A User's Manual for the BNW-II Optimization Code for Dry/Wet-Cooled Power Plants

May 1978

Prepared for the U.S. Department of Energy
under Contract No. EY-76-C-06-1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by

Battelle
Memorial Institute

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

The views, opinions and conclusions contained in this report are those of the contractor and do not necessarily represent those of the United States Government or the United States Department of Energy.

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
Under Contract EY-76-C-06-1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy \$____; Microfiche \$3.00

*Pages	NTIS Selling Price
001-025	\$4.00
026-050	\$4.50
051-075	\$5.25
076-100	\$6.00
101-125	\$6.50
126-150	\$7.25
151-175	\$8.00
176-200	\$9.00
201-225	\$9.25
226-250	\$9.50
251-275	\$10.75
276-300	\$11.00

3 3679 00049 3173

A USER'S MANUAL FOR THE
BNW-II OPTIMIZATION CODE
FOR DRY/WET-COOLED POWER PLANTS

VOLUME II

Daniel J. Braun
Judith A. Bamberger
David J. Braun
Duane W. Faletti
Lawrence E. Wiles

May 1978

Prepared for the U.S. Department of Energy
under Contract No. EY-76-C-06-1830

Pacific Northwest Laboratory
Richland, Washington 99352

6

.

.

.

.

.

.

PREFACE

This document has been issued in two volumes to facilitate handling. Volume I is a narrative description of the code's algorithms, as well as logic, input and output information. Volume II is an appendix of Volume I, providing a listing of the BNW-II dry/wet ammonia heat rejection optimization code.

APPENDIX I

BNW-II COMPUTER CODE LISTING

APPENDIX I
BNW-II COMPUTER CODE LISTING

Figure I.1 is a subroutine linkage chart indicating which subroutines may call or may be called by others. This chart should be of assistance in using the listing making up the remainder of this appendix.

- • INDICATES CALLING PROGRAM
- INDICATES CALLED PROGRAM

FIGURE I.1. Dry/Wet Ammonia (NH_3) Model Subroutine Linkages

```

PROGRAM AMCIRC (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)      BNM18      2
C                                                                BNM18      3
C      PROGRAM AMCIRC IS A PROGRAM WHICH DETERMINES THE OPTIMUM  BNM18      4
C      DESIGN OF A WET/DRY COOLED POWER PLANT WITH AMMONIA AS THE  BNM18      5
C      INTERMEDIATE FLUID. THE OPTIMUM DESIGN IS DETERMINED BY    BNM18      6
C      REPEATING THE DESIGN OF THE COOLING SYSTEM OVER A RANGE    BNM18      7
C      OF DESIGN CONDITIONS INORDER TO FIND THE COOLING SYSTEM    BNM18      8
C      WITH THE SMALLEST INCREMENTAL COST. THIS IS ACCOMPLISHED   BNM18      9
C      BY VARYING FIVE PARAMETERS OF THE PLANT AND COOLING SYSTEM  BNM18     10
C      OVER RANGES OF VALUES. THESE PARAMETERS ARE VARIED       BNM18     11
C      SYSTEMATICALLY ACCORDING TO TECHNIQUES THAT PERFORM PATTERN BNM18     12
C      AND GRADIENT SEARCHES.                                     BNM18     13
C      THE DRY COOLING SYSTEM OPTIMIZED BY PROGRAM AMCIRC IS      BNM18     14
C      COMPOSED OF A CONDENSER/REBOILER (CONDENSATION OF STEAM    BNM18     15
C      AND BOILING OF AMMONIA), PIPING SYSTEM (TRANSPORTS AMMONIA BNM18     16
C      VAPOR OUT AND AMMONIA LIQUID FROM THE WET/DRY COOLING      BNM18     17
C      TOWERS), AND POLYGONAL SHAPED TOWER SYSTEM (HORIZONTAL     BNM18     18
C      ONE-PASS HOTERV HEAT EXCHANGERS FORMING THE LENGTH OF THE  BNM18     19
C      SIDES OF THE TOWERS WITH COCURRENT AMMONIA FLOW IN THE TUBES BNM18     20
C      OF THE HEAT EXCHANGER                                     BNM18     21
C                                                                BNM18     22
C      DIMENSION PCST(16)                                         BIGCOM      2
C      LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG             BIGCOM      3
C      COMMON                                                      BIGCOM      4
C      $ AFT, ALPHA, ANG(3)                                       BIGCOM      5
C      $ ,BPLIM(16)                                               BIGCOM      6
C      $ ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF BIGCOM      7
C      $ ,CRJ, CTURB, CDANG, CLUVR, CHAHS, CVM                  BIGCOM      8
C      $ ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF              BIGCOM      9
C      $ ,EFFP, EFS                                              BIGCOM     10
C      $ ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG BIGCOM     11
C      $ ,FIXV,FXTTD,FXTVAR,FXTTD,FXTLNG                         BIGCOM     12
C      $ ,GREFF                                                  BIGCOM     13
C      $ ,HXNP,HPCST,HCD                                         BIGCOM     14
C      $ ,ITMAX, ITMIN                                           BIGCOM     15
C      $ ,JCONS                                                  BIGCOM     16
C      $ ,KCONV, KALEXT                                          BIGCOM     17
C      $ ,MXEXT                                                  BIGCOM     18
C      $ ,NTA,NSIDES,NBUNHI                                      BIGCOM     19
C      COMMON                                                      BIGCOM     20
C      $ ODR                                                      BIGCOM     21
C      $ ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL               BIGCOM     22
C      $ ,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL BIGCOM     23
C      $ ,PBP,REDUCE, REDUCV, ROOFL, RHOUT                       BIGCOM     24
C      $ ,QREJ, QREDUCE, QREDUCV                                 BIGCOM     25
C      $ ,SIGMAG, SAAF, SEGL                                      BIGCOM     26
C      $ ,TD, TPO(4), TEFF, TLIM, THFIN, TLPA, TFIX            BIGCOM     27
C      $ ,TCD, TW                                                BIGCOM     28
C      $ ,UCS, UWS                                               BIGCOM     29
C      $ ,WFW, WATCONA, WATCOST                                  BIGCOM     30
C      $ ,VAS(5)                                                  BIGCOM     31
C      $ ,XDEPA, XW, XD                                          SINK        2
C      COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1, SINK        3
C      $ ,GIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPOW1, SINK        4
C      $ ,FPW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41, SINK        5
C      $ ,REWA1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPRP, SW41, SW31, SINK        6
C      $ ,SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN, SINK        7
C      $ ,BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1

```

```

$ , TL41, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITC1, CSC1, CEPRE1, DEPIP1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFE1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTRF1, STRUC1, CFMPF1, HPPF1, TOTCF1, TP1, EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMT01, CTOWD1 SINK 14
$ , SQRJ1, SQRJS1, ATUBC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTD1 SINK 15
$ , CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPC1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCWD1(16), DEPER1(16), DEPERQ1(16) SINK 17
$ , WBR1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51 SINK 18
COMMON /SCALER/ HRFAC1, ATUB, CPERA, SSCD, PLANC1, CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WLRT1, PLANCT1 SCALER 3
COMMON /SUPPLY/ VAL(5), CPLN, CP1P, CCOS, W3, COSM, EFF, SUPPLY 2
$ QIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW, SUPPLY 3
$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4, SUPPLY 4
$ RFWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3, SUPPLY 5
$ SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2, SUPPLY 6
$ RP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTSX, VELOX SUPPLY 7
$ , TLAX, UCON, PMCS1, FMCS1, FBACC, EFFC, CH, CA, CS SUPPLY 8
$ , CLTC, CFC, CPCC, FITC, CSC, CEPRE, DELPIP, AST, OLDCS1 SUPPLY 9
$ , CAPCS1, XNFAN, BLDANG, CPLEN, DPFE1, WHX, WTTUB, ADIA, ABLN SUPPLY 10
$ , WTHDR, WTRFM, STRUCC, CFPERF, HPPERF, TOTCF, TPC, EFFIN, ANTU SUPPLY 11
$ , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP SUPPLY 12
$ , ACTRPD, ADJRPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY 13
$ , CSRD, WATERW, WSTRCT, CFOUN, HUBDIA, TOWLEN, NUMTOW, CTOWD SUPPLY 14
$ , SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCTD SUPPLY 15
$ , CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST SUPPLY 16
$ , PWD(16), WATCWD(16), DEPER(16), DEPERQ(16) SUPPLY 17
$ , WBR, HTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5 SUPPLY 18
COMMON /VARVAR/ TPER(16), TA(16), TAWB(16) BNW18 27
COMMON /INDIS/ DIST BNW18 28
COMMON /TIME/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY BNW18 29
81 FORMAT(11TD USED IN THE FOLLOWING CALCULATIONS IS ="F8.3) BNW18 30
930 FORMAT(102, "AMBIENT TURBINE", T28, "HEAT", T83, "COST TO", BNW18 31
$ T93, "POWER COST", T105, "PCT TIME", T115, "PORTION OF") BNW18 32
931 FORMAT(104, "TEMP", T10, "OUTLET", T20, "BACK", T28, "RATE", T50, "HX" BNW18 33
$ , T57, "HX", T64, "POWER", T72, "CHANGE IN", T83, "REPLACE", BNW18 34
$ , T93, "AT AMBIENT", T104, "AT AMBIENT", T115, "INCREMENTAL") BNW18 35
932 FORMAT(111, "TEMP", T18, "PRESSURE", T27, "FACTOR", T35, "RANGE" BNW18 36
$ , T42, "TTDP", T49, "LMTD", T57, "ITD", T62, "GENERATED" BNW18 37
$ , T72, "FUEL COST", T83, "LOST CAP", T95, "TEMP", T106, "TEMP" BNW18 38
$ , T115, "POWER COST") BNW18 39
933 FORMAT( T02, 131(" -"), T9, " ", T17, " ", T26, " ", T33, " ", T40, " " BNW18 40
$ , T47, " ", T54, " ", T61, " ", T71, " ", T81, " ", T92, " ", T103, " " BNW18 41
$ , T114, " ") BNW18 42
934 FORMAT( T03, "DEG F", T11, "DEG F", T19, "IN, HG", T35, "DEG F" BNW18 43
$ , T41, "DEG F", T48, "DEG F", T56, "DEG F", T62, "MEGAWATTS" BNW18 44
$ , T72, "MILLS/KWH", T82, "MILLS/KWH", T93, "MILLS/KWH" BNW18 45
$ , T106, "PERCENT", T115, "MILLS/KWH") BNW18 46
944 FORMAT(110, T91, "FINAL INCREMENTAL COST", G11, 5) BNW18 47
945 FORMAT(110, T96, "CAPACITY CHARGE $", G15, 9) BNW18 48
946 FORMAT(110, T2, "PERCENT OF", T13, "PERCENT OF", /, T2, "HX DELUGED", T13, BNW18 49
1 "HEAT REJECT", /, T13, "BY WET HX", T26, "WATER EVAPORATED") BNW18 50
947 FORMAT(12, 42(" -"), T11, " ", T24, " ") BNW18 51
948 FORMAT(126, "ACRE FEET") BNW18 52
949 FORMAT(12, F10, 4, T13, F10, 4, T26, F10, 4) BNW18 53

```


	FIRST=.TRUE.	BNW18	54
	FRST = .TRUE.	BNW18	55
C		BNW18	56
C	READ IN THE EXTERNALLY FIXED VARIABLES OF THE AMMONIA	BNW18	57
C	DRY COLING TOWER SYSTEM AND THE INITIAL STARTING POINT FOR	BNW18	58
C	THE OPTIMIZATION ROUTINE A DESCRIPTION OF THE INPUT CARDS	BNW18	59
C	IS GIVEN IN SUBROUTINE SETUP	BNW18	60
C		BNW18	61
C	CALL SETUP(TSTAR,TEND)	BNW18	62
C		BNW18	63
C	INPUT SUMMARY AND CASE DESCRIPTION	BNW18	64
C		BNW18	65
	CALL INPSUM	BNW18	66
	DO 7 IS=1,5	BNW18	67
7	VAR(IS)=0.0	BNW18	68
	TD=TSTAR	BNW18	69
1	WRITE(6,81)TD	BNW18	70
	K=4	BNW18	71
C		BNW18	72
C	SCALE UP THE STEAM SUPPLY SYSTEM OF THE POWER PLANT BECAUSE	BNW18	73
C	OF OFF-RATING CONDITIONS	BNW18	74
C		BNW18	75
C	CALL SSCALE	BNW18	76
C		BNW18	77
	IF(FSHOT.EQ."CONSTANT ") GO TO 10	BNW18	78
	IF(FSHOT.NE."SKIP SHOT ") GO TO 4	BNW18	79
	CAF = 10.	BNW18	80
	TCOS = 1.E+37	BNW18	81
	TCOS1 = 1.E+37	BNW18	82
	DO 44 I = 1, 5	BNW18	83
	VAR(I) = VAS(I)	BNW18	84
	VAL(I) = VAS(I)	BNW18	85
44	CONTINUE	BNW18	86
	GO TO 22	BNW18	87
C		BNW18	88
C	COARSE PATTERN SEARCH FOR OPTIMUM POINT	BNW18	89
C		BNW18	90
4	CALL SHOT(1)	BNW18	91
C		BNW18	92
C	IF LOWEST COST COOLING SYSTEM HAS INCREMENTAL COST ABOVE	BNW18	93
C	ZERO GO TO 5 IF IT IS LESS THAN ZERO REDUCE FRONTAL AREA	BNW18	94
C	OF THE HEAT EXCHANGER BY 75 PERCENT	BNW18	95
C		BNW18	96
	IF(TCOS1.GT.0.0) GO TO 5	BNW18	97
	VAS(4)=VAS(4)/4.	BNW18	98
	GO TO 4	BNW18	99
5	L=0	BNW18	100
C		BNW18	101
C	EXTEND THE AREA OF INVESTIGATION FOR THE FIVE VARIABLES	BNW18	102
C	IN THE SEARCH FOR ANOTHER MINIMUM	BNW18	103
C		BNW18	104
	CALL XTEND(L)	BNW18	105
C		BNW18	106
C	IF A NEW MINIMUM HAS BEEN FOUND START WITH THE COARSE	BNW18	107
C	PATTERN SEARCH ONCE AGAIN	BNW18	108
C		BNW18	109
	IF(L.EQ.1) GO TO 4	BNW18	110

C		BNW18	111
C	FINE PATTERN SEARCH FOR OPTIMUM POINT	BNW18	112
C		BNW18	113
	CALL SHOT(2)	BNW18	114
	DO 21 I = 1, 5	BNW18	115
	VAL(I) = VAR(I)	BNW18	116
21	CONTINUE	BNW18	117
22	CALL CALC(VAL(1),VAL(2),VAL(3),VAL(4),VAL(5),1)	BNW18	118
	CALL STORE	BNW18	119
2	JCONS=0	BNW18	120
C		BNW18	121
C	GRADIENT SEARCH FOR OPTIMUM POINT	BNW18	122
C		BNW18	123
	CALL SERCH	BNW18	124
	COST1 = COST2	BNW18	125
	COST2 = TCOS1	BNW18	126
C		BNW18	127
C	IF SERCH HAS DETERMINED AN OPTIMUM GO TO 10 BUT IF IT	BNW18	128
C	HAS NOT FOUND AN OPTIMUM CALL SERCH AGAIN	BNW18	129
C		BNW18	130
	IF(JCONS .EQ. 0) GO TO 20	BNW18	131
	K=K+1	BNW18	132
	IF(K.GT.0) GO TO 2	BNW18	133
	IF(ABS(COST1 - COST2)/COST2 .LT. 0.00) GO TO 20	BNW18	134
	K = 1	BNW18	135
	GO TO 2	BNW18	136
10	CONTINUE	BNW18	137
	CALL CALC(FIX,FIXV,FIXTD,FIXL,DEEPL,1)	BNW18	138
	CALL STORE	BNW18	139
20	CONTINUE	BNW18	140
C		BNW18	141
C	PRINTOUT OF OPTIMUM DESIGN OF THE COOLING SYSTEM	BNW18	142
C		BNW18	143
	CALL OUT2(RBP,HRFAC1,SSCD,CASS1,PLANCT1,PLANC1,CTURB,TCO)	BNW18	144
	CALL OUT4(1)	BNW18	145
	CALL OUT4(2)	BNW18	146
	CALL RPTHXD	BNW18	147
	CALL RPTHXC(AFRO1)	BNW18	148
	CALL RPTDEL	BNW18	149
	CALL RPTSUP(DESVELV,NUMTO1,CTOWD1,WBB1,HTOW1,NTOWDE1)	BNW18	150
	CALL RPTRET(CTOWD1,POHCIR,PSTAC1,PUFIT1,PMPCS1,RPTPL1,	BNW18	151
5	SEPCS1,PIPCD1)	BNW18	152
	CALL RPRT2(EFFC1,CONMAT,CONMA2)	BNW18	153
	CALL RPTFAN	BNW18	154
	CALL ERRMSG(3)	BNW18	155
	WRITE(6,100)	BNW18	156
100	FORMAT(1H1)	BNW18	157
C		BNW18	158
C	PRINTOUT OF OPERATING PARAMETERS AND CONDITIONS OF THE	BNW18	159
C	PLANT VERSUS AMBIENT TEMPERATURE ALSO PRINTOUT OF INCRE-	BNW18	160
C	MENTAL POWER PRODUCTION COSTS ATTRIBUTED TO EACH AMBIENT	BNW18	161
C	TEMPERATURE AND THE TOTAL INCREMENTAL POWER PRODUCTION COSTS	BNW18	162
C		BNW18	163
	WRITE(6,930)	BNW18	164
	WRITE(6,931)	BNW18	165
	WRITE(6,932)	BNW18	166
	WRITE(6,933)	BNW18	167

PROGRAM AMCIRC 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

WRITE(6,934)	BNW18	168
WRITE(6,933)	BNW18	169
CLSJM=0.0	BNW18	170
FCSUM = 0.0	BNW18	171
DO 3 I=1,NTA	BNW18	172
3 CALL VARIT(TA(I),TPER(I),PCST(I),I,CLSJM,FCSUM)	BNW18	173
WRITE(6,946)	BNW18	174
WRITE(6,947)	BNW18	175
WRITE(6,948)	BNW18	176
WRITE(6,947)	BNW18	177
DO 9 I = 1,NTA	BNW18	178
WRITE(6,949) DEPER1(I)*100.,DEPERQ1(I)*100.,WATCHD1(I)/2719015.	BNW18	179
9 CONTINUE	BNW18	180
ACOS=0.0	BNW18	181
DO 8 I=1,NTA	BNW18	182
ACOS=ACOS+PCST(I)	BNW18	183
8 CONTINUE	BNW18	184
WRITE(6,944) ACOS	BNW18	185
WRITE(6,945) CAPCS1	BNW18	186
TD=TD * 5.	BNW18	187
FIRST = .TRUE.	BNW18	188
KALEXT = 0	BNW18	189
IF(TD.LE.TEND) GOTO 1	BNW18	190
6 CONTINUE	BNW18	191
C PRINTOUT OF THE CAPITAL AND UNIT ENERGY COSTS OF THE DRY	BNW18	192
C COOLING TOWER SYSTEM	BNW18	193
C	BNW18	194
CALL SUMCOS(FCR, PSIZE, CAPF, CCDS1, CPIP1, CONBA1, ATUBC1, CPLEN1	BNW18	195
\$,FBAC1, FMCS1, STRUC1, CFOUN1, CAPCS1, SPCD1, SSCD, HRFAC1	BNW18	196
\$,HFAZS, YFPMIN, PLANC, CLAN1, CLSUM, FCSUM, COSM1, CSTLV1	BNW18	197
\$,CSTHS1,CFANE1*XNFAN1/(YFPMIN+1.),CYLRN1*XNFAN1,WATCONA,WATCOST)	BNW18	198
CALL SUMMARY	BNW18	199
END	BNW18	200
	BNW18	201

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE CALC(T1,FVAIR,TTD,ELENH,ZD,M)

AMCALC 2

AMCALC 3

AMCALC 4

AMCALC 5

AMCALC 6

AMCALC 7

AMCALC 8

AMCALC 9

AMCALC 10

AMCALC 11

AMCALC 12

AMCALC 13

AMCALC 14

AMCALC 15

AMCALC 16

AMCALC 17

AMCALC 18

AMCALC 19

AMCALC 20

AMCALC 21

AMCALC 22

AMCALC 23

AMCALC 24

AMCALC 25

AMCALC 26

AMCALC 27

AMCALC 28

AMCALC 29

AMCALC 30

AMCALC 31

AMCALC 32

AMCALC 33

AMCALC 34

AMCALC 35

AMCALC 36

AMCALC 37

AMCALC 38

AMCALC 39

AMCALC 40

AMCALC 41

AMCALC 42

AMCALC 43

AMCALC 44

AMCALC 45

AMCALC 46

AMCALC 47

AMCALC 48

AMCALC 49

AMCALC 50

AMCALC 51

AMCALC 52

AMCALC 53

AMCALC 54

AMCALC 55

AMCALC 56

AMCALC 57

AMCALC 58

SUBROUTINE CALC IS USED FOR THE ANALYSIS OF THE AMMONIA WET/DRY COOLING SYSTEM. IN THIS SUBROUTINE THE CONDENSER/REBOILER, PIPING SYSTEM, HEAT EXCHANGER, TOWERS, AND DELUGE SYSTEM ARE DESIGNED. THE COSTS FOR ALL OF THESE SYSTEMS ARE FOUND ALONG WITH THE INCREMENTAL COST FOR OPERATING THE PLANT WITH THE DRY/WET COOLING SYSTEM OVER THE ENTIRE YEAR.

THE FOLLOWING FIVE VARIABLES ARE THE FIVE INDEPENDENT VARIABLES THAT ARE USED TO DESIGN THE AMMONIA COOLING SYSTEM.

T1 - TURBINE OUTLET TEMPERATURE (DEG F)
 TTD1 - TEMPERATURE DIFFERENCE BETWEEN THE OUTLET TEMPERATURE OF THE TURBINE AND THE TEMPERATURE OF THE AMMONIA IN THE CONDENSER/REBOILER (DEG F)
 FVAIR - VELOCITY OF THE AIR ENTERING THE HEAT EXCHANGER (FT/SEC)
 ELENH - LENGTH OF THE HEAT EXCHANGER TUBES (FT)
 ZD - HEAT EXCHANGER DEPTH IN NUMBER OF TUBES (DIMENSIONLESS)

DEFINITION OF VARIABLES

AAIR - AIRSIDE AREA OF THE HEAT EXCHANGER (SQ FT)
 AFC - ANNUAL COST OF THE FAN SYSTEM (\$/YEAR)
 AFRON - FRONTAL AREA OF THE HEAT EXCHANGER (SQ FT)
 ANTU - NUMBER OF TRANSFER UNITS IN THE HEAT EXCHANGER (DIMENSIONLESS)
 AHPS - AREA PER SHELL OF THE CONDENSER/REBOILER (SQ FT)
 ATUR - SURFACE AREA OF THE BARE TUBES OF THE HEAT EXCHANGER (SQ FT)
 CDANG - ANGLE OF THE HEAT EXCHANGER BUNDLES FROM THE CIRCUMFERENCE OF THE COOLING TOWERS (DEGREES)
 CONF - THERMAL CONDUCTIVITY OF THE FINS IN THE HEAT EXCHANGER (BTU/HR-FT-DEG F)
 CONL - THERMAL CONDUCTIVITY OF THE TUBE LINER (BTU/HR-FT-DEG F)
 CPA - SPECIFIC HEAT OF THE AIR (BTU/LBM-DEG F)
 CPIP - COST OF THE PIPING SYSTEM (\$)
 CPW - SPECIFIC HEAT OF THE AMMONIA (BTU/LBM-DEG F)
 CTOWD - DIAMETER OF CIRCULAR COOLING TOWERS (FT)
 DELPA - AIRSIDE PRESSURE DROP ACROSS THE HEAT EXCHANGER (LBF/SQ FT)
 DELPIP - PRESSURE DROP OF THE AMMONIA THROUGH THE SUPPLY AND RETURN PIPING (LBF/SQ FT)
 DELPR - PRESSURE DROP OF LIQUID FROM TOWERS TO TURBINE BUILDING (LBF/SQ FT)
 DELPS - PRESSURE DROP OF VAPOR FROM TURBINE BUILDING TO THE TOWERS (LBF/SQ FT)
 DELPW - PRESSURE DROP OF THE AMMONIA THROUGH THE WHOLE PIPING SYSTEM (LBF/SQ FT)
 DELPWC - PRESSURE DROP IN THE CONDENSER/REBOILER (LBF/SQ FT)
 DELPWT - PRESSURE DROP THROUGH THE TUBES OF THE HEAT EXCHANGER (LBF/SQ FT)

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	DENAV	- AVERAGE DENSITY OF THE AIR IN THE HEAT EXCHANGER	AMCALC	59
C		(LBF/SQ FT)	AMCALC	60
C	DENIN	- DENSITY OF THE AIR ENTERING THE HEAT EXCHANGER	AMCALC	61
C		(LBM/CU FT)	AMCALC	62
C	DENOUT	- DENSITY OF THE AIR LEAVING THE HEAT EXCHANGER	AMCALC	63
C		(LBM/CU FT)	AMCALC	64
C	DENSIF	- DENSITY OF THE AIR ENTERING THE HEAT EXCHANGER	AMCALC	65
C		(LBM/CU FT)	AMCALC	66
C	DENSIV	- DENSITY OF AMMONIA VAPOR (LBM/CU FT)	AMCALC	67
C	DENSIW	- DENSITY OF AMMONIA LIQUID (LBM/CU FT)	AMCALC	68
C	DEPTH	- DEPTH OF THE HEAT EXCHANGER (FT)	AMCALC	69
C	DESVEL	- DESIGN VELOCITY OF AMMONIA LIQUID (FT/SEC)	AMCALC	70
C	DESVELD	- DESIGN VELOCITY OF THE DELUGE WATER IN THE DELUGE	AMCALC	71
C		PIPING (FT/SEC)	AMCALC	72
C	DESVELV	- DESIGN VELOCITY OF AMMONIA VAPOR (FT/SEC)	AMCALC	73
C	DFIN	- FIN DIAMETER OF THE TUBES IN THE HEAT EXCHANGER	AMCALC	74
C		(IN)	AMCALC	75
C	DI	- INSIDE DIAMETER OF THE TUBES IN THE HEAT EXCHANGER	AMCALC	76
C		(IN)	AMCALC	77
C	DIST	- DISTANCE FROM TURBINE BUILDING TO COOLING TOWERS	AMCALC	78
C		(FT)	AMCALC	79
C	DPTINW	- AIRSIDE PRESSURE DROP ACROSS THE HEAT EXCHANGER	AMCALC	80
C		(IN H2O)	AMCALC	81
C	EFF	- EFFECTIVENESS OF THE HEAT EXCHANGER (DIMENSIONLESS)	AMCALC	82
C	EFFIN	- FIN EFFECTIVENESS OF THE TUBES IN THE HEAT	AMCALC	83
C		EXCHANGER (DIMENSIONLESS)	AMCALC	84
C	EFFP	- PUMP EFFICIENCY (DIMENSIONLESS)	AMCALC	85
C	EFFS	- OVERALL SURFACE EFFICIENCY OF THE FINNED TUBES	AMCALC	86
C		(DIMENSIONLESS)	AMCALC	87
C	ELENG	- LENGTH OF THE HEAT EXCHANGER TUBES (FT)	AMCALC	88
C	ELEV	- ELEVATION OF THE PLANT SITE (FT)	AMCALC	89
C	ENGTH	- LENGTH OF THE HEAT EXCHANGER TUBES (IN)	AMCALC	90
C	FACTORD	- RATIO OF THE AMOUNT OF DELUGE WATER PUT ON THE	AMCALC	91
C		HEAT EXCHANGER TO THE AMOUNT OF WATER EVAPORATED	AMCALC	92
C		(DIMENSIONLESS)	AMCALC	93
C	FAIR	- FRICTION FACTOR OF THE PRESSURE DROP THROUGH THE	AMCALC	94
C		HEAT EXCHANGER (DIMENSIONLESS)	AMCALC	95
C	GAIR	- MASS FLUX OF THE AIR IN THE HEAT EXCHANGER	AMCALC	96
C		(LBM/HR-SQ FT)	AMCALC	97
C	GWAT	- MASS FLUX OF THE AMMONIA ON THE INSIDE OF THE TUBES	AMCALC	98
C		IN THE HEAT EXCHANGER (LBM/HR-SQ FT)	AMCALC	99
C	HFG	- HEAT OF VAPORIZATION OF THE AMMONIA (BTU/LBM)	AMCALC	100
C	HGMAX	- AIRSIDE PRESSURE DROP OF THE HEAT EXCHANGER	AMCALC	101
C		AT THE REFERENCE TEMPERATURE OF 70 DEG F	AMCALC	102
C		(IN H2O)	AMCALC	103
C	HI	- INSIDE HEAT TRANSFER COEFFICIENT OF THE TUBES OF	AMCALC	104
C		THE HEAT EXCHANGER (BTU/HR-SQ FT-DEG F)	AMCALC	105
C	HO	- OUTSIDE HEAT TRANSFER COEFFICIENT OF THE HEAT	AMCALC	106
C		EXCHANGER (BTU/HR-SQ FT-DEG F)	AMCALC	107
C	HPWAT	- HORSEPOWER LOSS FOR THE TOTAL PIPING SYSTEM (HP)	AMCALC	108
C	HPWATD	- HORSEPOWER LOSS THROUGH THE DELUGE PIPING (HP)	AMCALC	109
C	HPWAT1	- HORSEPOWER LOSS THROUGH THE SUPPLY AND RETURN	AMCALC	110
C		PIPING AND THE TUBES OF THE HEAT EXCHANGER (HP)	AMCALC	111
C	HPWAT2	- HORSEPOWER LOSS THROUGH THE TUBING OF THE CON-	AMCALC	112
C		DENSER/REBOILER (HP)	AMCALC	113
C	HRFAC2	- HEAT RATE FACTOR OF THE TURBINE (DIMENSIONLESS)	AMCALC	114
C	HTOW	- HEIGHT OF THE COOLING TOWERS (FT)	AMCALC	115

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	HYDDIA	- HYDRAULIC DIAMETER OF THE TUBING ARRANGEMENT	AMCALC	116
C		(IN)	AMCALC	117
C	NHUNHI	- NUMBER OF HEAT EXCHANGER BUNDLES HIGH THE COOLING	AMCALC	118
C		TOWER ARE (DIMENSIONLESS)	AMCALC	119
C	NSIDES	- NUMBER OF SIDES THE POLYGONAL COOLING TOWERS HAVE	AMCALC	120
C		(DIMENSIONLESS)	AMCALC	121
C	NTA	- NUMBER OF TEMPERATURE INCREMENTS IN THE AMBIENT	AMCALC	122
C		TEMPERATURE RANGE OF THE PLANT SITE (DIMENSIONLESS)	AMCALC	123
C	NTOWDE	- NUMMR OF THE COOLING TOWERS THAT ARE DELUGED	AMCALC	124
C		(DIMENSIONLESS)	AMCALC	125
C	NUMTOW	- NUMBER OF CIRCULAR COOLING TOWERS	AMCALC	126
C		(DIMENSIONLESS)	AMCALC	127
C	NW	- NUMBER OF TUBES IN WIDTH OF THE HEAT EXCHANGER	AMCALC	128
C		(DIMENSIONLESS)	AMCALC	129
C	ODL	- OUTSIDE DIAMETER OF THE TUBE LINER (IN)	AMCALC	130
C	ODR	- ROOT DIAMETER OF FINNED TUBE IN THE HEAT EXCHANGER	AMCALC	131
C		(IN)	AMCALC	132
C	P	- BACK PRESSURE OF THE TURBINE (IN HGA)	AMCALC	133
C	PF	- FIN PITCH OF THE TUBES IN THE HEAT EXCHANGER (IN)	AMCALC	134
C	PIPCSTD	- COST OF THE PIPING USED TO DELUGE THE HEAT	AMCALC	135
C		EXCHANGER (\$)	AMCALC	136
C	PIPCSTL	- LIQUID PIPING COST (\$)	AMCALC	137
C	PIPCSTV	- VAPOR PIPING COST (\$)	AMCALC	138
C	PL	- LONGITUDINAL PITCH OF THE TUBES (IN)	AMCALC	139
C	PMPCST	- COST OF THE PUMPING SYSTEM (\$)	AMCALC	140
C	POHCIR	- INDIRECT COST FACTOR FOR THE CIRCULATION PIPING	AMCALC	141
C		(DIMENSIONLESS)	AMCALC	142
C	POHLEC	- INDIRECT COST FACTOR FOR THE ELECTRICAL SYSTEMS	AMCALC	143
C		(DIMENSIONLESS)	AMCALC	144
C	PPOW	- PUMP POWER (HP)	AMCALC	145
C	PPOWD	- PUMP POWER FOR THE DELUGE PIPING (HP)	AMCALC	146
C	PRW	- PRANDTL NUMBER OF THE AMMONIA (DIMENSIONLESS)	AMCALC	147
C	PSIZE	- SIZE OF THE PLANT (MGW)	AMCALC	148
C	PUFITC	- PUMP FITTING COSTS FOR THE THE AMMONIA SYSTEM	AMCALC	149
C		(1000 \$)	AMCALC	150
C	QIN	- HEAT INPUT TO THE PLANT (BTU/HR)	AMCALC	151
C	QREJ	- HEAT REJECTION TO THE ENVIRONMENT (BTU/HR)	AMCALC	152
C	RANGE	- TEMPERATURE DIFFERENCE OF THE AIR ENTERING AND	AMCALC	153
C		EXITING THE HEAT EXCHANGER (DEG F)	AMCALC	154
C	REAIR	- REYNOLDS NUMBER OF THE AIR IN THE HEAT EXCHANGER	AMCALC	155
C		(DIMENSIONLESS)	AMCALC	156
C	REWAT	- REYNOLDS NUMBER OF THE AMMONIA FLOW THROUGH THE	AMCALC	157
C		TUBES OF THE HEAT EXCHANGER (DIMENSIONLESS)	AMCALC	158
C	RPTPL	- PUMP MOTOR ELECTRICAL COST (\$)	AMCALC	159
C	SF	- SPACE BETWEEN THE FINS OF THE HEAT EXCHANGER (IN)	AMCALC	160
C	TAIRAV	- AVERAGE TEMPERATURE OF THE AIR IN THE HEAT	AMCALC	161
C		EXCHANGER (DEG F)	AMCALC	162
C	TCOS	- INCREMENTAL POWER PRODUCTION COST (\$/KWH)	AMCALC	163
C	TCWFCS	- TOTAL COST OF THE PIPING SYSTEM (\$)	AMCALC	164
C	TD	- AMBIENT DESIGN TEMPERATURE (DEG F)	AMCALC	165
C	TEFF	- THERMAL EFFECTIVENESS OF THE PLANT AT THE DESIGN	AMCALC	166
C		BACK PRESSURE (DIMENSIONLESS)	AMCALC	167
C	TEFFM	- THERMAL EFFECTIVENESS OF THE PLANT (DIMENSIONLESS)	AMCALC	168
C	THCONW	- THERMAL CONDUCTIVITY OF THE AMMONIA LIQUID	AMCALC	169
C		(BTU/HR-FT-DEG F)	AMCALC	170
C	THFIN	- THICKNESS OF THE FINS OF THE TUBES IN THE	AMCALC	171
C		HEAT EXCHANGER (IN)	AMCALC	172

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	TIN	- TEMPERATURE OF THE AMMONIA ENTERING THE SUPPLY	AMCALC	173
C		PIPING (DEG F)	AMCALC	174
C	TINHX	- TEMPERATURE OF AMMONIA ENTERING THE HEAT	AMCALC	175
C		EXCHANGER (DEG F)	AMCALC	176
C	TLA	- LENGTH OF THE TUBES IN THE CONDENSER/REBOILER (FT)	AMCALC	177
C	TTD1	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED	AMCALC	178
C		STEAM AND AMMONIA IN THE CONDENSER/REBOILER (DEG F)	AMCALC	179
C	TTD2	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	AMCALC	180
C		PIPING (DEG F)	AMCALC	181
C	TWATAV	- TEMPERATURE OF THE AMMONIA IN THE CONDENSER/	AMCALC	182
C		REBOILER (DEG F)	AMCALC	183
C	T4	- TEMPERATURE OF THE AIR EXITING THE HEAT EXCHANGER	AMCALC	184
C		(DEG F)	AMCALC	185
C	U	- OVERALL HEAT TRANSFER COEFFICIENT OF THE HEAT	AMCALC	186
C		EXCHANGER (BTU/HR-SQ FT-DEG F)	AMCALC	187
C	VAIR	- VELOCITY OF THE AIR IN THE HEAT EXCHANGER (FT/SEC)	AMCALC	188
C	VELD	- INLET VELOCITY OF THE AMMONIA ENTERING	AMCALC	189
C		THE CONDENSER/REBOILER (FT/SEC)	AMCALC	190
C	VELDD	- OUTLET VELOCITY OF THE AMMONIA LEAVING THE	AMCALC	191
C		CONDENSER/REBOILER (FT/SEC)	AMCALC	192
C	VISA	- VISCOSITY OF AIR IN THE HEAT EXCHANGER (LBM/FT-HR)	AMCALC	193
C	VISV	- VISCOSITY OF AMMONIA VAPOR (LBM/FT-HR)	AMCALC	194
C	VISW	- VISCOSITY OF THE AMMONIA (LBM/FT-HR)	AMCALC	195
C	VOL	- VOLUME OF THE HEAT EXCHANGER (CU FT)	AMCALC	196
C	VWAT	- VAPOR VELOCITY OF THE AMMONIA IN THE ENTRANCE OF	AMCALC	197
C		THE TUBES OF THE HEAT EXCHANGER (FT/SEC)	AMCALC	198
C	WATCONA	- AMOUNT OF WATER ALLOWED TO BE EVAPORATED OVER THE	AMCALC	199
C		WHOLE YEAR WHEN DELUGING THE HEAT EXCHANGER	AMCALC	200
C		(LBM/YEAR)	AMCALC	201
C	WR	- BUNDLE WIDTH OF HEAT EXCHANGER (FT)	AMCALC	202
C	WIDTH	- WIDTH OF THE HEAT EXCHANGER (FT)	AMCALC	203
C	WLRAT	- WIDTH LENGTH RATIO OF THE HEAT EXCHANGER (FT/FT)	AMCALC	204
C	W3	- MASS FLOW RATE OF THE AMMONIA (LBM/HR)	AMCALC	205
C	W4	- MASS FLOW RATE OF THE AIR (LBM/HR)	AMCALC	206
C	W5	- MAXIMUM AMOUNT OF WATER PUMPED THROUGH THE DELUGED	AMCALC	207
C		PIPING SYSTEM (GPM)	AMCALC	208
C	XD	- LONGITUDINAL PITCH OF THE TUBES IN THE HEAT	AMCALC	209
C		EXCHANGER (IN)	AMCALC	210
C	XDG	- DIAGONAL PITCH OF THE TUBES IN THE HEAT EXCHANGER	AMCALC	211
C		(IN)	AMCALC	212
C	XNP	- NUMBER OF PASSES IN THE CONDENSER/REBOILER	AMCALC	213
C		(DIMENSIONLESS)	AMCALC	214
C	XNS	- NUMBER OF SHELLS IN THE CONDENSER/REBOILER	AMCALC	215
C		(DIMENSIONLESS)	AMCALC	216
C	XNTS	- NUMBER OF TUBES PER SHELL (DIMENSIONLESS)	AMCALC	217
C	XQUALY	- EXIT QUALITY OF THE AMMONIA LEAVING THE	AMCALC	218
C		CONDENSER/REBOILER (DIMENSIONLESS)	AMCALC	219
C	XW	- TRANSVERSE PITCH OF THE TUBES (IN)	AMCALC	220
C	ZD	- TUBE DEPTH OF THE HEAT EXCHANGER (DIMENSIONLESS)	AMCALC	221
C			AMCALC	222
C	DEFINITION OF ARRAYS		AMCALC	223
C			AMCALC	224
C	ANG	- THE ANGLE OF THE HEAT EXCHANGER TUBES FROM THE	AMCALC	225
C		HORIZONTAL (DEG) AND THE SINE AND COSINE OF THAT	AMCALC	226
C		ANGLE (DIMENSIONLESS)	AMCALC	227
C	DEPER	- FRACTION OF THE HEAT EXCHANGER THAT IS DELUGED	AMCALC	228
C		FOR EACH AMBIENT TEMPERATURE INCREMENT	AMCALC	229

74/74 OPT=1

FTN 4,5+414

06/05/78 07,59.59

C		(DIMENSIONLESS)	AMCALC	230
C	TPER	- FRACTION OF THE YEAR THAT THE AMBIENT AND WET BULB	AMCALC	231
C		TEMPERATURE CURVES EXIST (DIMENSIONLESS)	AMCALC	232
C	TPO	- ARRAY OF COEFFICIENTS FOR THE CUBIC CURVE FIT	AMCALC	233
C		OF HEAT RATE AS A FUNCTION OF TURBINE BACK PRESSURE	AMCALC	234
C		(DIMENSIONLESS)	AMCALC	235
C	WATCWD	- WATER CONSUMPTION OF THE HEAT EXCHANGER OVER THE	AMCALC	236
C		WHOLE YEAR FOR EACH AMBIENT TEMPERATURE INCREMENT	AMCALC	237
C		(LBM/YEAR)	AMCALC	238
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG		BIGCOM	2
	COMMON		BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)		BIGCOM	4
	\$,BPLIM(16)		BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	6
	\$,CRJ, CTURB, CDANG, CLUVR, CHAILE, CVM		BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	8
	\$,EFFP, EFS		BIGCOM	9
	\$,FCO,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG		BIGCOM	10
	\$,FIXV,FXTTD,FXTVAR,FXTTDD,FXTLNG		BIGCOM	11
	\$,GREFF		BIGCOM	12
	\$,HXNP,HPCST,HCD		BIGCOM	13
	\$,ITMAX, ITMIN		BIGCOM	14
	\$,JCONS		BIGCOM	15
	\$,KCONV, KALEXT		BIGCOM	16
	\$,MXEXT		BIGCOM	17
	\$,NTA,NSIDES,NBUNHI		BIGCOM	18
	COMMON		BIGCOM	19
	\$ ODR		BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL		BIGCOM	21
	\$,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL		BIGCOM	22
	\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT		BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV		BIGCOM	24
	\$,SIGMAG, SAAF, SEGL		BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX		BIGCOM	26
	\$,TCD, TW		BIGCOM	27
	\$,UCS, UWS		BIGCOM	28
	\$,WFE, WATCONA, WATCOST		BIGCOM	29
	\$,VAS(5)		BIGCOM	30
	\$,XDEPA, XW, XD		BIGCOM	31
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY	2	
	\$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY	3	
	\$ FPOW, DELFC, WIDTH, LENG, VAIR, VWAT, HI, HC, T4,	SUPPLY	4	
	\$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,	SUPPLY	5	
	\$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY	6	
	\$ BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX	SUPPLY	7	
	\$, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY	8	
	\$, CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPPI, AST,OLDCST	SUPPLY	9	
	\$,CAPCST, XNFAN,BLDANG, CPLEN, DPFEI, WHX, WTTUB, ADIA, ABLN	SUPPLY	10	
	\$, WTHDR, WTFRM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY	11	
	\$, AJRF, WATF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY	12	
	\$, ACTRPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13	
	\$, CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14	
	\$,SQPJ,SQRJS,ATUBC,CRA,TTD1,TTD2,DELPS,CSTLVR,PIPCST	SUPPLY	15	
	\$,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY	16	
	\$,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)	SUPPLY	17	
	\$,WBR,MTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5	SUPPLY	18	
	COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,	SINK	2	

SUBROUTINE CALC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

$ QIN1, CLAN1, REAT1, Z1, HRFA2S, W41, U1, DEPW1, PPOW1, SINK 3
$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, M01, T41, SINK 4
$ REWA1, NW1, NT1, NP1, ZPLNC2, ZSI212, ZSPBP, SW41, SW31, SINK 5
$ SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SPS13, WT2MIN, SINK 6
$ BP2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBA1, XNTS1, VELD1 SINK 7
$ , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITCO1, CSC1, CEPRE1, DEPI1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFE1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTR1, STRUC1, CFMPF1, HPPF1, TOTCF1, TP1, EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMTO1, CTOWD1 SINK 14
$ , SQRJ1, SQRJ1, ATURC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTO1 SINK 15
$ , CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCWD1(16), DEPER1(16), DEPERO1(16) SINK 17
$ , WRB1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51 SINK 18
COMMON /SCALER/ HRFAC1, ATUB, CPERA, SSCD, PLANC1, CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WLRT1, PLANCT1 SCALER 3
COMMON /DJB/ DI, XDG, SF AMCALC 243
COMMON /INDIS/ DIST AMCALC 244
COMMON /LACALL/ SRN AMCALC 245
COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY AMCALC 246
COMMON /HEADEX/ CHH, CN, CHM, CMW, CRJ, CWJ, CST, CMO, CSR, CSM, PITCHF, CPM, AMCALC 247
1 PRESS, HEDMAT, HEDTYP, NPASS, WB, TSP, CSH, CSHP AMCALC 248
COMMON /SURFEX/ ODL, DUMLST(15) AMCALC 249
COMMON /HXD/ AI, ATOT, SFA, RFA, ACS AMCALC 250
LOGICAL LOOPER FANDEK 2
COMMON /FAN/ FANDAP(153,10), FANDAH(153,10), FMCPF, FBCPF, P2, R, S, FANDEK 3
$ VELREC, AFC, ELEV, EHR, LOOPER, CTMAX FANDEK 4
COMMON /PROP/ CPW, THCONW, DENSIW, VISW, HFG, AMCALC 252
* CPV, THCONV, DENSV, VISV, SIGMA, AMCALC 253
* CPA, THCONA, DENSA, VISA AMCALC 254
COMMON /VARVAR/ TPER(16), TA(16), TAWB(16) AMCALC 255
DATA PI/3.14159/, GC/32.0/ AMCALC 256
1002 FORMAT(5X, "AI, PF, SFA, EFA, RFA =", 5G12.6/5X, "ATOT, HXVOL, ART, AF, ACS = AMCALC 257
1", 5G12.6/5X, "AFT, ALPHA, SIGMAG =", 3G12.6/ AMCALC 258
KCONV=0 AMCALC 259
LOOPER = .FALSE. AMCALC 260
CTMAX = 0.0 AMCALC 261
IF (FXTLNG) ELENH = FIXL AMCALC 262
TTD1 = TTD AMCALC 263
WRB = WR AMCALC 264
COUNT = COUNT + 1.0 AMCALC 265
C AMCALC 266
C HEAT REJECTED BY THE TURBINE AMCALC 267
C AMCALC 268
C BACK PRESSURE OF TURBINE AS A FUNCTION OF THE SATURATION AMCALC 269
C TEMPERATURE AMCALC 270
P=EXP(17.168-9240./(T1+460.)) AMCALC 271
BP2=0 AMCALC 272
C AMCALC 273
C HEAT RATE FACTOR OF THE PLANT AT THE DESIGN BACK PRESSURE AMCALC 274
HRFAC2=TPO(1)+TPO(2)*P+TPO(3)*P**2+TPO(4)*P**3 AMCALC 275
C AMCALC 276
C EFFICIENCY OF THE PLANT AT THE DESIGN BACKPRESSURE AMCALC 277
TEFFM=TEFF/HRFAC2 AMCALC 278
C AMCALC 279

```

SUBROUTINE CALC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	HEAT PUT IN BY THE BOILER (BTU/HR)	AMCALC	280
C	QIN=3413.*PSIZE*1000./TEFFM	AMCALC	281
C	HEAT REJECTED TO THE ENVIRONMENT (BTU/HR)	AMCALC	282
C	QREJ=QIN*(1.*TEFFM)	AMCALC	283
C	SQRJ = QREJ	AMCALC	284
C		AMCALC	285
C	CALCULATION OF THE AMMONIA HEAT OF VAPORIZATION	AMCALC	286
C		AMCALC	287
C	TAIRAV = TD	AMCALC	288
C	TWATAV = T1 = TTD1	AMCALC	289
C	CALL PRPERT(TWATAV,TAIRAV,ELEV)	AMCALC	290
C	DENSIF = DENSIA	AMCALC	291
C	PRW = CPW*VISW/THCONW	AMCALC	292
C		AMCALC	293
C	MASS FLOW RATE OF AMMONIA THROUGH THE HEAT EXCHANGER	AMCALC	294
C		AMCALC	295
C	W3 = QREJ/HFG	AMCALC	296
C		AMCALC	297
C	*****UNIT GEOMETRIES OF THE HEAT EXCHANGER	AMCALC	298
C		AMCALC	299
C	INSIDE AREA PER FOOT (FT**2/FT)	AMCALC	300
C	AI = PI*DI*12.0/144.0	AMCALC	301
C		AMCALC	302
C	FIN PITCH (FINS/IN)	AMCALC	303
C	PF = 1.0/(SF + THFIN)	AMCALC	304
C		AMCALC	305
C	SIDE FIN AREA (FT**2/FT)	AMCALC	306
C	SFA = 2.0*PF*(XW*XD - PI*ODR**2/4.)/12.	AMCALC	307
C		AMCALC	308
C	ROOT FIN AREA (FT**2/FT)	AMCALC	309
C	RFA = PI*ODR*(1.00 - PF*THFIN)/12.0	AMCALC	310
C		AMCALC	311
C	TOTAL SURFACE AREA (FT**2/FT)	AMCALC	312
C	ATOT = SFA + RFA	AMCALC	313
C		AMCALC	314
C	HEAT EXCHANGER VOLUME (FT**2/FT)	AMCALC	315
C	HXVOL = XW*XD*1./144.	AMCALC	316
C		AMCALC	317
C	CROSS-SECTIONAL ROOT TUBE AREA (FT**2/FT)	AMCALC	318
C	ART = ODR/12.0	AMCALC	319
C		AMCALC	320
C	CROSS-SECTIONAL FIN TUBE AREA (FT**2/FT)	AMCALC	321
C	AF = PF*(XW - ODR)*THFIN/12.	AMCALC	322
C		AMCALC	323
C	CROSS-SECTIONAL AREA (FT**2/FT)	AMCALC	324
C	ACS = XW/12.0	AMCALC	325
C		AMCALC	326
C	AFTP = AIR SIDE FIN AREA/TOTAL AIR SIDE AREA	AMCALC	327
C	AFTF = SFA/(SFA + RFA)	AMCALC	328
C		AMCALC	329
C	ALPHA = AIR SIDE HEAT TRANSFER AREA/H. X. VOLUME	AMCALC	330
C	ALPHA = ATOT/HXVOL	AMCALC	331
C		AMCALC	332
C	SIGMAG = FREE FLOW AREA/FRONTAL AREA	AMCALC	333
C	SIGMAG = 1. - (ART + AF)/ACS	AMCALC	334
C		AMCALC	335
C		AMCALC	336

SUBROUTINE CALC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

      IF(KDEBUG.NE.0) WRITE(6,1002) AI, PF, SFA, EFA, REA, ATOT, HXVOL,
      $ ART, AF, ACS, AFTR, ALPHA, SIGMAG
      C
      C      DESIGN OF THE CONDENSER/REBOILER
      C
      CALL SPDES(T1,TTD1,XNS,XNP,QREJ,TLA,XQUALY,VELD,VELDO,ARPS,XNTS,
      1DELWC,LINOR)
      C
      C      CHECK IF NUMBER OF TUBES IN DEPTH IS TO BE HELD CONSTANT
      C
      IF(DEEPL.GT.0.00) ZD = DEEPL
      C
      C      GUESS THE TEMPERATURE DROP IN THE PIPING FROM THE
      C      CONDENSER/REBOILER TO THE HEAT EXCHANGER
      C
      TTD2 = 2.
      C
      C      *****
      C      *****BEGINNING OF ITERATION LOOP THAT DETERMINES THE HEAT *****
      C      *****EXCHANGER, TOWER, AND FAN CONFIGURATIONS *****
      C      *****
      160 CNW = QREJ/(FVAIR*3600.*DENSIF*ELENH*(XW/12.)*(T1 - TTD1 - TTD2 -
      1TD)*.9*CPA)
      KN1 = 0
      XNW1 = CNW
      C
      C      *****
      C      *****BEGINNING OF ITERATION LOOP FOR DETERMINING THE NUMBER *****
      C      *****OF HEAT EXCHANGER TUBES IN WIDTH *****
      C      *****
      170 RANGE = QREJ/(FVAIR*DENSIF*ELENH*CNW*XW*CPA*3600./12.)
      C
      C      EFFECTIVENESS OF THE HEAT EXCHANGER
      EFF = RANGE/(T1 - TTD1 - TTD2 - TD)
      IF(EFF.GE.1..OR.EFF.LE.0.0) GO TO 250
      TAIRAV = TD + RANGE/2.0
      TWATAV = T1 - TTD1 - TTD2
      CALL PRPERT(TWATAV,TAIRAV,ELEV)
      C
      C      NUMBER OF TRANSFER UNITS IN THE HEAT EXCHANGER
      ANTU = - ALOG(1.0 - EFF)
      C
      C      DEPTH OF THE HEAT EXCHANGER
      IF(ZD .EQ. 0) GO TO 250
      DEPTH = ZD*X0/12.0
      C
      C      LENGTH OF TUBES AND FRONTAL AREA OF THE HEAT EXCHANGER
      ELENG = ELENH
      ENGTN = ELENG*12.0
      WIDTH = CNW*XW/12.0
      WLRAT = WIDTH/ELENG
      AFRON = ELENG*WIDTH
      NW2 = CNW
      WT2 = WIDTH

```

AMCALC 337
 AMCALC 338
 AMCALC 339
 AMCALC 340
 AMCALC 341
 AMCALC 342
 AMCALC 343
 AMCALC 344
 AMCALC 345
 AMCALC 346
 AMCALC 347
 AMCALC 348
 AMCALC 349
 AMCALC 350
 AMCALC 351
 AMCALC 352
 AMCALC 353
 AMCALC 354
 AMCALC 355
 AMCALC 356
 AMCALC 357
 AMCALC 358
 AMCALC 359
 AMCALC 360
 AMCALC 361
 AMCALC 362
 AMCALC 363
 AMCALC 364
 AMCALC 365
 AMCALC 366
 AMCALC 367
 AMCALC 368
 AMCALC 369
 AMCALC 370
 AMCALC 371
 AMCALC 372
 AMCALC 373
 AMCALC 374
 AMCALC 375
 AMCALC 376
 AMCALC 377
 AMCALC 378
 AMCALC 379
 AMCALC 380
 AMCALC 381
 AMCALC 382
 AMCALC 383
 AMCALC 384
 AMCALC 385
 AMCALC 386
 AMCALC 387
 AMCALC 388
 AMCALC 389
 AMCALC 390
 AMCALC 391
 AMCALC 392
 AMCALC 393

C	AIR SIDE FRICTION FACTOR AND HEAT TRANSFER COEFFICIENT	AMCALC	394
C	OF THE HEAT EXCHANGER	AMCALC	395
C		AMCALC	396
C	MAXIMUM AIR VELOCITY AND TOTAL MASS FLOW THROUGH THE HEAT	AMCALC	397
C	EXCHANGER	AMCALC	398
	VAIR = FVAIR/SIGMAG	AMCALC	399
	W4 = FVAIR*AFR0N*DENSIF*3600.0	AMCALC	400
C		AMCALC	401
C	MAXIMUM MASS FLUX THROUGH THE HEAT EXCHANGER	AMCALC	402
	GAIR = VAIR*DENSIF*3600.0	AMCALC	403
C		AMCALC	404
C	AIRSIDE HEAT TRANSFER AND FRICTION FACTOR COEFFICIENTS	AMCALC	405
	REAI = GAIR*4.*SIGMAG/(ALPHA*VISA)	AMCALC	406
	CALL HOTERV(FAIR,H0,SIGMAG,ALPHA,XD,GAIR)	AMCALC	407
C		AMCALC	408
C	FIN EFFICIENCY OF THE FINNED TUBES OF THE HEAT EXCHANGER	AMCALC	409
	CALL FINEFF(H0,EFFIN)	AMCALC	410
C		AMCALC	411
C	OVERALL SURFACE EFFICIENCY OF THE FINNED TUBES OF THE	AMCALC	412
C	HEAT EXCHANGER	AMCALC	413
	EFS = 1.0 - AFTR*(1.0 - EFFIN)	AMCALC	414
C		AMCALC	415
C	*****	AMCALC	416
C	*****BEGINNING OF ITERATION LOOP THAT DETERMINES THE TUBE *****	AMCALC	417
C	*****DEPTH OF THE HEAT EXCHANGER *****	AMCALC	418
C	*****	AMCALC	419
C		AMCALC	420
	KN = 0	AMCALC	421
	ZD1 = 2.	AMCALC	422
C		AMCALC	423
C	MASS FLUX OF AMMONIA IN TUBES OF THE HEAT EXCHANGER	AMCALC	424
225	GWAT = W3/((ZD1/HXNP)*CNW*PI*DI*DI/(4.*144.))	AMCALC	425
C		AMCALC	426
C	VAPOR VELOCITY OF AMMONIA AT INLET OF THE TUBES OF THE	AMCALC	427
C	HEAT EXCHANGER	AMCALC	428
	VWAT = GWAT/(DENSIV*3600.)	AMCALC	429
C		AMCALC	430
C	INSIDE AMMONIA HEAT TRANSFER COEFFICIENT OF THE TUBES	AMCALC	431
C	OF THE HEAT EXCHANGER	AMCALC	432
	CALL HTCLO(DI,ENGTH,ANG,GWAT,1.,0.,PRW,DENSIW,DENSIV,VISW*.41338,	AMCALC	433
	1VTSV*.41338,THCONW,CPW,HI,HTC,HTB,HTN,HTK,REWAT)	AMCALC	434
C		AMCALC	435
C	OVERALL HEAT TRANSFER COEFFICIENT OF THE HEAT EXCHANGER	AMCALC	436
C		AMCALC	437
	REFF = ATOT/(2.0*PI)	AMCALC	438
	U = 1.0 / (1.0/(EFS*H0) +	AMCALC	439
	* REFF*ALOG(ODL/DI)/CONL *	AMCALC	440
	* ATOT/(AI*HI))	AMCALC	441
C		AMCALC	442
C	AIRSIDE AREA OF THE HEAT EXCHANGER	AMCALC	443
	AAIR = ANTU*CPA*W4/U	AMCALC	444
C		AMCALC	445
C	VOLUME OF THE HEAT EXCHANGER	AMCALC	446
	VOL = AAIR/ALPHA	AMCALC	447
C		AMCALC	448
C	TUBE DEPTH OF THE HEAT EXCHANGER	AMCALC	449
	DEPTH1 = VOL/AFR0N	AMCALC	450

	PZD = ZD1	AMCALC	451
	ZD1 = 12.0*DEPTH1/XD	AMCALC	452
C		AMCALC	453
C	CONVERGENCE CRITERIA OF THE TUBE DEPTH OF THE HEAT	AMCALC	454
C	EXCHANGER	AMCALC	455
C		AMCALC	456
	IF(ABS(ZD1 - PZD)/ZD1.LT..00001) GO TO 230	AMCALC	457
	KN = KN + 1	AMCALC	458
	IF(KN.GT.70) WRITE(6,1000) KN,PZD,ZD1,AFRON	AMCALC	459
1000	FORMAT(5X,"KN,PZD,ZD1,AFRON =",I3,3G12.6/	AMCALC	460
	IF(KN.GT.80) GO TO 250	AMCALC	461
	Z = ZD1	AMCALC	462
	GO TO 225	AMCALC	463
C		AMCALC	464
C	*****	AMCALC	465
C	*****END OF ITERATION LOOP FOR DETERMINING THE TUBE DEPTH OF *****	AMCALC	466
C	*****THE HEAT EXCHANGER *****	AMCALC	467
C	*****	AMCALC	468
C		AMCALC	469
C	SLOPE FINDING TECHNIQUE FOR FINDING THE WIDTH OF THE HEAT	AMCALC	470
C	EXCHANGER THAT MATCHES ITS DEPTH	AMCALC	471
230	IF(KN1.GE.1) GO TO 240	AMCALC	472
	YNW1 = ZD1	AMCALC	473
	XNW2 = CNW + 500.	AMCALC	474
	CNW = CNW + 500.	AMCALC	475
	KN1 = KN1 + 1	AMCALC	476
	GO TO 170	AMCALC	477
240	CONTINUE	AMCALC	478
	YNW2 = ZD1	AMCALC	479
	NW = XNW	AMCALC	480
	SLOPE = (YNW1 - YNW2)/(XNW1 - XNW2)	AMCALC	481
	BLOPE = (YNW2*XNW1 - XNW2*YNW1)/(XNW1 - XNW2)	AMCALC	482
	XNW = (ZD - BLOPE)/SLOPE	AMCALC	483
	IF(XNW.LE.0.00) XNW = XNW2 + 1000.0	AMCALC	484
	IF(XNW.LE.0.00) GO TO 320	AMCALC	485
	YNW1 = YNW2	AMCALC	486
	XNW1 = XNW2	AMCALC	487
	XNW2 = XNW	AMCALC	488
	CNW = XNW	AMCALC	489
C		AMCALC	490
C	CONVERGENCE CRITERIA FOR THE HEAT EXCHANGER WIDTH	AMCALC	491
C	(CONVERGENCE IS DONE BY COMPARING THE ACTUAL VERSUS THE	AMCALC	492
C	DESIRED TUBES IN DEPTH OF THE HEAT EXCHANGER FOR THE	AMCALC	493
C	CORRESPONDING HEAT EXCHANGER WIDTH)	AMCALC	494
	IF(ABS(ZD - ZD1).LT..001) GO TO 300	AMCALC	495
	KN1 = KN1 + 1	AMCALC	496
	IF(KN1.GT.70) WRITE(6,1030) KN1,NW,AFRON,WIDTH,ZD1,YNW2,YNW1,XNW2,	AMCALC	497
	1XNW1	AMCALC	498
1030	FORMAT(5X,"KN1,NW,AFRON,WIDTH =",I3,I12,7G12.6)	AMCALC	499
	IF(KN1.GT.80) GO TO 250	AMCALC	500
	GO TO 170	AMCALC	501
C		AMCALC	502
C	*****	AMCALC	503
C	*****END OF ITERATION LOOP FOR DETERMINING THE WIDTH OF THE *****	AMCALC	504
C	*****HEAT EXCHANGER *****	AMCALC	505
C	*****	AMCALC	506
C		AMCALC	507

SUBROUTINE CALC

T4/T4 OPT=1

FTN 4,5+414

06/05/78 07.59.59

250	KCONV = 1	AMCALC	508
	LVC = M	AMCALC	509
	GO TO 320	AMCALC	510
300	Z = ZD	AMCALC	511
C		AMCALC	512
C	AIR SIDE PRESSURE DROP ACROSS THE HEAT EXCHANGER	AMCALC	513
C		AMCALC	514
C	AVERAGE DENSITY OF THE AIR IN THE HEAT EXCHANGER	AMCALC	515
	T4 = TD + RANGE	AMCALC	516
	DENOUT = FLUID(7,2,T4,ELEV,"CALC4")	AMCALC	517
	DENIN = FLUID(7,2,TD,ELEV,"CALC 3")	AMCALC	518
	DENAV = (DENIN + DENOUT)/2.0	AMCALC	519
C		AMCALC	520
C	MAXIMUM VELOCITY IN THE HEAT EXCHANGER BASED ON THE	AMCALC	521
C	AVERAGE DENSITY OF THE AIR	AMCALC	522
	VAIR = GAIR/(3600.0*DENAV)	AMCALC	523
	AIRFF = FAIR	AMCALC	524
C		AMCALC	525
C	PRESSURE DROP ACROSS THE HEAT EXCHANGER	AMCALC	526
	DELPA = DENAV * FAIR * ZD * VAIR**2 / GC	AMCALC	527
	DPTINW = DELPA/5.2022	AMCALC	528
C		AMCALC	529
C	DESIGN OF THE FAN SYSTEM	AMCALC	530
C		AMCALC	531
	HGMAX = DPTINW*0.07495/DENOUT	AMCALC	532
	IF(HGMAX .GT. 1.35) GO TO 320	AMCALC	533
C		AMCALC	534
C	COST ANALYSIS OF THE HEAT EXCHANGER	AMCALC	535
	CALL COSTEX(AFRON,ATOT)	AMCALC	536
C		AMCALC	537
C	DESIGN OF THE LEAST COST FAN SYSTEM FOR THE ABOVE HEAT	AMCALC	538
C	EXCHANGER DETERMINATION OF THE NUMBER AND DIAMETER	AMCALC	539
C	OF THE TOWERS IS ALSO DONE	AMCALC	540
	CALL FAN(DPTINW,AFRON)	AMCALC	541
	IF(.NOT. LOOPER .AND. AFC .EQ. 5.E+8) CALL ERRMSG(1)	AMCALC	542
	IF(LOOPER) CALL ERRMSG(2)	AMCALC	543
	WBB=HTOW/NBUNHI	AMCALC	544
C		AMCALC	545
C	IF AFC IS GREATER THAN .49E+9 IT MEANS NO SUITABLE FAN	AMCALC	546
C	WAS FOUND BY SUBROUTINE FAN IF THIS EXISTS TCOS IS	AMCALC	547
C	SET EQUAL TO A HIGH VALUE INORDER TO THROW OUT THIS	AMCALC	548
C	POINT IN THE SEARCH FOR A MINIMUM	AMCALC	549
	IF(AFC.GT..49E+9) KCONV = 1	AMCALC	550
	IF(AFC .GT. .49E+9) GO TO 320	AMCALC	551
C		AMCALC	552
C	DESIGN OF THE SUPPLY PIPING SYSTEM	AMCALC	553
C		AMCALC	554
	TIN = T1 = TTD1	AMCALC	555
	XTOW = NUMTOW	AMCALC	556
	DENSIV = FLUID(7,1,TIN,ELEV,"CALC5")	AMCALC	557
	VISV = FLUID(8,1,TIN,ELEV,"CALC6")	AMCALC	558
	CALL PIPCLS(XTOW,CTOWD,W3,TIN,DIST,DESVELV,WBB,REDUCV,QREDUCV,	AMCALC	559
	POHCIR,NSIDES,HTOW,NBUNHI,ELENG,DELPS,PIPCSTV,TINHX)	AMCALC	560
C		AMCALC	561
C	CONVERGENCE CRITERIA ON THE TEMPERATURE DROP OF THE	AMCALC	562
C	SUPPLY PIPING	AMCALC	563
C		AMCALC	564

	TTD22 = T1 - TTD1 - TINHX	AMCALC	565
	TTD23 = TTD2	AMCALC	566
	TTD2 = TTD22	AMCALC	567
	IF(TINHX.LE.TD) KCONV = 1	AMCALC	568
	IF(TTD2.GT.20.) KCONV = 1	AMCALC	569
	IF(KCONV.EQ.1) RETURN	AMCALC	570
	IF(ABS(TTD23 - TTD22).LT..1) GO TO 310	AMCALC	571
	CALL PRPERT(TINHX,TAIRAV,ELEV)	AMCALC	572
	PRW = CPW*VISW/THCONW	AMCALC	573
	GO TO 160	AMCALC	574
C		AMCALC	575
C	*****	AMCALC	576
C	*****END OF ITERATION LOOP FOR DETERMINING THE HEAT EX- *****	AMCALC	577
C	*****CHANGER, TOWER, AND FAN CONFIGURATIONS *****	AMCALC	578
C	*****	AMCALC	579
C		AMCALC	580
C	310 CONTINUE	AMCALC	581
C		AMCALC	582
C	DESIGN OF THE RETURN PIPING SYSTEM	AMCALC	583
C		AMCALC	584
C	CALL PIPCLR(XTOW,CTOWD,W3,DIST,DESVEL,WBB,REDUCE,QREDUCE,POHCIR,	AMCALC	585
C	\$ NSIDES,HTOW,NRUNHI,ELENG,DELPR,PIPCSTL)	AMCALC	586
C		AMCALC	587
C	PRESSURE DROP OF THE AMMONIA THROUGH THE TUBES OF THE	AMCALC	588
C	HEAT EXCHANGER	AMCALC	589
C		AMCALC	590
C	CALL DPCON(GOSW,DI,ENGTH,ANG,GWAT,1.,0.,DENSIW,DENSIV,VISW,.41338,	AMCALC	591
C	\$VISW,.41338,DELPWT,DPF,DPG,DPM,XLM,PHIL,PHIL2,VF,WATFF,RL,RV)	AMCALC	592
C	DELPWT = DELPWT*144.	AMCALC	593
C		AMCALC	594
C	COST OF PUMPS TO CIRCULATE AMMONIA AROUND THE PIPING	AMCALC	595
C		AMCALC	596
C	CALL PUMPCST(W3, DELPS, DELPR, DELPWT, DELPWC, XQUALY, DESVEL,	AMCALC	597
C	\$ PUMPCST, PUFITC)	AMCALC	598
C	TCWFCS = PIPCSL + PIPCSTV + PUMPCST*POHCIR	AMCALC	599
C		AMCALC	600
C	HORSEPOWER DISSIPATED BY THE AMMONIA FLOWING THROUGH	AMCALC	601
C	THE SYSTEM	AMCALC	602
C		AMCALC	603
C	DELPWP = DELPS + DELPR	AMCALC	604
C	DELPW = DELPWT + DELPWC + DELPS + DELPP	AMCALC	605
C	HPWAT1 = (DELPWT + DELPS + DELPR)*W3/(DENSIW*3600.*550.)	AMCALC	606
C	HPWAT2 = DELPWC*W3/(DENSIW*XQUALY*3600.*550.)	AMCALC	607
C	HPWAT = HPWAT1 + HPWAT2	AMCALC	608
C		AMCALC	609
C	ELECTRICAL COST OF THE CIRCULATION PUMPS	AMCALC	610
C		AMCALC	611
C	CALL PUMLEC(POHLEC, HPWAT, DIST, EFPF, RPTPL)	AMCALC	612
C		AMCALC	613
C	PUMP POWER REQUIRED TO DRIVE THE AMMONIA THROUGH THE	AMCALC	614
C	SYSTEM	AMCALC	615
C		AMCALC	616
C	PPOW = HPWAT/(1.341*EFPF)	AMCALC	617
C	C=1./((365.*24.*3600.*550.))	AMCALC	618
C	C=5.7654E-11	AMCALC	619
C	HPWATD=C*HTOW*FACTORD*WATCONA	AMCALC	620
C	PPOWD=HPWATD/(1.341*EFPF)	AMCALC	621

LIBROUTINE CALC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	PPOW=PPOW*PPOWD	AMCALC	622
	ATUR = (1.0 - AFTR)*AAIR	AMCALC	623
C		AMCALC	624
C	COSTING OF THE PLANT, LAND, PIPING, AND CONDENSER/	AMCALC	625
C	REROILER	AMCALC	626
C		AMCALC	627
	CALL SCALP(T1,RANGE,AFR0N,WLRAT,TCWFCS,NUMTOW)	AMCALC	628
	DENSIV = FLUID(7,1,TIN,ELEV,"CALC 7")	AMCALC	629
C		AMCALC	630
C	DETERMINATION OF THE BACK PRESSURE CURVE THAT THE TURBINE	AMCALC	631
C	CAN OPERATE AT OVER THE AMBIENT TEMPERATURE RANGE WITH THE	AMCALC	632
C	AMOUNT OF WATER ALLOCATED FOR DELUGGING OF THE HEAT EXCHANGER	AMCALC	633
C		AMCALC	634
	CALL CONSUMP	AMCALC	635
	IF(KCONV,EQ.1) RETURN	AMCALC	636
C		AMCALC	637
C	CALCULATE THE NUMBER OF TOWERS THAT HAVE DELUGE PIPING AND	AMCALC	638
C	COST THE DELUGE PIPING	AMCALC	639
C		AMCALC	640
	NTOWDE = DEPER(1)*XTOW * .99999	AMCALC	641
	XTOWDE = NTOWDE	AMCALC	642
	WATMAX = 0.0	AMCALC	643
	DO 315 I = 1,NTA	AMCALC	644
	WATCONM = WATCWD(I)*FACTORD/(TPER(I)*8760.)	AMCALC	645
	IF(WATMAX,LT.WATCONM) WATMAX = WATCONM	AMCALC	646
315	CONTINUE	AMCALC	647
	W5 = WATMAX/(60.*62.2*.13368)	AMCALC	648
	EVAPMX=W5/FACTORD	AMCALC	649
	CALL DELUGE(XTOWDE,CTOWD,DESVELD,W5,W5/FACTORD,DIST,PIPCSTD)	AMCALC	650
	PIPCSTD = PIPSTD*POHCIR	AMCALC	651
	CPIP = CPIP * PIPSTD*1000.	AMCALC	652
C		AMCALC	653
C	INCREASED COST OF OPERATING THE PLANT WITH THE ABOVE	AMCALC	654
C	DESIGNED COOLING SYSTEM THROUGHOUT THE WHOLE YEAR	AMCALC	655
C		AMCALC	656
	CALL NOVART(TCOS,RANGE)	AMCALC	657
	LVC=M	AMCALC	658
320	CONTINUE	AMCALC	659
C		AMCALC	660
	RETURN	AMCALC	661
	END	AMCALC	662

	SUBROUTINE CHNGE(M)	CHNGE	2
C		CHNGE	3
C	THIS ROUTINE IS CALLED BY SUBROUTINE SERCH WHEN PRESSURE DROP RE-	CHNGE	4
C	STRICTION IS ENCOUNTERED. IT SEARCHES BY CHANGING A VARIABLE	CHNGE	5
C	OTHER THAN THAT SELECTED BY SUBROUTINE SERCH.	CHNGE	6
C		CHNGE	7
	DIMENSION DP(5),DV(5),VAJ(5)	CHNGE	8
	COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD,PLANC1,CASSS1,	SCALER	2
	\$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANC1	SCALER	3
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFR, ALPHA, ANG(3)	BIGCOM	4
	* ,BPLIM(16)	BIGCOM	5
	\$,CASF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	\$,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
	\$,DFYN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFFP, EFS	BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTOR,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FXTTID,FXTVAR,FXTTID,FXTLNG	BIGCOM	11
	\$,GBEFF	BIGCOM	12
	\$,HXNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14
	\$,JCONS	BIGCOM	15
	\$,KCONV, KALEXT	BIGCOM	16
	\$,MXEXT	BIGCOM	17
	\$,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	\$ ODR	BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	\$,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
	\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
	\$,SIGMAG, SAAF, SEGL	BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	\$,TCD, TW	BIGCOM	27
	\$,UCS, UWS	BIGCOM	28
	\$,WFW, WATCONA, WATCOST	BIGCOM	29
	\$,VAS(5)	BIGCOM	30
	\$,XDFPA, XW, XD	BIGCOM	31
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY	2
	\$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY	3
	\$ PPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,	SUPPLY	4
	\$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPRP, SW4, SW3,	SUPPLY	5
	\$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY	6
	\$ BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX	SUPPLY	7
	\$, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY	8
	\$, CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPPI, AST,OLDCST	SUPPLY	9
	\$,CAPCST, XNFAN,BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN	SUPPLY	10
	\$, WTHDR, WTFRM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY	11
	\$, ATFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY	12
	\$, ACTBPD, ADJRPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13
	\$, CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14
	\$,SQRJ,SQRJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCST	SUPPLY	15
	\$,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY	16
	\$,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)	SUPPLY	17
	\$,WRR,HTOW,NTOWDE,CSTIF,CSJ,CVF,COP,W5	SUPPLY	18
	COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,	SINK	2

```

$ QIN1, CLAN1, REA11, Z1, HRF2S, W41, U1, DEPW1, PPOW1, SINK 3
$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41, SINK 4
$ REWA1, NW1, NT1, NP1, ZPLNC2, ZS1Z12, ZSPBP, SW41, SW31, SINK 5
$ SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SPS13, WT2MIN, SINK 6
$ BD2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBA1, XNTS1, VELD1 SINK 7
$ , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITCO1, CSC1, CEPRE1, DEPI1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFE1, WH1, WYTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTRF1, STRUC1, CFMPF1, HPPF1, TOTCF1, TP1, EFFIN1, ANTU1 SINK 11
$ , AIDFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTBP1, ADJBP1, ACTVH1, ADJUH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSRI, WATER1, WSTRC1, CFOUND1, HUBDI1, TOWLE1, NUMTO1, CTOWD1 SINK 14
$ , SQRJ1, SQRSJ1, ATURC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTD1 SINK 15
$ , CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCWD1(16), DEPER1(16), DEPERQ1(16) SINK 17
$ , WBB1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51 SINK 18
COMMON /LACALL/SRN CHNGE 13
COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY CHNGE 14
IDB=0 CHNGE 15
L=0 CHNGE 16
K1=0 CHNGE 17
DO 1 I=1,3 CHNGE 18
1 DV(I)=.05 CHNGE 19
DV(2) = 0.20 CHNGE 20
DV(4) = 2.00 CHNGE 21
DV(5) = 1.0 CHNGE 22
DO 3 I=1,5 CHNGE 23
VAJ(I)=VAR(I) CHNGE 24
3 VAL(I)=VAR(I) CHNGE 25
4 VAL(M)=(1.+DV(M))*VAR(M) CHNGE 26
IF(FXTMP) VAL(1) = TFIX CHNGE 27
IF(FXTLNG) VAL(4) = FIXL CHNGE 28
IF(FXTVAR) VAL(2) = FIXV CHNGE 29
IF(FXTTDD) VAL(3) = FIXTDD CHNGE 30
IF(VAL(M).LE.0.0) GO TO 36 CHNGE 31
IF(M.GT.3) GO TO 10 CHNGE 32
IF(VAL(1).LE.0.0) GOTO 36 CHNGE 33
10 SRN="/CHNGE=1/ " CHNGE 34
CALL CALC(VAL(1),VAL(2),VAL(3),VAL(4),VAL(5),1) CHNGE 35
IF(KCONV.EQ.1) GO TO 36 CHNGE 36
PA=DELPA CHNGE 37
PA1=DEPA1 CHNGE 38
DP(M)=DELPA-DEPA1 CHNGE 39
IIC = 5 CHNGE 40
IF(FXTMP) IIC = 4 CHNGE 41
IIB = 1 CHNGE 42
IF(DEEPL.GT.0.00) IIB = 2 CHNGE 43
DO 35 II = IIB,IIC CHNGE 44
I=6-II CHNGE 45
IF(I.EQ.5.AND.DV(1).GT..005) GO TO 35 CHNGE 46
IF(I.EQ.4) GO TO 35 CHNGE 47
11 VAL(I)=(1.+DV(I))*VAR(I) CHNGE 48
IF(VAL(I).LE.0.0) GO TO 34 CHNGE 49
VAJ(I)=VAL(I) CHNGE 50
IF(FXTMP) VAJ(1) = TFIX CHNGE 51
IF(FXTLNG) VAJ(4) = FIXL CHNGE 52
IF(FXTVAR) VAL(2) = FIXV CHNGE 53

```

IF(FXTTDD) VAL(3) = FIXTDD	CHNGE	54
IF(I.GT.3) GO TO 17	CHNGE	55
IF(VAJ(1) .LE. 0.0) GOTO 12	CHNGE	56
GO TO 17	CHNGE	57
12 VAJ(I)=VAR(I)	CHNGE	58
GO TO 34	CHNGE	59
17 J=I	CHNGE	60
IF(M.LT.I) J=M	CHNGE	61
SRN="/CHNGE=2/ "	CHNGE	62
CALL CALC(VAJ(1),VAJ(2),VAJ(3),VAJ(4),VAJ(5),J)	CHNGE	63
VAJ(I)=VAR(I)	CHNGE	64
IF(KCONV.EQ.1) GO TO 34	CHNGE	65
PA=DELPA	CHNGE	66
PA1=DEPA1	CHNGE	67
DP(I)=DELPA-DEPA1	CHNGE	68
E=0.	CHNGE	69
C=1.	CHNGE	70
D=1.	CHNGE	71
18 VAL(J)=(1.+DV(I)*(E-DP(M))/DP(I))*VAR(I)	CHNGE	72
IF(FXTMP) VAL(1) = TFIX	CHNGE	73
IF(FXTLNG) VAL(4) = FIXL	CHNGE	74
IF(FXTVAR) VAL(2) = FIXV	CHNGE	75
IF(FXTTDD) VAL(3) = FIXTDD	CHNGE	76
IF(VAL(I).LE.0.0) GO TO 34	CHNGE	77
IF(I.GT.3) GO TO 24	CHNGE	78
IF (VAL(1) .LE. 0.0) GOTO 34	CHNGE	79
24 SRN="/CHNGE=3/ "	CHNGE	80
CALL CALC(VAL(1),VAL(2),VAL(3),VAL(4),VAL(5),J)	CHNGE	81
IF(KCONV.EQ.1) GO TO 34	CHNGE	82
IF(DELPA.GE.XDEPA.AND.DELPA.LE.1.01*XDEPA GO TO 26	CHNGE	83
IF(DELPA.GE.1.01*XDEPA) GO TO 25	CHNGE	84
C=D/10.	CHNGE	85
IF(C.LT..001) GO TO 34	CHNGE	86
E=E+C	CHNGE	87
GO TO 18	CHNGE	88
25 D=C/10.	CHNGE	89
IF(D.LT..001) GO TO 34	CHNGE	90
E=E-D	CHNGE	91
GO TO 18	CHNGE	92
26 IF(TCOS.GE.TCOS1) GO TO 34	CHNGE	93
CALL STORE	CHNGE	94
L=1	CHNGE	95
DO 27 IJ=1,5	CHNGE	96
27 VAJ(IJ)=VAR(IJ)	CHNGE	97
VAL(M)=(1.+DV(M))*VAR(M)	CHNGE	98
IF(FXTMP) VAJ(1) = TFIX	CHNGE	99
IF (FXTMP) VAL(1) = TFIX	CHNGE	100
IF(FXTLNG) VAL(4) = FIXL	CHNGE	101
IF(FXTVAR) VAL(2) = FIXV	CHNGE	102
IF(FXTTDD) VAL(3) = FIXTDD	CHNGE	103
IF(VAL(M).LE.0.0) GO TO 36	CHNGE	104
IF(M.GT.3) GO TO 33	CHNGE	105
IF(VAL(1).GE.170..OR.VAL(1).LT.110.) GO TO 36	CHNGE	106
33 SRN="/CHNGE=4/ "	CHNGE	107
CALL CALC(VAL(1),VAL(2),VAL(3),VAL(4),VAL(5),M)	CHNGE	108
IF(KCONV.EQ.1) GO TO 36	CHNGE	109
PA1=DEPA1	CHNGE	110

SUBROUTINE CHNGE 74/74 OPT=1

FTN 4,5,4,4

06/05/78 07.59.59

```
      PA=DELPA
      DP(M)=DELPA-DEPA1
      GO TO 11
34  VAL(I)=VAR(I)
35  CONTINUE
36  DO 37 I=1,5
37  DV(I)=DV(I)
      K1=K1+1
      IF(K1.EQ.1) GO TO 4
      K1=0
      IF(DV(1).LE..005) GO TO 39
      DO 38 I=1,5
38  DV(I)=DV(I)/5.
      GO TO 4
39  IF(L.EQ.1.AND.IDB.NE.0) RETURN
103  FORMAT("          AND CHANGES MADE")
      RETURN
      END
```

```
CHNGE 111
CHNGE 112
CHNGE 113
CHNGE 114
CHNGE 115
CHNGE 116
CHNGE 117
CHNGE 118
CHNGE 119
CHNGE 120
CHNGE 121
CHNGE 122
CHNGE 123
CHNGE 124
CHNGE 125
CHNGE 126
CHNGE 127
CHNGE 128
```

C	FUNCTION CMARTIN(XMART, JMART, KMART)	CMART	2
C		CMART	3
C	FUNCTION CMARTIN SUPPLIES THE MARTINELLI COEFFICIENTS FOR	CMART	4
C	TWO-PHASE FLOW	CMART	5
C		CMART	6
C	DIMENSION PHI(9,6,2)	CMART	7
C		CMART	8
C	DEFINITION OF MARTINELLI INDICES FOR DATA SUPPLY	CMART	9
C		CMART	10
C	PHI(IMART, JMART, KMART)	CMART	11
C	IMART - COEFFICIENTS OF CURVE FITS (1 = 9)	CMART	12
C		CMART	13
C	JMART - FLOW REGIME (1 = 4)	CMART	14
C	1 -- VISCOUS - VISCOUS	CMART	15
C	2 -- TURBULENT - VISCOUS	CMART	16
C	3 -- VISCOUS - TURBULENT	CMART	17
C	4 -- TURBULENT - TURBULENT	CMART	18
C	HOLDUP CORRELATIONS (5 = 6)	CMART	19
C	5 -- MARTINELLI PARAMETER (X) LESS THAN ONE	CMART	20
C	6 -- MARTINELLI PARAMETER (X) GREATER THAN ONE	CMART	21
C		CMART	22
C	KMART - FLUID	CMART	23
C	1 -- LIQUID	CMART	24
C	2 -- VAPOR	CMART	25
C		CMART	26
C	MARTINELLI FUNCTIONAL COEFFICIENTS FOR THE LIQUID	CMART	27
C		CMART	28
C	DATA((PHI(IMART, JMART, 1), IMART = 1, 9), JMART = 1, 6)/	CMART	29
C	VISCOUS - VISCOUS	CMART	30
C	* 0.67995 , -0.42951 , 0.09563 , -0.00547 , 0.00142 , 0.00011 ,	CMART	31
C	* 0.00000 , 0.00000 , 0.00000 ,	CMART	32
C	TURBULENT - VISCOUS	CMART	33
C	* 1.24907 , -0.44314 , 0.06680 , -0.00521 , -0.00057 , 0.00012 ,	CMART	34
C	* 0.00000 , 0.00000 , 0.00000 ,	CMART	35
C	VISCOUS - TURBULENT	CMART	36
C	* 1.23807 , -0.46844 , 0.07189 , -0.00444 , -0.00070 , 0.00012 ,	CMART	37
C	* 0.00000 , 0.00000 , 0.00000 ,	CMART	38
C	TURBULENT - TURBULENT	CMART	39
C	* 1.44065 , -0.50445 , 0.06212 , -0.00106 , -0.00101 , 0.00003 ,	CMART	40
C	* 0.00000 , 0.00000 , 0.00000 ,	CMART	41
C	RL HOLDUP CORRELATION - MARTINELLI PARAMETER LESS	CMART	42
C	THAN ONE	CMART	43
C	* 0.22206 , 0.04251 , -0.00127 , 0.00002 , 0.00000 , 0.00000 ,	CMART	44
C	* 0.00000 , 0.00000 , 0.00000 ,	CMART	45
C	RL HOLDUP CORRELATION - MARTINELLI PARAMETER	CMART	46
C	GREATER THAN ONE	CMART	47
C	* 0.22918 , 0.11270 , 0.01113 , -0.00431 , 0.00050 , 0.00099 ,	CMART	48
C	* -0.00013 , -0.00007 , 0.00001 /	CMART	49
C		CMART	50
C	MARTINELLI FUNCTIONAL COEFFICIENTS FOR THE VAPOR	CMART	51
C		CMART	52
C		CMART	53
C	DATA((PHI(IMART, JMART, 2), IMART = 1, 9), JMART = 1, 6)/	CMART	54
C	VISCOUS - VISCOUS	CMART	55
C	* 1.10310 , 1.49456 , -0.01132 , 0.00014 , 0.00000 , 0.00000 ,	CMART	56
C	* 0.00000 , 0.00000 , 0.00000 ,	CMART	57
C	TURBULENT - VISCOUS	CMART	58

FUNCTION CMARTIN 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

      * 1.24906 , -0.55672 , 0.06678 , -0.00518 , -0.00057 , 0.00012 , CMART 59
      * 0.00000 , 0.00000 , 0.00000 , CMART 60
      C      VISCIOUS - TURBULENT CMART 61
      * 1.53450 , 0.53139 , 0.07181 , -0.00442 , -0.00069 , 0.00012 , CMART 62
      * 0.00000 , 0.00000 , 0.00000 , CMART 63
      C      TURBULENT - TURBULENT CMART 64
      * 1.44105 , 0.49541 , 0.06153 , -0.00113 , -0.00095 , 0.00003 , CMART 65
      * 0.00002 , 0.00000 , 0.00000 , CMART 66
      C      RG HOLDUP CORRELATION = MARTINELLI PARAMTER LESS CMART 67
      C      THAN ONE CMART 68
      * -0.25522 , -0.10583 , -0.02893 , -0.00884 , 0.00000 , 0.00000 , CMART 69
      * 0.00000 , 0.00000 , 0.00000 , CMART 70
      C      MARTINELLI PARAMETER GREATER THAN ONE CMART 71
      * -0.25522 , -0.10573 , -0.02893 , -0.00884 , 0.00000 , 0.00000 , CMART 72
      * 0.00000 , 0.00000 , 0.00000 / CMART 73
      C      CMART 74
      C      MARTINELLI PARAMETER CALCULATION CMART 75
      C      CMART 76
      IMART = 9 CMART 77
      J = JMART CMART 78
      K = KMART CMART 79
      SUM = 0.00 CMART 80
      IF(J .EQ. 1 .AND. K .EQ. 2) GO TO 75 CMART 81
      IF(J .EQ. 5 .AND. K .EQ. 1) GO TO 75 CMART 82
      DO 50 I = 1, IMART CMART 83
      SUM = SUM + PHI(I,J,K)*ALOG(XMART)**(I - 1) CMART 84
50 CONTINUE CMART 85
      CMARTIN = EXP(SUM) CMART 86
      IF(J .EQ. 6 .AND. K .EQ. 1) CMARTIN = SUM CMART 87
      RETURN CMART 88
75 DO 100 I = 1, IMART CMART 89
      SUM = SUM + PHI(I,J,K)*XMART**(I - 1) CMART 90
100 CONTINUE CMART 91
      CMARTIN = SUM CMART 92
      RETURN CMART 93
      END CMART 94

```

SUBROUTINE CONSUMP

SUBROUTINE CONSUMP IS USED TO DETERMINE THE BACK PRESSURE CURVE THAT THE TURBINE CAN OPERATE AT OVER THE ENTIRE YEAR WITH THE TOTAL AMOUNT OF ALLOCATED WATER EVAPORATED IN DELUGING THE WET/DRY TOWERS. IF DELUGING THE TOWER DOES NOT CONSUME ENOUGH WATER TO MAKE IT ABOVE THE AMOUNT ALLOWED TO BE CONSUMED THE DESIGN IS TERMINATED. THE SAME OCCURS IF THERE IS NOT ENOUGH WATER TO KEEP THE BACK PRESSURE AT THE RACK PRESSURE LIMIT CURVE.

DEFINITION OF VARIABLES

BPLZ = STORAGE VARIABLE USED IN THE SLOPE FINDING TECHNIQUE FOR THE CORRECT WET/DRY BACK PRESSURE (IN HGA)
 BPLZI = STORAGE VARIABLE, USED IN THE SLOPE FINDING TECHNIQUE FOR THE CORRECT WET/DRY BACK PRESSURE (IN HGA)
 BPLZII = STORAGE VARIABLE, USED IN THE SLOPE FINDING TECHNIQUE FOR THE CORRECT WET/DRY BACK PRESSURE (IN HGA)
 NTA = NUMBER OF TEMPERATURE DIVISIONS IN THE YEARLY TEMPERATURE PROFILE (DIMENSIONLESS)
 WATCONA = AMOUNT OF WATER THAT CAN BE EVAPORATED DURING THE YEAR (LBM/YEAR)
 WATCWDI = STORAGE VARIABLE, USED IN THE SLOPE FINDING TECHNIQUE FOR THE CORRECT WET/DRY BACK PRESSURE (LBM/YEAR)
 WATC12 = WATER EVAPORATED BY THE HEAT EXCHANGER OVER THE WHOLE YEAR WHEN THE BACK PRESSURE IS AT THE BACK PRESSURE SEPARATING ZONE 1 AND ZONE 2 (LBM/YEAR)
 WATC123 = WATER EVAPORATED BY THE HEAT EXCHANGER OVER THE WHOLE YEAR WHEN THE BACK PRESSURE IS AT THE BACK PRESSURE SEPARATING ZONE 1 FROM ZONE 3 OR ZONE 2 FROM ZONE 3 (LBM/YEAR)
 WATDET = AMOUNT OF WATER CONSUMED IF THE HEAT EXCHANGER IS DELUGED COMPLETELY YEAR AROUND (LBM/YEAR)
 WATWDI = STORAGE VARIABLE, USED IN THE SLOPE FINDING TECHNIQUE FOR THE CORRECT WET/DRY BACK PRESSURE (LBM/YEAR)

DEFINITION OF ARRAYS

BPLIM = MAXIMUM BACK PRESSURE LIMIT CURVE (IN HGA)
 BPLZI = BACK PRESSURE CURVE (IN HGA)
 DEPER = FRACTION OF THE HEAT EXCHANGER THAT IS DELUGED FOR EACH AMBIENT TEMPERATURE INCREMENT (DIMENSIONLESS)
 DEPERG = FRACTION OF THE HEAT LOAD THAT IS CARRIED OFF BY THE DELUGED PART OF THE HEAT EXCHANGER FOR EACH AMBIENT TEMPERATURE INCREMENT (DIMENSIONLESS)
 PDELUG = BACK PRESSURE CURVE WHEN THE HEAT EXCHANGER IS DELUGED COMPLETELY (IN HGA)
 PMAXDRY = ALL DRY BACK PRESSURE CURVE (IN HGA)
 PWD = RACK PRESSURE CURVE WHICH CAN INCLUDE ALL DRY OR ALL WET BACK PRESSURES (IN HGA)
 TDELUG = TURBINE STEAM TEMPERATURE CURVE WHEN THE HEAT

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

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	EXCHANGER IS DELUGED COMPLETELY (DEG F)	CONSUMP	59
C	TMAXDRY= ALL DRY TURBINE STEAM TEMPERATURE CURVE (DEG F)	CONSUMP	60
C	TWD = TURBINE STEAM TEMPERATURE CURVE WHICH CAN INCLUDE	CONSUMP	61
C	ALL DRY OR ALL WET TURBINE STEAM TEMPERATURES	CONSUMP	62
C	(DEG F)	CONSUMP	63
C	WATCWD = WATER CONSUMPTION OF THE HEAT EXCHANGER OVER THE	CONSUMP	64
C	WHOLE YEAR FOR EACH AMBIENT TEMPERATURE INCREMENT	CONSUMP	65
C	(LBM/YEAR)	CONSUMP	66
C	WATDE = WATER CONSUMPTION OF THE HEAT EXCHANGER WHEN IT IS	CONSUMP	67
C	COMPLETELY DELUGED OVER THE WHOLE YEAR FOR EACH	CONSUMP	68
C	AMBIENT TEMPERATURE INCREMENT (LBM/YEAR)	CONSUMP	69
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
	* ,BPLIM(16)	BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	\$,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFFP, EFS	BIGCOM	9
	\$,FCP,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FXTTD,FXTVAR,FXTTID,FXTLNG	BIGCOM	11
	\$,GREFF	BIGCOM	12
	\$,HYNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14
	\$,JCONS	BIGCOM	15
	\$,KCONV, KALEXT	BIGCOM	16
	\$,MXEXT	BIGCOM	17
	\$,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	\$,ODR	BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	\$,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POWSTC, POMSL	BIGCOM	22
	\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
	\$,SIGMAG, SAAF, SEGL	BIGCOM	25
	\$,TD, TPD(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	\$,TCD, TW	BIGCOM	27
	\$,UCS, UWS	BIGCOM	28
	\$,WV, WATCONA, WATCOST	BIGCOM	29
	\$,VAS(5)	BIGCOM	30
	\$,XJFPA, XW, XD	BIGCOM	31
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY	2
	\$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY	3
	\$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,	SUPPLY	4
	\$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,	SUPPLY	5
	\$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY	6
	\$ RP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX	SUPPLY	7
	\$, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY	8
	\$, CLYC, CFC, CPCC, FITCO, CSC,CEPREP,DELPPI, AST,OLDCST	SUPPLY	9
	\$,CAPCST, XNFAN,BLDANG, CPLEN, DPTEL, WHX, WTTUR, ADIA, ABLN	SUPPLY	10
	\$, WTHDR, WTFRM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY	11
	\$, AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY	12
	\$, ACTRPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13
	\$, CSRD, WATERW, WSTRCT, CFBOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14
	\$,SQRJ,SQRJS,ATUBC,CRA,TTD1,TTD2,DELPS,CSTLVR,PIPCST	SUPPLY	15
	\$,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY	16
	\$,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)	SUPPLY	17

\$	WRB,HTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5	SUPPLY	18
	DIMENSION BPLIM(16), PDELUG(16), TDELUG(16), WATDE(16),	CONSUMP	72
1	PMAXWD(16), TMAXWD(16), WATMBP(16), PMAXDRY(16),	CONSUMP	73
2	TMAXDRY(16), BPLZ1(16), TWD(16)	CONSUMP	74
	NDEBUG1 = 0	CONSUMP	75
	NDEBUG2 = 0	CONSUMP	76
C		CONSUMP	77
C	DETERMINATION OF THE ALL WET BACK PRESSURE CURVE	CONSUMP	78
	CALL DELUGT(PDELUG,TDELUG,WATDE,WATDET,BPLIM)	CONSUMP	79
	IF(KCONV.EQ.1) RETURN	CONSUMP	80
	PMAXDE = PDELUG(1)	CONSUMP	81
C		CONSUMP	82
C	DETERMINATION OF THE ALL DRY BACK PRESSURE CURVE AND THE	CONSUMP	83
C	WATER CONSUMPTION AT THE BACK PRESSURE LIMIT CURVE	CONSUMP	84
	CALL TRPMAX(BPLIM,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD,T,PMAXDRY,	CONSUMP	85
	1TMAXDRY,PDELUG,TDELUG,WATDE,0)	CONSUMP	86
	IF(KCONV.EQ.1) RETURN	CONSUMP	87
	IF(NDEBUG1.EQ.1)WRITE(6,190) PDELUG(1),PDELUG(NTA),WATDET, PWD(1)	CONSUMP	88
	1, PWD(NTA),PMAXDRY(1),PMAXDRY(NTA),WATCWD	CONSUMP	89
C		CONSUMP	90
C	RETURN IF THE ALL DRY MODE IS ENCOUNTERED	CONSUMP	91
	IF(WATCONA.EQ.0.0) RETURN	CONSUMP	92
C		CONSUMP	93
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	94
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	95
C		CONSUMP	96
C	IF BACK PRESSURE LIMIT CURVE IS A FLAT CURVE GO TO REGION TWO	CONSUMP	97
	IF(BPLIM(NTA).EQ.BPLIM(1)) GO TO 60	CONSUMP	98
C		CONSUMP	99
C	REGION ONE	CONSUMP	100
C		CONSUMP	101
C	DETERMINE IN WHICH STEP OF THE BACK PRESSURE CURVE THAT THE	CONSUMP	102
C	TOTAL AMOUNT OF WATER CONSUMPTION IS OBTAINED	CONSUMP	103
C		CONSUMP	104
C	INCREMENTING THE STEPS	CONSUMP	105
	DO 20 JK = 1,NTA	CONSUMP	106
	J = NTA - JK + 1	CONSUMP	107
	IF(JK.EQ.1) GO TO 5	CONSUMP	108
	IF(BPLIM(J).EQ.BPLIM(J+1)) GO TO 20	CONSUMP	109
C		CONSUMP	110
C	FILLING THE BACK PRESSURE ARRAY WITH THE STEP BACK PRESSURE	CONSUMP	111
5	DO 10 IK = JK, NTA	CONSUMP	112
	I = NTA - IK + 1	CONSUMP	113
	BPLZ1(I) = BPLIM(J)	CONSUMP	114
C		CONSUMP	115
C	IF INSIDE THE BACK PRESSURE LIMIT STEP THE MAXIMUM BACK	CONSUMP	116
C	PRESSURE IS ENCOUNTERED THE BACK PRESSURE ARRAY IS FILLED	CONSUMP	117
C	WITH THAT PRESSURE	CONSUMP	118
10	IF(BPLIM(J).GT.PMAXDRY(1).AND.JK.GT.1) BPLZ1(I) = PMAXDRY(1)	CONSUMP	119
	CALL TRPMAX(BPLZ1,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD,T,PMAXDRY,	CONSUMP	120
	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	121
C		CONSUMP	122
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	123
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	124
C		CONSUMP	125
C	CRITERIA FOR STAYING IN ZONE 1 OR GOING TO ZONE 2	CONSUMP	126
	IF(JK.EQ.1.AND.WATCWD.LT.WATCONA) GO TO 60	CONSUMP	127

C		CONSUMP	128
C	CRITERIA FOR DETERMINING WHICH STEP IN ZONE 1 HAS THE BACK	CONSUMP	129
C	PRESSURE WHICH WILL CONSUME THE REQUIRED AMOUNT OF WATER	CONSUMP	130
	IF(JK.GT.1.AND.WATCWD.LT.WATCONA) GO TO 30	CONSUMP	131
	20 WATWDT1 = WATCWD	CONSUMP	132
	30 BPLZ = BPLZ1(J+1)	CONSUMP	133
C		CONSUMP	134
C	PREDICTING WHICH BACK PRESSURE IN THE STEP OF ZONE 1 WILL	CONSUMP	135
C	CONSUME THE REQUIRED AMOUNT OF WATER	CONSUMP	136
	40 BPLZ1 = ((BPLZ1(J) - BPLZ)/(WATCWD - WATWDT1))*(WATCONA -	CONSUMP	137
	1WATWDT1) + BPLZ	CONSUMP	138
	IF(NDRUG2.EQ.1) WRITE(6,200) BPLZ1,BPLZ1(J),BPLZ1(J+1),WATCWD,	CONSUMP	139
	1WATWDT1	CONSUMP	140
	BPLZ = BPLZ1(J)	CONSUMP	141
	WATWDT1 = WATCWD	CONSUMP	142
C		CONSUMP	143
C	FILLING THE BACK PRESSURE ARRAY PAST THE AMBIENT TEMPERATURE	CONSUMP	144
C	WHERE THE STEP IN BACK PRESSURE STARTS WITH THE PREDICTED	CONSUMP	145
C	BACK PRESSURE	CONSUMP	146
	DO 50 IKK = JK,NTA	CONSUMP	147
	I = NTA - IKK + 1	CONSUMP	148
	50 BPLZ1(I) = BPLZ1	CONSUMP	149
C		CONSUMP	150
C	DETERMINATION OF THE WATER CONSUMPTION AT THE ESTIMATED	CONSUMP	151
C	BACK PRESSURE	CONSUMP	152
	CALL TBPMAX(BPLZ1,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD1,PMAXDRY,	CONSUMP	153
	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	154
	IF(NDRUG2.EQ.1) WRITE(6,260) (DEPER(I),I=1,8), (WATCWD(I),I=1,8)	CONSUMP	155
	260 FORMAT(4X,"DEPER(I)=",/,4X,8G15.5,/,4X,"WATCWD(I)=",/,4X,8G15.5/)	CONSUMP	156
C		CONSUMP	157
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	158
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	159
	GO TO 40	CONSUMP	160
C		CONSUMP	161
C	REGION TWO	CONSUMP	162
C		CONSUMP	163
C	IF THE MAXIMUM ALL WET BACK PRESSURE IS LARGER THAN THE	CONSUMP	164
C	MINIMUM BACK PRESSURE LIMIT ZONE 2 DOES NOT EXIST THEREFORE	CONSUMP	165
C	GO TO ZONE 3	CONSUMP	166
	60 IF(PDELUG(1).GE.BPLIM(NTA)) GO TO 130	CONSUMP	167
	WATC12 = WATCWD	CONSUMP	168
C		CONSUMP	169
C	FILLING THE BACK PRESSURE ARRAY WITH THE BACK PRESSURE THAT	CONSUMP	170
C	SEPARATES ZONES 2 AND 3	CONSUMP	171
	DO 70 I = 1, NTA	CONSUMP	172
	70 BPLZ1(I) = PDELUG(1)	CONSUMP	173
C		CONSUMP	174
C	DETERMINATION OF THE WATER CONSUMPTION FOR THE BACK PRESSURE	CONSUMP	175
C	THAT SEPARATES ZONES 2 AND 3	CONSUMP	176
	CALL TBPMAX(BPLZ1,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD1,PMAXDRY,	CONSUMP	177
	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	178
C		CONSUMP	179
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	180
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	181
C		CONSUMP	182
C	CRITERIA FOR STAYING IN ZONE 2 OR GOING TO ZONE 3	CONSUMP	183
	IF(WATCWD.LT.WATCONA) GO TO 130	CONSUMP	184

	WATWDT1 = WATCWD	CONSUMP	185
	BPLZ = PDELUG(1)	CONSUMP	186
C		CONSUMP	187
C	DERTERMINE WHICH DRY BACK PRESSURE IS ABOVE THE MAXIMUM ALL	CONSUMP	188
C	WET BACK PRESSURE	CONSUMP	189
	DO 80 J = 1, NTA	CONSUMP	190
	I = NTA = J + 1	CONSUMP	191
	IF(PMAXDRY(I).GT.PDELUG(1)) GO TO 90	CONSUMP	192
	80 CONTINUE	CONSUMP	193
C		CONSUMP	194
C	FILLING THE BACK PRESSURE ARRAY WITH THE DRY BACK PRESSURE	CONSUMP	195
	90 DO 100 II = 1, NTA	CONSUMP	196
	100 BPLZ1(II) = PMAXDRY(I)	CONSUMP	197
	BPLZ1 = PMAXDRY(I)	CONSUMP	198
C		CONSUMP	199
C	DETERMINATION OF THE WATER CONSUMPTION FOR THE DRY BACK	CONSUMP	200
C	PRESSURE	CONSUMP	201
	CALL THPMAX(BPLZ1,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD1,PMAXDRY,	CONSUMP	202
	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	203
C		CONSUMP	204
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	205
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	206
C		CONSUMP	207
C	CRITERIA FOR DETERMINING WHICH DRY BACK PRESSURE STEP	CONSUMP	208
C	CONTAINS THE BACK PRESSURE WHICH WILL REQUIRE THE ALLOCATED	CONSUMP	209
C	AMOUNT OF WATER	CONSUMP	210
	IF(WATCWD1.LT.WATCONA) GO TO 110	CONSUMP	211
	WATWDT1 = WATCWD	CONSUMP	212
	BPLZ = BPLZ1	CONSUMP	213
C		CONSUMP	214
C	INCREMENTING TO THE NEXT DRY BACK PRESSURE	CONSUMP	215
	I = I + 1	CONSUMP	216
C		CONSUMP	217
C	SETTING THE WATER CONSUMPTION AND BACK PRESSURE AT THE	CONSUMP	218
C	UPPER LIMIT OF ZONE 2	CONSUMP	219
	IF(PMAXDRY(I).GT.BPLIM(NTA)) WATCWD = WATC12	CONSUMP	220
	IF(PMAXDRY(I).GT.BPLIM(NTA)) BPLZ1 = BPLIM(NTA)	CONSUMP	221
	IF(PMAXDRY(I).GT.BPLIM(NTA)) GO TO 110	CONSUMP	222
	GO TO 90	CONSUMP	223
C		CONSUMP	224
C	PREDICTING WHICH BACK PRESSURE IN THE DRY BACK PRESSURE STEP	CONSUMP	225
C	WILL CONSUME THE REQUIRED AMOUNT OF WATER	CONSUMP	226
	110 BPLZII = ((BPLZ1 - BPLZ)/(WATCWD - WATWDT1))*(WATCONA - WATWDT1)	CONSUMP	227
	1+BPLZ	CONSUMP	228
	IF(NDB1/G2.EQ.1) WRITE(6,220) BPLZII,BPLZ1,BPLZ,WATCWD,WATWDT1	CONSUMP	229
	BPLZ = BPLZ1	CONSUMP	230
	BPLZ1 = BPLZII	CONSUMP	231
	WATWDT1 = WATCWD	CONSUMP	232
C		CONSUMP	233
C	FILLING THE BACK PRESSURE ARRAY WITH THE PREDICTED BACK	CONSUMP	234
C	PRESSURE	CONSUMP	235
	DO 120 II = 1, NTA	CONSUMP	236
	120 BPLZ1(II) = BPLZII	CONSUMP	237
C		CONSUMP	238
C	DETERMINATION OF THE WATER CONSUMPTION AT THE ESTIMATED BACK	CONSUMP	239
C	PRESSURE	CONSUMP	240
	CALL THPMAX(BPLZ1,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD1,PMAXDRY,	CONSUMP	241

	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	242
	IF(NDRUG2.EQ.1) WRITE(6,260) (DEPER(I),I=1,8), (WATCWD(I),I=1,8)	CONSUMP	243
C		CONSUMP	244
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	245
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	246
	GO TO 110	CONSUMP	247
C		CONSUMP	248
C	ZONE 3	CONSUMP	249
C		CONSUMP	250
C	FILLING THE BACK PRESSURE ARRAY WITH THE DRY BACK PRESSURE	CONSUMP	251
	130 WATC[23] = WATCWD	CONSUMP	252
	BPLZ = PDELUG(NTA)	CONSUMP	253
	WATWDT1 = WATDET	CONSUMP	254
	DO 135 IJ = 1,NTA	CONSUMP	255
	I = NTA - IJ + 1	CONSUMP	256
	IF(PMAXDRY(I) .GT. PDELUG(I)) GO TO 136	CONSUMP	257
	135 CONTINUE	CONSUMP	258
	136 CONTINUE	CONSUMP	259
	140 DO 150 II = 1, NTA	CONSUMP	260
	150 BPLZ[II] = PMAXDRY(I)	CONSUMP	261
	BPLZI = PMAXDRY(I)	CONSUMP	262
C		CONSUMP	263
C	DETERMINATION OF THE WATER CONSUMPTION FOR THE DRY BACK	CONSUMP	264
C	PRESSURE	CONSUMP	265
	CALL TBPMAX(BPLZI,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD,T,PMAXDRY,	CONSUMP	266
	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	267
C		CONSUMP	268
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	269
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	270
C		CONSUMP	271
C	CRITERIA FOR DETERMINING WHICH DRY BACK PRESSURE STEP	CONSUMP	272
C	CONTAINS THE BACK PRESSURE WHICH WILL REQUIRE THE	CONSUMP	273
C	ALLOCATED AMOUNT OF WATER	CONSUMP	274
	IF(WATCWD.LT.WATCONA) GO TO 160	CONSUMP	275
	WATWDT1 = WATCWD	CONSUMP	276
	BPLZ = BPLZI	CONSUMP	277
	I = I + 1	CONSUMP	278
	GO TO 140	CONSUMP	279
C		CONSUMP	280
C	PREDICTING WHICH BACK PRESSURE IN THE DRY BACK PRESSURE STEP	CONSUMP	281
C	WILL CONSUME THE REQUIRED AMOUNT OF WATER	CONSUMP	282
	160 BPLZII = ((BPLZI - BPLZ)/(WATCWD - WATWDT1))* (WATCONA - WATWDT1)	CONSUMP	283
	1+ BPLZ	CONSUMP	284
	IF(NDRUG2.EQ.1) WRITE(6,240) BPLZII,BPLZI,BPLZ,WATCWD,WATWDT1	CONSUMP	285
	BPLZ = BPLZII	CONSUMP	286
	BPLZI = BPLZII	CONSUMP	287
	WATWDT1 = WATCWD	CONSUMP	288
C		CONSUMP	289
C	FILLING THE BACK PRESSURE ARRAY WITH THE PREDICTED BACK	CONSUMP	290
C	PRESSURE	CONSUMP	291
	DO 170 II = 1, NTA	CONSUMP	292
	170 BPLZ[II] = BPLZII	CONSUMP	293
C		CONSUMP	294
C	DETERMINATION OF THE WATER CONSUMPTION AT THE ESTIMATED BACK	CONSUMP	295
C	PRESSURE	CONSUMP	296
	CALL TBPMAX(BPLZ,PWD,TWD,DEPER,DEPERQ,WATCWD,WATCWD,T,PMAXDRY,	CONSUMP	297
	1TMAXDRY,PDELUG,TDELUG,WATDE,1)	CONSUMP	298

SUBROUTINE CONSUMP 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	IF(NDRUG2.EQ.1) WRITE(6,260) (DEPER(I),I=1,8), (WATCWD(I),I=1,8)	CONSUMP	299
C		CONSUMP	300
C	WATER CONSUMPTION CONVERGENCE CRITERIA	CONSUMP	301
	IF(ABS(WATCWD - WATCONA)/WATCONA.LT..005) RETURN	CONSUMP	302
	GO TO 160	CONSUMP	303
190	FORMAT(2X,"PDELUG(1-NTA),WATDET,PMAXWD(1-NTA),PMAXDRY(1-NTA),WATMB	CONSUMP	304
	1PT=","/,"2X,8G12.5/)	CONSUMP	305
200	FORMAT(2X,"BPLZI,BPLZI(J),BPLZI(J=1),WATCWD,WATWDT1=","5G12.6)	CONSUMP	306
220	FORMAT(2X,"BPLZII,BPLZI,BPLZ,WATCWD,WATWDT1=","5G12.6)	CONSUMP	307
240	FORMAT(2X,"BPLZII,BPLZI,BPLZ,WATCWD,WATWDT1,2=","5G12.6)	CONSUMP	308
	END	CONSUMP	309

SEVERITY DETAILS DIAGNOSIS OF PROBLEM

I BPLIM PREVIOUSLY DIMENSIONED ARRAY, FIRST DIMENSIONS WILL BE RETAINED.

SUBROUTINE COSTEX(AFRON,ATOT)

C		COSTEX	2
C		COSTEX	3
C	SUBROUTINE COSTEX DETERMINES THE COST OF THE HEAT EXCHANGER	COSTEX	4
C	BUNDLES OF THE DRY COOLING TOWERS. THE COST OF THE HEAT	COSTEX	5
C	EXCHANGER BUNDLE IS BROKEN DOWN INTO SEVERAL SUBCOMPONENTS	COSTEX	6
C	1. HEADER	COSTEX	7
C	2. TUBING	COSTEX	8
C	3. TUBING SEALANT	COSTEX	9
C	4. SPACERS	COSTEX	10
C	5. BUNDLE FRAME	COSTEX	11
C	6. BUNDLE ASSEMBLY	COSTEX	12
C	THE WEIGHT OF THE HEAT EXCHANGER BUNDLE AND THE WATER ARE	COSTEX	13
C	ALSO CALCULATED.	COSTEX	14
C		COSTEX	15
C	DEFINITION OF VARIABLES	COSTEX	16
C	ARC - HOLE FACTOR FOR THE HEADER COSTS (DIMENSIONLESS)	COSTEX	17
C	AT - CROSS-SECTIONAL AREA OF THE TUBE (SQ IN)	COSTEX	18
C	BSECF - BUNDLE SHIPPING AND ERECTION FACTOR OF THE HEAT	COSTEX	19
C	EXCHANGER (DECIMAL)	COSTEX	20
C	CA - BUNDLE ASSEMBLY AND FRAME COSTS (\$)	COSTEX	21
C	CRA - BUNDLE ASSEMBLY COST (\$)	COSTEX	22
C	CBJ - COST OF BOLTED HEADER JOINT (\$/FT)	COSTEX	23
C	CELAST - COST OF THE ELASTOMER (\$/LBF)	COSTEX	24
C	CEPREP - COST OF END PREPARATION FOR EACH TUBE (\$/TUBE)	COSTEX	25
C	CFS - UNIT FRAME COSTS (\$/LBF)	COSTEX	26
C	CH - COST OF THE HEADER FOR EACH BUNDLE	COSTEX	27
C	CHC - STEEL HEADER COSTS (\$/LBF)	COSTEX	28
C	CHF - BUNDLE FRAME COST (\$)	COSTEX	29
C	CHX - COST OF THE HEAT EXCHANGER (\$)	COSTEX	30
C	COATC - COST OF COATING THE AIR SIDE SURFACE AREA	COSTEX	31
C	(\$/SQ FT)	COSTEX	32
C	CPCC - COST OF COATING THE HEAT EXCHANGER TUBES (\$)	COSTEX	33
C	CRJ - COST OF ROLLED JOINTS FOR THE HEADER (\$/TUBE)	COSTEX	34
C	CS - COOLING SURFACE COST (\$)	COSTEX	35
C	CSC - TUBE SPACER COSTS (\$/TUBE-SPACER)	COSTEX	36
C	CSEALP - COST OF SEAL PLATE (\$/LBF)	COSTEX	37
C	CWJ - COST OF WELDED JOINT FOR THE HEADER (\$/TUBE)	COSTEX	38
C	DFIN - OUTSIDE DIAMETER OF FIN (IN)	COSTEX	39
C	DI - INSIDE DIAMETER OF TUBE (IN)	COSTEX	40
C	ELENG - LENGTH OF THE HEAT EXCHANGER TUBES (FT)	COSTEX	41
C	EPREPC - END PREPARATION COSTS (\$/TUBE)	COSTEX	42
C	FA - TOTAL TUBE FLOW AREA PER PASS SQ (IN)	COSTEX	43
C	FACT - HEADER FACTOR WHICH DEPENDS ON THE TYPE OF HEADER	COSTEX	44
C	(DIMENSIONLESS)	COSTEX	45
C	FITCO - TUBING COST (\$/FT)	COSTEX	46
C	FP - PRESSURE FACTOR (DIMENSIONLESS)	COSTEX	47
C	F1 - HEADER DEPTH MATERIAL FACTOR (IN)	COSTEX	48
C	F2 - HEADER WIDTH MATERIAL FACTOR (IN)	COSTEX	49
C	HD - HEADER DEPTH PER PASS (IN)	COSTEX	50
C	HEDMAT - TYPE OF HEADER MATERIAL (DIMENSIONLESS)	COSTEX	51
C	HEDTUB - NUMBER OF TUBES PER HEADER	COSTEX	52
C	HEDTYP - TYPE OF HEADER	COSTEX	53
C	HEDVOL - HEADER VOLUME (CU FT)	COSTEX	54
C	HF - FIN HEIGHT (IN)	COSTEX	55
C	HW - HEADER WIDTH (IN)	COSTEX	56
C	HXNP - NUMBER OF PASSES THROUGH THE HEAT EXCHANGER	COSTEX	57
C	(DIMENSIONLESS)	COSTEX	58

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	NW	- NUMBER OF HEAT EXCHANGER TUBES IN WIDTH	COSTEX	59
C		(DIMENSIONLESS)	COSTEX	60
C	ODL	- OUTSIDE DIAMETER OF TUBE (IN)	COSTEX	61
C	ODLINE	- OUTSIDE DIAMETER OF THE LINER (IN)	COSTEX	62
C	PCF	- PROCURMENT COST FACTOR (DECIMAL)	COSTEX	63
C	POHBAF	- INDIRECT CONSTRUCTION COST FOR HEAT EXCHANGER	COSTEX	64
C	PF	- FIN PITCH (FINS/IN)	COSTEX	65
C		BUNDLE (DECIMAL)	COSTEX	66
C	ROEL	- TUBING MATERIAL DENSITY (LBM/CU IN)	COSTEX	67
C	SF	- SPACING BETWEEN FINS (IN)	COSTEX	68
C	SS	- SPACING BETWEEN SPACERS (FT)	COSTEX	69
C	THFIN	- FIN THICKNESS (IN)	COSTEX	70
C	TR	- THICKNESS OF THE FIN AT THE ROOT OF THE FIN (IN)	COSTEX	71
C	TURVOL	- VOLUME OF WATER INSIDE THE TUBES (CU FT)	COSTEX	72
C	TW	- THICKNESS OF THE HEADER WALLS (IN)	COSTEX	73
C	WATERW	- TOTAL WEIGHT OF THE WATER IN THE HEAT EXCHANGER	COSTEX	74
C		BUNDLE (LBF)	COSTEX	75
C	WB	- WIDTH OF THE HEAT EXCHANGER BUNDLE (F)	COSTEX	76
C	WF	- WEIGHT OF THE FINS OF THE HEAT EXCHANGER (LBF)	COSTEX	77
C	WHX	- WEIGHT OF MATERIAL MAKING UP THE EXCHANGER (LBF)	COSTEX	78
C	WL	- WEIGHT OF MATERIAL IN THE HEAT EXCHANGER (LBF)	COSTEX	79
C	WTFRM	- WEIGHT OF THE HEAT EXCHANGER FRAME (LBF)	COSTEX	80
C	WTHDR	- WEIGHT OF THE HEAT EXCHANGER HEADER (LBF)	COSTEX	81
C	WTTUB	- WEIGHT OF THE TUBES IN THE HEAT EXCHANGER (LBF)	COSTEX	82
C	XD	- LONGITUDINAL TUBE SPACING BETWEEN TUBE ROWS (IN)	COSTEX	83
C	XNBUN	- NUMBER OF HEAT EXCHANGER BUNDLES (DIMENSIONLESS)	COSTEX	84
C	XW	- TRANSVERSE TUBE PITCH NORMAL TO AIR FLOW (IN)	COSTEX	85
C	Z	- NUMBER OF HEAT EXCHANGER TUBES IN DEPTH	COSTEX	86
C		(DIMENSIONLESS)	COSTEX	87
C	ZINCC	- COST OF THE ZINC FOR THE TUBE SPACERS (\$/LBM)	COSTEX	88
C			COSTEX	89
C	ARRAYS		COSTEX	90
C	TUBMA	- LINER MATERIAL	COSTEX	91
C	CL	- LINER FIXED COSTS (\$)	COSTEX	92
C	CLM	- LINER MATERIAL COSTS (\$/LB)	COSTEX	93
C	ROEL	- DENSITY OF LINER MATERIALS (LB/CU IN)	COSTEX	94
C	GAGLI	- LINER GAGE	COSTEX	95
C	THKLIN	- THICKNESS OF LINER (IN)	COSTEX	96
C	FINTY	- TYPE OF FIN	COSTEX	97
C	CFM	- FIN MATERIAL COSTS (\$/LB)	COSTEX	98
C	CF	- FINNING FIXED COSTS (\$/FT)	COSTEX	99
C	ODLINE	- COMMON DIAMETERS OF LINER (IN)	COSTEX	100
C	MAXFH	- MAXIMUM FIN HEIGHT (IN)	COSTEX	101
C	STANFT	- STANDARD FIN THICKNESS (IN)	COSTEX	102
C	FPL	- LOWEST FIN PITCH (FPI)	COSTEX	103
C	FPH	- HIGHEST FIN PITCH (FPI)	COSTEX	104
C	HEDTY	- TYPE OF HEADER	COSTEX	105
C	HEDMA	- HEADER MATERIAL	COSTEX	106
C	ROEHM	- HEADER MATERIAL DENSITY (LB/CU IN)	COSTEX	107
C	CHM	- COST OF HEADER MATERIAL (\$/LB)	COSTEX	108
C	CMW	- COST OF HEADER MACHINING AND WELDING (\$/FT)	COSTEX	109
C	CN	- NOZZEL AND ATTACHING COST (\$/HOLE)	COSTEX	110
C	CHH	- TUBE AND PLUGHOLE PREPARATION (\$/HOLE)	COSTEX	111
C	FF	- COST LENGTH FACTOR FOR TUBES (DIMENSIONLESS)	COSTEX	112
C	FINMA	- TYPE OF FIN MATERIAL	COSTEX	113
C	FPL	- LOWER LIMIT ON STANDARD FIN PITCHES THAT ARE	COSTEX	114
C		COMMERCIALY AVAILABLE (FINS/IN)	COSTEX	115

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	FRH - UPPER LIMIT ON STANDARD FIN PITCHES THAT ARE	COSTEX	116
C	COMMERCIALY AVAILABLE (FINS/IN)	COSTEX	117
C	MAXFH - MAXIMUM FIN HEIGHT FOUND COMMERCIALY (IN)	COSTEX	118
C	ROEF - DENSITY OF FIN MATERIAL (LBM/CU IN)	COSTEX	119
C	STANFT- FIN THICKNESS LIMITS FOUND COMMERCIALY (IN)	COSTEX	120
C		COSTEX	121
C		COSTEX	122
C	REAL NTUB	COSTEX	123
C		COSTEX	124
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
	* ,BPLIM(16)	BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	\$,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFFP, EFS	BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FXTID,FXTVAR,FXTTID,FXTLNG	BIGCOM	11
	\$,GREFF	BIGCOM	12
	\$,HXNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14
	\$,JCONS	BIGCOM	15
	\$,KCONV, KALEXT	BIGCOM	16
	\$,MXEXT	BIGCOM	17
	\$,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	\$ ODR	BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
	\$,RPP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
	\$,SIGMAG, SAAF, SEGL	BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	\$,TCD, TW	BIGCOM	27
	\$,UCS, UWS	BIGCOM	28
	\$,WFV, WATCONA, WATCOST	BIGCOM	29
	\$,VAS(5)	BIGCOM	30
	\$,XDEPA, XW, XD	BIGCOM	31
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY	2
	\$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY	3
	\$ FPOW, DELFC, WIOTH, ELENG, VAIR, VWAT, HI, HO, T4,	SUPPLY	4
	\$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,	SUPPLY	5
	\$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY	6
	\$ RP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX	SUPPLY	7
	\$, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CM, CA, CS	SUPPLY	8
	\$, CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPIP, AST,OLDGST	SUPPLY	9
	\$,CAPCST, XNFAN,BLDANG, CPLEN, DPTEL, WHX, WTTUB, ADIA, ABLN	SUPPLY	10
	\$, WTHDR, WTFRM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY	11
	\$, AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY	12
	\$, ACTAPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13
	\$, CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14
	\$,SORJ,SORJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCST	SUPPLY	15
	\$,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY	16
	\$,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)	SUPPLY	17
	\$,WBR,MTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5	SUPPLY	18
	COMMON /DJB/ DI,XDG,SF	COSTEX	127

\$,43750, .50000, 4*.625	COSTEX	185
\$,43750, .50000, 4*.625	COSTEX	186
\$,6*0.0	COSTEX	187
\$,43750, .50000, 4*.625	COSTEX	188
\$,6*0.0	COSTEX	189
\$,6*0.0	COSTEX	190
\$,6*0.0	COSTEX	191
\$,31250, .37500, .50000, 3*.625	COSTEX	192
\$,31250, .37500, .50000, 3*.625	COSTEX	193
\$,6*0.0	COSTEX	194
\$,31250, .37500, .50000, 3*.625	COSTEX	195
\$ /	COSTEX	196
DATA ((STANFT(I,J,K),I=1,6),J=1,7),K=1,2 / 42* .016, 42* .030 /	COSTEX	197
DATA ((FPL(I,J,K),I=1,6),J=1,7),K=1,2 /	COSTEX	198
\$ 6*2.0, 18*7.0, 18*5.0, 18*0.0, 6*7.0, 18*5.0 /	COSTEX	199
DATA ((FPH(I,J,K),I=1,6),J=1,7),K=1,2 /	COSTEX	200
\$ 6*27., 36*11., 18*0.0, 6*9.0, 18*11.0 /	COSTEX	201
DATA FINMA / "ALUMINUM ", "STEEL " /	COSTEX	202
DATA ROEF / 0.09751, 0.2840 /	COSTEX	203
	COSTEX	204
TABLE V	COSTEX	205
HEADER FABRICATION COSTS	COSTEX	206
	COSTEX	207
DATA HEDTY / "WELD REMOV", "WELD PLUG ", "FORM REMOV",	COSTEX	208
"FORM PLUG " /	COSTEX	209
DATA (HEDMA(I),I=1,3)/"STEEL ", "ALUMINUM ", "GALVANIZED" /	COSTEX	210
DATA ROEHM / .284, .09751, .284 /	COSTEX	211
DATA CHMAT / .53, 1.3, .57 /	COSTEX	212
DATA CMC / 1.05, 1.00, 0.95, 0.90 /	COSTEX	213
	COSTEX	214
	COSTEX	215
TABLE VI	COSTEX	216
TUBING LENGTH PENALTIES	COSTEX	217
	COSTEX	218
FOR COPPER ALLOYS	COSTEX	219
DATA (FF(1,J),J=1,6) / 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	COSTEX	220
DATA (FF(2,J),J=1,6) / 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	COSTEX	221
DATA (FF(3,J),J=1,6) / 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	COSTEX	222
DATA (FF(4,J),J=1,6) / 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	COSTEX	223
	COSTEX	224
FOR ALUMINUM	COSTEX	225
DATA (FF(5,J),J=1,6) / 1.00, 1.06, 1.10, 1.14, 1.18, 1.22 /	COSTEX	226
	COSTEX	227
FOR STEEL	COSTEX	228
DATA (FF(6,J),J=1,6) / 1.00, 1.09, 1.13, 1.17, 1.21, 1.25 /	COSTEX	229
DATA (FF(7,J),J=1,6) / 1.00, 1.09, 1.13, 1.17, 1.21, 1.25 /	COSTEX	230
	COSTEX	231
FOR STAINLESS STEEL	COSTEX	232
DATA (FF(8,J),J=1,6) / 1.00, 1.00, 1.04, 1.08, 1.12, 1.16 /	COSTEX	233
	COSTEX	234
DEFINING THE TYPE OF TUBING UNDER CONSIDERATION	COSTEX	235
	COSTEX	236
IF(.NOT.FIRST) GOTO 55	COSTEX	237
DO 10 I=1,8	COSTEX	238
ITUBMA = I	COSTEX	239
IF (TUBMAT .EQ. TUBMA(I)) GO TO 15	COSTEX	240
10 CONTINUE	COSTEX	241

PRINT 11	COSTEX	242
STOP	COSTEX	243
11 FORMAT(5X,"NO MATCH FOR LINER MATERIAL")	COSTEX	244
15 DO 20 J=1,13	COSTEX	245
IGAGLI = J	COSTEX	246
IF(ABS(GAGLIN-GAGLI(J)).LT..001) GOTO 25	COSTEX	247
20 CONTINUE	COSTEX	248
PRINT 21	COSTEX	249
21 FORMAT(5X,"NO MATCH FOR LINER GAGE")	COSTEX	250
STOP	COSTEX	251
25 DO 30 K=1,7	COSTEX	252
IFINTY = K	COSTEX	253
IF (FINTYP .EQ. FINTY(K)) GO TO 35	COSTEX	254
30 CONTINUE	COSTEX	255
PRINT 31	COSTEX	256
31 FORMAT(5X,"NO MATCH FOR TYPE OF FIN")	COSTEX	257
35 DO 40 L=1,2	COSTEX	258
IFINMA = L	COSTEX	259
IF (FINMAT .EQ. FINMA(L)) GO TO 45	COSTEX	260
40 CONTINUE	COSTEX	261
PRINT 41	COSTEX	262
41 FORMAT(5X,"NO MATCH FOR FIN MATERIAL")	COSTEX	263
45 IF (IFINTY .EQ. 7) GOTO 59	COSTEX	264
DO 50 I=1,6	COSTEX	265
IODLIN = I	COSTEX	266
IF(ODL .LE. ODLIN(I)) GO TO 55	COSTEX	267
50 CONTINUE	COSTEX	268
PRINT 51	COSTEX	269
51 FORMAT(5X,"NO MATCH FOR OUTSIDE DIAMETER OF LINER")	COSTEX	270
STOP	COSTEX	271
55 CONTINUE	COSTEX	272
IF(IFINTY .EQ. 7) GOTO 59	COSTEX	273
IF (FIRST) GOTO 59	COSTEX	274
C	COSTEX	275
C***** FINNED TUBE COSTS	COSTEX	276
C	COSTEX	277
C LINER TUBING COSTS	COSTEX	278
C	COSTEX	279
WL = 37.69911*ROEL(ITUBMA)*(ODL-THKLIN(IGAGLI))*THKLIN(IGAGLI)	COSTEX	280
C	COSTEX	281
LI=6	COSTEX	282
DO 57 I=3,8	COSTEX	283
IF(ELENG.GE.(10*I)) LI=I-2	COSTEX	284
57 CONTINUE	COSTEX	285
F=FF(ITUBMA,LI)	COSTEX	286
ADDER=0.0	COSTEX	287
IF(ITUBMA.LT.5) ADDER = F	COSTEX	288
IF(ITUBMA.LT.5) F=1.0	COSTEX	289
CLTC = (CLM(ITUBMA) * WL * CL(ITUBMA)) * F * ADDER	COSTEX	290
PCF = 1.10	COSTEX	291
CLTC = CLTC*PCF	COSTEX	292
C	COSTEX	293
C FINNING COSTS	COSTEX	294
C	COSTEX	295
59 PF = 1./(SF * THFIN)	COSTEX	296
GOTO (60,70,80,90,100,110,105) , IFINTY	COSTEX	297
C	COSTEX	298

C	FIN WEIGHTS	COSTEX	299
C		COSTEX	300
C	STRAIGHT FIN	COSTEX	301
60	ODR=ODL	COSTEX	302
	HF=(DFIN-ODR)/2.0	COSTEX	303
	WF = 37.69911*ROEF(IFINMA)*THFIN*ODL*PF*HF	COSTEX	304
	GO TO 120	COSTEX	305
C		COSTEX	306
C	FOOTED FIN	COSTEX	307
70	ODR=ODL + 2.*THFIN	COSTEX	308
	HF=(DFIN-ODR)/2.0	COSTEX	309
	WSF = 37.69911*ROEF(IFINMA)*THFIN*ODL*PF*HF	COSTEX	310
	WF = WSF*(SF=1./PF)*WSF/HF	COSTEX	311
	GO TO 120	COSTEX	312
C		COSTEX	313
C	DOUBLE FOOTED FIN	COSTEX	314
80	ODR= ODL + 4.*THFIN	COSTEX	315
	HF=(DFIN-ODR)/2.0	COSTEX	316
	WSF = 37.69911*ROEF(IFINMA)*THFIN*ODL*PF*HF	COSTEX	317
	WF = WSF*(SF=2./PF)*WSF/HF	COSTEX	318
	GO TO 120	COSTEX	319
C		COSTEX	320
C	EMBEDDED FIN	COSTEX	321
90	ODR=ODL	COSTEX	322
	HF=(DFIN-ODR)/2.0	COSTEX	323
	WSF = 37.69911*ROEF(IFINMA)*THFIN*ODL*PF*HF	COSTEX	324
	WF = 0.94*WSF	COSTEX	325
	GOTO 120	COSTEX	326
C		COSTEX	327
C	EXTRUDED FINS	COSTEX	328
100	CONTINUE	COSTEX	329
	TR = 0.035	COSTEX	330
	ODR=ODL + 2.*TR	COSTEX	331
	HF=(DFIN-ODR)/2.	COSTEX	332
	WF=37.69911*ROEF(IFINMA)*(THFIN*PF*HF*(ODR*HF)+(ODL*TR)*TR)	COSTEX	333
	GO TO 120	COSTEX	334
C		COSTEX	335
C	EXTRUDED FINS WITHOUT LINER	COSTEX	336
105	TP = THKLIN(IGAGLI)	COSTEX	337
	ODR = ODL	COSTEX	338
	HF = (DFIN-ODR) / 2.	COSTEX	339
	WF = 37.69911*ROEF(IFINMA)*(THFIN*PF*HF*(ODR*HF) + (ODL-TP) * TR)	COSTEX	340
	GOTO 120.	COSTEX	341
C		COSTEX	342
C	PLATE FINS	COSTEX	343
110	ODR=ODL+2.*THFIN	COSTEX	344
	APLATE = XW*XD = 3.14159*ODR**2/4.0	COSTEX	345
	WF = 12.0*ROEF(IFINMA)*(APLATE*THFIN + 3.14159*ODR*ODR*THFIN/4.0)*	COSTEX	346
	\$ PF	COSTEX	347
	AR = 37.69911*ODL*PF*THFIN	COSTEX	348
	GO TO 121	COSTEX	349
120	IF(HF.GT.MAXFH(ODLIN,IFINTY,IFINMA)) PRINT 115	COSTEX	350
115	FORMAT(5X,"HEIGHT OF FIN IS LARGER THAN THE MAXIMUM ALLOWABLE VALU	COSTEX	351
	+E")	COSTEX	352
	IF (THFIN .LT. STANFT(ODLIN,IFINTY,1)) PRINT 116	COSTEX	353
116	FORMAT(5X,"FIN THICKNESS IS LESS THAN THE SPECIFIED LIMIT")	COSTEX	354
	IF (THFIN .GT. STANFT(ODLIN,IFINTY,2)) PRINT 117	COSTEX	355

SUBROUTINE COSTEX 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

117	FORMAT(5X,"FIN THICKNESS IS GREATER THAN THE SPECIFIED LIMIT")	COSTEX	356
	IF (PF .LT. FPL(IODLIN,IFINTY,IFINMA)) PRINT 118	COSTEX	357
118	FORMAT(5X,"FIN PITCH IS LESS THAN THE SPECIFIED LIMIT")	COSTEX	358
	IF (PF .GT. FPH(IODLIN,IFINTY,IFINMA)) PRINT 119	COSTEX	359
119	FORMAT(5X,"FIN PITCH IS GREATER THAN THE SPECIFIED LIMIT")	COSTEX	360
121	CONTINUE	COSTEX	361
	IF (FIRST) GOTO 125	COSTEX	362
C		COSTEX	363
C	COST OF BONDING THE FIN TO THE TUBING - IF THERE IS NO	COSTEX	364
C	BONDING TO BE DONE, CFB SHOULD BE EQUAL TO ZERO	COSTEX	365
	CFC = CFM(IFINTY,IFINMA)*WF*(CF(IFINTY)+CFB*AB)	COSTEX	366
C		COSTEX	367
C	PROTECTIVE COATING COSTS	COSTEX	368
C		COSTEX	369
C	IF A PROTECTIVE COATING IS NOT WANTED, COATC IS SET	COSTEX	370
C	EQUAL TO ZERO IN THE INPUT	COSTEX	371
C		COSTEX	372
	AS = ATOT * ELENG * Z * NW	COSTEX	373
	CPCC = COATC*AS	COSTEX	374
C		COSTEX	375
C	COST OF THE TUBING AND FINS PER FOOT	COSTEX	376
C		COSTEX	377
	FITCO = CLTC+CFC+CPCC	COSTEX	378
C		COSTEX	379
C*****	TUBE SPACER COSTS	COSTEX	380
C		COSTEX	381
	CSC = ZINCC * 0.1 * (XW**2 - ODR**2) * CASTC	COSTEX	382
C		COSTEX	383
C*****	END PREPARATION COSTS	COSTEX	384
C		COSTEX	385
	CEPREP = EPREPC	COSTEX	386
C		COSTEX	387
C*****	TOTAL COOLING SURFACE COSTS	COSTEX	388
C		COSTEX	389
	CS = Z*NW*(FITCO*ELENG+CSC*((ELENG-.5*SS)/SS)*CEPREP)	COSTEX	390
	CS = CS * POMBAF	COSTEX	391
C		COSTEX	392
C	DEFINING THE CASE FOR THE HEADER	COSTEX	393
C		COSTEX	394
125	IF (.NOT. FIRST) GOTO 145	COSTEX	395
	DO 130 I=1,4	COSTEX	396
	IHEDTY = I	COSTEX	397
	IF (HEDTYP .EQ. HEDTY(I)) GO TO 135	COSTEX	398
130	CONTINUE	COSTEX	399
	PRINT 131	COSTEX	400
	STOP	COSTEX	401
131	FORMAT(5X,"NO MATCH FOR HEADER TYPE")	COSTEX	402
135	DO 140 I=1,3	COSTEX	403
	IHEDMA=I	COSTEX	404
	IF (HEDMAT.EQ.HEDMA(I)) GOTO 142	COSTEX	405
140	CONTINUE	COSTEX	406
	PRINT 141	COSTEX	407
	STOP	COSTEX	408
141	FORMAT(5X,"NO MATCH FOR HEADER MATERIAL")	COSTEX	409
142	FIRST=.FALSE.	COSTEX	410
	RETURN	COSTEX	411
C		COSTEX	412

SUBROUTINE COSTEX 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C*****	HEADER AND NOZZEL COSTS	COSTEX	413
C		COSTEX	414
C	145 DI=ODL=2.*THKLIN(IGAGLI)	COSTEX	415
C		COSTEX	416
C	NUMBER OF TUBES PER BUNDLE	COSTEX	417
C	HEDTUB = 12.0*Z*WBB/XW	COSTEX	418
C		COSTEX	419
C	FLOW AREA PER TUBE BUNDLE PER PASS	COSTEX	420
C	FA = 0.785398*DI*DI*HEDTUB/HXNP	COSTEX	421
C		COSTEX	422
C	HEADER SIZE MATERIAL CORRECTION FACTOR	COSTEX	423
C	F = SQRT(FA*0.5)/7.0	COSTEX	424
C		COSTEX	425
C	NUMBER OF BUNDLES IN THE COOLING TOWERS	COSTEX	426
C	XNBUN = NW*XW/(12.0*WBB)	COSTEX	427
C		COSTEX	428
C	NUMBER OF TUBE ROWS PER PASS	COSTEX	429
C	RP = Z/HXNP	COSTEX	430
C		COSTEX	431
C	HEADER DEPTH	COSTEX	432
C	HD = (XD*RP + 1.0)*HXNP + 2.0*F*TW	COSTEX	433
C		COSTEX	434
C	HEADER WIDTH	COSTEX	435
C	HW = FA/(2.0*XD*RP + 1.0)	COSTEX	436
C		COSTEX	437
C	LONGITUDINAL WELD FACTOR	COSTEX	438
C	A = 4.0*(HXNP + 1.0)	COSTEX	439
C	IF(IHEDTY .EQ. 3 .OR. IHEDTY .EQ. 4) A = 4.0*HXNP	COSTEX	440
C		COSTEX	441
C	THICKNESS OF THE HEADER WALL	COSTEX	442
C	IF(TW .GT. 0.00) GO TO 146	COSTEX	443
C	PRESS = 250.0	COSTEX	444
C	TWA = 0.500 + 0.0014*PRESS	COSTEX	445
C	IF(IHEDMA .EQ. 2) TWA = 0.500 + 0.0027*PRESS	COSTEX	446
C	TW = TWA	COSTEX	447
C	146 CONTINUE	COSTEX	448
C		COSTEX	449
C	HOLE FACTOR	COSTEX	450
C	B = 1.0	COSTEX	451
C	IF(IHEDTY .EQ. 2 .OR. IHEDTY .EQ. 4) B = 2.5	COSTEX	452
C		COSTEX	453
C	COST OF NOZZEL AND ATTACHING	COSTEX	454
C	CN = 5.0 + 4.0*SQRT(FA/3.14159)	COSTEX	455
C		COSTEX	456
C	COST OF HEADERS	COSTEX	457
C		COSTEX	458
C	CHP = CHMAT(IHEDMA)*ROEHM(IHEDMA)*((12.0*WBB*(4.0*HD + 2.0*	COSTEX	459
C	+ (HXNP + 1.0)*HW) + 2.0*HXNP*FA)*F*TW + CMW*(A*WBB + (8.0*HD +	COSTEX	460
C	+ 4.0*(HXNP + 1.0)*HW)/12.0) + 4.0*CBJ*(HD/12.0 + WBB) +	COSTEX	461
C	+ CHH*B*HEDTUB + 4.0*CN*SQRT(FA/3.14159)	COSTEX	462
C	CH = CHP*XNBUN*POHBAF	COSTEX	463
C	IF (WB .GT. 14.0) PRINT 150	COSTEX	464
C	150 FORMAT(5X,"THE SPECIFIED HEADER LENGTH IS BEYOND THE PRACTICAL LIM	COSTEX	465
C	+IT")	COSTEX	466
C		COSTEX	467
C	BUNDLE STIFFNER COSTS FOR PLATE FIN BUNDLES	COSTEX	468
C		COSTEX	469

SUBROUTINE COSTEX

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

IF (IFINTY .NE. 6) GO TO 160	COSTEX	470
CSP = CPBS*(XW*HD/Z)*TSP*ROEHM(IHEDMA) + CSHP	COSTEX	471
NSECT = ELENG/SEGL	COSTEX	472
CSTIF = CSP*(ELENG/SS)*HEDTUB*XNBUN*POHBAF	COSTEX	473
C	COSTEX	474
SECTION JOINT COST	COSTEX	475
C	COSTEX	476
CSJ = (2.0*(CPSJ(IHEDMA)*(XW*HD/Z)*TW*ROEHM(IHEDMA) + CSHP)*	COSTEX	477
+ HEDTUB + 2.0*CBJ*(HD/12.0 + WBB))*NSECT*XNBUN*POHBAF	COSTEX	478
C	COSTEX	479
BUNDLE FRAME COST	COSTEX	480
C	COSTEX	481
CVF = CST*ELENG*(77.0 + 2.0*WBB) * XNBUN * POHBAF	COSTEX	482
C	COSTEX	483
ALUMINUM DRAIN PLATE COSTS	COSTEX	484
C	COSTEX	485
WP = 4.0	COSTEX	486
TP = 0.250	COSTEX	487
CDP = CPBS*ROEHM(2)*ELENG*WP*12.0*TP*XNBUN*POHBAF	COSTEX	488
C	COSTEX	489
BUNDLE ASSEMBLY COST	COSTEX	490
C	COSTEX	491
CRA = (CRJ + CWJ)*HEDTUB*NSECT*XNBUN*POHBAF	COSTEX	492
CA = CRA + CVF	COSTEX	493
C	COSTEX	494
C**** TOTAL COST OF THE PLATE FINNED HORIZONTAL HEAT EXCHANGER	COSTEX	495
C	COSTEX	496
CHX = CS + CH + CSTIF + CSJ + CVF + CDP + CRA	COSTEX	497
GO TO 170	COSTEX	498
C	COSTEX	499
C***** BUNDLE ASSEMBLE AND FRAME COSTS	COSTEX	500
C	COSTEX	501
160 CONTINUE	COSTEX	502
CA = HEDTUB*(CRJ + CWJ) + 20.0*ELENG*(2.0 + WBB/(2.0*SS))*	COSTEX	503
+ SQRT(Z/6.0)*CST	COSTEX	504
CA = CA + XNBUN * POHBAF	COSTEX	505
C	COSTEX	506
C**** TOTAL COST OF VERTICAL HEAT EXCHANGER BUNDLE	COSTEX	507
C	COSTEX	508
CHX = CA + CH + CS	COSTEX	509
C	COSTEX	510
C***** WEIGHT OF HEAT EXCHANGER	COSTEX	511
C	COSTEX	512
MATERIAL TUBE WEIGHT OF THE COOLING TOWER	COSTEX	513
170 WTTUB = Z*NW*ELENG*(WL + WF)	COSTEX	514
C	COSTEX	515
MATERIAL HEADER WEIGHT OF THE COOLING TOWER	COSTEX	516
WTHDR = ROEHM(IHEDMA)*TW*(24.0*(WBB*(HW + HD) + 12.0*HW*HD) +	COSTEX	517
+ FA)*XNRUN	COSTEX	518
C	COSTEX	519
TOTAL FRAME WEIGHT OF THE HEAT EXCHANGER	COSTEX	520
C	COSTEX	521
WTFRM = 20.0*ELENG*(2.0 + WBB/(2.0*SS))*SQRT(Z/6.0)*XNBUN	COSTEX	522
C	COSTEX	523
TOTAL WEIGHT OF WATER IN THE HEAT EXCHANGER	COSTEX	524
TUBVOL = Z*NW*ELENG*3.14159*DI*DI/(144.0*4.0)	COSTEX	525
HEDVOL = 2.0*HD*HW*WBB/144.0 * XNBUN	COSTEX	525
WATERW = TUBVOL*DENSIV + (HEDVOL/2.)*DENSIV + (HEDVOL/2.)*DENSIV	COSTEX	526

SUBROUTINE COSTEX 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C
C WEIGHT OF THE HEAT EXCHANGER
C WHX = WTTUB + WTHDR + WTERM
C
C RETURN
C END

COSTEX 527
COSTEX 528
COSTEX 529
COSTEX 530
COSTEX 531
COSTEX 532

SUBROUTINE DELBAW

SUBROUTINE DELBAW CALCULATES THE HEAT TRANSFER AND THE WATER EVAPORATED FOR A DELUGED HEAT EXCHANGER. THE B AND W COMPUTATIONAL METHOD IS USED. THE DRIVING FORCE USED TO CALCULATE THE HEAT TRANSFER IS THE ENTHALPY (BTU/LB OF DRY AIR) AS IS COMMONLY USED IN WET TOWER DESIGN METHODS. ALL CONDUCTIVE AND CONVECTIVE TERMS ARE APPROPRIATELY TRANSFORMED FROM A LINEAR TEMPERATURE DEPENDENCE TO A ENTHALPIC DEPENDENCE.

SUBROUTINE DELBAW OBTAINS THE HEAT TRANSFER BY TAKING THE AVERAGE OF THE NUMBER OF TRANSFER UNITS AT THE LEADING EDGE AND AT THE TRAILING EDGE OF THE HEAT EXCHANGER AND CALCULATING A HEAT EXCHANGER EFFECTIVENESS. THIS EFFECTIVENESS IS THEN USED TO DETERMINE THE HEAT TRANSFERRED AND THE OUTLET TEMPERATURE OF THE AIR. THE EVAPORATION RATE OF WATER IS OBTAINED FROM THE CHANGE IN ABSOLUTE HUMIDITY OF THE AIR AND FROM THE MASS FLOWRATE OF THE AIR.

THE COMPUTATION OF THE EXIT CONDITIONS OF THE AIR EXITING THE HEAT EXCHANGER IS CONDUCTED BY SUCCESSIVE APPROXIMATIONS.

A NOMENCLATURE OF SOME OF THE MORE FREQUENTLY USED TERMS FOLLOWS.

AB - AREA OF THE TUBES BETWEEN THE FINS, SQ. FT.
 AF - AREA OF THE FINS, SQ. FT.
 AHI - ABSOLUTE HUMIDITY OF SATURATED AIR AT THE TUBESIDE TEMPERATURE, LB OF WATER/LB OF AIR
 AHIN - ABSOLUTE HUMIDITY OF THE AIR ENTERING THE HEAT EXCHANGER, LB. WATER/LB. AIR
 AHLVG - ABSOLUTE HUMIDITY OF THE AIR LEAVING THE HEAT EXCHANGER, LB OF WATER/LB OF AIR
 AHWB - ABSOLUTE HUMIDITY OF SATURATED AIR AT THE WET BULB TEMPERATURE, LB OF WATER/LB OF AIR
 AII - TUBESIDE AREA, SQ. FT.
 ATM - BAROMETRIC PRESSURE, ATMOSPHERES
 AW - AVERAGE TUBE WALL AREA, SQ. FT.
 RETAF - AIR SIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
 BETAI - TUBESIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
 CSI - HEAT CAPACITY OF SATURATED AIR AT THE TUBESIDE TEMPERATURE, BTU/LB. OF DRY AIR-F
 CSIN - HEAT CAPACITY OF THE AIR ENTERING THE HEAT EXCHANGER, BTU/LB OF DRY AIR-F
 CSLVG - HEAT CAPACITY OF THE AIR LEAVING THE HEAT EXCHANGER, BTU/LB. OF DRY AIR-F
 CSWB - SPECIFIC HEAT OF SATURATED AIR AT THE WET BULB TEMPERATURE, BTU/LB OF DRY AIR-DEG F
 DI - INSIDE DIAMETER OF TUBE, FT.
 ODL - OUTSIDE DIAMETER OF TUBE LINER, FT.
 EFF - DELUGED HEAT EXCHANGER EFFECTIVENESS

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

C		(EQUAL TO THE DIFFERENCES BETWEEN THE ENTHALPY	DELBAW	59
C		OF THE EXITING AND ENTERING AIR DIVIDED BY THE	DELBAW	60
C		DIFFERENCE BETWEEN THE ENTHALPY OF SATURATED	DELBAW	61
C		AIR AT THE TUBESIDE TEMPERATURE AND THE	DELBAW	62
C		ENTHALPY OF THE ENTERING AIR), DIMENSIONLESS.	DELBAW	63
C	FDQ	- QUANTITY USED FOR CONVERGENCE TEST, EQUAL TO	DELBAW	64
C		THE DIFFERENCE IN THE WATER EVAPORATION RATE	DELBAW	65
C		COMPUTED BY THE CURRENT AND BY THE PREVIOUS	DELBAW	66
C		ITERATION, DIVIDED BY THE WATER EVAPORATION	DELBAW	67
C		RATE COMPUTED BY THE CURRENT ITERATION,	DELBAW	68
C		DIMENSIONLESS.	DELBAW	69
C			DELBAW	70
C	HD	- METAL TO DELUGEATE HEAT TRANSFER COEFFICIENT,	DELBAW	71
C		BTU/HR-SQ.FT.-F	DELBAW	72
C	HI	- TUBESIDE HEAT TRANSFER COEFFICIENT, BTU/HR-SQ.	DELBAW	73
C		FT.-F	DELBAW	74
C	PPI	- PARTIAL PRESSURE OF WATER AT SATURATION AT THE	DELBAW	75
C		TUBESIDE TEMPERATURE, IN. HG.	DELBAW	76
C	PPIN	- PARTIAL PRESSURE OF WATER IN THE ENTERING	DELBAW	77
C		AIR, IN. HG.	DELBAW	78
C	PPLVG	- PARTIAL PRESSURE OF WATER IN THE AIR LEAVING	DELBAW	79
C		THE HEAT EXCHANGER, IN. HG.	DELBAW	80
C	PPWB	- PARTIAL PRESSURE OF WATER AT THE WET BULB	DELBAW	81
C		TEMPERATURE (SATURATED CONDITIONS) IN. HG.	DELBAW	82
C	PSATIN	- PARTIAL PRESSURE OF SATURATED AIR AT THE	DELBAW	83
C		TEMPERATURE OF THE ENTERING AIR, IN-HG	DELBAW	84
C	QSEC	- HEAT TRANSFER RATE, LB/HR.	DELBAW	85
C	QSEC1	- HEAT TRANSFER RATE COMPUTED BY CURRENT	DELBAW	86
C		ITERATION, LB/HR.	DELBAW	87
C	QSEC2	- HEAT TRANSFER RATE COMPUTED BY PREVIOUS	DELBAW	88
C		ITERATION, LB/HR.	DELBAW	89
C	RHIN	- RELATIVE HUMIDITY OF THE AIR	DELBAW	90
C		ENTERING THE HEAT EXCHANGER	DELBAW	91
C	RHLVG	- RELATIVE HUMIDITY OF THE AIR LEAVING THE	DELBAW	92
C		HEAT EXCHANGER	DELBAW	93
C	RHOUT	- RELATIVE HUMIDITY OF THE EXITING AIR,	DELBAW	94
C		DIMENSIONLESS	DELBAW	95
C	RII	- ENTHALPY OF THE SATURATED AIR AT THE TUBESIDE	DELBAW	96
C		TEMPERATURE BTU/LB. OF DRY AIR	DELBAW	97
C	RIIN	- ENTHALPY OF THE ENTERING AIR, BTU / LB	DELBAW	98
C		OF DRY AIR	DELBAW	99
C	RIL	- ENTHALPY OF THE AIR LEAVING THE HEAT	DELBAW	100
C		EXCHANGER, BTU/LB OF DRY AIR	DELBAW	101
C	RILOUT	- ESTIMATE OF THE ENTHALPY OF THE AIR LEAVING	DELBAW	102
C		THE HEAT EXCHANGER, BTU/LB OF DRY AIR	DELBAW	103
C	RILVG	- ENTHALPY OF THE AIR LEAVING THE HEAT EXCHANGER,	DELBAW	104
C		BTU/LB OF DRY AIR	DELBAW	105
C	RIMAX	- ENTHALPY OF SATURATED AIR AT TMAX, BTU/LB	DELBAW	106
C		OF DRY AIR	DELBAW	107
C	RIMIN	- ENTHALPY OF SATURATED AIR AT TMIN, BTU/BL	DELBAW	108
C		OF DRY AIR	DELBAW	109
C	RIWB	- ENTHALPY OF SATURATED AIR AT TWBIN, BTU/LB	DELBAW	110
C		OF DRY AIR	DELBAW	111
C		LB/HR	DELBAW	112
C	RKW	- THERMAL CONDUCTIVITY OF THE TUBE WALL, BTU/HR-	DELBAW	113
C		SQ.FT.-F/FT.	DELBAW	114
C	RMA	- MASS FLOW RATE OF AIR, LB/HR	DELBAW	115

C	RMEVAP - WATER EVAPORATION RATE, LB/HR	DELBAW	116
C	RMEVAP1- WATER EVAPORATION RATE COMPUTED DURING CURRENT	DELBAW	117
C	ITERATION, LB/HR	DELBAW	118
C	RMEVAP2- WATER EVAPORATION RATE COMPUTED DURING PREVIOUS	DELBAW	119
C	ITERATION, LB/HR	DELBAW	120
C	RNTUAV - ARITHMETIC AVERAGE OF THE NUMBER OF (DELUGE)	DELBAW	121
C	TRANSFER UNITS AT THE LEADING AND AT THE	DELBAW	122
C	TRAILING EDGE OF THE HEAT EXCHANGER,	DELBAW	123
C	DIMENSIONLESS	DELBAW	124
C	RNTUIN - NUMBER OF (DELUGE) TRANSFER UNITS AT THE	DELBAW	125
C	LEADING EDGE OF THE HEAT EXCHANGER,	DELBAW	126
C	DIMENSIONLESS	DELBAW	127
C	RNTULV - NUMBER OF (DELUGE) TRANSFER UNITS AT THE	DELBAW	128
C	TRAILING EDGE OF THE HEAT EXCHANGER,	DELBAW	129
C	DIMENSIONLESS	DELBAW	130
C	SIGIN - TUBESIDE TO AIR MASS TRANSFER COEFFICIENT	DELBAW	131
C	EVALUATED FOR CONDITIONS AT THE LEADING EDGE	DELBAW	132
C	OF THE HEAT EXCHANGER, LB MASS/SQ.FT.-HR	DELBAW	133
C	SIGLVG - TUBESIDE TO AIR MASS TRANSFER COEFFICIENT	DELBAW	134
C	EVALUATED FOR CONDITIONS AT THE TRAILING	DELBAW	135
C	EDGE OF THE HEAT EXCHANGER,	DELBAW	136
C	LB. OF DRY AIR/SQ.FT.-HR	DELBAW	137
C	SIGMA - MASS TRANSFER COEFFICIENT BETWEEN THE DELUGEATE	DELBAW	138
C	AND THE AIR, LB. OF DRY AIR/SQ.FT.-HR.	DELBAW	139
C	T - TEMPERATURE, DEG. F.	DELBAW	140
C	TAIN - TEMPERATURE OF THE AIR ENTERING THE HEAT	DELBAW	141
C	EXCHANGER, F	DELBAW	142
C	TAL - TEMPERATURE OF THE AIR LEAVING THE HEAT	DELBAW	143
C	EXCHANGER, F	DELBAW	144
C	TEST - ESTIMATE OF TEMPERATURE USED AS AN A FIRST	DELBAW	145
C	APPROXIMATION BY SUBROUTINE TCAIC	DELBAW	146
C	THW - TUBE WALL THICKNESS, FT.	DELBAW	147
C	TI - TUBESIDE TEMPERATURE	DELBAW	148
C	TMAX - MAXIMUM TEMPERATURE ALLOWED DUE TO CONSTRAINTS	DELBAW	149
C	UPON THE ANALOGY UPON WHICH THE HEAT TRANSFER	DELBAW	150
C	CALCULATION IS BASED, F	DELBAW	151
C	TMIN - MINIMUM TEMPERATURE ALLOWED TO PREVENT	DELBAW	152
C	POSSIBLE INSTABILITIES WITHIN THE	DELBAW	153
C	SUBROUTINES, F	DELBAW	154
C	TOUT - TEMPERATURE OF AIR LEAVING THE HEAT EX-	DELBAW	155
C	CHANGER, DEG. F	DELBAW	156
C	TWBIN - WET BULB TEMPERATURE OF THE AIR ENTERING THE	DELBAW	157
C	HEAT EXCHANGER, DEG. F	DELBAW	158
	LOGICAL FRST1, FRST2, FRST3	DELBAW	159
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
	* ,BPLIM(16)	BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	\$,CBJ, CTURR, CDANG, CLUVR, CHAITS, CVM	BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFP, EFS	BIGCOM	9
	\$,FCR,FIRST,FXIL,FCDS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FIXTDD,FXTVAR,FXTTDD,FXTLNG	BIGCOM	11
	\$,GREFF	BIGCOM	12
	\$,HXNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14

\$,JCONS	BIGCOM	15
\$,KCONV, KALEXT	BIGCOM	16
\$,MXEXT	BIGCOM	17
\$,NTA,NSIDES,NBUNHI	BIGCOM	18
COMMON	BIGCOM	19
\$ ODR	BIGCOM	20
\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
\$,RPP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
\$,SIGMAG, SAAF, SEGL	BIGCOM	25
\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
\$,TCD, TW	BIGCOM	27
\$,UCS, UWS	BIGCOM	28
\$,WFW, WATCONA, WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDIPA, XW, XD	BIGCOM	31
COMMON/DLUG/TAIN,TWBIN,TI,ATM,HI,SIGMA,RMA,QSEC,RMEVAP,VALREQ	DELBAW	161
COMMON/HXD/AI,ATOT,SFA,RFA,ACS	DELBAW	162
COMMON/DJB/DI,XDG,SF	DELBAW	163
COMMON/SURFEX/ODL,DUMLST(15)	DELBAW	164
COMMON/COUNT/NSLOPE,FRST3	DELBAW	165
COMMON /WETDRY/ NCYCLE,TMAX,RIMAX,TMIN,RIMIN	DELBAW	166
COMMON/RPRT4/R4(672),RR(3)	DELBAW	167
COMMON/CONS/HD,BETAF,BETAI,AB,AF,AII,AW,THW,RKW	DELBAW	168
DIMENSION TAL(10),RIL(10)	DELBAW	169
FP(2H,T) = RH*29.92*(0.000203*((T - 32.)/1.8)**2	DELBAW	170
+ - 0.0119*(T - 32.)/1.8 + 1.095)	DELBAW	171
+ *EXP(- 0.000426*((T - 32.)/1.8)**2	DELBAW	172
+ + 0.0828*(T - 32.)/1.8 - 5.163)	DELBAW	173
C FP(RH,T)=RH*EXP(17.168-9240./(T+460.))	DELBAW	174
FAH(P,ATM)=P*18.02/((ATM*29.92-P)*28.97)	DELBAW	175
FCS(AH)=.24+.45*AH	DELBAW	176
FDI(CS,T,AH)=CS*T+.1094.*AH	DELBAW	177
C	DELBAW	178
C	DELBAW	179
FRST1 = .T.	DELBAW	180
FRST2 = .T.	DELBAW	181
NDEBUG6 = 0	DELBAW	182
RHLVG = RHOUT	DELBAW	183
HD = HCD	DELBAW	184
AR = RFA*VALREQ	DELBAW	185
AF = SFA*VALREQ	DELBAW	186
AII = AI*VALREQ	DELBAW	187
THW = (ODL - DI)/12.	DELBAW	188
RKW = CONL	DELBAW	189
AW = (ODL + DI)/24.*VALREQ*3.14159	DELBAW	190
C	DELBAW	191
C	DELBAW	192
C	DELBAW	193
IF(NDEBUG6.EQ.1) WRITE(6,150)	DELBAW	194
150 FORMAT(1X,"TAIN,TWBIN,TI,ATM,RHLVG,HD,BETAF,AB",/,1X,	DELBAW	195
\$"AF,AI,HI,THW,RKW,SIGMA,RMA,BETAI",/,1X,"AW",///)	DELBAW	196
IF(NDEBUG6.EQ.1) WRITE(6,200) TAIN,TWBIN,TI,ATM,RHLVG,HD,BETAF,AB,	DELBAW	197
1AF,AII,HI,THW,RKW,SIGMA,RMA,BETAI,AW	DELBAW	198
200 FORMAT(1H0,1P8E11.3//1X,8E11.3//1X,8E11.3	DELBAW	199
C	DELBAW	200

C	THE MINIMUM AND MAXIMUM TEMPERATURES WITH THE CORRESPONDING	DELBAW	201
C	ENTHALPIES ARE COMPUTED IN SUBROUTINE LIMIT.	DELBAW	202
C	IF TAIN LIES OUTSIDE THESE BOUNDS THE COMPUTATION IS ABORTED.	DELBAW	203
C		DELBAW	204
	IF(FRST) CALL LIMIT(ATM,TMAX,RIMAX,TMIN,RIMIN)	DELBAW	205
	FRST = .F.	DELBAW	206
	IF(TAIN.LE.TMIN .OR. TAIN.GE.TMAX) WRITE(6,5) TAIN	DELBAW	207
	IF(TI.LE.TMIN .OR. TI.GE.TMAX) WRITE(6,7) TI	DELBAW	208
	IF(TI.LE.TMIN.OR.TI.GE.TMAX) KCONV = 1	DELBAW	209
	IF(TAIN.LE.TMIN.OR.TAIN.GE.TMAX) KCONV = 1	DELBAW	210
	IF(KCONV.EQ.1) RETURN	DELBAW	211
	5 FORMAT('0TAIN IS LESS THAN TMIN OR GREATER THAN TMAX IN DELUGE "	DELBAW	212
	5 , "TAIN=",1PE13.5)	DELBAW	213
	7 FORMAT('0TI IS LESS THAN TMIN OR GREATER THAN TMAX IN DELUGE. "	DELBAW	214
	5 , "TI=",1PE13.5)	DELBAW	215
C		DELBAW	216
C	PROPERTIES OF THE INLET AIR ARE COMPUTED.	DELBAW	217
C		DELBAW	218
	PPWR=FP(1.,TWBIN)	DELBAW	219
	AHWR=FAH(PPWR,ATM)	DELBAW	220
	CSWR=FCS(AHWR)	DELBAW	221
	RIWR=FRI(CSWR,TWBIN,AHWR)	DELBAW	222
	RIIN=RIWR	DELBAW	223
	AHIN=(RIIN-.24*TAIN)/(.45*TAIN+1094.)	DELBAW	224
	CSIN=.24+.45*AHIN	DELBAW	225
	PPIN=(AHIN*ATM*866.78240)/(18.02+AHIN*28.97)	DELBAW	226
	T = TAIN	DELBAW	227
	PSATIN = 29.92*(0.000203*((T - 32.)/1.8)**2	DELBAW	228
	+ - 0.0118*(T - 32.)/1.8 + 1.095)	DELBAW	229
	+ *EXP(- 0.000426*((T - 32.)/1.8)**2	DELBAW	230
	+ + 0.0928*(T - 32.)/1.8 + 5.163)	DELBAW	231
C	PSATIN=EXP(17.168-9240./(TAIN+460.))	DELBAW	232
	RHIN=PPIN/PSATIN	DELBAW	233
C		DELBAW	234
C	THE HEAT TRANSFER COEFFICIENT AT THE LEADING EDGE IS COMPUTED	DELBAW	235
C		DELBAW	236
	PPI=FP(1,0,TI)	DELBAW	237
	AHI=FAH(PPI,ATM)	DELBAW	238
	CSI=FCS(AHI)	DELBAW	239
	RII=FRI(CSI,TI,AHI)	DELBAW	240
	CALL SIGBAW(TAIN,RIIN,ATM,HD,BETAF,AR,AF,AII,AW,HI,BETAI,	DELBAW	241
	STHW,RKW,TI,RII,SIGMA,SIGIN,FRST1,KCONV,0)	DELBAW	242
	IF(KCONV.EQ.1) RETURN	DELBAW	243
C		DELBAW	244
C	THE NUMBER OF HEAT TRANSFER UNITS (BASED ON ENTHALPY DRIVING	DELBAW	245
C	FORCE) BASED ON CONDITIONS AT THE LEADING EDGE ARE COMPUTED.	DELBAW	246
C		DELBAW	247
	RNTUIN=SIGIN*(AB+AF)/RMA	DELBAW	248
	N = 0	DELBAW	249
C		DELBAW	250
C	ESTIMATION THE EXIT TEMPERATURE AND ENTHALPY OF THE AIR	DELBAW	251
C	LEAVING THE HEAT EXCHANGER	DELBAW	252
C		DELBAW	253
	IF(NSLOPE .LE. 2) GO TO 90	DELBAW	254
C		DELBAW	255
C	TEMPERATURE	DELBAW	256
	TA3 = TAIN	DELBAW	257

SUBROUTINE DELBAW 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	SLOPE = (TOUT2 - TOUT1)/(TA2 - TA1)	DELBAW	258
	TOUT3 = TOUT2 + SLOPE*(TA3 - TA2)	DELBAW	259
	TOUT = TOUT3	DELBAW	260
C		DELBAW	261
C	ENTHALPY	DELBAW	262
	RILOUT = RILOU1	DELBAW	263
	GO TO 110	DELBAW	264
90	CONTINUE	DELBAW	265
	IF(NSLOPE .LE. 1) GO TO 100	DELBAW	266
C		DELBAW	267
C	TEMPERATURE	DELBAW	268
	TOUT = TOUT2	DELBAW	269
C		DELBAW	270
C	ENTHALPY	DELBAW	271
	RILOUT = RILOU1	DELBAW	272
	GO TO 110	DELBAW	273
100	EFF = 1.0 - EXP(-RNTUIN)	DELBAW	274
	RILOUT = RIIN + EFF*(RII - RIIN)	DELBAW	275
	TEST = TAIN + 0.6*(TI - TAIN)	DELBAW	276
C		DELBAW	277
C	TEMPERATURE OF THE AIR LEAVING THE HEAT EXCHANGER OBTAINED	DELBAW	278
C	FROM TCALC (FROM A KNOWLEDGE OF ENTHALPY OF THE EXITING AIR).	DELBAW	279
C		DELBAW	280
	CALL TCALC(RILOUT,RHLVG,ATM,TEST,TDUM,"DLG AOUT ",KCONV)	DELBAW	281
	IF(KCONV.EQ.1) RETURN	DELBAW	282
	TOUT = TDUM	DELBAW	283
110	CONTINUE	DELBAW	284
	IF(NDRUG6.EQ.1)	DELBAW	285
	WRITE(6,410) TAIN,TA1,TA2,TA3,TOUT1,TOUT2,TOUT3,SLOPE,RILOUT	DELBAW	286
410	FORMAT(5X,"TAIN,TA1,TA2,TA3,TOUT1,TOUT2,TOUT3,SLOPE,RILOUT",	DELBAW	287
	+1P8E14.5,/1P8E14.5/)	DELBAW	288
	IF(NDRUG6.EQ.1)	DELBAW	289
	WRITE(6,460) RNTUIN,EFF,RIIN,RII,RILOUT,TAIN,TI,TOUT	DELBAW	290
460	FORMAT(5X,"RNTUIN,EFF,RIIN,RII,RILOUT,TAIN,TI,TOUT",/5X,	DELBAW	291
	+1P8E14.4/)	DELBAW	292
C		DELBAW	293
C	PROPERTIES OF EXITING AIR COMPUTED.	DELBAW	294
C		DELBAW	295
	PPLVG=FP(RHLVG,TOUT)	DELBAW	296
	AHLVG=FAH(PPLVG,ATM)	DELBAW	297
	CSLVG=FCS(AHLVG)	DELBAW	298
	RILVG=FRI(CSLVG,TOUT,AHLVG)	DELBAW	299
C		DELBAW	300
C	START OF ITERATION LOOP FOR EXITING CONDITIONS	DELBAW	301
C		DELBAW	302
10	CONTINUE	DELBAW	303
	N = N + 1	DELBAW	304
	TAL(N) = TDUM	DELBAW	305
C		DELBAW	306
C	THE HEAT TRANSFER COEFFICIENT AT THE TRAILING EDGE IS	DELBAW	307
C	COMPUTED.	DELBAW	308
C		DELBAW	309
	CALL SIGRAW(TOUT,RILVG,ATM,HD,BETAF,AB,AF,AII,AW,HI,BETAI,	DELBAW	310
	STHW,RKW,TI,RII,SIGMA,SIGLVG,FRST2,KCONV,1	DELBAW	311
	IF(KCONV.EQ.1) RETURN	DELBAW	312
C		DELBAW	313
C	THE NUMBER OF HEAT TRANSFER UNITS BASED ON CONDITIONS AT THE	DELBAW	314

C	TRAILING EDGE IS COMPUTED.	DELBAW	315
	RNTULV=SIGLVG*(AB+AF)/RMA	DELBAW	316
C		DELBAW	317
C	THE AVERAGE NO. OF HEAT TRANSFER UNITS IS CALCULATED.	DELBAW	318
C		DELBAW	319
	RNTUAV=(RNTUIN+RNTULV)/2.	DELBAW	320
C		DELBAW	321
C	THE ENTHALPY AND TEMPERATURE OF THE AIR EXITING THE	DELBAW	322
C	HEAT EXCHANGER IS COMPUTED.	DELBAW	323
C		DELBAW	324
	EFF = 1.-EXP(-RNTUAV)	DELBAW	325
	RILVG=RIIN + EFF*(RII-RIIN)	DELBAW	326
	RIL(N)=RILVG	DELBAW	327
	TEST = TDUM	DELBAW	328
	CALL TCALC(RILVG,RHLVG,ATM,TEST,TDUM,"DLG TAL(N)",KCONV)	DELBAW	329
	IF(KCONV.EQ.1) RETURN	DELBAW	330
	TOUT = TDUM	DELBAW	331
	TAL(N)=TDUM	DELBAW	332
C		DELBAW	333
C	PROPERTIES OF EXITING AIR ARE COMPUTED	DELBAW	334
C		DELBAW	335
	PPLVG = FP(RHLVG,TOUT)	DELBAW	336
	AHLVG = FAH(PPLVG,ATM)	DELBAW	337
	CSLVG = FCS(AHLVG)	DELBAW	338
	IF(N.EQ.1) QSEC1 = RMA*(PILVG - RIIN)	DELBAW	339
	IF(N.EQ.1) RMEVA1 = RMA*(AHLVG - AHIN)	DELBAW	340
	IF(N.EQ.1) GO TO 10	DELBAW	341
C		DELBAW	342
C	THE HEAT TRANSFER AND WATER EVAPORATION OF THE HEAT EXCHANGER	DELBAW	343
C	IS COMPUTED.	DELBAW	344
C		DELBAW	345
	QSEC2 = QSEC1	DELBAW	346
	RMEVA2 = RMEVA1	DELBAW	347
	QSEC1 = RMA*(RILVG - RIIN)	DELBAW	348
	RMEVA1 = RMA*(AHLVG - AHIN)	DELBAW	349
C		DELBAW	350
C	THE CHANGE IN HEAT REJECTED AND WATER EVAPORATED FROM THE	DELBAW	351
C	PREVIOUS ITERATION.	DELBAW	352
C		DELBAW	353
	FDQ = ABS(QSEC1 - QSEC2)/QSEC1	DELBAW	354
	FDM = ABS(RMEVA1 - RMEVA2)/RMEVA1	DELBAW	355
	IF(NDEBUG.EQ.1) WRITE(6,280)	DELBAW	356
280	FORMAT(1X,"N,TAL(N),RIL(N),FDQ,FDM,EFF,RNTUIN,RNTULV")	DELBAW	357
	IF(NDEBUG.EQ.1) WRITE(6,300) N,TAL(N),RIL(N),FDQ,FDM,EFF,RNTUIN,	DELBAW	358
	1RNTULV	DELBAW	359
300	FORMAT(1X,"FROM DELBAW \$300",I5,7E16.7//)	DELBAW	360
C		DELBAW	361
C	PROTECTION AGAINST EXCESSIVE NUMBER OF ITERATIONS.	DELBAW	362
	IF(N.GE.10)WRITE(6,350)N	DELBAW	363
350	FORMAT("UPPER ITERATION LIMIT REACHED IN DELUGE N=" I5)	DELBAW	364
	IF(N.GE.10) KCONV = 1	DELBAW	365
	IF(N.GE.10) RETURN	DELBAW	366
C		DELBAW	367
C	CONVERGENCE CRITERIA USING HEAT REJECTED AND MASS FLOW	DELBAW	368
C	RATE OF WATER EVAPORATED.	DELBAW	369
	IF(FDQ.GT. 0.001 .OR. FDM.GT. 0.001) GO TO 10	DELBAW	370
360	CONTINUE	DELBAW	371

SUBROUTINE DELBAW

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

C
C      STORAGE OF VARIABLES FOR EXTRAPOLATION TO THE NEXT
C      AMBIENT AIR CONDITIONS
C
      IF(.NOT.FRST3) GO TO 370
      TOUT1 = TOUT2
      TA1 = TA2
      TA2 = TAIN
370  TOUT2 = TOUT
      RLOU1 = RILVG
      ISL = (NSLOPE - 1)*26
      R4(ISL + 1) = TAIN
      R4(ISL + 2) = RIIN
      R4(ISL + 13) = AHIN
      R4(ISL + 14) = TOUT
      R4(ISL + 15) = RILVG
      R4(ISL + 24) = QSEC1
      R4(ISL + 25) = RMEVA1
      R4(ISL + 26) = AHLVG
      RR(1) = ATM
      RR(2) = RMA
      RR(3) = NSLOPE
      QSEC = QSEC1
      RMEVAP = RMEVA1
      FRST3 = .FALSE.
C
C      OUTPUT STATEMENTS.
C
      IF(NDRUG6.NE.1) RETURN
      DO 390 J=1,N
      WRITE(6,395)J,TAL(J),RIL(J)
390  CONTINUE
395  FORMAT(1X,"N,TAL(N) AND RIL(N)= ",15,1P2E17.8)
      WRITE(6,375)
375  FORMAT(1X,"N,QSEC,RMEVAP,UDIN,UDLVG,RNTUAV")
      WRITE(6,400)N,QSEC,RMEVAP,SIGIN,SIGLVG,RNTUAV
400  FORMAT(1X,"LEAVING DELBAW $400",1P5E15.6)
      WRITE(6,450)
450  FORMAT(1X,///)
      RETURN
      END

