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CARBIDE**

ECONOMIC EVALUATION OF THE ANNUAL CYCLE ENERGY SYSTEM (ACES)

Volume III — Appendices

ENERGY RESOURCES CENTER
HONEYWELL INC.
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Office of Buildings and Community Systems

**OPERATED BY
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DEPARTMENT OF ENERGY**

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ANNUAL CYCLE ENERGY SYSTEM (ACES)

Final Report

Volume III - Appendices

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for

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APPENDIX A

ACESIM: RESIDENTIAL PROGRAM LISTING

This appendix gives the listings of the four modules needed to perform the economic evaluation of the residential ACES. The modules listed are LODMOD_A, LODMOD_B, DESMOD, SIMMOD, and ECOMOD. LODMOD_A is the module of ACESIM used to determine the loads of the single-family residence located in Minneapolis and the multi-family residences located in Minneapolis, Atlanta, and Philadelphia. LODMOD_B is the module of ACESIM used to determine the loads of the single-family residences located in Atlanta and Philadelphia. DESMOD, SIMMOD, and ECOMOD are the modules of ACESIM used to determine the component sizes, energy consumption and economic characteristics, respectively of the residential ACES.

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A-3

LODMOD_A

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      B U H = 3 8 T
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      XXXX          XXXX          XXXX          XXXX          XXXX
      X            X X          X X          X          X
      XX          XXXX          XXXX          XXX          X
      X            X X          X X          X          X
      X X          X X          X X          X X          X
      XXXX          XXXX          XXXX          XXXX          X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

```

SS 3883T ENTERED GCS-AJ AT 11.413 FROM SYSTEM-0 TSS/S 0-09-12

```

0001 $      SNUMB 3883T
0002 $      COMMENT F00648 TSS MEDIA CONVERSION
0003 $      IDENT F00648-ACES
0004 $$     USERID F00648$
0005 AS     CONVER
0006 $      LIMITS ,,,50000
0007 $      SYSOUT OT,E1
0008 $      MULTI 1-1
0009 $      DATA IN,,COPY,ENDFC
0010 $      ENDCOPY IN
0011 $      ENDJOB
      TOTAL CARD COUNT THIS JOB = 001616

```

```

* ACTY-01 $CARD #0005 CONVER 08/31/79 SW=000000000000
BMC-TTL DATE 771205
$      MULTI 1-1
FILE #000001 TOT 001605 INPUT
INPUT COUNT 001605 OUTPUT COUNT 001605
BLOCKS SKIPPED 000000 IGNORE COUNT 000000
* NORMAL TERMINATION AT 001544 I=2060 SW=000000000000

```

START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/RC	MS/RE	ADDRESS	TH/PK#
11.414	11.428	0.011	0.013										
				LINES	1604	PROC	0.0003	I/O	0.001	IU	5	MEMORY	AK
				LIMIT	50000	LIMIT	0.2000	LIMIT		CU	5	M*T	91
				MC R	MSU450 *		22	0	1	1	1	0-0A-24	
				IN R	MSU450 *		858	0	39	39	49	0-0A-23	
				OT	SYOUT								
				P*	SYOUT								

RC-00 1604 LINES AT SIA. F1

```

ACTIVITY 01 COST=$ 0.60
*CUMULATIVE COST=$ 0.60

```

SNUMB = 3883T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 001604

\$ NOTE FILENAME LODMOD
\$ NOTE LABELS- A,R(E1)
\$ NOTE TABS/SETINGS* ASIS


```

10000C*****
10010C
10020C      LOADS PROGRAM FOR RESIDENTIAL ACES
10030C
10040C      THIS PROGRAM HAS BEEN DESIGNED TO CALCULATE THE HOURLY LOADS
10050C      FOR A SINGLE OR MULTI-FAMILY RESIDENCES (ONLY) EQUIPPED WITH AN
10060C      ACES CONFIGURATION. THIS PROGRAM IS ONE OF FOUR DISTINCT MODULES.
10070C      THEY ARE:
10080C          1. LOADS PROGRAM
10090C          2. DESIGN PROGRAM
10100C          3. SIMULATION PROGRAM
10110C          4. ECONOMIC ANALYSIS PROGRAM
10120C      IF THE LOADS HAVE BEEN ALREADY DETERMINED, THIS MODULE CAN BE
10130C      BYPASSED.
10140C
10150C      DEVELOPED BY HONEYWELL
10160C
10170C      CREATION DATE: JULY 6, 1978
10180C
10190C*****
10200C
10210      COMMON /BLOCK/1HOUR,1DAY,1MONTH,TSTOR,QHL(24,366),QHW(24,366),
10220      1      QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,HPEAK,
10230      1      THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR,A(200),
10240      1      NTABLE(20),XTEMP(24,366),BASLOD(24,366)
10250      COMMON /SOLAR/S(35)
10260      COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),
10270      1      TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
10280      COMMON /SLOAD/QTRAN(5),ABSORB(5)
10290      COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
10300      COMMON /YEARLY/TW(4),TAW(4),TR1,TR2,TA,TCE,TIM,TSBG,TG1,TG2,
10310      1      TG3,TX,TSBGI,TCEI,TWSI(4)
10320      COMMON/HOURLY/CONDL,XINF,TSR,QINCI,QINC2,ALFW,ALFR
10330      COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,EFFECT,
10340      1      WATVEL,WATTMP,CFA,FNCFM1
10350      DIMENSION MSIZE(12),DAY(24,15),TDAY(15),MONTH(12,15)
10360      DATA MSIZE/31,28,31,30,31,30,31,31,30,31,30,31/
10370      DATA ZERO/0./,TWNFOR/24./,ONE/1./,TWNFIV/25./
10380      REAL MHOTW,MONTH
10390C
10400C      INITIALIZE
10410C
10420      DO 20 I = 1, 24
10430          DO 10 J = 1, 366
10440              QC(I,J) = ZERO
10450              QHL(I,J) = ZERO
10460              QHW(I,J) = ZERO
10470              QINCI(I,J) = ZERO
10480              XTEMP(I,J) = ZERO
10490              BASLOD(I,J) = ZERO
10500 10      CONTINUE

```

```

10510      DB(I) = ZERO
10520      WB(I) = ZERO
10530      DP(I) = ZERO
10540      WS(I) = ZERO
10550      PB(I) = ZERO
10560      TC(I) = ZERO
10570      TQC(I) = ZERO
10580      WET(I) = ZERO
10590      DRY(I) = ZERO
10600 20    CONTINUE
10610      CLOAD = ZERO
10620      HCOND = ZERO
10630      CPEAK = ZERO
10640      DATA TRH/3./,TRC/1./,ONE/1./,ZERO/0./
10650      THOTWL = ZERO
10660      THLS = ZERO
10670      THWL = ZERO
10680      TINF = ZERO
10690      THLOAD = ZERO
10700      TCLOAD = ZERO
10710      TCONDL = ZERO
10720      TISR = ZERO
10730      IHOURL = TWNFOR
10740      DO 23 I = 1, 20
10750          NTABLE(I) = 0
10760 23    CONTINUE
10770      CALL INPUT
10780      IDAYS = IFIX(A(4))
10790      ISTART = IFIX(A(7))
10800      IDAY = ISTART - 1
10810      IEND = IFIX(A(8))
10820      IESCAP = 120 * 24 * (IEND - ISTART + 1)
10830      DO 25 I = 1, 12
10840          DO 25 J = 1, 15
10850              MONTH(I,J) = ZERO
10860 25    CONTINUE
10870      K = 1
10880      IF (IDAYS .EQ. 366) MS17F(2) = 29
10890      L = 1
10900      NDAY = 0
10910C
10920C      INITIALIZE SUN ARRAY
10930C
10940      S(1) = A(1)
10950      S(2) = A(2)
10960      S(3) = A(3)
10970      S(4) = A(7) - ONE
10980      S(5) = TWNFIV
10990      S(8) = A(17)
11000C

```

```

11010C      REWIND WEATHER TAPE AND POSITION IT
11020C
11030      INIT = ISTART - 1
11040      IF (INIT .EQ. 0) GO TO 40
11050      DO 30 I = 1, INIT
11060          READ(8) DB,DP,WB,WS,PS,TC,TOC,WET,DRY,IDUM,IMONTH,IDUM,IDUM
11070 30      CONTINUE
11080C
11090C      LOOP FOR SETTING UP OUTPUT SUMMARIES AND LOAD CALCULATIONS
11100C
11110 40      CONTINUE
11120      IF (S(4) .GE. FLOAT(IEND) .AND. S(5) .GE. TWNFIV) GO TO 120
11130      IF (NDAY .NE. MSIZE(L)) GO TO 50
11140      L = L + 1
11150      NDAY = 0
11160 50      CONTINUE
11170      DO 55 I = 1, 15
11180          TDAY(I) = ZERO
11190 55      CONTINUE
11200 60      CONTINUE
11210C
11220C      CALL SUBROUTINE TIME FOR HOURLY LOAD CALCULATIONS
11230C
11240      CALL TIME
11250C
11260C      OUTPUT AND SUMMARIES
11270C
11280      DAY(IHOUR,1) = QHL(IHOUR,IDAY)
11290      DAY(IHOUR,2) = QHW(IHOUR,IDAY)
11300      DAY(IHOUR,3) = QC(IHOUR,IDAY)
11310      DAY(IHOUR,4) = QINCI(IHOUR,IDAY)
11320      DAY(IHOUR,5) = CONDL
11330      DAY(IHOUR,6) = XINF
11340      DAY(IHOUR,7) = TSR
11350      DAY(IHOUR,8) = QINC1 * ALFW
11360      DAY(IHOUR,9) = QINC2 * ALFR
11370      DAY(IHOUR,10) = ABSORB(1) * ALFW
11380      DAY(IHOUR,11) = ABSORB(2) * ALFW
11390      DAY(IHOUR,12) = ABSORB(3) * ALFW
11400      DAY(IHOUR,13) = ABSORB(4) * ALFW
11410      DAY(IHOUR,14) = XTEMP(IHOUR,IDAY)
11420      DAY(IHOUR,15) = BASLOD(IHOUR,IDAY)
11430      DO 70 J = 1, 15
11440          TDAY(J) = TDAY(J) + DAY(IHOUR,J)
11450 70      CONTINUE
11460      S(5) = S(5) + ONE
11470      IF (S(5) .LE. TWNFOR) GO TO 60
11480C
11490C      HOURLY AND DAILY SUMMARY
11500C

```

```

11510      TDAY(14) = TDAY(14)/TWNFOR
11520      NDAY = NDAY + 1
11530      IF (K .GT. 20) GO TO 100
11540      IF (NTABLE(K) .EQ. 0 .OR. NTABLE(K) .NE. TDAY) GO TO 100
11550      K = K + 1
11560      WRITE(9,500) NDAY,L
11570      DO 80 I = 1, 24
11580          WRITE(9,510) I,(DAY(I,J),J = 1, 8)
11590          IF (I .EQ. 24) WRITE(9,520) (TDAY(J),J = 1, 8)
11600 80      CONTINUE
11610      WRITE(9,530)
11620      DO 90 I = 1, 24
11630          WRITE(9,510) I,(DAY(I,J),J = 9, 15)
11640          IF (I .EQ. 24) WRITE(9,520) (TDAY(J), J = 9, 15)
11650 90      CONTINUE
11660 100     CONTINUE
11670      DO 110 J = 1, 15
11680          MONTH(L,J) = TDAY(J) + MONTH(L,J)
11690 110     CONTINUE
11700      GO TO 40
11710 120     CONTINUE
11720      DO 125 I=1,12
11730          MONTH(I,14) = MONTH(I,14)/FLOAT(MSIZE(I))
11740 125     CONTINUE
11750      WRITE(9,540)
11760      DO 130 I = 1, 12
11770          WRITE(9,510) I,(MONTH(I,J), J = 1, 8)
11780 130     CONTINUE
11790      WRITE(9,530)
11800      DO 140 I = 1, 12
11810          WRITE(9,510) I,(MONTH(I,J),J = 9, 15)
11820 140     CONTINUE
11830      DAYC = ZERO
11840      PDAYC = ZERO
11850      DO 150 K=1,366
11860          IF(DAYC .GT. PDAYC) PDAYC = DAYC
11870          DAYC = ZERO
11880          DO 150 J=1,24
11890              DAYC = DAYC + QC(J,K)
11900              WRITE(11) QHL(J,K),QHW(J,K),QC(J,K),QINCI(J,K),
11910                  BASLOD(J,K),XTEMP(J,K)
11920 150     CONTINUE
11930      WRITE(9,550) TMLoad, TMLoad, THOTWL, TINF, TTSR, TCONDOL, CPEAK, HPEAK
11940      WRITE(9,560) HEATD, COOLD, SIZE1, SIZE2, FANCFM, FNCFM1, EVRGPM,
11950          1      EFFECT, WATVEL, WATTMP, CFA, PDAYC
11960      WRITE(9,570) TCEI, (TWSI(I), I=1,4), TS8G1, (TW(I), I=1,4),
11970          1      (TAW(I), I=1,4), TA, TCE, TR1, TR2, TIM, TX, TS8G,
11980          1      TG1, TG2, TG3
11990      WRITE(13) FANCFM, FNCFM1, SIZE1, SIZE2, HEATD
12000      ENDFILE 11

```

```

12010      STOP
12020C
12030C      FORMAT STATEMENTS
12040C
12050 500  FORMAT(1H1,45X,' HOURLY SUMMARY FOR DAY',I4,' MONTH',I4///11X,
12060      1 'QHL',11X,'QHW',12X,'QC',10X,'QINCI',9X,'CONDL',10X,'XINF',10X,
12070      1 'TSR',9X,'QINC1'//)
12080 510  FORMAT(1X,12,8(1X,E13.5))
12090 520  FORMAT(/' DAILY SUMMARY'///3X,8(1X,E13.5))
12100 530  FORMAT(//10X,'QINC2',8X,'ABSORB(1)',5X,'ABSORB(2)',
12110      1 5X,'ABSORB(3)',5X,'ABSORB(4)',8X,'XTEMP',7X,'BASLOD'//)
12120 540  FORMAT(1H1,' MONTHLY SUMMARY'///11X,'QHL',11X,'QHW',12X,'QC',10X,
12130      1 'QINCI',9X,'CONDL',10X,'XINF',10X,'TSR',9X,'QINC1'//)
12140 550  FORMAT(1H1,' YEARLY SUMMARY'///5X,'THLOAD',10X,'TCLDAD',10X,
12150      1 'THOTWL',11X,'TINF',12X,'TTSR',11X,'TCONDL',10X,'CPEAK',
12160      1 11X,'HPEAK'//8(1X,E15.8))
12170 560  FORMAT(1H1,' DESIGN PARAMETERS'///1X,'HEATING DESIGN LOAD',
12180      1 23X,E15.8/1X,'COOLING DESIGN LOAD',23X,E15.8/1X,
12190      1 'CAPACITY OF HEATING PLANT',17X,E15.8/1X,
12200      1 'CAPACITY OF COOLING PLANT',17X,E15.8/1X,
12210      1 'BLOWER CFM FOR COOLING SYSTEM',13X,E15.8/1X,
12220      1 'BLOWER CFM FOR HEATING SYSTEM',13X,E15.8/1X,
12230      1 'GAL./MIN. THROUGH EVAPORATOR',14X,E15.9/1X,
12240      1 'RATED EFFECTIVENESS OF HEAT EXCHANGER',5X,E15.8/1X,
12250      1 'WATER VELOCITY THROUGH HEAT EXCHANGER',5X,E15.8/1X,
12260      1 'WATER TEMPERATURE RISE',20X,E15.8/1X,
12270      1 'COIL FACE AREA',28X,E15.8/1X,'PEAK DAILY COOLING LOAD',
12280      1 19X,E15.8)
12290 570  FORMAT(1H1,' FINAL TEMPERATURES'///1X,'CEILING SURFACE',
12300      1 10X,F8.2/1X,'WALL SURFACE - NORTH',5X,F8.2/1X,
12310      1 13X,'- EAST',6X,F8.2/14X,'- SOUTH',5X,F8.2/14X,
12320      1 '- WEST',6X,F8.2/1X,'BASEMENT SURFACE',9X,F8.2/1X,
12330      1 'WALL - NORTH',13X,F8.2/6X,'- EAST',14X,F8.2/6X,
12340      1 '- SOUTH',13X,F8.2/6X,'- WEST',14X,F8.2/1X,
12350      1 'ATTIC WALL - NORTH',7X,F8.2/12X,'- EAST',8X,F8.2/
12360      1 12X,'- SOUTH',7X,F8.2/12X,'- WEST',8X,F8.2/1X,
12370      1 'ATTIC AIR',16X,F8.2/1X,'CEILING',18X,F8.2/1X,
12380      1 'ROOF #1',18X,F8.2/1X,'ROOF #2',18X,F8.2/1X,
12390      1 'INTERNAL MASS',12X,F8.2/1X,'SPACE',20X,F8.2/
12400      1 1X,'SLAB',21X,F8.2/1X,'GROUND #1',16X,F8.2/1X,
12410      1 'GROUND #2',16X,F8.2/1X,'GROUND #3',16X,F8.2)
12420C
12430C      LAST CARD OF MAIN PROGRAM.
12440C
12450      END
12460C
12470      SUBROUTINE INPUT
12480C
12490C*****
12500C

```

```

12510C      THIS SUBROUTINE READS IN THE FOLLOWING INFORMATION FROM FILE 5 AND
12520C      PRINTS IT OUT ONE FILE 9:
12530C
12540C      1.  TITLE
12550C      2.  THE INPUT PARAMETERS
12560C      3.  THE OUTPUT TABLE FOR DAYS LISTED
12570C
12580C      THIS SUBROUTINE ALSO CONTAINS THE DATA STATEMENTS FOR
12590C      WELL WATER DATA, HOT WATER SCHEDULE, OCCUPANCY SCHEDULE,
12600C      LIGHTING SCHEDULE, AND APPLIANCE SCHEDULE
12610C
12620C      DEVELOPED BY HONEYWELL
12630C
12640C
12650C *****
12660C
12670      COMMON /BLOCK/ I HOUR, I DAY, I MONTH, TSTOR, QHL(24,366), QHW(24,366),
12680      1      QC(24,366), QINCI(24,366), CLOAD, HLOAD, CPEAK, HPEAK,
12690      1      THOTWL, THLS, THWL, TINF, THLOAD, TCOVDL, TCLOAD, TTSR, A(200),
12700      1      NTABLE(20), XTEMP(24,366), HASLOD(24,366)
12710      COMMON /SCHDL/ TWELL(12), MHOTW(24), PEOPLE(24), XLIGHT(24)
12720      1, APPL(24)
12730      DATA TWELL/40.,41.,43.,44.,50.,57.,66.,64.,61.,59.,53.,47./
12740      REAL MHOTW
12750      DATA MHOTW /16.,0.,0.,0.,0.,0.,10.,33.,49.5,55.,48.,33.,
12760      25.,34.,20.,16.5,15.,20.,48.,81.,66.,48.,35.,33./
12770      DATA PEOPLE /1.,1.,1.,1.,1.,1.,9.,7.,4.,4.,2.,2.,2.,
12780      1      4.,4.,7.,9.,9.,9.,9.,1.,1./
12790      DATA XLIGHT /.3.,2.,1.,1.,1.,15.,2.,5.,4.,3.,2.,2.,3.,2.,2.,
12800      1      3.,4.,6.,8.,8.,7.,7.,5.,3/
12810      DATA APPL /.37.,37.,37.,37.,37.,6.,9.,41.,42.,40.,8.,5.,4.,
12820      1      4.,42.,4.,39.,8.,82.,92.,75.,7.,4.,37/
12830      DIMENSION LABEL(10), MARGIN(13)
12840      CHARACTER LABEL*6, MARGIN*6
12850      MAXA = 0
12860      READ(5,500) MARGIN
12870      WRITE(9,1000) MARGIN
12880      100 READ(5,2000) N, DUM, LABEL
12890      IF(N .LE. 0) GO TO 200
12900      IF(N .GT. MAXA) MAXA = N
12910      A(N) = DUM
12920      WRITE(9,3000) N, A(N), LABEL
12930      GO TO 100
12940      200 READ(5,4000) (NTABLE(I), I = 1, 20)
12950      WRITE(9,911)
12960      911 FORMAT(/////)
12970      WRITE(9,913) TWELL, MHOTW, PEOPLE, XLIGHT, APPL
12980      913 FORMAT(2X,22H WELL WATER TEMPERATURE,2X,12F8.3/
12990      12X,22H HOT WATER SCHEDULE,2X,12F8.3/26X,12F8.3/
13000      12X,22H OCCUPANCY SCHEDULE,2X,12F8.3/26X,12F8.3/

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13010      12X,22H      LIGHTING SCHEDULE,2X,12F8.3/26X,12F8.3/
13020      12X,22H      APPLIANCE SCHEDULE,2X,12F8.3/26X,12F8.3)
13030      WRITE(9,914) NTABLE
13040 914  FORMAT(/,2X,22H OUTPUT TABLE SCHEDULE,2X,12I8/26X,12I8)
13050      RETURN
13060      500 FORMAT(13A6)
13070 1000 FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6//)
13080 2000 FORMAT(15,F15.5,10A6)
13090 3000 FORMAT(3H A(,13,1H),G15.5,3X,10A6)
13100 4000 FORMAT(20I4)
13110C
13120C      LAST CARD OF SUBROUTINE INPUT
13130C
13140      END
13150      SUBROUTINE TIME
13160C
13170C*****
13180C
13190C      THIS SUBROUTINE COMPUTES THE SOLAR RADIATION COMPONENTS, DIRECT
13200C      NORMAL RADIATION, DIRECT RADIATION ON A HORIZONTAL SURFACE,
13210C      TOTAL RADIATION ON A HORIZONTAL SURFACE AND CALLS SUBROUTINE
13220C      HOUSE WHICH DETERMINES THE LOADS.
13230C
13240C      THE SUBROUTINE STATEMENT IS
13250C
13260C      SUBROUTINE TIME
13270C
13280C      DEVELOPED BY HONEYWELL
13290C
13300C
13310C*****
13320C
13330      COMMON /SLOAD/QTRAN(5),ABSORB(5)
13340      COMMON /SOLAR/S(35)
13350      COMMON /DIR/DIRH,DIRN,TOTH
13360      COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),
13370      1      TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
13380      COMMON /BLOCK/1HOUR,1DAY,1MONTH,TSTOR,QHL(24,366),QHW(24,366),
13390      1      QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
13400      1      HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCOND,TCLOAD,TTSR
13410      1      ,A(200),NTABLE(20),XTEMP(24,366),BASLON(24,366)
13420      COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
13430      DATA TWNTRE/23./,ONE/1./,TWO/2./,P011/.011/,P00792/.00792/,
13440      10PEM6/1.E-06/,P09/.09/,ZERO/0.0/,TWNFOR/24./
13450      REAL MHOTW
13460      MODE0 = ZERO
13470      MODE1 = ONE
13480C
13490      IF(S(5) .LE. TWNFOR) GO TO 10
13500      S(4) = S(4) + ONE

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13510      S(5) = S(5) - TWNFOR
13520      READ(8) DB,DP,WB,WS,PH,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,
13530      1          ICITY
13540      IMONTH = IDUM1
13550      CALL SUN(MODE0)
13560 10    IHOURL = IFIX(S(5))
13570      IDAY = IFIX(S(4))
13580C
13590C      COMPUTE SOLAR RADIATION COMPONENTS (CLOUD MODIFIED)
13600C
13610      CCOVER = TC(IHOURL)
13620      NYTYPE = IFIX(TOC(IHOURL))
13630      IF(NYTYPE .LT. 1) CCOVER = CCOVER/TWO
13640      CCF = ONE - P011 * CCOVER - P00792 * CCOVER ** 2
13650      CALL SUN(MODE1)
13660C
13670C      IF PRECIPITATION IS PRESENT THEN NO DIRECT OR DIFFUSE RADIATION
13680C
13690      IF (WET(IHOURL) .LT. OPEM6 .AND. DRY(IHOURL) .LT. OPEM6) GO TO 20
13700      S(23) = ZERO
13710      S(24) = ZERO
13720 20    CONTINUE
13730C
13740C      DIRECT NORMAL RADIATION (CLOUD MODIFIED)
13750C
13760      DIRN = (ONE - P09 * CCOVER) * S(24)
13770C
13780C      DIRECT RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
13790C
13800      DIRH = DIRN * S(13)
13810C
13820C      TOTAL RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
13830C
13840      TOTR = CCF * S(23)
13850C
13860C      DETERMINE LOADS BY CALLING SUBROUTINE HOUSE
13870C
13880      CALL HOUSE
13890      RETURN
13900C
13910C      LAST CARD OF SUBROUTINE TIME
13920C
13930      END
13940      SUBROUTINE HOUSE
13950C
13960C*****
13970C
13980C      THIS SUBROUTINE CALCULATES THE HEATING AND COOLING LOAD
13990C      FOR A RESIDENTIAL BUILDING.
14000C

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14010C THE SUBROUTINE STATEMENT IS
14020C
14030C SUBROUTINE HOUSE
14040C
14050C THIS SUBROUTINE CALCULATES THE FOLLOWING QUANTITIES:
14060C
14070C QHL(IHOUR,IDAY) = HOURLY HEATING LOAD
14080C QC(IHOUR,IDAY) = HOURLY COOLING LOAD
14090C QHW(IHOUR,IDAY) = HOURLY HOT WATER LOAD
14100C BASLOD(IHOUR,IDAY) = HOURLY BASE LOAD
14110C QINCI(IHOUR,IDAY) = HOURLY AVAILABLE ENERGY
14120C XTEMP(IHOUR,IDAY) = HOURLY GROUND TEMPERATURE
14130C CONDL = HOURLY CONDUCTION LOSS
14140C XINF = HOURLY INFILTRATION
14150C TSR = HOURLY TRANSMITTED SOLAR RADIATION
14160C CPEAK = COOLING LOAD PEAK FOR THE PERIOD OF SIMULATION
14170C HPEAK = HEATING LOAD PEAK FOR THE PERIOD OF SIMULATION
14180C TA = ATTIC TEMPERATURE
14190C TX = AIR SPACE TEMPERATURE
14200C WALLT(1) = WALL SURFACE TEMP. ON FOUR WALLS
14210C TW(1) = ROOM WALL TEMP. ON FOUR WALLS
14220C TINF = TOTAL INFILTRATION
14230C THOTWL = TOTAL HOT WATER LOAD
14240C THLOAD = TOTAL HEATING LOAD
14250C TCLOAD = TOTAL COOLING LOAD
14260C TCONDL = TOTAL CONDUCTION LOSS
14270C TTSR = TOTAL TRANSMITTED SOLAR RADIATION
14280C
14290C DEVELOPED BY HONEYWELL
14300C
14310C PROJECT: ACES
14320C
14330C CREATION DATE: 06/19/78
14340C
14350C *****
14360C
14370 COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
14380 1 QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
14390 1 HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
14400 1 ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
14410 COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),P3(24),TC(24)
14420 1 ,TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
14430 COMMON /SOLAR/S(35)
14440 COMMON /SLOAD/QTRAN(5),ABSORB(5)
14450 COMMON /HTPP/FF
14460 COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
14470 COMMON /YEARLY/TW(4),TAW(4),TR1,TR2,TA,ICE,TIM,TS3G,TG1,TG2,
14480 1 TG3,TX,TS8GI,TCEI,TWSI(4)
14490 COMMON /HOURLY/CONDL,XINF,TSR,QINCI,QINC2,ALFW,ALPR
14500 COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,EFFECT,

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14510      1          WATVEL,WATTMP,CFA,FNCFM1
14520      LOGICAL FIRST,COOLIN
14530      REAL NDYTP,MHOTW,KADX
14540      DIMENSION UAWI(4),UAWO(4),UAAWO(4),UAAWI(4),CRVAW(4),CRVW(4),
14550      1          AREAA(4),AREAW(4),HAWI(4),UWALL(4),UATTIC(4),
14560      1          WALLT(4),HA(4),UAAWX(4),TASS(4),HAW(4),UAWX(4),
14570      1          UAWXI(4),TASSS(4),XTEMP1(4),XTEMP2(4),XTEMP3(4),
14580      1          XTEMP4(4),XTEMP5(4),XTEMP6(4),XTEMP7(4)
14590      DATA FIRST/.TRUE./
14600      DATA PI/3.1414/,TWO/2./,ETP6/83.6/,UNET/1000./,P01/.01/,
14610      1          ETIN/18./,HUNDRD/100./,P79/.79/,THR3/33./,SIXTY/60./
14620      DATA OP08/1.08/,THRTWO/32./,ONE/1./,ZERO/0./,P1/.1/,P4/.4/,P5/.5/,
14630      1          P8/.8/,TTP32/8.33/,SIXTHR/63./,TFIFTY/250./,FHNDRO/500./
14640      1          ,FHUNDR/400./,FOURTY/40./,99X/666./,FOUR90/490./,ETHUND/1800
14650      1          ./,TEN/10./,P45/.45/,UNET61/1061./,OT75P4/1075.4/,FORP46/4.
14660      1          46/,P05030/.05030/,THREE/3./,TW25/25./
14670C
14680C      FIRST TIME THROUGH, INITIALIZE CONSTANTS FROM 'A' ARRAY. SKIP
14690C      INITIALIZATION ON SUCCEEDING CALLS.
14700C
14710      IF (.NOT. FIRST) GO TO 40
14720      OLDMTH = ZERO
14730      TIME = ZERO
14740      FF = A(22)
14750      ANG1 = A(6)
14760      ANG2 = A(5)
14770      ANG3 = A(151)
14780      ANG4 = A(152)
14790      ANG5 = A(153)
14800      ANG6 = A(154)
14810      THOTW = A(50)
14820      MHOTW = A(53)
14830      UCEIL = A(54)
14840      UWALL(1) = A(55)
14850      UWALL(2) = A(155)
14860      UWALL(3) = A(156)
14870      UWALL(4) = A(157)
14880      UAWI(1) = A(56)
14890      UGLASS = A(57)
14900      UDOOR = A(58)
14910      UFLOOR = A(59)
14920      UROOF = A(60)
14930      UATTIC(1) = A(61)
14940      UATTIC(2) = A(158)
14950      UATTIC(3) = A(159)
14960      UATTIC(4) = A(160)
14970      AHOTW = A(62)
14980      ACEIL = A(63)
14990      AREAW(1) = A(64)
15000      AREAW(2) = A(161)

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15010 AREAW(3) = A(162)
15020 AREAW(4) = A(163)
15030 AWALBG = A(65)
15040 AGLASN = A(66)
15050 AGLASE = A(67)
15060 AGLASS = A(68)
15070 AGLASW = A(69)
15080 ADOOR = A(70)
15090 AFLOOR = A(71)
15100 AROOF1 = A(72)
15110 AROOF2 = A(164)
15120 AREAA(1) = A(73)
15130 AREAA(2) = A(165)
15140 AREAA(3) = A(166)
15150 AREAA(4) = A(167)
15160 CFMINF = A(74)
15170 PEOPMX = A(76)
15180 APPLMX = A(77)
15190 XLTEMX = A(78) * ACEIL * PI
15200 AVENT = A(79)
15210C
15220C DESIGN VALUES FOR SIZING HEAT PUMP AND COOLING COIL
15230C
15240 ATTICT = A(80)
15250 WINDOWG = A(81)
15260 TOSAW = A(82)
15270 TOSAS = A(83)
15280 WOSAS = A(84)
15290 WINTS = A(85)
15300 OVRCPW = A(86)
15310 OVRCPS = A(87)
15320 TZONEW = A(88)
15330 TZONES = A(89)
15340 NSB = IFIX(A(90))
15350 SHADES = IFIX(A(92))
15360 ICALC = A(93)
15370 HEATD = A(94)
15380 COOLD = A(95)
15390C
15400C DETERMINE UA'S BETWEEN AMBIENT AND INDOORS
15410C
15420 UACEIL = UCEIL * ACEIL
15430 UAHOTW = UHOTW * AHOTW
15440 UAWBG = UWALBG * AWALBG
15450 GLASSA = AGLASN + AGLASE + AGLASS + AGLASW
15460 UAGLAS = UGLASS * GLASSA
15470 UAFLOR = UFLOOR * AFLOOR
15480 UAROF1 = UROOF * AROOF1
15490 UAROF2 = UROOF * AROOF2
15500 UADOOR = UDOOR * ADOOR

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15510      SUMUA = (UWALL(1) * AREAW(1) + UWALL(2) * AREAW(2) + UWALL(3) *
15520      1      AREAW(3) + UWALL(4) * AREAW(4)) + UADDOOR + UAFLOW +
15530      1      UAGLAS + OP08 * CFMINF
15540C
15550C      DETERMINE NODAL UA'S
15560C
15570      DO 5 I = 1, 4
15580          UAWI(I) = (UWALL(I) * AREAW(I)) * TWO
15590          UAWO(I) = UAWI(I)
15600          UAAWI(I) = (UATTIC(I) * AREAA(I)) * TWO
15610          UAAWO(I) = UAAWI(I)
15620 5      CONTINUE
15630      UACI = UACEIL * TWO
15640      UACO = UACI
15650      UARI1 = UAROF1 * TWO
15660      UARI2 = UAROF2 * TWO
15670      UARO1 = UARI1
15680      UARO2 = UARI2
15690C
15700C      SET WALL AND ROOF ABSORPTIVITIES
15710C
15720      ALFW = A(168)
15730      ALFR = A(173)
15740C
15750C      SET NODAL THERMAL CAPACITANCES
15760C
15770      CRVAW(1) = A(169)
15780      CRVAW(2) = A(170)
15790      CRVAW(3) = A(171)
15800      CRVAW(4) = A(172)
15810      CRVR1 = A(174)
15820      CRVR2 = A(175)
15830      CRVC = A(176)
15840      CRVW(1) = A(177)
15850      CRVW(2) = A(178)
15860      CRVW(3) = A(179)
15870      CRVW(4) = A(180)
15880      CRVSRG = A(181)
15890      CRVIM = A(182)
15900      CRVX = A(184)
15910      CRVG1 = ETP6 * AWALRG
15920C
15930C      SET THE OUTSIDE SURFACE COEFFICIENT AND THE INTERNAL
15940C      MASS HEAT TRANSFER COEFFICIENT
15950C
15960      HO = A(11)
15970      HAIM = A(183)
15980      HI = A(12)
15990      HACI = HI * ACEIL
16000      HAWBG = HI * AWALBG

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16010      DO 10 L = 1,4
16020          HAWI(L) = HI * AREAW(L)
16030 10      CONTINUE
16040C
16050C      INITILIZE NODAL TEMPERATURES
16060C
16070      DO 20 I = 1,4
16080          TAW(I) = A(186)
16090          TW(I) = A(185)
16100 20      CONTINUE
16110          TIM = A(191)
16120          TA = A(187)
16130          TCE = A(188)
16140          TR1 = A(189)
16150          TR2 = A(190)
16160          TX = A(191)
16170          TS8G = A(192)
16180          TG1 = A(193)
16190          TG2 = A(194)
16200          TG3 = A(195)
16210          TS8GI = A(138)
16220          TCEI = A(136)
16230      DO 25 L=1,4
16240          TWSI(L) = A(137)
16250 25      CONTINUE
16260C
16270C      SET THE TIME STEP AND THE GROUND CONDUCTIVITY
16280C
16290          DT = A(10)
16300          TCON = A(13)
16310          KAOX = TCON * AWAL8G/TWO
16320C
16330          IF(ICALC .NE. 0) GO TO 30
16340C
16350C      HEATING DESIGN LOAD
16360C
16370          HEATD = ( SUMUA * (TZONNEW - TOSAW) + UACEIL * (TZONNEW - TOSAW)
16380 1          + (TZONNEW - TWELL(1)) * (ONE/(ONE/UAWBS + THREE/KAOX))
16390 1          + SSX * (THOTW - TWELL(1))) * OVRCPW
16400C
16410C      COOLING DESIGN LOAD
16420C
16430          COOLD = -(SUMUA * (TZONES - TOSAS) + UACEIL * (TZONES - ATTICT)
16440 1          + UAHOTW * (TZONES - THOTW) - WINDWG * GLASSA
16450 1          - PEOPMX * FOUR90 - APPLMX - XLITEMX)
16460 1          * OVRCP'S
16470C
16480 30      CONTINUE
16490C
16500C      HEAT PUMP DESIGN

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16510C
16520 CALL WAHP(THRTWO,TZONW,QCOND,DEVAP,HP,COP)
16530 CHECK1 = COOLD/DEVAP
16540 CHECK2 = HEATD/QCOND
16550 COOLDA = A(197)
16560 DESL1 = ZERO
16570 DESL = HEATD
16580 IF(CHECK2 .LT. CHECK1) DESL1 = COOLDA/(TW25 - A(100) + A(101))
16590 IF(DESL1 .GT. COOLD) DESL1 = COOLD
16600 IF(DESL1/DEVAP .GT. DESL/QCOND) DESL = DESL1
16610 X = DESL/ONET
16620 IX = IFIX(X)
16630 SIZE1 = ONET * FLOAT(IX) + ONET
16640 SF1=SIZE1/QCOND
16650 IF(DESL .LE. DESL1) SF1 = SIZE1/DEVAP
16660 IF(DESL .LE. DESL1) SIZE1 = SF1 * QCOND
16670 SFP = SF1
16680 IB = IFIX((SFP-ONE)*ETHUND*P01)
16690 B = HUNDRO * (FLOAT(IB + 1) + ETIN)
16700 FNCFM1 = B
16710 EVPGPM = B * TEN / ETHUND
16720C
16730C COOLING COIL DESIGN
16740C
16750 TWI = THRTWO
16760C
16770C SET OT75P4 = 1061. + .4 * 32.
16780C
16790 EFFECT = P79
16800 FANCFM = COOLD/(OP08 * EFFECT * (TZONES - THRTWO))
16810 FANCFM = FLOAT(IFIX(FANCFM/HUNDRO) + 1) * HUNDRO
16820 SIZE2 = FANCFM * OP08 * (TZONES - THRTWO) * EFFECT
16830 SIZE2 = ONET * FLOAT(IFIX(SIZE2/ONET)) + ONET
16840 CFA = FANCFM/FHUNDRO
16850 GFT2 = COOLD/CFA
16860C
16870C SET P05030 = 1.66/33.
16880C
16890 WATVEL = FOURTY * P05030
16900 WATTMP = COOLD/(FHNDRO * FOURTY)
16910 FIRST = .FALSE.
16920C
16930C INTERMEDIATE CALCULATION FOR EQUATIONS INSIDE INNER LOOP
16940C
16950 TEMPO = OP08 * CFMINF
16960 TEMP1 = DT/CRVX
16970 TEMP2 = ONE - TEMP1 * (HAWBG + UAGLAS + HACI + HAWI(1) + HAWI(2)
16980 + HAWI(3) + HAWI(4) + HAIM + TEMPO + UAHOTW + UADOOR)
16990 TEMP4 = OP08 * AVENT * ACEIL
17000 TEMPS = TEMP4 + UARI1 + UARI2 + UAAWI(1) + UAAWI(2) + UAAWI(3)

