EACH RADIAL NODE VS. NODE DISTANCE FROM THE CENTER.
A = NODE TEMPERATURE

Y-axis labels: 22.54, 21.72, 20.90, 20.09, 18.45, 17.63, 16.82, 16.00

X-axis labels: -1.00, 2.52, 5.04, 7.56, 10.08, 12.60, 15.12, 17.64, 20.16, 22.68, 25.20

Legend: A

Radial Node Distance from Center (X)	Radial Node Distance from Center (Y)
-1.00	22.54
2.52	21.72
5.04	20.90
7.56	20.09
10.08	18.45
12.60	17.63
15.12	16.82
17.64	16.00
20.16	15.18
22.68	14.36
25.20	13.54

THE FOLLOWING PLOTS THE TEMPERATURE OF EACH RADIAL NODE VS. NODE DISTANCE FROM THE CENTER
A - NODE TEMPERATURE

Scatter plot showing the relationship between $\log_{10}(1 + 1000 \cdot (1 - R^2))$ on the x-axis and $\log_{10}(1 + 1000 \cdot (1 - R^2))$ on the y-axis. The plot displays a series of points forming a diagonal line, indicating a strong positive correlation. The axes are labeled with values 23.34 and 22.62.

ROUTINE TERMINATED AT MEPPS

MINI TERMINATED FOR MAX TIME AT 017745

CSCA-PLG83J 14 JUL 74 15:32:18 USEC CUB928 PU-011

CARDS IN 33 OUT 684 LINES 2478 PROCESSING TIME 156.20 SECONDS

LISTING AND SUBROUTINE COMPILATION: SPHERE P. 1

```

85 RUN FUN011,CUR02A, .150,6000/3000 5 JANSEN 3760 ELDO 7423576
9 ELY SPHERE/STES.1.681916. 35619
9 EOF 3
COMMON XFL0T(4,70), ABS(4,70),MX,XSM,XLC,YSM,YLC,NL,M,NXADJ,
1KXADJ
COMMON T10001,SPED(1000),BTRED(10),BTRED(10),BTRED(10),BTRED(10),
1BTRED(10),BTRED(10),BTRED(10),BTRED(10),BTRED(10),BTRED(10),
2 TMAX,TIMX1,TMAX,R1,C,ALPHA,G,BETA1,BETA2,TIM1,TIM
3 INC,NTIM,INOUT,NR,TMX1(1000),TMX1(1000),RMX1(1000),ZERO
4 T1(10),T2(10)
5 W(1000),WEXT(1000)
6 *H
IN = 5
NOUT = 6
DIMENSION VTEN(1000),VTEN(1000),VSS(1000)
CALL ETIME
C COMMENTS DEFENDING THE DATA TO BE READ IN AND THEIR ASSOCIATED
C FIELDS PRECEDE EACH DATA CARD TO BE READ IN. THE NUMBERS IN COLUMN
C 80 DESIGNATE THE CARD ORDER OF READ IN. COLUMN 3 DESIGNATES THE
C ORDER ON THE CARD.
C CARD ONE CONTAINS THE FOLLOWING IN CONSECUTIVE RIGHT ADJUSTED
C INTEGER FIELDS 5 COLUMNS WIDE
C
C 1 NDT - THE NUMBER OF DIFFERENT ITERATION TIME INCREMENTS TO BE TRIED
C UNITS - HOURS
C 2 NHETGN - THE NUMBER OF DIFFERENT HEAT GENERATION RATES TO BE TRIED
C UNITS - BTU/(HR)(FT ** 3)
C 3 NCOND - THE NUMBER OF DIFFERENT THERMAL CONDUCTIVITIES TO BE
C TRIED. UNITS - BTU/(HR)(FT ** 2)(DEG.F)(FT)
C
C 4 NBETA2 - NUMBER OF DIFFERENT CONSTANT COEFFICIENTS FOR THE SHRINK-
C AGE RATE OF THE SPHERE. UNITS - FT/HR
C
C 5 NBETA1 - NUMBER OF CONSTANT COEFF. FOR EXPANDING RATE OF SPHERE
C UNITS - FT/HR
C
C 6 NTIM1 - NUMBER OF DIFFERENT TIMES OF MAXIMUM RADIUS. UNITS- HOURS
C
C OF THE ABOVE ENTRIES ONLY NTIM1 IS ALLOWED TO EXCEED 5
C INC - TIME INCREMENT MULTIPLIER WHICH SPECIFIES THE TIME BETWEEN
C OUTPUT VALUES OF THE CENTER TEMPERATURE AS INC * DT
C (HOURS)
C READ(IN,1) NDT,NHETGN,NCOND,NBETA2,NBETA1,NTIM1, INC
1 FORMAT( 10I5 )
C
C THE FOLLOWING ENTRIES MUST BE FLOATING POINT, FIELD WIDTH = 15 COL.
C ALPHA - THERMAL DIFFUSIVITY - FT**2/ HR
C 1 H - SURFACE TO SURROUNDINGS HEAT TRANSFER COEFFICIENT
C 2 ZERO - MEDIUM TEMPERATURE
C 3 RUNTIM - DESIRED RUNNING TIME OF PROGRAM (MINUTES). THIS MUST BE
C LESS THAN THE TIME SPECIFIED ON THE RUNCARD
C (HOURS)
C DTOUT - TIME INCREMENT BETWEEN OUTPUT OF TOTAL SYSTEM INFORMATION
C
C READ(IN,3) ALPHA ,H, ZERO,RUNTIM, DTOUT
2 FORMAT( 3E15.5 )
C
C THE FOLLOWING ENTRIES ARE FLOATING POINT WITH A FIELD WIDTH OF
C 15 COL. PER ENTRY . A MAXIMUM OF FIVE ENTRIES ARE PERMITTED FOR
C EACH SUBSCRIPTED VARIABLE
C
C 1 DTRED(I) FOR I = 1 TO NDT - ITERATION TIME INCREMENT
C 2 SPED(I) FOR I = 1 TO NHETGN
C SPED IS THE VOLUMETRIC HEAT GENERATION RATE WITHIN THE SPHERE
C UNITS - BTU/(HR)(FT ** 3)
C 3 CRED(I) FOR I = 1 TO NCOND
C CRED - THERMAL CONDUCTIVITY OF SPHERE MATERIAL - BTU/(HR)(FT ** 2
C 1)(DEG. F)(FT)
C 4 BTRED(I) FOR I = 1 TO NBETA2
C BTRED - COEFFICIENT FOR CONSTANT RATE OF SHRINKAGE OF SPHERE
C (FT/ HR)
C 5 BTARED(I) FOR I = 1 TO NBETA1
C BTARED - COEFFICIENT FOR CONSTANT RATE OF EXPANSION OF SPHERE
C (FT/HR)
C READ(IN,3) (DTRED(I) ,I= 1, NDT )
3 FORMAT( 5E15.5 )
C READ(IN,3)(SPED(I), I = 1,NHETGN )
C READ(IN,3) (CRED(I), I= 1, NCOND )
C READ(IN,3) (BTRED(I),I = 1, NBETA2 )
C READ(IN,3) (BTARED(I),I = 1, NBETA1 )
C
C THE FOLLOWING ENTRY CAN HAVE UP TO 50 VALUES
C TIMRED(I) FOR I = 1,NTIM1
C TIMRED - THE APPROXIMATE TIME THAT THE MAXIMUM RADIUS IS REACHED.
C (HRS)
C THIS TIME IS AUTOMATICALLY CHOSEN SUCH THAT THE RESULTING
C MAXIMUM RADIUS IS SOME INTEGER FUNCTION OF 0.2 THE PACTAL
C MODF INCREMENT. THE VALUE CHOSEN IS ALWAYS WITHIN A DT
C OF THE SPECIFIED TIMRED
C THE FIELD WIDTH OF EACH ENTRY IS 20 COLUMNS.

```


LISTING AND SUBROUTINE COMPILATION: SPHERE P. 3

```

70 TIM = TIM + DT
   NOTEST = NR
   IF (TIM .LT. TIME + 1.E-6) GO TO 80
   RRR(NR) = 0.0
   R = R1 - HETAR*(TIM - TIME1)
   GO TO 90
80 R = ETAR + TIM
90 IF (TIM .GT. TIME + EPS) GO TO 93
   IF (R .GT. RTEST - EPS) NR = NR + 1
   IF (R .GT. RTEST - EPS) 4(NR) = TPROJ*R + S*R**3/(6.0*C)
   DRF = DRF1
   GO TO 95
93 IF (R .LT. RTEST + EPS) NR = NR + 1
   DRF = DRF1
95 KTIM = KTIM + 1
   TCENR(KTIM) = TNEXT(3)
   TIME(KTIM) = TIM/24.0
   RR = 0.0
   NRM1 = NR - 2
   IF (NR .LT. 6) NR = 6
   IF (TIM .GT. TIME1 .AND. R .LT. 3.0*ETA2*DT) GO TO 192
   DRT0 = DR
   DO 100 I = 4, NRM1
   RR = RR + DR
C   NON BOUNDARY NODES
   IF (NR .EQ. 5) RR = R/3.0
   IF (NR .EQ. 6) DRT0 = RR
   WNEXT(1) = DT*ALPHA*(W(1) + 1) - 2.0*W(1)*W(1-1)/DRT0 + 2*W(1)
   WCHK = TZERO + RR + S*RR**3/(6.0*C)
   IF (NR .GT. 5) GO TO 999
   DW = WNEXT(1) - W(1)
   WNEXT(1) = TNEXT(1) + RR + S*RR**3/(6.0*C) + DW
999 DUMY=DUMY
   IF (WNEXT(1) .LT. WCHK) WNEXT(1) = WCHK + EPS
   TNEXT(1) = WNEXT(1)/RR - S*RR**2/(6.0*C)
   IF (TNEXT(1) - T(1) .GT. 10.) WNEXT(1) = WCHK
   IF (TNEXT(1) .LT. TZERO) TNEXT(1) = TZERO
   RRR(1) = RR
   IF (WNEXT(1) .GT. WCHK) GO TO 100
   TNEXT(1) = TZERO
100 CONTINUE
   RF = RR + DRT0
   TNEXT(NR-1) = TNEXT(NR-2) - DRT0*(TNEXT(NR-2) - TPROJ)/(R - RF)
   IF (TNEXT(NR-1) .LT. TZERO) TNEXT(NR-1) = TZERO
   WNEXT(NR-1) = TNEXT(NR-1)*RF + S*RF**3/(6.0*C)
   RT00 = (NR-3)*DRT0
   WCHK = TZERO + RT00 + S*RT00**3/(6.0*C)
   IF (WNEXT(NR-1) .LT. WCHK) WNEXT(NR-1) = WCHK
C   TEMP AT RT = 0
110 TNX = TNEXT(NR-1)
   IF (TIM .GT. TIME + EPS) GO TO 133
   IF (R .LT. RTEST - EPS) GO TO 132
   TNX = TNEXT(NR-1)
   DRF = R - RTEST
   GO TO 132
133 IF (R .GT. RTEST + EPS) GO TO 132
   TNX = TNEXT(NR-1)
   DRF = RTEST - R
132 RABS = R - RF
   TNEXT(NR) = (4*RABS + TZERO + C*TNX)/(C + 4*RABS)
   TPROJ = 2.0 + TNEXT(NR) - TSURF
   IF (TPROJ .LT. TZERO) TPROJ = TZERO
   WPROJ = TPROJ*R + S*R**3/(6.0*C)
   TSURF = TNEXT(NR)
   WNEXT(NR) = TNEXT(NR)*R + S*R**2/(6.0*C)
   TNEXT(3) = 2.0 + TNEXT(4) - TNEXT(5)
   WNEXT(3) = 0.0
   IF (TNEXT(3) .LT. TZERO) TNEXT(3) = TZERO
   DTST = DTST + DT
   IF (DTST .LT. CLJ) GO TO 193
   DTST = 0.0
   LJJ = LJJ + 1
   VTIM(LJJ) = TIM/24.0
   RMAX(LJJ) = R
   VTCEN(LJJ) = TNEXT(1)
   VSSL(LJJ) = TZERO + S*R**2/(6.0*C)
193 DUMY=DUMY
   RRR(NR) = R
   DO 115 III = 3, NR
   IF (T(III) .LT. TMAX) GO TO 115
   TMAX = T(III)
   TMIN = TIM
   RMAX = R
115 CONTINUE
   IF (KTIM .EQ. 4000) KTIM = 0
   IF (TIM .LT. TIMEOUT - EPS) GO TO 117
   WRITE(OUT, 203)
203 FORMAT(1H, 59, TIME, CENTER TEMP, S, S, TEMP, SPHERE,
1 RADIUS,
1 IF (R1 .LT. P1) P1 = R
192 DO 154 L=1, LJJ
   WRITE(OUT, 202) VTIM(L), VTCEN(L), VSSL(L), RMAX(L)
202 FORMAT(1H, 68, 3, 1E15.5)
   XFLOT(1, L) = VTCEN(L)
   XFLOT(2, L) = VSSL(L)
   XFLOT(3, L) = 100.0*RMAX(L) + TZERO

```

LISTING AND SUBROUTINE COMPILATION: SPHERE P. 4

```

      ARS11=VTIME1
      ARS12=VTIME1
      ARS13=VTIME1
      IF (RMAX111) .GT. RMAX1 RMAX1 = RMAX111
150 CONTINUE
      VLG = TZERO + S*RMAX **2/16.0* C1
      MX = LUJ
      XSM = 0.0
      XLC = VTIMELUJ
      YSM = TZERO
      NZ = 3
      NL = 40
      KXADJ = 0
      KYADJ = 0
      WRITE(NOUT, 204)
200 FORMAT(1H, 11C) THE FOLLOWING IS PLOTTED AS A FUNCTION OF TIME.
      1 A- CENTER TEMP. 2B- STEADY STATE TEMP. 3C- SPHERE RADIUS.
      CALL ALPFL3
      WRITE(NOUT, 205)
205 FORMAT(1H, 51X, 5HTIME)
      IF (RUNTIM .LT. (SEC + 30.0/60.0)) STOP
      CALL REPORT
      CALL TVSP
      TINCUT = TINCUT + DTOUT
117 DO 120 I = 1, NR
      W(I) = WNEXT(I)
      T(I) = TNEXT(I)
120 CONTINUE
      CALL ETIMEP(SEC)
      IF ((SEC + 10.0/60.0) .LT. RUNTIM) GO TO 125
      CALL REPORT
      GO TO 192
125 IF (TIM .GT. TIM1 .AND. R .LT. 1.0*ETA2*CT) GO TO 190
      T(2) = T(1)
      W(2) = W(1)
      IF (TIM .LT. TIM1 - EPS) .AND. R .GT. RTEST - EPS) RTEST = RTEST + DR
      IF (TIM .GT. TIM1 - EPS) .AND. R .LT. RTEST + EPS) RTEST = RTEST - DR
      T(1) = T(2)
      W(1) = W(2)
      IF (TIM .LT. (TIM1 - EPS)) GO TO 70
130 IF (RTEST .EQ. 1) GO TO 70
      TIM1 = TIM
      CT = CT + ETA1/ETA2
      RI = R
      RTEST = 1
      RTEST = R - DR
      CALL TVSP
      CALL REPORT
      IF (NR .GT. RMAX) RMAX = NR
      GO TO 70
190 CONTINUE
191 TMAX(TIME) = TMAX
      TMAX(TIME) = TMAX
      RMAX(TIME) = RMAX
      WRITE(NOUT, 190)
190 FORMAT(1H, 20C) MAX. TEMPERATURE TIME OF MAX. TEMP SPHERE RADIUS
      1 AT MAX TEMP. MAXIMUM RADIUS OF SPHERE
      DO 150 I = 1, NTIM1
      XPLOT(1, I) = TMAX(I)
      XPLOT(2, I) = TMAX(I)
      XPLOT(3, I) = RMAX(I)
      ABS(1, I) = TMAX(I)
      ABS(2, I) = TMAX(I)
      ABS(3, I) = TMAX(I)
      WRITE(NOUT, 191) TMAX(I), RMAX(I), TMAX(I), TMAX(I)
170 FORMAT(1H, 20C) E16.5, E20.5, E27.5, E26.5
150 CONTINUE
      MX = NTIM1
      XSM = TMAX(1)
      XLC = TMAX(NTIM1)
      YSM = TZERO
      NZ = 3
      NL = 40
      KXADJ = 0
      KYADJ = 0
      DO 160 I = 1, NTIM1
      IF (VLG .LT. TMAX(I)) VLG = TMAX(I)
160 CONTINUE
      WRITE(NOUT, 200)
200 FORMAT(1H, 11C) THE FOLLOWING INFORMATION IS PLOTTED AS A FUNCTION
      1OF TIME: 1A- TIME OF MAXIMUM RADIUS 2B- MAXIMUM
      2TEMPERATURE 3C- MAXIMUM RADIUS 4D- TIME AT WHICH MAXIMUM TEMPERATURE OCCU
      5PS 6F- SPHC - SPHERE RADIUS AT TIME OF MAXIMUM TEMPRATU
      6RE
      CALL ALPFL3
      WRITE(NOUT, 210)
210 FORMAT(1H, 51X, 5HTIME OF SPHERE MAXIMUM RADIUS)
190 CONTINUE
      CALL REPORT
      STOP
      END

```

LISTING AND SUBROUTINE COMPILATION: SPHERE P. 5

```

8 ELT TVSP/SIFN+1.670613. 17769
9 EOF 3
      SUBROUTINE TVSP
      COMMON XFL0T(4,20), ABS(4,20), XN,XLC,YN,YLG,NL,M,KYADJ,
14YADJ
      COMMON T(100),TSP(100),TNT(100),TSP(100),TSP(100),TSP(100),
15TAR(100),TSP(100),TNT(100),TNT(100),TNT(100),TNT(100),
2 TMAX,TMIN,TMAX,TMIN,TMAX,TMIN,TMAX,TMIN,TMAX,TMIN,TMAX,TMIN,
3 TINC,ATIP,IN,OUT,NT,TX(100),TX(100),TX(100),TX(100),TX(100),TX(100),
4 T(100),T(100),T(100),T(100),T(100),T(100),T(100),T(100),T(100),T(100),
      IF(INF.LT.5) STOP
      WRITE(OUT,5) T
5 FORMAT(1H, 10NCURRENT TIME - E15.5 )
      WRITE(OUT,10)
10 FORMAT(1H, 80NNOE NUMBER, RADIAL DISTANCE FROM CENTER OF SPHER
      IC, AND NOE TEMPERATURE IN THAT ORDER. )
      NOUT = INF - 22/2 + 1.01
      DO 15 I = 1,NOUT
      II = NOUT + I - 2
      IZ = 2 + NOUT + I - 4
      IZ = II - 2
      IIZ = IIZ - 2
      IF(IIZ.GT.NR) T(IZ) = 0.0
      WRITE(OUT,20) I, IZ, X, E12.4, E12.4, IIZ, I
20 FORMAT(1H, 2I, 5X, E12.4, E12.4, 11X )
15 CONTINUE
      YLG = 0.0
      DO 40 IZ = 1, NR
      IZ = IZ - 2
      XFL0T(1,IZ) = T(IZ)
      ABS(1, IZ) = R(IZ)
      IF(XFL0T(1,IZ).GT. YLG) YLG = XFL0T(1,IZ)
40 CONTINUE
      NR = NR - 1
      R = R(1)
      WRITE(OUT,199)
199 FORMAT(// 1H, 80NSTEADY STATE TEMPERATURES CORRESPONDING TO THE
      ABOVE LISTED RADIAL TEMPERATURES )
      DO 100 IZ = 1, NR
      R = R(IZ)
      IF = TZERO + 5.0*(1-0.002 / 0.00216.0)
      WRITE(OUT, 101) IF
100 CONTINUE
101 FORMAT( 1H, E15.5 )
      NX = NR - 2
      XN = 0.0
      XLC = R(1)
      YN = TZERO
      NZ = 1
      NL = 0
      KYADJ = 0
      KYADJ = 0
      WRITE(OUT, 200)
200 FORMAT( 1H, 90THE FOLLOWING PLOTS THE TEMPERATURE OF EACH RAD
      IAL NOE VS NOE DISTANCE FROM THE CENTER /1H, 22NA - NOE
      TEMPERATURE )
      CALL ALFLY
      WRITE(OUT, 210)
210 FORMAT(1H, 50X, 13HPADIAL NOE DISTANCE FROM CENTER )
      RETURN
      END

```

```

8 ELT ALFLY/SIFN+1.670613. 40591
9 EOF 4
      SUBROUTINE ALFLY
      C
      CALF3 SUBROUTINE ALFLY PLOTS A FAMILY OF CURVES WITH ALPHABETIC CHRTS
      C X(1,J) = ARRAY OF X COORDINATES OF POINTS TO BE PLOTTED
      C Y(1,J) = ARRAY OF Y COORDINATES OF POINTS TO BE PLOTTED
      C WHERE I = INDEX ON CURVE WITHIN FAMILY
      C AND J = INDEX ON POINT WITHIN FAMILY
      C
      C XN = VALUE OF SMALLEST HASH-MARK ON X SCALE
      C XLC = VALUE OF LARGEST HASH-MARK ON X SCALE
      C YN = VALUE OF SMALLEST HASH-MARK ON Y SCALE
      C YLG = VALUE OF LARGEST HASH-MARK ON Y SCALE
      C
      C NZ = NUMBER OF CURVES IN FAMILY
      C NX = NUMBER OF POINTS IN EACH CURVE
      C ALTHOUGH PROGRAM-WISE THERE IS THE DESCRIPTION OF
      C THE SAME NUMBER OF POINTS PER CURVE, THIS IS NOT A
      C HASH-MARK BECAUSE XN,YN POINTS FILLING OUT A
      C CURVE WILL NOT BE PLOTTED IF YN < 0 OR CREATP.
      C NL = NUMBER OF LINES IN PLOT AND IS ROUNDED TO NEXT
      C LOWER MULTIPLE OF FIVE.
      C

```

LISTING AND SUBROUTINE COMPILATION: SPHERE P. 6

```

C      XNADJ = 0.0; YLG AD GIVEN CONTROLS MARKING OF X-SCALE
C      YNADJ = 0.0; YLG AD GIVEN CONTROLS MARKING OF Y-SCALE
C
C      XNADJ = 1.0; YLG RITS ROUNDED TO 0.0000 IN STEP 10 TO GIVE POINT
C      YNADJ = 1.0; YLG SOMEWHAT SMOOTHLY ROUNDED SO THAT CURVES
C      COVER RANGE AND SCALE HAS CONVENIENT MARKINGS
C
C      ROUNDED IF DESIGNED FOR XSH OR YSM = 0.0; CASE
C      MAY BE, AND MAY NOT GIVE GOOD RESULTS OTHERWISE.
C
C      FULL SCALE IN X-DIRECTION TAKES 101 SPACES, WITH THE SCALE
C      MARKED EVERY 10 SPACES.
C      FULL SCALE IN Y-DIRECTION TAKES NL+1 LINES, WITH THE SCALE
C      MARKED EVERY 5 LINES.
C      IF TWO POINTS COINCIDE WITHIN ONE PRINTING SPACE,
C      THE LETTER OF THE CURVE OF HIGHER INDEX I WILL
C      PREVAIL.
C
C      POINTS ON THE Y-AXIS WILL BE PLOTTED, BUT THOSE
C      ON THE X-AXIS WILL NOT.
C
C      PLOT TITLING AND SCALE IDENTIFICATION SHOULD BE WRITTEN
C      FROM THE CALLING PROGRAM.
C      CALL SETIO(1,2)
C      DIMENSION YOUT(101), YFRT(21), YFRT(11), AL(101)
C      DIMENSION CHAF(21)
C      COMMON      Y(1,70), X(1,70), MX,XSM,XLG,YSM,YLG,NL,MZ,MXADJ,
C      MYADJ
C      KXADJ = MXADJ + 1
C      KMYB = MYADJ + 1
C      LY=NL/5+1
C      NY=(LY-1)/2
C      MY=(LY-1)+5
C
C      SCALE X-AXIS
C 70 DELX=(XLG-XSM)/100.
C      XMIN=XSM-DELX/2.
C      XMAX=XLG+DELX/2.
C      IX=0
C      IF(DELX-1.0)101,101,102
C 101 IF(DELX-0.1)103,103,104
C 104 XT = DELX
C      GO TO 80
C 102 DO 105 I=1,15
C      XT=DELX/(10.**(I-1))
C      IF(XT-1.0)105,105,105
C 105 CONTINUE
C 106 IX=-I
C      GO TO 80
C 103 DO 107 I=1,15
C      XT=DELX/(10.**(I-1))
C      IF(XT-0.1)107,107,103
C 107 CONTINUE
C 108 IX=I
C      GO TO 109,811,KSWA
C 81 KSWA = 1
C      IF(XT-0.2)82,82,83
C 82 XTF = 0.2
C      GO TO 86
C 83 IF(XT-0.5)84,84,85
C 84 XTF = 0.5
C      GO TO 86
C 85 XTF = 1.
C 86 XLG = XTF * 10.**(12-IX)
C      GO TO 70
C
C      SCALE Y-AXIS
C 89 DELY = (YLG - YSM)/FLOAT(NY)
C      IY=0
C      IF(DELY-1.0)109,109,110
C 109 IF(DELY-0.1)111,111,112
C 112 YT = DELY
C      GO TO 90
C 110 DO 113 I=1,15
C      YT = DELY/(10.**(I-1))
C      IF(YT-1.0)113,113,113
C 113 CONTINUE
C 114 IY=-I
C      GO TO 90
C 111 DO 115 I=1,15
C      YT = DELY/(10.**(I-1))
C      IF(YT-0.1)115,115,115
C 115 CONTINUE
C 116 IY=I
C      GO TO 109,911,KSWB
C 91 KSWB = 1
C      IF(YT-0.2)92,92,93
C 92 YTF = 0.2
C      GO TO 96
C 93 IF(YT-0.5)94,94,95
C 94 YTF = 0.5
C      GO TO 96
C 95 YTF = 1.
C 96 YLG = YTF * (FLOAT(NY) * 10. ** (12-IY))
C      GO TO 81
C
C      BOTH SCALES HAVE BEEN READJUSTED TO CONVENIENT MAXIMA

```

LISTING AND SUBROUTINE COMPILATION: SPHERE P. 7

```

99 DO 100 I=1,LY
100 VFT(I)=I*VSM*10.00*IY+DELY*10.00*IY+IFLOAT(I-1)*10.00
DO 110 I=1,11
110 KFT(I)=I*SM*10.00*IY+DELY*10.00*IY+IFLOAT(I-1)*10.00
KY=1
JY=LY+1
YMIN=YSM*DELY/2.
YMAX=YLG*DELY/2.
DO 118 I=1,NY
118 YOUT(I)=0.
C
C EXAMINE THE Y-MAGNITUDES AND FLAG APPROPRIATE LINES FOR AN ENTRY
DO 117 I=1,M
DO 117 KK=1,MX
IF(Y(I,KK)-YMIN)117,120,120
120 IF(Y(I,KK)-YMAX)119,117,117
119 J=NY-IF(X(I,I,KK)-YMIN)/DELY+0.51+1
YOUT(J)=1.
YOUT(J+1)=1.
117 CONTINUE
DATA STAR,BLANK/1M+1M/
AL(1)=STAR
DATA CHAR/1564A B C D E F G H I
1 J K L P N O F D R S T
2 U V W X Y Z A
DO 121 I=2,101
121 AL(I)=BLANK
YMIN=YMAX-DELY
C
C EXAMINE EACH LINE FOR DATA
DO 122 K=1,NY
IF(YOUT(K))122C,200,124
124 DUNY=JUNY
DO 206 I=1,M
DO 125 KK=1,MX
IF(Y(I,KK)-YMIN)125,126,126
126 IF(Y(I,KK)-YMAX)127,125,125
127 IF(X(I,I,KK)-YMIN)125,128,128
128 IF(X(I,KK)-YMAX)129,125,125
129 J=IF(X(I,I,KK)-YMIN)/DELY+0.51+1
AL(J)=CHAR(I)
125 CONTINUE
C
206 CONTINUE
208 YMAX=YMIN
YMIN=YMAX-DELY
C AND ON LAST LINE, TAKE UP ANY SLACK IN THE RANGE CAUSED BY
C TRUNCATION OF THE RANGE DUE TO TRUNCATION OF DELY
IF(NY-1-K)210,210,123
210 YMIN=YMIN-DELY/100.
C
C TEST FOR AND DESIGNATE OUTPUT FORMAT FOR THIS LINE
123 NY=NY-1
IF(KY)130,130,131
130 KY=5
JIC=J+1
IF(JY-NT)135,132,135
133 WRITE(3,3) VFT(JY), (AL(I), I=1,101)
GOTO134
132 WRITE(3,4) IY, (AL(I), I=1,101)
GOTO134
131 WRITE(3,5) (AL(I), I=1,101)
134 IF(YOUT(K))122,122,136
136 AL(1)=STAR
DO 137 I=2,101
137 AL(I)=BLANK
122 CONTINUE
3 FORMAT (1H, 'F18.2,24',101A1)
4 FORMAT (1H, 'F18.2,10',101A1)
5 FORMAT (1H, 'F18.2,101A1)
6 FORMAT (1H, 'F18.2,101H)
1.....
7 FORMAT (1H, '116H
1
2)
8 FORMAT (1H, 'F18.2,10(F10.2)
9 FORMAT (1H, '7CH
1
WRITE(3,6) VFT(I)
WRITE(3,7)
WRITE(3,8) (X(I,I), I=1,11)
WRITE(3,9) IY
RETURN
END

```

LISTING AND SUBROUTINE COMPILATION: SPHERE P. 8

3 LLD-REPORT/SIEX-1-672721- 3001

6 OF 8

```

SUBROUTINE SPHERE
COMMON XFLD(4,1), ASD(4,7), NY, NSP, ALG, YSP, YLG, NL, IZ, KXADJ,
1KXADJ
COMMON T1(50), T2(50), T3(50), T4(50), T5(50), T6(50), T7(50), T8(50),
1BTAR(50), T10(50), T11(50), T12(50), T13(50), T14(50), T15(50),
2 TMAX, T1MAX, T2MAX, R1, C, ALPHA, S, BETAL, BETAL, T1, T2
3 INC, KTIM, IN, NOOT, NR, TMAX(1000), T1MAX(1000), T2MAX(1000), TZERO
4 IF (TIM .LT. 4) GO TO 10
WRITE(NOUT,35) TIM
35 FORMAT(1H1, 14HCURRENT TIME = ,E14.5)
WRITE(NOUT, 10) TMAX, T1MAX, T2MAX, R1, C, ALPHA, S, BETAL, BETAL
10 FORMAT(1H1, 10HMAXIMUM TIME, TIME OF MAX TEMP, MAX TEMP FACTUS
1 MAX, SECHT RADIUS THERM COND THERM DIFF HEAT GEN. RATE
2 TIME COEFFS /1H ,
3 120H TMAX T1MAX T2MAX
4 R1 C ALPHA S
5 BETAL BETAL /1H ,
6 120H(CEG. FAR.) (HOURS) (FEET)
7 (FEET) BTU/(HR.FT**2 FT**2/HR BTU/(HR.FT**3)
8 FT/HR /1H , 75H(CEG. FAR.) FT /1H ,
9 E14.5, E19.5, E17.5, E23.5, E15.5, E12.5, E14.5, E27.5)
WRITE(NOUT,19) TIM1
15 FORMAT(1H1, 22HTIME OF MAXIMUM RADIUS /140,5X, 7H(HOURS) /140,
1 E12.5)
WRITE(NOUT,20)
20 FORMAT(1H1, 4HTIME, 6X, 2HTEMP. AT CENTER OF SPHERE / 1
IF (INC .LT. 1) INC = 1
NKT = KTIM/4
DO 30 I7= 1,NKT, INC
I71 = NKT + I7
I72 = 2 * NKT + I7
I73 = 3 * NKT + I7
IF (I73 .LE. KTIM) GO TO 31
TIME(I73) = 0.0
TCENTR(I73) = 0.0
31 DUMY=DUMY
WRITE(NOUT,25) TIME(I71),TCENTR(I71),TIME(I71),TCENTR(I71),TIME(I72),
1 TCENTR(I72), TIME(I73), TCENTR(I73)
25 FORMAT(140, 40 F8.3, 3X, E15.5, 6X )
30 CONTINUE
RETURN
END

```

06140274 CJ8928FUNC11 300 15020 33 684 2971153219 1 C00C0

G

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PROGRAM NAME: TALUS

Descriptive Title: Transient Temperatures Around Buried Cylinders

Program Author: DeMier, Warren V.

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Geothermal, Radioactive Wastes, Cylinders

Programs/Subprograms

Necessary: TALUS/S9F5
RW/S1F5
CROFF/S1F5
ONE/S1F5
TWO/S1F5

Program Description: Computes temperature rise about a finite line heat source in an infinitely long cylindrical medium. Practical application in calculating temperature rise in salt around a radioactive waste container, buried in a mine, as a function of time.

Input Description: Input is by namelist, and is suitable for teletype. See internal program documentation for list and description of input variables. Physical variables include the radius of the cylindrical medium, the length of the line source, volume heat capacity of the medium, and diffusivity of the medium. From 1 to 8 nuclides may be present in the source. As many as eight different ages at burial may be specified for each nuclide. Output can be controlled by specifying the position at which the temperatures are to be calculated, the time at which the first temperature is to be calculated, the time increment between successive temperature calculations, and the number of times which are to be used. More than one case per run is possible.

Output Description:

Output is suitable for teletype and runs about 1 page per case for approximately ten time increments (1 additional line per time). Output includes an input summary. For each time requested, the calculated temperature and the quantity $\alpha t/r^2$ are printed. (α = diffusivity of medium.)

Users of Program:

G Jansen
WV DeMier
WJ Van Slyke
LG Niccoli (JCGS)

Documentation:

Equations appear in ORNL 3358. Results appear in letter from G. Jansen to G. L. Ritter, "Heat Transfer from Underground Caverns Containing Radioactive Waste," July 3, 1969.

Condition of Program:

Many single point anomalies appear in the thermal histories of the outputs because of the wide variations of the functions used in the analytical solution. Unfortunately, these anomalies (very high temperatures) usually occur near the time of maximum temperature. Because of this unreliability a table was generated (through repeated use of this program) for use in DIBUW.