```

```

DELBAW 372
DELBAW 373
DELBAW 374
DELBAW 375
DELBAW 376
DELBAW 377
DELBAW 378
DELBAW 379
DELBAW 380
DELBAW 381
DELBAW 382
DELBAW 383
DELBAW 384
DELBAW 385
DELBAW 386
DELBAW 387
DELBAW 388
DELBAW 389
DELBAW 390
DELBAW 391
DELBAW 392
DELBAW 393
DELBAW 394
DELBAW 395
DELBAW 396
DELBAW 397
DELBAW 398
DELBAW 399
DELBAW 400
DELBAW 401
DELBAW 402
DELBAW 403
DELBAW 404
DELBAW 405
DELBAW 406
DELBAW 407
DELBAW 408
DELBAW 409
DELBAW 410
DELBAW 411
DELBAW 412

```


SUBROUTINE DELUG

SUBROUTINE DELUG CALCULATES THE HEAT TRANSFER AND THE WATER EVAPORATION RATES FOR A DELUGED HEAT EXCHANGER. THE COMPUTATIONAL METHOD DEVELOPED BY D.K. KRIED AND EXTENDED TO FIN TUBES BY D. W. FALETTI IS USED. THE DRIVING FORCE USED TO CALCULATE THE HEAT TRANSFER IS THE ENTHALPY (BTU/LB OF DRY AIR) AS IS COMMONLY USED IN WET TOWER DESIGN METHOD DIVIDED BY THE HEAT CAPACITY OF AIR. ALL CONDUCTIVE AND CONVECTIVE TERMS ARE APPROPRIATELY TRANSFORMED FROM A LINEAR TEMPERATURE DEPENDENCE TO A ENTHALPIC DEPENDENCE.

SUBROUTINE DELUG OBTAINS THE HEAT TRANSFER BY TAKING THE AVERAGE OF THE NUMBER OF TRANSFER UNITS AT THE LEADING EDGE AND AT THE TRAILING EDGE OF THE HEAT EXCHANGER AND CALCULATING A HEAT EXCHANGER EFFECTIVENESS. THIS EFFECTIVENESS IS THEN USED TO DETERMINE THE HEAT TRANSFERRED AND THE OUTLET TEMPERATURE OF THE AIR. THE EVAPORATION RATE OF WATER IS OBTAINED FROM THE CHANGE IN ABSOLUTE HUMIDITY OF THE AIR AND FROM THE MASS FLOWRATE OF THE AIR.

THE COMPUTATION OF THE CONDITIONS OF THE AIR EXITING THE HEAT EXCHANGER IS CONDUCTED BY SUCCESSIVE APPROXIMATIONS.

A NOMENCLATURE OF SOME OF THE MORE FREQUENTLY USED TERMS FOLLOWS.

AB - AREA OF THE TUBES BETWEEN THE FINS, SQ. FT.
 AF - AREA OF THE FINS, SQ. FT.
 AHIN - ABSOLUTE HUMIDITY OF THE AIR ENTERING THE HEAT EXCHANGER, LB. WATER/LB. AIR
 AII - TUBESIDE AREA, SQ. FT.
 ATM - BAROMETRIC PRESSURE, ATMOSPHERES
 AW - AVERAGE TUBE WALL AREA, SQ. FT.
 RETAF - AIR SIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
 BETAI - TUBESIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
 CSI - HEAT CAPACITY OF SATURATED AIR AT THE TUBESIDE TEMPERATURE, BTU/LB. OF DRY AIR-F
 CSIN - HEAT CAPACITY OF THE AIR ENTERING THE HEAT EXCHANGER, BTU/LB OF DRY AIR-F
 CSLVG - HEAT CAPACITY OF THE AIR LEAVING THE HEAT EXCHANGER, BTU/LB. OF DRY AIR-F
 CSWB - SPECIFIC HEAT OF SATURATED AIR AT THE WET BULB TEMPERATURE, BTU/LB OF DRY AIR-DEG F
 DI - INTERNAL DIAMETER OF THE TUBES, FT.
 EFF - DELUGED HEAT EXCHANGER EFFECTIVENESS (EQUAL TO THE DIFFERENCE BETWEEN THE ENTHALPY OF THE EXITING AND OF THE ENTERING AIR DIVIDED BY THE DIFFERENCE BETWEEN THE ENTHALPY OF SATURATED AIR AT THE TUBESIDE TEMPERATURE AND THE ENTHALPY OF THE ENTERING AIR).

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

C		DIMENSIONLESS	DELUG	59
C	EFFIN	- FIN EFFICIENCY, DIMENSIONLESS	DELUG	60
C	FDM	- QUANTITY USED FOR CONVERGENCE TEST, EQUAL	DELUG	61
C		TO THE DIFFERENCE IN HEAT TRANSFER COMPUTED	DELUG	62
C		BY THE CURRENT AND BY THE PREVIOUS ITERATION	DELUG	63
C		DIVIDED BY THE HEAT TRANSFER COMPUTED BY THE	DELUG	64
C		CURRENT ITERATION, DIMENSIONLESS	DELUG	65
C	FDO	- QUANTITY USED FOR CONVERGENCE TEST, EQUAL TO	DELUG	66
C		THE DIFFERENCE OF THE WATER EVAPORATION RATE	DELUG	67
C		COMPUTED BY THE CURRENT AND BY THE PREVIOUS	DELUG	68
C		ITERATION, DIVIDED BY THE WATER EVAPORATION	DELUG	69
C		RATE COMPUTED BY THE CURRENT ITERATION,	DELUG	70
C		DIMENSIONLESS	DELUG	71
C	HI	- TUBESIDE HEAT TRANSFER COEFFICIENT, BTU/HR-SQ.	DELUG	72
C		FT.-F	DELUG	73
C	HD	- METAL TO DELUGEATE HEAT TRANSFER COEFFICIENT,	DELUG	74
C		BTU/HR-SQ.FT.-F	DELUG	75
C	ODL	- OUTSIDE DIAMETER OF THE LINER, FT.	DELUG	76
C	PPI	- PARTIAL PRESSURE OF WATER AT SATURATION AT THE	DELUG	77
C		TUBESIDE TEMPERATURE, IN. HG.	DELUG	78
C	PPIN	- PARTIAL PRESSURE OF WATER IN THE ENTERING	DELUG	79
C		AIR, IN. HG.	DELUG	80
C	PPLVG	- PARTIAL PRESSURE OF WATER IN THE AIR LEAVING	DELUG	81
C		THE HEAT EXCHANGER, IN. HG.	DELUG	82
C	PPWB	- PARTIAL PRESSURE OF WATER AT THE WET BULB	DELUG	83
C		TEMPERATURE OF THE ENTERING AIR (SATURATED	DELUG	84
C		CONDITIONS), IN. HG.	DELUG	85
C	PSATIN	- PARTIAL PRESSURE OF SATURATED AIR AT THE	DELUG	86
C		TEMPERATURE OF THE ENTERING AIR, IN. HG.	DELUG	87
C		OF THE ENTERING AIR, IN HG.	DELUG	88
C	QSEC1	- HEAT TRANSFER RATE COMPUTED BY CURRENT	DELUG	89
C		ITERATION, LB/HR	DELUG	90
C	QSEC2	- HEAT TRANSFER RATE COMPUTED BY PREVIOUS	DELUG	91
C		ITERATION, LB/HR	DELUG	92
C	QSEC	- HEAT TRANSFER FROM THE HEAT EXCHANGER SECTION	DELUG	93
C		DEFINED BY AB AND AF, BTU/HR	DELUG	94
C	RHIN	- RELATIVE HUMIDITY OF THE AIR ENTERING THE	DELUG	95
C		HEAT EXCHANGER, DIMENSIONLESS	DELUG	96
C	RHOUT	- RELATIVE HUMIDITY OF THE AIR LEAVING THE	DELUG	97
C		HEAT EXCHANGER, DIMENSIONLESS	DELUG	98
C	RII	- ENTHALPY OF SATURATED AIR AT THE TUBESIDE	DELUG	99
C		TEMPERATURE, BTU/LB OF DRY AIR	DELUG	100
C	RIIN	- ENTHALPY OF THE AIR ENTERING THE HEAT EXCHANGER	DELUG	101
C		BTU/LB. OF DRY AIR	DELUG	102
C	RILOUT	- ENTHALPY OF THE AIR EXITING THE HEAT EXCHANGER,	DELUG	103
C		BTU/LB OF DRY AIR	DELUG	104
C	RILOU1	- ENTHALPY OF THE AIR EXITING THE HEAT EXCHANGER,	DELUG	105
C		BTU/LB OF DRY AIR	DELUG	106
C	RILVG	- ENTHALPY OF THE AIR EXITING THE HEAT EXCHANGER,	DELUG	107
C		BTU/LB OF DRY AIR	DELUG	108
C	RIWB	- ENTHALPY OF SATURATED AIR AT TWBIN, BTU/LB	DELUG	109
C		OF DRY AIR	DELUG	110
C	RKW	- THERMAL CONDUCTIVITY OF THE TUBE WALL, BTU/HR-	DELUG	111
C		SQ.FT.-F/FT	DELUG	112
C	RMA	- MASS FLOW RATE OF AIR, LB/HR	DELUG	113
C	RMEVAP	- WATER EVAPORATION RATE, LB/AIR	DELUG	114
C	RMEVAP1	- WATER EVAPORATION RATE COMPUTED DURING CURRENT	DELUG	115

C	ITERATION, LB/HR	DELUG	116
C	RMEVAP2- WATER EVAPORATION RATE COMPUTED DURING PREVIOUS	DELUG	117
C	ITERATION, LB/HR	DELUG	118
C	RNTUAV - ARITHMETIC AVERAGE OF THE NUMBER OF (DELUGE)	DELUG	119
C	TRANSFER UNITS AT THE LEADING AND AT THE	DELUG	120
C	TRAILING EDGE OF THE HEAT EXCHANGER,	DELUG	121
C	DIMENSIONLESS	DELUG	122
C	RNTUIN - NUMBER OF (DELUGE) HEAT TRANSFER UNITS AT THE	DELUG	123
C	LEADING EDGE OF THE HEAT EXCHANGER,	DELUG	124
C	DIMENSIONLESS	DELUG	125
C	RNTULV - NUMBER OF (DELUGE) TRANSFER UNITS AT THE	DELUG	126
C	TRAILING EDGE OF THE HEAT EXCHANGER,	DELUG	127
C	DIMENSIONLESS	DELUG	128
C	TAIN - TEMPERATURE OF THE AIR ENTERING THE HEAT	DELUG	129
C	EXCHANGER, F	DELUG	130
C	TAL - TEMPERATURE OF THE AIR LEAVING THE HEAT	DELUG	131
C	EXCHANGER, F	DELUG	132
C	THW - TUBE WALL THICKNESS, FT.	DELUG	133
C	TEST - ESTIMATE OF TEMPERATURE OF AIR EXITING	DELUG	134
C	THE HEAT EXCHANGER, DEG. F.	DELUG	135
C	TI - TUBESIDE TEMPERATURE, DEG. F.	DELUG	136
C	TMAX - MAXIMUM TEMPERATURE ALLOWED DUE TO CONSTRAINTS	DELUG	137
C	UPON THE ANALOGY UPON WHICH THE HEAT TRANSFER	DELUG	138
C	CALCULATION IS BASED, F	DELUG	139
C	TMIN - MINIMUM TEMPERATURE ALLOWED TO PREVENT	DELUG	140
C	POSSIBLE INSTABILITIES WITHIN THE	DELUG	141
C	SUBROUTINES, F	DELUG	142
C	TOUT - TEMPERATURE OF AIR EXITING THE	DELUG	143
C	HEAT EXCHANGER, DEG. F.	DELUG	144
C	TWBIN - WET BULB TEMPERATURE OF THE ENTERING AIR,	DELUG	145
C	DEG. F.	DELUG	146
C	UDIN - TUBESIDE TO AIR HEAT TRANSFER COEFFICIENT	DELUG	147
C	(CONVERTED TO THE DRIVING FORCE OBTAINED BY	DELUG	148
C	DIVIDING THE ENTHALPY DIFFERENCE BY THE	DELUG	149
C	SPECIFIC HEAT OF HUMID AIR) AT THE LEADING	DELUG	150
C	EDGE OF THE HEAT EXCHANGER,	DELUG	151
C	BTU/HR-SQ.FT.-DEG. F	DELUG	152
C	UDLVG - TUBESIDE TO AIR HEAT TRANSFER COEFFICIENT	DELUG	153
C	(CONVERTED TO THE DRIVING FORCE OBTAINED BY	DELUG	154
C	DIVIDING THE ENTHALPY DIFFERENCE BY THE	DELUG	155
C	SPECIFIC HEAT OF AIR) AT THE TRAILING EDGE	DELUG	156
C	OF THE HEAT EXCHANGER,	DELUG	157
C	BTU/SQ.FT.-DEG. F-HR	DELUG	158
C	LOGICAL FRST1, FRST2, FRST3	DELUG	159
C	LOGICAL FIRST, FRST, FXTMP, FXTVAR, FXTTID, FXTLNG	BIGCOM	2
C	COMMON	BIGCOM	3
C	\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
C	* ,BDLIM(16)	BIGCOM	5
C	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2, CAF	BIGCOM	6
C	\$,CBJ, CTURB, CDANG, CLUVR, CHAHS, CVM	BIGCOM	7
C	\$,DFIN, DEEPL, DESVEL, DESVELV, DESVELD, DENSIF	BIGCOM	8
C	\$,EFP, EFS	BIGCOM	9
C	\$,FCR, FIRST, FIXL, FCOS, FFHX, FXTMP, FACTOR, FRST, FACTORD, FSHOT, FDELUG	BIGCOM	10
C	\$,FIXV, FIXTID, FXTVAR, FXTTID, FXTLNG	BIGCOM	11
C	\$,GREFF	BIGCOM	12
C	\$,HXNP, HPCST, HCD	BIGCOM	13
C	\$,ITMAX, ITMIN	BIGCOM	14

\$,JCONS	BIGCOM	15
\$,KCONV, KALEXT	BIGCOM	16
\$,MXEXT	BIGCOM	17
\$,NTA,NSIDES,NRUNH	BIGCOM	18
COMMON	BIGCOM	19
\$ ODR	BIGCOM	20
\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
\$,RBP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
\$,SIGMAG, SAAF, SEGL	BIGCOM	25
\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
\$,TCD, TW	BIGCOM	27
\$,UCS, UWS	BIGCOM	28
\$,WEV, WATCONA, WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDEPA, XW, XD	BIGCOM	31
COMMON/DLUG/TAIN,TWBIN,TI,ATM,HI,HOD,RMA,QSEC,RMEVAP,VALREQ	DELUG	161
COMMON/HXD/ AI,ATOT,SFA,RFA,ACS	DELUG	162
COMMON/DJB/DI,XDG,SF	DELUG	163
COMMON/SURFEX/ODL,DUMLST(15)	DELUG	164
COMMON/COUNT/NSLOPE,FRST3	DELUG	165
COMMON /WETDRY/ NCYCLE,TMAX,RIMAX,TMIN,RIMIN	DELUG	166
COMMON/PPRT4/R4(672),RR(3)	DELUG	167
COMMON/CONS/HD,BETAF,BETAI,AB,AF,AII,AW,THW,RKW	DELUG	168
DIMENSION TAL(10),RIL(10)	DELUG	169
FP(RH,T) = RH*29.92*(0.000203*((T - 32.)/1.8)**2	DELUG	170
+ - 0.0118*(T - 32.)/1.8 + 1.095)	DELUG	171
+ =EXP(- 0.000426*((T - 32.)/1.8)**2	DELUG	172
+ + 0.0028*(T - 32.)/1.8 - 5.163)	DELUG	173
C FP(RH,T)=RH*EXP(17.168-9240./(T+460.))	DELUG	174
FAH(P,ATM)=P*18.02/((ATM*29.92-P)*28.97)	DELUG	175
FCS(AH)=.24+.45*AH	DELUG	176
FRI(CS,T,AH)=CS*T+1094.*AH	DELUG	177
FRST1 = .T.	DELUG	178
FRST2 = .T.	DELUG	179
NDEBUG6=0	DELUG	180
RHLVG = RHOUT	DELUG	181
HD = HCD	DELUG	182
AB = RFA*VALREQ	DELUG	183
AF = SFA*VALREQ	DELUG	184
AII = AI*VALREQ	DELUG	185
THW = (ODL - DI)/12.	DELUG	186
RKW = CONL	DELUG	187
AW = (ODL + DI)/24.*VALREQ*3.14159	DELUG	188
C	DELUG	189
C	DELUG	190
C	DELUG	191
C	DELUG	192
C	DELUG	193
IF(NDEBUG6.EQ.1) WRITE(6,150)	DELUG	194
150 FORMAT(1X,"TAIN,TWBIN,TI,ATM,RHLVG,HD,BETAF,AR",//1X,	DELUG	195
1"AF,AI,HI,THW,RKW,HOD,RMA,BETAI",//1X,"AW",///)	DELUG	196
IF(NDEBUG6.EQ.1) WRITE(6,200) TAIN,TWBIN,TI,ATM,RHLVG,HD,BETAF,AB,	DELUG	197
1AF,AII,HI,THW,RKW,HOD,RMA,BETAI,AW	DELUG	198
200 FORMAT(1H0,1PBE11.3//1X,8E11.3//1X,8E11.3	DELUG	199
C	DELUG	200

THE INPUTS TO DELUG ARE PRINTED.

C		DELUG	201
C	THE MINIMUM AND MAXIMUM TEMPERATURES WITH THE CORRESPONDING	DELUG	202
C	ENTHALPIES ARE COMPUTED IN SUBROUTINE LIMIT.	DELUG	203
C	IF TAIN LIES OUTSIDE THESE BOUNDS THE COMPUTATION IS ABORTED.	DELUG	204
C		DELUG	205
C		DELUG	206
C	IF (FRST) CALL LIMIT(ATM,TMAX,RIMAX,TMIN,RIMIN)	DELUG	207
	FRST = .F.	DELUG	208
	IF (TAIN.LE.TMIN .OR. TAIN.GE.TMAX) WRITE(6,5) TAIN	DELUG	209
	IF (TI.LE.TMIN .OR. TI.GE.TMAX) WRITE(6,7) TI	DELUG	210
	IF (TI.LE.TMIN.OR.TI.GE.TMAX) KCONV = 1	DELUG	211
	IF (TAIN.LE.TMIN.OR.TAIN.GE.TMAX) KCONV = 1	DELUG	212
	IF (KCONV.EQ.1) RETURN	DELUG	213
	5 FORMAT("TAIN IS LESS THAN TMIN OR GREATER THAN TMAX IN DELUGE "	DELUG	214
	5, "TAIN=",1PE13.5)	DELUG	215
	7 FORMAT("TI IS LESS THAN TMIN OR GREATER THAN TMAX IN DELUGE. "	DELUG	216
	7, "TI=",1PE13.5)	DELUG	217
C		DELUG	218
C		DELUG	219
C	PROPERTIES OF THE INLET AIR AND TUBESIDE FLUID (IN ENTHALPIC	DELUG	220
C	EQUIVALENT) ARE COMPUTED.	DELUG	221
C		DELUG	222
C		DELUG	223
	PPWB=FP(1.,TWBIN)	DELUG	224
	AHWB=FAH(PPWB,ATM)	DELUG	225
	CSWB=FCS(AHWB)	DELUG	226
	RIWB=FRI(CSWB,TWBIN,AHWB)	DELUG	227
	RIIN=RIWB	DELUG	228
	AHIN=(RIIN-.24*TAIN)/(.45*TAIN+1094.)	DELUG	229
	CSIN=.24+.45*AHIN	DELUG	230
	PPIN=(AHIN*ATM*866.78240)/(18.02*AHIN*28.97)	DELUG	231
	PSATIN = FP(1.,TAIN)	DELUG	232
	RHIN=PPIN/PSATIN	DELUG	233
C		DELUG	234
C		DELUG	235
C	THE HEAT TRANSFER COEFFICIENT AT THE LEADING EDGE IS COMPUTED	DELUG	236
C		DELUG	237
C		DELUG	238
C		DELUG	239
	PPI=FP(1.0,TI)	DELUG	240
	AHI=FAH(PPI,ATM)	DELUG	241
	CSI=FCS(AHI)	DELUG	242
	RJI=FRI(CSI,TI,AHI)	DELUG	243
	CALL UDEL(TAIN,RIIN,ATM,HD,BETAF,AB,AF,AII,AW,HI,BETAI,THW,RKW,TI,	DELUG	244
	*RII,HOD,UDIN,EFFIN,FRST1,KCONV,0)	DELUG	245
	IF (KCONV.EQ.1) RETURN	DELUG	246
C		DELUG	247
C		DELUG	248
C	THE NUMBER OF HEAT TRANSFER UNITS (BASED ON ENTHALPY DRIVING	DELUG	249
C	FORCE) BASED ON CONDITIONS AT THE LEADING EDGE ARE COMPUTED.	DELUG	250
C		DELUG	251
C		DELUG	252
	RNTUIN=UDIN*(AB*EFFIN*AF)/(RMA*CSIN)	DELUG	253
	N = 0	DELUG	254
C		DELUG	255
C	ESTIMATION THE EXIT TEMPERATURE AND ENTHALPY OF THE AIR	DELUG	256
C	LEAVING THE HEAT EXCHANGER	DELUG	257

C	IF(NSLOPE .LE. 2) GO TO 90	DELUG	258
C	TEMPERATURE	DELUG	259
C	TA3 = TAIN	DELUG	260
	SLOPE = (TOUT2 - TOUT1)/(TA2 - TA1)	DELUG	261
	TOUT3 = TOUT2 + SLOPE*(TA3 - TA2)	DELUG	262
	TEST = TOUT3	DELUG	263
C		DELUG	264
C	ENTHALPY	DELUG	265
	RILOUT = RILOU1	DELUG	266
	GO TO 110	DELUG	267
90	CONTINUE	DELUG	268
	IF(NSLOPE .LE. 1) GO TO 100	DELUG	269
C		DELUG	270
C	TEMPERATURE	DELUG	271
C	TEST = TOUT2	DELUG	272
C		DELUG	273
C	ENTHALPY	DELUG	274
C	RILOUT = RILOU1	DELUG	275
	GO TO 110	DELUG	276
100	EFF = 1.0 - EXP(-RNTUIN)	DELUG	277
	RILOUT = RIIN + EFF*(RII - RIIN)	DELUG	278
	TEST = TAIN + 0.6*(TI - TAIN)	DELUG	279
C		DELUG	280
C		DELUG	281
C	TEMPERATURE OF THE AIR LEAVING THE HEAT EXCHANGER OBTAINED	DELUG	282
C	FROM TCALE (FROM A KNOWLEDGE OF ENTHALPY OF THE EXITING AIR).	DELUG	283
C		DELUG	284
C		DELUG	285
C		DELUG	286
110	CALL TCALE(RILOUT,RHLVG,ATM,TEST,TDUM,"DLG AOUT ",KCONV)	DELUG	287
	IF(KCONV.EQ.1) RETURN	DELUG	288
	TOUT = TDUM	DELUG	289
10	CONTINUE	DELUG	290
	N = N+1	DELUG	291
	TAL(N) = TDUM	DELUG	292
C		DELUG	293
C	PROPERTIES OF EXITING AIR COMPUTED.	DELUG	294
C		DELUG	295
	PPLVG=FP(RHLVG,TOUT)	DELUG	296
	AHLVG=FAH(PPLVG,ATM)	DELUG	297
	CSLVG=FCS(AHLVG)	DELUG	298
	RILVG=FRI(CSLVG,TOUT,AHLVG)	DELUG	299
C		DELUG	300
C	THE HEAT TRANSFER COEFFICIENT AT THE TRAILING EDGE IS	DELUG	301
C	COMPUTED.	DELUG	302
C		DELUG	303
	CALL UDEL(TOUT,RILVG,ATM,HD,BETAF,AB,AF,AII,AW,HI,BETAI,THW,RKW,	DELUG	304
	+TI,RII,HOD,UDLVG,EFFIN,FRST2,KCONV,1)	DELUG	305
	IF(KCONV.EQ.1) RETURN	DELUG	306
C		DELUG	307
C	THE NUMBER OF HEAT TRANSFER UNITS BASED ON CONDITIONS AT THE	DELUG	308
C	TRAILING EDGE IS COMPUTED.	DELUG	309
	RNTILV=UDLVG*(AB+EFFIN*AF)/(RMA+CSLVG)	DELUG	310
C		DELUG	311
C		DELUG	312
C	THE AVERAGE NO. OF HEAT TRANSFER UNITS IS CALCULATED.	DELUG	313
C		DELUG	314

	RNTUAV=(RNTUIN+RNTULV)/2.	DELUG	315
C		DELUG	316
C	THE ENTHALPY AND TEMPERATURE OF THE AIR EXITING THE	DELUG	317
C	HEAT EXCHANGER IS COMPUTED.	DELUG	318
C		DELUG	319
	EFF = 1 - EXP(-RNTUAV)	DELUG	320
	RILVG=RIIN + EFF*(RII-RIIN)	DELUG	321
	RIL(N)=RILVG	DELUG	322
	CALL TCALC(RILVG,RHLVG,ATM,TEST,TDUM,"DLG TAL(N)"*KCONV)	DELUG	323
	IF(KCONV.EQ.1) RETURN	DELUG	324
	TOUT = TDUM	DELUG	325
	TAL(N)=TDUM	DELUG	326
C		DELUG	327
C	THE HEAT TRANSFER AND WATER EVAPORATION OF THE HEAT EXCHANGER	DELUG	328
C	IS COMPUTED.	DELUG	329
C		DELUG	330
	QSEC2 = QSEC1	DELUG	331
	RMEVA2 = RMEVA1	DELUG	332
	QSEC1 = RMA*(RILVG - RIIN)	DELUG	333
	RMEVA1 = RMA*(AHLVG - AHIN)	DELUG	334
C		DELUG	335
C	THE CHANGE IN HEAT REJECTED AND WATER EVAPORATED FROM THE	DELUG	336
C	PREVIOUS ITERATION.	DELUG	337
C		DELUG	338
	FDQ = ABS(QSEC1 - QSEC2)/QSEC1	DELUG	339
	FDM = ABS(RMEVA1 - RMEVA2)/RMEVA1	DELUG	340
	IF(NDBG6.EQ.1) WRITE(6,280)	DELUG	341
280	FORMAT(1X,"N,TAL(N),RIL(N),FDQ,FDM,EFF,RNTUIN,RNTULV")	DELUG	342
	IF(NDBG6.EQ.1) WRITE(6,300) N,TAL(N),RIL(N),FDQ,FDM,EFF,RNTUIN,	DELUG	343
	1RNTULV	DELUG	344
300	FORMAT(1X,"FROM DELUGS300",I5,7E16.7, //	DELUG	345
C		DELUG	346
C		DELUG	347
C	PROTECTION AGAINST EXCESSIVE NUMBER OF ITERATIONS.	DELUG	348
	IF(N.GE.10) WRITE(6,350) N	DELUG	349
350	FORMAT("UPPER ITERATION LIMIT REACHED IN DELUGE N=" I5)	DELUG	350
	IF(N.GE.10) KCONV = 1	DELUG	351
	IF(N.GE.10) RETURN	DELUG	352
C		DELUG	353
C	CONVERGENCE CRITERIA USING HEAT REJECTED AND MASS FLOW	DELUG	354
C	RATE OF WATER EVAPORATED.	DELUG	355
C		DELUG	356
	IF(FDQ.GT. 0.001 .OR. FDM.GT. 0.001) GO TO 10	DELUG	357
360	CONTINUE	DELUG	358
C		DELUG	359
C	STORAGE OF VARIABLES FOR EXTRAPOLATION TO THE NEXT	DELUG	360
C	AMBIENT AIR CONDITIONS	DELUG	361
C		DELUG	362
	IF(.NOT.FRST3) GO TO 370	DELUG	363
	TOUT1 = TOUT2	DELUG	364
	TA1 = TA2	DELUG	365
	TA2 = TAIN	DELUG	366
370	TOUT2 = TOUT	DELUG	367
	PILOU1 = RILVG	DELUG	368
	QSEC = QSEC1	DELUG	369
	RMEVAP = RMEVA1	DELUG	370
	ISL = (NSLOPE - 1)*42	DELUG	371

SUBROUTINE DELUG

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
R4(ISL + 1) = TAIN
R4(ISL + 2) = RIIN
R4(ISL + 21) = AHIN
R4(ISL + 22) = TOUT
R4(ISL + 23) = RILVG
R4(ISL + 40) = QSEC1
R4(ISL + 41) = RMEVA1
R4(ISL + 42) = AHLVG
RP(1) = ATM
RP(2) = RMA
RP(3) = NSLOPE
FRST3 = .FALSE.
```

C
C
C
C

OUTPUT STATEMENTS.

```
IF(NDEBUG.NE.1) RETURN
DO 390 J=1,N
WRITE(6,395)J,TAL(J),RIL(J)
395 FORMAT(1X,"N,TAL(N) AND RIL(N)= ",I5,1P2E17,8)
390 CONTINUE
WRITE(6,375)
375 FORMAT(1X,"N,QSEC,RMEVAP,UDIN,UDLVG,RNTUAV")
WRITE(6,400)N,QSEC,RMEVAP,UDIN,UDLVG,RNTUAV
400 FORMAT(1X," LEAVING DELUGE #400",I7,1P5E15,6)
WRITE(6,450)
450 FORMAT(1X,///)
END
```

```
DELUG 372
DELUG 373
DELUG 374
DELUG 375
DELUG 376
DELUG 377
DELUG 378
DELUG 379
DELUG 380
DELUG 381
DELUG 382
DELUG 383
DELUG 384
DELUG 385
DELUG 386
DELUG 387
DELUG 388
DELUG 389
DELUG 390
DELUG 391
DELUG 392
DELUG 393
DELUG 394
DELUG 395
DELUG 396
DELUG 397
DELUG 398
DELUG 399
```


74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE DELUGE(CTOWDEL,TOWDIA,VELDEL,DELH2O,DELMUP,DISDEL,
IDELCST)

THIS SUBROUTINE APPROXIMATES THE COST OF THE DELUGE
PIPING SYSTEM. THIS IS DONE BY COSTING THE MAJOR
PORTIONS OF THE MAKEUP AND TOWER COMPONENTS. PIPE DIAMETERS
ARE DETERMINED FROM THE DELUGE FLOW RATE AND DESIGN
VELOCITY.

CONST1 - CONVERSION FACTOR
CTOWDEL - NUMBER OF DELUGED TOWERS
IDELCST - TOTAL COST OF THE DELUGE SYSTEM
DELH2O - DELUGE FLOW RATE (GPM)
DELMUP - MAKEUP FLOW RATE (GPM)
DELTOW - DELUGE FLOW RATE PER TOWER (GPM)
DIA - PIPE DIAMETER (IN)
DIADEL - MAXIMUM DIAMETER OF TOWER PIPING (IN)
DIAMUP - MAXIMUM DIAMETER OF MAKEUP PIPING (IN)
DISDEL - DISTANCE FROM DELUGE WATER SUPPLY AND TOWER
BOUNDARY (FT)
DISTCST - COST OF MAKEUP PIPING (\$1000)
GPMCST - PUMPING COSTS (\$/GPM)
IM,IT - INDICES FOR MAKEUP AND TOWER PIPING
NTOW - INTEGER NUMBER OF TOWERS DIVIDED BY 2
PIPCST - PIPE COST (\$1000)
PIPCSTM - COST OF MAKEUP PIPING (\$1000)
PIPLEN - APPROXIMATE MAKEUP PIPE LENGTH (FT)
PMPCST - MAKEUP PUMPING COSTS (\$1000)
RMODEL - DENSITY OF DELUGE WATER (LBM/FTCU)
TOWCST - COST OF TOWER COMPONENTS (\$1000)
TOWDIA - TOWER DIAMETER (FT)
TOWPIP - COST OF TOWER PIPING (\$1000)
TOWPMP - TOWER PUMPING COSTS (\$1000)
VALVCST - VALVE COST (\$1000)
VELDEL - DELUGE DESIGN VELOCITY (FT/SEC)

DIMENSION DIA(10), PIPCST(10), VALVCST(10)
DATA DIA/

* 6. , 12. , 18. , 24. , 30. ,
* 36. , 42. , 48. , 50. , 60. /

DATA PIPCST/
* .017 , .025 , .035 , .046 , .062 ,
* .087 , .116 , .147 , .182 , .218 /

DATA VALVCST/
* 3.250 , 3.959 , 6.250 , 8.986 , 10.125 ,
* 14.073 , 16.500 , 21.530 , 26.750 , 34.880 /

COST THE MAKEUP PIPING.

IF(DELH2O.EQ.0.0) RETURN
CONST1 = 1./(7.481*60.)
GPMCST = 2.50
NTOW=CTOWDEL/2.
PIPLEN=DISDEL+.5*TOWDIA+1.5*NTOW*TOWDIA
DIAMUP = SQRT(DELMUP*CONST1/VELDEL)*12.

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

SUBROUTINE DELUGEP 74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

```

      IF(DIAMUP.LT.DIA(1)) DIAMUP=DIA(1)
      DO 10 I=1,10
      IM=I
      IF(DIAMUP=DIA(IM)) 11,11,10
10  CONTINUE
11  DIAMUP=DIA(IM)
C
C      70 PERCENT OF THE LARGEST DIAMETER PIPE COST WAS USED
C      TO DETERMINE THE AVERAGE PIPE COST
C
      PIPCSTM=.70*PIPLEN*PIPCST(IM)
      PMPCST = DELMUP*GPMCST/1000.
C
C      90 PERCENT OF THE MAKEUP COSTS WERE FROM PIPE+VALVE
C      AND PUMP COSTS
C
      DISTCST=(PIPCSTM+PMPCST+VALVCST(IM))/,.90
C
C      COST THE TOWER COMPONENTS. PUMPS, VALVES AND
C      PIPING REPRESENT 51.5 PERCENT OF THE TOWER COSTS.
C
C      DETERMINE THE DIAMETER OF THE TOWER PIPING
C
      DELTOW=DELH20/CTOWDEL
      DIADEL = SQRT(DELTOW*CONST1/VELDEL)*12.
      IF(DIADEL.LT.DIA(1)) DIADEL=DIA(1)
      DO 20 I=1,10
      IT=I
      IF(DIADEL=DIA(IT)) 21,21,20
20  CONTINUE
21  DIADEL=DIA(IT)
      TOWPIP=3.*TOWDIA*PIPCST(IT)
      TOWPMP = DELTOW*GPMCST/1000.
      TOWCST=(TOWPIP+6.*VALVCST(IT)+TOWPMP)/.515
C
C      DETERMINE THE TOTAL DELUGE PIPING SYSTEM COSTS
C
      DELCST=DISTCST*CTOWDEL*TOWCST
      RETURN
      END

```

```

DELUGEP 59
DELUGEP 60
DELUGEP 61
DELUGEP 62
DELUGEP 63
DELUGEP 64
DELUGEP 65
DELUGEP 66
DELUGEP 67
DELUGEP 68
DELUGEP 69
DELUGEP 70
DELUGEP 71
DELUGEP 72
DELUGEP 73
DELUGEP 74
DELUGEP 75
DELUGEP 76
DELUGEP 77
DELUGEP 78
DELUGEP 79
DELUGEP 80
DELUGEP 81
DELUGEP 82
DELUGEP 83
DELUGEP 84
DELUGEP 85
DELUGEP 86
DELUGEP 87
DELUGEP 88
DELUGEP 89
DELUGEP 90
DELUGEP 91
DELUGEP 92
DELUGEP 93
DELUGEP 94
DELUGEP 95
DELUGEP 96
DELUGEP 97
DELUGEP 98
DELUGEP 99

```

C	SUBROUTINE DELUGT(PSATD,TSATD,WATCON,WATCONT,BPL)	DELUGT	2
C		DELUGT	3
C	SURROUTINE DELUGT IS USED TO DETERMINE THE OPERATION OF THE	DELUGT	4
C	POWER PLANT OVER THE ENTIRE YEAR WHEN THE ENTIRE HEAT	DELUGT	5
C	EXCHANGER IS DELUGED. IT DETERMINES THE BACK PRESSURE OF	DELUGT	6
C	THE TURBINE AND THE SATURATION TEMPERATURE OF THE STEAM IN	DELUGT	7
C	THE CONDENSER/REBOILER AS A FUNCTION OF THE AMBIENT AIR	DELUGT	8
C	TEMPERATURE AND WET BULB AMBIENT TEMPERATURE.	DELUGT	9
C		DELUGT	10
C	DEFINITION OF VARIABLES	DELUGT	11
C		DELUGT	12
C	ALPHA - RATIO OF HEAT TRANSFER AREA TO HEAT EXCHANGER	DELUGT	13
C	VOLUME (SQ FT/SQ FT)	DELUGT	14
C	CPA - SPECIFIC HEAT OF THE AIR AT THE DESIGN AMBIENT	DELUGT	15
C	TEMPERATURE (BTU/LBM-DEG F	DELUGT	16
C	CPW - SPECIFIC HEAT OF THE AMMONIA AT THE DESIGN AMBIENT	DELUGT	17
C	TEMPERATURE (BTU/LBM-DEG F	DELUGT	18
C	DELPS - DESIGN SUPPLY PIPING PRESSURE DROP (LB/SQ FT)	DELUGT	19
C	DELPS2 - OFF DESIGN SUPPLY PIPING PRESSURE DROP (LB/SQ FT)	DELUGT	20
C	DENSIF - DENSITY OF THE AMBIENT AIR ENTERING THE HEAT	DELUGT	21
C	EXCHANGER (LBM/CU FT)	DELUGT	22
C	DENSIV - DENSITY OF THE AMMONIA VAPOR LEAVING THE CONDENSER/	DELUGT	23
C	REBOILER AT DESIGN CONDITIONS (LBM/CU FT)	DELUGT	24
C	DENSIV2 - DENSITY OF THE AMMONIA VAPOR LEAVING THE CONDENSER/	DELUGT	25
C	REBOILER AT OFF DESIGN CONDITIONS (LBM/CU FT)	DELUGT	26
C	DENSIW - DENSITY OF THE AMMONIA LIQUID (LBM/CU FT)	DELUGT	27
C	DI - INSIDE DIAMETER OF THE HEAT EXCHANGER TUBES (IN)	DELUGT	28
C	EPF - EFFECTIVENESS OF THE HEAT EXCHANGER AT DESIGN	DELUGT	29
C	CONDITIONS (DIMENSIONLESS)	DELUGT	30
C	ELENG - LENGTH OF THE HEAT EXCHANGER TUBES (FT)	DELUGT	31
C	ELEV - ELEVATION OF THE PLANT SITE (FT)	DELUGT	32
C	FACTOR - RATIO OF THE AIR VELOCITY IN THE HEAT EXCHANGER	DELUGT	33
C	WHEN IT IS DELUGED TO THE AIR VELOCITY IN THE HEAT	DELUGT	34
C	EXCHANGER WHEN IT IS DRY (DIMENSIONLESS)	DELUGT	35
C	GAIR2 - MASS FLUX OF THE AIR THROUGH THE HEAT EXCHANGER	DELUGT	36
C	WHEN IT IS DELUGED (LBM/SQ FT-HR)	DELUGT	37
C	GWAT2 - MASS FLUX OF THE AMMONIA THROUGH THE TUBES OF THE	DELUGT	38
C	HEAT EXCHANGER (LBM/SQ FT-HR)	DELUGT	39
C	HFG2 - HEAT OF VAPORIZATION OF AMMONIA AT OFF DESIGN	DELUGT	40
C	CONDITIONS (BTU/LBM)	DELUGT	41
C	HI2 - INSIDE HEAT TRANSFER COEFFICIENT OF THE HEAT	DELUGT	42
C	EXCHANGER TUBES AT OFF DESIGN CONDITIONS	DELUGT	43
C	(BTU/HR-DEG F-SQ FT)	DELUGT	44
C	HO2 - AIR SIDE HEAT TRANSFER COEFFICIENT OF THE HEAT	DELUGT	45
C	EXCHANGER AT OFF DESIGN CONDITIONS	DELUGT	46
C	(BTU/HR-DEG F-SQ FT)	DELUGT	47
C	HRFAC1 - HEAT RATE FACTOR AT RATING CONDITION	DELUGT	48
C	(DIMENSIONLESS)	DELUGT	49
C	HRFAC2 - HEAT RATE FACTOR AT DESIGN CONDITIONS	DELUGT	50
C	(DIMENSIONLESS)	DELUGT	51
C	HRFAC4 - HEAT RATE FACTOR AT OFF DESIGN CONDITIONS	DELUGT	52
C	(DIMENSIONLESS)	DELUGT	53
C	NTA - NUMBER OF TEMPERATURE INCREMENTS IN THE AMBIENT	DELUGT	54
C	TEMPERATURE RANGE OF THE PLANT SITE	DELUGT	55
C	(DIMENSIONLESS)	DELUGT	56
C	NW - NUMBER OF TUBES IN THE WIDTH OF THE HEAT	DELUGT	57
C	EXCHANGER (DIMENSIONLESS)	DELUGT	58

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	P	- BACK PRESSURE OF THE TURBINE (IN HGA)	DELUGT	59
C	PATM	- ATMOSPHERIC PRESSURE AT THE PLANT SITE	DELUGT	60
C		(ATMOSPHERES)	DELUGT	61
C	PRW	- PRANDTL NUMBER OF THE AMMONIA LIQUID AT THE DESIGN	DELUGT	62
C		CONDITIONS (DIMENSIONLESS)	DELUGT	63
C	PSIZ13	- TOTAL POWER OUTPUT OF THE PLANT AT DESIGN	DELUGT	64
C		CONDITIONS (MEGAWATTS)	DELUGT	65
C	P12	- AMMONIA PRESSURE AT THE CONDENSER/REBOILER	DELUGT	66
C		(LBF/SQ FT)	DELUGT	67
C	P22	- AMMONIA PRESSURE AT THE HEAT EXCHANGER (LBF/SQ FT)	DELUGT	68
C	QIN1	- HEAT INPUT INTO THE POWER PLANT (BTU/HR)	DELUGT	69
C	QREJT1	- HEAT REJECTED AT THE DESIGN CONDITIONS OF THE	DELUGT	70
C		PLANT (BTU/HR)	DELUGT	71
C	QREJT2	- HEAT REJECTED AT THE OFF DESIGN CONDITIONS OF THE	DELUGT	72
C		PLANT (BTU/HR)	DELUGT	73
C	QSEC	- HEAT REJECTED PER UNIT DIMENSION OF THE HEAT	DELUGT	74
C		EXCHANGER WHEN IT IS DELUGED (BTU/HR-SQ FT)	DELUGT	75
C	RANGE	- TEMPERATURE RANGE OF THE AIR THROUGH THE HEAT	DELUGT	76
C		EXCHANGER AT DESIGN CONDITIONS (DEG F)	DELUGT	77
C	RMA	- MASS FLOW RATE OF AIR FLOWING THROUGH EACH UNIT	DELUGT	78
C		DIMENSION OF THE HEAT EXCHANGER (LBM/HR)	DELUGT	79
C	RMEV	- AMOUNT OF WATER EVAPORATED PER UNIT DIMENSION OF	DELUGT	80
C		THE HEAT EXCHANGER (LBM/HR AND THE TOTAL HEAT	DELUGT	81
C		EXCHANGER WHEN IT IS DELUGED (LBM/HR)	DELUGT	82
C	SIGMAG	- FREE FLOW AREA TO FRONTAL AREA OF THE HEAT	DELUGT	83
C		EXCHANGER (SQ FT/SQ FT)	DELUGT	84
C	TA	- AMBIENT TEMPERATURE (DEG F)	DELUGT	85
C	TAWB	- AMBIENT WETBULB TEMPERATURE (DEG F)	DELUGT	86
C	TEFF	- BASE THERMAL EFFICIENCY OF THE PLANT	DELUGT	87
C		(DIMENSIONLESS)	DELUGT	88
C	TEFF1	- RATED THERMAL EFFICIENCY OF THE PLANT	DELUGT	89
C		(DIMENSIONLESS)	DELUGT	90
C	TEFF3	- DESIGN THERMAL EFFICIENCY OF THE PLANT	DELUGT	91
C		(DIMENSIONLESS)	DELUGT	92
C	TEFF4	- OFF DESIGN THERMAL EFFICIENCY OF THE PLANT	DELUGT	93
C		(DIMENSIONLESS)	DELUGT	94
C	THCONW	- THERMAL CONDUCTIVITY OF THE AMMONIA AT DESIGN	DELUGT	95
C		CONDITIONS (BTU/HR-DEG F-FT)	DELUGT	96
C	TI	- TEMPERATURE OF THE AMMONIA AT THE INLET TO THE HEAT	DELUGT	97
C		EXCHANGER (DEG F)	DELUGT	98
C	TPER	- FRACTION OF THE YEAR THAT THE CORRESPONDING	DELUGT	99
C		AMBIENT TEMPERATURE EXISTS (DIMENSIONLESS)	DELUGT	100
C	TTD1	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM	DELUGT	101
C		AND AMMONIA IN THE CONDENSER/REBOILER AT DESIGN	DELUGT	102
C		CONDITIONS (DEG F)	DELUGT	103
C	TTD12	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM	DELUGT	104
C		AND AMMONIA IN THE CONDENSER/REBOILER AT OFF DESIGN	DELUGT	105
C		CONDITIONS (DEG F)	DELUGT	106
C	TTD2	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	DELUGT	107
C		PIPING (DEG F)	DELUGT	108
C	T1	- SATURATED STEAM TEMPERATURE IN THE CONDENSER/	DELUGT	109
C		REBOILER (DEG F)	DELUGT	110
C	VAIP	- MAXIMUM AIR VELOCITY THROUGH THE DRY HEAT	DELUGT	111
C		EXCHANGER (FT/SEC)	DELUGT	112
C	VISA	- VISCOSITY OF THE AIR AT THE AVERAGE AIR TEMPERATURE	DELUGT	113
C		IN THE DRY HEAT EXCHANGER (LBM/FT-HR)	DELUGT	114
C	VISV	- VISCOSITY OF THE AMMONIA VAPOR ENTERING THE HEAT	DELUGT	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C		EXCHANGER AT DESIGN CONDITIONS (LBM/FT-HR)	DELUGT	116
C	VISW	- VISCOSITY OF THE AMMONIA LIQUID ENTERING THE HEAT	DELUGT	117
C		EXCHANGER AT DESIGN CONDITIONS (LBM/FT-HR)	DELUGT	118
C	WATCONA	- AMOUNT OF WATER ALLOWED TO BE EVAPORATED OVER THE	DELUGT	119
C		WHOLE YEAR (LBM/YEAR)	DELUGT	120
C	WATCONT	- AMOUNT OF WATER EVAPORATED DURING THE WHOLE YEAR	DELUGT	121
C		BY THE COMPLETELY DELUGED HEAT EXCHANGER (LBM/YEAR)	DELUGT	122
C	W3	- MASS FLOW RATE OF AMMONIA AT DESIGN CONDITIONS	DELUGT	123
C		(LBM/HR)	DELUGT	124
C	W32	- MASS FLOW RATE OF AMMONIA AT OFF DESIGN CONDITIONS	DELUGT	125
C		(LBM/HR)	DELUGT	126
C	W4	- MASS FLOW RATE OF AMMONIA THROUGH THE HEAT	DELUGT	127
C		EXCHANGER AT DESIGN CONDITIONS (LBM/HR)	DELUGT	128
C	XD	- LONGITUDINAL PITCH OF THE TUBES IN THE HEAT	DELUGT	129
C		EXCHANGER (IN)	DELUGT	130
C	YPP	- PLANT SCALING FACTOR FOR FAN AND PUMP POWER LOSS	DELUGT	131
C		(DIMENSIONLESS)	DELUGT	132
C	Z	- HEAT EXCHANGER DEPTH IN NUMBER OF TUBES	DELUGT	133
C		(DIMENSIONLESS)	DELUGT	134
C	ZD	- HEAT EXCHANGER DEPTH IN NUMBER OF TUBES	DELUGT	135
C		(DIMENSIONLESS)	DELUGT	136
C			DELUGT	137
C	DEFINITION OF ARRAYS		DELUGT	138
C			DELUGT	139
C	ANG	- THE ANGLE OF THE HEAT EXCHANGER TUBES FROM THE	DELUGT	140
C		HORIZONTAL AND THE SINE AND COSINE OF THAT ANGLE	DELUGT	141
C	RPL	- BACK PRESSURE LIMIT CURVE (IN HGA)	DELUGT	142
C	PSATD	- TURBINE BACK PRESSURE CURVE WHEN THE HEAT EXCHANGER	DELUGT	143
C		IS DELUGED COMPLETELY (IN HGA)	DELUGT	144
C	TPO	- ARRAY OF COEFFICIENTS FOR THE CUBIC CURVE FIT OF	DELUGT	145
C		HEAT RATE FACTOR AS A FUNCTION OF TURBINE BACK	DELUGT	146
C		PRESSURE (DIMENSIONLESS)	DELUGT	147
C	TSATD	- TURBINE STEAM SATURATION CURVE WHEN THE HEAT	DELUGT	148
C		EXCHANGER IS DELUGED COMPLETELY (DEG F)	DELUGT	149
C	VTA	- AMBIENT TEMPERATURE CURVE (DEG F)	DELUGT	150
C	VTAWB	- AMBIENT WET BULB TEMPERATURE CURVE (DEG F)	DELUGT	151
C	VTPER	- FRACTION OF THE YEAR THAT THE AMBIENT AND WET BULB	DELUGT	152
C		TEMPERATURE INCREMENTS EXIST (DIMENSIONLESS)	DELUGT	153
C	WATCON	- WATER CONSUMPTION OF THE HEAT EXCHANGER WHEN IT IS	DELUGT	154
C		COMPLETELY DELUGED OVER THE WHOLE YEAR FOR EACH	DELUGT	155
C		AMBIENT TEMPERATURE INCREMENT (LBM/YEAR)	DELUGT	156
C			DELUGT	157
C	LOGICAL FRST3		DELUGT	158
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG		BIGCOM	2
	COMMON		BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)		BIGCOM	4
	\$,BPLIM(16)		BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	6
	\$,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM		BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	8
	\$,EFP, EFS		BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG		BIGCOM	10
	\$,FIXV,FXTDD,FXTVAR,FXTTDD,FXTLNG		BIGCOM	11
	\$,GREFF		BIGCOM	12
	\$,HXNP,HPCST,HCD		BIGCOM	13
	\$,ITMAX, ITMIN		BIGCOM	14
	\$,JCONS		BIGCOM	15

\$,KCONV, KALEXT	BIGCOM	16
\$,MXEXT	BIGCOM	17
\$,NTA,NSIDES,NBUNHI	BIGCOM	18
COMMON	BIGCOM	19
\$ ODR	BIGCOM	20
\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POMSTC, POMSCL	BIGCOM	22
\$, RBP,REDUCE, REDUCV, ROOFL, RHDUT	BIGCOM	23
\$, QREJ, QREDUCE, QREDUCV	BIGCOM	24
\$,SIGMAG, SAAF, SEGL	BIGCOM	25
\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
\$,TCD, TW	BIGCOM	27
\$,UCS, UWS	BIGCOM	28
\$,WFV, WATCONA, WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDEPA, XW, XD	BIGCOM	31
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY	2
\$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY	3
\$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,	SUPPLY	4
\$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPRP, SW4, SW3,	SUPPLY	5
\$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY	6
\$ RP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX	SUPPLY	7
\$, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY	8
\$, CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPPI, AST,OLDCST	SUPPLY	9
\$,CAPCST, XNFAN,BLDANG, CPLEN, DPFEI, WHX, WTTUB, ADIA, ABLN	SUPPLY	10
\$, WTHDR, WTFRM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY	11
\$, AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY	12
\$, ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13
\$, CSRD, WATERW, WSTRCT, CFOUND, HURDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14
\$,SQRJ,SQRJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCST	SUPPLY	15
\$,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY	16
\$,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)	SUPPLY	17
\$,WRB,MTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,WS	SUPPLY	18
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD,PLANC1,CASSS1,	SCALER	2
\$ GAIR, FAIR, HPAIR, HPWAT, WLRT, PLANC1	SCALER	3
COMMON /HXD/ AI,ATOT,SFA,RFA,ACS	DELUGT	162
COMMON /VARVAR/ VTPER(16), VTA(16), VTAWB(16)	DELUGT	163
COMMON/DJB/DI,XDG,SF	DELUGT	164
COMMON /SURFEX/ ODL,DUMLST(15)	DELUGT	165
COMMON/DLUG/TA,TAWB,TI,PATM,HI2,H02,RMA,QSEC,RMEV,VALREQ	DELUGT	166
COMMON/COUNT/NSLOPE,FRST3	DELUGT	167
COMMON/FAN/FANDAP(153,10),FANDAH(153,10),FMCPF,FBCPF,P2,R,S,	DELUGT	168
\$ VELDEC,AFC,ELEV,EHR,LOOPER,CTMAX	DELUGT	169
COMMON /PROP/ CPW, THCONW, DENSIV, VISW, HFG,	DELUGT	170
\$ CPV, THCONV, DENSIV, VISV, SIGMA,	DELUGT	171
\$ CPA, THCONA, DENSIA, VISA	DELUGT	172
DIMENSION PSATD(16), TSATD(16), WATCON(16 , BPL(16)	DELUGT	173
NDBG1 = 0	DELUGT	174
WATCNT = 0.0	DELUGT	175
NSLOPE = 0	DELUGT	176
ZD = Z	DELUGT	177
VALREQ = Z	DELUGT	178
C	DELUGT	179
C DESIGN THERMAL EFFECTIVENESS OF THE POWER PLANT	DELUGT	180
TEFF3 = TEFF/HRFAC2	DELUGT	181
C	DELUGT	182
C RATED THERMAL EFFECTIVENESS OF THE POWER PLANT	DELUGT	183

C	TEFF1 = TEFF/HRFAC1	DELUGT	184
C	HEAT INPUT INTO THE POWER PLANT	DELUGT	185
C	QIN1 = 3413.E+3*PSIZ13/TEFF1	DELUGT	186
C	HEAT REJECTED AT THE DESIGN THERMAL EFFECTIVENESS OF THE	DELUGT	187
C	POWER PLANT	DELUGT	188
5	QREJT1 = QIN1*(1. - TEFF3)	DELUGT	189
C		DELUGT	190
C	LOOP TO FIND THE BACK PRESSURE OF THE TURBINE OVER THE	DELUGT	191
C	AMBIENT TEMPERATURE RANGE	DELUGT	192
0		DELUGT	193
C	DO 100 J = 1,NTA	DELUGT	194
	I = NTA - J + 1	DELUGT	195
	NSLOPE = NSLOPE + 1	DELUGT	196
	FRST3 = .TRUE.	DELUGT	197
5	JK = 0	DELUGT	198
C		DELUGT	199
C	AMBIENT TEMPERATURE	DELUGT	200
	TA = VTA(I)	DELUGT	201
C		DELUGT	202
C	WET BULB AMBIENT TEMPERATURE	DELUGT	203
0	TAWB = VTAWB(I)	DELUGT	204
C		DELUGT	205
C	PERCENT OF THE YEAR AT THE ABOVE AMBIENT TEMPERATURE	DELUGT	206
	TPER = VTPER(I)	DELUGT	207
5		DELUGT	208
C	RANGE OF THE AIR AT THE DESIGN AMBIENT TEMPERATURE	DELUGT	209
C	RANGE = QREJT1/(W4*(1. + YFP)*CPA)	DELUGT	210
		DELUGT	211
C	INITIAL GUESS FOR THE ALL WET TURBINE SATURATED STEAM	DELUGT	212
0	TEMPERATURE	DELUGT	213
C	T1 = TAWB + TTD1 + TTD2 + (RANGE/EFF)	DELUGT	214
C		DELUGT	215
C	BACK PRESSURE OF THE TURBINE AT THE SATURATION TEMPERATURE	DELUGT	216
10	P = EXP(17.168 - 9240./(T1 + 460.))	DELUGT	217
5	JK = JK + 1	DELUGT	218
C		DELUGT	219
C	HEAT RATE FACTOR AT THE ABOVE BACK PRESSURE	DELUGT	220
	HRFAC4 = TPO(1) + TPO(2)*P + TPO(3)*P**2 + TPO(4)*P**3	DELUGT	221
C		DELUGT	222
C	THERMAL EFFECTIVENESS OF THE PLANT AT THE ABOVE BACK PRESSURE	DELUGT	223
0	TEFF4 = TEFF/HRFAC4	DELUGT	224
C		DELUGT	225
C	HEAT REJECTED AT THE ABOVE THERMAL EFFECTIVENESS OF THE	DELUGT	226
C	POWER PLANT	DELUGT	227
5	QREJT2 = QIN1*(1. - TEFF4)	DELUGT	228
C		DELUGT	229
C	TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM AND THE	DELUGT	230
C	AMMONIA IN THE CONDENSER/REBOILER	DELUGT	231
	TTD12 = (QREJT2/QREJT1)*TTD1	DELUGT	232
10		DELUGT	233
C	PRESSURE OF THE AMMONIA LEAVING THE CONDENSER/REBOILER	DELUGT	234
	P12 = FLUID(10,1,T1 - TTD12,ELEV,"DELUG 1")	DELUGT	235
	HFG2 = FLUID(9,1,T1 - TTD12,ELEV,"DELUG 2")	DELUGT	236
15	DENSIV2 = FLUID(7,1,T1 - TTD12,ELEV,"DELUG 3")	DELUGT	237
C		DELUGT	238
		DELUGT	239
		DELUGT	240

C	MASS FLOW RATE OF AMMONIA THROUGH THE COOLING SYSTEM	DELUGT	241
	W32 = QREJT2/HFG2	DELUGT	242
C		DELUGT	243
C	PRESSURE DROP OF AMMONIA THROUGH THE SUPPLY PIPING	DELUGT	244
	DELPS2 = DELPS*(W32**2*DENSIV/(DENSIV2*W3**2))	DELUGT	245
C		DELUGT	246
C	PRESSURE AT THE END OF THE SUPPLY PIPING	DELUGT	247
	P22 = P12 - DELPS2/144.	DELUGT	248
	TI = T1 - TTD1 - TTD2	DELUGT	249
	DELT1 = .001	DELUGT	250
C		DELUGT	251
C	LOOP TO DETERMINE THE TEMPERATURE OF THE AMMONIA AT THE END	DELUGT	252
C	OF THE SUPPLY PIPING	DELUGT	253
20	FTI = -P22 + FLUID(10,1,TI,ELEV,"DELUG 4")	DELUGT	254
	FTIDEL = -P22 + FLUID(10,1,TI + DELT1,ELEV,"DELUG 5")	DELUGT	255
	TIP1 = TI - DELT1*FTI/(FTIDEL - FTI)	DELUGT	256
	IF(ABS(TIP1 - TI).LT..0001) GO TO 30	DELUGT	257
	TI = TIP1	DELUGT	258
	GO TO 20	DELUGT	259
C		DELUGT	260
C	TEMPERATURE DROP IN THE AMMONIA FROM THE BEGINNING TO THE	DELUGT	261
C	END OF THE SUPPLY PIPING	DELUGT	262
30	TTD22 = T1 - TTD12 - TI	DELUGT	263
C	WRITE(6,500) TTD1,TTD12,TTD2,TTD22,QREJT2,QREJT1,P12,HFG2,DENSIV2,	DELUGT	264
C	DENSIV,W32,DELPS,DELPS2,P22,TI,WATCONT	DELUGT	265
C	500 FORMAT(2X,"TTD1,TTD12,TTD2,TTD22,QREJT2,QREJT1,P12,HFG2,DENSIV2,DE	DELUGT	266
C	1NSIV,W32,DELPS,DELPS2,P22,TI,WATCONT=",/,2X,RG12.5,/,2X,RG12.5/)	DELUGT	267
C		DELUGT	268
C	INSIDE HEAT TRANSFER COEFFICIENT OF THE HEAT EXCHANGER	DELUGT	269
C	WHEN IT IS DELUGED	DELUGT	270
	GWAT2 = W32/(ZD*NW*3.14159*DI*DI/(4.*144.))	DELUGT	271
	PRW = VISW*CPW/THCONW	DELUGT	272
	CALL HXCLD(DI,ELENG*12.,ANG,GWAT2,1.,0.,PRW,DENSIW,DENSIV,VISW*	DELUGT	273
	1.41338,VISW*.41338,THCONW,CPW,H12,HTC,HTB,HTN,HTK,REWAT2)	DELUGT	274
C		DELUGT	275
C	AIR SIDE HEAT TRANSFER COEFFICIENT OF THE HEAT EXCHANGER	DELUGT	276
C	WHEN IT IS DELUGED	DELUGT	277
	GAIR2 = FACTOR*VAIR*DENSIF*3600.	DELUGT	278
	IF(FDELUG.EQ."DELUG") CALL MOTERV(FAIR2,H02,SIGMAG,ALPHA,XD,	DELUGT	279
	1GAIR2,VISA)	DELUGT	280
	IF(FDELUG.EQ."DELBW") CALL MTCH(GAIR2,H02)	DELUGT	281
	PATM = EXP(3.39853 - 3.81835E-5*ELEV)/29.92	DELUGT	282
C		DELUGT	283
C	MASS FLOW RATE OF AIR THROUGH A UNIT PART OF THE HEAT	DELUGT	284
C	EXCHANGER	DELUGT	285
	RMA = FACTOR*VAIR*DENSIF*3600./ACS	DELUGT	286
C		DELUGT	287
C	CALCULATION OF THE HEAT REJECTED FROM THE ALL WET HEAT	DELUGT	288
C	EXCHANGER AND THE AMOUNT OF WATER USED	DELUGT	289
	IF(FDELUG.EQ."DELUG") CALL DELUG	DELUGT	290
	IF(FDELUG.EQ."DELBW") CALL DELBAW	DELUGT	291
	IF(KCONV.EQ.1) RETURN	DELUGT	292
	QREJTN = NW*ELENG*QSEC	DELUGT	293
	RMEV = NW*ELENG*RMEV	DELUGT	294
	IF(NDEBUG.EQ.1) WRITE(6,60) T1,P,GWAT2,H12,GAIR2,H02,TA,TAWB,TI,	DELUGT	295
	1PATM,RMA,QSEC,RMEV,QREJTN	DELUGT	296
C		DELUGT	297

SUBROUTINE DELUGT

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	USE OF THE CALCULATED HEAT REJECTED AND THE DESIRED HEAT	DELUGT	298
C	REJECTION TO ESTIMATE THE SATURATION TEMPERATURE OF THE	DELUGT	299
C	STEAM IN THE CONDENSER/REBOILER	DELUGT	300
	IF(JK.LE.1) T11 = T1	DELUGT	301
	IF(JK.LE.1) QREJTM = QREJTN	DELUGT	302
	IF(JK.LE.1) T1 = T1 - 5.	DELUGT	303
		DELUGT	304
	IF(JK.LE.1) QREJTM = QREJTN	DELUGT	305
	IF(JK.LE.1) T1 = T1 - 5.	DELUGT	306
	IF(JK.LE.1) GO TO 10	DELUGT	307
	SLOPE = (QREJTN - QREJTM)/(T1 - T11)	DELUGT	308
	T11 = T1	DELUGT	309
	T1 = T1 + (QREJTN - QREJTM)/SLOPE	DELUGT	310
C		DELUGT	311
C	CONVERGENCE CRITERIA FOR THE SATURATION TEMPERATURE OF THE	DELUGT	312
C	STEAM IN THE CONDENSER/REBOILER	DELUGT	313
	IF(ABS(T1 - T11)/T1.LT..0025) GO TO 40	DELUGT	314
	QREJTM = QREJTN	DELUGT	315
	GO TO 10	DELUGT	316
C		DELUGT	317
C	STORAGE OF VARIABLES	DELUGT	318
	40 TSATD(I) = T1	DELUGT	319
	PSATD(I) = P	DELUGT	320
	WATCON(I) = TPER*8760.*RMEV	DELUGT	321
	WATCONT = WATCON(I) + WATCONT	DELUGT	322
C		DELUGT	323
C	IF THE BACK PRESSURE CURVE OF THE DELUGED SYSTEM IS ABOVE	DELUGT	324
C	THE BACK PRESSURE LIMIT CURVE THIS DESIGN IS THROWN OUT	DELUGT	325
	IF(PSATD(I).GT.BPL(I)) KCONV = 1	DELUGT	326
	IF(PSATD(I).GT.BPL(I)) RETURN	DELUGT	327
	60 FORMAT(2X,"T1,P,GWAT2,HI2,GAIR2,M02,TA,TAWB,TI,PAIM,RMA,QSEC,RMEV,	DELUGT	328
	10QREJTN=",,2X,RG12.4,,/,,2X,6G12.4/)	DELUGT	329
	100 CONTINUE	DELUGT	330
C		DELUGT	331
C	IF THE AMOUNT OF WATER USED TO DELUGE THE HEAT EXCHANGER	DELUGT	332
C	ALL YEAR AROUND IS BELOW THE AMOUNT ALLOCATED THIS DESIGN	DELUGT	333
C	IS THROWN OUT	DELUGT	334
	IF(WATCONA.GE.WATCONT) KCONV = 1	DELUGT	335
	RETURN	DELUGT	336
	END	DELUGT	337

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE DPCON(GOWS,DTI,DL,ANG,GT,XI,XO,DENL,DENV,VISL,VISV,DP,
1 DPF,DPG,DPM,XLM,PHIL,PHIL2,VF,FL,RL,RV)

C		DPCON	2
C		DPCON	3
C		DPCON	4
C	SUBROUTINE DPCON CALCULATES THE TWO PHASE PRESSURE DROP	DPCON	5
C	INSIDE TUBES WHETHER IT BE CONDENSATION OR BOILING THE	DPCON	6
C	PRESSURE DROP IS CALCULATED ACCORDING TO THE METHOD OF	DPCON	7
C	LOCKHART AND MARTINELLI	DPCON	8
C		DPCON	9
C	DEFINITION OF VARIABLES	DPCON	10
C		DPCON	11
C	ANG(2) - THE SIN OF THE ANGLE THE TUBE MAKES FROM THE	DPCON	12
C	HORIZONTAL (DIMENSIONLESS)	DPCON	13
C	DENL - DENSITY OF THE LIQUID PHASE OF THE TWO PHASE FLOW	DPCON	14
C	DENV - DENSITY OF THE VAPOR PHASE OF THE TWO PHASE FLOW	DPCON	15
C	DL - LENGTH OF THE TUBE (IN)	DPCON	16
C	DP - TOTAL PRESSURE DROP IN THE TUBE (LBF/SQ IN)	DPCON	17
C	DPF - PRESSURE DROP DUE TO FRICTION (LBF/SQ IN)	DPCON	18
C	DPG - PRESSURE INCREASE DUE TO GRAVITY (LBF/SQ IN)	DPCON	19
C	DPM - PRESSURE DROP OR INCREASE DUE TO MOMENTUM LOSS OR	DPCON	20
C	GAIN (LBF/SQ IN)	DPCON	21
C	DR - DENSITY RATIO (LIQUID/VAPOR) (DIMENSIONLESS)	DPCON	22
C	DTI - INSIDE DIAMETER OF THE TUBING (IN)	DPCON	23
C	FL - LIQUID FANNING FRICTION FACTOR BASED ON THE VAPOR	DPCON	24
C	QUALITY AND THE INSIDE DIAMETER ON THE TUBE (DIM-	DPCON	25
C	ENSIONLESS)	DPCON	26
C	GT - MASS FLUX OF FLUID IN THE TUBE (LBM/HR-SQ FT)	DPCON	27
C	PHIL - MARTINELLI FUNCTION (DIMENSIONLESS)	DPCON	28
C	PHIL2 - MARTINELLI FUNCTION SQUARED (DIMENSIONLESS)	DPCON	29
C	RL - REYNOLDS NUMBER LIQUID FRACTION (DIMENSIONLESS)	DPCON	30
C	RV - REYNOLDS NUMBER VAPOR FRACTION (DIMENSIONLESS)	DPCON	31
C	SN - NUMBER OF DIVISIONS IN THE LENGTH OF THE TUBE	DPCON	32
C	(DIMENSIONLESS)	DPCON	33
C	VISL - VISCOSITY OF THE LIQUID (CENTIPOSE)	DPCON	34
C	VISV - VISCOSITY OF THE VAPOR (CENTIPOSE)	DPCON	35
C	XA - AVERAGE VAPOR QUALITY IN EACH SECTION OF THE TUBE	DPCON	36
C	(DIMENSIONLESS)	DPCON	37
C	XAV - AVERAGE VAPOR QUALITY IN THE TUBE	DPCON	38
C	XD - CHANGE IN VAPOR QUALITY FROM ONE END OF THE TUBE	DPCON	39
C	TO THE NEXT OR FOR EACH SECTION OF TUBE	DPCON	40
C	(DIMENSIONLESS)	DPCON	41
C	XI - INLET VAPOR QUALITY (DIMENSIONLESS)	DPCON	42
C	XLM - LOCKHART-MARTINELLI PARAMETER (DIMENSIONLESS)	DPCON	43
C	XO - EXIT VAPOR QUALITY (DIMENSIONLESS)	DPCON	44
C		DPCON	45
C	DIMENSION ANG(3)	DPCON	46
C	DHOMO(X)=(1.0-X)/DENL+X/DENV	DPCON	47
C	DPG = 0.0	DPCON	48
C	DPM = 0.0	DPCON	49
C		DPCON	50
C	PRESSURE DROP AS A RESULT OF FRICTION	DPCON	51
C		DPCON	52
C	SETUP OF VARIABLES FOR CALCULATION OF PRESSURE DROP	DPCON	53
C	INCREMENTALLY ALONG THE LENGTH OF THE TUBE	DPCON	54
C	DR = DENL/DENV	DPCON	55
C	XD = ABS(XI-XO)	DPCON	56
C	XAV = 0.5*(XI+XO)	DPCON	57
C	N = XD*10./0.01	DPCON	58

SUBROUTINE DPCON

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

N = N + 1	DPCON	59
SN = N	DPCON	60
XD = XD/SN	DPCON	61
SUM = 0.0	DPCON	62
SUG = 0.0	DPCON	63
XA = XI + XD*.5	DPCON	64
IF(XI.LT.XO) XA = XI - XD*.5	DPCON	65
C	DPCON	66
C PRESSURE DROP INCREMENTALLY CALCULATED ALONG THE LENGTH	DPCON	67
C OF THE PIPE	DPCON	68
DO 10 I = 1,N	DPCON	69
IF(XO.LT.XI) XA = XA - XD	DPCON	70
IF(XI.LT.XO) XA = XA + XD	DPCON	71
XV = AMAX1(0.10,XA)	DPCON	72
C	DPCON	73
C DETERMINATION OF MARTINELLI FUNCTION	DPCON	74
CALL DPLMNB(DTI,GT,XV,DR,VISL,VISV,PHIL,PHIL2,FL,XLM,RL,RV)	DPCON	75
6 SUG = SUG + 1./PHIL	DPCON	76
C	DPCON	77
C DETERMINATION OF THE SUM OF THE VARIABLE PARTS IN FRONT	DPCON	78
C OF THE TWO PHASE PRESSURE DROP EQUATION	DPCON	79
10 SUM = SUM + (1.0 - XV)**2*FL*PHIL2	DPCON	80
C	DPCON	81
C PRESSURE DROP INCURRED BY THE TWO PHASE FLOW IN THE PIPE	DPCON	82
C DUE TO FRICTION	DPCON	83
DPF = .333E-10 * DL*GT**2*SUM/(DTI*DENL*SN)	DPCON	84
C	DPCON	85
C INCREASE IN PRESSURE DUE TO GRAVITY	DPCON	86
C	DPCON	87
20 VF = 1. - SUG/SN	DPCON	88
DPG = -ANG(2)*DL*(DENV*VF + DENL*(1.-VF))/1728.	DPCON	89
C	DPCON	90
C INCREASE OR DROP IN PRESSURE DUE TO CHANGES IN MOMENTUM	DPCON	91
C THE MODEL IS BASED ON A HOMOGENEOUS MODEL THAT ASSUMES	DPCON	92
C THE CHANGE IN MOMENTUM APPLIES JUST TO THE VAPOR	DPCON	93
C	DPCON	94
30 DPM = GT**2/6.E10*(DHOMO(XO)-DHOMO(XI))	DPCON	95
DPM = DPM*XAV**2	DPCON	96
C	DPCON	97
C TOTAL PRESSURE DROP	DPCON	98
C	DPCON	99
90 DP = DPF + DPG + DPM	DPCON	100
RETURN	DPCON	101
END	DPCON	102

SUBROUTINE DPFFF

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	SUBROUTINE DPFFF(RE,FF,ILT)	DPFFF	2
C		DPFFF	3
C	SUBROUTINE DPFFF DETERMINES THE FANNING FRICTION FACTOR	DPFFF	4
C	FOR SMOOTH TUBES	DPFFF	5
C		DPFFF	6
C	DEFINITION OF VARIABLES	DPFFF	7
C		DPFFF	8
C	RE - REYNOLDS NUMBER (DIMENSIONLESS)	DPFFF	9
C	FF - FANNING FRICTION FACTOR (DIMENSIONLESS)	DPFFF	10
C		DPFFF	11
	ILT = 2	DPFFF	12
	IF (RE = 1600.) 30,30,10	DPFFF	13
10	IF (RE = 3950.) 40,40,20	DPFFF	14
20	IF (RE = 52000.) 50,50,60	DPFFF	15
C		DPFFF	16
C	LAMINAR FLOW REGIME	DPFFF	17
30	FF = 16./RE	DPFFF	18
	ILT = 1	DPFFF	19
	GO TO 70	DPFFF	20
C		DPFFF	21
C	TRANSITION FLOW REGIME	DPFFF	22
40	FF = 0.010	DPFFF	23
	IF (RE.LT.2000.) ILT = 1	DPFFF	24
	GO TO 70	DPFFF	25
C		DPFFF	26
C	TURBULENT FLOW REGIME	DPFFF	27
50	FF = 0.0791/RE**0.25	DPFFF	28
	GO TO 70	DPFFF	29
60	FF = 0.0460/RE**0.20	DPFFF	30
70	RETURN	DPFFF	31
	END	DPFFF	32

C	SUBROUTINE DPLMNB(DTI,GT,XD,DR,VISL,VISV,PHIL,PHIL2,FL,XLM,RL,RV)	DPLMNB	2
C		DPLMNB	3
C	SUBROUTINE DPLMNB DETERMINES THE MARTINELLI FUNCTION FOR	DPLMNB	4
C	BOILING INSIDE OF TUBES BY CURVE FITS OF THE LOCKHART-	DPLMNB	5
C	MARTINELLI PARAMETER	DPLMNB	6
C		DPLMNB	7
C	DEFINITION OF VARIABLES	DPLMNB	8
C		DPLMNB	9
C	DR = DENSITY RATIO (LIQUID/VAPOR) (DIMENSIONLESS)	DPLMNB	10
C	DTI = INSIDE DIAMETER OF THE TUBING (IN)	DPLMNB	11
C	FL = LIQUID FANNING FRICTION FACTOR (DIMENSIONLESS)	DPLMNB	12
C	FV = VAPOR FANNING FRICTION FACTOR (DIMENSIONLESS)	DPLMNB	13
C	GT = MASS FLUX OF FLUID IN THE TUBE (LBM/(HR-SQ FT))	DPLMNB	14
C	PHIL = MARTINELLI FUNCTION (DIMENSIONLESS)	DPLMNB	15
C	PHIL2 = MARTINELLI FUNCTION SQUARED (DIMENSIONLESS)	DPLMNB	16
C	RL = REYNOLDS NUMBER LIQUID FRACTION	DPLMNB	17
C	RV = REYNOLDS NUMBER VAPOR FRACTION	DPLMNB	18
C	VISL = VISCOSITY OF THE LIQUID (CENTIPOSE)	DPLMNB	19
C	VISV = VISCOSITY OF THE LIQUID VAPOR (CENTIPOSE)	DPLMNB	20
C	XA = VAPOR QUALITY OF THE FLUID (DIMENSIONLESS)	DPLMNB	21
C	XLM = LOCKHART-MARTINELLI PARAMETER (DIMENSIONLESS)	DPLMNB	22
C		DPLMNB	23
C	XA = PNLIM(1.E-9,.9999,XD)	DPLMNB	24
C		DPLMNB	25
C	LIQUID REYNOLDS NUMBER	DPLMNB	26
C	RL = DTI*GT*(1.-XA)/(VISL*29.)	DPLMNB	27
C		DPLMNB	28
C	VAPOR REYNOLDS NUMBER	DPLMNB	29
C	RV = DTI*GT*XA/(VISV*29.)	DPLMNB	30
C		DPLMNB	31
C	FANNING FRICTION FACTOR FOR THE LIQUID	DPLMNB	32
C	CALL DPFEE(RL,FL,ILTL)	DPLMNB	33
C		DPLMNB	34
C	FANNING FRICTION FACTOR FOR THE VAPOR	DPLMNB	35
C	CALL DPFEE(RV,FV,ILTV)	DPLMNB	36
C		DPLMNB	37
C	LOCKHART-MARTINELLI PARAMETER	DPLMNB	38
C	XLM = SQRT(FL/(FV*DR)) * (1.-XA)/XA	DPLMNB	39
C		DPLMNB	40
C	VISCOUS FLOW LIQUID = VISCOUS FLOW VAPOR	DPLMNB	41
C	IF(ILTL.EQ.1.AND.ILTV.EQ.1) JMART = 1	DPLMNB	42
C		DPLMNB	43
C	TURBULENT FLOW LIQUID = VISCOUS FLOW VAPOR	DPLMNB	44
C	IF(ILTL.EQ.2.AND.ILTV.EQ.1) JMART = 2	DPLMNB	45
C		DPLMNB	46
C	VISCOUS FLOW LIQUID = TURBULENT FLOW VAPOR	DPLMNB	47
C	IF(ILTL.EQ.1.AND.ILTV.EQ.2) JMART = 3	DPLMNB	48
C		DPLMNB	49
C	TURBULENT FLOW LIQUID = TURBULENT FLOW VAPOR	DPLMNB	50
C	IF(ILTL.EQ.2.AND.ILTV.EQ.2) JMART = 4	DPLMNB	51
C		DPLMNB	52
C	MARTINELLI FUNCTION	DPLMNB	53
C	PHIL = CMARTIN(XLM,JMART,1)	DPLMNB	54
C		DPLMNB	55
C	MARTINELLI FUNCTION SQUARED	DPLMNB	56
C	PHIL2 = PHIL*PHIL	DPLMNB	57
C	RETURN	DPLMNB	58

SUBROUTINE DPLMNR 74/74 OPT=1

FTN 4,5+414

06/05/79 07.59.59

END

DPLMNB 59

SUBROUTINE ERRMSG 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	SUBROUTINE ERRMSG (KEY)	ERRMSG	2
C		ERRMSG	3
C	IF KEY IS 1 INCREMENT THE COUNTER FOR NO FAN FOUND	ERRMSG	4
C	IF KEY I S 2 INCREMENT THE LOOP COUNTER	ERRMSG	5
C	IF KEY IS 3 PRINT THE COUNTERS	ERRMSG	6
C		ERRMSG	7
	IF (KEY .EQ. 1) NFKTR = NFKTR + 1	ERRMSG	8
	IF (KEY .EQ. 2) LPKTR = LPKTR + 1	ERRMSG	9
	IF (MOD (LPKTR,20) .EQ. 0 .AND. LPKTR .GT. 0) WRITE(6,200)LPKTR	ERRMSG	10
	IF (KEY .EQ. 3) WRITE(6,100) NFKTR,LPKTR	ERRMSG	11
100	FORMAT(////////" THE NUMBER OF TIME NO FAN WAS FOUND ",I20,	ERRMSG	12
	\$" THE NUMBER OF TIMES LOOP ESCAPE WAS REQUIRED =" ,I20)	ERRMSG	13
200	FORMAT(1X,I5," FAN LOOP ESCAPES REQUIRED SO FAR")	ERRMSG	14
	RETURN	ERRMSG	15
	END	ERRMSG	16

SUBROUTINE FAN(DPTINW, AFRON)

C		FAN	2
C		FAN	3
C	SUBROUTINE FAN SELECTS THE OPTIMUM FAN SYSTEM FOR THE PARTIC-	FAN	4
C	ULAR HEAT EXCHANGER GEOMETRY SELECTED. FOR THE PARTICULAR	FAN	5
C	FAN SYSTEM THE FOLLOWING PARAMETER ARE SPECIFIED-	FAN	6
C	1. BLADE DIAMETER	FAN	7
C	2. HUB DIAMETER	FAN	8
C	3. NUMBER OF BLADES PER FAN	FAN	9
C	4. BLADE ANGLE	FAN	10
C	KNOWING THE NUMBER OF FANS AND THE PACKING FACTOR OF THE	FAN	11
C	FANS, THE CIRCULAR TOWER DIAMETER CAN EASILY BE	FAN	12
C	DETERMINED. THE COST OF THE FAN SYSTEM IS THEN FOUND. THE	FAN	13
C	FAN SYSTEM RESULTING IN THE MINIMUM COST IS SPECIFIED AS THE	FAN	14
C	OPTIMUM.	FAN	15
C	IN THIS SUBROUTINE THERE ARE TWO ARRAYS WHICH CONTAIN DATA	FAN	16
C	FOR THE FOLLOWING FAN DIAMETERS (24,26,28,30,40,60). FOR	FAN	17
C	EACH FAN DIAMETER THERE IS PERFORMANCE DATA FOR FANS WITH	FAN	18
C	DIFFERENT NUMBER OF BLADES AND BLADE ANGLES. THE DATA	FAN	19
C	ARRAYS FANDAP CONTAINS THE FOLLOWING INFORMATION-	FAN	20
C	FANDAP(I,J)	FAN	21
C	J=1,5 - COEFFICIENTS FOR THIRD ORDER CURVE FIT OF VOLU-	FAN	22
C	METRIC FLOW RATE VERSUS TOTAL PRESSURE DROP ACROSS	FAN	23
C	THE FAN	FAN	24
C	J=6 - LOWER PRESSURE DROP LIMIT (IN WATER)	FAN	25
C	J=7 - UPPER PRESSURE DROP LIMIT (IN WATER)	FAN	26
C	J=8 - DIAMETER OF FAN(FT)	FAN	27
C	J=9 - NUMBER OF BLADES PER FAN	FAN	28
C	J=10 - BLADE ANGLE (DEGREES)	FAN	29
C	I=1,153 - DIFFERENT SETS OF DATA FOR EACH FAN AND	FAN	30
C	PERFORMANCE POINT	FAN	31
C	THE DATA ARRAY FANDAH CONTAINS THE FOLLOWING INFORMATION-	FAN	32
C	FANDAH (I,J)	FAN	33
C	J=1,5 - COEFFICIENTS FOR FOURTH ORDER CURVE FIT OF	FAN	34
C	HORSEPOWER VERSUS VOLUMETRIC FLOW RATE	FAN	35
C	J=6 - LOWER LIMIT ON VOLUMETRIC FLOW RATE OF AIR THROUGH	FAN	36
C	THE FAN FOR WHICH DATA IS AVAILABLE	FAN	37
C	J=7 - UPPER LIMIT ON VOLUMETRIC FLOW RATE OF AIR THROUGH	FAN	38
C	THE FAN FOR WHICH DATA IS AVAILABLE	FAN	39
C	J=8 - DIAMETER OF FAN(FT)	FAN	40
C	J=9 - NUMBER OF BLADES PER FAN	FAN	41
C	J=10 - BLADE ANGLE (DEGREES)	FAN	42
C		FAN	43
C	DEFINITION OF VARIABLES	FAN	44
C	A - AIR FLOW AREA OF THE FAN (SQ FT)	FAN	45
C	ARLN - NUMBER OF FAN BLADES (DIMENSIONLESS)	FAN	46
C	ADIA - FAN DIAMETER (FT)	FAN	47
C	AFRON - FRONTAL AREA OF THE HEAT EXCHANGER (SQ FT)	FAN	48
C	ANFCOS - ANNUAL FAN COSTS (\$)	FAN	49
C	ANSFPC - ANNUAL CAPITAL COST OF PLENUM, FOUNDATION, AND	FAN	50
C	STRUCTURES (\$)	FAN	51
C	ANSFPF - TOTAL ANNUAL COST OF THE FAN SYSTEM AND STRUCTURE	FAN	52
C	BAR - BAROMETRIC PRESSURE (IN HGA)	FAN	53
C	BLDANG - FAN BLADE ANGLE (DEGREES)	FAN	54
C	CAFF - PERCENTAGE OF TIME THE PLANT IS PRODUCING POWER	FAN	55
C	(PERCENT)	FAN	56
C	CDANG - COSINE OF THE ANGLE FOR THE DELTA HEAT EXCHANGER	FAN	57
C	ARRANGEMENT (DIMENSIONLESS)	FAN	58

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	CFM	- ESTIMATE OF THE VOLUMETRIC FLOW RATE OF AIR THROUGH EACH FAN (CU FT/MIN)	FAN	59
C			FAN	60
C	CFROS	- FAN STACK COSTS WITH AND WITHOUT VELOCITY RECOVERY (\$)	FAN	61
C			FAN	62
C	CI	- CONVERGENCE PARAMETER FOR THE VOLUMETRIC FLOW RATE THROUGH EACH FAN (DIMENSIONLESS)	FAN	63
C			FAN	64
C	CINC	- INCREMENTAL VOLUMETRIC FLOW RATE OF AIR USED IN DETERMINING THE FAN PERFORMANCE POINT (CU FT/MIN)	FAN	65
C			FAN	66
C	CMOT	- COST OF FAN MOTORS PER FAN (\$)	FAN	67
C	CPL	- COST OF PLENUM FOR THE ENTIRE TOWER SYSTEM (\$)	FAN	68
C	CPM	- COST OF PLENUM MATERIAL (\$/LBM)	FAN	69
C	CSR	- COST OF THE SPEED REDUCER (\$)	FAN	70
C	CVM	- FAN RING MATERIAL UNIT COST (\$/LBF)	FAN	71
C	DIST	- DISTANCE FROM THE CONDENSER ROOM TO THE FIRST CIRCULAR TOWER (FT)	FAN	72
C			FAN	73
C	DPTINW	- PRESSURE DROP ACROSS THE HEAT EXCHANGER (IN H2O)	FAN	74
C	DSGTM	- DISTANCE FROM THE SWITCH GEAR TO THE MOTOR (FT)	FAN	75
C	DTOW	- DIAMETER OF THE CIRCULAR TOWERS (FT)	FAN	76
C	DTTSG	- DISTANCE FROM THE TOWER TO THE SWITCH GEAR (FT)	FAN	77
C	EFCSF	- ESCALATION FACTOR FOR FAN COST (DIMENSIONLESS)	FAN	78
C	EHR	- HEAT RATE OF PLANT (BTU/KW-HR)	FAN	79
C	ELENG	- LENGTH OF HEAT EXCHANGER TUBES (FT)	FAN	80
C	ELEV	- PLANT ELEVATION FROM SEA LEVEL (FT)	FAN	81
C	FNAD	- FAN DIAMETER (FT)	FAN	82
C	FANLEC	- ELECTRICAL WIRING COSTS FOR THE FAN SYSTEM (\$)	FAN	83
C	FCOS	- PLANT FUEL COST (CENTS/MMBTU)	FAN	84
C	FCR	- FIXED CHARGE RATE ON CAPITAL FOR ONE YEAR (FRACTIONAL)	FAN	85
C			FAN	86
C	FCST	- CAPITAL COST OF THE FAN (\$)	FAN	87
C	FMC	- FAN MOTOR COST PER HORSEPOWER FOR MOTORS OF SMALL HORSEPOWER (\$/HP)	FAN	88
C			FAN	89
C	FNDG	- FOUNDATION COSTS FOR THE CIRCULAR TOWERS (\$)	FAN	90
C	FPOW	- POWER REQUIREMENTS OF THE FAN SYSTEM (KW)	FAN	91
C	GHEFF	- GEAR BOX EFFICIENCY OF THE FAN SYSTEM (PERCENT)	FAN	92
C	HR	-	FAN	93
C	HFR	- HEIGHT OF THE FAN RING (FT)	FAN	94
C	HPAIR	- HORSEPOWER REQUIREMENTS OF THE FAN SYSTEM (HP)	FAN	95
C	HPPF	- HORSEPOWER REQUIREMENTS OF EACH FAN (HP)	FAN	96
C	HUBDIA	- DIAMETER OF THE FAN HUB (FT)	FAN	97
C	I	- PERFORMANCE POINT OF A FAN (DIMENSIONLESS)	FAN	98
C	ITMAX	- MAXIMUM NUMBER OF TOWERS ALLOWED BY INPUT VARIABLE (DIMENSIONLESS)	FAN	99
C			FAN	100
C	ITMIN	- N	FAN	101
C	ITMIN	- MINIMUM NUMBER OF TOWERS ALLOWED BY INPUT VARIABLE (DIMENSIONLESS)	FAN	102
C			FAN	103
C	ITOWN	- NUMBER OF CIRCULAR TOWERS (DIMENSIONLESS)	FAN	104
C	LHF,LFE	- VARIABLES USED IN SPECIFYING WHICH FANS ARE TO BE CONSIDERED FOR USE IN THE FAN SYSTEM (DIMENSIONLESS)	FAN	105
C			FAN	106
C			FAN	107
C	NRUNHI	- HEIGHT OF THE TOWER IN NUMBER OF BUNDLES (DIMENSIONLESS)	FAN	108
C			FAN	109
C	NOF	- NUMBER OF FANS MAKING UP THE FAN SYSTEM (DIMENSIONLESS)	FAN	110
C			FAN	111
C	NSIDES	- NUMBER OF SIDES THE POLYGONAL COOLING TOWERS HAVE (DIMENSIONLESS)	FAN	112
C			FAN	113
C	PFACT	- PACKING FACTOR, RATIO OF CIRCULAR TOWER ROOF AREA TO FAN SWEEPED AREA (DIMENSIONLESS)	FAN	114
C			FAN	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	PLANC	- BASE PLANT COSTS (\$/KW)	FAN	116
C	POHFAN	- INDIRECT COST FACTOR FOR FANS (DECIMAL)	FAN	117
C	POHSTC	- INDIRECT COST FACTOR FOR CIRCULAR TOWER STRUCTURES (DECIMAL)	FAN	118
C			FAN	119
C	ROOFL	- CIRCULAR TOWER ROOF LOAD (LBF/SQ FT)	FAN	120
C	SAAF	- SHIPPING AND ASSEMBLY FACTOR (DECIMAL)	FAN	121
C	SPVOL	- SPECIFIC VOLUME OF THE AIR EXITING THE HEAT EXCHANGER (LBM/CU FT)	FAN	122
C			FAN	123
C	STRUCC	- CIRCULAR TOWER STRUCTURE COST (\$)	FAN	124
C	TAN19	- TANGENT OF 19 DEGREES TO BE USED IN COSTING OF ENTRY BELL TO THE FAN (DECIMAL)	FAN	125
C			FAN	126
C	TAN 8	- TANGENT OF 8 DEGREES TO BE USED IN COSTING OF EXIT STACK FROM THE FAN (DECIMAL)	FAN	127
C			FAN	128
C	TCSTF	- TOTAL COST OF THE FAN SYSTEM (\$)	FAN	129
C	TCSTPF	- TOTAL COST OF A FAN (\$)	FAN	130
C	TOTCFM	- TOTAL VOLUMETRIC FLOW RATE FOR THE AIR THROUGH THE FAN SYSTEM (CU FT/MIN)	FAN	131
C			FAN	132
C	TOTHP	- TOTAL HORSEPOWER REQUIREMENT OF THE FAN SYSTEM (HP)	FAN	133
C	TP	- TOTAL PRESSURE DIFFERENTIAL ACROSS THE FAN (IN H2O)	FAN	134
C	T4	- AIR EXIT TEMPERATURE FROM THE HEAT EXCHANGER (DEG F)	FAN	135
C			FAN	136
C	UCS	- UNIT COST OF THE STACK (\$/LBF)	FAN	137
C	UWS	- UNIT WEIGHT OF THE STACK (LBF/CU FT)	FAN	138
C	VEL	- AVERAGE VELOCITY OF THE AIR LEAVING THE FAN (FT/SEC)	FAN	139
C			FAN	140
C	VELREC	- SPECIFIES WHETHER VELOCITY RECOVERY STACKS ARE GOING TO BE USED OR NOT (DIMENSIONLESS)	FAN	141
C			FAN	142
C	VP	- NON RECOVERABLE AIR VELOCITY HEAT EXITING THE FAN (IN H2O)	FAN	143
C			FAN	144
C	WATERW	- WEIGHT OF WATER IN THE HEAT EXCHANGER TUBES AND BUNDLES (LBF)	FAN	145
C			FAN	146
C	WB	- APPROXIMATE BUNDLE WIDTH OF THE HEAT EXCHANGER (FT)	FAN	147
C	WBB	- BUNDLE WIDTH OF THE HEAT EXCHANGER (FT)	FAN	148
C	WFB	- UNIT WEIGHT OF THE ENTRY BELL (LBF/SQ FT)	FAN	149
C	WHX	- WIEGHT OF THE HEAT EXCHANGER (LBF)	FAN	150
C	WIDTH	- WIDTH OF THE HEAT EXCHANGER (F)	FAN	151
C	WPL	- WIEGHT OF THE PLENUM MATERIAL (LBF/ SQ FT)	FAN	152
C	W4	- MASS FLOW RATE OF AIR THROUGH THE HEAT EXCHANGER (LBM/HR)	FAN	153
C			FAN	154
C	XNFAN	- NUMBER OF FANS (DIMENSIONLESS)	FAN	155
C			FAN	156
	REAL NOF		FAN	157
	LOGICAL LOOPER		FANDEK	2
	COMMON/FAN/ FANDAP(153,10),FANDAH(153,10),FMCPF,FBCPF,P2,R,S,		FANDEK	3
	\$ VELREC, AFC, ELEV, EHR, LOOPER, CTMAX		FANDEK	4
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG		BIGCOM	2
	COMMON		BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)		BIGCOM	4
	* ,BPLIM(16)		BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	6
	\$,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM		BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	8
	\$,EFPF, EFS		BIGCOM	9
	\$,FCR,FIRST,FixL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG		BIGCOM	10
	\$,FixV,FixTID,FXTVAR,FXTTID,FXTLNG		BIGCOM	11
	\$,GrEFF		BIGCOM	12
	\$,HxNP,HPCST,HCD		BIGCOM	13