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17010      1      + UAWI(4) + UACO
17020      TEMP6 = DT/CRVG1
17030      TEMP7 = ONE - TEMP6 * TWO * KADX
17040      TEMP8 = KADX * TWELL(IMONTH)
17050      TEMP9 = DT/CRVR1
17060      TEMP10 = DT/CRVR2
17070      TEMP11 = DT/CRVC
17080      TEMP12 = DT/CRVIM
17090      TEMP13 = DT/CRVSBG
17100      HAR1 = HO * AROOF1
17110      HAR2 = HO * AROOF2
17120      UARX1 = ONE/(ONE/UARO1 + ONE/HAR1)
17130      UARX2 = ONE/(ONE/UARO2 + ONE/HAR2)
17140      UACX = ONE/(ONE/UACI + ONE/HACI)
17150      UAWBX = ONE/(ONE/UAWBG + ONE/HAWBG)
17160      TEMP16 = UARX1 + UARI1
17170      TEMP17 = UARX2 + UARI2
17180      TEMP18 = HACI + UACX
17190      TEMP19 = UACX + UACO
17200      TEMP20 = HAWBG + UAWBX
17210      TEMP21 = KADX + UAWHX
17220      TEMP22 = HAR1 + UARX1
17230      TEMP23 = HAR2 + UARX2
17240      DO 35 I = 1, 4
17250          HA(I) = HO * AREAA(I)
17260          UAAWX(I) = ONE/(ONE/UAAWO(I) + ONE/HA(I))
17270          TASS(I) = ALFW * AREAA(I)
17280          HAW(I) = HO * AREAW(I)
17290          UAWX(I) = ONE/(ONE/UAWO(I) + ONE/HAW(I))
17300          UAWXI(I) = ONE/(ONE/UAWI(I) + ONE/HAWI(I))
17310          TASSS(I) = ALFW * AREAW(I)
17320          XTEMP2(I) = HA(I) + UAAWX(I)
17330          XTEMP3(I) = UAAWX(I) + UAWI(I)
17340          XTEMP4(I) = HAWI(I) + UAWXI(I)
17350          XTEMP6(I) = HAW(I) + UAWX(I)
17360          XTEMP7(I) = UAWX(I) + UAWXI(I)
17370 35      CONTINUE
17380 40      CONTINUE
17390      J = IHOOR
17400C
17410C      CALCULATE INTERNAL PEOPLE, LIGHT, AND APPLIANCE SENSIBLE LOADS
17420C
17430      PEOPL = PEOPLE(J) * PEOPMX * TFIFTY
17440      XLIGT = XLIGHT(J) * XLTEMX
17450      APPL1 = APPL(J) * APPLMX
17460C
17470C      CALCULATE AVAILABLE RADIATION ON COLLECTOR SURFACE
17480C
17490      CALL SOLARQ(ANG1,ANG2,QAVAIL)
17500      QINCI(IHOOR,IDAY) = QAVAIL

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17510C
17520C   CALCULATE TRANSMITTED SOLAR RADIATION AND RADIATION THAT
17530C   IS IMPINGENT ON OUTSIDE SURFACES
17540C
17550   CALL WINDOW
17560   IF (SHADES .LT. ONE) GO TO 50
17570   QTRAN(1) = QTRAN(1)
17580   QTRAN(2) = QTRAN(2) * P4
17590   QTRAN(3) = QTRAN(3) * P1
17600   QTRAN(4) = QTRAN(4) * P4
17610 50   CONTINUE
17620   TSR = (QTRAN(1) * AGLASN + QTRAN(2) * AGLASE
17630 1       + QTRAN(3) * AGLASS + QTRAN(4) * AGLASN)
17640   TTSR = TTSR + TSR
17650C
17660C   CHECK FOR NIGHT SETBACK CONDITIONS
17670C
17680   IF (NSB .EQ. 0) GO TO 60
17690   IF ((J .LE. 6) .OR. (J .GT. 22)) TZNEW = SIXTHR
17700 60   CONTINUE
17710C
17720C   DETERMINE THE DOMESTIC HOT WATER TANK LOAD AND THE
17730C   INTERNAL LOAD
17740C
17750C   SET TTP32 = 8.3333
17760C
17770   MSHOTW = MHOTW(J) * TTP32 * (THOTW - TWELL(IMONTH))
17780   TINLOD = PEOP1 + XLIGHT * APPL1
17790C
17800C   DETERMINE AVAILABLE ENERGY ON THE ROOF SURFACES
17810C
17820   CALL SOLARQ(ANG3,ANG4,QINC1)
17830   CALL SOLARQ(ANG5,ANG6,QINC2)
17840C
17850C   SET INITIAL VALUES FOR EACH HOUR
17860C
17870   TBTU = ZERO
17880   ITX = ZERO
17890C
17900C   INTERMEDIATE CALCULATIONS FOR EQUATIONS INSIDE INNER LOOP
17910C
17920   DO 65 I = 1, 4
17930       XTEMP1(I) = HA(I) * DB(J) + TASS(I) * ABSORH(I)
17940       XTEMP5(I) = HAW(I) * DB(J) + TASSS(I) * ABSORH(I)
17950 65   CONTINUE
17960   TEMP3 = DB(J) * (TEMPO + UAGLAS + UADDOOR) + UAHOTW * THOTW
17970   TEMP14 = HAR1 * DB(J) + QINC1 * ALFR * AROOF1
17980   TEMP15 = HAR2 * DB(J) + QINC2 * ALFR * ARUOF2
17990   TEMP24 = DB(J) * TEMP4
18000C

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18010C      INTEGRATE DIFFERENTIAL EQUATIONS FOR REQUIRED DT
18020C
18030      N = IFIX(ONE/DT)
18040      DO 100 K=1,N
18050C
18060C      CALCULATE THERMOSTAT FUNCTION
18070C
18080      CALL TSTAT(TX,Q,TZONEW,TZONES)
18090C
18100C      DETERMINE THE SPACE AIR TEMPERATURE "TX"
18110C
18120      TX = TX * TEMP2 + TEMP1 * (Q + TINLOD + HACI * TCEI + HAWI(1) *
18130      1      TWSI(1) + HAWI(2) * TWSI(2) + HAWI(3) * TWSI(3) +
18140      1      HAWI(4) * TWSI(4) + HAIM * TIM + HAWBG * TSBGI + TEMP3)
18150C
18160C      DETERMINE THE ATTIC WALL TEMPERATURES
18170C
18180      DO 70 I=1,4
18190          TEMP = DT/CRVAW(I)
18200          TAS = (XTEMP1(I) + UAAWX(I) * TAW(I))/XTEMP2(I)
18210          TAW(I) = TAW(I) * (ONE - TEMP * XTEMP3(I)) +
18220      1      TEMP * (UAAWX(I) * TAS + UAAWI(I) * TA)
18230      70      CONTINUE
18240C
18250C      DETERMINE THE ROOF TEMPERATURES
18260C
18270C
18280      TRS1 = (TEMP14 + UARX1 * TR1)/TEMP22
18290      TRS2 = (TEMP15 + UARX2 * TR2)/TEMP23
18300C
18310      TR1 = TR1 * (ONE - TEMP9 * TEMP16) + TEMP9
18320      1      * (UARX1 * TRS1 + UARI1 * TA)
18330      TR2 = TR2 * (ONE - TEMP10 * TEMP17) + TEMP10
18340      1      * (UARX2 * TRS2 + UARI2 * TA)
18350C
18360C      DETERMINE THE CEILING TEMPERATURE
18370C
18380      TCEI = (HACI * TX + UACX * TCE)/TEMP18
18390      TCE = TCE * (ONE - TEMP11 * TEMP19) + TEMP11 * (UACO * TA + UACX * TCEI)
18400C
18410C      DETERMINE THE ATTIC TEMPERATURE
18420C
18430      TA = (TCE * UACO + TEMP24 + UARI1 * TR1 + UARI2 * TR2 +
18440      1      TAW(1) * UAAWI(1) + TAW(2) * UAAWI(2) + TAW(3) * UAAWI(3) +
18450      1      TAW(4) * UAAWI(4))/TEMP5
18460C
18470C      DETERMINE THE ROOM WALL TEMPERATURES
18480C
18490      DO 80 I=1,4
18500          TEMP = DT/CRVW(I)

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18510      TWSI(I) = (HAWI(I)*TX + UAWXI(I)*TW(I))/XTEMP4(I)
18520      WALLT(I) = (XTEMP5(I) + UAWX(I) * TW(I))/XTEMP6(I)
18530      TW(I) = TW(I) * (ONE - TEMP * XTEMP7(I)) +
18540      1      TEMP * (UAWX(I) * WALLT(I) + UAWXI(I) * TWSI(I))
18550 80      CONTINUE
18560C
18570C      DETERMINE THE INTERNAL MASS TEMPERATURE
18580C
18590      TIM = TIM*(ONE - TEMP12*HAIM) + TEMP12*(HAIM*TX + TSR)
18600C
18610C      DETERMINE THE BASEMENT TEMPERATURE (SURFACE TEMPERATURE BELOW GROUND
18620C      LEVEL
18630C
18640      TSBGI = (HAWBG * TX + UAWBX * TSBG)/TEMP20
18650      TSBG = TSBG*(ONE - TEMP13*TEMP21) + TEMP13*(KADX
18660      1*TG1 + UAWBX*TSBGI)
18670C
18680C      DETERMINE THE SURROUNDING EARTH TEMPERATURE ASSUMING ONE DIRECTIONAL
18690C      HEAT TRANSFER AND THAT THE GROUND TEMPERATURE AT A DISTANCE OF 6
18700C      FEET FROM THE WALL IS AT THE WELL WATER TEMPERATURE
18710C
18720C      SET AND RESET BOUNDARY CONDITIONS ON THE GROUND TEMP
18730C
18740      IF (OLDMTH .GE. IMONTH) GOTO 90
18750      OLDMTH = IMONTH
18760      IF (TWELL(IMONTH) .GT. TG1) TG1 = TWELL(IMONTH)
18770      IF (TWELL(IMONTH) .GT. TG2) TG2 = TWELL(IMONTH)
18780      IF (TWELL(IMONTH) .GT. TG3) TG3 = TWELL(IMONTH)
18790 90      CONTINUE
18800C
18810      TG1 = TG1 * TEMP7 + TEMP6 *
18820      1      (KADX * TG2 + KADX * TSBG)
18830      TG2 = TG2 * TEMP7 + TEMP6 *
18840      1      (KADX * TG3 + KADX * TG1)
18850      TG3 = TG3 * TEMP7 + TEMP6 *
18860      1      (TEMP8 + KADX * TG2)
18870C
18880      BTU = Q*DT
18890      TTX = TTX + TX*DT
18900      TBTU = TBTU + BTU
18910      TIME = TIME + DT
18920      BSLOD = HAWRG * (TSBGI + TTX)
18930 100     CONTINUE
18940C
18950      IF(TBTU .GT. ZERO) GO TO 120
18960      IF(TBTU .LT. ZERO) GO TO 110
18970C
18980C
18990C      OPERATION IN DEAD BAND
19000C

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19010      CLOAD = ZERO
19020      HLOAD = ZERO
19030      GO TO 130
19040 110 CONTINUE
19050C
19060C      CALCULATE COOLING LOADS
19070C
19080      QS = -TBTU
19090      QL = PEOP*P8
19100      HLOAD = ZERO
19110      TODB = DB(J)
19120      TODP = DP(J)
19130      CALL COIL(TODB,TODP,TWI,QL,QS,CFMINF,PANCFM,TTX,TF
19140      1,CLOAD,EFFECT)
19150      IF(CLOAD.GT.CPEAK) CPEAK = CLOAD
19160      TCLOAD = TCLOAD + CLOAD
19170      GO TO 130
19180 120 CONTINUE
19190C
19200C      CALCULATE HEATING LOADS
19210C
19220      CLOAD = ZERO
19230      HLOAD = TBTU
19240      IF (HLOAD.GT.HPEAK) HPEAK = HLOAD
19250      THLOAD = THLOAD + HLOAD
19260      TINLD = TINLD + TINLDD
19270      XINF = TEMPO*(TTX-DB(J))
19280      HLHOTW = UAHOTW * (THOTW - TTX)
19290      CONDL = HLOAD + TSR = XINF + HLHOTW + TINLDD
19300      TCONDL = TCONDL + CONDL
19310      TINF = TINF + XINF
19320C
19330 130 CONTINUE
19340      HLHOTW = UAHOTW * (THOTW - TTX)
19350      THWL = THWL + HLHOTW
19360      HOTWL = HGHOTW + HLHOTW
19370      THOTWL = THOTWL + HOTWL
19380      QHL(IHOUR,IDAY) = HLOAD
19390      QC(IHOUR,IDAY) = CLOAD
19400      QHW(IHOUR,IDAY) = HOTWL
19410      XTEMP(IHOUR,IDAY) = TTX
19420      BASLOD(IHOUR,IDAY) = BSLOD
19430C
19440      RETURN
19450C
19460C      LAST CARD OF SUBROUTINE HOUSE
19470C
19480      END
19490      SUBROUTINE TSTAT(TX,Q,TZNEW,TZONES)
19500C

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19510C*****
19520C
19530C      THIS SUBROUTINE WILL APPROXIMATE THE CONTROL OF THE
19540C      HONEYWELL CHRONOTHERM 1 . IT HAS A STEADY STATE DROOP
19550C      OF THREE DEGREES IN BOTH THE HEATING AND COOLING MODES.
19560C      THE THERMOSTAT DEADBAND IS DETERMINED BY THE WINTER AND
19570C      SUMMER SET POINTS.
19580C
19590C      DEVELOPED BY HONEYWELL
19600C
19610C*****
19620C      COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,EFFECT,
19630C      1      WATVEL,WATTMP,CFA,FNCFM1
19640C      DATA TRH/3./,TRC/1./,ONE/1./,ZERO/0./
19650C
19660C      HEAT = (TZNEW - TX)/TRH
19670C      IF(HEAT .GT. ONE) HEAT = ONE
19680C      IF(HEAT .LT. ZERO) HEAT = ZERO
19690C
19700C      COOL = (TX - TZONES)/TRC
19710C      IF(COOL .GT. ONE) COOL = ONE
19720C      IF(COOL .LT. ZERO) COOL = ZERO
19730C
19740C      Q = HEAT * SIZE1 - COOL * SIZE2
19750C
19760C      RETURN
19770C
19780C      LAST CARD OF SUBROUTINE TSTAT
19790C
19800C      END
19810C      SUBROUTINE SOLARQ(ANG1,ANG2,QAVAIL)
19820C
19830C*****
19840C
19850C      THIS SUBROUTINE CALCULATES THE SOLAR LOAD OF A RESIDENTIAL
19860C      BUILDING.
19870C
19880C      THE SUBROUTINE STATEMENT IS
19890C
19900C      SUBROUTINE SOLARQ(ANG1,ANG2,QAVAIL)
19910C
19920C      WHERE
19930C
19940C          ANG1      = THE ANGLE THE SURFACE MAKES WITH RESPECT TO
19950C                     HORIZONTAL
19960C          ANG2      = THE ANGLE THE SURFACE MAKES WITH RESPECT TO THE
19970C                     LOCAL AZMITH (DUE SOUTH IS 0, EAST + WEST = )
19980C          QAVAIL    = ENERGY INCIDENT ON SURFACE (BTU/SQ.FT.)
19990C
20000C      DEVELOPED BY HONEYWELL

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20010C
20020C      PROJECT: ACES
20030C
20040C      CREATION DATE: 06/21/78
20050C
20060C*****
20070      COMMON /BLOCK/IDHOUR, IDAY, IMONTH, TSTOR, QHL(24,366), QHW(24,366),
20080      1      QC(24,366), QINCI(24,366), CLOAD, HLOAD, CPEAK,
20090      1      HPEAK, THOTWL, THLS, THWL, TINF, THLOAD, TCOND, TCLOAD, TTSR
20100      1      , A(200), NTABLE(20), XTEMP(24,366), BASLOD(24,366)
20110      COMMON /DIR/DIRH, DIRN, TOTR
20120      COMMON /SOLAR/S(35)
20130      DATA POINT/, 0.17453/, ZERO/0./, ONE/1./, TWO/2./
20140C
20150C      CALCULATE SURFACE ANGLES
20160C
20170      TILT = ANG1 * POINT
20180      CTILT = COS(TILT)
20190      STILT = SIN(TILT)
20200      FTILT = (ONE - CTILT)/TWO
20210      AZIM = ANG2 * POINT
20220      CAZIM = COS(AZIM)
20230      SAZIM = SIN(AZIM)
20240      RHO = A(9)
20250C
20260C      COMPUTE ANGLE OF INCIDENCE WHERE
20270C          S(13) = THE DIRECTION COSINE WITH RESPECT TO THE SURFACE NORMAL
20280C          S(14) = THE DIRECTION COSINE WITH RESPECT TO LOCAL EAST
20290C          S(15) = THE DIRECTION COSINE WITH RESPECT TO LOCAL NORTH
20300C
20310      CTHETA = CTILT * S(13) + STILT * SAZIM * S(14) - STILT * CAZIM *
20320      1      S(15)
20330      IF (CTHETA .LT. ZERO) CTHETA = ZERO
20340C
20350C      COMPUTE DIRECT AND DIFFUSE SOLAR RADIATION IMPINGING ON AN
20360C      OBLIQUE SURFACE
20370C
20380      QDIR = DIRN * CTHETA
20390      QDIF = (TOTR - DIRH) * (ONE - FTILT) + RHO * TOTR * FTILT
20400      QAVAIL = QDIR + QDIF
20410      RETURN
20420      END
20430C
20440      SUBROUTINE SUN(MODE)
20450C
20460C*****
20470C
20480C      THIS SUBROUTINE COMPUTES DECLINATION, EQUATION OF TIME, APPARENT
20490C      SOLAR CONSTANT, ATMOSPHERIC EXTINCTION COEFFICIENT, SKY DIFFUSE
20500C      FACTOR, SUN RISE AND SUNSET TIMES ONCE EACH DAY, AND

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20510C THE SUN PARAMETERS.
20520C
20530C THE SUBROUTINE STATEMENT IS
20540C
20550C SUBROUTINE SUN(MODE)
20560C
20570C WHERE
20580C
20590C MODE IS SET TO 0 AT THE FIRST CALL OF EACH DAY
20600C
20610C S(1)= LATITUDE,DEGREES(+NORTH,-SOUTH)
20620C S(2)= LONGITUDE,DEGREES(+WEST,-EAST)
20630C S(3)= TIME ZONE NUMBER
20640C          STANDARD TIME          DAYLIGHT SAVING TIME
20650C          ATLANTIC             4              3
20660C          EASTERN              5              4
20670C          CENTRAL              6              5
20680C          MOUNTAIN             7              6
20690C          PACIFIC             8              7
20700C S(4)= DAYS(FROM START OF YEAR)
20710C S(5)= TIME,HOUR AFTER MIDNIGHT)
20720C S(6)= DAYLIGHT SAVING TIME INDICATOR
20730C S(8)= CLEARNESS NUMBER
20740C S(11)=SUN RISE TIME (HOURS AFTER MIDNIGHT)
20750C S(12)=SUN SET TIME
20760C S(13)=COSZ DIRECTION COSINES
20770C S(14)=COSN DIRECTION COSINES
20780C S(15)=COS(S) DIRECTION COSINES)
20790C S(16)=ALPHA DIRECTION COSINES NORMAL TO SURFACE
20800C S(20)=SOLAR ALTITUDE ANGLE, RADIANS
20810C S(21)=SOLAR AZIMUTH ANGLE, RADIANS
20820C S(22)=DIFFUSE SKY RADIATION ON HORIZONTAL SURFACE
20830C S(23)=TOTAL HORIZONTAL RADIATION ITH
20840C S(24)=DIRECT NORMAL RADIATION
20850C S(28)=SUN DECLINATION ANGLE DELTA, RADIANS
20860C S(29)=EQUATION OF TIME ,HOURS
20870C S(30) = SOLAR FACTOR A
20880C S(31) = SOLAR FACTOR B
20890C S(32) = SOLAR FACTOR C
20900C S(35)=SOLAR HOUR ANGLE OMEGA, RADIANS
20910C
20920C DEVELOPED BY HONEYWELL
20930C
20940C*****
20950C
20960C COMMON /SOLAR/ S(35)
20970C DIMENSION A0(5),A1(5),A2(5),A3(5),B1(5),B2(5),B3(5)
20980C DATA A0/.302,-.0002,368.44,.1717,.0905/
20990C DATA A1/-22.93,.4197,24.52,-.0344,-.0410/
21000C DATA A2/-.229,-3.2265,-1.14,.0032,.0073/

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21010 DATA A3/-.243,-.0903,-.109,.0024,.0015/
21020 DATA B1/3.851,-7.351,.58,-.0043,-.0034/
21030 DATA B2/.002,-9.3912,-.18,0,.0004/
21040 DATA B3/-.055,-.3361,.28,.0008,-.0006/
21050 DATA TWO/2./,THR66/366./,THREE/3./,ONE80/180./,SIXTY/60./
21060 1 ,FIFTIN/15./,TWELVE/12./,ONE/1./,ZERO/0./,OPEM6/1.E-6/
21070 DATA RPH/0.261799383/
21080 REAL LAT,LATD,LONG,MERID,LOND
21090C
21100 PI = 3.14159265
21110 TWOPI = 6.28318531
21120 IF(MODE .NE. 0) GO TO 20
21130 X= TWO *PI/THR66*S(4)
21140 C1=cos(X)
21150 C2=cos(TWO*X)
21160 C3=cos(THREE*X)
21170 S1=sin(X)
21180 S2=sin(TWO*X)
21190 S3=sin(THREE*X)
21200 DO 10 K=1,5
21210 KS=(K-1)+28
21220 S(KS)=A0(K)+A1(K)*C1+A2(K)*C2+A3(K)*C3+B1(K)*S1+B2(K)*S2
21230 1 + B3(K)*S3
21240 10 CONTINUE
21250 S(28) = S(28)*PI/ONE80
21260 S(29)=S(29)/SIXTY
21270 LATD=S(1)
21280 LONG=S(2)
21290 MERID=FIFTIN*S(3)
21300 LOND=LONG-MERID
21310 Y = S(28)
21320 YY=LATD*PI/ONE80
21330 HP=-SIN(Y)/COS(Y)*SIN(YY)/COS(YY)
21340 TR=TWELVE/PI*ARCOS(HP)
21350 S(11)=(TWELVE-TR)-S(29)+LOND/FIFTIN
21360 S(12) = S(11) + TWO*TR
21370C
21380C COMPUTE DAILY CONSTANTS
21390C
21400 TYY=SIN(YY)/COS(YY)
21410 TY=SIN(Y)/COS(Y)
21420 CY=cos(Y)
21430 SY=sin(Y)
21440 CYY=cos(YY)
21450 SYY=sin(YY)
21460 ACHP=ARCOS(HP)
21470 HP1 = ARCOS(HP)
21480 X1=ABS(HP1)
21490 GO TO 40
21500C

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21510C      COMPUTE THE FOLLOWING SUN PARAMETERS ON EACH DT CALL
21520C
21530      20 CONTINUE
21540C
21550C      COMPUTE SOLAR HOUR ANGLE
21560C
21570      H = -RPH*(S(5)-TWELVE+S(3)+S(29)-S(6)) + S(2)*PI/DN280
21580      S(35) = H
21590C
21600C      IS THE SUN UP
21610C
21620      X2=ABS(H)
21630      IF (X1 .LT. X2) GO TO 40
21640C
21650C      COMPUTE SOLAR DIRECTION COSINES
21660C
21670      S(13)=SYY*SY+CYY*CY*COS(H)
21680      S(14) = CY*SIN(H)
21690      S(15)=-SYY*CY*COS(H)+CYY*SY
21700C
21710C      COMPUTE SOLAR ALTITUDE AND AZIMUTH
21720C
21730      30 CONTINUE
21740      S(20)=ARSIN(S(13))
21750      S(21)=(PI-ARCOS(S(15)/COS(S(20))))*SIGN(ONE,H)
21760C
21770C      COMPUTE RADIATION INTENSITY
21780C
21790      CALL FXOPT(89,1,1,0)
21800      S(24)=S(30)*S(8)*EXP(-S(31)/S(13))
21810      IF(S(24) .LT. OPEM6) S(24) = ZERO
21820      CALL FXOPT(89,1,0,0)
21830      S(22)=S(32)*S(24)
21840      S(23) = (S(32) + S(13))*S(24)
21850      RETURN
21860      40 CONTINUE
21870      S(24) = ZERO
21880      S(22) = ZERO
21890      S(23) = ZERO
21900      RETURN
21910C
21920C      LAST CARD OF SUBROUTINE SUN
21930C
21940      END
21950C
21960      SUBROUTINE COIL(TO08,TODP,TWI,QL,QS,CFMINF,FANCFM,TX,TF
21970      1,CLOAD,EFFECT)
21980C
21990C*****
22000C

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22010C      THIS SUBROUTINE IS USED TO DETERMINE THE EXISTING LOAD ON A
22020C      COOLING COIL FOR A SPECIFIED SET OF CONDITIONS.  THE TOTAL
22030C      LOAD IS A FUNCTION OF THE EXIT CONDITIONS OF THE COIL AND
22040C      THEREFORE IS NOT KNOWN EXPLICITLY.  THIS ROUTINE WILL DETER-
22050C      MINE THE LOAD IN THE SPACE, THE SPACE HUMIDITY RATIO, AND
22060C      THE AMOUNT OF TIME THE COIL IS IN OPERATION EACH HOUR.
22070C      THE FOLLOWING IS A LIST OF INDEPENDENT VARIABLES:
22080C
22090C      TODB  = OUTDOOR AIR DRYBULB TEMP.          DEG. F
22100C      TODP  = OUTDOOR AIR DEWPOINT              DEG. F
22110C      TWI   = INLET WATER TEMP. TO COOLING COIL  DEG. F
22120C      QL    = LATENT LOAD IN THE SPACE           BTU/HR
22130C      QS    = SENSIBLE LOAD IN THE SPACE         BTU/HR
22140C      CFMINF = INFILTRATION CFM                  CFM
22150C      FANCFM = COOLING COIL FAN CFM              CFM
22160C      TX     = INDOOR AIR DRYBULB TEMP.          DEG. F
22170C      TF     = TIME FRACTION THE COOLING COIL IS ON
22180C      CLOAD  = TOTAL COOLING LOAD FOR THE HOUR    BTU
22190C      WO     = OUTDOOR HUMIDITY RATIO            LBMH2O/LBMAIR
22200C      WI     = INDOOR HUMIDITY RATIO            LBMH2O/LBMAIR
22210C
22220C      DEVELOPED BY HONEYWELL
22230C
22240C      *****
22250C
22260      DATA FP46/4.46/,ONET96/1096./,ONET61/1061./,P24/.24/,P45/.45/,
22270      1      ZERO/0./,P01/.01/,FIFTIN/15./,ONE/1./,P0001/.0001/,P1/.1/
22280C
22290C      ASSUMING NO DEHUMIDIFICATION, THE OUTDOOR AND INDOOR
22300C      HUMIDITY RATIOS ARE:
22310C
22320      TEMP0 = FP46 * CFMINF
22330      TEMP1 = FP46 * FANCFM
22340      TEMP2 = WO * (P45 * TODB + ONET61)
22350      WO = OMEGA(TODP)
22360      WI = WO + QL/(TEMP0*ONET96)
22370C
22380C      ASSUMING A CONSTANT COIL EFFECTIVENESS THE MAXIMUM CAPACITY IS:
22390C
22400      WE = OMEGA(TWI)
22410      QMAX = EFFECT*(TEMP1*(((P24+P45*WI)*TX+ONET61*WI)
22420      1      -((P24+P45*WE)*TWI+ONET61*WE)))
22430C
22440C      THE INLET ENTHALPY, ENTHALPY DROP ACROSS THE COIL, AND THE
22450C      EXIT ENTHALPY ARE:
22460C
22470      HI = P24*TX + WI*(P45*TX + ONET61)
22480      DH = QMAX/TEMP1
22490      HD = HI - DH
22500C

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22510C      CHECK TO SEE IF THE ASSUMPTION ON DEHUMIDIFICATION WAS CORRECT
22520C      IF IT WAS, DETERMINE THE LOAD AND RETURN, IF NOT GO TO TEN
22530C
22540      TE= OMGAIN(WI)
22550      HOTRY= P24*TE + WI*(P45*TE + ONET61)
22560      IF((HOTRY-HO) .GT. P1) GO TO 10
22570      QCOOL= QS + QL + TEMPO * (TEMP2
22580      + WI*(P45*TX + ONET61))
22590      IF(QCOOL .LT. ZERO) QCOOL= ZERO
22600      TF= QCOOL/QMAX
22610      CLOAD= QCOOL
22620 40    CONTINUE
22630      RETURN
22640C
22650C      USE TE FROM PREVIOUS SOLUTION ATTEMPT AS A FIRST GUESS
22660C      FOR THE EXITING AIR TEMP.
22670C
22680 10    CONTINUE
22690      SUM= ZERO
22700 20    CONTINUE
22710      CALL FUNC(CFMINF,FANCFM,WO,WIP,QL,TE,TWI,TX,HO,HOTRY
22720      1,EFFECT,QMAX)
22730C
22740C      USE NEWTONS METHOD TO SOLVE FOR TE AND WE
22750C
22760      SUM=SUM+ONE
22770      FX= HO - HOTRY
22780      DEL=P0001*TE
22790      TEP= TE + DEL
22800      CALL FUNC(CFMINF,FANCFM,WO,WIP,QL,TEP,TWI,TX,HO,HOTRY
22810      1,EFFECT,QMAX)
22820      FXD= HO - HOTRY
22830      FXP= (FXD -FX)/DEL
22840      TEN= TE = FX/FXP
22850      TE=TEN
22860      IF(ABS(FX) .GT. P01 .AND. SUM .LT. FIFTIN) GO TO 20
22870      IF(SUM .LT. FIFTIN) GO TO 30
22880      WRITE(9,121)
22890 121  FORMAT(/,'SUBROUTINE COIL HAS NOT CONVERGED',/)
22900      MODEC = 0
22910      GO TO 40
22920 30    CONTINUE
22930C
22940C      DETERMINE THE TIME FRACTION KNOWING THAT THE LATENT
22950C      INFILTRATION FOR THE COIL ON AND OFF PERIOD IS:
22960C
22970      XINFP= TEMPO * (TEMP2-WIP*(ONET61+P45*TX))
22980      XINF=TEMPO * (TEMP2-WI*(ONET61+P45*TX))
22990C
23000C      ON TIME

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23010C
23020      TF= (QS + QL + XINF)/(QMAX + XINFP + XINF)
23030      IF(TF .LT. ZERO)TF= ZERO
23040      IF(TF .GT. ONE)TF= ONE
23050      QCOOL= TF*QMAX
23060      CLOAD= QCOOL
23070      RETURN
23080C
23090C      LAST CARD OF SUBROUTINE COIL
23100C
23110      END
23120      SUBROUTINE FUNC(CFMINF,FANCFM,W0,WIP,QL,TE,TWI,TX,H0,HOTRY
23130      1,EFFECT,QMAX)
23140C
23150C*****
23160C
23170C      SUBROUTINE FUNC IS USED TO EVALUATE COOLING COIL EXIT
23180C      CONDITIONS
23190C
23200C      DEVELOPED BY HONEYWELL
23210C
23220C*****
23230C
23240      DATA FP46/4.46/,P24/.24/,P45/.45/,ONET61/1061./,ONET96/1096./
23250C      DETERMINE APPROPRIATE HUMIDITY RATIOS FROM TWI AND TE
23260C
23270      TEMP0 = FP46 * CFMINF
23280      TEMP1 = FP46 * FANCFM
23290      WX= OMEGA(TWI)
23300      WE= OMEGA(TE)
23310      WI= (TEMP0*W0 + QL/ONET96 + TEMP1*WE)/
23320      1      (TEMP0 + TEMP1)
23330C
23340C      DETERMINE QMAX, DH, HI, H0, WIP, AND HOTRY
23350C
23360      QMAX= EFFECT*(TEMP1*(((P24+P45*WI)*TX+ONET61*WI)-((P24
23370      1      +P45*WX)*TWI+ONET61*WX)))
23380      DH= QMAX/TEMP1
23390      HI= P24*TX + WI*(P45*TX + ONET61)
23400      H0= HI - DH
23410      WIP= WI
23420      HOTRY= P24*TE + WE*(P45*TE + ONET61)
23430      RETURN
23440C
23450C      LAST CARD OF SUBROUTINE FUNC
23460C
23470      END
23480      FUNCTION OMEGA(T)
23490C
23500C*****

```

```

23510C
23520C   THIS ROUTINE GIVES THE HUMIDITY RATIO AT THE SATURATION
23530C   TEMPERATURE T
23540C
23550C   DEVELOPED BY HONEYWELL
23560C
23570C *****
23580C
23590   DIMENSION X(4)
23600   DATA X/-10.3678,15.7772,1.02294,.0235739/,THRTWO/32./
23610C
23620   IF(T .LT. THRTWO) T = THRTWO
23630   OMEGA = EXP(X(1) + (X(2)/T) + (X(3) * ALOG(T)) + (X(4) * T))
23640   RETURN
23650C
23660C   LAST CARD OF FUNCTION OMEGA
23670C
23680   END
23690   FUNCTION OMEGA(W)
23700C
23710C *****
23720C
23730C   THIS ROUTINE GIVES THE SATURATION TEMPERATURE FOR THE
23740C   SPECIFIED HUMIDITY RATIO W
23750C
23760C   DEVELOPED BY HONEYWELL
23770C
23780C *****
23790C
23800   DIMENSION X(6)
23810   DATA SEVENT/7000./,X/-12.11464,2.59384,.0455714,4.60033E-4,
23820   1 2.27777E-6,4.31080E-9/
23830C
23840   WCHAIN = SEVENT * W
23850   OMEGA = X(1) + X(2) * WCHAIN - X(3) * WCHAIN * WCHAIN + X(4)
23860   1 * WCHAIN ** 3 - X(5) * WCHAIN ** 4 + X(6) * WCHAIN ** 5
23870   RETURN
23880C
23890C   LAST CARD OF FUNCTION OMEGA
23900C
23910   END
23920   SUBROUTINE WINDOW
23930C
23940C *****
23950C
23960C   THIS SUBROUTINE CALCULATES THE SOLAR RADIATION TRANSMITTED
23970C   PER SQ FT OF GLASS DUE TO CLEAR SKY DIRECT RADIATION
23980C
23990C   THE SUBROUTINE STATEMENT IS
24000C

```

24010C SUBROUTINE WINDOW

24020C
24030C THE EXTERIOR WALLS AND WINDOWS ARE ASSUMED TO BE VERTICAL
24040C SURFACES. CALCULATIONS ARE MADE FOR EACH OF THE FOUR VERTICAL
24050C EXPOSURES ALLOWING FOR + OR -45 DEGREES ROTATION FROM TRUE NESW.
24060C THE DIRECT NORMAL RADIATION IS CALCULATED FROM SUBROUTINE
24070C SUN FOR EACH HOUR. DIRECTION COSINES OF THE SUN'S RAYS WITH
24080C RESPECT TO LOCAL VERTICAL, LOCAL WEST AND LOCAL SOUTH ARE
24090C ALSO CALCULATED IN SUBROUTINE SUN. DIRECTION COSINES OF
24100C THE NORMAL TO EACH OF THE FOUR WALLS WITH RESPECT TO LOCAL
24110C VERTICAL, LOCAL WEST AND LOCAL SOUTH ARE CALCULATED. THE
24120C COSINE OF THE ANGLE OF INCIDENCE IS CALCULATED FOR EACH OF
24130C THE WALLS FROM THE DIRECTION COSINES OF THE NORMALS TO THE
24140C WALL AND THE SUN'S RAYS. THE SOLAR RADIATION INCIDENT ON
24150C EXTERIOR WALLS AND TRANSMITTED THROUGH THE WINDOWS IS THEN
24160C CALCULATED AS A FUNCTION OF THE ANGLE OF INCIDENCE FOR EACH
24170C OF THE FOUR EXPOSURES. THE MEAN ANGLE OF INCIDENCE FOR DIFFUSE
24180C SOLAR RADIATION IS ASSUMED TO BE 60 DEGREES. THE WINDOWS ARE
24190C ASSUMED TO BE DOUBLE GLAZED. INTERNAL AND EXTERNAL SHADING
24200C EFFECTS ARE NOT CONSIDERED.

24210C
24220C EXPLANATION OF VARIABLES:

24230C
24240C BOANG IS THE BUILDING ROTATION ANGLE (-45 DEG < BOANG < +45 DEG)

24250C
24260C RHOS IS THE REFLECTANCE OF THE GROUND IN FRONT OF THE WINDOW

24270C
24280C XN IS THE INDEX OF REFRACTION OF GLASS IN AIR

24290C
24300C XK IS THE PRODUCT OF THE EXTINCTION COEFFICIENT AND THE
24310C THICKNESS FOR EACH PANE OF GLASS (DIMENSIONLESS)

24320C
24330C TDR IS THE WINDOW TRANSMITTANCE FOR DIRECT SOLAR RADIATION
24340C (FUNCTION OF THE INCIDENCE ANGLE)

24350C
24360C TDF IS THE WINDOW TRANSMITTANCE FOR DIFFUSE SOLAR RADIATION
24370C (SKY RADIATION AND DIFFUSELY REFLECTED RADIATION FROM
24380C THE GROUND)

24390C
24400C QTRAN(I) IS THE SOLAR RADIATION TRANSMITTED THROUGH GLASS (BTUH/SQ FT)

24410C
24420C ABSORB(I) IS THE SOLAR RADIATION INCIDENT ON EACH EXTERIOR
24430C WALL (BTUH/SQ FT)

24440C
24450C WHERE

24460C
24470C I = 1 FOR NORTH EXPOSURE
24480C = 2 FOR EAST EXPOSURE
24490C = 3 FOR SOUTH EXPOSURE
24500C = 4 FOR WEST EXPOSURE

```

24510C
24520C      DEVELOPED BY HONEYWELL
24530C
24540C*****
24550C
24560      COMMON /BLOCK/IDAY,IMONTH,TSTOR,DHL(24,366),JHW(24,366),
24570      1      QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
24580      1      HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCOND,L,TCLJAD,TTSR
24590      1      ,A(200),NTABLE(20),XTEMP(24,366),HASLOC(24,366)
24600      COMMON /SOLAR/S(35)
24610      COMMON /SLOAD/QTRAN(5),ABSORB(5)
24620      COMMON /DIR/DIRH,DIRN,TOTH
24630      DATA TWO/2./,ONE/1./,P011/.011/,P00792/.00792/,ZERO/0./,THREE/3./
24640      1      ,P09/.09/,FSP3/57.3/
24650      DATA PI/3.1416/,XK/0.05/,XN/1.526/,TDF/0.672/,PS/.5/,P999/.999/
24660C
24670C      INITIALIZATION
24680C
24690      DO 10 I = 1, 5
24700          QTRAN(I) = ZERO
24710          ABSORB(I) = ZERO
24720 10      CONTINUE
24730      RHOS = A(9)
24740      BOANG = A(135)
24750C
24760C      DIRECT NORMAL RADIATION DUE TO CLOUDY SKY
24770C
24780      SDRNC=DIRN
24790C
24800C      DIRECT RADIATION ON HORIZONTAL SURFACE DUE TO CLOUDY SKY.
24810C
24820      SDRHC=DIRH
24830C
24840C      TOTAL RADIATION ON HORIZONTAL SURFACE DUE TO CLOUDY SKY
24850C
24860      STHC=TOTH
24870C
24880C      DIRECTION COSINES OF SUN'S RAYS WITH RESPECT TO LOCAL COORDINATES
24890C
24900      COSW = S(14)
24910      COSS = S(15)
24920      DO 500 IWALL = 1, 4.
24930C
24940C      CALCULATE WALL AZIMUTH WITH RESPECT TO SOUTH.
24950C
24960          WA= (THREE - FLOAT(IWALL)) * PI/TWO + BOANG/FSP3
24970C
24980C      DIRECTION COSINE OF NORMAL TO VERTICAL WALL WITH RESPECT TO
24990C      LOCAL WEST HORIZONTAL.
25000C