SAMPLE INPUT: TALUS

TALUS 09:45 02/17/74

100 OS RUN PUN016,CUB928,GEORGE,150,6000/3000 G JANSEN 3760 BLD
G 9423576

105 ON MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 OPUL TEL INFO00

115 OPRL TEL INFO00

120 OPRL TEL CUB928

125 OX ASG A=U0918

130 ON XQT CUR

200 FIND A,TALUS/S9F5

210 TRD A

220 FIND A,RW/S1F5

230 TRD A

240 FIND A,CROFF/S1F5

250 TRD A

260 FIND A,TW0/S1F5

270 TRD A

280 FIND A,BESMMM/S1F5

290 TRD A

300 FIND A,ERFC/S1F5

310 TRD A

320 FIND A,ONE/S1F5

330 TRD A

340 FIND A,BU/C0F5

350 TRD A

360 FIND A,TEEPEE/S1F5

370 TRD A

400 TRI A

1000 LIST,1

1021 PCH RW/S2F5

1022 PCH TALUS/S9F5

1023 PCH RW/S1F5

1024 PCH CROFF/S1F5

1025 PCH ONE/S1F5

1026 PCH TW0/S1F5

1027 PCH BESMMM/S1F5

1028 PCH ERFC/S1F5

1029 PCH TEEPEE/S1F5

1030 OIM FR5,* TALUS/S9F5,TALUS/S9F5,TALUS/R9F5

1035 OIM FR5,* RW/S1F5,RW/S1F5,RW/S1F5

1040 OIM FR5,* CROFF/S1F5,CROFF/S1F5,CROFF/R1F5

1050 OIM FR5,* ONE/S1F5,ONE/S1F5,ONE/R1F5

1060 OIM FR5,* TW0/S1F5,TW0/S1F5,TW0/R1F5

1062 OIM FR5,* BESMMM/S1F5,BESMMM/S1F5,BESMMM/R1F5

1064 OIM FR5,* ERFC/S1F5,ERFC/S1F5,ERFC/R1F5

1066 OIM FR5,* TEEPEE/S1F5,TEEPEE/S1F5,TEEPEE/R1F5

1070 OLI XQT TALUS/R9F5

1080 SLI A=100,B=100,P=100,PC=32.04,START=3150,DELT=3150,D=.0156

1090 DLAM=.263RE-5

1100 AGEBU=3.33,NUNU=1,N0ALPH=500,NUTMS=10,00=587,NUAGE=15

1110 SLI P=50 \$

1120 SLI P=25 \$

1130 SLI P=10 \$

1140 SLI P=5 \$

1150 SLI R=3 \$

1160 O FIN

READY

SAMPLE INPUT: TALUS

```

TALUS      09:49      02/17/74

100 QS RUN PUN025,CUB928,GEORGE,150,6000/3000      G JANSEN 3760 BLD
      G 9423576
105 ON MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 WPUL TEL INFO00
115 OPRL TEL INFO00
120 OPRL TEL CUB928
125 QX ASG A=U0918
130 ON XQT CUR
200 FIND A,TALUS/S9F5
210 TRD A
220 FIND A,RW/S1F5
230 TRD A
240 FIND A,CROFF/S1F5
250 TRD A
260 FIND A,TW0/S1F5
270 TRD A
280 FIND A,BESMMM/S1F5
290 TRD A
300 FIND A,ERFC/S1F5
310 TRD A
320 FIND A,UNE/S1F5
330 TRD A
340 FIND A,RV/S2F5
350 TRD A
360 FIND A,TEEPER/S1F5
370 TRD A
400 TRI A
1000 LIST,1
1021 PCH RW/S2F5
1022 PCH TALUS/S9F5
1023 PCH RW/S1F5
1024 PCH CROFF/S1F5
1025 PCH UNE/S1F5
1026 PCH TW0/S1F5
1027 PCH BESMMM/S1F5
1028 PCH ERFC/S1F5
1029 PCH TEEPER/S1F5
1030 QIM FR5,* TALUS/S9F5,TALUS/S9F5,TALUS/R9F5
1035 QIM FR5,* RW/S2F5,RW/S2F5,RV/S2F5
1040 QIM FR5,* CROFF/S1F5,CROFF/S1F5,CROFF/R1F5
1050 QIM FR5,* UNE/S1F5,UNE/S1F5,UNE/R1F5
1060 QIM FR5,* TW0/S1F5,TW0/S1F5,TW0/R1F5
1062 QIM FR5,* BESMMM/S1F5,BESMMM/S1F5,BESMMM/R1F5
1064 QIM FR5,* ERFC/S1F5,ERFC/S1F5,ERFC/R1F5
1066 QIM FR5,* TEEPER/S1F5,TEEPER/S1F5,TEEPER/R1F5
1070 WLI XQT TALUS/R9F5
1080 SLI A=100,B=100,R=100,PC=32.04,START=3150,DELT=3150,D=.0156
1090 DLAM=.2638E-5
1100 AQEDU=3.33,N0NU=1,N0ALPH=300,N0THS=10,00=387,N0AGE=13
1110 SLI R=50 S
1120 SLI R=25 S
1130 SLI R=10 S
1140 SLI R=5 S
1150 SLI R=3 S
1160 Q FIN
READY

```

SAMPLE OUTPUT: TALUS P. 1

NOT XOT TALUS/AMES
DATA LENGTH 320013
THIS ALLOCATION WAS DONE ON 17 FEB 74 AT 09:52:02

IE 6
IE 6
IE 6
IE 3
IE 6
IE 6
IE 6
IE 500
IE 500
IE 500

TEMPERATURE RISE AS FUNCTION OF TIME IN MINE AND AGE AT BURIAL RUN ON 17 FEB 74 AT 09:52:04
AGE AT BURIAL 3.33 YEARS

TIME	TEMP	ALPHA*TIME/R**2
3150.0000	-1.2756	.914-02
6300.0000	-1.0374	.4820-02
9450.0000	-1.1030	.1474-01
12600.0000	-.5316+00	.1960-01
15750.0000	-10.19	.2457-01
18900.0000	-4.539	.2940-01
22050.0000	-3.150	.3440-01
25200.0000	.1307	.3931-01
28350.0000	.3421	.4423-01
31500.0000	.5273	.4914-01

SUMMARY OF INPUT DATA FOR THE CASE ABOVE

SL2 =
A = .1000000+03,
R = .1000000+03,
B = .1000000+03,
DIFFUS = .1500000-01,
PC = .3200000+02,
START = .3150000+04,
DELT = .3150000+04,
TMF = .2715000+06,
ARF = .1500000+02,
HOIHS = 10,
HOALPH = 500,
CRIT = .9999999-04,
LOFL = 1,
BRF = .1500000+02,
SEID =
GRI(1,1) = 587+0000 001
GLAIN = 2.638000-06
IE 6
IE 6
IE 6
IE 5
IE 6
IE 6
IE 6
IE 500
IE 500
IE 500

TEMPERATURE RISE AS FUNCTION OF TIME IN MINE AND AGE AT BURIAL RUN ON 17 FEB 74 AT 09:52:06
AGE AT BURIAL 3.33 YEARS

TIME	TEMP	ALPHA*TIME/R**2
3150.0000	3.186	.1950-01
6300.0000	4.028	.3921-01
9450.0000	4.474	.5897-01
12600.0000	-.3599+09	.7852-01
15750.0000	10.70	.9820-01
18900.0000	10.48	.1179
22050.0000	11.50	.1370
25200.0000	7.966	.1572
28350.0000	10.23	.1769
31500.0000	12.66	.1950

SUMMARY OF INPUT DATA FOR THE CASE ABOVE

SL2 =
A = .1000000+03,
R = .5000000+02,
B = .1000000+03,
DIFFUS = .1500000-01,
PC = .3200000+02,
START = .3150000+04,
DELT = .3150000+04,
TMF = .2715000+06,
ARF = .1500000+02,
HOIHS = 10,
HOALPH = 500,
CRIT = .9999999-04,
LOFL = 1,
BRF = .1500000+02,
SEID =
GRI(1,1) = 587+0000 001

SAMPLE OUTPUT: TALUS P. 2

CLAMP 2.638000-06
 IE 6
 IE 6
 IE 6
 IE 6
 IE 6
 IE 6
 IE 101
 IE 101
 IE 153

TEMPERATURE RISE AS FUNCTION OF TIME IN MINE AND AGE AT BURIAL RUN ON 17 FEB 74 AT 09:52:07
 AGE AT BURIAL 1.33 YEARS

TIME	TEMP	ALPHA*TIME/K**2
3150.0000	66.03	.7652-01
2950.0000	69.60	.1572
2650.0000	72.97	.2359
12000.0000	71.734+10	.3145
10750.0000	62.35	.3931
10700.0000	49.02	.4717
22050.0000	54.73	.5504
25200.0000	65.50	.6292
28350.0000	72.13	.7076
31500.001	78.40	.7862

SUMMARY OF INPUT DATA FOR THE CASE ABOVE

SL2
 A = .10000000+03.
 R = .25000000+02.
 H = .10000000+03.
 DIFFUS = .15000000-01.
 PC = .32040000+02.
 START = .31500000+04.
 DELT = .31500000+04.
 THF = .27156000+06.
 ARF = .15000000+02.
 INTMS = 10.
 HOALPH = 500.
 CRIT = .99999998-04.
 LOFL = .
 BRP = .15000000+02.

SEND
 G*(1,1)= 507.0000 001
 CLAMP 2.638000-06

IE 6
 IE 6
 IE 6
 IE 6
 IE 6
 IE 6
 IE 107
 IE 107
 IE 107

TEMPERATURE RISE AS FUNCTION OF TIME IN MINE AND AGE AT BURIAL RUN ON 17 FEB 74 AT 09:52:07
 AGE AT BURIAL 1.33 YEARS

TIME	TEMP	ALPHA*TIME/K**2
3150.0000	66.03	.4914
2950.0000	117.1	.7080
2650.0000	139.9	1.474
12000.0000	1272+10	1.966
10750.0000	215.9	2.457
10700.0000	202.1	2.948
22050.0000	215.5	3.440
25200.0000	201.1	3.931
28350.0000	209.4	4.423
31500.001	216.8	4.914

SUMMARY OF INPUT DATA FOR THE CASE ABOVE

SL2
 A = .10000000+03.
 R = .10000000+02.
 H = .10000000+03.
 DIFFUS = .15000000-01.
 PC = .32040000+02.
 START = .31500000+04.
 DELT = .31500000+04.
 THF = .27156000+06.
 ARF = .15000000+02.
 INTMS = 10.
 HOALPH = 500.
 CRIT = .99999998-04.
 LOFL = .
 BRP = .15000000+02.

SEND
 G*(1,1)= 507.0000 001
 CLAMP 2.638000-06

IE 6
 IE 6
 IE 6
 IE 6
 IE 6
 IE 6
 IE 35
 IE 35
 IE 35

SAMPLE OUTPUT: TALUS P. 3

TEMPERATURE RISE AS FUNCTION OF TIME IN MINE AND AGE AT BURIAL RUN ON 17 FEB 74 AT 09:52:08
AGE AT BURIAL 3.33 YEARS

TIME	TEMP	ALPHA*TIME/R**2
31500.000	429.1	54.60
28300.000	396.2	49.14
25200.000	366.2	43.60
22000.000	337.7	38.22
18900.000	254.0	32.76
15750.000	207.8	27.30
12600.000	136.3	16.38
9450.000	152.8	10.32
6300.000	157.8	9.60

SUMMARY OF INPUT DATA FOR THE CASE ABOVE

```

SL2
A      = .10000000+03.
R      = .50000000+01.
B      = .10000000+03.
DIFFUS = .15000000+01.
PC     = .32000000+02.
START  = .31500000+04.
DELT   = .31500000+04.
TRF    = .27150000+06.
ARF    = .15000000+02.
NOTHS  = 10.
HVALPH = 500.
CRIT   = .99999996+04.
LOFL   = 0.
BRF    = .15000000+02.
SEIU
G0(1,1) = 537.0000    001
CLANG = 2.638000-06
IE 6
IE 6
IE 6
IE 6
IE 6
IE 6
IE 58
IE 58
IE 58
    
```

TEMPERATURE RISE AS FUNCTION OF TIME IN MINE AND AGE AT BURIAL RUN ON 17 FEB 74 AT 09:52:08
AGE AT BURIAL 3.33 YEARS

TIME	TEMP	ALPHA*TIME/R**2
31500.000	429.1	54.60
28300.000	396.2	49.14
25200.000	366.2	43.60
22000.000	337.7	38.22
18900.000	254.0	32.76
15750.000	207.8	27.30
12600.000	136.3	16.38
9450.000	152.8	10.32
6300.000	157.8	9.60

SUMMARY OF INPUT DATA FOR THE CASE ABOVE

```

SL2
A      = .10000000+03.
R      = .36000000+01.
B      = .10000000+03.
DIFFUS = .15000000+01.
PC     = .32000000+02.
START  = .31500000+04.
DELT   = .31500000+04.
TRF    = .27150000+06.
ARF    = .15000000+02.
NOTHS  = 10.
HVALPH = 500.
CRIT   = .99999998+04.
LOFL   = 0.
BRF    = .15000000+02.
SEIU
G0(1,1) = 537.0000    001
CLANG = 2.638000-06
    
```

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00125 OF MAIN PROGRAM

CSCX PL683J 17 FEB 74 9:51:41 USER CUL928 PUN025

CARDS-IN 53 OUT 718 LINES 2146 PROCESSING TIME 23.21 SECONDS

LISTING AND SUBROUTINE COMPILATION: TALUS P. 1

```

17. PUN FUNDIS-CENTRA. 150-0004/1000 6 JUN68 3760 0205 903576
3 ELY TALUS/5975.1-720512- 24520
4 ELY 8
5 ELY 8
6 ELY 8
7 ELY 8
8 ELY 8
9 ELY 8
10 ELY 8
11 ELY 8
12 ELY 8
13 ELY 8
14 ELY 8
15 ELY 8
16 ELY 8
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129 ELY 8
 
```

LISTING AND SUBROUTINE COMPILATION: TALUS P. 2

```

C PROGRAM IS USED TO COMPUTE TEMPERATURE RISE IN SANDWICH PLATE
C ACTUALLY TWO CONTAINERS BURIED IN A WALL. ONE HAS A FUNCTION OF TIME IN
C TIME AND AGE AT BURIAL
C
C *** *** *** SUBROUTINE REQUIRED *** *** ***
C
C (FROM LIBRARY) * (LEVEL 001)
C T00- TIME OF DAY * FROM COMPLEMENTARY 0000 FUNCTION
C T01- DATE * PW- REAL PART OF COMPLEX ERROR FUNC-
C T02- DEVIATE CHECK * TION WIZ).
C T03- OVERFLOW CHECK * ONE- SOLUTION OF TERM INDEPENDENT OF
C COS- COSINE * A AND B. (IFR01)
C EXP- EXPONENTIAL * TWO- SOLUTION OF TERM
C
C COSH- HYPERBOLIC COSINE *
C SQR- SQUARE ROOT * FROM Bessel FUNCTION J2(2.404834)
C
C INPUT DESCRIPTION
C INPUT IS BY NAMELIST. NAMELIST NAME IS: LI
C VARIABLE NAMES IDENTIFIED BY NAMELIST. THEIR TYPES, DIMENSIONS AND
C DEFINITIONS ARE AS FOLLOWS:
C
C NAME DIMENS TYPE DEFINITION
C
C A 1 R RADIUS OF INFINITELY LONG CYLINDER (MEDIUM IN WHICH
C HEAT SOURCE IS LOCATED). FT.
C
C B 1 R 0.5*LENGTH OF LINE SOURCE. FT.
C
C R 1 R RADIAL DISTANCE (MEASURED FROM CENTER OF INFINITE
C CYLINDER) AT WHICH TEMPS ARE TO BE CALCULATED. FT.
C
C PC 1 R VOLUME HEAT CAPACITY OF MEDIUM. BTU/CU FT DEGREE F
C
C START 1 R TIME AT WHICH FIRST TEMPERATURE IS TO BE CALCULATED
C +HRS
C
C DELT 1 R TIME INCREMENT BETWEEN TEMPERATURE CALCULATIONS +HRS
C
C D 1 R DIFFUSIVITY OF MEDIUM. SQ FT/HR.
C
C CONV 1 I CONTROL VARIABLE. ZERO TO SUPPRESS INTERMEDIATE
C PRINT OUT (CONVERGENCE, TERM1, TERM2, ETC). POSITIVE
C NON-ZERO TO GET PRINTOUT. ASSUMED ZERO IF NOT GIVEN
C AS INPUT.
C
C LOFL 1 I CONTROL VARIABLE FOR BYPASSING CALL TO SUBROUTINE ONE.
C SUBROUTINE ONE WILL BE CALLED ONLY IF LOFL=1
C LOFL MUST BE SET TO 1 ANY TIME INPUT VARIABLES
C OTHER THAN A OR B ARE BEING CHANGED.
C THE PROGRAM LOGIC SETS LOFL TO 1 FOR THE FIRST CASES
C FOR SUCCEEDING CASES LOFL IS SET TO ZERO EXCEPT
C WHEN KNS IS NON-ZERO IMPLYING A CHANGE IN VALUE FOR
C THE VARIABLE B. A VALUE OF LOFL IN NAMELIST INPUTS
C WILL ALWAYS OVERRIDE THE VALUE OF LOFL SELECTED BY
C PROGRAM LOGIC
C
C CLAM1 8 R DECAY CONSTANT FOR NUCLIDE 1. RECIPROCAL HOURS
C
C AGEBU 8 R AGE OF WASTE AT TIME OF BURIAL
C
C NNU 1 I NUMBER OF HEAT GENERATING NUCLIDES TO BE CONSIDERED
C 3 MAX.
C
C NALPH 1 I NUMBER OF ZEROS OF J2(2.404834) +500 MAXIMUM
C
C NDAGE 1 I NUMBER OF VALUES OF AGEBU FOR THIS DATA SET. 3 MAX.
C
C NTHS 1 I 1 + THE NUMBER OF TIMES DELT IS TO BE APPLIED
C (ASSUMED 20 IF NOT GIVEN IN INPUT)
C
C ODI(N) 8*8 P HEAT GENERATION RATE BTU/HR FT. OF NUCLIDE(I) AT
C AGEBU(I). COMPLETE LIST FOR 3 NUCLIDES AT ONE AGE.
C 8 AT NEXT AGE, ETC.
C
C CPIT 1 I CONVERGENCE CRITERIA FOR GETTING OUT OF SUMMING
C LOOP. USED IN SUBROUTINE TWO. IN DATA AS 0.0001
C
C ARF 1 R FACTOR TO CALCULATE "A" FROM R BY: A=ARF*R.
C (ASSUMED 15 IF NOT GIVEN AS INPUT)
C
C BRP 1 R FACTOR TO CALCULATE "B" FROM P BY: B=BRP*P.
C (ASSUMED 15 IF NOT GIVEN AS INPUT)
C
C TMR 1 R FACTOR TO CALCULATE TMR FROM TMR*TF*0.00075
C (ASSUMED 271500 IF NOT GIVEN AS INPUT)
C
C KNS 1 I CONTROL VARIABLE. ASSUMED ZERO IF NOT INPUT.
C IF KNS IS POSITIVE NON-ZERO THE PROGRAM WILL CON-
C TINUE A AND B. AND WILL COMPUTE A VALUE
C FOR START HAVING KNS SIGNIFICANT FIGURES. PA/19/69
C DELT WILL BE SET START.

```

C

0 ELT 00751F90107205120 24522
0 EOF 0

306.

LISTING AND SUBROUTINE COMPILATION: TALUS P. 4

```

C      MONIT IS A CONTROL VARIABLE, SET TO 1 TO GET THE VALUE
C      OF THE VARIABLE SUM IN STATEMENT 10 PRINTED FOR EACH
C      ITERATION. IF NOT 1, NO PRINT.
C      1 FORMAT(1X,MONIT,10X,CHECK INDICATOR ON AT Y2,1PE10.4, 4X, X2,
C      2E10.4,10X, ITERATION NO.,1X)
C      2 FORMAT(1X,10X,VALUE OF SUM IN SUBROUTINE ON AT Y2,1PE10.4, 4X, X2,
C      2E10.4,10X, ITERATION NO.,1X)
C      100000
C      DIMENSION FMT(10),FMT(10)
C      DATA (FMT(1),FMT(2),FMT(3),FMT(4),FMT(5),FMT(6),FMT(7),FMT(8),FMT(9),FMT(10))
C      DATA (1,2,3,4,5,6,7,8,9,10)
C      252X,10X,MONIT,10X,ITERATION NO.,1X,10X,VALUE OF SUM IN SUBROUTINE ON AT Y2,1PE10.4, 4X, X2,
C      2E10.4,10X, ITERATION NO.,1X)
C      NAMELIST /FMTS/ F1,F2,C1,A1,A2,UM
C      CALL OVCHK(UM)
C      CALL OVCHK(UM)
C      SPFY=1.-CFFC(1Y)
C      COSTXY=COS(2.X+Y)
C      Y2=Y+2
C      X2=X+X
C      CFX2=CFFC(X2)
C      F1=3.1415927
C      KLUE=2
C      SUM=0.0
C      F1= EXP(Y2-X2)+COSTXY+1.-CFFC(1Y)
C      F2= FMAX+1.-COSTXY/(2.-F1+Y2)
C      C1=4.-Y+CMX2/F1
C      DO 40 A=1,4N
C      YN=Y+4N
C      A1= (EXP(F1-.25)+A+2)/((N+2+4.YC)
C      A2=COS(HIN+X)-COSTXY
C      20 SUM=SUM+A1+A2
C      IF (MONIT.EQ.1) GO TO 30
C      CALL OVCHK(UM)
C      IF (X2.EQ.1) WRITE(6,1) IF,X,N
C      CALL OVERFL(UM)
C      IF (X2.EQ.1) WRITE(6,2) IF,X,N
C      K= N - 10*(1-1/10)
C      FMT(2)=SUM/FMT(1)
C      WRITE(6,FMT) SUM
C      IF (X2.EQ.10) WRITE(6,2)
C      2. FORMAT(1X)
C      30 IF (A1+A2/SUM).LT.CRT1) GO TO 70
C      40 CONTINUE
C      GO TO 80
C      70 KLUE=1
C      80 R=F1+F2+C1*SUM
C      IF (MONIT.EQ.1) GO TO 10
C      WRITE(6,FMT) SUM
C      10 CONTINUE
C      RETURN
C      END
C      8 ELT CPOFF/SIFS.1.720512. 24511
C      8 EOF 8
C      SUBROUTINE CPOFF(V,NC)
C      C A SUBROUTINE TO ROUND A NUMBER (V) TO NS SIGNIFICANT DIGITS.
C      C NS MUST BE GREATER THAN 0 AND LESS THAN 9
C      1 FORMAT(1X,SUBROUTINE CPOFF CALLED WITH REQUEST FOR ROUNDING TO
C      212. SIGNIFICANT FIGURES. NO ROUNDING DONE. V=,1PE20.7)
C      REAL X(1),FREAL(2),UPD2(1)
C      DATA (FREAL(1),J=1,2) /1241E 20,XXXXXX/
C      DATA (UPD2(1),J=1,2) /1241E 20,XXXXXX/
C      7A1
C      DATA M7-/
C      IF (NS.GT.0.AND.NS.LT.9) GO TO 10
C      WRITE(6,1) NC,V
C      RETURN
C      10 FREAL(2)=UPD2(1NS)
C      CALL NCCODE(X,6)
C      WRITE(6,FREAL) V
C      CALL NCCODE(X,6)
C      READ(6,FREAL) V
C      RETURN
C      END
C      8 ELT ONE/SIFS.1.720626. 46610
C      8 EOF 8
C      SUBROUTINE ONE
C      INTEGER OPT,CGN
C      PARAMETER NOTM=100
C      DIMENSION CLAMP(3),ALPHA(100),ACOS(10),TIME(100),TERM1
C      11(10),11,TERM2(100),R1,T(10),G(10),S1
C      COMMON A,C,F,CLAMP,NOMU,ALPHA,ALPHA,ALPHA,NLAGE,OPT,START,DELT,
C      1NOM1,TIME,3,C,CONV,TERM1,TERM2,TEST,T,LOFL,PI,CPT,CRT
C      DO 1 I=1,NOMU
C      DO 1 N2=1,ALPHA
C      CA=(N2-1)
C      TIME(N2)=START+CA*DELT
C      IF (TIME(N2)-10.1).GT.0

```

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LISTING AND SUBROUTINE COMPILATION: TALUS P. 6

```

21 DO 3 I=1,NONE
   DO 4 N=1,NONE
   IF (CONV.NE.O) WRITE (OPT,95) I,N2
25 FORMATTING: PRINT AT 11 IN OR TWO. NUCLIDE:13.0K AT TIME:10000
   RTCLAM(I)=TIME(N2)
   SS=ENF(I-PC)
   DO 777 N=1,NALPH
   SUMIN=0
777 CONTINUE
   TUM=0
   AM=0
   DO 7 N=1,NALPH
   TID=CLAM(I)-IC+ALPHA(N)*211
   VV=ALFA(N)*T
   LW=SS*MMIVV*11
   XX=SS*MMIALPHA(N)*11
   YY=(SS+2.1)/TT*(XX*2.1)
   AS=AS+TTT
   ZD=AS+TIME(N2)
   AD=AE/0
   AT=STRT(AD)
   AC=AT*AT
   AF=EXP(1-AT)
   IF (AS+ZZI-11.015*5.6
6   AI=EXP(TT+TIME(N2))
   AJ=ALC+D*TIME(N2)
   AK=B/SORT(AJ)
   AL=1-PRF(AK)
   AM=AL*AI
   AN=1-1.0*AM
   AO=AS+YY
   TUM=TUM+AN
   SUMIN=SUMIN+TUM
   GO TO 8
5   AI=EXP(TT+TIME(N2))
   AJ=ALC+D*TIME(N2)
   AK=B/SORT(AJ)
   AL=1-PRF(AK)
   AM=AL*AI
   AN=EXP(AE)
   AO=AT+TIME(N2)
   AR=SOPT(AE)
   AR=AT*AK
   AS=AS+AK
   FAS=1-PRF(AS)
   AT=INT(TAT)/0.0
   FAP=1-PRF(AR)
   AU=(AM+FAF)*0.5
   AV=(AM-1.0*(0.5*AN)+(0.5*AF)*AT-AJ)
   AH=AV+YY
   TUM=TUM+AH
   SUMIN=SUMIN+TUM
8   FNOIMS=NOIMS
12 TEST = AM/TUM
   IF (N.LT.3) GOTO 7
216 FORMATTING: N=IN+9K.5NTEST=1PE13.7)
   TEP2(N2)=SUMIN
   IF (CONV.NE.O) WRITE (OPT,216) N,TEST
   IF (N.LT.2) GO TO 7
   IF (ABS((SUMIN)-SUMIN-1)/((4-AXI)*SUMIN-1)*1.2-10)) LE.CRIT)
260 TO 5999 NOTE THIS IS A CONTINUATION OF ABOVE STATEMENT
7 CONTINUE
   WRITE (6,35) NALPH
35 FORMAT(3H N=IN)
   GO TO 222
9999 WRITE (6,55) N
55 FORMAT(3H N=IN)
222 AR=AH/SS
   B1=YY/SS
   B3=5*AN*5*AF
   ZIC=
   NNN=
   IF (CONV.NE.O) WRITE (6,DLIST2)
6 CONTINUE
   FIN=ISTART+(FNOIMS-1.1)*DELTA
   IF (CONV.LE.O) GO TO 1
   WRITE (OPT,10) ISTART,FIN,1
14 FORMATTING: INTERP/11H START TIME=C12.0.7H HOURS=13H FINISH TIME=C1
   12.0.7H HOURS/8H NUCLIDE:13)
   WRITE (OPT,15) (N2,TEP2(N2),C1,N2=1,NOIMS)
15 FORMATTING: (15H N2=13.2H ) *C12.0)
3 CONTINUE
   RETURN
   END

```

LISTING AND SUBROUTINE COMPILATION: TALUS P. 7

```

3 C LT BESMMX/SIFR.1.72P*17. 386*2
3 EOF 3
      FUNCTION BESMMX(X,M)
C----- M=1. JZERO(X)
C----- M=2. IZERO(X)
C----- M=3. JONE(X)
C----- M=4. IONE(X)
      DIMENSION FMT(4)
      DIMENSION TERM(2),T(1),X(12),BESSL(12)
      EQUIVALENCE (FMT,F,FMT2)
      DATA TWOM26,TWOM30/0.474081122,0.193446607/
      DATA TWOM26,PI,PIRG,PIHALF,PIFTH/0.191853,2.3551945,1.5707963,
10.78539816/
      DATA (FMT(I),I=1,4)/54NH/43H +--- ARG OF IZERO FUNCTION IS GREATER
1 THAN 68.0//
      DATA HIZERO,HICNE/5HTZERO,5HT-ONE/
      X=ABS(X)
      IF(X.GT.5.0) GO TO 400
      Z=0.5*X
      ZSQ=Z*Z
      GO TO (10,110,210,310),M
C----- JZERO. NORMAL SERIES INITIALIZATION
10  ZSQ=-ZSQ
   20  TEST=TWOM30
   30  TERM=ZSQ
      BESMMX=1.0+TERM
      BESSL=BESMMX
      C=1.0
      FNF1=2.0
      FNF2=2.0
C----- SUM NORMAL SERIES
   40  DO 40 N=1,100
      TERM=ZSQ*TERM/C
      BESMMX=BESMMX+TERM
C----- TEST TO CUT OFF SERIES
      IF((ABS(TERM).LT.TEST).OR.(BESSL.EQ.BESMMX)) GO TO 999
      BESSL=BESMMX
      FNF1=FNF1+1.0
      FNF2=FNF2+1.0
      C=FNF1*FNF2
   40  CONTINUE
C----- IZERO. NORMAL SERIES INITIALIZATION
110 TEST=TWOM26
   GO TO 20
C----- JONE. NORMAL SERIES INITIALIZATION
210 TEST=TWOM30
   ZSQ=-ZSQ
   220 C=2.0
      FNF1=1.0
      TERM=Z
      BESMMX=TERM
   GO TO 30
C----- IONE. NORMAL SERIES INITIALIZATION
310 TEST=TWOM26
   GO TO 220
C----- ASYMPTOTIC SERIES INITIALIZATION
400 X8(1)=1.0/(8.0*X)
   I1=1
   I2=2
   GO TO (410,510,610,710),M
C----- JZERO. ASYMPTOTIC SERIES INITIALIZATION
410 X8(2)=-X8(1)
   TEST=TWOM30
   420 T(1)=4.5*X8(1)*X8(2)
      T(2)=-X8(1)
      C=-25.0/3.0
      FNF1=3.0
      F2NF=5.0
      FM2N=-5.0
   430 BESSL(1)=1.0
      BESSL(2)=0.0
C----- SUM ASYMPTOTIC SERIES
440 DO 450 N=1,100
      TERM(1)=T(I2)
      BESSL(I2)=BESSL(I2)+TERM(I2)
      T(I2)=C*X8(I1)*T(I1)
C----- TEST TO CUT OFF SERIES
      IF((ABS(T(I2)).GE.ABS(T(I1))*.09*(ABS(T(I2)).LT.TEST)) GO TO 460
      FNF1=FNF1+1.0
      F2NF=F2NF+2.0
      FM2N=FM2N+2.0
      C=F2NF*FM2N/FNF1
      I1=I2
   450 I2=3-I1
   460 BESSL(1)=BESSL(1)+0.5*T(I1)
      IF(ABS(TERM(I2)).GE.ABS(T(I2))) GO TO 470
      T(I2)=-TERM(I2)
   470 BESSL(2)=BESSL(1)+0.5*T(I2)
      GO TO (810,920,830,820),M

```

LISTING AND SUBROUTINE COMPILATION: TALUS P. 8

```

C---- ZERO, ASYMPTOTIC SERIES INITIALIZATION
510 X(1)=X(1)
TEST=TWO*Z
IF(X.LE.83.0) GO TO 400
FMT(4)=H10NC
GO TO 900
C---- ONE, ASYMPTOTIC SERIES INITIALIZATION
510 X(1)=X(1)
TEST=TWO*Z
520 T(1)=1.1*X(1)*X(1)
T(2)=3.0*X(1)
CF=7.0
FNF1=3.0
FNF2=3.0
FNF3=7.0
GO TO 430
C---- ZONE, ASYMPTOTIC SERIES INITIALIZATION
510 X(1)=X(1)
TEST=TWO*Z
IF(X.LE.83.0) GO TO 620
FMT(4)=H10NC
GO TO 900
900 XMP=X-FIFTH
810 BESMM=(1.0/SGRT(FHALF*X))*(CESSL(1)*COS(XMP)-CESSL(2)*SIN(XMP))
GO TO 999
820 BESMM=(EXP(X)/SGRT(TWO*F*X))*(CESSL(1)-CESSL(2))
GO TO 999
830 XMP=X-FIFTH
GO TO 810
900 WRITE (6,FMT)
999 RETURN
END

```

8 ELT E9FC/SIF5.1.720517. 34853
8 EOF 8

```

FUNCTION ERFC(X)
DIMENSION A(5)
F=0.3275911
A(5)=0.254829592
A(4)=-0.284495736
A(3)=1.421413741
A(2)=-1.453152027
A(1)=1.061405425
T=1/(1+F*X)
S=A(1)
DO 1 I=2,5
1 S=S+T*A(I)
ERFC=S+T*EXP(-X**2)
RETURN
END

```

06170274 C08928FUNC16 100 2284 53 718 2121 95112 1 00000 6 5

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PROGRAM NAME: TEMP

Descriptive Title: Transient Temperature Gradients Near a Waste Tank with a Concrete Wall

Program Author: Richardson, Richard L.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Underground Tanks

Program Description: Estimates transient temperatures in a concrete wall and infinite extent of soil with an imposed linear rate of temperature rise followed by a constant temperature at the inside of the concrete. Analytical solution with one subroutine for calculating error functions. A table of temperatures and local temperature gradients in the concrete and in the soil is printed out as a function of time and position.

Users of Program: G. Jansen
R. Richardson
WV DeMier

Documentation: Results appear in letter from G. Jansen to P. Hatch, Isochem, "Transient Temperatures During Tank Startup," March 3, 1967.

Condition of Program: It works well.