```

$ ,ITMAX, ITMIN                                BIGCOM 14
$ ,JCONS                                         BIGCOM 15
$ ,KCONV, KALEXT                                BIGCOM 16
$ ,MXEXT                                         BIGCOM 17
$ ,NTA,NSIDES,NBUNHI                           BIGCOM 18
COMMON                                           BIGCOM 19
$ ODR                                           BIGCOM 20
$ ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL      BIGCOM 21
$ ,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POMHSL BIGCOM 22
$ ,RBP,REDUCE, REDUCV, ROOFL, RHOUT            BIGCOM 23
$ ,QREJ, QREDUCE, QREDUCV                      BIGCOM 24
$ ,SIGMAG, SAAF, SEGL                          BIGCOM 25
$ ,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX  BIGCOM 26
$ ,TCD, TW                                       BIGCOM 27
$ ,UCS, UWS                                     BIGCOM 28
$ ,WV, WATCONA, WATCOST                       BIGCOM 29
$ ,VAS(5)                                       BIGCOM 30
$ ,XDEPA, XW, XD                               BIGCOM 31
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF, SUPPLY 2
$ ,QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW, SUPPLY 3
$ ,FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4, SUPPLY 4
$ ,REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3, SUPPLY 5
$ ,SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2, SUPPLY 6
$ ,BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX SUPPLY 7
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS SUPPLY 8
$ , CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPWP, AST,OLDCST SUPPLY 9
$ ,CAPCST, XNFAN,BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN SUPPLY 10
$ , WTHOR, WTRFM,STRUCC,CFPERF,HPREF, TOTCF, TPC, EFFIN, ANTU SUPPLY 11
$ , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP SUPPLY 12
$ , ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY 13
$ , CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD SUPPLY 14
$ ,SQRJ,SQRJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCSTO SUPPLY 15
$ ,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST SUPPLY 16
$ ,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16) SUPPLY 17
$ ,WBR,HTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5 SUPPLY 18
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD,PLANC1,CASSS1, SCALER 2
$ ,GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANC1 SCALER 3
COMMON /HEADX/ CHH,CN,CHM,CMW,CRJ,CWJ,CST,CMO,CSR,CSM,PITCHF,CPM, FAN 162
1 PRESS,HEDMAT,HEDTYP,NPASS,WB,TSP,C5H,CSHP FAN 163
COMMON /FNLOOP/ LFB,LFE FAN 164
COMMON /PLCOST/ WPL FAN 165
COMMON /INDIS/ DIST FAN 166
COMMON /PME/ PMELEC FAN 167
COMMON/TOTAL/RECVEL,A60,EA60,VPCQEF,STATP FAN 168
DATA (FANDAP( 1,J),J=1,10) / FAN 169
$ .7961 ,.6520 ,.6.316 ,.11.944 ,.8.252 , FAN 170
$ .19 ,.625 , 24. , 6. , 6. / FAN 171
DATA (FANDAP( 2,J),J=1,10) / FAN 172
$ 1.069 ,.8172 ,.1262 ,.2533 ,.2331 , FAN 173
$ .25 ,.765 , 24. , 6. , 8. / FAN 174
DATA (FANDAP( 3,J),J=1,10) / FAN 175
$ 1.346 ,.1.635 ,.1.685 ,.1.666 ,.5886 , FAN 176
$ .31 ,.91 , 24. , 6. , 10. / FAN 177
DATA (FANDAP( 4,J),J=1,10) / FAN 178
$ .5643 ,.4.692 ,.14.336 ,.15.960 ,.6.562 , FAN 179
$ .365 ,.94 , 24. , 6. , 12. / FAN 180
DATA (FANDAP( 5,J),J=1,10) / FAN 181

```

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5,414

06/05/79 07.59.59

\$.4015	.6.087	,-16.629	.17.327	,-6.713	FAN	182
\$.42	.98	.24.	6. .14. /		FAN	183
DATA (FANDAP(6,J),J=1,10) /					FAN	184
\$ 1.337	.9316	,-4.656	.5.368	,-2.424	FAN	185
\$.477	.95	.24.	6. .16. /		FAN	186
DATA (FANDAP(7,J),J=1,10) /					FAN	187
\$ -3.074	.26.409	,-57.905	.54.456	,-19.277	FAN	188
\$.532	.1.01	.24.	6. .18. /		FAN	189
DATA (FANDAP(8,J),J=1,10) /					FAN	190
\$ 1.226	.3.829	,-11.905	.12.904	,-5.303	FAN	191
\$.605	.98	.24.	6. .20. /		FAN	192
DATA (FANDAP(9,J),J=1,10) /					FAN	193
\$ -17.189	.96.0	,-182.414	.152.343	,-47.879	FAN	194
\$.69	.1.016	.24.	6. .22. /		FAN	195
DATA (FANDAP(10,J),J=1,10) /					FAN	196
\$.9109	,-.6216	,-.0576	.09596	,-.0758	FAN	197
\$.205	.795	.24.	8. .6. /		FAN	198
DATA (FANDAP(11,J),J=1,10) /					FAN	199
\$ 1.069	,-.7222	.0581	.0384	,-.0676	FAN	200
\$.264	.969	.24.	8. .8. /		FAN	201
DATA (FANDAP(12,J),J=1,10) /					FAN	202
\$ 1.194	,-.6306	,-.0933	.01957	,-.00947	FAN	203
\$.327	.1.138	.24.	8. .10. /		FAN	204
DATA (FANDAP(13,J),J=1,10) /					FAN	205
\$ 1.442	,-1.399	.1.550	,-1.418	.4356	FAN	206
\$.383	.1.12	.24.	8. .12. /		FAN	207
DATA (FANDAP(14,J),J=1,10) /					FAN	208
\$.4597	.4.638	,-10.373	.8.728	,-2.718	FAN	209
\$.445	.1.21	.24.	8. .14. /		FAN	210
DATA (FANDAP(15,J),J=1,10) /					FAN	211
\$ 1.633	,-.5932	,-.5343	.6805	,-.3261	FAN	212
\$.529	.1.14	.24.	8. .16. /		FAN	213
DATA (FANDAP(16,J),J=1,10) /					FAN	214
\$.244	.7.202	,-14.895	.12.133	,-3.683	FAN	215
\$.612	.1.25	.24.	8. .18. /		FAN	216
DATA (FANDAP(17,J),J=1,10) /					FAN	217
\$ 2.321	,-2.232	.1.862	,-.7451	,-.0714	FAN	218
\$.7	.1.15	.24.	8. .20. /		FAN	219
DATA (FANDAP(18,J),J=1,10) /					FAN	220
\$ -12.148	.55.65	,-83.947	.55.657	,-13.939	FAN	221
\$.865	.1.24	.24.	8. .22. /		FAN	222
DATA (FANDAP(19,J),J=1,10) /					FAN	223
\$.8625	,-.2121	,-.6814	.5934	,-.1894	FAN	224
\$.25	.95	.24.	10. .6. /		FAN	225
DATA (FANDAP(20,J),J=1,10) /					FAN	226
\$ 1.307	,-2.057	.3.129	,-2.760	.8712	FAN	227
\$.32	.1.16	.24.	10. .18. /		FAN	228
DATA (FANDAP(21,J),J=1,10) /					FAN	229
\$ 1.140	,-.3050	,-.4077	.2543	,-.0612	FAN	230
\$.39	.1.365	.24.	10. .10. /		FAN	231
DATA (FANDAP(22,J),J=1,10) /					FAN	232
\$ 1.211	,-.1516	,-.5856	.3418	,-.07576	FAN	233
\$.46	.1.34	.24.	10. .12. /		FAN	234
DATA (FANDAP(23,J),J=1,10) /					FAN	235
\$ 1.247	.0813	,-.6502	.1965	,-.01166	FAN	236
\$.53	.1.4	.24.	10. .14. /		FAN	237
DATA (FANDAP(24,J),J=1,10) /					FAN	238

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 1.314	.,5641	,-1.534	.,8592	,-.1989	FAN	239
\$.62	.,1.37	., 24. ,	10. , 16. /		FAN	240
DATA (FANDAP(25,J),J=1,10) /					FAN	241
\$.5757	.,4.363	,-7.5248	.,4.961	,-1.231	FAN	242
\$.74	.,1.55	., 24. ,	10. , 18. /		FAN	243
DATA (FANDAP(26,J),J=1,10) /					FAN	244
\$ -.076	.,6.982	,-10.783	.,6.833	,-1.667	FAN	245
\$.84	.,1.44	., 24. ,	10. , 20. /		FAN	246
DATA (FANDAP(27,J),J=1,10) /					FAN	247
\$ -168.996	.,548.34	,-659.02	.,350.82	,-69.909	FAN	248
\$ 1.02	.,1.48	., 24. ,	10. , 22. /		FAN	249
DATA (FANDAP(28,J),J=1,10) /					FAN	250
\$ 1.090	.,1.005	.,2432	.,1717	,-1.515	FAN	251
\$.205	.,.55	., 26. ,	6. , 6. /		FAN	252
DATA (FANDAP(29,J),J=1,10) /					FAN	253
\$ 1.144	.,-.0621	,-3.590	.,6.245	,-4.382	FAN	254
\$.248	.,.66	., 26. ,	6. , 8. /		FAN	255
DATA (FANDAP(30,J),J=1,10) /					FAN	256
\$ 1.196	.,.1327	,-2.291	.,1.492	,-.2797	FAN	257
\$.295	.,.778	., 26. ,	6. , 10. /		FAN	258
DATA (FANDAP(31,J),J=1,10) /					FAN	259
\$ 1.576	.,-1.413	.,1.077	.,-.8904	,-.2331	FAN	260
\$.35	.,.84	., 26. ,	6. , 12. /		FAN	261
DATA (FANDAP(32,J),J=1,10) /					FAN	262
\$ -.3976	.,13.678	,-38.403	.,44.263	,-19.254	FAN	263
\$.41	.,.87	., 26. ,	6. , 14. /		FAN	264
DATA (FANDAP(33,J),J=1,10) /					FAN	265
\$ 2.497	.,-4.479	.,5.789	.,-2.571	,-1.061	FAN	266
\$.466	.,.85	., 26. ,	6. , 16. /		FAN	267
DATA (FANDAP(34,J),J=1,10) /					FAN	268
\$ -31.553	.,200.29	,-450.42	.,445.5	,-164.67	FAN	269
\$.525	.,.89	., 26. ,	6. , 18. /		FAN	270
DATA (FANDAP(35,J),J=1,10) /					FAN	271
\$ -37.986	.,229.06	,-493.08	.,468.48	,-166.93	FAN	272
\$.60	.,.88	., 26. ,	6. , 20. /		FAN	273
DATA (FANDAP(36,J),J=1,10) /					FAN	274
\$ 199.88	.,-940.76	.,1663.3	.,-1295.9	.,373.75	FAN	275
\$.722	.,.90	., 26. ,	6. , 22. /		FAN	276
DATA (FANDAP(37,J),J=1,10) /					FAN	277
\$ 1.166	.,-1.456	.,2.750	.,-4.222	.,1.818	FAN	278
\$.22	.,.605	., 26. ,	8. , 6. /		FAN	279
DATA (FANDAP(38,J),J=1,10) /					FAN	280
\$ 1.178	.,-.1032	,-2.070	.,3.033	,-1.935	FAN	281
\$.275	.,.755	., 26. ,	8. , 8. /		FAN	282
DATA (FANDAP(39,J),J=1,10) /					FAN	283
\$ 1.431	.,-.9074	.,.04604	.,.5361	,-.6993	FAN	284
\$.333	.,.885	., 26. ,	8. , 10. /		FAN	285
DATA (FANDAP(40,J),J=1,10) /					FAN	286
\$ 1.330	.,.5823	,-3.196	.,3.499	,-1.643	FAN	287
\$.39	.,.985	., 26. ,	8. , 12. /		FAN	288
DATA (FANDAP(41,J),J=1,10) /					FAN	289
\$.8602	.,3.760	.,-8.974	.,7.814	,-2.708	FAN	290
\$.45	.,1.083	., 26. ,	8. , 14. /		FAN	291
DATA (FANDAP(42,J),J=1,10) /					FAN	292
\$ 1.829	.,-.6431	,-.5586	.,.9619	,-.6993	FAN	293
\$.518	.,1.03	., 26. ,	8. , 16. /		FAN	294
DATA (FANDAP(43,J),J=1,10) /					FAN	295

\$ -6.905	,44.985	,-87.056	,72.668	,-22.635	,	FAN	296
\$.586	,1.14	, 26. ,	8. , 18. /			FAN	297
DATA (FANDAP(44,J),J=1,10) /						FAN	298
\$ -13.827	,76.312	,-138.97	,111.051	,-33.333	,	FAN	299
\$.68	,1.06	, 26. ,	8. , 20. /			FAN	300
DATA (FANDAP(45,J),J=1,10) /						FAN	301
\$ -14.507	,68.914	,-108.62	,75.63	,-20.0	,	FAN	302
\$.9	,1.125	, 26. ,	8. , 22. /			FAN	303
DATA (FANDAP(46,J),J=1,10) /						FAN	304
\$ 1.084	,-.5941	,.3743	,-.6713	,,2083	,	FAN	305
\$.23	,,78	, 26. ,	11. , 6. /			FAN	306
DATA (FANDAP(47,J),J=1,10) /						FAN	307
\$ 1.284	,-.9283	,.9886	,-1.0606	,,303	,	FAN	308
\$.29	,,98	, 26. ,	11. , 8. /			FAN	309
DATA (FANDAP(48,J),J=1,10) /						FAN	310
\$ 1.320	,-.09006	,-1.233	,1.396	,-.6345	,	FAN	311
\$.355	,1.15	, 26. ,	11. , 10. /			FAN	312
DATA (FANDAP(49,J),J=1,10) /						FAN	313
\$ 1.385	,,3155	,-1.958	,1.880	,-.7164	,	FAN	314
\$.415	,1.28	, 26. ,	11. , 12. /			FAN	315
DATA (FANDAP(50,J),J=1,10) /						FAN	316
\$ 1.376	,,7735	,-2.250	,1.701	,-.5449	,	FAN	317
\$.49	,1.415	, 26. ,	11. , 14. /			FAN	318
DATA (FANDAP(51,J),J=1,10) /						FAN	319
\$.4584	,5.911	,-11.267	,8.504	,-2.414	,	FAN	320
\$.57	,1.444	, 26. ,	11. , 16. /			FAN	321
DATA (FANDAP(52,J),J=1,10) /						FAN	322
\$ -6.278	,34.035	,-53.2655	,35.676	,-8.8359	,	FAN	323
\$.65	,1.525	, 26. ,	11. , 18. /			FAN	324
DATA (FANDAP(53,J),J=1,10) /						FAN	325
\$ -25.743	,103.427	,-144.837	,89.298	,-20.622	,	FAN	326
\$.89	,1.38	, 26. ,	11. , 20. /			FAN	327
DATA (FANDAP(54,J),J=1,10) /						FAN	328
\$ -67.994	,225.828	,-273.144	,146.373	,-29.455	,	FAN	329
\$ 1.11	,1.46	, 26. ,	11. , 22. /			FAN	330
DATA (FANDAP(55,J),J=1,10) /						FAN	331
\$ 1.141	,-.331	,-1.453	,-1.591	,2.453	,	FAN	332
\$.19	,,54	, 28. ,	6. , 6. /			FAN	333
DATA (FANDAP(56,J),J=1,10) /						FAN	334
\$ 1.045	,2.745	,-16.574	,30.038	,-20.517	,	FAN	335
\$.23	,,63	, 28. ,	6. , 8. /			FAN	336
DATA (FANDAP(57,J),J=1,10) /						FAN	337
\$.9281	,5.303	,-23.573	,36.246	,-20.781	,	FAN	338
\$.28	,,71	, 28. ,	6. , 10. /			FAN	339
DATA (FANDAP(58,J),J=1,10) /						FAN	340
\$ 1.058	,5.352	,-22.775	,33.866	,-18.871	,	FAN	341
\$.33	,,71	, 28. ,	6. , 12. /			FAN	342
DATA (FANDAP(59,J),J=1,10) /						FAN	343
\$ -3.092	,37.887	,-111.734	,139.178	,-64.532	,	FAN	344
\$.39	,,78	, 28. ,	6. , 14. /			FAN	345
DATA (FANDAP(60,J),J=1,10) /						FAN	346
\$ -1.439	,26.222	,-79.847	,102.926	,-50.00	,	FAN	347
\$.435	,,72	, 28. ,	6. , 16. /			FAN	348
DATA (FANDAP(61,J),J=1,10) /						FAN	349
\$ -22.914	,167.722	,-422.785	,467.638	,-193.335	,	FAN	350
\$.49	,,785	, 28. ,	6. , 18. /			FAN	351
DATA (FANDAP(62,J),J=1,10) /						FAN	352

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ -4.125	.46.711	,-131.308	.158.511	,-71.4578	FAN	353
\$.53	.76	, 28. ,	6. , 20. /		FAN	354
DATA (FANDAP(63,J),J=1,10) /					FAN	355
\$ -99.262	.607.748	,-1365.6	.1360.4	,-508.349	FAN	356
\$.58	.79	, 28. ,	6. , 22. /		FAN	357
DATA (FANDAP(64,J),J=1,10) /					FAN	358
\$ 1.149	,-.0283	,-3.051	.3.750	,-1.911	FAN	359
\$.20	.67	, 28. ,	8. , 6. /		FAN	360
DATA (FANDAP(65,J),J=1,10) /					FAN	361
\$ 1.386	,-.4003	,-2.450	.3.275	,-1.655	FAN	362
\$.255	.79	, 28. ,	8. , 8. /		FAN	363
DATA (FANDAP(66,J),J=1,10) /					FAN	364
\$ 1.479	,-.4131	,-.8639	,-.0806	.3017	FAN	365
\$.3	.9	, 28. ,	8. , 10. /		FAN	366
DATA (FANDAP(67,J),J=1,10) /					FAN	367
\$ 1.542	.1.115	,-6.969	.9.507	,-4.848	FAN	368
\$.36	.9	, 28. ,	8. , 12. /		FAN	369
DATA (FANDAP(68,J),J=1,10) /					FAN	370
\$.4543	.9.668	,-26.867	.28.991	,-11.655	FAN	371
\$.44	.98	, 28. ,	8. , 14. /		FAN	372
DATA (FANDAP(69,J),J=1,10) /					FAN	373
\$ -.1495	.13.991	,-36.402	.38.619	,-15.385	FAN	374
\$.49	.94	, 28. ,	8. , 16. /		FAN	375
DATA (FANDAP(70,J),J=1,10) /					FAN	376
\$ -1.626	.22.206	,-51.296	.49.975	,-18.322	FAN	377
\$.567	.98	, 28. ,	8. , 18. /		FAN	378
DATA (FANDAP(71,J),J=1,10) /					FAN	379
\$ -15.419	.94.430	,-191.291	.170.303	,-56.97	FAN	380
\$.62	.96	, 28. ,	8. , 20. /		FAN	381
DATA (FANDAP(72,J),J=1,10) /					FAN	382
\$ -182.795	.850.555	,-1466.4	.1121.9	,-321.938	FAN	383
\$.8	.1.01	, 28. ,	8. , 22. /		FAN	384
DATA (FANDAP(73,J),J=1,10) /					FAN	385
\$ 1.907	,-8.155	.26.542	,-39.870	.20.833	FAN	386
\$.203	.72	, 28. ,	9. , 6. /		FAN	387
DATA (FANDAP(74,J),J=1,10) /					FAN	388
\$ 1.707	,-2.471	.5.482	,-7.257	.3.078	FAN	389
\$.3	.1.025	, 28. ,	9. , 10. /		FAN	390
DATA (FANDAP(75,J),J=1,10) /					FAN	391
\$ -5.491	.43.171	,-95.661	.90.264	,-31.495	FAN	392
\$.443	.1.045	, 28. ,	9. , 14. /		FAN	393
DATA (FANDAP(76,J),J=1,10) /					FAN	394
\$ -11.476	.71.058	,-139.628	.119.048	,-37.792	FAN	395
\$.565	.1.08	, 28. ,	9. , 18. /		FAN	396
DATA (FANDAP(77,J),J=1,10) /					FAN	397
\$ -111.138	.485.02	,-778.16	.553.442	,-147.595	FAN	398
\$.82	.1.11	, 28. ,	9. , 22. /		FAN	399
DATA (FANDAP(78,J),J=1,10) /					FAN	400
\$.9182	,-.6397	.1263	,-1.283	.1.08	FAN	401
\$.118	.54	, 28. ,	10. , 2. /		FAN	402
DATA (FANDAP(79,J),J=1,10) /					FAN	403
\$ 1.191	,-.5515	,-.046	,-.974	.6976	FAN	404
\$.2	.8	, 28. ,	10. , 6. /		FAN	405
DATA (FANDAP(80,J),J=1,10) /					FAN	406
\$ 1.478	,-.2616	,-2.549	.3.408	,-1.70	FAN	407
\$.31	.1.03	, 28. ,	10. , 10. /		FAN	408
DATA (FANDAP(81,J),J=1,10) /					FAN	409

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 0.4844	,8.207	, -20.171	,19.338	, -6.894	FAN	410
\$.45	,1.15	, 28.	, 10.	, 14. /	FAN	411
DATA (FANDAP(82,J),J=1,10) /					FAN	412
\$ -12.856	,75.341	, -141.915	,115.921	, -35.119	FAN	413
\$.58	,1.17	, 28.	, 10.	, 18. /	FAN	414
DATA (FANDAP(83,J),J=1,10) /					FAN	415
\$ -131.140	,528.522	, -784.764	,516.323	, -127.273	FAN	416
\$.9	,1.21	, 28.	, 10.	, 22. /	FAN	417
DATA (FANDAP(84,J),J=1,10) /					FAN	418
\$.9394	, -6.355	, .3496	, -1.169	, .7752	FAN	419
\$.122	, .64	, 28.	, 12.	, 2. /	FAN	420
DATA (FANDAP(85,J),J=1,10) /					FAN	421
\$ 1.205	, -5.51	, .1897	, -1.018	, .6163	FAN	422
\$.216	, .94	, 28.	, 12.	, 6. /	FAN	423
DATA (FANDAP(86,J),J=1,10) /					FAN	424
\$ 1.504	, -1.562	, -1.506	,1.699	, -7.334	FAN	425
\$.33	,1.2	, 28.	, 12.	, 10. /	FAN	426
DATA (FANDAP(87,J),J=1,10) /					FAN	427
\$.6086	,6.967	, -15.551	,13.341	, -4.216	FAN	428
\$.48	,1.32	, 28.	, 12.	, 14. /	FAN	429
DATA (FANDAP(88,J),J=1,10) /					FAN	430
\$ 1.227	,4.416	, -9.275	,7.309	, -2.178	FAN	431
\$.7	,1.44	, 28.	, 12.	, 18. /	FAN	432
DATA (FANDAP(89,J),J=1,10) /					FAN	433
\$ 1.036	, -4.416	, -6.142	,15.126	, -14.698	FAN	434
\$.12	, .38	, 30.	, 8.	, 2. /	FAN	435
DATA (FANDAP(90,J),J=1,10) /					FAN	436
\$ 2.034	, -5.822	,13.159	, -16.404	,6.562	FAN	437
\$.22	, .64	, 30.	, 8.	, 6. /	FAN	438
DATA (FANDAP(91,J),J=1,10) /					FAN	439
\$ 1.109	,6.519	, -26.233	,35.842	, -18.121	FAN	440
\$.32	, .79	, 30.	, 8.	, 10. /	FAN	441
DATA (FANDAP(92,J),J=1,10) /					FAN	442
\$ -9.489	,76.086	, -183.816	,190.216	, -73.502	FAN	443
\$.51	, .85	, 30.	, 8.	, 14. /	FAN	444
DATA (FANDAP(93,J),J=1,10) /					FAN	445
\$ -1009.5	,5246.17	, -10188.02	,8781.48	, -2836.03	FAN	446
\$.71	, .88	, 30.	, 8.	, 18. /	FAN	447
DATA (FANDAP(94,J),J=1,10) /					FAN	448
\$ 5.9445	, -4.875	,0.	,0.	,0.	FAN	449
\$.88	, .91	, 30.	, 8.	, 22. /	FAN	450
DATA (FANDAP(95,J),J=1,10) /					FAN	451
\$ 1.055	, -7.416	, -2.354	,6.096	, -6.699	FAN	452
\$.12	, .4	, 30.	, 10.	, 2. /	FAN	453
DATA (FANDAP(96,J),J=1,10) /					FAN	454
\$ 1.611	, -1.705	,1.163	, -1.643	, .7516	FAN	455
\$.23	, .7	, 30.	, 10.	, 6. /	FAN	456
DATA (FANDAP(97,J),J=1,10) /					FAN	457
\$.5192	,9.050	, -26.526	,29.287	, -12.083	FAN	458
\$.34	, .9	, 30.	, 10.	, 10. /	FAN	459
DATA (FANDAP(98,J),J=1,10) /					FAN	460
\$ -9.716	,71.057	, -157.856	,150.679	, -53.458	FAN	461
\$.53	,1.0	, 30.	, 10.	, 14. /	FAN	462
DATA (FANDAP(99,J),J=1,10) /					FAN	463
\$ -504.715	,2209.6	, -3604.36	,2607.84	, -706.956	FAN	464
\$.82	,1.045	, 30.	, 10.	, 18. /	FAN	465
DATA (FANDAP(100,J),J=1,10) /					FAN	466

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ -3515.6	,13939.07	,=20708.7	,13672.5	,=-3385.42	FAN	467
\$.98	,1.08	, 30. , 10. , 22. /			FAN	468
DATA (FANDAP(101,J),J=1,10) /					FAN	469
\$ 1.076	,=.9295	,=.3826	,.4669	,=-.8643	FAN	470
\$.12	,.44	, 30. , 11. , 2. /			FAN	471
DATA (FANDAP(102,J),J=1,10) /					FAN	472
\$ 1.555	,=-1.08	,=.4653	,.5259	,=-.2670	FAN	473
\$.24	,.765	, 30. , 11. , 6. /			FAN	474
DATA (FANDAP(103,J),J=1,10) /					FAN	475
\$.9216	,6.142	,=-18.702	,18.968	,=-7.415	FAN	476
\$.35	,.98	, 30. , 11. , 10. /			FAN	477
DATA (FANDAP(104,J),J=1,10) /					FAN	478
\$ -18.274	,109.841	,=-218.930	,188.787	,=-60.351	FAN	479
\$.576	,1.07	, 30. , 11. , 14. /			FAN	480
DATA (FANDAP(105,J),J=1,10) /					FAN	481
\$ -3000.2	,12053.9	,=-18124.3	,12096.4	,=-3024.19	FAN	482
\$.917	,1.11	, 30. , 11. , 18. /			FAN	483
DATA (FANDAP(106,J),J=1,10) /					FAN	484
\$ -39.918	,78.558	,=-36.938	,0.0	,0.0	FAN	485
\$ 1.07	,1.16	, 30. , 11. , 22. /			FAN	486
DATA (FANDAP(107,J),J=1,10) /					FAN	487
\$ 1.032	,=.2723	,=-3.275	,6.874	,=-5.731	FAN	488
\$.125	,.485	, 30. , 12. , 2. /			FAN	489
DATA (FANDAP(108,J),J=1,10) /					FAN	490
\$ 1.523	,=.8049	,=-.869	,.9265	,=-.397	FAN	491
\$.245	,.83	, 30. , 12. , 6. /			FAN	492
DATA (FANDAP(109,J),J=1,10) /					FAN	493
\$ 1.151	,4.199	,=-12.180	,11.996	,=-4.465	FAN	494
\$.36	,1.05	, 30. , 12. , 10. /			FAN	495
DATA (FANDAP(110,J),J=1,10) /					FAN	496
\$ -14.085	,83.829	,=-160.649	,132.788	,=-40.673	FAN	497
\$.55	,1.14	, 30. , 12. , 14. /			FAN	498
DATA (FANDAP(111,J),J=1,10) /					FAN	499
\$ -4789.04	,17939.56	,=-25154.2	,15654.5	,=-3648.91	FAN	500
\$.978	,1.19	, 30. , 12. , 18. /			FAN	501
DATA (FANDAP(112,J),J=1,10) /					FAN	502
\$ 1.876	,=.1865	,=-15.858	,53.187	,=-69.015	FAN	503
\$.13	,.385	, 40. , 8. , 2. /			FAN	504
DATA (FANDAP(113,J),J=1,10) /					FAN	505
\$ 2.608	,=2.762	,6.513	,=-15.566	,9.394	FAN	506
\$.225	,.64	, 40. , 6. , 6. /			FAN	507
DATA (FANDAP(114,J),J=1,10) /					FAN	508
\$ 1.969	,6.766	,=-22.052	,24.257	,=-11.119	FAN	509
\$.32	,.83	, 40. , 8. , 10. /			FAN	510
DATA (FANDAP(115,J),J=1,10) /					FAN	511
\$ -6.169	,63.616	,=-156.602	,163.373	,=-63.846	FAN	512
\$.447	,.91	, 40. , 8. , 14. /			FAN	513
DATA (FANDAP(116,J),J=1,10) /					FAN	514
\$ -5.464	,55.577	,=-127.737	,128.57	,=-49.557	FAN	515
\$.54	,.96	, 40. , 8. , 18. /			FAN	516
DATA (FANDAP(117,J),J=1,10) /					FAN	517
\$ -191.805	,955.903	,=-1748.194	,1419.63	,=-433.33	FAN	518
\$.75	,1.0	, 40. , 8. , 22. /			FAN	519
DATA (FANDAP(118,J),J=1,10) /					FAN	520
\$ 1.872	,.454	,=-11.977	,27.924	,=-27.683	FAN	521
\$.14	,.38	, 40. , 10. , 2. /			FAN	522
DATA (FANDAP(119,J),J=1,10) /					FAN	523

74/74 OPT=1

FTN 4.5.414

06/05/78 07.59.59

\$ 2.222	,2.029	, -9.762	,10.841	, -5.528	FAN	522
\$.253	,.72	, 40. , 10. , 6. /			FAN	525
DATA (FANDAP(120,J),J=1,10) /					FAN	526
\$ 1.717	,10.358	, -31.846	,36.638	, -16.245	FAN	527
\$.367	,.92	, 40. , 10. , 10. /			FAN	528
DATA (FANDAP(121,J),J=1,10) /					FAN	529
\$ -10.728	,85.651	, -189.652	,179.696	, -63.371	FAN	530
\$.495	,1.02	, 40. , 10. , 14. /			FAN	531
DATA (FANDAP(122,J),J=1,10) /					FAN	532
\$ -90.812	,472.054	, -875.215	,713.056	, -216.564	FAN	533
\$.59	,1.073	, 40. , 10. , 18. /			FAN	534
DATA (FANDAP(123,J),J=1,10) /					FAN	535
\$ -251.346	,1060.7	, -1650.93	,1141.51	, -296.667	FAN	536
\$.80	,1.127	, 40. , 10. , 22. /			FAN	537
DATA (FANDAP(124,J),J=1,10) /					FAN	538
\$ 1.920	, -1.696	,3.019	, -8.274	,3.907	FAN	539
\$.14	,.44	, 40. , 12. , 2. /			FAN	540
DATA (FANDAP(125,J),J=1,10) /					FAN	541
\$ 2.661	, -1.195	,.1299	, -1.262	,.399	FAN	542
\$.265	,.84	, 40. , 12. , 6. /			FAN	543
DATA (FANDAP(126,J),J=1,10) /					FAN	544
\$.4204	,17.453	, -43.184	,42.370	, -15.566	FAN	545
\$.39	,1.06	, 40. , 12. , 10. /			FAN	546
DATA (FANDAP(127,J),J=1,10) /					FAN	547
\$ -11.44	,76.814	, -145.248	,117.676	, -35.539	FAN	548
\$.52	,1.17	, 40. , 12. , 14. /			FAN	549
DATA (FANDAP(128,J),J=1,10) /					FAN	550
\$ -7.134	,51.677	, -90.389	,68.768	, -19.929	FAN	551
\$.635	,1.24	, 40. , 12. , 18. /			FAN	552
DATA (FANDAP(129,J),J=1,10) /					FAN	553
\$ -448.199	,1598.46	, -2116.83	,1245.43	, -275.191	FAN	554
\$.99	,1.3	, 40. , 12. , 22. /			FAN	555
DATA (FANDAP(130,J),J=1,10) /					FAN	556
\$ 1.843	, -0.07846	, -6.985	,17.722	, -17.908	FAN	557
\$.145	,.48	, 40. , 14. , 2. /			FAN	558
DATA (FANDAP(131,J),J=1,10) /					FAN	559
\$ 2.625	, -1.142	,.7597	, -2.214	,1.017	FAN	560
\$.27	,.93	, 40. , 14. , 6. /			FAN	561
DATA (FANDAP(132,J),J=1,10) /					FAN	562
\$.8452	,13.03	, -29.085	,25.619	, -8.539	FAN	563
\$.40	,1.19	, 40. , 14. , 10. /			FAN	564
DATA (FANDAP(133,J),J=1,10) /					FAN	565
\$ -3.555	,39.492	, -78.853	,64.69	, -19.54	FAN	566
\$.573	,1.28	, 40. , 14. , 14. /			FAN	567
DATA (FANDAP(134,J),J=1,10) /					FAN	568
\$ -39.186	,178.576	, -272.965	,181.609	, -44.911	FAN	569
\$.68	,1.35	, 40. , 14. , 18. /			FAN	570
DATA (FANDAP(135,J),J=1,10) /					FAN	571
\$ -118.82	,406.731	, -504.396	,278.236	, -57.944	FAN	572
\$ 1.12	,1.435	, 40. , 14. , 22. /			FAN	573
DATA (FANDAP(136,J),J=1,10) /					FAN	574
\$ 4.988	, -2.081	, -24.207	,55.248	, -45.947	FAN	575
\$.155	,.492	, 60. , 12. , 4. /			FAN	576
DATA (FANDAP(137,J),J=1,10) /					FAN	577
\$ 5.529	, -2.2277	, -27.832	,50.082	, -33.077	FAN	578
\$.195	,.59	, 60. , 12. , 6. /			FAN	579
DATA (FANDAP(138,J),J=1,10) /					FAN	580

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 2.068	,38.609	, -157.76	,240.715	, -137.116	FAN	581
\$.236	,.66	, 60.	, 12.	, 8.	FAN	582
DATA (FANDAP(139,J),J=1,10) /					FAN	583
\$ 2.644	,37.353	, -146.207	,215.777	, -119.45	FAN	584
\$.28	,.73	, 60.	, 12.	, 10.	FAN	585
DATA (FANDAP(140,J),J=1,10) /					FAN	586
\$ -41.658	,396.76	, -1195.8	,1548.1	, -740.92	FAN	587
\$.333	,.744	, 60.	, 12.	, 12.	FAN	588
DATA (FANDAP(141,J),J=1,10) /					FAN	589
\$ -7.944	,124.78	, -369.35	,456.25	, -210.91	FAN	590
\$.397	,.76	, 60.	, 12.	, 14.	FAN	591
DATA (FANDAP(142,J),J=1,10) /					FAN	592
\$ -40.774	,349.5	, -929.9	,1076.8	, -468.43	FAN	593
\$.47	,.76	, 60.	, 12.	, 16.	FAN	594
DATA (FANDAP(143,J),J=1,10) /					FAN	595
\$ -1619.9	,9661.7	, -21438.7	,21080.3	, -7758.4	FAN	596
\$.59	,.786	, 60.	, 12.	, 18.	FAN	597
DATA (FANDAP(144,J),J=1,10) /					FAN	598
\$ 4.129	,=3.795	,7758	, -8.697	,8.977	FAN	599
\$.12	,.48	, 60.	, 16.	, 2.	FAN	600
DATA (FANDAP(145,J),J=1,10) /					FAN	601
\$ 4.804	,=3.225	, -1.142	, -3.317	,2.953	FAN	602
\$.154	,.62	, 60.	, 16.	, 4.	FAN	603
DATA (FANDAP(146,J),J=1,10) /					FAN	604
\$ 5.296	,=8909	, -9.21	,8.711	, -3.366	FAN	605
\$.202	,.76	, 60.	, 16.	, 6.	FAN	606
DATA (FANDAP(147,J),J=1,10) /					FAN	607
\$ 6.2175	,=3.071	, -1.696	, -2.459	,2.489	FAN	608
\$.25	,.76	, 60.	, 16.	, 8.	FAN	609
DATA (FANDAP(148,J),J=1,10) /					FAN	610
\$ 5.008	,14.169	, -55.056	,68.651	, -31.803	FAN	611
\$.31	,.93	, 60.	, 16.	, 10.	FAN	612
DATA (FANDAP(149,J),J=1,10) /					FAN	613
\$ 5.504	,13.941	, -45.551	,47.755	, -19.574	FAN	614
\$.366	,.90	, 60.	, 16.	, 12.	FAN	615
DATA (FANDAP(150,J),J=1,10) /					FAN	616
\$ -34.38	,265.14	, -612.11	,604.01	, -220.51	FAN	617
\$.46	,.98	, 60.	, 16.	, 14.	FAN	618
DATA (FANDAP(151,J),J=1,10) /					FAN	619
\$ 25.353	,=96.07	,197.51	, -185.15	,62.299	FAN	620
\$.58	,.91	, 60.	, 16.	, 16.	FAN	621
DATA (FANDAP(152,J),J=1,10) /					FAN	622
\$ -220.95	,1153.5	, -2169.	,1802.6	, -562.09	FAN	623
\$.70	,.98	, 60.	, 16.	, 18.	FAN	624
DATA (FANDAP(153,J),J=1,10) /					FAN	625
\$ -390.836	,841.7	, -445.22	,0.0	,0.0	FAN	626
\$.95	,1.0	, 60.	, 16.	, 22.	FAN	627
DATA (FANDAH(1,J),J=1,10) /					FAN	628
\$ -93.866	,983.678	, -2376.14	,2520.20	, -1060.61	FAN	629
\$ 400000.	,760000.	, 24.	, 6.	, 6.	FAN	630
DATA (FANDAH(2,J),J=1,10) /					FAN	631
\$ 7.793	,288.38	, -481.24	,349.65	, -139.86	FAN	632
\$ 400000.	,860000.	, 24.	, 6.	, 8.	FAN	633
DATA (FANDAH(3,J),J=1,10) /					FAN	634
\$ -115.79	,1005.09	, -1846.07	,1498.74	, -486.6	FAN	635
\$ 400000.	,950000.	, 24.	, 6.	, 10.	FAN	636
DATA (FANDAH(4,J),J=1,10) /					FAN	637

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 90.754	,=163.62	,729.59	,=-848.42	,281.78	,	FAN	638
\$ 400000.	,1025000.	, 24.,	6., 12. /			FAN	639
DATA (FANDAH(5,J),J=1,10) /						FAN	640
\$ 155.98	,=527.75	,1464.58	,=-1447.9	,460.03	,	FAN	641
\$ 400000.	,1100000.	, 24.,	6., 14. /			FAN	642
DATA (FANDAH(6,J),J=1,10) /						FAN	643
\$ -196.02	,1138.28	,=-1400.76	,749.81	,=163.17	,	FAN	644
\$ 650000.	,1180000.	, 24.,	6., 16. /			FAN	645
DATA (FANDAH(7,J),J=1,10) /						FAN	646
\$ 206.61	,=579.29	,1312.33	,=-1087.12	,296.36	,	FAN	647
\$ 500000.	,1250000.	, 24.,	6., 18. /			FAN	648
DATA (FANDAH(8,J),J=1,10) /						FAN	649
\$ 705.77	,=2402.05	,3785.21	,=-2521.68	,601.4	,	FAN	650
\$ 800000.	,1330000.	, 24.,	6., 20. /			FAN	651
DATA (FANDAH(9,J),J=1,10) /						FAN	652
\$ 721.32	,=2194.49	,3143.5	,=-1889.81	,405.8	,	FAN	653
\$ 750000.	,1400000.	, 24.,	6., 22. /			FAN	654
DATA (FANDAH(10,J),J=1,10) /						FAN	655
\$ 177.57	,=697.3	,1776.89	,=-2005.05	,757.58	,	FAN	656
\$ 400000.	,780000.	, 24.,	8., 6. /			FAN	657
DATA (FANDAH(11,J),J=1,10) /						FAN	658
\$ 185.52	,=582.33	,1372.23	,=-1437.06	,501.17	,	FAN	659
\$ 400000.	,880000.	, 24.,	8., 8. /			FAN	660
DATA (FANDAH(12,J),J=1,10) /						FAN	661
\$ 143.97	,=192.78	,439.12	,=-444.8	,119.46	,	FAN	662
\$ 400000.	,970000.	, 24.,	8., 10. /			FAN	663
DATA (FANDAH(13,J),J=1,10) /						FAN	664
\$ 169.15	,=256.19	,512.11	,=-361.99	,36.131	,	FAN	665
\$ 500000.	,1050000.	, 24.,	8., 12. /			FAN	666
DATA (FANDAH(14,J),J=1,10) /						FAN	667
\$ -77.675	,1050.7	,=-1876.53	,1567.15	,=530.3	,	FAN	668
\$ 500000.	,1140000.	, 24.,	8., 14. /			FAN	669
DATA (FANDAH(15,J),J=1,10) /						FAN	670
\$ 148.08	,=168.6	,627.63	,=-604.74	,160.84	,	FAN	671
\$ 700000.	,1240000.	, 24.,	8., 16. /			FAN	672
DATA (FANDAH(16,J),J=1,10) /						FAN	673
\$ 142.97	,=189.66	,786.1	,=-749.69	,204.99	,	FAN	674
\$ 650000.	,1330000.	, 24.,	8., 18. /			FAN	675
DATA (FANDAH(17,J),J=1,10) /						FAN	676
\$ -235.94	,1539.71	,=-2094.92	,1360.06	,=354.31	,	FAN	677
\$ 900000.	,1400000.	, 24.,	8., 20. /			FAN	678
DATA (FANDAH(18,J),J=1,10) /						FAN	679
\$ -112.06	,849.65	,=-906.93	,564.88	,=163.17	,	FAN	680
\$ 900000.	,1400000.	, 24.,	8., 22. /			FAN	681
DATA (FANDAH(19,J),J=1,10) /						FAN	682
\$ 22.074	,483.11	,=-1316.1	,1603.54	,=833.33	,	FAN	683
\$ 400000.	,780000.	, 24.,	10., 6. /			FAN	684
DATA (FANDAH(20,J),J=1,10) /						FAN	685
\$ 58.107	,431.89	,=-1131.38	,1196.97	,=524.48	,	FAN	686
\$ 400000.	,880000.	, 24.,	10., 8. /			FAN	687
DATA (FANDAH(21,J),J=1,10) /						FAN	688
\$ 112.44	,139.49	,=-323.24	,300.12	,=-145.69	,	FAN	689
\$ 400000.	,970000.	, 24.,	10., 10. /			FAN	690
DATA (FANDAH(22,J),J=1,10) /						FAN	691
\$ -100.95	,1345.91	,=-2651.05	,2365.19	,=839.16	,	FAN	692
\$ 550000.	,1060000.	, 24.,	10., 12. /			FAN	693
DATA (FANDAH(23,J),J=1,10) /						FAN	694

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ -196.47	,1864.5	,=-3537.84	,3061.97	,=-1031.47	FAN	695
\$ 580000.	,1140000.	, 24., 10., 14. /			FAN	696
DATA (FANDAH(24,J),J=1,10) /					FAN	697
\$ -436.64	,2801.51	,=-4681.25	,3571.12	,=-1051.86	FAN	698
\$ 720000.	,1250000.	, 24., 10., 16. /			FAN	699
DATA (FANDAH(25,J),J=1,10) /					FAN	700
\$ -27.599	,620.01	,=-768.57	,558.36	,=-191.62	FAN	701
\$ 650000.	,1330000.	, 24., 10., 18. /			FAN	702
DATA (FANDAH(26,J),J=1,10) /					FAN	703
\$ -762.28	,3309.25	,=-4177.96	,2502.21	,=-599.65	FAN	704
\$ 850000.	,1400000.	, 24., 10., 20. /			FAN	705
DATA (FANDAH(27,J),J=1,10) /					FAN	706
\$ -279.88	,1653.67	,=-2140.73	,1475.52	,=-414.92	FAN	707
\$ 900000.	,1400000.	, 24., 10., 22. /			FAN	708
DATA (FANDAH(28,J),J=1,10) /					FAN	709
\$ -59.966	,641.02	,=-1263.86	,1123.39	,=-414.92	FAN	710
\$ 500000.	,900000.	, 26., 6., 6. /			FAN	711
DATA (FANDAH(29,J),J=1,10) /					FAN	712
\$ 147.46	,=-436.19	,915.07	,=-784.62	,209.79	FAN	713
\$ 500000.	,990000.	, 26., 6., 8. /			FAN	714
DATA (FANDAH(30,J),J=1,10) /					FAN	715
\$ 46.130	,166.75	,=-282.52	,272.1	,=-126.46	FAN	716
\$ 500000.	,1080000.	, 26., 6., 10. /			FAN	717
DATA (FANDAH(31,J),J=1,10) /					FAN	718
\$ 138.96	,=-252.12	,498.13	,=-354.08	,67.873	FAN	719
\$ 500000.	,1180000.	, 26., 6., 12. /			FAN	720
DATA (FANDAH(32,J),J=1,10) /					FAN	721
\$ 172.97	,=-372.85	,722.82	,=-517.47	,114.80	FAN	722
\$ 500000.	,1270000.	, 26., 6., 14. /			FAN	723
DATA (FANDAH(33,J),J=1,10) /					FAN	724
\$ -.3206	,452.26	,=-648.81	,493.49	,=-156.59	FAN	725
\$ 750000.	,1350000.	, 26., 6., 16. /			FAN	726
DATA (FANDAH(34,J),J=1,10) /					FAN	727
\$ 130.3	,=-92.296	,235.95	,=-117.56	,2.759	FAN	728
\$ 700000.	,1430000.	, 26., 6., 18. /			FAN	729
DATA (FANDAH(35,J),J=1,10) /					FAN	730
\$ 162.10	,=-194.34	,432.03	,=-278.64	,53.34	FAN	731
\$ 900000.	,1500000.	, 26., 6., 20. /			FAN	732
DATA (FANDAH(36,J),J=1,10) /					FAN	733
\$ 322.67	,=-447.74	,423.14	,=-95.091	,=-15.494	FAN	734
\$ 940000.	,1500000.	, 26., 6., 22. /			FAN	735
DATA (FANDAH(37,J),J=1,10) /					FAN	736
\$ -350.23	,2212.31	,=-4250.	,3636.36	,=-1212.12	FAN	737
\$ 600000.	,940000.	, 26., 8., 6. /			FAN	738
DATA (FANDAH(38,J),J=1,10) /					FAN	739
\$ 93.709	,.7433	,115.75	,=-152.03	,23.31	FAN	740
\$ 600000.	,1040000.	, 26., 8., 8. /			FAN	741
DATA (FANDAH(39,J),J=1,10) /					FAN	742
\$ 160.08	,=-245.62	,483.82	,=-364.34	,67.599	FAN	743
\$ 600000.	,1150000.	, 26., 8., 10. /			FAN	744
DATA (FANDAH(40,J),J=1,10) /					FAN	745
\$ 77.046	,115.59	,=-11.038	,=-49.109	,=-3.771	FAN	746
\$ 600000.	,1250000.	, 26., 8., 12. /			FAN	747
DATA (FANDAH(41,J),J=1,10) /					FAN	748
\$ 176.39	,=-257.33	,583.44	,=-449.33	,100.18	FAN	749
\$ 600000.	,1340000.	, 26., 6., 14. /			FAN	750
DATA (FANDAH(42,J),J=1,10) /					FAN	751

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ -474.23	,2189.22	,-2769.16	,1597.82	,-363.64		FAN	752
\$ 840000.	,1440000.	, 26. ,	8. , 16. /			FAN	753
DATA (FANDAH(43,J),J=1,10) /						FAN	754
\$ 193.55	,-288.44	,678.44	,-479.25	,100.02		FAN	755
\$ 600000.	,1520000.	, 26. ,	8. , 18. /			FAN	756
DATA (FANDAH(44,J),J=1,10) /						FAN	757
\$ -559.84	,2354.58	,-2794.35	,1546.54	,-335.66		FAN	758
\$ 1050000.	,1570000.	, 26. ,	8. , 20. /			FAN	759
DATA (FANDAH(45,J),J=1,10) /						FAN	760
\$ -4347.74	,13226.42	,-14504.08	,7162.39	,-1342.66		FAN	761
\$ 1150000.	,1600000.	, 26. ,	8. , 22. /			FAN	762
DATA (FANDAH(46,J),J=1,10) /						FAN	763
\$ -324.08	,2261.12	,-4454.17	,3924.24	,-1363.64		FAN	764
\$ 600000.	,970000.	, 26. ,	11. , 6. /			FAN	765
DATA (FANDAH(47,J),J=1,10) /						FAN	766
\$ 297.49	,-674.34	,923.08	,-453.77	,0.0		FAN	767
\$ 600000.	,1080000.	, 26. ,	11. , 8. /			FAN	768
DATA (FANDAH(48,J),J=1,10) /						FAN	769
\$ 166.74	,-105.07	,169.48	,-24.391	,-71.678		FAN	770
\$ 600000.	,1190000.	, 26. ,	11. , 10. /			FAN	771
DATA (FANDAH(49,J),J=1,10) /						FAN	772
\$ -121.21	,1158.54	,-1704.69	,1170.09	,-335.11		FAN	773
\$ 600000.	,1300000.	, 26. ,	11. , 12. /			FAN	774
DATA (FANDAH(50,J),J=1,10) /						FAN	775
\$ -34.067	,818.08	,-1116.29	,766.02	,-230.43		FAN	776
\$ 600000.	,1390000.	, 26. ,	11. , 14. /			FAN	777
DATA (FANDAH(51,J),J=1,10) /						FAN	778
\$ 12.918	,602.92	,-670.08	,415.16	,-126.02		FAN	779
\$ 600000.	,1500000.	, 26. ,	11. , 16. /			FAN	780
DATA (FANDAH(52,J),J=1,10) /						FAN	781
\$ 223.46	,-.088	,80.012	,1.166	,-34.965		FAN	782
\$ 600000.	,1600000.	, 26. ,	11. , 18. /			FAN	783
DATA (FANDAH(53,J),J=1,10) /						FAN	784
\$ -3.929	,1038.49	,-1360.42	,847.22	,-208.33		FAN	785
\$ 1000000.	,1600000.	, 26. ,	11. , 20. /			FAN	786
DATA (FANDAH(54,J),J=1,10) /						FAN	787
\$ -3555.68	,11081.15	,-11777.08	,5652.78	,-1041.67		FAN	788
\$ 1170000.	,1600000.	, 26. ,	11. , 22. /			FAN	789
DATA (FANDAH(55,J),J=1,10) /						FAN	790
\$ 32.976	,97.99	,-185.86	,213.99	,-116.55		FAN	791
\$ 500000.	,1020000.	, 28. ,	6. , 6. /			FAN	792
DATA (FANDAH(56,J),J=1,10) /						FAN	793
\$ 80.295	,-71.86	,154.45	,-110.7	,11.083		FAN	794
\$ 500000.	,1110000.	, 28. ,	6. , 8. /			FAN	795
DATA (FANDAH(57,J),J=1,10) /						FAN	796
\$ 85.09	,-39.55	,76.619	,-26.452	,-17.992		FAN	797
\$ 500000.	,1220000.	, 28. ,	6. , 10. /			FAN	798
DATA (FANDAH(58,J),J=1,10) /						FAN	799
\$ 163.72	,-352.71	,588.45	,-352.27	,56.818		FAN	800
\$ 730000.	,1330000.	, 28. ,	6. , 12. /			FAN	801
DATA (FANDAH(59,J),J=1,10) /						FAN	802
\$ -30.521	,391.0	,-386.5	,205.0	,-55.028		FAN	803
\$ 500000.	,1450000.	, 28. ,	6. , 14. /			FAN	804
DATA (FANDAH(60,J),J=1,10) /						FAN	805
\$ 522.91	,-1352.27	,1663.48	,-841.6	,145.26		FAN	806
\$ 1030000.	,1560000.	, 28. ,	6. , 16. /			FAN	807
DATA (FANDAH(61,J),J=1,10) /						FAN	808

SUBROUTINE FAN

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

\$ 744.29	,=-1905.75	,2170.	,=-1022.22	,166.67	FAN	809
\$ 1000000.	,1630000.	, 28.	, 6.	, 18.	FAN	810
DATA (FANDAH(62,J),J=1,10) /					FAN	811
\$ 550.31	,=-1015.79	,914.44	,=-298.92	,21.461	FAN	812
\$ 1250000.	,1700000.	, 28.	, 6.	, 20.	FAN	813
DATA (FANDAH(63,J),J=1,10) /					FAN	814
\$ -190.67	,1135.05	,=-1362.37	,760.4	,=-159.66	FAN	815
\$ 1280000.	,1760000.	, 28.	, 6.	, 22.	FAN	816
DATA (FANDAH(64,J),J=1,10) /					FAN	817
\$ -51.432	,688.46	,=-1396.44	,1273.01	,=-461.14	FAN	818
\$ 500000.	,1050000.	, 28.	, 8.	, 6.	FAN	819
DATA (FANDAH(65,J),J=1,10) /					FAN	820
\$ 27.126	,271.6	,=-455.18	,381.06	,=-143.86	FAN	821
\$ 530000.	,1180000.	, 28.	, 8.	, 8.	FAN	822
DATA (FANDAH(66,J),J=1,10) /					FAN	823
\$ 157.28	,=-318.65	,623.34	,=-446.78	,91.05	FAN	824
\$ 550000.	,1280000.	, 28.	, 8.	, 10.	FAN	825
DATA (FANDAH(67,J),J=1,10) /					FAN	826
\$ 297.63	,=-873.87	,1501.18	,=-1021.21	,231.07	FAN	827
\$ 650000.	,1400000.	, 28.	, 8.	, 12.	FAN	828
DATA (FANDAH(68,J),J=1,10) /					FAN	829
\$ 177.36	,=-395.03	,889.58	,=-672.74	,160.98	FAN	830
\$ 600000.	,1540000.	, 28.	, 8.	, 14.	FAN	831
DATA (FANDAH(69,J),J=1,10) /					FAN	832
\$ 79.603	,=-25.755	,395.79	,=-348.17	,80.492	FAN	833
\$ 900000.	,1600000.	, 28.	, 8.	, 16.	FAN	834
DATA (FANDAH(70,J),J=1,10) /					FAN	835
\$ 250.75	,=-520.49	,949.34	,=-600.17	,122.38	FAN	836
\$ 930000.	,1700000.	, 28.	, 8.	, 18.	FAN	837
DATA (FANDAH(71,J),J=1,10) /					FAN	838
\$ 311.62	,=-376.48	,398.49	,=-114.14	,=-4.087	FAN	839
\$ 1200000.	,1750000.	, 28.	, 8.	, 20.	FAN	840
DATA (FANDAH(72,J),J=1,10) /					FAN	841
\$ -257.36	,1167.2	,=-1145.64	,581.78	,=-120.54	FAN	842
\$ 1250000.	,1770000.	, 28.	, 8.	, 22.	FAN	843
DATA (FANDAH(73,J),J=1,10) /					FAN	844
\$ -18.151	,483.04	,=-828.15	,703.03	,=-274.70	FAN	845
\$ 500000.	,1050000.	, 28.	, 9.	, 6.	FAN	846
DATA (FANDAH(74,J),J=1,10) /					FAN	847
\$ 102.65	,7.178	,38.104	,39.954	,=-66.374	FAN	848
\$ 500000.	,1290000.	, 28.	, 9.	, 10.	FAN	849
DATA (FANDAH(75,J),J=1,10) /					FAN	850
\$ 125.18	,=-50.834	,318.54	,=-260.86	,51.636	FAN	851
\$ 600000.	,1570000.	, 28.	, 9.	, 14.	FAN	852
DATA (FANDAH(76,J),J=1,10) /					FAN	853
\$ 188.11	,=-95.277	,404.56	,=-307.01	,61.861	FAN	854
\$ 950000.	,1770000.	, 28.	, 9.	, 18.	FAN	855
DATA (FANDAH(77,J),J=1,10) /					FAN	856
\$ -7314.5	,19307.41	,=-18251.29	,7656.64	,=-1207.28	FAN	857
\$ 1250000.	,1770000.	, 28.	, 9.	, 22.	FAN	858
DATA (FANDAH(78,J),J=1,10) /					FAN	859
\$ 1416.94	,=-8770.24	,21006.06	,=-22060.6	,8484.84	FAN	860
\$ 500000.	,830000.	, 28.	, 10.	, 2.	FAN	861
DATA (FANDAH(79,J),J=1,10) /					FAN	862
\$ -88.9	,810.41	,=-1370.82	,1144.03	,=-422.	FAN	863
\$ 550000.	,1070000.	, 28.	, 10.	, 6.	FAN	864
DATA (FANDAH(80,J),J=1,10) /					FAN	865

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 131.94	,=73.089	,191.66	,=-68.245	,=-48.295	FAN	866
\$ 570000.	,1320000.	, 28., 10., 10. /			FAN	867
DATA (FANDAH(81,J),J=1,10) /					FAN	868
\$ 224.08	,=-284.12	,540.09	,=-336.88	,55.138	FAN	869
\$ 500000.	,1580000.	, 28., 10., 14. /			FAN	870
DATA (FANDAH(82,J),J=1,10) /					FAN	871
\$ 718.7	,=1798.52	,2459.26	,=-1336.48	,259.29	FAN	872
\$ 850000.	,1770000.	, 28., 10., 18. /			FAN	873
DATA (FANDAH(83,J),J=1,10) /					FAN	874
\$ -1153.75	,4181.1	,=-4529.62	,2243.76	,=-426.4	FAN	875
\$ 1200000.	,1770000.	, 28., 10., 22. /			FAN	876
DATA (FANDAH(84,J),J=1,10) /					FAN	877
\$ 1161.37	,=6675.67	,14912.2	,=-14463.5	,5109.47	FAN	878
\$ 500000.	,860000.	, 28., 12., 2. /			FAN	879
DATA (FANDAH(85,J),J=1,10) /					FAN	880
\$ -257.57	,1727.79	,=-2934.3	,2274.14	,=-724.96	FAN	881
\$ 550000.	,1180000.	, 28., 12., 6. /			FAN	882
DATA (FANDAH(86,J),J=1,10) /					FAN	883
\$ 90.637	,287.08	,=-415.77	,341.86	,=-146.78	FAN	884
\$ 570000.	,1340000.	, 28., 12., 10. /			FAN	885
DATA (FANDAH(87,J),J=1,10) /					FAN	886
\$ 454.87	,=-1066.	,1726.52	,=-1108.2	,233.1	FAN	887
\$ 500000.	,1630000.	, 28., 12., 14. /			FAN	888
DATA (FANDAH(88,J),J=1,10) /					FAN	889
\$ 555.85	,=920.47	,1271.64	,=-674.16	,108.39	FAN	890
\$ 650000.	,1770000.	, 28., 12., 18. /			FAN	891
DATA (FANDAH(89,J),J=1,10) /					FAN	892
\$ 71.003	,=-131.14	,292.2	,=-268.88	,66.078	FAN	893
\$ 500000.	,920000.	, 30., 8., 2. /			FAN	894
DATA (FANDAH(90,J),J=1,10) /					FAN	895
\$.6823	,399.64	,=-784.08	,706.5	,=-243.37	FAN	896
\$ 500000.	,1220000.	, 30., 8., 6. /			FAN	897
DATA (FANDAH(91,J),J=1,10) /					FAN	898
\$ 140.32	,=-267.88	,605.71	,=-460.68	,109.65	FAN	899
\$ 500000.	,1490000.	, 30., 8., 10. /			FAN	900
DATA (FANDAH(92,J),J=1,10) /					FAN	901
\$ 223.24	,=353.83	,529.46	,=-270.74	,40.306	FAN	902
\$ 500000.	,1770000.	, 30., 8., 14. /			FAN	903
DATA (FANDAH(93,J),J=1,10) /					FAN	904
\$ -469.74	,1952.01	,=-2176.9	,1114.75	,=-216.07	FAN	905
\$ 1000000.	,1770000.	, 30., 8., 18. /			FAN	906
DATA (FANDAH(94,J),J=1,10) /					FAN	907
\$ -2790.78	,7918.48	,=-7719.83	,3355.91	,=-546.08	FAN	908
\$ 1400000.	,1770000.	, 30., 8., 22. /			FAN	909
DATA (FANDAH(95,J),J=1,10) /					FAN	910
\$ -2116.64	,11988.3	,=-24400.	,21818.2	,=-7272.73	FAN	911
\$ 600000.	,940000.	, 30., 10., 2. /			FAN	912
DATA (FANDAH(96,J),J=1,10) /					FAN	913
\$ -155.27	,1062.	,=-1749.98	,1364.18	,=-420.48	FAN	914
\$ 600000.	,1260000.	, 30., 10., 6. /			FAN	915
DATA (FANDAH(97,J),J=1,10) /					FAN	916
\$ 70.014	,278.3	,=-479.95	,404.31	,=-128.79	FAN	917
\$ 600000.	,1530000.	, 30., 10., 10. /			FAN	918
DATA (FANDAH(98,J),J=1,10) /					FAN	919
\$ 48.686	,424.68	,=-556.3	,368.77	,=-94.019	FAN	920
\$ 600000.	,1870000.	, 30., 10., 14. /			FAN	921
DATA (FANDAH(99,J),J=1,10) /					FAN	922

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 1838.82	,=4736.59	,5146.6	,=-2386.56	,400.67	,	FAN	923
\$ 1110000.	,1870000.	, 30.,	10., 18. /			FAN	924
DATA (FANDAH(100,J),J=1,10) /						FAN	925
\$ 3840.5	,=8553.07	,7718.76	,=-3055.38	,449.55	,	FAN	926
\$ 1440000.	,1870000.	, 30.,	10., 22. /			FAN	927
DATA (FANDAH(101,J),J=1,10) /						FAN	928
\$ 573.86	,=2682.76	,5269.32	,=-4489.9	,1363.64	,	FAN	929
\$ 600000.	,950000.	, 30.,	11., 2. /			FAN	930
DATA (FANDAH(102,J),J=1,10) /						FAN	931
\$ 104.31	,=77.393	,160.7	,=-29.672	,=47.348	,	FAN	932
\$ 600000.	,1280000.	, 30.,	11., 6. /			FAN	933
DATA (FANDAH(103,J),J=1,10) /						FAN	934
\$ -166.28	,1106.85	,=1431.07	,844.31	,=-197.5	,	FAN	935
\$ 600000.	,1560000.	, 30.,	11., 10. /			FAN	936
DATA (FANDAH(104,J),J=1,10) /						FAN	937
\$ 105.35	,142.38	,=-19.254	,=-15.095	,=-2.55	,	FAN	938
\$ 700000.	,1870000.	, 30.,	11., 14. /			FAN	939
DATA (FANDAH(105,J),J=1,10) /						FAN	940
\$ 1262.38	,=3070.33	,3409.94	,=-1571.34	,255.68	,	FAN	941
\$ 1040000.	,1870000.	, 30.,	11., 18. /			FAN	942
DATA (FANDAH(106,J),J=1,10) /						FAN	943
\$ 6428.32	,=14968.6	,13695.	,=-5504.54	,821.78	,	FAN	944
\$ 1450000.	,1870000.	, 30.,	11., 22. /			FAN	945
DATA (FANDAH(107,J),J=1,10) /						FAN	946
\$ -58.06	,308.6	,102.27	,=-616.16	,303.03	,	FAN	947
\$ 600000.	,950000.	, 30.,	12., 2. /			FAN	948
DATA (FANDAH(108,J),J=1,10) /						FAN	949
\$ -272.65	,1420.3	,=-1840.91	,1030.3	,=-227.27	,	FAN	950
\$ 600000.	,1290000.	, 30.,	12., 6. /			FAN	951
DATA (FANDAH(109,J),J=1,10) /						FAN	952
\$ -107.44	,844.15	,=-980.16	,527.	,=-119.46	,	FAN	953
\$ 600000.	,1580000.	, 30.,	12., 10. /			FAN	954
DATA (FANDAH(110,J),J=1,10) /						FAN	955
\$ 172.04	,=-76.343	,334.06	,=-244.14	,48.077	,	FAN	956
\$ 700000.	,1870000.	, 30.,	12., 14. /			FAN	957
DATA (FANDAH(111,J),J=1,10) /						FAN	958
\$ 867.44	,=1854.72	,2097.31	,=-952.54	,148.6	,	FAN	959
\$ 1050000.	,1870000.	, 30.,	12., 18. /			FAN	960
DATA (FANDAH(112,J),J=1,10) /						FAN	961
\$ 642.58	,=-1667.56	,1862.69	,=-928.03	,170.45	,	FAN	962
\$ 1000000.	,1620000.	, 40.,	8., 2. /			FAN	963
DATA (FANDAH(113,J),J=1,10) /						FAN	964
\$ -234.8	,936.78	,=-837.06	,339.56	,=-55.0	,	FAN	965
\$ 1000000.	,2160000.	, 40.,	8., 6. /			FAN	966
DATA (FANDAH(114,J),J=1,10) /						FAN	967
\$ 59.02	,212.2	,=-81.972	,14.603	,=-2.878	,	FAN	968
\$ 1000000.	,2570000.	, 40.,	8., 10. /			FAN	969
DATA (FANDAH(115,J),J=1,10) /						FAN	970
\$ 420.1	,=458.47	,450.55	,=-159.26	,18.324	,	FAN	971
\$ 1200000.	,3040000.	, 40.,	8., 14. /			FAN	972
DATA (FANDAH(116,J),J=1,10) /						FAN	973
\$ 502.08	,=434.25	,352.16	,=-95.755	,7.843	,	FAN	974
\$ 1700000.	,3320000.	, 40.,	8., 18. /			FAN	975
DATA (FANDAH(117,J),J=1,10) /						FAN	976
\$ -266.24	,1014.48	,=-557.16	,149.48	,=-15.597	,	FAN	977
\$ 2200000.	,3550000.	, 40.,	8., 22. /			FAN	978
DATA (FANDAH(118,J),J=1,10) /						FAN	979

IRROUTINE FAN

74/74 OPT=1

FTN 4,5+414

05/05/78 07.59.59

\$ 2876.11	,=7688.44	,8025.69	,=-3689.81	,625.0	,	FAN	980
\$ 1200000.	,1700000.	, 40.	, 10.	, 2.	/	FAN	981
DATA (FANDAH(119,J),J=1,10) /						FAN	982
\$ -904.63	,2572.63	,=-2225.35	,866.9	,=-130.21	,	FAN	983
\$ 1200000.	,2260000.	, 40.	, 10.	, 6.	/	FAN	984
DATA (FANDAH(120,J),J=1,10) /						FAN	985
\$ 29.648	,465.32	,=-341.49	,132.62	,=-22.035	,	FAN	986
\$ 1200000.	,2740000.	, 40.	, 10.	, 10.	/	FAN	987
DATA (FANDAH(121,J),J=1,10) /						FAN	988
\$ -556.8	,1461.13	,=-834.02	,221.53	,=-23.765	,	FAN	989
\$ 1270000.	,3180000.	, 40.	, 10.	, 14.	/	FAN	990
DATA (FANDAH(122,J),J=1,10) /						FAN	991
\$ 621.15	,=428.07	,299.22	,=-60.185	,1.457	,	FAN	992
\$ 1800000.	,3460000.	, 40.	, 10.	, 18.	/	FAN	993
DATA (FANDAH(123,J),J=1,10) /						FAN	994
\$ 9056.63	,=-11236.6	,5513.37	,=-1173.03	,91.146	,	FAN	995
\$ 2500000.	,3740000.	, 40.	, 10.	, 22.	/	FAN	996
DATA (FANDAH(124,J),J=1,10) /						FAN	997
\$ -230.79	,658.96	,=-336.11	,37.037	,0.0	,	FAN	998
\$ 1200000.	,1720000.	, 40.	, 12.	, 2.	/	FAN	999
DATA (FANDAH(125,J),J=1,10) /						FAN	1000
\$ -254.45	,908.1	,=-574.62	,157.2	,=-18.939	,	FAN	1001
\$ 1200000.	,2330000.	, 40.	, 12.	, 6.	/	FAN	1002
DATA (FANDAH(126,J),J=1,10) /						FAN	1003
\$ -151.19	,779.21	,=-444.03	,119.08	,=-14.569	,	FAN	1004
\$ 1200000.	,2830000.	, 40.	, 12.	, 10.	/	FAN	1005
DATA (FANDAH(127,J),J=1,10) /						FAN	1006
\$ 543.7	,=459.81	,452.62	,=-152.95	,16.208	,	FAN	1007
\$ 1300000.	,3270000.	, 40.	, 12.	, 14.	/	FAN	1008
DATA (FANDAH(128,J),J=1,10) /						FAN	1009
\$ 1111.47	,=-1181.9	,794.01	,=-202.17	,16.754	,	FAN	1010
\$ 1860000.	,3610000.	, 40.	, 12.	, 18.	/	FAN	1011
DATA (FANDAH(129,J),J=1,10) /						FAN	1012
\$ -13201.1	,17641.5	,=-8397.4	,1786.5	,=-143.23	,	FAN	1013
\$ 2540000.	,3750000.	, 40.	, 12.	, 22.	/	FAN	1014
DATA (FANDAH(130,J),J=1,10) /						FAN	1015
\$ -6179.5	,17637.9	,=-18314.6	,8430.56	,=-1458.33	,	FAN	1016
\$ 1200000.	,1730000.	, 40.	, 14.	, 2.	/	FAN	1017
DATA (FANDAH(131,J),J=1,10) /						FAN	1018
\$ 227.15	,112.24	,=-105.4	,60.29	,=-16.572	,	FAN	1019
\$ 1200000.	,2330000.	, 40.	, 14.	, 6.	/	FAN	1020
DATA (FANDAH(132,J),J=1,10) /						FAN	1021
\$ 181.38	,234.11	,=-57.838	,=-7284	,=-1.093	,	FAN	1022
\$ 1200000.	,2870000.	, 40.	, 14.	, 10.	/	FAN	1023
DATA (FANDAH(133,J),J=1,10) /						FAN	1024
\$ -103.26	,846.19	,=-428.34	,105.65	,=-11.837	,	FAN	1025
\$ 1270000.	,3360000.	, 40.	, 14.	, 14.	/	FAN	1026
DATA (FANDAH(134,J),J=1,10) /						FAN	1027
\$ 754.94	,=702.92	,618.55	,=-182.21	,16.936	,	FAN	1028
\$ 1920000.	,3720000.	, 40.	, 14.	, 18.	/	FAN	1029
DATA (FANDAH(135,J),J=1,10) /						FAN	1030
\$ 1717.77	,=-1161.5	,466.83	,=-55.358	,=-.8156	,	FAN	1031
\$ 2640000.	,3750000.	, 40.	, 14.	, 22.	/	FAN	1032
DATA (FANDAH(136,J),J=1,10) /						FAN	1033
\$ -27.579	,253.49	,=-106.3	,21.961	,=-2.126	,	FAN	1034
\$ 2000000.	,4250000.	, 60.	, 12.	, 4.	/	FAN	1035
DATA (FANDAH(137,J),J=1,10) /						FAN	1036

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

$ -15.899 ,293.64 , -122.47 ,25.347 , -2.262 , FAN 1037
$ 2000000. ,4750000. , 60. , 12. , 6. / FAN 1038
DATA (FANDAH(138,J),J=1,10) / FAN 1039
$ 253.5 , -26.009 ,41.5 , -9.273 ,.4242 , FAN 1040
$ 2000000. ,5220000. , 60. , 12. , 8. / FAN 1041
DATA (FANDAH(139,J),J=1,10) / FAN 1042
$ 219.06 ,37.044 ,28.83 , -8.833 ,.5606 , FAN 1043
$ 2000000. ,5650000. , 60. , 12. , 10. / FAN 1044
DATA (FANDAH(140,J),J=1,10) / FAN 1045
$ 417. , -96.1665 ,67.171 , -11.709 ,.5361 , FAN 1046
$ 2250000. ,6170000. , 60. , 12. , 12. / FAN 1047
DATA (FANDAH(141,J),J=1,10) / FAN 1048
$ -760.05 ,915.66 , -243.21 ,30.626 , -1.576 , FAN 1049
$ 3250000. ,6700000. , 60. , 12. , 14. / FAN 1050
DATA (FANDAH(142,J),J=1,10) / FAN 1051
$ -1483.86 ,1518.16 , -419.53 ,53.4 , -2.615 , FAN 1052
$ 4100000. ,7000000. , 60. , 12. , 16. / FAN 1053
DATA (FANDAH(143,J),J=1,10) / FAN 1054
$ 2267.4 , -1224.36 ,330.67 , -36. ,1.33 , FAN 1055
$ 4500000. ,7000000. , 60. , 12. , 18. / FAN 1056
DATA (FANDAH(144,J),J=1,10) / FAN 1057
$ -165.98 ,544.46 , -304.18 ,79.677 , -8.727 , FAN 1058
$ 2000000. ,3700000. , 60. , 16. , 2. / FAN 1059
DATA (FANDAH(145,J),J=1,10) / FAN 1060
$ -75.05 ,442.02 , -203.89 ,41.82 , -3.628 , FAN 1061
$ 2000000. ,4250000. , 60. , 16. , 4. / FAN 1062
DATA (FANDAH(146,J),J=1,10) / FAN 1063
$ 70.414 ,251.15 , -86.013 ,14.616 , -1.285 , FAN 1064
$ 2000000. ,4850000. , 60. , 16. , 6. / FAN 1065
DATA (FANDAH(147,J),J=1,10) / FAN 1066
$ -94.021 ,440.34 , -147.36 ,24.961 , -1.903 , FAN 1067
$ 2700000. ,5250000. , 60. , 16. , 8. / FAN 1068
DATA (FANDAH(148,J),J=1,10) / FAN 1069
$ -20.122 ,394.28 , -107.34 ,14.133 , -0.9016 , FAN 1070
$ 2000000. ,5930000. , 60. , 16. , 10. / FAN 1071
DATA (FANDAH(149,J),J=1,10) / FAN 1072
$ 502.59 , -132.89 ,102.98 , -19.495 ,1.03 , FAN 1073
$ 3170000. ,6370000. , 60. , 16. , 12. / FAN 1074
DATA (FANDAH(150,J),J=1,10) / FAN 1075
$ 390.34 ,84.842 ,12.235 , -3.344 ,.0746 , FAN 1076
$ 2500000. ,7000000. , 60. , 16. , 14. / FAN 1077
DATA (FANDAH(151,J),J=1,10) / FAN 1078
$ -1498.49 ,1558.69 , -401.72 ,48.621 , -2.346 , FAN 1079
$ 4700000. ,7000000. , 60. , 16. , 16. / FAN 1080
DATA (FANDAH(152,J),J=1,10) / FAN 1081
$ 5656.16 , -3754.3 ,1080.28 , -133.41 ,6. , FAN 1082
$ 4200000. ,7000000. , 60. , 16. , 18. / FAN 1083
DATA (FANDAH(153,J),J=1,10) / FAN 1084
$ 1251.93 , -90.429 ,13.143 ,0.0 ,0.0 , FAN 1085
$ 5250000. ,7000000. , 60. , 16. , 22. / FAN 1086
DATA PI /3,14159265/ FAN 1087
DATA TANH /.1405/, TANH/.344/, HB/5./ FAN 1088
123 FORMAT(1X,4G12,4) FAN 1089
10 FORMAT(5F10,4,2F10,5,3F3,0) FAN 1090
15 FORMAT(5F10,4,2F10,1,3F3,0) FAN 1091
C FAN 1092
C FUNCTION TO DETERMINE VOLUMETRIC FLOW RATE FROM THE PRESSURE FAN 1093

```

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	RISE ACROSS THE FAN,	FAN	1094
C		FAN	1095
	TCFMPF(I,P)=1.E06*(FANDAP(I,1)*FANDAP(I,2)*P*FANDAP(I,3)*P*P* SFANDAP(I,4)*P*P*P*FANDAP(I,5)*P*P*P*P)	FAN	1096
C		FAN	1097
C		FAN	1098
C		FAN	1099
C	SPECIFIC VOLUME OF AIR LEAVING THE HEAT EXCHANGER AT THE	FAN	1100
C	ELEVATION SPECIFIED FOR THE PLANT	FAN	1101
C		FAN	1102
	BARLN=3.39853-3.81835E-5*ELEV	FAN	1103
	BAR=EXP(BARLN)	FAN	1104
	SPVOL=(T4+459.67)/1.325/BAR	FAN	1105
C		FAN	1106
C	TOTAL VOLUMETRIC FLOW RATE OF THE FAN SYSTEM	FAN	1107
C		FAN	1108
	TOTCFM=W4*SPVOL/60.	FAN	1109
	AFC=S.E08	FAN	1110
	AC=0.	FAN	1111
	AHP=0.	FAN	1112
	ADIA=0.	FAN	1113
	ARLN=0.	FAN	1114
	ABLA=0.	FAN	1115
	ANF=0.	FAN	1116
	AVEL=0.	FAN	1117
C		FAN	1118
C	EXIT STACK FACTOR USED TO COMPUTE STACK EXIT DIAMETER WHEN	FAN	1119
C	VELOCITY RECOVERY IS USED. VELOCITY RECOVERY IS BASED ON	FAN	1120
C	13 FOOT HIGH STACKS FOR 28 FOOT DIAMETER FANS. THE DIFFUSER	FAN	1121
C	ANGLE IS 8 DEGREES.	FAN	1122
C	ESF=2.*TAN(8DEG)*13./28.	FAN	1123
C		FAN	1124
	ESF=0.1305	FAN	1125
C		FAN	1126
C	VELOCITY PRESSURE COEFFICIENT USED TO COMPUTE VELOCITY	FAN	1127
C	PRESSURE IN INCHES OF WATER,	FAN	1128
C	VPCOEF=0.07495*29.92*13.5951/(2.*32.174*144.*14.696)	FAN	1129
C		FAN	1130
	VPCOEF=2.239E-04	FAN	1131
C		FAN	1132
	STATP=0.07495*SPVOL*DPTINW	FAN	1133
C		FAN	1134
	RECVFL=VELREC	FAN	1135
	IF(LFE.LT.1) LFE = 153	FAN	1136
	IF(LFB.LT.1) LFB = 1	FAN	1137
C		FAN	1138
C	START OF ITERATIVE LOOP FOR DETERMINING THE OPTIMUM FAN	FAN	1139
C	SYSTEM	FAN	1140
C		FAN	1141
	DO 400 I=LFB,LFE	FAN	1142
	IF(I.EQ.27) GO TO 400	FAN	1143
	IF(I.EQ.103) GO TO 400	FAN	1144
	IF(I.EQ.122) GO TO 400	FAN	1145
C		FAN	1146
C	INITIALIZATION OF FAN OPTIMIZATION PARAMETERS	FAN	1147
C		FAN	1148
	TP=0.	FAN	1149
	RCFMPF=0.	FAN	1150

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	CFMPF=0.	FAN	1151
	NQF=0	FAN	1152
	HPDF=0.	FAN	1153
	TOTHP=0.	FAN	1154
	FCST=0.	FAN	1155
	CMOT=0.	FAN	1156
	CSR=0.	FAN	1157
	CFD=0.	FAN	1158
	CEC=0.	FAN	1159
	CPL=0.	FAN	1160
	TCSTPF=0.	FAN	1161
	TCSTF=0.	FAN	1162
	VEL=0.	FAN	1163
	CJNC=80000.	FAN	1164
	CFM=400000.	FAN	1165
	FLOWP=0.	FAN	1166
	TP=0.	FAN	1167
	DF=0.	FAN	1168
	CI=0.	FAN	1169
C		FAN	1170
C	CROSS-SECTIONAL FLOW AREA FOR THE FAN DEPENDING ON THE FAN	FAN	1171
C	DIAMETER	FAN	1172
C		FAN	1173
	IF(I.LE.27) A=429.08	FAN	1174
	IF(I.GT.27.AND.I.LE.54) A=495.96	FAN	1175
	IF(I.GT.54.AND.I.LE.88) A=584.5	FAN	1176
	IF(I.GT.88.AND.I.LE.111) A=658.37	FAN	1177
	IF(I.GT.111.AND.I.LE.135) A=1123.91	FAN	1178
	IF(I.GT.135) A=2680.4	FAN	1179
	FAND=FANDAP(I,8)	FAN	1180
	EXITD=(1.+ESF)*FAND	FAN	1181
	EXITA=0.7854*EXITD*EXITD	FAN	1182
	EA60=1./(60.*EXITA)	FAN	1183
	A60=1./(60.*A)	FAN	1184
C		FAN	1185
C	DETERMINE THE NUMBER FANS, THE VOLUMETRIC FLOW RATE THROUGH	FAN	1186
C	EACH FAN, AND THE TOTAL PRESSURE DROP ACROSS EACH FAN	FAN	1187
C		FAN	1188
C		FAN	1189
C	*****	FAN	1190
C		FAN	1191
C	THIS ITERATION SCHEME DETERMINES THE OPERATING POINT FOR	FAN	1192
C	FAN "I". THE OPERATING POINT IS THE INTERSECTION OF THE FAN	FAN	1193
C	PRESSURE CURVE AND THE TOTAL PRESSURE CURVE. THE ITERATION	FAN	1194
C	USES THE FAN DATA AS CFM VERSUS TOTAL PRESSURE, PLOTTED AS	FAN	1195
C	Y VERSUS X. THE POINTS (XP,YP) REFER TO THE POINTS ON THE	FAN	1196
C	FAN PRESSURE CURVE. THE POINTS (XT,YT) REFER TO THE POINTS	FAN	1197
C	ON THE TOTAL PRESSURE CURVE. THE LIMITING VALUES OF CFM AND	FAN	1198
C	AND FAN PRESSURE FROM THE FAN DATA ARE USED TO GET THE	FAN	1199
C	LIMITING POINTS OF THE FAN PRESSURE CURVE AND THE TOTAL	FAN	1200
C	PRESSURE CURVE. THESE POINTS ARE USED TO DETERMINE TWO	FAN	1201
C	STRAIGHT LINES, YP=AP*XP+BP AND YT=AT*XT+BT. THE	FAN	1202
C	INTERSECTION OF THESE LINES IS THE NEW FLOW RATE FOR THE NEXT	FAN	1203
C	ITERATION. THE ITERATIONS CONTINUE UNTIL CONSECUTIVE	FAN	1204
C	INTERSECTIONS ARE NEARLY IDENTICAL.	FAN	1205
C		FAN	1206
C		FAN	1207
	KJ=0		

SUBROUTINE FAN

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

K=0	FAN	1208
XP2=FANDAP(I,6)	FAN	1209
YP2=TCFMPF(I,XP2)	FAN	1210
SAVEP2=YP2	FAN	1211
XP4=FANDAP(I,7)	FAN	1212
YP4=TCFMPF(I,XP4)	FAN	1213
SAVEP4=YP4	FAN	1214
YT1=YP4	FAN	1215
XT1=TOTALP(YT1)	FAN	1216
YT3=YP2	FAN	1217
XT3=TOTALP(YT3)	FAN	1218
IF(XT1.GT.XP4) GO TO 400	FAN	1219
IF(XT3.LT.XP2) GO TO 400	FAN	1220
20 K=K+1	FAN	1221
IF(K.GT.20) GO TO 400	FAN	1222
AP=(YP2-YP4)/(XP2-XP4)	FAN	1223
BP=YP2-AP*XP2	FAN	1224
AT=(YT1-YT3)/(XT1-XT3)	FAN	1225
BT=YT1-AT*XT1	FAN	1226
YT1=(AT*BP-AP*BT)/(AT-AP)	FAN	1227
IF(KI.EQ.0) GO TO 12	FAN	1228
IF(ABS((COMPAR-YT1)/COMPAR).LT.0.001) GO TO 30	FAN	1229
12 KI=1	FAN	1230
COMPAR=YT1	FAN	1231
XT1=TOTALP(YT1)	FAN	1232
XP2=XT1	FAN	1233
IF(XT1.LT.FANDAP(I,6))XP2=FANDAP(I,6)	FAN	1234
YP2=TCFMPF(I,XP2)	FAN	1235
YT3=YP2	FAN	1236
XT3=TOTALP(YT3)	FAN	1237
XP4=XT3	FAN	1238
IF(XT3.GT.FANDAP(I,7))XP4=FANDAP(I,7)	FAN	1239
YP4=TCFMPF(I,XP4)	FAN	1240
GO TO 20	FAN	1241
C	FAN	1242
C*****	FAN	1243
C	FAN	1244
30 CFMPF=YT1	FAN	1245
RCFMPF=CFMPF*1.E-06	FAN	1246
TP=XT1	FAN	1247
VP=TP-STATP	FAN	1248
C	FAN	1249
C	FAN	1250
C	FAN	1251
NOF=TOTCFM/CFMPF	FAN	1252
C	FAN	1253
C	FAN	1254
C	FAN	1255
R1=RCFMPF	FAN	1256
R2=R1*R1	FAN	1257
R3=R2*R1	FAN	1258
R4=R3*R1	FAN	1259
HPPF=FANDAH(I,1)*FANDAH(I,2)*R1+FANDAH(I,3)*R2+FANDAH(I,4)*R3+	FAN	1260
\$FANDAH(I,5)*R4	FAN	1261
HPPF=HPPF/.07495/SPVOL	FAN	1262
HPPF=HPPF/GSEFF	FAN	1263
IF(HPPF.LT.0.0) WRITE(6,7727) I, RCFMPF, YT1, COMPAR, XT1,	FAN	1264

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07,59,59

```

      $ XP2, YP2, YT3, XT3, XP4, YP4, HPPF
7727 FORMAT("01,RCFMPF,YT1=",T21,I4,1P2G20.8/
      $ "00COMPAR,XT1,XP2,YP2=",T24,4G20.8/
      $ "0YT3,XT3,XP4,YP4=",T24,4G20.8/
      $ "0HPPF = " ,G20.8)
      IF (HPPF .LT. 0.0) GOTO 400
C
C      CALCULATION OF THE NUMBER OF CIRCULAR TOWERS BASED ON AN
C      ALLOWABLE FAN PACKING FACTOR
C
      TOWN = PI*FANDAP(I,8)**2*NOF*TAN(2.*PI/(2.*NSIDES))*PFACT/(ELENG**
12*NSIDES)
      ITOWN = TOWN*.9999
      IF (ITOWN .LT. ITMIN) GOTO 400
      IF (ITOWN .GT. ITMAX) GOTO 400
C
C      CALCULATION OF THE DIAMETER AND THE HEIGHT OF THE TOWERS
C
      DTOW = ELENG/SIN(2.*PI/(2.*NSIDES))
      BUNHI = AFRON/(ITOWN*NSIDES*WB*ELENG)
      NBUNHI = BUNHI *.9999
      WRB = AFRON/(ITOWN*NSIDES*NBUNHI*ELENG)
      HTOW = WB*NBUNHI
C
C      FAN ELECTRICAL WIRING COSTS
C
      VM=2300.
      IF (HPPF .LT. 250.) VM = 480.
      IF (HPPF .GT. 2000.) VM = 6900.
      DPTWR = DIST
      DTTSG = DTOW / 4. * (ITOWN*(3./2.) - 1.)
      DSGTM = DTOW / 2. + DTTSG / 2.
      IF (HPPF .LT. 251.) TRMA = 225000./NOF + 7.88*HPPF + (116. - .159
      $ * HPPF) * HPPF
      IF (HPPF .GE. 251.) TRMA = 225000./NOF + 7.88*HPPF +
      $ 870./SQRT(HPPF) * HPPF
      VS = 7200.
      IF (HPPF .LT. 2000.) VS = 13800.
      VS = 7200.
      IF (HPPF .LT. 550.) VS = 13800.
      TRMB = (DPTWR+DTTSG-1000.) * (37. + .47*HPPF*NOF/ SQRT(VS)
      $ + .5 * NOF) / NOF
      TRMC = (100. + 1.1*HPPF) * (DSGTM-250.) / SQRT(VM)
      CSR = HPPF * 55. + HPPF** 1.5 * 1000.
      FANLEC = TRMA + TRMB + TRMC
C
C      FAN MOTOR COSTS
C
      FMC = 26.62
      IF (HPPF .GT. 300.) FMC = 24.33
      BIGMC = 0.0
      IF (HPPF .GT. 300.) BIGMC = 8000.
      CMOT = HPPF * FMC + BIGMC
C
C      TOTAL HORSEPOWER REQUIREMENT OF THE FAN SYSTEM
C
70 TOTHP=HPPF*NOF

```

FAN 1265
 FAN 1266
 FAN 1267
 FAN 1268
 FAN 1269
 FAN 1270
 FAN 1271
 FAN 1272
 FAN 1273
 FAN 1274
 FAN 1275
 FAN 1276
 FAN 1277
 FAN 1278
 FAN 1279
 FAN 1280
 FAN 1281
 FAN 1282
 FAN 1283
 FAN 1284
 FAN 1285
 FAN 1286
 FAN 1287
 FAN 1288
 FAN 1289
 FAN 1290
 FAN 1291
 FAN 1292
 FAN 1293
 FAN 1294
 FAN 1295
 FAN 1296
 FAN 1297
 FAN 1298
 FAN 1299
 FAN 1300
 FAN 1301
 FAN 1302
 FAN 1303
 FAN 1304
 FAN 1305
 FAN 1306
 FAN 1307
 FAN 1308
 FAN 1309
 FAN 1310
 FAN 1311
 FAN 1312
 FAN 1313
 FAN 1314
 FAN 1315
 FAN 1316
 FAN 1317
 FAN 1318
 FAN 1319
 FAN 1320
 FAN 1321

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	CAPITAL COSTS OF THE FAN	FAN	1322
C		FAN	1323
	IF (I.LT.88) FCST=FANDAP(I,9)=(22.4*FANDAP(I,8)-60.)+19.2*FANDAP(I,8	FAN	1324
	*)	FAN	1325
	IF (I.GE.88) FCST=FANDAP(I,9)*(51.2*FANDAP(I,8)-950.)+136.6*FANDAP(I	FAN	1326
	*,8)-2700.	FAN	1327
	EFCSF = 1.05	FAN	1328
	FCST = FCST * EFCSF	FAN	1329
	HFR = 13. / 28. * FAND	FAN	1330
C		FAN	1331
C	STACK COSTS WITH VELOCITY RECOVERY	FAN	1332
	IF (VELREC.EQ.1.) CFROS= UCS * UWS * PI * (FAND*HFR*TANS) * HFR	FAN	1333
	\$ * SQRT(1. + TAN8**2)	FAN	1334
	\$ * UCS * UWS * PI * (FAND*HB*TAN19) * HB	FAN	1335
	\$ * SQRT(1. + TAN19**2)	FAN	1336
C		FAN	1337
C	STACK COSTS WITH OUT VELOCITY RECOVERY	FAN	1338
	IF (VELREC.EQ.0.) CFROS = CVM * WFM * PI * FAND**2 / 6.	FAN	1339
	\$ * UCS * UWS * PI * (FAND * HB * TAN19) * HB	FAN	1340
	\$ * SQRT(1. + TAN19**2)	FAN	1341
C		FAN	1342
C	INCREASING THE FAN COSTS TO TAKE INTO ACCOUNT FOR SHIPPING	FAN	1343
C	AND ASSEMBLY OF FAN SYSTEM COMPONENTS	FAN	1344
	CFROS = CFROS*POHFAN	FAN	1345
	FCST = FCST*POHFAN	FAN	1346
	CSR = CSR*POHFAN	FAN	1347
	CMOT = CMOT*POHFAN	FAN	1348
	FANLEC = FANLEC*POHLEC	FAN	1349
C		FAN	1350
C	TOTAL CAPITAL COST OF THE FAN SYSTEM	FAN	1351
	TCSTPF = FCST + CMOT + CSR + FANLEC + CFROS	FAN	1352
	TCSTF = TCSTPF * NOF	FAN	1353
C		FAN	1354
C	ANNUAL COST OF THE FAN SYSTEM	FAN	1355
C		FAN	1356
	ANFCOS=(TCSTF*TOTHP*.7457*PLANC)*FCR*EHR*FCOS/10**8*TOTHP*	FAN	1357
	\$,7457*CAPF*8760.	FAN	1358
C		FAN	1359
C	COST OF PLENUM	FAN	1360
C		FAN	1361
	CPL = CPM * WPL * (ITOWN * PI/4. * DTOW**2 - NOF * PI/4. * (FAND+3.5)	FAN	1362
	\$ **2)	FAN	1363
	CPL=CPL * POHSTC	FAN	1364
C		FAN	1365
C	STRUCTURAL AND FOUNDATION COSTS OF THE CIRCULAR TOWER	FAN	1366
C		FAN	1367
	CALL STRUCT(ITOWN,NSIDES,HTOW,ELENG,SEGL,NRUNHI,WMX,WATERW,FAND,	FAN	1368
	INOF,ROOFL,STRUCC,FNDC)	FAN	1369
	STRUCC = STRUCC*POHSTC	FAN	1370
	FNDC = FNDC*POHSTC	FAN	1371
	ANSFPC = (CPL + STRUCC + FNDC)*FCR	FAN	1372
C		FAN	1373
C	ANNUAL FAN, STRUCTURAL AND FOUNDATION COSTS	FAN	1374
C		FAN	1375
	ANSFPE = ANSFPC + ANFCOS	FAN	1376
	150 IF (ANSFPE.GT. AFC) GOTO 400	FAN	1377
C		FAN	1378

SUBROUTINE FAN

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	STORAGE OF DESIGN PARAMETERS FOR THE LEAST COST FAN SYSTEM TO	FAN	1379
C	TO BE PRINTED OUT BY THE SUBROUTINE RPTFAN	FAN	1380
C		FAN	1381
	AFC = ANSFPE	FAN	1382
	AFCH = ANFCOS	FAN	1383
	AC=TCSTF	FAN	1384
	AWP=TOTHP	FAN	1385
	ADIA=FANDAP(I,8)	FAN	1386
	ARLN=FANDAP(I,9)	FAN	1387
	BLDANG=FANDAP(I,10)	FAN	1388
	XNFAN=NOF	FAN	1389
	XTOWN = TOWN	FAN	1390
	NUMTOW = ITOWN	FAN	1391
	CTOWD = DTOW	FAN	1392
	AVEL=VEL	FAN	1393
	CFPERF=CFMPF	FAN	1394
	HPPERF=HPPF	FAN	1395
	TPC=TP	FAN	1396
	TOTCF=TOTCFM	FAN	1397
	FRCDF = FCST	FAN	1398
	FMCPF = CMOT + CSR	FAN	1399
	CPLEN=CPL	FAN	1400
	CYLRNG = CFROS	FAN	1401
	HPAIR=TOTHP	FAN	1402
	FPOW=TOTHP/1.341	FAN	1403
	DPFEL=(VP/(.07495*SPVOL))*5.2022	FAN	1404
	DPHX = DPTINW * 5.20218 / 144.	FAN	1405
	HUBDIA = SQRT (ADIA**2 - 4.*A/3.14159)	FAN	1406
	TCTPF = TCSTPF	FAN	1407
	FDCPF = FCST	FAN	1408
	FMTRC = CMOT	FAN	1409
	ACCTP= (DPTINW + VP/(.07495*SPVOL)) * 5.2018/144.	FAN	1410
	CFANEL = FANLEC	FAN	1411
	ADJTP = TP * 5.20218/144.	FAN	1412
	ACTBPD = DPHX	FAN	1413
	ADJBPD = DPHX * .07495*SPVOL	FAN	1414
	ACTVH = DPFEL/144.	FAN	1415
	ADJVH = VP * 5.20218 / 144.	FAN	1416
	ACTPPF = HPPERF	FAN	1417
	ADJPPF = HPPF * SPVOL * .07495	FAN	1418
	TWPAIR = HPAIR	FAN	1419
	TCTF = AC	FAN	1420
	AFSCST = AFC	FAN	1421
	AFCST = AFCH	FAN	1422
	CSRD = CSR	FAN	1423
400	CONTINUE	FAN	1424
	IF (CTMAX .EQ. 0.0) KTMAX = 0	FAN	1425
	IF (ABS (CTMAX - XTOWN) .LT. .0001) LOOPER = .TRUE.	FAN	1426
	CTMAX = AMAX1 (CTMAX, XTOWN)	FAN	1427
	KTMAX = KTMAX + 1	FAN	1428
	IF (KTMAX .GT. 10) LOOPER = .TRUE.	FAN	1429
	IF (LOOPER) AFC = 5.E+8	FAN	1430
	RETURN	FAN	1431
	END	FAN	1432

SUBROUTINE FINEFF 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	SUBROUTINE FINEFF(HO,EFFIN)	FINEFF	2
C		FINEFF	3
C	SUBROUTINE FINEFF CALCULATES THE FIN EFFECTIVENESS OF AN	FINEFF	4
C	EXTENDED FIN USING DUSINBERRE'S RELATIONSHIP AND A CURVE	FINEFF	5
C	FIT OF THE DIFFERENCE BETWEEN DUSINBERRE'S AND THE BESSEL	FINEFF	6
C	FUNCTION SOLUTION OF THE FIN EFFECTIVENESS SECOND ORDER	FINEFF	7
C	DIFFERENTIAL EQUATION WITH CONSTANT FIN THICKNESS.	FINEFF	8
C		FINEFF	9
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFT, ALPHA, ANG(3)	BIGCOM	4
	* ,BOLIM(16)	BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAP	BIGCOM	6
	\$,C3J, CTURB, CDANG, CLUVR, CHAILE, CVM	BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFFP, EFS	BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FXTID,FXTVAR,FXTID,FXTLNG	BIGCOM	11
	\$,GREFF	BIGCOM	12
	\$,HXNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14
	\$,JCONS	BIGCOM	15
	\$,KCONV, KALEXT	BIGCOM	16
	\$,MEXT	BIGCOM	17
	\$,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	\$ ODR	BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	\$,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
	\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
	\$,OREJ, QREDUCE, QREDUCV	BIGCOM	24
	\$,SIGMAG, SAAF, SEGL	BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	\$,TCD, TW	BIGCOM	27
	\$,UCS, UWS	BIGCOM	28
	\$,WCV, WATCONA, WATCOST	BIGCOM	29
	\$,VAS(5)	BIGCOM	30
	\$,XDPA, XW, XD	BIGCOM	31
	LOGICAL PATH	FINEFF	11
	DATA PATH /.TRUE./	FINEFF	12
	DATA A, R / 0.06313766, 0.00745032 /	FINEFF	13
C		FINEFF	14
C	DUSINBERRE'S RELATIONSHIP	FINEFF	15
C		FINEFF	16
	IF(.NOT. PATH) GO TO 10	FINEFF	17
	RE = DFIN/12.0/2.0	FINEFF	18
	RR = ODR/12.0/2.0	FINEFF	19
	RC = RE - RR	FINEFF	20
	YR = THFIN/12.0/2.0	FINEFF	21
	CST1 = RE/RR	FINEFF	22
	AW = RC*RC*SQRT(CST1)/CONF/YB/3.0	FINEFF	23
	PATH = .FALSE.	FINEFF	24
10	CONTINUE	FINEFF	25
	EFFD = 1.0/(1.0 + HO*AW)	FINEFF	26
C		FINEFF	27
C	DUSINBERRE'S AND BESSEL FUNCTION SOLUTION DIFFERENCE	FINEFF	28
C		FINEFF	29

SUBROUTINE FINEFF 74/74 OPT=1

FTN 4,5+414

06/05/78 07,59.59

C DELTA = A*(1.0 - EXP(-B*H0))
C EFFECTIVENESS OF FIN
C EFFIN = EFFD + DELTA
C RETURN
END

FINEFF 30
FINEFF 31
FINEFF 32
FINEFF 33
FINEFF 34
FINEFF 35
FINEFF 36
FINEFF 37

FUNCTION FLUID

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

FUNCTION FLUID(NPROP,NFLUID,TEMP,ALTID,LOCAT)
DIMENSION LOCAT(2)
DIMENSION COLLAJ(12,8,2)
DIMENSION FLU(2), PROP(12,3)
LOGICAL WARN
IFLAG3 = 1

```

```

SUBROUTINE FLUID DETERMINES THE THERMODYNAMIC AND PHYSICAL
PROPERTIES OF SATURATED AMMONIA AND AIR. THE VALUES ARE
DETERMINED BY CURVE FITS OF THE PROPERTIES VERSUS TEMPERATURE.
THE LIQUID PROPERTIES OF AMMONIA ARE FOR SATURATED AMMONIA.
THE THERMODYNAMIC PROPERTIES FOR AMMONIA GAS ARE FOR ATMOS-
PHERIC PRESSURE WHILE THE PHYSICAL PROPERTIES ARE FOR
SATURATED AMMONIA GAS.

```

```

COLLAJ(NFLUID, NPROP, ICLA)

```

```

NFLUID = FLUID INDEX

```

```

= 1 = AMMONIA
= 2 = AIR

```

```

NPROP = PROPERTY INDEX

```

```

= 1 = SPECIFIC HEAT (LIQUID) (BTU/LBM-DEG F)
= 2 = THERMAL CONDUCTIVITY (LIQUID) (BTU/HR-FT-DEG F)
= 3 = DENSITY (LIQUID) (LBM/CU FT)
= 4 = VISCOSITY (LIQUID) (LBM/FT-HR)
= 5 = SPECIFIC HEAT (GAS) (BTU/LBM-DEG F)
= 6 = THERMAL CONDUCTIVITY (GAS) (BTU/HR-FT-DEG F)
= 7 = DENSITY (GAS) (LBM/CU FT)
= 8 = VISCOSITY (GAS) (LBM/FT-HR)
= 9 = HEAT OF VAPORIZATION (BTU/LBM)
=10 = PRESSURE AS A FUNCTION OF TEMPERATURE (PSI)
=11 = TEMPERATURE AS A FUNCTION OF PRESSURE (DEG F)
=12 = SURFACE TENSION (LBF/FT)

```

```

ICLA = COEFFICIENTS, LIMITS AND ADJUSTMENT FACTORS

```

```

= 1 = FIRST COEFFICIENT
= 2 = SECOND COEFFICIENT
= 3 = THIRD COEFFICIENT
= 4 = FOURTH COEFFICIENT
= 5 = LOWER TEMPERATURE LIMIT
= 6 = UPPER TEMPERATURE LIMIT
= 7 = FIRST ADJUSTMENT FACTOR, ADDED TO TEMPERATURE
= 8 = SECOND ADJUSTMENT FACTOR, DIVIDED INTO TEMPERATURE

```

```

DATA VALUES FOR AMMONIA

```

```

DATA((COLLAJ(I,J,1), J = 1,8), I = 1, 9)/

```

```

      LIQUID SPECIFIC HEAT (1,J,1)
* 1.0880      , -4.15152E-05, 7.34848E-06, 0.0      , 0.0      ,
* 200.0      , 0.00      , 1.000,
      LIQUID THERMAL CONDUCTIVITY (2,J,1)

```

```

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

```

FUNCTION FLUID

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	* 3.348732E-01,	-7.24969E-04,	-7.37431E-09,	0.0			FLUID	59
	* 188.0	, 0.00	, 1.000,				FLUID	60
C		LIQUID DENSITY (3,J,1)					FLUID	61
	* 41.266	, -3.93362E-02,	-9.16190E-05,	0.0			FLUID	62
	* 200.0	, 0.00	, 1.000,				FLUID	63
C		LIQUID VISCOSITY (4,J,1)					FLUID	64
	* 5.370136E-01,	-3.05283E-03,	6.727532E-06,	0.0			FLUID	65
	* 188.0	, 0.00	, 1.000,				FLUID	66
C		SPECIFIC HEAT OF GAS (5,J,1)					FLUID	67
	* 4.853833E-01,	1.716071E-04,	1.398809E-07,	0.0			FLUID	68
	* 180.0	, 0.00	, 1.000,				FLUID	69
C		THERMAL CONDUCTIVITY OF GAS (6,J,1)					FLUID	70
	* 1.161967E-02,	3.020539E-05,	2.388301E-08,	0.0			FLUID	71
	* 180.0	, 0.00	, 1.000,				FLUID	72
C		DENSITY OF GAS (7,J,1)					FLUID	73
	* 9.059293E-02,	5.588934E-03,	-4.04296E-05,	4.343057E-07,	0.0		FLUID	74
	* 200.0	, 0.00	, 1.000,				FLUID	75
C		VISCOSITY OF GAS (8,J,1)					FLUID	76
	* 2.375058E-02,	4.175724E-05,	8.421106E-08,	0.0			FLUID	77
	* 188.0	, 0.00	, 1.000,				FLUID	78
C		HEAT OF VAPORIZATION (9,J,1)					FLUID	79
	* 5.667073E+02,	-6.09783E-01,	-2.75342E-03,	0.0			FLUID	80
	* 200.0	, 0.00	, 1.000/				FLUID	81
	DATA((COLLAJ(I,J,1), J = 1, 8), I = 10, 12)/						FLUID	82
C		PRESSURE AS A FUNCTION OF TEMPERATURE (10,J,1)					FLUID	83
	* 2.983273E+01,	8.155492E-01,	5.019419E-03,	4.990846E-05,	0.0		FLUID	84
	* 190.0	, 0.00	, 1.000,				FLUID	85
C		TEMPERATURE AS A FUNCTION OF PRESSURE (11,J,1)					FLUID	86
	* -1.50307E+01,	7.921579E-01,	-1.33280E-03,	8.885735E-07,	30.0		FLUID	87
	* 710.0	, 0.00	, 1.000,				FLUID	88
C		SURFACE TENSION (12,J,1)					FLUID	89
	* 2.0213E-03	, -8.1309E-06	, 0.0	, 0.0	, 30.0		FLUID	90
	* 200.0	, 0.00	, 1.000/				FLUID	91
C							FLUID	92
C							FLUID	93
C		DATA VALUES FOR AIR (PRESSURE OF ONE ATMOSPHERE)					FLUID	94
C		DATA((COLLAJ(I,J,2), J = 1, 8), I = 1, 8)/					FLUID	95
C		LIQUID SPECIFIC HEAT (1,J,2)					FLUID	96
	* 0.0	, 0.0	, 0.0	, 0.0	, 0.0		FLUID	98
	* 0.0	, 0.0	, 0.0				FLUID	99
C		LIQUID THERMAL CONDUCTIVITY (2,J,2)					FLUID	100
	* 0.0	, 0.0	, 0.0	, 0.0	, 0.0		FLUID	101
	* 0.0	, 0.0	, 0.0				FLUID	102
C		LIQUID DENSITY (3,J,2)					FLUID	103
	* 0.0	, 0.0	, 0.0	, 0.0	, 0.0		FLUID	104
	* 0.0	, 0.0	, 0.0				FLUID	105
C		LIQUID VISCOSITY (4,J,2)					FLUID	106
	* 0.0	, 0.0	, 0.0	, 0.0	, 0.0		FLUID	107
	* 0.0	, 0.0	, 0.0				FLUID	108
C		SPECIFIC HEAT OF GAS (5,J,2)					FLUID	109
	* 2.403053E-01,	6.7987568E-7,	1.5005827E-8,	7.041570E-11,	-40.0		FLUID	110
	* 140.0	, 0.0	, 1.0				FLUID	111
C		THERMAL CONDUCTIVITY OF GAS (6,J,2)					FLUID	112
	* 1.3069044E-2,	2.6570901E-5,	5.0393357E-8,	-4.11082E-10,	-40.0		FLUID	113
	* 140.0	, 0.0	, 1.0				FLUID	114
C		DENSITY OF GAS (7,J,2)					FLUID	115

FUNCTION FLUID

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

```

      * 8.6353904E-2, -1.874752E-4, 3.7316434E-7, -4.66929E-10, -40.0 , FLUID 116
      * 140.0 , 0.0 , 1.0 , FLUID 117
      C      VISCOSITY OF GAS (8,J,2) FLUID 118
      * 3.9387711E-2, 6.8722417E-5, -3.483392E-8, 2.452409E-11, -40.0 , FLUID 119
      * 140.0 , 0.0 , 1.0 / FLUID 120
      C      FLUID 121
      C      FLUID 122
      DATA (FLU(I), I = 1, 2)/"WATER","AIR"/ FLUID 123
      C      FLUID 124
      C      DATA FOR PRINTING OF ERROR MESSAGES FLUID 125
      C      FLUID 126
      DATA((PROP(I,J), J = 1, 3), I = 1, 12)/ FLUID 127
      * "SPECIFIC H","HEAT OF LIQ","UID FLUID 128
      * "THERMAL CO","DUCTIVITY"," OF LIQUID", FLUID 129
      * "DENSITY OF"," LIQUID "," FLUID 130
      * "VISCOSITY ","OF LIQUID "," FLUID 131
      * "SPECIFIC H","HEAT OF GAS"," FLUID 132
      * "THERMAL CO","DUCTIVITY"," OF GAS FLUID 133
      * "DENSITY OF"," GAS "," FLUID 134
      * "VISCOSITY ","OF GAS "," FLUID 135
      * "HEAT OF VA","PORIZATION"," FLUID 136
      * "PRESSURE A","S A FUNCTI","ON OF T FLUID 137
      * "TEMPERATUR","E AS A FUN","CTION OF P", FLUID 138
      * "SURFACE TE","NSION AS A"," FUNCTION"/ FLUID 139
      C      FLUID 140
      C      DETERMINATION OF ERROR IN INPUTS FLUID 141
      C      FLUID 142
      IF(NFLUID .GT. 2) RETURN FLUID 143
      NF = NFLUID FLUID 144
      NP = NPROP FLUID 145
      C      FLUID 146
      C      AIR PROPERTIES NOT AVAILABLE FLUID 147
      C      FLUID 148
      IF(NF .EQ. 2 .AND. NP .LE. 4) GO TO 50 FLUID 149
      WARNE = .FALSE. FLUID 150
      C      FLUID 151
      C      PROPERTIES ASKED FOR OUTSIDE THE RANGE OF TEMPERATURES FLUID 152
      C      ALLOWED FOR FLUID 153
      IF (TEMP .LT. COLLAJ(NP,5,NF)) WARN = .TRUE. FLUID 154
      IF (TEMP .GT. COLLAJ(NP,6,NF)) WARN = .TRUE. FLUID 155
      C      FLUID 156
      C      FLUID PROPERTY CALCULATION FLUID 157
      C      FLUID 158
      T = (TEMP + COLLAJ(NP,7,NF))/COLLAJ(NP,8,NF) FLUID 159
      FLUID = COLLAJ(NP,1,NF) + COLLAJ(NP,2,NF)*T + COLLAJ(NP,3,NF)*T**2 FLUID 160
      * + COLLAJ(NP,4,NF)*T**3 FLUID 161
      C      FLUID 162
      C      ALTITUDE CORRECTION FOR DENSITY OF AIR FLUID 163
      C      FLUID 164
      IF(NF .EQ. 2 .AND. NP .EQ. 7) FLUID = FLUID 165
      $ 1.325 * EXP(3.39853 - 3.81835E-5 * ALTITD) / (TEMP + 459.67) FLUID 166
      C      FLUID 167
      C      PRINTING OF ERRORS FLUID 168
      C      FLUID 169
      IF(.NOT. WARN) RETURN FLUID 170
      IF(IFLAG3 .EQ. 0) RETURN FLUID 171
      C      FLUID 172

```

FUNCTION FLUID

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	TEMPERATURE LIMITS EXCEEDED ERROR PRINTOUT	FLUID	173
	WRITE(6,1) TEMP, (PROP(NPROP,I),I=1,3), FLUID, FLU(NFLUID),	FLUID	174
	* COLLAJ(NP,5,NF), COLLAJ(NP,6,NF), LOCAT	FLUID	175
	1 FORMAT("0***WARNING***")	FLUID	176
	*" THE INPUT TEMPERATURE ("F8.3,") FOR DETERMINING THE ".3A10,	FLUID	177
	* " ("F8.3,"))"/	FLUID	178
	*" FOR ".A9," IS OUTSIDE THE RANGE OF "F8.3," TO " F8.3/	FLUID	179
	*" THE CALL TO FLUID WAS IN ".2A10//)	FLUID	180
	RETURN	FLUID	181
C		FLUID	182
C	AIR PROPERTY ERROR PRINTOUT	FLUID	183
	50 WRITE(6,60) NP	FLUID	184
	60 FORMAT(5X,"THIS PROPERTY OF AIR IS NOT AVAILABLE IN FUNCTION FLUID	FLUID	185
	* *** WARNING *** NP = ",I2/)	FLUID	186
	FLUID = 0.000	FLUID	187
C		FLUID	188
	RETURN	FLUID	189
	END	FLUID	190

SUBROUTINE FRICT

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	SUBROUTINE FRICT(DIA,GT,VIS,ID,F)	FRICT	2
C		FRICT	3
C	SUBROUTINE FRICT FOR GIVEN VALUES OF INSIDE DIAMETER (IN),	FRICT	4
C	MASS FLUX (LBM/SQ FT-SEC), AND VISCOSITY (LBM/FT-HR),	FRICT	5
C	DETERMINES THE FRICTION FACTOR OF DRAWN TUBING (ID=1), STEEL	FRICT	6
C	PIPE (ID=2), OR CAST IRON PIPE (ID=3) USING MOODY FRICTION	FRICT	7
C	FACTOR CHART EQUATIONS	FRICT	8
C	REFERENCE, KNUDSEN, J.G. AND KATZ, D.L. "FLUID DYNAMICS AND	FRICT	9
C	HEAT TRANSFER", MCGRAW-HILL, NEW YORK, 1958, P. 176	FRICT	10
C		FRICT	11
C	DIMENSION EP(3)	FRICT	12
C		FRICT	13
C	INSIDE SURFACE PROTUBERANCES FOR COMMERCIAL TUBING AND PIPE	FRICT	14
C		FRICT	15
C	DATA EP/0.00006,0.0018,0.0102/	FRICT	16
C		FRICT	17
C	CALCULATE REYNOLDS NUMBER AND DETERMINE IF IN LAMINAR OR	FRICT	18
C	TURBULENT REGION	FRICT	19
C		FRICT	20
C	RE = 300.*GT*DIA/VIS	FRICT	21
C	IF (RE=2000.)100,101,101	FRICT	22
C		FRICT	23
C	CALCULATE LAMINAR FLOW FRICTION FACTOR	FRICT	24
C		FRICT	25
C	100 F=16./RE	FRICT	26
C	F = 4.*F	FRICT	27
C	RETURN	FRICT	28
C		FRICT	29
C	CALCULATE RECIPROCAL OF RELATIVE ROUGHNESS AND RECIPROCAL OF	FRICT	30
C	SQUARE ROOT OF FRICTION FACTOR FOR FULLY TURBULENT FLOW	FRICT	31
C		FRICT	32
C	101 RF=DIA/EP(ID)	FRICT	33
C	FF=4.*ALOG10(RF)+2.28	FRICT	34
C		FRICT	35
C	CHECK TO DETERMINE IF TURBULENT FLOW IS FULLY DEVELOPED	FRICT	36
C		FRICT	37
C	CF=RF*FF/RE	FRICT	38
C	IF (CF=0.01)104,103,103	FRICT	39
C		FRICT	40
C	DETERMINE RECIPROCAL OF SQUARE ROOT OF FRICTION FACTOR FOR	FRICT	41
C	TRANSITION FLOW INITIALLY ASSUMING IT TO BE THE SAME AS FOR	FRICT	42
C	FULLY TURBULENT FLOW	FRICT	43
C		FRICT	44
C	103 TRF=FF	FRICT	45
C	107 TRFC=FF=4.*ALOG10(1.+4.67*RF*TRF/RE)	FRICT	46
C		FRICT	47
C	IF CALCULATED AND ASSUMED VALUES OF RECIPROCAL OF SQUARE ROOT	FRICT	48
C	OF TRANSITION FLOW FRICTION FACTOR DO NOT AGREE WITHIN	FRICT	49
C	SPECIFIED LIMITS, ASSUME NEW VALUE EQUAL TO CALCULATED VALUE	FRICT	50
C	AND REPEAT CALCULATION	FRICT	51
C		FRICT	52
C	IF ((ABS(TRFC-TRF)/TRF)=0.001)105,105,106	FRICT	53
C	106 TRF=TRFC	FRICT	54
C	GO TO 107	FRICT	55
C		FRICT	56
C	CALCULATE FULLY DEVELOPED TURBULENT FLOW OR TRANSITION FLOW	FRICT	57
C	FRICTION FACTOR	FRICT	58

CURROUTINE FRIC 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
C
  105 FF=TPF
  104 F=1./FF**2
      F = 4.*F
C
      RETURN
      END
```

```
FRIC 59
FRIC 60
FRIC 61
FRIC 62
FRIC 63
FRIC 64
FRIC 65
```

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE HEADER(DOTM,DOTBR,DESVEL,RHO,RED,J,NN,DIAJ,DIA,TCST,
\$RCST,UPCST,ELCOST,FLGCST,EJCST)

THIS SUBROUTINE DETERMINES DESIGN AND COST INFORMATION FOR
THE MAIN CIRCULATION PIPING AND THE QUADRANT PIPING.

DEFINITION OF VARIABLES

APIPCST - ABOVE GROUND PIPE COST (\$1000/FT)
DESVEL - DESIGN VELOCITY (FT/SEC)
DIA - PIPE COMPONENT DIAMETER (INCHES)
DOTBR - MASS FLOW RATE TO BRANCH, I.E., TO CIRCULAR TOWER
OR TO TUBE BUNDLE (LBM/HR)
DOTM - MASS FLOW RATE IN GIVEN HEADER SECTION (LBM/HR)
EJCST - EXPANSION JOINT COST (\$1000)
ELCOST - 90 DEGREE ELBOW COST (\$1000)
FLGCST - FLANGE COST (\$1000)
NKOS - NUMBER OF POSITIONS IN UNIT COST ARRAYS
NN - IF=0 THEN MAIN CIRCULATION HEADER IS DESIGNED
IF=1 THEN QUADRANT HEADER IS DESIGNED
PIPCST - BELOW GROUND PIPE COST (\$1000/FT)
RED - ALLOWABLE REDUCTION IN DIAMETER BETWEEN ADJACENT
HEADER SECTIONS (INCHES). IF RED=0 THE PROGRAM
CALCULATES THE REDUCTION
REDCOST - REDUCER COST (\$1000)
REDUCT - REDUCTION IN DIAMETER BETWEEN ADJACENT HEADER
SECTIONS (INCHES). ONLY USED WHEN RED=0
RHO - DENSITY (LBM/CUFT)
TEECOST - TEE COST (\$1000)
UPCST - UNIT PIPE COST (\$1000/FT)
VACST - VALVE COST (\$1000), VALVES ARE MOTOR OPERATED
BUTTERFLY VALVES

DIMENSION DIAM(24), FLGCST(24), EJCST(24), REDCST(24), ELCST(24),
\$, VACST(24), TEECST(24), PIPCT(24), APIPCST(24)

DATA DIAM /

\$ 6.	12.	18.	24.	30.	36.
\$ 42.	48.	54.	60.	66.	72.
\$ 78.	84.	90.	96.	102.	108.
\$ 114.	120.	126.	132.	138.	144.

DATA FLGCST/

\$.136,	.520,	1.03,	1.92,	3.17,	4.42,
\$ 6.82,	9.22,	12.0,	14.7,	21.1,	27.5,
\$ 33.9,	40.4,	46.8,	53.2,	59.7,	66.1,
\$ 72.5,	78.9,	85.4,	91.8,	98.2,	105.

DATA TEECST/

\$.344,	.935,	1.96,	3.82,	14.8,	25.8,
\$ 31.7,	37.6,	53.4,	69.1,	87.9,	107.
\$ 125.	145.	163.	182.	201.	220.
\$ 239.	258.	277.	296.	314.	333.