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```

25010      BETA = SIN(WA)
25020C
25030C      DIRECTION COSINE OF NORMAL TO VERTICAL WALL WITH RESPECT TO
25040C      LOCAL SOUTH HORIZONTAL
25050C
25060      GAMMA = COS(WA)
25070C
25080C      CALCULATE THE COSINE OF ANGLE OF INCIDENCE
25090C
25100      COSAOI = COSW * BETA = COSS * GAMMA
25110      IF (COSAOI .LT. ZERO) COSAOI = ZERO
25120      IF (COSAOI .GT. ONE) WRITE(6,1000) COSAOI
25130C
25140C      CALCULATE INCIDENT RADIATION
25150C
25160      QSINC = COSAOI * SDNC
25170      QDIFS = (STHC * SDRHC) * P5 + RHOS * STHC * P5
25180      QINCIS = QSINC + QDIFS
25190C
25200C      DETERMINE THE TRANSMISSION COEFFICIENT
25210C
25220      IF (COSAOI .LE. ZERO) TR = ZERO
25230      IF (COSAOI .LE. ZERO) GO TO 400
25240C
25250C      CALCULATE THE ANGLE OF INCIDENCE AND THE ANGLE OF REFLECTION
25260C
25270      AOI = ACOS(COSAOI)
25280      AOR = ASIN(SIN(AOI)/XN)
25290C
25300C      CALCULATE INTERMEDIATE STEPS FOR THE TRANSMISSION COEFFICIENT
25310C      AS A FUNCTION OF THE ANGLE OF INCIDENCE
25320C
25330      IF (COSAOI .GT. P999) GO TO 300
25340      R1 = (SIN(AOI - AOR)/SIN(AOI + AOR)) ** 2
25350      RX = (TAN(AOI - AOR)/TAN(AOI + AOR))
25360      R2 = RX * RX
25370      TR = P5 * (((ONE - R1)/(THREE * R1 + ONE)) + ((ONE - R2)/
25380      1 (THREE * R2 + ONE)))
25390      GO TO 400
25400 300 CONTINUE
25410      R = ((XN - ONE)/(XN + ONE)) ** 2
25420      TR = (ONE - R)/(THREE * R + ONE)
25430 400 CONTINUE
25440C
25450C      CALCULATE THE TRANSMISSION COEFFICIENT FOR DIRECT RADIATION
25460C
25470      TDR = TR * EXP(-TWO * XK/COS(AOR))
25480C
25490C      CALCULATE THE TRANSMITTED RADIATION
25500C

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```

25510      QTRAN(IWALL) = QSINC * TDR + QDIFS * TDF
25520C
25530C      CALCULATE THE INCIDENT RADIATION ON THE WALL SURFACE
25540C
25550      ABSORB(IWALL) = QINCIS
25560C
25570 500      CONTINUE
25580      RETURN
25590 1000 FORMAT(/,1X,'COASOI = ',F12.8)
25600C
25610C      LAST CARD OF SUBROUTINE WINDOW
25620C
25630      END
25640      SUBROUTINE WAHP(TWI,TAI,QCOND,GEVAP,HP,COP)
25650C
25660C*****
25670C      THIS ROUTINE PREDICTS THE PERFORMANCE OF A WATER TO
25680C      AIR HEAT PUMP AS A FUNCTION OF THE EVAPORATOR AND
25690C      CONDENSER INLET TEMPERATURES
25700C
25710C      DEVELOPED BY HONEYWELL
25720C
25730C*****
25740C
25750      COMMON /HTPP/FF
25760      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
25770 1      P00155/.00155/,P7336/.7336/,T9P23/29.23/,EIGHTY/80./,
25780 1      F569/4569./,T523/2523./,SIX2PS/62.S/,TWPS/12.S/,PI/3.141/,
25790 1      T545/2545./,P00159/.00159/,P6875/.6875/
25800C
25810      EET = TWI
25820      ECT = TAI
25830      BTU = ONET23 * (EET - THRTWO) + SIXFT - THUND * ECT
25840      Y = T9P23 * (ECT - EIGHTY) + F569
25850      XM = (Y - T523)/SIX2PS
25860      WATTS = XM * (EET - TWPS) + T523
25870      COP = BTU/(WATTS * PI) + FF
25880      QCOND = BTU
25890      BTUM = QCOND/COP
25900      GEVAP = QCOND - BTUM
25910      QCOND = QCOND * (P00155 * EET + P7336)
25920      GEVAP = GEVAP * (P00159 * EET + P6875)
25930      QMOT = QCOND - GEVAP
25940      COP = QCOND/QMOT
25950      HP = QMOT/T545
25960      RETURN
25970C
25980C      LAST CARD OF SUBROUTINE WAHP
25990C
26000      END

```



```
*****
*****
-- 3 0 --      DATE 08-31-79      TIME 11.528      ID = E1      GCS-AJ
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A-41

LODMOD_B

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SNUMB = 3888T
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  XXXX      XXXX      XXXX      XXXX      XXXX
  X          X X      X X      X X      X
  XXX        XXXX      XXXX      XXXX      X
  X          X X      X X      X X      X
  X X        X X      X X      X X      X
  XXXX      XXXX      XXXX      XXXX      X
  
```

XXX
 XX

SS 3888T ENTERED GCS-AJ AT 11.472 FROM SYSTEM=0 TSS/S 0-08-02

```

0001 S      SNUMB 3888T
0002 S      COMMENT F00648      TSS MEDIA CONVERSION
0003 S      IDENT  F00648-ACES
0004 SS     USERID F00648S
0005 AS     CONVER
0006 S      LIMITS ,,,50000
0007 S      SYSOUT OT,E1
0008 S      MULTI 1-1
0009 S      DATA  IN,,COPY,ENDFC
0010 S      ENDCOPY IN
0011 S      ENDJOB
      TOTAL CARD COUNT THIS JOB = 002094
  
```

```

* ACTY-01 SCARD #0005 CONVER 08/31/79 SW=000000000000
BMC-TTL DATE 771205
$ MULTI 1-1
FILE #000001 TOT 002083 INPUT
INPUT COUNT 002083 OUTPUT COUNT 002083
BLOCKS SKIPPED 000000 IGNORE COUNT 000000
* NORMAL TERMINATION AT 001544 I=2060 SW=000000000000
  
```

START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/RC	MS/RE	ADDRESS	IN/PK#	MEMORY	8K
11.476	11.480	0.000	0.004												
LIMIT 50000 LIMIT 0.2000 LIMIT															
MC R MSU450 * 22 0 1 1 1 0-08-01															
IN R MSU450 * 1078 0 49 49 49 0-08-01															
OT SYOUT															
P* SYOUT															

RC-00 2082 LINES AT STA. E1

ACTIVITY 01 COST=\$ 0.77
 *CUMULATIVE COST=\$ 0.77

SNUMB = 3888T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 002082

\$ NOTE FILENAME BKACE
\$ NOTE LABELS- A,R(E1)
\$ NOTE TABS/SETTINGS- ASIS

```

10000C*****
10010C
10020C      LOADS PROGRAM FOR RESIDENTIAL ACES
10030C
10040C      THIS PROGRAM HAS BEEN DESIGNED TO CALCULATE THE HOURLY LOADS
10050C      FOR A SINGLE OR MULTI-FAMILY RESIDENCES (ONLY) EQUIPPED WITH AN
10060C      ACES CONFIGURATION. THIS PROGRAM IS ONE OF FOUR DISTINCT MODULES.
10070C      THEY ARE:
10080C          1. LOADS PROGRAM
10090C          2. DESIGN PROGRAM
10100C          3. SIMULATION PROGRAM
10110C          4. ECONOMIC ANALYSIS PROGRAM
10120C      IF THE LOADS HAVE BEEN ALREADY DETERMINED, THIS MODULE CAN BE
10130C      BYPASSED.
10140C
10150C      DEVELOPED BY HONEYWELL
10160C
10170C      CREATION DATE: JULY 6, 1978.
10180C
10190C*****
10200C
10210      COMMON /BLOCK/ I HOUR, I DAY, I MONTH, TSTOR, QHL(24,366), QHW(24,366),
10220      1 QC(24,366), QINCI(24,366), CLOAD, HLOAD, CPEAK, HPEAK,
10230      1 THOTWL, THLS, THWL, TINF, THLOAD, TCOND, TCLOAD, TTSR, A(200),
10240      1 NTABLE(20), XTEMP(24,366), BASLOD(24,366)
10250      COMMON /SOLAR/ S(35)
10260      COMMON /WEATHER/ DB(24), DP(24), WB(24), WS(24), PB(24), TC(24),
10270      1 TOC(24), WET(24), DRY(24), IYEAR, IDUM1, IDUM2, ICITY
10280      COMMON /SLOAD/ QTRAN(5), ABSORH(5)
10290      COMMON /SCHDL/ TWELL(12), MHOTW(24), PEOPLE(24), XLIGHT(24), APPL(24)
10300      COMMON /TEMP/ TW(7), TAW(6), TR(6), TA(6), TIM, TFLI, TSL, TCR, TTE,
10310      1 TX, TCE(3), TWSI(7), TCEI(3)
10320      COMMON /HOURLY/ CONDL, XINF, TSR, QINC1, QINC2, ALFW, ALFR
10330      COMMON /DESIGN/ HEATD, COOLD, SIZE1, SIZE2, FANCFM, EVPGPM, EFFECT,
10340      1 WATVEL, WATTMP, CFA, FNCFM1
10350      DIMENSION MSIZE(12), DAY(24,15), TDAY(15), MONTH(12,15)
10360      DATA MSIZE/31,28,31,30,31,30,31,31,30,31,30,31/
10370      DATA ZERO/0./, TWNFOR/24./, ONE/1./, TWNFIV/25./
10380      REAL MHOTW, MONTH
10390C
10400C      INITIALIZE
10410      SUMM=0.
10420C
10430      DO 20 I = 1, 24
10440          DO 10 J = 1, 366
10450              QC(I,J) = ZERO
10460              QHL(I,J) = ZERO
10470              QHW(I,J) = ZERO
10480              QINCI(I,J) = ZERO
10490              XTEMP(I,J) = ZERO
10500              BASLOD(I,J) = ZERO

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```

10510 10.      CONTINUE
10520          DB(I) = ZERO
10530          WB(I) = ZERO
10540          DP(I) = ZERO
10550          WS(I) = ZERO
10560          PB(I) = ZERO
10570          TC(I) = ZERO
10580          TOC(I) = ZERO
10590          WET(I) = ZERO
10600          DRY(I) = ZERO
10610 20      CONTINUE
10620          CLOAD = ZERO
10630          HCOND = ZERO
10640          CPEAK = ZERO
10650          HPEAK = ZERO
10660          THOTWL = ZERO
10670          THLS = ZERO
10680          THWL = ZERO
10690          TINF = ZERO
10700          THLOAD = ZERO
10710          TCLOAD = ZERO
10720          TCONDL = ZERO
10730          TTSR = ZERO
10740          THQUR = TWNFUR
10750          DO 23 I = 1, 20
10760              NTABLE(I) = 0
10770 23      CONTINUE
10780          CALL INPIIT
10790          IDAYS = IFIX(A(4))
10800          ISTART = IFIX(A(7))
10810          IDAY = ISTART + 1
10820          IEND = IFIX(A(8))
10830          IESCAP = 120 * 24 * (IEND - ISTART + 1)
10840          DO 25 I = 1, 12
10850              DO 25 J = 1, 15
10860                  MONTH(I,J) = ZERO
10870 25      CONTINUE
10880          K = 1
10890          IF (IDAYS .EQ. 366) MSIZE(2) = 29
10900          L = 1
10910          NDAY = 0
10920C
10930C      INITIALIZE SUN ARRAY
10940C
10950          S(1) = A(1)
10960          S(2) = A(2)
10970          S(3) = A(3)
10980          S(4) = A(7) - ONE
10990          S(5) = TWNFIV
11000          S(8) = A(17)

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11010C
11020C      REWIND WEATHER TAPE AND POSITION IT
11030C
11040      INIT = ISTART - 1
11050      IF (INIT .EQ. 0) GO TO 40
11060      DO 30 I = 1, INIT
11070          READ(8) DB,OP,WB,WS,PB,TC,TOC,WET,DRY,IDUM,IMONTH,IDUM,IDUM
11080 30      CONTINUE
11090C
11100C      LOOP FOR SETTING UP OUTPUT SUMMARIES AND LOAD CALCULATIONS
11110C
11120 40      CONTINUE
11130      IF(S(4).GE.FLOAT(IEND).AND.S(5).GE.TWNFIV) GO TO 120
11140      IF (NDAY .NE. MSIZE(L)) GO TO 50
11150      L = L + 1
11160      NDAY = 0
11170 50      CONTINUE
11180      DO 55 I = 1, 15
11190          TDAY(I) = ZERO
11200 55      CONTINUE
11210 60      CONTINUE
11220C
11230C      CALL SUBROUTINE TIME FOR HOURLY LOAD CALCULATIONS
11240C
11250      CALL TIME
11260C
11270C      OUTPUT AND SUMMARIES
11280C
11290      DAY(IHOUR,1) = QHL(IHOUR,IDAY)
11300      DAY(IHOUR,2) = QHW(IHOUR,IDAY)
11310      DAY(IHOUR,3) = QC(IHOUR,IDAY)
11320      DAY(IHOUR,4) = QINCI(IHOUR,IDAY)
11330      DAY(IHOUR,5) = CONDL
11340      DAY(IHOUR,6) = XINF
11350      DAY(IHOUR,7) = TSR
11360      DAY(IHOUR,8) = QINC1 * ALFW
11370      DAY(IHOUR,9) = QINC2 * ALFR
11380      DAY(IHOUR,10) = ABSORB(1) * ALFW
11390      DAY(IHOUR,11) = ABSORB(2) * ALFW
11400      DAY(IHOUR,12) = ABSORB(3) * ALFW
11410      DAY(IHOUR,13) = ABSORB(4) * ALFW
11420      DAY(IHOUR,14) = XTEMP(IHOUR,IDAY)
11430      DAY(IHOUR,15) = BASLOD(IHOUR,IDAY)
11440      DO 70 J = 1, 15
11450          TDAY(J) = TDAY(J) + DAY(IHOUR,J)
11460 70      CONTINUE
11470      S(5)=S(5)+1.
11480      IF(S(5).LE.TWNFOR) GO TO 60
11490C
11500C      HOURLY AND DAILY SUMMARY

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11510C
11520   TDAY(14) = TDAY(14)/TWNFOR
11530   NDAY = NDAY + 1
11540   IF (K .GT. 20) GO TO 100
11550   IF (NTABLE(K) .EQ. 0 .OR. NTABLE(K) .NE. IDAY) GO TO 100
11560   K = K + 1
11570   WRITE(9,500) NDAY,L
11580   DO 80 I = 1, 24
11590       WRITE(9,510) I,(DAY(I,J),J = 1, 8)
11600       IF (I .EQ. 24) WRITE(9,520) (TDAY(J),J = 1, 8)
11610 80   CONTINUE
11620       WRITE(9,530)
11630       DO 90 I = 1, 24
11640           WRITE(9,510) I,(DAY(I,J),J = 9, 15)
11650           IF (I .EQ. 24) WRITE(9,520) (TDAY(J), J = 9, 15)
11660 90   CONTINUE
11670 100  CONTINUE
11680       DO 110 J = 1, 15
11690           MONTH(L,J) = TDAY(J) + MONTH(L,J)
11700 110  CONTINUE
11710       GO TO 40
11720 120  CONTINUE
11730       DO 125 I=1,12
11740           MONTH(I,14) = MONTH(I,14)/FLOAT(MSIZE(I))
11750 125  CONTINUE
11760       WRITE(9,540)
11770       DO 130 I = 1, 12
11780           WRITE(9,510) I,(MONTH(I,J), J = 1, 8)
11790 130  CONTINUE
11800       WRITE(9,530)
11810       DO 140 I = 1, 12
11820           WRITE(9,510) I,(MONTH(I,J),J = 9, 15)
11830 140  CONTINUE
11840 632  CONTINUE
11850       DAYC = ZERO
11860       PDAYC = ZERO
11870       DO 150 K=1,366
11880           IF(DAYC .GT. PDAYC) PDAYC = DAYC
11890           DAYC = ZERO
11900           DO 150 J=1,24
11910               DAYC = DAYC + QC(J,K)
11920               WRITE(11) QHL(J,K),QHW(J,K),QC(J,K),QINCI(J,K),
11930                   1 BASLOD(J,K),XTEMP(J,K)
11940 150  CONTINUE
11950       WRITE(9, 50)THLOAD,TCLOAD,THOTWL,TINF,ITSR,TCOVDL,CPEAK,HPEAK
11960       WRITE(9, 60)HEATD,COOLD,SIZE1,SIZE2,FANCFM,FNCFM1,EVPGPM,
11970       1 EFFECT,WATVEL,WATTMP,CFA,PDAYC
11980       WRITE(9,570) (TCEI(I),I=1,3),(TWSI(I),I=1,7),TFLI,
11990       1 (TW(I),I=1,7),
12000       1 (TAW(I),I=1,6),TA(1),TA(3),TA(5),(TCE(I),I=1,3),

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12010      1 (TR(I),I=1,6),TIM,TX,TSL,TCR
12020      WRITE(13) FANCFM,FNCFM1,SIZE1,SIZE2,HEATD
12030      ENDFILE 11
12040      STOP
12050C
12060C      FORMAT STATEMENTS
12070C
12080 500   FORMAT(1H1,45X,' HOURLY SUMMARY FOR DAY',I4,' MONTH',14///11X,
12090      1 'QHL',11X,'QHW',12X,'QC',10X,'QINCI',9X,'CONDL',10X,'XINF',10X,
12100      1 'TSR',9X,'QINC1'//)
12110 510   FORMAT(1X,12,8(1X,E13.5))
12120 520   FORMAT(/' DAILY SUMMARY'///3X,8(1X,E13.5))
12130 530   FORMAT(//10X,'QINC2',8X,'ABSORB(1)',5X,'ABSORB(2)',
12140      1 5X,'ABSORB(3)',5X,'ABSORB(4)',8X,'XTEMP',7X,'BASLOD'//)
12150 540   FORMAT(1H1,' MONTHLY SUMMARY'///11X,'QHL',11X,'QHW',12X,'QC',10X,
12160      1 'QINCI',9X,'CONDL',10X,'XINF',10X,'TSR',9X,'QINC1'//)
12170 550   FORMAT(1H1,' YEARLY SUMMARY'///5X,'THLOAD',10X,'TCLOAD',10X,
12180      1 'THOTWL',11X,'TINF',12X,'TISR',11X,'TCONDL',10X,'CPEAK',
12190      1 11X,'HPEAK'//8(1X,E15.8))
12200 560   FORMAT(1H1,' DESIGN PARAMETERS'///1X,'HEATING DESIGN LOAD',
12210      1 23X,E15.8/1X,'COOLING DESIGN LOAD',23X,E15.8/1X,
12220      1 'CAPACITY OF HEATING PLANT',17X,E15.8/1X,
12230      1 'CAPACITY OF COOLING PLANT',17X,E15.8/1X,
12240      1 'BLOWER CFM FOR COOLING SYSTEM',13X,E15.8/1X,
12250      1 'BLOWER CFM FOR HEATING SYSTEM',13X,E15.8/1X,
12260      1 'GAL./IN. THROUGH EVAPORATOR',14X,E15.8/1X,
12270      1 'RATED EFFECTIVENESS OF HEAT EXCHANGER',5X,E15.8/1X,
12280      1 'WATER VELOCITY THROUGH HEAT EXCHANGER',5X,E15.8/1X,
12290      1 'WATER TEMPERATURE RISE',20X,E15.8/1X,
12300      1 'COIL FACE AREA',28X,E15.8/1X,'PEAK DAILY COOLING LOAD',
12310      1 19X,E15.8)
12320 570   FORMAT(1H1,' INITIAL TEMPERATURES'///1X,
12330      1 'CEILING SURFACES',10X,'TOP - ',2X,F8.2,
12340      1 5X,'NORTH - ',2X,F8.2,5X,'SOUTH - ',2X,F8.2/,
12350      1 1X,'WALL SURFACE - SOUTH KNEE',5X,F8.2/,
12360      1 1X,13X,' - NORTH KNEE',5X,F8.2/1X,
12370      1 13X,' - NORTH WALL',5X,F8.2/1X,
12380      1 13X,' - EAST WALL',5X,F8.2/1X,
12390      1 13X,' - SOUTH WALL',5X,F8.2/1X,
12400      1 13X,' - WEST WALL',5X,F8.2/1X,
12410      1 13X,' - GARAGEWALL',5X,F8.2/1X,
12420      1 'FLOOR SURFACE',17X,F8.2/1X,
12430      1 'WALL - SOUTH KNEE',13X,F8.2/1X,
12440      1 5X,' - NORTH KNEE',13X,F8.2/1X,
12450      1 5X,' - NORTH WALL',13X,F8.2/1X,
12460      1 5X,' - EAST WALL',13X,F8.2/1X,
12470      1 5X,' - SOUTH WALL',13X,F8.2/1X,
12480      1 5X,' - WEST WALL',13X,F8.2/1X,
12490      1 5X,' - GARAGEWALL',13X,F8.2/1X,
12500      1 'ATTIC WALL + TOP EAST',10X,F8.2/1X,

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12510      1 12X,'-TOP W/ST',10X,F8.2/1X,
12520      1 12X,'-S   E,ST',10X,F8.2/1X,
12530      1 12X,'-S   W/ST',10X,F8.2/1X,
12540      1 12X,'-N   E,ST',10X,F8.2/1X,
12550      1 12X,'-N   W/ST',10X,F8.2/1X,
12560      1 'ATTIC' AIR - TOP ATTIC',9X,F8.2/1X,
12570      1 8X,'- SOUTH ATTIC',9X,F8.2/1X,
12580      1 8X,'- NORTH ATTIC',9X,F8.2/1X,
12590      1 'CEILING - TOP CEILING',9X,F8.2/1X,
12600      1 8X,'- SOUTH CEILING',9X,F8.2/1X,
12610      1 8X,'- NORTH CEILING',9X,F8.2/1X,
12620      1 'ROOF    - TOP SOUTH',11X,F8.2/1X,
12630      1 6X,'- SOUTH SLANT',11X,F8.2/1X,
12640      1 6X,'- SOUTH LOWER',11X,F8.2/1X,
12650      1 6X,'- TOP NORTH',11X,F8.2/1X,
12660      1 6X,'- NORTH SLANT',11X,F8.2/1X,
12670      1 6X,'- NORTH LOWER',11X,F8.2/1X,
12680      1 'INTERNAL MISS',17X,F8.2/1X,
12690      1 'SPACE',28X,F8.2/1X,
12700      1 'SLAB',29X,F8.2/1X,
12710      1 'CRUSHED ROCK',21X,F8.2)
12720C    LAST CARD OF MAIN PROGRAM
12730C
12740      END
12750      SUBROUTINE INPUT
12760C
12770C *****
12780C
12790C      THIS SUBROUTINE READS IN THE FOLLOWING INFORMATION FROM FILE 5 AND
12800C      PRINTS IT OUT ONE FILE 9:
12810C
12820C      1. TITLE
12830C      2. THE INPUT PARAMETERS
12840C      3. THE OUTPUT TABLE FOR DAYS LISTED
12850C
12860C      THIS SUBROUTINE ALSO CONTAINS THE DATA STATEMENT, FOR
12870C      WELL WATER DATA, HOT WATER SCHEDULE, OCCUPANCY SCHEDULE,
12880C      LIGHTING SCHEDULE, AND APPLIANCE SCHEDULE
12890C      DEVELOPED BY HONEYWELL
12900C
12910C *****
12920C
12930      COMMON /BLOCK/ I HOUR, I DAY, I MONTH, I STOR, QHL(24, /66), QHW(24, 366),
12940      1      QC(24, 366), QINCI(24, 366), /LOAD, HLOAD, C/ EAK, HPEAK,
12950      1      THOTWL, THLS, THWL, TINF, THL/ AD, TCOND, T/ LOAD, TTSR, A(200),
12960      1      NTABL(20), XTEMP(24, 366), /ASLOD(24, 366)
12970      COMMON /SCHD/ TWELL(12), MHOTW( /4), PEOPLE(24), XLIGHT(24)
12980      1, APPL(24)
12990      DATA TWELL /15., 42., 40., 39., 41., 45., 51., 55., 57., 57., 55., 50./
13000      REAL MHOTW

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13010 DATA MHOTW /,4475,0.,0.,0.,0.,1.,.3.,.9275,1.4475,1.68,1.38,.9,
13020 1 .72,1.02,.54,.48,.42,.75,1.352,2.32,1.12,1.38,1.09,.9275/
13030 DATA PEOPLE (1.,1.,1.,1.,1.,1.,1.,.75,.5,.5,.5,.5,
13040 1 .5,.5,.75,.75,1.,.4.,1.,1.,1.,1.,1./
13050 DATA XLIGHT (0.,0.,0.,0.,0.,0.,.5,.5,.5,.5,.2,.2,.5,.5,.5,
13060 1 .8,.8,.8,.8,.8,.2,.2,.2/
13070 DATA APPL /0.,0.,0.,0.,0.,0.,.7,.7,.4,.4,.4,.6,.4,.4,.4,
13080 1 .5,.75,.9,.9,.75,.75,.25,.25,0./
13090 DIMENSION LABEL(10),MARGIN(11)
13100 CHARACTER LABEL*6, MARGIN*6
13110 MAXA = 0
13120 READ(5,500) MARGIN
13130 WRITE(9,1000) MARGIN
13140 100 READ(5,2000) N, DUM, LABEL
13150 IF(N .LE. 0) GO TO 200
13160 IF(N .GT. MAXA) MAXA = N
13170 A(N) = DUM
13180 WRITE(9,3000) N, A(N), LAB/L
13190 GO TO 100
13200 200 READ(5,4000) (NTABLE(I),I = 1, 20)
13210 WRITE(9,911)
13220 911 FORMAT(//////)
13230 WRITE(9,913) TWELL,MHOTW,PEOPLE,XLIGHT,APPL
13240 913 FORMAT(2X,22WELL WATER TEMPERATURE,2X,12F8.3/
13250 12X,22H HO WATER SCHE/ULE,2X,12F8.3/26X,12F8.3/
13260 12X,22H OCCUPANCY SCHE/ULE,2X,12F8.3/26X,12F8.3/
13270 12X,22H LIGHTING SCHEDULE,2X,12F8.3/26X,12F8.3/
13280 12X,22H APPLIANCE SCHEDULE,2X,12F8.3/26X,12F8.3)
13290 WRITE(9,914) NTABLE
13300 914 FORMAT(//2X,22H OUTPUT TABLE SCHE/ULE,2X,1I8/26X,12I8)
13310 RETURN
13320 500 FORMAT(13A6)
13330 1000 FORMAT(1H1,17H INPUT PARAMETERS,/,13A6//)
13340 2000 FORMAT(15,F15.5,10A6)
13350 3000 FORMAT(3H A(,13,1H),G15.5,3X,10A6)
13360 4000 FORMAT(20I4)
13370C
13380C LAST CARD OF SUBROUTINE INPUT
13390C
13400C END
13410C SUBROUTINE TIME
13420C
13430C*****
13440C
13450C THIS SUBROUTINE COMPUTES THE SOLAR RADIATION COMPONENTS, DIRECT
13460C NORMAL RADIATION, DIRECT RADIATION ON A HORIZONTAL SURFACE,
13470C TOTAL RADIATION ON A HORIZONTAL SURFACE AND CALLS SUBROUTINE
13480C HOUSE WHICH DETERMINES THE LOADS.
13490C
13500C THE SUBROUTINE STATEMENT IS

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13510C
13520C      SUBROUTINE TIME
13530C
13540C      DEVELOPED BY HONEYWELL
13550C
13560C *****
13570C
13580      COMMON /SLOAD/QTRAN(5),ABSQR8(5)
13590      COMMON /SOLAR/S(35)
13600      COMMON /DIR/DIRH,DIRN,TOTH
13610      COMMON /WEATHER/DB(24),DP(4),WB(4),WS(24),PB(24),TC(24),
13620      1      TOC(24),WET(24),DY(24),IYEAR,IDUM1,IDUM2,ICITY
13630      COMMON /BLOCK/IDHOUR,IDAY,IMONTH,ISTOR,QHL(24,366),QHW(24,366),
13640      1      QC(24,366),QINCI(24,366),FLOAD,HLOAD,CPEAK,
13650      1      HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCOND,TCLOAD,TTSH
13660      1      ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
13670      COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
13680      DATA TWINH/23./,UNE/1./,TWO/2./,P011/.011/,P00792/.00792/,
13690      10PEM6/1.E-06/,P09/.09/,ZERO/0./,TWNFOR/24./
13700      REAL MHOTW
13710      MODE0 = ZERO
13720      MODE1 = ONE
13730C
13740      IF(S(5) .LE. TWNFOR) GO TO 10
13750      S(4) = S(4) + ONE
13760      S(5)=S(5)-24.
13770      READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,
13780      1      ICITY
13790      IMONTH = IDUM1
13800      CALL SUN(MODE0)
13810 10      IDHOUR = IFIX(S(5))
13820      IDAY = IFIX(S(4))
13830C
13840C      COMPUTE SOLAR RADIATION COMPONENTS (CLOUD MODIFIED)
13850C
13860      CCOVER = TC(IDHOUR)
13870      NYTYPE = IFIX(TOC(IDHOUR))
13880      IF(NYTYPE .LT. 1) CCOVER = CCOVER/TWO
13890      CCF = ONE - P011 * CCOVER - P00792 * CCOVER ** 2
13900      CALL SUN(MODE1)
13910C
13920C      IF PRECIPITATION IS PRESENT THEN NO DIRECT OR DIFFUSE RADIATION
13930C
13940      IF (WET(IDHOUR) .LT. OPE16 .AND. DRY(IDHOUR) .LT. OPEM6) GO TO 20
13950      S(23) = ZERO
13960      S(24) = ZERO
13970 20      CONTINUE
13980C
13990C      DIRECT NORMAL RADIATION (CLOUD MODIFIED)
14000C

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14010      DIRN = (ONE - P09 * CCOVER) * S(24)
14020C
14030C      DIRECT RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
14040C
14050      DIRH = DIRN * S(13)
14060C
14070C      TOTAL RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
14080C
14090      TOTR = CCF * S(23)
14100C
14110C      DETERMINE LOADS BY CALLING SUBROUTINE HOUSE
14120C
14130      CALL HOUSE
14140      RETURN
14150C
14160C      LAST CARD OF SUBROUTINE TIME
14170C
14180      END
14190      SUBROUTINE TSTAT(TI,Q,TZONEW,TZONES)
14200C
14210C*****
14220C      THIS SUBROUTINE WILL APPROXIMATE THE CONTROL OF THE
14230C      HONEYWELL CHRO/OTHERM 1 . IT HAS A STEADY STATE DROOP
14240C      OF THREE DEGREES IN BOTH THE HEATING AND COOLING MODES.
14250C      THE THERMISTAT DEADBAND IS DETERMINED BY THE WINTER AND
14260C      SUMMER SET POINTS.
14270C
14280C      DEVELOPED BY HONEYWELL
14290C
14300C*****
14310      COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,EFFECT,
14320      1      WATVEL,WATTMP,CFA,FNCFM1
14330      DATA TR/3./,TRC/1./,ONE/1./,ZERO/0./
14340C
14350      HEAT = (TZONEW - TX)/TRH
14360      IF(HEAT .GT. ONE) HEAT = ONE
14370      IF(HEAT .LT. ZERO) HEAT = ZERO
14380C
14390      COOL = (TX - TZONES)/TRC
14400      IF(COOL .GT. ONE) COOL = ONE
14410      IF(COOL .LT. ZERO) COOL = ZERO
14420C
14430      Q = HEAT * SIZE1 - COOL * SIZE2
14440C
14450      RETURN
14460C
14470C      LAST CARD OF SUBROUTINE TSTAT
14480C
14490      END
14500      SUBROUTINE SPILARG(ANG1,ANG2,QAVAIL)

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14510C
14520C*****
14530C
14540C      THIS SUBROUTINE CALCULATES THE SOLAR LOAD OF A RESIDENTIAL
14550C      BUILDING.
14560C
14570C      THE SUBROUTINE STATEMENT IS
14580C
14590C      SUBROUTINE SOLARQ(ANG1,ANG2,QAVAIL)
14600C
14610C      WHERE
14620C
14630C          ANG1      = THE ANGLE THE SURFACE MAKES WITH RESPECT TO
14640C                     HORIZONTAL
14650C          ANG2      = THE ANGLE THE SURFACE MAKES WITH RESPECT TO THE
14660C                     LOCAL AZMITH (DUE SOUTH IS 0, EAST + WEST = )
14670C          QAVAIL    = ENERGY INCIDENT ON SURFACE (BTU/SQ.FT.)
14680C
14690C      DEVELOPED BY HONEYWELL
14700C
14710C      PROJECT: ACES
14720C
14730C      CREATION DATE: 06/21/78
14740C
14750C*****
14760      COMMON /BLOCK/IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
14770      1      QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
14780      1      HPEAK,THOTWL,THL3,THWL,TINF,THLOAD,TCOND,TCLOAD,TTSR
14790      1      ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
14800      COMMON /DIR/DIRH,DIRN,TOTM
14810      COMMON /SOLAR/S(35)
14820      DATA POINT/.017453/,ZERO/0./,ONE/1./,TWO/2./
14830C
14840C      CALCULATE SURFACE ANGLES
14850C
14860      TILT = ANG1 * POINT
14870      CTILT = COS(TILT)
14880      STILT = SIN(TILT)
14890      FTILT = (ONE - CTILT)/TWO
14900      AZIM = ANG2 * POINT
14910      CAZIM = COS(AZIM)
14920      SAZIM = SIN(AZIM)
14930      RHO = A(9)
14940C
14950C      COMPUTE ANGLE OF INCIDENCE WHERE
14960C          S(13) = THE DIRECTION COSINE WITH RESPECT TO THE SURFACE NORMAL
14970C          S(14) = THE DIRECTION COSINE WITH RESPECT TO LOCAL EAST
14980C          S(15) = THE DIRECTION COSINE WITH RESPECT TO LOCAL NORTH
14990C
15000      CTHETA = CTILT * S(13) + STILT * SAZIM * S(14) - STILT * CAZIM *

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15010      1      S(15)
15020      IF (CTHETA .LT. ZERO) CTHETA = ZERO
15030C
15040C      COMPUTE DIRECT AND DIFFUSE SOLAR RADIATION IMPINGING ON AN
15050C      OBLIQUE SURFACE
15060C
15070      QDIR = DIRN * CTHETA
15080      QDIF = (TOTH - DIRH) * (ONE - FTILT) + RHO * TOTH * FTILT
15090      QAVAIL = QDIR + QDIF
15100      RETURN
15110      END
15120C
15130      SUBROUTINE SUN(MODE)
15140C
15150C*****
15160C
15170C      THIS SUBROUTINE COMPUTES DECLINATION, EQUATION OF TIME, APPARENT
15180C      SOLAR CONSTANT, ATMOSPHERIC EXTINCTION COEFFICIENT, SKY DIFFUSE
15190C      FACTOR, SUN RISE AND SUNSET TIMES ONCE EACH DAY, AND
15200C      THE SUN PARAMETERS.
15210C
15220C      THE SUBROUTINE STATEMENT IS
15230C
15240C      SUBROUTINE SUN(MODE)
15250C
15260C      WHERE
15270C
15280C      MODE IS SET TO 0 AT THE FIRST CALL OF EACH DAY
15290C
15300C      S(1)= LATITUDE, DEGREES(+NORTH, -SOUTH)
15310C      S(2)= LONGITUDE, DEGREES(+WEST, -EAST)
15320C      S(3)= TIME ZONE NUMBER
15330C           STANDARD TIME      DAYLIGHT SAVING TIME
15340C      ATLANTIC      4              3
15350C      EASTERN       5              4
15360C      CENTRAL       6              5
15370C      MOUNTAIN      7              6
15380C      PACIFIC       8              7
15390C      S(4)= DAYS(FROM START OF YEAR)
15400C      S(5)= TIME, HOUR AFTER MIDNIGHT)
15410C      S(6)= DAYLIGHT SAVING TIME INDICATOR
15420C      S(8)= CLEARNESS NUMBER
15430C      S(11)=SUN RISE TIME (HOURS AFTER MIDNIGHT)
15440C      S(12)=SUN SET TIME
15450C      S(13)=COSZ      DIRECTION COSINES
15460C      S(14)=COSN      DIRECTION COSINES
15470C      S(15)=COS(S)    DIRECTION COSINES)
15480C      S(16)=ALPHA     DIRECTION COSINES NORMAL TO SURFACE
15490C      S(20)=SOLAR ALTITUDE ANGLE, RADIAN
15500C      S(21)=SOLAR AZIMUTH ANGLE, RADIAN

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15510C S(22)=DIFFUSE SKY RADIATION ON HORIZONTAL SURFACE
15520C S(23)=TOTAL HORIZONTAL RADIATION ITH
15530C S(24)=DIRECT NORMAL RADIATION
15540C S(28)=SUN DECLINATION ANGLE DELTA, RADIANS
15550C S(29)=EQUATION OF TIME ,HOURS
15560C S(30) = SOLAR FACTOR A
15570C S(31) = SOLAR FACTOR B
15580C S(32) = SOLAR FACTOR C
15590C S(35)=SOLAR HOUR ANGLE OMEGA, RADIANS
15600C DEVELOPED BY HONEYWELL
15610C *****
15620C
15630 COMMON /SOLAR/ S(35)
15640 DIMENSION A0(5),A1(5),A2(5),A3(5),B1(5),B2(5),B3(5)
15650 DATA A0/.302,-.0002,368.44,.1717,.0905/
15660 DATA A1/-22.93,.4197,24.52,-.0344,-.0410/
15670 DATA A2/-229,-3.2265,-1.14,.0032,.0073/
15680 DATA A3/-.243,-.0403,-.109,.0024,.0015/
15690 DATA B1/3.851,-7.351,.58,-.0043,-.0034/
15700 DATA B2/.002,-9.3912,-.18,0,.0004/
15710 DATA B3/-.055,-.3361,.28,.0008,-.0006/
15720 DATA TWO/2./,THR66/366./,THREE/3./,ONE80/180./,SIXTY/60./
15730 1 ,FIFTIN/15./,TWELVE/12./,ONE/1./,ZERO/0./,OPEM6/1.E-6/
15740 DATA RPH/0.261799383/
15750 REAL LAT,LATD,LONG,MERID,LOND
15760C
15770 PI = 3.14159265
15780 TWOPI = 6.28318531
15790 IF(MODE .NE. 0) GO TO 20
15800 X= TWO *PI/THR66*S(4)
15810 C1=COS(X)
15820 C2=COS(TWO*X)
15830 C3=COS(THRE*X)
15840 S1=SIN(X)
15850 S2=SIN(TWO*X)
15860 S3=SIN(THRE*X)
15870 DO 10 K=1,5
15880 KS=(K-1)+28
15890 S(KS)=A0(K)*A1(K)*C1+A2(K)*C2+A3(K)*C3+B1(K)*S1+B2(K)*S2
15900 1 + B3(K)*S3
15910 10 CONTINUE
15920 S(28) = S(28)*PI/ONE80
15930 S(29)=S(29)/SIXTY
15940 LATD=S(1)
15950 LONG=S(2)
15960 MERID=FIFTIN*S(3)
15970 LOND=LONG-MERID
15980 Y = S(28)
15990 YY=LATD*PI/ONE80
16000 HP=-SIN(Y)/COS(Y)*SIN(YY)/COS(YY)