SAMPLE INPUT: TEMP

TEMP 10:28 02/17/74

100 QS RUN PUN021,CUBS28,GEORGE,150,6000/3000 G JANSEN-3760 BLD

G 9423576

101 QN MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFO00

115 @PRL TEL INFO00

120 @PRL TEL CUR928

125 @X ASG A=U1145(JJ1145)

130 @N XQT CUR

150 FIND A,ERFC/SIFS

160 TRD A

170 FIND A,TEMP/SIFS

180 TRD A

350 TRI A

351 PCH TEMP/SIFS

352 PCH ERFC/SIFS

360 @IM FR5,* TEMP/SIFS,TEMP/SIFS,TEMP/RIFS

380 @IM FR5,* ERFC/SIFS,ERFC/SIFS,ERFC/RIFS

1000 @LI XQT TEMP/RIFS

1010	1.0	0.5	0.01	0.005	2.0	0.0986	14.
1020	40.	0.0001	-1.5	-1.0	-0.5	+0.0	+
1030	1.0	+2.0	6.0	8.0	10.0	70.0	
1040	8	4.0	6.0	8.0	10.0	70.0	
1050	0.0	24.	48.	120.	576.	1440.	28
1060	80.	5000.					

1060 @ FIN
READY

ALL NOT TYPED
ON A LLIGHT SENSITIVE PAPER
THIS ALLOCATION WAS DONE ON 17 FEB-74 AT 10:53:53

INPUT VARIABLES

RELATIVELY CONSTANT INPUT VARIABLES WITH VALUES

K(1) - THERMAL CONDUCTIVITY OF CONCRETE, 1.0000 BTU/HR.FT.².DEGREES(F)/FT

K(2) - THERMAL CONDUCTIVITY OF SOIL, .50000 BTU/HR-FT-20 DEGREES (F)/FT

A(1) - THERMAL DIFFUSIVITY OF CONCRETE, .01000 FT**2/HR

A(2) - THERMAL DIFFUSIVITY OF SOIL. .00500 FT.²/HR

L - CONCRETE THICKNESS, 2.0000 FT

A - ARBITRARY CONSTANT INPUT PARAMETER, .09860 DEGREES(F)/HR

TO - FILLING TIME, AN INPUT PARAMETER, 1440.00 HR

TEMP(1,0) = "INITIAL TEMPERATURE SYSTEM, ASSUMED INDEPENDENT OF POSITION," 70.00000 DEGREES(F)

ZERO - 00010000

TABLE OF VALUES OF TEMPERATURE IN DEGREES FAHRENHEIT

TIME, DAYS	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)	X(11)	X(12)
	-2.00	-1.50	-1.00	-0.50	-0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
0.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.00	72.37	70.84	70.12	70.02	70.00	70.00	-0.20	70.00	70.00	70.00	70.00	70.00
1.00	-5.451+00	-1.661+00	-0.550-01	-7.362-02	-0.418-03	-1.263-02	-1.702-05	-3.374-12	4.696-28	0.000	0.000	0.000
2.00	74.73	71.95	70.68	70.20	70.06	70.06	70.00	70.00	70.00	70.00	70.00	70.00
2.00	-7.708+00	-3.799+00	-1.547+00	-5.213-01	-1.216-01	-2.432-01	-1.985-03	-2.415-06	-4.397-15	2.567-26	0.000	0.000
5.00	81.83	76.87	73.77	71.98	71.07	71.07	70.09	70.09	70.00	70.00	70.00	70.00
5.00	-3.177-01	-7.703-02	-0.700-02	-2.585-02	-1.077-02	-2.349-02	-2.447-04	-1.272-03	-1.034-06	-3.000-11	-0.012-10	-0.000-05
20.00	126.79	115.30	106.04	98.70	93.26	93.26	79.82	73.68	70.35	70.02	70.00	70.00
20.00	-2.537+01	-2.068+01	-1.646+01	-1.273+01	-9.371+00	-1.877+01	-9.039+00	-3.881+00	-4.602-01	-3.075-02	-1.105-03	-2.657-05
60.00	211.90	198.34	179.13	160.05	155.03	155.03	121.91	100.31	78.95	72.16	70.42	70.00
60.00	-3.767-01	-3.201+01	-2.829+01	-2.403+01	-2.098+01	-4.615+01	-2.575+01	-1.703+01	-5.903+00	-1.652+00	-3.675-01	-0.451-02
120.00	211.90	205.49	199.04	192.68	186.45	186.45	162.69	141.27	107.91	87.50	77.04	72.44
120.00	-1.300+01	-1.295+01	-1.282+01	-1.261+01	-1.231+01	-2.462+01	-2.274+01	-1.997+01	-1.331+01	-7.374+00	-3.442+00	-1.373+00
208.33	211.90	207.54	203.12	196.70	194.33	194.33	177.25	160.99	132.15	109.47	93.25	82.63
208.33	-8.907+00	-8.886+00	-8.845+00	-8.777+00	-8.681+00	-1.736+01	-1.673+01	-1.574+01	-1.296+01	-0.956+00	-0.599+00	-0.402+00

TABLE OF VALUES OF TEMPERATURE IN DEGREES CENTIGRADE

	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)	X(11)	X(12)
TIME, DAYS	-2.00	-1.50	-1.00	-.50	-.00	.00	1.00	2.00	4.00	6.00	8.00	10.00
.00	21.11 0.900	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000	21.11 0.000
1.00	22.43 -3.020+00	21.47 -1.045+00	21.18 -2.520-01	21.12 -0.091-02	21.11 -3.560-03	21.11 -7.127-13	21.11 -0.482-07	21.11 -1.875-12	21.11 2.609+20	21.11 0.000	21.11 0.000	21.11 0.000
2.00	23.74 -0.202+00	22.19 -2.609+00	21.49 -0.592-01	21.22 -2.697-01	21.14 -0.750-02	21.14 -1.351-01	21.11 -1.103-01	21.11 -1.342-06	21.11 -2.443-15	21.11 1.426-26	21.11 0.000	21.11 0.000
5.00	27.00 -0.760+00	24.93 -0.508+00	23.21 -2.627+00	22.21 -1.436+00	21.79 -0.525-01	21.70 -1.305+00	21.16 -1.307-01	21.11 -7.067-03	21.11 -1.963-06	21.11 -1.869-11	21.11 -3.768-19	21.11 1.620-25
20.00	52.06 -1.400+01	46.20 -1.149+01	41.13 -0.146+00	37.09 -7.090+00	34.03 -5.250+00	34.03 -1.041+01	26.57 -5.922+00	23.16 -2.134+00	21.31 -2.557-01	31.12 -1.708-02	21.11 -0.140-04	21.11 -1.153-05
60.00	99.99 -2.000+01	90.22 -1.023+01	81.74 -1.572+01	74.47 -1.138+01	68.35 -1.115+01	68.35 -2.231+01	60.95 -1.486+01	37.95 -9.447+00	26.09 -1.280+00	22.31 -9.177-01	21.34 -2.043-01	21.15 -1.134-02
120.00	99.99 -7.221+00	95.30 -7.197+00	92.93 -7.124+00	89.27 -7.060+00	85.01 -0.040+00	85.01 -1.360+01	72.00 -1.263+01	65.79 -1.110+01	42.17 -7.396+00	30.83 -4.097+00	25.02 -1.912+00	22.49 -7.627-01
200.00	99.99 -0.304+00	97.52 -0.375+00	95.03 -0.914+00	92.01 -0.076+00	79.18 -0.023+00	79.18 -0.046+00	40.70 -0.296+00	71.66 -2.753+00	55.04 -7.199+00	43.04 -3.586+00	34.03 -3.066+00	27.15 -0.227+00

CSCA PLGB3J 17 FEB 74 10:51:25 USER GUY22 PUL021

CARDS IN 22 OUT 146 LINES 414 PROCESSING TIME 27.75 SECONDS

LISTING AND SUBROUTINE COMPILATION: TEMP P. 1

19 CONTINUE

LISTING AND SUBROUTINE COMPILATION: TEMP P. 2

```

100 TEMPI(I,J)=5*(TEMP0
GRAD(I,J)=0.0
16 CONTINUE
WRITE (3,600)X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X13,X14,X15,X16,X17,X18,X19,X20,X21,X22,X23,X24,X25,X26,X27,X28,X29,X30,X31,X32,X33,X34,X35,X36,X37,X38,X39,X40,X41,X42,X43,X44,X45,X46,X47,X48,X49,X50,X51,X52,X53,X54,X55,X56,X57,X58,X59,X60,X61,X62,X63,X64,X65,X66,X67,X68,X69,X70,X71,X72,X73,X74,X75,X76,X77,X78,X79,X80,X81,X82,X83,X84,X85,X86,X87,X88,X89,X90,X91,X92,X93,X94,X95,X96,X97,X98,X99,X100,X101,X102,X103,X104,X105,X106,X107,X108,X109,X110,X111,X112,X113,X114,X115,X116,X117,X118,X119,X120,X121,X122,X123,X124,X125,X126,X127,X128,X129,X130,X131,X132,X133,X134,X135,X136,X137,X138,X139,X140,X141,X142,X143,X144,X145,X146,X147,X148,X149,X150,X151,X152,X153,X154,X155,X156,X157,X158,X159,X160,X161,X162,X163,X164,X165,X166,X167,X168,X169,X170,X171,X172,X173,X174,X175,X176,X177,X178,X179,X180,X181,X182,X183,X184,X185,X186,X187,X188,X189,X190,X191,X192,X193,X194,X195,X196,X197,X198,X199,X200,X201,X202,X203,X204,X205,X206,X207,X208,X209,X210,X211,X212,X213,X214,X215,X216,X217,X218,X219,X220,X221,X222,X223,X224,X225,X226,X227,X228,X229,X230,X231,X232,X233,X234,X235,X236,X237,X238,X239,X240,X241,X242,X243,X244,X245,X246,X247,X248,X249,X250,X251,X252,X253,X254,X255,X256,X257,X258,X259,X260,X261,X262,X263,X264,X265,X266,X267,X268,X269,X270,X271,X272,X273,X274,X275,X276,X277,X278,X279,X280,X281,X282,X283,X284,X285,X286,X287,X288,X289,X290,X291,X292,X293,X294,X295,X296,X297,X298,X299,X300,X301,X302,X303,X304,X305,X306,X307,X308,X309,X310,X311,X312,X313,X314,X315,X316,X317,X318,X319,X320,X321,X322,X323,X324,X325,X326,X327,X328,X329,X330,X331,X332,X333,X334,X335,X336,X337,X338,X339,X340,X341,X342,X343,X344,X345,X346,X347,X348,X349,X350,X351,X352,X353,X354,X355,X356,X357,X358,X359,X360,X361,X362,X363,X364,X365,X366,X367,X368,X369,X370,X371,X372,X373,X374,X375,X376,X377,X378,X379,X380,X381,X382,X383,X384,X385,X386,X387,X388,X389,X390,X391,X392,X393,X394,X395,X396,X397,X398,X399,X400,X401,X402,X403,X404,X405,X406,X407,X408,X409,X410,X411,X412,X413,X414,X415,X416,X417,X418,X419,X420,X421,X422,X423,X424,X425,X426,X427,X428,X429,X430,X431,X432,X433,X434,X435,X436,X437,X438,X439,X440,X441,X442,X443,X444,X445,X446,X447,X448,X449,X450,X451,X452,X453,X454,X455,X456,X457,X458,X459,X460,X461,X462,X463,X464,X465,X466,X467,X468,X469,X470,X471,X472,X473,X474,X475,X476,X477,X478,X479,X480,X481,X482,X483,X484,X485,X486,X487,X488,X489,X490,X491,X492,X493,X494,X495,X496,X497,X498,X499,X500,X501,X502,X503,X504,X505,X506,X507,X508,X509,X510,X511,X512,X513,X514,X515,X516,X517,X518,X519,X520,X521,X522,X523,X524,X525,X526,X527,X528,X529,X530,X531,X532,X533,X534,X535,X536,X537,X538,X539,X540,X541,X542,X543,X544,X545,X546,X547,X548,X549,X550,X551,X552,X553,X554,X555,X556,X557,X558,X559,X560,X561,X562,X563,X564,X565,X566,X567,X568,X569,X570,X571,X572,X573,X574,X575,X576,X577,X578,X579,X580,X581,X582,X583,X584,X585,X586,X587,X588,X589,X590,X591,X592,X593,X594,X595,X596,X597,X598,X599,X600,X601,X602,X603,X604,X605,X606,X607,X608,X609,X610,X611,X612,X613,X614,X615,X616,X617,X618,X619,X620,X621,X622,X623,X624,X625,X626,X627,X628,X629,X630,X631,X632,X633,X634,X635,X636,X637,X638,X639,X640,X641,X642,X643,X644,X645,X646,X647,X648,X649,X650,X651,X652,X653,X654,X655,X656,X657,X658,X659,X660,X661,X662,X663,X664,X665,X666,X667,X668,X669,X670,X671,X672,X673,X674,X675,X676,X677,X678,X679,X680,X681,X682,X683,X684,X685,X686,X687,X688,X689,X690,X691,X692,X693,X694,X695,X696,X697,X698,X699,X700,X701,X702,X703,X704,X705,X706,X707,X708,X709,X710,X711,X712,X713,X714,X715,X716,X717,X718,X719,X720,X721,X722,X723,X724,X725,X726,X727,X728,X729,X730,X731,X732,X733,X734,X735,X736,X737,X738,X739,X740,X741,X742,X743,X744,X745,X746,X747,X748,X749,X750,X751,X752,X753,X754,X755,X756,X757,X758,X759,X760,X761,X762,X763,X764,X765,X766,X767,X768,X769,X770,X771,X772,X773,X774,X775,X776,X777,X778,X779,X780,X781,X782,X783,X784,X785,X786,X787,X788,X789,X790,X791,X792,X793,X794,X795,X796,X797,X798,X799,X800,X801,X802,X803,X804,X805,X806,X807,X808,X809,X810,X811,X812,X813,X814,X815,X816,X817,X818,X819,X820,X821,X822,X823,X824,X825,X826,X827,X828,X829,X830,X831,X832,X833,X834,X835,X836,X837,X838,X839,X840,X841,X842,X843,X844,X845,X846,X847,X848,X849,X850,X851,X852,X853,X854,X855,X856,X857,X858,X859,X860,X861,X862,X863,X864,X865,X866,X867,X868,X869,X870,X871,X872,X873,X874,X875,X876,X877,X878,X879,X880,X881,X882,X883,X884,X885,X886,X887,X888,X889,X890,X891,X892,X893,X894,X895,X896,X897,X898,X899,X900,X901,X902,X903,X904,X905,X906,X907,X908,X909,X910,X911,X912,X913,X914,X915,X916,X917,X918,X919,X920,X921,X922,X923,X924,X925,X926,X927,X928,X929,X930,X931,X932,X933,X934,X935,X936,X937,X938,X939,X940,X941,X942,X943,X944,X945,X946,X947,X948,X949,X950,X951,X952,X953,X954,X955,X956,X957,X958,X959,X960,X961,X962,X963,X964,X965,X966,X967,X968,X969,X970,X971,X972,X973,X974,X975,X976,X977,X978,X979,X980,X981,X982,X983,X984,X985,X986,X987,X988,X989,X990,X991,X992,X993,X994,X995,X996,X997,X998,X999,X1000,X1001,X1002,X1003,X1004,X1005,X1006,X1007,X1008,X1009,X1010,X1011,X1012,X1013,X1014,X1015,X1016,X1017,X1018,X1019,X1020,X1021,X1022,X1023,X1024,X1025,X1026,X1027,X1028,X1029,X1030,X1031,X1032,X1033
```

Q ELT: EFC/SIFC.1.701130. 44601
Q EOF Q

```

FUNCTION ERFC(X)
  DIMENSION A(5)
  Z=0.3275911
  A(5)=0.254269592
  A(4)=-0.284496736
  A(3)=1.421413741
  A(2)=-1.453152027
  A(1)=1.061405429
  Y=1/(1+P*X)
  S=A(1)
  D=1-I=2.0
  S=S+T+A(I)
  EPFC=S+*EXP(-X**2)
  RETURN
END

```

06170278 CU9928FUNC21 100 2775 22 146 41105325 1 00000

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PROGRAM NAME: THERM

Descriptive Title: Transient Temperature Gradients Near a Waste Tank with Arbitrary Temperature

Program Author: Loe, Alton L.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Transient, Underground Tanks, Radioactive Waste

Program Description: Estimates transient temperatures in a concrete wall and infinite extent of soil with an arbitrary broken line temperature history imposed in a waste tank. An analytical solution in the X direction. A table of temperatures and local gradients is printed out as a function of time and position. Ten subroutines. Same physical problem is solved by THRM but logic is easier to follow here. Useful for concrete thermal stress and soil conductivity determination.

Users of Program: G Jansen
JR Nance
WV DeMier

Documentation: None

Condition of Program: A comparison of the analytically calculated temperature gradients with the temperature difference between points shows a discrepancy.

SAMPLE INPUT: THERM

THERM 11:37 02/23/74

100 @S RUN PUN027,CUB928,GEORGE,150,6000/3000 G JANSEN 3760 BLD

C 0431574

105 @N MGO KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFO00

115 @PPL TEL INFO00

120 @PPL TEL CUB928

125 @X ASG A=00231

130 @N XQT CUR

140 FIND A,THERM/SIFS

150 TRD A

160 FIND A,HEAD/SIFS

170 TRD A

180 FIND A,PPH11/SIFS

190 TRD A

192 FIND A,PPH12/SIFS

194 TRD A

200 FIND A,F1/SIFS

210 TRD A

220 FIND A,F2/SIFS

230 TRD A

240 FIND A,PF1/SIFS

250 TRD A

260 FIND A,PF2/SIFS

270 TRD A

280 FIND A,PH11/SIFS

290 TRD A

300 FIND A,PH12/SIFS

310 TRD A

320 FIND A,ERFC/S2F5

330 TRD A

990 TRI A

995 PCH,1

1000 @IM FR5,* THERM/SIFS,THERM/SIFS,THERM/RIFS

1010 @IM FR5,* HEAD/SIFS,HEAD/SIFS,HEAD/RIFS

1020 @IM FR5,* PPH11/SIFS,PPH11/SIFS,PPH11/RIFS

1025 @IM FR5,* PPH12/SIFS,PPH12/SIFS,PPH12/RIFS

1030 @IM FR5,* F1/SIFS,F1/SIFS,F1/RIFS

1040 @IM FR5,* F2/SIFS,F2/SIFS,F2/RIFS

1050 @IM FR5,* PF1/SIFS,PF1/SIFS,PF1/RIFS

1060 @IM FR5,* PF2/SIFS,PF2/SIFS,PF2/RIFS

1070 @IM FR5,* PH11/SIFS,PH11/SIFS,PH11/RIFS

1080 @IM FR5,* PH12/SIFS,PH12/SIFS,PH12/RIFS

1090 @IM FR5,* ERFC/S2F5,ERFC/S2F5,ERFC/R2F5

1100 @LI XQT THERM/RIFS

1110 THERM DEBUG TEST CASE

1120 \$LIST X1=.129,X2=1,XL=.667,A1=.01,A2=.0303,R1=55,R2=150,ZERU=.0000

1130 T=70,1100,2130,2130,2130,4X=2,4T=5,PERIOD=10.33,WHUG=0,

1140 X=-.0001,.00015

1150 @ FIN

READY

SAMPLE OUTPUT: THERM

WCI ACT THERM/REFS

DRUM LENGTH 014200

THIS ALLOCATION WAS DONE ON 23 FEB 74 AT 11:17:38

THERM DEBUG TEST CASE

TABLE OF VALUES OF TEMPERATURES IN DEGREES F

	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)	X(11)	X(12)
TIME: HOURS	-1.00	.00										
0.000	7.000+01	7.000+01										
	0.000	0.000										
1.033+01	9.909+01	0.675+01										
	-4.072+02	-0.024+01										
2.066+01	2.350+02	1.743+02										
	-1.020+03	-2.097+02										
3.099+01	4.180+02	2.902+02										
	-2.390+03	-3.090+02										
4.132+01	5.471+02	3.716+02										
	-2.460+03	-3.173+02										

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00110 OF MAIN PROGRAM

CSCX RLM83J 23 FEB 74 11:16:56 USER CUR928 PUN027

CARDS IN 47 OUT 313 LINES 814 PROCESSING TIME 40.01 SECONDS

LISTING AND SUBROUTINE COMPILATION: THERM P. 1

```

AS RUN F00017.C0F92A. .150.0000/1000 G JANSEN 3700 BLOC 0023576
8 FLT THERM/SIFS.1.740222. 00005
9 CCF 8
C PROGRAM THERM
C TO DELETE DEBUG STATEMENTS NOT UNDER CONTROL OF NPUC COMPILE WITH
PARAMETER IFZIG=1
COMMON S,V,AM,K1,K2,AL,A1,A2,R1,R2,ZERO
DIMENSION A(99),T(99),TEMP(12,99),X(12),GRAD(12,99),ANAME(12)
DIMENSION H(99)
REAL K1,K2
NAMELIST/LIST/K1,K2,AL,A1,A2,R1,R2,ZERO,T,X,NX,NT,PERIOD
2.NBUC
C READ DATA
901 READ(5,201) ANAME
201 FORMAT(12A6)
READ(5,LIST)
NTM1=NT-1
NXM1=NX-1
F=0.0
H(1)=0.
DO 21 I=2,NT
21 H(I)=H(I-1)+PERIOD
AM=SQRT(A1/A2)
V=K2*AM/K1
B=(V-1.)/(V+1.)
C CALCULATE RAMPS
DO 1000 I=1,NX
1000 A(I-1)=(T(I)-T(I-1))/PERIOD
C DEBUG PRINTOUTS
IF(NSUB.EQ.0) GO TO 3
WRITE(6,1003)
1003 FORMAT(5H1 = ,(E20.3))
WRITE(6,1004)PERIOD
1004 FORMAT(10H1PERIOD = ,(E20.3))
1001 WRITE(6,1002) A
1002 FORMAT(5H1A = ,(E20.3))
29 CONTINUE
C TEST X
IF(X(1).GT.0.) GO TO 2
IF(X(1).LT.(-AL)) GO TO 3
GO TO 4
3 WRITE(6,10)
10 FORMAT(27H X(1) IS LESS THAN AL. CANNOT PROCEED)
GO TO 901
4 DO 5 I=1,NX
DELETE 2000,IFZIG
2001 FORMAT(11H * CONTROL AT DC 5. T=*,T3)
WRITE(6,2001) T
2000 CONTINUE
XI=X(I)
TEMP(I,2)=A(1)*FHI1(XI,PERIOD) + T(1)
5 GRAD(I,2)=A(1)*FHI1(XI,PERIOD)
C X LESS THAN ZERO BUT GREATER THAN -AL
DO 100 J=3,NT
DO 101 I=1,NX
DELETE 2003, IFZIG
2004 FORMAT(11H * CONTROL AT DC 101. J=*,I3,6X,*I=*,I3)
WRITE(6,2004) J,I
2003 CONTINUE
TEMP=0.0
GRAD=0.0
JH1=J-1
DO 102 K=2,JH1
DELETE 2005,IFZIG
2006 FORMAT(11H * CONTROL AT DC 102. K=*,I3)
WRITE(6,2006) K
2005 CONTINUE
XI=X(I)
TEMP=A(K-1)*(FHI1(XI,H(J)-H(K-1))-FHI1(XI,H(J)-H(K)))+TEMP0
102 GRAD=A(K-1)*(FHI1(XI,H(J)-H(K-1))-FHI1(XI,H(J)-H(K)))+GRAD0
TEMP(I,J)=TEMP0+A(J-1)*FHI1(XI,PERIOD)+T(1)
GRAD(I,J)=GRAD0+A(J-1)*FHI1(XI,PERIOD)
IF(X(1)+1).GT.0. GO TO 101
101 CONTINUE
103 NF=I+1 & NF IS USED TO SET THE STARTING VALUE OF A LATER DO INDEX
100 CONTINUE
C FOR X GREATER THAN ZERO
2 IF(NF.EQ.0) NF=1
DO 251 I=NF,NX
DELETE 2007, IFZIG
2008 FORMAT(11H * CONTROL AT DC 251. T=*,I3)
WRITE(6,2008) T
2007 CONTINUE
XI=X(I)
TEMP(I,2)=A(1)*FHI2(XI,PERIOD) + T(1)
251 GRAD(I,2)=A(1)*FHI2(XI,PERIOD)
DO 200 J=3,NT
DO 200 I=NF,NX
DELETE 2010, IFZIG
2012 FORMAT(11H * CONTROL AT DC 1200. J=*,I3,6X,*I=*,I3)
WRITE(6,2012) J,I
2010 CONTINUE

```

LISTING AND SUBROUTINE COMPILATION: THERM P. 2

```

      XI=X(I)
      TEMPO=0.0
      GRADO=0.0
      JMI=J-1
      DO 204 K=2,JMI
      DELETE 2020,IFZIG
2021 FORMAT(1H,'CONTROL AT DO 204.' K=I,I)
      WRITE(6,2021) K
2020 CONTINUE
      TEMPO=TEMPO+A(K-1)*(FHI2(XI,HIJ)-HIK-1)-FHI2(XI,HIJ)-HIK)
      GRADO=GRADO+A(K-1)*(FFHI2(XI,HIJ)-HIK-1)-FFHI2(XI,HIJ)-HIK)
204 CONTINUE
      TEMF(I,J)=TEMPO+A(IJ-1)*FHI2(XI,PERIOD)*T(I)
200 GRAD(I,J)=GRADO+A(IJ-1)*FFHI2(XI,PERIOD)
      DO 858 I=1,NX
398 TEMF(I,1)=T(I)
C      PRINT OUT
      N=1
      CALL HEAD(X,N,NX,ANAME)
      DO 900 J=1,NT
      WRITE(6,14)F,(TEMF(I,J),I=1,NX)
      WRITE(6,15)GRAD(I,J),I=1,NX)
      N=N+1
      IF(N.GE.35) CALL HEAD(X,N,NX,ANAME)
      F=F+PERIOD
900 CONTINUE
14 FORMAT(1X,1F13E10.3)
15 FORMAT(11X,1F12E10.3)
C      START NEXT CASE
      GO TO 901
      END

a ELT HEAD/SIFS.1.740222. 99977
a EOF a
      SUBROUTINE HEAD(X,N,NX,NAME)
      REAL X(12),HDC(12)
      WRITE(6,10) HDC
10 FOPAT(1H1,12A6)
      WRITE(6,11)
11 FORMAT(1H1,12X,12A6)
      117X,'X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10) X(11) X(12)'
      WRITE(6,12)X(I),I=1,NX)
12 FOPAT(17X,12(F9.2,6X))
      WRITE(6,13)
13 FORMAT(11H TIME,HOURS)
      N=1
      RETURN
      END

a ELT FFHI1/SIFS.1.740222. 73575
a EOF a
      FUNCTION FFHI1(X,T)
      PARAMETER IFZIG=1
C      TO DELETE DEBUG PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON 9,V,AN,K1,K2,AL,A1,A2,R1,R2,ZERO
      FF=0.
      AN=1.
      F=0.
100 F=F+3*(AN-1.)*(FF1(12,AN-1.)*AL*X,T)+3*FF1
      1 ((2,AN-1.)*AL-X,T))
      IF((ABS(F)-ABS(FF)).LE.ZERO) GO TO 200
      FF=F
      AN=AN+1.
      IF(AN.GE.1000.) GO TO 251
      GO TO 100
251 WRITE(6,252) AN
252 FORMAT(13H FUNCTION FFHI1 HAS NO CONVERGENCE N=,F5.2)
200 FFHI1=F
      DELETE 300,IFZIG
1 FORMAT(' FFHI1=',1F12.5,' X=',1F12.5,' T=',1F12.5)
      WRITE(6,1) F,X,T
300 CONTINUE
      RETURN
      END

```

LISTING AND SUBROUTINE COMPILATION: THERM P. 3

```

B ELT FFH12/SIF5.1.740222. 44979
B EOF B
      FUNCTION FFH12(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUG PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,R1,R2,ZERO
      C=2./(1.+V)
      AN=1.
      F=0.
      FF=0.
100 F=F+C*S*(AN-1.)*CF2((2.*AN-1.)*AL*AM*X,T)*AM
      IF((AES(F)-AES(FF)).LE.ZERO) GO TO 200
      FF=F
      AN=AN+1.
      IF(AN.GE.1000.) GO TO 251
      GO TO 100
251 WRITE(6,252) AN
252 FORMAT(3H FUNCTION FFH12 HAS NO CONVERGENCE. N= ,F5.2)
200 FFH12=F
      DELETE 300,IFZIG
1 FORMAT(' FFH12=*,1F12.5, X=*,E12.5, T=*,E12.5)
      WRITE(6,1) F,X,T
300 CONTINUE
      RETURN
      END

```

```

B ELT F1/SIF5.1.740222. 44980
B EOF B
      FUNCTION F1(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUG PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,R1,R2,ZERO
      F1=(T*(X**2)/(2.*A1))*ERFC(X/(T*SQRT(A1*T)))
      F1=F1-X*SQRT(T/(3.1416*A1))*EXP((-1.*X**2)/(4.*A1*T))
      DELETE 300,IFZIG
1 FORMAT(' F1=*,1F12.5, X=*,E12.5, T=*,E12.5)
      WRITE(6,1) F1,X,T
300 CONTINUE
      RETURN
      END

```

```

B ELT F2/SIF5.1.740222. 44981
B EOF B
      FUNCTION F2(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUG PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,R1,R2,ZERO
      F2=(T*(X**2)/(2.*A1))*ERFC(X/(T*SQRT(A1*T)))
      F2=F2-X*SQRT(T/(3.1416*A1))*EXP((-1.*X**2)/(4.*A1*T))
      DELETE 300,IFZIG
1 FORMAT(' F2=*,1F12.5, X=*,E12.5, T=*,E12.5)
      WRITE(6,1) F2,X,T
300 CONTINUE
      RETURN
      END

```

```

B ELT FF1/SIF5.1.740222. 44982
B EOF B
      FUNCTION FF1(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUG PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,R1,R2,ZERO
      FF1=(X/A1)*ERFC(X/(T*SQRT(A1*T)))-2.*SQRT(T/3.1416/A1)*EXP((-1.)*
      X**2/(4.*A1*T))
      DELETE 300,IFZIG
1 FORMAT(' FF1=*,1F17.5, X=*,E12.5, T=*,E12.5)
      WRITE(6,1) FF1,X,T
300 CONTINUE
      RETURN
      END

```

```

B ELT FF2/SIF5.1.740222. 44983
B EOF B
      FUNCTION FF2(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUG PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,R1,R2,ZERO
      FF2=(X/A1)*ERFC(X/(T*SQRT(A1*T)))-2.*SQRT(T/3.1416/A1)*EXP((-1.)*
      X**2/(4.*A1*T))
      DELETE 300,IFZIG
1 FORMAT(' FF2=*,1F12.5, X=*,E12.5, T=*,E12.5)
      WRITE(6,1) FF2,X,T
300 CONTINUE
      RETURN
      END

```

LISTING AND SUBROUTINE COMPILATION: THERM P. 4

```

8 ELT FHI1/SIF5.1.740222. 44984
8 EOF 8
      FUNCTION FHI1(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUS PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,P1,P2,ZERO
      F=0.
      AN=0.
      FF=0.
100 AN=AN+1.
      F=F+((AN-2.)*C1
      1      ((2.4N-1.)*AL*X.T)-B*F1((2.4N-1.)*AL-X.T))
      IF((ABS(F)-ABS(FF)).LE.ZERO) GO TO 210
      FF=F
      IF(AN.GE.1000.) GO TO 251
      GO TO 100
251 WRITE(6,251) AN
252 FORMAT(36H FUNCTION FHI1 HAS NO CONVERGENCE N= ,F5.2)
200 FHI1=F
      DELETE 300,IFZIG
      1 FORMAT(' FHI1=*,IFE12.5,* X=*,E12.5,* T=*,E12.5)
      WRITE(6,1) F,X,T
300 CONTINUE
      RETURN
      END

```

```

8 ELT FHI2/SIF5.1.740222. 44995
8 EOF 8
      FUNCTION FHI2(X,T)
      PARAMETER IFZIG=1
C TO DELETE DEBUS PRINTOUT (MOST OF IT) COMPILE WITH IFZIG=1
      COMMON B,V,AM,K1,K2,AL,A1,A2,P1,P2,ZERO
      AN=0.
      FF=0.
      F=0.
      C=2./(1.+V)
100 AN=AN+1.
      F=F+C*((AN-1.)*F2((2.4N-1.)*AL+AM*X.T)
      IF((ABS(F)-ABS(FF)).LE.ZERO) GO TO 200
      FF=F
      IF(AN.GE.1000.) GO TO 251
      GO TO 100
251 WRITE(6,252) AN
252 FORMAT(36H FUNCTION FHI2 HAS NO CONVERGENCE N= ,F5.2)
200 FHI2=F
      DELETE 300,IFZIG
      1 FORMAT(' FHI2=*,IFE12.5,* X=*,E12.5,* T=*,E12.5)
      WRITE(6,1) F,X,T
300 CONTINUE
      RETURN
      END

```

```

8 ELT EPFC/S2F5.1.740222. 44986
8 EOF 8
      FUNCTION EPFC(X)
      DIMENSION A(5)
      F=0.3275911
      A(5)=0.254329592
      A(4)=-0.284496736
      A(3)=1.421413741
      A(2)=-1.457152027
      A(1)=1.061405429
      T=1/(1+F*X)
      S=A(1)
      DO 1 I=2,5
      1 S=S+A(I)
      EPFC=S+EXP(-X**2)
      RETURN
      END
06230274 C49928FUNC27 100 4001 47 313 814111656 1 00000 C S

```

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PROGRAM NAME: THRM

Descriptive Title: Transient Temperature Gradients Near a Waste Tank with Arbitrary Temperature

Program Author: Richardson, Richard L.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Transient, Underground Tanks, Radioactive Waste

Program Description: Calculates the one-dimensional transient heat flow through a concrete wall during start up of an underground waste storage tank. THRM prints temperatures and gradients at up to 10 positions in the wall or soil for each time interval specified. Input is a wall temperature for each equal time interval during the heatup of the tank. Calculations are made with a semi-infinite conducting medium. Useful for concrete thermal stress and soil conductivity determination.

Input Description: Input is by namelist and is suitable for teletype input. See internal program documentation for list and description of input variables.

Physical input quantities include the thermal conductivity, the density, the specific heat capacity of the tank wall and the medium around the tank and the tank wall thickness. Output can be controlled by specifying the positions at which the temperatures are to be computed, the input temperatures (in the wall), the time interval to be used, the type of temperature units to be used, etc. More than one case per run is possible.

Output Description:

Output is suitable for line printer rather than teletype output. Output includes an input summary and description, and a table of temperatures at each position for every time interval.

Users of Program:

G Jansen
WV DeMier
RL Richardson
JR Nance

Documentation:

Results appear in letter from G. Jansen to P. Hatch, ARHCO, "Transient Temperatures in Heat Treating of AY Tanks," May 28, 1968.