DATA PIPCT/

\$.06,	.113,	.147,	.219,	.409,	.599,
\$.720,	.841,	1.08,	1.31,	1.57,	1.84,

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

SUBROUTINE HEADER 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

$ 2.10 , 2.36 , 2.62 , 2.88 , 3.15 , 3.41 ,
$ 3.67 , 3.93 , 4.19 , 4.46 , 4.72 , 4.98 /
DATA ELCST/
$ .275 , .715 , 1.35 , 2.94 , 9.54 , 16.1 ,
$ 27.4 , 38.8 , 51.9 , 65.1 , 87.6 , 110. ,
$ 133. , 155. , 178. , 200. , 222. , 245. ,
$ 268. , 290. , 312. , 335. , 357. , 380. /
C
DATA EJCST/
$ .586 , 1.67 , 3.15 , 6.15 , 9.72 , 13.3 ,
$ 14.5 , 23.8 , 30.9 , 38.2 , 51.9 , 65.8 ,
$ 79.5 , 93.3 , 107. , 121. , 135. , 148. ,
$ 162. , 176. , 190. , 203. , 217. , 231. /
C
DATA REDCST/
$ .80 , .320 , .787 , 1.78 , 5.58 , 9.40 ,
$ 13.2 , 16.9 , 26.7 , 36.5 , 52.3 , 68.2 ,
$ 84.1 , 100. , 116. , 132. , 148. , 163. ,
$ 179. , 195. , 211. , 227. , 243. , 259. /
C
DATA APIPCST/
$ .034 , .073 , .096 , .155 , .332 , .510 ,
$ .614 , .719 , .939 , 1.16 , 1.41 , 1.67 ,
$ 1.91 , 2.16 , 2.41 , 2.66 , 2.99 , 3.16 ,
$ 3.41 , 3.66 , 3.91 , 4.16 , 4.42 , 4.67 /
DATA NKOS /24/
RCST=0
CONST1=4./(3.1416*3600.)
C
C
C CALCULATE THE REQUIRED DIAMETER BASED ON MASS FLOW RATE AND
C DESIGN VELOCITY. THE DIAMETER ASSIGNED TO THIS HEADER
C SECTION IS THE NEXT LARGEST PIPE IN 6 INCH INCREMENTS FROM
C THE ARRAY DIAM.
C
C
C DIA=SQRT(DOTM*CONST1/(RHO*DESVEL))*12.
C DO 10 II = 1,NKOS
C I=II
C IF(DIA=DIAM(I))11,11,10
10 CONTINUE
11 DIA=DIAM(I)
C
C
C THE MAIN CIRCULATION HEADER HAS AN EXPANSION JOINT AND
C APPROPRIATE FLANGES AT THE CONDENSER INLET AND OUTLET.
C
C
C IF(J.EQ.1.AND. NN.EQ.1)FLGCST=3.*FLGCST(I)
C IF(J.EQ.1.AND.NN.EQ.1)EJCST=EJCST(I)
C
C
C IN THE STATEMENTS THROUGH STATEMENT 12 THE REDUCTION IN
C DIAMETER BETWEEN ADJACENT HEADER SECTIONS IS SPECIFIED.
C THE REDUCER COST IS DETERMINED. THE INDEXES USED TO DEFINE
C THE ARRAY POSITIONS FOR OTHER COMPONENT COSTS ARE DETERMINED.
C
C
C FOR J=1 THIS ROUTINE IS BY-PASSED BECAUSE THE FIRST HEADER
C WILL NOT HAVE A REDUCER PRECEDING IT.
C
C IF(J.EQ.1) GO TO 12
C

```

```

HEADER 59
HEADER 60
HEADER 61
HEADER 62
HEADER 63
HEADER 64
HEADER 65
HEADER 66
HEADER 67
HEADER 68
HEADER 69
HEADER 70
HEADER 71
HEADER 72
HEADER 73
HEADER 74
HEADER 75
HEADER 76
HEADER 77
HEADER 78
HEADER 79
HEADER 80
HEADER 81
HEADER 82
HEADER 83
HEADER 84
HEADER 85
HEADER 86
HEADER 87
HEADER 88
HEADER 89
HEADER 90
HEADER 91
HEADER 92
HEADER 93
HEADER 94
HEADER 95
HEADER 96
HEADER 97
HEADER 98
HEADER 99
HEADER 100
HEADER 101
HEADER 102
HEADER 103
HEADER 104
HEADER 105
HEADER 106
HEADER 107
HEADER 108
HEADER 109
HEADER 110
HEADER 111
HEADER 112
HEADER 113
HEADER 114
HEADER 115

```

```

C      THE PROGRAM MAY HAVE A SPECIFIED VALUE OF RED WHICH FIXES THE REDUCTION IN PIPE DIAMETERS BETWEEN HEADER SECTIONS. RED MUST BE A MULTIPLE OF 6. IF RED=0 THE ROUTINE CALCULATES A REDUCTION. FOR EXAMPLE, HEADER SECTION J-1 HAS BEEN ASSIGNED A DIAMETER OF 96 INCHES. IT IS DETERMINED THAT HEADER SECTION J SHOULD BE 84 INCHES. THE REQUIRED REDUCTION IS 12 INCHES. IF RED=0 THEN A 96 INCH REDUCER IS COSTED AND HEADER SECTION J WILL BE ASSIGNED A DIAMETER OF 78 INCHES. IF RED=6 INCHES A 96 INCH REDUCER IS COSTED BUT DIAMETER J WOULD BE ASSIGNED A VALUE OF 90 INCHES. IF RED=12 INCHES THEN A 96 INCH REDUCER IS COSTED AND DIAMETER J IS ASSIGNED A VALUE OF 84 INCHES. IF RED=18 INCHES OR MORE THEN NO REDUCER IS SPECIFIED AND DIAMETER J IS ASSIGNED A VALUE OF 96 INCHES. LARGE VALUES OF RED RESULT IN PIPE SIZES LARGER THAN REQUIRED BUT FEWER REDUCERS ARE REQUIRED.
C
C      CALCULATION OF REDUCTION, RED NOT SPECIFIED.
C
C      IF (RED.NE.0.) GO TO 13
C      IF (DIA.EQ.DIAJ) GO TO 12
C      REDUCT=DIAJ-DIA
C      M=REDUCT/6.+.01
C      IJK=1
C      GO TO 14
C
C      RED SPECIFIED, POSSIBLE REASSIGNMENT OF DIAMETER J.
C
13 IF (DIA.GT.DIAJ-RED) GO TO 15
C      DIA=DIAJ-RED
C      M=RED/6.+.01
C      IJK=(DIA-DIAM(I))/6.+.01
14 K=0
C      JJ=M
C
C      DETERMINE REDUCER COST. IT HAS BEEN ASSUMED FROM THE REDUCER COST DATA THAT, FOR EXAMPLE, A 96 INCH REDUCER WILL COST THE SAME WHETHER THE REDUCTION IS TO 90, 84, OR 78 INCHES. IF THE TOTAL REDUCTION BETWEEN ADJACENT HEADER SECTIONS EXCEEDS 18 INCHES THEN AN ADDITIONAL REDUCER MUST BE COSTED. IN THE EXAMPLE, THIS WOULD BE A 78 INCH REDUCER. IF THE TOTAL REDUCTION EXCEEDS 36 INCHES, SAY 96 TO 54, THEN A 96, 78, AND 60 INCH REDUCER WOULD BE COSTED, AND SO ON.
C
16 CONTINUE
C      IF (IJK+JJ.GT.NKOS) STOP "IN HEADER IJK+JJ EXCEEDS NKOS"
C      RCST = RCST + REDCST(IJK+JJ)
C      K=K+1
C      JJ=M-3*K
C      IF (JJ.LE.0) GO TO 12
C      GO TO 16
C
15 DIA=DIAJ
12 M=(DIA-DIAM(I))/6.+.01
C      IF (I+M.GT. NKOS) STOP "IN HEADER I+M EXCEEDS NKOS"
C
C      IF THE LAST HEADER SECTION IS BEING DESIGNED USE AN ELBOW RATHER THAN A TEE.

```

SUBROUTINE HEADER 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	IF (ABS(DOTM-DOTBR).LT..0001)ELCOST=ELCST(I+M)	HEADER	173
C		HEADER	174
C	TEE COSTS ARE ASSUMED TO BE .67 TIMES THE COST OF A TEE	HEADER	175
C	OF THE "RUN" DIAMETER PLUS .33 TIMES THE COST OF A TEE OF THE	HEADER	176
C	"BRANCH" DIAMETER. DETERMINE THE "RUN" PORTION OF THE TEE	HEADER	177
C	COST HERE.	HEADER	178
C		HEADER	179
	IF (DOTM.GT.DOTBR)TCST=.67*TEECST(I+M)	HEADER	180
C		HEADER	181
C	MAIN CIRCULATION PIPING IS UNDERGROUND. QUADRANT PIPING IS	HEADER	182
C	ABOVE GROUND. FITTINGS COSTS WERE NOT DEPENDENT ON ABOVE OR	HEADER	183
C	BELOW GROUND SPECIFICATION.	HEADER	184
C		HEADER	185
	IF (NN .EQ. 0) UPCST = APIPCST(I+M)	HEADER	186
	IF (NN .NE. 0) UPCST = PIPCST(I+M)	HEADER	187
	RETURN	HEADER	188
	END	HEADER	189

SUBROUTINE HLAMMO

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

SUBROUTINE HLAMMO(TIN,DOTMA,DIA,HLENGTH,DIV,TOUT,DELP)	HLAMMO	2
COMMON/PROP/CPW,THCONW,DENSIW,VISW,HFG,	HLAMMO	3
1 CPV,THCONV,DENSIV,VISV,SIGMA,	HLAMMO	4
1 CPA,THCONA,DENSIA,VISA	HLAMMO	5
C	HLAMMO	6
C SUBROUTINE HLAMMO CALCULATES THE PRESSURE AND TEMPERATURE	HLAMMO	7
C DROPS OF AMMONIA DUE TO THE FLUID FLOW OF ITS VAPOR	HLAMMO	8
C INSIDE A LENGTH OF PIPE	HLAMMO	9
C	HLAMMO	10
C DEFINITION OF VARIABLES	HLAMMO	11
C	HLAMMO	12
C DELP - PRESSURE DROP IN THE PIPE (LBF/SQ FT)	HLAMMO	13
C DELTX - SEGMENT OF THE PIPE (FT)	HLAMMO	14
C DENSIV - DENSITY OF THE AMMONIA VAPOR (LBM/CU FT)	HLAMMO	15
C DIA - DIAMETER OF PIPE (IN)	HLAMMO	16
C DIV - NUMBER OF DIVISIONS OF AMMONIA IN THE LENGTH OF	HLAMMO	17
C THE PIPE (DIMENSIONLESS)	HLAMMO	18
C DOTMA - MASS FLOW RATE IN THE PIPE (LBM/HR)	HLAMMO	19
C F - FRICTION FACTOR FOR THE VAPOR FLOW (DIMENSIONLESS)	HLAMMO	20
C G - MASS FLUX OF AMMONIA IN THE PIPE (LBM/SQ FT HR)	HLAMMO	21
C HLENGTH - LENGTH OF THE PIPE (FT)	HLAMMO	22
C P1 - PRESSURE OF THE AMMONIA AT THE FRONT OF THE PIPE	HLAMMO	23
C (LBF/SQ IN)	HLAMMO	24
C P2 - PRESSURE OF THE AMMONIA AT THE END OF THE PIPE	HLAMMO	25
C (LBF/SQ IN)	HLAMMO	26
C TIN - TEMPERATURE AT THE BEGINNING OF THE PIPE	HLAMMO	27
C TOUT - TEMPERATURE AT THE END OF THE PIPE	HLAMMO	28
C	HLAMMO	29
C DELP = 0.0	HLAMMO	30
C J = 0	HLAMMO	31
C GA = 32.16*3600.*3600.	HLAMMO	32
C	HLAMMO	33
C NUMBER OF DIVISIONS IN THE PIPE	HLAMMO	34
C I = DIV * .01	HLAMMO	35
C	HLAMMO	36
C INLET PRESSURE	HLAMMO	37
C P1 = FLUID(10,1,TIN,ELEV,"CALC 1")	HLAMMO	38
C	HLAMMO	39
C LENGTH OF PIPE SEGMENTS	HLAMMO	40
C DELTX = HLENGTH/DIV	HLAMMO	41
C	HLAMMO	42
C MASS FLUX OF AMMONIA THROUGH THE PIPE	HLAMMO	43
C G = DOTMA/(3.14159*DIA**2/(4.*144.))	HLAMMO	44
10 J = J + 1	HLAMMO	45
C	HLAMMO	46
C FRICTION FACTOR IN THE PIPE	HLAMMO	47
C CALL FRIC(DIA,G/3600.,VISV,2,F)	HLAMMO	48
C	HLAMMO	49
C PRESSURE DROP IN THE SEGMENT OF PIPE PLUS THE SUM OF THE	HLAMMO	50
C PRECEDING PRESSURE DROPS CAUSED BY PRECEDING SEGMENTS	HLAMMO	51
C OF PIPE	HLAMMO	52
C DELP = F*G**2*DELTx/(2.*GA*DENSIV*(DIA/12.)) + DELP	HLAMMO	53
C	HLAMMO	54
C NEW PRESSURE AT THE END OF THE SEGMENT OF PIPE	HLAMMO	55
C P2 = P1 - DELP/144.	HLAMMO	56
C	HLAMMO	57
C NEW TEMPERATURE OF AMMONIA AT THE END OF THE SEGMENT OF	HLAMMO	58

SUBROUTINE HLAMMO 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	PIPE	HLAMMO	59
	TI = FLUID(11,1,P2,ELEV,"CALC 1P")	HLAMMO	60
	DELT I = .001	HLAMMO	61
20	FTI = -P2 + FLUID(10,1,TI,ELEV,"CALC 2")	HLAMMO	62
	FTIDEL = -P2 + FLUID(10,1,TI+DELT I,ELEV,"CALC 3")	HLAMMO	63
	TIP1 = TI - DELT I*FTI/(FTIDEL - FTI)	HLAMMO	64
	IF(ABS(TIP1 - TI).LT..0001) GO TO 30	HLAMMO	65
	TI = TIP1	HLAMMO	66
	GO TO 20	HLAMMO	67
30	TOUT = TI	HLAMMO	68
C		HLAMMO	69
C	NEW VAPOR DENSITY AND VISCOSITY OF THE VAPOR AT THE END	HLAMMO	70
C	OF THE SEGMENT OF PIPE	HLAMMO	71
	DENSIV = FLUID(7,1,TOUT,ELEV,"CALC 4")	HLAMMO	72
	VISV = FLUID(8,1,TOUT,ELEV,"CALC 5")	HLAMMO	73
	IF(J.EQ.1) GO TO 40	HLAMMO	74
	GO TO 10	HLAMMO	75
40	CONTINUE	HLAMMO	76
	RETURN	HLAMMO	77
	END	HLAMMO	78

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	SUBROUTINE HOTERV(FAIR,H0,SIGMAG,ALPHA,XD,GAIR)	HOTERV	2
C		HOTERV	3
C	HOTERV CALCULATES THE FRICTION FACTOR AND HEAT TRANSFER	HOTERV	4
C	COEFFICIENT FOR AIR FLOW NORMAL TO A BANK OF TUBES WITH	HOTERV	5
C	CONTINUOUS PLATE FINS (HOTERV SURFACE)	HOTERV	6
C		HOTERV	7
C	DEFINITION OF VARIABLES	HOTERV	8
C	CONA = THERMAL CONDUCTIVITY OF AIR (BTU/HR FT DEG F)	HOTERV	9
C	DH = HYDRAULIC DIAMETER OF SURFACE (FT)	HOTERV	10
C	FAIR = AIR SIDE FRICTION FACTOR FOR HOTERV INLINE TUBE	HOTERV	11
C	SURFACE (DIMENSIONLESS)	HOTERV	12
C	F1-F2 = CORRELATION COEFFICIENTS FOR AIR SIDE FRICTION	HOTERV	13
C	FACTOR (DIMENSIONLESS)	HOTERV	14
C	GAIR = AIR SIDE MASS FLUX AT THE MINIMUM FLOW AREA	HOTERV	15
C	(LBM/SQ FT HR)	HOTERV	16
C	H0 = AIR SIDE HEAT TRANSFER COEFFICIENT	HOTERV	17
C	(BTU/HR SQ FT DEG F)	HOTERV	18
C	H1-H3 = CORRELATION COEFFICIENTS FOR AIR SIDE HEAT	HOTERV	19
C	TRANSFER COEFFICIENT (DIMENSIONLESS)	HOTERV	20
C	PR = PRANDTL NUMBER OF AIR (DIMENSIONLESS)	HOTERV	21
C	REAIR = REYNOLDS NUMBER OF AIR AT THE MINIMUM FLOW AREA	HOTERV	22
C	(DIMENSIONLESS)	HOTERV	23
C	XD = LONGITUDINAL TUBE PITCH (IN)	HOTERV	24
C		HOTERV	25
C	COMMON/PROP/CPW,THCONW,DENSIW,VISW,HFG,	HOTERV	26
C	1 CPV,THCONV,DENSIV,VISV,SIGMA,	HOTERV	27
C	2 CPA,THCONA,DENSIA,VISA	HOTERV	28
C		HOTERV	29
C	DATA F1, F2 / 4.781062, -0.240/	HOTERV	30
C	DATA H1, H2, H3 / 0.18534135, 0.5767722, 0.33333 /	HOTERV	31
C		HOTERV	32
C	AIR SIDE HYDRAULIC DIAMETER AND REYNOLDS NUMBER	HOTERV	33
C		HOTERV	34
C	DH = 4.0*SIGMAG/ALPHA	HOTERV	35
C	REAIR = GAIR*DH/VISA	HOTERV	36
C		HOTERV	37
C	AIR SIDE FRICTION FACTOR	HOTERV	38
C		HOTERV	39
C	FAIRP = F1*REAIR**F2	HOTERV	40
C	FAIR = FAIRP	HOTERV	41
C		HOTERV	42
C	HEAT TRANSFER COEFFICIENT	HOTERV	43
C		HOTERV	44
C	PR = VISA*CPA/THCONA	HOTERV	45
C	CONA = THCONA	HOTERV	46
C	H0 = (CONA/DH)*H1*(REAIR**H2)*(PR**H3)	HOTERV	47
C	RETURN	HOTERV	48
C	END	HOTERV	49


```

SUBROUTINE HTCLO(DTI,DL,ANG,GT,XI,X2,PRL,DENL,DENV,VISL,VISV,TKL,
1CPL,HTL,HTC,HTR,HTN,HTK,RET)
  DIMENSION ANG(3)

```

C		HTCLO	2
C		HTCLO	3
C		HTCLO	4
C		HTCLO	5
C	SUBROUTINE HTCLO CALCULATES THE TUBESIDE TWO-PHASE LIQUID	HTCLO	6
C	FILM HEAT TRANSFER COEFFICIENT FOR THE CONDENSATION OF	HTCLO	7
C	A FLUID ON THE WALLS OF A TUBE	HTCLO	8
C		HTCLO	9
C	DEFINITION OF VARIABLES	HTCLO	10
C		HTCLO	11
C	ARG(1) - ANGLE THE TUBE MAKES FROM THE HORIZONTAL (RAD)	HTCLO	12
C	ARG(2) - SINE OF THE ANGLE THE TUBE MAKES FROM THE	HTCLO	13
C	HORIZONTAL (DIMENSIONLESS)	HTCLO	14
C	DENL - DENSITY OF THE LIQUID (LBM/CU FT)	HTCLO	15
C	DENV - DENSITY OF THE VAPOR (LBM/CU FT)	HTCLO	16
C	DL - LENGTH OF THE LIQUID AND VAPOR TUBE (IN)	HTCLO	17
C	DR - RATIO OF THE DENSITIES (DIMENSIONLESS)	HTCLO	18
C	DTI - INSIDE DIAMETER OF THE TUBE (IN)	HTCLO	19
C	GT - MASS FLUX OF THE FLUID THROUGH THE TUBE (LBM/	HTCLO	20
C	HR-SQ FT)	HTCLO	21
C	HTB - HEAT TRANSFER COEFFICIENT ACCORDING TO THE CORRELA-	HTCLO	22
C	TION BY BOYKO AND KRÜZHILIN (BTU/HR-SQ FT-DEG F)	HTCLO	23
C	HTC - HEAT TRANSFER COEFFICIENT ACCORDING TO THE	HTCLO	24
C	CORRELATION BY CHATO (BTU/HR-SQ FT-DEG F)	HTCLO	25
C	HTK - HEAT TRANSFER COEFFICIENT ACCORDING TO THE	HTCLO	26
C	CORRELATION BY KIRKBRIDE AND BADGER (BTU/HR-SQ FT-	HTCLO	27
C	DEG F)	HTCLO	28
C	HTN - HEAT TRANSFER COEFFICIENT ACCORDING TO THE	HTCLO	29
C	CORRELATION BASED ON THE NUSSELT TYPE ANALYSIS	HTCLO	30
C	(BTU/HR-SQ FT-DEG F)	HTCLO	31
C	PRL - PRANDTL NUMBER OF THE LIQUID (DIMENSIONLESS)	HTCLO	32
C	RET - REYNOLDS NUMBER (DIMENSIONLESS)	HTCLO	33
C	TKL - THERMAL CONDUCTIVITY OF THE LIQUID (BTU/HR-FT-DEG F)	HTCLO	34
C	VISL - VISCOSITY OF THE LIQUID (CENTIPOISE)	HTCLO	35
C	XD - CHANGE IN VAPOR QUALITY FROM THE INLET TO THE EXIT	HTCLO	36
C	OF THE TUBE (DIMENSIONLESS)	HTCLO	37
C	XI - INLET QUALITY (DIMENSIONLESS)	HTCLO	38
C	XD - EXIT QUALITY (DIMENSIONLESS)	HTCLO	39
C		HTCLO	40
C	DR = DENL/DENV	HTCLO	41
C	RET = DTI*GT/(VISL*29.)	HTCLO	42
C	XD = AMIN1(X2,.999)	HTCLO	43
C		HTCLO	44
C	GRAVITY CONTROLLED STRATIFIED CONDENSATION (CHATO)	HTCLO	45
C	ANGLE OF THE CONDENSATE = 120 DEGREES	HTCLO	46
C	XD = AMAX1(XI-XD,.001)	HTCLO	47
C	HTC = 924.*TKL*(DENL*(DENL-DENV)*DL*ANG(3 /	HTCLO	48
C	1 (VISL*DTI**2*GT*XD))**.33	HTCLO	49
C		HTCLO	50
C	PRESSURE GRADIENT CONTROLLED ANNULAR CONDENSATION (BOYKO-	HTCLO	51
C	KRÜZHILIN)	HTCLO	52
C	FTP = (SQRT(1. + (DR - 1.)*XI) + SQRT(1. + (DR - 1.)*XD)).5	HTCLO	53
C	HTR = .024*TKL*RET**.8*PRL**.43*FTP/DTI*12.	HTCLO	54
C	KOOL = 0	HTCLO	55
C	IF (ANG(1) = 0.017) 30,30,50	HTCLO	56
C	30 IF (HTC = HTR) 100,100,40	HTCLO	57
C	40 KOOL = 1	HTCLO	58

SUBROUTINE HTCLO

74/74 OPT=1

FTN 4,5+414

06/05/78 07,59,59

	GO TO 100	HTCLO	59
	50 PPN = TKL*(4.18E8*ANG(2)*DENL*(DENL-DENV)/(VISL*2.42)**2)**.33	HTCLO	60
C		HTCLO	61
C	GRAVITY CONTROLLED VERTICALLY LAMINAR CONDENSATION (NUSSELT)	HTCLO	62
	HTN = 1.47*PPN/(RET*(1.-XO))**.33	HTCLO	63
C		HTCLO	64
C	GRAVITY CONTROLLED VERTICALLY TURBULENT CONDENSATION	HTCLO	65
C	(KIRKBRIDE-BADGER)	HTCLO	66
	HTK = .0077*(RET*(1.-XO))**.4*PPN	HTCLO	67
100	HTL = AMAX1(HTC,HTB,HTN,HTK)	HTCLO	68
	RETURN	HTCLO	69
	END	HTCLO	70

	SUBROUTINE HYDLOS(DIA,VEL,VIS,RHO,ID,HDL)	HYDLOS	2
C		HYDLOS	3
C	SUBROUTINE HYDLOS FOR GIVEN VALUES OF INSIDE DIAMETER,	HYDLOS	4
C	VELOCITY, VISCOSITY, AND DENSITY; DETERMINES THE FRICTION	HYDLOS	5
C	HEAD LOSS PER FEET OF DRAWN TUBING (ID=1), STEEL PIPE (ID=2),	HYDLOS	6
C	OR CAST IRON PIPE (ID=3) USING MOODY FRICTION FACTOR CHART	HYDLOS	7
C	EQUATIONS	HYDLOS	8
C	REFERENCE, KNUDSEN, J.G. AND KATZ, D.L. "FLUID DYNAMICS AND	HYDLOS	9
C	HEAT TRANSFER", MCGRAW-HILL, NEW YORK, 1958, P.176	HYDLOS	10
C		HYDLOS	11
C	DIMENSION EP(3)	HYDLOS	12
C		HYDLOS	13
C	INSIDE SURFACE PROTUBERANCES FOR COMMERCIAL TUBING AND PIPE	HYDLOS	14
C		HYDLOS	15
C	DATA EP/0.00006,0.0018,0.0102/	HYDLOS	16
C		HYDLOS	17
C	CALCULATE PEYNOLDS NUMBER AND DETERMINE IF IN LAMINAR OR	HYDLOS	18
C	TURBULENT REGION	HYDLOS	19
C		HYDLOS	20
C	PE=300.*RHO*VEL*DIA/VIS	HYDLOS	21
C	IF(RE=2000.)100,101,101	HYDLOS	22
C		HYDLOS	23
C	CALCULATE LAMINAR FLOW FRICTION FACTOR	HYDLOS	24
C		HYDLOS	25
100	F=16./RE	HYDLOS	26
	GO TO 102	HYDLOS	27
C		HYDLOS	28
C	CALCULATE RECIPROCAL OF RELATIVE ROUGHNESS AND RECIPROCAL OF	HYDLOS	29
C	SQUARE ROOT OF FRICTION FACTOR FOR FULLY TURBULENT FLOW	HYDLOS	30
C		HYDLOS	31
101	RF=DIA/EP(ID)	HYDLOS	32
	FF=4.*ALOG10(RF)+2.28	HYDLOS	33
C		HYDLOS	34
C	CHECK TO DETERMINE IF TURBULENT FLOW IS FULLY DEVELOPED	HYDLOS	35
C		HYDLOS	36
C	CF=RF*FF/RE	HYDLOS	37
	IF(CF=0.01)104,103,103	HYDLOS	38
C		HYDLOS	39
C	DETERMINE RECIPROCAL OF SQUARE ROOT OF FRICTION FACTOR	HYDLOS	40
C	FOR TRANSITION FLOW INITIALLY ASSUMING IT TO BE THE SAME AS	HYDLOS	41
C	FOR FULLY TURBULENT FLOW	HYDLOS	42
C		HYDLOS	43
103	TRF=FF	HYDLOS	44
107	TRFC=FF-4.*ALOG10(1.+4.67*RF*TRF/RE)	HYDLOS	45
C		HYDLOS	46
C	IF CALCULATED AND ASSUMED VALUES OF RECIPROCAL OF SQUARE ROOT	HYDLOS	47
C	OF TRANSITION FLOW FRICTION FACTOR DO NOT AGREE WITHIN	HYDLOS	48
C	SPECIFIED LIMITS, ASSUME NEW VALUE EQUAL TO CALCULATED VALUE	HYDLOS	49
C	AND REPEAT CALCULATION	HYDLOS	50
C		HYDLOS	51
	IF((ABS(TRFC-TRF)/TRF)=0.001)105,105,106	HYDLOS	52
106	TRF=TRFC	HYDLOS	53
	GO TO 107	HYDLOS	54
C		HYDLOS	55
C	CALCULATE FULLY DEVELOPED TURBULENT FLOW OR TRANSITION FLOW	HYDLOS	56
C	FRICTION FACTOR	HYDLOS	57
C		HYDLOS	58

SUBROUTINE HYDLOS 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
105 FF=TRF
104 F=1./FF**2
C
C      DETERMINE FRICTION HEAD LOSS
C
102 HDLS=74.594*F*VEL**2/DIA
C
      RETURN
      END
```

```
HYDLOS 59
HYDLOS 60
HYDLOS 61
HYDLOS 62
HYDLOS 63
HYDLOS 64
HYDLOS 65
HYDLOS 66
HYDLOS 67
```

C	SUBROUTINE INPSUM	INPSUM	2
C	THIS ROUTINE REPORTS INPUT SUMMARY AND CASE DESCRIPTION	INPSUM	3
C		INPSUM	4
	LOGICAL FIRST,FRST,FXTEMP,FXTVAR,FXTTDD,FXTLNG	INPSUM	5
	COMMON	BIGCOM	2
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	3
	* ,BPLIM(16)	BIGCOM	4
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	5
	\$,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	6
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	7
	\$,EFPF, EFS	BIGCOM	8
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTEMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG	BIGCOM	9
	\$,FIXV,FXTTDD,FXTVAR,FXTTDD,FXTLNG	BIGCOM	10
	\$,GREFF	BIGCOM	11
	\$,HXNP,HPCST,HCD	BIGCOM	12
	\$,ITMAX, ITMIN	BIGCOM	13
	\$,JCONS	BIGCOM	14
	\$,KCONV, KALEXT	BIGCOM	15
	\$,MXEXT	BIGCOM	16
	\$,NTA,NSIDES,NBUNHI	BIGCOM	17
	COMMON	BIGCOM	18
	\$ ODR	BIGCOM	19
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	20
	\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	21
	\$,RRP,REDUCE, REDUCV, ROOFL, RROUT	BIGCOM	22
	\$,QREJ, QREDUCE, QREDUCV	BIGCOM	23
	\$,SIGMAG, SAAF, SEGL	BIGCOM	24
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	25
	\$,TCD, TW	BIGCOM	26
	\$,UCS, UWS	BIGCOM	27
	\$,WFFV, WATCONA, WATCOST	BIGCOM	28
	\$,VAS(5)	BIGCOM	29
	\$,XDEPA, XW, XD	BIGCOM	30
	LOGICAL LOOPER	BIGCOM	31
	COMMON/FAN/ FANDAP(153,10),FANDAM(153,10),FMCPF,FBCPF,P2,R,S,	FANDEK	2
	\$ VELREC, AFC, ELEV, EHR, LOOPER, CTMAX	FANDEK	3
	COMMON /TINEZ/ CCM	FANDEK	4
	126 FORMAT(//79X,"COEFFICIENTS FOR POLYNOMIAL CURVE FIT")	INPSUM	8
	127 FORMAT(70X,"A0",11X,"A1",11X,"A2",11X,"A3",11X,"A4")	INPSUM	9
	128 FORMAT(" HEAT RATE FACTOR AS FUNCTION OF BACKPRESSURE (INCHES OF M	INPSUM	10
	ERCURY) ",1P5E13.5//)	INPSUM	11
	129 FORMAT(T4,"TURBINE RATING BACKPRESSURE",F6.2," INCHES OF MERCURY")	INPSUM	12
	130 FORMAT(T4,"SITE ELEVATION",F7.0," FEET ABOVE SEA LEVEL")	INPSUM	13
	202 FORMAT(1W1,T30,"I N P U T S U M M A R Y A N D C A S E	INPSUM	14
	\$ D E S C R I P T I O N //)	INPSUM	15
	204 FORMAT(T2,3("-----"),T90,2("-----"),"-")	INPSUM	16
	206 FORMAT(T2,"OPTIONS SELECTED FOR THIS RUN",T90,"STARTING CONDITIONS	INPSUM	17
	\$")	INPSUM	18
	200 FORMAT(1W0)	INPSUM	19
	210 FORMAT(T4,"EXCHANGER DEPTH UNCONSTRAINED")	INPSUM	20
	211 FORMAT(1W4,T78,"NUMBER OF H,X, TUBES IN DEPTH ZD",F10.0)	INPSUM	21
	207 FORMAT (T4,"FRICTION FACTOR AND HT TRFR COEFF BY ",A10)	INPSUM	22
	208 FORMAT(T6,"UPPER LIMIT ON TURBINE TEMP",F6.1," F")	INPSUM	23
	215 FORMAT(T4,"EXCHANGER DEPTH CONSTRAINED TO ",A4,1X,F5.1," TUBES")	INPSUM	24
	218 FORMAT(T4,"EXIT TEMPERATURE OF TURBINE CONSTRAINED TO ",F6.1," F")	INPSUM	25
	219 FORMAT(T4,"EXIT TEMPERATURE OF TURBINE UNCONSTRAINED")	INPSUM	26
		INPSUM	27

220	FORMAT(1H+,T80,"TURBINE OUTLET TEMPERATURE, T1",F10.3," F")	INPSUM	28
225	FORMAT(1H+,T74,"EXCHANGER LENGTH UNCONSTRAINED")	INPSUM	29
226	FORMAT(1H+,T74,"LENGTH OF HEAT EXCHANGER TUBES ELEN",F10.1,	INPSUM	30
	1" FEET")	INPSUM	31
230	FORMAT(1H+,T74,"EXCHANGER LENGTH FIXED AT ",F5.0," FEET")	INPSUM	32
233	FORMAT(1H+,T74,"TERMINAL TEMPERATURE DIFFERENCE CONSTRAINED TO ",F5.2,	INPSUM	33
	1" F")	INPSUM	34
234	FORMAT(1H+,T74,"TERMINAL TEMPERATURE DIFFERENCE UNCONSTRAINED")	INPSUM	35
235	FORMAT(1H+,T74,"TERMINAL TEMPERATURE DIFFERENCE TTD1",F10.3," F")	INPSUM	36
240	FORMAT(1H+,T74,"RUN WITH VELOCITY RECOVERY")	INPSUM	37
245	FORMAT(1H+,T74,"RUN WITHOUT VELOCITY RECOVERY")	INPSUM	38
255	FORMAT(1H+,T74,"NTU CALCULATION IS BY ",Z10)	INPSUM	39
260	FORMAT(1H+,T74,"FRONTAL AIR VELOCITY CONSTRAINED TO ",F5.2," FT/SEC")	INPSUM	40
261	FORMAT(1H+,T74,"FRONTAL AIR VELOCITY UNCONSTRAINED")	INPSUM	41
262	FORMAT(1H+,T74,"FRONTAL AIR VELOCITY, VAIR",F7.2," FT/SEC")	INPSUM	42
300	FORMAT(1H+,T51,"UNIT COSTS AND COSTING FACTORS"/T51,Z30("=")//)	INPSUM	43
305	FORMAT(1H+,T2,"FUEL ",F7.3," CENTS/MMBTU")	INPSUM	44
	\$,T30,"POWER PLANT CONSTRUCTION",F11.3," \$/KW")	INPSUM	45
	\$,T104,"FIXED CHARGE RATE",F9.3)	INPSUM	46
310	FORMAT(1H+,T2,"LAND ",F7.3," \$/SQ FT")	INPSUM	47
	\$,T30,"REPLACEMENT POWER",7X,F11.3," MILLS/KWH")	INPSUM	48
	\$,T106,"CAPACITY FACTOR",F9.3)	INPSUM	49
315	FORMAT(1H+,T2,"MOTORS",F7.3," \$ / HP")	INPSUM	50
	\$,T30,"STEAM SUPPLY",T54,F11.3," \$/KW TURBINE OUTPUT")	INPSUM	51
	\$,T98,"BASE THERMAL EFFICIENCY",F9.3)	INPSUM	52
320	FORMAT(1H+,T30,"CAPACITY CHARGE",T54,F11.3," \$/MWH")	INPSUM	53
	\$,T93,"CONSTRUCTION COST MULTIPLIER",F9.3)	INPSUM	54
325	FORMAT(1H+,T95,"MAINT COSTS /CAPITAL COSTS",F9.3)	INPSUM	55
	WRITE(6,202)	INPSUM	56
	WRITE(6,204)	INPSUM	57
	WRITE(6,206)	INPSUM	58
	WRITE(6,204)	INPSUM	59
	WRITE(6,200)	INPSUM	60
	WRITE(6,208) TLIM	INPSUM	61
	WRITE(6,207) FFHX	INPSUM	62
C		INPSUM	63
C		INPSUM	64
	IF(FXTMP)WRITE(6,218)	INPSUM	65
	IF(.NOT.FXTMP) WRITE(6,219)	INPSUM	66
	WRITE(6,220) VAS(1)	INPSUM	67
C		INPSUM	68
	IF(FXTVAR) WRITE(6,260)	INPSUM	69
	IF(.NOT.FXTVAR) WRITE(6,261)	INPSUM	70
	WRITE(6,262) VAS(2)	INPSUM	71
C		INPSUM	72
	IF(FXTTDD) WRITE(6,233)	INPSUM	73
	IF(.NOT.FXTTDD) WRITE(6,234)	INPSUM	74
	WRITE(6,235) VAS(3)	INPSUM	75
C		INPSUM	76
	IF(FXTLNG) WRITE(6,230) FIXL	INPSUM	77
	IF(.NOT.FXTLNG) WRITE(6,225)	INPSUM	78
	WRITE(6,226) VAS(4)	INPSUM	79
C		INPSUM	80
	IF(DEEPL.GT.0.00) WRITE(6,215) DEEPL	INPSUM	81
	IF(DEEPL.EQ.0.00) WRITE(6,210)	INPSUM	82
	WRITE(6,211) VAS(5)	INPSUM	83
C		INPSUM	84

SUBROUTINE INPSUM 74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

	IF (VELREC.EQ.0.00) WRITE(6,245)	INPSUM	85
	IF (VELREC.NE.0.00) WRITE(6,240)	INPSUM	86
C		INPSUM	87
C		INPSUM	88
C		INPSUM	89
	WRITE(6,126)	INPSUM	90
	WRITE(6,127)	INPSUM	91
	WRITE(6,128) (TPO(I),I=1,4)	INPSUM	92
	WRITE(6,129) RRP	INPSUM	93
	WRITE(6,130) ELEV	INPSUM	94
C		INPSUM	95
	WRITE(6,300)	INPSUM	96
	WRITE(6,305) FCOS,PLANC,FCR	INPSUM	97
	WRITE(6,310) COSTL,PWCOS,CAPF	INPSUM	98
	WRITE(6,315) HPCST,CSSPKW,TEFF	INPSUM	99
	WRITE(6,320) CAPCHG,CCM	INPSUM	100
	WRITE(6,325) PER	INPSUM	101
	RETURN	INPSUM	102
	END	INPSUM	103

```

SUBROUTINE LIMIT(ATM,TMAX,RIMAX,TMIN,RIMIN)
C      SUBROUTINE LIMIT CALCULATES THE MAXIMUM AND MINIMUM ALLOWABLE LIMIT
C      TEMPERATURES. THE MINIMUM TEMPERATURE TO TWO DEGREES F. THE LIMIT
C      MAXIMUM TEMPERATURE IS ARBITRARILY SET EQUAL TO 2 DEG F. LIMIT
C      F LESS THAN THE BOILING POINT (THE ENTHALPY/LB OF LIMIT
C      DRY AIR HAS NO PHYSICAL MEANING FOR PARTIAL PRESSURES LIMIT
C      EQUAL TO OR EXCEEDING THE ATMOSPHERIC PRESSURE) LIMIT
C      WHICH CAN CAUSE INSTABILITIES IN SUBROUTINE T'CALC. LIMIT
C      LIMIT
C      LIMIT
C      FUNCTIONS FP, FAH, FCS AND FRI COMPUTE THE PARTIAL PRESSURE LIMIT
C      OF WATER (IN. HG.), ABSOLUTE HUMIDITY (LB OF WATER / LIMIT
C      LB OF DRY AIR), HEAT CAPACITY (BTU/DEG. F-LB OF DRY AIR) AND LIMIT
C      ENTHALPY (BTU/LB OF DRY AIR), RESPECTIVELY. LIMIT
C      FP(PH,T) = RH*29.92*(0.000203*((T - 32.)/1.8)**2
      * - 0.0118*((T - 32.)/1.8 + 1.095)
      * *EXP(- 0.000426*((T - 32.)/1.8)**2
      * + 0.0828*((T - 32.)/1.8 - 5.163)
C      FP(PH,T)=RH*EXP(17.168-9240./(T+460.))
      FAH(P,ATM)=P*18.02/((ATM*29.92-P)*28.97)
      FCS(AH)=.24+.45*AH
      FRI(CS,T,AH)=CS*T+1094.*AH
C      THE RELATIVE HUMIDITY IS SET EQUAL TO 1.
      RH = 1.
C      THE BOILING POINT IS COMPUTED.
      T = -460. -9240./(ALOG(ATM*29.92/RH)-17.168)
      TMAX = T+2.
      PMAX=FP(PH,TMAX)
      AHMAX=FAH(PMAX,ATM)
      CSMAX=FCS(AHMAX)
      RIMAX=FRI(CSMAX,TMAX,AHMAX)
C      THE MINIMUM ALLOWED TEMPERATURE IS ARBITRARILY SET EQUAL
C      TO 2 DEGREES F. AND THE CORRESPONDING VALUES OF PARTIAL
C      PRESSURE, ABSOLUTE HUMIDITY, SPECIFIC HEAT AND ENTHALPY
C      ARE COMPUTED.
      TMIN = 2.
      PMIN=FP(PH,TMIN)
      AHMIN=FAH(PMIN,ATM)
      CSMIN=FCS(AHMIN)
      PJMIN=FRI(CSMIN,TMIN,AHMIN)
      WRITE(6,10) TMAX,TMIN,RIMAX ,RIMIN
10  FORMAT('00IN SR LIMIT TMAX,TMIN,RIMAX,RIMIN=',1P4E15,5)
      RETURN
      END

```


74/74 OPT=1

FTN 4,50414

06/05/78 C

```

SUBROUTINE MTCH(GAIR,SIGMA)
C
C      SUBROUTINE MTCH CALCULATES THE MASS TRANSFER COEFFICIENT
C      AS A FUNCTION OF THE MASS FLOW RATE OF AIR THROUGH THE
C      WETTED HOTERV SURFACE
C
C      DEFINITION OF VARIABLES
C      GAIR  = MASS FLUX OF AIR THROUGH THE HEAT EXCHANGE SURFACE
C              AT THE MINIMUM FLOW AREA (LBM/HR-SQ FT)
C      SIGMA = MASS TRANSFER COEFFICIENT (BTU/HR-SQ FT-DEGREE F)
C
C      DATA A1, A2 / 0.124789, 0.615 /
C      SIGMA = A1*(GAIR**A2)
C
C      RETURN
C      END

```

SUBROUTINE NOVART(VCST,RANGE)

C		NOVART	2
C		NOVART	3
C	SUBROUTINE NOVART DETERMINES THE PERFORMANCE OF A PLANT	NOVART	4
C	DESIGNED AT A SPECIFIC AMBIENT TEMPERATURE OVER A WHOLE	NOVART	5
C	YEAR THE ROUTINE ALSO DETERMINES THE INCREMENTAL COST OF	NOVART	6
C	OPERATING THE POWER PLANT OVER THE ENTIRE YEAR	NOVART	7
C		NOVART	8
C	DEFINITION OF VARIABLES	NOVART	9
C		NOVART	10
C	CAPCHG - CAPACITY CHARGE (\$/MEGAWATT)	NOVART	11
C	CAPCST - CAPITAL COST FOR AUXILIARY POWER (\$)	NOVART	12
C	CAPF - CAPACITY FACTOR (DIMENSIONLESS)	NOVART	13
C	CCOS - COST OF THE HEAT EXCHANGER (\$)	NOVART	14
C	CLAND - COST OF THE LAND (\$)	NOVART	15
C	CONBAS - COST OF THE CONDENSER/REBOILER (\$)	NOVART	16
C	COSH - MAINTAINENCE COST (MILLS/KWH)	NOVART	17
C	CRIP - COST OF THE PIPING (\$)	NOVART	18
C	CSTCL - AUXILIARY POWER COST (MILLS/KWH)	NOVART	19
C	DELFC - INCREASED FUEL COST FOR THE PLANT (MILLS/KWH)	NOVART	20
C	FCOS - FUEL COST (\$/MM BTU)	NOVART	21
C	FCR - FIXED CHARGE RATE (DIMENSIONLESS)	NOVART	22
C	FPOW - FAN POWER (KWH)	NOVART	23
C	HRFAC1 - HEAT RATE FACTOR AT RATING CONDITION(DIMENSIONLESS)	NOVART	24
C	HRFAC2 - HEAT RATE FACTOR AT DESIGN CONDITIONS (DIMENSION-	NOVART	25
C	LESS)	NOVART	26
C	HRFAC4 - HEAT RATE FACTOR AT OFF DESIGN CONDITIONS	NOVART	27
C	(DIMENSIONLESS)	NOVART	28
C	NTA - NUMBER OF TEMPERATURE INCREMENTS IN THE TEMPERATURE	NOVART	29
C	RANGE OF THE SITE	NOVART	30
C	P - BACK PRESSURE OF THE TURRINE (IN HGA)	NOVART	31
C	PARCOS - INCREMENTAL POWER PRODUCTION COST AT THE AMBIENT	NOVART	32
C	TEMPERATURE (MILLS/KWH)	NOVART	33
C	PGEN - POWER GENERATING BY THE PLANT (MEGAWATTS)	NOVART	34
C	PPOW - PUMP POWER (KWH)	NOVART	35
C	PSIZE - PLANT SIZE (MEGAWATTS)	NOVART	36
C	PSI713 - TOTAL POWER OUTPUT OF PLANT AT DESIGN	NOVART	37
C	CONDITIONS (MEGAWATTS)	NOVART	38
C	PTOT - TOTAL POWER OUTPUT OF PLANT AT OFF DESIGN	NOVART	39
C	CONDITIONS (MEGAWATTS)	NOVART	40
C	PWCOS - REPLACEMENT POWER COST (MILLS/KWH)	NOVART	41
C	P22 - AMMONIA PRESSURE AT THE HEAT EXCHANGER (LBF/SQ FT)	NOVART	42
C	QIN1 - HEAT INPUT INTO THE POWER PLANT (BTU/HR)	NOVART	43
C	QREJCT1 - HEAT REJECTED AT THE DESIGN CONDITIONS OF THE PLANT	NOVART	44
C	(BTU/HR)	NOVART	45
C	QREJCT2 - HEAT REJECTED AT THE OFF DESIGN CONDITIONS OF THE	NOVART	46
C	PLANT (BTU/HR)	NOVART	47
C	SPCD - DIFFERENTIAL COST OF PLANT EXCLUDING THE COOLING	NOVART	48
C	SYSTEM (\$)	NOVART	49
C	TEFF - BASE THERMAL EFFICIENCY OF THE PLANT(DIMENSIONLESS)	NOVART	50
C	TEFF1 - RATED THERMAL EFFICIENCY OF THE PLANT	NOVART	51
C	(DIMENSIONLESS)	NOVART	52
C	TEFF3 - DESIGN THERMAL EFFICIENCY OF THE PLANT	NOVART	53
C	(DIMENSIONLESS)	NOVART	54
C	TEFF4 - OFF DESIGN THERMAL EFFICIENCY OF THE PLANT	NOVART	55
C	(DIMENSIONLESS)	NOVART	56
C	TPER - FRACTION OF THE YEAR THAT THE CORRESPONDING	NOVART	57
C	AMBIENT TEMPERATURE EXISTS (DIMENSIONLESS)	NOVART	58

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	VCST	- INCREMENTAL INCREASE IN COST OF THE POWER PRODUCED	NOVART	59
C		BY THE OPTIMUM POWER PLANT DUE TO THE COOLING	NOVART	60
C		SYSTEM (MILLS/KWH)	NOVART	61
C	YFP	- PLANT SCALING FACTOR FOR FAN AND PUMP POWER LOSS	NOVART	62
C		(DIMENSIONLESS)	NOVART	63
C			NOVART	64
C	DEFINITION OF ARRAYS		NOVART	65
C	PWD	- WET/DRY BACK PRESSURE CURVE FOR THE AMBIENT	NOVART	66
C		TEMPERATURE RANGE (IN HGA)	NOVART	67
C	TPO	- ARRAY OF COEFFICIENTS FOR THE CUBIC CURVE FIT OF	NOVART	68
C		HEAT RATE FACTOR AS A FUNCTION OF TURBINE BACK	NOVART	69
C		PRESSURE (DIMENSIONLESS)	NOVART	70
C	VTPER	- FRACTION OF THE YEAR THAT THE AMBIENT AND WET BULB	NOVART	71
C		TEMPERATURE INCREMENTS EXIST (DIMENSIONLESS)	NOVART	72
	COMMON /VARVAR/	VTPER(16), VTA(16), VTAWB(16)	NOVART	73
	COMMON /PROP/	CPW, THCONW, DENS1W, VISW, HFG,	NOVART	74
		CPV, THCONV, DENSIV, VISV, SIGMA,	NOVART	75
		CPA, THCONA, DENSIA, VISA	NOVART	76
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG		BIGCOM	2
	COMMON		BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)		BIGCOM	4
	\$,BOLIM(16)		BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	6
	\$,CRJ, CTURB, CDANG, CLUVR, CHA1LS, CVM		BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	8
	\$,EFPF, EFS		BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG		BIGCOM	10
	\$,FIXV,FXTTID,FXTVAR,FXTTID,FXTLNG		BIGCOM	11
	\$,GBEFF		BIGCOM	12
	\$,HXNP,HPCST,HCD		BIGCOM	13
	\$,ITMAX, ITMIN		BIGCOM	14
	\$,JCONS		BIGCOM	15
	\$,KCONV, KALEXT		BIGCOM	16
	\$,MXEXT		BIGCOM	17
	\$,NTA,NSIDES,NBUNHI		BIGCOM	18
	COMMON		BIGCOM	19
	\$,ODR		BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL		BIGCOM	21
	\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL		BIGCOM	22
	\$,RBP,REDUCE, REDUCV, ROOFL, RHOUT		BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV		BIGCOM	24
	\$,SIGMAG, SAAF, SEGL		BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPA, TFIX		BIGCOM	26
	\$,TCD, TW		BIGCOM	27
	\$,UCS, UWS		BIGCOM	28
	\$,WFEV, WATCONA, WATCOST		BIGCOM	29
	\$,VAS(5)		BIGCOM	30
	\$,XDEPA, XW, XD		BIGCOM	31
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,		SUPPLY	2
	\$,GIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,		SUPPLY	3
	\$,FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,		SUPPLY	4
	\$,DEWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,		SUPPLY	5
	\$,SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,		SUPPLY	6
	\$,RP2, NW2, TCOS, DELPA,DELPAW,DELPAWC,CONBAS, XNTSX, VELDX		SUPPLY	7
	\$,TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS		SUPPLY	8
	\$,CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELP1P, AST,OLDCST		SUPPLY	9
	\$,CAPCST, XNFAN,BLDANG, CPLEN, DPFL, WHX, WTTUR, ADIA, ABLN		SUPPLY	10

S.	WTHDR, WTRFM, STRUCC, CPERF, HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY	11
S.	AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY	12
S.	ACTRPD, ADJRPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13
S.	CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14
S.	SQRJ, SQRJS, ATUBC, CRA, TTD1, TTD2, DELPS, CSTLVR, PIPCSTD	SUPPLY	15
S.	CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY	16
S.	PWD(16), WATCWD(16), DEPER(16), DEPERQ(16)	SUPPLY	17
S.	WRB, HTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5	SUPPLY	18
COMMON	/SCALER, HRFAC1, ATUB, CPERA, SSCD, PLANCI, CASSS1,	SCALER	2
S.	GAIR, FAIR, HPAIR, HPWAT, WLRT, PLANCT1	SCALER	3
COMMON	/TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINDR, XNP, XQUALY	NOVART	80
	DIENSION VLIST(9), XCOST(16)	NOVART	81
	DATA NTRIP/0/	NOVART	82
	DATA VLIST /"CCOS", "SPCD", "CLAND", "CPIP", "CDNRAS", "COSM"	NOVART	83
	S, "TPER", "PARCOS", "VCST"/	NOVART	84
C		NOVART	85
C	DESIGN THERMAL EFFECTIVENESS OF THE POWER PLANT	NOVART	86
	TEFF3=TEFF/HRFAC2	NOVART	87
C		NOVART	88
C	RATED THERMAL EFFECTIVENESS OF THE POWER PLANT	NOVART	89
	TEFF1 = TEFF/HRFAC1	NOVART	90
C		NOVART	91
C	HEAT INPUT INTO THE POWER PLANT	NOVART	92
	QIN1 = 3413.E+3*PSIZ13/TEFF1	NOVART	93
	VCST = 0.0	NOVART	94
C		NOVART	95
C	LOOP TO FIND THE INCREMENTAL COST OF THE COOLING SYSTEM	NOVART	96
C		NOVART	97
	DO 400 I = 1, NTA	NOVART	98
C		NOVART	99
C	PERCENT OF THE YEAR AT THE ABOVE AMBIENT TEMPERATURE	NOVART	100
	TPER = VTPER(I)	NOVART	101
C	BACK PRESSURE AT THE AMBIENT TEMPERATURE	NOVART	102
	P = PWD(I)	NOVART	103
C		NOVART	104
C	HEAT RATE FACTOR AT THE ABOVE BACK PRESSURE	NOVART	105
	HRFAC4 = TPO(1) + TPO(2)*P + TPO(3)*P**2 + TPO(4)*P**3	NOVART	106
C		NOVART	107
C	THERMAL EFFECTIVENESS OF THE PLANT AT THE ABOVE BACK	NOVART	108
C	PRESSURE	NOVART	109
	TEFF4 = TEFF/HRFAC4	NOVART	110
C		NOVART	111
C	HEAT REJECTED AT THE ABOVE THERMAL EFFECTIVENESS OF THE	NOVART	112
C	POWER PLANT	NOVART	113
	QREJCT2 = QIN1*(1. - TEFF4)	NOVART	114
C		NOVART	115
C	HEAT REJECTED AT THE DESIGN THERMAL EFFECTIVENESS OF	NOVART	116
C	THE POWER PLANT	NOVART	117
	QREJCT1 = QIN1*(1. - TEFF3)	NOVART	118
	SQRJS = QREJCT1	NOVART	119
C		NOVART	120
C	POWER OUTPUT OF THE LOW-PRESSURE TURBINE AT THE SPECIFIC	NOVART	121
C	AMBIENT TEMPERATURE	NOVART	122
	40 PYOT = QIN1 * TEFF4/3413.E+3	NOVART	123
C		NOVART	124
C	POWER OUTPUT OF THE PLANT AT THE SPECIFIC AMBIENT TEM-	NOVART	125
C	PERATURE	NOVART	126

PGEN=PTOT-PPOW/1000.-FPOW/1000.	NOVART	127
TEFFD=TEFF4	NOVART	128
IF(PGEN.GE.PSIZE) GO TO 50	NOVART	129
C	NOVART	130
C COST OF THE AUXILIARY POWER REQUIRED TO MAKE UP FOR LOST	NOVART	131
C CAPACITY ON HOT DAYS	NOVART	132
CSTCL=(PSIZE-PGEN)/PSIZE*PWCOS	NOVART	133
TEFFD=TEFF3	NOVART	134
GO TO 60	NOVART	135
50 CSTCL = 0.0	NOVART	136
C	NOVART	137
C INCREASED FUEL COST OF THE PLANT DUE TO OFF DESIGN	NOVART	138
C CONDITIONS	NOVART	139
60 DELFC = FCOS*3413.E-5 * ((1.+YFP)/TEFFD-1./TEFF)	NOVART	140
IF(T.NF.1) GO TO 100	NOVART	141
CAPCST = 0.0	NOVART	142
C	NOVART	143
IF(PSIZE.LE.PGEN) GO TO 100	NOVART	144
C	NOVART	145
C CAPITAL CHARGE FOR THE AUXILIARY POWER	NOVART	146
CAPCST=CAPCHG*(PSIZE-PGEN)	NOVART	147
100 CONTINUE	NOVART	148
C	NOVART	149
C INCREASE IN COST OF OPERATING THE PLANT AT THIS AMBIENT	NOVART	150
C TEMPERATURE DUE TO THE USE OF THE COOLING SYSTEM	NOVART	151
C	NOVART	152
PARCOS = (CCOS + SPCD + CLAND + CPIP + CONBAS + CAPCST) * FCR/	NOVART	153
\$ (PSIZE * CAPF * 8760.) + COSM * DELFC + CSTCL	NOVART	154
\$ * WATCONA*(.1203/1000.)=WATCOST/(PSIZE*CAPF*8760.)	NOVART	155
C	NOVART	156
C FRACTION OF THE YEAR THAT THIS AMBIENT TEMPERATURE EXISTS	NOVART	157
C TIMES THE INCREMENTAL COST OF THE COOLING SYSTEM AT	NOVART	158
C THIS AMBIENT TEMPERATURE	NOVART	159
XCOST(I)=TPER*PARCOS	NOVART	160
800 CONTINUE	NOVART	161
C	NOVART	162
C SUMMING THE PRODUCTS TO OBTAIN THE TOTAL INCREMENTAL COST	NOVART	163
C OF THE COOLING SYSTEM	NOVART	164
DO 820 I=1,NTA	NOVART	165
VCST=VCST+XCOST(I)	NOVART	166
820 CONTINUE	NOVART	167
C	NOVART	168
NDEBUG=0	NOVART	169
IF(NDEBUG.EQ.0) RETURN	NOVART	170
NTRIP=NTRIP+1	NOVART	171
WRITE(6,902) NTRIP	NOVART	172
WRITE(6,900) CCOS,SPCD,CLAND,CPIP,CONBAS,COSM,TPER,PARCOS,VCST	NOVART	173
WRITE(6,901) VLIST	NOVART	174
900 FORMAT(1H ,9G14.6)	NOVART	175
901 FORMAT(1H ,9(4X,A6,4X))	NOVART	176
902 FORMAT("NOVART CALL NO.",I10)	NOVART	177
RETURN	NOVART	178
END		

SUBROUTINE OUT2

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

	SUBROUTINE OUT2(RBP,HRFAC1,SSCD,CASSS1,PLANCT1,PLANC1,CTURE,TCD)	OUT2	2
C		OUT2	3
C	THIS ROUTINE REPORTS STEAM SUPPLY COSTS DUE TO INCREASED HEAT RATE	OUT2	4
C	AT RATING BACKPRESSURE.	OUT2	5
C		OUT2	6
	1 FORMAT(1H0,T3,"STEAM SUPPLY SCALING TO COMPENSATE FOR INCREASED ",	OUT2	7
	\$ "HEAT RATE AT RATING BACKPRESSURE. RBP=",F5.2,T97,"IN. HG",	OUT2	8
	\$ T113,"HRFAC1=",F11.6)	OUT2	9
	2 FORMAT(T17,"STEAM SUPPLY COST DIFFERENTIAL \$",F12.0	OUT2	10
	\$,T91,"TURBINE COST DIFFERENTIAL",F11.0,T128,"\$/KW")	OUT2	11
	3 FORMAT(T2,"PLANT COST INCLUDING STEAM SUPPLY AND TURBINE \$",F12.0	OUT2	12
	\$,T66,"PLANT UNIT COST INCLUDING STEAM SUPPLY AND TURBINE",F11.0	OUT2	13
	\$,T128,"\$")	OUT2	14
	WRITE(6,1) RBP,HRFAC1	OUT2	15
	WRITE(6,2) SSCD, TCD	OUT2	16
	WRITE(6,3) PLANCT1,PLANC1	OUT2	17
	RETURN	OUT2	18
	END	OUT2	19

```

C      SUBROUTINE OUT4(KWHICH)
C
C      WHEN CALLED WITH KWHICH = 1 THIS ROUTINE REPORTS CONDITIONS AFTER
C      SCALING PLANT AND STEAM SUPPLY BUT RE-
C      FORE SCALING FOR FANS AND PUMPS
C
C      WHEN CALLED WITH KWHICH NOT 1 THE ROUTINE REPORTS CONDITIONS AFTER
C      SCALING FOR FANS AND PUMPS
C
C      LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG
C      COMMON
C      $ AFTR, ALPHA, ANG(3)
C      $ BPLIM(16)
C      $ CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2, CAF
C      $ CRJ, CTURB, CDANG, CLUVR, CHAHS, CVM
C      $ DFIN, DEEPL, DESVEL, DESVELV, DESVELD, DENSIF
C      $ EFFF, EFS
C      $ FCR, FIRST, FIXL, FCOS, FFHX, FXTMP, FACTOR, FRST, FACTORD, FSHOT, FDELJG
C      $ FIXV, FIXTDD, FXTVAR, FXTTDD, FXTLNG
C      $ GREFF
C      $ HXNP, HPCST, HCD
C      $ ITMAX, ITMIN
C      $ JCONS
C      $ KCONV, KALEXT
C      $ MXEXT
C      $ NTA, NSJDES, NBUNHI
C      COMMON
C      $ ODR
C      $ PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL
C      $ POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POMSCL
C      $ RBP, REDUCE, REDUCV, ROOFL, RHOUT
C      $ QREJ, QREDUCE, QREDUCV
C      $ SIGMAG, SAAF, SEGL
C      $ TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX
C      $ TCD, TW
C      $ UCS, UWS
C      $ WFV, WATCONA, WATCOST
C      $ VAS(5)
C      $ XDEPA, XW, XD
C      COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF, SUPPLY
C      $ GIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW, SUPPLY
C      $ PPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4, SUPPLY
C      $ REWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3, SUPPLY
C      $ SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2, SUPPLY
C      $ BP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTSX, VELDX SUPPLY
C      $ TLAX, UCON, PMCST, FMCST, FBACC, EFFF, CH, CA, CS SUPPLY
C      $ CLTC, CFC, CPCC, FITCO, CSC, CEPREP, DELPIP, AST, OLD CST SUPPLY
C      $ CAPCST, XNFAN, BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN SUPPLY
C      $ WTHDR, WTFRM, STRUCC, CFPERF, HPPERF, TOTCF, TPC, EFFIN, ANTU SUPPLY
C      $ AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP SUPPLY
C      $ ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY
C      $ CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD SUPPLY
C      $ SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPSTD SUPPLY
C      $ CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST SUPPLY
C      $ PWD(16), WATCWD(16), DEPER(16), DEPERQ(16) SUPPLY
C      $ WBB, HTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5 SUPPLY
C      COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1, SINK
C      $ GIN1, CLAN1, REAIR1, Z1, HRFAC2S, W41, U1, DEPW1, PPOW1, SINK

```

```

$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41, SINK 4
$ RFWA1, NW1, NT1, NP1, ZPLNC2, ZSIZ12, ZSPRP, SW41, SW31, SINK 5
$ SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SPS13, WT2MIN, SINK 6
$ BP2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBA1, XNTS1, VELD1 SINK 7
$ , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITC01, CSC1, CEPRE1, DEPI1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFE1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTRF1, STRUC1, CFMPF1, HPPF1, TOTCF1, TP1, EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRC1, CFOUND1, HUBD11, TOWLE1, NUMT01, CTOWD1 SINK 14
$ , SQPJ1, SQJUS1, ATUBC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTD1 SINK 15
$ , CSTHS1, CYLRN1, CFANEL, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCWD1(16), DEPER1(16), DEPERQ1(16) SINK 17
$ , WBR1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51 SINK 18
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD, PLANC1, CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANCT1 SCALER 3
COMMON /DJB/ DI, XDG, SF OUT4 14
901 FORMAT(' CONDITIONS AFTER SCALING PLANT AND STEAM SUPPLY (BEFORE OUT4 15
*SCALING FOR FANS AND PUMPS)', T88, 'HRFAC2=', G15.7) OUT4 16
906 FORMAT(1X, T88, 'PSIZ12=', G15.7, ' MW') OUT4 17
911 FORMAT(1X, T88, 'PLANC2=', G15.7, ' $/KW') OUT4 18
916 FORMAT(1X, T88, ' SPBP=', G15.9, ' $') OUT4 19
917 FORMAT(1X, T81, 'BACK PRESSURE=', G15.7, ' IN, HG') OUT4 20
918 FORMAT(1X, T79, 'SAT TEMPERATURE=', G15.9, ' DEG F') OUT4 21
921 FORMAT(1X, T12, 'AMMONIA FLOW RATE ', G15.9, ' LB MASS / HR') OUT4 22
923 FORMAT(1X, T14, ' HEAT REJECTED ', G15.9, ' BTU/HR') OUT4 23
926 FORMAT(1X, T14, 'AIR FLOW RATE ', G15.9, ' LB MASS / HR') OUT4 24
931 FORMAT(1X, T14, ' PUMP POWER ', G15.9, ' KILOWATTS') OUT4 25
936 FORMAT(1X, T14, ' FAN POWER ', G15.9, ' KILOWATTS') OUT4 26
941 FORMAT(1X, T14, 'HX SURFACE AREA ', G15.9, ' SQ FT') OUT4 27
946 FORMAT(1X, T14, ' FRONTAL AREA ', G15.9, ' SQ FT') OUT4 28
951 FORMAT(1X, T11, 'WIDTH/LENGTH RATIO ', G15.9) OUT4 29
956 FORMAT(1X, T15, ' WIDTH ', I11, T45, ' TUBES') OUT4 30
961 FORMAT(1X, T15, ' WIDTH ', G15.9, ' FEET') OUT4 31
962 FORMAT(1X, T9, 'NO. CONDENSER TUBES ', G15.9) OUT4 32
963 FORMAT(1X, T8, 'CONDENSER TUBE LENGTH ', G15.9, ' FT.') OUT4 33
964 FORMAT(1X, T13, 'AMMONIA VELOCITY ', G15.9, ' FT/SEC') OUT4 34
965 FORMAT(1X, T7, 'CONDENSER HT TRFR AREA ', G15.9, ' SQ FT TOTAL') OUT4 35
1001 FORMAT(1X, 'SCALING FOR FAN AND PUMP POWER REQUIREMENTS', OUT4 36
* T80, 'SCALING FACTOR ', G15.9) OUT4 37
1005 FORMAT(1X, T88, ' PSIZE ', G15.9, ' MW') OUT4 38
1006 FORMAT(1X, T88, 'PSIZ13 ', G15.9, ' MW') OUT4 39
1011 FORMAT(1X, T88, 'PTOTAL ', G15.9, ' MW') OUT4 40
1016 FORMAT(1X, T88, 'PLANC3 ', G15.9, ' $/KW') OUT4 41
1021 FORMAT(1X, T88, ' SPC ', G15.9, ' $') OUT4 42
1026 FORMAT(1X, T88, ' SPCD ', G15.9, ' $') OUT4 43
8888 FORMAT(1H0, I2(' ** ** ** '))// OUT4 44
WRITE(6, 8888) OUT4 45
WL RTP = WIDT1/ELEN1 OUT4 46
IF(KWHICH.NE.1) GOTO 2000 OUT4 47
WRITE(6, 901) HRFAC2S OUT4 48
WRITE(6, 906) ZSIZ12 OUT4 49
WRITE(6, 911) ZPLNC2 OUT4 50
WRITE(6, 916) ZSPBP OUT4 51
WRITE(6, 917) BP2MIN OUT4 52
WRITE(6, 918) VAR(1) OUT4 53

```


SUBROUTINE OUT4

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

WRITE(6,921) W31	OUT4	54
WRITE(6,923) SQRJ1	OUT4	55
WRITE(6,926) W41	OUT4	56
WRITE(6,931) (PPOW1/(1.+YFPMIN))	OUT4	57
WRITE(6,936) (FPOW1/(1.+YFPMIN))	OUT4	58
WRITE(6,941) (AAIR1/(1.+YFPMIN))	OUT4	59
WRITE(6,946) (AFRO1/(1.+YFPMIN))	OUT4	60
WRITE(6,951) WL RTP/(1.+YFPMIN)	OUT4	61
WRITE(6,956) NW2MIN	OUT4	62
WRITE(6,961) WT2MIN	OUT4	63
WRITE(6,965) AST1	OUT4	64
WRITE(6,962) XNTS1	OUT4	65
WRITE(6,963) TLA1	OUT4	66
WRITE(6,964) VELD1	OUT4	67
RETURN	OUT4	68
2000 CONTINUE	OUT4	69
WRITE(6,1001) (1.+YFPMIN)	OUT4	70
WRITE(6,1005) PSIZE	OUT4	71
WRITE(6,1006) SPS13	OUT4	72
WRITE(6,1011) PTOT1	OUT4	73
WRITE(6,1016) PLNC31	OUT4	74
WRITE(6,1021) SPC1	OUT4	75
WRITE(6,1026) SPCD1	OUT4	76
WRITE(6,921) SW31	OUT4	77
WRITE(6,923) SQRJS1	OUT4	78
WRITE(6,926) SW41	OUT4	79
WRITE(6,931) PPOW1	OUT4	80
WRITE(6,936) FPOW1	OUT4	81
WRITE(6,941) AAIR1	OUT4	82
WRITE(6,946) AFRO1	OUT4	83
WRITE(6,951) WL RTP	OUT4	84
WRITE(6,956) NW1	OUT4	85
WRITE(6,961) WIDT1	OUT4	86
WRITE(6,965) AST1 * (1. + YFPMIN)	OUT4	87
WRITE(6,962) XNTS1 * (1. + YFPMIN)	OUT4	88
WRITE(6,963) TLA1	OUT4	89
WRITE(6,964) VELD1	OUT4	90
RETURN	OUT4	91
END	OUT4	92

	DATA DIAM /	PIPCLR 173
	\$ 6. , 12. , 18. , 24. , 30. , 36. ,	PIPCLR 174
	\$ 42. , 48. , 54. , 60. , 66. , 72. ,	PIPCLR 175
	\$ 78. , 84. , 90. , 96. , 102. , 108. ,	PIPCLR 176
	\$ 114. , 120. , 126. , 132. , 138. , 144. /	PIPCLR 177
C		PIPCLR 178
	DATA FLGCST/	PIPCLR 179
	\$.136, .520, 1.03 , 1.92 , 3.17 , 4.42 ,	PIPCLR 180
	\$ 6.82 , 9.22 , 12.0 , 14.7 , 21.1 , 27.5 ,	PIPCLR 181
	\$ 33.9 , 40.4 , 46.8 , 53.2 , 59.7 , 66.1 ,	PIPCLR 182
	\$ 72.5 , 78.9 , 85.4 , 91.8 , 98.2 , 105. /	PIPCLR 183
C		PIPCLR 184
	DATA TEECST/	PIPCLR 185
	\$.344, .935, 1.96 , 3.82 , 14.8 , 25.8 ,	PIPCLR 186
	\$ 31.7 , 37.6 , 53.4 , 69.1 , 87.9 , 107. ,	PIPCLR 187
	\$ 126. , 145. , 163. , 182. , 201. , 220. ,	PIPCLR 188
	\$ 239. , 258. , 277. , 296. , 314. , 333. /	PIPCLR 189
C		PIPCLR 190
	DATA PIPCST/	PIPCLR 191
	\$.06, .113, .147, .219, .409, .599,	PIPCLR 192
	\$.720, .841, 1.08 , 1.31 , 1.57 , 1.84 ,	PIPCLR 193
	\$ 2.10 , 2.36 , 2.62 , 2.88 , 3.15 , 3.41 ,	PIPCLR 194
	\$ 3.67 , 3.93 , 4.19 , 4.46 , 4.72 , 4.95 /	PIPCLR 195
C		PIPCLR 196
	DATA VACST/	PIPCLR 197
	\$ 2.87 , 7.09 , 16.9 , 26.7 , 52.2 , 77.8 ,	PIPCLR 198
	\$ 109. , 141. , 164. , 187. , 213. , 240. ,	PIPCLR 199
	\$ 265. , 293. , 319. , 346. , 372. , 399. ,	PIPCLR 200
	\$ 425. , 452. , 478. , 505. , 531. , 558. /	PIPCLR 201
C		PIPCLR 202
	DATA ELCST/	PIPCLR 203
	\$.275, .715, 1.35 , 2.94 , 9.54 , 16.1 ,	PIPCLR 204
	\$ 27.4 , 38.8 , 51.9 , 65.1 , 87.6 , 110. ,	PIPCLR 205
	\$ 133. , 155. , 178. , 200. , 222. , 245. ,	PIPCLR 206
	\$ 268. , 290. , 312. , 335. , 357. , 380. /	PIPCLR 207
C		PIPCLR 208
	DATA EL45/	PIPCLR 209
	\$.230, .558, .947, 2.16 , 7.67 , 13.2 ,	PIPCLR 210
	\$ 20.2 , 27.2 , 37.7 , 48.1 , 66.2 , 84.3 ,	PIPCLR 211
	\$ 102. , 120. , 138. , 157. , 175. , 193. ,	PIPCLR 212
	\$ 211. , 229. , 247. , 265. , 283. , 301. /	PIPCLR 213
C		PIPCLR 214
	DATA APIPCST/	PIPCLR 215
	\$.034 , .073 , .096 , .155, .332, .510,	PIPCLR 216
	\$.614, .719, .939, 1.16 , 1.41 , 1.67 ,	PIPCLR 217
	\$ 1.91 , 2.16 , 2.41 , 2.66 , 2.99 , 3.16 ,	PIPCLR 218
	\$ 3.41 , 3.66 , 3.91 , 4.16 , 4.42 , 4.67 /	PIPCLR 219
	DATA NFS,NFL /200,200/	PIPCLR 220
C		PIPCLR 221
	ICHORD=NSIDES/4	PIPCLR 222
	IF(ICHORD.EQ.0) ICHORD = 2	PIPCLR 223
	ICHECK = ICHORD/2	PIPCLR 224
	IF(2*ICHECK=ICHORD.LT.0) ICHORD = ICHORD+1	PIPCLR 225
	IF(ICHORD.LE.0) STOP "IN PIPCLR ICHORD .LE. ZERO"	PIPCLR 226
	NRUNPQD=ICHORD*NBUNHI	PIPCLR 227
	NRUN=NRUNPQD	PIPCLR 228
	IF(NRUNPQD.LE.0) STOP "IN PIPCLR NRUNPQD IS ZERO OR LESS"	PIPCLR 229

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C		(\$1000)	PIPCLR	116
C	TCST	- TEE COST (\$1000)	PIPCLR	117
C	THITE	- HEIGHT OF TOWER (FEET)	PIPCLR	118
C	TOWDIA	- DIAMETER OF CIRCULAR TOWER (FT)	PIPCLR	119
C	TRQCOST	- TOTAL RETURN QUADRANT PIPING COSTS (\$1000)	PIPCLR	120
C	TRTDCST	- TOTAL RETURN DISTRIBUTION AND TOWER PIPING COSTS (\$1000)	PIPCLR	121
C			PIPCLR	122
C	TUBEL	- LENGTH OF HEAT EXCHANGER TUBES (FEET)	PIPCLR	123
C	UPCST	- UNIT PIPE COST (\$1000/FT)	PIPCLR	124
C	UPPPCST	- UNIT PIPE COST FOR EXTERIOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLR	125
C			PIPCLR	126
C	UPVPCST	- UNIT PIPE COST FOR INTERIOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLR	127
C			PIPCLR	128
C	VACST	- VALVE COST (\$1000), VALVES ARE MOTOR OPERATED BUTTERFLY VALVES	PIPCLR	129
C			PIPCLR	130
C	VEJCS	- COST OF AN EXPANSION JOINT IN THE INTERIOR VERTICAL QUADRANT PIPING (\$1000)	PIPCLR	131
C			PIPCLR	132
C	VELO	- FLUID VELOCITY BASED ON FLOW RATE AND NOMINAL PIPE DIAMETER (FT/SEC)	PIPCLR	133
C			PIPCLR	134
C	VFLGCST	- COST OF FLANGE FOR THE INTERIOR VERTICAL QUADRANT PIPING (\$1000)	PIPCLR	135
C			PIPCLR	136
C	VHEDR	- LENGTH OF INTERIOR VERTICAL QUADRANT HEADER (FEET)	PIPCLR	137
C	VISW	- VISCOSITY OF LIQUID AMMONIA (LBM/FT HR)	PIPCLR	138
C	VREDUCR	- ALLOWABLE REDUCTION DIAMETER BETWEEN ADJACENT QUADRANT HEADER SECTIONS (\$1000)	PIPCLR	139
C			PIPCLR	140
C			PIPCLR	141
	COMMON/PROP/CPW,THCONW,DENSIW,VISW,HFG,		PIPCLR	142
	\$ CPV,THCONV,DENSIV,VISV,SIGMA,		PIPCLR	143
	\$ CPA,THCONA,DENSIA,VISA		PIPCLR	144
	COMMON /RPTRET/		PIPCLR	145
	\$ SDELL, SOESVE, DIARD, DIART, SDOOMA, DYNHDL		PIPCLR	146
	\$, HEDR(200)		PIPCLR	147
	\$, JR		PIPCLR	148
	\$, KR		PIPCLR	149
	\$, SPIPCS		PIPCLR	150
	\$, QHEDR(200), QRLCST		PIPCLR	151
	\$, RDIA(200), RPCST(200), RRCST(200), RTCST(200), RBFCST, RCOST		PIPCLR	152
	\$, RQDIA(200), RQPCST(200), RQRCST(200), RQTCST(200), REJCS, RELCST		PIPCLR	153
	\$, RFLGCST, RQCOST, RTDCST		PIPCLR	154
	\$, STOWDI, TRQCOST, TRTDCST		PIPCLR	155
C			PIPCLR	156
	COMMON /PCDIM/ NFS,NFL		PIPCLR	157
	COMMON /PME/ PMELEC		PIPCLR	158
	COMMON /QPTRET/		PIPCLR	159
	\$ RPDIA(200), RVDIA(200), LR		PIPCLR	160
	\$, PHEDR(200), VHEDR(200)		PIPCLR	161
	\$, RPRCST(200), RVRCST(200)		PIPCLR	162
	\$, RPTCST(200), RVTCT(200)		PIPCLR	163
	\$, PRLCST, VRLCST		PIPCLR	164
	\$, RPPCST(200), RVPCST(200)		PIPCLR	165
	\$, RRCOST, RVCOST		PIPCLR	166
	\$, INT, NRUN		PIPCLR	167
	DIMENSION UPPPCST(200), UPVPCST(200)		PIPCLR	168
	DIMENSION UPIPCST(200)		PIPCLR	169
	DIMENSION DIAM(24), TEECST(24), PIPCST(24), ELCST(24), EL45(24)		PIPCLR	170
	\$, VACST(24), FLGCST(24), APIPCST(24)		PIPCLR	171
C			PIPCLR	172

C	KP	- IDENTIFIES QUADRANT HEADER SECTION	PIPCLR	59
C	LAYER	- NUMBER OF TUBE BUNDLE LAYERS PER TOWER	PIPCLR	60
C	LR	- IDENTIFIES VERTICAL QUADRANT HEADER SECTION	PIPCLR	61
C	NBUNPQD	- NUMBER OF BUNDLES PER QUADRANT	PIPCLR	62
C	NFL	- UPPER LIMIT TO NUMBER OF TUBE BUNDLES PER QUADRANT	PIPCLR	63
C	NFS	- UPPER LIMIT TO NUMBER OF CIRCULAR TOWERS	PIPCLR	64
C	NPS	- UPPER LIMIT OF THE NUMBER OF TOWER LAYERS	PIPCLR	65
C	NQS	- UPPER LIMIT OF THE NUMBER OF CHORDS PER QUADRANT	PIPCLR	66
C	NRLPQ	- NUMBER OF RETURN LINES PER QUADRANT	PIPCLR	67
C	PEJCST	- COST OF AN EXPANSION JOINT IN EXTERIOR VERTICAL QUADRANT PIPING (\$1000)	PIPCLR	68
C	PFLGCST	- COST OF FLANGE VERTICAL QUADRANT PIPING (\$1000)	PIPCLR	69
C	PHEDR	- LENGTH OF VERTICAL QUADRANT HEADER SECTION (FT)	PIPCLR	70
C	PIPCST	- BELOW GROUND PIPE COST (\$1000/FT)	PIPCLR	71
C	PIPCSTL	- TOTAL CIRCULATION RETURN PIPING COST (\$1000)	PIPCLR	72
C	POHCIR	- INDIRECT COST FACTOR FOR CIRCULATION PIPING	PIPCLR	73
C	PREDUCR	- ALLOWABLE REDUCTION IN DIAMETER BETWEEN ADJACENT QUADRANT HEADER SECTIONS (INCHES)	PIPCLR	74
C	PRLCST	- COST OF 90 DEGREE ELBOW AT END OF QUADRANT HEADER (\$1000)	PIPCLR	75
C	QHEDR	- LENGTH OF QUADRANT HEADER SECTION (FT)	PIPCLR	76
C	QREDUCR	- ALLOWABLE REDUCTION IN DIAMETER BETWEEN ADJACENT QUADRANT HEADER SECTIONS (INCHES)	PIPCLR	77
C	QRLCST	- COST OF 90 DEG ELBOW AT END OF QUADRANT HEADER (\$1000)	PIPCLR	78
C	RHFCST	- COST OF BUNDLE FITTINGS (\$1000)	PIPCLR	79
C	RCOST	- COST OF MAIN CIRCULATION PIPING (\$1000)	PIPCLR	80
C	RCST	- REDUCER COST (\$1000)	PIPCLR	81
C	REDUCR	- ALLOWABLE REDUCTION IN DIAMETER BETWEEN ADJACENT MAIN CIRCULATION HEADER SECTIONS (INCHES)	PIPCLR	82
C	REJCST	- COST OF EXPANSION JOINT AT CONDENSER/REBOILER INLET (\$1000)	PIPCLR	83
C	RELCST	- COST OF 90 DEG ELBOW AT END OF MAIN CIRCULATION HEADER (\$1000)	PIPCLR	84
C	PFLGCST	- TOTAL COST OF APPROPRIATE FLANGES AT CONDENSER/REBOILER INLET (\$1000)	PIPCLR	85
C	RHO	- DENSITY OF AMMONIA LIQUID (LBM/CUFT)	PIPCLR	86
C	RPCST	- COST OF PIPE FOR MAIN CIRCULATION HEADER (\$1000)	PIPCLR	87
C	RPDIA	- COMPONENT DIAMETER OF EXTERIOR VERTICAL QUADRANT HEADER SECTION (INCHES)	PIPCLR	88
C	RPRCST	- COST OF REDUCER FOR EXTERIOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLR	89
C	RPTCST	- COST OF TEE FOR EXTERIOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLR	90
C	RQCOST	- COST OF QUADRANT PIPING (\$1000)	PIPCLR	91
C	RQDIA	- COMPONENT DIAMETER OF QUADRANT HEADER SECTION (INCHES)	PIPCLR	92
C	RQPCST	- COST OF PIPE FOR QUADRANT HEADER (\$1000)	PIPCLR	93
C	RQRCST	- COST OF REDUCER FOR QUADRANT HEADER (\$1000)	PIPCLR	94
C	RRCST	- COST OF REDUCER IN MAIN CIRCULATION HEADER (\$1000)	PIPCLR	95
C	RTCST	- COST OF TEE IN MAIN CIRCULATION HEADER (\$1000)	PIPCLR	96
C	RTDCST	- COST OF DISTRIBUTION AND TOWER PIPING (\$1000)	PIPCLR	97
C	RVDIA	- COMPONENT DIAMETER OF INTERIOR VERTICAL QUADRANT HEADER SECTION (INCHES)	PIPCLR	98
C	RVRCST	- COST OF REDUCER FOR INTERIOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLR	99
C	RVTCST	- COST OF TEE FOR INTERIOR VERTICAL QUADRANT HEADER	PIPCLR	100
C			PIPCLR	101
C			PIPCLR	102
C			PIPCLR	103
C			PIPCLR	104
C			PIPCLR	105
C			PIPCLR	106
C			PIPCLR	107
C			PIPCLR	108
C			PIPCLR	109
C			PIPCLR	110
C			PIPCLR	111
C			PIPCLR	112
C			PIPCLR	113
C			PIPCLR	114
C			PIPCLR	115

SUBROUTINE PIPCLR (CTOW, TOWDIA, DOTMA, DIST, DESVELL, BUNWIDT, REDUCR,
 \$ QREDUCR, POHCIR, NSIDES, HTOW, NBUNHI, TUBEL, DELL, PIPCSTL)

C		PIPCLR	2
C		PIPCLR	3
C		PIPCLR	4
C	THIS SUBROUTINE DESIGNS AND COSTS THE RETURN PIPING SYSTEM	PIPCLR	5
C	WHICH TRANSPORTS THE LIQUID AMMONIA. THIS INCLUDES ALL THE	PIPCLR	6
C	PIPE, VALVES, AND FITTINGS BETWEEN THE HEAT EXCHANGER AND	PIPCLR	7
C	THE CONDENSER/REBOILER. PIPE DIAMETER IS DETERMINED FROM THE	PIPCLR	8
C	AMMONIA FLOW RATE AND THE LIQUID DESIGN VELOCITY. VALVE AND	PIPCLR	9
C	FITTING SIZES CORRESPOND TO THE PIPE SIZES WITH THE SAME	PIPCLR	10
C	FLOW RATE.	PIPCLR	11
C		PIPCLR	12
C	DEFINITION OF VARIABLES	PIPCLR	13
C		PIPCLR	14
C	APIPCST - ABOVE GROUND PIPE COST (\$1000/FT)	PIPCLR	15
C	BRCHDIA - DIAMETER OF DISTRIBUTION PIPING OR BUNDLE FITTINGS	PIPCLR	16
C	(INCHES), IS USED TO GET "BRANCH" PORTION OF THE	PIPCLR	17
C	TEE COSTS	PIPCLR	18
C	HRCST - COST OF "BRANCH" PORTION OF TEE COST (\$1000)	PIPCLR	19
C	RUNWIDT - WIDTH OF TUBE BUNDLE (FT)	PIPCLR	20
C	COANG - ANGLE OF DELTA HEAT EXCHANGER (DEGREES)	PIPCLR	21
C	CPW - SPECIFIC HEAT OF AMMONIA LIQUID (BTU/LBM DEG F)	PIPCLR	22
C	CTOW - NUMBER OF CIRCULAR TOWERS	PIPCLR	23
C	DELL - PRESSURE DROP IN RETURN CIRCULATION PIPING FOR	PIPCLR	24
C	LIQUID AMMONIA (PSF)	PIPCLR	25
C	DELPBR - PRESSURE DROP IN BUNDLE FITTINGS (PSF)	PIPCLR	26
C	DELPD,T - PRESSURE DROP IN DISTRIBUTION PIPING, TOWER PIPING	PIPCLR	27
C	(T), (PSF)	PIPCLR	28
C	DELRH,Q - PRESSURE DROP IN MAIN CIRCULATION HEADER, QUADRANT	PIPCLR	29
C	HEADER (Q), (PSF)	PIPCLR	30
C	DENSIW - DENSITY OF AMMONIA LIQUID (LBM/CU FT)	PIPCLR	31
C	DERRP,V - PRESSURE DROP IN EXTERIOR VERTICAL PIPING (P),	PIPCLR	32
C	INTERIOR VERTICAL PIPING (V)	PIPCLR	33
C	DESVELL - AMMONIA LIQUID DESIGN VELOCITY (FT/SEC)	PIPCLR	34
C	DIAH - DIAMETER OF MAIN CIRCULATION RETURN HEADER (INCHES)	PIPCLR	35
C	DIAPD - DIAMETER OF DISTRIBUTION PIPING (INCHES)	PIPCLR	36
C	DIART - DIAMETER OF TOWER PIPING (INCHES)	PIPCLR	37
C	DIST - DISTANCE FROM CONDENSER/REBOILER TO BOUNDARY OF	PIPCLR	38
C	TOWERS (FT)	PIPCLR	39
C	DOTMA - TOTAL MASS FLOW RATE (LBM/HR)	PIPCLR	40
C	DOTMAR,Q,T - MASS FLOW RATE TO TUBE BUNDLE, QUADRANT (Q),	PIPCLR	41
C	TOWER (T), (LBM/HR)	PIPCLR	42
C	DOTMAE,I - MASS FLOW RATE TO EXTERIOR (E) AND INTERIOR (I)	PIPCLR	43
C	VERTICAL QUADRANT PIPING (LBM/HR)	PIPCLR	44
C	DOTREM - FLOW RATE REMAINING IN HEADER SECTION (LBM/HR)	PIPCLR	45
C	DYNHDL - DYNAMIC HEAD LOSS (FT OF AMMONIA)	PIPCLR	46
C	ELCST - 90 DEG ELBOW COST (\$1000)	PIPCLR	47
C	FL45 - 45 DEG ELBOW COST (\$1000)	PIPCLR	48
C	EQLN - EQUIVALENT LENGTH (FT)	PIPCLR	49
C	FLGCST - FLANGE COST (\$1000)	PIPCLR	50
C	HEAD - HEAD LOSS (FT OF AMMONIA/100 FT OF EQUIVALENT	PIPCLR	51
C	LENGTH)	PIPCLR	52
C	HEDR - LENGTH OF MAIN CIRCULATION HEADER SECTION (FT)	PIPCLR	53
C	ICHORD - NUMBER OF CHORDS PER QUADRANT	PIPCLR	54
C	ID - INDEX REFERS TO DISTRIBUTION PIPING	PIPCLR	55
C	INT - NUMBER OF INTERIOR VERTICAL QUADRANT RETURN LINES	PIPCLR	56
C	IT - INDEX REFERS TO TOWER PIPING	PIPCLR	57
C	JR - IDENTIFIES MAIN CIRCULATION HEADER SECTION	PIPCLR	58

DOTMAT=DOTMA/CTOW	PIPCLR	230
DOTMAQ=DOTMAT/4.	PIPCLR	231
DOTMAB=DOTMAQ/NBUNPGD	PIPCLR	232
CONST1=4./(3.1416*3600.)	PIPCLR	233
RCOST=0.	PIPCLR	234
RQCoST=0.	PIPCLR	235
DO 1 I=1,NFS	PIPCLR	236
1 PRCST(I)=0.	PIPCLR	237
DO 2 I=1,NFL	PIPCLR	238
2 RQRCST(I)=0.	PIPCLR	239
DELPH=0.	PIPCLR	240
DELRO=0.	PIPCLR	241
DELRP=0.	PIPCLR	242
DELRV=0.	PIPCLR	243
RVCOST=0.	PIPCLR	244
RPCOST=0.	PIPCLR	245
NQS=100	PIPCLR	246
NPS=100	PIPCLR	247
RELCST=0.	PIPCLR	248
RFLGCST=0.	PIPCLR	249
REJCST=0.	PIPCLR	250
DO 40 I=1,NFS	PIPCLR	251
40 PRCST(I)=0.	PIPCLR	252
C	PIPCLR	253
C THE DENSITY AND VISCOSITY OF THE AMMONIA LIQUID ARE ASSUMED	PIPCLR	254
C CONSTANT IN THE RETURN PIPING AND ARE EVALUATED AT THE HEAT	PIPCLR	255
C EXCHANGER OUTLET CONDITIONS,	PIPCLR	256
C	PIPCLR	257
RHO=DENSIW	PIPCLR	258
VIS=VISW	PIPCLR	259
CONST2=4.*144./(3.1416*3600.)	PIPCLR	260
JR=1	PIPCLR	261
DOTREM=DOTMA	PIPCLR	262
C	PIPCLR	263
C IN THE STATEMENTS THROUGH 47 + 1 THE MAIN CIRCULATION PIPING	PIPCLR	264
C IS DESIGNED AND COSTED. THE PRESSURE DROP IS DETERMINED FOR	PIPCLR	265
C PUMPING REQUIREMENTS.	PIPCLR	266
C	PIPCLR	267
C CALL HEADER TO DESIGN AND COST THE COMPONENTS OF HEADER	PIPCLR	268
C SECTION JR. ALL HEADER SECTION COMPONENTS ARE DETERMINED	PIPCLR	269
C BETWEEN STATEMENTS 43 AND 42 = 1.	PIPCLR	270
C	PIPCLR	271
43 CALL HEADER(DOTREM,DOTMAT,DESVELL,RHO,REDUCR,JR,1,DIAJ,	PIPCLR	272
SDIAR,TCST,RCST,UPCST,RELCST,RFLGCST,REJCST)	PIPCLR	273
C	PIPCLR	274
C THE DIAMETER OF HEADER SECTION JR (DIAR) IS REPLACED BY DIAJ	PIPCLR	275
C IN ORDER TO COMPARE THE DIAMETER OF SECTION JR WITH SECTION	PIPCLR	276
C JR + 1 TO DETERMINE REDUCER REQUIREMENTS. RDIA IS THE STORED	PIPCLR	277
C VALUE OF THE DIAMETER OF HEADER SECTION JR.	PIPCLR	278
C	PIPCLR	279
DIAJ=DIAR	PIPCLR	280
RDIA(JR)=DIAR	PIPCLR	281
PTCST(JR) = TCST	PIPCLR	282
C	PIPCLR	283
C ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER SECTION.	PIPCLR	284
C THE COST OF A REDUCER IS BASED ON THE LARGEST DIAMETER OF	PIPCLR	285
C THE REDUCER.	PIPCLR	286

C	IF(JR.GT.1) PRCST(JR-1)=RCST	PIPCLR	287
	UPIPCST(JR)=UPCST	PIPCLR	288
C		PIPCLR	289
C	DETERMINE LENGTH OF HEADER SECTION. THE FIRST HEADER SECTION	PIPCLR	290
C	IS DESIGNATED HEADER SECTION 1. ALL EVEN NUMBERED HEADER	PIPCLR	291
C	SECTIONS ARE EFFECTIVELY ZERO LENGTH BECAUSE THE CIRCULAR	PIPCLR	292
C	TOWERS ARE PAIRED ON OPPOSITE SIDES OF THE MAIN CIRCULATION	PIPCLR	293
C	HEADER. THERE IS ONE HEADER SECTION DESIGNATED FOR EACH	PIPCLR	294
C	CIRCULAR TOWER.	PIPCLR	295
C		PIPCLR	296
	IF(JR.EQ.1) GO TO 10	PIPCLR	297
	IF(MOD(JR,2).EQ.0) HEDR(JR)=0.	PIPCLR	298
	IF(MOD(JR,2).NE.0) HEDR(JR)=1.5*TOWDIA	PIPCLR	299
	GO TO 11	PIPCLR	300
10	HEDR(JR)=DIST+.5*TOWDIA	PIPCLR	301
11	CONTINUE	PIPCLR	302
C		PIPCLR	303
C	DETERMINE THE HEAD LOSS AND PRESSURE DROP IN HEADER SECTION	PIPCLR	304
C	JR. THE EQUIVALENT LENGTH INCLUDES AN L/D OF 20 FOR THE TEE	PIPCLR	305
C	"RUN".	PIPCLR	306
C		PIPCLR	307
	EQLN=HEDR(JR)+20.*DIAR/12.	PIPCLR	308
	VELO=DOTREM*CONST2/(RHO*DIAR*DIAR)	PIPCLR	309
	CALL HYDLOS(DIAR,VELO,VIS,RHO,2,HEAD)	PIPCLR	310
	DELRH=DELRH+HEAD*RHO*EQLN/100.	PIPCLR	311
		PIPCLR	312
C		PIPCLR	313
C	SUBTRACT OUT THE FLOW TO ONE CIRCULAR TOWER TO GET THE FLOW	PIPCLR	314
C	IN HEADER SECTION JR + 1.	PIPCLR	315
C		PIPCLR	316
	DOTREM=DOTREM-DOTMAT	PIPCLR	317
C		PIPCLR	318
C	IF THE REMAINING FLOW IS ZERO THEN THE LAST HEADER SECTION	PIPCLR	319
C	HAS BEEN DESIGNED.	PIPCLR	320
C		PIPCLR	321
	IF(DOTREM.LE.0.) GO TO 42	PIPCLR	322
	JR=JR+1	PIPCLR	323
	IF(JR .GT. NFS) PIPCSTL = 1.E+40	PIPCLR	324
	IF(JR .GT. NFS) RETURN	PIPCLR	325
	GO TO 43	PIPCLR	326
C		PIPCLR	327
C	DETERMINE THE DIAMETER OF THE DISTRIBUTION PIPING.	PIPCLR	328
C		PIPCLR	329
42	BRCHDIA=SQRT(DOTMAT*CONST1/(RHO*DESVELL))*12.	PIPCLR	330
	IF(BRCHDIA.LT.DIAM(1)) BRCHDIA=DIAM(1)	PIPCLR	331
	DO 44 I=1,23	PIPCLR	332
	II=I	PIPCLR	333
	IF(BRCHDIA-DIAM(II))45,45,44	PIPCLR	334
44	CONTINUE	PIPCLR	335
45	BRCHDIA=DIAM(II)	PIPCLR	336
C		PIPCLR	337
C	THE COST OF A TEE IS ASSUMED TO BE .67 TIMES THE COST OF A	PIPCLR	338
C	TEE OF THE "RUN" DIAMETER PLUS .33 TIMES THE COST OF A TEE	PIPCLR	339
C	OF THE "BRANCH" DIAMETER. THE "RUN" PORTION WAS DETERMINED	PIPCLR	340
C	IN SUBROUTINE "HEADER". THE "BRANCH" PORTION IS DETERMINED	PIPCLR	341
C	HERE.	PIPCLR	342
C		PIPCLR	343

	RRCST=.33*TEECST(II)	PIPCLR	344
	DO 46 I=1,JR	PIPCLR	345
	RTCST(I)=RTCST(I)+BRCST	PIPCLR	346
46	RPCST(I)=UPIPCST(I)*HEDR(I)	PIPCLR	347
	RTCST(JR)=0.	PIPCLR	348
	DO 47 I=1,JR	PIPCLR	349
	IF(I,LT,JR)RCOST=RCOST+RPCST(I)+RRCST(I)+RTCST(I)	PIPCLR	350
	IF(I,EQ,JR)RCOST=RCOST+RPCST(I)+RRCST(I)+RELCST	PIPCLR	351
47	CONTINUE	PIPCLR	352
	RCOST=RCOST+RFLGCST+REJCST	PIPCLR	353
C		PIPCLR	354
C	IN THE STATEMENTS THROUGH 51 + 4 THE DISTRIBUTION PIPING IS	PIPCLR	355
C	DESIGNED. INDEXES FOR UNIT COST ARRAYS ARE DEFINED.	PIPCLR	356
C	PRESSURE LOSS IS EVALUATED.	PIPCLR	357
C		PIPCLR	358
	DIARD=SQRT(DOTMAT*CONST1/(RHO*DESVELL))*12.	PIPCLR	359
	IF(DIARD,LT,DIAM(1))DIARD=DIAM(1)	PIPCLR	360
	DO 50 I=1,23	PIPCLR	361
	ID=I	PIPCLR	362
	IF(DIARD=DIAM(ID))51,51,50	PIPCLR	363
50	CONTINUE	PIPCLR	364
51	DIARD=DIAM(ID)	PIPCLR	365
C		PIPCLR	366
C	THE EQUIVALENT LENGTH INCLUDES THE LENGTH OF PIPE CONNECTING	PIPCLR	367
C	THE MAIN CIRCULATION HEADER TO THE TOWER DISTRIBUTION HEADER.	PIPCLR	368
C	THIS LENGTH IS ASSUMED TO BE .2 TIMES THE TOWER DIAMETER.	PIPCLR	369
C		PIPCLR	370
	EQLEN=.2*TOWDIA+200.*DIARD/12.	PIPCLR	371
	VELO=DOTMAT*CONST2/(RHO*DIARD*DIARD)	PIPCLR	372
	CALL HYDLOS(DIARD,VELO,VIS,RHO,2,HEAD)	PIPCLR	373
	DELPD=HEAD*RHO=EQLEN/100.	PIPCLR	374
C		PIPCLR	375
C	IN THE STATEMENTS THROUGH 53 + 4 THE TOWER PIPING IS	PIPCLR	376
C	DESIGNED. INDEXES FOR UNIT COST ARRAYS ARE DEFINED.	PIPCLR	377
C	PRESSURE LOSS IS EVALUATED.	PIPCLR	378
C		PIPCLR	379
	DIART=SQRT(DOTMAQ*CONST1/(RHO*DESVELL))*12.	PIPCLR	380
	IF(DIART,LT,DIAM(1))DIART=DIAM(1)	PIPCLR	381
	DO 52 I=1,23	PIPCLR	382
	IT=I	PIPCLR	383
	IF(DIART=DIAM(IT))53,53,52	PIPCLR	384
52	CONTINUE	PIPCLR	385
53	DIART=DIAM(IT)	PIPCLR	386
	EQLEN=TOWDIA+60.*DIART/12.	PIPCLR	387
	VELO=DOTMAQ*CONST2/(RHO*DIART*DIART)	PIPCLR	388
	CALL HYDLOS(DIART,VELO,VIS,RHO,2,HEAD)	PIPCLR	389
	DELPT=HEAD*RHO=EQLEN/100.	PIPCLR	390
	DELTD = DELPT + DELPD	PIPCLR	391
C		PIPCLR	392
C		PIPCLR	393
C		PIPCLR	394
C	SUM THE PRESSURE DROPS IN THE TOWER AND DISTRIBUTION PIPING.	PIPCLR	395
C		PIPCLR	396
C		PIPCLR	397
C	COMPUTE THE COST OF THE DISTRIBUTION AND TOWER PIPING. PIPE	PIPCLR	398
C	LENGTHS INCLUDE THE LENGTH OF PIPE CONNECTING THE MAIN CIRC-	PIPCLR	399
C	ULATION HEADER TO THE TOWER DISTRIBUTION HEADER (.2*TOWDIA)	PIPCLR	400

C	AND THE TOTAL LENGTH OF PIPE CONNECTING THE TOWER	PIPCLR	401
C	DISTRIBUTION HEADER TO THE FOUR QUADRANT HEADERS (3.25*	PIPCLR	402
C	TOWDIA). THESE LENGTHS ARE GENERAL APPROXIMATIONS. THE	PIPCLR	403
C	TOWER DISTRIBUTION HEADER IS ASSUMED TO APPROXIMATE THE	PIPCLR	404
C	COST OF FOUR TEES. INDEX "ID" REFERS TO THE DISTRIBUTION	PIPCLR	405
C	PIPING, "IT" TO THE TOWER PIPING.	PIPCLR	406
C		PIPCLR	407
	RTDCST=.2*TOWDIA*PIPCST(ID)+4.*(1.67*TEECST(ID)+.33*TEECST(IT))	PIPCLR	408
	S=.3.25*TOWDIA*PIPCST(IT)+10.*ELCST(IT)+2.*EL45(IT)	PIPCLR	409
	S+.4.*VACST(IT)+8.*FLGCST(IT)	PIPCLR	410
	TRTDCST=RTDCST*CTOW	PIPCLR	411
C		PIPCLR	412
C	IN THE STATEMENTS THROUGH 67 + 11 THE QUADRANT PIPING IS DE-	PIPCLR	413
C	SIGNED AND COSTED. THE PRESSURE LOSS IN THE QUADRANT HEADER	PIPCLR	414
C	AND BUNDLE FITTINGS IS DETERMINED.	PIPCLR	415
C	THE QUADRANT PIPING CAN BE SEPARATED INTO TWO GROUPS- THE	PIPCLR	416
C	PORTION THAT RUNS ALONG THE BASE OF THE QUADRANT AND	PIPCLR	417
C	DISTRIBUTES NH3 TO THE CHORDS (HORIZONTAL) AND THE	PIPCLR	418
C	PIPING THAT DISTRIBUTES NH3 TO THE TUBE BUNDLES (VERTICAL)	PIPCLR	419
C		PIPCLR	420
C		PIPCLR	421
C	EACH QUADRANT MUST HAVE INDEPENDENT PIPING SO THAT PARTIAL	PIPCLR	422
C	SHUTDOWN IS AVAILABLE. THE TUBE BUNDLES ARE INSTALLED WITH	PIPCLR	423
C	A SLIGHT SLOPE TO ACCOMODATE THE FLOW OF NH3 LIQUID. TO	PIPCLR	424
C	FACILITATE DESIGN EACH QUADRANT MUST HAVE AN EVEN NUMBER OF	PIPCLR	425
C	CHORDS.	PIPCLR	426
C		PIPCLR	427
C	TO DESIGN THE VERTICAL RETURN PIPING TWO SITUATIONS MUST BE	PIPCLR	428
C	CONSIDERED-THE PIPING AT THE ENDS OF THE QUADRANT (EXTERIOR)	PIPCLR	429
C	WHICH SUPPLIES ONLY ONE CHORD AND THE PIPING INBETWEEN THE	PIPCLR	430
C	EXTERIOR PIPING (INTERIOR) WHICH SUPPLIES TWO CHORDS.	PIPCLR	431
C		PIPCLR	432
C	DOTMAE AND DOTMAI ARE THE FLOWS TO THE EXTERIOR AND	PIPCLR	433
C	INTERIOR VERTICAL PIPING, RESPECTIVELY.	PIPCLR	434
C		PIPCLR	435
C	DESIGN AND COST THE HORIZONTAL QUADRANT PIPING	PIPCLR	436
C		PIPCLR	437
	NRLPQ = ICHORD/2 + 1	PIPCLR	438
	IF(NRLPQ.GT.200) STOP "IN PIPCLR NRLPQ EXCEEDS 200"	PIPCLR	439
	DO 60 I=1,NRLPQ	PIPCLR	440
60	RQRCST(I) = 0.	PIPCLR	441
	KR= 1	PIPCLR	442
	DOTREM=DOTMAQ	PIPCLR	443
	DOTMAE=DOTMAQ/ICHORD	PIPCLR	444
	DOTMAI=.2.*DOTMAE	PIPCLR	445
63	DOTMAH=DOTMAI	PIPCLR	446
	IF(KR.EQ.1.OR.KR.EQ.NRLPQ) DOTMAH=DOTMAE	PIPCLR	447
	CALL HEADER(DOTREM,DOTMAH,DESVELL,RHO,QREDUCR,KR,0,DIAJ,DIAR,TCST,	PIPCLR	448
	SRCSST,UPCST,QRCSST,QFLCST,QEJCST)	PIPCLR	449
C		PIPCLR	450
C	THE DIAMETER OF HEADER SECTION KR (DIAR) IS REPLACED BY DIAJ	PIPCLR	451
C	IN ORDER TO COMPARE THE DIAMETER OF SECTION KR WITH KR+1 TO	PIPCLR	452
C	DETERMINE REDUCER REQUIREMENTS. RQDIA IS THE STORED VALUE OF	PIPCLR	453
C	THE DIAMETER OF HEADER SECTION KR,	PIPCLR	454
C		PIPCLR	455
	DIAJ=DIAR	PIPCLR	456
	RQDIA(KR)=DIAR	PIPCLR	457

	RQTCST(KR)=TCST	PIPCLR	458
C		PIPCLR	459
C	ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER	PIPCLR	460
C	SECTION. THE COST OF A REDUCER IS BASED OF THE LARGEST	PIPCLR	461
C	DIAMETER OF THE REDUCER.	PIPCLR	462
C		PIPCLR	463
	IF(KR.GT.1) RQRCST(KR-1)=RCST	PIPCLR	464
	UPIPCST(KR)=UPCST	PIPCLR	465
C		PIPCLR	466
C	THE FIRST QUADRANT HEADER IS ASSUMED TO HAVE ZERO LENGTH.	PIPCLR	467
C	THE PIPE LENGTH FOR THE REMAINING SECTIONS IS THE CHORD	PIPCLR	468
C	LENGTH (TUBEL).	PIPCLR	469
C		PIPCLR	470
	IF(KR.EQ.1) QHEDR(KR)=0.	PIPCLR	471
	IF(KR.GT.1) QHEDR(KR)=2.*TUBEL	PIPCLR	472
C		PIPCLR	473
C	DETERMINE THE HEAD LOSS AND PRESSURE DROP IN THE HORIZONTAL	PIPCLR	474
C	QUADRANT HEADER SECTION.	PIPCLR	475
C		PIPCLR	476
	EQLN=QHEDR(KR)*20.*DIAR/12.	PIPCLR	477
	VELO=DOTREM*CONST1/(RHO*DIAR*DIAR)	PIPCLR	478
	CALL HYDLOS(DIAR,VELO,VIS,RHO,2,HEAD)	PIPCLR	479
	DELRO=DELRO+HEAD=RHO*EQLN/100.	PIPCLR	480
C		PIPCLR	481
C	SUBTRACT OUT THE FLOW TO ONE TUBE BUNDLE. IF THE FLOW	PIPCLR	482
C	REMAINING IS ZERO THEN THE LAST HORIZONTAL QUADRANT HEADER	PIPCLR	483
C	SECTION HAS BEEN DESIGNED.	PIPCLR	484
C		PIPCLR	485
	DOTREM=DOTREM-DOTMAH	PIPCLR	486
	IF(DOTREM.LE.0) GO TO 62	PIPCLR	487
	KP=KP+1	PIPCLR	488
	IF(KR.GT.NQS) PIPCSTL=1.E+40	PIPCLR	489
	IF(KR.GT.NQS) RETURN	PIPCLR	490
	GO TO 63	PIPCLR	491
	62 CONTINUE	PIPCLR	492
C		PIPCLR	493
C	NOW DESIGN THE VERTICAL QUADRANT HEADER PIPING. THE	PIPCLR	494
C	EXTERIOR PIPING WILL BE DESIGNED FIRST.	PIPCLR	495
C		PIPCLR	496
	IF(NBUNHI.GT.200) STOP "IN PIPCLR LAYER EXCEEDS 200"	PIPCLR	497
	DO 70 I=1,NBUNHI	PIPCLR	498
	70 RPRCST(I)=0	PIPCLR	499
	LR=1	PIPCLR	500
	DOTREM=DOTMAE	PIPCLR	501
	73 CALL HEADER(DOTREM,DOTMAH,DESVELL,RHO,PREDUCR,LR,0,DIAJ,DIAR,TCST,	PIPCLR	502
	SRCSST,UPCST,PRCST,PFLGCST,PEJCST)	PIPCLR	503
C		PIPCLR	504
C	THE DIAMETER OF HEADER SECTION LR (DIAR) IS REPLACED BY DIAJ	PIPCLR	505
C	IN ORDER TO COMPARE THE DIAMETER OF SECTION LR WITH LR+1 TO	PIPCLR	506
C	DETERMINE REDUCER REQUIREMENTS. RPDIA IS THE STORED VALUE OF	PIPCLR	507
C	THE DIAMETER OF HEADER SECTION LR.	PIPCLR	508
C		PIPCLR	509
	DIAJ=DIAR	PIPCLR	510
	RPDIA(LR)=DIAR	PIPCLR	511
	RPTCST(LR)=TCST	PIPCLR	512
C		PIPCLR	513
C	ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER SECTION.	PIPCLR	514

SUBROUTINE PIPCLR

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	THE COST OF THE REDUCER IS BASED ON THE LARGEST DIAMETER	PIPCLR	515
C	OF THE REDUCER.	PIPCLR	516
C		PIPCLR	517
	IF(LR.GT.1) RPRCST(LR-1)=RCST	PIPCLR	518
	UPPPCST(LR)=UPCST	PIPCLR	519
C		PIPCLR	520
C	THE FIRST QUADRANT HEADER IS ASSUMED TO HAVE ZERO LENGTH.	PIPCLR	521
C	THE LENGTH OF THE TEE "RUN" IS ASSUMED TO BE 1.75 TIMES THE	PIPCLR	522
C	PIPE DIAMETER. THIS LENGTH IS SUBTRACTED.	PIPCLR	523
C		PIPCLR	524
	IF(LR.EQ.1) PHEDR(LR)=0.	PIPCLR	525
	IF(LR.GT.1) PHEDR(LR)=BUNWIDT-1.75*DIAR/12.	PIPCLR	526
C		PIPCLR	527
C	DETERMINE THE HEADLOSS AND PRESSURE DROP IN THE EXTERIOR	PIPCLR	528
C	VERTICAL QUADRANT HEADER SECTION.	PIPCLR	529
C		PIPCLR	530
	EQLN=PHEDR(LR) +20.*DIAR/12.	PIPCLR	531
	DELRP=DELRP+HEAD*RHO*EQLN/100.	PIPCLR	532
C		PIPCLR	533
C	SUBTRACT THE FLOW TO ONE TUBE BUNDLE. IF THE FLOW	PIPCLR	534
C	REMAINING IS ZERO, THEN THE LAST VERTICAL EXTERIOR QUADRANT	PIPCLR	535
C	HEADER SECTION HAS BEEN DESIGNED.	PIPCLR	536
C		PIPCLR	537
	DOTREM=DOTREM-DOTMAB	PIPCLR	538
	IF(DOTREM.LE.0.) GO TO 72	PIPCLR	539
	LR=LR+1	PIPCLR	540
	IF(LR.GT.NPS) PIPCSTL=1.E+40	PIPCLR	541
	IF(LR.GT.NPS) RETURN	PIPCLR	542
	GO TO 73	PIPCLR	543
	72 CONTINUE	PIPCLR	544
C		PIPCLR	545
C	NOW DESIGN THE INTERIOR PORTION OF THE VERTICAL QUADRANT	PIPCLR	546
C	HEADER PIPING.	PIPCLR	547
C		PIPCLR	548
C	DETERMINE THE NUMBER OF INTERIOR RETURN LINES.	PIPCLR	549
C		PIPCLR	550
	INT=ICHORD/2+1	PIPCLR	551
	IF(INT.LE.0) GO TO 90	PIPCLR	552
C		PIPCLR	553
	DO 80 I=1,NBUNHI	PIPCLR	554
	80 RVRCT(I)=0.	PIPCLR	555
	LR=1	PIPCLR	556
	DOTREM=DOTMAI	PIPCLR	557
	DOTMAV=2.*DOTMAB	PIPCLR	558
	83 CALL HEADER(DOTREM,DOTMAV,DESVELL,RHO,VREDUCR,LR,0,DIAJ,DIAR,TCST,	PIPCLR	559
	SRCT,UPCST,VRLCST,VFLGCST,VEJCST)	PIPCLR	560
C		PIPCLR	561
C	THE DIAMETER OF HEADER SECTION LR (DIAR) IS REPLACED BY DIAJ	PIPCLR	562
C	IN ORDER TO COMPARE THE DIAMETER OF SECTION LR WITH LR+1	PIPCLR	563
C	TO DETERMINE REDUCER REQUIREMENTS. RVDIA IS THE STORED	PIPCLR	564
C	VALUE OF THE DIAMETER OF HEADER SECTION LR.	PIPCLR	565
C		PIPCLR	566
	DIAJ=DIAR	PIPCLR	567
	RVDIA(LR)=DIAR	PIPCLR	568
	RVTCST(LR)=TCST	PIPCLR	569
C		PIPCLR	570
C	ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER SECTION.	PIPCLR	571

C	THE COST IS BASED OF THE LARGEST DIAMETER OF THE REDUCER.	PIPCLR	572
C		PIPCLR	573
	IF(LR.GT.1) RVR CST(LR=1)=RCST	PIPCLR	574
	UPVPCST(LR)=UPCST	PIPCLR	575
C		PIPCLR	576
C	THE FIRST QUADRANT HEADER IS ASSUMED TO HAVE ZERO LENGTH.	PIPCLR	577
C	THE LENGTH OF THE TEE "RUN" IS ASSUMED TO BE 1.75 TIMES	PIPCLR	578
C	THE PIPE DIAMETER. THIS LENGTH IS SUBTRACTED.	PIPCLR	579
C		PIPCLR	580
	IF(LR.EQ.1) VHEDR(LR)=0.	PIPCLR	581
	IF(LR.GT.1) VHEDR(LR)=BUNWIDT-1.75*DIAR/12.	PIPCLR	582
C		PIPCLR	583
C	DETERMINE THE HEADLOSS AND PRESSURE DROP IN THE INTERIOR	PIPCLR	584
C	VERTICAL QUADRANT HEADER SECTION.	PIPCLR	585
C		PIPCLR	586
	EQLN=VHEDR(LR) +20.*DIAR/12.	PIPCLR	587
	VELO=DOTREM*CONST1/(RHO*DIAR*DIAR)	PIPCLR	588
	CALL HYDLOS(DIAR,VELO,VIS,RHO,2,HEAD)	PIPCLR	589
	DELRV=DELRV+HEAD*RHO*EQLN/100.	PIPCLR	590
C		PIPCLR	591
C	SUBTRACT THE FLOW TO TWO TUBE BUNDLES. IF THE FLOW	PIPCLR	592
C	REMAINING IS ZERO, THEN THE LAST VERTICAL INTERIOR QUADRANT	PIPCLR	593
C	HEADER SECTION HAS BEEN DESIGNED.	PIPCLR	594
C		PIPCLR	595
	DOTREM=DOTREM-DOTMAV	PIPCLR	596
	IF(DOTREM.LE.0.) GO TO 90	PIPCLR	597
	LR=LR+1	PIPCLR	598
	IF(LR.GT.NPS) PIPCSTL=1.E+40	PIPCLR	599
	IF(LR.GT.NPS) RETURN	PIPCLR	600
	GO TO 83	PIPCLR	601
C		PIPCLR	602
C	COMPUTE THE DIAMETER OF THE BUNDLE FITTINGS	PIPCLR	603
C		PIPCLR	604
	90 BRCHDIA=SQRT(DOTMAB*CONST1/(RHO*DESVELL))*.12.	PIPCLR	605
	IF(BRCHDIA.LT.DIAM(1)) BRCHDIA=DIAM(1)	PIPCLR	606
	DO 91 I=1,23	PIPCLR	607
	II=I	PIPCLR	608
	IF(BRCHDIA=DIAM(II)) 92,92,91	PIPCLR	609
	91 CONTINUE	PIPCLR	610
	92 BRCHDIA=DIAM(II)	PIPCLR	611
C		PIPCLR	612
C	DETERMINE THE COST OF THE BUNDLE FITTINGS	PIPCLR	613
C	THE PIPE CONNECTING THE QUADRANT HEADER	PIPCLR	614
C	TO THE TUBE BUNDLE HEADER	PIPCLR	615
C		PIPCLR	616
	RBF CST=3.*APIPCST(II)+ELCST(II)+2.*FLGCST(II)	PIPCLR	617
C		PIPCLR	618
C	THE BRANCH PORTION OF THE TEE COST IS ASSUMED TO BE .33	PIPCLR	619
C	TIMES THE BRANCH DIAMETER.	PIPCLR	620
C		PIPCLR	621
	BRCST=.33*TEECST(II)	PIPCLR	622
C		PIPCLR	623
C	EVALUATE THE COST OF THE QUADRANT HEADER	PIPCLR	624
C		PIPCLR	625
C	FIRST DETERMINE THE COST OF THE HORIZONTAL SECTION.	PIPCLR	626
C		PIPCLR	627
	DO 93 I=1,KR	PIPCLR	628

SUBROUTINE PIPCLR

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

93	RQPCST(I)=UPIPCST(I)*QHEDR(I)	PIPCLR	629
	RQTCST(KR)=0.	PIPCLR	630
	DO 94 I=1,KR	PIPCLR	631
	IF(I.LT.KR) RQPCST(I)=RQPCST(I)+RQTCST(I)+RQRCST(I)	PIPCLR	632
	IF(I.EQ.KR) RQPCST(I)=RQPCST(I)+RQRCST(I)+RQRCST	PIPCLR	633
94	CONTINUE	PIPCLR	634
C		PIPCLR	635
C	SECOND EVALUATE THE COST OF THE VERTICAL EXTERIOR QUADRANT	PIPCLR	636
C	HEADER PIPING	PIPCLR	637
C		PIPCLR	638
	DO 95 I=1,LR	PIPCLR	639
	RPTCST(I)=RPTCST(I)+BRCST	PIPCLR	640
95	RPPCST(I)=UPPPCST(I)*PHEDR(I)	PIPCLR	641
	RPTCST(LR)=0.	PIPCLR	642
	DO 96 I=1,LR	PIPCLR	643
	IF(I.LT.LR) RPCOST=RPCOST+RPPCST(I)+RPTCST(I)+RPRCST(I)	PIPCLR	644
	IF(I.EQ.LR) RPCOST=RPCOST+RPPCST(I)+RPRCST(I)+PRLCST	PIPCLR	645
96	CONTINUE	PIPCLR	646
C		PIPCLR	647
C	THIRD EVALUATE THE COST OF THE VERTICAL INTERIOR QUADRANT	PIPCLR	648
C	HEADER PIPING	PIPCLR	649
C		PIPCLR	650
	IF(INT.LE.0) GO TO 99	PIPCLR	651
	DO 97 I=1,LR	PIPCLR	652
	RVTCST(I)=RVTCST(I)+2.*BRCST	PIPCLR	653
97	RVPCST(I)=UPVPCST(I)*VHEDR(I)	PIPCLR	654
	DO 98 I=1,LR	PIPCLR	655
	IF(I.LT.LR) RVCOST=RVCOST+RVPCST(I)+RVTCST(I)+RVRCST(I)	PIPCLR	656
	IF(I.EQ.LR) RVCOST=RVCOST+RVPCST(I)+RVRCST(I)+RVTCST(I)	PIPCLR	657
98	CONTINUE	PIPCLR	658
99	CONTINUE	PIPCLR	659
C		PIPCLR	660
C	DETERMINE THE TOTAL COST OF THE RETURN QUADRANT PIPING	PIPCLR	661
C		PIPCLR	662
	RQPCSTL=RCOST+2.*RPCOST+INT*RVCOST+RBFCST*NBUNPQD	PIPCLR	663
	TRQPCSTL=RQPCSTL*CTOW*4.	PIPCLR	664
	DELRLQ=DELRLQ+DELRLP+DELRLV	PIPCLR	665
C	DETERMINE HEAD LOSS AND PRESSURE DROP IN THE BUNDLE FITTINGS.	PIPCLR	666
C		PIPCLR	667
	EQLEN = 150. * BRCHDIA/12.	PIPCLR	668
	VELO=DOTMAB*CONST2/(RHO*BRCHDIA*BRCHDIA)	PIPCLR	669
	CALL HYDLOS(BRCHDIA,VELO,VIS,RHO,2,HEAD)	PIPCLR	670
	DELPBR=HEAD*RHO*EQLEN/100.	PIPCLR	671
C		PIPCLR	672
C	DETERMINE TOTAL COST AND PRESSURE DROP IN RETURN PIPING	PIPCLR	673
C	SYSTEM.	PIPCLR	674
C		PIPCLR	675
	PIPCSTL=RCOST+TRTDCST+TRQPCSTL	PIPCLR	676
	PIPCSTL = PIPCSL = POHCIR	PIPCLR	677
	DELL=DELPH+DELTD+DELRLQ+DELPBR	PIPCLR	678
	DYNHDL=DELL/RHO	PIPCLR	679
C		PIPCLR	680
C	STORE VALUES IN COMMON BLOCK /RPTRET/ FOR LATER USE IN	PIPCLR	681
C	OUTPUT.	PIPCLR	682
C		PIPCLR	683
	SDESVE = DESVELL	PIPCLR	684
	SDOTMA = DOTMA	PIPCLR	685

SUBROUTINE PIPCLR 74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

SIPCS = PIPCSTL
STOWDI = TOWDIA
SDELL = DELL
RETURN
END

PIPCLR 686
PIPCLP 687
PIPCLR 688
PIPCLR 689
PIPCLR 690

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

SUBROUTINE PIPCLS(CTOW,TOWDIA,DOTMA,TCONOUT,DIST,DESVELV,BUNWIDT,	PIPCLS	2
S REDUCS, QREDUCS, POHCIR, NSIDES, HTOW, NBUNHI, TUBEL, DELV, PIPCSTV,	PIPCLS	3
STHXIN)	PIPCLS	4
C	PIPCLS	5
C THIS SUBROUTINE DESIGNS AND COSTS THE SUPPLY PIPING SYSTEM	PIPCLS	6
C WHICH TRANSPORTS THE VAPOR AMMONIA. THIS INCLUDES ALL THE	PIPCLS	7
C PIPE, VALVES, AND FITTINGS BETWEEN THE HEAT EXCHANGER AND	PIPCLS	8
C THE CONDENSER/REBOILER. PIPE DIAMETER IS DETERMINED FROM THE	PIPCLS	9
C AMMONIA FLOW RATE AND THE VAPOR DESIGN VELOCITY. VALVE AND	PIPCLS	10
C FITTING SIZES CORRESPOND TO THE PIPE SIZES WITH THE SAME	PIPCLS	11
C FLOW RATE.	PIPCLS	12
C	PIPCLS	13
C AMMONIA PROPERTIES ARE FIRST EVALUATED AT THE CONDENSER/	PIPCLS	14
C REBOILER OUTLET TEMPERATURE. CONDITIONS ARE ASSUMED TO BE	PIPCLS	15
C SATURATED. AFTER DESIGNING EACH HEADER OR PIPE SECTION THE	PIPCLS	16
C PRESSURE DROP IS DETERMINED IN THAT SECTION BY CALLING	PIPCLS	17
C HLAMMO. THIS PROVIDES THE OUTLET TEMPERATURE OF THAT	PIPCLS	18
C SECTION WHICH BECOMES THE INLET TEMPERATURE FOR THE NEXT	PIPCLS	19
C SECTION.	PIPCLS	20
C	PIPCLS	21
C DEFINITION OF VARIABLES	PIPCLS	22
C	PIPCLS	23
C APIPCST = ABOVE GROUND PIPE COST (\$1000/FT)	PIPCLS	24
C BRCHDIA = DIAMETER OF DISTRIBUTION PIPING OR BUNDLE FITTINGS	PIPCLS	25
C (INCHES). IS USED TO GET "BRANCH" PORTION OF THE	PIPCLS	26
C TEE COSTS	PIPCLS	27
C BRGST = COST OF "BRANCH" PORTION OF TEE COST (\$1000)	PIPCLS	28
C BSDYNHD = DYNAMIC HEAD LOSS IN BUNDLE FITTINGS	PIPCLS	29
C (FT OF AMMONIA)	PIPCLS	30
C BUNWIDT = WIDTH OF TUBE BUNDLE (FT)	PIPCLS	31
C COANG = ANGLE OF DELTA HEAT EXCHANGER (DEGREES)	PIPCLS	32
C CPV = SPECIFIC HEAT OF AMMONIA VAPOR (BTU/LBM DEG F)	PIPCLS	33
C CTOW = NUMBER OF CIRCULAR TOWERS	PIPCLS	34
C DDOYND = DYNAMIC HEAD LOSS IN DISTRIBUTION PIPING (FT OF	PIPCLS	35
C AMMONIA)	PIPCLS	36
C DELP = PRESSURE DROP IN HEADER SECTION (PSF)	PIPCLS	37
C DELPBS = PRESSURE DROP IN BUNDLE FITTINGS (PSF)	PIPCLS	38
C DELPD,T = PRESSURE DROP IN DISTRIBUTION PIPING, TOWER PIPING	PIPCLS	39
C (T), (PSF)	PIPCLS	40
C DELSH,Q = PRESSURE DROP IN MAIN CIRCULATION HEADER, QUADRANT	PIPCLS	41
C HEADER (Q), (PSF)	PIPCLS	42
C DELSP = PRESSURE DROP IN VERTICAL QUADRANT HEADER (PSF)	PIPCLS	43
C DELV = PRESSURE DROP IN SUPPLY CIRCULATION PIPING FOR	PIPCLS	44
C VAPOR AMMONIA (PSF)	PIPCLS	45
C DENS = DENSIV	PIPCLS	46
C DENSIV = DENSITY OF AMMONIA VAPOR (LBM/CU FT)	PIPCLS	47
C DESVELV = AMMONIA VAPOR DESIGN VELOCITY (FT/SEC)	PIPCLS	48
C DIAS = DIAMETER OF MAIN CIRCULATION SUPPLY HEADER (INCHES)	PIPCLS	49
C DIASD = DIAMETER OF DISTRIBUTION PIPING (INCHES)	PIPCLS	50
C DIAST = DIAMETER OF TOWER PIPING (INCHES)	PIPCLS	51
C DIST = DISTANCE FROM CONDENSER/REBOILER TO BOUNDARY OF	PIPCLS	52
C TOWERS	PIPCLS	53
C DOTMA = TOTAL MASS FLOW RATE (LBM/HR)	PIPCLS	54
C DOTMAB,Q,T = MASS FLOW RATE TO TUBE BUNDLE, QUADRANT (Q),	PIPCLS	55
C TOWER (T), (LBM/HR)	PIPCLS	56
C DOTMAH = MASS FLOW RATE TO VERTICAL SECTION OF QUADRANT	PIPCLS	57
C PIPING (LBM/HR)	PIPCLS	58

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	DOTREM	- FLOW RATE REMAINING IN HEADER SECTION (LBM/HR)	PIPCLS	59
C	DYNHDS	- DYNAMIC HEAD LOSS IN MAIN CIRCULATION HEADER (FT OF AMMONIA)	PIPCLS	60
C			PIPCLS	61
C	DYNHDSV	- DYNAMIC HEAD LOSS IN CIRCULATION VAPOR SUPPLY PIPING (FT OF AMMONIA)	PIPCLS	62
C			PIPCLS	63
C	ELCST	- 90 DEG ELBOW COST (\$1000)	PIPCLS	64
C	EL45	- 45 DEG ELBOW COST (\$1000)	PIPCLS	65
C	EQLN	- EQUIVALENT LENGTH (FT)	PIPCLS	66
C	FLGCST	- FLANGE COST (\$1000)	PIPCLS	67
C	HEDR	- LENGTH OF MAIN CIRCULATION HEADER SECTION (FT)	PIPCLS	68
C	ICHORD	- NUMBER OF CHORDS PER QUADRANT	PIPCLS	69
C	ID	- INDEX REFERS TO DISTRIBUTION PIPING	PIPCLS	70
C	IT	- INDEX REFERS TO TOWER PIPING	PIPCLS	71
C	JS	- IDENTIFIES MAIN CIRCULATION HEADER SECTION	PIPCLS	72
C	KS	- IDENTIFIES QUADRANT HEADER SECTION	PIPCLS	73
C	NRUNHI	- NUMBER OF BUNDLES VERTICAL	PIPCLS	74
C	LS	- IDENTIFIES VERTICAL QUADRANT HEADER SECTION	PIPCLS	75
C	NSUNPQD	- NUMBER OF BUNDLES PER QUADRANT	PIPCLS	76
C	NFL	- UPPER LIMIT TO NUMBER OF TUBE BUNDLES PER QUADRANT	PIPCLS	77
C	NFS	- UPPER LIMIT TO NUMBER OF CIRCULAR TOWERS	PIPCLS	78
C	NPS	- UPPER LIMIT TO NUMBER OF TOWER LAYERS	PIPCLS	79
C	NQS	- UPPER LIMIT TO NUMBER OF CHORDS PER QUADRANT	PIPCLS	80
C	NSLPQ	- NUMBER OF SUPPLY LINES PER QUADRANT	PIPCLS	81
C	PDYNHDS	- DYNAMIC HEAD LOSS IN VERTICAL QUADRANT HEADER (FEET OF NH3)	PIPCLS	82
C			PIPCLS	83
C	PSJCST	- COST OF EXPANSION JOINT IN VERTICAL QUADRANT PIPING (\$1000)	PIPCLS	84
C			PIPCLS	85
C	PSLGCST	- COST OF FLANGE VERTICAL QUADRANT PIPING (\$1000)	PIPCLS	86
C	QDIACST	- COST OF BRANCH PORTION OF HORIZONTAL QUADRANT HEADER	PIPCLS	87
C			PIPCLS	88
C	QDIAH	- DIAMETER OF HORIZONTAL QUADRANT PIPING (IN) USED TO GET THE BRANCH PORTION OF THE TEE COSTS	PIPCLS	89
C			PIPCLS	90
C	PIPCSTV	- TOTAL CIRCULATION SUPPLY PIPING COST (\$1000)	PIPCLS	91
C	QDYNHDS	- DYNAMIC HEAD LOSS IN QUADRANT HEADER (FT OF AMMONIA)	PIPCLS	92
C			PIPCLS	93
C	POHCIR	- INDIRECT COST FACTOR FOR CIRCULATION PIPING	PIPCLS	94
C	QHEDR	- LENGTH OF QUADRANT HEADER SECTION (FT)	PIPCLS	95
C	QREDUCS	- ALLOWABLE REDUCTION IN DIAMETER BETWEEN ADJACENT QUADRANT HEADER SECTIONS (INCHES)	PIPCLS	96
C			PIPCLS	97
C	QSLCST	- COST OF 90 DEG ELBOW AT END OF QUADRANT HEADER (\$1000)	PIPCLS	98
C			PIPCLS	99
C	SHFCST	- COST OF BUNDLE FITTINGS (\$1000)	PIPCLS	100
C	SCOST	- COST OF MAIN CIRCULATION PIPING (\$1000)	PIPCLS	101
C	SPDIA	- COMPONENT DIAMETER OF THE VERTICAL QUADRANT HEADER SECTION (IN)	PIPCLS	102
C			PIPCLS	103
C	SPPCST	- COST OF PIPE FOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLS	104
C	SPPCST	- COST OF REDUCER FOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLS	105
C			PIPCLS	106
C	SPTCST	- COST OF TEE FOR VERTICAL QUADRANT HEADER (\$1000)	PIPCLS	107
C	RCST	- REDUCER COST (\$1000)	PIPCLS	108
C	REDUCS	- ALLOWABLE REDUCTION IN DIAMETER BETWEEN ADJACENT MAIN CIRCULATION HEADER SECTIONS (INCHES)	PIPCLS	109
C			PIPCLS	110
C	SEJCST	- COST OF EXPANSION JOINT AT CONDENSER/REBOILER OUTLET (\$1000)	PIPCLS	111
C			PIPCLS	112
C	SELCST	- COST OF 90 DEG ELBOW AT END OF MAIN CIRCULATION HEADER (\$1000)	PIPCLS	113
C			PIPCLS	114
C	SFLGCST	- TOTAL COST OF APPROPRIATE FLANGES AT CONDENSER/	PIPCLS	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C		REBOILER OUTLET (\$1000)	PIPCLS	116
C	SPCST	= COST OF PIPE FOR MAIN CIRCULATION HEADER (\$1000)	PIPCLS	117
C	SQCOST	= COST OF QUADRANT PIPING (\$1000)	PIPCLS	118
C	SQDIA	= COMPONENT DIAMETER OF QUADRANT HEADER SECTION	PIPCLS	119
C		(INCHES)	PIPCLS	120
C	SQPCST	= COST OF PIPE FOR QUADRANT HEADER (\$1000)	PIPCLS	121
C	SQRCST	= COST OF REDUCER FOR QUADRANT HEADER (\$1000)	PIPCLS	122
C	SRCST	= COST OF REDUCER IN MAIN CIRCULATION HEADER (\$1000)	PIPCLS	123
C	STCST	= COST OF TEE IN MAIN CIRCULATION HEADER (\$1000)	PIPCLS	124
C	STDCST	= COST OF DISTRIBUTION AND TOWER PIPING (\$1000)	PIPCLS	125
C	TCONOUT	= TEMPERATURE OF AMMONIA VAPOR AT CONDENSER/REBOILER	PIPCLS	126
C		OUTLET (DEG F)	PIPCLS	127
C	TCST	= TEE COST (\$1000)	PIPCLS	128
C	TDYNHD	= DYNAMIC HEAD LOSS IN TOWER PIPING (FT OF AMMONIA)	PIPCLS	129
C	THTE	= HEIGHT OF TOWER (FEET)	PIPCLS	130
C	TUBEL	= LENGTH OF HEAT EXCHANGER TUBES (FEET)	PIPCLS	131
C	THXIN	= TEMPERATURE OF AMMONIA VAPOR AT HEAT EXCHANGER	PIPCLS	132
C		INLET (DEG F)	PIPCLS	133
C	TIN, TOUT	= TEMPERATURE OF AMMONIA VAPOR AT INLET AND OUTLET	PIPCLS	134
C		TO EACH HEADER OR PIPE SECTION (DEG F)	PIPCLS	135
C	TOWDIA	= DIAMETER OF CIRCULAR TOWER (FT)	PIPCLS	136
C	TSQCOST	= TOTAL SUPPLY QUADRANT PIPING COSTS (\$1000)	PIPCLS	137
C	TSTDCST	= TOTAL SUPPLY DISTRIBUTION AND TOWER PIPING COSTS	PIPCLS	138
C		(\$1000)	PIPCLS	139
C	TUBLEN	= LENGTH OF HEAT EXCHANGER TUBE (FT); IT IS ASSUMED	PIPCLS	140
C		(\$1000)	PIPCLS	141
C	TUBLEN	= LENGTH OF HEAT EXCHANGER TUBE (FT); IT IS ASSUMED	PIPCLS	142
C		THAT THE TOWER HEIGHT EQUALS TUBLEN	PIPCLS	143
C	UPCST	= UNIT PIPE COST (\$1000/FT)	PIPCLS	144
C	VACST	= VALVE COST (\$1000), VALVES ARE MOTOR OPERATED	PIPCLS	145
C		BUTTERFLY VALVES	PIPCLS	146
C			PIPCLS	147
C			PIPCLS	148
C	COMMON/PROP/CPW,THCONW,DENSIW,VISW,HFG,		PIPCLS	149
C	\$ CPV,THCONV,DENSIV,VISV,SIGMA,		PIPCLS	150
C	\$ CPA,THCONA,DENSIA,VISA		PIPCLS	151
C	COMMON /RPTSUP/		PIPCLS	152
C	\$ SDELV, DIASD, DIAST, SDOTMA, DYNHDV		PIPCLS	153
C	\$, HEDR(200)		PIPCLS	154
C	\$, JS		PIPCLS	155
C	\$, KS		PIPCLS	156
C	\$, SPCSTV		PIPCLS	157
C	\$, QSLCST, QHEDR(200)		PIPCLS	158
C	\$, SRFCST, SCOST, SEJCST, SELCST, SFLGCST, SQCOST, STDCST		PIPCLS	159
C	\$, SDIA(200), SPCST(200), SQDIA(200), SQPCST(200), SQRCST(200)		PIPCLS	160
C	\$, STCST(200), SRCST(200), STCST(200)		PIPCLS	161
C	\$, STCONO, STHXIN, STOWDI, TSQCOST, TSTDCST		PIPCLS	162
C	COMMON /PCDIM/ NFS,NFL		PIPCLS	163
C	COMMON /OPTSUP/		PIPCLS	164
C	\$SPDIA(200), LS, PHEDR(200), SPPCST(200), SPRCST(200), SPYCST(200)		PIPCLS	165
C	\$, SPCOST, PSLCST, PSLGCST, PSJCST, UPPCST(200)		PIPCLS	166
C	\$,PF,NRUN		PIPCLS	167
C	DIMENSION UPIPCST(200)		PIPCLS	168
C	DIMENSION DIAM(24), TEECST(24), PIPCST(24), ELCST(24), EL45(24)		PIPCLS	169
C	\$, VACST(24), FLGCST(24), APIPCST(24)		PIPCLS	170
C			PIPCLS	171
C	DATA DIAM /		PIPCLS	172

SUBROUTINE PIPCLS 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$ 6. , 12. , 18. , 24. , 30. , 36. ,	PIPCLS 173
\$ 42. , 48. , 54. , 60. , 66. , 72. ,	PIPCLS 174
\$ 78. , 84. , 90. , 96. , 102. , 108. ,	PIPCLS 175
\$ 114. , 120. , 126. , 132. , 138. , 144. /	PIPCLS 176
C DATA FLGCST/	PIPCLS 177
\$.136, .520, 1.03 , 1.92 , 3.17 , 4.42 ,	PIPCLS 178
\$ 6.82 , 9.22 , 12.0 , 14.7 , 21.1 , 27.5 ,	PIPCLS 179
\$ 33.9 , 40.4 , 46.8 , 53.2 , 59.7 , 66.1 ,	PIPCLS 180
\$ 72.5 , 78.9 , 85.4 , 91.8 , 98.2 , 105. /	PIPCLS 181
C DATA TEECST/	PIPCLS 182
\$.344, .935, 1.96 , 3.82 , 14.8 , 25.8 ,	PIPCLS 183
\$ 31.7 , 37.6 , 53.4 , 69.1 , 87.9 , 107. ,	PIPCLS 184
\$ 126. , 145. , 163. , 182. , 201. , 220. ,	PIPCLS 185
\$ 239. , 258. , 277. , 296. , 314. , 333. /	PIPCLS 186
C DATA PIPCST/	PIPCLS 187
\$.06, .113, .147, .219, .409, .599,	PIPCLS 188
\$.720, .841, 1.08 , 1.31 , 1.57 , 1.84 ,	PIPCLS 189
\$ 2.10 , 2.36 , 2.62 , 2.88 , 3.15 , 3.41 ,	PIPCLS 190
\$ 3.67 , 3.93 , 4.19 , 4.46 , 4.72 , 4.98 /	PIPCLS 191
C DATA VACST/	PIPCLS 192
\$ 2.87 , 7.09 , 16.9 , 26.7 , 52.2 , 77.8 ,	PIPCLS 193
\$ 109. , 141. , 164. , 187. , 213. , 240. ,	PIPCLS 194
\$ 266. , 293. , 319. , 346. , 372. , 399. ,	PIPCLS 195
\$ 425. , 452. , 478. , 505. , 531. , 558. /	PIPCLS 196
C DATA ELCST/	PIPCLS 197
\$.275, .715, 1.35 , 2.94 , 9.54 , 16.1 ,	PIPCLS 198
\$ 27.4 , 38.8 , 51.9 , 65.1 , 87.6 , 110. ,	PIPCLS 199
\$ 133. , 155. , 178. , 200. , 222. , 245. ,	PIPCLS 200
\$ 268. , 290. , 312. , 335. , 357. , 380. /	PIPCLS 201
C DATA EL45/	PIPCLS 202
\$.230, .558, .947, 2.16 , 7.67 , 13.2 ,	PIPCLS 203
\$ 20.2 , 27.2 , 37.7 , 48.1 , 66.2 , 84.3 ,	PIPCLS 204
\$ 102. , 120. , 138. , 157. , 175. , 193. ,	PIPCLS 205
\$ 211. , 229. , 247. , 265. , 283. , 301. /	PIPCLS 206
C DATA APIPCST/	PIPCLS 207
\$.034 , .073 , .096 , .155, .332, .510,	PIPCLS 208
\$.614, .719, .939, 1.16 , 1.41 , 1.67 ,	PIPCLS 209
\$ 1.91 , 2.16 , 2.41 , 2.66 , 2.99 , 3.16 ,	PIPCLS 210
\$ 3.41 , 3.66 , 3.91 , 4.16 , 4.42 , 4.67 /	PIPCLS 211
C 100 FORMAT(8F10.2)	PIPCLS 212
PF=POHCIR	PIPCLS 213
NPS=100	PIPCLS 214
NQS=100	PIPCLS 215
ICHORD=NSIDES/4	PIPCLS 216
IF(ICHORD.EQ.0) ICHORD=2	PIPCLS 217
ICHECK=ICHORD/2	PIPCLS 218
IF(2*ICHECK=ICHORD.LT.0) ICHORD=ICHORD+1	PIPCLS 219
IF(ICHORD.LE.0) STOP "IN PIPCLS ICHORD .LE.ZERO"	PIPCLS 220
NBUNPD=ICHORD*NBUNHI	PIPCLS 221
	PIPCLS 222
	PIPCLS 223
	PIPCLS 224
	PIPCLS 225
	PIPCLS 226
	PIPCLS 227
	PIPCLS 228
	PIPCLS 229

	NBUN=NRUNPQD	PIPCLS	230
	DOTMAT=DOTMA/CTOW	PIPCLS	231
	DOTMAQ=DOTMAT/4.	PIPCLS	232
	DOTMAR=DOTMAQ/NBUNPQD	PIPCLS	233
	TIN=TCNOU	PIPCLS	234
	CONST1=4./((3.1416*3600.))	PIPCLS	235
	DELSH=0.	PIPCLS	236
	DYNHDS=0.	PIPCLS	237
	SCOST=0.	PIPCLS	238
	DIACST=0.	PIPCLS	239
	DIAH=0.	PIPCLS	240
	PDYNHDS=0.	PIPCLS	241
	DELSQ=0.	PIPCLS	242
	SPCOST=0.	PIPCLS	243
	DO 1 I=1,NFS	PIPCLS	244
	1 SRCST(I)=0.	PIPCLS	245
	DO 2 I=1,NFL	PIPCLS	246
	2 SQRCST(I)=0.	PIPCLS	247
	DELSQ=0.	PIPCLS	248
	QDYNHDS=0.	PIPCLS	249
	SQRCST=0.	PIPCLS	250
	SELCST=0.	PIPCLS	251
	SFLGCST=0.	PIPCLS	252
	SEJCST=0.	PIPCLS	253
	DOTREM=DOTMA	PIPCLS	254
	JS=1	PIPCLS	255
C		PIPCLS	256
C	IN THE STATEMENTS THROUGH 17 + 1 THE MAIN CIRCULATION PIPING	PIPCLS	257
C	IS DESIGNED AND COSTED. THE DYNAMIC HEAD LOSS AND PRESSURE	PIPCLS	258
C	DROP ARE DETERMINED FOR PUMPING REQUIREMENTS.	PIPCLS	259
C		PIPCLS	260
C	CALL HEADER TO DESIGN AND COST THE COMPONENTS OF HEADER	PIPCLS	261
C	SECTION JS. ALL HEADER SECTION COMPONENTS ARE DETERMINED	PIPCLS	262
C	BETWEEN STATEMENTS 13 AND 12 - 1.	PIPCLS	263
C		PIPCLS	264
C	13 CALL HEADER(DOTREM,DOTMAT,DESVELV,DENSIV,REDUCS,JS,1,DIAJ,	PIPCLS	265
	SDIAS,TCST,RCST,UPCST,SELCST,SFLGCST,SEJCST)	PIPCLS	266
C		PIPCLS	267
C	THE DIAMETER OF HEADER SECTION JS (DIAR) IS REPLACED BY DIAJ	PIPCLS	268
C	IN ORDER TO COMPARE THE DIAMETER OF SECTION JS WITH SECTION	PIPCLS	269
C	JS + 1 TO DETERMINE REDUCER REQUIREMENTS. SDIA IS THE STORED	PIPCLS	270
C	VALUE OF THE DIAMETER OF HEADER SECTION JS.	PIPCLS	271
C		PIPCLS	272
	DIAJ=DIAS	PIPCLS	273
	SDIA(JS)=DIAS	PIPCLS	274
	STCST(JS)=TCST	PIPCLS	275
C		PIPCLS	276
C	ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER SECTION.	PIPCLS	277
C	THE COST OF A REDUCER IS BASED ON THE LARGEST DIAMETER OF	PIPCLS	278
C	THE REDUCER.	PIPCLS	279
C		PIPCLS	280
	IF(JS.GT.1)SRCST(JS-1)=RCST	PIPCLS	281
	UPICST(JS)=UPCST	PIPCLS	282
C		PIPCLS	283
C	DETERMINE LENGTH OF HEADER SECTION. THE FIRST HEADER SECTION	PIPCLS	284
C	IS DESIGNATED HEADER SECTION 1. ALL EVEN NUMBERED HEADER	PIPCLS	285
C	SECTIONS ARE EFFECTIVELY ZERO LENGTH BECAUSE THE CIRCULAR	PIPCLS	286

C	TOWERS ARE PAIRED ON OPPOSITE SIDES OF THE MAIN CIRCULATION	PIPCLS	287
C	HEADER. THERE IS ONE HEADER SECTION DESIGNATED FOR EACH	PIPCLS	288
C	CIRCULAR TOWER.	PIPCLS	289
C		PIPCLS	290
	IF(JS,EQ.1)GO TO 10	PIPCLS	291
	IF(MOD(JS,2),EQ.0)HEDR(JS)=0.	PIPCLS	292
	IF(MOD(JS,2),NE.0)HEDR(JS)=1.5*TOWDIA	PIPCLS	293
	GO TO 11	PIPCLS	294
	10 HEDR(JS)=DIST+.5*TOWDIA	PIPCLS	295
C		PIPCLS	296
C	DETERMINE THE OUTLET TEMPERATURE AND DYNAMIC HEAD LOSS FOR	PIPCLS	297
C	HEADER SECTION JS. THE EQUIVALENT LENGTH INCLUDES AN L/D OF	PIPCLS	298
C	20 FOR THE TEE "RUN". THE OUTLET TEMPERATURE BECOMES THE	PIPCLS	299
C	INLET TEMPERATURE FOR THE NEXT HEADER SECTION. SAVE THE	PIPCLS	300
C	VAPOR DENSITY TO COMPUTE DYNAMIC HEAD LOSS. HLAMMO PROVIDES	PIPCLS	301
C	A NEW VAPOR DENSITY (THROUGH COMMON) FOR THE NEXT HEADER	PIPCLS	302
C	SECTION.	PIPCLS	303
C		PIPCLS	304
	11 EQLEN=HEDR(JS)+20.*DIAS/12.	PIPCLS	305
C		PIPCLS	306
C	SUBTRACT OUT THE FLOW TO ONE CIRCULAR TOWER TO GET THE FLOW	PIPCLS	307
C	IN HEADER SECTION JS + 1.	PIPCLS	308
C		PIPCLS	309
	DENS=DENSIV	PIPCLS	310
	CALL HLAMMO(TIN,DOTREM,DIAS,EQLEN,1.,TOUT,DELP)	PIPCLS	311
	DELSH=DELSH+DELP	PIPCLS	312
	DYNHDS=DYNHDS+DELP/DENS	PIPCLS	313
	TIN=TOUT	PIPCLS	314
	DOTREM=DOTREM-DOTMAT	PIPCLS	315
C		PIPCLS	316
C	IF THE REMAINING FLOW IS ZERO THEN THE LAST HEADER SECTION	PIPCLS	317
C	HAS BEEN DESIGNED.	PIPCLS	318
C		PIPCLS	319
	IF(DOTREM.LE.0.)GO TO 12	PIPCLS	320
	JS=JS+1	PIPCLS	321
	IF(JS.GT.NFS) PIPCSTV = 1.E+40	PIPCLS	322
	IF(JS.GT.NFS) RETURN	PIPCLS	323
	GO TO 13	PIPCLS	324
C		PIPCLS	325
C	DETERMINE THE DIAMETER OF THE DISTRIBUTION PIPING.	PIPCLS	326
C		PIPCLS	327
	12 BRCHDIA=SQRT(DOTMAT*CONST1/(DENSIV*DESVELV))=12.	PIPCLS	328
	IF(BRCHDIA.LT.DIAM(1))BRCHDIA=DIAM(1)	PIPCLS	329
	DO 14 I=1,24	PIPCLS	330
	II=I	PIPCLS	331
	IF(BRCHDIA=DIAM(II))15,15,14	PIPCLS	332
	14 CONTINUE	PIPCLS	333
	15 BRCHDIA=DIAM(II)	PIPCLS	334
C		PIPCLS	335
C	THE COST OF A TEE IS ASSUMED TO BE .67 TIMES THE COST OF A	PIPCLS	336
C	TEE OF THE "RUN" DIAMETER PLUS .33 TIMES THE COST OF A TEE	PIPCLS	337
C	OF THE "BRANCH" DIAMETER. THE "RUN" PORTION WAS DETERMINED	PIPCLS	338
C	IN SUBROUTINE "HEADER". THE "BRANCH" PORTION IS DETERMINED	PIPCLS	339
C	HERE.	PIPCLS	340
C		PIPCLS	341
	BRCST=.33*TEECST(II)	PIPCLS	342
	DO 16 I=1,JS	PIPCLS	343