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16010      TR=TWELVE/PI*ARCOS(HP)
16020      S(11)=(TWELVE-TR)-S(29)+LONO/FIFTIN
16030      S(12) = S(11) + TWO*TR
16040C
16050C      COMPUTE DAILY CONSTANTS
16060C
16070      TYY=SIN(YY)/COS(YY)
16080      TY=SIN(Y)/COS(Y)
16090      CY=COS(Y)
16100      SY=SIN(Y)
16110      CYY=COS(YY)
16120      SYY=SIN(YY)
16130      ACHP=ARCOS(HP)
16140      HP1 = ARCOS(HP)
16150      X1=ABS(HP1)
16160      GO TO 40
16170C
16180C      COMPUTE THE FOLLOWING SUN PARAMETERS ON EACH DT CALL
16190C
16200 20 CONTINUE
16210C
16220C      COMPUTE SOLAR HOUR ANGLE
16230C
16240      H = -RPH*(S(5)-TWELVE+S(3)+S(29)-S(6)) + S(2)*PI/ONE80
16250      S(35) = H
16260C
16270C      IS THE SUN UP
16280C
16290      X2=ABS(H)
16300      IF (X1 .LT. X2) GO TO 40
16310C
16320C      COMPUTE SOLAR DIRECTION COSINES
16330C
16340      S(13)=SYY*SY+CYY*CY*COS(H)
16350      S(14) = CY*SIN(H)
16360      S(15)=-SYY*CY*COS(H)+CYY*SY
16370C
16380C      COMPUTE SOLAR ALTITUDE AND AZIMUTH
16390C
16400 30 CONTINUE
16410      S(20)=ARSIN(S(13))
16420      S(21)=(PI-ARCOS(S(15)/COS(S(20))))*SIGN(ONE,H)
16430C
16440C      COMPUTE RADIATION INTENSITY
16450C
16460      CALL FXOPT(89,1,1,0)
16470      S(24)=S(30)*S(8)*EXP(-S(31)/S(13))
16480      IF(S(24) .LT. OPEM6) S(24) = ZERO
16490      CALL FXOPT(89,1,0,0)
16500      S(22)=S(32)*S(24)

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16510      S(23) = (S(32) + S(13))*S(24)
16520      RETURN
16530 40    CONTINUE
16540      S(24) = ZERO
16550      S(22) = ZERO
16560      S(23) = ZERO
16570      RETURN
16580C
16590C      LAST CARD OF SUBROUTINE SUN
16600C
16610      END
16620C
16630      SUBROUTINE COIL(TODB,TODP,TWI,QL,QS,CFMINF,FANCFM,TX,TF
16640      1,CLOAD,EFFECT)
16650C
16660C*****
16670C      THIS SUBROUTINE IS USED TO DETERMINE THE EXISTING LOAD ON A
16680C      COOLING COIL FOR A SPECIFIED SET OF CONDITIONS. THE TOTAL
16690C      LOAD IS A FUNCTION OF THE EXIT CONDITIONS OF THE COIL AND
16700C      THEREFORE IS NOT KNOWN EXPLICITLY. THIS ROUTINE WILL DETER-
16710C      MINE THE LOAD IN THE SPACE, THE SPACE HUMIDITY RATIO, AND
16720C      THE AMOUNT OF TIME THE COIL IS IN OPERATION EACH HOUR.
16730C      THE FOLLOWING IS A LIST OF INDEPENDENT VARIABLES:
16740C
16750C      TODB      = OUTDOOR AIR DRYBULB TEMP.          DEG. F
16760C      TODP      = OUTDOOR AIR DEWPOINT              DEG. F
16770C      TWI       = INLET WATER TEMP. TO COOLING COIL  DEG. F
16780C      QL        = LATENT LOAD IN THE SPACE            BTU/HR
16790C      QS        = SENSIBLE LOAD IN THE SPACE          BTU/HR
16800C      CFMINF    = INFILTRATION CFM                   CFM
16810C      FANCFM    = COOLING COIL FAN CFM               CFM
16820C      TX        = INDOOR AIR DRYBULB TEMP.           DEG. F
16830C      TF        = TIME FRACTION THE COOLING COIL IS ON
16840C      CLOAD     = TOTAL COOLING LOAD FOR THE HOUR     BTU
16850C      WO        = OUTDOOR HUMIDITY RATIO              LBMH2O/LBMAIR
16860C      WI        = INDOOR HUMIDITY RATIO              LBMH2O/LBMAIR
16870C      DEVELOPED BY HONEYWELL
16880C
16890C*****
16900C
16910      DATA FP46/4.46/,UNET96/1096./,UNET61/1061./,P24/.24/,P45/.45/,
16920      1      ZERO/0./,P01/.01/,FIFTIN/15./,UNE/1./,P0001/.0001/,P1/.1/
16930C
16940C      ASSUMING NO DEHUMIDIFICATION, THE OUTDOOR AND INDOOR
16950C      HUMIDITY RATIOS ARE:
16960C
16970      TEMP0 = FP46 * CFMINF
16980      TEMP1 = FP46 * FANCFM
16990      TEMP2 = WO * (P45 * TODB + UNET61)
17000      WO= OMEGA(TODP)

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17010      WI= WO + QL/(TEMP0*ONET96)
17020C
17030C      ASSUMING A CONSTANT COIL EFFECTIVENESS THE MAXIMUM CAPACITY IS:
17040C
17050      WE= OMEGA(TWI)
17060      QMAX= EFFECT*(TEMP1*(((P24+P45*WI)*TX+ONET61*WI)
17070      1      -((P24+P45*WE)*TWI+ONET61*WE)))
17080C
17090C      THE INLET ENTHALPY, ENTHALPY DROP ACROSS THE COIL, AND THE
17100C      EXIT ENTHALPY ARE:
17110C
17120      HI= P24*TX + WI*(P45*TX + ONET61)
17130      DH= QMAX/TEMP1
17140      HO= HI - DH
17150C
17160C      CHECK TO SEE IF THE ASSUMPTION ON DEHUMIDIFICATION WAS CORRECT
17170C      IF IT WAS, DETERMINE THE LOAD AND RETURN, IF NOT GO TO TEN
17180C
17190      TE= OMGAIN(WI)
17200      HOTRY= P24*TE + WI*(P45*TE + ONET61)
17210      IF((HOTRY-HO) .GT. P1) GO TO 10
17220      QCOOL= QS + QL + TEMP0 * (TEMP2
17230      1      - WI*(P45*TX + ONET61))
17240      IF(QCOOL .LT. ZERO) QCOOL= ZERO
17250      TFE= QCOOL/QMAX
17260      CLOAD= QCOOL
17270 40      CONTINUE
17280      RETURN
17290C
17300C      USE TE FROM PREVIOUS SOLUTION ATTEMPT AS A FIRST GUESS
17310C      FOR THE EXITING AIR TEMP.
17320C
17330 10      CONTINUE
17340      SUM= ZERO
17350 20      CONTINUE
17360      CALL FUNC(CFMINF,FANCFM,WO,WIP,QL,TE,TWI,TX,HO,HOTRY
17370      1,EFFECT,QMAX)
17380C
17390C      USE NEWTONS METHOD TO SOLVE FOR TE AND WE
17400C
17410      SUM=SUM+ONE
17420      FX= HO - HOTRY
17430      DEL=P0001*TE
17440      TEP= TE + DEL
17450      CALL FUNC(CFMINF,FANCFM,WO,WIP,QL,TEP,TWI,TX,HO,HOTRY
17460      1,EFFECT,QMAX)
17470      FXD= HO - HOTRY
17480      FXP= (FXD -FX)/DEL
17490      TEN= TE + FX/FXP
17500      TE=TEN

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17510      IF(ABS(FX) .GT. P01 .AND. SUM .LT. FIFTIN) GO TO 20
17520      IF(SUM .LT. FIFTIN) GO TO 30
17530      WRITE(9,121)
17540 121  FORMAT(/,'SUBROUTINE COIL HAS NOT CONVERGED',/)
17550      MODEC = 0
17560      GO TO 40
17570 30  CONTINUE
17580C
17590C      DETERMINE THE TIME FRACTION KNOWING THAT THE LATENT
17600C      INFILTRATION FOR THE COIL ON AND OFF PERIOD IS:
17610C
17620      XINFP= TEMPO * (TEMP2-WIP*(ONET61+P45*TX))
17630      XINF=TEMPO * (TEMP2-WI*(ONET61+P45*TX))
17640C
17650C      ON TIME
17660C
17670      TF= (QS + QL + XINF)/(QMAX - XINFP + XINF)
17680      IF(TF .LT. ZERO)TF= ZERO
17690      IF(TF .GT. ONE)TF= ONE
17700      QCOOL= TF*QMAX
17710      CLOAD= QCOOL
17720      RETURN
17730C
17740C      LAST CARD OF SUBROUTINE COIL
17750C
17760      END
17770      SUBROUTINE FUNC(CFMINF,FANCFM,WO,WIP,QL,TE,TWI,IX,H0,HOTRY
17780      1,EFFECT,QMAX)
17790C
17800C*****
17810C
17820C      SUBROUTINE FUNC IS USED TO EVALUATE
17830C      COOLING COIL EXIT CONDITIONS
17840C
17850C      DEVELOPED BY HONEYWELL
17860C
17870C*****
17880C
17890      DATA FP46/4.46/,P24/.24/,P45/.45/,ONET61/1061./,ONET96/1096./
17900C      DETERMINE APPROPRIATE HUMIDITY RATIOS FROM TWI AND TE
17910C
17920      TEMPO = FP46 * CFMINF
17930      TEMP1 = FP46 * FANCFM
17940      WX= OMEGA(TWI)
17950      WE= OMEGA(TE)
17960      WI= (TEMPO*WO + QL/ONET96 + TEMP1*WE)/
17970      1  (TEMPO + TEMP1)
17980C
17990C      DETERMINE QMAX, DH, HI, HO, WIP, AND HOTRY
18000C

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18010      QMAX= EFFECT*((TEMP1*(((P24+P45*WI)*TX+ONET61*NI)-((P24
18020      1      +P45*WX)*TWI+ONET61*WX)))
18030      DH= QMAX/TEMP1
18040      HI= P24*TX + WI*(P45*TX + ONET61)
18050      HO= HI - DH
18060      WIP= WI
18070      MOTRY= P24*TE + WE*(P45*TE + ONET61)
18080      RETURN
18090C
18100C      LAST CARD OF SUBROUTINE FUNC
18110C
18120      END
18130      FUNCTION UMEGA(T)
18140C
18150C*****
18160C
18170C      THIS ROUTINE GIVES THE HUMIDITY RATIO AT THE
18180C      SATURATION TEMPERATURE, T
18190C
18200C      DEVELOPED BY HONEYWELL
18210C
18220C*****
18230C
18240      DIMENSION X(4)
18250      DATA X/=-10.3678,15.7772,1.02294,.0235739/,THRTWO/32./
18260C      THIS ROUTINE GIVES THE HUMIDITY RATIO AT THE SATURATION
18270C      TEMPERATURE T
18280      IF(T .LT. THRTWO) T = THRTWO
18290      OMEGA = EXP(X(1) + (X(2)/T) +(X(3) * ALOG(T)) + (X(4) * T))
18300      RETURN
18310C
18320C      LAST CARD OF FUNCTION OMEGA
18330C
18340      END
18350      FUNCTION UMGAIN(W)
18360C
18370C*****
18380C      THIS ROUTINE GIVES THE SATURATION TEMPERATURE FOR THE
18390C      SPECIFIED HUMIDITY RATIO W
18400C      DEVELOPED BY HONEYWELL
18410C
18420C*****
18430      DIMENSION X(6)
18440      DATA SEVENT/7000./,X/-12.11464,2.59384,.0455714,4.60033E-4,
18450      1      2.27777E-6,4.31080E-9/
18460C
18470C      THIS ROUTINE GIVES THE SATURATION TEMP. FOR THE SPECIFIED
18480C      HUMIDITY RATIO W
18490C
18500      WGRAIN = SEVENT * W

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18510      OMGAIN = X(1) + X(2) * WGRAIN - X(3) * WGRAIN * WGRAIN + X(4)
18520      1      * WGRAIN ** 3 - X(5) * WGRAIN ** 4 + X(6) * WGRAIN ** 5
18530      RETURN
18540C
18550C      LAST CARD OF FUNCTION OMGAIN
18560C
18570      END
18580      SUBROUTINE WINDOW
18590C
18600C*****
18610C
18620C      THIS SUBROUTINE CALCULATES THE SOLAR RADIATION TRANSMITTED
18630C      PER SQ FT OF GLASS DUE TO CLEAR SKY DIRECT RADIATION
18640C
18650C      THE SUBROUTINE STATEMENT IS
18660C
18670C      SUBROUTINE WINDOW
18680C
18690C      THE EXTERIOR WALLS AND WINDOWS ARE ASSUMED TO BE VERTICAL
18700C      SURFACES. CALCULATIONS ARE MADE FOR EACH OF THE FOUR VERTICAL
18710C      EXPOSURES ALLOWING FOR + OR -45 DEGREES ROTATION FROM TRUE NESW.
18720C      THE DIRECT NORMAL RADIATION IS CALCULATED FROM SUBROUTINE
18730C      SUN FOR EACH HOUR. DIRECTION COSINES OF THE SUN'S RAYS WITH
18740C      RESPECT TO LOCAL VERTICAL, LOCAL WEST AND LOCAL SOUTH ARE
18750C      ALSO CALCULATED IN SUBROUTINE SUN. DIRECTION COSINES OF
18760C      THE NORMAL TO EACH OF THE FOUR WALLS WITH RESPECT TO LOCAL
18770C      VERTICAL, LOCAL WEST AND LOCAL SOUTH ARE CALCULATED. THE
18780C      COSINE OF THE ANGLE OF INCIDENCE IS CALCULATED FOR EACH OF
18790C      THE WALLS FROM THE DIRECTION COSINES OF THE NORMALS TO THE
18800C      WALL AND THE SUN'S RAYS. THE SOLAR RADIATION INCIDENT ON
18810C      EXTERIOR WALLS AND TRANSMITTED THROUGH THE WINDOWS IS THEN
18820C      CALCULATED AS A FUNCTION OF THE ANGLE OF INCIDENCE FOR EACH
18830C      OF THE FOUR EXPOSURES. THE MEAN ANGLE OF INCIDENCE FOR DIFFUSE
18840C      SOLAR RADIATION IS ASSUMED TO BE 60 DEGREES. THE WINDOWS ARE
18850C      ASSUMED TO BE DOUBLE GLAZED. INTERNAL AND EXTERNAL SHADING
18860C      EFFECTS ARE NOT CONSIDERED.
18870C
18880C      EXPLANATION OF VARIABLES:
18890C
18900C      ROANG IS THE BUILDING ROTATION ANGLE (-45 DEG < ROANG < +45 DEG)
18910C
18920C      RHOS IS THE REFLECTANCE OF THE GROUND IN FRONT OF THE WINDOW
18930C
18940C      XN IS THE INDEX OF REFRACTION OF GLASS IN AIR
18950C
18960C      XK IS THE PRODUCT OF THE EXTINCTION COEFFICIENT AND THE
18970C      THICKNESS FOR EACH PANE OF GLASS (DIMENSIONLESS)
18980C
18990C      TDR IS THE WINDOW TRANSMITTANCE FOR DIRECT SOLAR RADIATION
19000C      (FUNCTION OF THE INCIDENCE ANGLE)

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19010C
19020C   TOF IS THE WINDOW TRANSMITTANCE FOR DIFFUSE SOLAR RADIATION
19030C   (SKY RADIATION AND DIFFUSELY REFLECTED RADIATION FROM
19040C   THE GROUND)
19050C
19060C   QTRAN(I) IS THE SOLAR RADIATION TRANSMITTED THROUGH GLASS (BTUH/SQ FT)
19070C
19080C   ABSORB(I) IS THE SOLAR RADIATION INCIDENT ON EACH EXTERIOR
19090C   WALL (BTUH/SQ FT)
19100C
19110C   WHERE
19120C
19130C       I = 1 FOR NORTH EXPOSURE
19140C       = 2 FOR EAST EXPOSURE
19150C       = 3 FOR SOUTH EXPOSURE
19160C       = 4 FOR WEST EXPOSURE
19170C   DEVELOPED BY HONEYWELL
19180C
19190C
19200C *****
19210C
19220   COMMON /BLOCK/IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
19230   1   QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
19240   1   HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
19250   1   ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
19260   COMMON /SOLAR/S(35)
19270   COMMON /SLDAD/QTRAN(5),ABSORB(5)
19280   COMMON /DIR/DIRH,DIRN,TOTH
19290   DATA TWO/2./,ONE/1./,P011/.011/,P00792/.00792/,ZERO/0./,THREE/3./
19300   1   ,P09/.09/,FSP3/57.3/
19310   DATA PI/3.1416/,XK/0.05/,XN/1.526/,TDF/0.672/,P5/.5/,P999/.999/
19320C
19330C   INITIALIZATION
19340C
19350   DO 10 I = 1, 5
19360       QTRAN(I) = ZERO
19370       ABSORB(I) = ZERO
19380 10   CONTINUE
19390   RHOS = A(9)
19400   BOANG = A(135)
19410C
19420C   DIRECT NORMAL RADIATION DUE TO CLOUDY SKY
19430C
19440   SDNC=DIRN
19450C
19460C   DIRECT RADIATION ON HORIZONTAL SURFACE DUE TO CLOUDY SKY
19470C
19480   SDRHC=DIHH
19490C
19500C   TOTAL RADIATION ON HORIZONTAL SURFACE DUE TO CLOUDY SKY

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19510C
19520      STHC=TOTH
19530C
19540C      DIRECTION COSINES OF SUN'S RAYS WITH RESPECT TO LOCAL COORINATES
19550C
19560      COSW = S(14)
19570      COSS = S(15)
19580      OO 500 IWALL = 1, 4
19590C
19600C      CALCULATE WALL AZIMUTH WITH RESPECT TO SOUTH.
19610C
19620          WA= (THREE = FLOAT(IWALL)) * PI/TWO + BOANG/FSP3
19630C
19640C      DIRECTION COSINE OF NORMAL TO VERTICAL WALL WITH RESPECT TO
19650C      LOCAL WEST HORIZONTAL.
19660C
19670          BETA = SIN(WA)
19680C
19690C      DIRECTION COSINE OF NORMAL TO VERTICAL WALL WITH RESPECT TO
19700C      LOCAL SOUTH HORIZONTAL
19710C
19720          GAMMA = COS(WA)
19730C
19740C      CALCULATE THE COSINE OF ANGLE OF INCIDENCE
19750C
19760          COSAOI = COSW * BETA - COSS * GAMMA
19770          IF (COSAOI .LT. ZERO) COSAOI = ZERO
19780          IF (COSAOI .GT. ONE) WRITE(6,1000) COSAOI
19790C
19800C      CALCULATE INCIDENT RADIATION
19810C
19820          QSINC = COSAOI * SDNC
19830          QDIFS = (STHC - SDRHC) * P5 + RHOS * STHC * P5
19840          QINCIS = QSINC + QDIFS
19850C
19860C      DETERMINE THE TRANSMISSION COEFFICIENT
19870C
19880          IF (COSAOI .LE. ZERO) TR = ZERO
19890          IF (COSAOI .LE. ZERO) GO TO 400
19900C
19910C      CALCULATE THE ANGLE OF INCIDENCE AND THE ANGLE OF REFLECTION
19920C
19930          AOI = ACOS(COSAOI)
19940          AOR = ASIN(SIN(AOI)/XN)
19950C
19960C      CALCULATE INTERMEDIATE STEPS FOR THE TRANSMISSION COEFFICIENT
19970C      AS A FUNCTION OF THE ANGLE OF INCIDENCE
19980C
19990          IF (COSAOI .GT. P999) GO TO 300
20000          R1 = (SIN(AOI - AOR)/SIN(AOI + AOR)) ** 2

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20010      RX = (TAN(AOI - AOR)/TAN(AOI + AOR))
20020      R2 = RX * RX
20030      TR = P5 * (((ONE - R1)/(THREE * R1 + ONE)) + ((ONE - R2)/
20040      1      (THREE * R2 + ONE)))
20050      GO TO 400
20060 300    CONTINUE
20070      R = ((XN - ONE)/(XN + ONE)) ** 2
20080      TR = (ONE - R)/(THREE * R + ONE)
20090 400    CONTINUE
20100C
20110C      CALCULATE THE TRANSMISSION COEFFICIENT FOR DIRECT RADIATION
20120C
20130      TDR = TR * EXP(-TWO * XK/COS(AOR))
20140C
20150C      CALCULATE THE TRANSMITTED RADIATION
20160C
20170      QTRAN(IWALL) = QSINC * TDR + QDIFS * TDR
20180C
20190C      CALCULATE THE INCIDENT RADIATION ON THE WALL SURFACE
20200C
20210      ABSORB(IWALL) = QINCIS
20220C
20230 500    CONTINUE
20240      RETURN
20250 1000   FORMAT(/,1X,'COSSAOI = ',F12.8)
20260C
20270C      LAST CARD OF SUBROUTINE WINDOW
20280C
20290      END
20300C
20310      SUBROUTINE WAHP(TWI,TAI,QCOND,QEVAP,HP,COP)
20320C
20330C*****
20340C      THIS ROUTINE PREDICTS THE PERFORMANCE OF A WATER TO
20350C      AIR HEAT PUMP AS A FUNCTION OF THE EVAPORATOR AND
20360C      CONDENSER INLET TEMPERATURES.
20370C
20380C      DEVELOPED BY HONEYWELL
20390C
20400C*****
20410C
20420      COMMON /HTPP/FF
20430      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
20440      1      P00155/.00155/,P7336/.7336/,T9P23/29.23/,EIGHTY/80./,
20450      1      F569/4569./,T523/2523./,SIX2P5/62.5/,TWPS/12.5/,PI/3.141/,
20460      1      T545/2545./,P00159/.00159/,P6875/.6875/
20470C
20480      EET = TWI
20490      ECT = TAI
20500      BTU = ONET23 * (EET - THRTWO) + SIXFT - THUND * ECT

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20510      Y = 19P23 * (ECT - EIGHTY) + F569
20520      XM = (Y - T523)/SIX2P5
20530      WATTS = XM * (EET - TWP5) + T523
20540      COP = BTU/(WATTS * PI) + FF
20550      QCOND = BTU
20560      BTUM = QCOND/COP
20570      QEVAP = QCOND - BTUM
20580      QCOND = QCOND * (P00155 * EET + P7336)
20590      QEVAP = QEVAP * (P00159 * EET + P6875)
20600      QMOT = QCOND - QEVAP
20610      COP = QCOND/QMOT
20620      HP = QMOT/T545
20630      RETURN
20640C
20650C      LAST CARD OF SUBROUTINE WAMP
20660C
20670      END
20680      SUBROUTINE HOUSE
20690C
20700C*****
20710C
20720C      THIS SUBROUTINE CALCULATES THE HEATING AND COOLING LOAD
20730C      FOR A RESIDENTIAL BUILDING.
20740C
20750C      THE SUBROUTINE STATEMENT IS
20760C
20770C      SUBROUTINE HOUSE
20780C
20790C      DEVELOPED BY HONEYWELL
20800C
20810C      PROJECT ACES-2 STORY HOUSE ORNL-DWG 78-2174
20820C
20830C      CREATION DATE:09/26/78
20840C
20850C*****
20860C
20870      COMMON/BLOCK/1HOUR,1DAY,1MONTH,TSTOR,QHL(24,366),QHW(24,366),
20880      1      QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
20890      1      HPEAK,THOTWL,THLS,THWL,TINF,TMLOAD,TCONDLE,TCLDAD,TISR
20900      1      ,A(200),
20910      1      NTABLE(20),XTEMP(24,366),BASLUD(24,366)
20920      LOGICAL FIRST,COOLIN
20930      COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24)
20940      1      ,TOC(24),WET(24),DRY(24),1YEAR,1DUM1,1DUM2,1CITY
20950      REAL NDYTP,MHOTW,KADK
20960      REAL NINTY
20970      DIMENSION UWALL(7),UROOF(6),ACE(3),AWALL(7),AAWALL(6),
20980      1AROO(6),UAWXI(7),UAWXO(7),HAWI(7),HAWO(7),UAWI(7),UAWO(7),
20990      2UAAWX(6),HAAWI(6),HAAWO(6),UARX(6),HARX(6),HARI(6),UARI(6),
21000      3 HIW(7),HIC(3),HACO(3),UACX(3),HOW(7),TAS(6),

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21010 4 TWSI(7),TRI(6),TI(6),TWS(7),HAWS(6),CONS1(6),
21020 SCONS2(6),CONS4(6),CONS5(6),CONS6(6),CONS7(3),HAWSW(7)
21030 DIMENSION HAWSW2(7),TCE(3),TCEI(3)
21040 DIMENSION UAAWO(6),TO(7),UARO(6)
21050 DIMENSION UACI(3),UARXI(6)
21060 DIMENSION TRS(6),CONS11(7),CONS3(7),HO(7),
21070 IQAAA(6),QAA(7),QAR(6),UAAWI(6),HIR(6),HACI(3)
21080 COMMON /SOLAR/S(35)
21090 COMMON /SLOAD/QTRAN(5),ABSORB(5)
21100 COMMON/HTPP/FF
21110 COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
21120 COMMON/TEMP/TW(7),TAW(6),TR(6),TA(6),TIM,TFI,ISL,TCR,TTE,
21130 TX,TCE,TWSI,TCEI
21140 COMMON/DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,
21150 1 EFFECT,WATVEL,WATTMP,CFA,FNCFM1
21160 COMMON/HOURLY/CONDL,XINF,TSR,QINC1,QINC2,ALFW,ALFR
21170 COMMON /DIR/DIRH,DIRN,TOTH
21180 DIMENSION SHDXW(20),SHDXD(20),SHDXSA(20),SHDXNW(20)
21190 DIMENSION UARXTPH(6),HQQ(6),HQR(6),DTQCC(3),DTQCN(7)
21200 DATA FIRST/.TRUE./
21210 DATA OP08/1.08/,THRTWO/32./,ONE/1./,ZERO/0./,P1/.1/,P4/.4/,P5/.5/
21220 1 ,P8/.8/,TTP32/33.32/,SIXTHR/63./,TFIFTY/250./,FHMDRD/500./
21230 1 ,FHMDRD/400./,FOURTY/40./,SSP3/77.3/,FOUR90/490./,ETHMDRD/1800
21240 1 ./,TEN/10./,P45/.45/,ONET61/1061./,OT75P4/1075.4/,FORP46/4.
21250 1 46/,P13833/.13833/
21260 DATA CHECK/0.0/
21270 DATA PT/3.1416/
21280 DATA TWO/2.00/,THOU/1000./,HUND/100./,ET/18./,P79/.79/,
21290 1 SHM45/34./
21300 DATA TWEL/12./,FOUR/4.0/,SEVEN/7.0/,FIFT/15.0/,FIVE/5.0/,
21310 1 EIGHT/8./,THIR775/37.75/,THREE/3./,FRT2/42./,NINTY/90./,
21320 2 080/180./,FP25/4.25/,TP414/3.414/,TW2/22./,SIX/6./
21330 DATA OLDMTH/0.0/
21340 DATA P9/.58/,PD/.70/,TW25/25./,P01/.01/
21350 MODEC = ONE
21360 MODES = ONE
21370 MODEW = ONE
21380C
21390C FIRST TIME THROUGH, INITIALIZE CONSTANTS FROM 'A' ARRAY. SKIP
21400C INITIALIZATION ON SUCCEEDING CALLS.
21410C
21420 IF (.NOT. FIRST) GO TO 10
21430 TIME=ZEKO
21440 THOTW = A(50)
21450 USTAG = A(51)
21460 USTHG = A(52)
21470 UHOTW = A(53)
21480 UCEIL = A(54)
21490 UCE=UCEIL
21500 UWALL(1)=A(18)

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21510    UWALL(2)=A(18)
21520    UWALL(3)=A(34)
21530    UWALL(4)=A(34)
21540    UWALL(5)=A(34)
21550    UWALL(6)=A(34)
21560    UWALL(7)=A(35)
21570    UGLASS=A(57)
21580    UDOOR=A(58)
21590    UFLOOR=A(59)
21600    USL=A(55)
21610    UCR=A(51)
21620    UROOF(1)=A(32)
21630    UROOF(2)=A(33)
21640    UROOF(3)=UROOF(1)
21650    UROOF(4)=UROOF(1)
21660    UROOF(5)=UROOF(2)
21670    UROOF(6)=UROOF(1)
21680    UAWALL=UWALL(3)
21690C SET UP SURFACE AREAS FROM A-ARRAY VALUES
21700    ACE(1)=A(63)
21710    ACE(2)=A(64)
21720    ACE(3)=A(52)
21730    AWALL(1)=A(155)
21740    AWALL(2)=A(156)
21750    AWALL(3)=A(157)
21760    AWALL(4)=A(158)
21770    AWALL(5)=A(159)
21780    AWALL(6)=A(160)
21790    AWALL(7)=A(161)
21800    AAWALL(1)=A(162)
21810    AAWALL(2)=A(163)
21820    AAWALL(3)=A(164)
21830    AAWALL(4)=A(165)
21840    AAWALL(5)=A(166)
21850    AAWALL(6)=A(167)
21860    AFLOOR=A(71)
21870    AROOF(1)=A(72)
21880    AROOF(2)=A(73)
21890    AROOF(3)=A(74)
21900    AROOF(4)=AROOFF(1)
21910    AROOF(5)=AROOFF(2)
21920    AROOF(6)=AROOFF(3)
21930C
21940    CFMINF=A(75)
21950    PEOPMX = A(76)
21960    APPLMX = A(77)
21970    ACEIL=ACE(1)+ACE(2)+ACE(3)
21980    XLTFMX=A(78)*ACEIL*TP414
21990    AVENT = A(79)
22000C SET UP DATA ARRAY FOR SHADING SOUTH WINDOWS,SOUTH WALL.

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22010      SHRATW=1.
22020      SHRATD=1.
22030      SHADES=1.
22040      SHRATWW=1.
22050      SHDXW(1)=TWEL
22060      SHDXW(2)=FOUR
22070      SHDXW(3)=SEVEN
22080      SHDXW(4)=ONE
22090      SHDXW(5)=FIFT
22100      SHDXW(6)=FIFT
22110      SHDXW(7)=FIVE
22120      DO 1937 I=12,20
22130      SHDXW(1)=ZERO
22140 1937 SHDXSW(I)=ZERO
22150C
22160C SET UP ARRAY FOR SHADING SOUTH SG DOOR,SOUTH WALL
22170      SHDXD(1)=FP25
22180      SHDXD(2)=EIGHT
22190      SHDXD(3)=SEVEN
22200      SHDXD(4)=ZERO
22210      SHDXD(5)=TWO
22220      SHDXD(6)=THIR775
22230      SHDXD(7)=FIVE
22240      SHDXD(8)=SIX
22250      SHDXD(9)=ZERO
22260      SHDXD(10)=TWO
22270      SHDXD(11)=ZERO
22280      DO 1938 I=12,20
22290 1938 SHDXD(I)=ZERO
22300      SHDXSW(1)=FRT2
22310      SHDXSW(2)=EIGHT
22320C DESIGN VALUES FOR SIZING HEAT PUMP AND COOLING COIL
22330C SET UP DATA ARRAY FOR W WALL SHADING BY GARAGE,S WALL BY OVERHANG
22340      DO 1939 I=3,15
22350      SHDXWW(I)=ZERO
22360 1939 SHDXSW(I)=ZERO
22370      DO 1940 I=17,20
22380 1940 SHDXWW(I)=ZERO
22390      SHDXWW(12)=TWEL
22400      SHDXWW(16)=-NINTY*PI/080
22410      SHDXWW(1)=11.
22420      SHDXWW(2)=8.
22430      SHDXSW(3)=SEVEN
22440      SHDXSW(7)=FIVE
22450C FIN DATA FOR S WINDOW
22460      SHDXW(8)=SIX
22470      SHDXW(9)=ONE
22480      SHDXW(10)=FIFT
22490      SHDXW(11)=-THREE
22500C

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22510C
22520C
22530C
22540      ATTICT=A(80)
22550      WINDOWG = A(81)
22560      TOSAW = A(82)
22570      TOSAS = A(83)
22580      WOSAS = A(84)
22590      WINTS = A(85)
22600      OVRCPW = A(86)
22610      OVRCPS = A(87)
22620      TZONEW = A(88)
22630      TZONE = A(89)
22640      NSB = IFIX(A(90))
22650      SHADES = IFIX(A(92))
22660      CALC = A(93)
22670      HEATD = A(94)
22680      COOLD = A(95)
22690C SET  THERMAL CAPACITIES BY SELECTING A-ARRAY DATA(PER AREA)
22700      CRVX=A(184)
22710C
22720      CRVTTE=A(48)
22730      CRVW=A(169)
22740      CRVAW=CRVW
22750      CRVIM=A(182)
22760      CRVR=A(170)
22770      CRVSR=A(171)
22780      CRVC=A(172)
22790      CRVF=A(174)
22800      CRVKW=A(175)
22810      CRVCR=A(177)
22820      CRVSL=A(176)
22830C SET  WALL AND ROOF ABS
22840      ALFW=A(168)
22850      ALFR=A(173)
22860C SET  HEAT TRANSFER COEFFICIENTS
22870      HO(1)=A(19)
22880      HO(2)= A(19)
22890      HO(3)=A(11)
22900      HO(4)=A(11)
22910      HO(5)=A(11)
22920      HO(6)=A(11)
22930      HO(7)=A(19)
22940      HI=A(12)
22950      HAIM=A(183)
22960      HOC=A(12)
22970      HOR=A(45)
22980      HIR(1)=A(46)
22990      HIR(2)=A(47)
23000      HIR(3)=A(46)

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23010      HIR(4)=A(46)
23020      HIR(5)=A(47)
23030      HIR(6)=A(46)
23040      ADOOR=A(70)
23050      AHOTW=A(62)
23060      AGLASN=A(66)
23070      AGLASE=A(67)
23080      AGLASS=A(68)
23090      AGLASW=A(69)
23100      UGLAS=A(57)
23110      HIC(1)=A(36)
23120      UND=A(178)
23130      ANDOOR=A(179)
23140      UAFLOOR=UFLOOR*AFLOOR
23150      UAGLAS=UGLAS*(AGLASN+AGLASE+AGLASS+AGLASW)
23160      UAHOTW=UHOTW*AHOTW
23170      UADOOR=UDOOR*ADOOR*UND*ANDOOR
23180      HIC(2)=HIC(1)
23190      HIC(3)=HIC(1)
23200      HAF=A(20)
23210      UPF=A(41)
23220      FP=A(30)
23230      INF2=OP08*AVENT*ACE(2)
23240      INF1=OP08*AVENT*ACE(1)
23250      INF3=OP08*AVENT*ACE(3)
23260      KADX=ONE/TWEL
23270      UAXTE=KADX*AFLOOR
23280      UAXCR=UCR*AFLOOR*TWO
23290      UAXF=UFLOOR*AFLOOR*TWO
23300      UAFXI=ONE/((ONE/UAXF)-(ONE/HAF))
23310      UAFXO=UAXF
23320      UAXSL=USL*AFLOOR*TWO
23330      UCRTE=UAXCR+UAXCR
23340      USFSL=UAXSL+UAXSL
23350      USSLR=UAXSL+UAXCR
23360C DETERMINE NODAL UA'S FOR ROOM WALLS
23370      DO 700 I=1,7
23380      UAWI(I)=UWALL(I)*AWALL(I)*TWO
23390      UAWO(I)=UAWI(I)
23400      HAWI(I)=HI*AWALL(I)
23410      HAWO(I)=HO(I)*AWALL(I)
23420      UAWXI(I)=ONE/((ONE/UAWI(I))-(ONE/HAWI(I)))
23430C
23440      UAWXO(I)=ONE/((ONE/UAWO(I))-(ONE/HAWO(I)))
23450 700 CONTINUE
23460C DETERMINE NODAL UA'S FOR ATTIC WALLS
23470      DO 701 I=1,6
23480      UAAWO(I)=UAWALL*AAWALL(I)*TWO
23490      UAAWI(I)=UAAWO(I)
23500      HAAWI(I)=HI*AAWALL(I)

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23510C
23520      HAAWO(I)=HO(3)*AAWALL(I)
23530      UAAWX(I)=ONE/((ONE/UAAWO(I))-(ONE/HAAWO(I)))
23540 701  CONTINUE
23550C DETERMINE NODAL UA'S FOR ROOF
23560      DO 702 I=1,6
23570      UARO(I)=UROOF(I)*AROF(I)*TWO
23580      UARI(I)=UARO(I)
23590      HARO(I)=HOR*AROF(I)
23600      HARI(I)=HIR(I)*AROF(I)
23610      UARXI(I)=ONE/((ONE/UARI(I))-(ONE/HARI(I)))
23620 702  UARX(I)=ONE/((ONE/UARO(I))-(ONE/HARO(I)))
23630C DETERMINE NODAL UA'S FOR CEILING SURFACES
23640      DO 703 I=1,3
23650      UACO(I)=UCEIL*ACE(I)*TWO
23660      UACI(I)=UACO(I)
23670      HACI(I)=HIC(I)*ACE(I)
23680      HACO(I)=HOC*ACE(I)
23690      UACX(I)=ONE/((ONE/UACI(I))-(ONE/HACI(I)))
23700 703  CONTINUE
23710C COMPUTE CONSTANTS USED IN DYNAMIC EQUATIONS
23720      DT=A(10)
23730      SUM1=ZERO
23740      DO 730 I=1,7
23750 730  SUM1=SUM1+HAWI(I)
23760      UAFLOOR=HAF
23770      DO 731 I=1,3
23780 731  SUM1=SUM1+HACI(I)
23790      SUM1=SUM1+HAIM+UAFLOOR+UAGLAS+OP08*CFMINF+UAHOTW+UADJOR
23800      SUM1=SUM1+HARI(2)+HARI(5)
23810      S1=ONE-DT*SUM1/CRVX
23820      DO 732 I=1,6
23830      HAWS(I)=HAAWO(I)+UAAWX(I)
23840      CONS1(I)=ONE-(DT/(CRVAW*AAWALL(I)))*(UAAWX(I)+UAAWI(I))
23850      CONS2(I)=(DT/(CRVAW*AAWALL(I)))
23860      CONS3(I)=HARO(I)+UARX(I)
23870      CONS4(I)=ONE-(DT/(CRVR*AROF(I)))*(UARX(I)+UARXI(I))
23880      CONS5(I)=(DT/(CRVR*AROF(I)))
23890 732  CONTINUE
23900      DO 733 I=1,3
23910      CONS6(I)=UACX(I)+HACI(I)
23920 733  CONS7(I)=ONE-(DT/(CRVC*ACE(I)))*(UACX(I)+UACO(I))
23930      CONS8=UAAWI(1)+UAAWI(2)+UARI(1)+UARI(4)+
23940      1 UACO(1)+OP08*AVENT*ACE(1)
23950      CONS9=UAAWI(3)+UAAWI(4)+UARI(3)+OP08*AVENT*ACE(2)+
23960      1 UACO(2)+UAWO(1)
23970      CONS10=UAAWI(5)+UAAWI(6)+UARI(6)+OP08*AVENT*ACE(3)+UACO(3)
23980      1 + UAWO(2)
23990      DTX=DT/CRVX
24000      DTIM=DT/CRVIM