Condition of Program:

Gives low temperatures in regions of very high temperature gradients. This may be due to not using enough terms in the series expansion for these conditions. The results of programs THRM and THERM should be compared for the same conditions.

SAMPLE INPUT: THRM

```

THRM      OR:44      02/15/74

100 QS RUN PUN020,CUR928,GEORGE,59,2000/1000      G JANSEN 3760 PLD
      G 8423576
105 @N MSG KEEP AT FED. RLDG FOR PICKUP AT 5:00PM BY G.JANSEN
110 @PUL TEL INFO00
115 @PRL TEL INFO00
120 @PRL TEL CUR928
125 @X ASG A=U1145(JJ1145)
130 @N XGT CUR
150 FIND A,THRM/S6F5
160 TRD A
170 FIND A,ERFC/S1F5
180 TRD A
350 TRI A
352 PCH THRM/S6F5
354 PCH ERFC/S1F5
1070 @WITH FR5,* THRM/S6F5,THRM/S6F5,THRM/R6F5
1080 -54,54
1090 DATA (TM(I),I=1,99)/S9*212./,NOX,NOTMP,L,KUTU,KITU,X/17*0/
1100 -56,56
1110 DATA (UNIT(I),I=1,4)/24H FAHRENHEIT CENTIGRADE /
1115 @IM FR5,* ERFC/S1F5,ERFC/S1F5,ERFC/P1F5
1120 @N XGT THRM/R6F5
1125 CASE NO. 6 DAVIS TEST ON KAOLITE B14 BLOCK
1130 $LIST NOX=11,NOTMP=15,KITU=0,KC=.129,YS=.5,DC=55.,DS=48.
1140 CPC=.22,CPS=.2,L=.6657,KUTU=0,ZERO=.00001
1150 X=-.67,-.33,-.00,+.00,.75,1.04,1.50,2.25,3.00,3.33,3.67
1160 TM=85,482,940,1040,1085,1097,13*1100,KF=1 $
1170 @ FIN
READY

```

SAMPLE OUTPUT: THRM P. 1

ON XOT THRM/RGFS

DRUM LENGTH 016070

THIS ALLOCATION WAS DONE ON 15 FEB 74 AT 09:24:58

SOPUT
NOX = 11,
NOTMP = 19,
KITU = ,
KOTU = ,
KC = .12900000+00,
KS = .50000000+00,
UC = .55000000+02,
DS = .48000000+02,
CPC = .22000000+00,
CPS = .20000000+00,
L = .66670000+00,
ZERO = .10000000-04,
A1 = .10661157-01,
A2 = .52033333-01,
KF = 1,
SEND

RUN 15 FEB 74 09:24:58

CASE NO. 6 DAVIS TEST ON KAOLINE BINDER BLOCK

ONE DIMENSIONAL TRANSIENT HEAT FLOW THROUGH A CONCRETE WALL DURING

STARTUP OF AN UNDERGROUND WASTE STORAGE TANK

INPUT VARIABLES

RELATIVELY CONSTANT INPUT VARIABLES WITH VALUES

K(1) - THERMAL CONDUCTIVITY OF CONCRETE, .12900 BTU/HR*FT**2*DEGREES(F)/FT

K(2) - THERMAL CONDUCTIVITY OF SOIL, .50000 BTU/HR*FT**2*DEGREES(F)/FT

A(1) - THERMAL DIFFUSIVITY OF CONCRETE, .01066 FT**2/HR

A(2) - THERMAL DIFFUSIVITY OF SOIL, .05208 FT**2/HR

L - CONCRETE THICKNESS, .66670 FT

DENSITY OF CONCRETE, 55.00000 LBS/FT**3

DENSITY OF SOIL, 48.00000 LBS/FT**3

SPECIFIC HEAT OF CONCRETE, .22000 BTU/(LB*DEG F)

SPECIFIC HEAT OF SOIL, .20000

TEMP(X,0) - INITIAL TEMPERATURE SYSTEM, ASSUMED INDEPENDENT OF POSITION, 85.00000 DEGREES(F)

ZERO = .00001000

RATE OF CHANGE OF TEMPERATURE IS ASSUMED TO BE CONSTANT FOR 24 HOUR PERIODS. THE BOUNDARY TEMPERATURES ARE SPECIFIED IN THE DATA AND IN THE SOLUTION UNDER THE HEADING X(1).

SAMPLE OUTPUT: THRM P. 2

TABLE OF VALUES OF TEMPERATURE IN DEGREES FAHRENHEIT

TIME, HOURS	X(1) -0.7	X(2) -0.33	X(3) .00	X(4) .00	X(5) .75	X(6) 1.00	X(7) 1.50	X(8) 2.25	X(9) 3.00	X(10) 3.53	X(11) 3.67
0.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
1.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
2.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
3.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
4.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
5.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
6.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
7.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
8.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
9.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
10.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
11.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
12.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
13.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
14.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
15.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
16.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
17.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
18.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00141 OF MAIN PROGRAM

CSCX RL683J 15 FEB 74 9:24:28 USER CUB928 PUN020

CARDS IN 26 OUT 256 LINES 404 PROCESSING TIME 29.74 SECONDS

LISTING AND SUBROUTINE COMPILATION: THRM P. 1

```

95 RUN F00020,C00000, .59,00000000 0 JANSEN 3760 BLOC 9423576
9 0LT THRM/SEFF.1.00000000 N0000
3 00F.1
C PROGRAM THRM
C THE FIRST CARD OF EACH CASE MUST BE A TITLE CARD. IT MAY CONTAIN UP
C TO 72 COLUMNS OF ALPHANUMERIC CHARACTERS. CAN BE BLANK BUT MUST BE
C PRESENT.
C REMAINING DATA ARE READ BY NAMELIST (ELIST). ONLY VARIABLES WHOSE
C VALUES ARE TO BE CHANGED NEED BE ENTERED AFTER THE FIRST CASE.
C
C NAME DIMENSION DESCRIPTION
C ----
C NOX 1 ----NUMBER OF POSITION VALUES X(I)
C
C NOTMP 1 ----NUMBER OF TEMPERATURES TM(I)
C
C KITU 1 ----KIND OF INPUT TEMP UNITS.
C 0 FOR FAHRENHEIT, 1 FOR CELSIUS.
C FAHRENHEIT IS ASSUMED IF KITU IS UNDEFINED
C
C KC 1 ----THERMAL CONDUCTIVITY OF TANK WALL,BTU/(HR*FT*DEG F)
C
C KS 1 ----CONDUCTIVITY OF MEDIUM AROUND TANK.
C
C DC 1 ----DENSITY OF TANK WALL, POUNDS/FT**3
C
C DS 1 ----DENSITY OF MEDIUM AROUND TANK
C
C CFC 1 ----SPECIFIC HEAT CAPACITY OF TANK WALL, BTU/(LB*DEG F)
C
C CPS 1 ----SPECIFIC HEAT CAPACITY OF MEDIUM AROUND TANK
C
C L 1 ----TANK WALL THICKNESS,FEET
C
C KOTU 1 ----KIND OF OUTPUT TEMPERATURE UNITS
C 0 FOR FAHRENHEIT, 1 FOR CELSIUS, 2 FOR 90°H.
C FAHRENHEIT IS ASSUMED IF KOTU IS UNDEFINED.
C
C ZERO 1 ----CONVERGENCE CRITERION FOR INFINITE SERIES.
C TRY 0.00001
C
C X 12 ----POSITIONS AT WHICH TEMPS ARE TO BE COMPUTED. FEET.
C TANK-SOIL INTERFACE IS REFERENCE OR ZERO POINT.
C POSITIONS IN TANK WALL MUST BE NEGATIVE.
C POSITIONS IN SOIL MUST BE POSITIVE.
C
C TM 99 ----INPUT TEMPERATURES (UNITS AS SPECIFIED BY KITU).
C TM(1)=TEMP AT DAY ZERO, TM(2)=TEMP AT DAY 1,ETC.
C
C KF 1 ----INPUT VARIABLE FOR SETTING UP TO RUN WITH TIME
C PERIODS OF 1 HOUR OR 1 DAY. KF=1 FOR HOURS, KF=24
C FOR DAYS.
C
C DIMENSION TITLE(12),T(2),Y(2)
C REAL K1,K2,A1,A2,L,TEMP(12,350),GRAD(12,350),X(12),TM(350),A(350)
C INU,UNIT(4),H(12),TE(12,350),GR(12,350),B(350)
C REAL KC,KS
C DATA TM/99*212./,NOX,NOTMP,L,KOTU,KITU,X/17*0/
C DATA KC,KS,DC,DS,CFC,CPS,ZERO/10.,5.,10.,110.,.22,.18,.00001/
C DATA UNIT(1),UNIT(2),UNIT(3),UNIT(4)/244 FAHRENHEIT CENTIGRADE
C DATA (H(I),I=1,12)/72HX(1) X(2) X(3) X(4) X(5) X(6) X(7) X(
C 8) X(9) X(10) X(11) X(12)/
C NAMELIST /LIST/ NOX,NOTMP,KITU,KOTU,KC,KS,DC,DS,CFC,CPS,L,ZERO,X,
C ZTM,KF
C NAMELIST /OFUT/ NOX,NOTMP,KITU,KOTU,KC,KS,DC,DS,CFC,CPS,L,ZERO,
C ZAL,AZ,KF
C CALL SETIO(3,2)
C CALL SETIO(2,1)
C CALL DOY(Y)
C CALL IUQ(1)
C RTFI=1.7724539
2000 CONTINUE
C READ (2,97) TITLE
C READ (2,LIST)
C K1=KC
C K2=KS
C A1=K1/(DC*CFC)
C A2=K2/(DS*CPS)
C WRITE (3,CFUT)
C WRITE(3,93)TITLE,Y,T
C H=NOX
C K=NOTMP
C 97 FORMAT(12A1)
C 98 FORMAT(1H,12A6,RX,4HPUN,4A6)
C IF (KITU.GT.0) GO TO 90
C DO 39 I=1,K
C TM(I)=(TM(I)-72.)*0.55555555
C 39 CONTINUE
C 40 CONTINUE
C KM1=X-1
C DO 3 I=1,KM1
C 2 A(I)= (TM(I+1)- TM(I))*1.8/KF
C TM(I)=TM(I)+1.8*32.
C PC1=K1/A1
C PC2=K2/A2

```

LISTING AND SUBROUTINE COMPILATION: THRM P. 2

```

NU=STPT(KC2-K7/18710+11)
JF(KC2-11/100+1)
C1=STPT(A1/A2)
C2=2*STPT(A1)
C0=16*STPT(A1)
XI=X(1)
ASSIGN 11 TO KA
JF(KX1) 11-9-9
9 ASSIGN 12 TO KA
X2=X1+C1
10 CONTINUE
TEMP(C1)=TEMP(1)
C0AD(C1)=C0
C0 16 J=1,K
TJ=J+24
KKK=1
IF(TFZITJ).LE.KFINKK4=2
RT=STPT(TJ)
60 TO (C1-IC3)+PKK
102 TL=TJ-KF
RTL=STPT(TL)
103 SUM=0
DSM=0
C0 15 N=1,ZC0
EN=(Z-N-1)*L
BTN=BT*(N-1)
AA=(EN-XI)/C2
AS=AA+2
TA=TJ+2+AS
RT=AA/RT
EPA=ERFC(AA/RTL)
S4=EPA+TA
EAL=RT*EXP(-AS/TJ)/RTFZ
E4=EAL+2+AA
60 TO KK
11 AB=(EN-XI)/C2
BJT=A(J)
BS=AB+2
TB=TJ+2+BS
RT=AB/RT
EPB=ERFC(BS/RTL)
S3=EPB+TB
EXB=RT*EXP(-BS/TJ)/RTFZ
E3=EXB+2+AB
60 TO (11C-111)+KKK
110 TAL=TL+2+AS
TBL=TL+2+AS
ERAL=ERFC(AA/RTL)
SAL=ERAL+TA
Z9BL=ERFC(AB/RTL)
SBL=ERL+TBL
EXAL=RTL*EXP(-AS/TL)/RTFZ
EAL=EXAL+2+AA
EXBL=RTL*EXP(-BS/TL)/RTFZ
E3L=EXBL+2+AB
TERN=BTN*(SA-SAL+TAL-CA-BT*(C2-SBL+SBL-E3))
DTRN=BTN*(AA*(EPA-ERAL)+EXAL-EXA+BT*(E4-EPB+EBL)+EYBL-EY9)/C2
60 TO 122
111 TERN=BTN*(SA-CA-BT*(EP-EPI))
DTRN=BTN*(AA*(EPA-ERAL)+EXAL-EXA+BT*(E4-EPB+EBL)+EYBL-EY9)/C2
60 TO 122
12 BJJ=2+BJJ/(1+NU)
60 TO (12C-121)+KKK
120 TAL=TL+2+AS
ERAL=ERFC(AA/RTL)
SAL=ERAL+TA
EXAL=RTL*EXP(-AS/TL)/RTFZ
EAL=EXAL+2+AA
TERN=BTN*(SA-SAL+EAL-CA)
DTRN=BTN*(AA*(EPA-ERAL)+EXAL-EXA)/C1/C2
60 TO 122
121 TERN=BTN*(SA-CA)
DTRN=BTN*(AA*(EPA-ERAL)+EXA)/C1/C2
122 SUM=SUM+TERN
DSM=DSM+DTRN
IF(ABS(TEPM)-Z200)150,14,15
15 CONTINUE
150 TE(I,J)=SUM
GR(I,J)=DSM
D=0
S=TEMP(1)
C0 151 JJ=1,J
SW=SM+BJJ)*TE(I,J-JJ+1)
151 D=DM+BJJ)*GR(I,J-JJ+1)
TEMP(I,J)=SW
C0AD(I,J)=DM
16 CONTINUE
WRITE (3,600)K1,K2,A1,A2,L
WRITE (3,600) OC,OS,CFC,CFS
IF(KOTU,C2,1) GO TO 700

```

2 ELT ERFC/21FS.1.7C1170. 44501
2 COF 2

06190274 CUB928FUYH10 100 2974 26 386 404 92070 1 0000

PROGRAM NAME: TIESOC

Descriptive Title: Strontium and Cesium Capsule Temperature Estimation

Program Author: DeMier, Warren V.

Computer: UNIVAC 1108, CYBER 74

Operating System: CSCX, GPS, SCOPE 3.4

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Radioactive Waste, Encapsulation, Strontium-90, Cesium-137, Heat Transfer

Program Description: Computes steady-state temperatures in a system of unconsolidated heat generating materials encapsulated in metal containers having annular or circular cross-section. Cylinder orientation may be horizontal or vertical. Surrounding medium may be air or water. Double wall with air between walls is allowed. Container material may be stainless steel (type 316) or Hastelloy C. Provision is made for inputting view factor for radiant heat transfer in arrays of more than one cylinder.

Thermal conductivity of heat generating medium is computed from the theoretical density of the unconsolidated material and the value of thermal conductivity at 100% theoretical density. In present form only SrF_2 and CsCl are allowable heat generating materials, but adaption to use with other materials would not be difficult. Program has 18 subroutines.

Input Description: Input is by namelist and is suitable for teletype input. More than one case per run is possible. Input for the first case usually requires 1-3 teletype lines. Additional cases require only one line. Internal program documentation contains list and description of input variables.

Output Description:

Output is suitable for both teletype and line printer. Approximately half a teletype page of output per case is produced.

Output includes summary of physical conditions and temperatures at centerline (T1), inner surface of inner shell (T2), outer surface of inner shell (T3), inner surface of outer shell (T4), outer surface of outer shell (T5).

Users of Program:

LK Mudge
G Jansen
WV DeMier
JR Nance (JAJ)
RL Engel
JL McElroy

Documentation:

Results and equations are presented in letter from L. K. Mudge to G. L. Borsheim, ARHCO, "Steady State Temperatures in Waste Capsules," January 8, 1971.

Condition of Program:

It runs well. It should not be misused for systems with large air gaps because it does not include convection heat transfer in the air gap.

SAMPLE INPUT: TIESOC

TIESOC 09:07 02/17/74

100 OS RUN PUN013,CURSOR,GEORGE.152,PC00/3000 G JANSEN 3760 BLD
G 9403576

105 ON MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 OPUL TEL INFO00

115 OPPL TEL INFO00

120 OPPL TEL CUR928

125 OX MSG A=U1145(JUL145)

130 ON YOT CUR

150 FIND A,TIESOC/SIFS

160 TRD A

170 FIND A,PEQUA/SIFS

180 TRD A

190 FIND A,YAIR/SIFS

200 TRD A

210 FIND A,KSUL/SIFS

220 TRD A

230 FIND A,TPLINT/SIFS

240 TRD A

250 FIND A,KUNC/SIFS

260 TRD A

270 FIND A,KMET/SIFS

280 TRD A

290 FIND A,HRAD/SIFS

300 TRD A

310 FIND A,TLOOK/SIFS

320 TRD A

330 FIND A,TIESOC/S2FS

340 TRD A

350 FIND A,KWATER/SIFS

360 TRD A

370 FIND A,GPFR/SIFS

380 TRD A

390 FIND A,CH20/SIFS

400 TRD A

410 FIND A,TIESOC/SIFS

420 TRD A

430 FIND A,FIRNAC/SIFS

440 TRD A

450 FIND A,HCONV/SIFS

460 TRD A

470 FIND A,HCONV/SIFS

480 TRD A

490 FIND A,OUTPUT/SIFS

500 TRD A

510 FIND A,INPUT/SIFS

520 TRD A

530 TRI A

540 PCH,1

560 LIST,1

1000 @IM FRS,* TIESOC/SIFS,TIESOC/SIFS,TIESOC/PIFS

1010 @IM FRS,* YAIR/SIFS,YAIR/SIFS,YAIR/PIFS

1020 @IM FRS,* PEQUA/SIFS,PEQUA/PIFS,PEQUA/PIFS

1030 @IM FRS,* KSUL/SIFS,KSUL/SIFS,KSUL/PIFS

1040 @IM FRS,* TPLINT/SIFS,TPLINT/SIFS,TPLINT/PIFS

1050 @IM FRS,* KUNC/SIFS,KUNC/SIFS,KUNC/PIFS

1060 @IM FRS,* KMET/SIFS,KMET/SIFS,KMET/PIFS

1070 @IM FRS,* HRAD/SIFS,HRAD/SIFS,HRAD/PIFS

1080 @IM FRS,* TLOOK/SIFS,TLOOK/SIFS,TLOOK/PIFS

1090 @IM FRS,* INPUT/SIFS,INPUT/SIFS,INPUT/PIFS

1100 @IM FRS,* KWATER/SIFS,KWATER/SIFS,KWATER/PIFS

1110 @IM FRS,* GPFR/SIFS,GPFR/SIFS,GPFR/PIFS

1120 @IM FRS,* CH20/SIFS,CH20/SIFS,CH20/PIFS

1130 @IM FRS,* FIRNAC/SIFS,FIRNAC/SIFS,FIRNAC/PIFS

1140 @IM FRS,* HCONV/SIFS,HCONV/SIFS,HCONV/PIFS

1150 @IM FRS,* HCONV/SIFS,HCONV/SIFS,HCONV/PIFS

1160 @IM FRS,* OUTPUT/SIFS,OUTPUT/SIFS,OUTPUT/PIFS

1180 ON YOT TIESOC/PIFS

1190 SIN KIND=2,METAL=1,P=3.59,4.1,4.1,4.3125,

1200 PCTI=80,F2=0.8,

1210 TA=100,S=17000,7=72,EI=1.0,F3=0.8 \$

1220 SIN S=85000

1230 SIN S=340000

1240 SIN S=8500, F3=0.55

1250 SIN S=170000

1260 SIN S=340000

1270 @ FIN

READY

SAMPLE OUTPUT: TIESOC P. 1

END NOT TIESOC/REF

CRUM LENGTH 022424
THIS ALLOCATION WAS DONE ON 17 FEB 74 AT 09:24:39

CONVERGENCE SPEC NOT MET IN COMPUTING DELTS LAST DELTS
WAS .20
PREVIOUS DELTS WAS .20
ERROR WAS 100.000 REQUESTED MAX ERROR WAS .100

OUTPUT FROM PROGRAM TIESOC RUN ON 17 FEB 74 AT 09:24:39
FOR SP2 OF 80.00% THEOR. DENSITY = 1.71010E+24 BTU/HR PER CU FT
ENCAPSULATED IN TYPE 316 SST CYLINDER ORIENTATION: VERTICAL
THIS OUTPUT IS FOR CYLINDER IN AIR

R1= 3.99000 IN.	T1=1625.3	DT1=1044.9	KEFF=4.50E-01
	(924.3 C)		
R2= 4.10000 IN.	T2= 652.4	DT2= 2.3	KMET=1.13E+01
	(323.0 C)		
R3= 4.10000 IN.	T3= 638.1	DT3= .0	KAIR=2.59E-02 HR=0.00
	(322.3 C)		
R4= 4.31250 IN.	T4= 638.1	DT4= 4.2	KMET=1.13E+01
	(322.3 C)		
Z=72.00000 IN.	T5= 638.9	DT5= 543.0	HC=1.31E+00 HR=3.49E+00
	(322.0 C)		
E1=1.00 E2= .80 E3= .80 E4=1.00	TA= 100.0	V FACTOR=1.00	

OUTPUT FROM PROGRAM TIESOC RUN ON 17 FEB 74 AT 09:24:39
FOR SP2 OF 80.00% THEOR. DENSITY = 3.50000E+23 BTU/HR PER CU FT
ENCAPSULATED IN TYPE 316 SST CYLINDER ORIENTATION: VERTICAL
THIS OUTPUT IS FOR CYLINDER IN AIR

R1= 3.99000 IN.	T1= 935.2	DT1= 500.5	KEFF=4.89E-01
	(519.5 C)		
R2= 4.10000 IN.	T2= 464.7	DT2= 1.2	KMET=1.05E+01
	(240.4 C)		
R3= 4.10000 IN.	T3= 453.5	DT3= .0	KAIR=2.24E-02 HR=0.00
	(239.7 C)		
R4= 4.31000 IN.	T4= 453.5	DT4= 2.3	KMET=1.05E+01
	(239.7 C)		
Z=72.00000 IN.	T5= 451.2	DT5= 361.2	HC=1.26E+00 HR=2.36E+00
	(238.4 C)		
E1=1.00 E2= .80 E3= .80 E4=1.00	TA= 100.0	V FACTOR=1.00	

OUTPUT FROM PROGRAM TIESOC RUN ON 17 FEB 74 AT 09:24:39
FOR SP2 OF 80.00% THEOR. DENSITY = 3.40000E+24 BTU/HR PER CU FT
ENCAPSULATED IN TYPE 316 SST CYLINDER ORIENTATION: VERTICAL
THIS OUTPUT IS FOR CYLINDER IN AIR

R1= 3.99000 IN.	T1=2635.7	DT1=1953.4	KEFF=4.82E-01
	(1557.6 C)		
R2= 4.10000 IN.	T2= 835.3	DT2= 4.2	KMET=1.23E+01
	(474.1 C)		
R3= 4.10000 IN.	T3= 831.2	DT3= .0	KAIR=3.30E-02 HR=0.00
	(471.8 C)		
R4= 4.31250 IN.	T4= 831.2	DT4= 7.7	KMET=1.23E+01
	(471.0 C)		
Z=72.00000 IN.	T5= 873.4	DT5= 773.4	HC=1.34E+00 HR=5.43E+00
	(497.5 C)		
E1=1.00 E2= .80 E3= .80 E4=1.00	TA= 100.0	V FACTOR=1.00	

SAMPLE OUTPUT: TIESOC P. 2

OUTPUT FROM PROGRAM TIESOC RUN ON 17 FEB 74 AT 09:24:39

FOR SPEC OF 80-004 THEOR. DENSITY $\rho = 0.50010 \pm 0.001$ BTU/HR PER CU FT
ENCAPSULATED IN TYPE 316 SST CYLINDER ORIENTATION: VERTICAL

THIS OUTPUT IS FOR CYLINDER IN AIR

R1= 3.99000 IN. T1=1012.9 DT1= 503.3 KEFF=4.87-01
(540.9 C)
R2= 4.10000 IN. T2= 509.5 DT2= 1.2 KMET=1.07+01
(255.3 C)
R3= 4.10000 IN. T3= 508.4 DT3= .8 KAIR=2.31-02 HR=0.00
(254.7 C)
R4= 4.31250 IN. T4= 508.4 DT4= 2.2 KMET=1.07+01
(254.7 C)
Z=72.00000 IN. T5= 506.1 DT5= 105.2 MC=1.22+00 HR=1.96+00
(253.4 C)
E1=1.00 E2= .30 E3= .60 E4=1.00 TA= 100.0 V FACTOR=1.00

OUTPUT FROM PROGRAM TIESOC RUN ON 17 FEB 74 AT 09:24:39

FOR SPEC OF 80-004 THEOR. DENSITY $\rho = 1.77010 \pm 0.004$ BTU/HR PER CU FT
ENCAPSULATED IN TYPE 316 SST CYLINDER ORIENTATION: VERTICAL

THIS OUTPUT IS FOR CYLINDER IN AIR

R1= 3.99000 IN. T1=1759.1 DT1=1043.9 KEFF=4.50-01
(999.5 C)
R2= 4.10000 IN. T2= 715.2 DT2= 2.2 KMET=1.16+01
(379.2 C)
R3= 4.10000 IN. T3= 713.0 DT3= .8 KAIR=2.70-02 HR=0.00
(378.2 C)
R4= 4.31250 IN. T4= 713.0 DT4= 4.1 KMET=1.16+01
(378.2 C)
Z=72.00000 IN. T5= 708.9 DT5= 608.9 MC=1.31+00 HR=2.96+00
(376.5 C)
E1=1.00 E2= .80 E3= .60 E4=1.00 TA= 100.0 V FACTOR=1.00

OUTPUT FROM PROGRAM TIESOC RUN ON 17 FEB 74 AT 09:24:39

FOR SPEC OF 80-004 THEOR. DENSITY $\rho = 3.40000 \pm 0.004$ BTU/HR PER CU FT
ENCAPSULATED IN TYPE 316 SST CYLINDER ORIENTATION: VERTICAL

THIS OUTPUT IS FOR CYLINDER IN AIR

R1= 3.99000 IN. T1=2901.7 DT1=1931.0 KEFF=4.87-01
(1594.5 C)
R2= 4.10000 IN. T2= 975.7 DT2= 4.0 KMET=1.27+01
(521.5 C)
R3= 4.10000 IN. T3= 966.7 DT3= .6 KAIR=3.14-02 HR=0.00
(519.5 C)
R4= 4.31250 IN. T4= 966.7 DT4= 7.5 KMET=1.27+01
(519.5 C)
Z=72.00000 IN. T5= 959.1 DT5= 109.2 MC=1.35+00 HR=4.74+00
(515.1 C)
E1=1.00 E2= .80 E3= .60 E4=1.00 TA= 100.0 V FACTOR=1.00

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 02142 OF INPUT

INPUT CALLED AT SEQUENCE NUMBER 02113 OF MAIN PROGRAM

CSCA PL083J 17 FEB 74 4:23:19 USER C04928 P04.013

CARDS IN 73 OUT 1 LINES 2371 PROCESSING TIME 40.95 SECONDS

LISTING AND SUBROUTINE COMPILATION: TIESOC P. 1

```

25 .RUN FENCEL,CURR25, 3 17050000ZBLD G JENSEN 31F BLTG 042350Z
3 LIT 105500Z/04.0.00515. 00002
0 LOP 5
INTERIOR TLAB(5)
PARAMETER IF21000
CAL 0010.00.00.00.00.00
COMMON/HR5/DEL1=DEL2=DEL3=DEL4=DEL5=DEL6=DEL7=DEL8=DEL9=DEL10=DEL11=DEL12=DEL13=DEL14=DEL15=DEL16=DEL17=DEL18=DEL19=DEL20=DEL21=DEL22=DEL23=DEL24=DEL25=DEL26=DEL27=DEL28=DEL29=DEL30=DEL31=DEL32=DEL33=DEL34=DEL35=DEL36=DEL37=DEL38=DEL39=DEL40=DEL41=DEL42=DEL43=DEL44=DEL45=DEL46=DEL47=DEL48=DEL49=DEL50=DEL51=DEL52=DEL53=DEL54=DEL55=DEL56=DEL57=DEL58=DEL59=DEL60=DEL61=DEL62=DEL63=DEL64=DEL65=DEL66=DEL67=DEL68=DEL69=DEL70=DEL71=DEL72=DEL73=DEL74=DEL75=DEL76=DEL77=DEL78=DEL79=DEL80=DEL81=DEL82=DEL83=DEL84=DEL85=DEL86=DEL87=DEL88=DEL89=DEL90=DEL91=DEL92=DEL93=DEL94=DEL95=DEL96=DEL97=DEL98=DEL99=DEL100=DEL101=DEL102=DEL103=DEL104=DEL105=DEL106=DEL107=DEL108=DEL109=DEL110=DEL111=DEL112=DEL113=DEL114=DEL115=DEL116=DEL117=DEL118=DEL119=DEL120=DEL121=DEL122=DEL123=DEL124=DEL125=DEL126=DEL127=DEL128=DEL129=DEL130=DEL131=DEL132=DEL133=DEL134=DEL135=DEL136=DEL137=DEL138=DEL139=DEL140=DEL141=DEL142=DEL143=DEL144=DEL145=DEL146=DEL147=DEL148=DEL149=DEL150=DEL151=DEL152=DEL153=DEL154=DEL155=DEL156=DEL157=DEL158=DEL159=DEL160=DEL161=DEL162=DEL163=DEL164=DEL165=DEL166=DEL167=DEL168=DEL169=DEL170=DEL171=DEL172=DEL173=DEL174=DEL175=DEL176=DEL177=DEL178=DEL179=DEL180=DEL181=DEL182=DEL183=DEL184=DEL185=DEL186=DEL187=DEL188=DEL189=DEL190=DEL191=DEL192=DEL193=DEL194=DEL195=DEL196=DEL197=DEL198=DEL199=DEL200=DEL201=DEL202=DEL203=DEL204=DEL205=DEL206=DEL207=DEL208=DEL209=DEL210=DEL211=DEL212=DEL213=DEL214=DEL215=DEL216=DEL217=DEL218=DEL219=DEL220=DEL221=DEL222=DEL223=DEL224=DEL225=DEL226=DEL227=DEL228=DEL229=DEL230=DEL231=DEL232=DEL233=DEL234=DEL235=DEL236=DEL237=DEL238=DEL239=DEL240=DEL241=DEL242=DEL243=DEL244=DEL245=DEL246=DEL247=DEL248=DEL249=DEL250=DEL251=DEL252=DEL253=DEL254=DEL255=DEL256=DEL257=DEL258=DEL259=DEL260=DEL261=DEL262=DEL263=DEL264=DEL265=DEL266=DEL267=DEL268=DEL269=DEL270=DEL271=DEL272=DEL273=DEL274=DEL275=DEL276=DEL277=DEL278=DEL279=DEL280=DEL281=DEL282=DEL283=DEL284=DEL285=DEL286=DEL287=DEL288=DEL289=DEL290=DEL291=DEL292=DEL293=DEL294=DEL295=DEL296=DEL297=DEL298=DEL299=DEL300=DEL301=DEL302=DEL303=DEL304=DEL305=DEL306=DEL307=DEL308=DEL309=DEL310=DEL311=DEL312=DEL313=DEL314=DEL315=DEL316=DEL317=DEL318=DEL319=DEL320=DEL321=DEL322=DEL323=DEL324=DEL325=DEL326=DEL327=DEL328=DEL329=DEL330=DEL331=DEL332=DEL333=DEL334=DEL335=DEL336=DEL337=DEL338=DEL339=DEL340=DEL341=DEL342=DEL343=DEL344=DEL345=DEL346=DEL347=DEL348=DEL349=DEL350=DEL351=DEL352=DEL353=DEL354=DEL355=DEL356=DEL357=DEL358=DEL359=DEL360=DEL361=DEL362=DEL363=DEL364=DEL365=DEL366=DEL367=DEL368=DEL369=DEL370=DEL371=DEL372=DEL373=DEL374=DEL375=DEL376=DEL377=DEL378=DEL379=DEL380=DEL381=DEL382=DEL383=DEL384=DEL385=DEL386=DEL387=DEL388=DEL389=DEL390=DEL391=DEL392=DEL393=DEL394=DEL395=DEL396=DEL397=DEL398=DEL399=DEL400=DEL401=DEL402=DEL403=DEL404=DEL405=DEL406=DEL407=DEL408=DEL409=DEL410=DEL411=DEL412=DEL413=DEL414=DEL415=DEL416=DEL417=DEL418=DEL419=DEL420=DEL421=DEL422=DEL423=DEL424=DEL425=DEL426=DEL427=DEL428=DEL429=DEL430=DEL431=DEL432=DEL433=DEL434=DEL435=DEL436=DEL437=DEL438=DEL439=DEL440=DEL441=DEL442=DEL443=DEL444=DEL445=DEL446=DEL447=DEL448=DEL449=DEL450=DEL451=DEL452=DEL453=DEL454=DEL455=DEL456=DEL457=DEL458=DEL459=DEL460=DEL461=DEL462=DEL463=DEL464=DEL465=DEL466=DEL467=DEL468=DEL469=DEL470=DEL471=DEL472=DEL473=DEL474=DEL475=DEL476=DEL477=DEL478=DEL479=DEL480=DEL481=DEL482=DEL483=DEL484=DEL485=DEL486=DEL487=DEL488=DEL489=DEL490=DEL491=DEL492=DEL493=DEL494=DEL495=DEL496=DEL497=DEL498=DEL499=DEL500=DEL501=DEL502=DEL503=DEL504=DEL505=DEL506=DEL507=DEL508=DEL509=DEL510=DEL511=DEL512=DEL513=DEL514=DEL515=DEL516=DEL517=DEL518=DEL519=DEL520=DEL521=DEL522=DEL523=DEL524=DEL525=DEL526=DEL527=DEL528=DEL529=DEL530=DEL531=DEL532=DEL533=DEL534=DEL535=DEL536=DEL537=DEL538=DEL539=DEL540=DEL541=DEL542=DEL543=DEL544=DEL545=DEL546=DEL547=DEL548=DEL549=DEL550=DEL551=DEL552=DEL553=DEL554=DEL555=DEL556=DEL557=DEL558=DEL559=DEL560=DEL561=DEL562=DEL563=DEL564=DEL565=DEL566=DEL567=DEL568=DEL569=DEL570=DEL571=DEL572=DEL573=DEL574=DEL575=DEL576=DEL577=DEL578=DEL579=DEL580=DEL581=DEL582=DEL583=DEL584=DEL585=DEL586=DEL587=DEL588=DEL589=DEL590=DEL591=DEL592=DEL593=DEL594=DEL595=DEL596=DEL597=DEL598=DEL599=DEL600=DEL601=DEL602=DEL603=DEL604=DEL605=DEL606=DEL607=DEL608=DEL609=DEL610=DEL611=DEL612=DEL613=DEL614=DEL615=DEL616=DEL617=DEL618=DEL619=DEL620=DEL621=DEL622=DEL623=DEL624=DEL625=DEL626=DEL627=DEL628=DEL629=DEL630=DEL631=DEL632=DEL633=DEL634=DEL635=DEL636=DEL637=DEL638=DEL639=DEL640=DEL641=DEL642=DEL643=DEL644=DEL645=DEL646=DEL647=DEL648=DEL649=DEL650=DEL651=DEL652=DEL653=DEL654=DEL655=DEL656=DEL657=DEL658=DEL659=DEL660=DEL661=DEL662=DEL663=DEL664=DEL665=DEL666=DEL667=DEL668=DEL669=DEL670=DEL671=DEL672=DEL673=DEL674=DEL675=DEL676=DEL677=DEL678=DEL679=DEL680=DEL681=DEL682=DEL683=DEL684=DEL685=DEL686=DEL687=DEL688=DEL689=DEL690=DEL691=DEL692=DEL693=DEL694=DEL695=DEL696=DEL697=DEL698=DEL699=DEL700=DEL701=DEL702=DEL703=DEL704=DEL705=DEL706=DEL707=DEL708=DEL709=DEL710=DEL711=DEL712=DEL713=DEL714=DEL715=DEL716=DEL717=DEL718=DEL719=DEL720=DEL721=DEL722=DEL723=DEL724=DEL725=DEL726=DEL727=DEL728=DEL729=DEL730=DEL731=DEL732=DEL733=DEL734=DEL735=DEL736=DEL737=DEL738=DEL739=DEL740=DEL741=DEL742=DEL743=DEL744=DEL745=DEL746=DEL747=DEL748=DEL749=DEL750=DEL751=DEL752=DEL753=DEL754=DEL755=DEL756=DEL757=DEL758=DEL759=DEL760=DEL761=DEL762=DEL763=DEL764=DEL765=DEL766=DEL767=DEL768=DEL769=DEL770=DEL771=DEL772=DEL773=DEL774=DEL775=DEL776=DEL777=DEL778=DEL779=DEL780=DEL781=DEL782=DEL783=DEL784=DEL785=DEL786=DEL787=DEL788=DEL789=DEL790=DEL791=DEL792=DEL793=DEL794=DEL795=DEL796=DEL797=DEL798=DEL799=DEL800=DEL801=DEL802=DEL803=DEL804=DEL805=DEL806=DEL807=DEL808=DEL809=DEL810=DEL811=DEL812=DEL813=DEL814=DEL815=
```