	STCST(I)=STCST(I)+BRCST	PIPCLS	344
16	SPCST(I)=HEDR(I)*UPIPCST(I)	PIPCLS	345
	STCST(JS)=0.	PIPCLS	346
	DO 17 I=1,JS	PIPCLS	347
	IF(I.LT.JS)SCOST=SCOST+SPCST(I)+BRCST(I)+STCST(I)	PIPCLS	348
	IF(I.EQ.JS)SCOST=SCOST+SPCST(I)+BRCST(I)+SELCST	PIPCLS	349
17	CONTINUE	PIPCLS	350
	SCOST=SCOST+SFLGCST+SEJCS	PIPCLS	351
C		PIPCLS	352
C	IN THE STATEMENTS THROUGH 21 + 4 THE DISTRIBUTION PIPING IS	PIPCLS	353
C	DESIGNED. INDEXES FOR UNIT COST ARRAYS ARE DEFINED.	PIPCLS	354
C	PRESSURE LOSS AND DYNAMIC HEAD LOSS ARE EVALUATED.	PIPCLS	355
C		PIPCLS	356
	DIASD=SQRT(DOTMAT*CONST1/(DENSIV*DESVELV)) *12.	PIPCLS	357
	DO 20 I=1,24	PIPCLS	358
	ID=I	PIPCLS	359
	IF(DIASD-DIAM(ID))21,21,20	PIPCLS	360
20	CONTINUE	PIPCLS	361
21	DIASD=DIAM(ID)	PIPCLS	362
	EQLN=.2*TOWDIA+200.*DIASD/12.	PIPCLS	363
C		PIPCLS	364
C	THE EQUIVALENT LENGTH INCLUDES THE LENGTH OF PIPE CONNECTING	PIPCLS	365
C	THE MAIN CIRCULATION HEADER TO THE TOWER DISTRIBUTION HEADER.	PIPCLS	366
C	THIS LENGTH IS ASSUMED TO BE .2 TIMES THE TOWER DIAMETER.	PIPCLS	367
C		PIPCLS	368
	DENS=DENSIV	PIPCLS	369
	CALL HLAMMO(TIN,DOTMAT,DIASD,EQLN,1.,TOUT,DELPD)	PIPCLS	370
	DDYNHD=DELPD/DENS	PIPCLS	371
C		PIPCLS	372
C	THE TEMPERATURE OUT OF THE DISTRIBUTION PIPING IS THE	PIPCLS	373
C	TEMPERATURE INTO THE TOWER PIPING.	PIPCLS	374
C		PIPCLS	375
5	TIN=TOUT	PIPCLS	376
C		PIPCLS	377
C	IN THE STATEMENTS THROUGH 23 + 4 THE TOWER PIPING IS	PIPCLS	378
C	DESIGNED. INDEXES FOR UNIT COST ARRAYS ARE DEFINED.	PIPCLS	379
C	PRESSURE LOSS AND DYNAMIC HEAD LOSS ARE EVALUATED.	PIPCLS	380
C		PIPCLS	381
	DIASD=SQRT(DOTMAQ*CONST1/(DENSIV*DESVELV)) *12.	PIPCLS	382
	DO 22 I=1,24	PIPCLS	383
	IT=I	PIPCLS	384
	IF(DIASD-DIAM(IT))23,23,22	PIPCLS	385
22	CONTINUE	PIPCLS	386
23	DIASD=DIAM(IT)	PIPCLS	387
	EQLN=TOWDIA+80.*DIASD/12.	PIPCLS	388
	DENS=DENSIV	PIPCLS	389
	CALL HLAMMO(TIN,DOTMAQ,DIASD,EQLN,1.,TOUT,DELPT)	PIPCLS	390
	TDYNHD=DELPT/DENS	PIPCLS	391
C		PIPCLS	392
C	THE TEMPERATURE OUT OF THE TOWER PIPING IS THE TEMPERATURE	PIPCLS	393
C	INTO THE QUADRANT PIPING.	PIPCLS	394
C		PIPCLS	395
5	TIN=TOUT	PIPCLS	396
C		PIPCLS	397
C	COMPUTE THE COST OF THE DISTRIBUTION AND TOWER PIPING. PIPE	PIPCLS	398
C	LENGTHS INCLUDE THE LENGTH OF PIPE CONNECTING THE MAIN CIRC-	PIPCLS	399
C	ULATION HEADER TO THE TOWER DISTRIBUTION HEADER (.2*TOWDIA)	PIPCLS	400

C	AND THE TOTAL LENGTH OF PIPE CONNECTING THE TOWER	PIPCLS	401
C	DISTRIBUTION HEADER TO THE FOUR QUADRANT HEADERS (3.25*	PIPCLS	402
C	TOWDIA). THESE LENGTHS ARE GENERAL APPROXIMATIONS. THE	PIPCLS	403
C	TOWER DISTRIBUTION HEADER IS ASSUMED TO APPROXIMATE THE	PIPCLS	404
C	COST OF FOUR TEES. INDEX "ID" REFERS TO THE DISTRIBUTION	PIPCLS	405
C	PIPING, "IT" TO THE TOWER PIPING.	PIPCLS	406
C		PIPCLS	407
	STDCST=.2*TOWDIA*PIPCST(ID)+4.*(1.67*TEECST(ID)+.33*TEECST(IT))	PIPCLS	408
	S+(3.25*TOWDIA)*PIPCST(IT)+14.*ELCST(IT)+2.*EL45(IT)	PIPCLS	409
	S+4.*VACST(I)+8.*FLGCST(IT)	PIPCLS	410
	TSTDCST=STDCST*CTOW	PIPCLS	411
C		PIPCLS	412
C	IN THE STATEMENTS THROUGH 35 + 11 THE QUADRANT PIPING IS DE-	PIPCLS	413
C	SIGNED AND COSTED. THE DYNAMIC HEAD LOSS AND PRESSURE DROP	PIPCLS	414
C	IN THE QUADRANT HEADER AND BUNDLE FITTINGS ARE DETERMINED.	PIPCLS	415
C		PIPCLS	416
C		PIPCLS	417
C		PIPCLS	418
C	THE QUADRANT PIPING CAN BE SEPARATED INTO TWO GROUPS - THE	PIPCLS	419
C	PORTION THAT RUNS ALONG THE TOP OF THE QUADRANT AND	PIPCLS	420
C	DISTRIBUTES NH3 TO THE CHORDS (HORIZONTAL) AND THE PIPING	PIPCLS	421
C	THAT DISTRIBUTES NH3 TO THE TUBE BUNDLES (VERTICAL)	PIPCLS	422
C		PIPCLS	423
C	EACH QUADRANT MUST HAVE INDEPENDENT PIPING SO THAT	PIPCLS	424
C	PARTIAL SHUT DOWN IS AVAILABLE. TO FACILITATE DESIGN	PIPCLS	425
C	EACH QUADRANT MUST HAVE AN EVEN NUMBER OF CHORDS.	PIPCLS	426
C		PIPCLS	427
C	DESIGN AND COST THE HORIZONTAL PIPING.	PIPCLS	428
C		PIPCLS	429
	NSLPQ=ICHORD/2	PIPCLS	430
	IF(NSLPQ,GT,200) STOP "IN PIPCLS NSLPQ EXCEEDS 200"	PIPCLS	431
	DO 30 I=1,NSLPQ	PIPCLS	432
30	SQRCS(I)=0.	PIPCLS	433
	KS=1	PIPCLS	434
	DOTREM=DOTMAQ	PIPCLS	435
	DOTMAH=2.*DOTMAQ/ICHORD	PIPCLS	436
31	CALL HEADER(DOTREM,DOTMAH,DESVELV,DENSIV,OREDCS,KS,0,DIAJ,DIAS,TC	PIPCLS	437
	SST,RCST,UPCST,OSLCST,SFLGCST,SEJCST)	PIPCLS	438
C		PIPCLS	439
C	THE DIAMETER OF HEADER SECTION KS (DIAS) IS REPLACED BY DIAJ	PIPCLS	440
C	IN ORDER TO COMPARE THE DIAMETER OF SECTION KS WITH KS+1 TO	PIPCLS	441
C	DETERMINE REDUCER REQUIREMENTS. SODIA IS THE STORED VALUE	PIPCLS	442
C	OF THE DIAMETER OF HEADER SECTION KS.	PIPCLS	443
C		PIPCLS	444
	DIAJ=DIAS	PIPCLS	445
	SODIA(KS)=DIAS	PIPCLS	446
	SQTCST(KS)=TCST	PIPCLS	447
C		PIPCLS	448
C	ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER SECTION.	PIPCLS	449
C	THE COST OF A REDUCER IS BASED ON THE LARGEST DIAMETER OF	PIPCLS	450
C	THE REDUCER.	PIPCLS	451
C		PIPCLS	452
	IF(KS,GT,1) SQRCS(KS-1)=RCST	PIPCLS	453
	UPIPCST(KS)=UPCST	PIPCLS	454
C		PIPCLS	455
C	THE FIRST QUADRANT HEADER IS ASSUMED TO HAVE ZERO LENGTH.	PIPCLS	456
C	LENGTH OF THE REMAINING SECTIONS IS THE CHORD LENGTH (TUBEL).	PIPCLS	457

		PIPCLS	458
		PIPCLS	459
C	THE FIRST QUADRANT HEADER IS ASSUMED TO HAVE ZERO LENGTH.	PIPCLS	460
C	LENGTH OF THE REMAINING SECTIONS IS THE CHORD LENGTH (TUBEL).	PIPCLS	461
C		PIPCLS	462
	IF(KS.EQ.1) QHEDR(KS)=0.	PIPCLS	463
	IF(KS.GT.1) QHEDR(KS)=2.*TUBEL	PIPCLS	464
C		PIPCLS	465
C	DETERMINE THE DYNAMIC HEADLOSS AND PRESSURE DROP IN THE	PIPCLS	466
C	QUADRANT HEADER SECTION. SAVE THE VAPOR DENSITY BECAUSE IT	PIPCLS	467
C	MUST BE USED IN COMPUTING DYNAMIC HEADLOSS BUT IS REDEFINED	PIPCLS	468
C	IN HLAMMO. THE NEW VALUE OF DENSITY FROM HLAMMO, LIKE	PIPCLS	469
C	THE TEMPERATURE, TOUT, APPLIES TO THE NEXT HEADER SECTION.	PIPCLS	470
C		PIPCLS	471
	DENS=DENSIV	PIPCLS	472
	EQLN=QHEDR(KS)+20.*DIAS/12.	PIPCLS	473
	CALL HLAMMO(TIN,DOTREM,DIAS,EQLN,1.,TOUT,DELP)	PIPCLS	474
	DELSQ=DELSQ+DELP	PIPCLS	475
	QDYNHDS=QDYNHDS+DELP/DENS	PIPCLS	476
	TIN=TOUT	PIPCLS	477
C		PIPCLS	478
C	SUBTRACT THE FLOW TO ONE VERTICAL SECTION. IF THE FLOW	PIPCLS	479
C	REMAINING IS ZERO THEN THE LAST HEADER SECTION HAS BEEN	PIPCLS	480
C	DESIGNED.	PIPCLS	481
C		PIPCLS	482
	DOTREM=DOTREM-DOTMAH	PIPCLS	483
	IF(DOTREM.LE.0) GO TO 32	PIPCLS	484
	KS=KS+1	PIPCLS	485
	IF(KS.GT.NQS) PIPCSTV=1.E+40	PIPCLS	486
	IF(KS.GT.NQS) RETURN	PIPCLS	487
	GO TO 31	PIPCLS	488
C		PIPCLS	489
C	COMPUTE THE DIAMETER OF THE HORIZONTAL QUADRANT	PIPCLS	490
C	HEADER FITTINGS.	PIPCLS	491
C		PIPCLS	492
	32 QDIAM=SQRT(DOTMAH*CONST1/(DESVELV*DENSIV) *12.	PIPCLS	493
	IF(QDIAM.LT.DIAM(1)) QDIAM=DIAM(1)	PIPCLS	494
	DO 33 I=1,24	PIPCLS	495
	II=I	PIPCLS	496
	IF(QDIAM=DIAM(II)) 34,34,33	PIPCLS	497
	33 CONTINUE	PIPCLS	498
	34 QDIAM=DIAM(II)	PIPCLS	499
C		PIPCLS	500
C	THE PORTION OF THE TEECOST ATTRIBUTED TO THE "BRANCH" IS	PIPCLS	501
C	.33 TIMES THE COST OF A TEE OF THE "BRANCH" DIAMETER.	PIPCLS	502
C		PIPCLS	503
	QDIACST=.33*TEECST(II)	PIPCLS	504
C		PIPCLS	505
C	NOW DESIGN THE VERTICAL QUADRANT HEADER PIPING	PIPCLS	506
C		PIPCLS	507
	IF(NBRUNHI.GT.200) STOP "IN PIPCLS LAYER EXCEEDS 200"	PIPCLS	508
	DO 40 I=1,NBRUNHI	PIPCLS	509
	40 SPRCST(I)=0.	PIPCLS	510
	LS=1	PIPCLS	511
	DOTREM=DOTMAH	PIPCLS	512
	DOTMAV=2.*DOTMAH	PIPCLS	513
	42 CALL HEADER(DOTREM,DOTMAV,DESVELV,DENSIV,PREDUCS,LS,0,DIAM,DIAS,TC	PIPCLS	514

	SSST,RCST,UPCST,PSLCST,PSLGCST,PSJCST)	PIPCLS	515
C		PIPCLS	516
C	THE DIAMETER OF HEADER SECTION LS (DIAS) IS REPLACED BY DIAJ	PIPCLS	517
C	IN ORDER TO COMPARE THE DIAMETER OF SECTION KS WITH KS+1	PIPCLS	518
C	TO DETERMINE REDUCER REQUIREMENTS. SPDIA IS THE STORED	PIPCLS	519
C	VALUE OF THE DIAMETER OF HEADER SECTION LS.	PIPCLS	520
C		PIPCLS	521
	DIAJ=DIAS	PIPCLS	522
	SPDIA(LS)=DIAS	PIPCLS	523
	SPTCST(LS)=TCST	PIPCLS	524
C		PIPCLS	525
C	ASSIGN THE COST OF A REDUCER TO THE PRECEDING HEADER SECTION.	PIPCLS	526
C	THE COST OF A REDUCER IS BASED ON THE LARGEST DIAMETER OF	PIPCLS	527
C	THE REDUCER.	PIPCLS	528
		PIPCLS	529
	IF(LS.GT.1) SPRCST(LS-1)=RCST	PIPCLS	530
	UPPCST(LS)=UPCST	PIPCLS	531
C		PIPCLS	532
C	THE FIRST QUADRANT HEADER IS ASSUMED TO HAVE ZERO LENGTH.	PIPCLS	533
C	THE LENGTH OF THE TEE "RUN" IS ASSUMED TO BE 1.75 TIMES	PIPCLS	534
C	THE PIPE DIAMETER. THIS LENGTH IS SUBTRACTED.	PIPCLS	535
C		PIPCLS	536
	IF(LS.EQ.1) PHEDR(LS)=0.	PIPCLS	537
	IF(LS.GT.1) PHEDR(LS)=BUNWIDT-1.75*DIAS/12.	PIPCLS	538
C		PIPCLS	539
C	DETERMINE THE DYNAMIC HEADLOSS AND PRESSURE DROP IN THE	PIPCLS	540
C	QUADRANT HEADER SECTION. SAVE THE VAPOR DENSITY BECAUSE IT	PIPCLS	541
C	MUST BE USED IN COMPUTING DYNAMIC HEADLOSS BUT IS REDEFINED	PIPCLS	542
C	IN HLAMMO. THE NEW VALUE OF DENSITY FROM HLAMMO, LIKE	PIPCLS	543
C	THE TEMPERATURE, TOUT, APPLIES TO THE NEXT HEADER SECTION.	PIPCLS	544
C		PIPCLS	545
	DENS=DENSIV	PIPCLS	546
	EQLN=PHEDR(LS)+20.*DIAS/12.	PIPCLS	547
	CALL HLAMMO(TIN,DOTREM,DIAS,EQLN,1.,TOUT,DELP)	PIPCLS	548
	DELSP=DELSP+DELP	PIPCLS	549
	PDOYNHDS=PDOYNHDS+DELP/DENS	PIPCLS	550
	TIN=TOUT	PIPCLS	551
C		PIPCLS	552
C	SUBTRACT THE FLOW TO TWO TUBE BUNDLES. IF THE FLOW	PIPCLS	553
C	REMAINING IS ZERO THEN THE LAST HEADER SECTION HAS BEEN	PIPCLS	554
C	DESIGNED.	PIPCLS	555
C		PIPCLS	556
	DOTREM=DOTREM-DOTMAB*2.	PIPCLS	557
	IF(DOTREM.LE.0) GO TO 41	PIPCLS	558
	LS=LS+1	PIPCLS	559
	IF(LS.GT.NPS) PIPCSTV=1.E+40	PIPCLS	560
	IF(LS.GT.NPS) RETURN	PIPCLS	561
	GO TO 42	PIPCLS	562
C		PIPCLS	563
C	COMPUTE THE DIAMETER OF THE BUNDLE FITTINGS.	PIPCLS	564
C		PIPCLS	565
5	41 BRCHDIA=SQRT(DOTMAB*CONST1/(DESVELV*DENSIV))*12.	PIPCLS	566
	IF(BRCHDIA.LT.DIAM(1)) BRCHDIA=DIAM(1)	PIPCLS	567
	DO 43 I=1,24	PIPCLS	568
	II=I	PIPCLS	569
	IF(BRCHDIA=DIAM(II)) 44,44,43	PIPCLS	570
5	43 CONTINUE	PIPCLS	571


```

      44 BRCHDIA=DIAM(II)
C      THE PORTION OF THE TEECOST ATTRIBUTED TO THE "BRANCH" IS
C      .33 TIMES THE COST OF A TEE OF THE "BRANCH" DIAMETER.
C      BRCST=.33*TEECST(II)
C      THE PIPE CONNECTING THE QUADRANT HEADER
C      DETERMINE THE COST OF THE BUNDLE FITTINGS
C      TO THE TUBE BUNDLE HEADER
C      SBFCST=2.*APIPCST(II)+2.*FLGCST(II)
C      EVALUATE THE COST OF THE QUADRANT HEADER.
C      FIRST DETERMINE THE COST OF THE HORIZONTAL SECTION.
C
      DO 50 I=1,KS
      SQTCTST(I)=SQTCTST(I)+QDIACST
50    SQPCST(I)=QHEDR(I)*UPIPCST(I)
      SQTCTST(KS)=0.
      DO 51 I=1,KS
      IF(I,LT,KS) SQCOST=SQCOST+SQPCST(I)+SQRCST(I)+SQTCTST(I)
      IF(I,EQ,KS) SQCOST=SQCOST+SQPCST(I)+SQRCST(I)+QSLCST
51    CONTINUE
C      SECOND EVALUATE THE COST OF THE VERTICAL QUADRANT HEADER
C      PIPING.
C
      DO 52 I=1,LS
      SPTCTST(I)=SPTCTST(I)+BRCST*2.
52    SPPCST(I)=UPPPCST(I)*PHEDR(I)
      SPTCTST(LS)=0.
      DO 53 I=1,LS
      SPCCTST=SPCCTST+SPPCST(I)+SPRCST(I)+SPTCTST(I)
53    CONTINUE
C      DETERMINE THE TOTAL COST OF THE SUPPLY QUADRANT PIPING.
C
      SQCOST=SQCOST+NSLPQ*SPCCTST+NBUNPQD*SBFCST
      TSQCOST=SQCOST*CTOW*4.
C      DETERMINE THE PRESSURE DROP AND DYNAMIC HEADLOSS IN THE
C      QUADRANT PIPING.
C
      DELSQ=DELSQ+DELSQ
      QDYNHDS=QDYNHDS+PDYNHDS
C      COMPUTE DYNAMIC HEAD LOSS IN BUNDLE FITTINGS.
C
      DENS=DENSIV
      EQLEN = 120. * BRCHDIA/12.
      CALL HLAMMO(TIN,DOTMAB,BRCHDIA,EQLEN,1.,TOUT,DELPBS)
      BSDYNHD=DELPBS/DENS
C      THE VAPOR TEMPERATURE AT THE HEAT EXCHANGER INLET HAS BEEN

```

```

      PIPCLS 572
      PIPCLS 573
      PIPCLS 574
      PIPCLS 575
      PIPCLS 576
      PIPCLS 577
      PIPCLS 578
      PIPCLS 579
      PIPCLS 580
      PIPCLS 581
      PIPCLS 582
      PIPCLS 583
      PIPCLS 584
      PIPCLS 585
      PIPCLS 586
      PIPCLS 587
      PIPCLS 588
      PIPCLS 589
      PIPCLS 590
      PIPCLS 591
      PIPCLS 592
      PIPCLS 593
      PIPCLS 594
      PIPCLS 595
      PIPCLS 596
      PIPCLS 597
      PIPCLS 598
      PIPCLS 599
      PIPCLS 600
      PIPCLS 601
      PIPCLS 602
      PIPCLS 603
      PIPCLS 604
      PIPCLS 605
      PIPCLS 606
      PIPCLS 607
      PIPCLS 608
      PIPCLS 609
      PIPCLS 610
      PIPCLS 611
      PIPCLS 612
      PIPCLS 613
      PIPCLS 614
      PIPCLS 615
      PIPCLS 616
      PIPCLS 617
      PIPCLS 618
      PIPCLS 619
      PIPCLS 620
      PIPCLS 621
      PIPCLS 622
      PIPCLS 623
      PIPCLS 624
      PIPCLS 625
      PIPCLS 626
      PIPCLS 627
      PIPCLS 628

```

SUBROUTINE PIPCLS

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	DETERMINED ON THE BASIS OF THE ACCUMULATIVE PRESSURE DROPS	PIPCLS	629
C	IN THE SUPPLY PIPING.	PIPCLS	630
C		PIPCLS	631
	THXIN = TOUT	PIPCLS	632
C		PIPCLS	633
C	DETERMINE TOTAL COST, PRESSURE DROP, AND DYNAMIC HEAD LOSS	PIPCLS	634
C	IN THE SUPPLY PIPING SYSTEM.	PIPCLS	635
C		PIPCLS	636
	PIPCSTV=SCOST+TSTDCST+TSQCOST	PIPCLS	637
	PIPCSTV = PIPCV + POHCIR	PIPCLS	638
	DELV=DELSH+DELPD+DELPT+DELSQ+DELPBS	PIPCLS	639
	DYNHDS=DYNHDS+DDYNHD+TDYNHD+QDYNHDS+BSDYNHD	PIPCLS	640
C		PIPCLS	641
C	STORE VALUES IN COMMON BLOCK /RPTRET/ FOR LATER USE IN	PIPCLS	642
C	OUTPUT.	PIPCLS	643
C		PIPCLS	644
	SDELV = DELV	PIPCLS	645
	SDOTMA = DOTMA	PIPCLS	646
	SPCSTV = PIPCV	PIPCLS	647
	STHXIN = THXIN	PIPCLS	648
	STCONO = TCONOUT	PIPCLS	649
	STHXIN = THXIN	PIPCLS	650
	STOWDI = TOWDIA	PIPCLS	651
	RETURN	PIPCLS	652
	END	PIPCLS	653

FUNCTION PNLIM

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	FUNCTION PNLIM(AMIN,AMAX,AFUNC)	PNLIM	2
C	FUNCTION PNLIM LIMITS AFUNC BETWEEN AMIN AND AMAX	PNLIM	3
C	PNLIM=AFUNC	PNLIM	4
C	IF AFUNC IS LESS THAN AMIN SET PNLIM EQUAL TO AMIN	PNLIM	5
C	IF (AFUNC=AMIN) 10,10,20	PNLIM	6
10	PNLIM=AMIN	PNLIM	7
	GO TO 50	PNLIM	8
C	IF AMAX IS LESS THAN AMIN JUST SET PNLIM EQUAL TO AFUNC	PNLIM	9
C	20 IF (AMAX=AMIN) 50,50,30	PNLIM	10
C	IF AFUNC IS GREATER THAN AMAX SET PNLIM EQUAL TO AMAX	PNLIM	11
C	30 IF (AFUNC=AMAX) 50,50,40	PNLIM	12
	40 PNLIM=AMAX	PNLIM	13
	50 RETURN	PNLIM	14
	END	PNLIM	15
		PNLIM	16
		PNLIM	17
		PNLIM	18
		PNLIM	19
		PNLIM	20

```

C      SUBROUTINE PRPERT(TWATAV,TAIRAV,ALTITD)
C
C      SUBROUTINE PRPERT DETERMINES THE THERMODYNAMIC AND PHYSICAL
C      PROPERTIES OF AIR AND SATURATED AMMONIA
C
C      DEFINITION OF VARIABLES
C
C      CPA      - HEAT CAPACITY OF AIR (BTU/LBM-DEG F)
C      CPU      - HEAT CAPACITY OF AMMONIA VAPOR (BTU/LBM-DEG F)
C      CPW      - HEAT CAPACITY OF AMMONIA LIQUID (BTU/LBM-DEG F)
C      DENSIA   - DENSITY OF AIR (LBM/CU FT)
C      DENSIV   - DENSITY OF AMMONIA VAPOR (LBM/CU FT)
C      DENSIV   - DENSITY OF AMMONIA LIQUID (LBM/CU FT)
C      HFG      - HEAT OF VAPORIZATION OF AMMONIA (BTU/LBM)
C      SIGMA    - SURFACE TENSION OF AMMONIA (LBF/FT)
C      TAIRAV   - AVERAGE AIR TEMPERATURE (DEG F)
C      THCONA   - THERMAL CONDUCTIVITY OF AIR (BTU/HR-FT-DEG F)
C      THCONV   - THERMAL CONDUCTIVITY OF AMMONIA VAPOR (BTU/HR-FT-
C                DEG F)
C      THCONW   - THERMAL CONDUCTIVITY OF AMMONIA LIQUID (BTU/HR-FT-
C                DEG F)
C      TWATAV   - AMMONIA TEMPERATURE (DEG F)
C      VISA     - VISCOSITY OF THE AIR (LBM/HR-FT)
C      VISV     - VISCOSITY OF THE AMMONIA VAPOR (LBM/FT-HR)
C      VISW     - VISCOSITY OF THE AMMONIA LIQUID (LBM/FT-HR)
C
C      COMMON / PROP/ CPW, THCONW, DENSIV, VISW, HFG,
C      *              CPV, THCONV, DENSIV, VISV, SIGMA,
C      *              CPA, THCONA, DENSIA, VISA
C
C      AMMONIA PROPERTIES
C      CPW = FLUID(1,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 1")
C      THCONW = FLUID(2,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 2")
C      DENSIV = FLUID(3,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 3")
C      VISW = FLUID(4,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 4")
C      CPV = FLUID(5,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 5")
C      THCONV = FLUID(6,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 6")
C      DENSIV = FLUID(7,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 7")
C      VISV = FLUID(8,1,TWATAV,ALTITD,"SUBROUTINE PRPERT 8")
C      HFG = FLUID(9,1,TWATAV,ALTITD,"SUBROUTINE PRPERT8.5")
C      SIGMA = FLUID(12,1,TWATAV,ALTITD,"SUBROUTINE PRPERT8.7")
C
C      AIR PROPERTIES
C      CPA = FLUID(5,2,TAIRAV,ALTITD,"SUBROUTINE PRPERT 9")
C      THCONA = FLUID(6,2,TAIRAV,ALTITD,"SUBROUTINE PRPERT 10")
C      DENSIA = FLUID(7,2,TAIRAV,ALTITD,"SUBROUTINE PRPERT 11")
C      VISA = FLUID(8,2,TAIRAV,ALTITD,"SUBROUTINE PRPERT 12")
C
C      RETURN
C      END

```

SUBROUTINE PUMLEC

74/74

OPT=1

FTN 4,5+414

06/05/78 07.59.59

	SUBROUTINE PUMLEC(POHLEC, HPWAT, DIST, EFPF, RPTPL)	PUMLEC	2
	DATA NPMP /2/	PUMLEC	3
	DATA DSGTM /100./	PUMLEC	4
C		PUMLEC	5
C....	COMPUTE PUMP MOTOR ELECTRICAL COSTS	PUMLEC	6
C		PUMLEC	7
C	NPMP, SET BY DATA STATEMENT. THE NUMBER OF PUMPS	PUMLEC	8
C		PUMLEC	9
	HPPMP = HPWAT/(NPMP*EFPF)	PUMLEC	10
	IF(HPPMP .LT. 251.) TRMA = 112500./NPMP + 7.88 * HPPMP	PUMLEC	11
\$	+ (116.-.159*HPPMP)*HPPMP	PUMLEC	12
	IF(HPPMP .GE. 251. .AND. HPPMP .LE. 4000.) TRMA = 112500./NPMP	PUMLEC	13
\$	+ 7.88*HPPMP + 870./SQRT(HPPMP)*HPPMP	PUMLEC	14
	IF(HPPMP .GT. 2000.) TRMA = 112500./NPMP + 7.88 * HPPMP	PUMLEC	15
	VS = 7200.	PUMLEC	16
	IF (HPPMP .LT. 2000.) VS = 13800.	PUMLEC	17
	VM = 6900.	PUMLEC	18
	IF(HPPMP .LT. 2000.) VM = 2300.	PUMLEC	19
	IF (HPPMP .LT. 251.) VM = 480.	PUMLEC	20
	TRMB = (DIST/2. - 1000.)*(37. + .47*HPPMP*NPMP/SQRT(VS)	PUMLEC	21
\$	+ .5 *NPMP) / NPMP	PUMLEC	22
	TRMC = (100. + 1.1 * HPPMP) * (DSGTM -250.) / SQRT(VM)	PUMLEC	23
	PMELEC = (TRMA + TRMB + TRMC) * PDHLEC	PUMLEC	24
	RPTPL = PMELEC/1000. * NPMP	PUMLEC	25
	RETURN	PUMLEC	26
	END	PUMLEC	27

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE PUMPCST(W3, DELPS, DELPR, DELPWT, DELPWC, X, DESVEL,
\$ PUMPCST, PUFITC)

SUBROUTINE PUMPCST DETERMINES THE COST OF THE PUMPS AND
THE FITTINGS FOR THE AMMONIA LOOP

DEFINITION OF VARIABLES

CPA - HEAT CAPACITY OF AIR (BTU/LBM-DEG F)
CPV - HEAT CAPACITY OF AMMONIA VAPOR (BTU/LBM-DEG F)
CPA - HEAT CAPACITY OF AMMONIA LIQUID (BTU/LBM-DEG F)
DELPR - PRESSURE DROP IN THE RETURN PIPING (LBF/SQ FT)
DELPS - PRESSURE DROP IN THE SUPPLY PIPING (LBF/SQ FT)
DELPWC - PRESSURE DROP IN THE CONDENSER/REBOILER
(LBF/SQ FT)
DELPWT - PRESSURE DROP IN THE HEAT EXCHANGER (LBF/SQ FT)
DENSIW - DENSITY OF AMMONIA LIQUID (LBM/CU FT)
DESVEL - DESIGN LIQUID VELOCITY (FT/SEC)
DIA - DIAMETER OF THE VALVES AND FLANGES (IN)
GPM1 - GALLONS PER MINUTE OF AMMONIA IN THE RETURN
PIPING (GPM)
GPM2 - GALLONS PER MINUTE OF AMMONIA ENTERING THE CON-
DENSER/REBOILER (GPM)
PIPCSP1 - FLANGE AND VALVE COST FOR PUMPING IN THE RETURN
PIPING (K\$)
PIPCSP2 - FLANGE AND VALVE COST FOR PUMPING IN THE LOOP TO
THE CONDENSER/REBOILER (K\$)
PUMPCST - TOTAL COST OF PUMPING SYSTEM (K\$)
PUMPCS2 - COST OF PUMP FOR LOOP TO THE CONDENSER/
REBOILER (K\$)
TDH1 - DYNAMIC HEAD TO BE MADE UP BY THE RETURN PUMP (FT)
TDH2 - DYNAMIC HEAD TO BE MADE UP BY THE PUMP IN THE
CONDENSER/REBOILER LOOP (FT)
W3 - MASS FLOW OF AMMONIA (LBM/HR)
X - EXIT QUALITY OF FLUID EXITING THE CONDENSER/
REBOILER (DIMENSIONLESS)

DIMENSION DIAM(24), FLGCST(24), VACST(24)
COMMON/PROP/CPW,THCONW,DENSIW,VISW,HFG,
1 CPV,THCONV,DENSIV,VISV,SIGMA,
2 CPA,THCONA,DENSIA,VISA

DATA DIAM /

\$ 6. , 12. , 18. , 24. , 30. , 36. ,
\$ 42. , 48. , 54. , 60. , 66. , 72. ,
\$ 78. , 84. , 90. , 96. , 102. , 108. ,
\$ 114. , 120. , 126. , 132. , 138. , 144. /

DATA VACST/

\$ 2.87 , 7.09 , 16.9 , 26.7 , 52.2 , 77.8 ,
\$ 109. , 141. , 164. , 187. , 213. , 240. ,
\$ 266. , 293. , 319. , 346. , 372. , 399. ,
\$ 425. , 452. , 478. , 505. , 531. , 558. /

DATA FLGCST/

\$.136 , .520 , 1.03 , 1.92 , 3.17 , 4.42 ,
\$ 6.82 , 9.22 , 12.0 , 14.7 , 21.1 , 27.5 ,
\$ 33.9 , 40.4 , 46.8 , 53.2 , 59.7 , 66.1 ,
\$ 72.5 , 78.9 , 85.4 , 91.8 , 98.2 , 105. /

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

SUBROUTINE PUMPCST 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	DATA NKOS/24/	PMPGST	59
C	CONST1 IS 4 / (PI*3600)	PMPGST	60
C	DATA CONST1 / 3.536777 E=04 /	PMPGST	61
C		PMPGST	62
C	DIAMETER OF PIPE RETURNING FROM THE HEAT EXCHANGER	PMPGST	63
C	DIA = SQRT(W3*CONST1/(DENSIW*DESVEL))*12.	PMPGST	64
	DO 10 II = 1, NKOS	PMPGST	65
	I = II	PMPGST	66
	IF(DIA - DIAM(I)) 11,11,10	PMPGST	67
10	CONTINUE	PMPGST	68
C		PMPGST	69
C	DAIMETER OF PIPE ENTERING TME CONDENSER/REBOILER	PMPGST	70
C	11 DIA = SORT(W3*CONST1/(DENSIW*DESVEL*X))*12.	PMPGST	71
	DO 12 JJ = 1,NKOS	PMPGST	72
	J = JJ	PMPGST	73
	IF(DIA - DIAM(J)) 13,13,12	PMPGST	74
12	CONTINUE	PMPGST	75
C		PMPGST	76
C	FLANGE AND VALVE COSTS FOR BOTH PUMPS	PMPGST	77
C	13 PIPCSP1 = 2.*FLGCST(I) + 2. * VACST(I)	PMPGST	78
	PIPCSP2 = 2.*FLGCST(J) + 2.*VACST(J)	PMPGST	79
	PUFITC = PIPCSP1 + PIPCSP2	PMPGST	80
C		PMPGST	81
C	PUMP COSTS	PMPGST	82
	GPM1 = W3*7.481/(DENSIW*60.)	PMPGST	83
	GPM2 = W3*7.481/(DENSIW*X*60.)	PMPGST	84
	TDH1 = (DELPS + DELPR + DELPWT)/DENSIW	PMPGST	85
	TDH2 = DELPWC/DENSIW	PMPGST	86
	PUMPCS1 = (0.032*TDH1 + 1.54)*GPM1	PMPGST	87
	PUMPCS2 = (0.032*TDH2 + 1.54)*GPM2	PMPGST	88
	PUMPCS1 = PUMPCS1 / 1000.	PMPGST	89
	PUMPCS2 = PUMPCS2 / 1000.	PMPGST	90
C		PMPGST	91
C	TOTAL COST OF PUMPING SYSTEM	PMPGST	92
	PMPGST = PUMPCS1 + PUMPCS2 + PIPCSP1 + PIPCSP2	PMPGST	93
	RETURN	PMPGST	94
	END	PMPGST	95
		PMPGST	96

	SUBROUTINE RPRT2 (EFFC, TUBEM, TUBEM2)	RPRT2	2
C		RPRT2	3
C	THIS ROUTINE REPORTS CONDENSER DESIGN AND COSTS	RPRT2	4
C		RPRT2	5
	COMMON/KPRT2/UCON,HOCON,HICON,HWCN,HFC,VELD,VELDO,TTD,TS,XNP,	RPRT2	6
	DELPC,ARPS,TLA,XNTS,XNS	RPRT2	7
	COMMON /KPRT3/ TUBCST,SHLCST,FETCST,CHX	RPRT2	8
6090	FORMAT(1H1)	RPRT2	9
6100	FORMAT(	RPRT2	10
	C T40,20("=")/T41,"C O N D E N S E R"/T40,20("="))	RPRT2	11
6105	FORMAT(	RPRT2	12
	L T04,"--- DESIGN CONDITIONS ---"	RPRT2	13
	R,T72,"--- DESIGN OPERATING CONDITIONS ---"//)	RPRT2	14
6110	FORMAT(	RPRT2	15
	L T16,"STEAM TEMPERATURE",F6,1," F"	RPRT2	16
	R,T60,"OVERALL HEAT TRANSFER COEFFICIENT ",F8,2," BTU/HR SQ FT DEG	RPRT2	17
	RF")	RPRT2	18
6115	FORMAT(	RPRT2	19
	L T14,"AMMONIA TEMPERATURE",F6,1," F"	RPRT2	20
	R,T62,"STEAM HEAT TRANSFER COEFFICIENT",F8,2,"BTU/HR SQ FT DEG F")	RPRT2	21
6120	FORMAT(	RPRT2	22
	L T11,"INLET AMMONIA VELOCITY",F8,2,"FT/SEC"	RPRT2	23
	R,T60,"AMMONIA HEAT TRANSFER COEFFICIENT",F8,2,"BTU/HR SQ FT DEG F"	RPRT2	24
	R)	RPRT2	25
6125	FORMAT(	RPRT2	26
	L T10,"OUTLET AMMONIA VELOCITY",F8,2,"FT/SEC"	RPRT2	27
	R,T63,"WALL HEAT TRANSFER COEFFICIENT",F8,2,"BTU/HR SQ FT DEG F")	RPRT2	28
6128	FORMAT(	RPRT2	29
	L T05,"PRESSURE DROP THRU CONDENSER",F8,1,"LB/SQ FT"	RPRT2	30
	R,T64,"FORCED CONVECTION COEFFICIENT",F8,2,"BTU/HR SQ FT DEG F")	RPRT2	31
6130	FORMAT(	RPRT2	32
	L/T06,"--- CONDENSER DESCRIPTION ---"	RPRT2	33
	R,T79,"--- CONDENSER COSTS ---"//)	RPRT2	34
6135	FORMAT(	RPRT2	35
	L T17,"NUMBER OF SHELLS",I6,	RPRT2	36
	R T76,"TUBING MATERIAL \$",F14,2,2X(" ",2A10,""))	RPRT2	37
6140	FORMAT(	RPRT2	38
	L T05,"HEAT TRANSFER AREA PER SHELL",G11,5," SQ FT"	RPRT2	39
	R T85,"SHELLS \$",F14,2)	RPRT2	40
6145	FORMAT(	RPRT2	41
	L T07,"NUMBER OF PASSES PER SHELL",I6,	RPRT2	42
	R T77,"FIELD ERECTION \$",F14,2)	RPRT2	43
6150	FORMAT(	RPRT2	44
	L T22,"TUBE LENGTH",I6,T45,"FEET")	RPRT2	45
6155	FORMAT(	RPRT2	46
	L T08,"NUMBER OF TUBES PER SHELL",I6	RPRT2	47
	R,T68,"TOTAL COST OF CONDENSER \$",F14,0)	RPRT2	48
C		RPRT2	49
	WRITE(6,6090)	RPRT2	50
	WRITE(6,6100)	RPRT2	51
	WRITE(6,6105)	RPRT2	52
	WRITE(6,6110) TS,UCON	RPRT2	53
	WRITE(6,6115) TS-TTD, HOCON	RPRT2	54
	WRITE(6,6120) VELD, HICON	RPRT2	55
	WRITE(6,6125) VELDO, HWCN	RPRT2	56
	WRITE(6,6128) DELPC, HFC	RPRT2	57
	WRITE(6,6130)	RPRT2	58

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	CPM	- COST OF PLENUM MATERIAL PER POUND (\$/LBM)	SCALP	59
C	CS	- COOLING SURFACE COST (\$)	SCALP	60
C	CSE	- COST OF HEADER SEALANT FOR CONNECTING PLASTIC TUBES	SCALP	61
C		TO THE HEADER (\$)	SCALP	62
C	CSTHS	- COST OF THE HAIL SCREENS FOR THE ENTIRE FRONTAL	SCALP	63
C		AREA OF THE HEAT EXCHANGER (\$)	SCALP	64
C	CSTLVR	- COST OF THE LOUVERS FOR CONTROLLING THE AIR FLOW	SCALP	65
C		TO THE HEAT EXCHANGERS (\$)	SCALP	66
C	CWARA	- RATIO OF HEAT CAPACITY OF THE WATER TO THE AIR	SCALP	67
C		(DIMENSIONLESS)	SCALP	68
C	CYLRNG	- COST OF THE FAN RING AND THE VELOCITY RECOVERY	SCALP	69
C		STACK IF THEY ARE USED (\$/FAN)	SCALP	70
C	DELFC	- INCREMENTAL FUEL COST FOR THE SCALED UP PLANT	SCALP	71
C		(MILLS/KW HR)	SCALP	72
C	ELENG	- LENGTH OF HEAT EXCHANGER TUBES (FT)	SCALP	73
C	FBACC	- COST OF FAN BLADES AFTER SCALING UP THE NUMBER OF	SCALP	74
C		FANS (\$)	SCALP	75
C	FBCPF	- COST OF FAN BLADES PER FAN (\$/FAN)	SCALP	76
C	FCBZ	- FUEL COST FOR THE BASE PLANT WITH A ZERO COST ONCE	SCALP	77
C		THROUGH COOLING SYSTEM (MILLS/HW HR)	SCALP	78
C	FCB3	- FUEL COST FOR THE SCALED UP PLANT (MILLS /KW HR)	SCALP	79
C	FCOS	- COST OF FUEL FOR POWER PLANT (CENTS/BTU)	SCALP	80
C	FCR	- FIXED CHARGE RATE FOR CAPITAL PER YEAR (PERCENT/YR)	SCALP	81
C	FIXL	- THE FIXED LENGTH OF HEAT EXCHANGER TUBES SPECIFIED	SCALP	82
C		BY THE INPUT TO THE CODE (FT)	SCALP	83
C	FMCPE	- FAN MOTOR COST PER FAN (\$/FNA)	SCALP	84
C	FMCST	- TOTAL FAN MOTOR COST FOR THE FAN SYSTEM AFTER	SCALP	85
C		SCALE UP (\$)	SCALP	86
C	FPOW	- POWER REQUIREMENTS OF THE FAN SYSTEM (KW)	SCALP	87
C	HPAIR	- HORSEPOWER REQUIREMENTS OF THE FAN SYSTEM (HP)	SCALP	88
C	HPWAT	- HORSEPOWER REQUIREMENTS OF THE WATER PUMPING	SCALP	89
C		SYSTEM (HP)	SCALP	90
C	HRFAC1	- HEAT RATE FACTOR AT POINT ON (DIMENSIONLESS)	SCALP	91
C	HRFAC2	- HEAT RATE FACTOR AT POINT TWO (DIMENSIONLESS)	SCALP	92
C	HRFR21	- RATIO OF HRFAC2 TO HRFAC1 USED FOR SCALING UP	SCALP	93
C		PLANT TO DESIGN CONDITIONS (DIMENSIONLESS)	SCALP	94
C	HSLVA	- SURFACE AREA COVERED BY HAIL SCREENS OR LOUVERS	SCALP	95
C		(SQ FT)	SCALP	96
C	ITOWN	- NUMBER OF CIRCULAR TOWERS (DIMENSIONLESS)	SCALP	97
C	KCONV	- INTERNAL VARIABLE FOR SPECIFYING THAT THE SET OF	SCALP	98
C		INPUT VARIABLES LEAD TO UNREASONABLE VALUES	SCALP	99
C		(DIMENSIONLESS)	SCALP	100
C	KGA	- VARIABLE FOR SPECIFYING GAGE OF TUBES USED IN THE	SCALP	101
C		CONDENSER (DIMENSIONLESS)	SCALP	102
C	LD	- VARIABLE FOR SPECIFYING THE DIAMETER OF THE	SCALP	103
C		CONDENSER TUBING (DIMENSIONLESS)	SCALP	104
C	NEGV	- STOPS THE PROGRAM IF THE SCALED UP FRONTAL AREA,	SCALP	105
C		MASS FLOW OF AIR AND SPECIFIC VOLUME OF AIR IS LESS	SCALP	106
C		THAN ZERO (DIMENSIONLESS)	SCALP	107
C	NUMTOW	- NUMBER OF CIRCULAR TOWERS (DIMENSIONLESS)	SCALP	108
C	NW	- NUMBER OF HEAT EXCHANGER TUBES IN WIDTH	SCALP	109
C		(DIMENSIONLESS)	SCALP	110
C	PER	- PERCENTAGE OF TOTAL CAPITAL COSTS OF DRY COOLING	SCALP	111
C		TOWER ALLOWED FOR MAINTENANCE COST (PERCENT)	SCALP	112
C	PLANC	- BASE PLANT COSTS (\$/KW)	SCALP	113
C	PLANC1	- PLANT COSTS AT POINT ONE (\$/KW)	SCALP	114
C	PLANC2	- PLANT COST AT POINT TWO (\$/KW)	SCALP	115

```

C      SUBROUTINE SCALP(T1,RANGE,AFRON,WLRAT,TCWFCS,ITOWN)      SCALP      2
C                                                                SCALP      3
C      SUBROUTINE SCALP SCALES THE PLANT AND DRY COOLING TOWER  SCALP      4
C      DESIGNS AND COSTS LINEARLY UPWARD OR DOWNWARD TO ACCOUNT SCALP      5
C      FOR THE FOLLOWING FACTORS-                                SCALP      6
C          1. THE DESIGN TEMPERATURE OF THE POWER PLANT DOES   SCALP      7
C              NOT CORRESPOND TO THE RATED BACK PRESSURE OF THE SCALP      8
C              STEAM TURBINE.                                    SCALP      9
C          2. PART OF THE TOTAL POWER OUTPUT OF THE PLANT IS    SCALP     10
C              USED IN SUPPLYING POWER TO THE FAN AND PUMPING    SCALP     11
C              SYSTEMS.                                           SCALP     12
C      THE FOLLOWING ARE POINTS ON THE HEAT RATE FACTOR CURVE WHICH SCALP     13
C      ARE USED IN DESCRIBING THE SCALING OF THE PLANT AND DRY COOL- SCALP     14
C      ING TOWERS. AT EACH OF THESE POINTS THE HEAT RATE FACTOR, SCALP     15
C      PLANT SIZE AND PLANT COSTS ARE DETERMINED.              SCALP     16
C                                                                SCALP     17
C      POINT 0 - CONVENTIONAL TURBINE OPERATING AT RATED BACK   SCALP     18
C                  PRESSURE                                       SCALP     19
C      POINT 1 - STEAM TURBINE OPERATING AT RATED BACK PRESSURE SCALP     20
C      POINT 2 - STEAM TURBINE OPERATING AT SYSTEM DESIGN EXIT SCALP     21
C                  TEMPERATURE WITH OUTPUT OF TURBINE GENERATOR EQUAL SCALP     22
C                  TO THE DESIGN POWER OUTPUT                    SCALP     23
C      POINT 3 - STEAM TURBINE OPERATING AT SYSTEM DESIGN EXIT SCALP     24
C                  TEMPERATURE WITH THE POWER OUTPUT OF PLANT EQUAL SCALP     25
C                  TO THE DESIGN POWER OUTPUT                    SCALP     26
C      THE DIFFERENCE BETWEEN POINT TWO AND THREE IS THE PLANT HAS SCALP     27
C      BEEN SCALED UP TO ACCOUNT FOR THE POWER CONSUMPTION OF THE SCALP     28
C      FANS AND PUMPS. BETWEEN POINT ONE AND TWO THE POWER PLANT SCALP     29
C      HAS BEEN SCALED UP OR DOWN TO ACCOUNT FOR AN INCREASE OR SCALP     30
C      DECREASE IN THE HEAT RATE FACTOR.                        SCALP     31
C                                                                SCALP     32
C      DEFINITION OF VARIABLES                                  SCALP     33
C                                                                SCALP     34
C      AAIR      - AIR SIDE HEAT TRANSFER AREA OF HEAT EXCHANGER SCALP     35
C                  (SQ FT)                                       SCALP     36
C      ADIA      - FAN BLADE DIAMETER (FT)                      SCALP     37
C      AFRON     - FRONTAL AREA OF THE HEAT EXCHANGER NORMAL TO AIR SCALP     38
C                  FLOW (SQ FT)                                  SCALP     39
C      ATUBC     - HEAT EXCHANGER TUBE COST ($)                 SCALP     40
C      BSECF     - BUNDLE SHIPPING AND ERECTION COST FACTOR (DIMEN- SCALP     41
C                  SIONLESS)                                     SCALP     42
C      CA        - BUNDLE ASSEMBLY COST ($)                     SCALP     43
C      CAPE      - PERCENT OF TIME PLANT IS GENERATING POWER DURING SCALP     44
C                  THE YEAR (PERCENT)                           SCALP     45
C      CCOOS     - TOTAL COST OF THE DRY COOLING TOWER ($)      SCALP     46
C      CFANEL    - COST OF THE ELECTRICAL WIRING FOR THE FAN SYSTEM SCALP     47
C                  ($)                                           SCALP     48
C      CFOUND    - COST OF THE FOUNDATION FOR THE DRY COOLING TOWERS SCALP     49
C                  ($)                                           SCALP     50
C      CH        - BUNDLE COSTS FOR THE HEAT EXCHANGER ($)     SCALP     51
C      CHAILS    - COST OF HAIL SCREENS PER UNIT AREA ($/SQ FT) SCALP     52
C      CLAND     - COST OF LAND COVERED BY THE DRY COOLING TOWERS ($) SCALP     53
C      CLUVR     - COST OF LOUVERS PER UNIT AREA ($/SQ FT)     SCALP     54
C      CONBAS    - COST OF THE SURFACE CONDENSER ($)            SCALP     55
C      COSM      - INCREMENTAL MAINTENANCE COSTS OF DRY COOLING ($) SCALP     56
C      CPIP      - COST OF THE PIPING SYSTEM ($)                SCALP     57
C      CPLEN     - COST OF THE PLENUM ON TOP OF THE COOLING TOWERS ($) SCALP     58

```

```

$-----"/25X,"CIRCULATION PIPING"/52X,"COST IN 10**" " RPTSUP 59
$3 DOLLARS FOR"/40X,"-----" RPTSUP 60
$---"/12X,"HEADER DIAMETER LENGTH PIPE TEES REDUCE RPTSUP 61
$RS EXPANSION FLANGES"/21X,"(INCHES) (FEET)",33X,"JOINT(1) (3 RPTSUP 62
$)"/) RPTSUP 63
217 FORMAT(///10X,"FITTINGS COST PER BUNDLE $",F5.3," *10**3") RPTSUP 64
C RPTSUP 65
WRITE(6,213) RPTSUP 66
WRITE(6,216) RPTSUP 67
DO 201 I=1,JS RPTSUP 68
IF(I.GT.1) GO TO 202 RPTSUP 69
WRITE(6,203) I,SDIA1(I),HEDR1(I),SPCST1(I)*PF,STCST1(I)*PF, RPTSUP 70
SSPCST1(I)*PF,SEJCS1*PF,SFLGC1*PF RPTSUP 71
GO TO 201 RPTSUP 72
202 IF(I.EQ.JS) GO TO 210 RPTSUP 73
WRITE(6,203) I,SDIA1(I),HEDR1(I),SPCST1(I)*PF,STCST1(I)*PF, RPTSUP 74
SSRCST1(I)*PF RPTSUP 75
GO TO 201 RPTSUP 76
210 WRITE(6,203) I,SDIA1(I),HEDR1(I),SPCST1(I)*PF,SELCT*PF, RPTSUP 77
SSRCST1(I)*PF RPTSUP 78
201 CONTINUE RPTSUP 79
WRITE(6,204) SCOST1*PF RPTSUP 80
WRITE(6,205) RPTSUP 81
DO 206 I=1,KS RPTSUP 82
IF(I.EQ.KS) GO TO 207 RPTSUP 83
WRITE(6,214) I,SQDIA1(I),QHEDR1(I),SQPCS1(I)*PF,SQTCST1(I)*PF, RPTSUP 84
SSQRCST1(I)*PF RPTSUP 85
GO TO 206 RPTSUP 86
207 WRITE(6,214) I,SQDIA1(I),QHEDR1(I),SQPCS1(I)*PF,OSLCS1, RPTSUP 87
SSQRCST1(I)*PF RPTSUP 88
206 CONTINUE RPTSUP 89
WRITE(6,305) RPTSUP 90
305 FORMAT(/25X,"VERTICAL QUADRANT SUPPLY PIPING "/42X,"COST RPTSUP 91
$IN 10**3 DOLLARS FOR "/40X,30(")/12X,"HEADER DIAMETER LENGTH RPTSUP 92
$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/) RPTSUP 93
DO 306 I=1,LS RPTSUP 94
WRITE(6,214) I,SPDIA1(I),PHEDS1(I),SPPCST1(I),SPTCST1(I),SPRCST1(I RPTSUP 95
$) RPTSUP 96
306 CONTINUE RPTSUP 97
WRITE(6,517) NBUN RPTSUP 98
517 FORMAT(///10X,"NUMBER OF BUNDLES PER QUADRANT",I10) RPTSUP 99
WRITE(6,217) SBFCST1*PF RPTSUP 100
WRITE(6,215) SQCOS1*PF RPTSUP 101
WRITE(6,208) TSQCST1*PF RPTSUP 102
WRITE(6,209) NUMTOW,NTOWDE1,CTOWD1,HTOW1,WBB1,DIA1SD1,DIAS1,STDCS1 RPTSUP 103
1*PF,TSTDC1*PF RPTSUP 104
WRITE(6,211) DESVELV, DOTMA1, TC0N01, THXIN1, DELV1,DYNHD1, PIPCS1 RPTSUP 105
RETURN RPTSUP 106
END RPTSUP 107

```

```

SUBROUTINE RPTSUP(DESVELV,NUMTOW,CTOWD1,WBB1,HTOW1,NTOWDE1)
C
C THIS ROUTINE REPORTS RETURN PIPING DESIGN AND COSTS
C
COMMON /KPTSUP/
$ DELV1, DIASD1, DIAST1, DOTMA1, DYNHD1
$, HEORI(200)
$, JSSAVE
$, KSSAVE
$, PIPCS1
$, QSLCS1, QHEDR1(200)
$, SBFCS1, SCOST1, SEJCS1, SELCST, SFLGC1, SQCOS1, STDCS1
$, SDIAL(200), SPCST1(200), SQDIA1(200), SQPCS1(200), SQRCS1(200)
$, SPTCS1(200), SRCST1(200), STCST1(200)
$, TCONO1, THXIN1, TOWD11, TSQC01, TSTDC1
COMMON /KKSUP/
$, SPDIA1(200), LSSAVE, PHEDS1(200), SPPCST1(200), SPRCST1(200)
$, SPTCST1(200), SPCOST1, PSLCST1, PSLGCS1, PSJCST1, UPPPCS1(200)
$, PF, NRUN
LS=LSSAVE
JS = JSSAVE
KS = KSSAVE
C
203 FORMAT(1H,14X,I2,1X,7F10.1)
204 FORMAT(///40X,"TOTAL COST OF CIRCULATION SUPPLY PIPING $",F5.0,
$ " *10**3"////)
205 FORMAT(/25X,"HORIZONTAL QUADRANT SUPPLY PIPING"
$ //42X,"COST IN 10**3 DOLLARS FOR"/40X
$, "-----"/12X,"HEADER DIAMETER LENGTH
$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)
208 FORMAT(///42X,"TOTAL COST OF QUADRANT SUPPLY HEADERS $",F5.0,
$ " *10**3"////)
209 FORMAT(/25X,"TOWER SUPPLY PIPING"
$ //10X,"NUMBER OF TOWERS",21X,I5
$ /10X,"NUMBER OF TOWERS WITH DELUGE PIPING",2X,I5
$ /10X,"TOWER DIAMETER",23X,F5.0," FEET"/
$ 10X,"TOWER HEIGHT",25X,F5.1," FEET"/
$ 10X,"BUNDLE WIDTH",25X,F5.1," FEET"/
$ 10X, "DIAMETER OF PIPE FROM CIRCULATION
$/10X,"HEADER TO TOWER DISTRIBUTION HEADER",F7.0," INCHES"/10X,"DI
$ AMETER OF TOWER DISTRIBUTION PIPE",F7.0," INCHES"/10X,"COST OF DI
$ STRIBUTION PIPING PER TOWER $",F5.0," *10**3"///40X,"TOTAL COST O
$ F TOWER DISTRIBUTION PIPING $",F5.0," *10**3"////)
211 FORMAT(10X,"VAPOR DESIGN VELOCITY",F5.0," FPS"/
$ 10X,"MASS FLOW RATE",1PE10.3," LBM/HR"/
$ 10X,"CONDENSER OUTLET TEMPERATURE",0PF7.2," DEG. F"/
$ 10X,"HEAT EXCHANGER INLET TEMPERATURE",F7.2," DEG. F"/
$ 10X,"SUPPLY PIPING PRESSURE DROP",F7.1," PSF"/
$ 10X,"SUPPLY PIPING DYNAMIC HEAD",F7.1," FEET"////
$ 47X,"TOTAL SUPPLY PIPING SYSTEM COST $",F6.0," *10**3"////)
213 FORMAT(1H1)
214 FORMAT(1H,13X,I2,1X,7F10.1)
215 FORMAT(/10X,"COST OF SUPPLY HEADERS PER QUADRANT $",F5.1,
$ " *10**3")
216 FORMAT(30X,"-----"/30X,"SUPPLY PIPING"/30X,"-----

```

```

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

```

SUBROUTINE RPTRET 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

506 CONTINUE	RPTRET	116
600 CONTINUE	RPTRET	117
WRITE(6,517) NBUN	RPTRET	118
517 FORMAT(///10X,"NUMBER OF BUNDLES PER QUADRANT",I10)	RPTRET	119
WRITE(6,217) RBFC51*PF	RPTRET	120
WRITE(6,215) RQCOS1*PF	RPTRET	121
WRITE(6,208) TRQC01*PF	RPTRET	122
WRITE(6,209) CTOWD1, DIARD1, DIART1, RTDCS1*PF, TRTDC1*PF	RPTRET	123
WRITE(6,211) DESVE1, DOTMA1, DELL1, DYNWD1, PIPCS1	RPTRET	124
WRITE(6,300)	RPTRET	125
WRITE(6,310) (PUMPC1=PUFIT1)*PF, PUFIT1*PF, RPTPL1	RPTRET	126
WRITE(6,320) (PUMPC1=PF) * RPTPL1	RPTRET	127
WRITE(6,330) SEPCS1	RPTRET	128
WRITE(6,340) PIPCTD1	RPTRET	129
RETURN	RPTRET	130
END	RPTRET	131

217	FORMAT(///10X,"FITTINGS COST PER BUNDLE \$",F7.3," *10**3")	RPTRET	59
C		RPTRET	60
300	FORMAT(///T50,9("=")/T50,"P U M P S"/T50,9("=")///)	RPTRET	61
310	FORMAT(T10,"PUMP COST",T30,"\$",F8.0,"*10**3"	RPTRET	62
	\$ /T10,"PUMP FITTINGS",T30,"\$",F8.0,"*10**3"	RPTRET	63
	\$ /T10,"PUMP ELECTRICAL", T30,"\$",F8.0,"*10**3")	RPTRET	64
320	FORMAT(//T60,"PUMP STATION",T80, "\$", F8.0,"*10**3")	RPTRET	65
330	FORMAT(///T10,"SEPARATOR COST",T30,"\$",F11.0,"*10**3")	RPTRET	66
340	FORMAT(///T10,"DELUGE PIPING COST",T30,"\$",F11.0,"*10**3")	RPTRET	67
C		RPTRET	68
	JR=JRSAVE	RPTRET	69
	KR=KRSAVE	RPTRET	70
	LR=LPSAVE	RPTRET	71
	WRITE(6,213)	RPTRET	72
	WRITE(6,216)	RPTRET	73
	DO 201 I=1,JR	RPTRET	74
	IF(I.GT.1) GO TO 202	RPTRET	75
	WRITE(6,203) I, RDIAL(I), HEDR1(I), RPCST1(I)*PF, RTCST1(I)*PF	RPTRET	76
	\$,RRCST1(I)*PF, REJCS1*PF, RFLGC1*PF	RPTRET	77
	GO TO 201	RPTRET	78
202	IF(I.EQ.JR) GO TO 210	RPTRET	79
	WRITE(6,203) I, RDIAL(I), HEDR1(I), RPCST1(I)*PF, RTCST1(I)*PF	RPTRET	80
	\$,RRCST1(I)*PF	RPTRET	81
	GO TO 201	RPTRET	82
210	WRITE(6,203) I, RDIAL(I), HEDR1(I), RPCST1(I)*PF, RELCS1*PF	RPTRET	83
	\$,RRCST1(I)*PF	RPTRET	84
201	CONTINUE	RPTRET	85
	WRITE(6,204) RCAST1*PF	RPTRET	86
	WRITE(6,205)	RPTRET	87
	DO 206 I=1,KR	RPTRET	88
	IF(I.EQ.KR)GO TO 207	RPTRET	89
	WRITE(6,214) I, RQDIAL(I), QHEDR1(I), RQPCST1(I)*PF, RQTCST1(I)*PF	RPTRET	90
	\$,RQRCST1(I)*PF	RPTRET	91
	GO TO 206	RPTRET	92
207	WRITE(6,214) I, RQDIAL(I), QHEDR1(I), RQPCST1(I)*PF, QRLCS1*PF	RPTRET	93
	\$,RQRCST1(I)*PF	RPTRET	94
206	CONTINUE	RPTRET	95
	WRITE(6,405)	RPTRET	96
405	FORMAT(/25X,"EXTERIOR VERTICAL QUADRANT RETURN PIPING"/42X,"COST	RPTRET	97
	\$IN 10**3 DOLLARS FOR "/40X,30("=")/12X,"HEADER DIAMETER LENGTH	RPTRET	98
	\$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)	RPTRET	99
	DO 406 I=1,LR	RPTRET	100
	IF(I.EQ.LR) GO TO 407	RPTRET	101
	WRITE(6,214) I,RPDIAL(I),PHEDR1(I),RPPCST1(I)*PF,RPTCST1(I)*PF,	RPTRET	102
	\$RPRCST1(I)*PF	RPTRET	103
	GO TO 406	RPTRET	104
407	WRITE(6,214) I,RPDIAL(I),PHEDR1(I),RPPCST1(I)*PF,PRLCST1*PF,	RPTRET	105
	\$RPRCST1(I)*PF	RPTRET	106
406	CONTINUE	RPTRET	107
	IF(INT.LE.0) GO TO 600	RPTRET	108
	WRITE(6,505)	RPTRET	109
505	FORMAT(/25X,"INTERIOR VERTICAL QUADRANT RETURN PIPING"/42X,"COST	RPTRET	110
	\$IN 10**3 DOLLARS FOR "/40X,30("=")/12X,"HEADER DIAMETER LENGTH	RPTRET	111
	\$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)	RPTRET	112
	DO 506 I=1,LR	RPTRET	113
	WRITE(6,214) I,RVDIAL(I),VHEDR1(I),RVPCST1(I)*PF,RVTCST1(I)*PF,	RPTRET	114
	\$SPVRCST1(I)*PF	RPTRET	115

SUBROUTINE RPTRET 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	SUBROUTINE RPTRET(CTOWD1, PF, PSTAC1, PUFIT1, PUMPC1, RPTPL1, \$ SEP\$1, PIPCTD1)	RPTRET	2
		RPTRET	3
C	THIS ROUTINE REPORTS RETURN PIPING DESIGN AND COSTS	RPTRET	4
C		RPTRET	5
C	COMMON /KPTRET/ \$ DELL1, DESVE1, DIARD1, DIART1, DOTMA1, DYNHD1 \$ HEDR1(200) \$ JRSAVE \$ KRSAVE \$ PIPCS1 \$ QHEDR1(200), QRLCS1 \$ RDIA1(200), RPCST1(200), RRCST1(200), RTCST1(200), RBFCST1, RCOST1 \$ RQDIA1(200), RQPCS1(200), RQRCS1(200), RQTCST1(200), REJCS1 \$ RELCS1, RFLGC1, RQCOS1, RTDCS1 \$ TOWD11, TRQCO1, TRTDC1 COMMON /KKRET/ \$ RPDIA1(200), RVDIA1(200), LRSAVE \$ PHEDR1(200), VHEDR1(200) \$ RPRCST1(200), RVRCST1(200) \$ RPTCST1(200), RUTCST1(200) \$ PRLCST1, VRLCST1 \$ PPPCST1(200), RVPCST1(200) \$ RPCOST1, RVCOST1 \$ JNT, NBUN	RPTRET	6
		RPTRET	7
		RPTRET	8
		RPTRET	9
		RPTRET	10
		RPTRET	11
		RPTRET	12
		RPTRET	13
		RPTRET	14
		RPTRET	15
		RPTRET	16
		RPTRET	17
		RPTRET	18
		RPTRET	19
		RPTRET	20
		RPTRET	21
		RPTRET	22
		RPTRET	23
		RPTRET	24
		RPTRET	25
		RPTRET	26
C	203 FORMAT(1H, 14X, I2, 1X, 7F10.1)	RPTRET	27
	204 FORMAT(///40X, "TOTAL COST OF CIRCULATION RETURN PIPING \$", F5.0, \$ " *10**3"////)	RPTRET	28
	205 FORMAT(25X, "HORIZONTAL QUADRANT RETURN PIPING" \$ //42X, "COST IN 10**3 DOLLARS FOR"/40X	RPTRET	29
	\$, "-----"//12X, "HEADER DIAMETER LENGTH \$ PIPE TEES REDUCERS"/21X, "(INCHES) (FEET)"/)	RPTRET	30
	208 FORMAT(///42X, "TOTAL COST OF QUADRANT RETURN HEADERS \$", F5.0, \$ " *10**3"////)	RPTRET	31
	209 FORMAT(25X, "TOWER RETURN PIPING" \$ //10X, "TOWER DIAMETER", 23X, F5.0, " FEET"/	RPTRET	32
	\$10X, "DIAMETER OF PIPE FROM CIRCULATION \$ "/10X, "HEADER TO TOWER DISTRIBUTION HEADER", F7.0, " INCHES"/10X, "DI	RPTRET	33
	\$AMETER OF TOWER DISTRIBUTION PIPE", F7.0, " INCHES"/10X, "COST OF DI	RPTRET	34
	\$STRIBUTION PIPING PER TOWER \$", F5.0, " *10**3"////40X, "TOTAL COST O	RPTRET	35
	\$F TOWER DISTRIBUTION PIPING \$", F5.0, " *10**3"////)	RPTRET	36
	211 FORMAT(10X, "LIQUID DESIGN VELOCITY", F5.0, " FPS"/	RPTRET	37
	\$ 10X, "MASS FLOW RATE", 1PE10.3, " LBM/HR"/	RPTRET	38
	\$ 10X, "RETURN PIPING PRESSURE DROP", 0PF7.1, " PSF"/	RPTRET	39
	\$ 10X, "RETURN PIPING DYNAMIC HEAD", F7.1, " FEET"////	RPTRET	40
	\$ 47X, "TOTAL RETURN PIPING SYSTEM COST \$", F6.0, " *10**3"////)	RPTRET	41
	213 FORMAT(1H1)	RPTRET	42
	214 FORMAT(1H, 13X, I2, 1X, 7F10.1)	RPTRET	43
	215 FORMAT(/10X, "COST OF RETURN HEADERS PER QUADRANT \$", F5.1, \$ " *10**3")	RPTRET	44
	216 FORMAT(30X, "-----"//30X, "RETURN PIPING"/30X, "-----" \$ "-----"//25X, "CIRCULATION PIPING"/52X, "COST IN 10**" " RPTRET	RPTRET	45
	\$3 DOLLARS FOR"/40X, "-----" RPTRET	RPTRET	46
	\$ "-----"//12X, "HEADER DIAMETER LENGTH PIPE TEES REDUCE RPTRET	RPTRET	47
	\$RS EXPANSION FLANGES"/21X, "(INCHES) (FEET)", 33X, "JOINT(1) (3 RPTRET	RPTRET	48
	\$)"/)	RPTRET	49
		RPTRET	50
		RPTRET	51
		RPTRET	52
		RPTRET	53
		RPTRET	54
		RPTRET	55
		RPTRET	56
		RPTRET	57
		RPTRET	58

SUBROUTINE RPTHXD 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

WRITE(6,6655) CASTC,CHH
WRITE(6,6660) EPREPC,CN
WRITE(6,6662) CBJ
WRITE(6,6665) CMW
WRITE(6,6670) CLTC1, CST
WRITE(6,6675) CPCC1
WRITE(6,6680) CFC1
WRITE(6,6685) FITC01
WRITE(6,6695) CSC1

C

RETURN
END

RPTHXD 112
RPTHXD 113
RPTHXD 114
RPTHXD 115
RPTHXD 116
RPTHXD 117
RPTHXD 118
RPTHXD 119
RPTHXD 120
RPTHXD 121
RPTHXD 122
RPTHXD 123

SUBROUTINE RPTHXD

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

6660	FORMAT(	RPTHXD	55
	LT9,"END PREPARATION \$",G10.4,"/TUBE"	RPTHXD	56
	R,T66,"NOZZEL AND ATTACHING \$",F8.3,"/HOLE")	RPTHXD	57
6662	FORMAT(	RPTHXD	58
	R,T67,"MOLTED HEADER JOINT \$",F8.3,"/FT"	RPTHXD	59
6665	FORMAT(	RPTHXD	60
	RT58,"HEADER MACHINING AND WELDING \$",F8.3,"/FT")	RPTHXD	61
6670	FORMAT(	RPTHXD	62
	LT09,"LINER TUBING \$",G11.5,"/FT",	RPTHXD	63
	RT70,"STRUCTURAL STEEL \$",F8.3,"/LB")	RPTHXD	64
6675	FORMAT(	RPTHXD	65
	LT03,"PROTECTIVE COATING \$",G11.5,"/FT"	RPTHXD	66
	R)	RPTHXD	67
6680	FORMAT(	RPTHXD	68
	LT14,"FINNING \$",G11.5,"/FT"	RPTHXD	69
	R)	RPTHXD	70
6685	FORMAT(/	RPTHXD	71
	LT29,"FINNED TUBE \$",G11.5,"/FT"	RPTHXD	72
	R)	RPTHXD	73
6695	FORMAT(	RPTHXD	74
	LT28,"TUBE SPACERS \$",G11.5,"/FT"	RPTHXD	75
	R)	RPTHXD	76
C		RPTHXD	77
6617	FORMAT(	RPTHXD	78
	L T27,"LINER GAGE ",F5.1	RPTHXD	79
	R,T65,"FIN TYPE ",Z410)	RPTHXD	80
6700	FORMAT(	RPTHXD	81
	L T18,"TUBES THRU EACH FIN",F8.0,T47,"TUBES"	RPTHXD	82
	R,T56,"AREA OF PLATE FIN ",F11.1," SQ IN,"	RPTHXD	83
6710	FORMAT(	RPTHXD	84
	LT9,"LINER TUBING INSIDE DIAMETER ",F7.4,T47,"INCH"	RPTHXD	85
	R,T60,"HEADER LENGTH",F11.3," FEET")	RPTHXD	86
	WRITE(6,6600)	RPTHXD	87
	DO 20 I=1,3	RPTHXD	88
	IF (DANGLE .LT. 1.E-30) WRITE(6,6602)	RPTHXD	89
	IF (DANGLE .GT. 0.0) WRITE(6,6602) DANGLE*180. / 3.14159	RPTHXD	90
20	CONTINUE	RPTHXD	91
	WRITE(6,6601)	RPTHXD	92
	WRITE(6,6603) SS ,ODR	RPTHXD	93
	WRITE(6,6605) XW ,THFIN	RPTHXD	94
	WRITE(6,6610) XD ,DFIN	RPTHXD	95
	WRITE(6,6615) XDG ,SF	RPTHXD	96
	WRITE(6,6617) GAGLIN,FINTYP,XFINTY	RPTHXD	97
	IF(FINTYP .EQ. "PLATE ") WRITE(6,6700 NTUB,APLATE	RPTHXD	98
	WRITE(6,6620) TUBMAT,XTUBMA,FINMAT	RPTHXD	99
	WRITE(6,6625) CONL,CONF	RPTHXD	100
	WRITE(6,6630) ODL,HEDTYP,XHEDTY	RPTHXD	101
	WRITE(6,6710) DI, WB	RPTHXD	102
	WRITE(6,6601)	RPTHXD	103
	WRITE(6,6601)	RPTHXD	104
C		RPTHXD	105
	DO 30 I=1,3	RPTHXD	106
30	WRITE(6,6635)	RPTHXD	107
	WRITE(6,6601)	RPTHXD	108
	WRITE(6,6640) CFB,HEDMAT,CHM	RPTHXD	109
	WRITE(6,6645) COATC,CRJ	RPTHXD	110
	WRITE(6,6650) ZINCC,CWJ	RPTHXD	111

```

COMMON /DJB/ DI, XDG, SF RPTHXD 14
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF, SUPPLY 2
$ QIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW, SUPPLY 3
$ FPCW, DELFC, WIDTH, ELENG, VAIR, VWAT, H1, HC, T4, SUPPLY 4
$ REWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3, SUPPLY 5
$ SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2, SUPPLY 6
$ RP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTSX, VELDX SUPPLY 7
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS SUPPLY 8
$ , CLTC, CFC, CPCC, FITCO, CSC, CEPREP, DELPIP, AST, OLDCST SUPPLY 9
$ , CAPCST, XNFAN, BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN SUPPLY 10
$ , WTHDP, WTFRM, STRUCC, CFPERF, HPPERF, TOTCF, TPC, EFFI, ANTU SUPPLY 11
$ , AIRPF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP SUPPLY 12
$ , ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY 13
$ , CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD SUPPLY 14
$ , SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCST SUPPLY 15
$ , CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST SUPPLY 16
$ , PWD(16), WATCWD(16), DEPER(16), DEPERO(16) SUPPLY 17
$ , WBB, MTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5 SUPPLY 18
6600 FORMAT(1H1) RPTHXD 16
6601 FORMAT(1H ) RPTHXD 17
6602 FORMAT(1H+,T10," NON - D E L T A H E A T E X C H A N G E RPTHXD 18
$ R D E S C R I P T I O N",T10,F5.1," DEG ") RPTHXD 19
6603 FORMAT( RPTHXD 20
L T22,"SUPPORT SPACING ",F7.3,T47,"FEET" RPTHXD 21
R T60,"ROOT DIAMETER" ,F8.4,T82,"INCH") RPTHXD 22
6605 FORMAT( RPTHXD 23
L T8,"TUBE PITCH NORMAL TO AIR FLOW ",F7.3,T47,"INCH" RPTHXD 24
R T60,"FIN THICKNESS",F8.4,T82,"INCH") RPTHXD 25
6610 FORMAT( RPTHXD 26
L T2,"TUBE PITCH IN DIRECTION OF AIR FLOW ",F7.3,T47,"INCH" RPTHXD 27
R ,T61,"FIN DIAMETER ",F8.4,T82,"INCH") RPTHXD 28
6615 FORMAT( RPTHXD 29
LT18,"TUBE DIAGONAL PITCH ",F7.3,T47,"INCH" RPTHXD 30
R,T62,"FIN SPACING" ,F8.4,T82,"INCH") RPTHXD 31
6620 FORMAT( RPTHXD 32
LT23,"LINER MATERIAL ",2A10 RPTHXD 33
R,T61,"FIN MATERIAL ",2A10) RPTHXD 34
6625 FORMAT( RPTHXD 35
L T11,"LINER THERMAL CONDUCTIVITY",F7.3 RPTHXD 36
R,T56,"FIN THERMAL COND. ",G11.4,T83,"BTU/(HR SQ FT DEG F)/FT") RPTHXD 37
6630 FORMAT( RPTHXD 38
LTR,"LINER TUBING OUTSIDE DIAMETER " ,F7.4,T47,"INCH" RPTHXD 39
R,T62,"HEADER TYPE ",2A10) RPTHXD 40
6635 FORMAT(1H+ RPTHXD 41
LT38,"--- U N I T C O S T S ---") RPTHXD 42
6640 FORMAT( RPTHXD 43
LT13,"FIN BONDING $",G10.4,"/SQ FT" RPTHXD 44
R,T58,"HEADER MATERIAL (" ,1A10," ) $",F8.3,"/LB") RPTHXD 45
6645 FORMAT( RPTHXD 46
LT6,"PROTECTIVE COATING $",G10.4,"/SQ FT" RPTHXD 47
R,T58,"ROLLED JOINT, TUBE TO HEADER $",F8.3,"/TUBE") RPTHXD 48
6650 FORMAT( RPTHXD 49
LTR,"ZINC FOR SPACERS $",G10.4,"/LB" RPTHXD 50
R,T58,"WELDED JOINT, TUBE TO HEADER $",F8.3,"/TUBE") RPTHXD 51
6655 FORMAT( RPTHXD 52
LT10,"SPACER CASTING $",G10.4,"/EA" RPTHXD 53
R,T56,"TURE AND PLUG HOLE PREPARATION $",F8.3,"/HOLE") RPTHXD 54

```

```

C      SUBROUTINE RPTHXD                                RPTHXD      2
C      THIS ROUTINE REPORTS HEAT EXCHANGER DESCRIPTION AND UNIT COST DATA RPTHXD      3
C      LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG RPTHXD      4
C      COMMON                                            BIGCOM      2
$      AFTR, ALPHA, ANG(3)                                BIGCOM      3
$      ,BPLIM(16)                                          BIGCOM      4
$      ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF BIGCOM      5
$      ,CBJ, CTURB, CDANG, CLUVR, CHAHS, CVM              BIGCOM      6
$      ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF          BIGCOM      7
$      ,EFPF, EFS                                          BIGCOM      8
$      ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG BIGCOM      9
$      ,FIXV,FXTTDD,FXTVAR,FXTTDD,FXTLNG                BIGCOM     10
$      ,GREFF                                              BIGCOM     11
$      ,HXNP,HPCST,HCD                                    BIGCOM     12
$      ,ITMAX, ITMIN                                      BIGCOM     13
$      ,JCONS                                             BIGCOM     14
$      ,KCONV, KALEXT                                     BIGCOM     15
$      ,MXEXT                                             BIGCOM     16
$      ,NTA,NSIDES,NBUNHI                                BIGCOM     17
C      COMMON                                            BIGCOM     18
$      ODR                                                BIGCOM     19
$      ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL          BIGCOM     20
$      ,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL BIGCOM     21
$      ,RBP,REDUCE, REDUCV, ROOFL, RHOUT                BIGCOM     22
$      ,QREJ, QREDUCE, QREDUCV                          BIGCOM     23
$      ,SIGMAG, SAAF, SEGL                              BIGCOM     24
$      ,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX      BIGCOM     25
$      ,TCD, TW                                           BIGCOM     26
$      ,UCS, UWS                                          BIGCOM     27
$      ,WV, WATCONA, WATCOST                             BIGCOM     28
$      ,VAS(5)                                             BIGCOM     29
$      ,XDEPA, XW, XD                                    BIGCOM     30
C      COMMON /HEADX/ CHH, CN, CHM, CMW, CRJ, CWJ, CST   RPTHXD      7
$      , CMO, CSR, CSM, PITCHF, CPM, PRESS,HEDMAT,HEDTYP, NPASS RPTHXD      8
$      ,WB,TSP,CSH,CSHP                                   RPTHXD      9
C      COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1, SINK      2
$      ,GIN1, CLAN1, REAT1, Z1,HFA2S, W41, U1, DEPW1, PPW1, SINK      3
$      ,FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41, SINK      4
$      ,REWA1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPBP, SW41, SW31, SINK      5
$      ,SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN, SINK      6
$      ,BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1 SINK      7
$      , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CAL, CS1 SINK      8
$      , CLTC1, CFC1, CPCC1,FITC01, CSC1,CEPRE1,DEPI1, AST1,OLDCS1 SINK      9
$      ,CAPCS1,XNFAN1,BLDAN1,CPLEN1,DPFEL1, WH1, WTTU1, ADI1, ABL1 SINK     10
$      , WTHD1, WTRF1,STRUC1,CFMPF1, HPPF1,TOTCF1, TP1,EFFIN1, ANTU1 SINK     11
$      ,AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK     12
$      ,ACTBP1, ADJBP1, ACTVH1, ADJVV1, ADJPP1, THPA11, TCTF1, AFCST1 SINK     13
$      ,CSR1, WATER1, WSTRC1, CFOUN1, HUBDI1, TOWLE1, NUMT01, CTOWD1 SINK     14
$      ,SORJ1,SQRJ1,ATUBC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPCD1 SINK     15
$      ,CSTHS1, CYLRN1, CFANEL, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK     16
$      ,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16) SINK     17
$      ,WBR1,HTOW1,NTOWDE1,CSTIF1,CSJ1,CVF1,CDP1,W51 SINK     18
C      COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2GE, LINOR, XNP, XQUALY RPTHXD     11
C      COMMON /SURFEX/ ODL,GAGLIN, NTUB,TUBMAT,FINTYP,FINMAT, CFB RPTHXD     12
$      ,APLATE, COATC, ZINCC, CASTC, SS,EPREPC,XTUBMA,XHEDTY,XFINTY RPTHXD     13

```

SUBROUTINE RPTHXC

74/74

OPT=1

FTN 4.5+414

06/05/78 07.59.59

WRITE(6,6420) SIGMAG,WTHD1	RPTHXC	128
WRITE(6,6424) AFRON=ROOFL, ROOFL	RPTHXC	129
WRITE(6,6430) FITCOL/ATOT	RPTHXC	130
WRITE(6,6440) NTUCAL	RPTHXC	131
WRITE(6,6500)	RPTHXC	132
C	RPTHXC	133
WRITE(6,6515) IFIX(SW31), CS1	RPTHXC	134
WRITE(6,6520) IFIX(SW41),CH1	RPTHXC	135
WRITE(6,6525) Z1, Z1*XD/12., CBA1 + CVF1	RPTHXC	136
WRITE(6,6530) NW1, WIDT1, CPLEN1	RPTHXC	137
WRITE(6,6532) ELEN1, CSTLV1	RPTHXC	138
WRITE(6,6533) CSTHS1	RPTHXC	139
WRITE(6,6535) STRUC1	RPTHXC	140
WRITE(6,6537) IFIX(AAIR1), CFOUN1	RPTHXC	141
WRITE(6,6540) IFIX(AFRON)	RPTHXC	142
IF(FHXX, EQ, "HOTERV ")	RPTHXC	143
WRITE(6,6541) CSTIF1, CSJ1, CVF1, CDP1, CBA1	RPTHXC	144
RETURN	RPTHXC	145
END	RPTHXC	146

6560	FORMAT(T73,"AIR",T85,"AMMONIA")	RPTHXC	71
6565	FORMAT(T70,25("="))	RPTHXC	72
6570	FORMAT(T50,"REYNOLDS NUMBER"	RPTHXC	73
	\$,2(1PE13.5,E14.5,3X))	RPTHXC	74
6575	FORMAT(T48,"VELOCITY (FT/SEC)"	RPTHXC	75
	\$,2(1PE13.5,E14.5,3X))	RPTHXC	76
6580	FORMAT(T34,"PRESSURE DROP (LBS FORCE/SQ IN)"	RPTHXC	77
	\$,2(1PE13.5,E14.5,3X))	RPTHXC	78
6581	FORMAT(T44,"INLET TEMPERATURE (F)",1PE13.5,E14.5)	RPTHXC	79
6582	FORMAT(T45,"EXIT TEMPERATURE (F)",1PE13.5,E14.5)	RPTHXC	80
6583	FORMAT(T56,"RANGE (F)",1PE13.5,E14.5)	RPTHXC	81
6584	FORMAT(T61,"TTD1",7X,1PE13.5)	RPTHXC	82
6585	FORMAT(T29,"HEAT TRFR COEFF (BTU/MR SQ FT DEG F)"	RPTHXC	83
	\$,2(1PE13.5,E14.5,3X))	RPTHXC	84
6586	FORMAT(T62,"NTU",7X,1PE13.5)	RPTHXC	85
6587	FORMAT(T50,"FRICTION FACTOR"	RPTHXC	86
	\$,2(1PE13.5,E14.5,3X))	RPTHXC	87
6590	FORMAT(T35,"HEAT TRFR SURFACE AREA (SQ FT "	RPTHXC	88
	\$,1PE13.5,E14.5)	RPTHXC	89
6592	FORMAT(T35,"EXIT TEMPERATURE (F)"	RPTHXC	90
	\$,2(1PE13.5,E14.5,3X))	RPTHXC	91
6595	FORMAT(T35,"OVERALL U (BTU/MR SQ FT DEG F "	RPTHXC	92
	\$,7X,1PE13.5,E14.5)	RPTHXC	93
6600	FORMAT(T52,"EFFECTIVENESS"	RPTHXC	94
	\$,T76,F7,4)	RPTHXC	95
6610	FORMAT(T51,"FIN EFFICIENCY"	RPTHXC	96
	\$,T76,F7,4)	RPTHXC	97
6620	FORMAT (T07,"LOG MEAN TEMPERATURE DIFFERENCE"	RPTHXC	98
	\$,T46,F7,2,T76,F7,2)	RPTHXC	99
C		RPTHXC	100
	WRITE(6,6500)	RPTHXC	101
501	FORMAT(1H)	RPTHXC	102
	WRITE(6,6505)	RPTHXC	103
	WRITE(6,6510)	RPTHXC	104
	WRITE(6,6512) XNFAN1, HXNP	RPTHXC	105
	WRITE(6,6505)	RPTHXC	106
	WRITE(6,6500)	RPTHXC	107
	WRITE(6,6565)	RPTHXC	108
	WRITE(6,6560)	RPTHXC	109
	WRITE(6,6555)	RPTHXC	110
	WRITE(6,6570) REA11, REWA1	RPTHXC	111
	WRITE(6,6575) VAIR1, VWAT1	RPTHXC	112
	WRITE(6,6580) DEPA1/144., DPWT1/144.	RPTHXC	113
	WRITE(6,6585) H01, H11	RPTHXC	114
	WRITE(6,6587) AIRFF1, WATFF1	RPTHXC	115
	WRITE(6,6581) TD, THXIN1	RPTHXC	116
	WRITE(6,6582) T41, THXIN1	RPTHXC	117
	WRITE(6,6583) T41-TD	RPTHXC	118
	WRITE(6,6584) VAR(3)	RPTHXC	119
	WRITE(6,6586) ANTU1	RPTHXC	120
	WRITE(6,6595) U1	RPTHXC	121
	WRITE(6,6600) EFF1	RPTHXC	122
	WRITE(6,6610) EFFIN1	RPTHXC	123
	WRITE(6,501)	RPTHXC	124
	WRITE(6,6390) WATER1	RPTHXC	125
	WRITE(6,6400) AFTR, WTTU1	RPTHXC	126
	WRITE(6,6410) ALPHA, WTRF1	RPTHXC	127

6390	FORMAT(	R T69,"WT OF AMMONIA ",F14.0," LB")	RPTHXC	14
6400	FORMAT(	L T9,"AFT", G14.8	RPTHXC	15
		R,T71,"WT OF TUBES ",F14.0," LB")	RPTHXC	16
6410	FORMAT(	L T8,"ALPHA", G14.8	RPTHXC	17
		R,T71,"WT OF FRAME ",F14.0," LB")	RPTHXC	18
6420	FORMAT(	L T8,"SIGMA", G14.8	RPTHXC	19
		R,T71,"WT OF HEADER",F14.0," LB")	RPTHXC	20
6422	FORMAT(	R T71,"WT OF STRUCT",F14.0," LB")	RPTHXC	21
6424	FORMAT(	L T71," ROOF LOAD",F14.0," LB"	RPTHXC	22
		R,T106,"(",F8.2," LB/SQ FT)")	RPTHXC	23
6430	FORMAT(	L T3,"FITCO/ATOT", G14.8	RPTHXC	24
		\$)	RPTHXC	25
6440	FORMAT (IHO,2A10,T15,"NTU EFFECTIVENESS CORRELATION USED")		RPTHXC	26
6500	FORMAT(IHO)		RPTHXC	27
6505	FORMAT(T35,30("="))		RPTHXC	28
6510	FORMAT(T36,"H E A T E X C H A N G E R")		RPTHXC	29
6512	FORMAT(IH,T90,F6.1," FANS",T110,F4.1," PASS")		RPTHXC	30
6515	FORMAT(	L T2," AMMONIA FLOW RATE",I11," LBM/HR"	RPTHXC	31
		R,T71," COOLING SURFACE \$",F10.0)	RPTHXC	32
6520	FORMAT(	L T2," AIR FLOW RATE",I11," LBM/HR"	RPTHXC	33
		R,T71," HEADER AND NOZZEL \$",F10.0)	RPTHXC	34
6525	FORMAT(	L T2," TUBES IN DEPTH",F11.2," TUBES (" ,F7.1," FT DEEP)"	RPTHXC	35
		R,T71,"BUNDLE ASSEMBLY AND FRAME \$",F10.0)	RPTHXC	36
6530	FORMAT(	L T2,"TUBES ACROSS FRONT",I11," TUBES (" ,F7.1," FT WIDE)"	RPTHXC	37
		R,T71," PLENUM \$",F10.0)	RPTHXC	38
6532	FORMAT(IX	L ,T6,"LENGTH OF TUBES",F10.0," FEET"	RPTHXC	39
		R, T71," LOUVERS \$",F10.0	RPTHXC	40
6533	FORMAT (IX	R, T71," HAIL SCREENS \$",F10.0	RPTHXC	41
6535	FORMAT(	R T71," STRUCTURE \$",F10.0)	RPTHXC	42
6537	FORMAT(	L T8,"SURFACE AREA",I11," SQ FT",	RPTHXC	43
		R T71," FOUNDATION \$",F10.0)	RPTHXC	44
6540	FORMAT(	L T2," FRONTAL AREA",I11," SQ FEET"	RPTHXC	45
		R)	RPTHXC	46
6550	FORMAT(T40,2("FOR",F5.0," DEGREE F AMBIENT ")))		RPTHXC	47
6541	FORMAT(	R T77,"BUNDLE STIFFNER COST \$",F10.0/	RPTHXC	48
		R ,T79,"SECTION JOINT COST \$",F10.0/	RPTHXC	49
		R ,T80,"BUNDLE FRAME COST \$",F10.0/	RPTHXC	50
		R ,T80,"DRAIN PLATE COST \$",F10.0/	RPTHXC	51
		P ,T79,"BUNDLE ASSEMBLY COST \$",F10.0)	RPTHXC	52
6555	FORMAT(T70,11("="),2X,11("="))		RPTHXC	53
			RPTHXC	54
			RPTHXC	55
			RPTHXC	56
			RPTHXC	57
			RPTHXC	58
			RPTHXC	59
			RPTHXC	60
			RPTHXC	61
			RPTHXC	62
			RPTHXC	63
			RPTHXC	64
			RPTHXC	65
			RPTHXC	66
			RPTHXC	67
			RPTHXC	68
			RPTHXC	69
			RPTHXC	70

	SUBROUTINE RPTHXC(AFRON)	RPTHXC	2
C		RPTHXC	3
C	THIS ROUTINE REPORTS HEAT EXCHANGER DESIGN, OPERATING CONDITIONS	RPTHXC	4
C	AND COST	RPTHXC	5
C		RPTHXC	6
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
	* ,BPLIM(16)	BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	\$,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFFP, EFS	BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTOR,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FXTTD,FXTVAR,FXTTD,FXTLNG	BIGCOM	11
	\$,GBEFF	BIGCOM	12
	\$,HXNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14
	\$,JCONS	BIGCOM	15
	\$,KCONV, KALEXT	BIGCOM	16
	\$,MXEXT	BIGCOM	17
	\$,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	\$ ODR	BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
	\$,RBP,REDUCE, REDUCV, ROOFL, RMDUT	BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
	\$,SIGMAG, SAAF, SEGL	BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	\$,TCD, TW	BIGCOM	27
	\$,UCS, UWS	BIGCOM	28
	\$,WV, WATCONA, WATCOST	BIGCOM	29
	\$,VAS(5)	BIGCOM	30
	\$,XDEPA, XW, XD	BIGCOM	31
	COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,	SINK	2
	\$ QIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPOW1,	SINK	3
	\$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41,	SINK	4
	\$ REW1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPRP, SW41, SW31,	SINK	5
	\$ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,	SINK	6
	\$ BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1	SINK	7
	\$, TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1	SINK	8
	\$, CLTC1, CFC1, CPCC1,FITC01, CSC1,CEPRE1,DEPI1, AST1,OLDCS1	SINK	9
	\$,CAPCS1,XNFAN1,BLDAN1,CPLEN1,DPFEL1, WH1, WTTU1, ADI1, ABL1	SINK	10
	\$, WTHO1, WTR1,STRUC1,CFMPF1, HPPF1,TOTCF1, TP1,EFFIN1, ANTU1	SINK	11
	\$, AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1	SINK	12
	\$, ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1	SINK	13
	\$, CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMTO1, CTOWD1	SINK	14
	\$,SORJ1,SORJS1,ATURC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPECTD1	SINK	15
	\$,CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1	SINK	16
	\$,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16)	SINK	17
	\$,WBRI,HTOW1,NTOWD1,CSTIF1,CSJ1,CVF1,CDP1,W51	SINK	18
C		RPTHXC	9
	COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY	RPTHXC	10
	COMMON /HXD/ AI,ATOT,SFA,RFA,ACS	RPTHXC	11
	COMMON /ESCAL/ BSECF	RPTHXC	12
	COMMON /KPTSUP/ DUM(2017),THXIN1,DUM2(3)	RPTHXC	13

SUBROUTINE RPTFAN 74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

WRITE(6,1040) ADI1
WRITE(6,1050) BLDAN1
WRITE(6,1060) ABL1
WRITE(6,1070) XNFAN1
WRITE(6,1000)
WRITE(6,1000)
WRITE(6,1080)
WRITE(6,1000)
WRITE(6,1085)
WRITE(6,1090) CFMPF1
WRITE(6,1100) FDCPF1, TOTCF1
WRITE(6,1120) FMTRC1, ACTTP1, ADJTP1
WRITE(6,1130) CSRI,ACTBP1, ADJBPI
WRITE(6,1140) CYLRN1, ACTVH1, ADJVH1
WRITE(6,1145) CFANE1, HPPF1, ADJPP1
WRITE(6,1150) THPAI1
WRITE(6,1190) AFCST1
RETURN
END

RPTFAN 69
RPTFAN 70
RPTFAN 71
RPTFAN 72
RPTFAN 73
RPTFAN 74
RPTFAN 75
RPTFAN 76
RPTFAN 77
RPTFAN 78
RPTFAN 79
RPTFAN 80
RPTFAN 81
RPTFAN 82
RPTFAN 83
RPTFAN 84
RPTFAN 85
RPTFAN 86
RPTFAN 87

DATA (IMOTOR(I,K),I=1,4), K=1,3)/	RPTFAN	12
* "TOTALLY EN","CLOSED SQU","IRREL CAGE"," MOTOR "	RPTFAN	13
* "EXPLOSION ","PROOF SQUI","RREL CAGE ","MOTOR "	RPTFAN	14
* "TWO SPEED ","SQUIRREL C","AGE "," "	RPTFAN	15
DATA (IDRIVE(I,K),I=1,3),K=1,2)/	RPTFAN	16
* "SPIRAL BEV","EL GEAR DR","IVE "	RPTFAN	17
* "V-BELT DR","VE "," "	RPTFAN	18
DATA (IPITCH(I,K),I=1,3),K=1,2)/	RPTFAN	19
* "MANUAL PIT","CH BLADES "," "	RPTFAN	20
* "AUTO-VARIA","BLE PITCH ","BLADES "	RPTFAN	21
DATA (IRECOVY(I,K), I=1,5),K=1,2)/	RPTFAN	22
* "FANS NOT E","QUIPPED WI","TM VELOCITY","Y RECOVERY",	RPTFAN	23
* " DIFFUSERS",	RPTFAN	24
* "FANS EQUIP","PED WITH V","ELOCIY RE","COVERY DIF",	RPTFAN	25
* "FUSERS " /	RPTFAN	26
C	RPTFAN	27
1000 FORMAT(1H)	RPTFAN	28
1005 FORMAT(1H1)	RPTFAN	29
1010 FORMAT(T52,"F A N S")	RPTFAN	30
1020 FORMAT(T51,"-----")	RPTFAN	31
1030 FORMAT(T16,"--- DRIVE SYSTEM ---",T82,"--- FAN GEOMETRY ---")	RPTFAN	32
1040 FORMAT(T84,"BLADE DIAMETER ",F6.2," FEET")	RPTFAN	33
1050 FORMAT(T87,"BLADE ANGLE ",F6.2," DEGREES")	RPTFAN	34
1060 FORMAT(T78,"NUMBER OF BLADES/FAN ",F6.2)	RPTFAN	35
1070 FORMAT(T84,"NUMBER OF FANS ",F6.0)	RPTFAN	36
1080 FORMAT(T17,"--- FAN COSTS ---",T78,"--- DESIGN CONDITIONS ---")	RPTFAN	37
C	RPTFAN	38
1085 FORMAT (T100,"(ACTUAL)",T122,"(ADJUSTED)")	RPTFAN	39
1090 FORMAT(T73,"VOLUMETRIC FLOW RATE/FAN ",F12.0," CU FT/MIN")	RPTFAN	40
1100 FORMAT(T16,"BLADE AND HUB COST/FAN \$",F10.0,T71,	RPTFAN	41
* "TOTAL VOLUMETRIC FLOW RATE ",F12.0," CU FT/MIN")	RPTFAN	42
1120 FORMAT(T24,"MOTOR COST/FAN \$",F10.0,T70,	RPTFAN	43
* "TOTAL AIR PRESSURE DROP OF H.X. ",F8.5," PSI",T120,F8.5)	RPTFAN	44
1130 FORMAT(T10,"SPEED REDUCER DRIVE COST/FAN \$",F10.0,T69,	RPTFAN	45
* "PRESSURE DROP ACROSS H.X. BUNDLE ",F8.5," PSI",T120,F8.5)	RPTFAN	46
1140 FORMAT(T24,"STACK COST/FAN \$",F10.0,T72,	RPTFAN	47
* "NON-RECOVERABLE VELOCITY HEAD ",F8.5," PSI",T120,F8.5)	RPTFAN	48
1145 FORMAT(T19,"ELECTRICAL COST/FAN \$",F10.0	RPTFAN	49
\$,T83,"HORSEPOWER/FAN",F13.0," HP",T116,F12.0)	RPTFAN	50
1150 FORMAT(T79,	RPTFAN	51
* "FAN POWER REQUIREMENTS ",F8.0," HP")	RPTFAN	52
1190 FORMAT(T2,"*** ANNUAL OPERATIONAL COSTS \$",F10.0)	RPTFAN	53
1200 FORMAT(T37,5A10)	RPTFAN	54
1210 FORMAT(	RPTFAN	55
R T86,"HUB DIAMETER ",F6.2," FEET")	RPTFAN	56
WRITE(6,1000)	RPTFAN	57
WRITE(6,1000)	RPTFAN	58
WRITE(6,1020)	RPTFAN	59
WRITE(6,1010)	RPTFAN	60
WRITE(6,1020)	RPTFAN	61
WRITE(6,1000)	RPTFAN	62
IF(VELREC.EQ.0) WRITE(6,1200) (RECOVY(I,1),I=1,5)	RPTFAN	63
IF(VELREC.EQ.1) WRITE(6,1200) (RECOVY(I,2),I=1,5)	RPTFAN	64
WRITE(6,1000)	RPTFAN	65
WRITE(6,1030)	RPTFAN	66
WRITE(6,1000)	RPTFAN	67
WRITE(6,1210) HUBDI1	RPTFAN	68

```

C      SUBROUTINE RPTFAN
C
C      THIS ROUTINE REPORTS FAN DESCRIPTION AND COSTS
C
      LOGICAL LOOPER
      COMMON/FAN/ FANDAP(153,10),FANDAM(153,10),FMCPF,FBCPF,P2,R,S,
      $ VELREC, AFC, ELEV, EHR, LOOPER, GTMAX
      LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG
      COMMON
      $ AFTR, ALPHA, ANG(3)
      $ ,BPLIM(16)
      $ ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF
      $ ,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM
      $ ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF
      $ ,EFFP, EFS
      $ ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELJG
      $ ,FIXV,FXTTD,FXTVAR,FXTTD,FXTLNG
      $ ,GREFF
      $ ,HXNP,HPCST,HCD
      $ ,ITMAX, ITMIN
      $ ,JCONS
      $ ,KCONV, KALEXT
      $ ,MxEXT
      $ ,NTA,NSIDES,NBUNHI
      COMMON
      $ ODR
      $ ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL
      $ ,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL
      $ ,RBP,REDUCE, REDUCV, ROOFL, RHOUT
      $ ,OREJ, OREDUCE, OREDUCV
      $ ,SIGMAG, SAAF, SEGL
      $ ,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX
      $ ,TCD, TW
      $ ,UCS, UWS
      $ ,WV, WATCONA, WATCOST
      $ ,VAS(5)
      $ ,XDEPA, XW, XD
C
      COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,
      $ SIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPW1,
      $ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41,
      $ REWA1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPRP, SW41, SW31,
      $ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,
      $ BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1
      $ , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1
      $ , CLTC1, CFC1, CPCC1,FITC1, CSC1,CEPRE1,DEPI1, AST1,OLDCSI
      $ ,CAPCS1,XNFAN1,BLDAN1,CPLN1,DPFEL1, WH1, WTTU1, ADI1, ABL1
      $ , WTHD1, WTR1,STRUC1,CFMPF1, HPPF1,TOTCF1, TP1,EFFIN1, ANTU1
      $ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1
      $ , ACTRP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA1, TCTF1, AFCST1
      $ , CSR1, WATER1, WSTRC1, CFOUN1, HUBD1, TOWLE1, NUMT01, CTOWD1
      $ ,SORJ1,SQRJ1,ATURC1,CBA1,TD01,TD02,DELPS1,CSTLV1,PIPCD1
      $ ,CSTHS1, CYLRN1, CFANE1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1
      $ ,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16)
      $ ,WBB1,HTOW1,NTOWD1,CSTIF1,CSJ1,CVF1,CDP1,W51
      REAL MOTOR(4,3), DRIVE(3,2), PITCH(3,2), RECOVY(5,2)
C

```

```

RPTFAN      2
RPTFAN      3
RPTFAN      4
RPTFAN      5
FANDEK      2
FANDEK      3
FANDEK      4
BIGCOM      2
BIGCOM      3
BIGCOM      4
BIGCOM      5
BIGCOM      6
BIGCOM      7
BIGCOM      8
BIGCOM      9
BIGCOM     10
BIGCOM     11
BIGCOM     12
BIGCOM     13
BIGCOM     14
BIGCOM     15
BIGCOM     16
BIGCOM     17
BIGCOM     18
BIGCOM     19
BIGCOM     20
BIGCOM     21
BIGCOM     22
BIGCOM     23
BIGCOM     24
BIGCOM     25
BIGCOM     26
BIGCOM     27
BIGCOM     28
BIGCOM     29
BIGCOM     30
BIGCOM     31
RPTFAN      8
SINK        2
SINK        3
SINK        4
SINK        5
SINK        6
SINK        7
SINK        8
SINK        9
SINK       10
SINK       11
SINK       12
SINK       13
SINK       14
SINK       15
SINK       16
SINK       17
SINK       18
RPTFAN     10
RPTFAN     11

```

```

      DO 40 I = 1, NNN
      N1 = (I - 1) * 42 + 22
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
40  CONTINUE
      WRITE(6,1000)
      WRITE(6,1045)
      DO 50 I = 1, NNN
      N1 = (I - 1) * 42 + 32
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
50  CONTINUE
      WRITE(6,1000)
      WRITE(6,1046)
      DO 55 I = 1, NNN
      N1 = (I - 1) * 42 + 42
      N2 = N1
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
55  CONTINUE
      GO TO 100
10  WRITE(6,1050)
      DO 60 I = 1, NNN
      N1 = (I - 1) * 26 + 1
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
60  CONTINUE
      WRITE(6,1000)
      WRITE(6,1055)
      DO 70 I = 1, NNN
      N1 = (I - 1) * 26 + 11
      N2 = N1 + 2
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
70  CONTINUE
      WRITE(6,1000)
      WRITE(6,1025)
      WRITE(6,1000)
      WRITE(6,1060)
      DO 80 I = 1, NNN
      N1 = (I - 1) * 26 + 14
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
80  CONTINUE
      WRITE(6,1000)
      WRITE(6,1065)
      DO 90 I = 1, NNN
      N1 = (I - 1) * 26 + 24
      N2 = N1 + 2
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
90  CONTINUE
100 CONTINUE
      RETURN
      END

```

```

RPTDEL      87
RPTDEL      88
RPTDEL      89
RPTDEL      90
RPTDEL      91
RPTDEL      92
RPTDEL      93
RPTDEL      94
RPTDEL      95
RPTDEL      96
RPTDEL      97
RPTDEL      98
RPTDEL      99
RPTDEL     100
RPTDEL     101
RPTDEL     102
RPTDEL     103
RPTDEL     104
RPTDEL     105
RPTDEL     106
RPTDEL     107
RPTDEL     108
RPTDEL     109
RPTDEL     110
RPTDEL     111
RPTDEL     112
RPTDEL     113
RPTDEL     114
RPTDEL     115
RPTDEL     116
RPTDEL     117
RPTDEL     118
RPTDEL     119
RPTDEL     120
RPTDEL     121
RPTDEL     122
RPTDEL     123
RPTDEL     124
RPTDEL     125
RPTDEL     126
RPTDEL     127
RPTDEL     128
RPTDEL     129
RPTDEL     130
RPTDEL     131
RPTDEL     132
RPTDEL     133
RPTDEL     134
RPTDEL     135
RPTDEL     136
RPTDEL     137
RPTDEL     138

```

	*T68,"DTDR",T80,"HI",T92,"CSS",T104,"TS",T116,"RIS")	RPTDEL	30
1055	FORMAT(T8,"TI",T20,"PII",T32,"A4IN")	RPTDEL	31
1060	FORMAT(T8,"TOUT",T20,"RILVG",T32,"SIGLVG",T44,"SIGMA",T56,"UDPS",	RPTDEL	32
	*T68,"DTDR",T80,"HI",T92,"CSS",T104,"TS",T116,"RIS")	RPTDEL	33
1065	FORMAT(T8,"QSEC",T20,"RMEVAP",T32,"AHLVG")	RPTDEL	34
1070	FORMAT(	RPTDEL	35
	L T20,"HD",T27,1PE12.4,	RPTDEL	36
	C T56,"BETA F",T63,1PE12.4,	RPTDEL	37
	P T92,"BETA I",T99,1PE12.4/,	RPTDEL	38
	L T20,"AB",T27,1PE12.4	RPTDEL	39
	C T56,"AF",T63,1PE12.4,	RPTDEL	40
	R T92,"AI",T99,1PE12.4/,	RPTDEL	41
	L T20,"AW",T27,1PE12.4,	RPTDEL	42
	C T56,"THW",T63,1PE12.4,	RPTDEL	43
	R T92,"RWK",T99,1PE12.4/,	RPTDEL	44
	L T20,"ATM",T27,1PE12.4,	RPTDEL	45
	C T56,"RMA",T63,1PE12.4)	RPTDEL	46
1075	FORMAT(T5,1P10E12.4)	RPTDEL	47
	NNN = SR(3)	RPTDEL	48
	WRITE(6,1000)	RPTDEL	49
	WRITE(6,1000)	RPTDEL	50
	WRITE(6,1015)	RPTDEL	51
	WRITE(6,1000)	RPTDEL	52
	WRITE(6,1010)	RPTDEL	53
	WRITE(6,1000)	RPTDEL	54
	WRITE(6,1015)	RPTDEL	55
	WRITE(6,1000)	RPTDEL	56
	WRITE(6,1000)	RPTDEL	57
	WRITE(6,1070) (B(I),I=1,9), (SR(II),II =1,2)	RPTDEL	58
	WRITE(6,1000)	RPTDEL	59
	WRITE(6,1020)	RPTDEL	60
	WRITE(6,1000)	RPTDEL	61
	IF(FDELUG.EQ."DELBAW ") GO TO 10	RPTDEL	62
	WRITE(6,1030)	RPTDEL	63
	DO 20 I = 1, NNN	RPTDEL	64
	N1 = (I - 1) * 42 + 1	RPTDEL	65
	N2 = N1 + 9	RPTDEL	66
	WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)	RPTDEL	67
20	CONTINUE	RPTDEL	68
	WRITE(6,1000)	RPTDEL	69
	WRITE(6,1035)	RPTDEL	70
	DO 30 I = 1, NNN	RPTDEL	71
	N1 = (I - 1) * 42 + 11	RPTDEL	72
	N2 = N1 + 9	RPTDEL	73
	WRITE(6,1075) (SPRT4(IJ),IJ=N1,N2)	RPTDEL	74
30	CONTINUE	RPTDEL	75
	WRITE(6,1000)	RPTDEL	76
	WRITE(6,1036)	RPTDEL	77
	DO 35 I = 1, NNN	RPTDEL	78
	N1 = (I - 1) * 42 + 21	RPTDEL	79
	N2 = N1	RPTDEL	80
	WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)	RPTDEL	81
35	CONTINUE	RPTDEL	82
	WRITE(6,1000)	RPTDEL	83
	WRITE(6,1025)	RPTDEL	84
	WRITE(6,1000)	RPTDEL	85
	WRITE(6,1040)	RPTDEL	86

SUBROUTINE RPTDEL

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	SUBROUTINE RPTDEL	RPTDEL	2
C	THIS ROUTINE REPORTS THE OUTPUT FROM THE DELUGING ROUTINES	RPTDEL	3
C	(DELUG, UDEL OR DELBAW, SIGBAW)	RPTDEL	4
C		RPTDEL	5
C		RPTDEL	6
C		RPTDEL	7
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	S AFTR, ALPHA, ANG(3)	BIGCOM	4
	S ,BPLIM(16)	BIGCOM	5
	S ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	S ,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
	S ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	S ,EFFP, EFS	BIGCOM	9
	S ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG	BIGCOM	10
	S ,FIXV,FIXTID,FXTVAR,FXTTID,FXTLNG	BIGCOM	11
	S ,GBEFF	BIGCOM	12
	S ,HXNP,HPCST,HCD	BIGCOM	13
	S ,ITMAX, ITMIN	BIGCOM	14
	S ,JCONS	BIGCOM	15
	S ,KCONV, KALEXT	BIGCOM	16
	S ,MXEXT	BIGCOM	17
	S ,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	S ODR	BIGCOM	20
	S ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	S ,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	22
	S ,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
	S ,QREJ, QREDUCE, QREDUCV	BIGCOM	24
	S ,SIGMAG, SAAF, SEGL	BIGCOM	25
	S ,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	S ,TCD, TW	BIGCOM	27
	S ,UCS, UWS	BIGCOM	28
	S ,WFV, WATCONA, WATCOST	BIGCOM	29
	S ,VAS(5)	BIGCOM	30
	S ,XDEPA, XW, XD	BIGCOM	31
	COMMON/KPRT4/SPRT4(672),SR(3)	RPTDEL	9
	COMMON /HXD/ A(5)	RPTDEL	10
	COMMON /CONS/ B(9)	RPTDEL	11
C		RPTDEL	12
1000	FORMAT(1H)	RPTDEL	13
1005	FORMAT(1H1)	RPTDEL	14
1010	FORMAT(T51,"DELUGED HEAT EXCHANGER DATA")	RPTDEL	15
1015	FORMAT(T51,29(" "))	RPTDEL	16
1020	FORMAT(T50,"LEADING EDGE OF HEAT EXCHANGER")	RPTDEL	17
1025	FORMAT(T50,"TRAILING EDGE OF HEAT EXCHANGER")	RPTDEL	18
1030	FORMAT(T8,"TAIN",T20,"RIIN",T32,"UDIN",T44,"UDRS",T56,"HOD",T68,	RPTDEL	19
	+ "DTDRIR",T80,"UDRA",T92,"UDPP",T104,"EFFIN",T116,"HI")	RPTDEL	20
1035	FORMAT(T8,"CSR",T20,"DTDR",T32,"TR",T44,"RIR",T56,"TS",T68,"RIS",	RPTDEL	21
	+ T80,"TFAV",T92,"RIFAV",T104,"TI",T116,"RII")	RPTDEL	22
1036	FORMAT(T8,"AHIN")	RPTDEL	23
1040	FORMAT(T8,"TOUT",T20,"RILVG",T32,"UDLVG",T44,"UDRS",T56,"HOD",T68,	RPTDEL	24
	+ "DTDRIR",T80,"UDRA",T92,"UDPP",T104,"EFFIN",T116,"HI")	RPTDEL	25
1045	FORMAT(T8,"CSR",T20,"DTDR",T32,"TR",T44,"RIR",T56,"TS",T68,"RIS",	RPTDEL	26
	+ T80,"TFAV",T92,"RIFAV",T104,"QSEC",T116,"RMEVAP")	RPTDEL	27
1046	FORMAT(T8,"AHLVG")	RPTDEL	28
1050	FORMAT(T8,"TAIN",T20,"RIIN",T32,"SIGIN",T44,"SIGMA",T56,"UDPS",	RPTDEL	29

SUBROUTINE RPRT2

74/74

OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
WRITE(6,6135) (IFIX(XNS)),TUBCST,TUBEM,TUBEM2
WRITE(6,6140) ARPS,SHLCST
WRITE(6,6145) (IFIX(XNP)),FETCST
WRITE(6,6150) (IFIX(TLA))
WRITE(6,6155) (IFIX(XNTS)),(TUBCST+SHLCST+FETCST)
RETURN
END
```

```
RPRT2      59
RPRT2      60
RPRT2      61
RPRT2      62
RPRT2      63
RPRT2      64
RPRT2      65
```

SUBROUTINE RPTDEL

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C
C
C
C
C

SUBROUTINE RPTDEL

THIS ROUTINE REPORTS THE OUTPUT FROM THE DELUGING ROUTINES
(DELUG, UDEL OR DELBAW, SIGBAW)LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG
COMMON

\$ AFTR, ALPHA, ANG(3)
 * ,BDLIM(16)
 \$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF
 \$,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM
 \$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF
 \$,EFFP, EFS
 \$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG
 \$,FIXV,FXTTID,FXTVAR,FXTTID,FXTLNG
 \$,GBEFF
 \$,HXNP,HPCST,HCD
 \$,ITMAX, ITMIN
 \$,JCONS
 \$,KCONV, KALEXT
 \$,MXEXT
 \$,NTA,NSIDES,NBUNHI
 COMMON
 \$ ODR
 \$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL
 \$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL
 \$,RRP,REDUCE, REDUCV, ROOFL, RHOUT
 \$,QREJ, QREDUCE, QREDUCV
 \$,SIGMAG, SAAF, SEGL
 \$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX
 \$,TCD, TW
 \$,UCS, UWS
 \$,WFEV, WATCONA, WATCOST
 \$,VAS(5)
 \$,XDEPA, XW, XD
 COMMON/KPRT4/SPRT4(672),SR(3)
 COMMON /HXD/ A(5)
 COMMON /CONS/ B(9)

C

1000 FORMAT(1H)
 1005 FORMAT(1H1)
 1010 FORMAT(T51,"DELUGED HEAT EXCHANGER DATA")
 1015 FORMAT(T51,29(" "))
 1020 FORMAT(T50,"LEADING EDGE OF HEAT EXCHANGER")
 1025 FORMAT(T50,"TRAILING EDGE OF HEAT EXCHANGER")
 1030 FORMAT(T8,"TAIN",T20,"RIIN",T32,"UDIN",T44,"UDRS",T56,"HOD",T68,
 + "DTDRIR",T80,"UDRA",T92,"UDPP",T104,"EFFIN",T116,"HI")
 1035 FORMAT(T8,"CSR",T20,"DTDR",T32,"TR",T44,"RIR",T56,"TS",T68,"RIS",
 + T80,"TFAV",T92,"RIFAV",T104,"TI",T116,"RII")
 1036 FORMAT(T8,"AHIN")
 1040 FORMAT(T8,"TOUT",T20,"RILVG",T32,"UDLVG",T44,"UDRS",T56,"HOD",T68,
 + "DTDRIR",T80,"UDRA",T92,"UDPP",T104,"EFFIN",T116,"HI")
 1045 FORMAT(T8,"CSR",T20,"DTDR",T32,"TR",T44,"RIR",T56,"TS",T68,"RIS",
 + T80,"TFAV",T92,"RIFAV",T104,"QSEC",T116,"RMEVAP")
 1046 FORMAT(T8,"AHLVG")
 1050 FORMAT(T8,"TAIN",T20,"RIIN",T32,"SIGIN",T44,"SIGMA",T56,"UDPS",

RPTDEL 2
 RPTDEL 3
 RPTDEL 4
 RPTDEL 5
 RPTDEL 6
 RPTDEL 7
 BIGCOM 2
 BIGCOM 3
 BIGCOM 4
 BIGCOM 5
 BIGCOM 6
 BIGCOM 7
 BIGCOM 8
 BIGCOM 9
 BIGCOM 10
 BIGCOM 11
 BIGCOM 12
 BIGCOM 13
 BIGCOM 14
 BIGCOM 15
 BIGCOM 16
 BIGCOM 17
 BIGCOM 18
 BIGCOM 19
 BIGCOM 20
 BIGCOM 21
 BIGCOM 22
 BIGCOM 23
 BIGCOM 24
 BIGCOM 25
 BIGCOM 26
 BIGCOM 27
 BIGCOM 28
 BIGCOM 29
 BIGCOM 30
 BIGCOM 31
 RPTDEL 9
 RPTDEL 10
 RPTDEL 11
 RPTDEL 12
 RPTDEL 13
 RPTDEL 14
 RPTDEL 15
 RPTDEL 16
 RPTDEL 17
 RPTDEL 18
 RPTDEL 19
 RPTDEL 20
 RPTDEL 21
 RPTDEL 22
 RPTDEL 23
 RPTDEL 24
 RPTDEL 25
 RPTDEL 26
 RPTDEL 27
 RPTDEL 28
 RPTDEL 29

	*T68,"DTDR",T80,"HI",T92,"CSS",T104,"TS",T116,"RIS")	RPTDEL	30
1055	FORMAT(T8,"TI",T20,"RII",T32,"AHIN")	RPTDEL	31
1060	FORMAT(T8,"TOUT",T20,"RILVG",T32,"SIGLVG",T44,"SIGMA",T56,"UDPS",	RPTDEL	32
	*T68,"DTDR",T80,"HI",T92,"CSS",T104,"TS",T116,"RIS")	RPTDEL	33
1065	FORMAT(T8,"QSEC",T20,"RMEVAP",T32,"AHLVG")	RPTDEL	34
1070	FORMAT(	RPTDEL	35
	L T20,"WD",T27,1PE12.4,	RPTDEL	36
	C T56,"BETAF",T63,1PE12.4,	RPTDEL	37
	R T92,"BETAI",T99,1PE12.4/,	RPTDEL	38
	L T20,"AB",T27,1PE12.4	RPTDEL	39
	C T56,"AF",T63,1PE12.4,	RPTDEL	40
	R T92,"AII",T99,1PE12.4/,	RPTDEL	41
	L T20,"AW",T27,1PE12.4,	RPTDEL	42
	C T56,"THW",T63,1PE12.4,	RPTDEL	43
	R T92,"RKW",T99,1PE12.4/,	RPTDEL	44
	L T20,"ATM",T27,1PE12.4,	RPTDEL	45
	C T56,"RMA",T63,1PE12.4)	RPTDEL	46
1075	FORMAT(T5,1P10E12.4)	RPTDEL	47
	NNN = SR(3)	RPTDEL	48
	WRITE(6,1000)	RPTDEL	49
	WRITE(6,1000)	RPTDEL	50
	WRITE(6,1015)	RPTDEL	51
	WRITE(6,1000)	RPTDEL	52
	WRITE(6,1010)	RPTDEL	53
	WRITE(6,1000)	RPTDEL	54
	WRITE(6,1015)	RPTDEL	55
	WRITE(6,1000)	RPTDEL	56
	WRITE(6,1000)	RPTDEL	57
	WRITE(6,1070) (B(I),I=1,9), (SR(II),II =1,2)	RPTDEL	58
	WRITE(6,1000)	RPTDEL	59
	WRITE(6,1020)	RPTDEL	60
	WRITE(6,1000)	RPTDEL	61
	IF(FDELUG.EQ."DELBAW ") GO TO 10	RPTDEL	62
	WRITE(6,1030)	RPTDEL	63
	DO 20 I = 1, NNN	RPTDEL	64
	N1 = (I - 1) * 42 + 1	RPTDEL	65
	N2 = N1 + 9	RPTDEL	66
	WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)	RPTDEL	67
20	CONTINUE	RPTDEL	68
	WRITE(6,1000)	RPTDEL	69
	WRITE(6,1035)	RPTDEL	70
	DO 30 I = 1, NNN	RPTDEL	71
	N1 = (I - 1) * 42 + 11	RPTDEL	72
	N2 = N1 + 9	RPTDEL	73
	WRITE(6,1075) (SPRT4(IJ), IJ=N1,N2)	RPTDEL	74
30	CONTINUE	RPTDEL	75
	WRITE(6,1000)	RPTDEL	76
	WRITE(6,1036)	RPTDEL	77
	DO 35 I = 1, NNN	RPTDEL	78
	N1 = (I - 1) * 42 + 21	RPTDEL	79
	N2 = N1	RPTDEL	80
	WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)	RPTDEL	81
35	CONTINUE	RPTDEL	82
	WRITE(6,1000)	RPTDEL	83
	WRITE(6,1025)	RPTDEL	84
	WRITE(6,1000)	RPTDEL	85
	WRITE(6,1040)	RPTDEL	86

SUBROUTINE RPTDEL

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

```

      DO 40 I = 1, NNN
      N1 = (I - 1) * 42 + 22
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
40  CONTINUE
      WRITE(6,1000)
      WRITE(6,1045)
      DO 50 I = 1, NNN
      N1 = (I - 1) * 42 + 32
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
50  CONTINUE
      WRITE(6,1000)
      WRITE(6,1046)
      DO 55 I = 1, NNN
      N1 = (I - 1) * 42 + 42
      N2 = N1
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
55  CONTINUE
      GO TO 100
10  WRITE(6,1050)
      DO 60 I = 1, NNN
      N1 = (I - 1) * 26 + 1
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
60  CONTINUE
      WRITE(6,1000)
      WRITE(6,1055)
      DO 70 I = 1, NNN
      N1 = (I - 1) * 26 + 11
      N2 = N1 + 2
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
70  CONTINUE
      WRITE(6,1000)
      WRITE(6,1025)
      WRITE(6,1000)
      WRITE(6,1060)
      DO 80 I = 1, NNN
      N1 = (I - 1) * 26 + 14
      N2 = N1 + 9
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
80  CONTINUE
      WRITE(6,1000)
      WRITE(6,1065)
      DO 90 I = 1, NNN
      N1 = (I - 1) * 26 + 24
      N2 = N1 + 2
      WRITE(6,1075) (SPRT4(IJ), IJ = N1,N2)
90  CONTINUE
100 CONTINUE
      RETURN
      END

```

```

RPTDEL      87
RPTDEL      88
RPTDEL      89
RPTDEL      90
RPTDEL      91
RPTDEL      92
RPTDEL      93
RPTDEL      94
RPTDEL      95
RPTDEL      96
RPTDEL      97
RPTDEL      98
RPTDEL      99
RPTDEL     100
RPTDEL     101
RPTDEL     102
RPTDEL     103
RPTDEL     104
RPTDEL     105
RPTDEL     106
RPTDEL     107
RPTDEL     108
RPTDEL     109
RPTDEL     110
RPTDEL     111
RPTDEL     112
RPTDEL     113
RPTDEL     114
RPTDEL     115
RPTDEL     116
RPTDEL     117
RPTDEL     118
RPTDEL     119
RPTDEL     120
RPTDEL     121
RPTDEL     122
RPTDEL     123
RPTDEL     124
RPTDEL     125
RPTDEL     126
RPTDEL     127
RPTDEL     128
RPTDEL     129
RPTDEL     130
RPTDEL     131
RPTDEL     132
RPTDEL     133
RPTDEL     134
RPTDEL     135
RPTDEL     136
RPTDEL     137
RPTDEL     138

```

C	SUBROUTINE RPTFAN	RPTFAN	2
C	THIS ROUTINE REPORTS FAN DESCRIPTION AND COSTS	RPTFAN	3
C	LOGICAL LOOPER	RPTFAN	4
	COMMON/FAN/ FANDAP(153,10),FANDAM(153,10),FMCPF,FBCPF,P2,R,S,	FANDEK	2
	\$ VELDEC, AFC, ELEV, EHR, LOOPER, GTMAX	FANDEK	3
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	FANDEK	4
	COMMON	BIGCOM	2
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	3
	\$,BPLIM(16)	BIGCOM	4
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	5
	\$,CAJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	6
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	7
	\$,EFFP, EFS	BIGCOM	8
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG	BIGCOM	9
	\$,FIXV,FIXTID,FXTVAR,FXTTID,FXTLNG	BIGCOM	10
	\$,GREFF	BIGCOM	11
	\$,HXNP,HPCST,HCD	BIGCOM	12
	\$,ITMAX, ITMIN	BIGCOM	13
	\$,JCONS	BIGCOM	14
	\$,KCONV, KALEXT	BIGCOM	15
	\$,MxEXT	BIGCOM	16
	\$,NTA,NSIDES,NBUNHI	BIGCOM	17
	COMMON	BIGCOM	18
	\$ ODR	BIGCOM	19
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	20
	\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL	BIGCOM	21
	\$,RBP,REDUCE, REDUCV, ROOFL, RHOIT	BIGCOM	22
	\$,OREJ, GREduce, GREduceV	BIGCOM	23
	\$,SIGMAG, SAAF, SEGL	BIGCOM	24
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPA, TFIX	BIGCOM	25
	\$,TCD, TW	BIGCOM	26
	\$,UCS, UWS	BIGCOM	27
	\$,WFV, WATCONA, WATCOST	BIGCOM	28
	\$,VAS(5)	BIGCOM	29
	\$,XDEPA, XW, XD	BIGCOM	30
C	COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,	RPTFAN	31
	\$,GIN1, CLAN1, REA11, Z1,HRFA25, W41, U1, DEPW1, PPOW1,	SINK	2
	\$,FPow1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, M01, T41,	SINK	3
	\$,REWA1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPRP, SW41, SW31,	SINK	4
	\$,SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,	SINK	5
	\$,BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1	SINK	6
	\$,TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CHI, CAL, CS1	SINK	7
	\$,CLTC1, CFC1, CPCC1,FITCO1, CSC1,CEPRE1,DEPIP1, AST1,OLDCS1	SINK	8
	\$,CAPCS1,XNFAN1,BLDAN1,CPLN1,DPFEL1, WH1, WTTU1, ADI1, ABL1	SINK	9
	\$,WTHD1, WTR1,STRUC1,CFMPF1, HPPF1,TOTCF1, TP1,EFFIN1, ANTU1	SINK	10
	\$,AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1	SINK	11
	\$,ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1	SINK	12
	\$,CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMTOL, CTOWD1	SINK	13
	\$,SQRJ1,SQRJ51,ATURC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPCD1	SINK	14
	\$,CSTHS1, CYLRN1, CFANE1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1	SINK	15
	\$,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16)	SINK	16
	\$,WBB1,HTOW1,NTOWD1,CSTIF1,CSJ1,CVF1,CDP1,W51	SINK	17
	REAL MOTOR(4,3), DRIVE(3,2), PITCH(3,2), RECOVY(5,2)	RPTFAN	18
C		RPTFAN	19
		RPTFAN	11

```

      DATA (IMOTOR(I,K),I=1,4), K=1,3)/
      * "TOTALLY EN","CLOSED SQU","IRREL CAGE"," MOTOR      ",
      * "EXPLOSION ","PROOF SQUI","RREL CAGE ","MOTOR      ",
      * "TWO SPEED ","SQUIRREL C","AGE          ","          "/
      DATA (IDRIVE(I,K),I=1,3),K=1,2)/
      * "SPIRAL BEV","EL GEAR DR","IVE          ",
      * "V=BELT DRI","VE          ","          "/
      DATA (IPITCH(I,K),I=1,3),K=1,2)/
      * "MANUAL PIT","CH BLADES ","          ",
      * "AUTO-VARIA","BLE PITCH ","BLADES      "/
      DATA (IRECOVY(I,K), I=1,5),K=1,2)/
      * "FANS NOT E","QUIPPED WI","TH VELOCIT","Y RECOVERY",
      * " DIFFUSERS",
      * "FANS EQUIP","PED WITH V","ELOCITY RE","COVERY DIF",
      * "FUSERS      "/
C
1000 FORMAT(1H )
1005 FORMAT(1H1)
1010 FORMAT(T52,"F A N S")
1020 FORMAT(T51,"-----")
1030 FORMAT(T16,"--- DRIVE SYSTEM ---",T82,"--- FAN GEOMETRY ---")
1040 FORMAT(T84,"BLADE DIAMETER ",F6.2," FEET")
1050 FORMAT(T87,"BLADE ANGLE ",F6.2," DEGREES")
1060 FORMAT(T78,"NUMBER OF BLADES/FAN ",F6.2)
1070 FORMAT(T84,"NUMBER OF FANS ",F6.0)
1080 FORMAT(T17,"--- FAN COSTS ---",T78,"--- DESIGN CONDITIONS ---")
C
1085 FORMAT (T100,"(ACTUAL)",T122,"(ADJUSTED)")
1090 FORMAT(T73,"VOLUMETRIC FLOW RATE/FAN ",F12.0," CU FT/MIN")
1100 FORMAT(T16,"BLADE AND HUB COST/FAN $",F10.0,T71,
      * "TOTAL VOLUMETRIC FLOW RATE ",F12.0," CU FT/MIN")
1120 FORMAT(T24,"MOTOR COST/FAN $",F10.0,T70,
      * "TOTAL AIR PRESSURE DROP OF H.X. ",F8.5," PSI",T120,F8.5)
1130 FORMAT(T10,"SPEED REDUCER DRIVE COST/FAN $",F10.0,T69,
      * "PRESSURE DROP ACROSS H.X. BUNDLE ",F8.5," PSI",T120,F8.5)
1140 FORMAT(T24,"STACK COST/FAN $",F10.0,T72,
      * "NON-RECOVERABLE VELOCITY HEAD ",F8.5," PSI",T120,F8.5)
1145 FORMAT(T19,"ELECTRICAL COST/FAN $",F10.0
      * $ ,T83,"HORSEPOWER/FAN",F13.0," HP",T116,F12.0)
1150 FORMAT(T79,
      * "FAN POWER REQUIREMENTS ",F8.0," HP")
1190 FORMAT(T2,"*** ANNUAL OPERATIONAL COSTS $",F10.0)
1200 FORMAT(T37,5A10)
1210 FORMAT(
      * R T86,"HUB DIAMETER ",F6.2," FEET")
      * WRITE(6,1000)
      * WRITE(6,1000)
      * WRITE(6,1020)
      * WRITE(6,1010)
      * WRITE(6,1020)
      * WRITE(6,1000)
      * IF(VELREC.EQ.0) WRITE(6,1200) (RECOVY(I,1),I=1,5)
      * IF(VELREC.EQ.1) WRITE(6,1200) (RECOVY(I,2),I=1,5)
      * WRITE(6,1000)
      * WRITE(6,1030)
      * WRITE(6,1000)
      * WRITE(6,1210) HUBDI1

```