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24010      DO 740 I=1,7
24020      HAWSW(I)=HAWI(I)+UAWXI(I)
24030      HAWSW2(I)=HAWO(I)+UAWXO(I)
24040 740   CONS11(I)=ONE-(DT/(CRVW*AWALL(I)))*(UAWXO(I)+UAWXI(I))
24050      CONS12=(ONE-(DT/CRVIM)*HAIM)
24060      CONS13=HAF+UAFXI
24070      CONS14=ONE-(DT/(CRVF*AFLOOR))*(UAFXI+UAFXO)
24080C
24090C      INITILIZE NODAL TEMPERATURES
24100C
24110      TR(1)=A(133)
24120      TR(2)=A(110)
24130      TR(3)=A(111)
24140      TR(4)=A(189)
24150      TR(5)=A(191)
24160      TR(6)=A(195)
24170      TAW(1)=A(112)
24180      TAW(2)=A(127)
24190      TAW(3)=A(113)
24200      TAW(4)=A(132)
24210      TAW(5)=A(186)
24220      TAW(6)=A(187)
24230      TA(1)=A(114)
24240      TA(2)=TA(1)
24250      TA(3)=A(115)
24260      TA(4)=TA(3)
24270      TA(5)=A(194)
24280      TA(6)=TA(5)
24290      TCE(1)=A(136)
24300      TCE(2)=A(116)
24310      TCE(3)=A(196)
24320      TSL=A(192)
24330      TCR=A(193)
24340      TTE=A(194)
24350      TF=A(199)
24360      TW(1)=A(117)
24370      TW(2)=A(185)
24380      TW(3)=A(128)
24390      TW(4)=A(129)
24400      TW(5)=A(130)
24410      TW(6)=A(131)
24420      TW(7)=A(118)
24430      TIM=A(197)
24440C REDEFINE THERMAL CAPACITIES FOR FLOOR,SLAB,CRUSHED ROCK,EARTH
24450      CRVF=CRVF*AFLOOR
24460      CRVSL=CRVSL*AFLOOR
24470      CRVCR=CRVCR*AFLOOR
24480      CRVTTE=CRVTTE*AFLOOR
24490      DTCR=DT/CRVCR
24500      OTSL=DT/CRVSL

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24510      DTF=DT/CRVF
24520C
24530      OMDT1=(ONE-DTSL*USFSL)
24540      OMDT2=(ONE-DTCR*UCRTTE)
24550      UCRTTE=UAXCR+UAXTTE
24560      DO 893 I=1,7
24570 893   DTOCW(I)=DT/(CRVW*AWALL(I))
24580C
24590C
24600      TX=A(190)
24610C
24620C      SET THE TIME STEP AND THE GROUND CONDUCTIVITY
24630C
24640      XKCON = A(13)
24650C
24660      IF(CALC.LT.ONE)GO TO 110
24670C
24680C      HEATING DESIGN LOAD
24690      SUMU=ZERO
24700      UACEIL=ZERO
24710      TWW=A(37)
24720      UAFLO1=UPP*FP
24730C      SSP3 = 2.32 * 4. * 8.33
24740C      DETERMINE UA'S BETWEEN AMBIENT AND OUTSIDE TEMPS
24750      DO 718 I=1,7
24760 718   SUMU=SUMU+UWALL(I)*AWALL(I)
24770      DO 719 I=1,3
24780 719   UACEIL=UACEIL+UCF*ACE(I)
24790C      ADD SLANT ROOF TO CEILING UA
24800      UACEIL=UACEIL+TWO*UROOF(2)*AROO(2)
24810      SUMUA=SUMU+UADOOR+UAFLO1+UAGLAS+OP08*CFMINF
24820C
24830      HEATD = ( SUMUA * (TZONFW - TOSAW) + UACEIL * (TZONEW - TOSAW)
24840 1      + SSP3 * (THOTW - FOURTY)) * OVRCPW
24850      UTTE=A(13)
24860      RT=ONE/UFLDOR+ONE/USL+ONE/UCR+ONE/UTTE
24870      UFT=ONF/RT
24880      UAFLO=UFT*AFLOOR
24890      HEATD=HEATD+UAFLO*(TZONEW-TWW)
24900C      COOLING DESIGN LOAD
24910C
24920      COOLO = -(SUMUA * (TZONES - TOSAS) + UACEIL * (TZONES - ATTICT)
24930 1      + UAHOTW * (TZONES - THOTW) - WINDWG * (AGLASN + AGLASE
24940 1      + AGLASS + AGLASW) - PEOPMX * FOUR90 - APPLMX - XLTEMX)
24950 1      * OVRCP5
24960C
24970 110 CONTINUE
24980C
24990C      HEAT PUMP DESIGN
25000C

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25010 CALL WAHP(THRTWO,TZONEW,QCOND,QEVAP,HP,COP)
25020 CHECK1 = COOLD/QEVAP
25030 CHECK2 = HEATD/QCOND
25040 COOLDA = A(96)
25050 DESL1 = ZERO
25060 DESL = HEATD
25070 IF(CHECK2 .LT. CHECK1) DESL1 = COOLDA/(TW25 - A(100) + A(101))
25080 IF(DESL1 .GT. COOLD) DESL1 = COOLD
25090 IF(DESL1/QEVAP .GT. DESL/QCOND) DESL = DESL1
25100 X = DESL/THOU
25110 IX = IFIX(X)
25120 SIZE1 = THOU * FLOAT(IX) + THOU
25130 SF1=SIZE1/QCOND
25140 IF(DESL .LE. DESL1) SF1 = SIZE1/QEVAP
25150 IF(DESL .LE. DESL1) SIZE1 = SF1 * QCOND
25160 SFP = SF1
25170 IB = IFIX((SFP-ONE)*ETHUND*P01)
25180 B = HUND * (FLOAT(IB + 1) + ET)
25190 FNCFM1 = B
25200 EVPGPM = B * TEN / ETHUND
25210C
25220C COOLING COIL DESIGN
25230C
25240 TWI = THRTWO
25250C
25260C OT75P4 = 1061. + .4 * 32.
25270C
25280 EFFECT=P79
25290 FANCFM=COOLD/(OP08*EFFECT*(TZONES-THRTWO))
25300 FANCFM=FLOAT(IFIX(FANCFM/HUND)+1)*HUND
25310 SIZE2=FANCFM*OP08*(TZONES-THRTWO)*EFFECT
25320 SIZE2=THOU*FLOAT(IFIX(SIZE2/THOU))+THOU
25330 CFA = FANCFM/FHUNDR
25340 CFT2 = COOLD/CFA
25350C
25360C P13833 = 1.66/12.
25370C
25380 WATVEL = TEN * P13833
25390 WATTMP = COOLD/(FHNRD * TEN)
25400 WRITE(9,101)
25410 101 FORMAT(1H1,/, ' DESIGN PARAMETERS ',/)
25420 WRITE(9,102)HEATD,COOLD,SIZE1,FANCFM,EVPGPM,EFFECT,WATVEL,WATTMP,
25430 1 CFA,FNCFM1
25440 102 FORMAT(V)
25450C
25460C DONE WITH DESIGN PROCEDURE
25470C WRITE(9,401)
25480C 401 FORMAT(////, 'THOUR IDAY QHL QHW QC
25490C 1 QINCI ABSORB(5) DB(J) TA ' ,////)
25500C

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25510      FIRST = .FALSE.
25520 10    CONTINUE
25530      J = IHOUP
25540C
25550C      CALCULATE INTERNAL PEOPLE, LIGHT, AND APLIANCE SENSIBLE LOADS
25560C
25570      PEOPL = PEOPLE(J) * PEOPMX * TFIFTY
25580      XLIGHT = XLIGHT(J) * XLITEMX
25590      APPL1 = APPL(J) * APPLMX
25600C
25610C      CALCULATE AVAILABLE RADIATION ON COLLECTOR SURFACE
25620C
25630      ANG1=A(6)
25640      ANG2=A(5)
25650      CALL SOLARQ(ANG1,ANG2,QAVAIL)
25660      QINCI(IHOUP,IOAY) = QAVAIL
25670C
25680C      CALCULATE TRANSMITTED SOLAR RADIATION AND RADIATION THAT
25690C      IS IMPINGINT ON OUTSIDE SURFACES
25700C SELECT SOLAR ANGLES FOR INPUT TO SHADE SUBROUTINE
25710      PHI=S(21)*PI/080
25720      XQ=S(20)*PI/080
25730      COSZ=SIN(XQ)
25740      CALL WINDOW(MODEW)
25750      IF (SHADES .LT. ONE) GO TO 15
25760      QTRAN(1)=QTRAN(1)*PS
25770      QTRAN(2)=QTRAN(2)*PS
25780      QTRAN(3)=QTRAN(3)*PS
25790      QTRAN(4)=QTRAN(4)*PS
25800 15    CONTINUE
25810C INCORPORATE SHADING OF SOUTH GLASS
25820      CALL SHADE(SHDXW,PHI,COSZ,SHRATW)
25830      TSR = (QTRAN(1) * AGLASN + QTRAN(2) * AGLASF
25840      1 + QTRAN(3)*AGLASS*SHRATW+QTRAN(4)*AGLASW)
25850      CALL SHADE(SHDXD,PHI,COSZ,SHRATD)
25860      IF(SHADES.LT.ONE) GO TO 138
25870      TSR=TSR+QTRAN(3)*SHRATD*ADOOR*PD/PS
25880      GO TO 157
25890 138   TSR=TSR+QTRAN(3)*SHRATD*ADOOR
25900 157   CONTINUE
25910C      TSR=0.
25920      TTGR = TTGR + TSR
25930C
25940      ANG3=A(151)
25950      ANG4=A(152)
25960      ANG5=A(153)
25970      ANG6=A(154)
25980C      CHECK FOR NIGHT SETBACK CONDITIONS
25990C
26000C SET WALL OUTSIDE TEMPS EXCEPT FOR KNEE-WALLS

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26010      TO(3)=DB(J)
26020      TO(4)=DB(J)
26030      TO(5)=DB(J)
26040      TO(6)=DB(J)
26050      TO(7)=DB(J)
26060      IF(NSB.EQ.0) GO TO 20
26070      IF((J.LE.SIX).OR.(J.GT.TW2)) TZONEW=SIXTHR
26080 20    CONTINUE
26090C
26100C      DETERMINE THE DOMESTIC HOT WATER TANK LOAD AND THE
26110C      INTERNAL LOAD
26120C
26130C      TTP32 = 4. * 8.3333
26140C
26150      HGHTW = MHOTW(J) * TTP32 * (THOTW - TWELL(IMONTH))
26160      TINLDD = PEOPL + XLIGT +APPL1
26170      DO 883 I=1,6
26180 883    UARXIPH(I)=UARXI(I)+HARI(I)
26190      DO 889 I=1,3
26200 889    DTOCC(I)=DT/(CRVC*ACE(I))
26210      INFA1D=INFA1*DB(J)
26220      INFA2D=INFA2*DB(J)
26230      INFA3D=INFA3*DB(J)
26240C
26250C      DETERMINE AVAILABLE ENERGY ON THE ROOF SURFACES
26260C
26270      CALL SOLARQ(ANG3,ANG4,QINC1)
26280      CALL SOLARQ(ANG5,ANG6,QINC2)
26290C
26300C      COMPUTE HOURLY "CONSTANTS"
26310      CHRLD=OPOR*CFMINF*DB(J)+UAHOTW*THOTW+UADDDR*DB(J)+TINLDD
26320      1 +UAGLAS*DB(J)
26330C      SOLAR HEAT GAINS ATTIC WALLS,WALLS,ROOF
26340      QAAA(1)=ABSORB(2)*AAWALL(1)*ALFW
26350      QAAA(2)=ABSORB(4)*AAWALL(2)*ALFW
26360      QAAA(3)=ABSORB(2)*AAWALL(3)*ALFW
26370      QAAA(4)=ABSORB(4)*AAWALL(4)*ALFW
26380      QAAA(5)=ABSORB(2)*AAWALL(5)*ALFW
26390      QAAA(6)=ABSORB(4)*AAWALL(6)*ALFW
26400      QAA(1)=ZERO
26410      QAA(2)=ZERO
26420      QAA(3)=ABSORB(1)*AWALL(3)*ALFW
26430      QAA(4)=ABSORB(2)*AWALL(4)*ALFW
26440      CALL SHADE(SHDXSW,PHI,COSZ,SHADE5)
26450      QAA(5)=ABSORB(3)*AWALL(5)*SHADE5*ALFW
26460      CALL SHADE(SHDXWW,PHI,COSZ,SHRATWW)
26470 1112  FORMAT(1X,3E12.6)
26480      QAA(6)=ABSORB(4)*AWALL(6)*ALFW
26490      QAA(6)=QAA(6)*SHRATWW
26500      QAA(7)=ZERO

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26510      DO 713 I=1,3
26520 713  QAR(I)=QINC1*ALFR*AROOF(I)
26530      DO 714 I=4,6
26540 714  QAR(I)=QINC2*ALFR*AROOF(I)
26550C SET INITIAL VALUES FOR EACH HOUR
26560C COMPUTE HOURLY CONSTANTS HDQ,HDQR
26570      DO 888 I=1,6
26580      HDQ(I)=HAAWO(I)*DB(J)+QAAA(I)
26590      HDQR(I)=HARO(I)*DB(J)+QAR(I)
26600 888  CONTINUE
26610      TBTU=ZERO
26620      TTX=ZERO
26630C
26640C      INTEGRATE DIFFERENTIAL EQUATIONS FOR REQUIRED DT
26650C
26660      N=IFIX(ONE/DT)
26670      SUMT=0.
26680      DO 500 K=1,N
26690C
26700C      CALCULATE THERMOSTAT FUNCTION
26710C
26720      CALL TSTAT(TX,Q,TZNEW,TZONES)
26730C
26740C      DETERMINE THE SPACE AIR TEMPERATURE "TX"
26750      TX=TX+S1+DT/CRVX*((CHRLD+Q)+HAWI(1)*TWSI(1)+HAWI(2)*TWSI(2)+
26760      1  HAWI(3)*TWSI(3)+HAWI(4)*TWSI(4)+HAWI(5)*TWSI(5)+HAWI(6)
26770      1  *TWSI(6)+HAWI(7))
26780      2  *TWSI(7)+HACI(1)*TCEI(1)+HACI(2)*TCEI(2)+HACI(3)*
26790      3  TCEI(3)+HARI(2)*TRI(2)+HARI(5)*TRI(5)+HAIM*TIM+
26800      4  HAF*TFI)
26810C DETERMINE THE ATTIC WALL TEMPERATURES
26820C EXTERIOR SURFACE TEMP=TAS
26830      DO 800 I=1,6
26840      TAS(I)=(HDQ(I)+UAAWX(I)*TAW(I))/
26850      1  HAWS(I)
26860 800  TAW(I)=TAW(I)*CONS1(I)+CONS2(I)*{UAAWX(I)*TAS(I)+UAAWI(I)*TA(I)}
26870C DETERMINE ROOF TEMPERATURES ATTIC ANT SLANT ROOF/CEILING
26880C EXTERIOR ROOF SURFACE T=TRS
26890C SET TEMPS UNDER ROOF SURFACES
26900      TI(1)=TA(1)
26910      TI(2)=TX
26920      TI(3)=TA(5)
26930      TI(4)=TA(1)
26940      TI(5)=TX
26950      TI(6)=TA(3)
26960      TO(1)=TA(3)
26970      TO(2)=TA(5)
26980      DO 801 I=1,6
26990      TRS(I)=(HDQR(I)+UARX(I)*TR(I))/CONS3(I)
27000      TRI(I)=(UARX1(I)*IW(I)+HARI(I)*TI(I))/UARXIPH(I)

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27010 801 TR(I)=TR(I)*CONS4(I)+CONS5(I)*(UARX(I)*TRS(I)+JARXI(I)*TRI(I))
27020C DETERMINE CEILING TEMPERATURES (3 NODES)
27030 DO 802 I=1,3
27040 KK=2+I
27050 TCEI(I)=(UACX(I)*TCE(I)+HACI(I)*TX)/CONS6(I)
27060 TCE(I)=TCE(I)*CONS7(I)+DTCOC(I)*(UACO(I)*TA(KK)+UACX(I)*
27070 1 TCEI(I))
27080 802 CONTINUE
27090C DETERMINE ATTIC AIR TEMPERATURES (3 ATTICS)
27100 TA(1)=(UAAWI(1)*TAW(1)+UAAWI(2)*TAW(2)+UARI(1)*TR(1)+UARI(4)*
27110 1 TR(4)+INFA1D+UACO(1)*TCE(1))/CONS8
27120 TA(2)=TA(1)
27130 TA(3)=(UAAWI(3)*TAW(3)+UAAWI(4)*TAW(4)+UARI(3)*TR(3)+UAWO(2)*
27140 1 TW(2)+INFA2D+UACO(2)*TCE(2))/CONS9
27150 TA(4)=TA(3)
27160 TA(5)=(UAAWI(5)*TAW(5)+UAAWI(6)*TAW(6)+UARI(6)*TR(6)+INFA3D
27170 1 +UACO(3)*TCE(3)+UAWO(1)*TW(1))/CONS10
27180 TA(6)=TA(5)
27190C DETERMINE THE ROOM WALL TEMPERATURES (7 NODES)
27200C 1= N KNEEWALL;2=S KNEEWALL;3=N WALL;4=E WALL;5=S WALL;6=W WALL;7=W GAR WAL
27210 DO 803 I=1,7
27220 TWSI(I)=(HAWI(I)*TX+UAWXI(I)*TW(I))/HAWSW(I)
27230 TWS(I)=(HAWO(I)*TO(I)+QAA(I)+UAWXO(I)*TW(I))/HAWSW2(I)
27240 803 TW(I)=TW(I)*CONS11(I)+DTCOW(I)*(UAWXO(I)*TWS(I)
27250 1 +UAWXI(I)*TWSI(I))
27260C DETERMINE THE INTERNAL MASS TEMPERATURE
27270 TIM=TIM*CONS12+DTIM*(HAIM*TX+TSR)
27280C DETERMINE THE FLOOR TEMPERATURE
27290 TFI=(HAF*TX+UAFXI*TF)/CONS13
27300 TF=TF*CONS14+DTF*(TFI*UAFXI+UAFXO*TSLI)
27310C DETERMINE SURFACE TEMPERATURES AT SLAB, CRUSHED ROCK, 12 INCHES OF EARTH
27320C ASSUMING THAT THE GROUND T AT 6 FEET BELOW THE CRUSHED ROCK IS AT TWELL
27330 TSLI=(UAFXO*TF+UAXSL*TSL)/(UAFXO+UAXSL)
27340 TSL=TSI*OMDT1+DTSL*(TSLI*UAXSL+
27350 1 UAXSL*TCRI)
27360 TCRI=(UAXSL*TSI+UAXCR*TCR)/USSLR
27370 TCR=TCR*OMDT2
27380 1 +DTCR*(UAXCR*TCRI+UAXCR*TTEI)
27390 TTEI=(UAXCR*TCR+UAXTTE*TTE)/UCRTTE
27400 TTE=TWELL(IMONTH)
27410C
27420C
27430C
27440 755 CONTINUE
27450C
27460 BTU = Q*DT
27470 TTX = TTX+TX*DT
27480 TBTU = TBTU+BTU
27490 TIME = TIME + DT
27500 500 CONTINUE

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27510C
27520      IF(TBTU.GT.ZERO) GO TO 240
27530      IF(TBTU.LT.ZERO) GO TO 250
27540C
27550C
27560C      OPERATION IN DEAD BAND
27570C
27580      CLOAD=ZERO
27590      HLOAD=ZERO
27600      GO TO 80
27610 250 CONTINUE
27620C
27630C      CALCULATE COOLING LOADS
27640C
27650      QS = -TBTU
27660      QL = PEOP*P8
27670      HLOAD=ZERO
27680      TODB = DB(J)
27690      TODP = DP(J)
27700      CALL COIL(TODB,TODP,TWI,QL,QS,CFMINF,FANCFM,TTX,TFF
27710      1,CLOAD,EFFECT )
27720      IF(CLOAD.GT.CPEAK) CPEAK = CLOAD
27730      TCLOAD = TCLOAD + CLOAD
27740      GO TO 80
27750 240 CONTINUE
27760C
27770C      CALCULATE HEATING LOADS
27780C
27790      CLOAD=ZERO
27800      HLOAD = TBTU
27810      IF(HLOAD.GT.HPEAK) HPEAK = HLOAD
27820      THLOAD = THLOAD + HLOAD
27830      TTINLD = TTINLD + TINLOD
27840      XINF = OP08*CFMINF*(TTX-DB(J))
27850      HLHOTW = UAHOTW + (THOTW - TTX)
27860      CONDL = HLOAD + TSR - XINF + HLHOTW + TINLOD
27870      TCONDL = TCONDL + CONDL
27880      TINF = TINF + XINF
27890C
27900 80 CONTINUE
27910      HLHOTW = UAHOTW + (THOTW - TTX)
27920      THWL = THWL + HLHOTW
27930      HUIWL = HUHOTW + HLHOTW
27940      THOTWL = THOTWL + HOTWL
27950      QHL(IHOUR,IDAY) = HLOAD
27960      QH(IHOUR,IDAY) = CLOAD
27970      QHW(IHOUR,IDAY) = HOTWL
27980      XTEMP(IHOUR,IDAY)=TTX
27990      RETURN
28000      END

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28010      SUBROUTINE SHADE(SHDX,PHI,COSZ,SHRAT)
28020C
28030C*****
28040C      THIS PROGRAM CALCULATES SHADOW CAST BY OVERHANG AND SIDE FINS
28050C      PHI= SOLAR AZIMUTH ANGLE
28060C      COSZ= COSINE OF SOLAR ZENITH ANGLE
28070C      SHRAT= SHADE RATIO: RATIO OF SUNLIT AREA TO TOTAL AREA
28080C      HT= WINDOW HEIGHT
28090C      FL= WINDOW LENGTH
28100C      FP= DEPTH OF OVERHANG
28110C      AW= DISTANCE FROM TOP OF WINDOW TO OVERHANG
28120C      BWL= DISTANCE OF OVERHANG EXTENDED BEYOND LEFT EDGE OF WINDOW
28130C      D= DEPTH OF VERTICAL PROJECTION AT END OF OVERHANG
28140C      FP1= DEPTH OF LEFT FIN
28150C      A1= DISTANCE OF LEFT FIN EXTENDED ABOVE TOP OF WINDOW
28160C      B1= DISTANCE FROM LEFT EDGE OF WINDOW TO LEFT FIN
28170C      C1= DISTANCE OF LEFT FIN STOP SHORT ABOVE BOTTOM OF WINDOW
28180C      FP2= DEPTH OF RIGHT FIN
28190C      A2= DISTANCE OF RIGHT FIN EXTENDED ABOVE TOP OF WINDOW
28200C      B2= DISTANCE FROM RIGHT EDGE OF WINDOW TO RIGHT FIN
28210C      C2= DISTANCE OF THE RIGHT FIN STOP SHORT ABOVE BOTTOM OF WINDOW
28220C      WAZI= WINDOW AZIMUTH ANGLE
28230C*****
28240C
28250      DIMENSION SHDX(20)
28260      FL=SHDX(1)
28270      HT=SHDX(2)
28280      FP=SHDX(3)
28290      AW=SHDX(4)
28300      BWL=SHDX(5)
28310      BWR=SHDX(6)
28320      D=SHDX(7)
28330      FP1=SHDX(8)
28340      A1=SHDX(9)
28350      B1=SHDX(10)
28360      C1=SHDX(11)
28370      FP2=SHDX(12)
28380      A2=SHDX(13)
28390      B2=SHDX(14)
28400      C2=SHDX(15)
28410      WAZI=SHDX(16)
28420      SHRAT=1.
28430 1103 A=AW
28440      H=HT
28450      GAMMA=PHI-WAZI
28460      COSG=COS(GAMMA)
28470      IF(COSG) 100,100,104
28480 100  SHRAT=0.
28490      GO TO 2000
28500 104  CONTINUE

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28510      SBETA=COSE
28520      IF(SBETA) 101,100,152
28530 152   SING=SIN(GAMMA)
28540      IF(SING) 1201,100,1200
28550 1200  CONTINUE
28560      VERT=SBETA/S|RT(1.-SBETA*SBETA)/COSG
28570      HORIZ=ABS(SING)/COSG
28580      TCETA=VERT/HORIZ
28590      IF(GAMMA) 151,154,154
28600C      SUN ON LEFT
28610 154   B=BWL
28620      GO TO 156
28630C      SUN ON RIGHT
28640 155   B=BWR
28650 156   ARSHF=0.
28660      AREAV=0.
28670      ARSIF=0.
28680      AREA0=0.
28690      AREA1=0.
28700      ARSH1=0.
28710      FL3=0.
28720      H3=0.
28730      H1=H
28740      FL1=FL
28750      K=1
28760      L=1
28770      T1=FP*VERT
28780      FM1=FP*HORIZ
28790      IF(FP) 37,17,153
28800 153   T=T1
28810      FM=FM1
28820      AB=B*TCETA
28830      UC=(FL+D)*TCETA
28840      DE=(H+A)*TCETA
28850C      HORIZONTAL OVERHUNG "AREA0"
28860      IF(T-A) 27,27,2
28870 2     IF(AB-A) 14,14,3
28880 3     IF(DE-B) 12,12,4
28890 4     IF(FM-B) 11,11,5
28900 5     IF(DE-(FL+B))0,0,6
28910 6     IF(FM-(FL+B))9,7,7
28920C      HORIZ 9
28930 7     AREA0=FL*(0.5*(AB+UG)-A)
28940      GO TO 37
28950 8     IF(T-(H+A))9,10,10
28960C      HORIZ 7
28970 9     AREA0=(T-A)*FL-((FM-B)**2)*TCETA*0.5
28980      L=2
28990      GO TO 21
29000C      HORIZ 8

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29010 10  AREA0=H*FL-(DE*B)**2*TCETA*0.5
29020      GO TO 37
29030C      HORIZ 3
29040 11  AREA0=FL*(T-A)
29050      L=2
29060      GO TO 24
29070 12  IF(T-(H+A))11,13,13
29080C      HORIZ 2
29090 13  AREA0=H*FL
29100      GO TO 68
29110 14  IF(UG-A)27,27,15
29120 15  IF(DE-(FL+B))18,18,16
29130 16  IF(FM-(FL+B))20,17,17
29140C      HORIZ 6
29150 17  AREA0=(UG-A)**2/TCETA*0.5
29160      GO TO 37
29170 18  IF(T-(H+A))20,19,19
29180C      HORIZ 5
29190 19  AREA0=H*(FL-(A+0.5*A)/TCETA+B)
29200      GO TO 37
29210C      HORIZ 4
29220 20  AREA0=(T-A)*(FL+B-FM*(1.+A/T)*0.5)
29230      L=2
29240C      VERT PROJ "AREA/"
29250 21  FL3=FL+B-FM
29260      IF(T+D-(H+A))22,22,23
29270C      VERT 8
29280 22  H3=D
29290      GO TO 3700
29300C      VERT 9
29310 23  H3=H+A-T
29320      GO TO 3700
29330 24  FL3=FL
29340      IF(T+D-(H+A))26,26,25
29350C      VERT 7
29360 25  H3=H+A-T
29370      AREAV=H3*FL3
29380      GO TO 68
29390C      VERT 6
29400 26  H3=D
29410      GO TO 3700
29420 27  IF(T+D-A)37,37,28
29430 28  IF(FM-B)34,34,29
29440 29  IF(FM-(FL+B))31,37,37
29450 31  FL3=FL+B-FM
29460      IF(T+D-(H+A))33,33,32
29470C      VERT 5
29480 32  H3=H
29490      GO TO 3700
29500C      VERT 4

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29510 33  H3=T+D-A
29520      GO TO 3700
29530 34  IF(T+D-(H+A))36,35,35
29540C      VERT 2
29550 35  AREAV=H*FL
29560      GO TO 68
29570C      VERT 3
29580 36  H3=T+D-A
29590      FL3=FL
29600 3700 AREAV=FL3*H3
29610C      SIDE FIN AND SHORT SIDE FIN
29620C      SIDE FIN "AREA1" "ARSLF"
29630 37  IF(GAMMA)66,68,74
29640 74  FPF=FP1
29650      AF=A1
29660      BF=B1
29670      CX=C1
29680      GO TO 84
29690 66  FPF=FP2
29700      AF=A2
29710      BF=B2
29720      CX=C2
29730 84  IF(FPF)68,68,67
29740 67  T=FPF*VERT
29750      FM=FPF*HORIZ
29760      AF1=AF
29770      IF(ARFA0) 73,73,88
29780C      TEST FOR OVERLAP OF /IN AND OVERHUNG SHADOW
29790 88  AT=A*(BF-B)*TCETA
29800      IF(AT-AF)711,73,73
29810C      OVERLAP EXISTS..L=2 IF OVERHUNG SHADOW HAS HORIZ EDGE IN WINDOW
29820 711 GO TO (621,712),L
29830C      TEST FOR TYPE OF OVERLAP
29840 712 IF((FM-BF)-(FM1-B))621,622,622
29850C      SET L=1,SHADOW INTERSECT ON INCL. EDGE OF OVERHUNG SHADOW
29860C      FIN SHADOW IS BELOW INCL. EDGE OF OVERHUNG SHADOW
29870 621 AF=AT
29880      L=1
29890      GO TO 73
29900C      L IS 2,HORIZ EDGE OF OVERHUNG SHADOW IS ABOVE HORIZ EDGE
29910C      NOT IN OVERHUNG SHADOW IS FIN SHADOW
29920 622 AREA1=FL*(T1-A)-AREAU
29930C      RESET TO CALC FIN SHADOW BELOW HORIZ EDGE OF OVERHUNG SHADOW
29940      AF=T1-A+AF1
29950      H=H+AF1-AF
29960C      SHADOW OF FIN(K=1ON GLASS K=2 ON VERT PROJ SHADOW
29970 73  AB=BF*TCETA
29980      UG=(FL+BF)*TCETA
29990      DE=(H+AF)/TCETA
30000      DJ=CX/TCETA

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30010      IF (FM-BF) 69,69,38
30020 38    IF (AB-AF) 39,50,50
30030 39    IF (UG-AF) 48,48,40
30040 40    IF (T-AF) 47,47,41
30050 41    IF (UG-(H+AF)) 44,44,42
30060 42    IF (T-(H+AF)) 91,80,80
30070C      FIN 9
30080 80    AREA1=H*((AF+H*0.5)/TCETA-BF)+ARF A1
30090      GO TO 58
30100 44    IF (FM-(FL+BF)) 91,89,89
30110C      FIN 8
30120 89    AREA1=H*FL-(UG-AF)**2/TCETA*0.5+AREA1
30130      GO TO 58
30140C      FIN 7
30150 91    AREA1=(FM-BF)*H-(T-AF)**2/TCETA*0.5+AREA1
30160      GO TO 63
30170 48    IF (FM-(FL+BF)) 47,47,49
30180C      FIN 3
30190 47    AREA1=H*(FM-BF)+AREA1
30200      GO TO 63
30210C      FIN 2
30220 49    AREA1=H*FL+AREA1
30230      GO TO 58
30240 50    IF (DE-BF) 69,69,51
30250 51    IF (UG-(H+AF)) 55,55,52
30260 52    IF (T-(H+AF)) 93,94,94
30270C      FIN 6
30280 94    AREA1=(DE-BF)**2/TCETA*0.5+AREA1
30290      GO TO 58
30300C      FIN 4
30310 93    AREA1=(FM-BF)*(H+AF-(T+AB)*0.5)+AREA1
30320      GO TO 63
30330 55    IF (FM-(FL+BF)) 93,99,99
30340C      FIN 5
30350 99    AREA1=FL*(H+(BF+FL*0.5)*TC/TA+AF)+AREA1
30360C      SHORT SIDE FIN "ARSH1","ARSHF"
30370 58    IF (DJ-BF) 69,69,59
30380 59    IF (DJ-(FL+BF)) 61,61,60
30390C      SHORT 3
30400 60    ARSH1=-FL*(IX-(BF+FL/2.)*TC/TA)
30410      GO TO 69
30420C      SHORT 4
30430 61    ARSH1=-(CX-IB)**2/TCETA*0.5
30440      GO TO 69
30450 63    IF (DJ-BF) 69,69,64
30460 64    IF (DJ-FM) 61,61,65
30470C      SHORT 2
30480 65    ARSHU=-(FM-IF)*(CX-(T+AB)*0.5)
30490 69    GO TO (77,7),K
30500 76    ARSH1=-ARSH

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30510      AREA1=-AREA1
30520 77    ARSHF=ARSHF+ARSH1
30530      ARSIF=ARSIF+AREA1
30540      GO TO (78,61),K
30550 78    IF(AREAV)68,68,72
30560C      RESET PARAMETERS TO DEDUCT FIN SHADOW OVERLAP ON VERT PROJ SHAD
30570 72    K=2
30580      AREA1=0.
30590      ARSH1=0.
30600      B8F=BF
30610      BF=FM1-B+BF
30620      IF(BF)186,185,185
30630 186   BF=B8F
30640 185   IF(HT+A-T1-D)87,87,188
30650 188   CX=CX-(HT+A-T1-D)
30660      IF(CX) 85,87,87
30670 85    CX=0.
30680 87    AF=T1-A+AF
30690      H=H3
30700      FL=FL3
30710      GO TO 73
30720C      SHADEC AREA. "ARSHA"
30730 68    ARSHA=AREAD+AREAV+ARSHF+ARSIF
30740      SHRAT=(FL1*H1-ARSHA)/(FL1*H1)
30750      FL=FL1
30760 2000  CONTINUE
30770      RETURN
30780      END

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1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840.

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*****
*****
-- 3 0 --      DATE 08-31-79      TIME 11.676      ID = E1      GCS-AJ
*****
*****

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3892T ENTERED GCS-AJ AT 11.491 FROM SYSTEM-0 TSS/S 0-08-13

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0001 S      SNUMB      3892T
0002 S      COMMENT    F00648          TSS MEDIA CONVERSION
0003 S      IDENT      F00648-ACE3
0004 SS     USERID     F00648$
0005 AS     CONVER
0006 S      LIMITS      ,,,50000
0007 S      SYSOUT      OT,E1
0008 S      MULTI       1-1
0009 S      DATA       IN,,COPY,ENDFC
0010 S      ENDCOPY     IN
0011 S      ENDJOB
TOTAL CARD COUNT THIS JOB = 001696

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* ACTY-01 \$CARD #0005 CONVER 08/31/79 SW=000000000000
 BMC-TTL DATE 771205
 \$ MULTI 1-1
 FILE #000001 TOT 001685 INPUT
 INPUT COUNT 001685 OUTPUT COUNT 001685
 BLOCKS SKIPPED 000000 IGNORE COUNT 000000
 * NORMAL TERMINATION AT 001544 I=2060 SW=000000000000

START	STOP	SWAP	LAPSE	FC/D	TYPE	HUSY	IP/AT	FP/RT	IS/HC	MS/HE	ADDRESS	TH/PK#
11.493	11.496	0.000	0.003									
				MC R	MSU450 *	22	0	1	1	1	0-0A-13	
				IN R	MSU450 *	902	0	41	41	41	0-0A-13	
				OT	SYOUT							
				P*	SYOUT							

RC-00 1684 LINES AT STA. E1

ACTIVITY 01 COST=\$ 0.63
 *CUMULATIVE COST=\$ 0.63

SNUMB = 38921, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 001684

\$ NOTE FTIFNAME DEFMOD
 \$ NOTE LABELS- A,R(E1)
 \$ NOTE TABS/SETTINGS- ASIS

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10000C*****
10010C
10020C    DESIGN PROGRAM FOR RESIDENTIAL ACES
10030C
10040C    THIS PROGRAM HAS BEEN DESIGNED TO CALCULATE THE TANK SIZE AND
10050C    COLLECTOR SIZE FOR THE FULL ACES CONFIGURATION AND THE
10060C    MINIMUM ACES CONFIGURATION FOR SINGLE OR MULTI-FAMILY RESIDENCES
10070C    (ONLY) IN NORTHERN AND SOUTHERN CLIMATES. THIS PROGRAM IS ONE
10080C    OF FOUR DISTINCT MODULES. THEY ARE:
10090C        1. LOADS PROGRAM
10100C        2. DESIGN PROGRAM
10110C        3. SIMULATION PROGRAM
10120C        4. ECONOMIC ANALYSIS PROGRAM
10130C
10140C    IF THE TANK SIZE AND COLLECTOR SIZE HAVE ALREADY BEEN DETERMINED,
10150C    THIS MODULE CAN BE BYPASSED.
10160C    NDAYS IS THE NUMBER OF DAYS IN THE YEAR.
10170C
10180C    DEVELOPED BY HONEYWELL
10190C
10200C    CREATION DATE: 8/22/78
10210C
10220C    EXPLANATION OF VARIABLES IN COMMON BLOCK, PASS.
10230C
10240C    KADX IS THE CONDUCTIVITY OF THE GROUND AROUND THE TANK
10250C
10260C    HEIGHT IS THE ALLOWABLE HEIGHT OF THE TANK.
10270C
10280C    PF IS THE VOLUMETRIC PACKING FACTOR OF THE ICE IN THE TANK.
10290C
10300C    UTANKA IS THE OVERALL U OF THE TANK FROM THE WATER TO THE AIR.
10310C
10320C    UTANKW IS THE OVERALL U OF THE TANK FROM THE WATER TO THE OUTSIDE
10330C    SURFACE OF THE TANK.
10340C
10350C    UWAL IS THE U OF THE WALL BELOW GROUND.
10360C
10370C    TTANK IS THE TEMPERATURE OF THE TANK.
10380C
10390C    TAVE IS THE AVERAGE SPACE TEMPERATURE.
10400C
10410C
10420C    TQHLHW IS THE TOTAL WINTER SPACE HEATING LOAD.
10430C
10440C    TQHWHW IS THE TOTAL WINTER HOT WATER LOAD.
10450C
10460C    TQHWHS IS THE TOTAL HOT WATER LOAD IN THE SUMMER.
10470C
10480C    TQHLHS IS THE TOTAL SPACE HEATING LOAD IN THE SUMMER.
10490C
10500C    TQCCS IS THE TOTAL COOLING LOAD IN THE SUMMER.