LISTING AND SUBROUTINE COMPILATION: TIESOC P. 2

```

PRR=APLOT-TOT/2*INC+110.
DTIC=ICF-TOT+.5
T1=T2*DT
IF(T99,LE,C99) GOTO 801
ATT CONTINUE
WRITE(6,1) TL42(1),TL48(1),DT,TL43(1),TOT,ERR,ERR1
801 DILLDT
CONTINUE
DO 802 I=1,4
802 R(I)=R(I)+1.
VFX=VF
CALL OUTPUT(T1,T2,T3,T4,T5,KIND,N,TAL,Z1,C2,PCTD,S,T4,R,Z,VFX)
GOTO 100
END

      B ELY FEQUA/SIFS,1,C90515, 50962
      B ECF 3
      FUNCTION FEQUA(F,V,CUM1,DU42,ICLW)
      FEQUA=ABS(F-(F+.2)*F)*ALOG((F+1)/F)-F
      RETURN
      END

      B ELY KAIR/SIFS,1,C90515, 50960
      B ECF 3
      SUBROUTINE KAIR(TCF,VK)
      C
      C--- TABLE LOOKUP FOR THERMAL CONDUCTIVITY OF AIR
      C TCF = TEMPERATURE IN DEGREES F. (RANGE 0.0 TO 3000 F)
      C VK = THERMAL CONDUCTIVITY (BTU FT/HR FT DEC F)
      C
      REAL K(16),T(16)
      DATA (T(I),I=1,16)/0.,12.,100.,200.,300.,400.,500.,600.,700.,
2 800.,900.,1000.,1500.,2000.,2500.,3000./
      DATA(K(I),I=1,16)/.0112,.0113,.0114,.0115,.0116,.0117,.0118,.0119,
2 .0120,.0121,.0122,.0123,.0124,.0125,.0126,.0127/
      NEL=16
      CALL TLOOKINEL(T,K,TCF,VK)
      RETURN
      END
      C2/03/69

      B ELY KSOL/SIFS,1,C90515, 50975
      B ECF 3
      SUBROUTINE KSOL(K,T,KWHICH)
      REAL K,SP(16),CS(16),TEMP(16)
      C
      C THE DATA BELOW ARE NOT K OF SPF2, BUT ARE (15.0-K) TO PROVIDE THE
      C ASCENDING ORDER REQUIRED BY TABLE LOOKUP ROUTINE, TLOOK.
      C
      C THE DATA FOR K OF CSCL ARE HANDLED SIMILARLY EXCEPT THEY ARE (1.0-K).
      C
      DATA(SP(I),I=1,16)/1.90,2.1,2.25,2.4,2.6,2.8,3.0,3.1,3.3,3.5,
2 3.7,3.8,3.9,4.1,4.2,4.3,4.4,4.5/
      DATA(TEMP(I),I=1,16)/70.,80.,100.,150.,200.,250.,300.,400.,500.,
2 600.,700.,800.,900.,1100.,1200.,1400./
      DATA(CS(I),I=1,16)/.025,.027,.035,.045,.055,.065,.075,.085,.095,
2 .105,.115,.125,.135,.145,.155/
      NEL=16
      GO TO (100,200),KWHICH & 100 FOR CSCL, 200 FOR SPF2
      100 CALL TLOOK (INEL,TEMP,CS,T,K)
      K=1-BK
      RETURN
      200 CALL TLOOK (INEL,TEMP,SP,T,K)
      K=5-BK
      RETURN
      END

      B ELY TFLINT/SIFS,1,C90515, 50981
      B ECF 3
      SUBROUTINE TFLINT(XN=1,XN=X,YNM1,YN,Y)
      C
      C A 2-POINT INTERPOLATION ROUTINE
      C
      C X = THE VALUE OF THE INDEPENDENT VARIABLE FOR WHICH THE
      C CORRESPONDING VALUE OF Y IS WANTED.
      C Y = THE VALUE OF THE DEPENDENT VARIABLE.
      C XNM1,YNM1 = A POINT ON THE CURVE ON ONE SIDE OF X,Y.
      C XN,YN = A POINT ON THE CURVE ON THE OTHER SIDE OF X,Y.
      C
      Y=(X-XNM1)*(YN-YNM1)/(XN-XNM1)+YNM1
      RETURN
      END

```

LISTING AND SUBROUTINE COMPILATION: TIESOC P. 3

```

3 FLT KONG/1105.1, KONG 515. 509885 1 11
2 107 a
SUBROUTINE MUNC1(EFF, F, F02, L, SALT)
REAL FRANGE(12), ARANGE(12), KEFF
EXTERNAL F02UA
LOGICAL FIRST
DATA FIRST/.TRUE./
DATA F2, F1, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0/
DATA FRANGE(1), F1, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01,
2 F05, F1, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01, F1P,
DATA F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01, F1P,
23 F01, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01, F1P,
3 F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01, F1P,
4 F05, F01, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01,
5 F05, F01, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01,
6 F05, F01, F1P, F1P1, F0, F02, DELX, F101, VFUNC, -1.0, F05, F01,
NAMELIST/SL2/C, D, T, L, SALT, F, F02, FHIGH, PLLX, VFUNC, ARG
1 FORMAT(1H, 20, 'HAD ARG FOR ALTS IN S.R. MUNC 1
V=1-F02/110. & V HERE EQUIV TO (1-V) IN SCHLAPMAN VOSS.
V=V+3
CALL KAP1(T, C)
CALL KSL2(C, L, SALT) ELSELT=1 FOR SRFZ, =1 FOR CSCL.
IF(FIRST) CALL SL2T1(C, IFF1STURN SL2 OFF FOR FIRST F1ENAC CALL.
FIRST=.FALSE.
IF(V, LT, VFRANGE(1)) GOTO 98
IF(V, GT, VFRANGE(12)) GOTO 99
DO 100 I=2, 22
IF(V, LE, VFRANGE(I)) GOTO 195
180 CONTINUE
185 FLOW=1.0, I=1
FHIGH=FFRANGE(1)
VFUNC=1.
CALL F1ENAC(FEGUA, V, F2, F3, ICD, F, FLOW, FHIGH, DELX, 0, VFUNC)
C=D-C-0
FF1=F+1
FCND=F-CND
F1=C-D/(C+FCND)
ARG=C/(C+FF1/(F+3))
IF(ARG) 200, 200, 202
200 WRITE(6, 1)
WRITE(6, BUE)
STOP
202 F2=ALOE(ARG)
F3=F+FF1-C/D/(C+FCND)
B1=F-F3-F2
A=C-F1+B
E=C-CB + A*(1-VK)
KEFF=1.536+C+.959
RETURN
20 WRITE(6, 2)
2 FORMAT(1H, A VALUE OF V=1FE13.7-2BM CANNOT BE USED IN EQ. FOR P
RETURN
END

```

```

8 ELT KMET/21F5.1.69C515. 50995
9 EOF 3
SUBROUTINE KMET(T,K,MYTPE)
REAL K
GOTO (100,200),MYTPE
100 K=.0003-T+.5
RETURN
200 K=.0006-T+.625
RETURN
END

```

```

8 ELT H943/SIFS.1.590515. 5100N
8 EOF 8
      SUBROUTINE H943(E1,E2,T1,T2,VF,HP)
C   E1 IS EMISSIVITY OF SURFACE 1
C   E2 IS EMISSIVITY OF SURFACE 2
C   T1 IS TEMPERATURE OF SURFACE 1 (FAHRENHEIT)
C   T2 IS TEMPERATURE OF SURFACE 2 (FAHRENHEIT)
C   VF IS VIEW FACTOR
C   HP IS AREA OF SURFACE 1 SQ FT
C   H9 IS RADIATION HEAT TRANSFER COEFFICIENT BTU/HR FT SQ FT
      DATA SIGMA/.1712E-8/
      F1=1/E1+1/E2-1
      T1=T1-460.
      T2=T2-460.
      FFC=((T1/100.)**.4-(T2/100.)**.4)*.1E+8.
      H9=VF*SIGMA*FFC/(F1*(T1-T2))
      RETURN
      END

```

LISTING AND SUBROUTINE COMPILATION: TIESOC P. 4

[illegible]

```

ELT TIESC/SZ54.1.E912C9. F0093
8 EOF 8
  INTERSE TL49(5)
  PARAMETER IF2IG=0
  REAL R(1),X4,MX,KEFF
  COMMON/ANS/DEL1,DEL2,DEL3,DEL4,DEL5,HC5,HPS,CCN4,HF3,CCN3,CON2
2 CONT
  DATA TL49/200,DEL1, DEL2, DEL3, DEL4, DEL5 /
1 FORMAT(39H COMVENTION SPEC NOT MET IN COMPUTING .AS.7M .LAST .AS.
  2/5M WAS .F7.2/1CM PREVIOUS .AS.5M WAS .F7.2/1CM .ERROR WAS .F8.3.
  3 2M . REQUESTED MAX ERROR WAS.F1.3)
10C CALL INPUT(METAL,KCND,P,DTIG,DT2C,DT3C,CT4G,DT5G,FCIO,E1,E2,EPC1,
  2ERD2,EPD3,ERD4,ERD5,TA,S,Z,VF,KHV)
  D=Z/12.
  DO 40 I=1,4
40 R(I)=R(I)/12.
  FSSR7=.5*SOR(1)**2
C FIND TS. TEMP OF OUTER SURFACE OUTER SHELL
  A1=3.14159*2.*PI*1.0
  DO 400 Z=1.5C
  TOT=DT5G
  TTS=TA+TOT
  IF(MV.EG.2) GOTO 43
  DON=Z*R(1)
  CALL MCON4(TTS,TA,CON,HC,FR,GRI)
  GO TO 44
43 CALL MCONV(TTS,TA,C,HC,FP,GPI)
44 HRC=0
  IF(VF.CT.1.E-8) CALL HR3(E1,1.,TTS,TA,VF,HRI)
  HT=HC*HP
  DT=FSSR7/(R(1)*4PI)
  ERR=(DT-TOT)/CT5C*100.
  DT5G=(TOT+TOT)*.5 +ERR/1
  TS=TA+DT
  DELETE 47,IFZIG
2 FORMAT(1M .39HCC=.1FE1C.4.5M HRC=E1C.4.5M GPC=E1C.4.5M PRC=
  2E1C.7.1M .39HDT=.1D1.4.5M TOT=E1C.4.5M ERR=.E1B.4.5M TET:
  3 E10.4)
  WRITE(6,2) HC,HP,CP,FP,DT,TOT,ERR,TS
47 CONTINUE
  IF(A1/2*EPD3,LC,EPD5) GOTO 4C1
40C CONTINUE
  WRITE(6,1) TL49(5),TL48(5),DT,TL48(5),TOT,ERR,EPD5
401 DELS=DT
  MCS=MC
  MRS=MR

```


LISTING AND SUBROUTINE COMPILATION: TIESOC P. 5

```

C FIND T1. TEMP OF INNER SURFACE OF OUTER SHELL
DO 500 I=1,100
  T1=DT1
  T1=T1+DT1
  TAV=T1+.5*DT1 SAVE TEMP FOR K OF METAL
  CALL KMET(TAV,KH,METAL)
  DT=FSSP/ALOG(P(1)/P(1)/4M
  ERR=ABS(DT-T1)/DT*100.
  DT2=(DT+T1)*.5
  T1=DT2
  IF(ERR.LE.EP01) GOTO 501
500 CONTINUE
  WRITE(6,1) TLAB(1),TLAB(9),DT,TLAB(1),DT,ERR,EP01
501 DEL=DT
  CONN=KN
C FIND T3. TEMP AT OUTER SURFACE OF INNER SHELL
DO 600 I=1,100
  T3=DT3
  T3=T3+DT3
  TAV=T3+.5*DT3 B AVG T FOR AIR PROPERTIES
  CALL KAIR(TAV,KA)
  A=P(1)/3.14159*2.5
  CALL HPAC(E1,E2,T3,T4,L,H9)
  DT=FSSP/ALOG(P(2)/P(1)/(KA+P(2)*H)*ALOG(P(2)/P(1)))
  ERR=ABS(DT-T3)/DT*100.
  DT3=(DT+T3)*.5
  T3=DT3
  IF(ERR.LE.EP02) GOTO 601
600 CONTINUE
  WRITE(6,1) TLAB(3),TLAB(13),DT,TLAB(3),DT,ERR,EP02
601 DEL2=DT
  CON2=KA
  HP3=HR
DO 700 I=1,100 FIND TEMP AT INNER SURFACE OF INNER SHELL
  T2=DT2
  T2=T2+DT2
  TAV=T2+.5*DT2 SAVE TEMP FOR K OF METAL
  CALL KMET(TAV,KH,METAL)
  DT=FSSP/ALOG(P(2)/P(1)/4M
  ERR=ABS(DT-T2)/DT*100.
  DT2=(DT+T2)*.5
  T2=DT2
  IF(ERR.LE.EP02) GOTO 701
700 CONTINUE
  WRITE(6,1) TLAB(2),TLAB(12),DT,TLAB(2),DT,ERR,EP02
701 DEL2=DT
  CON2=KH
DO 800 I=1,100 FIND TEMP AT CENTERLINE
  T1=T1+DT1
  T1=T2+DT2
  TAV=T2+.5*DT2 B AVG TEMP FOR K OF SALT
  CALL KUNICEFF(TAV,KCTO,KIND)
  DT=FSSP/(2.*KEFF)
  ERR=ABS(DT-T1)/DT*100.
  DT1=(DT+T1)*.5
  T1=DT1
  IF(ERR.LE.EP01) GOTO 801
800 CONTINUE
  WRITE(6,1) TLAB(1),TLAB(11),DT,TLAB(1),DT,ERR,EP01
801 DEL1=DT
  CON1=KEFF
DO 840 I=1,4
  B40 P(I)=P(I)*12.
  VFX=VF
  CALL OUTPUT(T1,T2,T3,T4,T5,KIND,METAL,E1,E2,PCT,S,TA,R,Z,VFX,KHVI)
  GOTO 100
END

B ELT KWATER/SIF5.1.7C1015. 52209
B EOF 3
SUBROUTINE KWATER(TDF,VK)
C
C --- TABLE LOOKUP FOR CONDUCTIVITY OF WATER
C TDF = TEMPERATURE IN DEGREES F (RANGE 40 TO 140 F)
C VK = THERMAL CONDUCTIVITY (BTU FT/HR FT DEG F)
C
  REAL K(16),T(16)
  DATA (T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10),T(11),T(12),T(13),T(14),T(15),T(16))
  / 200.,250.,300.,350.,400.,450.,500.,550.,600.,650.,700.,750.,800.,850.,900.,950.
  DATA (K(1),K(2),K(3),K(4),K(5),K(6),K(7),K(8),K(9),K(10),K(11),K(12),K(13),K(14),K(15),K(16))
  / .394,.396,.398,.399,.401,.403,.405,.407,.409,.411,.413,.415,.417,.419,.421,.423
  NCL=16
  CALL TL20F(NCL,T,K,TDF,VK)
  RETURN
END

B ELT GRFR/SIF4.1.7C1020. 31670
B EOF 2
SUBROUTINE GRFR(I3,D,FP,GP,DELTI)
C
C ROUTINE TO DETERMINE GRAIN SIZE AND PPM/TL NUMBERS FOR AIR IN THE

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LISTING AND SUBROUTINE COMPILATION: TIESOC P. 6

[illegible]

8 CLT CH23/SIF-1-1-701070- 31671
 8 EOF 8
 SUBROUTINE CH23/ITS-TA-DZ-MC-FC-FC
 PARAPETER IFZIC-1
 C TS IS TEMP OF MFT SURFACE (FAHRENHEIT)
 C TA IS TEMP OF WATER (FAHRENHEIT)
 C DZ IS THE CHARACTERISTIC DIMENSION FT (L IN HEADINGS)

LISTING AND SUBROUTINE COMPILATION: TIESOC P. 7

```

C      NO IN THE CONVECTION COEFFICIENT DIVISION IS LEG F3
C      FR IN THE FRAXITE NUMBER
C      DRITS IN THE GRASHOF NUMBER
C      IF2=0.15+0.15
C      DELT1=0.7A
C      CALL XWATER (TF,NO)
C      CALL XWATER (NO,FR,GR,DELTA)
C      XCOR=FR
C      DELETE 100,IF2IG
C      NAMELIST /OUT/ NO,DELTA,DT,TF,GR,FR
C      101TF(6,OUT)
200 CONTINUE
C      HCONC=1.13+COR*FR1+.00333333/DT
C      RETURN
C      END

3 ELT TIESOC/21F5.1-710304. 36975
5 EOF 5
C      INTEGER TLAB(5)
C      PARAMETER IF2IG=1
C      REAL PI(4),KA,KH,KHFF,STON(100),GOF(100)
C      COMMON /ANS/DEL1,DEL2,DEL3,DEL4,DEL5,HCS,HFS,CONC,HSE,CON7,CON2
C      2 CON1
C      COMMON /ENVF/MEC
C      DATA TLAB/30MDEL1,DEL2,DEL3,DEL4,DEL5 /
C      1 FORMAT(30H CONVECTION SPEC ACT MET IN COMPUTING WAS WITH LAST 46.
C      2 75H WAS 47.7/10H PREVIOUS 45.5H WAS 47.1/10H TREFD WAS 47B.3.
C      3 27H . REQUESTED MAX ERROR WAS 45.9.31)
C      3 FORMAT( 30H CYCLING AT ITERATION 1-100 IN CALCULATING TS. 77 GRASHOF
C      2 FRAXITE PRODUCT ITERATING BETWEEN 45.2.7 AND 46.2.7. COEFFS
C      20NDING VALUES FOR NO WERE 45.2.7 AND 46.2.7. THE LOWER VALUE
C      4WAS USED TO CALCULATE TS.1)
100 CALL INFUTENETAL(KIND,P,DT1G,DT2G,DT3G,DT4G,DT5G,PCTD,E1,E2,E3,
C      1EN,E21,
C      2ERD2,ERD3,ERD4,ERD5,TA,S,I,VF,KHV)
C      D=2/12.
C      DO NO I=1,4
C      40 RI(1:PI(1)/12.
C      FSSR2=5.5+PI(1)+2
C      C FIND TS. TEMP OF OUTER SURFACE OUTER SHELL
C      A1=3.14159+2.4*PI(1)+0
C      IF(ALL.EQ.2)HCONC=10.
C      DO 400 I=1,100
C      TOT=TSO
C      TTS=TA+TOT
C      IF(1-LT.30) GOTO 41
C      IF(STON(I-1).GE.STON(I-3)) GOTO 41
C      HCONC=11*STON(I-1)*STON(I-2)
C      DTSG=1.E+30
C      VPLT=1.0+2.0*PI(1)+.5*PI(1)+.1*STON(I-1)*STON(I-2)
C      GOTO 44
41 CONTINUE
C      D=HCONC+R(1)
C      IF(HCONC.EQ.2) GOTO 42
C      IF(KHV.EQ.2) GOTO 43
C      CALL HCONHTTS.TA,CONC,HCONC,FR,GR)
C      GO TO 44
42 CALL CHZDTTS.TA,CONC,HCONC,FR,GR)
C      HCONC
C      HPS=0.0
C      KHV=2
C      STON(I)=HT
C      GOTO 45
43 CALL HCONVHTTS.TA,D,HCONC,FR,GR)
C      HPS=0.0
C      STON(I)=HCONC
C      SGF(I)=FR+GR
C      IF(VF.GT.1.E-9) CALL HPADEZ.E4-TTS.TA,TF,HPS)
C      HT=HCONC+HPS
45 DT=FSSRC/(PI(1)+HT)
C      ERR=ABS(TOT-TDT)/DTSG+100.
C      DTSG=(DT-TDT)+.5
C      TTS=TA+DT
C      DELETE 47,IF2IG
C      2 FORMAT(11H 30H HCONC=45E10.4.5H HPS=E10.4.5H GPF=E10.4.5H PRD=
C      2E10.4.5H 30H HCONC=E10.4.5H TOT=E10.4.5H ERR=E10.4.5H TSS=
C      3E10.4)
C      WRITE(6,2) HCONC,HPS,GP,PP,DT,TOT,ERR,TSS
47 CONTINUE
C      IF(ERP.LE.ERP5) GOTO 401
400 CONTINUE
C      WRITE(6,1) TLAB(5),TLAB(5),DT,TLAB(5),TOT,ERR,ERP5
401 A1=1.0
C      HCONC=0
C      HPS=0
C      DTSG=DT
C      C FIND TS. TEMP OF INNER SURFACE OF OUTER SHELL
C      DO 500 I=1,100
C      TOT=TSO
C      TTS=TA+TOT
C      TAVTTS = .5*(TOT+TTS) SAVG TEMP FOR K OF METAL
C      CALL HMETITAV,KH,METAL)
C      DT=FSSRC+ALC(PI(1)/9.33)/KH
C      ERR=ABS(TOT-TDT)/DTNC+100.
C      DTNC=(DT-TDT)+.5
C      TTS=TA+DT
C      IF(ERP.LE.ERP5) GOTO 501

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LISTING AND SUBROUTINE COMPILATION: TIESOC P. 8

```

END CONTINUE
WRITE(6,1) TLAB(1),TLAB(2),CT,TLAB(3),TDT,ERR,EPD3
501 DELT=CT
CON2=KM
C FIND T3. TEMP AT OUTER SURFACE OF INNER SHELL
DO 600 I=1,100
TDT=DTIG
T3=T4+TDT
TAV=T3+.5*TDT 3 AVG T FOR AIR PROPERTIES
CALL KAPIT(TAV,K4)
A3=P(3)+3.14159*2.*T
CALL KRAJ(E1+E2+T3+.75,1.,-3)
DT=FSSRO*ALOC(P(3)/P(1))/(KA+R(2)+HF*ALOC(P(3)/P(1)))
EPR=ABS(DT-TDT)/DTIG*100.
DTIG=(CT+TDT)*.5
T3=T4+DT
IF (EPR,LE,EPD3) GOTO 601
600 CONTINUE
WRITE(6,1) TLAB(2),TLAB(3),CT,TLAB(3),TDT,ERR,EPD3
601 DELT=DT
CON3=KA
MR3=MR
DO 700 I=1,100 FIND TEMP AT INNER SURFACE OF INNER SHELL
TDT=DTIG
T2=T3+TDT
TAV=T2+.5*TDT 3AVE TEMP FOR K OF METAL
CALL KMET(TAV,KM,METAL)
DT=FSSRO*ALOC(R(1)/R(2))/KM
ERR=ABS(DT-TDT)/DTIG*100.
DTIG=(CT+TDT)*.5
T2=T3+DT
IF (ERR,LE,EPD2) GOTO 701
700 CONTINUE
WRITE(6,1) TLAB(2),TLAB(3),CT,TLAB(3),TDT,ERR,EPD2
701 DELT=DT
CON2=KM
DO 800 I=1,100 FIND TEMP AT CENTERLINE
TDT=DTIG
T1=T2+TDT
TAV=T2+.5*TDT 3 AVG TEMP FOR K OF SALT
CALL KUNC(KEFF,TAV,CTD,KIND)
DT=FSSRO/(2.*KEFF)
EPR=ABS(DT-TDT)/DTIG*100.
DTIG=(CT+TDT)*.5
T1=T2+DT
IF (EPR,LE,EPD1) GOTO 801
800 CONTINUE
WRITE(6,1) TLAB(1),TLAB(3),CT,TLAB(3),TDT,ERR,EPD1
801 DELT=DT
CON1=KEFF
DO 840 I=1,4
840 R(I)=R(1)*12.
VFX=VF
CALL OUTPUT(T1,T2,T3,T4,T5,KIND,METAL,
.E1,E2,E3,E4,CTD,S,TA,P,2,VFX,KMV)
GOTO 100
END

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8 EIT FIBNAC/SIFS.1.710304. 35976
8 EOF 8
SUBROUTINE FIBNAC(DUMMY,F1,F2,F3,F4,X,XMIN,XMAX,DELT,N,FMAX)
DIMENSION FIB(64)
EXTERNAL DUMMY
INTEGER N
C SUBROUTINE TO DETERMINE THE MAXIMUM OR MINIMUM OF A UNIMODAL FUNCTION
C OF ONE VARIABLE BY THE FIBONACCI SEARCH METHOD.
C CALL LIST 1. DUMMY--NAME OF FUNCTION SUBPROGRAM TO CALCULATE FUNCTION.
C 2. F1--PARAMETER FOR USE IN DUMMY SUBPROGRAM (REAL)
C 3. F2--DITTO
C 4. F3--DITTO
C 5. F4--DITTO EXCEPT INTEGER
C 6. X--VALUE OF VARIABLE AT EXTREMUM (OUTPUT)
C 7. XMIN--LOWER LIMIT OF INTERVAL TO BE EXPLORED
C 8. XMAX--UPPER LIMIT OF INTERVAL TO BE EXPLORED
C 9. N--MAXIMUM FIBONACCIAN NUMBER TO BE USED. A NUMBER OTHER
C THAN ZERO WILL DETERMINE ACCURACY OF X RATHER THAN DELT
C 10. FMAX--ON INPUT MUST BE +1.0 FOR MAXIMUM, -1.0 FOR MINIMUM
C --ON OUTPUT WILL BE VALUE OF FUNCTION AT EXTREMUM.
100 CALL SLTST(2,KDIOFX)
GOTO(103,101),KDIOFX
C SENSILIGHT 2 MUST BE OFF ON FIRST ENTRY TO SUBROUTINE, AND LEFT ON
C ON SUBSEQUENT ENTRIES.
C GENERATE FIBONACCIAN NUMBERS F1-F12=0-F12=0.FIB(1)=F-02.FIB(2)=
C USED TO ALLOW THE ENLPOINTS OF THE INTERVAL TO BE INCLUDED.
101 FIB(1)=1.
FIB(2)=1.
FIB(3)=1.
DO 102 I=4,64
102 FIB(I)=FIB(I-1)+FIB(I-2)

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LISTING AND SUBROUTINE COMPILATION: TIESOC P. 9

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103 N1=N+2
    CALL SLITF (2)
5103 IF (N1-100) GO TO 104
C DETERMINE N2 = 100 - N1
104 XC=(XMAX-XMIN)/DELX
    N1=3
    N2=10
    DO 107 I=1,7
5104 IF (XC-FIB(N1)) 106,105,105
105 N1=N1-N2
    GOTO 107
106 N1=N1-N2
107 N2=(N2+1)/2
C BEGIN SEARCH
108 N2=N1-3
    N1ST=MAX(N1,N2)
    IF (N1ST-CT.3E) GOTO 201
109 XM=XMIN
    XC=(XMAX-XMIN)/FIB(N1)
    X2=XM+XC+FIB(N2+2)
    F2=DUMPMY(X2,F1,F2,F3,F4)
7110 GO TO 113
110 N2=N2-1
5110 IF (N2) 115,115,111
111 IF (FMAX*(F2-F1)) 112,114,114
112 F2=F1
    X2=X1
113 X1=X2-XC+FIB(N2)
    F1=DUMPMY(X1,F1,F2,F3,F4)
    GO TO 110
114 F1=F2
    X1=X2
    X2=X1+XC+FIB(N2)
    F2=DUMPMY(X2,F1,F2,F3,F4)
    GO TO 110
115 IF (FMAX*(F2-F1)) 115,116,117
116 X=X1
    FMAX=F1
    GOTO 118
117 X=X2
    FMAX=F2
118 RETURN
201 IF (KTST.LT.62) GOTO 203
    WRITE (6,202)
202 FORMAT (18H FIB NMBR .GT. 62)
    RETURN
203 WRITE (6,204) DELX,XMIN,XMAX
204 FORMAT (18H FIB NMBR .GT. 30. 3E15.8)
    GO TO 103
END

```

08/04/71

B ELT MCCNV/SIFS.1.710804. 36977
B EOF 3

```

SUBROUTINE MCCNV(TS,TA,DZ,HC,PP,GP)
PARAMETER (FZIG=1)
TS IS TEMP OF HOT SURFACE (FAHRENHEIT)
TA IS TEMP OF AMBIENT (FAHRENHEIT)
DZ IS THE CHARACTERISTIC DIMENSION (FT. IL IN MCQMS)
GP IS THE CONNECTION COEFF. (TU/HR FT DEG)
GP IS THE GRASHOF NUMBER
1 FORMAT (THE GRASHOF FRAGDTL PRODUCT (1E13.7) EXCEEDS 10**12 08/04/71
2M S.P. MCCNV) 08/04/71
2 FORMAT (1M 2MGRASHOF FRAGDTL PRODUCT (1E13.7.30M) LESS THAN 10
2**4 IN S.P. MCCNV)
TF=.5*(TS+TA)
DELT=TS-TA
CALL VAP(TF,AC)
CALL GRF(TF,DZ,FR,GR,DELT)
X=GR*FR
DELET=2ND*TFZIG
NAMELIST/OUT/ AC,DELT,DZ,TF,GR,FR
WRITE (6,OUT)
200 CONTINUE
C EQUATIONS SWITCHED --- 08/11/71
IF (X.LT.1.E+12) GOTO 1200
IF (X.LT.1.E+4) GOTO 400
IF (X.LT.1.E+0) GOTO 900
MC=AC*.1*(GP*FR)***.3333333/DZ
RETURN
900 MC=AC*.5*(GP*FR)***.25/DZ
RETURN
1200 WRITE (6,1) X
MC=AC*.13*(GP*FR)***.7333333/DZ
RETURN
400 WRITE (6,2) X
MC=AC*.5*(GP*FR)***.25/DZ
RETURN
END

```

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LISTING AND SUBROUTINE COMPILATION: TIESOC P. 10

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8 ELT MCONH/215.1.710004. 70970
9 EOF 3
SUBROUTINE MCONHITS,TA,DT,HC,FR,GP
TO FIND FREE CONVECTION COEFFICIENT FOR HORIZONTAL CYLINDER
TS IS TEMP OF HOT SURFACE, FLOWMETER
TA IS TEMP OF AMBIENT, FLOWMETER
DT IS THE CHARACTERISTIC DIMENSION, FT. IS SURFED IN METER
HC IS THE CONVECTION COEFFICIENT, BTU/HR SQ FT
FR IS THE FRANZEL NUMBER
GP IS THE GRASHOF NUMBER
TF=.5*(TS-TA)
DELT=(TS-TA)
CALL KAP (TF,AC)
CALL SPFRITF,DT,FR,GP,DELT)
X=GR*FR
IFIX,GT,1.E+12,DT,X,LT,1000.1 GOTO 600
20 IFIX,LT,1.E+9) GOTO 400
MCO=.18*DELT*(1./X.)
RETURN
400 MCO=.53*AC*(GP*FR)***.25/32
RETURN
600 WRITE(6,13X,T3,TA
1 FORMATE('GRASHOF FRANZEL PRODUCT OUT OF RANGE (10**3 TO 10**12) IN
15.9. MCONH/' PRODUCT='1FE15.7.' TS='E15.7.' TA='E15.7)
GOTO 20
END

```

08/09/71

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8 ELT OUTPUT/515.1.710004. 36980
9 EOF 3
SUBROUTINE OUTPUT(T1,T2,T3,T4,T5,KINE,METAL,
E1,E2,E3,E4,FCO,5,TA,R0,
2 Y,K)
REAL P(4)
INTEGER DATE(2),TIME(2),MCD(2),MPC(2),JFU,DET,MUC(2)
2 MCD(2),MPC(2)
INTEGER JAC(2)
DATA WAI/3HACR,SHWATE/
DATA MCD(1),MPC(1)/12HTYPE,316 DST/
DATA MCD(2),MPC(2)/12HASTELLOY C /
DATA MUC(1),MUC(2)/12H SSCL SRF2 /
DATA DET/1H./JFU/6/
DATA MCD/12HMETAL AL /
DATA MCD/12HMOPTZOVERITE/
COMMON/ANS/DEL1,DEL2,DEL3,DEL4,DEL5,MCS,MRS,CEN,MRS,CON3,CON2
2 CON1
COMMON/ENVIS/PCR
1 FORMATE(1H,*)
2 FORMATE(2H)OUTPUT FROM PROGRAM TIESOC,11X,7HRUN ON ,246.44 AT ,24609/23/70
2)
3 FORMATE(4H FCO,246.2HCF,FCO,2,2H THE THERM. DENSITY S=.1FE11.5,
217H BTU/HR SQ FT)
4 FORMATE(17H ENCAPSULATED IN ,246. CYLINDER ORIENTATIONS ,*246)
5 FORMATE(4H R1=,F6.5,4H IN.,5H T1=,F6.1,5H DT1=,F6.1,7H KMET=,
2 1FE7.2)
6 FORMATE(4H R2=,F6.5,4H IN.,5H T2=,F6.1,5H DT2=,F6.1,7H KMET=,
2 1FE7.2)
7 FORMATE(4H R3=,F6.5,4H IN.,5H T3=,F6.1,5H DT3=,F6.1,7H KMET=,
2 1FE7.2,5H MFC=E7.2)
8 FORMATE(4H R4=,F6.5,4H IN.,5H T4=,F6.1,5H DT4=,F6.1,7H KMET=,
2 1FE7.2)
9 FORMATE(4H T5=,F6.5,4H IN.,5H T5=,F6.1,5H DT5=,F6.1,7H MCO=,
2 1FE7.2,5H MPC=E7.2)
10 FORMATE(4H E1=,F6.2,4H E2=,F6.2,4H E3=,F6.2,4H E4=,F6.2,
.5H TAC=,F6.1)
11 FORMATE(2H (,F6.1,3H C1/2H ,)
12 FORMATE(14H,507,9H FACTOR=,F6.2)
13 FORMATE(17H)OUTPUT IS FOR CYLINDER IN ,*A5//)
TCIF=(F-32.)/1.8
C1=TC(T1)
C2=TC(T2)
C3=TC(T3)
C4=TC(T4)
C5=TC(T5)
CALL COVDATE)
CALL TOSTIME)
WRITE(OFU,1) TOT,COY
WRITE(OFU,2) DATE,TIME
WRITE(OFU,3) TOT
WRITE(OFU,4) MUC(1),MUC(2),FCO,5
WRITE(OFU,5) MCD(1),MCD(2),MPC(1),MPC(2)
WRITE(OFU,6) WAI,MCO)
WRITE(OFU,7) TOT
WRITE(OFU,8) T1,DEL1,CON1
WRITE(OFU,9) T2,DEL2,CON2
WRITE(OFU,10) T3,DEL3,CON3,MRS
WRITE(OFU,11) T4,DEL4,CON4
WRITE(OFU,12) T5,DEL5,MCS,MRS
WRITE(OFU,13) C1
WRITE(OFU,14) C2
WRITE(OFU,15) C3
WRITE(OFU,16) C4
WRITE(OFU,17) C5
WRITE(OFU,18) TAC,FCO,DEL5,MCS,MRS
WRITE(OFU,19) C5

```

08/09/71

08/09/71

08/09/71

08/09/71

08/09/71

08/09/71

08/09/71

08/09/71

08/09/71

350

PROGRAM NAME: UTTA

Descriptive Title: Underground Waste Tank Approximate Model - No Air Flow

Program Author: Nance, James R.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Underground Tank, Radioactive Waste

Program Description: Uses an approximate model to estimate steady-state temperatures in underground waste tanks. Developed from results of HOTANK runs but much faster. Effect of heat generation rate, cake thickness, overburden depth, tank geometry, thermal properties and enclosed vapor spaces. No subroutines.