```

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

```

SUBROUTINE RPTFAN 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

WRITE(6,1040) ADI1
WRITE(6,1050) BLDAN1
WRITE(6,1060) ABL1
WRITE(6,1070) XNFAN1
WRITE(6,1000)
WRITE(6,1000)
WRITE(6,1080)
WRITE(6,1000)
WRITE(6,1085)
WRITE(6,1090) CFMPF1
WRITE(6,1100) FDCPF1, TOTCF1
WRITE(6,1120) FMTRC1, ACTYP1, ADJTP1
WRITE(6,1130) CSR1, ACTBP1, ADJBP1
WRITE(6,1140) CYLRN1, ACTVM1, ADJVM1
WRITE(6,1145) CFANE1, HPPF1, ADJPP1
WRITE(6,1150) THPAI1
WRITE(6,1190) AFCST1
RETURN
END

RPTFAN	69
RPTFAN	70
RPTFAN	71
RPTFAN	72
RPTFAN	73
RPTFAN	74
RPTFAN	75
RPTFAN	76
RPTFAN	77
RPTFAN	78
RPTFAN	79
RPTFAN	80
RPTFAN	81
RPTFAN	82
RPTFAN	83
RPTFAN	84
RPTFAN	85
RPTFAN	86
RPTFAN	87

SUBROUTINE RPTHXC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE RPTHXC(AFRON)

C
C
C
CTHIS ROUTINE REPORTS HEAT EXCHANGER DESIGN, OPERATING CONDITIONS
AND COST

LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG

COMMON

\$ AFR, ALPHA, ANG(3)

* ,BPLIM(16)

\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF

\$,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM

\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF

\$,EFFP, EFS

\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG

\$,FIXV,FIXTDD,FXTVAR,FXTTDD,FXTLNG

\$,GBEFF

\$,HXNP,HPCST,HCD

\$,ITMAX, ITMIN

\$,JCONS

\$,KCONV, KALEXT

\$,MXEXT

\$,NTA,NSIDES,NBUNHI

COMMON

\$ ODR

\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL

\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL

\$,RBP,REDUCE, REDUCV, ROOFL, RHOUT

\$,QREJ, QREDUCE, QREDUCV

\$,SIGMAG, SAAF, SEGL

\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX

\$,TCD, TW

\$,UCS, UWS

\$,WFEV, WATCONA, WATCOST

\$,VAS(5)

\$,XDEPA, XW, XD

COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,

\$ QIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPOW1,

\$ FROW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41,

\$ REW1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPRP, SW41, SW31,

\$ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,

\$ BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1

\$, TL41, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CAL, CS1

\$, CLTC1, CFC1, CPCC1,FITC01, CSC1,CEPRE1,DEPI1, AST1,OLDCS1

\$,CAPCS1,XNFAN1,BLDAN1,CPLN1,DPFEL1, WH1, WTTU1, ADI1, ABL1

\$, WTHD1, WTR1,STRUC1,CFMPF1, HPPF1,TOTCF1, TP1,EFFIN1, ANTU1

\$, AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1

\$, ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1

\$, CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMT01, CTOWD1

\$,SQRJ1,SQRJS1,ATURC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPCD1

\$,CSTHS1, CYLRN1, CFANEL, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1

\$,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16)

\$,WBR1,HTOW1,NTOWD1,CSTIF1,CSJ1,CVF1,CDP1,W51

C

COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD20E, LINOR, XNP, XQUALY

COMMON /HXD/ AI,ATOT,SFA,RFA,ACS

COMMON /ESCAL/ BSECF

COMMON /KPTSUP/ DUM(2017),THXIN1,DUM2(3)

RPTHXC	2
RPTHXC	3
RPTHXC	4
RPTHXC	5
RPTHXC	6
BIGCOM	2
BIGCOM	3
BIGCOM	4
BIGCOM	5
BIGCOM	6
BIGCOM	7
BIGCOM	8
BIGCOM	9
BIGCOM	10
BIGCOM	11
BIGCOM	12
BIGCOM	13
BIGCOM	14
BIGCOM	15
BIGCOM	16
BIGCOM	17
BIGCOM	18
BIGCOM	19
BIGCOM	20
BIGCOM	21
BIGCOM	22
BIGCOM	23
BIGCOM	24
BIGCOM	25
BIGCOM	26
BIGCOM	27
BIGCOM	28
BIGCOM	29
BIGCOM	30
BIGCOM	31
SINK	2
SINK	3
SINK	4
SINK	5
SINK	6
SINK	7
SINK	8
SINK	9
SINK	10
SINK	11
SINK	12
SINK	13
SINK	14
SINK	15
SINK	16
SINK	17
SINK	18
RPTHXC	9
RPTHXC	10
RPTHXC	11
RPTHXC	12
RPTHXC	13

6390	FORMAT(	RPTHXC	14
	R T69,"WT OF AMMONIA ",F14.0," LB")	RPTHXC	15
6400	FORMAT(	RPTHXC	16
	L T9,"AFTTR", G14.8	RPTHXC	17
	R,T71,"WT OF TUBES ",F14.0," LB")	RPTHXC	18
6410	FORMAT(	RPTHXC	19
	L T8,"ALPHA", G14.8	RPTHXC	20
	R,T71,"WT OF FRAME ",F14.0," LB")	RPTHXC	21
6420	FORMAT(	RPTHXC	22
	L T8,"SIGMA", G14.8	RPTHXC	23
	R,T71,"WT OF HEADER",F14.0," LB")	RPTHXC	24
6422	FORMAT(	RPTHXC	25
	R T71,"WT OF STRUCT",F14.0," LB")	RPTHXC	26
6424	FORMAT(	RPTHXC	27
	L T71," ROOF LOAD",F14.0," LB"	RPTHXC	28
	R,T106,"(",F8.2," LB/SQ FT)")	RPTHXC	29
6430	FORMAT(	RPTHXC	30
	L T3,"FITCO/ATOT", G14.8	RPTHXC	31
	\$)	RPTHXC	32
6440	FORMAT (IHO,2A10,T15,"NTU EFFECTIVENESS CORRELATION USED")	RPTHXC	33
6500	FORMAT(IHO)	RPTHXC	34
6505	FORMAT(T35,30("-"))	RPTHXC	35
6510	FORMAT(T36,"H E A T E X C H A N G E R")	RPTHXC	36
6512	FORMAT(IH+,T90,F6.1," FANS",T110,F4.1," PASS")	RPTHXC	37
6515	FORMAT(	RPTHXC	38
	L T2," AMMONIA FLOW RATE",I11," LBM/HR"	RPTHXC	39
	R,T71," COOLING SURFACE \$",F10.0)	RPTHXC	40
6520	FORMAT(	RPTHXC	41
	L T2," AIR FLOW RATE",I11," LBM/HR"	RPTHXC	42
	R,T71," HEADER AND NOZZEL \$",F10.0)	RPTHXC	43
6525	FORMAT(	RPTHXC	44
	L T2," TUBES IN DEPTH",F11.2," TUBES ("F7.1," FT DEEP)"	RPTHXC	45
	R,T71,"BUNDLE ASSEMBLE AND FRAME \$",F10.0)	RPTHXC	46
6530	FORMAT(	RPTHXC	47
	L T2,"TUBES ACROSS FRONT",I11," TUBES ("F7.1," FT WIDE)"	RPTHXC	48
	R,T71," PLENUM \$",F10.0)	RPTHXC	49
6532	FORMAT(1X	RPTHXC	50
	L ,T6,"LENGTH OF TUBES",F10.0," FEET"	RPTHXC	51
	R, T71," LOUVERS \$",F10.0	RPTHXC	52
6533	FORMAT (1X	RPTHXC	53
	R, T71," HAIL SCREENS \$",F10.0	RPTHXC	54
6535	FORMAT(	RPTHXC	55
	R T71," STRUCTURE \$",F10.0)	RPTHXC	56
6537	FORMAT(	RPTHXC	57
	L T8,"SURFACE AREA",I11," SQ FT",	RPTHXC	58
	R T71," FOUNDATION \$",F10.0)	RPTHXC	59
6540	FORMAT(	RPTHXC	60
	L T2," FRONTAL AREA",I11," SQ FEET"	RPTHXC	61
	R)	RPTHXC	62
6550	FORMAT(T40,2("FOR",F5.0," DEGREE F AMBIENT ")	RPTHXC	63
6541	FORMAT(	RPTHXC	64
	R T77,"BUNDLE STIFFNER COST \$",F10.0/	RPTHXC	65
	R ,T79,"SECTION JOINT COST \$",F10.0/	RPTHXC	66
	R ,T80,"BUNDLE FRAME COST \$",F10.0/	RPTHXC	67
	R ,T80,"DRAIN PLATE COST \$",F10.0/	RPTHXC	68
	P ,T79,"BUNDLE ASSEMBLY COST \$",F10.0)	RPTHXC	69
6555	FORMAT(T70,11("-"),2X,11("-"))	RPTHXC	70

```

6560 FORMAT(T73,"AIR",T85,"AMMONIA")
6565 FORMAT(T70,25("-"))
6570 FORMAT(T50,"REYNOLDS NUMBER"
      & ,2(1PE13.5,E14.5,3X))
6575 FORMAT(T48,"VELOCITY (FT/SEC)"
      & ,2(1PE13.5,E14.5,3X))
6580 FORMAT(T34,"PRESSURE DROP (LBS FORCE/SQ IN)"
      & ,2(1PE13.5,E14.5,3X))
6581 FORMAT(T44,"INLET TEMPERATURE (F)",1PE13.5,E14.5)
6582 FORMAT(T45,"EXIT TEMPERATURE (F)",1PE13.5,E14.5)
6583 FORMAT(T56,"RANGE (F)",1PE13.5,E14.5)
6584 FORMAT(T61,"TTD1",7X,1PE13.5)
6585 FORMAT(T29,"HEAT TRFR COEFF (BTU/HR SQ FT DEG F)"
      & ,2(1PE13.5,E14.5,3X))
6586 FORMAT(T62,"NTU",7X,1PE13.5)
6587 FORMAT(T50,"FRICTION FACTOR"
      & ,2(1PE13.5,E14.5,3X))
6590 FORMAT(T35,"HEAT TRFR SURFACE AREA (SQ FT "
      & ,1PE13.5,E14.5)
6592 FORMAT(T35,"EXIT TEMPERATURE (F)"
      & ,2(1PE13.5,E14.5,3X))
6595 FORMAT(T35,"OVERALL U (BTU/HR SQ FT DEG F "
      & ,7X,1PE13.5,E14.5)
6600 FORMAT(T52,"EFFECTIVENESS"
      & ,T76,F7.4)
6610 FORMAT(T51,"FIN EFFICIENCY"
      & ,T76,F7.4)
6620 FORMAT (T07,"LOG MEAN TEMPERATURE DIFFERENCE"
      & ,T46,F7.2,T76,F7.2)

```

C

```

      WRITE(6,6500)
501 FORMAT(1H )
      WRITE(6,6505)
      WRITE(6,6510)
      WRITE(6,6512) XNFAN1, HXNP
      WRITE(6,6505)
      WRITE(6,6500)
      WRITE(6,6565)
      WRITE(6,6560)
      WRITE(6,6555)
      WRITE(6,6570) REAI1, REWA1
      WRITE(6,6575) VAIR1, VWAT1
      WRITE(6,6580) DEPA1/144., DPWT1/144.
      WRITE(6,6585) H01, H11
      WRITE(6,6587) AIRFF1, WATFF1
      WRITE(6,6581) TD, THXIN1
      WRITE(6,6582) T41, THXIN1
      WRITE(6,6583) T41-TD
      WRITE(6,6584) VAR(3)
      WRITE(6,6586) ANTU1
      WRITE(6,6595) U1
      WRITE(6,6600) EFF1
      WRITE(6,6610) EFFIN1
      WRITE(6,501)
      WRITE(6,6390) WATER1
      WRITE(6,6400) AFTR, WTTU1
      WRITE(6,6410) ALPHA, WFR1

```

```

RPTHXC      71
RPTHXC      72
RPTHXC      73
RPTHXC      74
RPTHXC      75
RPTHXC      76
RPTHXC      77
RPTHXC      78
RPTHXC      79
RPTHXC      80
RPTHXC      81
RPTHXC      82
RPTHXC      83
RPTHXC      84
RPTHXC      85
RPTHXC      86
RPTHXC      87
RPTHXC      88
RPTHXC      89
RPTHXC      90
RPTHXC      91
RPTHXC      92
RPTHXC      93
RPTHXC      94
RPTHXC      95
RPTHXC      96
RPTHXC      97
RPTHXC      98
RPTHXC      99
RPTHXC     100
RPTHXC     101
RPTHXC     102
RPTHXC     103
RPTHXC     104
RPTHXC     105
RPTHXC     106
RPTHXC     107
RPTHXC     108
RPTHXC     109
RPTHXC     110
RPTHXC     111
RPTHXC     112
RPTHXC     113
RPTHXC     114
RPTHXC     115
RPTHXC     116
RPTHXC     117
RPTHXC     118
RPTHXC     119
RPTHXC     120
RPTHXC     121
RPTHXC     122
RPTHXC     123
RPTHXC     124
RPTHXC     125
RPTHXC     126
RPTHXC     127

```

SUBROUTINE RPTHXC

74/74

OPT=1

FTN 4,5+414

06/05/78 07.59.59

WRITE(6,6420) SIGMAG,WTMD1	RPTHXC	128
WRITE(6,6424) AFRON=ROOFL, ROOFL	RPTHXC	129
WRITE(6,6430) FITCOL/ATOT	RPTHXC	130
WRITE(6,6440) NTUCAL	RPTHXC	131
WRITE(6,6500)	RPTHXC	132
C	RPTHXC	133
WRITE(6,6515) IFIX(SW31), CS1	RPTHXC	134
WRITE(6,6520) IFIX(SW41),CH1	RPTHXC	135
WRITE(6,6525) Z1, Z1*XD/12., CBA1 + CVF1	RPTHXC	136
WRITE(6,6530) NW1, WIDT1, CPLEN1	RPTHXC	137
WRITE(6,6532) ELEN1, CSTLV1	RPTHXC	138
WRITE(6,6533) CSTHS1	RPTHXC	139
WRITE(6,6535) STRUC1	RPTHXC	140
WRITE(6,6537) IFIX(AAIR1), CFOUND1	RPTHXC	141
WRITE(6,6540) IFIX(AFRON)	RPTHXC	142
IF(PFHX.EQ."HOTERV")	RPTHXC	143
WRITE(6,6541) CSTIF1, CSJ1, CVF1, CDP1, CBA1	RPTHXC	144
RETURN	RPTHXC	145
END	RPTHXC	146

	SUBROUTINE RPTHXD	RPTHXD	2
C		RPTHXD	3
C	THIS ROUTINE REPORTS HEAT EXCHANGER DESCRIPTION AND UNIT COST DATA	RPTHXD	4
C		RPTHXD	5
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG	BIGCOM	2
	COMMON	BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
	* ,BPLIM(16)	BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
	\$,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
	\$,EFFP, EFS	BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG	BIGCOM	10
	\$,FIXV,FXTTID,FXTVAR,FXTTID,FXTLNG	BIGCOM	11
	\$,GREFF	BIGCOM	12
	\$,HXNP,HPCST,HCD	BIGCOM	13
	\$,ITMAX, ITMIN	BIGCOM	14
	\$,JCONS	BIGCOM	15
	\$,KCONV, KALEXT	BIGCOM	16
	\$,MXEXT	BIGCOM	17
	\$,NTA,NSIDES,NBUNHI	BIGCOM	18
	COMMON	BIGCOM	19
	\$ ODR	BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
	\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSC	BIGCOM	22
	\$,RBP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
	\$,SIGMAG, SAAF, SEGL	BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
	\$,TCD, TW	BIGCOM	27
	\$,UCS, UWS	BIGCOM	28
	\$,WFW, WATCONA, WATCOST	BIGCOM	29
	\$,VAS(5)	BIGCOM	30
	\$,XDEPA, XW, XD	BIGCOM	31
	COMMON /HEADEX/ CHH, CN, CHM, CMW, CRJ, CWJ, CST	RPTHXD	7
	\$, CMO, CSR, CSM, PITCHF, CPM, PRESS,HEDMAT,HEDTYP, NPASS	RPTHXD	8
	\$,WR,TSP,CSH,CSHP	RPTHXD	9
	COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,	SINK	2
	\$ GIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPOW1,	SINK	3
	\$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41,	SINK	4
	\$ REW41, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPBP, SW41, SW31,	SINK	5
	\$ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,	SINK	6
	\$ BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1	SINK	7
	\$, TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CHI, CA1, CS1	SINK	8
	\$, CLTC1, CFC1, CPCC1,FITC01, CSC1,CEPRE1,DEPI1, AST1,OLDCS1	SINK	9
	\$,CAPCS1,XNFAN1,BLDAN1,CPLEN1,DPPF1, WH1, WTTU1, ADI1, ABL1	SINK	10
	\$, WTHD1, WTR1,STRUC1,CFMPF1, HPPF1,TOTCF1, TPI,EFFIN1, ANTU1	SINK	11
	\$, AIRPF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1	SINK	12
	\$, ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1	SINK	13
	\$, CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMT01, CTOWD1	SINK	14
	\$,SORJ1,SORJS1,ATUBC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPCTD1	SINK	15
	\$,CSTHS1, CYLRN1, CFANEL, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1	SINK	16
	\$,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16)	SINK	17
	\$,WR1,MTOW1,NTOWD1,CSTIF1,CSJ1,CVF1,CDP1,W51	SINK	18
	COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY	RPTHXD	11
	COMMON /SURFEX/ ODL,GAGLIN, NTUB,TUBMAT,FINTYP,FINMAT, CFB	RPTHXD	12
	\$,APLATE, COATC, ZINCC, CASTC, SS,EPREPC,XTUBMA,XHEDTY,XFINTY	RPTHXD	13

```

COMMON /DJB/ DI, XDG, SF
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,
$ QIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW,
$ FPCW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HC, T4,
$ REWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3,
$ SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2,
$ RP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTSX, VELDX,
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS,
$ , CLTC, CFC, CPCC, FITCO, CSC, CEPREP, DELPIP, AST, OLDCST,
$ , CAPCST, XNFAN, BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN,
$ , WTHDP, WIFRM, STRUCC, CFPERF, HPPERF, TOTCF, TPC, EFFI, ANTU,
$ , AIRPF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP,
$ , ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST,
$ , CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD,
$ , SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCST,
$ , CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCT, RPTPL, SEPCST,
$ , PWD(16), WATCHD(16), DEPER(16), DEPERO(16),
$ , WBB, MTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5
RPTHXD 14
SUPPLY 2
SUPPLY 3
SUPPLY 4
SUPPLY 5
SUPPLY 6
SUPPLY 7
SUPPLY 8
SUPPLY 9
SUPPLY 10
SUPPLY 11
SUPPLY 12
SUPPLY 13
SUPPLY 14
SUPPLY 15
SUPPLY 16
SUPPLY 17
SUPPLY 18
6600 FORMAT(1H1) RPTHXD 16
6601 FORMAT(1H ) RPTHXD 17
6602 FORMAT (1H+,T10," NON - D E L T A H E A T E X C H A N G E
$ R D E S C R I P T I O N",T10,F5.1," DEG ") RPTHXD 18
6603 FORMAT( RPTHXD 19
L T22,"SUPPORT SPACING ",F7.3,T47,"FEET" RPTHXD 20
R T60,"ROOT DIAMETER" ,F8.4,T82,"INCH") RPTHXD 21
6605 FORMAT( RPTHXD 22
L T8,"TUBE PITCH NORMAL TO AIR FLOW ",F7.3,T47,"INCH" RPTHXD 23
R T60,"FIN THICKNESS",F8.4,T82,"INCH") RPTHXD 24
6610 FORMAT( RPTHXD 25
L T2,"TUBE PITCH IN DIRECTION OF AIR FLOW ",F7.3,T47,"INCH" RPTHXD 26
R T61,"FIN DIAMETER ",F8.4,T82,"INCH") RPTHXD 27
6615 FORMAT( RPTHXD 28
LT18,"TUBE DIAGONAL PITCH ",F7.3,T47,"INCH" RPTHXD 29
R,T62,"FIN SPACING" ,F8.4,T82,"INCH") RPTHXD 30
6620 FORMAT( RPTHXD 31
LT23,"LINER MATERIAL ",2A10 RPTHXD 32
R,T61,"FIN MATERIAL ",2A10) RPTHXD 33
6625 FORMAT( RPTHXD 34
L T11,"LINER THERMAL CONDUCTIVITY",F7.3 RPTHXD 35
R,T56,"FIN THERMAL COND. ",G11.4,T83,"BTU/(HR SQ FT DEG F)/FT") RPTHXD 36
6630 FORMAT( RPTHXD 37
L T8,"LINER TUBING OUTSIDE DIAMETER " ,F7.4,T47,"INCH" RPTHXD 38
R,T62,"HEADER TYPE ",2A10) RPTHXD 39
6635 FORMAT(1H+ RPTHXD 40
LT38,"--- U N I T C O S T S ---") RPTHXD 41
6640 FORMAT( RPTHXD 42
LT13,"FIN BONDING $",G10.4,"/SQ FT" RPTHXD 43
R,T58,"HEADER MATERIAL (" ,1A10," ) $",F8.3,"/LB") RPTHXD 44
6645 FORMAT( RPTHXD 45
LT6,"PROTECTIVE COATING $",G10.4,"/SQ FT" RPTHXD 46
R,T58,"ROLLED JOINT, TUBE TO HEADER $",F8.3,"/TUBE") RPTHXD 47
6650 FORMAT( RPTHXD 48
L T8,"ZINC FOR SPACERS $",G10.4,"/LB" RPTHXD 49
R,T58,"WELDED JOINT, TUBE TO HEADER $",F8.3,"/TUBE") RPTHXD 50
6655 FORMAT( RPTHXD 51
LT10,"SPACER CASTING $",G10.4,"/EA" RPTHXD 52
R,T56,"TURE AND PLUG HOLE PREPARATION $",F8.3,"/HOLE") RPTHXD 53
RPTHXD 54

```

SUBROUTINE RPTHXD 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

6660	FORMAT(	RPTHXD	55
	LT9,"END PREPARATION \$",G10.4,"/TUBE"	RPTHXD	56
	R,T66,"NOZZEL AND ATTACHING \$",F8.3,"/HOLE")	RPTHXD	57
6662	FORMAT(	RPTHXD	58
	R,T67,"BOLTED HEADER JOINT \$", F8.3,"/FT"	RPTHXD	59
6665	FORMAT(	RPTHXD	60
	RT58,"HEADER MACHINING AND WELDING \$",F8.3,"/FT")	RPTHXD	61
6670	FORMAT(	RPTHXD	62
	LT09,"LINER TUBING \$",G11.5,"/FT",	RPTHXD	63
	RT70,"STRUCTURAL STEEL \$",F8.3,"/LB")	RPTHXD	64
6675	FORMAT(	RPTHXD	65
	LT03,"PROTECTIVE COATING \$",G11.5,"/FT"	RPTHXD	66
	R)	RPTHXD	67
6680	FORMAT(	RPTHXD	68
	LT14,"FINNING \$",G11.5,"/FT"	RPTHXD	69
	R)	RPTHXD	70
6685	FORMAT(/	RPTHXD	71
	LT29,"FINNED TUBE \$",G11.5,"/FT"	RPTHXD	72
	R)	RPTHXD	73
6695	FORMAT(	RPTHXD	74
	LT28,"TUBE SPACERS \$",G11.5,"/FT"	RPTHXD	75
	R)	RPTHXD	76
C		RPTHXD	77
6617	FORMAT(	RPTHXD	78
	L T27,"LINER GAGE ",F5.1	RPTHXD	79
	R ,T65,"FIN TYPE ",Z410)	RPTHXD	80
6700	FORMAT(	RPTHXD	81
	L T18,"TUBES THRU EACH FIN",F8.0,T47,"TUBES"	RPTHXD	82
	R,T56,"AREA OF PLATE FIN ",F11.1," SQ IN,"	RPTHXD	83
6710	FORMAT(	RPTHXD	84
	LT9,"LINER TUBING INSIDE DIAMETER ",F7.4,T47,"INCH"	RPTHXD	85
	R,T60,"HEADER LENGTH",F11.3," FEET")	RPTHXD	86
	WRITE(6,6600)	RPTHXD	87
	DO 20 I=1,3	RPTHXD	88
	IF (DANGLE .LT. 1.E-30) WRITE(6,6602)	RPTHXD	89
	IF (DANGLE .GT. 0.0) WRITE(6,6602) DANGLE*180. / 3.14159	RPTHXD	90
20	CONTINUE	RPTHXD	91
	WRITE(6,6601)	RPTHXD	92
	WRITE(6,6603) SS ,ODR	RPTHXD	93
	WRITE(6,6605) XW ,THFIN	RPTHXD	94
	WRITE(6,6610) XD ,DFIN	RPTHXD	95
	WRITE(6,6615) XDG ,SF	RPTHXD	96
	WRITE(6,6617) GAGLIN,FINTYP,XFINTY	RPTHXD	97
	IF(FINTYP .EQ. "PLATE ") WRITE(6,6700 NTUB,APLATE	RPTHXD	98
	WRITE(6,6620) TUBMAT,XTUBMA,FINMAT	RPTHXD	99
	WRITE(6,6625) CONL,CONF	RPTHXD	100
	WRITE(6,6630) ODL,HEDTYP,XHEDTY	RPTHXD	101
	WRITE(6,6710) DI, WB	RPTHXD	102
	WRITE(6,6601)	RPTHXD	103
	WRITE(6,6601)	RPTHXD	104
C		RPTHXD	105
	DO 30 I=1,3	RPTHXD	106
30	WRITE(6,6635)	RPTHXD	107
	WRITE(6,6601)	RPTHXD	108
	WRITE(6,6640) CFB,HEDMAT,CHM	RPTHXD	109
	WRITE(6,6645) COATC,CRJ	RPTHXD	110
	WRITE(6,6650) ZINCC,CWJ	RPTHXD	111

SUBROUTINE RPTHXD 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

WRITE(6,6655) CASTC,CHH
WRITE(6,6660) EPREPC,CN
WRITE(6,6662) CBJ
WRITE(6,6665) CMW
WRITE(6,6670) CLTC1, CST
WRITE(6,6675) CPCC1
WRITE(6,6680) CFC1
WRITE(6,6685) FITC01
WRITE(6,6695) CSC1

C

RETURN
END

RPTHXD 112
RPTHXD 113
RPTHXD 114
RPTHXD 115
RPTHXD 116
RPTHXD 117
RPTHXD 118
RPTHXD 119
RPTHXD 120
RPTHXD 121
RPTHXD 122
RPTHXD 123

```

      SUBROUTINE RPTRET(CTOWD1, PF, PSTAC1, PUFIT1, PUMPC1, RPTPL1,
      $ SEP0S1, PIPCTD1)
C
C   THIS ROUTINE REPORTS RETURN PIPING DESIGN AND COSTS
C
      COMMON /KPTRET/
      $ DELL1, DESVE1, DIARD1, DIART1, DOTMA1, DYNHDI
      $, HEDR1(200)
      $, JRSAVE
      $, KRSAVE
      $, PIPCS1
      $, QHEDR1(200), QRLCS1
      $, RDIAL(200), RPCST1(200), RRCST1(200), RTCST1(200), RBFCST1, RCOST1
      $, RQDIAL(200), RQPCS1(200), RQRCST1(200), RQTCS1(200), REJCS1
      $, RELCS1, RFLGC1, RQCOS1, RTDCS1
      $, TOWD11, TRQCO1, TRTDC1
      COMMON /KKRET/
      $ RPDIAL(200), RVDIAL(200), LRSAVE
      $, PHEDR1(200), VHEDR1(200)
      $, RPRCST1(200), RVRCST1(200)
      $, RPTCST1(200), RUTCST1(200)
      $, PRLCST1, VRLCST1
      $, PPPCST1(200), RVPCST1(200)
      $, RPCOST1, RVCOST1
      $, INT, NBUN
C
      203 FORMAT(1H ,14X,I2,1X,7F10.1)
      204 FORMAT(///40X,"TOTAL COST OF CIRCULATION RETURN PIPING $",F5.0,
      $ " *10**3"////)
      205 FORMAT(/25X,"HORIZONTAL QUADRANT RETURN PIPING"
      $ //42X,"COST IN 10**3 DOLLARS FOR"/40X
      $,"-----"/12X,"HEADER DIAMETER LENGTH
      $ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)
      208 FORMAT(///42X,"TOTAL COST OF QUADRANT RETURN HEADERS $",F5.0,
      $ " *10**3"////)
      209 FORMAT(/25X,"TOWER RETURN PIPING"
      $ //10X,"TOWER DIAMETER",23X,F5.0," FEET"/
      $10X, "DIAMETER OF PIPE FROM CIRCULATION
      $"/10X,"HEADER TO TOWER DISTRIBUTION HEADER",F7.0," INCHES"/10X,"DI
      $AMETER OF TOWER DISTRIBUTION PIPE",F7.0," INCHES"/10X,"COST OF DI
      $STRIBUTION PIPING PER TOWER $",F5.0," *10**3"///40X,"TOTAL COST 0
      $F TOWER DISTRIBUTION PIPING $",F5.0," *10**3"////)
      211 FORMAT(10X,"LIQUID DESIGN VELOCITY",F5.0," FPS"/
      $ 10X,"MASS FLOW RATE",1PE10.3," LBM/HR"/
      $ 10X,"RETURN PIPING PRESSURE DROP",0PF7.1," PSF"/
      $ 10X,"RETURN PIPING DYNAMIC HEAD",F7.1," FEET"////
      $ 47X,"TOTAL RETURN PIPING SYSTEM COST $",F6.0," *10**3"///)
      213 FORMAT(1H1)
      214 FORMAT(1H ,13X,I2,1X,7F10.1)
      215 FORMAT( /10X,"COST OF RETURN HEADERS PER QUADRANT $",F5.1,
      $ " *10**3")
      216 FORMAT(30X,"-----"/30X,"RETURN PIPING"/30X,"-----"
      $-----"/25X,"CIRCULATION PIPING"/52X,"COST IN 10**"
      $3 DOLLARS FOR"/40X,"-----"
      $-----"/12X,"HEADER DIAMETER LENGTH PIPE TEES REDUCE
      $RS EXPANSION FLANGES"/21X,"(INCHES) (FEET)",33X,"JOINT(1) (3
      $)"/)
      RPTRET 2
      RPTRET 3
      RPTRET 4
      RPTRET 5
      RPTRET 6
      RPTRET 7
      RPTRET 8
      RPTRET 9
      RPTRET 10
      RPTRET 11
      RPTRET 12
      RPTRET 13
      RPTRET 14
      RPTRET 15
      RPTRET 16
      RPTRET 17
      RPTRET 18
      RPTRET 19
      RPTRET 20
      RPTRET 21
      RPTRET 22
      RPTRET 23
      RPTRET 24
      RPTRET 25
      RPTRET 26
      RPTRET 27
      RPTRET 28
      RPTRET 29
      RPTRET 30
      RPTRET 31
      RPTRET 32
      RPTRET 33
      RPTRET 34
      RPTRET 35
      RPTRET 36
      RPTRET 37
      RPTRET 38
      RPTRET 39
      RPTRET 40
      RPTRET 41
      RPTRET 42
      RPTRET 43
      RPTRET 44
      RPTRET 45
      RPTRET 46
      RPTRET 47
      RPTRET 48
      RPTRET 49
      RPTRET 50
      RPTRET 51
      RPTRET 52
      RPTRET 53
      RPTRET 54
      RPTRET 55
      RPTRET 56
      RPTRET 57
      RPTRET 58

```

217	FORMAT(///10X,"FITTINGS COST PER BUNDLE \$",F7.3," *10**3")	RPTRET	59
C		RPTRET	60
300	FORMAT(///T50.9("=")/T50,"P U M P S"/T50.9("=")///)	RPTRET	61
310	FORMAT(T10,"PUMP COST",T30,"\$",F8.0,"*10**3"	RPTRET	62
	\$ /T10,"PUMP FITTINGS",T30,"\$",F8.0,"*10**3"	RPTRET	63
	\$ /T10,"PUMP ELECTRICAL", T30,"\$",F8.0,"*10**3")	RPTRET	64
320	FORMAT(//T60,"PUMP STATION",T80, "\$", F8.0,"*10**3")	RPTRET	65
330	FORMAT(///T10,"SEPARATOR COST",T30,"\$",F11.0,"*10**3")	RPTRET	66
340	FORMAT(///T10,"DELUGE PIPING COST",T30,"\$",F11.0,"*10**3")	RPTRET	67
C		RPTRET	68
	JR=JRSAVE	RPTRET	69
	KR=KRSAVE	RPTRET	70
	LR=LRSAVE	RPTRET	71
	WRITE(6,213)	RPTRET	72
	WRITE(6,216)	RPTRET	73
	DO 201 I=1,JR	RPTRET	74
	IF(I.GT.1) GO TO 202	RPTRET	75
	WRITE(6,203) I, RDIAL(I), HEDR1(I), RPCST1(I)*PF, RTCST1(I)*PF	RPTRET	76
	\$,RRCST1(I)*PF, REJCS1*PF, RFLGC1*PF	RPTRET	77
	GO TO 201	RPTRET	78
202	IF(I.EQ.JR) GO TO 210	RPTRET	79
	WRITE(6,203) I, RDIAL(I), HEDR1(I), RPCST1(I)*PF, RTCST1(I)*PF	RPTRET	80
	\$,RRCST1(I)*PF	RPTRET	81
	GO TO 201	RPTRET	82
210	WRITE(6,203) I, RDIAL(I), HEDR1(I), RPCST1(I)*PF, RELCS1*PF	RPTRET	83
	\$,RRCST1(I)*PF	RPTRET	84
201	CONTINUE	RPTRET	85
	WRITE(6,204) RCAST1*PF	RPTRET	86
	WRITE(6,205)	RPTRET	87
	DO 206 I=1,KR	RPTRET	88
	IF(I.EQ.KR)GO TO 207	RPTRET	89
	WRITE(6,214) I, RQDIAL(I), QHEDR1(I), RQPCST1(I)*PF, RQTCST1(I)*PF	RPTRET	90
	\$,RQRCST1(I)*PF	RPTRET	91
	GO TO 206	RPTRET	92
207	WRITE(6,214) I, RQDIAL(I), QHEDR1(I), RQPCST1(I)*PF, QRLCS1*PF	RPTRET	93
	\$,RQRCST1(I)*PF	RPTRET	94
206	CONTINUE	RPTRET	95
	WRITE(6,405)	RPTRET	96
405	FORMAT(/25X,"EXTERIOR VERTICAL QUADRANT RETURN PIPING"/42X,"COST	RPTRET	97
	\$IN 10**3 DOLLARS FOR "/40X,30("=")/12X,"HEADER DIAMETER LENGTH	RPTRET	98
	\$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)	RPTRET	99
	DO 406 I=1,LR	RPTRET	100
	IF(I.EQ.LR) GO TO 407	RPTRET	101
	WRITE(6,214) I,RPDIAL(I),PHEDR1(I),RPPCST1(I)*PF,RPTCST1(I)*PF,	RPTRET	102
	\$RPRCST1(I)*PF	RPTRET	103
	GO TO 406	RPTRET	104
407	WRITE(6,214) I,RPDIAL(I),PHEDR1(I),RPPCST1(I)*PF,PRLCST1*PF,	RPTRET	105
	\$RPRCST1(I)*PF	RPTRET	106
406	CONTINUE	RPTRET	107
	IF(INT.LE.0) GO TO 600	RPTRET	108
	WRITE(6,505)	RPTRET	109
505	FORMAT(/25X,"INTERIOR VERTICAL QUADRANT RETURN PIPING"/42X,"COST	RPTRET	110
	\$IN 10**3 DOLLARS FOR "/40X,30("=")/12X,"HEADER DIAMETER LENGTH	RPTRET	111
	\$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)	RPTRET	112
	DO 506 I=1,LR	RPTRET	113
	WRITE(6,214) I,RVDIAL(I),VHEDR1(I),RVPCST1(I)*PF,RVTCST1(I)*PF,	RPTRET	114
	\$RVRCST1(I)*PF	RPTRET	115

SUBROUTINE RPTRET 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
506 CONTINUE
600 CONTINUE
      WRITE(6,517) NBUN
517 FORMAT(///10X,"NUMBER OF BUNDLES PER QUADRANT",I10)
      WRITE(6,217) RBFC1*PF
      WRITE(6,215) RQCOS1*PF
      WRITE(6,208) TRQCO1*PF
      WRITE(6,209) CTOWD1, DIARD1, DIART1, RTDCS1*PF, TRTDC1*PF
      WRITE(6,211) DESVE1, DOTMA1, DELL1, DYNHD1, PIPCS1
      WRITE(6,300)
      WRITE(6,310) (PUMPC1-PUFIT1)*PF, PUFIT1*PF, RPTPL1
      WRITE(6,320) (PUMPC1*PF) * RPTPL1
      WRITE(6,330) SEPCS1
      WRITE(6,340) PIPCTD1
      RETURN
      END
```

```
RPTRET 116
RPTRET 117
RPTRET 118
RPTRET 119
RPTRET 120
RPTRET 121
RPTRET 122
RPTRET 123
RPTRET 124
RPTRET 125
RPTRET 126
RPTRET 127
RPTRET 128
RPTRET 129
RPTRET 130
RPTRET 131
```

```

C      SUBROUTINE RPTSUP(DESVELV,NUMTOW,CTOWD1,WBB1,HTOW1,NTOWD1)
C      THIS ROUTINE REPORTS RETURN PIPING DESIGN AND COSTS
C
COMMON /KPTSUP/
$  DELV1, DIASD1, DIAST1, DOTMA1, DYNMD1
$  HEDR1(200)
$  JSSAVE
$  KSSAVE
$  PIPCS1
$  QSLCS1, QHEDR1(200)
$  SBFCS1, SCOST1, SEJCS1, SELCST, SFLGC1, SQCOS1, STDCS1
$  SDIA1(200), SPCST1(200), SQDIA1(200), SQPCS1(200), SQRCST1(200)
$  SQTCS1(200), SRCST1(200), STCST1(200)
$  TCONO1, THXIN1, TOWD1, TSQC01, TSTDC1
COMMON /KKSUP/
$  SPDIA1(200), LSSAVE, PHEDS1(200), SPPCST1(200), SPRCST1(200)
$  SPTCST1(200), SPCOST1, PSLCST1, PSLGCS1, PSJCST1, UPPPCS1(200)
$  PF, NRUN
LS=LSSAVE
JS = JSSAVE
KS = KSSAVE
C
203 FORMAT(1H,14X,I2,1X,7F10.1)
204 FORMAT(///40X,"TOTAL COST OF CIRCULATION SUPPLY PIPING  $",F5.0,
$ " *10**3"////)
205 FORMAT(/25X,"HORIZONTAL QUADRANT SUPPLY PIPING"
$
$ //42X,"COST IN 10**3 DOLLARS FOR"/40X
$ ,"-----"/12X,"HEADER DIAMETER LENGTH
$  PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/)
208 FORMAT(///42X,"TOTAL COST OF QUADRANT SUPPLY HEADERS  $",F5.0,
$ " *10**3"////)
209 FORMAT(/25X,"TOWER SUPPLY PIPING"
$ //10X,"NUMBER OF TOWERS",21X,I5
$ /10X,"NUMBER OF TOWERS WITH DELUGE PIPING",2X,I5
$ /10X,"TOWER DIAMETER",23X,F5.0," FEET"/
$ 10X,"TOWER HEIGHT",25X,F5.1," FEET"/
$ 10X,"BUNDLE WIDTH",25X,F5.1," FEET"/
$ 10X, "DIAMETER OF PIPE FROM CIRCULATION
$ //10X,"HEADER TO TOWER DISTRIBUTION HEADER",F7.0," INCHES"/10X,"DI
$ AMETER OF TOWER DISTRIBUTION PIPE",F7.0," INCHES"/10X,"COST OF DI
$ STRIBUTION PIPING PER TOWER  $",F5.0," *10**3"///40X,"TOTAL COST O
$ F TOWER DISTRIBUTION PIPING  $",F5.0," *10**3"////)
211 FORMAT(10X,"VAPOR DESIGN VELOCITY",F5.0," FPS"/
$ 10X,"MASS FLOW RATE",1PE10.3," LBM/HR"/
$ 10X,"CONDENSER OUTLET TEMPERATURE",0PF7.2," DEG. F"/
$ 10X,"HEAT EXCHANGER INLET TEMPERATURE",F7.2," DEG. F"/
$ 10X,"SUPPLY PIPING PRESSURE DROP",F7.1," PSF"/
$ 10X,"SUPPLY PIPING DYNAMIC HEAD",F7.1," FEET"////
$ 47X,"TOTAL SUPPLY PIPING SYSTEM COST  $",F6.0," *10**3"////)
213 FORMAT(1H1)
214 FORMAT(1H,13X,I2,1X,7F10.1)
215 FORMAT( /10X,"COST OF SUPPLY HEADERS PER QUADRANT  $",F5.1,
$ " *10**3")
216 FORMAT(30X,"-----"/30X,"SUPPLY PIPING"/30X,"-----

```

```

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

```



```

$-----"/25X,"CIRCULATION PIPING"/52X,"COST IN 10**" " RPTSUP 59
$3 DOLLARS FOR"/40X,"-----" RPTSUP 60
$-----"/12X,"HEADER DIAMETER LENGTH PIPE TEES REDUCE RPTSUP 61
$RS EXPANSION FLANGES"/21X,"(INCHES) (FEET)",33X,"JOINT(1) (3 RPTSUP 62
$)"/) RPTSUP 63
217 FORMAT(///10X,"FITTINGS COST PER BUNDLE $",F5.3," *10**3") RPTSUP 64
C RPTSUP 65
WRITE(6,213) RPTSUP 66
WRITE(6,216) RPTSUP 67
DO 201 I=1,JS RPTSUP 68
IF(I.GT.1) GO TO 202 RPTSUP 69
WRITE(6,203) I,SDIA1(I),HEDR1(I),SPCST1(I)*PF,STCST1(I)*PF, RPTSUP 70
SSRCST1(I)*PF,SEJCS1*PF,SFLGC1*PF RPTSUP 71
GO TO 201 RPTSUP 72
202 IF(I.EQ.JS) GO TO 210 RPTSUP 73
WRITE(6,203) I,SDIA1(I),HEDR1(I),SPCST1(I)*PF,STCST1(I)*PF, RPTSUP 74
SSRCST1(I)*PF RPTSUP 75
GO TO 201 RPTSUP 76
210 WRITE(6,203) I,SDIA1(I),HEDR1(I),SPCST1(I)*PF,SELCS1*PF, RPTSUP 77
SSRCST1(I)*PF RPTSUP 78
201 CONTINUE RPTSUP 79
WRITE(6,204) SCOST1*PF RPTSUP 80
WRITE(6,205) RPTSUP 81
DO 206 I=1,KS RPTSUP 82
IF(I.EQ.KS) GO TO 207 RPTSUP 83
WRITE(6,214) I,SQDIA1(I),QHEDR1(I),SQPCS1(I)*PF,SQTCST1(I)*PF, RPTSUP 84
SSQRCST1(I)*PF RPTSUP 85
GO TO 206 RPTSUP 86
207 WRITE(6,214) I,SQDIA1(I),QHEDR1(I),SQPCS1(I)*PF,QLCS1, RPTSUP 87
SSQRCST1(I)*PF RPTSUP 88
206 CONTINUE RPTSUP 89
WRITE(6,305) RPTSUP 90
305 FORMAT(/25X,"VERTICAL QUADRANT SUPPLY PIPING "/42X,"COST RPTSUP 91
$IN 10**3 DOLLARS FOR "/40X,30("=")/12X,"HEADER DIAMETER LENGTH RPTSUP 92
$ PIPE TEES REDUCERS"/21X,"(INCHES) (FEET)"/) RPTSUP 93
DO 306 I=1,LS RPTSUP 94
WRITE(6,214) I,SPDIA1(I),PHEDS1(I),SPPCST1(I),SPTCST1(I),SPRCST1(I RPTSUP 95
$) RPTSUP 96
306 CONTINUE RPTSUP 97
WRITE(6,517) NBUN RPTSUP 98
517 FORMAT(///10X,"NUMBER OF BUNDLES PER QUADRANT",I10) RPTSUP 99
WRITE(6,217) SBFCST1*PF RPTSUP 100
WRITE(6,215) SQCOS1*PF RPTSUP 101
WRITE(6,208) TSQCOT1*PF RPTSUP 102
WRITE(6,209) NUMTOW,NTOWDE1,CTOWD1,HTOW1,WBB1,DIA$D1,DIAS1,STDCS1 RPTSUP 103
1*PF,TSTDC1*PF RPTSUP 104
WRITE(6,211) DESVELV, DOTMA1, TCNO1, THXIN1, DELV1,DYNHD1, PIPCS1 RPTSUP 105
RETURN RPTSUP 106
END RPTSUP 107

```

C	SUBROUTINE SCALP(T1,RANGE,AFRONT,WLRAT,TCWFCS,ITOWN)	SCALP	2
C		SCALP	3
C	SUBROUTINE SCALP SCALES THE PLANT AND DRY COOLING TOWER	SCALP	4
C	DESIGNS AND COSTS LINEARLY UPWARD OR DOWNWARD TO ACCOUNT	SCALP	5
C	FOR THE FOLLOWING FACTORS-	SCALP	6
C	1. THE DESIGN TEMPERATURE OF THE POWER PLANT DOES	SCALP	7
C	NOT CORRESPOND TO THE RATED BACK PRESSURE OF THE	SCALP	8
C	STEAM TURBINE.	SCALP	9
C	2. PART OF THE TOTAL POWER OUTPUT OF THE PLANT IS	SCALP	10
C	USED IN SUPPLYING POWER TO THE FAN AND PUMPING	SCALP	11
C	SYSTEMS.	SCALP	12
C	THE FOLLOWING ARE POINTS ON THE HEAT RATE FACTOR CURVE WHICH	SCALP	13
C	ARE USED IN DESCRIBING THE SCALING OF THE PLANT AND DRY COOL-	SCALP	14
C	ING TOWERS. AT EACH OF THESE POINTS THE HEAT RATE FACTOR,	SCALP	15
C	PLANT SIZE AND PLANT COSTS ARE DETERMINED.	SCALP	16
C		SCALP	17
C	POINT 0 - CONVENTIONAL TURBINE OPERATING AT RATED BACK	SCALP	18
C	PRESSURE	SCALP	19
C	POINT 1 - STEAM TURBINE OPERATING AT RATED BACK PRESSURE	SCALP	20
C	POINT 2 - STEAM TURBINE OPERATING AT SYSTEM DESIGN EXIT	SCALP	21
C	TEMPERATURE WITH OUTPUT OF TURBINE GENERATOR EQUAL	SCALP	22
C	TO THE DESIGN POWER OUTPUT	SCALP	23
C	POINT 3 - STEAM TURBINE OPERATING AT SYSTEM DESIGN EXIT	SCALP	24
C	TEMPERATURE WITH THE POWER OUTPUT OF PLANT EQUAL	SCALP	25
C	TO THE DESIGN POWER OUTPUT	SCALP	26
C	THE DIFFERENCE BETWEEN POINT TWO AND THREE IS THE PLANT HAS	SCALP	27
C	BEEN SCALED UP TO ACCOUNT FOR THE POWER CONSUMPTION OF THE	SCALP	28
C	FANS AND PUMPS. BETWEEN POINT ONE AND TWO THE POWER PLANT	SCALP	29
C	HAS BEEN SCALED UP OR DOWN TO ACCOUNT FOR AN INCREASE OR	SCALP	30
C	DECREASE IN THE HEAT RATE FACTOR.	SCALP	31
C		SCALP	32
C	DEFINITION OF VARIABLES	SCALP	33
C		SCALP	34
C	AAIP - AIR SIDE HEAT TRANSFER AREA OF HEAT EXCHANGER	SCALP	35
C	(SQ FT)	SCALP	36
C	ADIA - FAN BLADE DIAMETER (FT)	SCALP	37
C	AFRONT - FRONTAL AREA OF THE HEAT EXCHANGER NORMAL TO AIR	SCALP	38
C	FLOW (SQ FT)	SCALP	39
C	ATURBC - HEAT EXCHANGER TUBE COST (\$)	SCALP	40
C	BSECF - BUNDLE SHIPPING AND ERECTION COST FACTOR (DIMEN-	SCALP	41
C	SIONLESS)	SCALP	42
C	CA - BUNDLE ASSEMBLY COST (\$)	SCALP	43
C	CAPE - PERCENT OF TIME PLANT IS GENERATING POWER DURING	SCALP	44
C	THE YEAR (PERCENT)	SCALP	45
C	CCOS - TOTAL COST OF THE DRY COOLING TOWER (\$)	SCALP	46
C	CFANEL - COST OF THE ELECTRICAL WIRING FOR THE FAN SYSTEM	SCALP	47
C	(\$)	SCALP	48
C	CFOUND - COST OF THE FOUNDATION FOR THE DRY COOLING TOWERS	SCALP	49
C	(\$)	SCALP	50
C	CH - BUNDLE COSTS FOR THE HEAT EXCHANGER (\$)	SCALP	51
C	CHAILS - COST OF HAIL SCREENS PER UNIT AREA (\$/SQ FT)	SCALP	52
C	CLAND - COST OF LAND COVERED BY THE DRY COOLING TOWERS (\$)	SCALP	53
C	CLUVR - COST OF LOUVERS PER UNIT AREA (\$/SQ FT)	SCALP	54
C	CONBAS - COST OF THE SURFACE CONDENSER (\$)	SCALP	55
C	COSM - INCREMENTAL MAINTENANCE COSTS OF DRY COOLING (\$)	SCALP	56
C	CPIP - COST OF THE PIPING SYSTEM (\$)	SCALP	57
C	CPLEN - COST OF THE PLENUM ON TOP OF THE COOLING TOWERS (\$)	SCALP	58

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	CPM	- COST OF PLENUM MATERIAL PER POUND (\$/LBM)	SCALP	59
C	CS	- COOLING SURFACE COST (\$)	SCALP	60
C	CSE	- COST OF HEADER SEALANT FOR CONNECTING PLASTIC TUBES TO THE HEADER (\$)	SCALP	61
C			SCALP	62
C	CSTHS	- COST OF THE HAIL SCREENS FOR THE ENTIRE FRONTAL AREA OF THE HEAT EXCHANGER (\$)	SCALP	63
C			SCALP	64
C	CSTLVR	- COST OF THE LOUVERS FOR CONTROLLING THE AIR FLOW TO THE HEAT EXCHANGERS (\$)	SCALP	65
C			SCALP	66
C	CWARA	- RATIO OF HEAT CAPACITY OF THE WATER TO THE AIR (DIMENSIONLESS)	SCALP	67
C			SCALP	68
C	CYLRNG	- COST OF THE FAN RING AND THE VELOCITY RECOVERY STACK IF THEY ARE USED (\$/FAN)	SCALP	69
C			SCALP	70
C	DELFC	- INCREMENTAL FUEL COST FOR THE SCALED UP PLANT (MILLS/KW HR)	SCALP	71
C			SCALP	72
C	ELENG	- LENGTH OF HEAT EXCHANGER TUBES (FT)	SCALP	73
C	FBACC	- COST OF FAN BLADES AFTER SCALING UP THE NUMBER OF FANS (\$)	SCALP	74
C			SCALP	75
C	FBCPF	- COST OF FAN BLADES PER FAN (\$/FAN)	SCALP	76
C	FCBZ	- FUEL COST FOR THE BASE PLANT WITH A ZERO COST ONCE THROUGH COOLING SYSTEM (MILLS/HW HR)	SCALP	77
C			SCALP	78
C	FCB3	- FUEL COST FOR THE SCALED UP PLANT (MILLS /KW HR)	SCALP	79
C	FCOS	- COST OF FUEL FOR POWER PLANT (CENTS/BTU)	SCALP	80
C	FCR	- FIXED CHARGE RATE FOR CAPITAL PER YEAR (PERCENT/YR)	SCALP	81
C	FIXL	- THE FIXED LENGTH OF HEAT EXCHANGER TUBES SPECIFIED BY THE INPUT TO THE CODE (FT)	SCALP	82
C			SCALP	83
C	FMCPE	- FAN MOTOR COST PER FAN (\$/FNA)	SCALP	84
C	FMCST	- TOTAL FAN MOTOR COST FOR THE FAN SYSTEM AFTER SCALE UP (\$)	SCALP	85
C			SCALP	86
C	FPOW	- POWER REQUIREMENTS OF THE FAN SYSTEM (KW)	SCALP	87
C	HPAIR	- HORSEPOWER REQUIREMENTS OF THE FAN SYSTEM (HP)	SCALP	88
C	HPWAT	- HORSEPOWER REQUIREMENTS OF THE WATER PUMPING SYSTEM (HP)	SCALP	89
C			SCALP	90
C	HRFAC1	- HEAT RATE FACTOR AT POINT ONE (DIMENSIONLESS)	SCALP	91
C	HRFAC2	- HEAT RATE FACTOR AT POINT TWO (DIMENSIONLESS)	SCALP	92
C	HRFR21	- RATIO OF HRFAC2 TO HRFAC1 USED FOR SCALING UP PLANT TO DESIGN CONDITIONS (DIMENSIONLESS)	SCALP	93
C			SCALP	94
C	HSLVA	- SURFACE AREA COVERED BY HAIL SCREENS OR LOUVERS (SQ FT)	SCALP	95
C			SCALP	96
C	ITOWN	- NUMBER OF CIRCULAR TOWERS (DIMENSIONLESS)	SCALP	97
C	KCONV	- INTERNAL VARIABLE FOR SPECIFYING THAT THE SET OF INPUT VARIABLES LEAD TO UNREASONABLE VALUES (DIMENSIONLESS)	SCALP	98
C			SCALP	99
C	KGA	- VARIABLE FOR SPECIFYING GAGE OF TUBES USED IN THE CONDENSER (DIMENSIONLESS)	SCALP	100
C			SCALP	101
C	LD	- VARIABLE FOR SPECIFYING THE DIAMETER OF THE CONDENSER TUBING (DIMENSIONLESS)	SCALP	102
C			SCALP	103
C	NEGV	- STOPS THE PROGRAM IF THE SCALED UP FRONTAL AREA, MASS FLOW OF AIR AND SPECIFIC VOLUME OF AIR IS LESS THAN ZERO (DIMENSIONLESS)	SCALP	104
C			SCALP	105
C			SCALP	106
C			SCALP	107
C	NUMTOW	- NUMBER OF CIRCULAR TOWERS (DIMENSIONLESS)	SCALP	108
C	NW	- NUMBER OF HEAT EXCHANGER TUBES IN WIDTH (DIMENSIONLESS)	SCALP	109
C			SCALP	110
C	PER	- PERCENTAGE OF TOTAL CAPITAL COSTS OF DRY COOLING TOWER ALLOWED FOR MAINTENANCE COST (PERCENT)	SCALP	111
C			SCALP	112
C	PLANC	- BASE PLANT COSTS (\$/KW)	SCALP	113
C	PLANC1	- PLANT COSTS AT POINT ONE (\$/KW)	SCALP	114
C	PLANC2	- PLANT COST AT POINT TWO (\$/KW)	SCALP	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	PLANC3	- PLANT COSTS AT POINT THREE	SCALP	116
C	PMELEC	- COST OF ELECTRICAL WIRING FOR WATER PUMPING SYSTEM	SCALP	117
C		(\$)	SCALP	118
C	POHCND	- INDIRECT COSTS FOR SURFACE CONDENSER AS A PERCENT-	SCALP	119
C		AGE OF BASE COSTS (PERCENT)	SCALP	120
C	POHSCL	- INDIRECT COSTS FOR AHIL SCREENS AND LOUVERS	SCALP	121
C		AS A PERCENTAGE OF BASE COSTS (PERCENT)	SCALP	122
C	POHSTC	- INDIRECT COSTS FOR THE STRUCTURES AND FOUNDATION	SCALP	123
C		FOR THE CIRCULAR TOWER AS A PERCENTAGE OF BASE	SCALP	124
C		COSTS (PERCENT)	SCALP	125
C	PPOW	- POWER REQUIREMENTS OF THE WATER PUMPING SYSTEM (KW)	SCALP	126
C	PSIZE	- SPECIFIED POWER OUTPUT OF THE PLANT AND MAKE UP	SCALP	127
C		SYSTEM TO THE POWER GRID (MW)	SCALP	128
C	PSIZ12	- POWER OUTPUT OF TURBINE AT THE TURBINE RATED BACK	SCALP	129
C		PRESSURE FOR A POWER OUTPUT OF THE TURBINE OF	SCALP	130
C		PSIZE AT DESIGN CONDITIONS (MW)	SCALP	131
C	PSIZ13	- POWER OUTPUT OF TURBINE AT THE TURBINE RATED BACK	SCALP	132
C		PRESSURE FOR A POWER OUTPUT OF THE PLANT OF PIZSE	SCALP	133
C		AT DESIGN CONDITIONS (MW)	SCALP	134
C	PTOTAL	- TOTAL POWER OUTPUT OF THE TURBINE AT DESIGN	SCALP	135
C		CONDITIONS (MW)	SCALP	136
C	RANGE	- TEMPERATURE DIFFERENCE OF THE WATER ENTERING	SCALP	137
C		AND LEAVING THE HEAT EXCHANGER (DEG F)	SCALP	138
C	ROOFL	- ROOF LOAD DESIGN CONDITIONS FOR STRUCTURAL COSTS OF	SCALP	139
C		CIRCULAR TOWERS (LBF/SQ FT)	SCALP	140
C	SAFRON	- SCALED UP FRONTAL AREA OF THE HEAT EXCHANGER	SCALP	141
C		NORMAL TO AIR FLOW (SQ FT)	SCALP	142
C	SPBP	- INCREMENTAL PLANT COST BETWEEN PLANT DESIGNED AT	SCALP	143
C		RATED CONDITIONS (POINT 1) AND AT DESIGN CONDITIONS	SCALP	144
C		(POINT 2) (\$)	SCALP	145
C	SPC	- COST OF PLANT AT DESIGN CONDITIONS (POINT 3)	SCALP	146
C	SPCD	- INCREMENTAL COST OF PLANT USING DRY COOLING TOWERS	SCALP	147
C		AT DESING CONDITIONS (POINT 3) OVER PLANT AT RATED	SCALP	148
C		CONDITIONS (POINT 1) (\$)	SCALP	149
C	STRUCC	- STRUCTURAL COST OF THE CIRCULAR TOWERS (\$)	SCALP	150
C	SWLRAT	- SCALED UP WIDTH TO LENGTH RATIO OF THE HEAT	SCALP	151
C		EXCHANGER (DIMENSIONLESS)	SCALP	152
C	SW3	- SCALED UP MASS FLOW RATE OF WATER THROUGH THE	SCALP	153
C		HEAT EXCHANGER (LBM/HR)	SCALP	154
C	SW4	- SCALED UP MASS FLOW RATE OF AIR THROUGH THE HEAT	SCALP	155
C		EXCHANGER (LBM/HR)	SCALP	156
C	TCWFCS	- TOTAL COST OF THE PIPING SYSTEM (K\$)	SCALP	157
C	TD	- DESIGN TEMPERATURE OF THE DRY COOLING TOWER (DEG F)	SCALP	158
C	TEFF	- RATED BACK PRESSURE EFFICIENCY OF THE STEAM	SCALP	159
C		TURBINE (PERCENT)	SCALP	160
C	TLA	- LENGTH OF CONDENSER TUBING (FT)	SCALP	161
C	T4	- EXIT TEMPERATURE OF THE AIR FROM THE HEAT EXCHANGER	SCALP	162
C		(DEG F)	SCALP	163
C	VA	- SPECIFIC VOLUME FO THE AIR (CU FT/LBM)	SCALP	164
C	WATERW	- WEIGHT OF WATER IN THE HEAT EXCHANGER BUNDLES (LBM)	SCALP	165
C	WMX	- TOTAL WERIGHT OF THE HEAT EXCHANGER EXCLUDING	SCALP	166
C		WATER (LBM)	SCALP	167
C	WIDTH	- TOTAL HEAT EXCHANGER WIDTH (FT)	SCALP	168
C	WLRAT	- RATIO OF THE WIDTH TO THE LENGTH OF THE HEAT	SCALP	169
C		EXCHANGER (DIMENSIONLESS)	SCALP	170
C	WPL	- WEIGHT OF THE PLENUM PER UNIT AREA (LBF/SQ FT)	SCALP	171
C	WSTRUCT	- TOTAL WEIGHT OF THE COOLING TOWER STRUCTURES (LBF)	SCALP	172

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	WTFRM	- TOTAL WEIGHT OF THE HEAT EXCHANGER FRAM (LBF)	SCALP	173
C	WTHDR	- TOTAL WEIGHT OF THE HEAT EXCHANGER HEADERS (LBF)	SCALP	174
C	WTTUB	- TOTAL WEIGHT OF THE HEAT EXCHANGER TUBES (LBF)	SCALP	175
C	W3	- MASS FLOW RATE OF THE WATER THROUGH THE HEAT	SCALP	176
C	W4	- MASS FLOW RATE OF THE AIR THROUGH THE HEAT	SCALP	177
C		EXCHANGER (LBM/HR)	SCALP	178
C	XNFAN	- NUMBER OF FANS IN THE FAN SYSTEM (DIMENSIONLESS)	SCALP	179
C	XNS	- NUMRER OF SHELLS IN THE SURFACE CONDENSER	SCALP	180
C		(DIMENSIONLESS)	SCALP	181
C	XNTS	- NUMBER OF CONDENSER TUBES PER SHELL (DIMENSIONLESS)	SCALP	182
C	XW	- TRANSVERS PITCH BETWEEN ADJACENT TUBES IN THE SAME	SCALP	183
C		TUBE ROW OF THE HEAT EXCHANGER FROM CENTERLINE TO	SCALP	184
C		CENTERLINE (IN)	SCALP	185
C	YFPP1	- PLANT SCALING FACTOR TO TAKE INTO ACCOUNT FOR PUMP	SCALP	186
C		AND FAN POWER	SCALP	187
C			SCALP	188
C			SCALP	189
	LOGICAL NEGV		BIGCOM	2
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG		BIGCOM	3
	COMMON		BIGCOM	4
	S AFTR, ALPHA, ANG(3)		BIGCOM	5
	* ,BPLIM(16)		BIGCOM	6
	S ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	7
	S ,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM		BIGCOM	8
	S ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	9
	S ,EFFP, EFS		BIGCOM	10
	S ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACORD,FSHOT,FDELUG		BIGCOM	11
	S ,FIXV,FXTTD,FXTVAR,FXTTDD,FXTLNG		BIGCOM	12
	S ,GBEFF		BIGCOM	13
	S ,HXNP,HPCST,HCD		BIGCOM	14
	S ,ITMAX, ITMIN		BIGCOM	15
	S ,JCONS		BIGCOM	16
	S ,KCONV, KALEXT		BIGCOM	17
	S ,MXEXT		BIGCOM	18
	S ,NTA,NSIDES,NRUNHI		BIGCOM	19
	COMMON		BIGCOM	20
	S ODP		BIGCOM	21
	S ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL		BIGCOM	22
	S ,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL		BIGCOM	23
	S ,RBP,REDUCE, REDUCV, ROOFL, RHOUT		BIGCOM	24
	S ,QREJ, QREDUCE, QREDUCV		BIGCOM	25
	S ,SIGMAG, SAAF, SEGL		BIGCOM	26
	S ,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX		BIGCOM	27
	S ,TCD, TW		BIGCOM	28
	S ,UCS, UWS		BIGCOM	29
	S ,WFFV, WATCONA, WATCOST		BIGCOM	30
	S ,VAS(5)		BIGCOM	31
	S ,XDEPA, XW, XD		BIGCOM	2
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, CDSM, EFF,	SUPPLY		3
	S QIN, CLAND, REATR, Z,HRFAC2, W4, U,DELPH, PPOW,	SUPPLY		4
	S FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, H1, HO, T4,	SUPPLY		5
	S REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,	SUPPLY		6
	S SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY		7
	S RP2, NW2, TCOS, DELPA,DELPHW,DELPHWC,CONBAS, XNTSX, VELDX	SUPPLY		8
	S , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY		9
	S , CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPIP, AST,OLDCST	SUPPLY		10
	S ,CAPCST, XNFAN,BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN	SUPPLY		11
	S , WTHDR, WTFRM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY		

```

$ , AIRPF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP    SUPPLY    12
$ , ACTRPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST    SUPPLY    13
$ , CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD    SUPPLY    14
$ , SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCSTD    SUPPLY    15
$ , CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST    SUPPLY    16
$ , PWD(16), WATCWD(16), DEPER(16), DEPERQ(16)    SUPPLY    17
$ , WBB, HTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5    SUPPLY    18
COMMON /SINK/ VAR(5), CPLN1, CPl1, CCOS1, W31, COSM1, EFF1,    SINK      2
$   GIN1, CLAN1, REA11, Z1, HRFA2S, W41, U1, DEPW1, PPW1,    SINK      3
$   FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41,    SINK      4
$   REWA1, NW1, NT1, NP1, ZPLNC2, ZSIZ12, ZSPBP, SW41, SW31,    SINK      5
$   SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SPS13, WT2MIN,    SINK      6
$   BP2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBA1, XNTS1, VELD1    SINK      7
$   , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CAL, CS1    SINK      8
$   , CLTC1, CFC1, CPCC1, FITC01, CSC1, CEPRE1, DEPI1, ASY1, OLDOS1    SINK      9
$   , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFE1, WH1, WTTU1, ADI1, ABL1    SINK     10
$   , WTHD1, WTRF1, STRUC1, CFMPF1, HPPF1, TOTCF1, TP1, EFFIN1, ANTU1    SINK     11
$   , AIRPF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTP1, ADJTP1    SINK     12
$   , ACTRP1, ADJB1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1    SINK     13
$   , CSR1, WATER1, WSTRC1, CFOUND1, HUBD11, TOWLE1, NUMT01, CTOWD1    SINK     14
$   , SQRJ1, SQRJS1, ATUBC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTD1    SINK     15
$   , CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1    SINK     16
$   , PWD1(16), WATCWD1(16), DEPER1(16), DEPERQ1(16)    SINK     17
$   , WBB1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51    SINK     18
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD, PLANC1, CASSS1,    SCALER    2
$   GAIR, FAIR, HPAIR, HPWAT, WLRTF, PLANCT1    SCALER    3
COMMON /LACALL/ SRN    SCALP    194
COMMON /ESCAL/ BSECF    SCALP    195
COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY    SCALP    196
COMMON /TUBE/ KGA, LD, TID(7,6)    SCALP    197
COMMON /PLCOST/ WPL    SCALP    198
COMMON /PME/ PMELEC    SCALP    199
COMMON /HEADEX/ CHH, CN, CHM, CMW, CRJ, CWJ, CST, CM0, CSR, CSM, RITCHF, CPM,    SCALP    200
1 PRESS, HEDMAT, HEDTYP, NPASS, WB, TSP, CSH, CSHP    SCALP    201
LOGICAL LOOPER    FANDEK    2
COMMON /FAN/ FANDAP(153,10), FANDAM(153,10), FMCPF, FBCPF, P2, R, S,    FANDEK    3
$ VELREC, AFC, ELEV, EHR, LOOPER, ETMAX    FANDEK    4
DATA NEGV/, FALSE, /    SCALP    203
901 FORMAT(1X, A10, "T1, RANGE, CHARA, AFRON, WLRAT", 5G14.4)    SCALP    204
NAMLIST /DBNL/ FLOSS, AFRON, VA, W4, THITE, TD, T4, CHARA, RANGE    SCALP    205
XTOW = ITOWN    SCALP    206
C    SCALP    207
C    SCALP    208
C    SCALP    209
C    SCALP    210
C    SCALP    211
C    SCALP    212
C    SCALP    213
C    SCALP    214
C    SCALP    215
C    SCALP    216
C    SCALP    217
C    SCALP    218
C    SCALP    219
C    SCALP    220
C    SCALP    221
C    SCALP    222

```

SCALING FACTOR FROM POINT 1 TO POINT 2 TO ACCOUNT FOR CHANGE
IN HEAT RATE FACTOR

HRFR21=HRFAC2/HRFAC1

POWER OUTPUT OF TURBINE AT RATED BACK PRESSURE(POINT 1) WHICH
GIVES REQUIRED POWER OUTPUT PSIZE AT THE DESIGN
BACK PRESSURE (POINT 2)

PSIZ12=PSIZE*HRFR21

PLANT COSTS AT DESIGN CONDITIONS (POINT 2) WHICH INCLUDE
STEAM SUPPLY AND BACK PRESSURE SCALING TO POINT 2

PLANC2=PLANC1 * HRFR21

SUBROUTINE SCALP

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C		SCALP	223
C	INCREMENTAL COST OF SCALING UP PLANT DUE TO INCREASED HEAT	SCALP	224
C	RATE FACTOR	SCALP	225
C		SCALP	226
C	SPBD=(PLANC2-PLANC)*PSIZE*1.E+3	SCALP	227
C		SCALP	228
C	SCALING FACTOR FOR SCALING PLANT SIZE TO MEET PUMP AND FAN	SCALP	229
C	POWER REQUIREMENTS	SCALP	230
C		SCALP	231
C	IF(PSIZE=1000.-PPOW-FPOW,LE,0.0) KCONV=1	SCALP	232
C	IF(KCONV.EQ.1) RETURN	SCALP	233
C	YFP = (PSIZE*1.E+3)/(PSIZE*1.E+3 - PPOW - FPOW) - 1.0	SCALP	234
C		SCALP	235
C	POWER OUTPUT OF THE TURBINE GENERATOR AT THE RATED	SCALP	236
C	BACK PRESSURE (POINT 1) WHICH MEETS THE POWER REQUIREMENTS OF	SCALP	237
C	THE FANS AND PUMPS (POINT 3) AND THE POWER OUTPUT OF THE	SCALP	238
C	PLANT AT THE DESIGN BACK PRESSURE (POINT 2)	SCALP	239
C		SCALP	240
C	PSIZ13=(1.+YFP)*PSIZ12	SCALP	241
C		SCALP	242
C	TOTAL POWER OUTPUT OF THE PLANT AT POINT 3	SCALP	243
C		SCALP	244
C	PTOTAL = PSIZE * (1.+YFP)	SCALP	245
C		SCALP	246
C	PLANT COST AT POINT 3 EXCLUDING THE DRY COOLING TOWER COST	SCALP	247
C		SCALP	248
C	PLANC3=PLANC2*(1.+YFP)	SCALP	249
C	SPC=PLANC3*PSIZE*1.E+3	SCALP	250
C		SCALP	251
C	INCREMENTAL COST OF PLANT DUE TO DRY COOLING TOWERS	SCALP	252
C		SCALP	253
C	SPCD = (PLANC3-PLANC) * PSIZE * 1000.	SCALP	254
C		SCALP	255
C	SCALING UP THE DRY COOLING TOWER DIMENSIONS AND THE COSTS	SCALP	256
C	ASSOCIATED WITH IT	SCALP	257
C		SCALP	258
C	INDEPENDENT PARAMETERS OF THE DRY COOLING TOWER	SCALP	259
C		SCALP	260
C	YFPP1=YFP + 1.	SCALP	261
C	SW3=W3*YFPP1	SCALP	262
C	SW4=W4*YFPP1	SCALP	263
C	SAFRON=AFRON*YFPP1	SCALP	264
C	SWLRAT=WLRAT * YFPP1	SCALP	265
C		SCALP	266
C	SURFACE CONDENSER DIMENSIONS AND COSTS	SCALP	267
C		SCALP	268
C	ISUR = 1	SCALP	269
C	CALL SURCON(ISUR, KGA, LD, TLA, XNTS, ARPS, XNS, CONBAS, CONMAT	SCALP	270
C	,POHCND)	SCALP	271
C	XNTS = XNTS*YFPP1	SCALP	272
C	CONBAS = CONBAS*YFPP1	SCALP	273
C		SCALP	274
C	SCALE THE NUMBER OF TUBES IN WIDTH AND THE WIDTH OF THE	SCALP	275
C	HEAT EXCHANGER	SCALP	276
C		SCALP	277
C	IF(FXTLNG) WIDTH=SAFRON/FIXL	SCALP	278
C	IF(.NOT.FXTLNG) WIDTH=SQRT(SWLRAT*SAFRON)	SCALP	279

	TOWLEN = WIDTH / (XTOW*2.)	SCALP	280
	NW=WIDTH/XW*12.	SCALP	281
C		SCALP	282
C	CHECK ON THE EXIT TEMPERATURE OF THE AIR LEAVING THE HEAT	SCALP	283
C	EXCHANGER	SCALP	284
C		SCALP	285
	T4 = RANGE * TD	SCALP	286
	VA=53.35*(TD*460.)/(15.*144.)	SCALP	287
	IF(FLOSS.LT.0.0) NEGV=.TRUE.	SCALP	288
	IF(SAFRON.LT.0.0) NEGV=.TRUE.	SCALP	289
	IF(VA.LT.0.0) NEGV=.TRUE.	SCALP	290
	IF(SW4.LT.0.0) NEGV=.TRUE.	SCALP	291
	IF(THIE.LT.0.0) NEGV=.TRUE.	SCALP	292
	IF(NEGV) WRITE(6,DBNL)	SCALP	293
	IF(NEGV) STOP	SCALP	294
41	CONTINUE	SCALP	295
	UNSHPA=HPAIR	SCALP	296
	UNSNFA=XNFAN	SCALP	297
C		SCALP	298
C	FAN AND PUMP POWER	SCALP	299
C		SCALP	300
	FPOW=FPOW * YFPP1	SCALP	301
	PPOW=PPOW * YFPP1	SCALP	302
	FPPOW = PPOW + FPOW	SCALP	303
	HPWATE=HPWAT * YFPP1	SCALP	304
	HPAIR= HPAIR * YFPP1	SCALP	305
	FDPD=HPWAT + HPAIR	SCALP	306
	XNFAN=XNFAN*YFPP1	SCALP	307
C		SCALP	308
C	FAN BLADE COSTS	SCALP	309
C		SCALP	310
	FBACC=FBCPF*XNFAN	SCALP	311
	FCST=FBACC*FMCST	SCALP	312
C		SCALP	313
C	THE NUMBER OF FANS AND THE MOTOR, BLADE, AND ELECTRICAL	SCALP	314
C	WIRING COSTS OF THE FAN SYSTEM	SCALP	315
C		SCALP	316
	FMCST=XNFAN*FMCPF	SCALP	317
	CFANEL = CFANEL * YFPP1	SCALP	318
C		SCALP	319
C	ELECTRICAL WIRING OF THE PIPING SYSTEM	SCALP	320
C		SCALP	321
	PMELEC = PMELEC * YFPP1	SCALP	322
C		SCALP	323
C	DIMENSIONS AND WEIGHT OF THE HEAT EXCHANGER	SCALP	324
C		SCALP	325
	ATUBC = CS + CH + CSTIF + CSJ + CVF + CDP + CBA	SCALP	326
	ATUBC = ATUBC*YFPP1	SCALP	327
	AAIR=AAIR * YFPP1	SCALP	328
	WHX=WHX*YFPP1	SCALP	329
	WTTUB=WTTUB*YFPP1	SCALP	330
	WTHDR=WTHDR*YFPP1	SCALP	331
	WTFRM=WTFRM*YFPP1	SCALP	332
	WATERW = WATERW * YFPP1	SCALP	333
C		SCALP	334
C	INCREASED FUEL COST OF THE PLANT	SCALP	335
C		SCALP	336

SUBROUTINE SCALP

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C		SCALP	337
C	FUEL COST, FOR THE BASE PLANT WITH A CONVENTIONAL TURBINE	SCALP	338
C	OPERATING AT RATED BACK PRESSURE	SCALP	339
C		SCALP	340
	FCBZ= FCOS * 3413.E-5 / TEFF	SCALP	341
C		SCALP	342
C	INCREASED FUEL COST FOR THE SCALED UP PLANT	SCALP	343
C		SCALP	344
	FCB3 = FCOS * 3413.E-5*(HRFAC2/TEFF) * (1.+YFP)	SCALP	345
	DELFC= FCB3-FCBZ	SCALP	346
C		SCALP	347
C	LAND AND PIPING COSTS	SCALP	348
C		SCALP	349
	TEDIA=TEDIA * (1. + YFP)	SCALP	350
	CLAND = COSTL*SAFRON	SCALP	351
	SEPCST = (6.3971 * W3/60. - 140264.71) / 1000.	SCALP	352
	SEPCST = SEPCST * POHCIR	SCALP	353
	TCWFCS = TCWFCS + SEPCST * RPTPL	SCALP	354
	CPIP = TCWFCS * YFPP1 * 1000.	SCALP	355
C		SCALP	356
C	TOWER DIAMETERS	SCALP	357
C		SCALP	358
	BUNHI = SAFRON/(ITOWN*NSIDES*WB*ELENG)	SCALP	359
	NBUNHI = BUNHI * .9999	SCALP	360
	WBB = SAFRON/(ITOWN*NSIDES*NBUNHI*ELENG)	SCALP	361
	HTOW = WBB*NBUNHI	SCALP	362
C		SCALP	363
C	PLENUM SIZE AND COSTS	SCALP	364
C		SCALP	365
	CPLEN = CPM*WPL*(.25*ELENG**2*NSIDES*ITOWN/TAN(2.*3.14159/(2.*	SCALP	366
	INSIDES))	SCALP	367
	\$ = XNFAN * 3.14159/4. * (ADIA*3.5)**2)	SCALP	368
	CPLEN = CPLEN * POHSTC	SCALP	369
C		SCALP	370
C	STRUCTURE AND FOUNDATION COSTS	SCALP	371
C		SCALP	372
	CALL STRUCT(ITOWN,NSIDES,HTOW,ELENG,SEGL,NBUNHI,WMX,WATERW,ADIA,	SCALP	373
	1XNFAN,ROOFL,STRUCC,CFOUND)	SCALP	374
	STRUCC = STRUCC*POHSTC	SCALP	375
	CFOUND = CFOUND*POHSTC	SCALP	376
C		SCALP	377
C	LOUVER AND HAIL SCREEN COSTS	SCALP	378
C		SCALP	379
	HSLVA = ITOWN*NSIDES*HTOW*ELENG	SCALP	380
	CSTLVR = CLUVR * HSLVA * POHSC	SCALP	381
	CSTHS = CHAILS * HSLVA * POHSC	SCALP	382
C		SCALP	383
C	TOTAL COST OF DRY COOLING TOWER	SCALP	384
C		SCALP	385
	CCOS = FBACC * ATUBC * FMCST * CPLEN * STRUCC * CFOUND	SCALP	386
	\$ + CSTLVR * CSTHS * CFANEL*XNFAN/YFPP1 + CYLRNG*XNFAN	SCALP	387
C		SCALP	388
C	MAINTENANCE COST OF THE DRY COOLING TOWERS	SCALP	389
C		SCALP	390
	COSM = PER * (CCOS + CPIP * CONBAS) / (PSIZE*CAPF*8760.)	SCALP	391
C		SCALP	392
C	INCREMENTAL COST OF DRY COOLING TOWER (NOT USED IN	SCALP	393

SUBROUTINE SCALP 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C
C

OPTIMIZATION)

OLDOST* (CCOS*SPCD+CLAND+CPIP*CONBAS)*FCR/(PSIZE*CAPF*8760.)
\$ * COSM* DELFC
RETURN
END

SCALP 394
SCALP 395
SCALP 396
SCALP 397
SCALP 398
SCALP 399

```

C      SUBROUTINE SERCH
C      THIS ROUTINE SEEKS MINIMUM BY SINGLE VARIABLE SEARCH METHOD
C
COMMON /LACALL/ SRN
DIMENSION C(5)
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,
$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,
$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,
$ DEWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,
$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,
$ BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS
$ , CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELP1P, AST,OLDCST
$ ,CAPCST, XNFAN,BLDANG, CPLEN, DPFL, WHX, WTTUR, ADIA, ABLN
$ , WTHDR, WTRFM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU
$ , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP
$ , ACTRPD, ADJBDP, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST
$ , CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD
$ ,SQRJ,SQRJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCST
$ ,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST
$ ,PWD(16),WATCHD(16),DEPER(16),DEPERQ(16)
$ ,WBB,HTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5
COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,
$ QIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPOW1,
$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, HI1, HO1, T41,
$ REW1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPBP, SW41, SW31,
$ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,
$ BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1
$ , TL1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1
$ , CLTC1, CFC1, CPCC1,FITCO1, CSC1,CEPRE1,DEPI1, AST1,OLDCS1
$ ,CAPCS1,XNFAN1,BLDAN1,CPLEN1,DPFL1, WH1, WTTU1, ADI1, ABL1
$ , WTHD1, WTRF1,STRU1,CFMPF1, HPPF1,TOTCF1, TP1,EFFIN1, ANTU1
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1
$ , ACTRP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA1, TCTF1, AFCST1
$ , CSR1, WATER1, WSTRC1, CFOUND1, HUBD1, TOWLE1, NUMTOW1, CTOWD1
$ ,SQRJ1,SQRJS1,ATUBC1,CBA1,TTD1,TTD2,DELPS1,CSTLV1,PIPCD1
$ ,CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1
$ ,PWD1(16),WATCHD1(16),DEPER1(16),DEPERQ1(16)
$ ,WBB1,HTOW1,NTOWDE1,CSTIF1,CSJ1,CVF1,CDP1,W51
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD,PLANC1,CASS1,
$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANCT1
LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG
COMMON
$ AFTR, ALPHA, ANG(3)
$ ,BPLIM(16)
$ ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF
$ ,CRJ, CTURB, CDANG, CLUVR, CHAILE, CVM
$ ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF
$ ,EFFP, EFS
$ ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG
$ ,FIXV,FIXTTD,FXTVAR,FXTTID,FXTLNG
$ ,GREFF
$ ,HXNP,HPCST,HCD
$ ,ITMAX, ITMIN
$ ,JCONS
$ ,KCONV, KALEXT

```

```

SERCH 2
SERCH 3
SERCH 4
SERCH 5
SERCH 6
SERCH 7
SUPPLY 2
SUPPLY 3
SUPPLY 4
SUPPLY 5
SUPPLY 6
SUPPLY 7
SUPPLY 8
SUPPLY 9
SUPPLY 10
SUPPLY 11
SUPPLY 12
SUPPLY 13
SUPPLY 14
SUPPLY 15
SUPPLY 16
SUPPLY 17
SUPPLY 18
SINK 2
SINK 3
SINK 4
SINK 5
SINK 6
SINK 7
SINK 8
SINK 9
SINK 10
SINK 11
SINK 12
SINK 13
SINK 14
SINK 15
SINK 16
SINK 17
SINK 18
SCALER 2
SCALER 3
BIGCOM 2
BIGCOM 3
BIGCOM 4
BIGCOM 5
BIGCOM 6
BIGCOM 7
BIGCOM 8
BIGCOM 9
BIGCOM 10
BIGCOM 11
BIGCOM 12
BIGCOM 13
BIGCOM 14
BIGCOM 15
BIGCOM 16

```

SUBROUTINE SERCH

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

\$,MXEXT	BIGCOM	17
\$,NTA,NSIDES,NRUNHI	BIGCOM	18
COMMON	BIGCOM	19
\$ ODP	BIGCOM	20
\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
\$,POWBAF, POWFAN, POWLEC, POWCIR, POWCND, POWSTC, POWSCL	BIGCOM	22
\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
\$,SIGMAG, SAAF, SEGL	BIGCOM	25
\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
\$,TCD, TW	BIGCOM	27
\$,UCS, UWS	BIGCOM	28
\$,WFFV, WATCONA, WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDEPA, XW, XD	BIGCOM	31
COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY	SERCH	12
DO 50 IVAL=1,5	SERCH	13
50 VAL(IVAL)=VAR(IVAL)	SERCH	14
SPN="/SERCH=1/ "	SERCH	15
C(1)=5.	SERCH	16
C(2)=1.	SERCH	17
C(3)=1.	SERCH	18
C(4)=CAF	SERCH	19
IF(VAR(5) .GT. 20.0) C(5) = 8.0	SERCH	20
IF(VAR(5) .LE. 20.0) C(5) = 4.0	SERCH	21
IF(VAR(5) .LE. 10.0) C(5) = 2.0	SERCH	22
IC = 5	SERCH	23
IF(FXTMP) IC = 4	SERCH	24
IR = 1	SERCH	25
IF(DEEPL.GT.0.00) IB = 2	SERCH	26
DO 8 I = IB,IC	SERCH	27
M=6-I	SERCH	28
K=3	SERCH	29
DO 9 IK=1,5	SERCH	30
9 VAL(IK)=VAR(IK)	SERCH	31
KC=0	SERCH	32
1 J=0	SERCH	33
2 VAL(M)=VAR(M)+C(M)	SERCH	34
IF(FXTMP) VAL(1) = TFIX	SERCH	35
IF(FXTLNG) VAL(4) = FIXL	SERCH	36
IF(FXTVAR) VAL(2) = FIXV	SERCH	37
IF(FXTTDD) VAL(3) = FIXTTD	SERCH	38
IF(M.GT.3) GO TO 10	SERCH	39
IF(VAL(1).GT.180.) GO TO 4	SERCH	40
10 SPN="/SERCH=2/ "	SERCH	41
CALL CALC(VAL(1),VAL(2),VAL(3),VAL(4),VAL(5),M)	SERCH	42
IF(KCONV.EQ.1) GO TO 4	SERCH	43
IF(DELPA.LE.XDEPA) GO TO 3	SERCH	44
IF(TCOS.GE.TCOS1) GO TO 4	SERCH	45
J=1	SERCH	46
CALL STORE	SERCH	47
GO TO 2	SERCH	48
3 IF(K.EQ.1) KC=1	SERCH	49
4 IF(J.EQ.1) GO TO 7	SERCH	50
5 VAL(M)=VAR(M)-C(M)	SERCH	51
IF(FXTMP) VAL(1) = TFIX	SERCH	52
IF(FXTLNG) VAL(4) = FIXL	SERCH	53

SUBROUTINE SERCH

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

IF(FXTVAR) VAL(2) = FIXV	SERCH	54
IF(FXTTDD) VAL(3) = FIXTDD	SERCH	55
IF(VAL(M).LE.0.0) GO TO 7	SERCH	56
SRN="/SERCH=3/ "	SERCH	57
CALL CALC(VAL(1),VAL(2),VAL(3),VAL(4),VAL(5),M)	SERCH	58
IF(KCONV.EQ.1) GO TO 7	SERCH	59
IF(DEIPA.LE.XDEPA) GO TO 6	SERCH	60
IF(TCOS.GE.TCOS1) GO TO 7	SERCH	61
CALL STORE	SERCH	62
KC=0	SERCH	63
GO TO 5	SERCH	64
6 IF(K.EQ.1) KC=1	SERCH	65
7 IF(KC.EQ.1) CALL CHNGE(M)	SERCH	66
K=K-1	SERCH	67
IF(K.EQ.0) GO TO 8	SERCH	68
IF(M.EQ.5 .AND. C(M).EQ.1.0) GO TO 8	SERCH	69
IF(M.EQ.5) C(M) = C(M)*5.0/2.0	SERCH	70
C(M)=C(M)/5.	SERCH	71
GO TO 1	SERCH	72
8 CONTINUE	SERCH	73
RETURN	SERCH	74
END	SERCH	75

74/74 OPT=1

FTN 4,5+414

06/05/78 07,59.59

```

C      SUBROUTINE SETUP(TSTAR,TEND)
C      THIS ROUTINE READS ALL INPUT DATA FOR THE RUN AND PRINTS EACH
C      VALUE READ
C
C      INPUT DESCRIPTION
C      FOR BNWII DRY/WET COOLING TOWER AMMONIA
C      M A Y 1 9 7 8
C
C      IN THE DESCRIPTIONS BELOW THE SYMBOL (DF) MEANS
C      DECIMAL FRACTION
C
C      CARD TYPE COLUMNS FORMAT NAME OF P VARIABLE E DESCRIPTION AND (UNITS)
C
C      A1 1-80 (8A10) DESCR(1) R COMMENTS OR CASE DESCRIPTION TO BE
C      PRINTED AT TOP OF FIRST OUTPUT PAGE.
C      ANY NUMBER OF TYPE A1 CARDS MAY BE
C      USED BUT A BLANK A1 CARD IS NOT
C      ALLOWED.
C
C      A2 1-80 BLANK IN ALL COLUMNS. ONE TYPE A2 CARD ONLY
C
C      B1 1-10 (E10.0) TSTAR R LOWEST DESIGN TEMPERATURE TO USE
C      (DEGREES F)
C      11-20 E10.0) TEND R HIGHEST DESIGN TEMPERATURE TO USE
C      (DEGREES F)
C      21-30 E10.0) VAS(1) R INITIAL VALUE FOR TURBINE OUTLET
C      TEMPERATURE (DEGREES F)
C      31-40 E10.0) VAS(2) R INITIAL VALUE FOR VELOCITY OF AIR
C      ENTERING THE HEAT EXCHANGER (FT/SEC)
C      41-50 E10.0) VAS(3) R INITIAL VALUE FOR TTD1, TERMINAL
C      TEMPERATURE DIFFERENCE (DEGREES F)
C      51-60 E10.0) VAS(4) R INITIAL VALUE FOR LENGTH OF HEAT
C      EXCHANGER TUBES (FT)
C      61-70 E10.0) VAS(5) R INITIAL VALUE FOR THE NUMBER OF
C      HEAT EXCHANGER TUBES IN DEPTH

```

C					SETUP	59
CC					SETUP	60
C	B2	1-10	(E10.0, TFIX	R FIXED TUBINE OUTLET TEMPERATURE (F)	SETUP	61
C				ENTRY IS IGNORED IF BLANK OR ZERO	SETUP	62
C					SETUP	63
C		11-20	E10.0, FIXV	R FIXED FACE VELOCITY OF THE AIR	SETUP	64
C				ENTERING THE HEAT EXCHANGER (FT/SEC)	SETUP	65
C				ENTRY IS IGNORED IF BLANK OR ZERO	SETUP	66
C					SETUP	67
C		21-30	E10.0, FIXTTD	R FIXED TERMINAL TEMPERATURE	SETUP	68
C				DIFFERENCE OF THE SURFACE CONDENSER	SETUP	69
C				(F) ENTRY IS IGNORED IF BLANK OR	SETUP	70
C				ZERO	SETUP	71
C					SETUP	72
C		31-40	E10.0, FIXL	R FIXED LENGTH OF HEAT EXCHANGER (FT)	SETUP	73
C				IGNORED IF SET EQUAL TO ZERO	SETUP	74
C				ENTRY IS IGNORED IF BLANK OR ZERO	SETUP	75
C					SETUP	76
C				IF THE ABSOLUTE VALUE OF FIXL=0.	SETUP	77
C				THEN THE PROGRAM WILL CALCULATE	SETUP	78
C				THE LENGTH.	SETUP	79
C					SETUP	80
C		41-50	E10.0) DEEPL	R FIXED NUMBER OF TUBES IN DEPTH	SETUP	81
C				ENTRY IS IGNORED IF BLANK OR ZERO	SETUP	82
C					SETUP	83
C					SETUP	84
C	.....				SETUP	85
C	.....				SETUP	86
C					SETUP	87
C	C1	1-40	(8F5.0, TA(I)	R TEMPERATURES REPRESENTATIVE OF	SETUP	88
C				TPER(I) FRACTION OF YEAR (DEGREES F)	SETUP	89
C					SETUP	90
C		41-80	8F5.0) TPER(I)	R FRACTION OF YEAR OVER WHICH TEMPERA-	SETUP	91
C				TURE TA(I) IS TYPICAL. (DF)	SETUP	92
C				C A U T I O N - HIGHEST TA	SETUP	93
C				MUST BE FIRST	SETUP	94
C					SETUP	95
C	.....				SETUP	96
C					SETUP	97
C	C2	1-40	(8F5.0, TA(I)	R CONTINUATION OF TA(I) FOR I= 9 TO 16	SETUP	98
C					SETUP	99
C		41-80	8F5.0) TPER(I)	R CONTINUATION OF TPER(I)	SETUP	100
C					SETUP	101
C				NOTE - A TYPE C2 CARD IS REQUIRED EVEN IF BLANK.	SETUP	102
C					SETUP	103
C	.....				SETUP	104
C	.....				SETUP	105
C					SETUP	106
C	C1A	1-40	(8F5.0, TAWB(I)	R WET BULB AIR TEMPERATURE REPRESENTA-	SETUP	107
C				TIVE OF TPER(I) FRACTION OF YEAR	SETUP	108
C				(DEGREES F)	SETUP	109
C					SETUP	110
C		41-80	8F5.0) BPLIM(I)	R BACK PRESSURE LIMIT ON THE STEAM	SETUP	111
C				TURBINE REPRESENTATIVE OF TPER(I)	SETUP	112
C				FRACTION OF YEAR (IN. HG.)	SETUP	113
C					SETUP	114
C	.....				SETUP	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.50

C.....					SETUP	116
C					SETUP	117
C	C2A	1-40	(BF5.0, TAWB(I)	R CONTINUATION OF TAWB(I) FOR I = 9	SETUP	118
C				TO 16	SETUP	119
C					SETUP	120
C		41-80	BF5.0) BPLIM(I)	R CONTINUATION OF BPLIM(I) FOR I = 9	SETUP	121
C				TO 16	SETUP	122
C					SETUP	123
C				NOTE - A TYPE C2A CARD IS REQUIRED EVEN IF BLANK	SETUP	124
C					SETUP	125
C.....					SETUP	126
C.....					SETUP	127
C					SETUP	128
C	D1	4-10	(E10.0, PSIZE	R BASE PLANT SIZE (MEGAWATTS)	SETUP	129
C					SETUP	130
C		11-20	E10.0, TEFF	R BASE THERMAL EFFICIENCY (DF)	SETUP	131
C					SETUP	132
C		21-30	E10.0, CAPF	R CAPACITY FACTOR (DF)	SETUP	133
C					SETUP	134
C		31-40	E10.0, FCR	R FIXED CHARGE RATE (DF)	SETUP	135
C					SETUP	136
C		41-50	E10.0, PER	R RATIO MAINTENANCE COST TO CAPITAL	SETUP	137
C				COST (DF)	SETUP	138
C					SETUP	139
C		51-60	E10.0, CCM	R CONSTRUCTION COST MULTIPLIER (DF)	SETUP	140
C					SETUP	141
C		61-70	E10.0, ELEV	R SITE ELEVATION ABOVE SEA LEVEL (FT)	SETUP	142
C					SETUP	143
C		71-80	E10.0) ROOFL	R ROOF LOAD (LB/SQ FT)	SETUP	144
C					SETUP	145
C.....					SETUP	146
C.....					SETUP	147
C					SETUP	148
C	E1	1-10	(E10.0, FCOS	R FUEL COST (CENTS/MMBTU)	SETUP	149
C					SETUP	150
C		11-20	E10.0, PWCOS	R REPLACEMENT POWER COST (MILLS/KWH)	SETUP	151
C					SETUP	152
C		21-30	E10.0, PLANC	R POWER PLANT CONSTRUCTION COST (\$/KW)	SETUP	153
C					SETUP	154
C		31-40	E10.0, COSTL	R COST OF LAND (\$/SQ FT)	SETUP	155
C					SETUP	156
C		41-50	E10.0, CSSPKW	R COST OF STEAM SUPPLY (\$/KW)	SETUP	157
C					SETUP	158
C		51-60	E10.0, CAPCHG	R CAPACITY CHARGE (\$/MEGAWATT)	SETUP	159
C					SETUP	160
C		61-70	E10.0, HPCST	R COST OF ELECTRIC MOTORS (\$/HP)	SETUP	161
C					SETUP	162
C		71-80	E10.0) CTURB	R ADDITIONAL TURBINE COST BECAUSE OF	SETUP	163
C				NUCLEAR POWER PLANT (\$/KW)	SETUP	164
C					SETUP	165
C.....					SETUP	166
C					SETUP	167
C				INDIRECT COST FACTORS FOR -	SETUP	168
C	E2	1-10	(E10.0, POHBAF	R BUNDLE ASSEMBLE AND FRAME	SETUP	169
C					SETUP	170
C		11-20	E10.0, POHFAN	R FANS	SETUP	171
C					SETUP	172

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	21-30	E10.0	POHLEC	R	ELECTRICAL	SETUP	173
C						SETUP	174
C	31-40	E10.0	POHCIR	R	CIRCULATION PIPING	SETUP	175
C						SETUP	176
C	41-50	E10.0	POHCND	R	CONDENSER	SETUP	177
C						SETUP	178
C	51-60	E10.0	POHSTC	R	STRUCTURE	SETUP	179
C						SETUP	180
C	61-70	E10.0	POHSCL	R	SCREENS AND LOUVERS	SETUP	181
C						SETUP	182
C	.....					SETUP	183
C						SETUP	184
C	F1 1-10	(F10.0)	RBP	R	TURBINE RATING BACK PRESSURE (INCHES	SETUP	185
C					OF MERCURY)	SETUP	186
C						SETUP	187
C	11-70	4F15.8)	TPO(I)	R	COEFFICIENTS FOR THIRD ORDER POLY-	SETUP	188
C					NOMIAL FOR HEAT RATE AS A FUNCTION	SETUP	189
C					OF TURBINE BACK PRESSURE.	SETUP	190
C						SETUP	191
C	.....					SETUP	192
C	.....					SETUP	193
C						SETUP	194
C	G1 1-10	E10.0	EFFP	R	EFFICIENCY OF PUMPS (DF)	SETUP	195
C						SETUP	196
C	.....					SETUP	197
C	.....					SETUP	198
C						SETUP	199
C	H1 1-10	(E10.0)	VELREC	R	CONTROL VARIABLE.	SETUP	200
C					=1 FOR VELOCITY RECOVERY	SETUP	201
C					=0 FOR NO VELOCITY RECOVERY	SETUP	202
C						SETUP	203
C	11-20	E10.0	XDEPA	R	MINIMUM AIR SIDE PRESSURE DROP THRU	SETUP	204
C					HEAT EXCHANGER (LB FORCE/SQ FT)	SETUP	205
C						SETUP	206
C	21-30	E10.0	TLIM	R	MAXIMUM STEAM TEMPERATURE FOR THE	SETUP	207
C					TURBINE (DEGREES F).	SETUP	208
C					ASSUMED 180 IF FIELD IS BLANK OR 0.	SETUP	209
C						SETUP	210
C	31-40	E10.0	TOWMIN	R	THE MINIMUM ALLOWABLE NUMBER OF	SETUP	211
C					TOWERS PER GROUP.	SETUP	212
C					ASSUMED 1 IF NOT SPECIFIED	SETUP	213
C						SETUP	214
C	41-50	E10.0	TOWMAX	R	THE MAXIMUM ALLOWABLE NUMBER OF	SETUP	215
C					TOWERS PER GROUP ASSUMED 9999 IF	SETUP	216
C					NOT SPECIFIED	SETUP	217
C						SETUP	218
C	51-60	E10.0)	PFACT	R	PACKING FACTOR, RATIO OF CIRCULAR	SETUP	219
C					TOWER ROOF AREA TO FAN SWEEP AREA	SETUP	220
C					(DF)	SETUP	221
C						SETUP	222
C	.....					SETUP	223
C						SETUP	224
C	H2 1-10	E10.0	GBEFF	R	FAN GEARBOX EFFICIENCY	SETUP	225
C						SETUP	226
C	.....					SETUP	227
C	.....					SETUP	228
C						SETUP	229

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	I1	1-10	(E10.0, CPM	R	PLENUM COST (\$/LB)	SETUP	230
C						SETUP	231
C		11-20	E10.0, WPL	R	WEIGHT OF PLENUM MATERIAL (LB/SQ FT)	SETUP	232
C						SETUP	233
C		21-30	E10.0, CLUVR	R	COST OF LOUVERS (\$/SQ FT)	SETUP	234
C						SETUP	235
C		31-40	E10.0, CHAHS	R	COST OF HAIL SCREENS (\$/SQ FT)	SETUP	236
C						SETUP	237
C		41-50	E10.0, UCS	R	UNIT COST OF STACK \$/LB	SETUP	238
C						SETUP	239
C		51-60	E10.0, UWS	R	UNIT WT OF STACK LB/CU FT	SETUP	240
C						SETUP	241
C		61-70	E10.0, CVM	R	FAH RING MATERIAL UNIT COST \$/LB	SETUP	242
C						SETUP	243
C		71-80	E10.0) WFF	R	UNIT WT OF STRAIGHT CYLINDER LB/SQ F	SETUP	244
C						SETUP	245
C	.....					SETUP	246
C	.....					SETUP	247
C						SETUP	248
C	J1	1-10	(F10.0, HXNP	R	NUMBER OF PASSES THRU HEAT EXCHANGER	SETUP	249
C						SETUP	250
C		11-20	F10.0, WB	R	HEADER LENGTH (FEET)	SETUP	251
C						SETUP	252
C		21-30	F10.0, NTUB	R	NUMBER OF TUBES THRU PLATE FINS	SETUP	253
C						SETUP	254
C		31-40	F10.0, SS	R	SUPPORT SPACING (FT)	SETUP	255
C						SETUP	256
C		41-50	F10.0) ANGLE	R	HEAT EXCHANGER ANGLE (DEGREES)	SETUP	257
C						SETUP	258
C	.....					SETUP	259
C						SETUP	260
C	J2	1-10	(F10.0, DESVEL	R	DESIGN VELOCITY (LIQUID) FOR PIPING	SETUP	261
C					(FT/SEC)	SETUP	262
C						SETUP	263
C		11-20	F10.0, REDUCE	R	MINIMUM STEP CHANGE IN PIPE DIAMETER	SETUP	264
C					FOR LIQUID PHASE TOWER PIPING (INCH-	SETUP	265
C					ES)	SETUP	266
C					MAY BE 6, 12, OR 18	SETUP	267
C						SETUP	268
C		21-30	F10.0, QREDUCE	R	MINIMUM STEP CHANGE IN PIPE DIAMETER	SETUP	269
C					FOR LIQUID PHASE QUADRANT HEADERING	SETUP	270
C					(INCHES)	SETUP	271
C					MAY BE 6, 12, OR 18	SETUP	272
C						SETUP	273
C		31-40	F10.0) DIST	R	DISTANCE FROM TOWER TO CONDENSER	SETUP	274
C					ROOM (FT)	SETUP	275
C						SETUP	276
C	.....					SETUP	277
C						SETUP	278
C	J3	1-10	(F10.0, DESVELV	R	DESIGN VELOCITY (VAPOR) FOR PIPING.	SETUP	279
C					(FT/SEC)	SETUP	280
C						SETUP	281
C		11-20	F10.0, REDUCEV	R	MINIMUM STEP CHANGE IN PIPE DIAMETER	SETUP	282
C					FOR VAPOR PHASE TOWER PIPING	SETUP	283
C					(INCHES)	SETUP	284
C					MAY BE 6, 12, OR 18	SETUP	285
C						SETUP	286

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	21-30	F10.0.	QREDUCV	R	MINIMUM STEP CHANGE IN PIPE DIAMETER	SETUP	287	
C					FOR VAPOR PHASE QUADRANT HEADERING	SETUP	288	
C					(INCHES)	SETUP	289	
C					MAY BE 6, 12, OR 18	SETUP	290	
C						SETUP	291	
C	31-40	F10.0.	DESVELD	R	DESIGN VELOCITY OF WATER THROUGH	SETUP	292	
C					THE DELUGE PIPING (FT/SEC)	SETUP	293	
C						SETUP	294	
C	41-50	F10.0)	FACTORD	R	RATIO OF WATER FLOWING THROUGH	SETUP	295	
C					THE DELUGE WATER SYSTEM TO THE	SETUP	296	
C					AMOUNT OF MAKE UP WATER	SETUP	297	
C						SETUP	298	
C	.....					SETUP	299	
C						SETUP	300	
C	J4	1-10	(F10.0.	WATCONA	R	ALLOWED WATER CONSUMPTION	SETUP	301
C					(ACRE-FEET)	SETUP	302	
C						SETUP	303	
C	11-20	F10.0.	WATCOST	R	COST OF THE DELUGE WATER	SETUP	304	
C					(\$/1000 GAL	SETUP	305	
C						SETUP	306	
C	21-30	F10.0.	FACTOR	R	RATIO OF THE WET AIR VELOCITY OVER	SETUP	307	
C					THE DRY AIR VELOCITY OF THE HEAT	SETUP	308	
C					EXCHANGER (DIMENSIONLESS)	SETUP	309	
C						SETUP	310	
C	31-40	F10.0.	HCD	R	METAL TO DELUGEATE HEAT TRANSFER	SETUP	311	
C					COEFFICIENT (BTU/HR-SQ FT-DEG F)	SETUP	312	
C						SETUP	313	
C	41-50	F10.0.	BETAF	R	AIR SIDE FOULING COEFFICIENT	SETUP	314	
C					(BTU/HR-SQ FT DEG F)	SETUP	315	
C						SETUP	316	
C	51-60	F10.0.	BETAI	R	TUBESIDE FOULING COEFFICIENT	SETUP	317	
C					(BTU/HR-SQ FT-DEG F)	SETUP	318	
C						SETUP	319	
C	61-70	F10.0)	RHOUT	R	RELATIVE HUMIDITY OF THE AIR	SETUP	320	
C					LEAVING THE HEAT EXCHANGER	SETUP	321	
C						SETUP	322	
C	.....					SETUP	323	
C	.....					SETUP	324	
C						SETUP	325	
C	K1	1-10	(E10.0.	XW	R	TUBE TRANSVERSE PITCH (NORMAL TO AIR	SETUP	326
C					FLOW) (INCHES)	SETUP	327	
C						SETUP	328	
C	11-20	E10.0.	X0	R	TUBE PITCH IN DIRECTION OF AIR FLOW	SETUP	329	
C					(INCHES)	SETUP	330	
C						SETUP	331	
C	21-30	E10.0.	XDG	R	TUBE DIAGONAL PITCH (INCHES)	SETUP	332	
C						SETUP	333	
C	31-40	E10.0.	SF	R	FIN SPACING (INCHES)	SETUP	334	
C						SETUP	335	
C	41-50	E10.0.	DFIN	R	FIN DIAMETER (INCHES)	SETUP	336	
C						SETUP	337	
C	51-60	E10.0)	THFIN	R	FIN THICKNESS (INCHES)	SETUP	338	
C						SETUP	339	
C	.....					SETUP	340	
C	.....					SETUP	341	
C						SETUP	342	
C	L1	1-10	(F10.0.	ODL	R	HX LINER OUTSIDE DIAMETER (INCHES)	SETUP	343

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C					SETUP	344
C	11-20	F10.0, DI	R	HX LINER INSIDE DIAMETER (INCHES)	SETUP	345
C					SETUP	346
C	21-30	F10.0, GAGLIN	R	GAGE OF HX LINER TUBE (MAY BE	SETUP	347
C				22. 20. 19. 18. 17. 16. 15.	SETUP	348
C				14.5 14. 13. 12. 11. 10.)	SETUP	349
C					SETUP	350
C	31-50	2A10, TUBMAT,	R	LINER MATERIAL. MUST BEGIN IN COL 3	SETUP	351
C		XTUBMA	R		SETUP	352
C					SETUP	353
C				MAY BE -	SETUP	354
C				ADMIRALTY	SETUP	355
C				COPPER	SETUP	356
C				CU=10 NI	SETUP	357
C				CU=30 NI	SETUP	358
C				ALUMINUM	SETUP	359
C				STEEL WELDED	SETUP	360
C				STEEL SEAMLESS	SETUP	361
C				WELDED SST	SETUP	362
C					SETUP	363
C	51-60	F10.0) CONL	R	THERMAL CONDUCTIVITY OF LINER MATER-	SETUP	364
C				IAL (BTU/(HR SQFT DEG F/ FT))	SETUP	365
C					SETUP	366
C	.....				SETUP	367
C	.....				SETUP	368
C					SETUP	369
C	M1	1-20 (2A10	R	TYPE OF FIN. MUST START IN COLUMN 1.	SETUP	370
C		FINFINTY			SETUP	371
C					SETUP	372
C				MAY BE -	SETUP	373
C				STRAIGHT FIN	SETUP	374
C				SINGLE FOOT	SETUP	375
C				DOUBLE FOOT	SETUP	376
C				EMBEDDED	SETUP	377
C				EXTRUDED	SETUP	378
C				PLATE	SETUP	379
C				NO LINER	SETUP	380
C					SETUP	381
C				IF NO LINER THEN FIN MATERIAL	SETUP	382
C				MUST BE ALUMINUM	SETUP	383
C					SETUP	384
C	21-30	A10, FINMAT	R	FIN MATERIAL. MUST START IN COL. 21	SETUP	385
C					SETUP	386
C				MAY BE -	SETUP	387
C				ALUMINUM	SETUP	388
C				STEEL	SETUP	389
C					SETUP	390
C	31-40	F10.0) CONF	R	THERMAL CONDUCTIVITY OF FIN MATERIAL	SETUP	391
C				(BTU/(HR SQFT DEG F/FT))	SETUP	392
C					SETUP	393
C	.....				SETUP	394
C	.....				SETUP	395
C					SETUP	396
C	N1	1-10 (E10.0, CFB	R	FIN BONDING COST (\$/SQ FT)	SETUP	397
C					SETUP	398
C	11-20	E10.0, COATC	R	FIN PROTECTIVE COATING COST (\$/SQFT)	SETUP	399
C					SETUP	400

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	21-30	E10.0,	ZINCC	R	ZINC COST FOR SPACERS (\$/LB)	SETUP	401
C						SETUP	402
C	31-40	E10.0,	CASTC	R	FIXED CASTING COST FOR SPACERS (\$/SPACER)	SETUP	403
C						SETUP	404
C	41-50	E10.0)	EPREPC	R	END PREPARATION COST (\$/TUBE)	SETUP	405
C						SETUP	406
C						SETUP	407
C						SETUP	408
C						SETUP	409
C	P1	1-20	(2A10,	HEDTYP,	R	HEADER TYPE, MUST START IN COLUMN 1	SETUP
C				XHEDTY	R	MAY BE -	SETUP
C						SETUP	412
C						SETUP	413
C					WELD REMOVABLE	SETUP	414
C					WELD PLUG	SETUP	415
C					FORM REMOVABLE	SETUP	416
C					FORM PLUG	SETUP	417
C						SETUP	418
C	21-30	A10,	HEDMAT	R	HEADER MATERIAL, MUST START IN COLUMN 21, MAY BE -	SETUP	419
C						SETUP	420
C					ALUMINUM	SETUP	421
C					STEEL	SETUP	422
C						SETUP	423
C	31-40	F10.0,	TW	R	THICKNESS OF HEADER MATERIAL (INCHES)	SETUP	424
C						SETUP	425
C	41-50	F10.0,	SEGL	R	HEAT EXCHANGER SECTION LENGTH (FEET)	SETUP	426
C						SETUP	427
C						SETUP	428
C	51-60	I10)	NSIDES	I	NUMBER OF SIDES PER TOWER	SETUP	429
C						SETUP	430
C						SETUP	431
C						SETUP	432
C						SETUP	433
C	Q1	1-10	(E10.0,	CRJ	R	COST OF ROLLED JOINT, TUBE TO HEADER (\$/TUBE)	SETUP
C						SETUP	435
C						SETUP	436
C	11-20	E10.0,	CWJ	R	COST OF WELDED JOINT, TUBE TO HEADER (\$/TUBE)	SETUP	437
C						SETUP	438
C						SETUP	439
C	21-30	E10.0,	CHH	R	TUBE AND PLUG HOLE PREPARATION COST (\$/HOLE)	SETUP	440
C						SETUP	441
C						SETUP	442
C	31-40	E10.0,	CN	R	NOZZEL AND ATTACHING COST (\$/HOLE)	SETUP	443
C						SETUP	444
C	41-50	E10.0,	CMW	R	COST OF HEADER MACHINING AND WELDING (\$/FT)	SETUP	445
C						SETUP	446
C						SETUP	447
C						SETUP	448
C	51-60	E10.0,	CST	R	STRUCTURAL STEEL COST (\$/LB)	SETUP	449
C						SETUP	450
C	61-70	E10.0)	CBJ	R	COST OF BOLTED HEADER JOINT (\$/FT)	SETUP	451
C						SETUP	452
C						SETUP	453
C						SETUP	454
C						SETUP	455
C	Q2	1-10	F10.0,	CSH	R	BUNDLE STIFFNER HOLE PREPARATION COST (\$/HOLE)	SETUP
C						SETUP	456
C						SETUP	457

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C					SETUP	458
C	11-20	F10.0.	CSHP	R TUBE HOLE PREPARATION COST FOR	SETUP	459
C				SECTION JOINT (\$/HOLE)	SETUP	460
C					SETUP	461
C	21-30	F10.0.	TSP	R PLATE THICKNESS FOR BUNDLE STIFFNERS	SETUP	462
C				(IN)	SETUP	463
C	.....				SETUP	464
C	.....				SETUP	465
C					SETUP	466
C	R1	1-10	(E10.0.	XNS R NUMBER OF CONDENSER SHELLS	SETUP	467
C					SETUP	468
C	11-20	E10.0.	VELN	R NOMINAL DESIGN VELOCITY THRU CONDENSER TUBES (FT/SEC)	SETUP	469
C					SETUP	470
C	21-30	E10.0.	ODC	R CONDENSER TUBE O.D. (INCHES)	SETUP	471
C					SETUP	472
C	31-40	E10.0.	GA	R CONDENSER TUBE WALL GAGE. MAY BE	SETUP	473
C				12. 14. 16. 18. 20. 22. 24.	SETUP	474
C					SETUP	475
C	41-50	E10.0.	TKCT	R THERMAL CONDUCTIVITY OF CONDENSER TUBING	SETUP	476
C				(BTU/(HR SQFT DEG F/FT)).	SETUP	477
C					SETUP	478
C	51-60	E10.0.	TTD2QE	R TERMINAL TEMPERATURE DIFFERENCE ESTIMATE	SETUP	479
C				(DEGREES F)	SETUP	480
C					SETUP	481
C					SETUP	482
C	61-80	2A10)	CONMAT.	R CONDENSER TUBING MATER-	SETUP	483
C			CONMA2	R IAL. MUST START IN	SETUP	484
C				COLUMN 61. MAY BE -	SETUP	485
C					SETUP	486
C				ADMIRALTY	SETUP	487
C				CU-10 NI	SETUP	488
C				304 S/S WELDED	SETUP	489
C					SETUP	490
C	.....				SETUP	491
C					SETUP	492
C	R2	1-10	(E10.0.	XNP R NUMBER OF PASSES THRU CONDENSER	SETUP	493
C					SETUP	494
C	11-2	E10.0.	TLA	R CONDENSER TUBING LENGTH (FEET)	SETUP	495
C					SETUP	496
C	21-3	E10.0)	XQUALY	R AMMONIA VAPOR QUALITY OUT OF CONDENSER.	SETUP	497
C					SETUP	498
C					SETUP	499
C	.....				SETUP	500
C					SETUP	501
C	R3	1-5	(I5)	LINOR R CONTROL VARIABLE	SETUP	502
C				=1 FOR LINDE TUBING	SETUP	503
C				=0 FOR BARE TUBES	SETUP	504
C					SETUP	505
C	.....				SETUP	506
C	.....				SETUP	507
C					SETUP	508
C	S1	1-5	(I5.	LFB I LFB AND LFE SPECIFY FIRST AND LAST	SETUP	509
C		6-10	I5.	LFE I POSITION TO BE CONSIDERED IN THE	SETUP	510
C				TABLE OF FANS. DEFAULT VALUES ARE	SETUP	511
C				LFB=1 AND LFE=153	SETUP	512
C					SETUP	513
C					SETUP	514

06/05/78 07.59.59

.....

				DIAMETER	IFAN	LEAN	SETUP	
				24.	1	27	SETUP	515
				26.	28	54	SETUP	516
				28.	55	88	SETUP	517
				30.	89	111	SETUP	518
				40.	112	135	SETUP	519
				60.	136	153	SETUP	520
11-15	IS)	MXEXT	I	THE MAXIMUM ALLOWABLE NUMBER OF CALLS TO SUBROUTINE XTEND FOR ANY ONE DESIGN TEMPERATURE.			SETUP	521
				DEFAULT VALUE IS 10			SETUP	522
							SETUP	523
							SETUP	524
							SETUP	525
							SETUP	526
							SETUP	527
							SETUP	528
							SETUP	529
							SETUP	530
							SETUP	531
							SETUP	532
							SETUP	533
1	1-10	A10	FFHX	R	CONTROL VARIABLE FOR SPECIFYING METHOD TO USE IN COMPUTING FRICTION FACTOR. MUST START IN COLUMN 1 . MAY BE -		SETUP	534
				HOTERV			SETUP	535
							SETUP	536
							SETUP	537
							SETUP	538
							SETUP	539
							SETUP	540
11-20	A10	FSHOT	R	CONTROL VARIABLE FOR SPECIFYING TYPE OF SEARCH ROUTINE TO BE USED IN SEARCH FOR OPTIMUM MAY BE -		SETUP	541	
				SKIP SHOT			SETUP	542
				CONSTANT			SETUP	543
							SETUP	544
							SETUP	545
21-30	A10	FDELUG	R	CONTROL VARIABLE FOR SELECTING TYPE OF METHOD TO CALCULATE EVAPORATIVE HEAT TRANSFER MAY BE -		SETUP	546	
				DELUG			SETUP	547
				DELBW			SETUP	548
							SETUP	549
							SETUP	550
							SETUP	551
							SETUP	552
							SETUP	553
							SETUP	554
							SETUP	555
							SETUP	556
							SETUP	557
							SETUP	558
							SETUP	559
							SETUP	560
							SETUP	561
							SETUP	562
							SETUP	563
							SETUP	564
							SETUP	565
							SETUP	566
							SETUP	567
							SINK	2
							SINK	3
							SINK	4
							SINK	5

SUBROUTINE SETUP

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

$ SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SPS13, WT2MIN, SINK 6
$ BP2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBA1, XNTS1, VELD1 SINK 7
$ , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITC01, CSC1, CEPRE1, DEPI1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFEL1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTRF1, STRUC1, CFMPF1, HPPF1, TOTCF1, TP1, EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTRP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRC1, CFOUND1, HUBD11, TOWLE1, NUMT01, CTOWD1 SINK 14
$ , SQRJ1, SQRJ51, ATUBC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTD1 SINK 15
$ , CSTHS1, CYLRN1, CFANE1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCWD1(16), DEPER1(16), DEPERQ1(16) SINK 17
$ , WBB1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDPI, W51 SINK 18
COMMON /SCALER/ HRFAC1, ATUB, CPERA, SSCD, PLANC1, CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANC1 SCALER 3
COMMON /FNLOOP/ LFB, LFE SETUP 570
COMMON /PLCOST/ WPL SETUP 571
DIMENSION DESCR(8) SETUP 572
COMMON /DZZ/ SETUP 573
$ DESKEP(10,8), NOCRDS SETUP 574
LOGICAL FIRST, FRST, FXTMP, FXTVAR, FXTTDD, FXTLNG BIGCOM 2
COMMON BIGCOM 3
$ AFTR, ALPHA, ANG(3) BIGCOM 4
* , BBLIM(16) BIGCOM 5
$ , CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2, CAF BIGCOM 6
$ , CRJ, CTURB, CDANG, CLUVR, CHA1LS, CVM BIGCOM 7
$ , DFIN, DEEPL, DESVEL, DESVELV, DESVELD, DENSIF BIGCOM 8
$ , EFFP, EFS BIGCOM 9
$ , FCR, FIRST, FIXL, FCOS, FFHX, FXTMP, FACTOR, FRST, FACTORD, FSHOT, FDELUG BIGCOM 10
$ , FIXV, FIXTDD, FXTVAR, FXTTDD, FXTLNG BIGCOM 11
$ , GREFF BIGCOM 12
$ , HXNP, HPCST, HCD BIGCOM 13
$ , ITMAX, ITMIN BIGCOM 14
$ , JCONS BIGCOM 15
$ , KCONV, KALEXT BIGCOM 16
$ , MXEXT BIGCOM 17
$ , NTA, NSIDES, NBUH1 BIGCOM 18
COMMON BIGCOM 19
$ ODR BIGCOM 20
$ , PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL BIGCOM 21
$ , POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL BIGCOM 22
$ , RBP, REDUCE, REDUCV, ROOFL, RHOUT BIGCOM 23
$ , QREJ, QREDUCE, QREDUCV BIGCOM 24
$ , SIGMAG, SAAF, SEGL BIGCOM 25
$ , TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TPIX BIGCOM 26
$ , TCD, TW BIGCOM 27
$ , UCS, UWS BIGCOM 28
$ , WFF, WATCONA, WATCOST BIGCOM 29
$ , VAS(5) BIGCOM 30
$ , XDEPA, XW, XD BIGCOM 31
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF, SUPPLY 2
$ , QIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW, SUPPLY 3
$ , FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4, SUPPLY 4
$ , REWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3, SUPPLY 5
$ , SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2, SUPPLY 6
$ , BP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTS, VELDX SUPPLY 7
$ , TLAX, UCON, PMCS1, FMCS1, FBACC, EFFC, CH, CA, CS SUPPLY 8

```


SUBROUTINE SETUP

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

```

$ , CLTC, CFC, CPCC, FITCO, CSC, CEPREP, DELPIP, AST, OLD CST SUPPLY 9
$, CAPCST, XNFAN, BLDANG, CPLEN, DPPEL, WHX, WTTUB, ADIA, ABLN SUPPLY 10
1 $, WTHDR, WTFRM, STRUCC, CPERF, HPPERF, TOTCF, TPC, EFFIN, ANTU SUPPLY 11
$, AIPPF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP SUPPLY 12
$, ACTBPD, ADJBPD, ACTVM, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY 13
$, CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD SUPPLY 14
5 $, SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCST SUPPLY 15
$, CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCT, RPTPL, SEPCST SUPPLY 16
$, PWD(16), WATCWD(16), DEPER(16), DEPERQ(16) SUPPLY 17
$, WBB, HTOW, NTOWDE, CSTIF, CSJ, CVF, COP, W5 SUPPLY 18
COMMON /VARVAR/ TPER(16), TA(16), TAWB(16 SETUP 577
COMMON /FAN/ FANDAP(153,10), FANDAM(153,10), FMCPF, FBCPF, P2, R, S, SETUP 578
1 $VELREC, AFC, ELEV, EHR SETUP 579
COMMON /CONS/ HD, BETAF, BETAI, XX(6) SETUP 580
DATA BLANK/" "/ SETUP 581
C SURFACE CONDENSER TUBE OD AND TUBE GAGE ARRAYS SETUP 582
C DATA TOD/0.625,0.750,0.875,1.000,1.125,1.250/ SETUP 583
5 DATA TGA/12.,14.,16.,18.,20.,22.,24./ SETUP 584
C SETUP 585
C CONDENSER TUBE ID AND GPM PER FPS VELOCITY THROUGH TUBE AS A SETUP 586
C FUNCTION OF TUBE GAGE AND TUBE OD. SETUP 587
C SETUP 588
C SETUP 589
DATA TID/0.407,0.459,0.495,0.527,0.555,0.569,0.581, SETUP 590
$ 0.532,0.584,0.620,0.652,0.680,0.694,0.706, SETUP 591
$ 0.657,0.709,0.745,0.777,0.805,0.819,0.831, SETUP 592
$ 0.782,0.834,0.870,0.902,0.930,0.944,0.956, SETUP 593
5 $ 0.907,0.959,0.995,1.027,1.055,1.069,1.081, SETUP 594
$ 1.032,1.084,1.120,1.152,1.180,1.194,1.206/ SETUP 595
89 FORMAT("INPUT ERROR. THE SUM OF THE TPER(I) SHOULD BE 1.0000") SETUP 596
6000 FORMAT(1H1///T10,"BNWII DRY/WET COOLING TOWER COST MODEL --" SETUP 597
$, "AMMONIA CIRCULAR TOWER VERSION") SETUP 598
1 $, T85, "THIS RUN MADE", A10, 5X, A10) SETUP 599
5001 FORMAT(8A10) SETUP 600
6001 FORMAT(T21,8A10) SETUP 601
5002 FORMAT(8E10,0) SETUP 602
5012 FORMAT(6E10,0,110) SETUP 603
6002 FORMAT(/1X,8G15,8) SETUP 604
6012 FORMAT(/1X,6G15,8,115) SETUP 605
5003 FORMAT(16F5,0) SETUP 606
6003 FORMAT (/1X8F8,1,8F8,4) SETUP 607
5004 FORMAT(F10,0,4F15,8) SETUP 608
6004 FORMAT(/1X,F10,2,4G15,8) SETUP 609
5005 FORMAT(16F10,0) SETUP 610
6005 FORMAT(/1X,6G15,8) SETUP 611
5006 FORMAT(3F10,0,2A10,F10,0) SETUP 612
6006 FORMAT(/1X,3F10,5,1X,2A10,F10,5) SETUP 613
5007 FORMAT (3A10,5F10,0) SETUP 614
6007 FORMAT (/1X,2A10,1X,A10,5G15,8) SETUP 615
5008 FORMAT(8I5) SETUP 616
6008 FORMAT(/1X,8I6) SETUP 617
5009 FORMAT(6E10,0,2A10) SETUP 618
1 6009 FORMAT(/1X,6G15,8,5X,2A10) SETUP 619
5010 FORMAT(3A10,2F10,0,110) SETUP 620
6010 FORMAT(/1X,2A10,1X,A10,2G10,2,110) SETUP 621
5011 FORMAT(7E10,0,2F5,0) SETUP 622
6011 FORMAT(/1X,8G15,8,610,4) SETUP 623

```

5014	FORMAT(4A10)	SETUP	624
6014	FORMAT(/1X,4A10)	SETUP	625
7060	FORMAT(T6,"TSTAR",T21,"TEND",T36,"VAS(1)",T51,"VAS(2)",T66, \$"VAS(3)",T81,"VAS(4)",T96,"VAS(5)")	SETUP	626
7061	FORMAT(T6,"TFIX",T21,"FIXV",T36,"FIXTTD",T51,"FIXL",T66,"DEEPL")	SETUP	627
7090	FORMAT(4X,"TA(1)",3X"TA(2)",3X"TA(3)",3X"TA(4)",3X"TA(5)" \$3X"TA(6)",3X"TA(7)",3X"TA(8)",1X"TPER(1)",1X"TPER(2)",1X"TPER(3)" \$1X"TPER(4)",1X"TPER(5)",1X"TPER(6)",1X"TPER(7)",1X"TPER(8)")	SETUP	628
7120	FORMAT(4X"TA(9)",2X"TA(10)",2X"TA(11)",2X"TA(12)",2X"TA(13)" \$2X"TA(14)",2X"TA(15)",2X"TA(16)",1X"TPER(9) TPER(10) TPER(11) TPER(12) \$2TPER(13) TPER(14) TPER(15) TPER(16)")	SETUP	629
7130	FORMAT(4X,"TWB(1) TWB(2) TWB(3) TWB(4) TWB(5) TWB(6) TWB(7) 1 TWB(8)",1X,"BPLM(1) BPLM(2) BPLM(3) BPLM(4) BPLM(5) BPLM(6) BPLM(7) 27) BPLM(8)")	SETUP	630
7140	FORMAT(4X,"TWB(9) TWB(10) TWB(11) TWB(12) TWB(13) TWB(14) TWB(15) 1 TWB(16)",1X,"BPLM(9) BPLM(10) BPLM(11) BPLM(12) BPLM(13) BPLM(14) BPLM(15) 215) BPLM(16)")	SETUP	631
7150	FORMAT(T5,"PSIZE",T23,"TEFF",T38,"CAPF",T54,"FCR",T69,"PER" \$,T84,"CCM",T96,"ELEV",T108,"RODFL")	SETUP	632
7180	FORMAT(T5,"FCOS",T23,"PWCOS",T38,"PLANC",T52,"COSIL",T67,"CSSPKW" \$,T82,"CAPCHG",T97,"HPCST",T112,"CTURB")	SETUP	633
7185	FORMAT (T5,"POHBAF",T20,"POHFAN",T35,"POHLEC",T50,"POHCIR", \$ T65,"POHCND",T80,"POHSTC",T95,"POHSCL")	SETUP	634
7210	FORMAT(T5,"RBP",T17,"TPO(1)",9X"TPO(2)",9X"TPO(3)",9X"TPO(4)")	SETUP	635
7240	FORMAT(T5,"EFFP")	SETUP	636
7270	FORMAT(T4,"VELREC",T20,"XDEPA",T35,"TLIM",T50,"TOWMIN",T65, \$ "TOWMAX",T90,"PFACT")	SETUP	637
7280	FORMAT(5X,"GBEFF")	SETUP	638
7300	FORMAT(T5,"CPM",T20,"WPL",T35,"CLUVR",T50,"CHAILS",T65,"UCS",T80 \$,T95,"CVM",T110,"WV")	SETUP	639
7330	FORMAT(T5,"HXNP",T24,"WB",T44,"NTUB",T58,"SS",T75,"ANGLE")	SETUP	640
7335	FORMAT(T5,"DESVL",T21,"REDUCE",T35,"QREDUCE",T50,"DIST")	SETUP	641
7340	FORMAT(T5,"DESVLV",T21,"REDUCV",T35,"QREDUCV",T50,"DESVELD",T65, 1"FACTORD")	SETUP	642
7345	FORMAT(T5,"WATCONA",T20,"WATCOST",T36,"FACTOR",T50,"HCD",T65, 1"RETAF",T80,"BETAI",T95,"RHOUT")	SETUP	643
7360	FORMAT(5X,"XW",13X,"XD",13X,"XDG",12X,"SF",13X,"DFIN",11X, \$ "THFIN")	SETUP	644
7390	FORMAT(5X"ODL",12X"DI",03X"GAGLIN",9X"UBMA",13X"CONL")	SETUP	645
7420	FORMAT(3X"FINTP",14X"FINMAT",4X"CONF")	SETUP	646
7450	FORMAT(5X"CFB",12X"COATC",10X"ZINCC",10X"CASTC",10X,"EPREPC")	SETUP	647
7480	FORMAT(T4,"HEDTYP",T24,"HEDMAT",T36,"TW",T50,"SEGL",T65,"NSIDES")	SETUP	648
7490	FORMAT(T5,"CSH",12X,"CSHP",12X,"TSP")	SETUP	649
7510	FORMAT(5X,"CRJ",12X,"CWJ",12X,"CMH",12X,"CN",12X,"CMW",12X,"CST", \$ 12X,"CBJ")	SETUP	650
7540	FORMAT(5X"XNS",12X"VELN",11X"ODC",12X"GA",10X"TKCT",10X,"TTD2QE" \$,15X"CONMAT")	SETUP	651
7550	FORMAT(5X,"XNP",10X,"TLA",10X,"XQUALY")	SETUP	652
7555	FORMAT(3X,"LINOR")	SETUP	653
7570	FORMAT(T4,"LFB",T11,"LFE",T15,"MXEXT")	SETUP	654
7580	FORMAT(5X,"FFHX",6X,"FSHOT",5X,"FDELUG")	SETUP	655
		SETUP	656
		SETUP	657
		SETUP	658
		SETUP	659
		SETUP	660
		SETUP	661
		SETUP	662
		SETUP	663
		SETUP	664
		SETUP	665
		SETUP	666
		SETUP	667
		SETUP	668
		SETUP	669
		SETUP	670
		SETUP	671
		SETUP	672
		SETUP	673
		SETUP	674
		SETUP	675
		SETUP	676
		SETUP	677
		SETUP	678
		SETUP	679
		SETUP	680

SUBROUTINE SETUP

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

CALL TIME(HEURE)	SETUP	681
WRITE(6,6000) DOY,HEURE	SETUP	682
C	SETUP	683
CARDS A1 - A2	SETUP	684
N=0	SETUP	685
30 READ(5,5001) DESCR	SETUP	686
DO 35 I=1,8	SETUP	687
IF(DESCR(I).NE.BLANK) GOTO 37	SETUP	688
35 CONTINUE	SETUP	689
GOTO 40	SETUP	690
37 WRITE(6,6001) DESCR	SETUP	691
N=N+1	SETUP	692
DO 38 K=1,8	SETUP	693
DESCR(N,K)=DESCR(K)	SETUP	694
888 CONTINUE	SETUP	695
NOCRDS=N	SETUP	696
GOTO 30	SETUP	697
40 CONTINUE	SETUP	698
C	SETUP	699
CARD B1	SETUP	700
READ(5,5011) TSTAR, TEND, VAS(1), VAS(2), VAS(3), VAS(4), VAS(5)	SETUP	701
WRITE(6,6011) TSTAR, TEND, VAS(1), VAS(2), VAS(3), VAS(4), VAS(5)	SETUP	702
WRITE(6,7060)	SETUP	703
C	SETUP	704
CARD B2	SETUP	705
READ(5,5011) TFIX, FIXV, FIXTTD, FIXL, DEEPL	SETUP	706
WRITE(6,6011) TFIX, FIXV, FIXTTD, FIXL, DEEPL	SETUP	707
WRITE(6,7061)	SETUP	708
C	SETUP	709
CARD C1	SETUP	710
READ(5,5003) (TA(I),I=1,8) , (TPER(I),I=1,8)	SETUP	711
WRITE(6,6003) (TA(I),I=1,8) , (TPER(I),I=1,8)	SETUP	712
WRITE(6,7090)	SETUP	713
C	SETUP	714
CARD C2	SETUP	715
READ(5,5003) (TA(I),I=9,16) , (TPER(I),I=9,16)	SETUP	716
WRITE(6,6003) (TA(I),I=9,16) , (TPER(I),I=9,16)	SETUP	717
WRITE(6,7120)	SETUP	718
C	SETUP	719
CARD C1A	SETUP	720
READ(5,5003) (TAWB(I),I=1,8) , (BPLIM(I),I=1,8)	SETUP	721
WRITE(6,6003) (TAWB(I),I=1,8) , (BPLIM(I),I=1,8)	SETUP	722
WRITE(6,7130)	SETUP	723
C	SETUP	724
CARD C2A	SETUP	725
READ(5,5003) (TAWB(I),I=9,16) , (BPLIM(I),I=9,16)	SETUP	726
WRITE(6,6003) (TAWB(I),I=9,16) , (BPLIM(I),I=9,16)	SETUP	727
WRITE(6,7140)	SETUP	728
C	SETUP	729
CARD D1	SETUP	730
READ(5,5002) PSIZE, TEFF, CAPF, FCR, PER, CCM, ELEV, ROOFL	SETUP	731
WRITE(6,6002) PSIZE, TEFF, CAPF, FCR, PER, CCM, ELEV, ROOFL	SETUP	732
WRITE(6,7150)	SETUP	733
C	SETUP	734
CARD E1	SETUP	735
READ(5,5002) FCOS, PWCOS, PLANC, COSTL, CSSPKW, CAPCHG, HPCST	SETUP	736
S, CTURB	SETUP	737

WRITE(6,6002) FCOS, PWCOS, PLANC, COSTL, CSSPKW, CAPCHG, HPCST	SETUP	738
\$, CTURB	SETUP	739
WRITE(6,7180)	SETUP	740
C	SETUP	741
CARD E2	SETUP	742
READ(5,5002) POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC	SETUP	743
\$,POHSCL	SETUP	744
WRITE(6,6002) POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC	SETUP	745
\$,POHSCL	SETUP	746
WRITE(6,7185)	SETUP	747
C	SETUP	748
CARD F1	SETUP	749
READ(5,5004) RBP, (TPO(I),I=1,4)	SETUP	750
WRITE(6,6004) RBP, (TPO(I),I=1,4)	SETUP	751
WRITE(6,7210)	SETUP	752
C	SETUP	753
CARD G1	SETUP	754
READ(5,5002) EFFF	SETUP	755
WRITE(6,6002) EFFF	SETUP	756
WRITE(6,7240)	SETUP	757
C	SETUP	758
CARD H1	SETUP	759
READ(5,5002) VELREC,XDEPA,TLIM,TOWMIN,TOWMAX,PFACT	SETUP	760
WRITE(6,6002) VELREC,XDEPA,TLIM,TOWMIN,TOWMAX,PFACT	SETUP	761
WRITE(6,7270)	SETUP	762
ITMIN = TOWMIN + 1.E-30	SETUP	763
IF (ITMIN .LT. 1) ITMIN = 1	SETUP	764
ITMAX = TOWMAX + 1.E-30	SETUP	765
IF (ITMAX .LT. 1) ITMAX = 9999	SETUP	766
IF (ITMAX .LT. ITMIN) STOP"TOWMAX IS LESS THAN TOWMIN"	SETUP	767
IF(TLIM.LE,0.0) TLIM = 180.	SETUP	768
C	SETUP	769
CARD H2	SETUP	770
READ(5,5012) GBEFF	SETUP	771
WRITE(6,6012) GBEFF	SETUP	772
WRITE(6,7280)	SETUP	773
C	SETUP	774
CARD I1	SETUP	775
READ(5,5002) CPM, WPL, CLUVR, CHAILS, UCS, UWS, CVM, WFV	SETUP	776
WRITE(6,6002) CPM, WPL, CLUVR, CHAILS, UCS, UWS, CVM, WFV	SETUP	777
WRITE(6,7300)	SETUP	778
C	SETUP	779
CARD J1	SETUP	780
READ(5,5005) HXNP, WB, NTUB, SS, ANGLE	SETUP	781
WRITE(6,6005) HXNP, WB, NTUB, SS, ANGLE	SETUP	782
WRITE(6,7330)	SETUP	783
C	SETUP	784
CARD J2	SETUP	785
READ(5,5002) DESVEL, REDUCE, QREDUCE, DIST	SETUP	786
WRITE(6,6002) DESVEL, REDUCE, QREDUCE, DIST	SETUP	787
WRITE(6,7335)	SETUP	788
C	SETUP	789
CARD J3	SETUP	790
READ(5,5002) DESVELV,REDUCV,QREDUCV,DESVELD,FACTORD	SETUP	791
WRITE(6,6002) DESVELV,REDUCV,QREDUCV,DESVELD,FACTORD	SETUP	792
WRITE(6,7340)	SETUP	793
C	SETUP	794

SUBROUTINE SETUP

74/74

OPT=1

FTN 4,5+414

06/05/78 07.59.59

CARD J4	READ(5,5002) WATCONA,WATCOST,FACTOR,HCD,BETAF,BETAI,RHOUT	SETUP	795
	WRITE(6,6002) WATCONA,WATCOST,FACTOR,HCD,BETAF,BETAI,RHOUT	SETUP	796
	WRITE(6,7345)	SETUP	797
C		SETUP	798
CARD K1		SETUP	799
	READ(5,5002) XW,XD,XDG,SF,DFIN,THFIN	SETUP	800
	WRITE(6,6002) XW,XD,XDG,SF,DFIN,THFIN	SETUP	801
	WRITE(6,7360)	SETUP	802
C		SETUP	803
CARD L1		SETUP	804
	READ(5,5006) ODL, DI, GAGLIN, TUBMAT, XTUBMA, CONL	SETUP	805
	WRITE(6,6006) ODL, DI, GAGLIN, TUBMAT, XTUBMA, CONL	SETUP	806
	WRITE(6,7390)	SETUP	807
C		SETUP	808
CARD M1		SETUP	809
	READ(5,5007) FINTYP, XFINTY, FINMAT, CONF	SETUP	810
	WRITE(6,6007) FINTYP, XFINTY, FINMAT, CONF	SETUP	811
	WRITE(6,7420)	SETUP	812
	IF(FINTYP.EQ."NO LINER ".AND.FINMAT.NE."ALUMINUM ")	SETUP	813
	\$ STOP "ILLEGAL FIN MATERIAL FOR UNLINED TUBING"	SETUP	814
C		SETUP	815
CARD N1		SETUP	816
	READ(5,5002) CFB, COATC, ZINCC, CASTC, EPREPC	SETUP	817
	WRITE(6,6002) CFB, COATC, ZINCC, CASTC, EPREPC	SETUP	818
	WRITE(6,7450)	SETUP	819
C		SETUP	820
CARD P1		SETUP	821
	READ(5,5010) HEDTYP,XHEDTY,HEDMAT,TW,SEGL,NSIDES	SETUP	822
	WRITE(6,6010) HEDTYP,XHEDTY,HEDMAT,TW,SEGL,NSIDES	SETUP	823
	WRITE(6,7480)	SETUP	824
C		SETUP	825
CARD Q1		SETUP	826
	READ(5,5002) CRJ, CWJ, CHH, CN, CMW, CST, CBJ	SETUP	827
	WRITE(6,6002) CRJ, CWJ, CHH, CN, CMW, CST, CBJ	SETUP	828
	WRITE(6,7510)	SETUP	829
C		SETUP	830
CARD Q2		SETUP	831
	IF(FINTYP.NE."PLATE ") GO TO 200	SETUP	832
	READ(5,5002) CSH, CSHP, TSP	SETUP	833
	WRITE(6,6002) CSH, CSHP, TSP	SETUP	834
	WRITE(6,7490)	SETUP	835
	200 CONTINUE	SETUP	836
C		SETUP	837
CARD R1		SETUP	838
	READ(5,5009) XNS, VELN, ODC, GA, TKCT, TTD2QE, CONMAT, CONMA2	SETUP	839
	WRITE(6,6009) XNS, VELN, ODC, GA, TKCT, TTD2QE, CONMAT, CONMA2	SETUP	840
	WRITE(6,7540)	SETUP	841
C		SETUP	842
CARD R2		SETUP	843
	READ(5,5002) XNP, TLA, XQUALY	SETUP	844
	WRITE(6,6002) XNP, TLA, XQUALY	SETUP	845
	WRITE(6,7550)	SETUP	846
C		SETUP	847
CARD R3		SETUP	848
	READ(5,5008) LINOR	SETUP	849
	WRITE(6,6008) LINOR	SETUP	850
		SETUP	851

WRITE(6,7555)	SETUP	852
C	SETUP	853
CARD S1	SETUP	854
READ(5,5008) LFB, LFE, MXEXT	SETUP	855
WRITE(6,6008) LFB, LFE, MXEXT	SETUP	856
WRITE(6,7570)	SETUP	857
IF (MXEXT .LT. 1) MXEXT = 10	SETUP	858
IF (LFE .LT. LFB) STOP "LFB EXCEEDS LFE ON INPUT CARD"	SETUP	859
C	SETUP	860
CARD T1	SETUP	861
READ(5,5014) FFHX,FSHOT,FDELUG	SETUP	862
WRITE(6,6014) FFHX,FSHOT,FDELUG	SETUP	863
WRITE(6,75A0)	SETUP	864
IF(FFHX.NE."PFR" .AND. FFHX.NE."FRICHO")	SETUP	865
IF(AND. FFHX.NE."HOTERV")	SETUP	866
STOP "*** UNRECOGNIZED FFHX ON CARD T1"	SETUP	867
C	SETUP	868
EHR = 3414.43 / TEFF	SETUP	869
IF(FIXL.GT.0.0) FXTLNG=.TRUE.	SETUP	870
IF(FIXV.GT.0.00) FXTVAR=.TRUE.	SETUP	871
IF(FIXTTD.GT.0.00) FXTTID=.TRUE.	SETUP	872
IF(TFIX.GT.0.00) FXTMP=.TRUE.	SETUP	873
DO 45 J=1,16	SETUP	874
IF(TPER(J).LT.1.E-20) GOTO 46	SETUP	875
NTA=J	SETUP	876
45 CONTINUE	SETUP	877
46 CONTINUE	SETUP	878
SMPER=0.0	SETUP	879
DO 20 I=1,16	SETUP	880
20 SMPER=SMPER + TPER(I)	SETUP	881
IF(ABS(SMPER-1.0).LT.1.E-10) GOTO 22	SETUP	882
WRITE(6,89)	SETUP	883
STOP	SETUP	884
22 CONTINUE	SETUP	885
C	SETUP	886
C	SETUP	887
C DETERMINE POSITION OF TUBE O.D. AND GAGE IN RESPECTIVE ARRAYS	SETUP	888
C	SETUP	889
DO 99 I=1,6	SETUP	890
LD = I	SETUP	891
IF(ABS(ODC-TOD(LD)).LT..001) GOTO 1011	SETUP	892
99 CONTINUE	SETUP	893
STOP "ILLEGAL VALUE FOR CONDENSER TUBE OD"	SETUP	894
C	SETUP	895
1011 DO 98 I= 1,7	SETUP	896
KGA = I	SETUP	897
IF(ABS(GA-TGA(KGA)).LT..001) GOTO 100	SETUP	898
98 CONTINUE	SETUP	899
STOP "ILLEGAL VALUE FOR CONDENSER TUBE GAGE"	SETUP	900
C	SETUP	901
100 CONTINUE	SETUP	902
WATCONA = WATCONA*2719015.	SETUP	903
ANG(1) = ANGLE*3.141592654/180.	SETUP	904
ANG(2) = SIN(ANG(1))	SETUP	905
ANG(3) = COS(ANG(1))	SETUP	906
IF(ABS(ANG(3)).LT..0001) ANG(3) = 0.0	SETUP	907
C	SETUP	908

SUBROUTINE SETUP	74/74	OPT=1	FTN 4,5+414	06/05/78	07.59.59
C	CALL COSTEX	TO EVALUATE ODR		SETUP	909
C				SETUP	910
	CALL COSTEX	(DUMX1,DUMX2)		SETUP	911
C				SETUP	912
	RETURN			SETUP	913
	END			SETUP	914