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10510C
 10520C AWALBG IS THE AREA OF WALL BELOW GROUND.
 10530C
 10540C BH IS THE BEGINNING OF THE HEATING SEASON.
 10550C
 10560C COP IS THE HEAT PUMP COEFFICIENT OF PERFORMANCE
 10570C
 10580C
 10590C TQINCW IS THE SOLAR INSOLATION AVAILABLE DURING THE WINTER
 10600C
 10610C TQINCS IS THE SOLAR INSOLATION AVAILABLE DURING THE SUMMER
 10620C
 10630C PCT IS THE PERCENTAGE OF THE HEIGHT DIMENSIONS OF THE TANK
 10640C THAT IS ABOVE GROUND (IF PCT=0, THE TANK IS ASSUMED TO BE
 10650C COMPLETELY BELOW GROUND).
 10660C
 10670C DMINQ IS THE TOTAL HEAT NEEDED FOR THE MINIMUM ACES DESIGN
 10680C
 10690C DMINBL IS THE TOTAL BASEMENT LOAD FOR THE MINIMUM ACES DESIGN
 10700C
 10710C CPRVT IS THE THERMAL CAPACITANCE OF THE TANK ON A SQ.FT. BAS.
 10720C
 10730C CPRVW IS THE THERMAL CAPACITANCE OF THE WALL BELOW GROUND
 10740C
 10750C TAMBA IS THE AMBIENT TEMPERATURE.
 10760C
 10770C AREAC IS THE AREA OF THE COLLECTOR.
 10780C
 10790C CK IS THE INTERCEPT OF THE COLLECTOR EFFICIENCY CURVE
 10800C
 10810C C IS THE SLOPE OF THE COLLECTOR EFFICIENCY CURVE
 10820C
 10830C FF IS A FACTOR TO ADJUST THE COP OF THE HEATPUMP IF DESIRED
 10840C
 10850C PUMP IS THE ENERGY NEEDED BY THE PANEL PUMP
 10860C
 10870C PUME IS THE ENERGY NEEDED BY THE EVAPORATOR PUMP
 10880C
 10890C PUMC IS THE ENERGY NEEDED BY THE COOLING PUMP
 10900C
 10910C FANH IS THE ENERGY THE NEEDED BY HEATING BLOWER
 10920C
 10930C FANC IS THE ENERGY NEEDED BY THE COOLING BLOWER
 10940C
 10950C IN IS THE OPTION TO PUT THE TANK INSIDE OR OUTSIDE THE HOUSE
 10960C
 10970C *****
 10980C
 10990 COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UNAL,TTANK,TAVE,TWELA,
 11000 1 TQHLHW,TQHHWW,TBLDHW,TBLOCW,TQCCW,TQHHWS,TQHLWS,


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11010      1      TBLOCS,TBLOHS,TQCCS,AWALBG,TIME,RC,34,COP,TQCS,TMLHS,
11020      1      TMLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINRL,
11030      1      CPRVT,CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,
11040      1      PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN,AA,BB
11050      COMMON/BLOCK/IDAY,IMONTH,QHL,QHW,QC,
11060      1      QINCI,BASLOD,XTEMP,A(200),
11070      1      TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
11080      COMMON /STOP/ENDC,TTANK2
11090      COMMON /CPO/COP1
11100      COMMON /PEK1/PEK
11110      REAL KADX
11120      LOGICAL NORTH,FULL,IN,BOTH
11130      DATA ZERO/0./,ONE/1./,TWO/2./,DELTA/1.365/
11140      DATA TWELL/45.,42.,40.,39.,41.,45.,51.,55.,57.,57.,55.,50./
11150      LOGICAL FIRST
11160C
11170C      INITIALIZATION
11180      TQMLHW = ZERO
11190      TQINCS = ZERO
11200      TQINCW = ZERO
11210      TQCCW = ZERO
11220      TQHWWH = ZERO
11230      TQHWHS = ZERO
11240      TQCCS = ZERO
11250      TQMLHS = ZERO
11260      TBLO = ZERO
11270      DAYC = ZERO
11280      PDAYC = ZERO
11290      DMINQ1 = ZERO
11300      DMINQ2 = ZERO
11310      DMINBL = ZERO
11320C
11330C      READ IN INPUT FILES
11340C
11350      CALL DINPUT
11360C
11370      TZONEW = A(88)
11380      THOTW = A(50)
11390      AA = A(31)
11400      BB = A(38)
11410      AA = AA * A(102)
11420      TTANK2 = A(96)
11430      ENDC = A(97)
11440      AWALBG = A(65)
11450      KADX = A(28)/TWO
11460      UWALBG = A(56)
11470      HWALRG = A(12)
11480      UTANKT = A(139)
11490      HEIGHT = A(140)
11500      PF = A(141)

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11510 PCT = A(142)
11520 UWAL = ONE/(ONE/UWALRG + ONE/HWALRG)
11530 NDAYS = A(8)
11540 UTANKA = JTANKT
11550 UTANKB = A(21)
11560 UTANKW = UTANKH
11570 CPRVT = A(143)
11580 CPRVW = A(144)
11590 SET = A(145)
11600 TTANK = A(146)
11610 CK = A(147)
11620 C = A(148)
11630 TAMBA = A(149)
11640 AREAC = A(150)
11650 FF = A(22)
11660 SET2 = A(23)
11670 SET3 = A(24)
11680 PUMP = A(25)
11690 PUME = A(26)
11700 PUMC = A(27)
11710 PUMW = A(16)
11720 FANC = FANCFM * DELTA
11730 FANH = FANCFM1 * DELTA
11740 XPER = A(29)
11750 FULL = .FALSE.
11760 IF (SET .GT. ZERO) FULL = .TRUE.
11770 BOTH = .FALSE.
11780 IN = .FALSE.
11790 IF (SET2 .GT. ZERO) IN = .TRUE.
11800 IF (SET3 .GT. ZERO) BOTH = .TRUE.
11810C
11820C DETERMINE THE BEGINNING OF THE COOLING SEASON AND THE BEGINNING OF
11830C THE HEATING SEASON.
11840C
11850 SCALE = ONE
11860 CALL WAHP(TTANK,TZONEW,QCOND,QEVAP,HP)
11870 CALL WWHP(TTANK,THOTW,QCOND1,QEVAP1,HP1,COP1)
11880 SCALE = SIZE/QCOND
11890 CALL BEGIN
11900C
11910C DETERMINE THE LOADS DURING THE HEATING SEASON
11920C
11930 REWIND(10)
11940 DO 710 I=1,366
11950 DO 810 J=1,24
11960 READ(10)QHL,QHW,QC,QINCI,XX,YY
11970 TQC = TQC + QC
11980 TQH = TQH + QHL
11990 TQW = TQW + QHW
12000 TQI = TQI + QINCI

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12010 810 CONTINUE
12020 710 CONTINUE
12030 WRITE(9,811)TQC,TQH,TQW,TQI
12040 811 FORMAT(1X,4(F15.2,4X))
12050 REWIND(10)
12060 IBEGIN = 1
12070 IEND = IFIX(BC - ONE)
12080 10 CONTINUE
12090 DO 40 I = IBEGIN, IEND
12100     DO 30 J = 1, 24
12110         READ(10) QHL,QHW,QC,QINCI,BASLOD,XTEMP
12120         TQHLHW = TQHLHW + QHL
12130         TQCCW = TQCCW + QC
12140         TQHHWW = TQHHWW + QHW
12150         TBLO = TBLO + BASLOD
12160         IF(I .LE. 19 .OR. I .GT. 31) GO TO 20
12170         DMINQ1 = DMINQ1 + QHL
12180         DMINQ2 = DMINQ2 + QHW
12190         DMINBL = DMINBL + BASLOD
12200 20 CONTINUE
12210         TWINCW = TWINCW + QINCI
12220 30 CONTINUE
12230 40 CONTINUE
12240 IF (IEND .NE. IFIX(BC - ONE)) GO TO 50
12250C
12260C DETERMINE THE LOADS DURING THE COOLING SEASON
12270C
12280 CONTINUE
12290 IBHM1 = IFIX(BH - ONE)
12300 IBC = IFIX(BC)
12310 DO 70 I = IBC, IBHM1
12320     DO 60 J = 1, 24
12330         READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
12340         TQHWHS = TQHWHS + QHW
12350         TQCCS = TQCCS + QC
12360         TQHLHS = TQHLHS + QHL
12370         TQINCS = TQINCS + QINCI
12380         DAYC = DAYC + QC
12390 60 CONTINUE
12400         IF(DAYC .GT. PDAYC) PDAYC = DAYC
12410         DAYC = ZERO
12420 70 CONTINUE
12430 IF(IEND .NE. IFIX(BC - ONE))GO TO 50
12440 IBEGIN = IFIX(BH)
12450 IEND = NDAYS
12460 GO TO 10
12470C
12480C CALCULATE THE TOTAL HEAT LOAD IN THE WINTER.
12490C
12500 50 QHTOT = TQHHWW + TQHLHW

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12510C
12520C LOGIC TO DETERMINE IF THE SYSTEM IS IN A NORTHERN OR
12530C SOUTHERN CLIMATE
12540C
12550 NORTH = .FALSE.
12560 IF (QHTOT .GT. TQCCS/(ONE - ONE/COP)) NORTH = .TRUE.
12570C
12580C DETERMINE THE VOLUME OF THE ICE STORAGE TANK FOR FULL ACES.
12590C
12600 IF (.NOT. FULL) GO TO 80
12610 CALL TANK(NORTH,VOLUME,BOTH)
12620 AREA = VOLUME/HEIGHT
12630 SIDE = SQRT(AREA)
12640 SID = SIDE
12650C
12660C DETERMINE THE SIZE OF THE COLLECTORS.
12670C
12680 CALL PANEL(NORTH,VOLUME,SIDE,SIZEE,PANUM)
12690 SIDE = FLOAT(IFIX(SIDE)) + ONE
12700 VOLUME = SIDE * SIDE * HEIGHT
12710 SIZ = PANUM * AREAC
12720 GO TO 90
12730 80 CONTINUE
12740C
12750C DETERMINE THE VOLUME OF THE ICE STORAGE TANK FOR THE MINIMUM ACES.
12760C
12770 CALL TANK2(VOLUME)
12780 AREA = VOLUME/HEIGHT
12790 SIDE = SQRT(AREA)
12800 SID = SIDE
12810 NORTH = .TRUE.
12820C
12830C DETERMINE THE SIZE OF THE COLLECTORS
12840C
12850 CALL PANEL(NORTH,VOLUME,SIDE,SIZEE,PANUM)
12860 SIDE = FLOAT(IFIX(SIDE)) + ONE
12870 VOLUME = SIDE * SIDE * HEIGHT
12880 SIZ = PANUM * AREAC
12890 90 CONTINUE
12900 WRITE(9,1000)
12910 1000 FORMAT(1H1)
12920 WRITE(9,1001)
12930 1001 FORMAT(////////,45X,'ACES COMPONENT SIZES',1X)
12940 IF(.NOT.FULL) GO TO 105
12950 WRITE(9,1002)
12960 1002 FORMAT(////,30X,'THE LISTED COMPONENT SIZES ARE FOR THE',
12970 12X,'FULL ACES',1X)
12980 GO TO 110
12990 105 CONTINUE
13000 WRITE(9,1003)

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13010 1003 FORMAT(////,30X,'THE LISTED COMPONENT SIZES ARE FOR THE',
13020      12X,'MINIMUM ACES',1X)
13030 110 CONTINUE
13040      WRITE(9,1004)VOLUME
13050 1004 FORMAT(////,30X,'THE VOLUME OF THE ACES STORAGE TANK IS',F10.2,
13060      11X,'CUBIC FEET')
13070      WRITE(9,1005)SIZEE
13080 1005 FORMAT(////,30X,'THE AREA OF THE COLLECTOR/CONVECTOR ARRAY IS',
13090      .1F10.2,1X,'SQUARE FEET')
13100      WRITE(9,1006)SID
13110 1006 FORMAT(////,30X,'THE SIDE DIMENSION OF THE TANK IS ',F10.2,
13120      11X'FEET')
13130      WRITE(9,1007)PANUM
13140 1007 FORMAT(////,30X,'THE FRACTIONAL NUMBER OF PANELS NEEDED ARE',
13150      .1F10.2,1X)
13160      WRITE(13)8C,8H,SIZE,SIZE2,SID,SIZ,TQHLHW,TQHWHW,TQCCW,
13170      1 TQHLHS,TQHWHS,TQCCS,VOLUME,SIZEE,PDAYC,PEK
13180      STOP
13190C
13200C      LAST CARD OF MAIN PROGRAM
13210C
13220      END
13230      SUBROUTINE DINPUT
13240C
13250C*****
13260C
13270C      THIS SUBROUTINE REWINDS TAPES, READS IN TAPE FROM THE LOADS
13280C      PROGRAM, AND THE FOLLOWING INFORMATION FROM TAPE 5:
13290C          1. TITLE
13300C          2. INPUT PARAMETERS
13310C          3. WELL WATER TEMPERATURES
13320C
13330C      PROJECT: ACES
13340C
13350C      DEVELOPED BY HONEYWELL
13360C
13370C      CREATION DATE: 8/23/78
13380C
13390C*****
13400C
13410C
13420      COMMON /BLOCK/1HOUR,1DAY,1MONTH,QHL,QHW,
13430      1      QC,QINCI,BASLOD,
13440      1      XTEMP,A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
13450C
13460      DIMENSION LABEL(10),MARGIN(10)
13470      CHARACTER LABEL*6,MARGIN*6
13480C
13490      REWIND (8)
13500      REWIND(10)

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13510      MAXA = 0
13520      READ(5,500) MARGIN
13530      WRITE(9,1000) MARGIN
13540 100   CONTINUE
13550      READ(5,2000) N,DUM,LABEL
13560      IF (N .LE. 0) GO TO 200
13570      IF (N .GT. MAXA) MAXA = N
13580      A(N) = DUM
13590      WRITE(9,3000) N,A(N),LABEL
13600      GO TO 100
13610 200   CONTINUE
13620      WRITE(9,913) TWELL
13630      READ(11)FANCFM,FNCFM1,SIZE,SIZE2,HEATO
13640      WRITE(9,211)
13650 211   FORMAT(1X,'          FANCFM          FANCFM1          SIZE1
13660      1SIZE2          HEATO')
13670      WRITE(9,212)FANCFM,FNCFM1,SIZE,SIZE2,HEATO
13680 212   FORMAT(V)
13690      RETURN
13700 500   FORMAT(13A6)
13710 1000  FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6//)
13720 2000  FORMAT(15,F15.5,10A6)
13730 3000  FORMAT(3H A(,13,1H),G15.5,3X,10A6)
13740 913   FORMAT(2X,22HWELL WATER TEMPERATURE,2X,12F8.3)
13750C
13760C      LAST CARD OF SUBROUTINE DINPUT.
13770C
13780C      END
13790      SUBROUTINE BEGIN
13800C
13810C*****
13820C
13830C      THIS SUBROUTINE DETERMINES THE BEGINNING OF THE HEATING SEASON,
13840C      THE BEGINNING OF THE COOLING SEASON. THE TOTAL HEATING LOAD FOR
13850C      A WEEK, THE TOTAL COOLING LOAD FOR A WEEK.
13860C
13870C      THE SUBROUTINE STATEMENT IS
13880C
13890C      SUBROUTINE BEGIN
13900C
13910C      OTHER VARIABLES USED:
13920C
13930C      WTH IS AN OUTPUT PARAMETER WHICH CONTAINS THE TOTAL HEATING LOAD
13940C      FOR THE WEEK WHEN THE HEATING SEASON BEGINS.
13950C
13960C      WTC IS AN OUTPUT PARAMETER WHICH CONTAINS THE TOTAL COOLING LOAD
13970C      FOR THE WEEK WHEN THE COOLING SEASON BEGINS
13980C
13990C      PROJECT: ACES
14000C

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14010C   DEVELOPED BY HONEYWELL
14020C
14030C   CREATION DATE:  AUGUST 16,1978
14040C
14050C *****
14060C
14070      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWALL,TTANK,TAVE,TWELA,
14080      1      TQHLHW,TQHHWW,TBLDHW,TBLOCW,TQCCW,TQHHWS,TQHLHS,TBLOCS,
14090      1      TBLDHS,TQCCS,AWALRG,TIME,BC,BH,COP,TCCS,TMLHS,THLHW,
14100      1      TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,CPRVW,TAMBA,
14110      1      AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN
14120      1      ,AA,BB
14130      COMMON /BLOCK/IMOUR,IDAY,IMONTH,QHL,QHW,
14140      1      QC,QINCI,BASLOD,XTEMP,
14150      1      A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
14160      COMMON /CPO/COP1
14170      DATA ZERO/0./,ONE/1./,FORTEN/14./,SIX/6./
14180      REAL KADX
14190      LOGICAL IN
14200C
14210C   INITIALIZE
14220C
14230      REWIND(10)
14240      BH = ZERO
14250      BC = ZERO
14260      DAY = ZERO
14270      WTH = ZERO
14280      WTC = ZERO
14290C
14300C   LOOP TO DETERMINE WEEKLY HEATING AND COOLING LOADS
14310C
14320      DO 20 I = 1, NDAYS
14330          TH = ZERO
14340          TC = ZERO
14350          DO 10 J = 1, 24
14360              READ(10) QHL,QHW,QC,QINCI,BASLOD,XTEMP
14370              TH = TH + QHL * (ONE - ONE/COP) + QHW * (ONE - ONE/COP1)
14380              TC = TC + QC
14390      10      CONTINUE
14400              WTC = WTC + TC
14410              WTH = WTH + TH
14420              DAY = DAY + ONE
14430              IF (DAY .LT. FORTEN) GO TO 20
14440              DAY = ZERO
14450              IF (BC .LE. ZERO .AND. WTC .GT. WTH) BC = I - SIX
14460              IF (BH .GT. ZERO) RETURN
14470              IF (BC .GE. ONE .AND. WTH .GT. WTC) BH = I - SIX
14480              WTC = ZERO
14490              WTH = ZERO
14500      20      CONTINUE

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14510      RETURN
14520C
14530C      LAST CARD OF SUBROUTINE BEGIN.
14540C
14550      END
14560      SUBROUTINE WAHP(TWI,TAI,QCOND,QEVAP,HP)
14570C
14580C*****
14590C
14600C      THIS SUBROUTINE PREDICTS THE PERFORMANCE OF A WATER TO AIR HEAT
14610C      PUMP AS A FUNCTION OF THE EVAPORATOR AND CONDENSER INLET TEMP-
14620C      ERATURE.
14630C
14640C      PROJECT:  ACES
14650C
14660C      DEVELOPED BY HONEYWELL
14670C
14680C      CREATION DATE 9/6/78
14690C
14700C*****
14710C
14720      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
14730      1          TQHLHW,TQHHWW,TBLDHW,TBLDCW,TQCCW,TQHHWS,TQHLHS,
14740      1          TBLDCS,TBLDHS,TQCCS,AWALHG,TIME,BC,BH,COP,TCCS,THLHS,
14750      1          THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,
14760      1          CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,
14770      1          NDAYS,XPER,SCALE,IN,AA,BB
14780      REAL KADX
14790      LOGICAL IN
14800      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
14810      1          P00155/.00155/,P7336/.7336/,T9P23/29.23/,EIGHTY/80./,
14820      1          F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.14/,
14830      1          T545/2545./,P00159/.00159/,P6875/.6875/
14840C
14850      EET = TWI
14860      ECT = TAI
14870      BTU = JNE123 * (EET - THRTWO) + SIXFT - THUND * ECT
14880      Y = T9P23 * (ECT - EIGHTY) + F569
14890      XM = (Y - T523)/SIX2P5
14900      WATTS = XM * (EET - TWP5) + T523
14910      COP = BTU/(WATTS * PI) + FF
14920      QCOND = BTU
14930      BTUM = QCOND/COP
14940      QEVAP = QCOND - BTUM
14950      QCOND = QCOND * (P00155 * EET + P7336) * SCALE
14960      QEVAP = QEVAP * (P00159 * EET + P6875) * SCALE
14970      QMOT = QCOND - QEVAP
14980      COP = QCOND/QMOT
14990      HP = QMOT/T545
15000      RETURN

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15010C
15020C      LAST CARD OF SUBROUTINE WAHP.
15030C
15040C      END
15050C      SUBROUTINE TANKLD(SIDE,TLOSS,SURFW,TLOSA,TEMP,TO,FIRST)
15060C
15070C*****
15080C
15090C      THIS SUBROUTINE WILL EVALUATE THE TOTAL TANK LOSS, THE BASEMENT WALL
15100C      OR FLOOR AREA REPLACED BY THE TANK, AND THE ENERGY TRANSFERRED
15110C      TO OR FROM THE AMBIENT AIR.
15120C
15130C      THE SUBROUTINE STATEMENT IS
15140C
15150C      SUBROUTINE TANKLD(SIDE,TLOSS,SURFW,TLOSA,TEMP,TO,FIRST)
15160C
15170C      WHERE
15180C
15190C      SIDE IS THE SIDE DIMENSION OF THE TANK.
15200C
15210C      TLOSS IS THE TOTAL TANK LOSS.
15220C
15230C      SURFW IS THE BASEMENT SURFACE AREA THAT THE TANK REPLACES.
15240C
15250C      TLOSA IS THE ENERGY LOSS FROM THE TANK TO THE BASEMENT.
15260C
15270C      TEMP IS THE BASEMENT TEMPERATURE
15280C
15290C      TO IS THE OUTSIDE TEMPERATURE
15300C
15310C      FIRST IS A LOGICAL VARIABLE.
15320C
15330C      PROJECT:  ACES
15340C
15350C      DEVELOPED BY HONEYWELL
15360C
15370C      CREATION DATE: 8/25/78
15380C
15390C*****
15400C
15410C      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
15420C      1      TQHLHW,TQHHWW,TBLOWH,TBLOWW,TQCCW,TQHHWS,TQHLHS,TBLOCS,
15430C      1      TBLOHS,TQCCS,AWALBG,TIME,HC,BH,COP,TCCS,THLHS,THLHW,TCCW,
15440C      1      TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,CPRVW,TAMBA,
15450C      1      AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN
15460C      1      ,AA,BB
15470C      COMMON /BLOCK/IMOUR,IDAY,IMONTH,QHL,QHW,
15480C      1      QC,QINCI,HASLOO,XTEMP,
15490C      1      A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
15500C      LOGICAL FIRST,IN

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15510 REAL KADX
15520 DATA ZERO/0./,TWO/2./,ONE/1./,ET3P6/83.6/
15530C
15540C INITIALIZATION ON FIRST PASS.
15550C
15560 IF (.NOT. FIRST) GO TO 10
15570 AX = ZERO
15580 IF (PCT .GE. ONE) AX = ONE
15590 XK = ZERO
15600 IF (PCT .GT. ZERO) XK = ONE
15610 CPRVP = ET3P6
15620 CPRV2 = CPRVT + CPRVP
15630 CPRV3 = CPRVT + CPRVP + CPRVW
15640 UTKN = UTANKA * XK
15650 UTKN1 = TWO * UTKN
15660 UTKN2 = UTKN1
15670 TEMP1 = ONE/UTANKW + ONE/KADX
15680 UTKND = ONE/(TEMP1 + AX/UWAL)
15690 UTKND1 = TWO * UTKND
15700 UTKND2 = UTKND1
15710 UTKNDW = ONE/(TEMP1 + XK/UWAL)
15720 UTKWD1 = TWO * UTKNDW
15730 UTKWD2 = UTKWD1
15740 TA = TFMP
15750 IF(.NOT. IN) TA = TO
15760 TTA = TTANK + (TA - TTANK)/TWO
15770 UD = ONE/(ONE/UTKND + TWO/KADX)
15780 QD = UD * (TTANK - TWELL(IMONTH))
15790 TTG1 = TTANK - QD/UTKND1
15800 TTG2 = TTG1 - QD/UTKND2
15810 TTG3 = TTG2 - QD/KADX
15820 UWD = ONE/(ONE/UTKNDW + TWO/KADX)
15830 QWD = UWD * (TTANK - TWELL(IMONTH))
15840 TTGW1 = TTANK - QWD/UTKWD1
15850 TTGW2 = TTGW1 - QWD/UTKWD2
15860 TTGW3 = TTGW2 - QWD/KADX
15870 TEMP2 = ONE/CPRVT
15880 TEMP3 = UTKN1 + UTKN2
15890 TEMP4 = ONE/CPRV2
15900 TEMP5 = UTKND1 + UTKND2
15910 TEMP6 = ONE/CPRV3
15920 TEMP7 = UTKWD1 + UTKWD2
15930 TEMP8 = ONE/CPRVP
15940 TEMP9 = UTKND2 + KADX
15950 TEMP10 = TWO * KADX
15960 TEMP11 = UTKWD2 + KADX
15970 TEMP12 = TEMP8 * KADX
15980 FIRST = .FALSE.
15990 10 CONTINUE
16000 TA = TFMP

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16010      IF (.NOT. IN) TA = TO
16020C
16030C      DETERMINE THE INTERNAL TANK SIZE ABOVE GROUND AND THE HEAT
16040C      THAT IS TRANSFERED TO OR FROM THE TANK.
16050C
16060      THTSD = TWO * HEIGHT * SIDE
16070      SIDESQ = SIDE * SIDE
16080      TTA = TTA * (ONE - TEMP2 * TEMP3) + TEMP2 * (TTANK * UTKN1
16090      1      + TA * UTKN2)
16100      QLOST = (THTSD * PCT + SIDESQ) * UTKN1 * (TTANK - TTA)
16110C
16120C      DETERMINE THE INTERNAL NODE TEMPERATURE BETWEEN THE TANK AND THE
16130C      GROUND (NO BASEMENT SURFACE).
16140C
16150      TTG1 = TTG1 * (ONE - TEMP4 * TEMP5) + TEMP4 * (UTNKD1 * TTANK
16160      1      + TTG2 * UTKND2)
16170      TTG2 = TTG2 * (ONE - TEMP8 * TEMP9) + TEMP8 * (UTNKD2 * TTG1
16180      1      + KADX * TTG3)
16190      TTG3 = TTG3 * (ONE - TEMP8 * TEMP10) + TEMP12 * (TTG2 +
16200      1      TWELL(IMONTH))
16210      QLOSG = (TWO * THTSD * (ONE - PCT) + SIDESQ) * UTKND1 * (TTANK -
16220      1      TTG1)
16230C
16240C      DETERMINE THE INTERNAL NODE TEMPERATURE BETWEEN THE TANK AND THE
16250C      GROUND (WITH A BASEMENT SURFACE), THE BASEMENT SURFACE
16260C      REPLACED BY THE TANK, THE TOTAL TANK LOSS, AND THE TANK LOSS TO
16270C      THE BASEMENT AIR.
16280C
16290      TTGW1 = TTGW1 * (ONE - TEMP6 * TEMP7) + TEMP6 * (UTKWD1 * TTANK
16300      1      + UTKWD2 * TTGW2)
16310      TTGW2 = TTGW2 * (ONE - TEMP8 * TEMP11) + TEMP8 * (UTKWD2 *
16320      1      TTGW1 + KADX * TTGW3)
16330      TTGW3 = TTGW3 * (ONE - TEMP8 * TEMP10) + TEMP12 * (TTGW2
16340      1      + TWELL(IMONTH))
16350      QLOSGW = ((ONE - XK) * SIDESQ + THTSD * PCT) * UTKWD1 * (TTANK -
16360      1      TTGW1)
16370C
16380      TLOSS = QLOST + QLOSG + QLOSGW
16390      SURFW = THTSD * PCT + SIDESQ
16400      TLOSA = (THTSD * PCT + SIDESQ) * UTKN2 * (TTA - TA)
16410      IF (PCT .LE. ZERO .OR. .NOT. IN) SURFW = ZERO
16420      IF (.NOT. IN) TLOSA = ZERO
16430      RETURN
16440C
16450C      LAST CARD OF SUBROUTINE TANKLD
16460C
16470      END
16480      SUBROUTINE COLECT(QINC,VEL,PANUM,QCOLL)
16490C
16500C*****

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16510C
16520C THIS SUBROUTINE WILL DETERMINE THE AMOUNT OF ENERGY THAT CAN
16530C BE COLLECTED FROM A SOLAR PANEL GIVEN THE PANEL PERFORMANCE
16540C CHARACTERISTICS, CK , C , AA , AND BH.
16550C
16560C THE SUBROUTINE STATEMENT IS
16570C
16580C SUBROUTINE COLECT(QINC,VEL,PANUM,QCOLL)
16590C
16600C WHERE
16610C
16620C QINC IS THE INCIDENT RADIATION.
16630C
16640C PANUM IS THE NUMBER OF PANELS.
16650C
16660C QCOLL IS THE ENERGY COLLECTED
16670C VEL IS THE WIND VELOCITY
16680C
16690C PROJECT: ACES
16700C
16710C DEVELOPED BY HONEYWELL
16720C
16730C CREATION DATE: 8/25/78
16740C
16750C *****
16760C
16770 COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
16780 1 TQHLHW,TQHWWH,TBLOWH,TBLOWW,TWLLW,TUHHHS,TQHLHS,TBLOCS,
16790 1 TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,
16800 1 TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINSL,CPRVT,CPRVW,TAMBA,
16810 1 AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN
16820 1 ,AA,BB
16830 REAL KADX
16840 LOGICAL IN
16850 DATA ZERO/0./,FIVE/5./
16860C
16870 IF(AA .LE. ZERO) GO TO 20
16880 ZZ = AA * EXP(BB * VEL * 1.151)
16890 C = CK/ZZ
16900 20 CONTINUE
16910 ETA = ZERO
16920 IF (QINC .LE. ZERO) GO TO 10
16930 ETA = CK - C * (TTANK - TAMBA)/QINC
16940 IF (ETA .LT. ZERO) ETA = ZERO
16950 10 CONTINUE
16960 Q = ETA * QINC
16970 IF (Q .LE. ZERO .AND. (TAMBA - FIVE) .GE. TTANK)
16980 1 Q = -C * (TTANK - TAMBA)
16990 QCOLL = Q * PANUM * AREAC
17000 RETURN

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17010C
17020C      LAST CARD OF SUBROUTINE COLECT.
17030C
17040C      END
17050C      SUBROUTINE TANK2(VOLUME)
17060C
17070C*****
17080C
17090C      THIS SUBROUTINE SIZES A TANK BASED ON THE MINIMUM ACES DESIGN
17100C      REQUIREMENT.  THE TANK HAS ENOUGH STORAGE TO MEET THE SPACE
17110C      AND DOMESTIC HOT WATER LOAD FOR 12 CONSECUTIVE SUNLESS DAYS
17120C      IN THE COLDER MONTHS OF THE YEAR.
17130C
17140C      THE SUBROUTINE STATEMENT IS
17150C
17160C      SUBROUTINE TANK2(VOLUME)
17170C
17180C      WHERE
17190C
17200C      VOLUME IS THE VOLUME OF THE ICE STORAGE BIN IN CUBIC FEET.
17210C
17220C      PROJECT:  ACES
17230C
17240C      DEVELOPED BY HONEYWELL
17250C
17260C      CREATION DATE: 8/25/78
17270C
17280C*****
17290C
17300      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
17310      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
17320      COMMON /PASS/KAOX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
17330      1      TQHLHW,TQHHWW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TJHLHS,TBLDCS,
17340      1      TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,T4LHS,THLHW,TCCW,
17350      1      TQINCH,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,CPRVW,TAMBA,
17360      1      AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANCL,NDAYS,XPER,SCALE,IN
17370      1      ,AA,BB
17380      COMMON /BLOCK/IDAY,IMONTH,QHL,QHW,
17390      1      QC,QINCI,BASLOD,XTEMP,
17400      1      A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
17410      REAL KADX
17420      LOGICAL IN,FIRST
17430      DATA ZERO/0./,ONE/1./,OPEM4/1.213944E-4/,FIFTIN/15./,T88/288./,
17440      1      P0001/.0001/
17450C
17460      REWIND(8)
17470      TEMA = ZERO
17480      TEMO = ZERO
17490      SUM = ZERO
17500C

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17510C      DETERMINE THE AVERAGE TEMPERATURE OVER THE PERIOD.
17520C
17530      DO 20 I = 1, 12
17540          READ(8) DB,OP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,ICITY
17550          IMONTH = IDUM1
17560          DO 10 J = 1, 24
17570              TEMA = TEMA + XTEMP
17580              TEMO = TEMO + DB(J)
17590      10      CONTINUE
17600      20      CONTINUE
17610          TIME = T88
17620          TAVE = TEMA/TIME
17630          TOAVE = TEMO/TIME
17640          T = TAVE
17650          TO = TOAVE
17660          TWI = A(50)
17670C
17680C      THE ENERGY NEEDED FOR HEATING IS...
17690C
17700      QOUT = DMINQ1 + DMINQ2
17710C
17720C      INITIAL GUESS ON TANK VOLUME IS...
17730C
17740      QICE1 = QOUT * (ONE - ONE/COP)
17750      VOLUME = (QICE1 * OPEM4)/PF
17760      AREA = VOLUME/HEIGHT
17770      SIDE = SQRT(AREA)
17780C
17790C      DETERMINE TANK LOSSES
17800C
17810      30      CONTINUE
17820          FIRST = .TRUE.
17830          CALL TANKLD(SIDE,TLOSS,SURFW,TLOSA,T,TO,FIRST)
17840C
17850C      DETERMINE THE ACTUAL REQUIRED HEAT OUTPUT.
17860C
17870      CALL WAHP(TTANK,T,SIZE1,QEVAP,HP)
17880      CALL WHP(TTANK,TWI,QCOND1,QEVAP1,HP1,COP1)
17890      HEAT = DMINQ1
17900      HEATMB = HEAT + DMINBL
17910      BASE1 = DMINBL * (ONE - SURFW/AWALBG)
17920      QNEED2 = DMINQ2/(ONE + (ONE - XPER)*PUMW/(QCOND1 + (ONE - XPER)
17930      *PUMW))
17940      TF2 = QNEED2/((PUMW*(ONE - XPER) + QCOND1) * TIME)
17950      QNEED1 = (HEATMB - BASE1 + TLOSA * TIME - TF2 * TIME * XPER *
17960      1 (PUME + PUMW))/(ONE + (FANH + XPER * PUME)/(SIZE1 + FANH
17970      1 + XPER * PUME))
17980      TF1 = QNEED1/((SIZE1 + FANH + XPER * PUME) * TIME)
17990      TF = TF1 + TF2
18000      QOUT = QNEED1 * (ONE - ONE/COP) + QNEED2 * (ONE - ONE/COP1)

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18010C
18020C THE AMOUNT OF ICE GENERATED AND THE MAXIMUM AMOUNT OF ICE
18030C POSSIBLE IS...
18040C
18050 CUFT = (QOUT + TLOSS * TIME
18060 1 = (ONE - XPER) * PUME * TIME * TF) * OPEM4
18070 CUFTN = PF * HEIGHT * SIDE * SIDE
18080 FX = CUFTN - CUFT
18090 DEL = P0001 * SIDE
18100 SIDP = SIDE + DEL
18110C
18120C REPEAT PREVIOUS PROCEDURE.
18130C
18140 FIRST = .TRUE.
18150 CALL TANKLD(SIDP,TLOSS,SURFW,TLOSA,T,T0,FIRST)
18160 HEAT = DMINQ1
18170 HEATMB = HEAT + DMINBL
18180 BASE1 = DMINBL * (ONE - SURFW/AWALBG)
18190 QNEED2 = DMINQ2/(ONE + (ONE - XPER)*PUMW/(QCOND1 + (ONE - XPER)
18200 1 *PUMW))
18210 TF2 = QNEED2/((PUMW*(ONE - XPER) + QCOND1) * TIME)
18220 QNEED1 = (HEATMB - BASE1 + TLOSA * TIME - TF2 * TIME * XPER *
18230 1 (PUME + PUMW))/(ONE + (FANH + XPER * PUME)/(SIZE1 + FANH
18240 1 + XPER * PUME))
18250 TF1 = QNEED1/((SIZE1 + FANH + XPER * PUME) * TIME)
18260 TF = TF1 + TF2
18270 QOUT = QNEED1 * (ONE - ONE/COP) + QNEED2 * (ONE - ONE/COP1)
18280C
18290C THE AMOUNT OF ICE GENERATED AND THE MAXIMUM AMOUNT OF ICE
18300C POSSIBLE IS...
18310C
18320 CUFT = (QOUT + TLOSS * TIME
18330 1 = (ONE - XPER) * PUME * TIME * TF) * OPEM4
18340 CUFTN = PF * HEIGHT * SIDP * SIDP
18350 FXD = CUFTN - CUFT
18360 FXP = (FXD - FX)/DEL
18370 SIDN = SIDE - FX/FXP
18380 SIDE = SIDN
18390 SUM = SUM + ONE
18400 WRITE(9,101)SIDE,CUFT,CUFTN,FX,FXD
18410 101 FORMAT(1X,5(F15.3,3X))
18420 IF (ABS(FX) .GT. ONE .AND. SUM .LT. FIFTIN) GO TO 30
18430 IF (SUM .GE. FIFTIN) WRITE(9,1000)
18440 1000 FORMAT(1X,'TANK2 HAS NOT CONVERGED')
18450 VOLUME = HEIGHT * SIDE * SIDE
18460 RETURN
18470C
18480C LAST CARD OF TANK2.
18490C
18500 END

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18510      SUBROUTINE TANK(NORTH,VOLUME,BOTH)
18520C
18530C*****
18540C
18550C      THIS SUBROUTINE WILL DETERMINE THE VOLUME OF THE ICE STORAGE TANK
18560C      FOR A FULL ANNUAL CYCLE ENERGY SYSTEM.
18570C
18580C      THE SUBROUTINE STATEMENT IS
18590C
18600C      SUBROUTINE TANK(NORTH,VOLUME,BOTH)
18610C
18620C      WHERE
18630C
18640C      NORTH IS A LOGICAL VARIABLE. IF DEFINED AS
18650C          .TRUE. = THE TANK IS SIZED FOR A NORTHERN CLIMATE.
18660C          .FALSE. = THE TANK IS SIZED FOR A SOUTHERN CLIMATE.
18670C
18680C      VOLUME IS THE VOLUME OF THE ICE STORAGE BIN IN CUBIC FEET.
18690C
18700C      BOTH IS A DELIMETER OPTION
18710C
18720C      PROJECT: ACES
18730C
18740C      DEVELOPED BY HONEYWELL
18750C
18760C      CREATION DATE: 8/22/78
18770C
18780C*****
18790C
18800      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWALI,TTANK,TAVE,TWELA,
18810      1      TQHLHW,TQHHWW,TBLDHW,TBLDCW,TQCCW,TQHHWS,TQHLHS,
18820      1      TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,
18830      1      TCCS,THLHS,THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINDL,
18840      1      CPRVT,CPRVW,TAMRA,AREAC,CK,C,FF,PUMP,
18850      1      PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN,AA,BB
18860      COMMON /YEARLY/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
18870      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
18880      COMMON /BLOCK/IDAY,IMONTH,QHL,QHW,
18890      1      QC,QINCI,BASLOD,XTEMP,
18900      1      A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
18910      DATA TWO/2./,ONE/1./,OPEM4/1.2131944E-4/,ZERO/0./
18920      REAL KADX
18930      LOGICAL NORTH,BOTH,IXIX
18940C
18950C      INITIALIZATION
18960C
18970      VOLUME = ZERO
18980      IXIX = .FALSE.
18990      IF(NORTH) IXIX = .TRUE.
19000 5      CONTINUE

```



```

19010C
19020C
19030C
19040      IF (.NOT. NORTH) GO TO 10
19050C
19060C      FOR NORTHERN CLIMATES.....
19070C
19080C      DESIGN TANK.
19090C
19100C      CALCULATE INITIAL GUESS ON TANK SIZE
19110C
19120      QICEI = TQCCS = (TQHLHS + TQHWHS) * (ONE - ONE/COP)
19130C
19140C      SET OPEM4 = .01747/144.
19150C
19160      VOLUMI = (QICEI * OPEM4)/PF
19170      AREA = VOLUMI/HEIGHT
19180      SIDE = SQRT(AREA)
19190      GO TO 20
19200 10    CONTINUE
19210C
19220C      FOR SOUTHERN CLIMATES.....
19230C
19240C      DESIGN TANK
19250C
19260C      CALCULATE INITIAL GUESS ON TANK SIZE
19270C
19280      QICEI = (TQHLHW + TQHWHW) * (ONE - ONE/COP) - TQCCW
19290      VOLUMI = (QICEI * OPEM4)/PF
19300      AREA = VOLUMI/HEIGHT
19310      SIDE = SQRT(AREA)
19320 20    CONTINUE
19330C
19340C      DETERMINE THE SIZE OF THE TANK.
19350C
19360      CALL NEWTON(NORTH,SIDE,VOLUME)
19370      IF (.NOT. BOTH) GO TO 30
19380      ICHECK = 1
19390      IF (NORTH) ICHECK = 0
19400      NORTH = .TRUE.
19410      IF (ICHECK .EQ. 0) NORTH = .FALSE.
19420      BOTH = .FALSE.
19430      VOLUMI = VOLUME
19440      GO TO 5
19450 30    CONTINUE
19460      IF (VOLUMI .LT. ONE) GO TO 40
19470      IF (VOLUMI .LT. VOLUME) VOLUME = VOLUMI
19480      IF (VOLUMI .LE. VOLUME) NORTH = .IXIX
19490      IF (VOLUMI .GT. VOLUME) NORTH = .NOT.IXIX
19500 40    CONTINUE

```