Users of Program: G Jansen
JR Nance (JAJ)
WV DeMier
HC Burkholder
WE Willingham

Documentation: Results are presented and compared with HOTANK output in letter from G. Jansen to W. L. Godfrey, ARHCO, "Effect of Air Cooling or Sand Filling of the Vapor Space on Cake Temperatures in Underground Tanks," September 6, 1968. Model is given in BNWL-262.

Condition of Program: It works fine, but the output is not self-explanatory.

SAMPLE INPUT: UTТА

UTТА 10:20 02/15/74

100 @S RUN PUN026,CUR92R,GEORGE,60,2000/999 G JANSEN 3760 BLD
G 9423576

105 @N MSG KEEP AT FED.BLDG FOR PICKUP AT 5:00PM BY G.JANSEN

110 @PUL TEL INFO00

115 @PRL TEL INFO00

120 @PRL TEL CUR92R

125 @X ASG A=U1145(JJ1145)

130 @N XQT CUR

150 FIND A,UTТА/S1F4

160 TRD A

350 TRI A

355 PCH UTТА/S1F4

360 @IM FPS,* UTТА/S1F4,UTТА/S1F4,UTТА/R1F4

1000 @N XQT UTТА/R1F4

1010 SAMPLE RUN NO 1

FROM EXAMPLE 1 P.55 BNWL-262

1020 36 70 70 1.5 1.5 1.5 1.5 200 155 37.5 36 16 0

1030 1 1.0

1040 1 0.15

1050 1 11.

1060 1 0.33

1070 1 0.564

1080 1 3000.

1090 @ FIN

READY

SAMPLE OUTPUT: UTTA

ON XRT UTTA/RIF

DRUM LENGTH 010070

THIS ALLOCATION WAS DONE ON 15 FEB 74 AT 11:00:21

SAMPLE RUN NO 1

FROM EXAMPLE 1 P.55 BURL-262

PAGE 1

UIGR	.035 FT	HA	1.500 BTU/HR SOFT	TA	.07 DEG F
LILR	37.500	H1	1.500	TH	.07
L1+2	.035	H2	1.500	LD	.30
L3	.155	H01	1.500	KV	.200 (BTU FT)/(HR SOFT DEG F)

LC	KS	L1	KC	S	GR	LG	T2	XH	TN	T1	TV1	UU/KS	KC/KS	T2-T1	K*DELT/O
.02	.150	11.0	.330	5.6400-01	1.00	.02	.1	.01	.1	.1	.1	1.0834-01	2.200	.08	2.0517-02

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00145 OF MAIN PROGRAM

CSCX PL683J 15 FEB 74 11: 6: 9 USER CU3928 PUN026

CARDS IN 21 OUT 217 LINES 295 PROCESSING TIME 10.42 SECONDS

LISTING AND SUBROUTINE COMPILATION: UTTA P. 1

```

25 RUN F00026,002029, .60,2000/979 5 JANSEN 3760 BLOC 9973576
3 FLY UTTA/STFR.1.074410. 7888
3 EOF 3
C
C 1107 PROGRAM UTTA
C AN UNDERGROUND TANK TEMPERATURE APPROXIMATION ROUTINE FORTRAN IV
C FOR ESTIMATING TEMPERATURES IN BURIED TANKS OF RADIOACTIVE WASTE
C HEAT GENERATION MAY BE UNIFORM THROUGHOUT CAKE OR MAY BE CONFINED TO
C SOME FRACTION OF THE CAKE
C
C NOMENCLATURE
C ALL THERMAL CONDUCTIVITY UNITS ARE BTU/HR SFT DEG F/FT
C S(1) VOLUMETRIC HEAT GENERATION RATE IN THE HEAT GENERATING
C PORTION OF THE CAKE. BTU/HR CU FT
C GR(1) RATIO OF HEIGHT OF GENERATING CAKE TO HEIGHT OF ENTIRE CAKE.
C L1(1) THICKNESS OF SOIL COVER OVER TANK (FT).
C KC(1) THERMAL CONDUCTIVITY OF CAKE.
C KS(1) THERMAL CONDUCTIVITY OF SOIL.
C X(1) RADIUS OF INSULATED SURFACE, BIOR (FT).
C X(2) AIR TEMPERATURE, TA (DEG F).
C X(3) WATER TABLE TEMPERATURE, TW (DEG F).
C X(4) HEAT TRSF COEFF. SOIL TO AIR, HA (BTU/HR SFT DEG F).
C X(5) HEAT TRSF COEFF. CAKE TO VAPOR SPACE, H1.
C X(6) HEAT TRSF COEFF. TOP OF VAPOR SPACE TO SOIL, H2.
C X(7) HEAT TRSF COEFF. SIDE OF VAPOR SPACE TO SOIL, H21.
C Y(8) THERMAL CONDUCTIVITY OF VAPOR, KV.
C X(9) DISTANCE FROM BOTTOM OF TANK TO WATER TABLE, L3 (FT).
C X(10) RADIUS OF TANK, L1R (FT).
C X(11) HEIGHT OF TANK, L1Z (FT).
C X(12) TOTAL CAKE HEIGHT (GENERATING + NON-GENERATING), LC (FT).
C L1(13) DIST FROM TK BOTTOM TO BOTTOM OF HEAT GEN LAYER, LD (FT).
C XI(14) PUSHMAN CONTROL VARIABLE, PCV, ON TYPE B CARD
C --IF PCV IS BLANK OR ZERO PROGRAM EXPECTS TO READ A NEW SET
C OF TYPE C,D,E,F,G CARDS IMMEDIATELY AFTER THE B-CARD.
C --IF PCV IS 140, PROGRAM RETAINS VALUES FROM PREVIOUSLY READ
C C,D,E,F,G CARDS AND EXPECTS NEXT CARD SET TO BE ONLY TWO
C CARDS, AN A CARD AND A B CARD.
C NGR NUMBER OF GP VALUES ON C-CARD 3 MAXIMUM
C NKS NUMBER OF KS VALUES ON D-CARD 3 MAXIMUM
C NL1 NUMBER OF L1 VALUES ON E-CARD 3 MAXIMUM
C NKC NUMBER OF KC VALUES ON F-CARD 3 MAXIMUM
C NS NUMBER OF S VALUES ON G-CARD 3 MAXIMUM
C
C *** ... FORMATS FOR INPUT *** ...
C A-CARD FIRST DATA CARD OF EACH SET CONTAINS 72 COLUMNS OF ALPHANERIC
C INFORMATION
C (12A6)
C
C 3-CARD X(1),I=1,14
C (14F5.0)
C
C C-CARD NGR,(GP(I),I=1,NGR)
C (12.8F7.3)
C
C D-CARD NKS,(KS(I),I=1,NKS)
C (12.8F7.3)
C
C E-CARD NL1,(L1(I),I=1,NL1)
C (12.8F7.3)
C
C F-CARD NKC,(KC(I),I=1,NKC)
C (12.8F7.3)
C
C G-CARD NS,(S(I),I=1,NS)
C (12.8F7.3)
C
C -ONLY NEW (CHANGED) VALUES NEED BE PUNCHED ON 3-CARDS AFTER THE FIRST
C 3-CARD
C -IF FIELD 14 ON A 3-CARD IS BLANK OR ZERO THE 3-CARD MUST BE FOLLOWED
C BY A COMPLETELY PUNCHED SET OF C,D,E,F,G CARDS.
C -IF FIELD 14 IS NOT BLANK OR NOT ZERO THE C,D,E,F,G CARDS MUST BE
C OMITTED, AND PREVIOUS VALUES WILL BE RETAINED FOR GR,KS,L1,KC,AND S.
C CALL SETIO (2,1)
C CALL SETIO (3,2)
C REAL LCI,S(8),L1(8),KC(8),KS(8),L2,X(14),Y(14),UJOKS(3,8,9),
C 2 KCONSI(8,8),TMTW(8,8),T2(8,8),XN(8,8),TN(8,8),T1(8,8)
C 3,3),TV1(8,8),KSJ,L1K,KCL,GR(8),LG(2),LGN,TG(8,8),JDSL(9,8,8),T
C NEXT(12),LD
C INTEGER PAGE
C 1 FORMAT (14F5.7)
C 2 FORMAT (12A6)
C 3 FORMAT (1H1,12A6,3H1,4HFACE,T4//5H BIOR,F8.3,3H FT,15X,2HHA,F8.3,
C 21H BTU/HR SFT,7X,2HTA,F7.2,6H DEG F/5H L1R,F8.3,19X,2HMI,F8.3,
C 319X,2HTW,F7.2,5H L1,2,F8.3,18X,2HMI,F8.3,19X,2HLC,F7.2//
C 45H L3,F8.3,17X,3HMI,
C 5F8.3,19X,2HKV,F8.3,25H (BTU FT)/HR SFT DEG F//4H LC,4X,2HMS,
C 64X,2H4L1,4X,2H4C,6X,1H5,7X,2H4R,7X,2H4G,5X,2HT2,5X,2H4N,4X,2HTN,
C 75X,2HT1,5X,3H4V1,4X,5H4U/KS,6X,5H4C/KC,4X,5HT2-TW,3X,5H4DEL7/2 //
C 8)
C 4 FORMAT(1H .OFF5.2,F8.3,F6.1,F6.7,1FE11.4,OFF5.2,F6.2,F7.1,F6.7,
C 2F7.1,F7.1,F7.1,1FE11.4,OFF9.3,F9.2,1FE11.4)
C 5 FORMAT(12.8F7.3)
C 6 FORMAT(1H0)
C 7 FORMAT(1H1)

```

LISTING AND SUBROUTINE COMPILATION: UTTA P. 2

```

C          CLEAR ARRAY
DO 50 I=1,4
  J(I)=1.E-15
  L(I)=1.E-15
  K(I)=1.E-15
  M(I)=1.E-15
  S(I)=1.E-15
50 CONTINUE
DO 55 I=1,19
  X(I)=1.E-15
55 X(I)=1.E-15
2222 CONTINUE
  PAGE=1
  LINE=45
  READ(2,1) TEST
  READ(2,1) (Y(I),I=1,19)
  DO 60 I=1,19
    IF(Y(I)) 56,60,49
56  X(I)=1.E-15
    GO TO 60
58  X(I)=Y(I)
60  CONTINUE
    LOOP = 1
    RIN=X(I)
    ADJR=1.6*X(I)
    IF(RIN-ADJR) 613,613,615
613  ASSIGN 8000 TO JGG
    GO TO 616
615  ASSIGN 7000 TO JGG
616  CONTINUE
    LCI=X(I)
    LD=X(I)
62  IF(Y(I)-1.E-10) 63,63,70
63  CONTINUE
    READ (2,5) NFP,(CP(I),I=1,NCP)
    READ (2,5) NPS,(KS(I),I=1,NKS)
    READ (2,5) NL1,(LI(I),I=1,NLI)
    READ (2,5) NVC,(KC(I),I=1,NKC)
    READ (2,5) NC,(CI(I),I=1,NC)
70  CONTINUE
    RM1=1./X(I)
    RM2=1./X(I)
    RMA=1./X(I)
    SM=5(I)
    RDM1=X(I)**2/X(I)**2-1.
    RDM2=X(I)/2.
    DO 80 I=1,NCP
      LG(I)=(LCI-LD)*GR(I)
80  CONTINUE
      L2=X(I) - LCI
      FDS=PM1+PHA+L2/X(I) +PM2
6300  DO 6999 J=1,NKS
      KSJ=KS(J)
      U33=KSJ*RM1/(X(I)*RDM2)
      U310=KSJ/X(I)
5000  DO 5999 K=1,NLI
      L1K = LI(K)
      DEE = (X(I)*L1K) + C.74463085
      FEE = (ADJR/DEE)**2
      FOO = (RIN/DEE)**2
9555  DO 5555 L=1,NKC
      KCL=KC(L)
      U3=1./((LC/KCL)+1./((U310+U33))
      KDOKS(I,K,L)=KCL/KSJ
9600  DO 4999 I=1,NCR
      LGN=LG(I)
      UU10=1./((FDS+L1K/KSJ)
      U71=1./((L2+L2/(X(I)*X(I)))+(L1K+L2*(X(I)-X(I))/2.)/(L5+KSJ+FRM
      Z1=2.*L2/X(I)))+(PHA/RM1)
      T0F=.5*KSJ*(FMI+2.*LCI/X(I))
      BDT=L1+L2+LCI/2.+X(I)/2.
      U72=T0F/BDT
      UU=U02+1./((LCI-LD-LGN)/KCL + 1./((UU10+U01))
      UUOKS(I,L,I) = UU/KSJ
3000  DO 3999 M=1,N5
      SM=5(M)
3010  TRM=SP+LGN*(1.+(UU+LGN/2./KCL)*UU*X(I)+UD*X(I)+(1.+LGN+UU/KCL)
      TCEN=UD+UD*(1.+LGN+UU/KCL)
      T2IL(I,M)=TRM/TCEN
      T2=T2IL(I,M)
      T2MIL(I,M)=T2-X(I)
      T2GL(I,M)=KSJ*T2MIL(I,M)/SM
      NMIL(I,M)=UD + T2MIL(I,M)/SM
      TXN=NMIL(I,M)
      GO TO JGG+(7*(CO-8000)
7000  GO TO (7000,7500),LOOP
7200  SM = SM + (1.-LC/LG-TXN)*((1.+FEE)**(-.5)-(1.+FEE)**(-.5)-1)
      2F001=(1.-.5)*(1.-F001)**(-.5))
      LOOP=2
      UUOKS(I,L,I)=UUOKS(I,L,I) + SM/SM
      GO TO 3010
7600  CONTINUE
8000  T2IL(I,M) = T2 + SM + TXN**2/2./KCL
      T2GL(I,M)=T2-SM+LGN*(LGN/2.-TXN)/KCL

```

LISTING AND SUBROUTINE COMPILATION: UTTA P. 3

```

TTC=TC(L,I,M)
T1(L,I,M)=TTC-SM*(LGN-TXN)*(LCI-LGN-LD)*(1.-UQZ/UU)/KCL
TV1(L,I,M)=T1(L,I,M)-SM*(LGN-TXN)*(1.-UQZ/UU)/X(5)
LOOP = 1
3499 CONTINUE
4999 CONTINUE
5555 CONTINUE
DO 599 LL=1,NKC
DO 499 II=1,NCF
DO 399 MM=1,NCS
IF (LINE-44) 6100,6030,6030
6030 CONTINUE
C START NEW PAGE AND WRITE HEADINGS
LINE= 10
WRITE(3,2)TEXT,FAGE,X(1),X(4),X(2),X(10),X(5),X(3),X(11),X(6),
2X(13),X(4),X(7),X(8)
PAGE=FAGE+1
6100 CONTINUE
C WRITE ANSWERS
WRITE(3,4)LCI,NS(J),L1(K),KC(LL),S(MM),GR(II),LG(II),T2(LL,II,MM),
2XNILL,II,MM),TNILL,II,MM),TI(LL,II,MM),TV1(LL,II,MM),UUOKS(K,LL,
3II),KCOKS(J,K,LL),T2TWILL,II,MM),TOSL(LL,II,MM)
LINE=LINE+1
399 CONTINUE
499 CONTINUE
599 CONTINUE
WRITE(3,6)
LINE=LINE + 1
5999 CONTINUE
6999 CONTINUE
GO TO 2222
END
06150274 CU6922FUND26 100 1042 21 217 29611 6 9 1 009 6 S

```

PROGRAM NAME: UTTANK

Descriptive Title: Underground Waste Tank Approximate Model -
Forced Convection Air Flow

Program Author: Nance, James R.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Heat Transfer, Underground Tank, Radioactive
Waste

Program Description: UTTANK estimates steady state temperatures in
buried tanks of radioactive waste, and the effect
of heat generation rate, cake thickness, overburden
depth, tank geometry, thermal properties and
enclosed vapor spaces. The vapor space above the
tank contents may be air-cooled. Developed from
results of HOTANK runs but much faster. No sub-
routines.

Input is suitable for teletype. Input is formatted
and consists of "A," "B," "C," "D," "E," "F," "G,"
"H" cards (teletype lines). Description of variables
is given in reprint of internal documentation.

Users of Program: G Jansen
JR Nance (JAJ)
WV DeMier
HC Burkholder
WE Willingham

Documentation: Repeat UTTA documentation.

Condition of Program: It works fine but the output is not self-explanatory.

SAMPLE INPUT: UTTANK

UTTANK 10:03 02/14/74

100 @S RIIN PIIN010,CIIR928,GEORGE,60,2000/899 G JANSEN 3760 BLD
 G 9423576
 105 @N MSG KEEP AT FED,BLDG FOR PICKUP AT 5:00PM BY G.JANSEN
 110 @PUL TEL INF000
 115 @PRL TEL INF000
 120 @PRL TEL CURS28
 125 @X ASG A=U1145(JJ1145)
 130 @N XQT CUR
 150 FIND A,UTTANK/S2F5
 160 TRD A
 350 TRI A
 355 FCH UTTANK/S2F5
 360 @IM FR5,* UTTANK/S2F5,UTTANK/S2F5,UTTANK/R2F5
 1000 @N XQT UTTANK/R2F5
 1010 SAMPLE RUN NO 1 FROM EXAMPLE 1 P.55 BNWL-262
 1020 36 70 70 1.5 1.5 1.5 1.5 200 155 37.5 36 16 0
 1030 1 1.0
 1040 1 0.15
 1050 1 11.
 1060 1 0.33
 1070 1 0.564
 1080 1 3000.
 1090 @ FIN
 READY

SAMPLE OUTPUT: UTTANK

JN XOT UTTANK/R2F5

FROM LENGTH 011230
THIS ALLOCATION WAS DONE ON 14 FEB 74 AT 13:21:24

SAMPLE RUN NO 1 FROM EXAMPLE 1 P.55 BNNL-262 RUN ON 14 FEB 74 AT 13:21:24 PAGE 1

BIGR .036 FT	HA 1.500 BTU/HR SGFT	TA .07 DEG F
LILR 37.500	H1 1.500	TW .07
L1+2 .036	H2 1.500	LD .03
L3 .155	H01 1.500	KV .200 (BTU FT./HR SGFT DEG F)

LC	KS	L1	KC	S	GR	LS	T2	XN	TN	T1	TV1	UU/KS	KC/KS	AIR-CFM	K=KELT/O.
----	----	----	----	---	----	----	----	----	----	----	-----	-------	-------	---------	-----------

.02	.150	11.0	.330	5.6400-01	1.00	.02	.1	.00	.1	.1	.1	3.3753+00	2.200	3000.00	3.9863-03
-----	------	------	------	-----------	------	-----	----	-----	----	----	----	-----------	-------	---------	-----------

EXECUTION TERMINATE BY AN ATTEMPT TO READ THRU AN END OF FILE
I/O CALLED AT SEQUENCE NUMBER 00144 OF MAIN PROGRAM

CSCX RL683J 14 FEB 74 13:21:3 USER CUB928 PUH010
CARDS IN 21 OUT 233 LINES 316 PROCESSING TIME 14.93 SECONDS

LISTING AND SUBROUTINE COMPILATION: UTTANK P. 1

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35 RUN FUNCTION=UUTTANK, 4001000000, 1 JANSEN 1760 BLCC #423176
1 UTTANK/STC-1.680473, 61074
2 FOR 8
3 1100 PROGRAM UTTANK, FORTRAN 4
4 AN UNDERGROUND TANK TEMPERATURE APPROPRIATE IN ROUTINE, FORTRAN IV
5 FOR ESTIMATING TEMPERATURES IN BURIED TANKS OF RADIOACTIVE WASTE
6 HEAT GENERATION MAY BE UNIFORM THROUGHOUT CAKE OR MAY BE CONFINED TO
7 SOME FRACTION OF THE CAKE
8
9 Nomenclature
10 ALL THERMAL CONDUCTIVITY UNITS ARE BTU/HR-FT-DEG F/FT
11 S(1) VOLUMETRIC HEAT GENERATION RATE IN THE HEAT GENERATING
12 PORTION OF THE CAKE, BTU/HR-FT
13 ER(1) RATIO OF HEIGHT OF GENERATING CAKE TO HEIGHT OF ENTIRE CAKE.
14 LI(1) THICKNESS OF SOIL COVER OVER TANK (FT).
15 KC(1) THERMAL CONDUCTIVITY OF CAKE.
16 SI(1) THERMAL CONDUCTIVITY OF SOIL.
17 AR(1) AIR RATE TO VAPOR SPACE (CFM).
18 X(1) RADIUS OF INSULATED SURFACE (FT).
19 Y(1) AIR TEMPERATURE, TA (DEG F).
20 Z(1) WATER TABLE TEMPERATURE, TW (DEG F).
21 H(1) HEAT TRF COEFF. SOIL TO AIR, H1 (BTU/HR-FT-DEG F).
22 H(2) HEAT TRF COEFF. CAKE TO VAPOR SPACE, H2.
23 H(3) HEAT TRF COEFF. TOP OF VAPOR SPACE TO SOIL, H3.
24 H(4) HEAT TRF COEFF. SIDE OF VAPOR SPACE TO SOIL, H4.
25 THERMAL CONDUCTIVITY OF VAPOR, KV.
26 DISTANCE FROM BOTTOM OF TANK TO WATER TABLE, L3 (FT).
27 RADIUS OF TANK, LR (FT).
28 HEIGHT OF TANK, LT (FT).
29 TOTAL CAKE HEIGHT (GENERATING + NON-GENERATING), LC (FT).
30 DIST FROM TA BOTTOM TO PORTION OF HEAT GEN LAYER, LD (FT).
31 PROGRAM CONTROL VARIABLE, FCV, ON TYPE 8 CARD
32 --IF FCV IS BLANK OR ZERO PROGRAM EXPECTED TO READ A NEW SET
33 OF TYPE C,D,E,F,G CARDS IMMEDIATELY AFTER THE 8-CARD.
34 --IF FCV IS 1.0, PROGRAM RETAINS VALUES FROM PREVIOUSLY READ
35 C,D,E,F,G CARDS AND EXPECTS NEXT CARD SET TO BE ONLY TWO
36 CARDS, AN A CARD AND A B CARD
37 NGR NUMBER OF GR VALUES ON C-CARD 8 MAXIMUM
38 NKS NUMBER OF KS VALUES ON D-CARD 8 MAXIMUM
39 NLI NUMBER OF LI VALUES ON E-CARD 8 MAXIMUM
40 NKC NUMBER OF KC VALUES ON F-CARD 8 MAXIMUM
41 NS NUMBER OF S VALUES ON G-CARD 8 MAXIMUM
42 HAR NUMBER OF AP VALUES ON H-CARD 8 MAXIMUM
43
44 *** FORMATS FOR INPUT ***
45 A-CARD FIRST DATA CARD OF EACH SET CONTAINS 72 COLUMNS OF ALPHAMERIC
46 INFORMATION
47 (12A6)
48
49 B-CARD 11111-1111
50 (11F5.0)
51
52 C-CARD NGR(1:1),I=1,NGR)
53 (12.8F7.3)
54
55 D-CARD NKS(1:1),I=1,NKS)
56 (12.8F7.3)
57
58 E-CARD NLI(1:1),I=1,NLI)
59 (12.8F7.3)
60
61 F-CARD NKC(1:1),I=1,NKC)
62 (12.8F7.3)
63
64 G-CARD NS(1:1),I=1,NS)
65 (12.8F7.3)
66
67 H-CARD HAR(1:1),I=1,HAR)
68 (12.8F7.3)
69
70 -ONLY NEW (CHANGED) VALUES NEED BE FUNCHED ON B-CARDS AFTER THE FIRST
71 B-CARD
72 -IF FIELD 14 ON A B-CARD IS BLANK OR ZERO THE B-CARD MUST BE FOLLOWED
73 BY A COMPLETELY FUNCHED SET OF C,D,E,F,G CARDS.
74 -IF FIELD 14 IS NOT BLANK OR NOT ZERO THE C,D,E,F,G CARDS MUST BE
75 OPTIFIED, AND PREVIOUS VALUES WILL BE RETAINED FOR GR,KS,LI,KC,AND S.
76
77 CALL SETIO (2,1)
78 CALL SETIO (3,2)
79 REAL LCI(1:1),LI(1:1),KC(1:1),K2(1:1),L2,X(1:1),Y(1:1),UUOKS(1:1),
80 2 NOKS(1:1),T2HTW(1:1),T2(1:1),XN(1:1),TN(1:1),T1(1:1),
81 3,8),TV1(1:1),KSJ,LI,KC,C(1:1),LC(1:1),LGN,T2(1:1),T2L(1:1),T
82 NEXT(1:1),LD,AP(1:1),A(1:1),C(1:1),T2)
83 DATA FAIR,CPAIP, .059,-.241/
84 INTEGER FAC
85 1 FORMAT (11F5.3)
86 2 FORMAT (12A6)
87 3 FORMAT (11H1-12A6, 8H RUN ON-2A5, 1H AT-2A6, 1H PAGE-1X//
88 1 54 BICR,F8.3,1H FT,1X,24H4,F8.3,
89 212H BTU/HR SOFT,1X,24H4,F7.2,5H DEG F/54 LILP,F8.3,1X,24H1,F8.3,
90 319X,24H1,F7.2,5H L1,2,F8.3,1X,24H2,F7.2,5H L2,24H2,F7.2,
91 43H L3,F8.3,1X,1H401,
92 5F8.3,1X,24H4,F8.3,25H BTU FT/HR SOFT DEG F/HR LC,1X,24H5,
93 64X,24H1,1X,24H4,1X,1X,24H5,1X,24H5,1X,24H2,5X,24H4,1X,24H5,
94 75X,24H1,5X,24H1,1X,54H4,5X,1X,24H5,1X,24H5,1X,24H5,1X,24H5,1X,24H5,
95 8 3 //

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LISTING AND SUBROUTINE COMPILATION: UTTANK P. 2

361

[illegible]

PROGRAM NAME: ZIRKOV

Descriptive Title: Rate of Dissolution of Zircaloy Fuel Cladding
in Zirflex Dissolver

Program Author: Cahn, Deborah U.

Computer: UNIVAC 1108

Operating System: CSCX, GPS

Language: FORTRAN 5

Central Memory Words: Default

Average Execution Time: 30 CP sec

Keywords: Dissolver, Fuel Cladding, Zirflex Reaction

Program Description: Estimates the rate of dissolution of bare zirconium metal in a zirflex dissolver as a function of initial conditions and boiloff rate of ammonia. Time to dissolve is calculated together with pH, complexed zirconium, and ammonia concentration. Allowance is made for a variable specific surface area so that oxide pitting attack could be included. Finite difference in time. Ten subroutines.

Users of Program: G Jansen
DU Cahn (LLL)
MR Schwab (EXXON)

Documentation: Equations and earlier analog model are described in HW-71054.

Condition of Program: Tinkering with subroutine AMMON to fix the initial pH for a wide range of initial conditions has produced a fatal error. This subroutine should be completely rewritten. There may also be another error in that the zirconium concentration used for calculation fluoride complexing is the initial value rather than a contemporary value.