```

SUBROUTINE SHOT(L)
C
C THIS ROUTINE ESTABLISHES A STARTING PLACE FOR THE MINIMIZING PRO-
C CEDURE BY SAMPLING POINTS AROUND THE STARTING VALUES PROVIDED.
C
DIMENSION T(3), CWAR(4), RANG(5), AFRO(5), WLRA(4), VAM(5)
LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTID,FXTLNG
COMMON
$ AFTR, ALPHA, ANG(3)
$ ,BPLIM(16)
$ ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF
$ ,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM
$ ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF
$ ,EFFP, EFS
$ ,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG
$ ,FIXV,FXTTID,FXTVAR,FXTTID,FXTLNG
$ ,GREFF
$ ,HXNP,HPCST,HCD
$ ,ITMAX, ITMIN
$ ,JCONS
$ ,KCONV, KALEXT
$ ,MXEXT
$ ,NTA,NSIDES,NBUNHI
COMMON
$ ODR
$ ,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL
$ ,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL
$ ,RRP,REDUCE, REDUCV, ROOFL, RHOUT
$ ,QREJ, QREDUCE, QREDUCV
$ ,SIGMAG, SAAF, SEGL
$ ,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TPIX
$ ,TCD, TW
$ ,UCS, UWS
$ ,WFF, WATCONA, WATCOST
$ ,VAS(5)
$ ,XDEPA, XW, XD
COMMON /LACALL/ SRN
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,
$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,
$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,
$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPRP, SW4, SW3,
$ SPC,PTOTAL,PLANC3,SAFRON, AIR, YFP, SPCD,PSIZ13, WT2,
$ BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS
$ , CLYC, CFC, CPCC, FITCO, CSC,CEPREP,DELP1P, AST,OLDCST
$ ,CAPCST, XNFAN,BLDANG, CPLEN, DPFEL, WHX, WTTUB, ADIA, ABLN
$ , WTHDR, WTRFM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU
$ , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP
$ , ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST
$ , CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD
$ ,SQRJ,SQRJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCST
$ ,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST
$ ,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)
$ ,WBB,NTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5
COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,
$ QIN1, CLAN1, REAIR1, Z1,HRFA25, W41, U1, DEPW1, PPOW1,
$ FPOW1, DEFC1, WIDTH1, ELEN1, VAIR1, VWAT1, HI1, HO1, T41,

```

```

SHOT 2
SHOT 3
SHOT 4
SHOT 5
SHOT 6
SHOT 7
BIGCOM 2
BIGCOM 3
BIGCOM 4
BIGCOM 5
BIGCOM 6
BIGCOM 7
BIGCOM 8
BIGCOM 9
BIGCOM 10
BIGCOM 11
BIGCOM 12
BIGCOM 13
BIGCOM 14
BIGCOM 15
BIGCOM 16
BIGCOM 17
BIGCOM 18
BIGCOM 19
BIGCOM 20
BIGCOM 21
BIGCOM 22
BIGCOM 23
BIGCOM 24
BIGCOM 25
BIGCOM 26
BIGCOM 27
BIGCOM 28
BIGCOM 29
BIGCOM 30
BIGCOM 31
SHOT 9
SUPPLY 2
SUPPLY 3
SUPPLY 4
SUPPLY 5
SUPPLY 6
SUPPLY 7
SUPPLY 8
SUPPLY 9
SUPPLY 10
SUPPLY 11
SUPPLY 12
SUPPLY 13
SUPPLY 14
SUPPLY 15
SUPPLY 16
SUPPLY 17
SUPPLY 18
SINK 2
SINK 3
SINK 4

```


SUBROUTINE SHOT

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

```

$ REWAL, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPBP, SW41, SW31, SINK 5
$ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN, SINK 6
$ BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1 SINK 7
$ , TL41, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CAL, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1,FITC1, CSC1,CEPRE1,DEPI1, AST1,OLDCS1 SINK 9
$ ,CAPCS1,XNFAN1,BLDAN1,CPLEN1,DPFEL1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTR1,STRUC1,CFMPF1, HRPF1,TOTCF1, TP1,EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTAP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMT01, CTOWD1 SINK 14
$ ,SQRJ1,SQRJ51,ATUBC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPCTD1 SINK 15
$ ,CSTHS1, CYLRN1, CFANE1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ ,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16) SINK 17
$ ,WBR1,HTOW1,NTOWDE1,CSTIF1,CSJ1,CVF1,CDP1,W51 SINK 18
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD,PLANC1,CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANCT1 SCALER 3
COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY SHOT 13
9500 FORMAT('0IN SHOT AT CHECKPOINT A; VAR(4)=",1PE12.4,6X,"VAM(4)=", SHOT 14
$E12.4,6X,"DAFRO=",E12.4) SHOT 15
9501 FORMAT('0IN SHOT AT CHECKPOINT B. I=",I1,6X,"DAFRO=",1PE12.4,6X, SHOT 16
$ "VAR(4)=",E12.4,6X,"AFRO(I)=",E12.4) SHOT 17
9502 FORMAT('0IN SHOT AT CHECKPOINT C. I=",I1,6X,"VAR(4)=",1PE12.4, SHOT 18
$ 6X,"FAF=",E12.4) SHOT 19
9503 FORMAT('0IN SHOT AFRO WILL BE BAD BECAUSE VAS(4)=",1PE12.4) SHOT 20
IDB=0 SHOT 21
IF(L.EQ,2) GO TO 31 SHOT 22
DO 1 IS=1,5 SHOT 23
1 VAM(IS)=0.0 SHOT 24
TCOS1=0. SHOT 25
TCOS2=0. SHOT 26
ITT = 3 SHOT 27
IF(FXTEMP) ITT = 1 SHOT 28
DO 20 I = 1, ITT SHOT 29
T(I)=VAS(1)+(I-2)*5. SHOT 30
IF(FXTEMP) T(I) = TFIX SHOT 31
IF (T(I) .GT. 180.) T(I) = 180. SHOT 32
20 IF (T(I) .LE. 0.0) T(I) = 10.0 SHOT 33
IF(.NOT. FXTTDD) GO TO 200 SHOT 34
LC = 1 SHOT 35
CWAR(1) = FIXTTD SHOT 36
GO TO 210 SHOT 37
200 CONTINUE SHOT 38
DO 21 I=1,4 SHOT 39
CWAR(I)=VAS(3)+(I-2)*2. SHOT 40
21 IF(CWAR(I).LE.0.) CWAR(I)=.5 SHOT 41
LC = 4 SHOT 42
210 CONTINUE SHOT 43
IF(DEEPL.GT.0.00) GO TO 220 SHOT 44
LW = 4 SHOT 45
DO 22 I = 1, LW SHOT 46
WLRA(I) = VAS(5) + (I - 2) SHOT 47
22 IF(WLRA(I) .LE. 0.) WLRA(I) = 1.0 SHOT 48
GO TO 221 SHOT 49
220 LW = 1 SHOT 50
WLRA(1) = DEEPL SHOT 51
221 CONTINUE SHOT 52
IF(.NOT. FXTLNG) GO TO 23 SHOT 53

```

SUBROUTINE SHOT

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

LA = 1	SHOT	54
AFRO(1) = FIXL	SHOT	55
GO TO 25	SHOT	56
23 LA = 5	SHOT	57
DO 24 I = 1, LA	SHOT	58
AFRO(I) = VAS(4) + (I - 3)*10.0	SHOT	59
24 IF (AFRO(I) .LE. 10.0) AFRO(I) = 10.0	SHOT	60
25 CONTINUE	SHOT	61
LR = 5	SHOT	62
DO 26 I = 1, LR	SHOT	63
RANG(I) = VAS(2) + (I - 3)*2.00	SHOT	64
26 IF (RANG(I) .LE. 0.0) RANG(I) = 1.0	SHOT	65
IF (.NOT. FXTVAR) GO TO 260	SHOT	66
LP = 1	SHOT	67
RANG(1) = FIXV	SHOT	68
260 CONTINUE	SHOT	69
DT1=1.	SHOT	70
DCWAR=1.	SHOT	71
DAFRO=1.	SHOT	72
DWLRA=1.	SHOT	73
GO TO 52	SHOT	74
31 DT1=VAR(1)=VAM(1)	SHOT	75
DCWAR=VAR(3)=VAM(3)	SHOT	76
DAFRO=VAR(4)=VAM(4)	SHOT	77
IF (DAFRO.LE.0.0.AND.IDB.NE.0) WRITE(6,9500) VAR(4),VAM(4),DAFRO	SHOT	78
DWLRA=VAR(5)=VAM(5)	SHOT	79
IF (DT1.EQ.0.0.OR.DT1.EQ.VAR(1)) GO TO 33	SHOT	80
DO 32 I=1,3	SHOT	81
T(I) = VAR(1) - (I-1) * DT1/2.	SHOT	82
IF (FXTMP) T(I) = TFIX	SHOT	83
32 CONTINUE	SHOT	84
GO TO 35	SHOT	85
33 DO 34 I=1,3	SHOT	86
T(I)=VAR(1)+(I-2)*2.	SHOT	87
IF (FXTMP) T(I) = TFIX	SHOT	88
34 IF (T(I).GE.170.) T(I)=170.	SHOT	89
35 CONTINUE	SHOT	90
IF (FXTMP) ITT = 1	SHOT	91
IF (DCWAR .EQ. 0.00 .OR. DCWAR .EQ. VAR(3)) GO TO 37	SHOT	92
DO 36 I=1,4	SHOT	93
CWAR(I)=VAR(3) - (I-1)*DCWAR/3.	SHOT	94
IF (CWAR(I).LE.0.0) CWAR(I)=0.25	SHOT	95
36 CONTINUE	SHOT	96
LC = 4	SHOT	97
GO TO 39	SHOT	98
37 DO 38 I=1,3	SHOT	99
CWAR(I)=VAR(3) + (I-2)	SHOT	100
IF (CWAR(I).LE.0.0) CWAR(I)=0.25	SHOT	101
38 CONTINUE	SHOT	102
LC=3	SHOT	103
39 CONTINUE	SHOT	104
IF (.NOT. FXTTID) GO TO 390	SHOT	105
LC = 1	SHOT	106
CWAR(1) = FIXTID	SHOT	107
390 CONTINUE	SHOT	108
IF (.NOT. FXTLNG) GO TO 47	SHOT	109
LA = 1	SHOT	110

SUBROUTINE SHOT

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

AFRO(1) = FIXL	SHOT	111
GO TO 43	SHOT	112
47 LA = 5	SHOT	113
IF(DAFRO.EQ. 0.0 .OR. DAFRO.EQ. VAR(4)) GO TO 41	SHOT	114
DO 40 I = 1, LA	SHOT	115
AFRO(I) = VAR(4) - (I - 3)*DAFRO/2.0	SHOT	116
40 IF(AFRO(I) .LE. 0.0) AFRO(I) = 10.0	SHOT	117
IF(IDB.EQ.0) GOTO 43	SHOT	118
DO 8040 I=1,3	SHOT	119
IF(AFRO(I).LE.0.0) WRITE(6,9501) I,DAFRO,VAR(4),AFRO(I)	SHOT	120
8040 CONTINUE	SHOT	121
GO TO 43	SHOT	122
41 FAF = 5.0	SHOT	123
TC=ABS(FAF-VAR(4))	SHOT	124
IF(TC .LT. 20.0) FAF = FAF/2.0	SHOT	125
DO 42 I = 1, LA	SHOT	126
AFRO(I) = VAR(4) + (I - 3)*FAF	SHOT	127
IF(AFRO(I) .LE. 0.0) AFRO(I) = 10.0*I	SHOT	128
42 CONTINUE	SHOT	129
IF(IDR.EQ.0) GOTO 43	SHOT	130
DO 8042 I=1,3	SHOT	131
IF(AFRO(I).LE.0.0) WRITE(6,9502) I,VAR(4),FAF	SHOT	132
8042 CONTINUE	SHOT	133
43 IF(DWLRA.EQ.0.0.OR.DWLRA.EQ.VAR(5)) GO TO 45	SHOT	134
DO 44 I=1.4	SHOT	135
WLRA(I) = VAR(5) - (I - 1)*DWLRA	SHOT	136
44 IF(WLRA(I) .LE. 0.) WLRA(I) = 1.0	SHOT	137
GO TO 51	SHOT	138
45 IF(DEEPL.GT.0.00) GO TO 460	SHOT	139
LW = 3	SHOT	140
DO 46 I = 1, LW	SHOT	141
WLRA(I) = VAR(5) + (I - 2)*1.0	SHOT	142
46 IF(WLRA(I) .LE. 0.) WLRA(I) = 1.0	SHOT	143
GO TO 51	SHOT	144
460 LW = 1	SHOT	145
WLRA(1) = DEEPL	SHOT	146
51 LR = 5	SHOT	147
DO 48 I = 1, LR	SHOT	148
RANG(I) = VAS(2) + (I - 3)*0.50	SHOT	149
48 IF(RANG(I) .LE. 0.00) RANG(I) = 1.0	SHOT	150
IF(.NOT. FXTVAR) GO TO 480	SHOT	151
LR = 1	SHOT	152
RANG(1) = FIXV	SHOT	153
480 CONTINUE	SHOT	154
52 DO 150 IT = 1, ITT	SHOT	155
IF(FXTMP.AND.IT.GT.1) GO TO 150	SHOT	156
DO 151 IC = 1,LC	SHOT	157
IF(CWAR(IC).EQ.0.0) WRITE(6,9504) IC	SHOT	158
9504 FORMAT("0IN SHOT, DIVISION BY ZERO, CWAR(",I2,")=0.0")	SHOT	159
DO 152 IR = 1,LR	SHOT	160
DO 153 IW = 1,LW	SHOT	161
DO 154 IA = 1,LA	SHOT	162
KCALC=1	SHOT	163
IF(IR.GT.1.OR.IC.GT.1) KCALC=2	SHOT	164
IF(IA.GT.1) KCALC=4	SHOT	165
IF(IW.GT.1) KCALC=5	SHOT	166
SPN="/SHOT=1/ "	SHOT	167

SUBROUTINE SHOT

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

CALL CALC(T(IT),RANG(IR),CWAR(IC),AFRO(IA),WLRA(IW),KCALC)	SHOT	168
IF(KCONV,EQ.1) GO TO 154	SHOT	169
IF(DELPA,LE,XDEPA) GO TO 16	SHOT	170
IF(TCOS1,EQ.0.) GO TO 14	SHOT	171
IF(TCOS,GE,TCOS1) GO TO 16	SHOT	172
IF(TCOS2,EQ.0.) GO TO 18	SHOT	173
IF(TCOS1,GE,TCOS2) GO TO 14	SHOT	174
18 TCOS2=TCOS1	SHOT	175
DO 19 II=1,5	SHOT	176
19 VAM(II)=VAR(II)	SHOT	177
14 TCOS1=TCOS	SHOT	178
VAR(1)=T(IT)	SHOT	179
VAR(2)=RANG(IR)	SHOT	180
VAR(3)=CWAR(IC)	SHOT	181
VAR(4)=AFRO(IA)	SHOT	182
VAR(5)=WLRA(IW)	SHOT	183
CAF=AFRO(1)*.1	SHOT	184
GO TO 154	SHOT	185
16 IF(L,EQ,2) GO TO 154	SHOT	186
IF(TCOS2,EQ.0.) GO TO 17	SHOT	187
IF(TCOS,GE,TCOS2) GO TO 154	SHOT	188
17 TCOS2=TCOS	SHOT	189
VAM(1)=T(IT)	SHOT	190
VAM(3)=CWAR(IC)	SHOT	191
VAM(4)=AFRO(IA)	SHOT	192
VAM(5)=WLRA(IW)	SHOT	193
154 CONTINUE	SHOT	194
153 CONTINUE	SHOT	195
152 CONTINUE	SHOT	196
151 CONTINUE	SHOT	197
150 CONTINUE	SHOT	198
IF(IDB,EQ.0) RETURN	SHOT	199
WRITE(6,553)TCOS1,VAR(1),VAR(2),VAR(3),VAR(4),VAR(5)	SHOT	200
553 FORMAT(" TCOS1="E12.5," T11="F4.0," RANG1="F7.4," CWAR1="F7.3,	SHOT	201
1" AFRO1="E10.3," WLRA1="F4.0)	SHOT	202
RETURN	SHOT	203
END	SHOT	204

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

SUBROUTINE SIGBAW(TA,RIA,ATM,HD,BETAF,AB,AF,AI,AW,HI,BETAI,
STHW,RKW,TI,RII,SIGMA,SIG,PATH,KCONV,NTREST)

SUBROUTINE SIGBAW CALCULATES THE OVERALL MASS TRANSFER
COEFFICIENT BETWEEN THE TUBESIDE FLUID AND THE AIR, THIS
MASS TRANSFER COEFFICIENT USES ENTHALPY AS THE DRIVING FORCE
(ENTHALPY DIFFERENCE IS ANALOGOUS TO TEMPERATURE DIFFERENCE).

A NOMENCLATURE OF SOME OF THE MORE FREQUENTLY USED
TERMS FOLLOWS.

AB	- AREA OF THE TUBES BETWEEN THE FINS, SQ. FT.
AF	- AREA OF THE FINS, SQ. FT.
AHS	- ABSOLUTE HUMIDITY OF SATURATED AIR AT TEMPERATURE TS, BTU/LB OF DRY AIR
AI	- TUBESIDE AREA, SQ. FT.
ATM	- BAROMETRIC PRESSURE, ATMOSPHERES
AW	- AVERAGE TUBE WALL AREA, SQ. FT.
BETAF	- AIR SIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
BETAI	- TUBESIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
CSS	- HEAT CAPACITY OF SATURATED AIR AT THE DELUGEATE-AIR INTERFACE
DTDR	- QUANTITY FOR TRANSFORMING THE TUBESIDE TO DELUGEATE HEAT TRANSFER COEFFICIENT (BASED ON TEMPERATURE) TO THE TUBESIDE TO DELUGEATE COEFFICIENT (BASED ON ENTHALPY) EQUAL TO $(TI - TS) / (RII - RIS)$, DEG. F-LB MASS/BTU
HD	- METAL TO DELUGEATE HEAT TRANSFER COEFFICIENT, BTU/HR-SQ.FT.-F
HI	- TUBESIDE HEAT TRANSFER COEFFICIENT, BTU/HR-SQ.FT.-F
PS	- PARTIAL PRESSURE OF WATER (SATURATED CONDITIONS) AT TEMPERATURE TS, IN. HG.
RHS	- RELATIVE HUMIDITY AT THE DELUGEATE-AIR INTERFACE, TAKEN TO BE 1.0 (SATURATED) DIMENSIONLESS FRAC
RIA	- ENTHALPY OF THE AIR (BULK CONDITIONS), BTU/LB OF DRY AIR
RII	- ENTHALPY OF SATURATED AIR AT THE TUBESIDE TEMPERATURE, BTU/LB OF DRY AIR
RIMAX	- ENTHALPY OF SATURATED AIR AT TMAX, BTU/LB OF DRY AIR
RIMIN	- ENTHALPY OF SATURATED AIR AT TMIN, BTU/LB OF DRY AIR
RIS	- ENTHALPY OF SATURATED AIR AT THE TEMPERATURE OF THE DELUGEATE-AIR INTERFACE, TS, BTU/LB OF DRY AIR
RKW	- THERMAL CONDUCTIVITY OF THE TUBE WALL, BTU/HR-SQ.FT.-F/FT
SIG	- TUBESIDE TO AIR MASS TRANSFER COEFFICIENT, LB OF DRY AIR/SQ.FT.-HR.
SIGMA	- DELUGEATE TO AIR MASS TRANSFER COEFFICIENT, LB OF DRY AIR/SQ.FT.-HR.
TA	- BULK TEMPERATURE OF AIR, DEG. F.
TAIN	- TEMPERATURE OF THE AIR ENTERING THE HEAT

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

```

C      EXCHANGER, F                                SIGBAW  59
C      TAL - TEMPERATURE OF THE AIR LEAVING THE HEAT EXCHANGER, F    SIGBAW  60
C      TEST - ESTIMATE OF TEMPERATURE USED AS AN A FIRST              SIGBAW  61
C      APPROXIMATION BY SUBROUTINE TCAIC, DEG. F                      SIGBAW  62
C      THW - TUBE WALL THICKNESS, FT.                                SIGBAW  63
C      TI - TUBESIDE TEMPERATURE, DEG. F                            SIGBAW  64
C      TMAX - MAXIMUM TEMPERATURE ALLOWED DUE TO CONSTRAINTS          SIGBAW  65
C      UPON THE ANALOGY UPON WHICH THE HEAT TRANSFER                  SIGBAW  66
C      CALCULATION IS BASED, F (SEE SUBROUTINE LIMIT)                 SIGBAW  67
C      TMIN - MINIMUM TEMPERATURE ALLOWED TO PREVENT                  SIGBAW  68
C      POSSIBLE INSTABILITIES WITHIN THE                             SIGBAW  69
C      SUBROUTINES, F                                                SIGBAW  70
C      TS - TEMPERATURE OF THE DELUGEATE-AIR INTERFACE, DEG          SIGBAW  71
C      UDPS - OVERALL MASS TRANSFER COEFFICIENT BETWEEN THE          SIGBAW  72
C      TUBESIDE FLUID AND THE DELUGEATE-AIR INTERFACE,               SIGBAW  73
C      LB OF DRY AIR/SQ.FT.-HR.                                       SIGBAW  74
C      UPS - OVERALL (TEMPERATURE DRIVING FORCE) HEAT                 SIGBAW  75
C      TRANSFER COEFFICIENT BETWEEN THE TUBESIDE                     SIGBAW  76
C      FLUID AND THE DELUGEATE-AIR INTERFACE,                         SIGBAW  77
C      BTU/SQ.FT.-HR.-DEG. F.                                         SIGBAW  78
C                                                                    SIGBAW  79
C                                                                    SIGBAW  80
C                                                                    SIGBAW  81
C      LOGICAL PATH, FRST3                                           SIGBAW  82
C      COMMON /WETDRY/ NCYCLE,TMAX,RIMAX,TMIN,RIMIN                  SIGBAW  83
C      COMMON/COUNT/NSLOPE,FRST3                                     SIGBAW  84
C      COMMON/RPRT4/R4(672),RR(3)                                    SIGBAW  85
C      DATA MAX/20/                                                 SIGBAW  86
C                                                                    SIGBAW  87
C      FP(RH,T) = RH*29.92*(0.000203*((T - 32.)/1.8)**2             SIGBAW  88
C      + 0.0118*(T - 32.)/1.8 + 1.095)                               SIGBAW  89
C      + *EXP( - 0.000426*((T - 32.)/1.8)**2)                       SIGBAW  90
C      + 0.0828*(T - 32.)/1.8 + 5.163)                               SIGBAW  91
C      FP(RH,T)=RH*EXP(17.168-9240./(T+460.))                         SIGBAW  92
C      FAH(P,ATM)=P*18.02/((ATM*29.92-P)*28.97)                     SIGBAW  93
C      FCS(AH)=.24+.45*AH                                             SIGBAW  94
C      FRI(CS,T,AH)=CS*T*1094.*AH                                     SIGBAW  95
C                                                                    SIGBAW  96
C      THE QUANTITIES INPUTED TO SIGBAW ARE PRINTED OUT.            SIGBAW  97
C                                                                    SIGBAW  98
C      NDBUG5 = 0                                                     SIGBAW  99
C      NDBUG51 = 0                                                    SIGBAW 100
C      IF(NDBUG5 .EQ. 1) WRITE(6,75)                                  SIGBAW 101
75  FORMAT(1H0,"TA,RIA,ATM,HD,BETAF,AB,AF,AI",/,1X,                 SIGBAW 102
C      $"AW,HI,BETA1,THW,RKW,TI,RII,SIGMA,SIG,NTREST",/)            SIGBAW 103
C      IF(NDBUG5 .EQ. 1) WRITE(6,100)TA,RIA,ATM,HD,BETAF,AB,AF,AI,AW, SIGBAW 104
C      +HI,BETA1,THW,RKW,TI,RII,SIGMA,SIG,NTREST                    SIGBAW 105
100  FORMAT(1X,"FROM SIGBAW",8E12.5/1X,8E12.5,10X,E12.5,I5,///)    SIGBAW 106
C      N=0                                                            SIGBAW 107
C                                                                    SIGBAW 108
C      AN INITIAL ESTIMATE OF TS IS MADE WHEN NTREST IS NOT EQUAL   SIGBAW 109
C      TO ONE AND PATH IS TRUE                                       SIGBAW 110
C                                                                    SIGBAW 111
C      IF(NTREST .EQ. 0) TAIN = TA                                    SIGBAW 112
C      IF(.NOT. PATH .AND. NTREST .EQ. 1) GO TO 1200                 SIGBAW 113
C      IF(NSLOPE .LE. 2) GO TO 1010                                   SIGBAW 114
C      IF(NTREST .EQ. 1) GO TO 1005                                   SIGBAW 115

```

DEL = TAIN - TAIN2	SIGBAW	116
DIVID = DEL/(TAIN2 - TAIN1)	SIGBAW	117
SLTS = (TS02 - TS01)*DIVID	SIGBAW	118
TS = TS02 + SLTS	SIGBAW	119
GO TO 1200	SIGBAW	120
1005 SLTS = (TS12 - TS11)*DIVID	SIGBAW	121
TS = TS12 + SLTS	SIGBAW	122
GO TO 1200	SIGBAW	123
1010 IF(NSLOPE .LE. 1) GO TO 1030	SIGBAW	124
IF(NTREST .EQ. 1) GO TO 1020	SIGBAW	125
TS = TS02	SIGBAW	126
GO TO 1200	SIGBAW	127
1020 TS = TS12	SIGBAW	128
GO TO 1200	SIGBAW	129
1030 TS = (TA + TI)/2.0	SIGBAW	130
1200 RHS = 1.0	SIGBAW	131
IF(NDEBUG.EQ.1)	SIGBAW	132
1WRITE(6,380) DEL,DIVID,SLTS,TS,TA,TAIN,TAIN1,TAIN2,TS01,TS02,TS11,	SIGBAW	133
+TS12,NSLOPE,PATH	SIGBAW	134
380 FORMAT(5X,"DEL,DIVID,SLTS,TS,TA,TAIN,TAIN1,TAIN2,TS01,TS02,TS11,TS	SIGBAW	135
+12,NSLOPE,PATH",/1P8E14.5,/1P5E14.5,L5/)	SIGBAW	136
C	SIGBAW	137
10 CONTINUE	SIGBAW	138
N=N+1	SIGBAW	139
C	SIGBAW	140
C APPROPRIATE WARNINGS ARE MADE AND THE PROGRAM IS STOPPED IF	SIGBAW	141
C THE MINIMUM OR MAXIMUM TEMPERATURE LIMITS ARE EXCEEDED.	SIGBAW	142
C	SIGBAW	143
IF(TS.LT.TMIN)WRITE(6,325)TS	SIGBAW	144
IF(TS.GE.TMAX)WRITE(6,325)TS	SIGBAW	145
325 FORMAT("IN SIGBAW TS IS LESS THAN TMIN OR GREATER THAN TMAX. TR=	SIGBAW	146
S",1PE13.5)	SIGBAW	147
IF(TS.LT.TMIN.OR.TS.GE.TMAX) KCONV = 1	SIGBAW	148
IF(TS.LT.TMIN.OR.TS.GE.TMAX) RETURN	SIGBAW	149
C	SIGBAW	150
C THE ENTHALPY AT THE DELUGEATE-AIR INTERFACE IS COMPUTED.	SIGBAW	151
C	SIGBAW	152
PS=FP(RHS,TS)	SIGBAW	153
AHS=FAM(PS,ATM)	SIGBAW	154
CSS=FCS(AHS)	SIGBAW	155
RIS=FRI(CSS,TS,AHS)	SIGBAW	156
C	SIGBAW	157
C THE HEAT AND MASS TRANSFER COEFFICIENTS BETWEEN THE TUBESIDE	SIGBAW	158
C FLUID AND THE DELUGEATE-AIR INTERFACE ARE COMPUTED.	SIGBAW	159
C	SIGBAW	160
UPS=1./((AB+AF)*(1./(HI*AI)+1./(BETA*AI)+THW/(RKW*AW)+1./((AB+AF)	SIGBAW	161
S*HD)))	SIGBAW	162
DTDR = (TI - TS)/(RII - RIS)	SIGBAW	163
UDPS = UPS*DTDR	SIGBAW	164
C	SIGBAW	165
C THE MASS TRANSFER COEFFICIENT BETWEEN THE TUBESIDE FLUID	SIGBAW	166
C AND THE AIR IS COMPUTED.	SIGBAW	167
C	SIGBAW	168
SIG = 1.0/(1.0/UDPS + 1.0/SIGMA)	SIGBAW	169
C	SIGBAW	170
C OUTPUT IF DESIRED.	SIGBAW	171
C	SIGBAW	172

SUBROUTINE SIGBAW

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

IF(NDRUG5.EQ.1.AND.N.EQ.1) WRITE(6,150)	SIGBAW	173
150 FORMAT(1H0,1X," N TS RIS UPS	SIGBAW	174
UDPS SIG ",//)	SIGBAW	175
IF(NDRUG5.EQ.1) WRITE(6,200) N,TS,RIS,UPS,UDPS,SIG	SIGBAW	176
200 FORMAT(15,5E15.6)	SIGBAW	177
C	SIGBAW	178
C SOLUTION IS ITERATIVE, METHOD OF SUCCESSIVE APPROXIMATIONS	SIGBAW	179
C IS USED.	SIGBAW	180
C	SIGBAW	181
IF(N.GT.1) GO TO 250	SIGBAW	182
IF(PATH.AND.NSLOPE.LE.1) GO TO 10	SIGBAW	183
IF(N.LE.1) GO TO 400	SIGBAW	184
250 CONTINUE	SIGBAW	185
C	SIGBAW	186
C TEST TO PREVENT EXCESSIVE ITERATIONS.	SIGBAW	187
C	SIGBAW	188
IF(N.LT.MAX) GO TO 350	SIGBAW	189
WRITE(6,1000) N	SIGBAW	190
1000 FORMAT(" UDEL TERMINATED AT UPPER ITERATION LIMIT. N="I5)	SIGBAW	191
GO TO 500	SIGBAW	192
C	SIGBAW	193
C CONVERGENCE CRITERIA IS APPLIED.	SIGBAW	194
C	SIGBAW	195
350 CONTINUE	SIGBAW	196
IF(ABS((SIGS - SIG)/SIG) .LT. 0.001) GO TO 500	SIGBAW	197
C	SIGBAW	198
C THE ENTHALPY, RIS, AND TEMPERATURE, TS, AT THE DELUGEATE-AIR	SIGBAW	199
C INTERFACE IS COMPUTED.	SIGBAW	200
C	SIGBAW	201
400 CONTINUE	SIGBAW	202
RIS = RIA + (SIG/SIGMA)*(RII - RIA)	SIGBAW	203
TEST=TS	SIGBAW	204
CALL TCALC(RIS,1.,ATM,TEST,TS,"SIGBAW TS ",KCONV)	SIGBAW	205
IF(KCONV.EQ.1) RETURN	SIGBAW	206
C	SIGBAW	207
SIGS = SIG	SIGBAW	208
GO TO 10	SIGBAW	209
C	SIGBAW	210
500 CONTINUE	SIGBAW	211
C	SIGBAW	212
C STORAGE OF VARIABLES FOR EXTRAPDLATION TO THE NEXT	SIGBAW	213
C AMBIENT AIR CONDITIONS	SIGBAW	214
C	SIGBAW	215
IF(NTREST.EQ.1) GO TO 355	SIGBAW	216
IF(.NOT. PATH) GO TO 351	SIGBAW	217
IF(.NOT. FRST3) GO TO 351	SIGBAW	218
TS01 = TS02	SIGBAW	219
TAIN1 = TAIN2	SIGBAW	220
TAIN2 = TAIN	SIGBAW	221
351 TS02 = TS	SIGBAW	222
ISL = (NSLOPE - 1)*26	SIGBAW	223
R4(ISL + 3) = SIG	SIGBAW	224
R4(ISL + 4) = SIGMA	SIGBAW	225
R4(ISL + 5) = UDPS	SIGBAW	226
R4(ISL + 6) = DTDP	SIGBAW	227
R4(ISL + 7) = HI	SIGBAW	228
R4(ISL + 8) = CSS	SIGBAW	229

SUBROUTINE SIGBAW 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

R4(I SL + 9) = TS	SIGBAW	230
R4(I SL + 10) = RIS	SIGBAW	231
R4(I SL + 11) = TI	SIGBAW	232
R4(I SL + 12) = RII	SIGBAW	233
SIGS = SIG	SIGBAW	234
GO TO 370	SIGBAW	235
355 IF(.NOT. PATH) GO TO 356	SIGBAW	236
IF(.NOT. FRST3) GO TO 356	SIGBAW	237
TS11 = TS12	SIGBAW	238
356 TS12 = TS	SIGBAW	239
ISL = (NSLOPE - 1)*26	SIGBAW	240
R4(I SL + 16) = SIG	SIGBAW	241
R4(I SL + 17) = SIGMA	SIGBAW	242
R4(I SL + 18) = UDPS	SIGBAW	243
R4(I SL + 19) = DTDR	SIGBAW	244
R4(I SL + 20) = HI	SIGBAW	245
R4(I SL + 21) = CSS	SIGBAW	246
R4(I SL + 22) = TS	SIGBAW	247
R4(I SL + 23) = RIS	SIGBAW	248
SIGS = SIG	SIGBAW	249
370 CONTINUE	SIGBAW	250
IF(NDRUG5.EQ.1)	SIGBAW	251
1WRITE(6,390) TAIN1,TAIN2,TAIN,TS,TS01,TS02,TS11,TS12,PATH	SIGBAW	252
390 FORMAT(5X,"TAIN1,TAIN2,TAIN,TS,TS01,TS02,TS11,TS12,PATH",	SIGBAW	253
+ /1PRE14.5,L5/)	SIGBAW	254
PATH = .FALSE.	SIGBAW	255
C	SIGBAW	256
C OPTION TO OUTPUT QUANTITIES OF INTEREST.	SIGBAW	257
C	SIGBAW	258
IF(NDRUG51.NE.1) RETURN	SIGBAW	259
RETURN	SIGBAW	260
END	SIGBAW	261

SUBROUTINE SPDES(TS,TTD,XNS,XNP,CHLD,TLA,X,VELD,VELDO,ARPS,XNTS,
IDELP,LINOR)

C		SPDES	2
C		SPDES	3
C		SPDES	4
C	SUBROUTINE SPDES DESIGNS A CONDENSER/REBOILER ON THE	SPDES	5
C	BASIS OF THE TEMPERATURE DIFFERENCE BETWEEN THE SATURATED	SPDES	6
C	STEAM AND THE SATURATED AMMONIA, THE AMOUNT OF HEAT	SPDES	7
C	TO BE TRANSFERED, THE TEMPERATURE OF THE STEAM, THE	SPDES	8
C	LENGTH OF THE TUBES, AND THE EXIT QUALITY OF THE AMMONIA	SPDES	9
C	LEAVING THE TUBES THE CONDENSER/REBOILER CAN BE DESIGNED	SPDES	10
C	WITH TWO TYPES OF TUBES (1) BARE TUBES, AND (2) ENHANCED	SPDES	11
C	TUBES	SPDES	12
C	FOR BARE TUBES THE OUTSIDE COEFFICIENT IS PROVIDED BY	SPDES	13
C	NUSSULT AND THE INSIDE COEFFICIENT BY ROHSENOW	SPDES	14
C	FOR THE ENHANCED TUBES THE OUTSIDE AND INSIDE COEFFICIENTS	SPDES	15
C	ARE PROVIDED BY A REPORT FROM LINDE CORPORATION	SPDES	16
C		SPDES	17
C	DEFINITION OF VARIABLES	SPDES	18
C		SPDES	19
C	ARPS - AREA PER CONDENSER/REBOILER SHELL (SQ FT)	SPDES	20
C	AST - TOTAL AREA OF CONDENSER/REBOILER SHELLS (SQ FT)	SPDES	21
C	BETA - CONSTANT IN CORRELATION FOR HEAT TRANSFER ON	SPDES	22
C	THE OUTSIDE OF THE TUBE (BTU/HR-SQ FT-DEG F**3/4)	SPDES	23
C	C - SPACING BETWEEN CONDENSER/REBOILER TUBES (IN)	SPDES	24
C	CHLD - HEAT TRANSFERED IN THE CONDENSER/REBOILER (BTU/HR)	SPDES	25
C	CPW - SPECIFIC HEAT OF LIQUID AMMONIA (BTU/LBM-DEG F)	SPDES	26
C	DELP - PRESSURE DROP OF THE AMMONIA THROUGH THE CONDENSER/	SPDES	27
C	REBOILER (LBF/SQ FT)	SPDES	28
C	DELTA - AMMONIA SIDE TEMPERATURE DROP (DEG F)	SPDES	29
C	DELTK - WALL TEMPERATURE DROP (DEG F)	SPDES	30
C	DELTS - AVERAGE STEAM SIDE TEMPERATURE DROP (DEG F)	SPDES	31
C	DENSIV - DENSITY OF AMMONIA VAPOR (LBM/CU FT)	SPDES	32
C	DENSIW - DENSITY OF AMMONIA LIQUID (LBM/CU FT)	SPDES	33
C	DEPTHN - NUMBER OF TUBES IN DEPTH OF A TUBE BANK IN THE	SPDES	34
C	CONDENSER/REBOILER (DIMENSIONLESS)	SPDES	35
C	G - ACCELERATION DUE TO GRAVITY (FT/SQ HR)	SPDES	36
C	GT - AVERAGE MASS FLUX OF AMMONIA THROUGH THE CONDENSER/	SPDES	37
C	REBOILER TUBES (LBM/HR-SQ FT)	SPDES	38
C	HB - FORCED CONVECTION COEFFICIENT ON THE INSIDE OF THE	SPDES	39
C	CONDENSER/REBOILER TUBES (BTU/HR-SQ FT-DEG F)	SPDES	40
C	HFG - HEAT OF VAPORIZATION FOR SATURATED AMMONIA (BTU/	SPDES	41
C	LBM)	SPDES	42
C	HICON - HEAT TRANSFER COEFFICIENT ON THE INSIDE OF THE	SPDES	43
C	CONDENSER/REBOILER TUBES (BTU/HR-SQ FT-DEG F)	SPDES	44
C	HOCON - AVERAGE HEAT TRANSFER COEFFICIENT ON THE OUTSIDE OF	SPDES	45
C	THE CONDENSER/REBOILER TUBES (BTU/HR-SQ FT-DEG F)	SPDES	46
C	HSG1 - HEAT OF VAPORIZATION FOR SATURATED STEAM (BTU/LBM)	SPDES	47
C	HWCON - EFFECTIVE HEAT TRANSFER COEFFICIENT FOR THE	SPDES	48
C	CONDENSER/REBOILER TUBE WALL (BTU/HR-SQ FT-DEG F)	SPDES	49
C	KSF - THERMAL CONDUCTIVITY OF SATURATED WATER (BTU/HR-	SPDES	50
C	FT-DEG F)	SPDES	51
C	ODC - OUTSIDE DIAMETER OF THE CONDENSER TUBING (IN)	SPDES	52
C	PRW - PRANDTL NUMBER OF SATURATED AMMONIA (DIMENSIONLESS)	SPDES	53
C	QAO - HEAT FLUX THROUGH THE INSIDE CONDENSER/REBOILER	SPDES	54
C	TUBE WALL (BTU/HR-SQ FT)	SPDES	55
C	ROEF - DENSITY OF SATURATED WATER (LBM/CU FT)	SPDES	56
C	ROEG - DENSITY OF SATURATED STEAM (LBM/CU FT)	SPDES	57
C	SIGMA - SURFACE TENSION OF LIQUID AMMONIA (LBF/FT)	SPDES	58

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	THCONW	- THERMAL CONDUCTIVITY OF SATURATED AMMONIA (BTU/HR-FT-DEG F)	SPDES	59
C			SPDES	60
C	TID	- INSIDE DIAMETER OF THE CONDENSER/REBOILER TUBES (IN)	SPDES	61
C			SPDES	62
C	TKCT	- THERMAL CONDUCTIVITY OF THE CONDENSER/REBOILER TUBES (BTU/HR-FT-DEG F)	SPDES	63
C			SPDES	64
C	TLA	- CONDENSER/REBOILER TUBE LENGTH (FT)	SPDES	65
C	TLAA	- TOTAL FLOW PATH FOR THE AMMONIA (FT)	SPDES	66
C	TS	- TEMPERATURE OF THE SATURATED STEAM (DEG F)	SPDES	67
C	TTD	- TEMPERATURE DIFFERENCE BETWEEN THE STEAM AND AMMONIA (DEG F)	SPDES	68
C			SPDES	69
C	UCON	- OVERALL HEAT TRANSFER COEFFICIENT IN THE CONDENSER/REBOILER (BTU/HR-SQ FT-DEG F)	SPDES	70
C			SPDES	71
C	VEL	- INLET VELOCITY OF THE AMMONIA TO THE CONDENSER/REBOILER TUBES (FT/SEC)	SPDES	72
C			SPDES	73
C	VELD	- INLET VELOCITY OF THE AMMONIA TO THE CONDENSER/REBOILER TUBES (FT/SEC)	SPDES	74
C			SPDES	75
C	VELD0	- EXIT VELOCITY OF THE AMMONIA LEAVING THE CONDENSER/REBOILER TUBES (FT/SEC)	SPDES	76
C			SPDES	77
C	VISS	- VISCOSITY OF SATURATED WATER (LBM/FT-HR)	SPDES	78
C	VISV	- VISCOSITY OF SATURATED AMMONIA VAPOR (LBM/FT-HR)	SPDES	79
C	VISW	- VISCOSITY OF SATURATED AMMONIA LIQUID (LBM/FT-HR)	SPDES	80
C	VSF1	- SPECIFIC VOLUME OF SATURATED WATER (CU FT/LBM)	SPDES	81
C	VSG1	- SPECIFIC VOLUME OF SATURATED STEAM (CU FT/LBM)	SPDES	82
C	X	- EXIT QUALITY OF THE AMMONIA LEAVING THE CONDENSER/REBOILER TUBES (DIMENSIONLESS)	SPDES	83
C			SPDES	84
C	XNP	- NUMBER OF PASSES OF THE AMMONIA THROUGH THE CONDENSER (DIMENSIONLESS)	SPDES	85
C			SPDES	86
C	XNS	- NUMBER OF SHELLS IN THE CONDENSER/REBOILER (DIMENSIONLESS)	SPDES	87
C			SPDES	88
C	XNTS	- NUMBER OF TUBES PER SHELL (DIMENSIONLESS)	SPDES	89
C			SPDES	90
	REAL KSF		SPDES	91
	DIMENSION TSAT(64), VSG(64), VSF(64), HSG(64), ANG(3)		SPDES	92
	COMMON/PROP/CPW,THCONW,DENSIW,VISW,HFG,		SPDES	93
1	CPV,THCONV,DENSIV,VISV,SIGMA,		SPDES	94
2	CPA,THCONA,DENSIA,VISA		SPDES	95
	COMMON/OHTC/VELN,ODC,TKCT		SPDES	96
	COMMON/TUBE/KGA,LD,TID(7,6)		SPDES	97
	COMMON/RPRT2/UCONN,HCON,HICON,HWCON,HFC,VELD7,VELD07,TTD7,TS7,		SPDES	98
	1XNP7,DELPW7,ARPS7,TLA7,XNTS7,XNS7		SPDES	99
	COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY		2
\$	GIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY		3
\$	FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,	SUPPLY		4
\$	REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,	SUPPLY		5
\$	SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY		6
\$	BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX	SUPPLY		7
\$	, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY		8
\$	, CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELPPI, AST,OLDCST	SUPPLY		9
\$	CAPCST, XNFAN,BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN	SUPPLY		10
\$	WTHDR, WTRFM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU	SUPPLY		11
\$	AIRPF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP	SUPPLY		12
\$	ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY		13
\$	CSR0, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY		14
\$	SQRJ,SQRJS,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCSTD	SUPPLY		15
\$	CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST	SUPPLY		16
\$	PWD(16),WATCHD(16),DEPER(16),DEPERQ(16)	SUPPLY		17

	\$,WRB,HTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5	SUPPLY	18
C		SPDES	101
C	PROPERTIES OF STEAM VERSUS TEMPERATURE	SPDES	102
C		SPDES	103
	DATA TSAT/40.24,44.98,49.07,52.67,55.90,	SPDES	104
	1 58.82,61.5,63.97,66.27,68.42,70.44,72.34,74.14,75.85,	SPDES	105
	177.48,79.04,81.96,84.66,87.17,89.52,91.72,93.8,95.78,97.65,99.43,	SPDES	106
	2101.14,102.77,104.34,105.85,107.3,108.7,110.06,111.36,112.63,113.8	SPDES	107
	36.115,06,116.22,117.34,118.44,119.51,120.56,125.42,129.78,133.75,	SPDES	108
	4137.4,140.77,143.91,146.85,149.62,152.24,154.72,157.08,159.33,	SPDES	109
	5161.48,165.53,169.28,172.77,176.05,179.13,182.05,184.81,187.45,	SPDES	110
	6189.96,192.37/	SPDES	111
	DATA VSF/.016019,.016020,.016022,.016025,.016028,	SPDES	112
	1 .016032,.016035,.016039,.016043,.016047,.016051,.016055,	SPDES	113
	1.016058,.016062,.016066,.016070,.016077,.016084,.016091,.016097,	SPDES	114
	2.016104,.016110,.016116,.016122,.016128,.016134,.016139,.016145,	SPDES	115
	3.016150,.016155,.016160,.016165,.016170,.016175,.016180,.016184,	SPDES	116
	4.016189,.016194,.016198,.016202,.016207,.016227,.016246,.016264,	SPDES	117
	5.016281,.016297,.016312,.016327,.016341,.016354,.016367,.016380,	SPDES	118
	6.016392,.016403,.016426,.016447,.016467,.016486,.016505,.016522,	SPDES	119
	7.016539,.016556,.016572,.016587/	SPDES	120
	DATA VSG/2423.96,2038.97,1761.71,1552.30,1388.42,	SPDES	121
	1 1256.58,1148.17,1057.42,980.30,913.94,856.22,805.54,	SPDES	122
	1760.68,720.69,684.80,652.41,596.25,549.23,509.27,474.87,444.95,	SPDES	123
	2418.68,395.42,374.68,356.06,339.26,324.02,310.13,297.41,285.73,	SPDES	124
	3274.95,264.99,255.74,247.13,239.11,231.6,224.56,217.95,211.74,	SPDES	125
	4205.87,200.34,176.7,158.19,143.28,131.01,120.73,112.1,104.47,97.92,	SPDES	126
	592.17,87.08,82.53,78.46,74.77,68.38,63.03,58.48,54.55,51.14,48.143	SPDES	127
	6,45.486,43.116,40.989,39.067/	SPDES	128
	DATA HSFG/1070.8,1068.1,1065.8,1063.8,1062.0,	SPDES	129
	1 1060.3,1058.8,1057.4,1056.1,1054.9,1053.8,1052.7,1051.7,	SPDES	130
	11050.7,1049.8,1048.9,1047.3,1045.8,1044.3,1043.1,1041.8,1040.6,	SPDES	131
	21039.5,1038.4,1037.4,1036.4,1035.5,1034.6,1033.7,1032.9,1032.1,	SPDES	132
	31031.3,1030.6,1029.9,1029.1,1028.5,1027.8,1027.1,1026.5,1025.9,	SPDES	133
	41025.3,1022.5,1020.1,1017.7,1015.5,1013.6,1011.7,1010.1,1008.4,	SPDES	134
	51006.8,1005.4,1004.1,1002.6,1001.3,998.9,996.7,994.6,992.6,990.7,	SPDES	135
	6988.9,987.3,985.6,984.1,982.6/	SPDES	136
C		SPDES	137
C	SETTING OF CONSTANTS	SPDES	138
	ANG(1) = 0.0	SPDES	139
	ANG(2) = 0.0	SPDES	140
	ANG(3) = 1.0	SPDES	141
	G = 32.16*3600.*3600.	SPDES	142
	VELD = VELN	SPDES	143
	C = .25	SPDES	144
C		SPDES	145
C	PHYSICAL PROPERTIES OF STEAM	SPDES	146
	HSFG1 = TLU(TS,TSAT,HSFG,59)	SPDES	147
	VSF1 = TLU(TS,TSAT,VSF,59)	SPDES	148
	VSG1 = TLU(TS,TSAT,VSG,59)	SPDES	149
	PRW = CPW*VSW/THCONW	SPDES	150
	ROEF = 1./VSF1	SPDES	151
	ROEG = 1./VSG1	SPDES	152
	KSF = *3.363968E-01 + 2.04203E-03*(TS+460.)-1.42164E-06*(TS+460.)	SPDES	153
	1**2	SPDES	154
	VISS = 5.83897E-02*10.**((446.04/(TS+460.)-252.))	SPDES	155
C		SPDES	156

C	TUBE BANK DEPTH (10 FT) IN NUMBER OF TUBES	SPDES	157
	DEPTHN = 10.*12./(ODC + C)	SPDES	158
C	SETTING OF CONSTANT FOR OUTSIDE HEAT TRANSFER COEFFICIENT	SPDES	159
	BETA = .728*((G*ROEF*(ROEF-ROEG)*KSF**3*HSFG1)/((ODC/12.)*VISS))	SPDES	160
	1**25)/DEPTHN**1.6667	SPDES	161
	IF(LINOR.EQ.1) BETA = 16700./DEPTHN**1.6667	SPDES	162
C	SETTING OF CONSTANT FOR INSIDE HEAT TRANSFER COEFFICIENT	SPDES	163
	HB = ((CPW/(HFG*.015*(PRW)**1.7))**3)*VISW*HFG/(SIGMA/(DENSIW-	SPDES	164
	1DENSV))**5	SPDES	165
	IF(LINOR.EQ.1) HB = 582.628*HB	SPDES	166
	JI = 0	SPDES	167
C	BEGINNING OF ITERATION LOOP FOR VELOCITY OF AMMONIA INSIDE	SPDES	168
C	THE TUBES OF THE CONDENSER	SPDES	169
C	FORCED CONVECTION COEFFICIENT ON THE INSIDE OF THE	SPDES	170
C	CONDENSER TUBES	SPDES	171
	10 HFC = .023*(VELD*ODC*DENSIW*3600./((12.*VISW))**8*PRW**4*12.	SPDES	172
	1*THCONW/TID(KGA,LD)	SPDES	173
	JI = 0	SPDES	174
C	INITIAL GUESS FOR THE AMMONIA SIDE TEMPERATURE DROP	SPDES	175
	DELTA = TTD/2.	SPDES	176
C	BEGINNING OF ITERATION LOOP FOR THE AMMONIA SIDE	SPDES	177
C	TEMPERATURE DROP	SPDES	178
C	HEAT FLUX THROUGH THE INSIDE TUBE WALL	SPDES	179
	20 QAO = (TID(KGA,LD)/ODC)*(HFC*DELTA + HB*DELTA**3)	SPDES	180
	IF(LINOR.EQ.1) QAO = (TID(KGA,LD)/ODC)*(HFC*DELTA + HB*DELTA**2.72	SPDES	181
	1)	SPDES	182
C	DETERMINE TEMPERATURE DROP ACROSS THE WALL	SPDES	183
	DELTK = QAO*(ODC/24.)*ALOG(ODC/TID(KGA,LD))/TKCT	SPDES	184
C	AVERAGE TEMPERATURE DROP ACROSS THE CONDENSATE LAYER	SPDES	185
	DELTS = (QAO/BETA)**1.3333	SPDES	186
	IF(LINOR.EQ.1) DELTS = (QAO/BETA)**2.34	SPDES	187
C	TOTAL TEMPERATURE DROP BETWEEN THE STEAM AND THE AMMONIA	SPDES	188
	DELTT = DELTS + DELTK + DELTA	SPDES	189
	JI = JI + 1	SPDES	190
C	DETERMINATION OF NEXT GUESS FOR THE AMMONIA SIDE	SPDES	191
C	TEMPERATURE DROP AS A FUNCTION OF THE LAST TWO TOTAL	SPDES	192
C	TEMPERATURE DROPS AND THE SPECIFIED TOTAL TEMPERATURE DROP	SPDES	193
	DELTT2 = DELTT1	SPDES	194
	DELTT1 = DELTT	SPDES	195
	DELTA2 = DELTA1	SPDES	196
	DELTA1 = DELTA	SPDES	197
	IF (JI .LT. 2) DELTA = DELTA + .25	SPDES	198
	IF (JI.LT.2) GO TO 20	SPDES	199
	SLOPE = (DELTA1 - DELTA2)/(DELTT1 - DELTT2	SPDES	200
	DELTA = SLOPE*(TTD - DELTT1) + DELTA1	SPDES	201
C		SPDES	202
		SPDES	203
		SPDES	204
		SPDES	205
		SPDES	206
		SPDES	207
		SPDES	208
		SPDES	209
		SPDES	210
		SPDES	211
		SPDES	212
		SPDES	213

C	CONVERGENCE CRITERIA FOR THE AMMONIA SIDE TEMPERATURE DROP	SPDES	214
	IF(ABS((DELTA-DELTA1)/DELTA) .LT. .0001) GOTO 30	SPDES	215
	GO TO 20	SPDES	216
C		SPDES	217
C	VELOCITY OF AMMONIA BASED ON THE INSIDE WALL HEAT FLUX	SPDES	218
C	AND THE EXIT QUALITY OF THE AMMONIA	SPDES	219
	30 VEL = ODC*QAO*TLA*XNP/(75.*X*HFG*TID(KGA,LD)**2*DENSIW)	SPDES	220
C		SPDES	221
C	CONVERGENCE CRITERIA FOR THE VELOCITY OF AMMONIA THRU THE	SPDES	222
C	TUBES	SPDES	223
	IF(ABS((VELD=VEL)/VEL) .LT. .001) GOTO 40	SPDES	224
	VELD = VEL	SPDES	225
	GO TO 10	SPDES	226
C		SPDES	227
C	NUMBER OF TUBES AND SURFACE AREA PER SHELL AND TOTAL SURFACE	SPDES	228
C	AREA	SPDES	229
	40 ARPS = CHLD/(XNS*QAO)	SPDES	230
	XNTS = AINT(ARPS/(3.14159*(ODC/12.)*TLA) * 0.5)	SPDES	231
	XNTSX = XNTS*XNS	SPDES	232
	AST = ARPS*XNS	SPDES	233
C		SPDES	234
C	OVERALL HEAT TRANSFER COEFFICIENT	SPDES	235
	UCON = QAO/TTD	SPDES	236
C		SPDES	237
C	OUTSIDE HEAT TRANSFER COEFFICIENT	SPDES	238
	HOCON = QAO/DELTS	SPDES	239
C		SPDES	240
C	INSIDE HEAT TRANSFER COEFFICIENT	SPDES	241
	HICON = (QAO/DELTA) * ODC/TID(KGA,LD)	SPDES	242
C		SPDES	243
C	EFFECTIVE WALL HEAT TRANSFER COEFFICIENT	SPDES	244
	HWCON = QAO/DELTK	SPDES	245
C		SPDES	246
C	EXIT VELOCITY OF THE AMMONIA LEAVING THE CONDENSER TUBES	SPDES	247
	VELD0 = VELD*DENSIW*((1. - X)/DENSIW + X/DENSIV)	SPDES	248
C		SPDES	249
C	PRESSURE DROP THROUGH THE CONDENSER/REBOILER TUBING	SPDES	250
	GT = VELD*DENSIW*3600.	SPDES	251
	TLAA = TLA*12.*XNP	SPDES	252
	CALL DPCON(GOWS,TID(KGA,LD),TLAA,ANG,GT,0.,X,DENSIW,DENSIV,	SPDES	253
	1VISW*.41338,VISV*.41338,DELP,DPF,DPG,DPM,XLM,PHIL,PHIL2,VF,FL,RL,	SPDES	254
	2RV)	SPDES	255
	DELP = DELP*144.	SPDES	256
C		SPDES	257
C	STORAGE OF VARIABLES	SPDES	258
C		SPDES	259
	TLAX = TLA	SPDES	260
	VELDX = VELD	SPDES	261
	EFFC = 1.0	SPDES	262
	UCONN = UCON	SPDES	263
	TTD7 = TTD	SPDES	264
	VELD7 = VELD	SPDES	265
	VELD07 = VELD0	SPDES	266
	DELPW7 = DELP	SPDES	267
	ARPS7 = ARPS	SPDES	268
	TLA7 = TLA	SPDES	269
	XNTS7 = XNTS	SPDES	270

SUBROUTINE SPDES 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

XNS7 = XNS
XNP7 = XNP
TS7 = TS
RETURN
END

SPDES 271
SPDES 272
SPDES 273
SPDES 274
SPDES 275

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

SUBROUTINE SSCALE
C
C      SUBROUTINE SSCALE SCALES THE STEAM SUPPLY SYSTEM UP TO
C      OBTAIN THE SPECIFIED POWER OUTPUT OF THE PLANT (PSIZE) AT THE
C      RATED BACK PRESSURE OF THE STEAM TURBINE. THE INCREMENTAL
C      COST OVER THAT OF THE SYSTEM USING A CONVENTIONAL TURBINE IS
C      CALCULATED AT THE RATED BACK PRESSURE.
C
C      DEFINITION OF VARIABLES
C
C      CASSS1 - INCREMENTAL COST OF STEAM SUPPLY FOR MAKE UP OF
C              POWER OUTPUT DUE TO INCREASED HEAT RATE AT RATED
C              BACK PRESSURE ($)
C      CSSPKW - COST OF STEAM SUPPLY SYSTEM PER KILOWATT ($/KW)
C      HRFAC1 - HEAT RATE FACTOR OF STEAM TURBINE AT RATED BACK
C              PRESSURE (DIMENSIONLESS)
C      PLANC  - COST OF POWER PLANT PER KILOWATT ($/KW)
C      PSIZE  - PLANT SIZE (MW)
C      RBP    - STEAM TURBINE RATED BACK PRESSURE (IN HGA)
C      SSCD   - INCREMENTAL PLANT COST DUE TO INCREASED HEAT RATE
C              AT RATED BACK PRESSURE OF STEAM TURBINE ($)
C      TPO    - COEFFICIENTS OF THIRD ORDER HEAT RATE CURVE FIT
C              FOR STEAM TURBINE (DIMENSIONLESS)
C
C      LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG
COMMON
$  AFTR, ALPHA, ANG(3)
$  BPLIM(16)
$  CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2, CAF
$  CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM
$  DFIN, DEEPL, DESVEL, DESVELV, DESVELD, DENSIF
$  EFP, EFS
$  FCR, FIRST, FIXL, FCOS, FFHX, FXTMP, FACTOR, FRST, FACTORD, FSHOT, FDELUG
$  FIXV, FXTTDD, FXTVAR, FXTTDD, FXTLNG
$  GBEFF
$  HXNP, HPCST, HCD
$  ITMAX, ITMIN
$  JCONS
$  KCONV, KALEXT
$  MXEXT
$  NTA, NSIDES, NBUNHI
COMMON
$  ODR
$  PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL
$  POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL
$  RBP, REDUCE, REDUCV, ROOFL, RHOUT
$  QREJ, QREDUCE, QREDUCV
$  SIGMAG, SAAF, SEGL
$  TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX
$  TCD, TW
$  UCS, UWS
$  WFFV, WATCONA, WATCOST
$  VAS(5)
$  XDEPA, XW, XD
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF, SUPPLY
$  QIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW, SUPPLY
$  FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, H1, HO, T4, SUPPLY

```



```

$ REWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3, SUPPLY 5
$ SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2, SUPPLY 6
$ BP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTSX, VELDX SUPPLY 7
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS SUPPLY 8
$ , CLYC, CFC, CPCC, FITCO, CSC, CEPREP, DELPIP, AST, OLDCST SUPPLY 9
$ , CAPCST, XNFAN, BLDANG, CPLEN, DPFL, WHX, WTTUB, ADIA, ABLN SUPPLY 10
$ , WTHDR, WTRFM, STRUCC, CFPERF, HPPERF, TOTCF, TPC, EFFIN, ANTU SUPPLY 11
$ , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP SUPPLY 12
$ , ACTRPD, ADJBP, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY 13
$ , CSRD, WATERW, WSTRCT, CFOWN, HUBDIA, TOWLE, NUMTOW, CTOWD SUPPLY 14
$ , SQRJ, SQRJS, ATURC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCTD SUPPLY 15
$ , CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST SUPPLY 16
$ , PWD(16), WATCWD(16), DEPER(16), DEPERQ(16) SUPPLY 17
$ , WBB, MTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5 SUPPLY 18
COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1, SINK 2
$ QIN1, CLAN1, REA11, Z1, HRFAS2S, W41, U1, DEPW1, PPOW1, SINK 3
$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41, SINK 4
$ REW1, NW1, NT1, NP1, ZPLNC2, ZSIZ12, ZSPBP, SW41, SW31, SINK 5
$ SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SP513, WT2MIN, SINK 6
$ BP2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBAL, XNTS1, VELD1 SINK 7
$ , TL1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITCO1, CSC1, CEPRE1, DEPIP1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFL1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTRF1, STRUC1, CFMPF1, HPPF1, TOTCF1, TPI, EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTRP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRC1, CFOWN1, HUBD11, TOWLE1, NUMT01, CTOWD1 SINK 14
$ , SQRJ1, SQRJS1, ATUBC1, CBA1, TTD11, TTD21, DELPS1, CSTLV1, PIPCTD1 SINK 15
$ , CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCWD1(16), DEPER1(16), DEPERQ1(16) SINK 17
$ , WBB1, MTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51 SINK 18
COMMON /SCALER/ HRFAC1, ATUB, CPERA, SSSC, PLANC1, CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANC1 SCALER 3
C EQUATION FOR HEAT RATE FACTOR AS A FUNCTION OF TURBINE SSCALE 30
C BACK PRESSURE SSCALE 31
C SSCALE 32
C SSCALE 33
C HRF(P)=TPO(1) + TPO(2)*P + TPO(3)*P**2 + TPO(4)*P**3 SSCALE 34
C SSCALE 35
C HEAT RATE FACTOR AT RATED BACK PRESSURE SSCALE 36
C SSCALE 37
C HRFAC1=HRF(RBP) SSCALE 38
C SSCALE 39
C INCREMENTAL STEAM SUPPLY COST DUE TO INCREASED HEAT RATE SSCALE 40
C FACTOR AT RATED BACK PRESSURE ($) SSCALE 41
C SSCALE 42
C DTURBC = CTURB * PSIZE * 1000, SSCALE 43
C CASSS1 = CSSPKW * (HRFAC1 - 1.) * PSIZE * 1000, SSCALE 44
C SSSPC = PLANC * PSIZE * 1000. + CASSS1 SSCALE 45
C SSCALE 46
C PLANT COST TAKING INTO ACCOUNT INCREASED STEAM SUPPLY SSCALE 47
C COST ($/MW) SSCALE 48
C SSCALE 49
C PLANC1 = SSSPC + DTURBC SSCALE 50
C PLANC1 = PLANC1 / (PSIZE * 1000.) SSCALE 51
C SSCALE 52
C INCREMENTAL STEAM SUPPLY COST DUE TO INCREASED HEAT RATE SSCALE 53

```

SUBROUTINE SSCALE 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
C      OF TURBINE ($)
C
      SSPLC =SSSPC/(PSIZE*1000.)
      SSCD = (SSPLC - PLANC) * PSIZE * 1000.
      TCD = DTURBC
C
      RETURN
      END
```

```
SSCALE 54
SSCALE 55
SSCALE 56
SSCALE 57
SSCALE 58
SSCALE 59
SSCALE 60
SSCALE 61
```

SUBROUTINE STORE

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

SUBROUTINE STORE

C
C
C
C

THIS ROUTINE IS CALLED EACH TIME A NEW LOW COST IS FOUND.
IT STORES VALUES OF COST, DESIGN, ETC. FOR THE FINAL REPORT

COMMON /RPTSUP/ XPS(2021)
COMMON /RPTRET/ XPR(2020)
COMMON /QPTRET/ XXPR(2007)
COMMON /QPTSUP/ XXPS(1207)
COMMON /KKRET/ HMPR(2007)
COMMON /KKSUP/ HMP(1207)

COMMON/RPRT2/R2(15)

COMMON /RPRT3/ R3(4)

COMMON /KPTSUP/ HPS(2021)

COMMON /KPTRET/ HPR(2020)

COMMON /KPRT2/ SPRT2(15)

COMMON /KPRT3/ SPRT3(4)

COMMON/SINK/ VSTO(205)

COMMON/SUPPLY/VIN(205)

COMMON/RPRT4/R4(672),RR(3)

COMMON/KPRT4/SPRT4(672),SR(3)

LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG

COMMON

\$ AFTR, ALPHA, ANG(3)

\$,BPLIM(16)

\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF

\$,CBJ, CTURB, CDANG, CLUVR, CHAHS, CVM

\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF

\$,EFFP, EFS

\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTORD,FSHOT,FDELUG

\$,FIXV,FXTTD,FXTVAR,FXTTDD,FXTLNG

\$,GBEFF

\$,HXNP,HPCST,HCD

\$,ITMAX, ITMIN

\$,JCONS

\$,KCONV, KALEXT

\$,MXEXT

\$,NTA,NSIDES,NBUNHI

COMMON

\$ ODD

\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMOPL

\$,POHRAF, POHFAN, POHLEC, POMCIR, POHCND, POMSTC, POHSCL

\$,RBP,REDUCE, REDUCV, ROOFL, RHOUT

\$,GREJ, QREDUCE, QREDUCV

\$,SIGMAG, SAAF, SEGL

\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPA, TFIX

\$,TCD, TW

\$,UCS, UWS

\$,WFFV, WATCONA, WATCOST

\$,VAS(5)

\$,XDPA, XW, XD

DO 1 I = 1, 205

VSTO(I)=VIN(I)

1 CONTINUE

DO 3 I = 1, 15

SPRT2(I)=R2(I)

3 CONTINUE

STORE	2
STORE	3
STORE	4
STORE	5
STORE	6
STORE	7
STORE	8
STORE	9
STORE	10
STORE	11
STORE	12
STORE	13
STORE	14
STORE	15
STORE	16
STORE	17
STORE	18
STORE	19
STORE	20
STORE	21
STORE	22
BIGCOM	2
BIGCOM	3
BIGCOM	4
BIGCOM	5
BIGCOM	6
BIGCOM	7
BIGCOM	8
BIGCOM	9
BIGCOM	10
BIGCOM	11
BIGCOM	12
BIGCOM	13
BIGCOM	14
BIGCOM	15
BIGCOM	16
BIGCOM	17
BIGCOM	18
BIGCOM	19
BIGCOM	20
BIGCOM	21
BIGCOM	22
BIGCOM	23
BIGCOM	24
BIGCOM	25
BIGCOM	26
BIGCOM	27
BIGCOM	28
BIGCOM	29
STORE	24
STORE	25
STORE	26
STORE	27
STORE	28
STORE	29

SUBROUTINE STORE 74/74 OPT=1

FTN 4,5+414

06/05/78 07,59,59

DO 4 I=1,4	STORE	30
SPRT3(I)=R3(I)	STORE	31
4 CONTINUE	STORE	32
DO 50 I=1,2021	STORE	33
HPS(I) = XPS(I)	STORE	34
50 CONTINUE	STORE	35
C	STORE	36
DO 60 I=1,2020	STORE	37
HPR(I) = XPR(I)	STORE	38
60 CONTINUE	STORE	39
IF(FDELUG .EQ. "DELUG") N = RR(3)=42	STORE	40
IF(FDELUG .EQ. "DELBAW") N = RR(3)=26	STORE	41
DO 90 I = 1, N	STORE	42
SPRT4(I) = R4(I)	STORE	43
90 CONTINUE	STORE	44
DO 100 I = 1, 3	STORE	45
SR(I) = RR(I)	STORE	46
100 CONTINUE	STORE	47
DO 70 I=1,2007	STORE	48
MHPR(I)=XXPR(I)	STORE	49
70 CONTINUE	STORE	50
DO 80 I=1,1207	STORE	51
MHPS(I)=XXPS(I)	STORE	52
80 CONTINUE	STORE	53
JCONS=1	STORE	54
RETURN	STORE	55
END	STORE	56

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE STRUCT(NTOW,NSIDES,HTOW,BUNL,SEGL,NBUNHI,WHX,WATERW,
IDFAN,NOF,ROOFL,CSTRUC,CFND)
THIS SUBROUTINE CALCULATES THE STRUCTURAL AND FOUNDATION
COSTS FOR A SYSTEM OF ROUND COOLING TOWERS USING THE
DELUGED ROTARY SURFACE

DEFINE VARIABLES

APF -ROOF AREA PER FAN(FT**2)
AREAF -SWEPT AREA PER FAN(FT**2)
AREAT -ROOF AREA PER TOWER(FT**2)
BUNL -BUNDLE LENGTH(FT)
DFAN -FAN DIAMETER(FT)
DTOW -TOWER DIAMETER(FT)
HTOW -TOWER HEIGHT(FT)
NBUNCL -NUMBER OF BUNDLE COLUMNS
NBUNHI -NUMBER OF BUNDLES VERTICAL
NBUNS -NUMBER OF SEGMENTS PER BUNDLE
NOB -NUMBER OF BUNDLES PER TOWER
NOF -TOTAL NUMBER OF FANS
NOFPT -NUMBER OF FANS PER TOWER
NSIDES -NUMBER OF BUNDLES HORIZONTAL PER TOWER
NTOW -NUMBER OF TOWERS
ROOFL -ROOF LOAD(LBF)
SEGL -SEGMENT LENGTH(FT)
WHX -WEIGHT OF ALL HEAT EXCHANGER BUNDLES(LBF)
WTBUN -WEIGHT OF ONE BUNDLE(LBF)

CFC - COST OF FAN COLUMNS (\$)
CRC - COST OF BUNDLE COLUMNS (\$)
CFDF - COST OF FAN DECK FRAMING (\$)
CIF - COST OF INTERMEDIATE FRAMING (\$)
CXB - COST OF X-BRACING (\$)
CD - COST OF DECKING (\$)
CBA - COST OF BUNDLE ATTACHMENT PLATES (\$)
CFR - COST OF FLOW REDIRECTING SHEETS (\$)
CFND - COST OF THE FOUNDATION AND SITE PREPERATION (\$)
CSTRUC - COST OF THE FOUNDATION AND STRUCTURAL
ELEMENTS FOR THE ENTIRE SYSTEM OF ITOWN TOWERS (\$)

REAL NOF
PI=3.14159
NOB=NSIDES*NBUNHI
NRUNS=BUNL/SEGL+1
NBUNCL=NSIDES*NBUNS
WTBUN=(WHX*WATERW)/(NOB*NTOW)
FANDS = DFAN*DFAN
NOFPT=NOF/NTOW+1
AREAT = .25*BUNL**2*NSIDES/TAN(2*PI/(2*NSIDES))
APF=AREAT/NOFPT
SRAPF=SQRT(APF)
AREAF=.7854*NOFPT*FANDS

A=49.62*NOFPT*HTOW
B=APF*ROOFL
C=17.09*FANDS*18400.

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

SUBROUTINE STRUCT 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	CFC=A*((B+C)/129340.,+.4)	STRUCT	59
C	A=13.88*NBUNCL*HTOW	STRUCT	60
	B=NBUNHI*WTBUN/NBUNS	STRUCT	61
	C=ROOFL*AREAT/NBUNCL	STRUCT	62
	CBC=A*((B+C)/54810.,+.4.)	STRUCT	63
C	A=0.0682*AREAT*SRAPF	STRUCT	64
	B=17.0*FANDS/APF*ROOFL	STRUCT	65
	CFDF=A*(B/45.5+.5)	STRUCT	66
C	ILEVEL = HTOW/25.0	STRUCT	67
	CIF = 136.1*NOFPT*SRAPF*ILEVEL	STRUCT	68
C	A=16.74*NOFPT	STRUCT	69
	B=SQR(HTOW*HTOW*APF)	STRUCT	70
	CXB=A*B	STRUCT	71
C	CD=1.631*(AREAT-AREAF)	STRUCT	72
C	CBA=0.0282*WTBUN*NOB	STRUCT	73
C	CFR=8.189*NSIDES*BUNL*(NBUNHI-1)	STRUCT	74
C	CFND = (0.8202*AREAT + 0.0489*NOB*WTBUN)*NTOW/1.21	STRUCT	75
C	CSTRUC = NTOW*(CFC+CBC+CFDF+CIF+CXB+CD+CBA+CFR)/1.21	STRUCT	76
	RETURN	STRUCT	77
	END	STRUCT	78
		STRUCT	79
		STRUCT	80
		STRUCT	81
		STRUCT	82
		STRUCT	83
		STRUCT	84
		STRUCT	85
		STRUCT	86
		STRUCT	87

	SUBROUTINE SUMCOS(FCR,PSIZE,CAPF,CCOS1,CPIP1,CONBA1,ATUBC,CLEN,	SUMCOS	2
	\$FRACC,FMCST,STRUCC,CFOUND,CAPCST,SPCD1,SSCD,HRFAC1,HRFAC2,YFP,	SUMCOS	3
	\$ PLANC, CLAN1, CLSUM, FCSUM, COSM1, CSTLV1, CSTHS1, CFANE1, CYLRN1	SUMCOS	4
	\$,WATCONA,WATCOST)	SUMCOS	5
C		SUMCOS	6
C	THIS ROUTINE REPORTS THE FINAL CBST SUMMARY	SUMCOS	7
C		SUMCOS	8
	COMMON/SUMZ/	SUMCOS	9
	\$ COOLZ, CAPZ, SCALEZ, ENERGZ, BASEZ, OANDMZ, TOTAL	SUMCOS	10
	6001 FORMAT(1H1///,T17,"C A P I T A L C O S T S U M M A R Y "	SUMCOS	11
	\$,T72,"U N I T E N E R G Y C O S T S U M M A R Y"/	SUMCOS	12
	\$,T16,43("-"), T71,52("-")///)	SUMCOS	13
	6010 FORMAT(	SUMCOS	14
	L T2,"COOLING SYSTEM CAPITAL",T48,F13.0	SUMCOS	15
	R,T69,"COOLING SYSTEM CAPITAL",T119,G12.6/	SUMCOS	16
	6020 FORMAT(	SUMCOS	17
	L T4,"TOWER",T35,F13.0	SUMCOS	18
	R,T72,"TOWER",T106,G12.6)	SUMCOS	19
	6030 FORMAT(	SUMCOS	20
	L T7,"HEAT EXCHANGER",T23,F13.0	SUMCOS	21
	R,T75,"HEAT EXCHANGER",T93,G12.6)	SUMCOS	22
	6040 FORMAT(	SUMCOS	23
	L T7,"PLENUM",T23,F13.0	SUMCOS	24
	R,T75,"PLENUM",T93,G12.6)	SUMCOS	25
	6042 FORMAT(	SUMCOS	26
	L T7,"LOUVERS",T23,F13.0	SUMCOS	27
	R,T75,"LOUVERS",T93,G12.6)	SUMCOS	28
	6044 FORMAT(	SUMCOS	29
	L T7,"HAIL SCREENS",T23,F13.0	SUMCOS	30
	R,T75,"HAIL SCREENS",T93,G12.6)	SUMCOS	31
	6050 FORMAT(	SUMCOS	32
	L T7,"FAN SYSTEM",T23,F13.0	SUMCOS	33
	R,T75,"FAN SYSTEM",T93,G12.6)	SUMCOS	34
	6060 FORMAT(	SUMCOS	35
	L T7,"STRUCTURE",T23,F13.0	SUMCOS	36
	R,T75,"STRUCTURE",T93,G12.6)	SUMCOS	37
	6070 FORMAT(	SUMCOS	38
	L T7,"FOUNDATION",T23,F13.0	SUMCOS	39
	R,T75,"FOUNDATION",T93,G12.6/)	SUMCOS	40
	6080 FORMAT(	SUMCOS	41
	L T4,"PIPING",T35,F13.0	SUMCOS	42
	R,T72,"PIPING",T106,G12.6)	SUMCOS	43
	6090 FORMAT(	SUMCOS	44
	L T4,"CONDENSER",T35,F13.0	SUMCOS	45
	R,T72,"CONDENSER",T106,G12.6)	SUMCOS	46
	6100 FORMAT(	SUMCOS	47
	L T2,"CAPACITY PENALTY",T48,F13.0	SUMCOS	48
	R,T69,"CAPACITY PENALTY",T119,G12.6/)	SUMCOS	49
	6110 FORMAT(	SUMCOS	50
	L T2,"PLANT SCALING",T48,F13.0	SUMCOS	51
	R,T69,"PLANT SCALING",T119,G12.6)	SUMCOS	52
	6120 FORMAT(	SUMCOS	53
	L T4,"STEAM SUPPLY",T35,F13.0	SUMCOS	54
	R,T72,"STEAM SUPPLY",T106,G12.6)	SUMCOS	55
	6130 FORMAT(	SUMCOS	56
	L T4,"BASE PLANT",T35,F13.0	SUMCOS	57
	R,T72,"BASE PLANT",T106,G12.6)	SUMCOS	58

6132 FORMAT(	SUMCOS	59
L T7,"HEAT RATE",T38,F13.0	SUMCOS	60
R,T75,"HEAT RATE",T108,G12.6)	SUMCOS	61
6134 FORMAT(	SUMCOS	62
LT7,"FANS AND PUMPS",T38,F13.0	SUMCOS	63
R,T75,"FANS AND PUMPS",T108,G12.6/)	SUMCOS	64
6136 FORMAT(	SUMCOS	65
L T2,"WATER",T48,F13.0	SUMCOS	66
R,T69,"WATER",T119,G12.6/)	SUMCOS	67
6140 FORMAT(	SUMCOS	68
L T2,"LAND",T48,F13.0/)	SUMCOS	69
6150 FORMAT(	SUMCOS	70
L T48,13("=")/)	SUMCOS	71
6160 FORMAT(	SUMCOS	72
L T2,"TOTAL CAPITAL COST",T46,"\$ ",T48,F13.0	SUMCOS	73
R,T69,"TOTAL CAPITAL COST",T119,G12.6/)	SUMCOS	74
6170 FORMAT(	SUMCOS	75
R T69,"ENERGY PENALTY",T119,G12.6/)	SUMCOS	76
6180 FORMAT(	SUMCOS	77
R T69,"ADDITIONAL BASE PLANT FUEL",T119,G12.6/)	SUMCOS	78
6190 FORMAT(	SUMCOS	79
R T69,"OPERATION AND MAINTENANCE",T119,G12.6/)	SUMCOS	80
6200 FORMAT(	SUMCOS	81
R,T72,"TOTAL",T119,G12.6)	SUMCOS	82
YFPP1 = YFP + 1.	SUMCOS	83
FACTOR= FCR/(PSIZE*CAPF*8760)	SUMCOS	84
WRITE(6,6001)	SUMCOS	85
WRITE(6,6010) (CCOS1+CPIP1+CONBA1),((CCOS1+CPIP1+CONBA1)*FACTOR)	SUMCOS	86
WRITE(6,6020) CCOS1,CCOS1*FACTOR	SUMCOS	87
WRITE(6,6030) ATUBC,ATUBC*FACTOR	SUMCOS	88
WRITE(6,6040) CPLEN,CPLEN*FACTOR	SUMCOS	89
WRITE(6,6042) CSTLV1, CSTLV1*FACTOR	SUMCOS	90
WRITE(6,6044) CSTHS1, CSTHS1*FACTOR	SUMCOS	91
WRITE(6,6050) (FBACC + FMCST + CYLRN1 + CFANE1)	SUMCOS	92
\$ (FBACC + FMCST + CYLRN1 + CFANE1) * FACTOR	SUMCOS	93
WRITE(6,6060) STRUCC,STRUCC*FACTOR	SUMCOS	94
WRITE(6,6070) CFOUND,CFOUND*FACTOR	SUMCOS	95
WRITE(6,6080) CPIP1,CPIP1*FACTOR	SUMCOS	96
WRITE(6,6090) CONBA1,CONBA1*FACTOR	SUMCOS	97
WRITE(6,6100) CAPCST,CAPCST*FACTOR	SUMCOS	98
WRITE(6,6110) SPCD1,SPCD1*FACTOR	SUMCOS	99
WRITE(6,6120) SSCD*HRFAC2/HRFAC1*YFPP1,SSCD*HRFAC2/HRFAC1*YFPP1*	SUMCOS	100
\$FACTOR	SUMCOS	101
WRITE(6,6130) PLANC*(HRFAC2/HRFAC1*YFPP1-1.)*10.**3 * PSIZE,	SUMCOS	102
\$ PLANC*(HRFAC2/HRFAC1*YFPP1-1.)*10.**3 * PSIZE * FACTOR	SUMCOS	103
WRITE(6,6132) PLANC*(HRFAC2/HRFAC1 - 1.)*10.**3*PSIZE, PLANC*	SUMCOS	104
1(HRFAC2/HRFAC1 - 1.)*10.**3*PSIZE*FACTOR	SUMCOS	105
WRITE(6,6134) PLANC*HRFAC2/HRFAC1*(YFPP1 = 1.)*10.**3*PSIZE,PLANC*	SUMCOS	106
1HRFAC2/HRFAC1*(YFPP1 = 1.)*10.**3*PSIZE*FACTOR	SUMCOS	107
WRITE(6,6136) WATCONA*(.1203/1000.)*WATCOST,WATCONA*(.1203/1000.)*	SUMCOS	108
1*WATCOST/(PSIZE*CAPF*8760.)	SUMCOS	109
WRITE(6,6140) CLAN1	SUMCOS	110
WRITE(6,6150)	SUMCOS	111
WRITE(6,6160) CLAN1+SPCD1+CAPCST+CCOS1+CPIP1+CONBA1	SUMCOS	112
\$, (CLAN1+SPCD1+CAPCST+CCOS1+CPIP1+CONBA1)*FACTOR	SUMCOS	113
WRITE(6,6170) CLSUM	SUMCOS	114
WRITE(6,6180) FCSUM	SUMCOS	115

SUBROUTINE SUMCOS 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```
WRITE(6,6190) COSM1
TOTAL = (CLAN1 + SPCD1 + CAPCST + CCOS1 + CPIP1 + CONBA1) *
$ FACTOR + CLSUM + FCSUM + COSM1
S=WATCONA*(.1203/1000.)*WATCOST/(PSIZE*CAPF*8760,)
WRITE(6,6200) TOTAL
COOLZ=(CCOS1+CPIP1+CONBA1)*FACTOR
CAPZ=CAPCST*FACTOR
SCALEZ=SPCD1*FACTOR
ENERGZ=CLSUM
BASEZ=FCSUM
OANOMZ=COSM1
END
```

```
SUMCOS 116
SUMCOS 117
SUMCOS 118
SUMCOS 119
SUMCOS 120
SUMCOS 121
SUMCOS 122
SUMCOS 123
SUMCOS 124
SUMCOS 125
SUMCOS 126
SUMCOS 127
```

SUBROUTINE SUMMARY	SUMMARY	2
LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG	BIGCOM	2
COMMON	BIGCOM	3
\$ AFTR, ALPHA, ANG(3)	BIGCOM	4
* ,BPLIM(16)	BIGCOM	5
\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF	BIGCOM	6
\$,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM	BIGCOM	7
\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF	BIGCOM	8
\$,EFPF, EFS	BIGCOM	9
\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACTOR,FSHOT,FDELUG	BIGCOM	10
\$,FIXV,FXTTD,FXTVAR,FXTTD,FXTLNG	BIGCOM	11
\$,GBEFF	BIGCOM	12
\$,HXNP,HPCST,HCD	BIGCOM	13
\$,ITMAX, ITMIN	BIGCOM	14
\$,JCONS	BIGCOM	15
\$,KCONV, KALEXT	BIGCOM	16
\$,MXEXT	BIGCOM	17
\$,NTA,NSIDES,NBUNHI	BIGCOM	18
COMMON	BIGCOM	19
\$ ODR	BIGCOM	20
\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
\$,POHBAF, POMFAN, POHLEC, POHCIR, POHCND, POHSTC, POMSCL	BIGCOM	22
\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
\$,QREJ, QREDUCE, QREDUCV	BIGCOM	24
\$,SIGMAG, SAAF, SEGL	BIGCOM	25
\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
\$,TCD, TW	BIGCOM	27
\$,UCS, UWS	BIGCOM	28
\$,WEV, WATCONA, WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDEPA, XW, XD	BIGCOM	31
COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,	SINK	2
\$ QIN1, CLAN1, REAI1, Z1,HRFA2S, W41, U1, DEPW1, PPOW1,	SINK	3
\$ FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, H01, T41,	SINK	4
\$ REWA1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPBP, SW41, SW31,	SINK	5
\$ SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,	SINK	6
\$ B2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1	SINK	7
\$, LA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1	SINK	8
\$, CLTC1, CFC1, CPCC1,FITC01, CSC1,CEPRE1,DEPI1, AST1,OLDCS1	SINK	9
\$,CAPCS1,XNFAN1,BLDAN1,CPLN1,DPFEL1, WH1, WTTU1, AD11, ABL1	SINK	10
\$, WTHD1, WTR1,STRUC1,CFMPF1, HPPF1,TOTCF1, TPL,EFFIN1, ANTU1	SINK	11
\$, AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1	SINK	12
\$, ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1	SINK	13
\$, CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMT01, CTOWD1	SINK	14
\$,SQRJ1,SQRJ51,ATUBC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PICTD1	SINK	15
\$,CSTHS1, CYLRN1, CFANEL, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1	SINK	16
\$,PWD1(16),WATCWD1(16),DEPER1(16),DEPERQ1(16)	SINK	17
\$,WBB1,HTOW1,NTOWDE1,CSTIF1,CSJ1,CVF1,CDP1,W51	SINK	18
COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD,PLANC1,CASSS1,	SCALER	2
\$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANCT1	SCALER	3
COMMON/SUMZ/	SUMMARY	6
\$ COOLZ, CAPZ, SCALEZ, ENERGZ, BASEZ, OANDMZ, TOTAL	SUMMARY	7
COMMON/POWZ/	SUMMARY	8
\$ TBMXZ, POWMAX	SUMMARY	9
COMMON/DZZ/	SUMMARY	10
\$ DESKEP(10,8), NOCRDS	SUMMARY	11
WRITE(6,6010)	SUMMARY	12

DO 900 I=1,NOCRDS	SUMMARY	13
WRITE(6,6000) (DESKEP(I,K),K=1,8)	SUMMARY	14
900 CONTINUE	SUMMARY	15
WRITE(6,6020)	SUMMARY	16
WRITE(6,5000)	SUMMARY	17
WRITE(6,5010) SW41/1000000.	SUMMARY	18
WRITE(6,5020) VAIR1	SUMMARY	19
WRITE(6,5030) DEPA1/144.	SUMMARY	20
WRITE(6,5040) ACTVH1	SUMMARY	21
WRITE(6,5050) FPOW1/1000.	SUMMARY	22
NFANZ=XNFAN1*.01	SUMMARY	23
WRITE(6,5060) NFANZ	SUMMARY	24
WRITE(6,5070)	SUMMARY	25
WRITE(6,5080) W31/1000000.	SUMMARY	26
WRITE(6,5090) DPWT1/144.	SUMMARY	27
WRITE(6,5100) PPOW1/1000.	SUMMARY	28
WRITE(6,5110)	SUMMARY	29
WRITE(6,5120) NUMT01	SUMMARY	30
WRITE(6,5130) CTOWD1	SUMMARY	31
WRITE(6,5140) HTOW1	SUMMARY	32
WRITE(6,5150) AFR01/1000000.	SUMMARY	33
WRITE(6,5160) AAIR1/1000000.	SUMMARY	34
WRITE(6,5170) ELEN1	SUMMARY	35
NZ1=Z1*.01	SUMMARY	36
WRITE(6,5180) NZ1	SUMMARY	37
WRITE(6,5190)	SUMMARY	38
WRITE(6,5200) (AST1*(1.+YFPMIN))/1000000.	SUMMARY	39
WRITE(6,5210) VAR(3)	SUMMARY	40
WRITE(6,5220)	SUMMARY	41
WRITE(6,5230) BP2MIN	SUMMARY	42
WRITE(6,5240) TBPMXZ	SUMMARY	43
WRITE(6,5250) POWMAX	SUMMARY	44
WRITE(6,5260) DEPER1(1)=100.	SUMMARY	45
WRITE(6,5270) W51/FACTORD	SUMMARY	46
WRITE(6,5280)	SUMMARY	47
WRITE(6,5290) COOLZ	SUMMARY	48
WRITE(6,5300) CAPZ	SUMMARY	49
WRITE(6,5310) SSCD=HRFA2S/HRFAC1*(YFPMIN+1.)*FCR/(PSIZE*CAPF*8760.)	SUMMARY	50
WRITE(6,5311) PLANC=(HRFA2S/HRFAC1-1.)*1000.*FCR/(CAPF*8760.)	SUMMARY	51
WRITE(6,5312) PLANC=HRFA2S/HRFAC1*YFPMIN*1000.*FCR/(CAPF*8760.)	SUMMARY	52
WRITE(6,5320) ENERGZ	SUMMARY	53
WRITE(6,5330) BASEZ	SUMMARY	54
WRITE(6,5340) OANDMZ	SUMMARY	55
WRITE(6,5345) WATCONA*(.1203/1000.)*WATCOST/(PSIZE*CAPF*8760.)	SUMMARY	56
WRITE(6,5350) TOTAL	SUMMARY	57
5000 FORMAT(1X,T11,"AIR FLOW PARAMETERS"/)	SUMMARY	58
5010 FORMAT(1X,T16,"AIR FLOW RATE",T41,"10**6 LBM/HR",T56,F5,0)	SUMMARY	59
5020 FORMAT(1X,T16,"AIR VELOCITY",T41,"FT/SEC",T57,F5,1)	SUMMARY	60
5030 FORMAT(1X,T16,"DELTA P, H.X.",T41,"PSI",T58,F7,4)	SUMMARY	61
5040 FORMAT(1X,T16,"DELTA P, DISCHARGE",T41,"PSI",T58,F7,4)	SUMMARY	62
5050 FORMAT(1X,T16,"FAN POWER",T41,"MW",T57,F5,1)	SUMMARY	63
5060 FORMAT(1X,T16,"FANS",T41,"NUMBER",T56,I4,1)	SUMMARY	64
5070 FORMAT(1X,T11,"AMMONIA PARAMETERS"/)	SUMMARY	65
5080 FORMAT(1X,T16,"NH3 FLOW RATE",T41,"10**6 LBM/HR",T57,F5,1)	SUMMARY	66
5090 FORMAT(1X,T16,"DELTA P, NH3",T41,"PSI",T58,F6,3)	SUMMARY	67
5100 FORMAT(1X,T16,"PUMP POWER",T41,"MW",T58,F6,3,1)	SUMMARY	68
5110 FORMAT(1X,T11,"HEAT EXCHANGER DESIGN"/)	SUMMARY	69

5120	FORMAT(1X,T16,"TOWERS",T41,"NUMBER",T56,I4)	SUMMARY	70
5130	FORMAT(1X,T16,"APPROX. TOWER DIAMETER",T41,"FT",T56,F5.0)	SUMMARY	71
5140	FORMAT(1X,T16,"TOWER HEIGHT",T41,"FT",T56,F6.1)	SUMMARY	72
5150	FORMAT(1X,T16,"FRONTAL AREA",T41,"10**6 SQFT",T58,F6.3)	SUMMARY	73
5160	FORMAT(1X,T16,"HEAT TRANSFER AREA",T41,"10**6 SQFT",T57,F5.1)	SUMMARY	74
5170	FORMAT(1X,T16,"TUBE LENGTH",T41,"FT",T57,F5.1)	SUMMARY	75
5180	FORMAT(1X,T16,"TUBE ROWS IN DEPTH",T41,"NUMBER",T57,I3,/))	SUMMARY	76
5190	FORMAT(1X,T11,"CONDENSER DESIGN",/)	SUMMARY	77
5200	FORMAT(1X,T16,"HEAT TRANSFER AREA",T41,"10**6 SQFT",T58,F6.3)	SUMMARY	78
5210	FORMAT(1X,T16,"TTD",T41,"DEG F",T58,F5.2,/))	SUMMARY	79
5220	FORMAT(1X,T11,"PERFORMANCE PARAMETERS",/)	SUMMARY	80
5230	FORMAT(1X,T16,"DESIGN TBP",T41,"IN HG",T58,F5.2)	SUMMARY	81
5240	FORMAT(1X,T16,"MAXIMUM TBP",T41,"IN HG",T58,F5.2)	SUMMARY	82
5250	FORMAT(1X,T16,"POWER AT MAXIMUM TBP",T41,"MW",T55,F7.1)	SUMMARY	83
5260	FORMAT(1X,T16,"MAX. PERCENT DELUGE",T56,F6.1)	SUMMARY	84
5270	FORMAT(1X,T16,"MAX. EVAPORATION RATE",T41,"GPM",T54,F7.0/)	SUMMARY	85
5280	FORMAT(1X,T11,"COST SUMMARY",/)	SUMMARY	86
5290	FORMAT(1X,T16,"COOLING SYSTEM",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	87
5300	FORMAT(1X,T16,"CAPACITY",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	88
5310	FORMAT(1X,T16,"STEAM SUPPLY SCALING",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	89
5311	FORMAT(1X,T16,"HEAT RATE SCALING",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	90
5312	FORMAT(1X,T16,"FAN AND PUMP SCALING",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	91
5320	FORMAT(1X,T16,"ENERGY",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	92
5330	FORMAT(1X,T16,"BASE FUEL",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	93
5340	FORMAT(1X,T16,"O AND M",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	94
5345	FORMAT(1X,T16,"WATER",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	95
5350	FORMAT(1X,T16,"INCR. COST OF COOLING",T41,"MILLS/KWH",T57,F6.2)	SUMMARY	96
6000	FORMAT(1X,T11,BA10)	SUMMARY	97
6010	FORMAT(1H1)	SUMMARY	98
6020	FORMAT(1X,///)	SUMMARY	99
	RETURN	SUMMARY	100
	END	SUMMARY	101

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

SUBROUTINE SURCON (ISUR, KGA, LD, TLA, XNTS, ARPS, XNS, CONCS
$              ,CONMAT, POMCND)
SURCON      2
SURCON      3
SURCON      4
SURCON      5
SURCON      6
SURCON      7
SURCON      8
SURCON      9
SURCON     10
SURCON     11
SURCON     12
SURCON     13
SURCON     14
SURCON     15
SURCON     16
SURCON     17
SURCON     18
SURCON     19
SURCON     20
SURCON     21
SURCON     22
SURCON     23
SURCON     24
SURCON     25
SURCON     26
SURCON     27
SURCON     28
SURCON     29
SURCON     30
SURCON     31
SURCON     32
SURCON     33
SURCON     34
SURCON     35
SURCON     36
SURCON     37
SURCON     38
SURCON     39
SURCON     40
SURCON     41
SURCON     42
SURCON     43
SURCON     44
SURCON     45
SURCON     46
SURCON     47
SURCON     48
SURCON     49
SURCON     50
SURCON     51
SURCON     52
SURCON     53
SURCON     54
SURCON     55
SURCON     56
SURCON     57
SURCON     58

PROGRAM SURCON DETERMINES THE CAPITAL COST OF A SINGLE
PRESSURE OR SERIES-CONNECTED SURFACE CONDENSER. REFERENCE
"SURFACE CONDENSERS FOR LAND INSTALLATION", FORM PL1312,
WESTINGHOUSE ELECTRIC CORPORATION, 26 NOVEMBER 1968
UPDATED ON FEBRUARY 12, 1976 TO CURRENT PRICES

DEFINITION OF VARIABLES
ACCF - ACCESSORY COST CORRECTION FACTOR FOR THE CONDENSER
AODER - INCREASES COST OF TUBING MATERIAL
ARPS - AREA PER SHELL OF THE CONDENSER (SQ FT)
AUXCST - AUXILIARY COST ($)
CFAC - LENGTH CORRECTION FACTOR (DIMENSIONLESS)
CONCST - CONDENSER COST ($)
CONMAT - VARIABLE FOR CONDENSER MATERIAL (DIMENSIONLESS)
OSCT - QUANTITY DISCOUNT FOR TUBES (DIMENSIONLESS)
ERTCST - ERECTION COST ($/SQ FT)
F - TUBING LENGTH PENALTY (DIMENSIONLESS)
FETCST - FIELD ERECTION COST ($/SQ FT)
FOD - TUBE SIZE FACTOR (DIMENSIONLESS)
POMCND - INDIRECT COST FACTOR FOR THE TUBE, SHELL, AND
FIELD ERECTION COSTS (DIMENSIONLESS)
SHLCST - SHELL COST FOR THE CONDENSER ($)
TCTPFF - TOTAL COST OF TUBING MATERIAL ($/FT)
WT - WEIGHT OF TOTAL AMOUNT OF TUBES IN THE CONDENSER
(LBF)
XNS - NUMBER OF SHELLS IN THE CONDENSER (DIMENSIONLESS)
XNTS - NUMBER OF TUBES PER SHELL (DIMENSIONLESS)

DEFINITION OF ARRAYS
TUBMA - TUBE MATERIAL (NAMES)
CL - TUBE FIXED COSTS ($)
CLM - TUBE MATERIAL COSTS ($/LBM)
ROEL - DENSITY OF TUBE MATERIALS (LBM/CU IN)
GAGLI - TUBE GAGE (DIMENSIONLESS)
THKLIN - THICKNESS OF TUBE (IN)
ODLINE - COMMON DIAMETERS OF TUBES (IN)

LOGICAL FIRST
DIMENSION XLCST(6,2), SCC1(6), SCC2(6)
DIMENSION TUBMA(13), CL(10), CLM(10), ROEL(10), GAGLI(7),
* THKLIN(7), ODLINE(6), FF(10,7)
COMMON /RPRT3/ TUBCST,SHLCST,FETCST,CONBA7

TUBING MATERIALS, COSTS, AND DENSITY
DATA CL / 0.00, 0.00, 0.00, 0.08, 0.04, 0.38, 0.12, 0.20, 0.15,
* 0.10 /
DATA CLM / 1.30, 1.52, 1.83, 1.40, 1.36, 0.44, 0.32, 1.63, 7.60,
* 7.00 /
DATA ROEL / 0.308, 0.323, 0.323, 0.0975, .0975, 0.284, 0.284, .290
$ .0.163, 0.163 /

```

	DATA TUBMA / "ADMIRALTY ", "CU-10 NI ", "CU-30 NI ",	SURCON	59
	* "6061-T6 AL", "3003-H14 A", "STEEL SEAM",	SURCON	60
	* "STEEL WELD", "304 S/S WE", "TITANIUM 1",	SURCON	61
	* "TITANIUM 2", "LINDE CS14", "LINDE AL12",	SURCON	62
	* "LINDE SS16"/	SURCON	63
C		SURCON	64
C	STANDARD TUBE DIAMETERS, GAGE, AND THICKNESSES	SURCON	65
C		SURCON	66
	DATA ODLINE / 0.625, 0.750, 0.875, 1.000, 1.125, 1.250 /	SURCON	67
	DATA GAGLI / 12., 14., 16., 18., 20., 22., 24. /	SURCON	68
	DATA THKLIN / .109, .083, .065, .049, .035, .028, .021 /	SURCON	69
C		SURCON	70
C	TUBING LENGTH PENALTIES	SURCON	71
C		SURCON	72
C	FOR COPPER ALLOYS	SURCON	73
	DATA (FF(1,J),J=1,7) / 0.00, 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	SURCON	74
	DATA (FF(2,J),J=1,7) / 0.00, 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	SURCON	75
	DATA (FF(3,J),J=1,7) / 0.00, 0.00, 0.00, 0.00, 0.07, 0.08, 0.09 /	SURCON	76
C		SURCON	77
C	FOR ALUMINUM	SURCON	78
	DATA (FF(4,J),J=1,7) / 1.00, 1.00, 1.06, 1.10, 1.14, 1.18, 1.22 /	SURCON	79
	DATA (FF(5,J),J=1,7) / 1.00, 1.00, 1.06, 1.10, 1.14, 1.18, 1.22 /	SURCON	80
C		SURCON	81
C	FOR STEEL	SURCON	82
	DATA (FF(6,J),J=1,7) / 1.00, 1.00, 1.09, 1.13, 1.17, 1.21, 1.25 /	SURCON	83
	DATA (FF(7,J),J=1,7) / 1.00, 1.00, 1.09, 1.13, 1.17, 1.21, 1.25 /	SURCON	84
C		SURCON	85
C	FOR STAINLESS STEEL	SURCON	86
	DATA (FF(8,J),J=1,7) / 1.00, 1.00, 1.00, 1.04, 1.08, 1.12, 1.16 /	SURCON	87
C		SURCON	88
C	FOR TITANIUM	SURCON	89
	DATA (FF(9,J),J=1,7) / 0.00, 0.00, 0.00, 1.05, 1.05, 1.10, 1.10 /	SURCON	90
	DATA (FF(10,J),J=1,7) / 0.00, 0.00, 0.00, 1.05, 1.05, 1.10, 1.10 /	SURCON	91
C		SURCON	92
C	CONSTANTS FOR COST EQUATION FOR BASIC CONDENSER SHELL AS A	SURCON	93
C	FUNCTION OF TUBE O.D. (UPDATED FEBRUARY, 1976)	SURCON	94
C		SURCON	95
	DATA SCC1 / 0.00000, 7.69583, 8.805882, 10.83636, 12.954545,	SURCON	96
	* 15.22326 /	SURCON	97
	DATA SCC2 / 00000.00, 97125.00, 102164.71, 102181.82, 103272.73,	SURCON	98
	* 102237.21 /	SURCON	99
C		SURCON	100
C	COST OF FIELD ERECTION AND TUBING PER SQUARE FOOT OF	SURCON	101
C	SURFACE AREA IS BASED UPON INFORMATION SUPPLIED BY	SURCON	102
C	WESTINGHOUSE COMPANY AND AVERAGE WAGE LABOR RATES OBTAINED	SURCON	103
C	FROM JUNE 1975 CONSTRUCTION REVIEW	SURCON	104
C		SURCON	105
	DATA ERTCST / 2.50 /	SURCON	106
C		SURCON	107
	DATA FIRST/.TRUE./	SURCON	108
C		SURCON	109
C	DEFINING THE CASE UNDER CONSIDERATION	SURCON	110
C		SURCON	111
	IF(.NOT.FIRST) GOTO 55	SURCON	112
	LFLAG=0	SURCON	113
	DO 10 I = 1, 13	SURCON	114
	ITURMA = I	SURCON	115

IF(CONMAT.EQ. TUBMA(I)) GO TO 55	SURCON	116
10 CONTINUE	SURCON	117
WRITE(6,11)	SURCON	118
LFLAG=1	SURCON	119
11 FORMAT(5X,"NO MATCH FOR CONDENSER TUBE MATERIAL")	SURCON	120
IF(LFLAG.NE.0) STOP	SURCON	121
55 CONTINUE	SURCON	122
FIRST = .FALSE.	SURCON	123
C	SURCON	124
C DETERMINE TOTAL LENGTH OF TUBING REQUIRED AND CORRESPONDING	SURCON	125
C QUANTITY DISCOUNT	SURCON	126
C	SURCON	127
TOTLT=TLA*XNTS*XNS	SURCON	128
C	SURCON	129
IF(TOTLT=60000.)102,101,101	SURCON	130
101 DSCT=0.04	SURCON	131
GO TO 103	SURCON	132
102 IF(TOTLT=30000.)105,104,104	SURCON	133
104 DSCT=0.02	SURCON	134
GO TO 103	SURCON	135
105 DSCT=0.	SURCON	136
103 IF(ITUBMA.GE.11) GO TO 107	SURCON	137
KK = 7	SURCON	138
DO 106 I = 2, 8	SURCON	139
IF(TLA.GE. (10.0*I)) KK = I - 2	SURCON	140
106 CONTINUE	SURCON	141
F = FF(ITUBMA,KK)	SURCON	142
ADDER = 0.00	SURCON	143
IF(ITUBMA.LT. 4) ADDER = F	SURCON	144
IF(ITUBMA.LT. 4) F = 1.00	SURCON	145
C	SURCON	146
C DETERMINE TOTAL COST OF TUBING MATERIAL	SURCON	147
C	SURCON	148
WT = 12. * 3.14159 * ROEL(ITUBMA) * (ODLINE(LD)-THKLIN(KGA))	SURCON	149
S * THKLIN(KGA)	SURCON	150
TCSTPF = CLM(ITUBMA)*WT * CL(ITUBMA)	SURCON	151
TCSTPF = TCSTPF*F + ADDER	SURCON	152
C	SURCON	153
C TUBE COST ARE F.O.B. COSTS, 1.11 ACCOUNTS FOR PURCHASING	SURCON	154
C AND SHIPPING	SURCON	155
C	SURCON	156
TUBCST = TOTLT * TCSTPF * (1.11 + DSCT) * 1.05	SURCON	157
GO TO 110	SURCON	158
C	SURCON	159
C	SURCON	160
107 GO TO (108,109,114),ITUBMA-10	SURCON	161
108 TUBCST = TOTLT*1.5*1.05*(1.11-DSCT)	SURCON	162
GO TO 110	SURCON	163
109 TUBCST = TOTLT*1.6*1.05*(1.11-DSCT)	SURCON	164
GO TO 110	SURCON	165
114 TUBCST = TOTLT*2.5*1.05*(1.11-DSCT)	SURCON	166
110 TUBCST = TUBCST + PDMCND	SURCON	167
C	SURCON	168
C DETERMINE SHELL COST INCLUDING LENGTH, MULTIPRESSURE, AND	SURCON	169
C ACCESSORY COST CORRECTIONS, AS APPROPRIATE	SURCON	170
C	SURCON	171
CFAC = .016 * TLA * .58	SURCON	172

SUBROUTINE SURCON

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

		GO TO(100,111,112,113),ISUR	SURCON	173
	111	CFAC=CFAC+0.08	SURCON	174
		GO TO 100	SURCON	175
175	112	CFAC=CFAC+0.16	SURCON	176
		GO TO 100	SURCON	177
	113	CFAC=CFAC+0.03+XNS*0.02	SURCON	178
	C		SURCON	179
	100	FOD = 1.00	SURCON	180
180		IF(LD .LT. 4) FOD = 0.95	SURCON	181
		IF(LD .EQ. 6) FOD = 1.05	SURCON	182
		ACCF = (0.116*ALOG(XNTS) - 0.485)*FOD	SURCON	183
		IF(ITUBMA .EQ. 2) ACCF = (0.239*ALOG(XNTS - 1.416)*FOD	SURCON	184
	C		SURCON	185
185	C	THE CONDENSER SHELL COSTS WERE OBTAINED FROM WESTINGHOUSE'S	SURCON	186
	C	1973 PRICE LISTING 1312	SURCON	187
	C		SURCON	188
		AUXCST = 0.45*ARPS*XNS	SURCON	189
		BSHCST = (SCC1(LD)*XNTS + SCC2(LD))	SURCON	190
190		SHLCST=BSHCST*(CFAC+ACCF)*XNS + AUXCST	SURCON	191
		SHLCST = SHLCST + 1.05	SURCON	192
		SHLCST = SHLCST + POMCND	SURCON	193
	C		SURCON	194
195	C	DETERMINE COST OF FIELD ERECTION AND TUBING	SURCON	195
	C		SURCON	196
		FETCST=ERTCST*ARPS*XNS	SURCON	197
		FETCST = FETCST + 1.05	SURCON	198
		FETCST = FETCST + POMCND	SURCON	199
	C		SURCON	200
200	C	DETERMINE TOTAL COST OF CONDENSER	SURCON	201
	C		SURCON	202
		CONCST=TUBCST+SHLCST+FETCST	SURCON	203
		CONBA7=CONCST	SURCON	204
	C		SURCON	205
205		RETURN	SURCON	206
		END	SURCON	207

CARD NR. SEVERITY DETAILS DIAGNOSIS OF PROBLEM

160 I

AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

T4/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

SUBROUTINE TBPMAX(BPL,PSATMAX,TSATMAX,DPER,DPERQ,WATCON,WATCONT,
1PMAXDRY,TMAXDRY,PDELUG,TDELUG,WATDE,LICK)

SUBROUTINE TBPMAX DETERMINES THE OPERATION OF THE HEAT
TRANSFER SYSTEM OF THE POWER PLANT WHEN THE BACK PRESSURE
CURVE OF THE TURBINE IS SPECIFIED OVER THE WHOLE AMBIENT
TEMPERATURE RANGE. IT ALSO DETERMINES THE BACK PRESSURE OF
THE TURBINE OVER THE AMBIENT TEMPERATURE RANGE WHEN THE HEAT
EXCHANGER IS COMPLETELY DRY.

DEFINITION OF VARIABLES

AI - INSIDE AREA OF HEAT EXCHANGER PER TUBE (SQ FT/FT)
ALPHA - RATIO OF HEAT TRANSFER AREA TO HEAT EXCHANGER
VOLUME (SQ FT/SQ FT)
ANTU - NUMBER OF THERMAL UNITS OF THE DRY HEAT EXCHANGER
AT DESIGN CONDITIONS (DIMENSIONLESS)
ANTU2 - NUMBER OF THERMAL UNITS OF THE DRY HEAT EXCHANGER
AT OFF DESIGN CONDITIONS (DIMENSIONLESS)
ATOT - OUTSIDE AREA OF THE HEAT EXCHANGER PER UNIT
DIMENSION (SQ FT/FT)
CONL - THERMAL CONDUCTIVITY OF THE MATERIAL MAKING UP THE
HEAT EXCHANGER TUBING (BTU/HR-DEG F-FT)
CPA - SPECIFIC HEAT OF THE AIR AT THE DESIGN AMBIENT
TEMPERATURE (BTU/LBM-DEG F)
CPW - SPECIFIC HEAT OF THE AMMONIA AT THE DESIGN AMBIENT
TEMPERATURE (BTU/LBM-DEG F)
DELPS - DESIGN SUPPLY PIPING PRESSURE DROP (LB/SQ FT)
DELPS2 - OFF DESIGN SUPPLY PIPING PRESSURE DROP (LB/SQ FT)
DENSIF - DENSITY OF THE AMBIENT AIR ENTERING THE HEAT
EXCHANGER (LBM/CU FT)
DENSIV - DENSITY OF THE AMMONIA VAPOR LEAVING THE CONDENSER/
REBOILER AT DESIGN CONDITIONS (LBM/CU FT)
DENSIV2 - DENSITY OF THE AMMONIA VAPOR LEAVING THE CONDENSER/
REBOILER AT OFF DESIGN CONDITIONS (LBM/CU FT)
DENSIW - DENSITY OF THE AMMONIA LIQUID (LBM/CU FT)
DI - INSIDE DIAMETER OF THE HEAT EXCHANGER TUBES (IN)
EFF - EFFECTIVENESS OF THE DRY HEAT EXCHANGER AT DESIGN
CONDITIONS (DIMENSIONLESS)
EFF2 - EFFECTIVENESS OF THE DRY HEAT EXCHANGER AT OFF
DESIGN CONDITIONS (DIMENSIONLESS)
EFS - OUTSIDE SURFACE EFFECTIVENESS OF THE HEAT EXCHANGER
AT DESIGN CONDITIONS (DIMENSIONLESS)
ELENG - LENGTH OF THE HEAT EXCHANGER TUBES (FT)
ELEV - ELEVATION OF THE PLANT SITE (FT)
FACTOR - RATIO OF THE AIR VELOCITY IN THE HEAT EXCHANGER
WHEN IT IS DELUGED TO THE AIR VELOCITY IN THE HEAT
EXCHANGER WHEN IT IS DRY (DIMENSIONLESS)
GAIR2 - MASS FLUX OF THE AIR THROUGH THE HEAT EXCHANGER
WHEN IT IS DELUGED (LBM/SQ FT-HR)
GWAT2 - MASS FLUX OF THE AMMONIA THROUGH THE TUBES OF THE
HEAT EXCHANGER (LBM/SQ FT-HR)
HPG2 - HEAT OF VAPORIZATION OF AMMONIA AT OFF DESIGN
CONDITIONS (BTU/LBM)
HI2 - INSIDE HEAT TRANSFER COEFFICIENT OF THE HEAT
EXCHANGER TUBES AT OFF DESIGN CONDITIONS
(BTU/HR-DEG F-SQ FT)

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

C	H0	- AIR SIDE HEAT TRANSFER COEFFICIENT OF THE HEAT EXCHANGER AT DESIGN CONDITIONS (BTU/HR-DEG F-SQ FT)	TBPMAX	59
C			TBPMAX	60
C	H02	- AIR SIDE HEAT TRANSFER COEFFICIENT OF THE HEAT EXCHANGER AT OFF DESIGN CONDITIONS	TBPMAX	61
C		(BTU/HR-DEG F-SQ FT)	TBPMAX	62
C	HRFAC1	- HEAT RATE FACTOR AT RATING CONDITION	TBPMAX	63
C		(DIMENSIONLESS)	TBPMAX	64
C	HRFAC2	- HEAT RATE FACTOR AT DESIGN CONDITIONS	TBPMAX	65
C		(DIMENSIONLESS)	TBPMAX	66
C	HRFAC4	- HEAT RATE FACTOR AT OFF DESIGN CONDITIONS	TBPMAX	67
C		(DIMENSIONLESS)	TBPMAX	68
C	NTA	- NUMBER OF TEMPERATURE INCREMENTS IN THE AMBIENT TEMPERATURE RANGE OF THE PLANT SITE	TBPMAX	69
C		(DIMENSIONLESS)	TBPMAX	70
C	NW	- NUMBER OF TUBES IN THE WIDTH OF THE HEAT EXCHANGER (DIMENSIONLESS)	TBPMAX	71
C			TBPMAX	72
C	ODL	- OUTSIDE DIAMETER OF THE HEAT EXCHANGER TUBING (IN)	TBPMAX	73
C	P	- BACK PRESSURE OF THE TURBINE (IN HGA)	TBPMAX	74
C	PATM	- ATMOSPHERIC PRESSURE AT THE PLANT SITE	TBPMAX	75
C		(ATMOSPHERES)	TBPMAX	76
C	PERCENT	- FRACTION OF THE HEAT EXCHANGER DELUGED	TBPMAX	77
C		(DIMENSIONLESS)	TBPMAX	78
C	PERCENT1	- STORAGE VARIABLE FOR THE FRACTION OF THE HEAT EXCHANGER DELUGED (DIMENSIONLESS)	TBPMAX	79
C			TBPMAX	80
C	PRW	- PRANDTL NUMBER OF THE AMMONIA LIQUID AT THE DESIGN CONDITIONS (DIMENSIONLESS)	TBPMAX	81
C			TBPMAX	82
C	PSIZ13	- TOTAL POWER OUTPUT OF THE PLANT AT DESIGN CONDITIONS (MEGAWATTS)	TBPMAX	83
C			TBPMAX	84
C	P12	- AMMONIA PRESSURE AT THE CONDENSER/REBOILER (LBF/SQ FT)	TBPMAX	85
C			TBPMAX	86
C	P22	- AMMONIA PRESSURE AT THE HEAT EXCHANGER (LBF/SQ FT)	TBPMAX	87
C			TBPMAX	88
C	QDRY	- AMOUNT OF HEAT REJECTED BY THE DRY PART OF THE HEAT EXCHANGER (BTU/HR)	TBPMAX	89
C			TBPMAX	90
C	QIN1	- HEAT INPUT INTO THE POWER PLANT (BTU/HR)	TBPMAX	91
C	QREJTW	- AMOUNT OF HEAT REJECTED BY THE WET PART OF THE HEAT EXCHANGER (BTU/HR)	TBPMAX	92
C			TBPMAX	93
C	QREJT1	- HEAT REJECTED AT THE DESIGN CONDITIONS OF THE PLANT (BTU/HR)	TBPMAX	94
C			TBPMAX	95
C	QREJT2	- HEAT REJECTED AT THE OFF DESIGN CONDITIONS OF THE PLANT (BTU/HR)	TBPMAX	96
C			TBPMAX	97
C	QSEC	- AMOUNT OF HEAT REJECTED BY THE WET PART OF THE HEAT EXCHANGER PER UNIT DIMENSION (BTU/HR)	TBPMAX	98
C			TBPMAX	99
C	RANGE	- TEMPERATURE RANGE OF THE AIR THROUGH THE DRY PART OF THE HEAT EXCHANGER AT DESIGN CONDITIONS (DEG F)	TBPMAX	100
C			TBPMAX	101
C	RANGE2	- TEMPERATURE RANGE OF THE AIR THROUGH THE DRY PART OF THE HEAT EXCHANGER AT OFF DESIGN CONDITIONS (DEG F)	TBPMAX	102
C			TBPMAX	103
C	RANGE21	- TEMPERATURE RANGE OF THE AIR THROUGH THE DRY PART OF THE HEAT EXCHANGER AT OFF DESIGN CONDITIONS (DEG F)	TBPMAX	104
C			TBPMAX	105
C	RMA	- MASS FLOW RATE OF AIR FLOWING THROUGH EACH UNIT DIMENSION OF THE HEAT EXCHANGER (LBM/HR)	TBPMAX	106
C			TBPMAX	107
C	RMEV	- AMOUNT OF WATER EVAPORATED PER UNIT DIMENSION OF THE HEAT EXCHANGER (LBM/HR AND THE TOTAL HEAT EXCHANGER WHEN IT IS DELUGED (LBM/HR)	TBPMAX	108
C			TBPMAX	109
C	SIGMAG	- FREE FLOW AREA TO FRONTAL AREA OF THE HEAT EXCHANGER (SQ FT/SQ FT)	TBPMAX	110
C			TBPMAX	111
C			TBPMAX	112
C			TBPMAX	113
C			TBPMAX	114
C			TBPMAX	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	TA	- AMBIENT TEMPERATURE (DEG F)	TBPMAX	116
C	TAWB	- AMBIENT WETBULB TEMPERATURE (DEG F)	TBPMAX	117
C	TEFF	- BASE THERMAL EFFICIENCY OF THE PLANT	TBPMAX	118
C		(DIMENSIONLESS)	TBPMAX	119
C	TEFF1	- RATED THERMAL EFFICIENCY OF THE PLANT	TBPMAX	120
C		(DIMENSIONLESS)	TBPMAX	121
C	TEFF3	- DESIGN THERMAL EFFICIENCY OF THE PLANT	TBPMAX	122
C		(DIMENSIONLESS)	TBPMAX	123
C	TEFF4	- OFF DESIGN THERMAL EFFICIENCY OF THE PLANT	TBPMAX	124
C		(DIMENSIONLESS)	TBPMAX	125
C	TMCONW	- THERMAL CONDUCTIVITY OF THE AMMONIA AT DESIGN	TBPMAX	126
C		CONDITIONS (BTU/HR-DEG F-FT)	TBPMAX	127
C	TI	- TEMPERATURE OF THE AMMONIA AT THE INLET TO THE HEAT	TBPMAX	128
C		EXCHANGER (DEG F)	TBPMAX	129
C	TPER	- FRACTION OF THE YEAR THAT THE CORRESPONDING	TBPMAX	130
C		AMBIENT TEMPERATURE EXISTS (DIMENSIONLESS)	TBPMAX	131
C	TTD1	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM	TBPMAX	132
C		AND AMMONIA IN THE CONDENSER/REBOILER AT DESIGN	TBPMAX	133
C		CONDITIONS (DEG F)	TBPMAX	134
C	TTD12	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM	TBPMAX	135
C		AND AMMONIA IN THE CONDENSER/REBOILER AT OFF DESIGN	TBPMAX	136
C		CONDITIONS (DEG F)	TBPMAX	137
C	TTD2	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	TBPMAX	138
C		PIPING (DEG F)	TBPMAX	139
C	TTD22	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	TBPMAX	140
C		PIPING AT OFF DESIGN CONDITIONS (DEG F)	TBPMAX	141
C	T1	- SATURATED STEAM TEMPERATURE IN THE CONDENSER/	TBPMAX	142
C		REBOILER (DEG F)	TBPMAX	143
C	T11	- STORAGE VARIABLE FOR THE SATURATED STEAM	TBPMAX	144
C		TEMPERATURE IN THE CONDENSER/REBOILER (DEG F)	TBPMAX	145
C	U	- OVERALL HEAT TRANSFER COEFFICIENT OF THE HEAT	TBPMAX	146
C		EXCHANGER AT DESIGN CONDITIONS (BTU/HR-DEG F-SQ FT)	TBPMAX	147
C	U2	- OVERALL HEAT TRANSFER COEFFICIENT OF THE HEAT	TBPMAX	148
C		EXCHANGER AT OFF DESIGN CONDITIONS	TBPMAX	149
C		(BTU/HR-DEG F-SQ FT)	TBPMAX	150
C	VAIR	- MAXIMUM AIR VELOCITY THROUGH THE DRY HEAT	TBPMAX	151
C		EXCHANGER (FT/SEC)	TBPMAX	152
C	VISA	- VISCOSITY OF THE AIR AT THE AVERAGE AIR TEMPERATURE	TBPMAX	153
C		IN THE DRY HEAT EXCHANGER (LBM/FT-HR)	TBPMAX	154
C	VISV	- VISCOSITY OF THE AMMONIA VAPOR ENTERING THE HEAT	TBPMAX	155
C		EXCHANGER AT DESIGN CONDITIONS (LBM/FT-HR)	TBPMAX	156
C	VISW	- VISCOSITY OF THE AMMONIA LIQUID ENTERING THE HEAT	TBPMAX	157
C		EXCHANGER AT DESIGN CONDITIONS (LBM/FT-HR)	TBPMAX	158
C	WATCONA	- AMOUNT OF WATER ALLOWED TO BE EVAPORATED OVER THE	TBPMAX	159
C		WHOLE YEAR (LBM/YEAR)	TBPMAX	160
C	WATCONT	- AMOUNT OF WATER EVAPORATED DURING THE WHOLE YEAR	TBPMAX	161
C		BY THE PARTIALLY DELUGED HEAT EXCHANGER (LBM/YEAR)	TBPMAX	162
C	W3	- MASS FLOW RATE OF AMMONIA AT DESIGN CONDITIONS	TBPMAX	163
C		(LBM/HR)	TBPMAX	164
C	W32	- MASS FLOW RATE OF AMMONIA AT OFF DESIGN CONDITIONS	TBPMAX	165
C		(LBM/HR)	TBPMAX	166
C	W32D	- MASS FLOW RATE OF AMMONIA TO THE DRY PART OF THE	TBPMAX	167
C		HEAT EXCHANGER AT OFF DESIGN CONDITIONS (LBM/HR)	TBPMAX	168
C	W32W	- MASS FLOW RATE OF AMMONIA TO THE WET PART OF THE	TBPMAX	169
C		HEAT EXCHANGER AT OFF DESIGN CONDITIONS (LBM/HR)	TBPMAX	170
C	W4	- MASS FLOW RATE OF AIR THROUGH THE HEAT EXCHANGER	TBPMAX	171
C		AT DESIGN CONDITIONS (LBM/HR)	TBPMAX	172

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	YFP	- PLANT SCALING FACTOR FOR FAN AND PUMP POWER LOSS	TBPMAX	173
C	XD	- LONGITUDINAL PITCH OF THE TUBES IN THE HEAT EXCHANGER (IN)	TBPMAX	174
C			TBPMAX	175
C	YFP	- PLANT SCALING FACTOR FOR FAN AND PUMP POWER LOSS (DIMENSIONLESS)	TBPMAX	176
C			TBPMAX	177
C	Z	- HEAT EXCHANGER DEPTH IN NUMBER OF TUBES (DIMENSIONLESS)	TBPMAX	178
C			TBPMAX	179
C	ZD	- HEAT EXCHANGER DEPTH IN NUMBER OF TUBES (DIMENSIONLESS)	TBPMAX	180
C			TBPMAX	181
C			TBPMAX	182
C	DEFINITION OF ARRAYS		TBPMAX	183
C			TBPMAX	184
C	ANG	- THE ANGLE OF THE HEAT EXCHANGER TUBES FROM THE HORIZONTAL AND THE SINE AND COSINE OF THAT ANGLE	TBPMAX	185
C			TBPMAX	186
C	BPL	- BACK PRESSURE LIMIT CURVE (IN HGA)	TBPMAX	187
C	DPER	- FRACTION OF THE HEAT EXCHANGER THAT IS DELUGED FOR EACH AMBIENT TEMPERATURE INCREMENT (DIMENSIONLESS)	TBPMAX	188
C			TBPMAX	189
C	DPERG	- FRACTION OF THE HEAT LOAD THAT IS CARRIED OFF BY THE DELUGED PART OF THE HEAT EXCHANGER FOR EACH AMBIENT TEMPERATURE INCREMENT (DIMENSIONLESS)	TBPMAX	190
C			TBPMAX	191
C	PDELUG	- BACK PRESSURE CURVE WHEN THE HEAT EXCHANGER IS DELUGED COMPLETELY (IN HGA)	TBPMAX	192
C			TBPMAX	193
C	PMAXDRY	- ALL DRY BACK PRESSURE CURVE (IN HGA)	TBPMAX	194
C			TBPMAX	195
C	PSATMAX	- BACK PRESSURE CURVE WHICH CAN INCLUDE ALL DRY OR ALL WET BACK PRESSURES (IN HGA)	TBPMAX	196
C			TBPMAX	197
C	TDELUG	- TURBINE STEAM TEMPERATURE CURVE WHEN THE HEAT EXCHANGER IS DELUGED COMPLETELY (DEG F)	TBPMAX	198
C			TBPMAX	199
C	TMAXDRY	- ALL DRY TURBINE STEAM TEMPERATURE CURVE (DEG F)	TBPMAX	200
C	TPO	- ARRAY OF COEFFICIENTS FOR THE CUBIC CURVE FIT OF HEAT RATE FACTOR AS A FUNCTION OF TURBINE BACK PRESSURE (DIMENSIONLESS)	TBPMAX	201
C			TBPMAX	202
C			TBPMAX	203
C	TSATMAX	- TURBINE STEAM TEMPERATURE CURVE WHICH CAN INCLUDE ALL DRY OR ALL WET TURBINE STEAM TEMPERATURES (DEG F)	TBPMAX	204
C			TBPMAX	205
C			TBPMAX	206
C	VTA	- AMBIENT TEMPERATURE CURVE (DEG F)	TBPMAX	207
C	VTAWB	- AMBIENT WET BULB TEMPERATURE CURVE (DEG F)	TBPMAX	208
C	VTPER	- FRACTION OF THE YEAR THAT THE AMBIENT AND WET BULB TEMPERATURE INCREMENTS EXIST (DIMENSIONLESS)	TBPMAX	209
C			TBPMAX	210
C	WATCON	- WATER CONSUMPTION OF THE HEAT EXCHANGER OVER THE WHOLE YEAR FOR EACH AMBIENT TEMPERATURE INCREMENT (LBM/YEAR)	TBPMAX	211
C			TBPMAX	212
C			TBPMAX	213
C	WATDE	- WATER CONSUMPTION OF THE HEAT EXCHANGER WHEN IT IS COMPLETELY DELUGED OVER THE WHOLE YEAR FOR EACH AMBIENT TEMPERATURE INCREMENT (LBM/YEAR)	TBPMAX	214
C			TBPMAX	215
C			TBPMAX	216
C			TBPMAX	217
C	LOGICAL FRST3		TBPMAX	218
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG		BIGCOM	2
	COMMON		BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)		BIGCOM	4
	* ,BPLIM(16)		BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	6
	\$,CBJ, CTURB, CLUVR, CHAILS, CVM		BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	8
	\$,EFFP, EFS		BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG		BIGCOM	10
	\$,FIXV,FIXTDD,FXTVAR,FXTTDD,FXTLNG		BIGCOM	11
	\$,GBEFF		BIGCOM	12

\$,HXNP,HPCST,HCD	BIGCOM	13
\$,ITMAX,ITMIN	BIGCOM	14
\$,JCONS	BIGCOM	15
\$,KCONV,KALEXT	BIGCOM	16
\$,MxEXT	BIGCOM	17
\$,NTA,NSIDES,NBUNHI	BIGCOM	18
COMMON	BIGCOM	19
\$ ODP	BIGCOM	20
\$,PSIZE,PER,PWCOS,PLANC,PFACT,POMDPL	BIGCOM	21
\$,POHBAF,POHFAN,POHLEC,POHCIR,POHCND,POHSTC,POHSCL	BIGCOM	22
\$,RBP,REDUCE,REDUCV,ROOFL,RHOUT	BIGCOM	23
\$,QREJ,QREDUCE,QREDUCV	BIGCOM	24
\$,SIGMAG,SAAF,SEGL	BIGCOM	25
\$,TD,TPO(4),TEFF,TLIM,THFIN,TLRA,TFIX	BIGCOM	26
\$,TCD,TW	BIGCOM	27
\$,UCS,UWS	BIGCOM	28
\$,WV,WATCONA,WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDEPA,XW,XD	BIGCOM	31
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,	SUPPLY	2
\$ QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,	SUPPLY	3
\$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,	SUPPLY	4
\$ REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,	SUPPLY	5
\$ SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,	SUPPLY	6
\$ BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS,XNTSX,VELDX	SUPPLY	7
\$, TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS	SUPPLY	8
\$, CLTC, CFC, CPCC, FITCO, CSC,CEPREP,DELP1P, AST,OLDCST	SUPPLY	9
\$,CAPCST,XNFAN,BLDANG,CLEN,DPFEL, WHX,WTUB,ADIA,ABLN	SUPPLY	10
\$, WTHDR, WTRFM,STRUCC,CFPERF,HPPERF,TOTCF, TPC, EFFIN, ANTU	SUPPLY	11
\$, AIRPF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP	SUPPLY	12
\$, ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST	SUPPLY	13
\$, CSRD, WATERW, WSTRCT, CFOUND, HUBDIA, TOWLEN, NUMTOW, CTOWD	SUPPLY	14
\$,SORJ,SORJS,ATUBC,CRA,TTD1,TTD2,DELPS,CSTLVR,PIPCSTO	SUPPLY	15
\$,CSTHS,CYL RNG,CFANEL,PSTACS,PUFITC,PMPCST,RPTPL,SEPCST	SUPPLY	16
\$,PWD(16),WATCWD(16),DEPER(16),DEPERQ(16)	SUPPLY	17
\$,WBR,MTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5	SUPPLY	18
COMMON /SCALER/HRFAC1,ATUB,CPERA,SSCD,PLANC1,CASSS1,	SCALER	2
\$ GAIR,FAIR,HPAIR,HPWAT,WLRT,PLANC1	SCALER	3
COMMON /HXD/ AI,ATOT,SFA,RFA,ACS	TBPMAX	222
COMMON /VARVAR/ VTPER(16),VTA(16),VTAWB(16)	TBPMAX	223
COMMON /DJB/DI,XDG,SF	TBPMAX	224
COMMON /SURFEX/ ODL,DUMLST(15)	TBPMAX	225
COMMON /DLUG/TA,TAWB,TI,PATM,HI2,M02,RMA,QSEC,RMEV,VALREQ	TBPMAX	226
COMMON /COUNT/ NSLOPE,FRST3	TBPMAX	227
COMMON /FAN/ FANDAP(153,10),FANDAH(153,10),FMCPF,FBCPF,P2,R,S,	TBPMAX	228
\$ VELREC,AFC,ELEV,EHR,LOOPER,CTMAX	TBPMAX	229
COMMON /PROP/ CPW,THCONW,DENSIW,VISW,HFG,	TBPMAX	230
\$ CPV,THCONV,DENSIV,VISV,SIGMA,	TBPMAX	231
\$ CPA,THCONA,DENSIA,VISA	TBPMAX	232
DIMENSION BPL(16),PSATMAX(16),TSATMAX(16),WATCON(16),	TBPMAX	233
1 PMAXDRY(16),TMAXDRY(16),PDELUG(16),TDELUG(16),	TBPMAX	234
2 WATDE(16),DPER(16),DPERQ(16)	TBPMAX	235
NDBG1 = 0	TBPMAX	236
WATCON = 0.0	TBPMAX	237
NSLOPE = 0	TBPMAX	238
ZD = Z	TBPMAX	239
VALREQ = Z	TBPMAX	240

C		TBPMAX	241
C	DESIGN THERMAL EFFECTIVENESS OF THE POWER PLANT	TBPMAX	242
	TEFF3 = TEFF/HRFAC2	TBPMAX	243
C		TBPMAX	244
C	RATED THERMAL EFFECTIVENESS OF THE POWER PLANT	TBPMAX	245
	TEFF1 = TEFF/HRFAC1	TBPMAX	246
C		TBPMAX	247
C	HEAT INPUT INTO THE POWER PLANT	TBPMAX	248
	QIN1 = 3413.E+3*PSIZ13/TEFF1	TBPMAX	249
C		TBPMAX	250
C	HEAT REJECTED AT THE DESIGN THERMAL EFFECTIVENESS OF THE	TBPMAX	251
C	POWER PLANT	TBPMAX	252
	QREJT1 = QIN1*(1. - TEFF3)	TBPMAX	253
C		TBPMAX	254
C	RANGE OF THE AIR AT THE DESIGN AMBIENT TEMPERATURE	TBPMAX	255
	RANGE = QREJT1/(W4*(1. + YFP)*CPA)	TBPMAX	256
	IF(LICK.GT.0) GO TO 110	TBPMAX	257
C		TBPMAX	258
C	LOOP TO FIND THE BACK PRESSURE OF THE TURBINE OVER THE	TBPMAX	259
C	AMBIENT TEMPERATURE RANGE WITH AN ALL DRY HEAT EXCHANGER	TBPMAX	260
C		TBPMAX	261
	DO 100 J = 1, NTA	TBPMAX	262
	I = NTA - J + 1	TBPMAX	263
C		TBPMAX	264
C	AMBIENT TEMPERATURE	TBPMAX	265
	TA = VTA(I)	TBPMAX	266
C		TBPMAX	267
C	PERCENT OF THE YEAR AT THE ABOVE AMBIENT TEMPERATURE	TBPMAX	268
	TPED = VTPER(I)	TBPMAX	269
C		TBPMAX	270
C	INITIAL GUESS FOR THE ALL DRY TURBINE SATURATED STEAM	TBPMAX	271
C	TEMPERATURE	TBPMAX	272
	T1 = TA + RANGE/EFF + TTD1 + TTD2	TBPMAX	273
C		TBPMAX	274
C	BACK PRESSURE OF THE TURBINE AT THE SATURATION TEMPERATURE	TBPMAX	275
	10 P = EXP(17.168 - 9240./(T1 + 460.))	TBPMAX	276
C		TBPMAX	277
C	HEAT RATE FACTOR AT THE ABOVE BACK PRESSURE	TBPMAX	278
	HRFAC4 = TPO(1) + TPO(2)*P + TPO(3)*P**2 + TPO(4)*P**3	TBPMAX	279
C		TBPMAX	280
C	THERMAL EFFECTIVENESS OF THE PLANT AT THE ABOVE BACK PRESSURE	TBPMAX	281
	TEFF4 = TEFF/HRFAC4	TBPMAX	282
C		TBPMAX	283
C	HEAT REJECTED AT THE ABOVE THERMAL EFFECTIVENESS OF THE	TBPMAX	284
C	POWER PLANT	TBPMAX	285
	QREJT2 = QIN1*(1. - TEFF4)	TBPMAX	286
C		TBPMAX	287
C	TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM AND THE	TBPMAX	288
C	AMMONIA IN THE CONDENSER/REBOILER	TBPMAX	289
	TTD12 = (QREJT2/QREJT1)*TTD1	TBPMAX	290
C		TBPMAX	291
C	PRESSURE OF THE AMMONIA LEAVING THE CONDENSER/REBOILER	TBPMAX	292
	P12 = FLUID(10,1,T1 - TTD12,ELEV,"TBPMAX1")	TBPMAX	293
	HFG2 = FLUID(9,1,T1 - TTD12,ELEV,"TBPMAX2")	TBPMAX	294
	DENSIV2 = FLUID(7,1,T1-TTD12,ELEV,"TBPMAX3")	TBPMAX	295
C		TBPMAX	296
C	MASS FLOW RATE OF AMMONIA THROUGH THE COOLING SYSTEM	TBPMAX	297

C	W32 = QREJT2/HFG2	TBPMAX	298
C	PRESSURE DROP OF AMMONIA THROUGH THE SUPPLY PIPING	TBPMAX	299
C	DELPS2 = DELPS*(W32**2*DENSIV/(DENSIV2*W3**2))	TBPMAX	300
C	PRESSURE AT THE END OF THE SUPPLY PIPING	TBPMAX	301
C	P22 = P12 - DELPS2/144.	TBPMAX	302
C	T1 = T1 - TTD1 - TTD2	TBPMAX	303
C	DELTI = .001	TBPMAX	304
C	LOOP TO DETERMINE THE TEMPERATURE OF THE AMMONIA AT THE END	TBPMAX	305
C	OF THE SUPPLY PIPING	TBPMAX	306
C	20 FTI = -P22 + FLUID(10,1,T1,ELEV,"TBPMAX4")	TBPMAX	307
	FTIDEL = -P22 + FLUID(10,1,T1 + DELTI,ELEV,"TBPMAX5")	TBPMAX	308
	TIP1 = T1 - DELTI*FTI/(FTIDEL - FTI)	TBPMAX	309
	IF(ABS(TIP1 - T1).LT..0001) GO TO 30	TBPMAX	310
	T1 = TIP1	TBPMAX	311
	GO TO 20	TBPMAX	312
C	TEMPERATURE DROP IN THE AMMONIA FROM THE BEGINNING TO THE	TBPMAX	313
C	END OF THE SUPPLY PIPING	TBPMAX	314
C	30 TTD22 = T1 - TTD12 - T1	TBPMAX	315
C	TEMPERATURE RANGE OF THE AIR	TBPMAX	316
C	RANGE2 = QREJT2/(W4*(1. + YFP)*CRA)	TBPMAX	317
C	SATURATION TEMPERATURE OF THE STEAM IN THE CONDENSER/REBOILER	TBPMAX	318
C	T11 = RANGE2/EFF + TA + TTD12 + TTD22	TBPMAX	319
C	CONVERGENCE CRITERIA FOR THE SATURATION TEMPERATURE OF THE	TBPMAX	320
C	STEAM IN THE CONDENSER/REBOILER	TBPMAX	321
C	IF(ABS(T11 - T1)/T11.LT..0001) GO TO 40	TBPMAX	322
	T1 = T11	TBPMAX	323
	GO TO 10	TBPMAX	324
C	IF THE BACK PRESSURE AT ANY AMBIENT TEMPERATURE IS ABOVE THE	TBPMAX	325
C	MAXIMUM BACK PRESSURE ALLOWED ALL BACK PRESSURES ASSOCIATED	TBPMAX	326
C	WITH AMBIENT TEMPERATURES EQUAL TO AND ABOVE THAT TEMPERATURE	TBPMAX	327
C	ARE SET EQUAL TO THE MAXIMUM BACK PRESSURE PLUS .1 IN HGA	TBPMAX	328
C	40 IF(P.GT.BPL(1)) GO TO 105	TBPMAX	329
C	STORAGE OF BACK PRESSURE AND STEAM SATURATION TEMPERATURE	TBPMAX	330
C	OF THE TURBINE	TBPMAX	331
C	PMAXDRY(I) = P	TBPMAX	332
C	TMAXDRY(I) = T1	TBPMAX	333
C	100 CONTINUE	TBPMAX	334
	GO TO 110	TBPMAX	335
C	FILLING THE DRY BACK PRESSURE ARRAY WITH THE MAXIMUM BACK	TBPMAX	336
C	PRESSURE ALLOWABLE PLUS .1 IN HGA	TBPMAX	337
C	105 DO 106 JJ = J, NTA	TBPMAX	338
	II = NTA - JJ + 1	TBPMAX	339
	106 PMAXDRY(II) = BPL(1) + .1	TBPMAX	340
	110 CONTINUE	TBPMAX	341
C	BEGINNING OF THE LOOP TO DETERMINE THE DRY/WET SPLITS OF	TBPMAX	342
C	THE HEAT EXCHANGER FOR A SET BACK PRESSURE CURVE	TBPMAX	343
C		TBPMAX	344
C		TBPMAX	345
C		TBPMAX	346
C		TBPMAX	347
C		TBPMAX	348
C		TBPMAX	349
C		TBPMAX	350
C		TBPMAX	351
C		TBPMAX	352
C		TBPMAX	353
C		TBPMAX	354

	DO 200 J = 1,NTA	TBPMAX	355
	II = NTA - J + 1	TBPMAX	356
	IF(KCONV.EQ.1.AND.LICK.EQ.0) RETURN	TBPMAX	357
C		TBPMAX	358
C	WET BULB AMBIENT TEMPERATURE	TBPMAX	359
	TAWB = VTAWB(II)	TBPMAX	360
C		TBPMAX	361
C	PERCENT OF THE YEAR AT THE ABOVE AMBIENT TEMPERATURE	TBPMAX	362
	TPER = VTPER(II)	TBPMAX	363
C		TBPMAX	364
C	AMBIENT TEMPERATURE	TBPMAX	365
	TA = VTA(II)	TBPMAX	366
C		TBPMAX	367
C	DETERMINATION OF THE POINT AND SETTING OF THE VARIABLES WHERE	TBPMAX	368
C	DELUING OF THE HEAT EXCHANGER MUST BEGIN ON THE AMBIENT	TBPMAX	369
C	TEMPERATURE CURVE	TBPMAX	370
	IF(ABS(BPL(II) - PMAXDRY(II))/BPL(II).LT..0025.OR.PMAXDRY(II).LE.B	TBPMAX	371
	1PL(II)) PSATMAX(II) = PMAXDRY(II)	TBPMAX	372
	IF(ABS(BPL(II) - PMAXDRY(II))/BPL(II).LT..0025.OR.PMAXDRY(II).LE.B	TBPMAX	373
	1PL(II)) TSATMAX(II) = TMAXDRY(II)	TBPMAX	374
	IF(ABS(BPL(II) - PMAXDRY(II))/BPL(II).LT..0025.OR.PMAXDRY(II).LE.B	TBPMAX	375
	1PL(II)) WATCON(II) = 0.0	TBPMAX	376
	IF(ABS(BPL(II) - PMAXDRY(II))/BPL(II).LT..0025.OR.PMAXDRY(II).LE.B	TBPMAX	377
	1PL(II)) DPER(II) = 0.0	TBPMAX	378
	IF(ABS(BPL(II) - PMAXDRY(II))/BPL(II).LT..0025.OR.PMAXDRY(II).LE.B	TBPMAX	379
	1PL(II)) DPERQ(II) = 0.0	TBPMAX	380
	IF(ABS(BPL(II) - PMAXDRY(II))/BPL(II).LT..0025.OR.PMAXDRY(II).LE.B	TBPMAX	381
	1PL(II)) GO TO 200	TBPMAX	382
C		TBPMAX	383
C	DETERMINATION OF THE POINT WHERE COMPLETE DELUGING OF THE	TBPMAX	384
C	HEAT EXCHANGER OCCURS ON THE AMBIENT TEMPERATURE CURVE	TBPMAX	385
	IF(ABS(BPL(II) - PDELUG(II))/BPL(II).LT..0025.OR.BPL(II).LE.PDELU	TBPMAX	386
	IG(II)) GO TO 170	TBPMAX	387
	NSLOPE = NSLOPE + 1	TBPMAX	388
	FRST3 = .TRUE.	TBPMAX	389
C		TBPMAX	390
C	SATURATION TEMPERATURE OF THE STEAM IN THE CONDENSER/REBOILER	TBPMAX	391
C	DETERMINED FROM THE BACK PRESSURE CURVE	TBPMAX	392
	T1 = 9240./(17.168 - ALOG(BPL(II))) - 460.	TBPMAX	393
C		TBPMAX	394
C	HEAT RATE FACTOR AT THE BACK PRESSURE ON THE CURVE	TBPMAX	395
	HRFAC4 = TPO(1) + TPO(2)*BPL(II) + TPO(3)*BPL(II)**2 + TPO(4)*	TBPMAX	396
	1BPL(II)**3	TBPMAX	397
C		TBPMAX	398
C	THERMAL EFFECTIVENESS OF THE PLANT AT THE ABOVE BACK PRESSURE	TBPMAX	399
	TEFF4 = TEFF/HRFAC4	TBPMAX	400
C		TBPMAX	401
C	HEAT REJECTED AT THE ABOVE THERMAL EFFECTIVENESS OF THE	TBPMAX	402
C	POWER PLANT	TBPMAX	403
	QREJT2 = QIN1*(1. - TEFF4)	TBPMAX	404
C		TBPMAX	405
C	TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM AND THE	TBPMAX	406
C	AMMONIA IN THE CONDENSER/REBOILER	TBPMAX	407
	TTD12 = (QREJT2/QREJT1)*TTD1	TBPMAX	408
C		TBPMAX	409
C	PRESSURE OF THE AMMONIA LEAVING THE CONDENSER/REBOILER	TBPMAX	410
	P12 = FLUID(10,1,T1 - TTD12,ELEV,"TBPMAX6")	TBPMAX	411

SUBROUTINE TBPMAX

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

	HFG2 = FLUID(9,1,T1 - TTD12,ELEV,"TBPMAX7")	TBPMAX	412
	DENSIV2 = FLUID(7,1,T1 - TTD12,ELEV,"TBPMAX8")	TBPMAX	413
C		TBPMAX	414
C	MASS FLOW RATE OF AMMONIA THROUGH THE COOLING SYSTEM	TBPMAX	415
	W32 = QREJT2/HFG2	TBPMAX	416
C		TBPMAX	417
C	PRESSURE DROP OF AMMONIA THROUGH THE SUPPLY PIPING	TBPMAX	418
	DELPS2 = DELPS*(W32**2*DENSIV/(DENSIV2*W3**2))	TBPMAX	419
C		TBPMAX	420
C	PRESSURE AT THE END OF THE SUPPLY PIPING	TBPMAX	421
	P22 = P12 - DELPS2/144.	TBPMAX	422
	TI = T1 - TTD1 - TTD2	TBPMAX	423
	DELT1 = .001	TBPMAX	424
C		TBPMAX	425
C	LOOP TO DETERMINE THE TEMPERATURE OF THE AMMONIA AT THE END	TBPMAX	426
C	OF THE SUPPLY PIPING	TBPMAX	427
120	FTI = -P22 + FLUID(10,1,TI,ELEV,"TBPMAX9")	TBPMAX	428
	FTIDEL = -P22 + FLUID(10,1,TI + DELTI,ELEV,"TBPMAX10")	TBPMAX	429
	TIP1 = TI - DELTI*FTI/(FTIDEL - FTI)	TBPMAX	430
	IF(ABS(TIP1 - TI).LT..0001) GO TO 125	TBPMAX	431
	TI = TIP1	TBPMAX	432
	GO TO 120	TBPMAX	433
C		TBPMAX	434
C	TEMPERATURE DROP IN THE AMMONIA FROM THE BEGINNING TO THE	TBPMAX	435
C	END OF THE SUPPLY PIPING	TBPMAX	436
125	TTD22 = T1 - TTD12 - TI	TBPMAX	437
C		TBPMAX	438
C	INITIALIZING SOME OF THE VARIABLES FOR THE DRY/WET SPLIT OF	TBPMAX	439
C	THE HEAT EXCHANGER	TBPMAX	440
	JK = 0	TBPMAX	441
	QDRY = 0.0	TBPMAX	442
	W32D = 0.0	TBPMAX	443
	PERCENT = .80	TBPMAX	444
C		TBPMAX	445
C	BEGINNING OF LOOP TO DETERMINE THE PERCENT OF THE HEAT	TBPMAX	446
C	EXCHANGER THAT IS DELUGED	TBPMAX	447
C		TBPMAX	448
130	JK = JK + 1	TBPMAX	449
	IF(PERCENT.GT.1.) PERCENT = .99	TBPMAX	450
C		TBPMAX	451
C	IF THE AMBIENT TEMPERATURE IS GREATER THAN OR EQUAL TO THE	TBPMAX	452
C	TEMPERATURE OF THE AMMONIA ENTERING THE HEAT EXCHANGER ALL	TBPMAX	453
C	HEAT IS REJECTED FROM THE HEAT EXCHANGER BY THE WET MODE	TBPMAX	454
	IF((T1 - TTD12 - TTD22 - TA).LE.0.0) GO TO 150	TBPMAX	455
C		TBPMAX	456
C	INITIAL GUESS FOR THE TEMPERATURE DIFFERENCE OF THE AIR	TBPMAX	457
C	ACROSS THE DRY PART OF THE HEAT EXCHANGER	TBPMAX	458
	RANGE2 = (T1 - TTD12 - TTD22 - TA)*EFF	TBPMAX	459
C		TBPMAX	460
C	LOOP TO DETERMINE THE AMOUNT OF HEAT THAT IS REJECTED FROM	TBPMAX	461
C	THE DRY PART OF THE HEAT EXCHANGER	TBPMAX	462
C		TBPMAX	463
C	CALCULATION OF THE AMOUNT OF HEAT REJECTED FROM THE DRY PART	TBPMAX	464
C	OF THE HEAT EXCHANGER	TBPMAX	465
140	QDRY = RANGE2*CPA*PERCENT*W4*(1. + YFP)	TBPMAX	466
C		TBPMAX	467
C	MASS FLOW RATE OF AMMONIA TO THE DRY PART OF THE HEAT	TBPMAX	468

C	EXCHANGER	TBPMAX	469
	W32D = QDRY/HFG2	TBPMAX	470
C		TBPMAX	471
C	MASS FLUX OF AMMONIA THROUGH THE DRY HEAT EXCHANGER TUBES	TBPMAX	472
	GWAT2 = W32D/(ZD*NW*3.14159*DI*DI/(4.*144.))*PERCENT)	TBPMAX	473
	PRW = VISW*CPW/THCONW	TBPMAX	474
C		TBPMAX	475
C	INSIDE HEAT TRANSFER COEFFICIENT OF THE DRY HEAT EXCHANGER	TBPMAX	476
	CALL HTCLO(DI,ELENG=12.,ANG,GWAT2,1.,0.,PRW,DENSIW,DENSIV,VISW*	TBPMAX	477
	1.41338,VISV=.41338,THCONW,CPW,HI2,HTC,HTB,HTN,HTK,REWAT2)	TBPMAX	478
C		TBPMAX	479
C	OVERALL HEAT TRANSFER COEFFICIENT OF THE HEAT EXCHANGER	TBPMAX	480
	U2 = 1./(1./(HO*EFS) + ATOT*ALOG(ODL/DI)/(CONL*2.*3.14159) + ATOT/	TBPMAX	481
	1(AI*HI2))	TBPMAX	482
C		TBPMAX	483
C	NUMBER OF THERMAL UNITS IN THE HEAT EXCHANGER	TBPMAX	484
	ANTU2 = (ANTU/U)*U2	TBPMAX	485
C		TBPMAX	486
C	EFFECTIVENESS OF THE HEAT EXCHANGER	TBPMAX	487
	EFF2 = 1. - EXP(-ANTU2)	TBPMAX	488
C		TBPMAX	489
C	TEMPERATURE DIFFERENCE OF THE AIR ACROSS THE HEAT EXCHANGER	TBPMAX	490
	RANGE21 = (T1 - TTD12 - TTD22 - TA)*EFF2	TBPMAX	491
C		TBPMAX	492
C	CONVERGENCE CRITERIA FOR THE TEMPERATURE DIFFERENCE OF THE	TBPMAX	493
	AIR ACROSS THE HEAT EXCHANGER	TBPMAX	494
C	IF(ABS(RANGE21 - RANGE2)/RANGE2,LT..0025) GO TO 150	TBPMAX	495
	RANGE2 = RANGE21	TBPMAX	496
	GO TO 140	TBPMAX	497
C		TBPMAX	498
C	MASS FLOW RATE OF AMMONIA TO THE WET PART OF THE HEAT	TBPMAX	499
	EXCHANGER	TBPMAX	500
150	W32W = W32 - W32D	TBPMAX	501
	PATW = EXP(3.39853 - 3.81835E-5*ELEV)/29.92	TBPMAX	502
C		TBPMAX	503
C	MASS FLOW RATE OF AIR THROUGH THE HEAT EXCHANGER PER UNIT	TBPMAX	504
	DIMENSION	TBPMAX	505
C	RMA = FACTOR*VAIR=DENSIF*3600.*ACS	TBPMAX	506
C		TBPMAX	507
C	MASS FLUX OF AMMONIA THROUGH THE HEAT EXCHANGER TUBES	TBPMAX	508
	GWAT2 = W32W/(ZD*NW*3.14159*DI*DI/(4.*144.))*(1. - PERCENT))	TBPMAX	509
C	WRITE(6,240) GWAT2,T1,BPL(II),PERCENT,TA,TAWB,PMAXDRY(II),W32W,	TBPMAX	510
	1W32,W32D,QREJT1,QREJT2,QDRY	TBPMAX	511
C	240 FORMAT(2X,"GWAT2,T1,BPL(II),PERCENT,TA,TAWB,PMAXDRY(II),W32W,W32,W	TBPMAX	512
	132D,QREJT1,QREJT2,QDRY=",/,2X,8G15.5,/,2X,5G15.5/)	TBPMAX	513
C		TBPMAX	514
C	INSIDE HEAT TRANSFER COEFFICIENT OF THE WET HEAT EXCHANGER	TBPMAX	515
	CALL HTCLO(DI,ELENG=12.,ANG,GWAT2,1.,0.,PRW,DENSIW,DENSIV,VISW*	TBPMAX	516
	1.41338,VISV=.41338,THCONW,CPW,HI2,HTC,HTB,HTN,HTK,REWAT2)	TBPMAX	517
C		TBPMAX	518
C	MASS FLUX OF THE AIR THROUGH THE WET PART OF THE HEAT	TBPMAX	519
	EXCHANGER	TBPMAX	520
C	GAIR2 = FACTOR*VAIR=DENSIF*3600.	TBPMAX	521
C		TBPMAX	522
C	CALCULATION OF THE HEAT REJECTED FROM THE WET PART OF THE	TBPMAX	523
	HEAT EXCHANGER AND THE AMOUNT OF WATER USED	TBPMAX	524
C	IF(FDELUG.EQ."DELUG") CALL MOTERV(FAIR2,H02,SIGMAG,ALPHA,XD,	TBPMAX	525

1GAIR2,VISA)	TBPMAX	526
IF(FDELUG,EQ,"DELBW") CALL MTCH(GAIR2,H02)	TBPMAX	527
IF(FDELUG,EQ,"DELUG") CALL DELUG	TBPMAX	528
IF(FDELUG,EQ,"DELBW") CALL DELBW	TBPMAX	529
IF(KCONV,EQ,1) RETURN	TBPMAX	530
QREJTW = QSEC*NW*ELENG*(1. - PERCENT)	TBPMAX	531
RMEV = NW*ELENG*(1. - PERCENT)*RMEV	TBPMAX	532
IF(NDBG1,EQ,1) WRITE(6,220) T1,GWAT2,H12,GAIR2,H02,TA,TAWB,TI,	TBPMAX	533
1PATM,RMA,QSEC,RMEV,PERCENT,QREJTW,QDRY,WATCONT	TBPMAX	534
C	TBPMAX	535
C USE OF THE CALCULATED HEAT REJECTION FROM THE TOTAL HEAT	TBPMAX	536
C EXCHANGER AND THE DESIRED HEAT REJECTION TO ESTIMATE THE	TBPMAX	537
C AMOUNT OF HEAT EXCHANGER THAT NEEDS TO BE DELUGED	TBPMAX	538
IF(JK,LE,1) Y1 = QREJTW * QDRY	TBPMAX	539
IF(JK,LE,1) X1 = PERCENT	TBPMAX	540
IF(JK,LE,1) PERCENT = .20	TBPMAX	541
IF(JK,LE,1) GO TO 130	TBPMAX	542
Y2 = Y1	TBPMAX	543
X2 = X1	TBPMAX	544
Y1 = QREJTW * QDRY	TBPMAX	545
X1 = PERCENT	TBPMAX	546
SLOPE = (Y1 - Y2)/(X1 - X2)	TBPMAX	547
PERCENT1 = X1 + (QREJTW - Y1)/SLOPE	TBPMAX	548
C	TBPMAX	549
C CONVERGENCE CRITERIA FOR THE PERCENT OF THE HEAT EXCHANGER	TBPMAX	550
C THAT IS LEFT DRY	TBPMAX	551
C IF(ABS(PERCENT1 - PERCENT)/PERCENT.LT.,.001) GO TO 160	TBPMAX	552
PERCENT = PERCENT1	TBPMAX	553
GO TO 130	TBPMAX	554
C	TBPMAX	555
C STORAGE OF VARIABLES	TBPMAX	556
160 WATCON(II) = TPER*8760.*RMEV	TBPMAX	557
WATCONT = WATCONT + WATCON(II)	TBPMAX	558
TSATMAX(II) = T1	TBPMAX	559
PSATMAX(II) = BPL(II)	TBPMAX	560
DPER(II) = 1. - PERCENT	TBPMAX	561
DPERQ(II) = QREJTW/QREJTW2	TBPMAX	562
GO TO 200	TBPMAX	563
C	TBPMAX	564
C SETTING OF VARIABLES WHEN THE HEAT EXCHANGER IS COMPLETELY	TBPMAX	565
C DELUGED	TBPMAX	566
170 WATCON(II) = WATDE(II)	TBPMAX	567
TSATMAX(II) = TDELUG(II)	TBPMAX	568
PSATMAX(II) = PDELUG(II)	TBPMAX	569
DPER(II) = 1.0	TBPMAX	570
DPERQ(II) = 1.0	TBPMAX	571
WATCONT = WATCONT + WATCON(II)	TBPMAX	572
C	TBPMAX	573
C IF THE WATER CONSUMED OVER THE WHOLE YEAR AT THE MAXIMUM	TBPMAX	574
C BACK PRESSURE CURVE IS GREATER THAN THAT ALLOCATED THE	TBPMAX	575
C DESIGN IS THROWN OUT	TBPMAX	576
200 IF(WATCONT,GT.WATCONA.AND,LICK,EQ,0) KCONV = 1	TBPMAX	577
RETURN	TBPMAX	578
220 FORMAT(2X,"T1,GWAT2,H12,GAIR2,H02,TA,TAWB,TI,PATM,RMA,QSEC,RMEV,PE	TBPMAX	579
1RCENT,QREJTW,QDRY,WATCONT=",/,2X,8G15.4/,/,2X,8G15.4/)	TBPMAX	580
END	TBPMAX	581