```

19510      RETURN
19520C
19530C      LAST STATEMENT OF SUBROUTINE TANK.
19540C
19550      END
19560      SUBROUTINE NEWTON(NORTH,SIDE,VOLUME)
19570C
19580C*****
19590C
19600C      THIS SUBROUTINE DETERMINES THE SIZE OF A ICE BIN STORAGE TANK
19610C      BY EQUATING ENERGIES INTO AND OUT OF THE TANK OVER THE SEASON
19620C      OF INTEREST AND THE CORRECT DIMENSION.
19630C
19640C      THE SUBROUTINE STATEMENT IS
19650C
19660C      SUBROUTINE NEWTON(NORTH,SIDE,VOLUME)
19670C
19680C      WHERE
19690C
19700C      NORTH IS A LOGICAL VARIABLE. IF DEFINED AS
19710C          .TRUE. = THE TANK IS SIZED FOR A NORTHERN CLIMATE.
19720C          .FALSE. = THE TANK IS SIZED FOR A SOUTHERN CLIMATE.
19730C
19740C      SIDE IS THE SIDE DIMENSION OF THE TANK.
19750C
19760C      VOLUME IS THE VOLUME OF THE TANK.
19770C
19780C      PROJECT: ACES
19790C
19800C      DEVELOPED BY HONEYWELL
19810C
19820C      CREATION DATE: 8/22/78
19830C
19840C*****
19850C
19860      COMMON/PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,
19870      1          TWELA,TQHLHW,TQHHWW,TBLOHW,TBLOCW,TQCCW,TQHHWS,TQHLWS,
19880      1          TBLOCS,TBLOHS,TQCCS,AWALRG,TIME,RC,BH,COP,TCCS,THLWS,
19890      1          THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,
19900      1          CPRVT,CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,
19910      1          FANC,NDAYS,XPER,SCALE,IN,AA,BB
19920      COMMON /BLOCK/1HOUR,1DAY,1MONTH,QHL,QHW,
19930      1          QL,WINCI,BASLOD,XTEMP,
19940      1          A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
19950      REAL KADX
19960      LOGICAL IN,NORTH
19970      DATA P0001/.0001/,ZERO/0./,FIFTIN/15./,ONE/1./,QNEST/150000./
19980      DATA FIVE/5.0/
19990C
20000C

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20010C
20020      SUM = ZERO
20030 10   CONTINUE
20040      CALL STORAG(NORTH,SIDE,CUFTN,CUFT,PCUFT)
20050      FX = CUFTN - CUFT
20060      IF(.NOT,NORTH) FX = PF * HEIGHT * SIDE * SIDE - PCUFT
20070      DEL = P0001 * SIDE
20080      SIDP = SIDE + DEL
20090      CALL STORAG(NORTH,SIDP,CUFTN,CUFT,PCUFT)
20100      FXD = CUFTN - CUFT
20110      IF(.NOT,NORTH) FXD = PF * HEIGHT * SIDP * SIDP - PCUFT
20120      FXP = (FXD - FX)/DEL
20130      SIDN = SIDE - FX/FXP
20140      SIDE = SIDN
20150      SUM = SUM + ONE
20160C
20170C
20180C
20190      IF(A(145) .GT. ZERO .AND. SIDE .LT. FIVE) GO TO 1111
20200      WRITE(9,101)SIDE,CUFT,CUFTN,PCUFT,FX,FXD
20210 101   FORMAT(1X,6(F13.3,3X))
20220      IF (ABS(FX) .GT. ONE .AND. SUM .LT. FIFTIN) GO TO 10
20230      IF (SUM .GE. FIFTIN) WRITE(9,1000)
20240 1000  FORMAT(// ' NEWTON METHOD HAS NOT CONVERGED')
20250      VOLUME = HEIGHT * SIDE * SIDE
20260      RETURN
20270 1111  WRITE(9,1011)
20280 1011  FORMAT(1X, ' WARNING = TANK IS INCAPABLE OF STORING SUFFICIENT',
20290      1 ' ICE FOR TOTAL SUMMER OPERATION')
20300      VOLUME = ONEST
20310      RETURN
20320C
20330C      LAST CARD OF SUBROUTINE NEWTON.
20340C
20350      END
20360      SUBROUTINE STORAG(NORTH,SIDE,CUFTN,CUFT,PCUFT)
20370C
20380C*****
20390C
20400C      THIS SUBROUTINE DETERMINES THE ICE INVENTORY WITHIN A STORAGE TANK
20410C      AT THE END OF A GIVEN SEASON. IT WILL ALSO DETERMINE THE MAXIMUM
20420C      OR MINIMUM AMOUNT OF ICE THAT CAN BE STORED WITHIN THE TANK.
20430C
20440C      THE SUBROUTINE STATEMENT IS
20450C
20460C      SUBROUTINE STORAG(NORTH,SIDE,CUFTN,CUFT)
20470C
20480C      WHERE
20490C
20500C      NORTH IS A LOGICAL VARIABLE. IF DEFINED AS

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20510C      .TRUE. -
20520C      .FALSE. -
20530C
20540C      SIDE IS THE SIDE DIMENSION OF THE TANK.
20550C
20560C      CUFTN IS THE CUBIC FEET OF ICE THAT IS NEEDED
20570C
20580C      CUFT IS THE ACTUAL CUBIC FEET OF ICE
20590C
20600C      PROJECT: ACES
20610C
20620C      DEVELOPED BY HONEYWELL
20630C
20640C      CREATION DATE: 9/6/78
20650C
20660C *****
20670C
20680      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
20690      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
20700      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
20710      1      TQHLHW,TQHWW,TBLDHW,TBLDCW,TQCCW,TQHWS,TQHLHS,
20720      1      TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,
20730      1      THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,
20740      1      CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,
20750      1      NDAYS,XPER,SCALE,IN,AA,BB
20760      COMMON /BLOCK/IHOUR,IDAY,IMONTH,QHL,QHW,
20770      1      QC,QINCI,BASLOD,
20780      1      XTEMP,A(200),TWELL(12),FANCFM,FNCFM1,
20790      1      SIZE,SIZE1,SIZE2
20800      REAL KADX
20810      LOGICAL NORTH,FIRST,IN
20820      DATA ZERO/0./,ONE/1./,OPEM4/1.213944E-4/,THRTWO/32.0/
20830      DATA SIX2P4/62.4/,F7P24/57.24/,SEVFIV/75./,N05/105./
20840C
20850      REWIND(8)
20860      REWIND(10)
20870C
20880      TZONES = A(89)
20890      THOTWI = 005
20900      TTANK = A(146)
20910      PCUFT = ZERO
20920      VOLUME = HEIGHT * SIDE * SIDE
20930C
20940C      DETERMINE INITIAL CONDITIONS FOR A TANK SIZED FOR SOUTHERN CLIMATE
20950C      OR A NORTHERN CLIMATE
20960C
20970      CUFT = ZERO
20980      IBEGIN = IFIX(BH)
20990      IEND = NDAYS
21000      IDHM1 = IFIX(BH - ONE)

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21010      DO 25 I = 1, IBHM1
21020          READ(8)DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,ICITY
21030          DO 85 IKL = 1,24
21040              READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
21050 85      CONTINUE
21060 25      CONTINUE
21070 30      CONTINUE
21080          FIRST = .TRUE.
21090C
21100 40      CONTINUE
21110          DO 60 I = IBEGIN, IEND
21120              READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,ICITY
21130              IMONTH = IDUM1
21140              DO 50 J = 1,24
21150                  READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
21160                  T = XTEMP
21170                  TO = DB(J)
21180                  TWI = THOTWI
21190                  CALL WAHP(TTANK,T,SIZE1,DEVAP,HP)
21200                  CALL WWHP(TTANK,TWI,QCOND1,GEVAP1,HP1,COP1)
21210C
21220C          DETERMINE THE DYNAMIC TANK LOSS.
21230C
21240              CALL TANKLO(SIDE,TLOSS,SURFW,TLOSA,T,TO,FIRST)
21250C
21260C          THE TOTAL HEATING LOAD FOR THE HOUR IS...
21270C
21280              HEAT = QHL
21290C
21300C          IF THERE IS NO BASEMENT, THE TOTAL HEAT LOAD IS...
21310C
21320              HEATMB = HEAT + BASLOD
21330C
21340C          THE ADJUSTED BASEMENT LOAD AS A FUNCTION OF REPLACED SURFACE AREA
21350C          OF THE TANK IS...
21360C
21370              BASE1 = BASLOD * (ONE - SURFW/AWALBG)
21380C
21390C          THE ACTUAL HEAT DEMAND ACCOUNTING FOR THE CORRECTED BASEMENT SURFACE
21400C          AREA, THE ADDED FAN HEAT, AND THE HEAT FLOW FROM THE BASEMENT TO
21410C          THE TANK IS QNEED. QNEED IS EQUAL TO HEAT IF THE TANK AND THE FAN
21420C          SYSTEM ARE NOT IN THE HEATED SPACE.
21430C
21440              IF(QHL .GT. ZERO)QCOND1 = SIZE1
21450              QNEEDW = QHW/(ONE + (ONE - XPER) * PUMW/(QCOND1 + (ONE
21460 1          - XPER) * PUMW))
21470              TFW = QNEEDW/(QCOND1 + (ONE - XPER) * PUMW)
21480              QNEEDS = (HEATMB - BASE1 + TLOSA, = TFW * XPER * (PUME
21490 1          + PUMW))/(ONE + (FANH + PUME * XPER)/(SIZE1 +
21500 1          FANH + XPER * PUME))

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21510      TFS = QNEEDS/(SIZE1 + FANH + XPER * PUME)
21520      TF = TFS + TFW
21530C
21540C      ENERGY OUT OF THE TANK IS...
21550C
21560      IF (QNEEDS .GT. ZERO .AND. QHL .GT. ZERO) COP1 = COP
21570      QPE = PUME * TF * (ONE - XPER)
21580      QOUT = QNEEDW * (ONE - ONE/COP1) + QNEEDS * (ONE - ONE
21590      /COP)
21600      1 IF (QHL .LE. ZERO) QOUT = QNEEDW * (ONE - ONE/COP1)
21610      IF (QNEEDS .LE. ZERO) QOUT = QNEEDW * (ONE - ONE/COP1)
21620      IF (QNEEDS .LE. ZERO) QPE = PUME * TFW * (ONE - XPER)
21630      IF (QOUT .LE. ZERO) QPE = ZERO
21640C
21650C      THE TOTAL COOLING LOAD FOR THE HOUR IS...
21660C
21670      COOL = QC
21680C
21690C      IS THERE IS NO BASEMENT, THE TOTAL COOLING LOAD IS..
21700C
21710      COOLMB = COOL - BASLOD
21720C
21730C      THE ADJUSTED BASEMENT LOAD AS A FUNTION OF THE REPLACED SURFACE
21740C      AREA OF THE TANK IS...
21750C
21760      BASE2 = BASLOD * (ONE - SURFW/AWALBG)
21770C
21780C      THE ACTUAL COOLING DEMAND ACCOUNTING FOR THE CORRECTED BASEMENT
21790C      SURFACE AREA, THE ADDED FAN HEAT, AND THE HEAT FLOW FROM THE
21800C      BASEMENT TO THE TANK IS QNEED. QNEED IS EQUAL TO COOL IF THE TANK
21810C      AND THE FAN SYSTEM ARE NOT IN THE HEATED SPACE.
21820C
21830      RAT1 = (T - TTANK)/(TZONES - THRTWO)
21840      QNEED = (COOLMB + BASE2 - TLOSA + TFW * XPER * (PUME +
21850      1 PUMW))/(ONE - (FANC + PUMC * XPER)/(RAT1 * SIZE2))
21860      TF = QNEED/(RAT1 * SIZE2)
21870C
21880C      ENERGY INTO THE TANK IS....
21890C
21900      QPC = PUMC * TF * (ONE - XPER)
21910      QIN = QNEED
21920      IF (QPC .LE. ZERO) QIN = ZERO
21930      IF (QIN .LE. ZERO) QIN = ZERO
21940      IF (QIN .LE. ZERO) QPC = ZERO
21950C
21960C      DETERMINE TANK TEMPURATURE OR AMOUNT OF ICE IN TANK.
21970C
21980      QELE = QPC + QPE
21990      Q = ZERO
22000      QI = ZERO

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22010      IF (CUFT .GT. ZERO) GO TO 120
22020      TOLD = TTANK
22030 41      CONTINUE
22040      TTANK = TTANK + ONE/(SIX2P4 * (ONE-PF) * VOLUME + F7P24 *
22050      1      PF * VOLUME) * (QIN
22060      1      - QOUT - TLOSS - QI + QELE)
22070      IF (TTANK .GT. SEVFIV) TTANK = SEVFIV
22080      IF (TTANK .LE. THRTWO) Q = (SIX2P4 * (ONE-PF) * VOLUME +
22090      1      F7P24 * PF * VOLUME) * (TOLD - THRTWO)
22100      IF (TTANK .GT. THRTWO) GO TO 51
22110 120      TTANK = THRTWO
22120      CVOLD = CUFT
22130      CUFT = CUFT + (QOUT - QIN + TLOSS - Q - QELE) *
22140      1      OPEM4
22150      IF (CUFT .GT. ZERO) GO TO 51
22160      QI = CVOLD/OPEM4
22170      CUFT = ZERO
22180      GO TO 41
22190 51      CONTINUE
22200      IF (NORTH .AND. CUFT .GT. PF * HEIGHT * SIDE * SIDE)
22210      1      CUFT = PF * HEIGHT * SIDE * SIDE
22220      IF (CUFT .GT. PCUFT) PCUFT = CUFT
22230 50      CONTINUE
22240 60      CONTINUE
22250      REWIND(8)
22260      REWIND(10)
22270      IF (IEND .NE. NDAYS) GO TO 70
22280      IBEGIN = 1
22290      IEND = IFIX(HC - ONE)
22300      IF (NORTH) IEND = IFIX(BH - ONE)
22310      GO TO 40
22320 70      CONTINUE
22330      CUFTN = ZERO
22340      ERR = (SIX2P4 * (ONE - PF) * VOLUME + F7P24 * PF * VOLUME) *
22350      1      (TTANK - THRTWO) * OPEM4
22360      IF (NORTH .AND. TTANK .GT. THRTWO) CUFT = -ERR
22370      RETURN
22380C
22390C      LAST CARD OF SUBROUTINE STORAG.
22400C
22410      END
22420      SUBROUTINE PANEL(NORTH,VOLUME,SIDE,SIZE,PANUM)
22430C
22440C*****
22450C
22460C      THIS SUBROUTINE DETERMINES THE SIZE OF THE SOLAR COLLECTOR
22470C      NEED TO MEET THE DEMANDS OF THE FULL ACES SYSTEM.
22480C
22490C      THE SUBROUTINE STATEMENT IS
22500C

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```

22510C SUBROUTINE PANEL(NORTH,VOLUME,SIDE,SIZE)
22520C
22530C WHERE
22540C
22550C NORTH IS A LOGICAL VARIABLE. IF DEFINED AS
22560C .TRUE. - THE TANK IS SIZED FOR A NORTHERN CLIMATE.
22570C .FALSE. - THE TANK IS SIZED FOR A SOUTHERN CLIMATE.
22580C
22590C VOLUME IS THE VOLUME OF THE ICE STORAGE BIN IN CUBIC FEET.
22600C
22610C SIDE IS THE SIDE DIMENSION OF THE TANK.
22620C
22630C SIZE IS THE SIZE OF THE TANK.
22640C
22650C PROJECT ACES
22660C
22670C DEVELOPED BY HONEYWELL
22680C
22690C CREATION DATE: 8/29/78
22700C
22710C *****
22720C
22730C COMMON /PASS/ KADX,HEIGHT,PF,UTANKA,UTANKW,UTANKL,TTANK,TAVE,
22740C 1 TWELA,TQHLHW,TQHHWW,TBLDHW,TBLDCW,TQCCW,TQHWHWS,TQHLHS,
22750C 1 TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,
22760C 1 TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINVBL,CPRVT,CPRVW,
22770C 1 TAMBA,AREAC,CK,C,FF,PUMP,PUMF,PIIMC,PUMW,FANH,FANC,NDAYS,XPER,
22780C 1 SCALE,IN,AA,BB
22790C COMMON /TRY/QCOLLT
22800C LOGICAL NORTH,IN
22810C REAL KADX
22820C DATA ZERO/0./,ONE/1./,OPEM4/1.2131944E-4/,OP5/1.5/
22830C
22840C IF (.NOT. NORTH) GO TO 10
22850C
22860C DETERMINE APPROXIMATE SIZE OF COLLECTORS
22870C
22880C QINCT = TQINCW
22890C CALL COLECT(QINCT,ZERO,ONE,QCOLLT)
22900C QMELT = (TQHLHW + TQHHWW) * (ONE - ONE/COP) - TQCCW
22910C 1 = PF * VOLUME/OPEM4
22920C NUMPAN = IFIX(QMELT/QCOLLT) + 1
22930C PANUM = FLOAT(NUMPAN) * OP5
22940C
22950C SIZE FOR THE HEATING SEASON; SECANT METHOD.
22960C
22970C CALL BISCAN(VOLUME,SIDE,PANUM)
22980C
22990C THE INTEGER NUMBER OF PANELS, NEEDED TO MELT ICE FOR THE
23000C WINTER IS.....

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23010C
23020      NUMPAN = IFIX(PANUM) + 1
23030      SIZE = FLOAT(NUMPAN) * AREAC
23040      RETURN
23050 10    CONTINUE
23060      SIZE = ZERO
23070      RETURN
23080C
23090C      LAST CARD OF SUBROUTINE PANEL.
23100C
23110      END
23120      SUBROUTINE BISCAN(VOLUME, SIDE, PANUM)
23130C
23140C*****
23150C
23160C      THIS SUBROUTINE SIZES THE COLLECTOR FUELED TO QUATING ENERGIES
23170C      INTO AND OUT OF THE STORAGE TANK AND USING THE SECANT METHOD
23180C      TO DETERMINE THE CORRECT DIMENSIONS.
23190C
23200C      THE SUBROUTINE STATEMENT IS
23210C
23220C      SUBROUTINE SECANT(VOLUME, SIDE, PANUM)
23230C
23240C      WHERE
23250C
23260C      VOLUME IS THE VOLUME OF THE ICE STORAGE TANK IN CUBIC FEET.
23270C
23280C      SIDE IS THE SIDE DIMENSION OF THE TANK.
23290C
23300C      PANUM IS THE NUMBER OF COLLECTOR PANELS.
23310C
23320C      PROJECT:  ACES
23330C
23340C      DEVELOPED BY HONEYWELL
23350C
23360C      CREATION DATE: 9/6/78
23370C
23380C*****
23390C
23400      COMMON /PASS/KADX, HEIGHT, PF, UTANKA, UTANKW, UWAL, TTANK, TAVE, TWELA,
23410      1      TQHLHW, TQHHWW, TBLDHW, TBLCW, TQCCW, TQHWS, TQHLHS, TBLOCS,
23420      1      TBLOHS, TQCCS, AWALBG, TIME, BC, BH, COP, TCCS, THLHS, THLHW,
23430      1      TCCW, TQINCW, TQINCS, PCT, DMINQ1, DMINQ2, DMINBL, CPRVT,
23440      1      CPRVW, TAMBA, AREAC, CK, C, FF, PUMP, PUME, PUMC, PUMW, FANH, FANC,
23450      1      NDAYS, XPER, SCALE, IN, AA, BH
23460      COMMON /TRY/QCOLLT
23470      COMMON /PEK1/PEK
23480      LOGICAL IN
23490      REAL KADX
23500      DATA ZERO/0./, ONE/1./, FIFTIN/15./, ONEP05/1.05/, OPEM4/1.2131944E-4/

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23510      DATA TWO/2.0/,OPS/1.5/,TWENTY/20.0/
23520C
23530      ICHECK = 0
23540      XA = ZERO
23550      XB = PANUM
23560      FXA = PF * VOLUME - ((TQHLHW + TQHHW) * (ONE - ONE/COP) -
23570      1      TQCCW) * OPEM4
23580      SUM = ZERO
23590      10 CONTINUE
23600      PANUM = (XA + XB)/TWO
23610      CALL SIZES(PANUM,VOLUME,CUFT,ICHECK,SIDE,PCUFT)
23620      FX = PF * VOLUME - CUFT
23630      IF(FXA * FX .LE. ZERO) XB = PANUM
23640      IF(FXA * FX .GT. ZERO) XA = PANUM
23650      SUM = SUM + ONE
23660      WRITE(9,101)FXA,FX,XA,XB,PANUM,CUFT,PCUFT
23670      101 FORMAT(1X,7(F10.3,3X))
23680      IF (ABS(FX) .GT. ONE .AND. SUM .LT. TWENTY) GO TO 10
23690      IF (SUM .GE. TWENTY) WRITE(9,1000)
23700      1000 FORMAT(1X,'BISCAN IN PANEL HAS NOT CONVERGED')
23710C
23720C      CHECK TO SEE THAT THE ICE HAS NOT EXCEEDED HALF THE VOLUME OF
23730C      THE TANK AT ANY TIME THROUGH THE SEASON.
23740C
23750      FLAG = ONE
23760      SUM = ZERO
23770      FXNO = PF * VOLUME - PCUFT
23780      X0 = PANUM
23790      XN = X0 * OPS
23800      PANUM = XN
23810      20 CALL SIZES(PANUM,VOLUME,CUFT,ICHECK,SIDE,PCUFT)
23820      FXN = PF * VOLUME - PCUFT
23830      XNEW = XN - FXN * (XN - X0)/(FXN - FXNO)
23840      WRITE(9,102)X0,FXNO,XN,FXN,XNEW,CUFT,PCUFT
23850      102 FORMAT(1X,7(F10.3,3X))
23860      X0 = XN
23870      FXNO = FXN
23880      XN = XNEW
23890      PANUM = XN
23900      SUM = SUM + ONE
23910      IF(ABS(FXN) .GT. ONE .AND. SUM .LT. FIFTIN) GO TO 20
23920      IF(SUM .GE. FIFTIN) WRITE(9,1000)
23930      30 CONTINUE
23940      NUMPAN = IFIX(PANUM) + 1
23950      SIZE = FLOAT(NUMPAN) * AREAC
23960      PEK = ICHECK
23970      WRITE(9,9999)PEK
23980      9999 FORMAT(1X,F12.3)
23990      RETURN
24000C

```

```

24010C      LAST CARD OF SUBROUTINE SECANT.
24020C
24030      END
24040      SUBROUTINE SIZES(PANUM,VOLUME,CUFT,ICHECK,SIDE,PCUFT)
24050C
24060C*****
24070C
24080C      THIS SUBROUTINE DETERMINES THE AMOUNT OF ICE IN A TANK AT THE
24090C      END OF A HEATING SEASON GIVEN THE INITIAL TEMPERATURE OF THE TANK,
24100C      THE AREA OF THE COLLECTOR, AND THE FACT THAT THERE IS NO ICE AT
24110C      THE BEGINNING OF THE HEATING SEASON.
24120C
24130C      THE SUBROUTINE STATEMENT IS
24140C
24150C      SUBROUTINE SIZES(PANUM,VOLUME,TTANK,CUFT,FLAG,ICHECK,SIDE,PCUFT)
24160C
24170C      WHERE
24180C
24190C      PANUM IS THE NUMBER OF PANELS.
24200C
24210C      VOLUME IS THE VOLUME OF THE ICE STORAGE TANK IN CUBIC FEET.
24220C
24230C      CUFT IS CUBIC FEET OF ICE.
24240C
24250C      FLAG IS A DELEMETER OPTION
24260C
24270C      ICHECK IS A DELEMETER OPTION
24280C
24290C      SIDE IS THE SIDE DIMENSION OF THE TANK.
24300C
24310C      PCUFT IS THE PEAK CUBIC FEET OF ICE
24320C
24330C      PROJECT: ACES
24340C
24350C      DEVELOPED BY HONEYWELL
24360C
24370C      CREATION DATE: 8/25/78
24380C
24390C*****
24400C
24410      COMMON /PASS/KADY,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,
24420      1      TWELA,TQHLHW,TQHWW,TBLDHW,TBLDCW,TQCCW,TQHHS,TQHLHS,
24430      1      TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,HC,BH,COP,TCCS,THLHS,THLHW,
24440      1      TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINREL,CPRVT,CPRVW,
24450      1      TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,
24460      1      SCALE,IN,AA,BB
24470      COMMON /BLOCK/IDAY,IMONTH,DHL,QHW,
24480      1      QC,QINCI,HASLUD,XTEMP,
24490      1      A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
24500      COMMON /WEATHR/DH(24),DP(24),WH(24),WS(24),PH(24),TC(24),

```

```

24510      1      TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
24520      COMMON /STOP/ENDC,TTANK2
24530      REAL KADX
24540      LOGICAL FIRST,IN
24550      DATA ZERO/0./,ONE/1./,SIX2P4/62.4/,THRTWO/32./,OPEM4/1.2131944E-4/
24560      1      ,F7P24/57.24/,SEVFIV/75.0/,OOS/105./
24570C
24580C      INITIALIZE AND POSITION WEATHER TAPE.
24590C
24600      REWIND(8)
24610      REWIND(10)
24620      TZONES = A(89)
24630      THOTWI = 005
24640      FIRST = .TRUE.
24650      CUFT = ZERO
24660      TTANK = A(146)
24670      TQI=ZERO
24680      TQNS=ZERO
24690      TQNW=ZERO
24700      TQN=ZERO
24710      PCUFT = ZERO
24720      WRITE(9,911)HC,BH,ICHECK,ICHEC1,IBEGIN,IEND
24730      911  FORMAT(1X,2(F6.2,2X),4(I4,2X))
24740      IBHMI = IFIX(BH = ONE)
24750      DO 10 I = 1, IBHMI
24760          READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IDU1,IMONTH,IDU2,IDU3
24770          DO 110 IJK = 1,24
24780              READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
24790      110      CONTINUE
24800      10      CONTINUE
24810      IBEGIN = IFIX(BH)
24820      IEND = NDAYS
24830      30      CONTINUE
24840C
24850C      READ WEATHER TAPES AND PERFORM HOURLY ENERGY CALCULATIONS
24860C
24870      DO 80 I = IBEGIN, IEND
24880          READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,ICITY
24890          IMONTH = IDUM1
24900          IMOURE = 24
24910          DO 70 J = 1, IMOURE
24920              T = XTEMP
24930              READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
24940              TO = DB(J)
24950              TWI = THOTWI
24960              CALL WAHP(TTANK,T,SIZE1,GEVAP,HP)
24970              CALL WWHP(TTANK,TWI,QCOND1,GEVAP1,HP1,COP1)
24980C
24990C      DETERMINE THE DYNAMIC TANK LOSS.
25000C

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```

25010      CALL TANKLD(SIDE,TLOSS,SURFW,TLOSA,T,TO,FIRST)
25020C
25030C      ENERGY FROM THE COLLECTOR IS....
25040C
25050          VEL = WS(J)
25060          TAMBA = TO
25070          QINC = QINCI
25080          CALL COLLECT(QINC,VEL,PANUM,QCOLL)
25090          QPCC = ZERO
25100          QPAN = ZERO
25110          IF (TTANK .GT. SEVFIV) QCOLL = ZERO
25120          IF (I .GE. BH .AND. I .LE. ENDC .AND. TTANK .GT.
25130      1      TTANK2) QCOLL = ZERO
25140          IF (QCOLL .GT. ZERO) QPCC = PUMP * (ONE - XPER)
25150          IF (QCOLL .GT. ZERO) QPAN = PUMP * XPER
25160      TOI = TOI + QCOLL
25170C
25180C      THE TOTAL HEATING LOAD FOR THE HOUR IS....
25190C
25200          HEAT = QHL
25210C
25220C      IF THERE WERE NO BASEMENT, THE TOTAL HEAT LOAD IS....
25230C
25240          HEATMB = HEAT + BASLOD
25250C
25260C      THE ADJUSTED BASEMENT LOAD AS A FUNCTION OF THE REPLACED SURFACE
25270C      AREA OF THE TANK IS....
25280C
25290          BASE1 = BASLOD * (ONE - SURFW/AWALBG)
25300C
25310C      THE ACTUAL HEAT DEMAND ACCOUNTING FOR THE CORRECTED BASEMENT
25320C      SURFACE AREA, THE ADDED FAN HEAT, AND THE HEAT FLOW FROM THE
25330C      BASEMENT TO THE TANK IS QNEED. QNEED IS EQUAL TO HEAT
25340C      IF THE TANK AND THE FAN SYSTEM ARE NOT IN A HEATED SPACE.
25350C
25360          IF (QHL .GT. ZERO) QCOND1 = SIZE1
25370          QNEEDW = QHW / (ONE + (ONE - XPER) * PUMW / (QCOND1 +
25380      1      (ONE - XPER) * PUMW))
25390          TFW = QNEEDW / (QCOND1 + (ONE - XPER) * PUMW)
25400          QNEEDS = (HEATMB - BASE1 + TLOSA - QPAN - TFW * XPER * (
25410      1      PUME + PUMW)) /
25420      1      (ONE + (FANH + PUME * XPER) / (SIZE1 + FANH + XPER *
25430      1      PUME))
25440          TFS = QNEEDS / (SIZE1 + FANH + XPER * PUME)
25450          TF = TFS + TFW
25460C
25470C      ENERGY OUT OF THE TANK IS...
25480C
25490          IF (QNEEDS .GT. ZERO .AND. QHL .GT. ZERO) COP1 = COP
25500          QPE = PUME * TF * (ONE - XPER)

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25510      QOUT = QNEEDW * (ONE - ONE/COP1) + QNEEDS * (ONE - ONE/COP)
25520      IF (QHL .LE. ZERO) QOUT = QNEEDW * (ONE - ONE/COP1)
25530      IF (QNEEDS .LE. ZERO) QOUT = QNEEDW * (ONE - ONE/COP1)
25540      IF (QNEEDS .LE. ZERO) QPE = PUME * TFW * (ONE - XPER)
25550      IF (QOUT .LE. ZERO) QPE = ZERO
25560      TQNS = TQNS + QNEEDS
25570      TQNW = TQNW + QNEEDW
25580C
25590C      THE TOTAL COOLING LOAD FOR THE HOUR IS....
25600C
25610      COOL = QC
25620C
25630C      IF THERE IS NO BASEMENT, THE TOTAL COOLING LOAD IS...
25640C
25650      COOLMB = COOL - BASLOD
25660C
25670C      THE ADJUSTED BASEMENT LOAD AS A FUNCTION OF THE REPLACED
25680C      SURFACE AREA OF THE TANK IS...
25690C
25700      BASE2 = BASLOD * (ONE - SURFW/AWALBG)
25710C
25720C      THE ACTUAL COOLING DEMAND ACCOUNTING FOR THE CORRECTED BASEMENT
25730C      SURFACE AREA, THE ADDED FAN HEAT, AND THE HEAT FLOW FROM THE
25740C      BASEMENT IS QNEED. QNEED IS EQUAL TO COOL IF THE TANK AND
25750C      THE FAN SYSTEM ARE NOT IN A HEATED SPACE.
25760C
25770      RAT1 = (T - TTANK)/(TZONES - THRTWO)
25780      QNEED = (COOLMB + BASE2 + ILUSA + WPAN + TFW * XPER *
25790      1      (PUME + PUMW))/(ONE - (FANC + XPER * PUMC)/(RAT1
25800      1      * SIZE2))
25810      TF = QNEED/(RAT1 * SIZE2)
25820C
25830C      ENERGY INTO THE TANK FROM COOLING IS...
25840C
25850      QPC = PUMC * TF * (ONE - XPER)
25860      QIN = QNEED
25870      IF (QC .LE. ZERO) QIN = ZERO
25880      IF (QIN .LE. ZERO) QIN = ZERO
25890      IF (QIN .LE. ZERO) QPC = ZERO
25900      TQN = TQN + QNEED
25910C
25920C      DETERMINE TANK TEMPERATURE OR AMOUNT OF ICE IN TANK.
25930C
25940      QELE = QPCC + QPC + QPE
25950      Q = ZERO
25960      QI = ZERO
25970      IF (CUFT .GT. ZERO) GO TO 120
25980      TOLD = TTANK
25990      40      CONTINUE
26000      TTANK = TTANK + ONE/(SIX2P4 * (ONE - PF) * VOLUME + F7P24 *

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26010      1      PF * VOLUME) * (QIN
26020      1      - QOUT - TLOSS + QCOLL - QI + QELE)
26030      IF(TTANK .GT. SEVFIV) TTANK = SEVFIV
26040      IF(TTANK .LE. THRTWO) Q = (SIX2P4 * (ONE-PF) * VOLUME +
26050      1      F7P24 * PF * VOLUME) * (TOLD - THRTWO)
26060      IF (TTANK .GT. THRTWO) GO TO 60
26070 120      TTANK = THRTWO
26080      CVOLD = CUFT
26090      CUFT = CUFT + (QOUT - QIN + TLOSS - QCOLL - Q - QELE) *
26100      1      OPEM4
26110      IF (CUFT .GT. ZERO) GO TO 50
26120      QI = CVOLD/OPEM4
26130      CUFT = ZERO
26140      GO TO 40
26150 50      CONTINUE
26160      IF (CUFT .GT. PCUFT) PCUFT = CUFT
26170      IF (PCUFT .GT. PF * VOLUME .AND. CUFT .GE. PCUFT) ICHECK = I
26180      IF (PCUFT .GT. PF * VOLUME .AND. CUFT .GE. PCUFT) ICHECK = J
26190 60      CONTINUE
26200 70      CONTINUE
26210 80      CONTINUE
26220      REWIND(8)
26230      REWIND(10)
26240      IF (IEND .NE. NDAYS) GO TO 100
26250      IBEGIN = 1
26260      IEND = IFIX(BC - ONE)
26270      GO TO 30
26280 100     CONTINUE
26290      WRITE(9,912)TQNS,TQNW,TQN,TQI,TTANK
26300 912    FORMAT(1X,5(F15.2,4X))
26310      RETURN
26320C
26330C      LAST CARD OF SUBROUTINE SIZES.
26340C
26350C      END
26360      SUBROUTINE WWHP(TWIE,TWIC,QCOND1,GEVAP1,HP1,COP1)
26370C
26380C*****
26390C
26400C      THIS SUBROUTINE PREDICTS THE PERFORMANCE OF A WATER TO WATER HEAT
26410C      PUMP AS A FUNCTION OF THE EVAPORATOR AND CONDENSER INLET TEMP-
26420C      ERATURE.
26430C
26440C      PROJECT: ACES
26450C
26460C      DEVELOPED BY HONEYWELL
26470C
26480C      CREATION DATE 9/6/78
26490C
26500C*****

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```

26510C
26520      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,ITANK,TAVE,TWELA,
26530      1      TQHLHW,TQHWWH,TBLDHW,TBLDCW,TQCCW,TQHNHS,TQHLHS,
26540      1      TBLDCS,TBLDHS,TQCCS,AWALRG,TIME,BC,BH,COP,TCCS,THLHS,
26550      1      THLHW,TCCW,TQINCW,TQINCS,PCT,UMINQ1,UMINQ2,DMINHL,CPRVT,
26560      1      CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,
26570      1      NDAYS,XPER,SCALE,IN,AA,HH
26580      REAL KADX
26590      LOGICAL IN
26600      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
26610      1      P00097/.00097/,P7612/.7612/,T9P23/29.23/,EIGHTY/80./,
26620      1      F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.1414/,
26630      1      T545/2545./
26640C
26650      EET = TWIE
26660      ECT = TWIC
26670      BTU = ONET23 * (EET - THRTWO) + SIXFT * THUND * ECT
26680      Y = T9P23 * (ECT - EIGHTY) + F569
26690      XM = (Y - T523)/SIX2P5
26700      WATTS = XM * (EET - TWP5) + T523
26710      COP1 = BTU/(WATTS * PI) + FF
26720      QCOND1 = BTU * SCALE
26730      BTUM = QCOND1/COP1
26740      QEVAP1 = QCOND1 - BTUM
26750      HP1 = BTUM/T545
26760      RETURN
26770C
26780C      LAST CARD OF SUBROUTINE WWHP
26790C
26800      END

```

```
*****  
*****  
-- 3 0 --          DATE 08-31-79    TIME 11,776      ID = E1    GCS-AJ
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A-129

SIMMOD

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SNUMB = 3897T
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  XXXX      XXXX      XXXX      XXXXXX      XXXXX
  X          X X      X X      X          X
  XXX       XXXX      X X      X          X
  X X      X X      XXXX      X          X
  XXXX      XXXX      X          X          X
  
```

XX
 XXX

33 3897T ENTERED GCS-AJ AT 11.513 FROM SYSTEM-0 TSS/S 0-08-16

```

0001 S      SNUMB 3897T
0002 S      COMMENT F00648      TSS MEDIA CONVERSION
0003 S      IDENT F00648-ACES
0004 33     USERID F006483
0005 AS     CONVER
0006 S      LIMITS ,,,50000
0007 S      SYSOUT OT,E1
0008 S      MULTI 1-1
0009 S      DATA IN,,COPY,ENDFC
0010 S      ENDCOPY IN
0011 S      ENDJOB
      TOTAL CARD COUNT THIS JOB = 001717
  
```

```

* ACTY-01 SCARD #0005 CONVER 08/31/79 SW=0000000000000
BMC-TTL DATE 771205
S      MULTI 1-1
FILE #000001 TOT 001706 INPUT
INPUT COUNT 001706 OUTPUT COUNT 001706
BLOCKS SKIPPED 000000 IGNORE COUNT 000000
* NORMAL TERMINATION AT 001544 I=2060 SW=0000000000000
  
```

START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/NC	MS/NE	ADDRESS	T#/PK#
11.533	11.551	0.014	0.018										
				LINES	1705	PROC.	0.0003	I/O	0.001	TU	5	MEMORY	8K
				LIMIT	50000	LIMIT	0.2000	LIMIT		CU	5	M*T	140
				MC R	MSU450	*	22	0	1	1	1	0-0A-01	
				IN R	MSU450	*	924	0	42	42	42	0-0A-01	
				OT	SYOUT								
				P*	SYOUT								

RC-00 1705 LINES AT STA. E1

ACTIVITY 01 COST=\$ 0.63
 *CUMULATIVE COST=\$ 0.63

SNUMB = 3897T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 001705

\$ NOTE FILENAME SIMMOD
\$ NOTE LABELS= A,R(E1)
\$ NOTE TABS/SETTINGS= ASIS