SAMPLE INPUT: ZIRKOV P. 1

ZIRKOV 12:32 02/23/74

100 @S RUN PUN003,CUBS2R,GEORGE,150,6000/3000 G JANSEN 3760 BLD
G 9423576

110 @N MSG KEEP AT FED.BLDG OF PICKUP AT 5:00PM BY G.JANSEN

115 @PUL TEL INF000

120 @PRL TEL INF000

130 @PRL TEL CUF92R

140 @X ASG A=00231

150 @N XQT CUR

151 FIND A,ZIRKOV/SIFS

152 TRD A

153 FIND A,MISC/CODE

154 TRD A

155 FIND A,GETSET/SIFS

156 TRD A

157 FIND A,YNH3FD/SIFS

158 TRD A

159 FIND A,FINUP/SIFS

160 TRD A

161 FIND A,FIGIT/SIFS

162 TRD A

163 FIND A,AMMUN/SIFS

164 TRD A

165 FIND A,DES

166 TRD A

167 FIND A,DEI

168 TRD A

169 FIND A,DED

170 TRD A

171 FIND A,DEDIS

172 TRD A

173 TRI A

180 @IM PDP,* MISC/CODE,MISC/SISU

410 @IM FR5,* ZIRKOV/SIFS,ZIRKOV/SIFS,ZIRKOV/RIFS

420 @IM FR5,* GETSET/SIFS,GETSET/SIFS,GETSET/RIFS

430 @IM FR5,* YNH3FD/SIFS,YNH3FD/SIFS,YNH3FD/RIFS

440 @IM FR5,* FINUP/SIFS,FINUP/SIFS,FINUP/RIFS

450 @IM FR5,* FIGIT/SIFS,FIGIT/SIFS,FIGIT/RIFS

460 @IM FR5,* AMMUN/SIFS,AMMUN/SIFS,AMMUN/RIFS

490 @IM FR5,* DES,DES,DES/R

500 @IM FR5,* DEI,DEI,DEI/R

510 @IM FR5,* DED,DED,DED/R

520 @IM FR5,* DEDIS,DEDIS,DEDIS/R

530 @N XQT CUR

540 PCH ZIRKOV/SIFS

550 PCH MISC/SISU

560 PCH GETSET/SIFS

570 PCH YNH3FD/SIFS

580 PCH FINUP/SIFS

590 PCH FIGIT/SIFS

600 PCH AMMUN/SIFS

610 PCH DES

620 PCH DEI

630 PCH DED

640 PCH DEDIS

650 @N XQT ZIRKOV/RIFS

660 PUN NO. 1

670 @RAGGIT CNHAF0=5.5,CNHNH3=1.7,B=1.3,YK=4.5,E=10,CNWHCH=1,TEENY=0.0001

680 SMALL=.001,S0=2.12,UZPO=17.2,UD=238.6,ECV(1)=1.7,VM=.0163,CNPA0P=0.0

SAMPLE INPUT: ZIRKOV P. 2

```

690 RUN NO. 3
700 $BAGGIT B=1.0$
710 RUN NO. 4
720 $BAGGIT B=1.25$
730 RUN NO. 5
740 $BAGGIT B=1.50$
750 RUN NO. 6
760 $BAGGIT B=1.75$
770 RUN NO. 7
780 $BAGGIT B=2.0$
790 RUN NO. 8
800 $BAGGIT B=2.5$
810 RUN NO. 9
820 $BAGGIT B=3.0$
830 RUN NO. 10
840 $BAGGIT B=4.0$
850 RUN NO. 12
860 $BAGGIT CNH4FO=3.0,CNHNO3=.272,B=1.0,WZRO=9.0
870 RUN NO. 11
880 $BAGGIT CNH4FO=3.0,CNHNO3=.272,B=.50,KK=4.E-10,CWHICH=2,TEENY=.00001,
    FH=7.0,
890 SMALL=.001,SC=2.12,WZRO=9.009,VO=239.6, VM=.0163$
900 RUN NO. 13
910 $BAGGIT B=1.5$
920 RUN NO. 14
930 $BAGGIT B=2.5$
940 RUN NO. 15
950 $BAGGIT B=4.0$
960 RUN NO. 16
970 $BAGGIT CNH4FO=4.0,CNHNO3=0.353,B=.5,WZRO=12.33$
980 RUN NO. 17
990 $BAGGIT B=1.0$
1000 RUN NO. 18
1010 $BAGGIT B=1.5$
1020 RUN NO. 19
1030 $BAGGIT B=2.5$
1040 RUN NO. 20
1050 $BAGGIT B=4.0$
1060 RUN NO. 21
1070 $BAGGIT WZRO=3.005,B=1.0$
1080 RUN NO. 22
1090 $BAGGIT B=2.0$
1100 RUN NO. 23
1110 $BAGGIT B=2.5$
1120 RUN NO. 24
1130 $BAGGIT B=3.0$
1140 RUN NO. 25
1150 $BAGGIT B=4.0$
1160 RUN NO. 26(CLADDING CONDITION OXIDIZED)
1170 $BAGGIT K1=3.8066,B=1.0$
1180 RUN NO. 27(CLADDING CONDITION OXIDIZED)
1190 $BAGGIT B=2.0$
1200 RUN NO. 28(CLADDING CONDITION OXIDIZED)
1210 $BAGGIT B=2.5$

1220 RUN NO. 29(CLADDING CONDITION OXIDIZED)
1230 $BAGGIT B=3.0$
1240 RUN NO. 30(CLADDING CONDITION OXIDIZED)
1250 $BAGGIT B=4.0$
1260 DESUC TRIAL CASE
1270 $BAGGIT CNH4FO=5.5,CNHNO3=.5,B=1.75,KK=4.E-10,CWHICH=1,TEENY=.01$
1280 SMALL=.001,SC=2.12,WZRO=17.2,VO=239.6, VM=.0163$
999 @FIN

```

SAMPLE OUTPUT: ZIRKOV P. 1

ON XGT ZIRKOV/1108

DATA LENGTH 026174

THIS ALLOCATION WAS DONE ON 23 FEB 74 AT 13:23:50

ZIRPLEX DISSOLVER SIMULATION

CALCULATED BY ZIRKOV, A PROTRAN-V PROGRAM FOR THE UNIVAC-1108, USING EQUATIONS DESCRIBED BY P. A. SMITH IN HW-71054

INDEPENDENT INITIAL CONDITIONS

#ZRO = WEIGHT OF CLADDING, KG
SQ. = SPECIFIC SURFACE AREA OF CLADDING, SQ FT/KG

CHNH3O3 = AMMONIUM FLUORIDE MOLARITY

CHNH3O3 = AMMONIUM NITRATE MOLARITY

CZRO = DISSOLVED ZIRCONIUM MOLARITY

THREE ALTERNATE CHOICES FOR INITIAL AMMONIA CONCENTRATION

(1) NO INPUT AND CHNH3O3 ARE CALCULATED INTERNALLY

(2) PHENEGATIVE OF LOGARITHM OF HYDROGEN ION ACTIVITY, INITIAL AMMONIA MOLARITY IS CALCULATED FROM PH

(3) CHNH3O3 = INITIAL AMMONIA MOLARITY

OTHER INDEPENDENT VARIABLES

VOLUME OF SOLUTION IN DISSOLVER, LITERS

D = BOIL-UP RATE, GRAMS MOLES VAPOR/MIN SQ FT OF CLADDING

VOLUME OF SOLUTION, LITERS/GRAM MOLE OF SOLUTES PLUS SOLVENT

RHOZ = SPECIFIC GRAVITY OF ZIRCALOY CLADDING

MWMOLECULAR WEIGHT OF ZIRCALOY CLADDING

B1 = MOLES FLUORINE REACTED PER MOLE ZIRCONIUM DISSOLVED

B2 = MOLES AMMONIUM ION REACTED PER MOLE ZIRCONIUM DISSOLVED

B3 = MOLES AMMONIA FORMED PER MOLE ZIRCONIUM DISSOLVED

TWO ALTERNATE CHOICES FOR EQUILIBRIUM CONSTANTS

(1) NO INPUT, RELATER IONIZATION PRODUCT, K3 = AMMONIA IONIZATION CONSTANT

(2) K3/K4 MAY BE PUT IN AS K3/K4

VOLATILIZATION OF AMMONIA IS CALCULATED WITHIN PROGRAM FROM STORED DATA TAKEN FROM FIGURE 1 OF HW-71054

K1 = RATE CONSTANT FOR DISSOLUTION (MOLARITY WITH (-1-22) EXPONENT)/MIN SQ FT OF CLADDING

A1 = EXPONENT ON FREE FLUORIDE CONCENTRATION IN RATE EQUATION

A2 = EXPONENT ON AMMONIA CONCENTRATION IN RATE EQUATION

CALCULATED INITIAL CONDITIONS

A0 = INITIAL CLADDING AREA, SQ FT/LITER OF SOLUTION

TZRO = AVERAGE INITIAL CLADDING THICKNESS, MILS

MZRO = INITIAL ZIRCONIUM IN CLADDING, G MOLES/LITER OF SOLUTION IN DISSOLVER

RUN NO. 1

RUN ON 23 FEB 74 AT 13:23:51

INPUT SUMMARY

INITIAL CONDITIONS

CLADDING AREA (NOT INPUT) A0 = 1.52625-01 SQ FT/L

AMMONIUM NITRATE CONC. CHNH3O3 = 5.60000-01 G MOL/L

AMMONIUM FLUORIDE CONC. CHNH4F6 = 5.50000-00 G MOL/L

CLADDING WEIGHT WZRO = 1.72500-01 KG

DISSOLVED SOLUTION VOL. VUE = 2.58000-02 LITERS

CLADDING SPEC. SURF. AREA SUE = 2.12000-00 SQ FT/KG

ZR METAL (NOT INPUT) MZRO = 7.50000-01 G MOL/L

AV METAL THICKNESS (INPUT) TZRO = 2.10000-01 MILS

DISS. ZIRCONIUM CONC. CZRO = 5.00000 G MOL/L

FACTOR SPECIFIED TO DETERMINE INITIAL AMMONIA CONC. = INITIAL NH4+ CONC.

OPERATING VARIABLES

RATE CONSTANT FOR DISS. K1 = 1.14200-01

G MOL F-/G MOL ZR

B1 = 8

G MOL NH4+/G MOL ZR B2 = 4

G MOL NH3/G MOL ZR

B3 = 5

EXP. ON F- CONC. IN RATE EQ. A1 = 2.00000-00

EXP. ON H+ CONC. IN RATE EQ. A2 = 4.00000-01

MOLAL VOLUME VME = 1.00000-02 L/G MOL

MOL. WEIGHT ZH

MW = 9.12200-01 G/G MOL

IONIZATION CONSTANT K3/K4 = 4.01000-10 G MOL/L

ERROR TERMINATION IN NEXP65 ROUTINE

NEXP65 CALLED AT SEQUENCE NUMBER 00165 OF AMMON

AMMON CALLED AT SEQUENCE NUMBER 00175 OF GETSET

GETSET CALLED AT SEQUENCE NUMBER 00161 OF MAIN PROGRAM

ROUTINE TERMINATED AT MEPPS

CSCX PLH83J 23 FEB 74 13:22:28 USER CUB926 PUN003

CARDS IN 57 OUT 659 LINES 1259 PROCESSING TIME 77.46 SECONDS

SAMPLE OUTPUT: ZIRKOV P. 2

Q NOT ZIRKOV

END OF ALLOCATION

THIS ALLOCATION WAS DONE ON 21 AUG 68 AT 22:09:17

RUN NO. 1

RUN ON 21 AUG 68 AT 22:09:18

INPUT SUMMARY

INITIAL CONDITIONS

CLADDING AREA	A=	1.52825-01	SO FT/L
AMMONIUM NITRATE CONC.	CNH10=	5.00000-01	G MOL/L
AMMONIUM FLUORIDE CONC.	CNH1F=	5.50000-03	G MOL/L
CLADDING WEIGHT	MZR=	1.72000-01	KG
DISSOLVER SOLUTION VOL.	V0=	2.38600-02	LITERS
CLADDING SPEC. SURF. AREA	S=	2.12000-00	SO FT/KG
ZIRCONIUM METAL	MZR0=	7.90256-01	G MOL/L
ZIRCONIUM THICKNESS	ZZR=	3.10395-01	MILS
ZIRCONIUM CONC.	CZR=	0.00000	G MOL/L
INITIAL BOIL UP RATE	B=	0.5	G MOL/FT ² MIN
OPERATING VARIABLES			
RATE CONSTANT FOR DISS.	K1=	1.14200-01	G MOL F-/G MOL ZR
G MOL NH4+/G MOL ZR	B2=	4	G MOL NH3/6 MOL ZR
EXP. ON F- CONC. IN RATE EQ.	A1=	2.02000-00	EXP. ON H+ CONC. IN RATE EQ.
MOLAR VOLUME	VM=	1.63000-02	L/G MOL
IONIZATION CONSTANT	KW/KR=	4.00000-10	G MOL/L
AMMONIA CONC.	CNH30=	2.01760-03	G MOL/L
			B1= 6
			B3= 5
			A2= 4.60000-01
			MW= 9.12200-01 G/G MOL

8.5937500-02 SECONDS HAD ELAPSED UPON RETURN FROM S.R. GETSET

THETA(MIN)	CZR/MZR0	B+A	A/A0	CZR	CF=	PH	CNH3	YNH3
5.11	.068	7.64124-02	1.000	.051	5.196	8.000	2.31890-01	1.07023-01
10.22	.120	7.64124-02	1.000	.079	5.026	8.182	3.45781-01	1.19132-01
15.34	.129	7.64124-02	1.000	.102	4.888	8.284	4.30491-01	1.31420-01
20.45	.154	7.64124-02	1.000	.122	4.768	8.353	4.97033-01	1.40749-01
25.56	.177	7.64124-02	1.000	.140	4.661	8.404	5.51350-01	1.46185-01
30.58	.197	7.64124-02	1.000	.156	4.565	8.443	5.95088-01	1.49190-01
35.70	.216	7.64124-02	1.000	.171	4.479	8.475	6.34643-01	1.53922-01
40.81	.234	7.64124-02	1.000	.185	4.390	8.501	6.66641-01	1.59000-01
45.92	.251	7.64124-02	1.000	.198	4.311	8.522	6.93106-01	1.64332-01
51.03	.267	7.64124-02	1.000	.211	4.236	8.540	7.14917-01	1.68055-01
56.14	.282	7.64124-02	1.000	.223	4.165	8.554	7.32756-01	1.71032-01
61.17	.296	7.64124-02	1.000	.234	4.098	8.567	7.46052-01	1.73360-01
66.20	.307	7.64124-02	1.000	.244	4.034	8.577	7.54474-01	1.75015-01
71.39	.322	7.64124-02	1.000	.255	3.971	8.586	7.67306-01	1.76032-01
76.50	.335	7.64124-02	1.000	.265	3.911	8.593	7.73875-01	1.77671-01
81.62	.347	7.64124-02	1.000	.274	3.854	8.599	7.78408-01	1.78384-01
86.73	.359	7.64124-02	1.000	.284	3.798	8.604	7.81136-01	1.78811-01
91.75	.370	7.64124-02	1.000	.292	3.745	8.607	7.82250-01	1.78985-01
96.87	.381	7.64124-02	1.000	.301	3.693	8.610	7.81962-01	1.78940-01
101.98	.392	7.64124-02	1.000	.310	3.643	8.612	7.80394-01	1.78695-01
107.09	.402	7.64124-02	1.000	.318	3.594	8.614	7.77682-01	1.78276-01
112.20	.412	7.64124-02	1.000	.326	3.546	8.615	7.73950-01	1.77683-01
117.23	.422	7.64124-02	1.000	.333	3.500	8.615	7.69392-01	1.76983-01
122.34	.431	7.64124-02	1.000	.341	3.455	8.615	7.63950-01	1.76092-01
127.45	.441	7.64124-02	1.000	.348	3.411	8.614	7.57785-01	1.75111-01
132.56	.450	7.64124-02	1.000	.355	3.368	8.613	7.50978-01	1.74013-01
137.67	.458	7.64124-02	1.000	.362	3.326	8.611	7.43603-01	1.72813-01
142.79	.467	7.64124-02	1.000	.369	3.285	8.609	7.35728-01	1.71523-01
147.81	.475	7.64124-02	1.000	.376	3.246	8.607	7.27559-01	1.70171-01
152.92	.484	7.64124-02	1.000	.382	3.207	8.604	7.18671-01	1.68720-01
158.03	.492	7.64124-02	1.000	.389	3.168	8.601	7.09852-01	1.67194-01
163.15	.500	7.64124-02	1.000	.395	3.131	8.598	7.00551-01	1.65614-01
168.26	.507	7.64124-02	1.000	.401	3.094	8.594	6.91011-01	1.63971-01
173.37	.515	7.64124-02	1.000	.407	3.058	8.591	6.81273-01	1.62277-01
178.39	.522	7.64124-02	1.000	.413	3.023	8.587	6.71541-01	1.60567-01
183.51	.530	7.64124-02	1.000	.419	2.988	8.582	6.61515-01	1.58747-01
188.62	.537	7.64124-02	1.000	.424	2.954	8.578	6.51391-01	1.56970-01
193.73	.544	7.64124-02	1.000	.430	2.920	8.573	6.41198-01	1.55121-01
198.84	.551	7.64124-02	1.000	.435	2.888	8.569	6.30962-01	1.53245-01
203.87	.558	7.64124-02	1.000	.441	2.856	8.564	6.20880-01	1.51379-01
208.90	.564	7.64124-02	1.000	.446	2.824	8.559	6.10612-01	1.49480-01
214.00	.571	7.64124-02	1.000	.451	2.793	8.553	6.00103-01	1.47595-01
219.20	.577	7.64124-02	1.000	.456	2.762	8.548	5.89297-01	1.45619-01
224.31	.584	7.64124-02	1.000	.461	2.732	8.542	5.78237-01	1.43550-01
229.43	.590	7.64124-02	1.000	.466	2.702	8.535	5.66965-01	1.41385-01
234.45	.596	7.64124-02	1.000	.471	2.673	8.528	5.55575-01	1.39137-01
239.56	.602	7.64124-02	1.000	.476	2.644	8.521	5.44140-01	1.36876-01
244.68	.608	7.64124-02	1.000	.481	2.616	8.514	5.32471-01	1.34518-01
249.79	.614	7.64124-02	1.000	.485	2.588	8.506	5.20745-01	1.32063-01
254.90	.620	7.64124-02	1.000	.490	2.560	8.498	5.08997-01	1.29515-01
260.01	.626	7.64124-02	1.000	.495	2.533	8.490	4.97262-01	1.26976-01
265.04	.631	7.64124-02	1.000	.499	2.506	8.482	4.85769-01	1.24377-01
270.15	.637	7.64124-02	1.000	.503	2.479	8.473	4.74152-01	1.21787-01
275.26	.643	7.64124-02	1.000	.508	2.453	8.465	4.62637-01	1.19294-01
280.37	.648	7.64124-02	1.000	.512	2.427	8.456	4.51249-01	1.16806-01
285.48	.654	7.64124-02	1.000	.516	2.401	8.447	4.40013-01	1.14393-01
290.51	.659	7.64124-02	1.000	.521	2.376	8.438	4.28915-01	1.11944-01
295.62	.664	7.64124-02	1.000	.525	2.351	8.428	4.18259-01	1.09585-01

SAMPLE OUTPUT: ZIRKOV P. 3

300.73	.669	7.64124-02	1.000	.529	2.326	3.419	4.4750-01	1.2750-01
303.64	.674	7.64124-02	1.000	.533	2.332	3.469	4.4714-01	1.2714-01
310.93	.679	7.64124-02	1.000	.537	2.338	3.498	4.4680-01	1.2680-01
316.27	.683	7.64124-02	1.000	.541	2.344	3.540	4.4646-01	1.2646-01
321.09	.688	7.64124-02	1.000	.545	2.350	3.581	4.4612-01	1.2612-01
326.20	.693	7.64124-02	1.000	.549	2.357	3.571	4.4578-01	1.2578-01
331.32	.698	7.64124-02	1.000	.553	2.364	3.561	4.4544-01	1.2544-01
336.43	.703	7.64124-02	1.000	.557	2.371	3.550	4.4510-01	1.2510-01
341.54	.708	7.64124-02	1.000	.560	2.378	3.539	4.4476-01	1.2476-01
346.65	.713	7.64124-02	1.000	.564	2.384	3.527	4.4442-01	1.2442-01
351.68	.718	7.64124-02	1.000	.568	2.391	3.516	4.4408-01	1.2408-01
356.79	.723	7.64124-02	1.000	.571	2.397	3.504	4.4374-01	1.2374-01
361.90	.728	7.64124-02	1.000	.575	2.404	3.491	4.4340-01	1.2340-01
367.01	.732	7.64124-02	1.000	.578	2.411	3.479	4.4306-01	1.2306-01
372.12	.737	7.64124-02	1.000	.582	2.418	3.467	4.4272-01	1.2272-01
377.23	.741	7.64124-02	1.000	.586	2.424	3.455	4.4238-01	1.2238-01
382.26	.746	7.64124-02	1.000	.589	2.431	3.443	4.4204-01	1.2204-01
387.37	.750	7.64124-02	1.000	.593	2.438	3.431	4.4170-01	1.2170-01
392.48	.755	7.64124-02	1.000	.596	2.444	3.419	4.4136-01	1.2136-01
397.59	.759	7.64124-02	1.000	.600	2.451	3.407	4.4102-01	1.2102-01
402.71	.763	7.64124-02	1.000	.603	2.458	3.395	4.4068-01	1.2068-01
407.73	.768	7.64124-02	1.000	.607	2.464	3.383	4.4034-01	1.2034-01
412.84	.772	7.64124-02	1.000	.611	2.471	3.371	4.4000-01	1.2000-01
417.95	.776	7.64124-02	1.000	.615	2.478	3.359	4.3966-01	1.1966-01
423.07	.781	7.64124-02	1.000	.618	2.484	3.347	4.3932-01	1.1932-01
428.18	.785	7.64124-02	1.000	.622	2.491	3.335	4.3898-01	1.1898-01
433.29	.789	7.64124-02	1.000	.625	2.498	3.323	4.3864-01	1.1864-01
438.31	.793	7.64124-02	1.000	.629	2.504	3.311	4.3830-01	1.1830-01
443.43	.798	7.64124-02	1.000	.633	2.511	3.299	4.3796-01	1.1796-01
448.54	.802	7.64124-02	1.000	.637	2.518	3.287	4.3762-01	1.1762-01
453.65	.806	7.64124-02	1.000	.640	2.524	3.275	4.3728-01	1.1728-01
458.76	.810	7.64124-02	1.000	.644	2.531	3.263	4.3694-01	1.1694-01
463.87	.815	7.64124-02	1.000	.647	2.538	3.251	4.3660-01	1.1660-01
468.90	.819	7.64124-02	1.000	.650	2.544	3.239	4.3626-01	1.1626-01
474.01	.823	7.64124-02	1.000	.654	2.551	3.227	4.3592-01	1.1592-01
479.12	.827	7.64124-02	1.000	.657	2.558	3.215	4.3558-01	1.1558-01
484.23	.831	7.64124-02	1.000	.660	2.564	3.203	4.3524-01	1.1524-01
489.35	.835	7.64124-02	1.000	.663	2.571	3.191	4.3490-01	1.1490-01
494.37	.839	7.64124-02	1.000	.667	2.578	3.179	4.3456-01	1.1456-01
499.48	.844	7.64124-02	1.000	.670	2.584	3.167	4.3422-01	1.1422-01
504.59	.848	7.64124-02	1.000	.673	2.591	3.155	4.3388-01	1.1388-01
509.71	.852	7.64124-02	1.000	.677	2.598	3.143	4.3354-01	1.1354-01
514.82	.856	7.64124-02	1.000	.680	2.604	3.131	4.3320-01	1.1320-01
519.93	.860	7.64124-02	1.000	.683	2.611	3.119	4.3286-01	1.1286-01
524.95	.864	7.64124-02	1.000	.687	2.618	3.107	4.3252-01	1.1252-01
530.07	.868	7.64124-02	1.000	.690	2.624	3.095	4.3218-01	1.1218-01
535.18	.872	7.64124-02	1.000	.693	2.631	3.083	4.3184-01	1.1184-01
540.29	.876	7.64124-02	1.000	.697	2.638	3.071	4.3150-01	1.1150-01
545.40	.880	7.64124-02	1.000	.699	2.644	3.059	4.3116-01	1.1116-01
550.51	.884	7.64124-02	1.000	.701	2.651	3.047	4.3082-01	1.1082-01
555.54	.888	7.64124-02	1.000	.705	2.658	3.035	4.3048-01	1.1048-01
560.65	.892	7.64124-02	1.000	.708	2.664	3.023	4.3014-01	1.1014-01
565.76	.895	7.64124-02	1.000	.711	2.671	3.011	4.2980-01	1.0980-01
570.87	.899	7.64124-02	1.000	.715	2.678	3.000	4.2946-01	1.0946-01
575.98	.903	7.64124-02	1.000	.718	2.684	2.988	4.2912-01	1.0912-01
581.10	.907	7.64124-02	1.000	.722	2.691	2.976	4.2878-01	1.0878-01
586.12	.910	7.64124-02	1.000	.725	2.698	2.964	4.2844-01	1.0844-01
591.23	.914	7.64124-02	1.000	.728	2.704	2.952	4.2810-01	1.0810-01
596.35	.917	7.64124-02	1.000	.731	2.711	2.940	4.2776-01	1.0776-01
601.46	.921	7.64124-02	1.000	.733	2.718	2.928	4.2742-01	1.0742-01
606.57	.925	7.64124-02	1.000	.737	2.724	2.916	4.2708-01	1.0708-01
611.59	.928	7.64124-02	1.000	.740	2.731	2.904	4.2674-01	1.0674-01
616.71	.932	7.64124-02	1.000	.743	2.738	2.892	4.2640-01	1.0640-01
621.82	.935	7.64124-02	1.000	.747	2.744	2.880	4.2606-01	1.0606-01
626.93	.938	7.64124-02	1.000	.750	2.751	2.868	4.2572-01	1.0572-01
632.04	.942	7.64124-02	1.000	.752	2.758	2.856	4.2538-01	1.0538-01
637.15	.945	7.64124-02	1.000	.755	2.764	2.844	4.2504-01	1.0504-01
642.16	.949	7.64124-02	1.000	.758	2.771	2.832	4.2470-01	1.0470-01
647.29	.952	7.64124-02	1.000	.760	2.778	2.820	4.2436-01	1.0436-01
652.40	.955	7.64124-02	1.000	.763	2.784	2.808	4.2402-01	1.0402-01
657.51	.959	7.64124-02	1.000	.765	2.791	2.796	4.2368-01	1.0368-01
662.62	.962	7.64124-02	1.000	.768	2.798	2.784	4.2334-01	1.0334-01
667.74	.965	7.64124-02	1.000	.770	2.804	2.772	4.2300-01	1.0300-01
672.76	.968	7.64124-02	1.000	.773	2.811	2.760	4.2266-01	1.0266-01
677.87	.972	7.64124-02	1.000	.775	2.818	2.748	4.2232-01	1.0232-01
682.98	.975	7.64124-02	1.000	.778	2.824	2.736	4.2198-01	1.0198-01
688.10	.978	7.64124-02	1.000	.780	2.831	2.724	4.2164-01	1.0164-01
693.21	.981	7.64124-02	1.000	.783	2.838	2.712	4.2130-01	1.0130-01
698.32	.984	7.64124-02	1.000	.785	2.844	2.700	4.2096-01	1.0096-01
703.34	.987	7.64124-02	1.000	.788	2.851	2.688	4.2062-01	1.0062-01
708.46	.990	7.64124-02	1.000	.790	2.858	2.676	4.2028-01	1.0028-01
708.98	.990	7.64124-02	1.000	.792	2.864	2.664	4.1994-01	1.0000-01

RUN TIME FOR THIS CASE WAS 1.514843761 SEC

SAMPLE OUTPUT: ZIRKOV P. 4

RUN NO. 12

RUN ON 21 AUG 68 AT 22:11:15

INPUT SUMMARY

INITIAL CONDITIONS

CLADDING AREA A = 7.49665-02 SQ FT/L
 AMMONIUM LITRATE CONC. CNHNO3 = 2.72000-01 G MOL/L
 AMMONIUM FLUORIDE CONC. CNHF4 = 3.00000-00 G MOL/L
 CLADDING WEIGHT WZL = 9.00000-00 KG
 DISSOLVER SOLUTION VOL. VDS = 2.31673-02 LITERS
 CLADDING SPEC. SURF. AREA SA = 2.12000-00 SQ FT/KG
 ZIRCONIUM METAL MZR = 4.13576-01 G MOL/L
 ZIRCONIUM THICKNESS TZNS = 3.10395-01 MILS
 ZIRCONIUM CONC. CZNS = 0.00000 G MOL/L

OPERATING VARIABLES

RATE CONSTANT FOR DISS. K1 = 1.19200+01 G PJL F/G MOL ZR B1 = 6
 G MOL NH4F/G MOL ZR R2 = 4 G PJL NH3/6 MOL ZR B3 = 5
 EXP. ON F- CONC. IN RATE EQ. A1 = 2.02000+00 EXP. ON H+ CONC. IN RATE EQ. A2 = 4.60000-01
 MOLAR VOLUME VM = 1.63000-02 L/G MOL MOL. WEIGHT ZR MW = 9.12220+01 G/G MOL
 IONIZATION CONSTANT KW/KH = 4.00000-10 G MOL/L
 AMMONIA CONC. CNH3 = 2.22893-04 G MOL/L

1.1425781-01 SECONDS HAD ELAPSED UPON RETURN FROM S.R. GETSET

THETA(MIN)	CZR/MZRO	BFA	A/AO	CZR	CF	PH	CNH3	YHNS
7.40	.040	7.99665-02	1.000	.016	2.902	7.648	5.67600-02	7.51513-02
14.80	.064	7.99665-02	1.000	.026	2.842	7.784	7.71144-02	4.45827-02
22.21	.085	7.99665-02	1.000	.035	2.790	7.848	8.81883-02	8.25847-02
29.61	.104	7.99665-02	1.000	.043	2.743	7.853	9.45475-02	9.05965-02
37.01	.122	7.99665-02	1.000	.050	2.698	7.903	9.82897-02	9.12190-02
44.29	.139	7.99665-02	1.000	.057	2.656	7.915	9.99701-02	9.13396-02
51.69	.155	7.99665-02	1.000	.064	2.615	7.920	1.00241-01	9.13768-02
59.09	.171	7.99665-02	1.000	.071	2.575	7.920	9.93927-02	9.13688-02
66.49	.187	7.99665-02	1.000	.077	2.537	7.916	9.76777-02	9.11275-02
73.89	.202	7.99665-02	1.000	.083	2.499	7.909	9.53070-02	9.07167-02
81.29	.217	7.99665-02	1.000	.090	2.463	7.899	9.24671-02	9.01066-02
88.57	.231	7.99665-02	1.000	.095	2.427	7.883	8.93790-02	8.92974-02
95.97	.245	7.99665-02	1.000	.101	2.392	7.875	8.60784-02	8.82544-02
103.37	.259	7.99665-02	1.000	.107	2.357	7.862	8.27360-02	8.70411-02
110.76	.273	7.99665-02	1.000	.113	2.322	7.848	7.94440-02	8.56225-02
118.18	.287	7.99665-02	1.000	.119	2.289	7.833	7.62674-02	8.41684-02
125.58	.300	7.99665-02	1.000	.124	2.255	7.819	7.32470-02	8.26985-02
132.86	.313	7.99665-02	1.000	.130	2.223	7.805	7.04499-02	8.13149-02
140.25	.327	7.99665-02	1.000	.135	2.192	7.791	6.77550-02	8.00000-02
147.66	.339	7.99665-02	1.000	.140	2.159	7.776	6.52975-02	7.77715-02
155.06	.352	7.99665-02	1.000	.145	2.127	7.767	6.29766-02	7.47122-02
162.46	.364	7.99665-02	1.000	.151	2.096	7.753	6.07875-02	7.15646-02
169.74	.376	7.99665-02	1.000	.156	2.066	7.741	5.83532-02	6.83043-02
177.14	.388	7.99665-02	1.000	.161	2.036	7.723	5.55748-02	6.51387-02
184.54	.400	7.99665-02	1.000	.166	2.007	7.703	5.26870-02	6.19551-02
191.94	.412	7.99665-02	1.000	.170	1.977	7.682	4.98587-02	5.88246-02
199.35	.424	7.99665-02	1.000	.175	1.948	7.662	4.72081-02	5.57873-02
206.75	.436	7.99665-02	1.000	.180	1.919	7.642	4.47964-02	5.28472-02
214.02	.447	7.99665-02	1.000	.185	1.891	7.625	4.26272-02	4.99954-02
221.43	.459	7.99665-02	1.000	.190	1.862	7.608	4.07461-02	4.63811-02
228.83	.470	7.99665-02	1.000	.194	1.834	7.592	3.90258-02	4.29797-02
236.23	.481	7.99665-02	1.000	.199	1.807	7.573	3.74771-02	3.98048-02
243.63	.492	7.99665-02	1.000	.203	1.780	7.553	3.59844-02	3.68683-02
251.03	.503	7.99665-02	1.000	.208	1.753	7.544	3.46168-02	3.41169-02
258.31	.513	7.99665-02	1.000	.212	1.727	7.522	3.32219-02	3.15697-02
265.71	.524	7.99665-02	1.000	.217	1.700	7.493	3.18272-02	2.92250-02
273.11	.534	7.99665-02	1.000	.221	1.674	7.475	3.04262-02	2.70276-02
280.52	.545	7.99665-02	1.000	.225	1.648	7.453	2.89401-02	2.49865-02
287.92	.555	7.99665-02	1.000	.230	1.622	7.434	2.75592-02	2.31830-02
295.19	.565	7.99665-02	1.000	.234	1.597	7.417	2.64419-02	2.15786-02
302.59	.576	7.99665-02	1.000	.238	1.572	7.394	2.50156-02	2.01336-02
310.00	.586	7.99665-02	1.000	.242	1.547	7.364	2.12866-02	1.82450-02
317.40	.596	7.99665-02	1.000	.246	1.522	7.331	1.96114-02	1.67899-02
324.80	.606	7.99665-02	1.000	.251	1.497	7.302	1.82011-02	1.56283-02
332.20	.616	7.99665-02	1.000	.255	1.472	7.276	1.70768-02	1.46833-02
339.48	.626	7.99665-02	1.000	.259	1.447	7.257	1.61832-02	1.39336-02
346.84	.636	7.99665-02	1.000	.263	1.423	7.239	1.54173-02	1.33794-02
354.28	.645	7.99665-02	1.000	.267	1.399	7.223	1.47467-02	1.29407-02
361.68	.655	7.99665-02	1.000	.271	1.376	7.203	1.41428-02	1.26131-02
369.09	.664	7.99665-02	1.000	.275	1.352	7.194	1.35896-02	1.23790-02
376.49	.673	7.99665-02	1.000	.278	1.330	7.180	1.30777-02	1.19882-02
383.76	.682	7.99665-02	1.000	.282	1.308	7.167	1.26085-02	1.08124-02
391.17	.691	7.99665-02	1.000	.286	1.286	7.154	1.21376-02	1.03142-02
398.57	.699	7.99665-02	1.000	.289	1.265	7.120	1.16117-02	1.02571-02
405.97	.708	7.99665-02	1.000	.293	1.243	7.072	9.87412-03	1.02577-02
413.37	.717	7.99665-02	1.000	.297	1.221	7.027	8.87537-03	1.02170-02
420.63	.726	7.99665-02	1.000	.300	1.199	6.997	8.23749-03	1.02177-02
428.05	.735	7.99665-02	1.000	.304	1.177	6.975	7.76466-03	1.02337-02
435.45	.743	7.99665-02	1.000	.307	1.155	6.956	7.37820-03	1.02406-02
442.85	.752	7.99665-02	1.000	.311	1.133	6.934	7.03646-03	1.02417-02
450.25	.760	7.99665-02	1.000	.314	1.113	6.922	6.72757-03	1.02283-02
457.66	.769	7.99665-02	1.000	.318	1.093	6.909	6.44445-03	1.02117-02
464.93	.777	7.99665-02	1.000	.321	1.073	6.891	6.18414-03	1.02152-02
472.33	.784	7.99665-02	1.000	.324	1.054	6.880	5.94440-03	1.02000-02
479.74	.792	7.99665-02	1.000	.328	1.035	6.873	5.72275-03	1.02000-02
487.14	.800	7.99665-02	1.000	.331	1.016	6.861	5.56673-03	1.01700-02
494.54	.807	7.99665-02	1.000	.334	.998	6.852	5.41756-03	1.01471-02
501.94	.814	7.99665-02	1.000	.337	.981	6.844	5.37311-03	1.01471-02

SAMPLE OUTPUT: ZIRKOV P. 5

509.22	.821	7.99665-02	1.000	.539	.569	5.835	5.23697-03	5.84000-02
516.62	.817	7.99665-02	1.000	.542	.547	5.836	5.10150-03	5.79100-02
524.32	.814	7.99665-02	1.000	.545	.531	5.817	4.97159-03	5.66666-02
531.42	.800	7.99665-02	1.000	.547	.515	5.809	4.84612-03	5.56000-02
538.62	.847	7.99665-02	1.000	.550	.500	5.800	4.72092-03	5.46000-02
546.10	.853	7.99665-02	1.000	.553	.505	5.792	4.60074-03	5.36100-02
553.50	.858	7.99665-02	1.000	.555	.570	5.783	4.48645-03	5.26100-02
560.90	.864	7.99665-02	1.000	.557	.556	5.775	4.37691-03	5.17000-02
568.30	.870	7.99665-02	1.000	.560	.542	5.766	4.26994-03	5.14000-02
575.71	.875	7.99665-02	1.000	.562	.528	5.758	4.17841-03	5.06000-02
583.11	.881	7.99665-02	1.000	.564	.515	5.750	4.07918-03	4.99000-02
590.38	.886	7.99665-02	1.000	.566	.502	5.741	3.95471-03	4.92000-02
597.79	.891	7.99665-02	1.000	.568	.489	5.733	3.83163-03	4.85000-02
605.19	.896	7.99665-02	1.000	.571	.477	5.725	3.63146-03	4.78000-02
612.59	.901	7.99665-02	1.000	.573	.465	5.717	3.51400-03	4.72000-02
619.99	.906	7.99665-02	1.000	.575	.453	5.709	3.40294-03	4.66200-02
627.39	.910	7.99665-02	1.000	.578	.441	5.701	3.29473-03	4.60100-02
634.67	.915	7.99665-02	1.000	.578	.430	5.693	3.19002-03	4.54400-02
642.07	.919	7.99665-02	1.000	.582	.418	5.685	3.09176-03	4.48500-02
649.47	.924	7.99665-02	1.000	.582	.408	5.677	3.00001-03	4.43000-02
656.87	.928	7.99665-02	1.000	.584	.398	5.669	2.91406-03	4.37800-02
664.27	.932	7.99665-02	1.000	.585	.387	5.661	2.83454-03	4.32700-02
671.55	.936	7.99665-02	1.000	.587	.377	5.654	2.76040-03	4.27800-02
678.95	.940	7.99665-02	1.000	.589	.367	5.646	2.69243-03	4.22500-02
686.35	.944	7.99665-02	1.000	.592	.358	5.638	2.62972-03	4.18100-02
693.75	.948	7.99665-02	1.000	.592	.348	5.631	2.57185-03	4.13500-02
701.16	.952	7.99665-02	1.000	.594	.339	5.623	2.50076-03	4.09100-02
708.56	.955	7.99665-02	1.000	.595	.330	5.615	2.42137-03	4.04700-02
715.83	.959	7.99665-02	1.000	.597	.321	5.608	2.33460-03	4.00500-02
723.24	.962	7.99665-02	1.000	.598	.312	5.600	2.24843-03	3.96600-02
730.64	.966	7.99665-02	1.000	.599	.304	5.593	2.16280-03	3.92800-02
738.04	.969	7.99665-02	1.000	.401	.595	5.586	2.07665-03	3.88500-02
745.44	.973	7.99665-02	1.000	.402	.587	5.578	2.01894-03	3.84700-02
752.84	.976	7.99665-02	1.000	.404	.579	5.571	1.96860-03	3.81000-02
760.12	.979	7.99665-02	1.000	.405	.571	5.564	1.92643-03	3.77500-02
767.52	.982	7.99665-02	1.000	.406	.563	5.556	1.87271-03	3.74300-02
774.92	.985	7.99665-02	1.000	.407	.556	5.549	1.82624-03	3.70800-02
782.32	.988	7.99665-02	1.000	.409	.548	5.542	1.78098-03	3.67310-02
789.09	.990	7.99665-02	1.000	.409	.544	5.537	1.73245-03	3.65217-02

...RUN TIME FOR THIS CASE WAS 1.1403320+01 SEC.