```

C      SUBROUTINE TCALC(RI,RH,ATM,TEST,T,FROM,KCONV)
C
C      SUBROUTINE TCALC COMPUTES THE TEMPERATURE, T, FROM A
C      KNOWLEDGE OF
C      THE ENTHALPY (RI), RELATIVE HUMIDITY (RH), BAROMETRIC PRES-
C      SURE (ATM). TEST IS AN ESTIMATE FOR USE IN THE ITERATIVE
C      CALCULATION. LIMITS ARE PLACED UPON THE RANGE OF RI
C      WHICH WILL BE CONSIDERED IN ORDER TO PREVENT INSTABILITIES
C      IN TCALC. (FOR EXAMPLE, RI APPROACHES INFINITY AS THE
C      BOILING POINT IS REACHED--THUS, IF THE TEMPERATURE
C      CORRESPONDING TO RI IS NEAR THE BOILING POINT, THE
C      ITERATION WITHIN TCALC WILL BECOME UNSTABLE). THE UPPER
C      LIMIT OF RI IS RIMAX, THE LOWER LIMIT IS RIMIN. SEE
C      SUBROUTINE LIMIT FOR THE COMPUTATION OF RIMIN, RIMAX,
C      TMIN AND TMAX.
C
C      COMMON /WETDRY/ NCYCLE,TMAX,RIMAX,TMIN,RIMIN
C      COMMON/COUNT/NSLOPE,FRST3
C      DIMENSION TNEW(20),RINEW(20)
C      DATA MAX/20/
C      FUNCTION FP GIVES THE PARTIAL PRESSURE OF WATER, IN. HG.
C       $FP(RH,T) = RH * 29.92 * (0.000203 * ((T - 32.) / 1.8) ** 2$ 
C       $+ - 0.0118 * (T - 32.) / 1.8 + 1.095)$ 
C       $+ * EXP(- 0.000426 * ((T - 32.) / 1.8) ** 2$ 
C       $+ + 0.0828 * (T - 32.) / 1.8 - 5.163)$ 
C       $FP(RH,T) = RH * EXP(17.168 - 9240. / (T + 460.))$ 
C      FUNCTION FAH GIVES THE ABSOLUTE HUMIDITY, LB OF WATER/
C      LB OF AIR
C       $FAH(P,ATM) = P * 18.02 / ((ATM * 29.92 - P) * 28.97)$ 
C       $FCS(AH) = .24 + .45 * AH$ 
C      FUNCTION FCS GIVES THE HEAT CAPACITY OF HUMID AIR,
C      BTU/DEG F-LB OF DRY AIR
C       $FRI(CS,T,AH) = CS * T + 1094. * AH$ 
C      FUNCTION FRI GIVES THE ENTHALPY, BTU/LB OF DRY AIR
C      NDBUG3=0
C      IF(RI.LE.RIMIN .OR. RI.GE.RIMAX) WRITE(6,110) RI
C      IF(RI.LE.RIMIN .OR. RI.GE.RIMAX) KCONV = 1
C      IF(RI.LE.RIMIN .OR. RI.GE.RIMAX) RETURN
110  FORMAT('0IN TCALC RI IS LESS THAN RIMIN OR GREATER THAN RIMAX. ')
C      S,"RI" = ",1PE13.5)
C      N=0
C      IF(NDBUG3.EQ.1)WRITE(6,25)RI,RH,ATM,TEST,T
25  FORMAT(1X,/,1X,"ENTERING TCALC",5E17.8,/)
10  CONTINUE
C      N=N+1
C
C      TEST IS USED AS THE FIRST APPROXIMATION,
C
C      IF(N.EQ.1)TNEW(N)=TEST
C
C      IF EXTRAPOLATION GOES OUT OF TEMPERATURE BOUNDS, A NEW
C      ESTIMATE IS MADE. NOTE THAT TMAX AND TMIN ARE THE

```

```

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

```

SUBROUTINE TCALC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C	TEMPERATURES CORRESPONDING TO RIMAX AND RIMIN,	TCALC	59
C	RESPECTIVELY.	TCALC	60
C		TCALC	61
C		TCALC	62
	IF(TNEW(N).GT.TMAX)TNEW(N)=TNEW(N-1)+(TMAX-TNEW(N-1))/3.	TCALC	63
	IF(TNEW(N).LT.TMIN) TNEW(N)=TMIN	TCALC	64
	T=TNEW(N)	TCALC	65
C		TCALC	66
C		TCALC	67
C	A VALUE OF ENTHALPY CORRESPONDING TO THE TNEW(N),	TCALC	68
C	RINW(N), IS COMPUTED.	TCALC	69
C		TCALC	70
C		TCALC	71
	P=FP(RH,T)	TCALC	72
	AH=FAH(P,ATM)	TCALC	73
	CS=FCS(AH)	TCALC	74
	RIDUM=FRI(CS,T,AH)	TCALC	75
	RINW(N)=RIDUM	TCALC	76
C		TCALC	77
C		TCALC	78
C	THE DEVIATION IN ENTHALPY IS COMPUTED.	TCALC	79
C		TCALC	80
C		TCALC	81
	DRI=RI=RINW(N)	TCALC	82
C	IF(NDBG3.EQ.1)WRITE(6,50)N,TNEW(N),RINW(N),DRI	TCALC	83
C	50 FORMAT(1X,"FROM TCALC 50",I5,3E17.8)	TCALC	84
C		TCALC	85
C		TCALC	86
C	A TEST FOR CONVERGENCE IS COMPUTED.	TCALC	87
C		TCALC	88
C		TCALC	89
	IF(ABS(DRI).LT..0001) GO TO 40	TCALC	90
C		TCALC	91
C		TCALC	92
C	DIAGNOSTIC IF EXCESSIVE NUMBER OF ITERATIONS	TCALC	93
C		TCALC	94
C		TCALC	95
	IF(N.EQ.20) WRITE(6,170) FROM,N,RI,TEST,TNEW,RINW	TCALC	96
	S,TMAX,TMIN,NCALC	TCALC	97
170	FORMAT(1/"1SUBSCRIPT LIMIT IN TCALC. CALLED FROM "A10," N="	TCALC	98
	S ,I5/1X,"RI=",1P1E13.5,3X,"TEST=",E13.5/1X,"TNEW="	TCALC	99
	\$4(1X,1P5E13.5//1X,"RINW="4(1X,1P5E13.5//1X,"TMAX= ",E13.5/	TCALC	100
	\$1X,"TMIN= ",E13.5/1X,"NCALC= ",I5)	TCALC	101
	IF(N.EQ.20) RETURN	TCALC	102
C		TCALC	103
C		TCALC	104
C	A NEW ESTIMATE FOR T IS OBTAINED BY USE OF THE DERIVATIVE	TCALC	105
C	OF T WITH RESPECT TO ENTHALPY FOR N EQUAL TO 1. LINEAR	TCALC	106
C	INTERPOLATION/EXTRAPOLATION TECHNIQUES ARE USED THEREAFTER.	TCALC	107
C		TCALC	108
C		TCALC	109
	IF(N.NE.1)GO TO 45	TCALC	110
	TP=T+.0001	TCALC	111
	PP=FP(RH,TP)	TCALC	112
	AHP=FAH(PP,ATM)	TCALC	113
	CSP=FCS(AHP)	TCALC	114
	RIP=FRI(CSP,TP,AHP)	TCALC	115

SUBROUTINE TCALC

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	TM=T*.0001	TCALC	116
	PM=FD(RH, TM)	TCALC	117
	AHM=FAH(PM, ATM)	TCALC	118
	CSM=FCS(AHM)	TCALC	119
	RIM=FRI(CSM, TM, AHM)	TCALC	120
	DTDRI=.0002/(RIP-RIM)	TCALC	121
45	CONTINUE	TCALC	122
	IF(N.EQ.1)TNEW(N+1)=TNEW(N)+DTDRI*DRI	TCALC	123
	IF(N.GT.1)TNEW(N+1)=TNEW(N-1)+((RI-RINW(N-1))/(RINW(N)-RINW(N-1)))	TCALC	124
	1)))*(TNEW(N)-TNEW(N-1))	TCALC	125
	GO TO 10	TCALC	126
40	CONTINUE	TCALC	127
C		TCALC	128
C		TCALC	129
C	OUTPUT IF DESIRED.	TCALC	130
C		TCALC	131
C		TCALC	132
C	IF(NDEBUG3.EQ.1)WRITE(6,100)RI,AH,CS,RH,ATM,T,N,TEST	TCALC	133
100	FORMAT(1X,11HFROM TCALC,6E15.6,15,E15.6,//)	TCALC	134
	RETURN	TCALC	135
	END	TCALC	136

FUNCTION TLU

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

FUNCTION TLU(X,XT,YT,NT)	TLU	2
C	TLU	3
C	TLU	4
C	TLU	5
C	TLU	6
C	TLU	7
C	TLU	8
C	TLU	9
C	TLU	10
C	TLU	11
C	TLU	12
C	TLU	13
C	TLU	14
C	TLU	15
C	TLU	16
C	TLU	17
C	TLU	18
C	TLU	19
C	TLU	20
C	TLU	21
C	TLU	22
C	TLU	23
C	TLU	24
100 IF(XT(1)-XT(2))102,102,103	TLU	25
C	TLU	26
C	TLU	27
C	TLU	28
C	TLU	29
102 DO 99 I=1,NT	TLU	30
IF(X-XT(I))105,104,99	TLU	31
99 CONTINUE	TLU	32
C	TLU	33
C	TLU	34
C	TLU	35
C	TLU	36
103 DO 98 I=1,NT	TLU	37
IF(X-XT(I))98,104,105	TLU	38
98 CONTINUE	TLU	39
C	TLU	40
C	TLU	41
C	TLU	42
C	TLU	43
104 TLU=YT(I)	TLU	44
C	TLU	45
C	TLU	46
C	TLU	47
C	TLU	48
C	TLU	49
C	TLU	50
C	TLU	51
105 IF(I=2)106,106,107	TLU	52
106 J=I+1	TLU	53
GO TO 108	TLU	54
107 IF(I=NT)108,109,109	TLU	55
109 I=I-1	TLU	56
C	TLU	57
C	TLU	58

FUNCTION TLU

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

C	INTERPOLATION	TLU	59
C		TLU	60
108	X1=XT(I-2)	TLU	61
	X2=XT(I-1)	TLU	62
	X3=XT(I)	TLU	63
	X4=XT(I+1)	TLU	64
C		TLU	65
	TLU=(X-X2)*(X-X3)*(X-X4)/((X1-X2)*(X1-X3)*(X1-X4))*YT(I-2)	TLU	66
S	+ (X-X1)*(X-X3)*(X-X4)/((X2-X1)*(X2-X3)*(X2-X4))*YT(I-1)	TLU	67
S	+ (X-X1)*(X-X2)*(X-X4)/((X3-X1)*(X3-X2)*(X3-X4))*YT(I)	TLU	68
S	+ (X-X1)*(X-X2)*(X-X3)/((X4-X1)*(X4-X2)*(X4-X3))*YT(I+1)	TLU	69
C		TLU	70
	RETURN	TLU	71
C		TLU	72
101	WRITE(6,1000)X,XT(1),YT(1)	TLU	73
1000	FORMAT(1H),39H TABLE LOOK-UP: X NOT IN RANGE OF TABLE//	TLU	74
S	5X,34X =,F15.5,5X,7HXT(1) =,F15.5,5X,7HYT(1) =,F15.5)	TLU	75
C		TLU	76
	STOP	TLU	77
	END	TLU	78

FUNCTION TOTALP 74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	FUNCTION TOTALP(CFM)	TOTALP	2
	COMMON/TOTAL/RECVEL,A60,EA60,VPCOEF,STATP	TOTALP	3
C		TOTALP	4
C	THIS FUNCTION USES THE STATIC PRESSURE LOSS ACROSS THE HEAT	TOTALP	5
C	EXCHANGER AND A CALCULATION FOR THE VELOCITY PRESSURE LOSS	TOTALP	6
C	AT THE FAN EXIT TO DETERMINE THE TOTAL PRESSURE LOSS IN	TOTALP	7
C	INCHES OF WATER.	TOTALP	8
C		TOTALP	9
	VELNR=CFM/A60	TOTALP	10
	IF(RECVEL.EQ.0.) GO TO 10	TOTALP	11
C		TOTALP	12
C	EXIT VELOCITY WITH VELOCITY RECOVERY.	TOTALP	13
C		TOTALP	14
	VEL=CFM/EA60	TOTALP	15
	GO TO 20	TOTALP	16
C		TOTALP	17
C	EXIT VELOCITY WITHOUT VELOCITY RECOVERY.	TOTALP	18
C		TOTALP	19
	10 VEL=VELNR	TOTALP	20
	20 CONTINUE	TOTALP	21
C		TOTALP	22
C	CALCULATION FOR VELOCITY PRESSURE.	TOTALP	23
C		TOTALP	24
	IF(RECVEL.EQ.0.)VP=VPCOEF*VEL*VEL	TOTALP	25
	IF(RECVEL.EQ.1.)VP=VPCOEF*(0.2*VELNR*VELNR+0.8*VEL*VEL)	TOTALP	26
C		TOTALP	27
C	CALCULATION FOR TOTAL PRESSURE.	TOTALP	28
C		TOTALP	29
	TOTALP=VP+STATP	TOTALP	30
	RETURN	TOTALP	31
	END	TOTALP	32

SUBROUTINE UDEL(TA,RIA,ATM,HD,BETAF,AB,AF,AI,AW,HI,BETAI,THW,RKW,
+ TI,RII,HOD,UD,EFFIN,PATH,KCONV,NTREST)

SUBROUTINE UDEL CALCULATES THE OVERALL TRANSFORMED HEAT
TRANSFER COEFFICIENT BETWEEN THE TUBESIDE FLUID AND THE AIR.
THIS TRANSFORMED HEAT TRANSFER COEFFICIENT USES ENTHALPY AS
THE DRIVING FORCE (ENTHALPY DIFFERENCE DIVIDED BY HEAT
CAPACITY OF THE AIR IS ANALOGOUS TO TEMPERATURE
DIFFERENCE).

THE OVERALL TRANSFORMED COEFFICIENT IS CALCULATED FROM
TWO COEFFICIENTS, THAT BETWEEN THE TUBESIDE FLUID AND THE FIN
ROOT, UDPR, AND THAT BETWEEN THE FIN ROOT AND THE AIR, UDRA.
EACH OF THESE COEFFICIENTS ARE CALCULATED FROM LOWER ORDER
COEFFICIENTS. THE RESULTS ARE DEPENDENT UPON THREE TEMPERA-
TURES WHICH ARE UNKNOWN AT THE START OF THE CALCULATION, THE
TEMPERATURE AT THE FIN ROOT, THE AVERAGE TEMPERATURE OF THE
FIN AND THE TEMPERATURE OF THE DELUGEATE-AIR INTERFACE.

THUS THE CALCULATION IS CARRIED OUT BY THE METHOD OF
SUCCESSIVE APPROXIMATIONS.

A NOMENCLATURE OF SOME OF THE MORE FREQUENTLY USED
TERMS FOLLOWS.

AB	- AREA OF THE TUBES BETWEEN THE FINS, SQ. FT.
AF	- AREA OF THE FINS, SQ. FT.
AHR	- ABSOLUTE HUMIDITY OF SATURATED AIR AT TEMPERATURE TR, LB OF WATER/LB OF DRY AIR
AHS	- ABSOLUTE HUMIDITY OF SATURATED AIR AT TEMPERATURE TS, LB OF WATER/LB OF DRY AIR
AI	- TUBESIDE AREA, SQ. FT.
ATM	- BAROMETRIC PRESSURE, ATMOSPHERES
AW	- AVERAGE TUBE WALL AREA, SQ. FT.
BETAF	- AIR SIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
BETAI	- TUBESIDE FOULING COEFFICIENT, BTU/HR-SQ.FT.-F
CSR	- HEAT CAPACITY OF SATURATED AIR AT TEMPERATURE TR, BTU/LB. OF DRY AIR=F
CSS	- SPECIFIC HEAT OF SATURATED AIR AT TEMPERATURE TS, BTU/LB OF DRY AIR-DEG. F
DTDR	- FACTOR FOR CONVERTING FROM TEMPERATURE DRIVING FORCE TO ENTHALPY DRIVING FORCE BETWEEN THE TUBESIDE AND THE FIN ROOT, EQUAL TO (TI - TR) / (RII - RIR, DEG. F-LB OF DRY AIR / BTU
DTDRI	- DERIVATIVE OF THE TEMPERATURE-ENTHALPY CURVE AT TR, DEG F-LB OF DRY AIR/BTU
DTDRIR	- SAME AS DTDR THOUGH DTDRI MAY BE USED AS AN APPROXIMATION, DEG.F-LB OF DRY AIR/BTU
EFFIN	- FIN EFFICIENCY, DIMENSIONLESS
HD	- METAL TO DELUGEATE HEAT TRANSFER COEFFICIENT, BTU/HR-SQ.FT.-F
HI	- TUBESIDE HEAT TRANSFER COEFFICIENT,BTU/HR-SQ. FT.-F
HOD	- DELUGEATE TO AIR HEAT TRANSFER COEFFICIENT, BTU/HR-SQ.FT.-F
PR	- PARTIAL PRESSURE OF SATURATED AIR AT TEMPERATURE TR, IN. HG.
PS	- PARTIAL PRESSURE OF SATURATED AIR AT TEMPERATURE TS, IN. HG.

C	RHR	- RELATIVE HUMIDITY AT THE FIN ROOT, DIMENSION-	UDEL	59
C		LESS	UDEL	60
C	RIA	- ENTHALPY OF THE BULK AIR, BTU/LB OF DRY AIR	UDEL	61
C	RIFAV	- ENTHALPY OF SATURATED AIR AT TEMPERATURE	UDEL	62
C		TFAV, BTU/LB OF DRY AIR	UDEL	63
C	RII	- ENTHALPY OF SATURATED AIR AT THE TUBESIDE	UDEL	64
C		TEMPERATURE, BTU/LB OF DRY AIR	UDEL	65
C	RIR	- ENTHALPY OF SATURATED AIR AT TEMPERATURE	UDEL	66
C		TR, BTU/LB OF DRY AIR	UDEL	67
C	RIS	- ENTHALPY OF SATURATED AIR AT TEMPERATURE	UDEL	68
C		TS, BTU/LB OF DRY AIR	UDEL	69
C	RKW	- THERMAL CONDUCTIVITY OF THE TUBE WALL, BTU/HR-	UDEL	70
C		SQ.FT.-F/FT	UDEL	71
C	TAIN	- TEMPERATURE OF THE AIR ENTERING THE HEAT	UDEL	72
C		EXCHANGER, F	UDEL	73
C	TFAV	- AVERAGE TEMPERATURE OF THE FIN, DEG. F	UDEL	74
C	THW	- TUBE WALL THICKNESS, FT.	UDEL	75
C	TI	- TUBESIDE TEMPERATURE	UDEL	76
C	TMAX	- MAXIMUM TEMPERATURE ALLOWED DUE TO CONSTRAINTS	UDEL	77
C		UPON THE ANALOGY UPON WHICH THE HEAT TRANSFER	UDEL	78
C		CALCULATION IS BASED, F. (SEE SUBROUTINE LIMIT)	UDEL	79
C	TMIN	- MINIMUM TEMPERATURE ALLOWED TO PREVENT	UDEL	80
C		POSSIBLE INSTABILITIES WITHIN THE	UDEL	81
C		SUBROUTINES, F	UDEL	82
C	TR	- TEMPERATURE OF THE FIN ROOT, DEG. F	UDEL	83
C	TS	- TEMPERATURE OF THE DELUGEATE-AIR INTERFACE,	UDEL	84
C		DEG. F.	UDEL	85
C	UD	- TUBESIDE TO AIR HEAT TRANSFER COEFFICIENT	UDEL	86
C		(CONVERTED TO THE DRIVING FORCE OBTAINED	UDEL	87
C		BY DIVIDING THE ENTHALPY DIFFERENCE BY	UDEL	88
C		THE SPECIFIC HEAT OF HUMID AIR),	UDEL	89
C		BTU/HR-SQ.FT.-DEG. F	UDEL	90
C	UDN	- AN ARRAY FOR STORING VALUES OF UD	UDEL	91
C	UDPR	- TUBESIDE TO FIN ROOT HEAT TRANSFER COEFFICIENT	UDEL	92
C		(CONVERTED TO THE DRIVING FORCE OBTAINED BY	UDEL	93
C		DIVIDING THE ENTHALPY DIFFERENCE BY THE	UDEL	94
C		SPECIFIC HEAT OF HUMID AIR),	UDEL	95
C		BTU/HR-SQ.FT.-DEG. F	UDEL	96
C	UDRA	- FIN ROOT TO AIR HEAT TRANSFER COEFFICIENT	UDEL	97
C		(CONVERTED TO THE DRIVING FORCE OBTAINED BY	UDEL	98
C		DIVIDING THE ENTHALPY DIFFERENCE BY THE	UDEL	99
C		SPECIFIC HEAT OF HUMID AIR),	UDEL	100
C		BTU/HR-SQ.FT.-DEG. F	UDEL	101
C	UDRS	- FIN ROOT TO DELUGEATE HEAT TRANSFER	UDEL	102
C		COEFFICIENT (CONVERTED TO THE DRIVING FORCE	UDEL	103
C		OBTAINED BY DIVIDING THE ENTHALPY DIFFERENCE	UDEL	104
C		BY THE SPECIFIC HEAT OF HUMID AIR),	UDEL	105
C		BTU/HR-SQ.FT.-DEG. F	UDEL	106
C	UPR	- TUBESIDE TO FIN ROOT HEAT TRANSFER	UDEL	107
C		COEFFICIENT, BTU/SQ.FT.-HR-DEG. F.	UDEL	108
C			UDEL	109
C			UDEL	110
C			UDEL	111
	LOGICAL PATH: FRST3		UDEL	112
	COMMON /WETDRY/ NCYCLE,TMAX,RIMAX,TMIN,RIMIN		UDEL	113
	COMMON/COUNT/NSLOPE,FRST3		UDEL	114
	COMMON/RRPT4/R4(672),RR(3)		UDEL	115
	DIMENSION UDN(20),TRSAVE(20),TSSAVE(20),TFAVSA(20)		UDEL	

	DATA MAX/20/	UDEL	116
C		UDEL	117
C		UDEL	118
C	THE QUANTITIES INPUTED TO UDEL ARE PRINTED OUT.	UDEL	119
C		UDEL	120
	FP(RH,T) = RH*29.92*(0.000203*((T - 32.)/1.8)**2	UDEL	121
	+ 0.0118*(T - 32.)/1.8 + 1.095)	UDEL	122
	+ *EXP(- 0.000426*((T - 32.)/1.8)**2	UDEL	123
	+ 0.0828*(T - 32.)/1.8 + 5.163)	UDEL	124
C	FP(RH,T)=RH*EXP(17.168-9240./(T+460.))	UDEL	125
	FAH(P,ATM)=P*18.02/((ATM*29.92-P)*28.97)	UDEL	126
	FCS(AH)=.24+.45*AH	UDEL	127
	FRI(CS,T,AH)=CS*T+1094.*AH	UDEL	128
	NDBG5=0	UDEL	129
	NDBG51 = 0	UDEL	130
	IF(NDBG5.EQ.1) WRITE(6,100) TA,RIA,ATM,HD,BETAF,AB,AF,AI,AW,HI,	UDEL	131
	1BETAI,YHW,RKW,TI,RII,HOD,UD,NTREST	UDEL	132
100	FORMAT(1X,10HFROM UDEL .8E12.5/1X,8E12.5,10X,E12.5,I5,///)	UDEL	133
	N=0	UDEL	134
C		UDEL	135
C		UDEL	136
C	INITIAL ESTIMATES OF TR, TS AND TFAV ARE MADE WHEN	UDEL	137
C	NTREST IS SET EQUAL TO ONE.	UDEL	138
C		UDEL	139
	IF(NTREST.EQ. 0) TAIN = TA	UDEL	140
	IF(.NOT. PATH .AND. NTREST.EQ. 1) GO TO 10	UDEL	141
	IF(NSLOPE .LE. 2) GO TO 1010	UDEL	142
	DEL = TAIN - TAIN2	UDEL	143
	DIVID = DEL/(TAIN2 - TAIN1)	UDEL	144
	IF(NTREST.EQ. 1) GO TO 1005	UDEL	145
	SLTR = (TR02 - TR01)*DIVID	UDEL	146
	SLTS = (TS02 - TS01)*DIVID	UDEL	147
	SLTFAV = (TFAV02 - TFAV01)*DIVID	UDEL	148
	TR = TR02 + SLTR	UDEL	149
	TS = TS02 + SLTS	UDEL	150
	TFAV = TFAV02 + SLTFAV	UDEL	151
	UD = UD01	UDEL	152
	GO TO 1200	UDEL	153
1005	SLTR = (TR12 - TR11)*DIVID	UDEL	154
	SLTS = (TS12 - TS11)*DIVID	UDEL	155
	SLTFAV = (TFAV12 - TFAV11)*DIVID	UDEL	156
	TR = TR12 + SLTR	UDEL	157
	TS = TS12 + SLTS	UDEL	158
	TFAV = TFAV12 + SLTFAV	UDEL	159
	UD = UD11	UDEL	160
	GO TO 1200	UDEL	161
1010	IF(NSLOPE .LE. 1) GO TO 1030	UDEL	162
	IF(NTREST.EQ. 1) GO TO 1020	UDEL	163
	TR = TR02	UDEL	164
	TS = TS02	UDEL	165
	TFAV = TFAV02	UDEL	166
	UD = UD01	UDEL	167
	GO TO 1200	UDEL	168
1020	TR = TR12	UDEL	169
	TS = TS12	UDEL	170
	TFAV = TFAV12	UDEL	171
	UD = UD11	UDEL	172

SUBROUTINE UDEL

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

	GO TO 1200	UDEL	173
1030	TR = (TA + TI)/2.0	UDEL	174
C		UDEL	175
1200	RHR = 1.0	UDEL	176
10	CONTINUE	UDEL	177
C	WRITE(6,425) TR,TS,TFMV,UD,UD1	UDEL	178
	N=N+1	UDEL	179
C		UDEL	180
C	APPROPRIATE WARNINGS ARE MADE AND THE PROGRAM IS STOPPED IF	UDEL	181
C	THE MINIMUM OR MAXIMUM TEMPERATURE LIMITS ARE EXCEEDED.	UDEL	182
C		UDEL	183
	IF (TR .LT. TMIN) WRITE(6,325) TR	UDEL	184
	IF (TR .GE. TMAX) WRITE(6,325) TR	UDEL	185
325	FORMAT('0IN UDEL TR IS LESS THAN TMIN OR GREATER THAN TMAX. TR="	UDEL	186
S	,1PE13,5)	UDEL	187
	IF (TR,LT,TMIN,OR,TR,GE,TMAX) KCONV = 1	UDEL	188
	IF (TR,LT,TMIN,OR,TR,GE,TMAX) RETURN	UDEL	189
C		UDEL	190
C	THE ENTHALPY BASED HEAT TRANSFER COEFFICIENT BETWEEN THE FIN	UDEL	191
C	ROOT AND THE AIR IS COMPUTED.	UDEL	192
C		UDEL	193
	PR=FP(RHR,TR)	UDEL	194
	AHR=FAH(PR,ATM)	UDEL	195
5	CSR=FCS(AHR)	UDEL	196
	RIR=FRI(CSR,TR,AHR)	UDEL	197
C		UDEL	198
C	THE ENTHALPY AT THE DELUGEATE SURFACE, RIS IS CALCULATED	UDEL	199
C		UDEL	200
0	PS = FP(RHR,TS)	UDEL	201
	AHS = FAH(PS,ATM)	UDEL	202
	CSS = FCS(AHS)	UDEL	203
	RIS = FRI(CSS,TS,AHS)	UDEL	204
C		UDEL	205
5	THE ENTHALPY BASED HEAT TRANSFER COEFFICIENT BETWEEN THE FIN	UDEL	206
C	ROOT AND THE AIR IS COMPUTED.	UDEL	207
C		UDEL	208
C		UDEL	209
0	IF (PATH .AND. NSLOPE .LE. 1) GO TO 15	UDEL	210
	GO TO 20	UDEL	211
C		UDEL	212
C	THE DERIVATIVE OF THE ENTHALPY WITH RESPECT TO THE AIR	UDEL	213
C	TEMPERATURE AT TR IS USED AS AN APPROXIMATION FOR THE	UDEL	214
5	QUANTITY ((TR-TS)/(RIR-RIS)) FOR N=1.	UDEL	215
C		UDEL	216
C		UDEL	217
15	CONTINUE	UDEL	218
	TP=TR+.0001	UDEL	219
	PP=FP(RHR,TP)	UDEL	220
0	AHP=FAH(PP,ATM)	UDEL	221
	CSP=FCS(AHP)	UDEL	222
	RIP=FRI(CSP,TP,AHP)	UDEL	223
	TM=TR-.0001	UDEL	224
	PM=FP(RHR,TM)	UDEL	225
5	AHM=FAH(PM,ATM)	UDEL	226
	CSM=FCS(AHM)	UDEL	227
	RIM=FRI(CSM,TM,AHM)	UDEL	228
	DTDRIR=.0002/(RIP-RIM)	UDEL	229

	DTDRI = DTDRI	UDEL	230
	PATH = .FALSE.	UDEL	231
	GO TO 25	UDEL	232
20	DTDRI = (TR - TS)/(RIR - RIS)	UDEL	233
25	UDRS = CSR*DTDRI/(1./HD + 1./BETAF)	UDEL	234
	UDRA=1./(1./UDRS+1./HOD)	UDEL	235
	IF(UDRA .LE. 0.0) WRITE(6,75) UDRA,N	UDEL	236
	IF(UDRA .LE. 0.0) KCONV = 1	UDEL	237
	IF(UDRA .LE. 0.0) RETURN	UDEL	238
75	FORMAT('0IN UDEL UDRA IS ZERO OR NEGATIVE ',1PE13.5,' N=',15)	UDEL	239
C		UDEL	240
C		UDEL	241
C	THE FIN EFFICIENCY IS COMPUTED. FOR N=1, DT/DRI AT TR IS	UDEL	242
C	USED AS AN APPROXIMATION FOR DT/DRI AT TFAV.	UDEL	243
C		UDEL	244
C	CALCULATION OF EFFIN	UDEL	245
	IF(.NOT. PATH .OR. N .GT. 1) GO TO 80	UDEL	246
	TP=TFAV+.0001	UDEL	247
	PP=FP(1.0,TP)	UDEL	248
	AHP=FAH(PP,ATM)	UDEL	249
	CSP=FCS(AHP)	UDEL	250
	RIP=FRI(CSP,TP,AHP)	UDEL	251
	TM=TFAV+.0001	UDEL	252
	PM=FP(1.0,TM)	UDEL	253
	AHM=FAH(PM,ATM)	UDEL	254
	CSM=FCS(AHM)	UDEL	255
	RIM=FRI(CSM,TM,AHM)	UDEL	256
	DTDRI=.0002/(RIP-RIM)	UDEL	257
80	CONTINUE	UDEL	258
	HO = UDRA/(CSR*DTDRI)	UDEL	259
	CALL FINEFF(HO,EFFIN)	UDEL	260
	IF(EFFIN.LT.0.)WRITE(6,125)EFFIN,N	UDEL	261
125	FORMAT(1X,"EFFIN LESS THAN ZERO, EFFIN SET EQUAL TO ZERO,EFFIN =	UDEL	262
	1 "E15.6," N= ",15)	UDEL	263
	IF(EFFIN.LT.0.)EFFIN=0.	UDEL	264
C		UDEL	265
C	OPTION TO OUTPUT QUANTITIES OF INTEREST.	UDEL	266
C		UDEL	267
	IF(NDEBUG.EQ.1)WRITE(6,150)	UDEL	268
150	FORMAT(1X,"TR,DTDRI,TS,RHR,RIS,UDRA,DTDRI,EFFIN,N")	UDEL	269
	IF(NDEBUG.EQ.1)WRITE(6,200)TR,DTDRI,TS,RHR,RIS,	UDEL	270
	UDRA,DTDRI,EFFIN,N	UDEL	271
200	FORMAT(1X,15HFROM UDEL#200 ,4E15.6/1X,4E15.6,15,/))	UDEL	272
C		UDEL	273
C	THE "ALL DRY" AND THE TRANSFORMED HEAT TRANSFER COEFFICIENTS	UDEL	274
C	BETWEEN THE TUBESIDE FLUID AND THE FIN ROOT ARE COMPUTED.	UDEL	275
C		UDEL	276
	UPR=1./((AB+EFFIN*AF)*(1./(HI*AI)+1./(BETAI*AI)+THW/(RKW*AW)))	UDEL	277
	DTDR = (TI - TR)/(RII - RIR)	UDEL	278
	UDPR = UPR*CSR*DTDR	UDEL	279
C		UDEL	280
C	THE OVERALL TRANSFORMED HEAT TRANSFER COEFFICIENT BETWEEN	UDEL	281
C	THE TUBESIDE FLUID AND THE AIR IS COMPUTED.	UDEL	282
C		UDEL	283
	UDN(N)=1./(1./UDPR+1./UDRA)	UDEL	284
	UD1 = UD	UDEL	285
	UD = UDN(N)	UDEL	286

C		UDEL	287
C	THE ENTHALPY AND TEMPERATURE AT THE FIN ROOT IS COMPUTED.	UDEL	288
C		UDEL	289
	RIR=RIA+UDN(N)*(RII-RIA)/UDRA	UDEL	290
	IF(NDRUG5.EQ.1)WRITE(6,250)	UDEL	291
250	FORMAT(1X,"UPR,UDPR,UDN(N),RIR")	UDEL	292
	IF(NDRUG5.EQ.1)WRITE(6,300)UPR,UDPR,UDN(N),RIR	UDEL	293
300	FORMAT(1X,15HFROM UDEL#300 .4E15.6,I5,//	UDEL	294
	TEST=TR	UDEL	295
	CALL TCALC(RIR,1.,ATM,TEST,TR,"UD TR",KCONV)	UDEL	296
	IF(KCONV.EQ.1) RETURN	UDEL	297
C		UDEL	298
C	THE ENTHALPY AND TEMPERATURE AT THE DELUGEATE AIR INTERFERE	UDEL	299
C	IS COMPUTED.	UDEL	300
C		UDEL	301
	RIS = RIA + (UDRA/HOD)*(RIR - RIA)*(AB + EFFIN*AF)/(AB + AF)	UDEL	302
	TEST=TS	UDEL	303
	IF(PATH .AND. NSLOPE .LE. 1) TEST = TR	UDEL	304
	CALL TCALC(RIS,1.,ATM,TEST,TS,"UD TS",KCONV)	UDEL	305
	IF(KCONV.EQ.1) RETURN	UDEL	306
C		UDEL	307
C	THE AVERAGE ENTHALPY AND TEMPERATURE OF THE FIN (CORRESPOND-	UDEL	308
C	ING TO THE FIN EFFICIENCY) IS COMPUTED.	UDEL	309
C		UDEL	310
	RIFAV=RIA+EFFIN*(RIR-RIA)	UDEL	311
	TEST=TFAV	UDEL	312
	IF(PATH .AND. NSLOPE .LE. 1) TEST = TS	UDEL	313
	CALL TCALC(RIFAV,1.,ATM,TEST,TFAV,"UD TFAV",KCONV)	UDEL	314
	IF(KCONV.EQ.1) RETURN	UDEL	315
C		UDEL	316
C	STORAGE FOR LATER OUTPUT.	UDEL	317
C		UDEL	318
	IF(NDRUG51.EQ.1) TRSAVE(N)=TR	UDEL	319
	IF(NDRUG51.EQ.1) TSSAVE(N)=TS	UDEL	320
	IF(NDRUG51.EQ.1) TFAVSA(N)=TFAV	UDEL	321
C		UDEL	322
C	THE METHOD OF SUCCESSIVE APPROXIMATIONS IS USED.	UDEL	323
C		UDEL	324
	IF(PATH .AND. NSLOPE .LE. 1) GO TO 10	UDEL	325
C		UDEL	326
C	TEST TO PREVENT EXCESSIVE ITERATIONS.	UDEL	327
C		UDEL	328
	IF(N.LT.MAX) GO TO 350	UDEL	329
	WRITE(6,1000)N	UDEL	330
1000	FORMAT(" UDEL TERMINATED AT UPPER ITERATION LIMIT. N="I5)	UDEL	331
	UD=UDN(N)	UDEL	332
	GO TO 500	UDEL	333
C		UDEL	334
C	CONVERGENCE CRITERIA IS APPLIED.	UDEL	335
C		UDEL	336
350	IF(ABS((UDN(N)-UDN(N-1))/UDN(N)).GT..001) GO TO 10	UDEL	337
	UD=UDN(N)	UDEL	338
C		UDEL	339
C		UDEL	340
C	STORAGE OF VARIABLES FOR EXTRAPOLATION TO THE NEXT	UDEL	341
C	AMBIENT AIR CONDITIONS	UDEL	342
C		UDEL	343

SUBROUTINE UDEL

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

```

      IF (NTREST .EQ. 1) GO TO 355
      IF (.NOT. PATH) GO TO 351
      IF (.NOT. FRST3) GO TO 351
      TR01 = TR02
      TS01 = TS02
      TFAV01 = TFAV02
      TAIN1 = TAIN2
      TAIN2 = TAIN
351  TR02 = TR
      TS02 = TS
      TFAV02 = TFAV
      UD01 = UD
      ISL = (INSLOPE - 1)*42
      R4(ISL + 3) = UD
      R4(ISL + 4) = UDRS
      R4(ISL + 5) = MOD
      R4(ISL + 6) = DTDRI
      R4(ISL + 7) = UDRA
      R4(ISL + 8) = UDPR
      R4(ISL + 9) = EFFIN
      R4(ISL + 10) = HI
      R4(ISL + 11) = CSR
      R4(ISL + 12) = DTDRI
      R4(ISL + 13) = TR
      R4(ISL + 14) = RIR
      R4(ISL + 15) = TS
      R4(ISL + 16) = RIS
      R4(ISL + 17) = TFAV
      R4(ISL + 18) = RIFAV
      R4(ISL + 19) = TI
      R4(ISL + 20) = RII
      GO TO 370
355  IF (.NOT. PATH) GO TO 356
      IF (.NOT. FRST3) GO TO 356
      TR11 = TR12
      TS11 = TS12
      TFAV11 = TFAV12
356  TR12 = TR
      TS12 = TS
      TFAV12 = TFAV
      UD11 = UD
      ISL = (INSLOPE - 1)*42
      R4(ISL + 24) = UD
      R4(ISL + 25) = UDRS
      R4(ISL + 26) = MOD
      R4(ISL + 27) = DTDRI
      R4(ISL + 28) = UDRA
      R4(ISL + 29) = UDPR
      R4(ISL + 30) = EFFIN
      R4(ISL + 31) = HI
      R4(ISL + 32) = CSR
      R4(ISL + 33) = DTDRI
      R4(ISL + 34) = TR
      R4(ISL + 35) = RIR
      R4(ISL + 36) = TS
      R4(ISL + 37) = RIS
      R4(ISL + 38) = TFAV

```

```

      UDEL 344
      UDEL 345
      UDEL 346
      UDEL 347
      UDEL 348
      UDEL 349
      UDEL 350
      UDEL 351
      UDEL 352
      UDEL 353
      UDEL 354
      UDEL 355
      UDEL 356
      UDEL 357
      UDEL 358
      UDEL 359
      UDEL 360
      UDEL 361
      UDEL 362
      UDEL 363
      UDEL 364
      UDEL 365
      UDEL 366
      UDEL 367
      UDEL 368
      UDEL 369
      UDEL 370
      UDEL 371
      UDEL 372
      UDEL 373
      UDEL 374
      UDEL 375
      UDEL 376
      UDEL 377
      UDEL 378
      UDEL 379
      UDEL 380
      UDEL 381
      UDEL 382
      UDEL 383
      UDEL 384
      UDEL 385
      UDEL 386
      UDEL 387
      UDEL 388
      UDEL 389
      UDEL 390
      UDEL 391
      UDEL 392
      UDEL 393
      UDEL 394
      UDEL 395
      UDEL 396
      UDEL 397
      UDEL 398
      UDEL 399
      UDEL 400

```


SUBROUTINE UDEL

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

R4(I5L + 39) = RIFAV	UDEL	401
370 CONTINUE	UDEL	402
PATH = .FALSE.	UDEL	403
C	UDEL	404
C	UDEL	405
C	UDEL	406
OPTION TO OUTPUT QUANTITIES OF INTEREST.	UDEL	407
IF(NDRUG51.NE.1) RETURN	UDEL	408
WRITE(6,375)	UDEL	409
375 FORMAT(1X,"J,UDN(J),TA,TRSAVE(J),TSSAVE(J),TFAVSA(J),UD ")	UDEL	410
WRITE(6,150)	UDEL	411
WRITE(6,220)TR,DTDRI,TS,RHR,RIS,	UDEL	412
1UDRA,DTDRIR,EFFIN,N	UDEL	413
220 FORMAT(1X,15HFROM UDEL#220 ,4E15.6/1X,4E15.6,I5,//)	UDEL	414
WRITE(6,250)	UDEL	415
WRITE(6,320)UPR,UDPR,UDN(N),RIR	UDEL	416
320 FORMAT(1X,15HFROM UDEL#320 ,4E15.6,I5,//)	UDEL	417
WRITE(6,330)	UDEL	418
330 FORMAT(1X,"J,UDN(J),TA,TRSAVE(J),TSSAVE(J),TFAVSA(J),UD=)	UDEL	419
DO 360 J=1,N	UDEL	420
WRITE(6,400)J,UDN(J),TA,TRSAVE(J),TSSAVE(J),TFAVSA(J),UD	UDEL	421
400 FORMAT(1X,15HLEAVING UDEL ,I5,7E15.6,///)	UDEL	422
360 CONTINUE	UDEL	423
WRITE(6,450)	UDEL	424
450 FORMAT(1X,///)	UDEL	425
500 RETURN	UDEL	426
END		

SUBROUTINE VARIT(TA, TPER, PCST, KALL, CLSUM, FCSUM)

SUBROUTINE VARIT DETERMINES THE PERFORMANCE OF AN OPTIMUM POWER PLANT FOR A SPECIFIED AMBIENT TEMPERATURE THE SUBROUTINE ALSO DETERMINES THE INCREMENTAL COST OF OPERATING THE OPTIMUM POWER PLANT AT THAT AMBIENT TEMPERATURE

DEFINITION OF VARIABLES

CAPCHG - CAPACITY CHARGE (\$/MEGAWATT)
 CAPCST - CAPITAL COST FOR AUXILARY POWER (\$)
 CAPF - CAPICITY FACTOR (DIMENSIONLESS)
 CCOS1 - COST OF THE HEAT EXCHANGER AT OPTIMUM DESIGN CON-
 DITIONS (\$)
 CLAND1 - COST OF THE LAND AT OPTIMUM DESIGN CONDITIONS (\$)
 CLSUM - SUM OF THE PRODUCT BETWEEN THE AUXILARY POWER
 COST AND THE FRACTION OF THE YEAR THAT THE
 AMBIENT TEMPERATURE EXISTS (MILLS/KWH)
 CONRA1 - COST OF THE CONDENSER/REBOILER AT OPTIMUM DESIGN
 CONDITIONS (\$)
 COSM1 - MAINTAINENCE COST AT OPTIMUM DESIGN CONDITIONS
 (MILLS/KWH)
 CPA - SPECIFIC HEAT OF THE AIR (BTU/LBM-DEG F)
 CPIP1 - COST OF THE PIPING AT OPTIMUM DESIGN CONDITIONS (\$)
 CSTCL - AUXILIARY POWER COST (MILLS/KWH)
 DELFC - INCREASED FUEL COST FOR THE PLANT (MILLS/KWH)
 DELPS1 - PRESSURE DROP IN THE SUPPLY PIPING AT THE OPTIMUM
 DESIGN CONDITIONS (LBF/SQ FT)
 DELPS2 - PRESSURE DROP IN THE SUPPLY PIPING AT THE OFF DE-
 SIGN CONDITIONS (LBF/SQ FT)
 DENSIV - DENSITY OF THE VAPOR LEAVING THE CONDENSER/REBOILER
 AT OPTIMUM DESIGN CONDITIONS (LBM/CU FT)
 DENSIV2 - DENSITY OF THE VAPOR LEAVING THE CONDENSER/REBOILER
 AT OFF DESIGN CONDITIONS (LBM/CU FT)
 EFF - EFFECTIVENESS OF THE HEAT EXCHANGER (DIMENSIONLESS)
 EFF1 - EFFECTIVENESS OF THE HEAT EXCHANGER AT OPTIMUM
 DESIGN CONDITIONS (DIMENSIONLESS)
 FCOS - FUEL COST (\$/MM BTU)
 FCR - FIXED CHARGE RATE (DIMENSIONLESS)
 FCSUM - SUM OF THE PRODUCT BETWEEN THE FUEL COST INCREASE
 FOR THE PLANT DUE TO THE OFF DESIGN CONDITIONS
 AND THE FRACTION OF THE YEAR THAT THE AMBIENT
 TEMPERATURE EXISTS (MILLS/KWH)
 FPOW1 - FAN POWER AT OPTIMUM DESIGN CONDITIONS (KWH)
 HFG2 - HEAT OF VAPORIZATION AT OFF DESIGN CONDITIONS
 (BTU/LBM)
 HRFAC1 - HEAT RATE FACTOR AT RATING CONDITION(DIMENSIONLESS)
 HRFAC2 - HEAT RATE FACTOR AT DESIGN CONDITIONS (DIMENSION-
 LESS)
 HRFAC4 - HEAT RATE FACTOR AT OFF DESIGN CONDITIONS
 (DIMENSIONLESS)
 HRFA2S - HEAT RATE FACTOR AT OPTIMUM DESIGN CONDITIONS(DI-
 MENSIONLESS)
 HXITD - HEAT EXCHANGER ITD AT OFF DESIGN CONDITIONS (DEG F)
 HXLMTD - HEAT EXCHANGER LOG MEAN TEMPERATURE DIFFERENCE
 AT OFF DESIGN CONDITIONS (DEG F)

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

74/74 OPT=1

FTN 4.5+414

06/05/78 07.59.59

C	P	- BACK PRESSURE OF THE TURBINE (IN HGA)	VARIT	59
C	PCST	- PERCENT OF THE YEAR AT THE SPECIFIED AMBIENT	VARIT	60
C		TEMPERATURE TIMES THE INCREMENTAL COST AT THIS	VARIT	61
C		TEMPERATURE (MILLS/KWH)	VARIT	62
C	PGEN	- POWER GENERATING BY THE PLANT (MEGAWATTS)	VARIT	63
C	PPOW1	- PUMP POWER AT OPTIMUM DESIGN CONDITIONS (KWH)	VARIT	64
C	PSIZE	- PLANT SIZE (MEGAWATTS)	VARIT	65
C	PTOT	- TOTAL POWER OUTPUT OF PLANT AT OFF DESIGN	VARIT	66
C		CONDITIONS (MEGAWATTS)	VARIT	67
C	PWCOS	- REPLACEMENT POWER COST (MILLS/KWH)	VARIT	68
C	P12	- AMMONIA PRESSURE AT THE CONDENSER/REBOILER (LBF/	VARIT	69
C		SQ FT)	VARIT	70
C	P22	- AMMONIA PRESSURE AT THE HEAT EXCHANGER (LBF/SQ FT)	VARIT	71
C	QIN1	- HEAT INPUT INTO THE OPTIMUM POWER PLANT (BTU/HR)	VARIT	72
C	QREJCT1	- HEAT REJECTED AT THE OPTIMUM DESIGN CONDITIONS OF	VARIT	73
C		THE PLANT (BTU/HR)	VARIT	74
C	QREJCT2	- HEAT REJECTED AT THE OFF DESIGN CONDITIONS OF THE	VARIT	75
C		PLANT	VARIT	76
C	RANGE	- TEMPERATURE RANGE OF THE AIR AT OPTIMUM DESIGN	VARIT	77
C		CONDITIONS (DEG F)	VARIT	78
C	RANGE2	- TEMPERATURE RANGE OF THE AIR AT THE OFF DESIGN	VARIT	79
C		CONDITIONS (DEG F)	VARIT	80
C	SPCD1	- DIFFERENTIAL COST OF PLANT EXCLUDING THE COOLING	VARIT	81
C		SYSTEM AT OPTIMUM DESIGN CONDITIONS (\$)	VARIT	82
C	SPS13	- TOTAL POWER OUTPUT OF PLANT AT OPTIMUM DESIGN	VARIT	83
C		CONDITIONS (MEGAWATTS)	VARIT	84
C	TA	- AMBIENT TEMPERATURE (DEG F)	VARIT	85
C	TAMM	- TEMPERATURE OF THE AMMONIA LEAVING THE CONDENSER/	VARIT	86
C		REBOILER AT THE OPTIMUM DESIGN CONDITIONS FOR THE	VARIT	87
C		PLANT (DEG F)	VARIT	88
C	TCOS	- INCREMENTAL INCREASE IN COST OF THE POWER PRODUCED	VARIT	89
C		BY THE OPTIMUM POWER PLANT DUE TO THE COOLING	VARIT	90
C		SYSTEM (MILLS/KWH)	VARIT	91
C	TD	- DESIGN AMBIENT TEMPERATURE (DEG F)	VARIT	92
C	TEFF	- BASE THERMAL EFFICIENCY OF THE PLANT (DIMENSIONLESS)	VARIT	93
C	TEFF1	- RATED THERMAL EFFICIENCY OF THE PLANT	VARIT	94
C		(DIMENSIONLESS)	VARIT	95
C	TEFF3	- DESIGN THERMAL EFFICIENCY OF THE OPTIMUM PLANT	VARIT	96
C		(DIMENSIONLESS)	VARIT	97
C	TEFF4	- OFF DESIGN THERMAL EFFICIENCY OF THE PLANT	VARIT	98
C		(DIMENSIONLESS)	VARIT	99
C	TI	- TEMPERATURE OF THE AMMONIA AT THE INLET TO THE	VARIT	100
C		HEAT EXCHANGER (DEG F)	VARIT	101
C	TPER	- FRACTION OF THE YEAR THAT THE CORRESPONDING	VARIT	102
C		AMBIENT TEMPERATURE EXISTS (DIMENSIONLESS)	VARIT	103
C	TTD1	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED	VARIT	104
C		STEAM AND AMMONIA IN THE CONDENSER/REBOILER	VARIT	105
C		AT DESIGN CONDITIONS (DEG F)	VARIT	106
C	TTD11	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED	VARIT	107
C		STEAM AND AMMONIA IN THE CONDENSER/REBOILER	VARIT	108
C		AT OPTIMUM DESIGN CONDITIONS (DEG F)	VARIT	109
C	TTD12	- TEMPERATURE DIFFERENCE BETWEEN THE SATURATED	VARIT	110
C		STEAM AND AMMONIA IN THE CONDENSER/REBOILER	VARIT	111
C		AT OFF DESIGN CONDITIONS (DEG F)	VARIT	112
C	TTD2	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	VARIT	113
C		PIPING (DEG F)	VARIT	114
C	TTD21	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	VARIT	115

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

C		PIPING AT OPTIMUM DESIGN CONDITONS (DEG F)	VARIT	116
C	TTD22	- TEMPERATURE DROP OF THE AMMONIA IN THE SUPPLY	VARIT	117
C		PIPING AT OFF DESIGN CONDITIONS (DEG F)	VARIT	118
C	T1	- SATURATED STEAM TEMPERATURE IN THE CONDENSER/	VARIT	119
C		REBOILER (DEG F)	VARIT	120
C	W31	- MASS FLOW RATE OF AMMONIA AT OPTIMUM DESIGN	VARIT	121
C		CONDITIONS (LBM/HR)	VARIT	122
C	W32	- MASS FLOW RATE OF AMMONIA AT OFF DESIGN CONDITIONS	VARIT	123
C		(LBM/HR)	VARIT	124
C	W41	- MASS FLOW RATE OF AIR THROUGH THE HEAT EXCHANGER	VARIT	125
C		AT OPTIMUM DESIGN CONDITIONS (LBM/HR)	VARIT	126
C	YFPMIN	- OPTIMUM PLANT SCALING FACTOR FOR FAN AND PUMP	VARIT	127
C		POWER LOSS (DIMENSIONLESS)	VARIT	128
C			VARIT	129
C		DEFINITION OF ARRAYS	VARIT	130
C			VARIT	131
C	DEPERQ1	- FRACTION OF THE HEAT LOAD THAT IS CARRIED OFF BY	VARIT	132
C		THE DELUGED PART OF THE HEAT EXCHANGER FOR EACH	VARIT	133
C		AMBIENT TEMPERATURE INCREMENT (DIMENSIONLESS)	VARIT	134
C	DEPER1	- FRACTION OF THE HEAT EXCHANGER THAT IS DELUGED	VARIT	135
C		FOR EACH AMBIENT TEMPERATURE INCREMENT	VARIT	136
C		(DIMENSIONLESS)	VARIT	137
C	PWD1	- WET/DRY BACK PRESSURE CURVE FOR THE AMBIENT	VARIT	138
C		TEMPERATURE RANGE (IN MGA)	VARIT	139
C	TPO	- ARRAY OF COEFFICIENTS FOR THE CUBIC CURVE FIT OF	VARIT	140
C		HEAT RATE FACTOR AS A FUNCTION OF TURBINE BACK	VARIT	141
C		PRESSURE (DIMENSIONLESS)	VARIT	142
	LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG		BIGCOM	2
	COMMON		BIGCOM	3
	\$ AFTR, ALPHA, ANG(3)		BIGCOM	4
	* ,BPLIM(16)		BIGCOM	5
	\$,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF		BIGCOM	6
	\$,CBJ, CTURB, CDANG, CLUVR, CHAILS, CVM		BIGCOM	7
	\$,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF		BIGCOM	8
	\$,EFFP, EFS		BIGCOM	9
	\$,FCR,FIRST,FXL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG		BIGCOM	10
	\$,FIXV,FXTTDD,FXTVAR,FXTTDD,FXTLNG		BIGCOM	11
	\$,GBEFF		BIGCOM	12
	\$,HXNP,HPCST,HCD		BIGCOM	13
	\$,ITMAX, ITMIN		BIGCOM	14
	\$,JCONS		BIGCOM	15
	\$,KCONV, KALEXT		BIGCOM	16
	\$,MXEXT		BIGCOM	17
	\$,NTA,NSIDES,NBUNHI		BIGCOM	18
	COMMON		BIGCOM	19
	\$ ODR		BIGCOM	20
	\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL		BIGCOM	21
	\$,POHRAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POHSCL		BIGCOM	22
	\$,RBP,REDUCE, REDUCV, ROOFL, RHOUT		BIGCOM	23
	\$,QREJ, QREDUCE, QREDUCV		BIGCOM	24
	\$,SIGMAG, SAAF, SEGL		BIGCOM	25
	\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX		BIGCOM	26
	\$,TCD, TW		BIGCOM	27
	\$,UCS, UWS		BIGCOM	28
	\$,WV, WATCONA, WATCOST		BIGCOM	29
	\$,VAS(5)		BIGCOM	30
	\$,XDEPA, XW, XD		BIGCOM	31

```

COMMON /SCALER/HRFAC1, ATUB, CPERA, SSCD, PLANC1, CASSS1, SCALER 2
$ GAIR, FAIR, HPAIR, HPWAT, WL RTP, PLANCT1 SCALER 3
COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF, SUPPLY 2
$ QIN, CLAND, REAIR, Z, HRFAC2, W4, U, DELPW, PPOW, SUPPLY 3
$ FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4, SUPPLY 4
$ REWAT, NW, NT, NP, PLANC2, PSIZ12, SPBP, SW4, SW3, SUPPLY 5
$ SPC, PTOTAL, PLANC3, SAFRON, AAIR, YFP, SPCD, PSIZ13, WT2, SUPPLY 6
$ BP2, NW2, TCOS, DELPA, DELPWT, DELPWC, CONBAS, XNTSX, VELDX SUPPLY 7
$ , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS SUPPLY 8
$ , CLTC, CFC, CPCC, FITCO, CSC, CEPREP, DELPIP, AST, OLDCST SUPPLY 9
$ , CAPCST, XNFAN, BLDANG, CPLEN, DPFEL, WHX, WTTUB, ADIA, ABLN SUPPLY 10
$ , WTHDR, WTRFM, STRUCC, CFPERF, HPPERF, TOTCF, TPC, EFFIN, ANTU SUPPLY 11
$ , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTP, ADJTP SUPPLY 12
$ , ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST SUPPLY 13
$ , CSRD, WATERW, WSTRCT, CFOWN, HUBDIA, TOWLEN, NUMTOW, CTOWD SUPPLY 14
$ , SQRJ, SQRJS, ATUBC, CBA, TTD1, TTD2, DELPS, CSTLVR, PIPCTD SUPPLY 15
$ , CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST SUPPLY 16
$ , PWD(16), WATCHD(16), DEPER(16), DEPERQ(16) SUPPLY 17
$ , WBB, HTOW, NTOWDE, CSTIF, CSJ, CVF, CDP, W5 SUPPLY 18
COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1, SINK 2
$ QIN1, CLAN1, REA11, Z1, HRFAC2S, W41, U1, DEPW1, PPOW1, SINK 3
$ FPOW1, DEFC1, WIDTH1, ELENG1, VAIR1, VWAT1, HI1, HO1, T41, SINK 4
$ REWAT1, NW1, NT1, NP1, ZPLNC2, ZSIZ12, ZSPBP, SW41, SW31, SINK 5
$ SPC1, PTOT1, PLNC31, AFRO1, AAIR1, YFPMIN, SPCD1, SPS13, WT2MIN, SINK 6
$ BP2MIN, NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1, CONBA1, XNTS1, VELD1 SINK 7
$ , TLA1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1 SINK 8
$ , CLTC1, CFC1, CPCC1, FITCO1, CSC1, CEPRE1, DEPIP1, AST1, OLDCS1 SINK 9
$ , CAPCS1, XNFAN1, BLDAN1, CPLEN1, DPFEL1, WH1, WTTU1, ADI1, ABL1 SINK 10
$ , WTHD1, WTR1, STRUC1, CFMPF1, HPPF1, TOTCF1, TPL, EFFIN1, ANTU1 SINK 11
$ , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1 SINK 12
$ , ACTRP1, ADJBPD1, ACTVH1, ADJVH1, ADJPP1, THPA1, TCTF1, AFCST1 SINK 13
$ , CSR1, WATER1, WSTRCT1, CFOWN1, HUBD1, TOWLE1, NUMTOW1, CTOWD1 SINK 14
$ , SQRJ1, SQRJS1, ATUBC1, CBA1, TTD1, TTD2, DELPS1, CSTLV1, PIPCTD1 SINK 15
$ , CSTHS1, CYLRN1, CFANEL1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1 SINK 16
$ , PWD1(16), WATCHD1(16), DEPER1(16), DEPERQ1(16) SINK 17
$ , WBB1, HTOW1, NTOWDE1, CSTIF1, CSJ1, CVF1, CDP1, W51 SINK 18
COMMON /TINE/ XNS, TLA, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY VARIT 147
COMMON /FAN/ FANDAP(153,10), FANDAM(153,10), FMCPF, FBCPF, P2, R, S, VARIT 148
$ VELREC, AFC, ELEV, EHR VARIT 149
COMMON /PROP/ CPW, THCONW, DensiW, VISW, HFG, VARIT 150
* CPV, THCONV, DensiV, VISV, SIGMA, VARIT 151
* CPA, THCONA, DensiA, VISA VARIT 152
COMMON /POWZ/ VARIT 153
$ TBPMXZ, POWMAX VARIT 154
C VARIT 155
C DESIGN THERMAL EFFECTIVENESS OF THE POWER PLANT VARIT 156
TEFF3=TEFF/HRFA2S VARIT 157
C VARIT 158
C RATED THERMAL EFFECTIVENESS OF THE POWER PLANT VARIT 159
TEFF1=TEFF/HRFAC1 VARIT 160
C VARIT 161
C HEAT INPUT INTO THE POWER PLANT VARIT 162
QIN1=3413.E+3 * SPS13/TEFF1 VARIT 163
C VARIT 164
C HEAT REJECTED AT THE DESIGN THERMAL EFFECTIVENESS OF VARIT 165
THE POWER PLANT VARIT 166
GREJCT1 = QIN1*(1. - TEFF3) VARIT 167

```

	RANGE = (VAR(1) - TTD11 - TTD21 - TD)*EFF1	VARIT	168
	TAIRAV = TD + RANGE/2.	VARIT	169
	CPA = FLUID(5,2,TAIRAV,ELEV,"VARIT1")	VARIT	170
	TAMM = TD + RANGE/EFF1 + TTD21	VARIT	171
	DENSIV = FLUID(7,1,TAMM,ELEV,"CALC25")	VARIT	172
C		VARIT	173
C		VARIT	174
C	BACK PRESSURE AT THE AMBIENT TEMPERATURE	VARIT	175
	P = PW01(KALL)	VARIT	176
	T1 = 9240./(17,168 - ALOG(P)) - 460.	VARIT	177
C		VARIT	178
C	HEAT RATE FACTOR AT THE ABOVE BACK PRESSURE	VARIT	179
	HRFAC4=TP0(1)*TP0(2)*P*TP0(3)*P**2*TP0(4)*P**3	VARIT	180
C		VARIT	181
C	THERMAL EFFECTIVENESS OF THE PLANT AT THE ABOVE BACK	VARIT	182
C	PRESSURE	VARIT	183
	TEFF4=TEFF/HRFAC4	VARIT	184
C		VARIT	185
C	HEAT REJECTED AT THE ABOVE THERMAL EFFECTIVENESS OF THE	VARIT	186
C	POWER PLANT	VARIT	187
	QREJCT2 = QIN1*(1. - TEFF4)	VARIT	188
C		VARIT	189
C	TEMPERATURE DIFFERENCE BETWEEN THE SATURATED STEAM AND	VARIT	190
C	THE AMMONIA IN THE CONDENSER/REBOILER	VARIT	191
	TTD12 = (QREJCT2/QREJCT1) * TTD11	VARIT	192
C		VARIT	193
C	PRESSURE OF THE AMMONIA LEAVING THE CONDENSER/REBOILER	VARIT	194
	P12 = FLUID(10,1,T1-TTD12,ELEV,"CALC 22")	VARIT	195
	HFG2 = FLUID(9,1,T1-TTD12,ELEV,"CALC 20")	VARIT	196
	DENSIV2 = FLUID(7,1,T1-TTD12,ELEV,"CALC 21")	VARIT	197
C		VARIT	198
C	MASS FLOW RATE OF AMMONIA THROUGH THE COOLING SYSTEM	VARIT	199
	W32 = QREJCT2/HFG2	VARIT	200
C		VARIT	201
C	PRESSURE DROP OF AMMONIA THROUGH THE SUPPLY PIPING	VARIT	202
	DELPS2 = DELPS1 * (W32**2 * DENSIV/(DENSIV2 * W31**2))	VARIT	203
C		VARIT	204
C	PRESSURE AT THE END OF THE SUPPLY PIPING	VARIT	205
	P22 = P12 - DELPS2/144.	VARIT	206
	TI = T1 - TTD1 - TTD2	VARIT	207
	DELT1 = .001	VARIT	208
C		VARIT	209
C	LOOP TO DETERMINE THE TEMPERATURE OF THE AMMONIA AT THE	VARIT	210
C	END OF THE SUPPLY PIPING	VARIT	211
10	FTI = -P22 + FLUID(10,1,TI,ELEV,"CALC 23")	VARIT	212
	FTIDEL = -P22 + FLUID(10,1,TI+DELT1,ELEV,"CALC 24")	VARIT	213
	TIP1 = TI - DELT1*FTI/(FTIDEL - FTI)	VARIT	214
	IF(ABS(TIP1 - TI).LT..0001) GO TO 20	VARIT	215
	TI = TIP1	VARIT	216
	GO TO 10	VARIT	217
C		VARIT	218
C	TEMPERATURE DROP IN THE AMMONIA FROM THE BEGINNING TO THE	VARIT	219
C	END OF THE SUPPLY PIPING	VARIT	220
20	TTD22 = T1 - TTD12 - TI	VARIT	221
C		VARIT	222
C	TEMPERATURE RANGE OF THE AIR	VARIT	223
	IF(DEPER1(KALL),EQ,1.) RANGE2 = 0.0	VARIT	224

SUBROUTINE VARIT

74/74 OPT=1

FTN 4,5,414

06/05/78 07.59.59

```

      IF(DEPER1(KALL),EQ.1.) GO TO 40
      RANGE2 = (1. - DEPERQ1(KALL))*QREJCT2/(W41*(1. - DEPER1(KALL)))*(1.
1 * YFPMIN)*CPA)
C      POWER OUTPUT OF THE LOW-PRESSURE TURBINE AT THE SPECIFIC
C      AMBIENT TEMPERATURE
C 40 PTOT = QIN1 *TEFF4/3413.E+3
C      POWER OUTPUT OF THE PLANT AT THE SPECIFIC AMBIENT TEM-
C      PERATURE
C      PGEN = PTOT - PPOW1/1000. - FPOW1/1000.
      TEFFD=TEFF4
      IF(PGEN.GE.PSIZE) GO TO 50
C      COST OF THE AUXILIARY POWER REQUIRED TO MAKE UP FOR LOST
C      CAPACITY ON HOT DAYS
      CSTCL=(PSIZE-PGEN)/PSIZE*PWCOS
      TEFFD=TEFF3
      GO TO 60
50 CSTCL = 0.0
C      INCREASED FUEL COST OF THE PLANT DUE TO OFF DESIGN
C      CONDITIONS
C 60 DELFC = FCOS=3413.E-5 * ((1.+YFPMIN)/TEFFD-1./TEFF)
C      IF(KALL.NE.1) GO TO 70
      CAPCST=0.0
      IF(PSIZE.LE.PGEN) GO TO 70
C      CAPITAL CHARGE FOR THE AUXILIARY POWER
C      CAPCST=CAPCHG*(PSIZE-PGEN)
70 CONTINUE
C      INCREASE IN COST OF OPERATING THE PLANT AT THIS AMBIENT
C      TEMPERATURE DUE TO THE USE OF THE COOLING SYSTEM
C      TCOS = (CCOS1*SPCD1+CLAN1+CPIP1+CONBA1+CAPCST)*FCR/(PSIZE*CAPF*
* 8760.) + COSM1 + DELFC + CSTCL + WATCONA*(.1203/1000.)*WATCOST/
$(PSIZE*CAPF*8760.)
C      FRACTION OF THE YEAR THAT THIS AMBIENT TEMPERATURE EXISTS
C      TIMES THE INCREMENTAL COST OF THE COOLING SYSTEM AT
C      THIS AMBIENT TEMPERATURE
      PCST=TPER*TCOS
C      SUM OF THE PRODUCT BETWEEN THE AUXILIARY POWER COST AND
C      THE FRACTION OF THE YEAR THAT THE AMBIENT TEMPERATURE
C      EXISTS
      CLSUM = CLSUM + CSTCL * TPER
C      SUM OF THE PRODUCT BETWEEN THE FUEL COST INCREASE FOR THE
C      PLANT DUE TO THE OFF DESIGN CONDITIONS AND THE FRACTION
C      OF THE YEAR THAT THE AMBIENT TEMPERATURE EXISTS
      FCSUM = FCSUM + DELFC * TPER
      INRG=0
      IF(INRG,EQ.0) GOTO 800
935 FORMAT(T2,F6.1, T10,F6.1, T18,F6.2, T26,F7.4, T33,F7.3
S,T41,F6.3, T47,F7.2, T54,F7.2, T62,F8.3, T72,F7.5, T81,G11.5

```

VARIT 225
 VARIT 226
 VARIT 227
 VARIT 228
 VARIT 229
 VARIT 230
 VARIT 231
 VARIT 232
 VARIT 233
 VARIT 234
 VARIT 235
 VARIT 236
 VARIT 237
 VARIT 238
 VARIT 239
 VARIT 240
 VARIT 241
 VARIT 242
 VARIT 243
 VARIT 244
 VARIT 245
 VARIT 246
 VARIT 247
 VARIT 248
 VARIT 249
 VARIT 250
 VARIT 251
 VARIT 252
 VARIT 253
 VARIT 254
 VARIT 255
 VARIT 256
 VARIT 257
 VARIT 258
 VARIT 259
 VARIT 260
 VARIT 261
 VARIT 262
 VARIT 263
 VARIT 264
 VARIT 265
 VARIT 266
 VARIT 267
 VARIT 268
 VARIT 269
 VARIT 270
 VARIT 271
 VARIT 272
 VARIT 273
 VARIT 274
 VARIT 275
 VARIT 276
 VARIT 277
 VARIT 278
 VARIT 279
 VARIT 280
 VARIT 281

	\$ T93,F7.4, T106,F7.3, T115,G11.5)	VARIT	282
	936 FORMAT(1H0)	VARIT	283
	937 FORMAT(1X,"HRFAC4=",G11.5,T24,"TEFF4=",G11.5,T46,"QREJ=",G11.5,	VARIT	284
	\$ T65,"RANGE=",G11.5,T85,"VAR(3)=",G11.5,T108,"T11=",G11.5/	VARIT	285
	\$ 1X,"PTOTAL=",G11.5,T25,"PGEN=",G11.5,T46,"PPOW=",G11.5,	VARIT	286
	\$ T66,"FPOW=",G11.5,T87,"QIN1=",G11.5/	VARIT	287
	\$ 1X," TEFF3=",G11.5,T24,"TEFF1=",G11.5,T44,"YFPMIN=",G11.5)	VARIT	288
	WRITE(6,936)	VARIT	289
	WRITE(6,937) HRFAC4,TEFF4,QREJ,RANGE,VAR(3),T11,PTOTAL,PGEN,	VARIT	290
	\$ PPOW,PPOW,QIN1,TEFF3,TEFF1,YFPMIN	VARIT	291
	WRITE(6,938) HRFAC2,TEFF,HRFAC,HRFAC1,TEFFD,CCOS1,SPCD1,CLAN1,	VARIT	292
	\$ CPIP1,COSM1	VARIT	293
	938 FORMAT(1X,"HRFAC2=",G11.5,T25,"TEFF=",G11.5,T45,"HRFAC=",G11.5,	VARIT	294
	\$ T64,"HRFAC1=",G11.5,T86,"TEFFD=",G11.5,T106,"CCOS1=",G11.5/	VARIT	295
	\$ 1X," SPCD1=",G11.5,T24,"CLAN1=",G11.5,T45,"CPIP1=",G11.5,T65,	VARIT	296
	\$ "COSM1=",G11.5)	VARIT	297
	939 FORMAT(T2,"TAI,TAO,TAMM,T11,RANGE,TTD1",6G15.6)	VARIT	298
	800 CONTINUE	VARIT	299
	TAMM = T1 - TTD12 - TTD22	VARIT	300
	HXITD = T1 - TTD12 - TTD22 - TA	VARIT	301
	IF(HXITD.GT.0.0) HXLMTD = RANGE2/ALOG(HXITD/(HXITD - RANGE2))	VARIT	302
	IF(HXITD.LT.0.0) HXLMTD = 0.0	VARIT	303
5	810 CONTINUE	VARIT	304
	IF(KALL.EQ.1) TBPMXZ=P	VARIT	305
	IF(KALL.EQ.1) POWMAX=PGEN	VARIT	306
	WRITE(6,935) TA	VARIT	307
	\$,T1	VARIT	308
0	\$,P	VARIT	309
	\$,HRFAC4	VARIT	310
	\$,RANGE2	VARIT	311
	\$,TTD12	VARIT	312
	\$,HXLMTD	VARIT	313
'5	\$,HXITD	VARIT	314
	\$,PGEN	VARIT	315
	\$,DELEFC	VARIT	316
	\$,CSTCL	VARIT	317
	\$,TCOS	VARIT	318
30	\$,TPER = 100.	VARIT	319
	\$,PCST	VARIT	320
	IF(IDRG.EQ.0) RETURN	VARIT	321
	RETURN	VARIT	322
	END	VARIT	323

SUBROUTINE XTEND

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

```

C      SUBROUTINE XTEND(L)
C      THIS ROUTINE CHECKS EXTREME VALUES AT MINIMAL COST POINT.
C
      DIMENSION TTRY(2),RTRY(2),CTRY(2),ATRY(2),WTRY(2)
      COMMON /SINK/ VAR(5), CPLN1, CPIP1, CCOS1, W31, COSM1, EFF1,
$      QIN1, CLAN1, REA11, Z1,HRFA2S, W41, U1, DEPW1, PPOW1,
$      FPOW1, DEFC1, WIDT1, ELEN1, VAIR1, VWAT1, H11, HO1, T41,
$      REW1, NW1, NT1, NP1,ZPLNC2,ZSIZ12, ZSPBP, SW41, SW31,
$      SPC1, PTOT1,PLNC31, AFRO1, AAIR1,YFPMIN, SPCD1, SPS13,WT2MIN,
$      BP2MIN,NW2MIN, TCOS1, DEPA1, DPWT1, DPWC1,CONBA1, XNTS1, VELD1
$      , TL1, UCON1, PMCS1, FMCS1, FBAC1, EFFC1, CH1, CA1, CS1
$      , CLTC1, CFC1, CPCC1,FITC1, CSC1,CEPRE1,DEPIP1, AST1,OLDCS1
$      ,CAPCS1,XNFAN1,BLDAN1,CPLEN1,DPFEL1, WH1, WTTU1, ADI1, ABL1
$      , WTHD1, WTRF1,STRUC1,CFMPF1, HPPF1,TOTCF1, TPI,EFFIN1, ANTU1
$      , AIRFF1, WATFF1, XNMOD1, TCTPF1, FDCPF1, FMTRC1, ACTTP1, ADJTP1
$      , ACTBP1, ADJBP1, ACTVH1, ADJVH1, ADJPP1, THPA11, TCTF1, AFCST1
$      , CSR1, WATER1, WSTRC1, CFOUN1, HUBD11, TOWLE1, NUMTOL, CTOWD1
$      ,SORJ1,SORJ51,ATUBC1,CBA1,TTD11,TTD21,DELPS1,CSTLV1,PIPC1D1
$      ,CSTHS1, CYLRN1, CFANE1, PSTAC1, PUFIT1, PMPCS1, RPTPL1, SEPCS1
$      ,PWD1(16),WATCHD1(16),DEPER1(16),DEPERQ1(16)
$      ,WRB1,HTOW1,NTOWDE1,CSTIF1,CSJ1,CVF1,CDP1,W51
      COMMON /SUPPLY/ VAL(5), CPLN, CPIP, CCOS, W3, COSM, EFF,
$      QIN, CLAND, REAIR, Z,HRFAC2, W4, U, DELPW, PPOW,
$      FPOW, DELFC, WIDTH, ELENG, VAIR, VWAT, HI, HO, T4,
$      REWAT, NW, NT, NP,PLANC2,PSIZ12, SPBP, SW4, SW3,
$      SPC,PTOTAL,PLANC3,SAFRON, AAIR, YFP, SPCD,PSIZ13, WT2,
$      BP2, NW2, TCOS, DELPA,DELPWT,DELPWC,CONBAS, XNTSX, VELDX
$      , TLAX, UCON, PMCST, FMCST, FBACC, EFFC, CH, CA, CS
$      , CLTC, CFC, CPCC, FITCO, CSC,CEPRE,DELP1P, AST,OLDCST
$      ,CAPCST, XNFAN,BLDANG, CPLEN, DPFEL, WHX, WTTUB, ADIA, ABLN
$      , WTHDR, WTRFM,STRUCC,CFPERF,HPPERF, TOTCF, TPC, EFFIN, ANTU
$      , AIRFF, WATFF, XNMOD, TCTPF, FDCPF, FMTRC, ACCTTP, ADJTP
$      , ACTBPD, ADJBPD, ACTVH, ADJVH, ADJPPF, THPAIR, TCTF, AFCST
$      , CSR, WATERW, WSTRCT, CFOUN, HUBDIA, TOWLEN, NUMTOW, CTOWD
$      ,SORJ,SORJ5,ATUBC,CBA,TTD1,TTD2,DELPS,CSTLVR,PIPCSTD
$      ,CSTHS, CYLRNG, CFANEL, PSTACS, PUFITC, PMPCST, RPTPL, SEPCST
$      ,PWD(16),WATCHD(16),DEPER(16),DEPERQ(16)
$      ,WRB,HTOW,NTOWDE,CSTIF,CSJ,CVF,CDP,W5
      COMMON /TINE/ XNS, TL1, XNTS, ARPS, TTD2QE, LINOR, XNP, XQUALY
      LOGICAL FIRST,FRST,FXTMP,FXTVAR,FXTTDD,FXTLNG
      COMMON
$      AFTR, ALPHA, ANG(3)
$      * ,BPLIM(16)
$      ,CAPF, CSSPKW, CONF, CONL, COSTL, CAPCHG, CONMAT, CONMA2,CAF
$      ,CRJ, CTURB, CDANG, CLUVR, CHAILS, CVM
$      ,DFIN,DEEPL,DESVEL,DESVELV,DESVELD,DENSIF
$      ,EFFP, EFS
$      ,FCR,FIRST,FXIL,FCOS,FFHX,FXTMP,FACTOR,FRST,FACIORD,FSHOT,FDELUG
$      ,FIXV,FXTTD,FXTVAR,FXTTDD,FXTLNG
$      ,GBEFF
$      ,HXNP,HPCST,HCD
$      ,ITMAX, ITMIN
$      ,JCONS
$      ,KCONV, KALEXT
$      ,MXEXT
$      ,NTA,NSIDES,NBUNHI

```

```

XTEND 2
SINK 3
XTEND 4
XTEND 5
XTEND 6
SINK 2
SINK 3
SINK 4
SINK 5
SINK 6
SINK 7
SINK 8
SINK 9
SINK 10
SINK 11
SINK 12
SINK 13
SINK 14
SINK 15
SINK 16
SINK 17
SINK 18
SUPPLY 2
SUPPLY 3
SUPPLY 4
SUPPLY 5
SUPPLY 6
SUPPLY 7
SUPPLY 8
SUPPLY 9
SUPPLY 10
SUPPLY 11
SUPPLY 12
SUPPLY 13
SUPPLY 14
SUPPLY 15
SUPPLY 16
SUPPLY 17
SUPPLY 18
XTEND 9
BIGCOM 2
BIGCOM 3
BIGCOM 4
BIGCOM 5
BIGCOM 6
BIGCOM 7
BIGCOM 8
BIGCOM 9
BIGCOM 10
BIGCOM 11
BIGCOM 12
BIGCOM 13
BIGCOM 14
BIGCOM 15
BIGCOM 16
BIGCOM 17
BIGCOM 18

```

COMMON	BIGCOM	19
\$ NDR	BIGCOM	20
\$,PSIZE, PER, PWCOS, PLANC, PFACT, POMDPL	BIGCOM	21
\$,POHBAF, POHFAN, POHLEC, POHCIR, POHCND, POHSTC, POMHCL	BIGCOM	22
\$,RRP,REDUCE, REDUCV, ROOFL, RHOUT	BIGCOM	23
\$,GREJ, GREduce, GREduCV	BIGCOM	24
\$,SIGMAG, SAAF, SEGL	BIGCOM	25
\$,TD, TPO(4), TEFF, TLIM, THFIN, TLPRA, TFIX	BIGCOM	26
\$,TCD, TW	BIGCOM	27
\$,UCS, UWS	BIGCOM	28
\$,WEV, WATCONA, WATCOST	BIGCOM	29
\$,VAS(5)	BIGCOM	30
\$,XDEPA, XW, XD	BIGCOM	31
COMMON /LACALL/ SRN	XTEND	11
TTRY(1)=VAR(1)+20.	XTEND	12
IF (TTRY(1) .LE. 0.0) TTRY(1)=10.	XTEND	13
TTRY(2)=VAR(1)+20.	XTEND	14
IF(TTRY(2).GE.170.) TTRY(2)=170.	XTEND	15
IF(EXTEND) TTRY(1) = TFIX	XTEND	16
IF(EXTEND) TTRY(2) = TFIX	XTEND	17
CTRY(1)=VAR(3)+3.	XTEND	18
IF(CTRY(1).LE.0.) CTRY(1)=.5	XTEND	19
CTRY(2)=VAR(3)+2.	XTEND	20
ATRY(1) = VAR(4) + 30.0	XTEND	21
ATRY(2) = VAR(4) + 30.0	XTEND	22
IF(ATRY(2) .LT. 10.0) ATRY(2) = 10.0	XTEND	23
WTRY(1) = VAR(5)+2.0	XTEND	24
WTRY(2) = IFIX(VAR(5)/2.0)	XTEND	25
IF(WTRY(2) .LT. 1) WTRY(2) = 1.0	XTEND	26
RTRY(1) = VAR(2) + 3.0	XTEND	27
RTRY(2) = VAR(2) + 3.0	XTEND	28
DO 3 I=1,2	XTEND	29
SRN=XTEND-1/ "	XTEND	30
DO 3 IR=1,2	XTEND	31
IF(EXTVAR) RTRY(IR) = FIXV	XTEND	32
CALL CALC(TTRY(I),RTRY(IR),VAR(3),VAR(4),VAR(5),1)	XTEND	33
IF(KCONV,EQ.1) GO TO 3	XTEND	34
IF(DELPA,LE,XDEPA) GO TO 3	XTEND	35
IF(TCOS.GT..99*TCOS1) GO TO 3	XTEND	36
TCOS1=TCOS	XTEND	37
VAS(1)=TTRY(I)	XTEND	38
VAS(2) = RTRY(IR)	XTEND	39
VAS(3)=VAR(3)	XTEND	40
VAS(4)=VAR(4)	XTEND	41
VAS(5)=VAR(5)	XTEND	42
L=1	XTEND	43
3 CONTINUE	XTEND	44
DO 10 I=1,2	XTEND	45
SRN=XTEND-3/ "	XTEND	46
IF(EXTTID) CTRY(I) = FIXTID	XTEND	47
CALL CALC(VAR(1),VAR(2),CTRY(I),VAR(4),VAR(5),1)	XTEND	48
IF(KCONV,EQ.1) GO TO 10	XTEND	49
IF(DELPA,LE,XDEPA) GO TO 10	XTEND	50
IF(TCOS.GT..99*TCOS1) GO TO 10	XTEND	51
TCOS1=TCOS	XTEND	52
VAS(1)=VAR(1)	XTEND	53
VAS(2) = VAR(2)	XTEND	54

SUBROUTINE XTEND

74/74 OPT=1

FTN 4,5+414

06/05/78 07.59.59

VAS(3)=CTRY(I)	XTEND	55
VAS(4)=VAR(4)	XTEND	56
VAS(5)=VAR(5)	XTEND	57
L=1	XTEND	58
10 CONTINUE	XTEND	59
DO 11 I=1,2	XTEND	60
IF(FXTLNG) GO TO 11	XTEND	61
CALL CALC(VAR(1),VAR(2),VAR(3),ATRY(I),VAR(5),2*I)	XTEND	62
IF(KCONV,EQ,1) GO TO 11	XTEND	63
IF(DELPA,LE,XDEPA) GO TO 11	XTEND	64
IF(TCOS,GT,.99*TCOS1) GO TO 11	XTEND	65
TCOS1=TCOS	XTEND	66
VAS(1)=VAR(1)	XTEND	67
VAS(2) = VAR(2)	XTEND	68
VAS(3)=VAR(3)	XTEND	69
VAS(4)=ATRY(I)	XTEND	70
VAS(5)=VAR(5)	XTEND	71
L=1	XTEND	72
11 CONTINUE	XTEND	73
SRN="/XTEND=4/"	XTEND	74
DO 12 I=1,2	XTEND	75
IF(DEEPL,GT,0.0) GO TO 12	XTEND	76
CALL CALC(VAR(1),VAR(2),VAR(3),VAR(4),WTRY(I),3*I)	XTEND	77
IF(KCONV,EQ,1) GO TO 12	XTEND	78
IF(DELPA,LE,XDEPA) GO TO 12	XTEND	79
IF(TCOS,GT,.99*TCOS1) GO TO 12	XTEND	80
TCOS1=TCOS	XTEND	81
VAS(1)=VAR(1)	XTEND	82
VAS(2) = VAR(2)	XTEND	83
VAS(3)=VAR(3)	XTEND	84
VAS(4)=VAR(4)	XTEND	85
VAS(5)=WTRY(I)	XTEND	86
L=1	XTEND	87
12 CONTINUE	XTEND	88
SRN = "/XTEND=5/"	XTEND	89
DO 14 IR = 1, 2	XTEND	90
IF(FXTVAR) GO TO 14	XTEND	91
CALL CALC(VAR(1),RTRY(IR),VAR(3),VAR(4),VAR(5),1)	XTEND	92
IF(KCONV ,EQ. 1) GO TO 14	XTEND	93
IF(DELPA ,LE. XDEPA) GO TO 14	XTEND	94
IF(TCOS ,GT. 0.99*TCOS1) GO TO 14	XTEND	95
TCOS1 = TCOS	XTEND	96
VAS(1) = VAR(1)	XTEND	97
VAS(2) = RTRY(IR)	XTEND	98
VAS(3) = VAR(3)	XTEND	99
VAS(4) = VAR(4)	XTEND	100
VAS(5) = VAR(5)	XTEND	101
L = 1	XTEND	102
14 CONTINUE	XTEND	103
IF(L,EQ,1) WRITE(6,13)	XTEND	104
13 FORMAT(" XTEND CALLED, AND CHANGE MADE")	XTEND	105
IF (L ,EQ. 1) KALEXT = KALEXT + 1	XTEND	106
IF (KALEXT ,GT. MXEXT) STOP "CALLS TO S,R, EXTEND EXCEED MXEXT"	XTEND	107
RETURN	XTEND	108
END	XTEND	109

DISTRIBUTION

<u>No. of Copies</u>	<u>No. of Copies</u>
<u>OFFSITE</u>	
U.S. Department of Energy A. A. Churm Chicago Patent Group 9800 South Cass Avenue Argonne, IL 60439	U.S. Department of Energy N. Gerstein Chief, Special Projects Branch Division of Advanced Systems and Materials Washington, DC 20545
U.S. Department of Energy Office of Assistant General Counsel for Patents Washington, DC 20545	U.S. Department of Energy W. E. Mott Director, Energy Control Technology Division of Biomedical and Environmental Research Washington, DC 20545
27 DOE Technical Information Center	U.S. Department of Energy G. A. Newby Assistant Director, Office of Technical Development Division of Advanced Systems and Materials Washington, DC 20545
10 U.S. Department of Energy I. Helms Advanced Concepts Evaluation Branch - G-434 Division of Advanced Systems and Materials Washington, DC 20545	Allied Chemical Company B. R. Dickey 550 2nd Street Idaho Falls, ID 83401
U.S. Department of Energy W. F. Savage Chief, Advanced Concepts Evaluation Branch Division of Advanced Systems and Materials Washington, DC 20545	Allis-Chalmers Power Systems, Inc. J. S. Joyce 1135 South 70th Street West Allis, WI 53214
U.S. Department of Energy D. C. Bauer Director, Division of Advanced Systems and Materials Washington, DC 20545	Aluminum Company of America E. T. Wanderer Alcoa Technical Center Alcoa Center, PA 15069
U.S. Department of Energy R. B. Morrow Special Projects Branch Division of Advanced Systems and Materials Washington, DC 20545	American Electric Power H. J. Janzon 2 Broadway New York, NY 10004
	American Electric Power Service Corporation C. Swenson 2 Broadway New York, NY 10004

No. of
Copies

Aqua-Chem
R. M. Ahlgren
P.O. Box 421
Milwaukee, WI 53201

Arizona Public Service Co.
W. E. Campbell
P.O. Box 21666
Phoenix, AZ 85036

Arizona Public Service Co.
T. Woods
2121 W. Cheryl Drive
Phoenix, AZ 85021

Babcock & Wilcox
M. W. Peterson
Fossil Power Division
20 South Van Buren
Barberton, OH 44203

Baltimore Aircoil Co., Inc.
E. Schinner
P.O. Box 7322
Baltimore, MD 21227

Baltimore Gas & Electric Co.
G. C. Creel
Gas & Electric Building
Baltimore, MD 21203

Battelle-Geneva
J. P. Budliger
7 Route De Drizi
1227 Geneva, SWITZERLAND

Bechtel Corporation
P. Leung
P.O. Box 60860
Terminal Annex
Los Angeles, CA 90060

Bechtel Corporation
G. R. Reti
P.O. Box 3965
San Francisco, CA 94119

No. of
Copies

R. W. Beck and Associates
J. P. Rossie
400 Prudential Plaza
Denver, CO 80202

Betz Environmental Engineers
J. Soost
9317 J, Highway 99
Vancouver, WA 98665

Black, Crow and Eidsness, Inc.
C. G. Thompson
807 South McDonough
Montgomery, AL 35104

Black Hills Power and Light
Company
B. Westre
P.O. Box 1400
Rapid City, SD 57701

Boeing Aerospace Division
D. Gilbert (M.S. 2R00)
P.O. Box 3999
Seattle, WA 98124

Bonneville Power Administration
E. H. Hall
1002 N.E. Holladay Street
Box 3621
Portland, OR 97208

Burns and Roe, Inc.
700 Kinder Kamack Rd.
Oradel, NY 07649

California Energy Commission
C. Webb
1111 Howe Avenue
Sacramento, CA 95825

California State Energy
Resources Conservation
and Development Commission
L. E. Stamets
1111 Howe Avenue
Sacramento, CA 95825

No. of
Copies

Carolina Power & Light Co.
J. Sell
336 Fayetteville Street
Raleigh, NC 27602

Catalytic Construction Corp.
J. Morse
P.O. Box 11402
Charlotte, NC 28029

Ceramic Cooling Tower Co.
P. A. Frohwerk
P.O. Box 425
Fort Worth, TX 76101

Columbus and Southern Ohio
Electric Co.
L. W. Meridith
General Manager, Generation
Department
215 North Front Street
Columbus, OH 43215

Combustion Engineering
H. H. Osborn
Air Preheater Company
Wellsville, NY 14895

Commonwealth Edison
R. H. Holyoak
One First Plaza
P.O. Box 767
Chicago, IL 60690

Consolidated Edison Co.
of New York, Inc.
W. A. Messner
4 Irving Place
New York, NY 10003

Consolidated Edison Co.
of New York, Inc.
C. L. Newman
4 Irving Place
New York, NY 10003

No. of
Copies

Cornell University
F. K. Moore
Ithaca, NY 14850

Curtiss-Wright Corporation
R. J. Haberski
One Passaic Street
Wood Ridge, NJ 07075

Dames & Moore
L. Craton
Suite 1000
1100 Glendon Avenue
Los Angeles, CA 90024

Dames & Moore
P. Gottlieb
Suite 1000
1100 Glendon Avenue
Los Angeles, CA 90024

Delmarva Power & Light
F. Cook
800 King Street
Wilmington, DE 19801

Dow Chemical Company
E. Wagener
2800 Mitchell Drive
Walnut Creek, CA 94598

Duke Power Company
S. K. Blackley
P.O. Box 2178
Charlotte, NC 28201

Duquesne Light Co.
J. Latshaw
435 6th Avenue
Pittsburgh, PA 15219

Dynatech Company
E. Guyer
99 Erie Street
Cambridge, MA 02139

No. of
Copies

Ecodyne
J. Slotnik
607 First Street, S.W.
Massillon, OH 44646

Ecodyne Cooling Products Co.
J. K. Swindt
P.O. Box 1267
Santa Rosa, CA 95403

Ecodyne Cooling Products
K. D. Whitehead
P.O. Box 1267
Santa Rosa, CA 95403

Electric Power Research
Institute
J. Maulbetsch
3412 Hillview Avenue
P.O. Box 10412
Palo Alto, CA 94304

Empire State Electric Energy
Research Corp.
L. Geller
1271 Avenue of the Americas
New York, NY 10020

Environmental Protection
Agency
T. G. Brna (MD-61)
IERL/RTP
Research Triangle Park, NC 27711

Environmental Protection
Agency
A. Galley (WH-552)
401 M. Street SW
Washington, DC 20460

Environmental Protection Agency
M. Maxwell (MD-61)
IERL/RTP
Research Triangle Park, NC 27711

No. of
Copies

Environmental Protection Agency
F. H. Rainwater
Pacific Northwest Water
Laboratory
200 S.W. 35th Street
Corvallis, OR 97330

Environmental Protection Agency
F. A. Roberts
200 S.W. 35th Street
Corvallis, OR 97330

Environmental Sciences and
Services
W. G. Hoydysh
150 East 73rd Street
New York, NY 10021

Environmental Systems Corporation
K. Wilber
P.O. Box 2525
Knoxville, TN 37901

ERG Incorporated
G. M. Benson
Lowell 57th Street
Oakland, CA 94608

Exxon Research Center
J. G. Stevens
Bldg. 1, Rm. 2048
P.O. Box 8
Linden, NJ 07036

Federal Power Commission
E. Sligh
825 N. Capitol Street
Washington, DC 20426

Florida Power & Light Co.
C. Henderson
9250 W. Flagler Street
Miami, FL 33174

No. of
Copies

Foster Wheeler Energy Co.
E. L. Damon
110 S. Orange Avenue
Livingston, NJ 07039

Franklin Institute
A. M. Rubin
Twentieth & Parkway
Philadelphia, PA 19103

GEA Airexchangers, Inc.
B. Davis
P.O. Box 1377
Thomasville, GA 31792

General Atomic Company
A. C. Eulberg
P.O. Box 81608
San Diego, CA 92138

General Electric Co.
E. H. Miller
Large Steam Turbine Division
300 Nott Street
Schenectady, NY 12301

General Motors Corp.
R. K. Shah
Harrison Radiator Division
Lockport, NY 14094

Georgia Power Co.
T. E. Byerley
P.O. Box 4545
Atlanta, GA 30302

Gilbert Associates, Inc.
J. F. Sebald
525 Lancaster Avenue
Reading, PA 19603

Heat Transfer Research Inc.
J. E. Taborek
1000 S. Fremont Avenue
Alhambra, CA 91802

No. of
Copies

Hudson Products
M. W. Larinoff
6855 Horwin Drive
Houston, TX 77036

Hudson Products
E. C. Smith
6855 Horwin Drive
P.O. Box 36100
Houston, TX 77036

H2M Corporation
H. D. Freudenthal
500 Broad Hollow Road
Melville, NY 11746

Ingersoll-Rand
W. R. Scott, Jr.
Phillipsburg, NJ 08865

Italimpianti-Societa
Italiana Impianti p.a.
C. Rocco
Piazza, Piccapietra 9
18121 Genoe, ITALY

Los Angeles Department of
Water and Power
J. L. Mulloy
111 N. Hope Street
Los Angeles, CA 90012

Louisiana Power & Light Co.
D. L. Aswell
142 Delaronde Street
New Orleans, LA 70174

The Charles T. Main Co.
E. S. Miliaras
Southeast Tower
Prudential Center
Boston, MA 02199

Marley
C. A. Baird
12 S. 12th Street
Philadelphia, PA 19107

No. of
Copies

Marley
J. D. Holmberg
5800 Fox Ridge Drive
Mission, KS 66202

Marley
R. Landon
5800 Fox Ridge Drive
Mission, KS 66202

Martin Marietta Laboratories
L. Bongers
1450 South Rolling Road
Baltimore, MD 21227

Massachusetts Institute of
Technology
L. R. Glicksman
77 Massachusetts Avenue
Cambridge, MA 02139

Massachusetts Institute of
Technology
M. W. Golay
77 Massachusetts Avenue
Cambridge, MA 02139

Massachusetts Institute of
Technology
R. Harleman
Department of Civil Engineering
77 Massachusetts Avenue
Cambridge, MA 02139

McDonnell Douglas
Astronautics Co.
W. H. P. Drummond
5301 Balsa Avenue
Huntington Beach, CA 92647

McDonnell Douglas
Astronautics Co.
S. O'Hare
5301 Balsa Avenue
Huntington Beach, CA 92647

No. of
Copies

Minnesota Power Cooperative, Inc.
L. A. Hillier
Box 1318
Grand Forks, ND 58201

Montana Power Co.
R. Hofacher
40 E. Broadway
Butte, MT 59701

Niagara Blower
W. Kals
405 Lexington Avenue
New York, NY 10017

Northeast Utilities
R. H. Meyer
P.O. Box 270
Hartford, CT 06101

Northern States Power Co.
R. Stansfield
414 Nicollet Mall
Minneapolis, MN 55401

N.U.S. Corporation
S. Lefton
2 Palo Alto Square (Suite 624)
Palo Alto, CA 94304

Oak Ridge National Laboratory
J. W. Michel
OTEC Heat Exchange Project
Activity
Box Y
Oak Ridge, TN 37830

Orange & Rockland Utilities, Inc.
R. H. Metzger
Environmental Services Manager
75 West Route 59
Spring Valley, NJ 10977

No. of
Copies

Oregon State University
L. P. Davis
Department of Mechanical
Engineering
Corvallis, OR 97330

Oregon State University
C. E. Wicks
Department of Chemical
Engineering
Corvallis, OR 97330

Oregon State University
J. G. Knudson
Engineering Experiment
Station
Corvallis, OR 97330

Pacific Gas & Electric
A. A. Arie
77 Beale Street
San Francisco, CA 94106

Pacific Gas & Electric
F. F. Mautz
77 Beale Street
San Francisco, CA 94106

Pacific Power & Light Co.
W. C. Bruaer
Public Service Bldg.
Portland, OR 97204

Pennsylvania Power & Light
W. Dussinger
2 North Ninth Street
Allentown, PA 18101

Pennsylvania Power & Light
D. G. Pfeiffer
2 North Ninth Street
Allentown, PA 18101

PFR Engineering Systems, Inc.
T. Rozenmann, President
Suite 832
4676 Admiralty Way
Marina del Rey, CA 90291

No. of
Copies

Philadelphia Electric Co.
J. Allen
2301 Market Street
Philadelphia, PA 19101

Philadelphia Electric Co.
S. J. Kowalski
2301 Market Street, NZ-1
Philadelphia, PA 19101

Philadelphia Electric Co.
J. B. Machel
2301 Market Street, NZ-1
Philadelphia, PA 19101

Philadelphia Electric Co.
D. Marano
2301 Market Street, NZ-1
Philadelphia, PA 19101

Prof. Ing. Carlo Roma
Piazza delle Muse 8
Rome, ITALY

Pickard Low & Garrick
L. Rust
1200 18th St. NW
Suite 612
Washington, DC 20036

Power Generation Cooling
Systems
G. L. Henderson
4714-52nd Street S.
Seattle, Wa 98118

Public Service of Colorado
R. F. Walker
5900 E. 39th Avenue
Denver, CO 80207

Public Service Company
of Indiana
S. W. Shields
V. P. Engineering
100 E. Main Street
Plainfield, IN 46168

No. of
Copies

Public Service Company
of New Mexico
C. D. Bedford
P.O. Box 2267
Albuquerque, NM 87103

Public Service Company
of New Mexico
J. D. Maddox
Corporate Planning Dept.
Albuquerque, NM 87103

Quirk, Lawler and Mattusky,
Eng.
J. Lawler
505 5th Avenue
New York, NY 10017

Radian Corporation
F. B. Mesich
P.O. Box 9948
Austin, TX 78766

Research Cottrell
G. E. Collins
Hamon Cooling Tower Division
Box 750
Bound Brook, NJ 08805

Research Cottrell
R. H. Hannon
Hamon Cooling Tower Division
Box 750
Bound Brook, NJ 08805

Resources Conservation Company
H. Herrigel
P.O. Box 936
Renton, WA 98055

Resources for the Future
D. Abbey
1755 Massachusetts Avenue NW
Washington, DC 20036

No. of
Copies

Reynolds Aluminum Co.
R. Lindberg
Reynolds Metallurgical
Research Laboratory
Richmond, VA 23261

Richmond Field Station
H. H. Sephton
47th and Hoffman Blvd.
Richmond, CA 94804

San Diego Gas & Electric
R. G. Lacy
101 Ash Street
San Diego, CA 92107

Seattle City Light
T. R. Miller
Principal Mechanical Engineer
1015 Third Avenue
Seattle, WA 98104

Seattle City Light
R. L. Skone
1015 Third Avenue
Seattle, WA 98104

Southern California Edison
R. S. Currie
2244 Walnut Grove Avenue
Rosemead, CA 91770

Southern California Edison
W. C. Martin
2244 Walnut Grove Avenue
Rosemead, CA 91770

Southern California Edison
F. A. McCracken
2244 Walnut Grove Avenue
Rosemead, CA 91770

Southern Services, Inc.
C. H. Goodman
P.O. Box 2625
Birmingham, AL 35202

No. of
Copies

P. Sporn
Consultant Engineer
74 Trinity Pl., Suite 511
New York, NY 10006

Stanford University
A. L. London
Department of Mechanical
Engineering
Stanford, CA 94305

Stearns-Rogers, Inc.
J. Y. Parce
Box 5888
Denver, CO 80217

Stone & Webster Engineering
Corp.
D. H. Guild
225 Franklin Street
Boston, MA 02107

Tampa Electric Co.
H. I. Wilson
P.O. Box 111
Tampa, FL 33601

Tennessee Valley Authority
H. B. Flora, III
1320 Commerce Union Bank Bldg.
Chattanooga, TN 37401

Texas Electric Service Co.
W. Keel
115 W. Seventh Street
Fort Worth, TX 76102

Tucson Gas & Electric
A. A. Ward
220 W. 6th Street
Tucson, AZ 85701

Union Carbide Corp.
J. A. Bartz
Linde Division
61 East Park Drive
Tonawanda, NY 14150

No. of
Copies

Union Carbide Corp.
G. J. Kidd
ORGDP - K-25
P.O. Box P, Mail Stop 197
Oak Ridge, TN 37803

Union Carbide Corp.
F. Notaro
Linde Division
61 East Park Drive
Tonawanda, NY 14150

United Engineers &
Constructors
G. A. Englessen
30 S. 17th Street
Philadelphia, PA 19103

United Engineers &
Constructors, Inc.
M. Hu
30 S. 17th Street
Philadelphia, PA 19103

University of Bremen
K. Simhan
Bremen, WEST GERMANY

University of Iowa
J. F. Kennedy
Hydraulic Research Institute
Iowa City, IA 52240

University of Kentucky
T. E. Eaton
Mechanical Engineering
Department
Lexington, KY 40506

U.S. Congress
G. Haimes
214 Massachusetts Avenue NE
Washington, DC 20510

No. of
Copies

U.S. Fish and Wildlife
Service
B. L. Foder
Information Transfer
Specialist
National Power Plant Team
1451 Green Road
Ann Arbor, MI 48105

United States Steel Corp.
T. L. Myron
Research Laboratory
Monroeville, PA 15146

Utah Power & Light
M. W. Russon
1407 W. N. Temple
Salt Lake City, UT 84103

Vermont Yankee Nuclear Power
E. Gaines, Jr.
77 Grove Street
Rutland, VT 05701

Virginia Electric & Power Co.
S. Ragone
700 E. Franklin Street
Richmond, VA 23261

Washington Public Power
Supply System
J. Chasse
P.O. Box 968
300 George Washington Way
Richland, WA 99352

Washington State University
R. W. Crain, Jr.
Department of Mechanical
Engineering
Pullman, WA 99164

Washington Water Power Co.
D. L. Olson
E. 1411 Mission Avenue
Spokane, WA 99202

No. of
Copies

Water Purification Associates
H. Gold
238 Main Street
Cambridge, MA 02142

Western States Water Council
J. A. Barnett
Executive Director
220 South 2nd East
Suite 200
Salt Lake City, UT 84111

Westinghouse Electric Corp.
G. E. Jablonka
Power Generation Systems
Engineering
700 Braddock Avenue, Room 9L51
East Pittsburgh, PA 15112

Westinghouse Electric Corp.
K. Kesavan
Advanced Reactor Division
P.O. Box 158
Madison, PA 15663

Westinghouse Electric Corp.
G. J. Silvestri
Steam Turbines Division - G108
Lester Branch
Box 9175
Philadelphia, PA 19113

Westinghouse Electric Corp.
K. A. Oleson
Steam Turbines Division - G108
Lester Branch
Box 9175
Philadelphia, PA 19113

L. E. Wilkinson
Consultant
6582 Ganon Street, S.E.
Salem, OR 97301

No. of
Copies

William M. Rice University
W. G. Characklis
Environmental Science and
Engineering
Houston, TX 77001

ONSITE

DOE Richland Operations Office
Energy Programs Division

H. E. Ransom

Westinghouse Hanford Company
Hanford Engineering Develop-
ment Laboratory

J. Fletcher

Pacific Northwest Laboratory

R. T. Allemann
J. A. Bamberger
Daniel J. Braun
David J. Braun
J. W. Currie
D. E. Deonigi
R. L. Dillon
D. W. Dragnich
R. L. Drake
D. W. Faletti
J. W. Finnigan
T. J. Foley
B. C. Fryer
J. D. Goodenough
J. J. Hauth
A. J. Haverfield
C. H. Henager
A. B. Johnson
W. S. Kelly
R. S. Kemper
C. J. Knoll
W. V. Loscutoff
R. P. Marshall
D. E. Olesen

No. of
Copies

Pacific Northwest Laboratory (contd)

Y. Onishi
H. L. Parry
L. T. Pederson
H. C. Riches
J. R. Sheff
G. C. Smith
J. S. Stoakes
A. M. Sutey
R. D. Tokarz
D. S. Trent
M. Vagins
R. A. Walter
R. L. Watts
R. D. Widrig
L. E. Wiles
C. E. Willingham
F. R. Zaloudek
File - B. M. Johnson (30)
Technical Information (5)
Publishing Coordination (2)