EXECUTION TERMINATED BY AN ATTEMPT TO READ THRU AN END OF FILE

I/O CALLED AT SEQUENCE NUMBER 00161 OF GETSET

GETSET CALLED AT SEQUENCE NUMBER 00156 OF MAIN PROGRAM

SOLE PMD
NOT IN ERROR MODE - NO DUMP TAKEN

21 AUG 68 22: 9: 2 IDENT 549629 ACCOUNT CUB295 CARDS IN 451 CARDS OUT 61 PAGES 54 ELAPSED TIME 0: 2:26

CSC120UB AUG. 18, 1968

*****1*****5*****2*****5*****3*****5*****4*****5*****5*****6*****5*****7*****8*****9*****5*****0*****5*****1*****5*****2*****5*****3*****

LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 1

```

85 RUN FUND3-CUEN700  WITH-FUND/3112  E JANSEN 3700 BLOC 9423576
9 C1T ZIRKOV/S155-1.140171. 93213
8 END 8
C PROGRAM ZIRKOV
C A FORTRAN-V PROGRAM FOR THE UNIVAC IIII-2 SOLUTION TO SIMULATION OF
C DIFFERENTIAL EQUATIONS AS DESCRIBED BY P. J. JANSEN IN HW-71090.
C THERE ARE TWO SIMULTANEOUS NON-LINEAR ORDINARY DIFFERENTIAL EQUATIONS.
C *** SUBROUTINE ***
C
C (FROM LIBRARY)
C
C TOY- TIME OF DAY
C DOY- DATE
C ALGOLIO- LOG BASE 10
C ETIME- STARTS CLOCK
C ETIMEF- READS ELAPSED TIME
C (BEEF MATH ROUTINES FROM TAPE UNIT)
C DES,DED,DEI- LINKAGES TO DIFFERENTIAL EQUATION ROUTINE
C DEDIS- DIFFERENTIAL EQUATION ROUTINE
C ALSO REQUIRED-- PROCEDURE ELEMENT 'BOLIST' /P COPY NAME MISC
C ***
C
C INPUT DESCRIPTION
C FIRST CARD IN DATA DECK IS TITLE HEADING, ENTER 33 ALPHANUMERIC.
C DATA ENTERED T-POUCH NAMELIST/BAGGITT. VARIABLE NAMES RECOGNIZED BY
C NAMELIST, THEIR TYPES, DIMENSIONS, AND DEFINITIONS ARE AS FOLLOWS:
C
C *NOTE- 0 INDICATES VALUE IN DATA STATEMENT, OTHERWISE, A VALUE MUST
C BE ENTERED IN NAMELIST.
C *NOTE- * DENOTES VARIABLE IS IN BLANK COMMON
C
C NAME DIMENS TYPE DEFINITION USUAL
C VALUE
C
C *NOTE- SUFFIX *C* DENOTES INITIAL CONDITION
C * SO 1 R *SPECIFIC SURFACE AREA OF CLADDING, G FT/KG
C * VO 1 R *VOL OF DISSOLVER SOLUTION, LITERS
C * WZRO 1 R *WEIGHT OF CLADDING, KG
C * MW 1 R *MOL WEIGHT ZIRCONIUM, G/MOL
C * RHOZR 1 R *DENSITY OF ZR, G/CUBIC CM 91.22 0
C
C *CNH9FO 1 R *AMMONIUM FLUORIDE CONCENTRATION, G MOL/L 6.99 0
C * FH 1 R *LOG M+ ION CONC.
C * CNH3O 1 R *AMMONIA CONCENTRATION
C *CNHNO3 1 R *AMMONIUM NITRATE CONC., INITIAL
C * K1 1 R *RATE CONSTANT FOR DISSOLUTION, (G MOL/L)/(G MOL/L) * (1-42) 11.42E-5 0
C (FT)/(G MOL/L) (RECIPROCAL MIN)
C
C * A1 1 R *EXONENT ON FREE FLUORIDE ION CONC. IN RATE EQUAT. 2.02 0
C * A2 1 R *EXONENT ON M+ ION CONC. IN RATE EQUATION 1.0 0
C * VM 1 R *EMULAR VOLUME OF SOLUTION, L/G MOL
C * CZRO 1 R *ZP CONCENTRATION 0.0 0
C * B 1 R *BOIL-UP RATE, G MOL VAPO/20 FT MIN
C
C * VF 1 R *FRACTION OF ESTIMATED DISS TIME USED TO APPROX 0.01 0
C DTHETA
C * T 33 R *ARRAY USED BY BEEF MATH ROUTINE DES DED DEI DECIS 0.0 0
C * DTHETA0 1 R *TIME AT START
C * ECV 10 R *EXTRA CONTROL VARIABLES
C * KK 1 R *KW/KBIF NOT ENTERED IN NAMELIST, OTHERWISE, 0
C * KK=EXPERIMENTAL VALUE
C
C * TEENY 1 R *FRACTION ZR UNDISSOLVED AT END OF RUN
C * SMALL 0 R *CONVERGENCE REQUIREMENT FOR CNH3O ITERATION IN 0
C S.R. AMMON
C * CNH3CH 1 I *SELECTS METHOD OF CALC. CNH3O. SET=1 TO CALC. FROM 0
C INITIAL NH4+ CONC. SET=2 TO CALC. FROM GIVEN PH.
C SET=3 IF GIVEN AS INPUT THROUGH NAMELIST.
C
C * ADJINBE 1 I *CONTROL VARIABLE=1 IF A IS CONSTANT 0 0
C
C *** OTHER INPUT/OUTPUT ***
C
C * KW 1 R *IONIZATION CONSTANT H2O 1.0E-13 0
C * K9 1 R *IONIZATION CONSTANT NH3 1.0E-5 0
C * B1 1 I *RATIO G MOL F-/G MOL ZR 6 0
C * B2 1 I *RATIO G MOL NH4+/G MOL ZR 8 0
C * B3 1 I *RATIO G MOL NH3/G MOL ZR 5 0
C
C * AO 1 R *INITIAL CLADDING AREA 0
C * TZRO 1 R *THICKNESS ZP, MILS 0
C * CZO 1 R *CONC. ZP, LIT DEFEN. VARIABLE IN O.D.E. 0
C * CNH3 1 R *CONC. NH4, LIT DEFEN. VARIABLE IN O.D.E. 0
C * CFMN 1 R *CONC. FREE FLUORIDE ION 0
C
C * YNHY 1 R *MOLE FRACTION NHY IN VAPO 0
C * BETA 1 P *FRACTIONAL PART TO DECELERATE INTERVAL 0
C DTHETA
C * HMIN 1 R *MIN VALUE DTHETA 1 0
C * HMAX 1 R *MAX VALUE DTHETA 1 0
C * A 1 R *DTERMINED RELATIVE ERROR BETA, P/C 1.0 0
C
C * 1 R *RATIO UPPER BOUND RELAT. V. EPORP/ 1000. 0
C LOWER BOUND
C
C * INO 1 I *SELECTS METHOD OF O.D.E. SOLUTION 0 0
C

```

LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 2

```

C
  INCLUDE MISC.LIST
  DIMENSION FRAC(16)
  DATA FRAC/.001,.01,.05,.1,.2,.3,.4,.5,.6,.7,.8,.9,.95,.99,.999/
  2.99999/
  NFRAC=16
  CALL DEFINE
  1000 CALL ETIME
  1105 CALL GETSET
  CALL ETIMEF(SEC)
  WRITE(6,1)SEC
  1 FORMAT(1H0.1PE17.7+9H SECONDS HAS ELAPSED UPON RETURN FROM SUB. 2F 00700
  2ETSET)
  WRITE(6,19)
  19 FORMAT(1H0.125H TIME, METAL DISS., SOILOFF RATE, AREA 2F 00800
  2 DISS. ZP, FLUORIDE, HYDROGEN AMMONIA, AMMONIA 2F 00850
  3IN VAFOR/123H MINUTES FRACTION CU FT/MIN FRAC OF UNFEN 2F 00900
  4IT AREA MOLARITY MOLARITY ION MOLARITY MOLE FRAC 2F 00950
  5TION/115H (THETA) (CZP/MZRO) (S-A) (A/AD) 2F 00955
  6 (CZR) (CF-) (FH) (CNH3) (YNH3) 2F 00960
  CALL FINUP
C SEQUENCE TO SOLVE O.D.E. USING LIBRARY BEEF MATH ROUTINE
  NUM=2
  NUM1=2
  CALL DES(NUM1,INC,NTEST)
  10 IF (NTEST) 12,12,11
  11 CALL DEI(NUM,INC,NTEST)
C COMPUTE DERIVATIVES
  12 CALL FICIT
  Q1=A*K1
  Q2=CFMN**A1
  Q3=(CNH4O-B2*CZP)/CNH3
  Q4=(Q3*KK)**A2
  DCZR=Q1*Q2*Q4
  Q5=B3*DCZR
  Q6=A*3*YNH3
  DCNH3=Q5-Q6
  CALL DED(NARG)
  IF (NARG.EQ.0) GO TO 10
C EXIT FROM DIFFERENTIAL EQUATION SUBPROGRAM
  IF (NWRITE.LT.1) NWRITE=1
C FRAC IS FRACTION ZR DISSOLVED.DETERMINES IF PRINTOUT
  CHECK=FRAC(NWRITE)
  OV1=CZR/MZRO
  IF (OV1.LT.CHECK) GO TO 25
  NWRITE=NWRITE+1
  N=NWRITE
  DO 99 I=N,NFRAC
  CHECK=FRAC(I)
  IF (OV1.GE.CHECK) GO TO 30
  GO TO 20
  30 NWRITE=NWRITE+1
  99 CONTINUE
  20 CALL FINUP
C TEST IS AMOUNT ZP LEFT TO DISSOLVE G MOL/LITER
  25 TEST=MZRO-CZR
  IF (TEST-TEENY*MZRO) 22,22,21
  21 CALL ETIMEF(SEC)
  IF (SEC.LT.30.) GO TO 11
  22 CALL FINUP
  CALL ETIMEF(SEC)
  WRITE(6,2)SEC
  2 FORMAT(1H0.2FHRUN TIME FOR THIS CASE WAS.1PE19.7+9H SEC)
  GO TO 1000
  END

```

8 ELT MISC/5150.7.740223. 40211

3 EOF 2

MISC. FCOPY

```

DIMENSION T(33),TITLE(12),ECV(10),DATE(2),TIME(2),CUM(22)
EQUIVALENCE (T(1),NUM1),(T(24),CZP),(T(23),CNH3),(T(25),THETA),
2(T(26),THETA),(T(27),DCZP),(T(28),ULNH3)
EQUIVALENCE (T(29),BETA),(T(30),HMIN),(T(31),HMAX),
2(T(32),A),(T(33),E)
PEAL KW,K8,KK,K3,K1,K2,MZRO,MZR,MW
INTECEP CNH3CH,ACHNGE,B1,B2,B3
COMMON CNH3CH,ACHNGE,ECV,NUTNO,NWRITE,DATE,TIME,TITLE
COMMON VP,SD,VC,ZZRO,MW,RHOZP,FH,B,TEENY,SMALL
COMMON AD,A1,A2,B1,B2,B3,K1,K2,K3,K4,K5,KK
COMMON OV1,OV2,OV3,OV4,OV5,OV6,OV7,OV8,THAX
COMMON MZRO,TZRO,CNH3,CNH4O,CNH3O3,CNH4O,CFO,CHPLSN,CZRO,
2DCZRE,THETAU,CHFLUS,CFMN,MZF,TRATIO,XNH3,YNH3
COMMON SUM,CNH3,CZP,THETA,THETA,CUMY,BETA,HMIN,HMAX,A,M,E
COMMON CNH4O,K4,CFFFF,CHNGO,CNASH
DATA NUTNO/20./,VP/0.01/
DATA BETA,IND,HMIN,HMAX,A,M,E/.5,0.,1,10.,1.,1000.,1,E-6/
DATA ACHNGE/0./,M4,K4,K8,A1,A2/91.22,1,2-14,1,95-5,2,02.,96/
DATA RHOZP/K1/6.44,11.42/
DATA B1,B2,B3/6.4,5./,CZPO,THETAO/2.0./
END

```

LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 3

[illegible]

```

3  CLY YNH3FD/SIF5-1.74C223. 48216
4  EOF 8
      SUBROUTINE YNH3FD      3TC FIND YNH3-POLE FRACTION MH3 IN VAPOR
      INCLUDE *ISC-LIST
      DIMENSION ENTPLY(16)*TABLE(16)
      DATA ENTPLY(1),I=1,16/
1.0001,.0002,.0004,.0006,.001,.002,.003,.006,.01,.02,.03,.05,.16.
2.10,.20,.30/
      DATA (TABLE(I),I=1,16)/
1950,0.250,0.150,0.103,3.75,0.45,0.26,25.20,0.15,0.11,50.10,37.
29.50,8.75,6.80,4.25,3.16/
C   GIVEN XNH3,YNH3,MH3 FIND K3=YNH3/XNH3
      IF (XNH3.LE.ENTPLY(1)) GO TO 53
      IF (XNH3.GT.ENTPLY(15)) GO TO 55
      DO 49 L2=16
      IF(XNH3.GT.ENTPLY(L)) GO TO 49
C   LINEAR INTERPOLATION
      FACTOR=(XNH3-ENTPLY(L-1))/(ENTPLY(L)-ENTPLY(L-1))
      CORRES=TABLE(L)-TABLE(L-1)
      K3=TABLE(L-1)+FACTOR*CORRES
      GO TO 57
49  CONTINUE
53  K3=TABLE(1)
      GO TO 57
55  K3=1+.0.9/XNH3
      YNH3=.1*(1.-XNH3)
      RETURN
57  YNH3=K3*MH3
      RETURN
      END

```

NO	ELT FINUF/SIFS.174G223. 40217	NO
1	EOF 3	3
	SUBROUTINE FINUF	FN C0100
	INCLUDE MISC.LIST	FN C0200
	DIMENSION MOLL(11)/18MMINITIAL MM4= C0NC./MOLL(11)/18MM	FN C0250
2	./MOLL(11)/18MM4MMONIA C0NC INFUT/	FN C0251
1	FORMAT(14,12A6.8M PUN.ON,2A6.8M AT,2A6.1)	FN C0300
2	FORMAT(14,13INFUT,2UMMARY)	FN C0400
3	FORMAT(14M,5X,18MMINITIAL CONDITIONS)	FN C0401
4	FORMAT(14M,8X,24MCLADDING AREA(140T 24PUT) 7M	FN C0600
2	FT/L)	FN C0700
5	FORMAT(14M,9X,254MMMONIUM NITRATE C0NC. 7MCM403)=1PE11.5.8M 53M	FN C0701
2	MCL/L)	FN C0900
6	FORMAT(14M,9X,254MMMONIUM FLUOPIDE C0NC. 7MCM403)=1PE11.5.8M 53M	FN C1000
2	MCL/L)	FN C1100
7	FORMAT(14M,8X,24MCLADDING WEIGHT 7M	FN C1200
2)	W700=1PE11.5.7M 53M	FN C1300
8	FORMAT(14M,9X,25402SOLVER SOLUTION 70L. 7M	FN C1400
2	TEPS)	FN C1500
9	FORMAT(14M,9X,24MCLADDING SPEC. TAPP. AREA 7M	FN C1600
2	FT/VC)	FN C1700
10	FORMAT(14M,9X,25420 METAL(140T 24PUT) 7M	FN C1800
2	MCL/L)	FN C1900

LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 4

```

11 FORMAT(1H,3X,254V METAL THICKNESS INPUT,7H 1700,1PE11.5,5H 1700
2LS) FN 02100
12 FORMAT(1H,3X,254V ZIRCONIUM CONC. 7H 0700,1PE11.5,5H 0700
2ML/L) FN 02200
125 FORMAT(1H,3X,544FACTOR SPECIFIED TO DETERMINE INITIAL AMMONIA CONC. 7H 0250
2C,=,340) FN 02250
13 FORMAT(1H,5X,104OPERATING VARIABLES) FN 02300
14 FORMAT(1H,3X,314RATE CONSTANT FOR DIS. 3401,1PE11.5,13XFN 02350
2,314 MOL F-70 MOL ZR 3401,1PE11.5,13XFN 02400
15 FORMAT(1H,3X,214 MOL NH4+70 MOL ZR 3402,1PE11.5,13XFN 02450
2,314 MOL NH3/6 MOL ZR 3402,1PE11.5,13XFN 02500
16 FORMAT(1H,3X,314XF, ON F- CONC. IN RATE EQ. 3401,1PE11.5,13XFN 02550
2,314XF, ON H+ CONC. IN RATE EQ. 3402,1PE11.5,13XFN 02600
17 FORMAT(1H,3X,314MOLAR VOLUME 3403,1PE11.5,5H 3403
2L/G MOL,5X,314MOL. WEIGHT ZR 3403,1PE11.5,5H 3403
3 MOL) FN 02650
18 FORMAT(1H,3X,194IONIZATION CONSTANT, 5X 6401,1PE11.5,5H 6401
2OL/L) FN 02700
20 FORMAT(1H,5F10.2,5F10.5,1PE11.5,5F10.5,1PE11.5,1PE11.5,1PE11.5) FN 02750
500 FORMAT(1H,1,28H2IRZPLEX DISSOLVER SIMULATION,117H CALCULATED BY FN
1ZIRKOV,4 FROTRAN-V PROGRAM FOR THE UNIVAC-1113, USING EQUATIONS DEFN
3500 BY F.L. SMITH IN HW-71054// 31H INDEPENDENT INITIAL CONDITION
410NS// 31H 4200 WEIGHT OF CLADDING,KG/ 54H 50 SPECIFIC SFN
SURFACE AREA OF CLADDING,SG FT/KG// 30H 51H40AMMONIUM FLUORIDE FN
6MOLARITY// 35H 52H40AMMONIUM NITRATE MOLARITY// 39H 5300 501SFN
750LVED ZIRCONIUM MOLARITY// 44H THREE ALTERNATIVE CHOICES FOR IFN
INITIAL AMMONIA CONCENTRATION// 49H (1)NO INPUT,PH AND CNH3 FN
9400 CALCULATED INTERNALLY// 107H (2)PH=NEGATIVE OF LOGARITHM
1 OF HYDROGEN ION ACTIVITY,INITIAL AMMONIA MOLARITY IS CALCULATED FFN
100H FH/ 41H (3)CNH3=INITIAL AMMONIA MOLARITY) FN
501 FORMAT(1H,27404EP INDEPENDENT VARIABLES// 49H VOLUME OF FN
2 SOLUTION IN DISSOLVER,LITERS/ 61H 5 501L-UF RATE,GRAM MOLEFN
35 VAFOR/MIN SG FT OF CLADDING/ 75H VNMOLAR VOLUME OF SOLUTION FN
40N,LITERS/GRAM MOLE OF SOLUTES PLUS SOLVENT// 47H 5400RESPECTIFN
50 GRAVITY OF ZIRCALOY CLADDING/ 47H 5400MOLECULAR WEIGHT OF ZFN
610CALOY CLADDING// 61H 610MOLES FLUORINE REACTED PER MOLE 71FN
700NIUM DISSOLVED/ 65H 620MOLES AMMONIUM ION REACTED PER MOLEFN
80 ZIRCONIUM DISSOLVED/ 59H 630MOLES AMMONIA FORMED PER MOLE FN
9200NIUM DISSOLVED) FN
502 FORMAT(1H,54H TWO ALTERNATE CHOICES FOR EQUILIBRIUM CONSTANTFN
2TS/ 60H (1)NO INPUT,KW=WATER IONIZATION PRODUCT,K3=AMMONIEN
3A IONIZATION CONSTANT/ 44H (2)KW/K3 MAY BE PUT IN AS KW=FN
4W/K3/ 110H VOLATILIZATION OF AMMONIA IS CALCULATED WITHIN PRFN
50000 FROM STORED DATA TAKEN FROM FIGURE 1 OF HW-71054// 54H FN
6 61-RATE CONSTANT FOR DISSOLUTION,(MOLARITY WITH (-A1-A2)EXPONENTFN
71/MIN SG FT OF CLADDING/ 66H A1=EXPONENT ON FREE FLUORIDE COFN
80NTRATION IN RATE EQUATION/ 60H A2=EXPONENT ON AMMONIA CONFN
90NTRATION IN RATE EQUATION) FN
503 FORMAT(1H,29H4CALCULATED INITIAL CONDITIONS// 55H 40=INITIALFN
2 CLADDING AREA,SG FT/LITER OF SOLUTION/ 49H 1700=AVERAGE INITIEN
IAL CLADDING THICKNESS,MILS/ 78H 1700=INITIAL ZIRCONIUM IN CLADFN
DING,SG MOLES/LITER OF SOLUTION IN DISSOLVER) FN
CALL FIGHT FN 02900
WRITE(6,201)META,OV1,OV2,OV3,OV4,OV5,OV6,OV7,OV8 FN 02950
RETURN FN 03000
ENTRY DEFINE FN
WRITE(6,500) FN
WRITE(6,501) FN
WRITE(6,502) FN
WRITE(6,503) FN
RETURN FN
ENTRY INPUT FN 03100
WRITE(6,1)TITLE,DATE,TIME FN 03150
WRITE(6,2) FN 03200
WRITE(6,3) FN 03250
WRITE(6,4)FN 03300
WRITE(6,5)CNHNO3 FN 03350
WRITE(6,6)CNH4FD FN 03400
WRITE(6,7)JZ0 FN 03450
WRITE(6,8)J0 FN 03500
WRITE(6,9)J0 FN 03550
WRITE(6,10)JZ0 FN 03600
WRITE(6,11)JZ0 FN 03650
WRITE(6,12)JZ0 FN 03700
GO TO (100,200,300),CWHYTC FN 03750
100 WRITE(6,125) HOLL1 FN 03800
GO TO 99 FN 03850
200 WRITE(6,125) HOLL2 FN 03900
GO TO 99 FN 03950
300 WRITE(6,125) HOLL3 FN 04000
99 WRITE(6,13) FN 04050
WRITE(6,14)K1,R1 FN 04100
WRITE(6,15)J2,B3 FN 04150
WRITE(6,16)A1,A2 FN 04200
WRITE(6,17)VM,MW FN 04250
WRITE(6,18)KK FN 04300
RETURN FN 04350
END FN 04400

```

LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 5

```

8 ELT FIGHT/SIFE+1.740223+ 48214
8 EOF 8
SUBROUTINE FIGHT
INCLUDE MISC+LIST
IF (ACHNOC) 17.01A240
OV1=CZP/MRO
OV2=B+1
OV3=A/10
OV4=CZP
CFM=CNHAFD-P1+CZP
OV5=CFM
CNHAFD=CN+4FC+CNHNO3-EZ+CZP
XNH3=V+CNH3
CHFLUS=CA+NL+KA/CNH2
FHE=ALOG10(C+FLUS)
OV6=FH
OV7=CNH3
CALL YNH3D
OV8=YNH3
RETURN
END

```

```

F2 00100
F1 01200
F1 00300
F1 00400
F1 00500
F1 00600
F1 00700
F1 00800
F2 00900
F1 01000
F1 01100
F2 01200
F1 01300
F1 01400
F1 01500
F1 01600
F1 01700
F1 01800
F1 01900

```

```

8 ELT AMHON/SIFE+1.740223+ 48220
8 EOF 8
SUBROUTINE AMHON TO CALCULATE INITIAL AMMONIA CONCENTRATION
INCLUDE MISC+LIST
EQUVALENCE (CNH3C,CNH3O), (CZPD,CZRO), (CNHAFD,CNHAFD)
CNH3C=CN+CNH
GO TO (1,2,3), CNH3C
1 ALPHA=CNHAFD+CNHNO3+CNH3O
X=ALPHA
KK=KV/K3
2 FOFX=CNHNO3-CNACH+CNH2O
FOFX=FOFX+KA*(CNHAFD-B1+CZPD)/(KA+KV/K3+(ALPHA-X)/X)
X2=X**2/(1+ALPHA-KK-FOFX/KB1+X*FFCFX+2*(ALPHA-KK-ALPHA**2)-KK*ALP
1KA**2
X2=X2**(.1/.3)
IF (IABS(X)-ABS(X2)) .LE. S*ALL) GO TO 3
X=.333*X+.666*X2
CNH3C=X2
GO TO 4
3 W=CNH3C+CNHAFD+CNHNO3
W2=1/(1+KV/(KB+CNH3C))
W2=X2*(KB+CNH3C)/W+KA*(CNHAFD-B1+CZPD)/(KA+KV/KB+W/CNH3C)
IF (IABS(W)-ABS(W2)) .LE. S*ALL) GO TO 5
W=.333*W+.666*W2
GO TO 6
5 IF (CNH3C-OT) .GT. .005) GO TO 7
CNH3C=W2-CNHAFD-CNHNO3+72
7 CHFLSO=KV/K3+W2/X2
CFFREE=KA*(CNHAFD-B1+CZPD)/(KA+KV+W2/(KB+X2))
CNH3C=W2
CNH3C=X2
RETURN
2 CHFLSO=EXF(1-FH)
X2=KV/CHFLSO*(CNHAFD-B1+CZPD)/(1+CHFLSO*KA)
X2=X2-CHFLSO-CNHN03
X2=X2+KV/K3/CHFLSO
W2=KB/KV*X2+CHFLSO
GO TO 5
END

```

```

AM 00100
AM 00200
AM 00300
AM 00400
AM 00500
AM 00600
AM 00700
AM 00800
AM 00900
AM 01000
AM 01100
AM 01200
AM 01300
AM 01400
AM 01500
AM 01600
AM 01700
AM 01800
AM 01900

```

```

8 ELT DES+1.740223+ 48221
8 EOF 8
SUBROUTINE DES (NUM,IND,NTEST)
CALL CEDIS(NUM,IND,NTEST,1)
RETURN
END

```

```

CEDIS001
CEDIS002
CEDIS003
CEDIS004

```

```

8 ELT DEI+1.740223+ 48222
8 EOF 8
SUBROUTINE DEI(NUM,IND,NTEST)
CALL CEDIS(NUM,IND,NTEST,2)
RETURN
END

```

```

CEDIS005
CEDIS006
CEDIS007
CEDIS008

```

```

8 ELT DED+1.740223+ 48223
8 EOF 8
SUBROUTINE DED(NAPG)
I=3
CALL DEDIS(NUM,IND,NTEST,3)
NARG=0
IF (I.GT.3) NARG=1
RETURN
END

```

```

DEDIS009
DEDIS010
DEDIS011
DEDIS012
DEDIS013
DEDIS014
DEDIS015

```


LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 6

[illegible]

LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 7

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      TSXJCS=2
      DO 70 999
12  IF (ALPHA-1) SEC=901.902
907  DO 905 I=1,N
905  T(N2-I)=T(N11-I)
      DO 70 2212
901  DO 904 I=1,N
904  T(N1-I)=T(N11-I)
      GO TO 2212
900  DO 903 I=1,N
      T(N4-I)=T(N11-I)
      T(N5-I)=T(N12-I)
903  T(N6-I)=T(N10-I)
2212  ALPHA=ALPHA+1
23  PKA17(I)=T(N12)/2.
      PKA17(3)=PKA17(1)
      NFAS=3
      DO 70 7023
3000  GO TO (2F,3+24*NOCB,6) , TSXJCS
26  DO 3005 I=1,N
3026  T(N10-I)=0.
      ALPHA=0
      P=0
      IT(INTEST)=1
      RETURN
3  ENF1=0.
      DO 3003 I=1,N
      D(1)=T(N3-I)
      D(2)=T(N10-I)
      TEMP=T(N12)+((1./24.)*T(N3-I)-(5./24.)*T(N2-I)+(19./24.)*T(N1-I)-
13./8.)*T(N11-I)
      OF=OF+TEMP
      T(N10-I)=D(2)
      T(N12-I)=D(1)
3003  ENF1=MAX1(ENF1,(ABS(T(N3-I)-T(N12-I))/MAX1(4.495*(T(N12-I))))
9  IF (4.*OT,SW2) GO TO 5
      IF (ESAS-ENF1) 9017,9017,9013
9017  IF (4.*OT,DECRH) GO TO 7
      IF (ABS(T(N12)),LT,MHNGE) GO TO 14
7  TEMP=T(N12)
      T(N12)=T(N12)+EETA
      IF (ALPHA,EL,3) GO TO 8
      T(N12-I)=T(N12+1)-TEMP
      DO 3008 I=1,N
      T(N11-I)=T(N1-I)
      T(N12-I)=T(N3-I)
3008  T(N10-I)=T(N7-I)
9008  DO 9009 I=1,N
9009  T(N10-I)=T(N10-I)+T(N10-I)
6008  ALPHA=0
      R=0
C  IF P-C MODE CHECK IF INTEGRATION IS GOOD POINT
6  IF (IABS(JND),NE,C) GO TO 31
C  INC=C P-C MODE
      IF (ALPHA,NE,C) GO TO 30
C  ALPHA = 0
      IF (ABS(T(N12)),GT,MINT) GO TO 31
C  M DECREASED
      GO TO 900
C  ALPHA NOT 0

30  IF (ALPHA,LE,3) GO TO 2000
C  SUCCESS FROM C.E. ALPHA GREATER THAN 3 FOR P-C MODE
31  TFROM = 0
      RETURN
9013  IF (ESAPCM-ENF1) 14,14,9018
9018  IF (4.*CT,INCRH) GO TO 15
9  IF (ABS(T(N12)),GT,MHAXT) GO TO 5
15  R=R+1
      IF (R,LT,3) GO TO 5
10  T(N12)=T(N12)/BETA
      TSXJCS=4
      GO TO 999
14  R=0
5  DO 3005 I=1,N
      T(N4-I)=T(N1-I)
      T(N5-I)=T(N7-I)
3005  T(N2-I)=T(N1-I)
      ALPHA=ALPHA+1
      TSXJCS=5
999  IT(INTEST)=0
      RETURN
24  IF (NFAS,EL,4) GO TO 6
      NFAS=NFAS+1
7023  DO 9023 I=1,N
      T(N9-I)=PKA1(NFAS)+T(N4-I)+T(N12)+T(N11-I)
      TEMP=T(N9-I)/PKA1(NFAS)+PKA1(NFAS)+T(N10-I)
      IF (TEMP) 9014,3023,9014

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LISTING AND SUBROUTINE COMPILATION: ZIRKOV P. 8

9014 JTEMP=IACD/TC1000	DEDS201
IF (T(N12-1)) 9015,9023,9019	DEDS202
9015 JTEMP=IACD/TC1000	DEDS203
JTEMP=(JTEMP/TC1000)-IACD/JTEMP	DEDS204
IF (JTEMP) 9023,9023,9015	DEDS205
9016 IF (JTEMP-27) 9019, 9019, 9020	DEDS206
9020 JTEMP = 0.	DEDS207
GO TO 9023	DEDS208
9019 JTEMP = 2.*JTEMP	DEDS209
IACD=IACD/2JTEMP	DEDS210
IACD=JTEMP*IACD	DEDS211
9023 T(N12-1)=T(N12-1)+JTEMP	DEDS212
9023 T(N12-1)=T(N12-1)+PKA16.NPASSI+JTEMP*PKA19.NPASSI+T(N12-1)*KA15.NPASSI	DEDS213
ISS)	DEDS214
T(N12+1)=T(N12+1)+PKA17.NPASSI	DEDS215
TSXJCS=3	DEDS216
GO TO 999	DEDS217
8 T(N12+1)=T(N12+1)-4.*JTEMP	DEDS218
DO 1003 I=1,N	DEDS219
T(N11-1)=T(N11-1)	DEDS220
T(N12-1)=T(N12-1)	DEDS221
1003 T(N10-1)=T(N10-1)	DEDS222
GO TO 6003	DEDS223
32 ERROR = EPRN1	DEDS224
GO TO 37	DEDS225
33 ERROR = EPRN2	DEDS226
GO TO 37	DEDS227
34 ERROR = EPRN3	DEDS228
GO TO 37	DEDS229
35 ERROR = ERRE	DEDS230
GO TO 37	DEDS231
36 ERROR = EPR1	DEDS232
37 WRITE(6,8000) ERROR	DEDS233
CALL EXIT	DEDS234
8000 FORMAT(51HDIFFERENTIAL EQUATION SUBROUTINE DES INPUT ERROR	DEDS235
END	DEDS236
06230279 CUB928FUN003 200 7746 57 669 1259132228 1 C00C0	G S

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