```

10000C*****
10010C
10020C      SIMULATION PROGRAM FOR RESIDENTIAL ACES
10030C
10040C      THIS PROGRAM HAS BEEN DESIGNED TO SIMULATE THE RESIDENTIAL
10050C      SINGLE OR MULTI-FAMILY ACES OVER THE YEARLY CYCLE. BASED
10060C      ON THE USER SPECIFIED OPTION THIS PROGRAM CAN ALSO SIMULATE
10070C      FOUR CONVENTIONAL SYSTEMS:
10080C
10090C          1. ELECTRIC HOT WATER, HEATING, AND COOLING
10100C          2. HEATPUMP HEATING, AND COOLING - ELECTRIC HOT WATER
10110C          3. OIL HEATING - ELECTRIC COOLING, AND HOT WATER
10120C          4. GAS HEATING, AND HOT WATER - ELECTRIC COOLING
10130C
10140C      THE OUTPUT OF THIS PROGRAM IS THE HOURLY GAS, OIL, AND
10150C      ELECTRIC USAGE (IN BTU'S) FOR THE DESIRED SYSTEM. THIS
10160C      PROGRAM IS ONE OF FOUR DISTINCT MODULES. THEY ARE:
10170C
10180C          1. LOADS PROGRAM
10190C          2. DESIGN PROGRAM
10200C          3. SIMULATION PROGRAM
10210C          4. ECONOMIC ANALYSIS PROGRAM
10220C
10230C      THIS PROGRAM ALSO HAS THE CAPABILITY OF SIMULATING THE ACES
10240C      SYSTEM THAT UTILIZES A DUAL SOURCE EVAPORATOR.
10250C
10260C      PROJECT      ACES
10270C
10280C      DEVELOPED BY HONEYWELL
10290C
10300C      CREATION DATE      9/10/78
10310C
10320C*****
10330      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCFE,SCALE,QHL,
10340      1      QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
10350      1      KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
10360      1      CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
10370      1      SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
10380      1      TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
10390      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
10400      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
10410      COMMON /ZAP1/ZAP,PEK,PQBU1
10420      REAL KADX
10430      LOGICAL IN,FIRST
10440      DATA TWO/2.0/,ONE/1.0/,ZERO/0.0/,T8HUN/2800./,P005/0.005/
10450      DATA P01/0.01/,HUN/100./,ETHUN/1800./,OP365/1.365/,P7375/0.7375/
10460      DATA TWELL/45.,42.,40.,39.,41.,45.,51.,55.,57.,57.,55.,50./
10470      DATA PB4/.84/,005/105./
10480C
10490C      READ INPUT FILES
10500C

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10510      CALL DINPUT
10520C
10530C      INITIALIZE VARIABLES
10540C      •
10550      THOTW = 005
10560      TZONEW = A(88)
10570      TZONES = A(89)
10580      TOSAW = A(82)
10590      TOSAS = A(83)
10600      AWALBG = A(65)
10610      KADX = A(28)/TWO
10620      UWALBG = A(56)
10630      HWALBG = A(12)
10640      UTANKT = A(139)
10650      HEIGHT = A(140)
10660      PF = A(141)
10670      PCT = A(142)
10680      UWAL = ONE/(ONE/UWALBG + ONE/HWALBG)
10690      NDAYS = A(8)
10700      UTANKA = UTANKT
10710      UTANKB = A(21)
10720      UTANKW = UTANKB
10730      CPRVT = A(143)
10740      CPRVW = A(144)
10750      TTANK = A(146)
10760      CUTOFF = A(99)
10770      CK = A(147)
10780      C = A(148)
10790      TAMBA = A(149)
10800      AREAC = A(150)
10810      FF = A(22)
10820      XPER = A(29)
10830      SET2 = A(23)
10840      ISTRIP = IFIX(A(103))
10850      IN = .FALSE.
10860      IF(SET2 .GT. ZERO) IN = .TRUE.
10870      ICONV = IFIX(A(15))
10880      AA = A(31)
10890      BB = A(38)
10900      AA = AA * A(102)
10910      IBLDGT = IFIX(A(196))
10920      SIDE = SIDE
10930      PANUM = PANUM
10940      SCALE = ONE
10950      QC = ONE
10960      QHL = ZERO
10970      FLAG1 = ZERO
10980      IF(CUTOFF .GT. TZONEW) FLAG1 = ONE
10990      FLAG2 = ZERO
11000      IF(AA .LE. ZERO) FLAG2 = ONE

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11010 IF(AA .LE. ZERO .AND. CK .LT. P84) FLAG2 = TWO
11020 ELEBU = ZERO
11030 TELEBU = ZERO
11040 FIRST = .TRUE.
11050C
11060C SIZE FAN FOR AIR TO AIR SYSTEM
11070C
11080 IF(ICONV .LE. 0) GO TO 5
11090 SCALE = ONE
11100 CALL ATAMP(TOSAS,TZONES,QCOND,QEVAP,HP,AUX1,AUX2)
11110 SCALE = SIZE2/QEVAP
11120 IB = IFIX((SCALE - ONE)*T8HUN*P01)
11130 FANCMF = FLOAT((IB + 1) + T8HUN*P01)*HUN
11140 IB = IFIX((SCALE - ONE)*ETHUN*P01)
11150 FANCMH = FLOAT((IB + 1) + ETHUN*P01)*HUN
11160 GO TO 8
11170C
11180C SIZE FAN FOR WATER TO AIR SYSTEM
11190C
11200 5 SCALE = ONE
11210 CALL WWHP(TTANK,THOTW,QCOND1,QEVAP1,HP1,COP1)
11220 CALL WAMP(TTANK,TZONEW,QCOND,QEVAP,HP)
11230 SCALE = SIZE/QCOND
11240 SCALE0 = SCALE
11250 IB = IFIX((SCALE - ONE)*ETHUN*P01)
11260 FANCMH = FLOAT((IB + 1) + ETHUN*P01)*HUN
11270 IB = IFIX((SCALE - ONE) * T8HUN * P01)
11280 FANCMF = FLOAT((IB + ONE) + T8HUN * P01) * HUN
11290 TOTDET = TQHLHW * (ONE - ONE/COP) + TQHWHW * (ONE - ONE/COP1)
11300 TOTCOL = TQCCS - (TQHLHS * (ONE - ONE/COP) + TQHWHHS * (ONE
11310 1 - ONE/COP1))
11320C
11330C SIZE FAN FOR DUAL SOURCE SYSTEM
11340C
11350C IF(CUTOFF .GT. TZONEW) GO TO 8
11360C SCALE1 = (TZONEW - CUTOFF)/(TZONEW - TOSAW)
11370C SCALE = ONE
11380C QHL = ONE
11390C QC = ZERO
11400C CALL ATAMP(CUTOFF,TZONEW,QCOND,QEVAP,HP,AUX1,AUX2)
11410C SCALE = SCALE1*SIZE/QCOND
11420C IF(SCALE .LT. SCALE0) SCALE = SCALE0
11430C IF(SCALE .LE. SCALE0) GO TO 8
11440C IB = IFIX((SCALE - ONE)*T8HUN*P01)
11450C FANCMF = FLOAT((IB + 1) + T8HUN*P01)*HUN
11460C IB = IFIX((SCALE - ONE) * ETHUN * P01)
11470C FANCMH = FLOAT((IB + 1) + ETHUN*P01)*HUN
11480C
11490 8 CONTINUE
11500C

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11510 FANC = FANCFM*OP365
11520 FANH = FANCMH*OP365
11530 FANE = FANCME*P7375
11540 FANOIL = A(103) * OP365
11550 FANGAS = A(104) * OP365
11560 PUMW = A(16)
11570 PUMP = A(25)
11580 PUME = A(26)
11590 PUMC = A(27)
11600C
11610C SIZE AUXILLARY HEAT FOR AIRSOURCE ACES
11620C
11630 PQBU1 = ZERO
11640 QC = ZERO
11650 QHL = ONE
11660 IF(CUTOFF .GT. TZNEW .OR. ICONV .GT. 0) GO TO 9
11670 CALL ATAMP(CUTOFF,TZNEW,QCOND,QEVAP,HP,AUX1,AUX2)
11680 PQBU1 = SIZE - QCOND
11690 IF(PQBU1 .LT. ZERO)PQBU1 = ZERO
11700 9 CONTINUE
11710C
11720 FIRST = .TRUE.
11730 Z=18
11740 WRITE(14 + ICONV) IBLDGT
11750 IF(ICONV .EQ. 0)WRITE(14)SIZEE,VOLUME,SCALE,FLAG1,FLAG2
11760 WRITE(14 + ICONV)BH
11770C
11780C START SIMULATION AT THE BEGINNING OF THE HEATING SEASON
11790C
11800 REWIND(8)
11810 REWIND(10)
11820 IBHMI = IFIX(BH - ONE)
11830 IBEGIN = IFIX(BH)
11840 IEND = NDAYS
11850C
11860C POSITION TAPES
11870C
11880 DO 10 I=1,IBHMI
11890 READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IDU1,IDU2,IDU3,IDU4
11900 DO 20 K=1,24
11910 READ(10) QHW,QHW,QC,QINCI,BASLOD,XTEMP
11920 20 CONTINUE
11930 10 CONTINUE
11940C
11950C START SIMULATION
11960C
11970 70 CONTINUE
11980 DO 30 I=IBEGIN,IEND
11990 READ(8) DB,DP,WB,WS,PH,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,
12000 1 ICITY

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12010      IMONTH = IDUM1
12020      DO 40 J=1,24
12030      READ(10) QHL,QHW,QC,QINCI,BASLOD,XTEMP
12040      TO = DB(J)
12050      VEL = WS(J)
12060      T = XTEMP
12070C
12080C      IF NOT ACES CALL CONVENTIONAL SYSTEM SUBROUTINES
12090C
12100      IF(ICONV .EQ. 1) CALL CONV1(GAS,OIL,ELE,PEAK)
12110      IF(ICONV .EQ. 2) CALL CONV2(GAS,OIL,ELE,PEAK)
12120      IF(ICONV .EQ. 3) CALL CONV3(GAS,OIL,ELE,PEAK)
12130      IF(ICONV .EQ. 4) CALL CONV4(GAS,OIL,ELE,PEAK)
12140      IF(ICONV .GT. 0) GO TO 50
12150C
12160C      IF ACES SYSTEM CALL SUBROUTINE ACES
12170C
12180      CALL ACES(FIRST,GAS,OIL,ELE,ELEBU,PEAK)
12190C
12200      50 CONTINUE
12210C
12220      IF(I8LDGT .LT. 2) PEAK = ZERO
12230      WRITE(14 + ICONV) GAS,OIL,ELE,PEAK
12240      TQHL = TQHL + QHL
12250      TQHW = TQHW + QHW
12260      TQC = TQC + QC
12270      GAST = GAST + GAS
12280      OILT = OILT + OIL
12290      ELET = ELET + ELE
12300      TELEBU = TELEBU + ELEBU
12310      40 CONTINUE
12320      30 CONTINUE
12330      REWIND(8)
12340      REWIND(10)
12350      IF(IEND .NE. NDAYS) GO TO 60
12360      IBEGIN = 1
12370      IEND = I8HMI
12380      GO TO 70
12390      60 CONTINUE
12400      FLAG3 = ZERO
12410      IF(TELEBU .GT. ONE) FLAG3 = ONE
12420      WRITE(14 + ICONV) FLAG3
12430      WRITE(9,120)
12440      120 FORMAT(1H1)
12450      IF(ICONV .GT. 0) GO TO 1001
12460      WRITE(9,901)
12470      901 FORMAT('//////////,45X,'ANNUAL ENERGY USAGE OF THE ACES ')
12480      GO TO 1002
12490      1001 WRITE(9,902) ICONV
12500      902 FORMAT('//////////,45X,'ANNUAL ENERGY USAGE OF CONVENTIONAL',

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12510      1' SYSTEM',1X,11,1X)
12520 1002 CONTINUE
12530      WRITE(9,121)TQHL,TQHW,TQC,GAST,OILT,ELET,TELEBU,PEK,SCALE
12540 121 FORMAT(//////,1X,'THE TOTAL HEATING LOAD EQUALS ',F13.2,2X,'BTUS'
12550      1,9X,'THE TOTAL HOT WATER LOAD EQUALS',F13.2,2X,'BTUS',////,1X,'THE'
12560      2,' TOTAL COOLING LOAD EQUALS',F13.2,2X,'BTUS',9X,'THE YEARLY BTUS'
12570      3,' SUPPLIED BY THE GAS SYSTEM ARE',F13.2,////,1X,'THE YEARLY BTUS'
12580      4,' SUPPLIED BY THE OIL SYSTEM ARE',F13.2,6X,'THE YEARLY BTUS SUP'
12590      5,'PLIED BY THE ELECTRIC SYSTEM ARE',F13.2,////,1X,'THE TOTAL BACKUP'
12600      6,' ELECTRICITY NEEDED IN BTUS IS',F13.2,9X,'THE DAY THAT ICE WOU'
12610      7,'LD PEAK IN THE TANK IS',F13.2,////,1X,'THE HEAT PUMP SCALE FACTO'
12620      8,'R IS',F13.2)
12630      STOP
12640      END
12650      SUBROUTINE DINPUT
12660C
12670C*****
12680C
12690C      THIS SUBROUTINE REWINDS TAPES, READS IN TAPE FROM THE LOADS
12700C      PROGRAM, AND THE FOLLOWING INFORMATION FROM TAPE 5:
12710C          1. TITLE
12720C          2. INPUT PARAMETERS
12730C          3. WELL WATER TEMPERATURES
12740C
12750C      PROJECT: ACES
12760C
12770C      DEVELOPED BY HONEYWELL
12780C
12790C      CREATION DATE: 8/23/78
12800C
12810C*****
12820C
12830C
12840      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCFE,SCALE,DHL,
12850      1      QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FAVOIL,FANGAS,
12860      1      KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
12870      1      CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NAYS,XPER,IN,AA,88,
12880      1      SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHT,TQHLHW,TQHWHW,TOCCW,
12890      1      TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
12900      COMMON /ZAP1/ZAP,PEK,PQBUI
12910      COMMON /DESH/HEATO
12920      REAL KADX
12930      LOGICAL IN,FIRST
12940C
12950      DIMENSION LABEL(10),MARGIN(10)
12960      CHARACTER LABEL*6,MARGIN*6
12970      DATA ZERO/0.0/,ONE/1.0/,TWO/2.0/,PI/0.1/
12980C
12990      REWIND (8)
13000      REWIND(10)

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13010      MAXA = 0
13020      READ(5,500) MARGIN
13030      WRITE(9,1000) MARGIN
13040 100   CONTINUE
13050      READ(5,2000) N,DUM,LABEL
13060      IF (N .LE. 0) GO TO 200
13070      IF (N .GT. MAXA) MAXA = N
13080      A(N) = DUM
13090      WRITE(9,3000) N,A(N),LABEL
13100      GO TO 100
13110 200   CONTINUE
13120      WRITE(9,913) TWELL
13130      READ(11)FANCFM,FNCFM1,SIZE,SIZE2,HEATO
13140      WRITE(9,211)
13150 211   FORMAT(1X,'          FANCFM          FANCFM1          SIZE1
13160      1 SIZE2          HEATO')
13170      WRITE(9,212)FANCFM,FNCFM1,SIZE,SIZE2,HEATO
13180 212   FORMAT(V)
13190      READ(13)BC,BH,SIZE,SIZE2,SID,SIZ,TQHLHW,TQHHWN,TQCCN,TQHLHS,
13200      1 TQHHWS,TQCCS,VOLUME,SIZEE,ZAP,PEK
13210      IF(A(106) .GT. ZERO) SID = A(106)
13220      IF(A(107) .GT. ZERO) SIZ = A(107)
13230      SIDE = SID
13240      PANUM = SIZ/A(150)
13250      IF(PANUM .LT. P1) PANUM = ZERO
13260      VOLUME = FLOAT(IFIX(SIDE) + 1)**TWO * A(140)
13270      SIZEE = FLOAT(IFIX(PANUM) + 1) * A(150)
13280      IF(PANUM .LT. ONE) SIZEE = ZERO
13290      WRITE(9,212)BC,BH,SIZE,SIZE2,SID,SIZ,PANUM,VOLUME,SIZEE
13300      RETURN
13310 500   FORMAT(13A6)
13320 1000  FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6//)
13330 2000  FORMAT(15,F15.5,10A6)
13340 3000  FORMAT(3H A(,13,1H),G15.5,3X,10A6)
13350 913   FORMAT(2X,22HWELL WATER TEMPERATURE,2X,12F8.3)
13360C
13370C      LAST CARD OF SUBROUTINE DINPUT.
13380C
13390      END
13400      SUBROUTINE WAHP(TWI,TAI,QCOND,DEVAP,HP)
13410C
13420C*****
13430C
13440C      THIS SUBROUTINE PREDICTS THE PERFORMANCE OF A WATER TO AIR HEAT
13450C      PUMP AS A FUNCTION OF THE EVAPORATOR AND CONDENSER INLET TEMP-
13460C      ERATURE.
13470C
13480C      PROJECT: ACES
13490C
13500C      DEVELOPED BY HONEYWELL

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13510C
13520C      CREATION DATE 9/6/78
13530C
13540C*****
13550C
13560      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCFE,SCALE,QHL,
13570      1 QHW,QC,QINCI,BASLUD,XTEMP,TWELL(12),TO,T,COP,FAVOIL,FANGAS,
13580      1 KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
13590      1 CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NJAYS,XPER,IN,AA,BB,
13600      1 SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTDET,TQHLHW,TQHWW,TQCCW,
13610      1 TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
13620      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
13630      1 WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
13640      REAL KADX
13650      LOGICAL IN
13660      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
13670      1 P00155/.00155/,P7336/.7336/,T9P23/29.23/,EIGHTY/80./,
13680      1 F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.141/,
13690      1 T545/2545./,P00159/.00159/,P6875/.6875/
13700C
13710      EET = TWI
13720      ECT = TAI
13730      BTU = ONET23 * (EET - THRTWO) + SIXFT * THUND * ECT
13740      Y = T9P23 * (ECT - EIGHTY) + F569
13750      XM = (Y - T523)/SIX2P5
13760      WATTS = XM * (EET - TWP5) + T523
13770      COP = BTU/(WATTS * PI) + FF
13780      QCOND = BTU
13790      BTUM = QCOND/COP
13800      QEVAP = QCOND - BTUM
13810      QCOND = QCOND * (P00155 * EET + P7336) * SCALE
13820      QEVAP = QEVAP * (P00159 * EET + P6875) * SCALE
13830      QMOT = QCOND - QEVAP
13840      CUP = QCOND/UMOT
13850      HP = QMOT/T545
13860      RETURN
13870C
13880C      LAST CARD OF SUBROUTINE WAHP.
13890C
13900      END
13910      SUBROUTINE WWHP(TWIE,TWIC,QCOND1,QEVAP1,HP1,COP1)
13920C
13930C*****
13940C
13950C      THIS SUBROUTINE PREDICTS THE PERFORMANCE OF A WATER TO WATER HEAT
13960C      PUMP AS A FUNCTION OF THE EVAPORATOR AND CONDENSER INLET TEMP-
13970C      ERATURE.
13980C
13990C      PROJECT: ACES
14000C

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14010C   DEVELOPED BY HONEYWELL
14020C
14030C   CREATION DATE 9/6/78
14040C
14050C*****
14060C
14070   COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCFE,SCALE,QHL,
14080   1   QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANJIL,FANGAS,
14090   1   KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
14100   1   CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BH,
14110   1   SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHA,TQ4NHW,TQCCW,
14120   1   TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
14130   COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
14140   1   WET(24),DRY(24),IYEAR,IOUM1,IOUM2,ICITY
14150   REAL KADX
14160   LOGICAL IN
14170   DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/55000./,THUND/300./,
14180   1   P00097/.00097/,P7612/.7612/,T9P23/29.23/,EIGHTY/80./,
14190   1   F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.141/,
14200   1   T545/2545./
14210C
14220   EET = TWIE
14230   ECT = TWIC
14240   BTU = ONET23 * (EET - THRTWO) + SIXFT - THUND * ECT
14250   Y = T9P23 * (ECT - EIGHTY) + F569
14260   XM = (Y - T523)/SIX2P5
14270   WATTS = XM * (EET - TWP5) + T523
14280   COP1 = BTU/(WATTS * PI) + FF
14290   QCOND1 = BTU * SCALE
14300   BTUM = QCOND1/COP1
14310   QEVAP1 = QCOND1 - BTUM
14320   HP1 = BTUM/T545
14330   RETURN
14340C
14350C   LAST CARD OF SUBROUTINE WWHP
14360C
14370   END
14380   SUBROUTINE ATAHF(TAE,TAC,QCOND,QEVAP,HP,AUX1,AUX2)
14390C
14400C*****
14410C
14420C   THIS SUBROUTINE PREDICTS THE PERFORMANCE OF A AIR TO AIR HEAT
14430C   PUMP AS A FUNCTION OF THE EVAPORATOR AND CONDENSER INLET TEMP-
14440C   ERATURE.
14450C
14460C   PROJECT: ACES
14470C
14480C   DEVELOPED BY HONEYWELL
14490C
14500C   CREATION DATE 9/6/78

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14510C
14520C*****
14530C
14540      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCFE,SCALE,QHL,
14550      1      QHW,QC,QINCI,HASLOD,XTEMP,TWELL(12),TO,T,COP,FAVOIL,FANGAS,
14560      1      KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
14570      1      CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NJAYS,XPER,IN,AA,BB,
14580      1      SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TUIHET,TQHLHW,TQHWHW,TQCCW,
14590      1      TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
14600      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
14610      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
14620      REAL KADX
14630      LOGICAL IN
14640      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
14650      1      P00U97/.00097/,P7612/.7612/,T9P23/29.23/,EIGHTY/80./,
14660      1      F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.1414/,
14670      1      T545/2545./,OP0429/1.0429/,P0039/.0039/,P9774/.9774/,P0040
14680      1      /.0040/,ZERO/0.0/,P038/.038/,SP0593/7.0593/,TP61/3.61/
14690      1      ,OP25/1.25/,TWNFOR/24.0/,E68/868./,EL20/1120./,
14700      1      P8172/.8172/,P000147/.000147/,P7872/.7872/,P000267/.000267/
14710      1      ,FTP683/14.683/,P5566/.5566/,THOU/1000./,TP6091/2.6091
14720      1      /,P0214/.0214/,S3P36/63.36/,P2493/.2493/,SP9875/
14730      1      6.9875/,P0415/.0415/
14740C
14750      EET = TAE
14760      ECT = TAC
14770      IF(QC .GT. ZERO) EET = TAC
14780      IF(QC .GT. ZERO) ECT = TAE
14790C
14800C      IN HEATING MODE
14810C
14820      IF(QHL .LE. ZERO) GO TO 10
14830      QCOND = (FTP683 + P5566 * EET) * THOU * SCALE
14840      COP = TP6091 + P0214 * EET
14850      QMOT = QCOND/COP
14860      QEVAP = QCOND - QMOT
14870      HP = QMOT/T545
14880C
14890C      DEFROST
14900C
14910      T1 = DP(J)
14920      T2 = TAE
14930      PV = PVSF(T1)
14940      PG = PVSF(T2)
14950      RH = PV/PG
14960      IF(RH .LT. ZERO) RH = ZERO
14970      IF(RH .GT. ONE) RH = ONE
14980      DMAX = P038 * EXP(SP0593 * RH)
14990      T11 = TP61 * EXP(OP25 * RH)
15000      DEFPH = DMAX/TWNFOR*(ONE - ONE/T11 * ABS(THRTWO - TAE))

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15010      IF(DEFPH .LT. ZERO) DEFPH = ZERO
15020      AUX1 = E68 * DEFPH * SCALE
15030      AUX2 = EL20 * DEFPH * SCALE
15040      GO TO 20
15050C
15060C      IN COOLING MODE
15070C
15080      10 CONTINUE
15090      IF(QC .LE. ZERO) GO TO 30
15100      QEVP = (S3P36 - P2493 * ECT) * THOU * SCALE
15110      COP = SP9875 - P0415 * ECT
15120      QMOT = QEVP/COP
15130      HP = QMOT/T545
15140      QCOND = QMOT + QEVP
15150      AUX1 = ZERO
15160      AUX2 = ZERO
15170      GO TO 20
15180C
15190C      IN DEAD BAND
15200C
15210      30 CONTINUE
15220      QCOND = ZERO
15230      QEVP = ZERO
15240      COP = ZERO
15250      AUX1 = ZERO
15260      AUX2 = ZERO
15270      HP = ZERO
15280      20 CONTINUE
15290      RETURN
15300C
15310C      LAST CARD OF SUBROUTINE ATAMP
15320C
15330      END
15340      SUBROUTINE TANKLD(TLOSS,SURFW,TLOSA,TEMP,FIRST)
15350C
15360C*****
15370C
15380C      THIS SUBROUTINE WILL EVALUATE THE TOTAL TANK LOSS, THE BASEMENT WALL
15390C      OR FLOOR AREA REPLACED BY THE TANK, AND THE ENERGY TRANSFERRED
15400C      TO OR FROM THE AMBIENT AIR.
15410C
15420C      THE SUBROUTINE STATEMENT IS
15430C
15440C      SUBROUTINE TANKLD(SIDE,TLOSS,SURFW,TLOSA,TEMP,TO,FIRST)
15450C
15460C      WHERE
15470C
15480C      SIDE IS THE SIDE DIMENSION OF THE TANK.
15490C
15500C      TLOSS IS THE TOTAL TANK LOSS.

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15510C
15520C SURFW IS THE BASEMENT SURFACE AREA THAT THE TANK REPLACES.
15530C
15540C TLOSA IS THE ENERGY LOSS FROM THE TANK TO THE BASEMENT.
15550C
15560C TEMP IS THE BASEMENT TEMPERATURE
15570C
15580C TO IS THE OUTSIDE TEMPERATURE
15590C
15600C FIRST IS A LOGICAL VARIABLE.
15610C
15620C PROJECT: ACES
15630C
15640C DEVELOPED BY HONEYWELL
15650C
15660C CREATION DATE: 8/25/78
15670C
15680C *****
15690C
15700 COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCME,SCALE,QHL,
15710 1 QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
15720 1 KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
15730 1 CPRVW,AREAC,CK,C,FF,PUMP,PIIME,PIUMC,PIUMW,NDAYS,XPER,IN,AA,BB,
15740 1 SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTDET,TQHLHW,TQHWW,TQCCW,
15750 1 TQHLHS,TQHWS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
15760 COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
15770 1 WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
15780 LOGICAL FIROT,IN
15790 REAL KADX
15800 DATA ZERO/0./,TWO/2./,ONE/1./,ET3P6/83.6/
15810C
15820C INITIALIZATION ON FIRST PASS.
15830C
15840 IF (.NOT. FIRST) GO TO 10
15850 AX = ZERO
15860 IF (PCT .GE. ONE) AX = ONE
15870 XK = ZERO
15880 IF (PCT .GT. ZERO) XK = ONE
15890 CPRVP = ET3P6
15900 CPRV2 = CPRVT + CPRVP
15910 CPRV3 = CPRVT + CPRVP + CPRVW
15920 UTKN = UTANKA * XK
15930 UTKN1 = TWO * UTKN
15940 UTKN2 = UTKN1
15950 TEMP1 = ONE/UTANKW + ONE/KADX
15960 UTKND = ONE/(TEMP1 + AX/UWAL)
15970 UTKND1 = TWO * UTKND
15980 UTKND2 = UTKND1
15990 UTKNWD = ONE/(TEMP1 + XK/UWAL)
16000 UTKWD1 = TWO * UTKNWD

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16010   UTKWD2 = UTKWD1
16020   TA = TEMP
16030   IF (.NOT. IN) TA = TO
16040   TTA = TTANK + (TA - TTANK)/TWO
16050   UD = ONE/(ONE/UTNKD + TWO/KADX)
16060   QD = UD * (TTANK - TWELL(IMONTH))
16070   TTG1 = TTANK - QD/UTNKD1
16080   TTG2 = TTG1 - QD/UTNKD2
16090   TTG3 = TTG2 - QD/KADX
16100   UWD = ONE/(ONE/UTNKWD + TWO/KADX)
16110   QWD = UWD * (TTANK - TWELL(IMONTH))
16120   TTGW1 = TTANK - QWD/UTKWD1
16130   TTGW2 = TTGW1 - QWD/UTKWD2
16140   TTGW3 = TTGW2 - QWD/KADX
16150   TEMP2 = ONE/CPRVT
16160   TEMP3 = UTNK1 + UTNK2
16170   TEMP4 = ONE/CPRV2
16180   TEMP5 = UTNKD1 + UTNKD2
16190   TEMP6 = ONE/CPRV3
16200   TEMP7 = UTKWD1 + UTKWD2
16210   TEMP8 = ONE/CPRVP
16220   TEMP9 = UTNKD2 + KADX
16230   TEMP10 = TWO * KADX
16240   TEMP11 = UTKWD2 + KADX
16250   TEMP12 = TEMP8 * KADX
16260   FIRST = .FALSE.
16270 10  CONTINUE
16280   TA = TEMP
16290   IF (.NOT. IN) TA = TO
16300C
16310C   DETERMINE THE INTERNAL TANK SIZE ABOVE GROUND AND THE HEAT
16320C   THAT IS TRANSFERED TO OR FROM THE TANK.
16330C
16340   THTSD = TWO * HEIGHT * SIDE
16350   SIDESQ = SIDE * SIDE
16360   TTA = TTA * (ONE - TEMP2 * TEMP3) + TEMP2 * (TTANK * UTNK1
16370   + TA * UTNK2)
16380   QLOST = (THTSD * PCT + SIDESQ) * UTNK1 * (TTANK - TTA)
16390C
16400C   DETERMINE THE INTERNAL NODE TEMPERATURE BETWEEN THE TANK AND THE
16410C   GROUND (NO BASEMENT SURFACE).
16420C
16430   TTG1 = TTG1 * (ONE - TEMP4 * TEMP5) + TEMP4 * (UTNKD1 * TTANK
16440   + TTG2 * UTNKD2)
16450   TTG2 = TTG2 * (ONE - TEMP8 * TEMP9) + TEMP8 * (UTNKD2 * TTG1
16460   + KADX * TTG3)
16470   TTG3 = TTG3 * (ONE - TEMP8 * TEMP10) + TEMP12 * (TTG2 +
16480   TWELL(IMONTH))
16490   QLOSG = (TWO * THTSD * (ONE - PCT) + SIDESQ) * UTNKD1 * (TTANK -
16500   TTG1)

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16510C
16520C      DETERMINE THE INTERNAL NODE TEMPERATURE BETWEEN THE TANK AND THE
16530C      GROUND (WITH A BASEMENT SURFACE), THE BASEMENT SURFACE
16540C      REPLACED BY THE TANK, THE TOTAL TANK LOSS, AND THE TANK LOSS TO
16550C      THE BASEMENT AIR.
16560C
16570      TTGW1 = TTGW1 * (ONE - TEMP6 * TEMP7) + TEMP6 * (UTKWD1 * TTANK
16580      1      + UTKWD2 * TTGW2)
16590      TTGW2 = TTGW2 * (ONE - TEMP8 * TEMP11) + TEMP9 * (UTKWD2 *
16600      1      TTGW1 + KADX * TTGW3)
16610      TTGW3 = TTGW3 * (ONE - TEMP8 * TEMP10) + TEMP12 * (TTGW2
16620      1      + TWELL(IMONTH))
16630      QLOSGW = ((ONE - XK) * SIDESQ + THTSD * PCT) * UTKWD1 * (TTANK -
16640      1      TTGW1)
16650C
16660      TLOSS = QLOST + QLOSG + QLOSGW
16670      SURFW = THTSD * PCT + SIDESQ
16680      TLOSA = (THTSD * PCT + SIDESQ) * UTKWD2 * (TTA - TA)
16690      IF (PCT .LE. ZERO .OR. .NOT. IN) SURFW = ZERO
16700      IF (.NOT. IN) TLOSA = ZERO
16710      RETURN
16720C
16730C      LAST CARD OF SUBROUTINE TANKLD
16740C
16750      END
16760      SUBROUTINE COLECT(QINC,QCOLL)
16770C
16780C*****
16790C
16800C      THIS SUBROUTINE WILL DETERMINE THE AMOUNT OF ENERGY THAT CAN
16810C      BE COLLECTED FROM A SOLAR PANEL GIVEN THE PANEL PERFORMANCE
16820C      CHARACTERISTICS, CK , C , AA , AND BB.
16830C
16840C      THE SUBROUTINE STATEMENT IS
16850C
16860C      SUBROUTINE COLECT(QINC,VEL,PANUM,QCOLL)
16870C
16880C      WHERE
16890C
16900C      QINC IS THE INCIDENT RADIATION.
16910C
16920C      PANUM IS THE NUMBER OF PANELS.
16930C
16940C      QCOLL IS THE ENERGY COLLECTED
16950C      VEL IS THE WIND VELOCITY
16960C
16970C      PROJECT: ACES
16980C
16990C      DEVELOPED BY HONEYWELL
17000C

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17010C      CREATION DATE:  8/25/78
17020C
17030C*****
17040C
17050      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCFE,SCALE,QHL,
17060      1      QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
17070      1      KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
17080      1      CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
17090      1      SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
17100      1      TQHLHS,TQHWS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
17110      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
17120      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
17130      REAL KADX
17140      LOGICAL IN,FIRST
17150      DATA ZERO/0./,FIVE/5./
17160C
17170      IF(AA .LE. ZERO) GO TO 20
17180      ZZ = AA * EXP(BB * VEL * 1.151)
17190      C = CK/ZZ
17200      20 CONTINUE
17210      ETA = ZERO
17220      IF (QINC .LE. ZERO) GO TO 10
17230      ETA = CK - C * (TTANK - TO)/QINC
17240      IF (ETA .LT. ZERO) ETA = ZERO
17250      10 CONTINUE
17260      Q = ETA *QINC
17270      IF (Q .LE. ZERO .AND. (TO - FIVE) .GE. TTANK)
17280      1      Q = -C * (TTANK - TO)
17290      QCOLL = Q * PANUM * AREAC
17300      RETURN
17310C
17320C      LAST CARD OF SUBROUTINE COLECT.
17330C
17340      END
17350      FUNCTION PVSF(X)
17360C
17370C*****
17380C
17390C      THIS FUNCTION DETERMINES THE PARTIAL PRESSURE OF WATER
17400C      IN MOISTURE SATURATED AIR
17410C
17420C      THE FUNCTION STATEMENT IS
17430C
17440C      FUNCTION PVSF(X)
17450C
17460C      WHERE X IS THE SATURATION TEMPERATURE
17470C
17480C      PROJECT      ACES
17490C
17500C      DEVELOPED BY HONEYWELL

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17510C
17520C      CREATION DATE          9/10/78
17530C
17540C*****
17550C
17560      DATA F059P/459.688/,TW73P/273.16/,TH73P/373.16/,TN9P/29.921/
17570      DATA ONEP8/1.8/,ONE/1.0/,TEN/10.0/,ZERO/0.0/
17580      DIMENSION A(6)/-7.90298,5.02808,-1.3816E-7,11.344,8.1328E-3,
17590      1      -3.49149/,B(4)/-9.09718,-3.56654,0.876793,0.0060273/
17600      DIMENSION P(4)
17610      T = (X + F059P)/ONEP8
17620      IF(T .LT. TW73P) GO TO 3
17630      Z = TH73P/T
17640      P(1) = A(1)*(Z - ONE)
17650      P(2) = A(2)*ALOG10(Z)
17660      Z1 = A(4)*(ONE - ONE/Z)
17670      P(3) = A(3)*(TEN**Z1 - ONE)
17680      Z1 = A(6)*(Z - ONE)
17690      P(4) = A(5)*(TEN**Z1 - ONE)
17700      GO TO 4
17710      3 Z = TW73P/T
17720      P(1) = B(1)*(Z - ONE)
17730      P(2) = B(2)*ALOG10(Z)
17740      P(3) = B(3)*(ONE - ONE/Z)
17750      P(4) = ALOG10(B(4))
17760      4 SUM = ZERO
17770      DO 5 I=1,4
17780      5 SUM = SUM + P(I)
17790      PVSF = TW9P*TEN**SUM
17800      RETURN
17810      END
17820      SUBROUTINE CONV1(GAS,OIL,ELE,PEAK)
17830C
17840C*****
17850C
17860C      THIS SUBROUTINE WILL ESTIMATE THE HOURLY GAS OIL AND ELECTRIC
17870C      USAGE OF AN ELECTRIC HEATING SYSTEM, AN ELECTRIC COOLING
17880C      SYSTEM (CENTRAL), AND AN ELECTRIC HOT WATER SYSTEM
17890C
17900C      THE SUBROUTINE STATEMENT IS
17910C
17920C      SUBROUTINE CONV1(GAS,OIL,ELE)
17930C
17940C      WHERE
17950C
17960C      GAS IS THE HOURLY BTU'S SUPPLIED BY THE GAS SYSTEM
17970C
17980C      OIL IS THE HOURLY BTU'S SUPPLIED BY THE OIL SYSTEM
17990C
18000C      ELE IS THE HOURLY BTU'S SUPPLIED BY THE ELECTRIC SYSTEM

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18010C
18020C      PROJECT      ACES
18030C
18040C      DEVELOPED BY HONEYWELL
18050C
18060C      CREATION DATE      9/10/78
18070C
18080C*****
18090C
18100C      THE SUBROUTINE STATEMENT IS
18110C
18120C      SUBROUTINE CONV1(GAS,OIL,ELE)
18130C
18140C      WHERE
18150C
18160C      GAS IS THE HOURLY BTUS SUPPLIED BY THE GAS SYSTEM
18170C
18180C      OIL IS THE HOURLY BTUS SUPPLIED BY THE OIL SYSTEM
18190      DATA ONE/1.0/,OP365/1.365/,ZERO/0.0/,BTUHP/2545./,P7375/0.7375/
18200      DATA SEVTY/70000./,P33/.33/,P66/.66/
18210      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCME,SCALE,QHL,
18220      1 QHW,QC,QINCI,HASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
18230      1 KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BCLBH,PCT,CPRVT,FANC,
18240      1 CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
18250      1 SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHT,TQHLHW,TQ1HHW,TQCCW,
18260      1 TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
18270      COMMON /WEATHR/OB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
18280      1 WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
18290      REAL KADX
18300      LOGICAL IN,FIRST
18310C
18320      QNEED = ZERO
18330      TF = ZERO
18340      IF(QC .LE. ZERO) GO TO 20
18350      CALL ATAHF(TO,T,QCOND,GEVAP,HP,AUX1,AUX2)
18360      QNEED = QC/(ONE - FANH/GEVAP)
18370      TF = QNEED/GEVAP
18380      CD = DEGRAD(TF,ONE)
18390      HPD = HP/CD
18400C
18410      20 CONTINUE
18420      ELE = QHW + QHL + TF*(HPD*BTUHP + FANH + FANE)
18430      PECO = SEVTY
18440      IF(QHW .LE. ZERO) PECO = ZERO
18450      CAP = SIZE
18460      CENT = ZERO
18470      PER = QHL/CAP
18480      IF(PER .GT. ZERO .AND. PER .LT. P33) CENT = P33
18490      IF(PER .GT. P33 .AND. PER .LT. P66) CENT = P66
18500      IF(PER .GT. P66) CENT = ONE

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18510      PEAK1 = CENT * CAP
18520      PEAK2 = ZERO
18530      IF(TF .GT. ZERO) PEAK2 = BTUHP * HPD + FANH + FANE
18540      PEAK = PECO + PEAK1 + PEAK2
18550      GAS = ZERO
18560      OIL = ZERO
18570      RETURN
18580      END
18590      FUNCTION DEGRAD(TF,X)
18600C
18610C*****
18620C
18630C      THIS FUNCTION WILL DETERMINE THE DEGRADATION COEFFICIENT OF
18640C      THE AIR TO AIR HEAT PUMP AS A FUNCTION OF THE TIME FRACTION
18650C
18660C      THE FUNCTION STATEMENT IS
18670C
18680C      FUNCTION DEGRAD(TF)
18690C
18700C      WHERE TF IS THE TIME FRACTION
18710C
18720C
18730C      PROJECT      ACES
18740C
18750C      DEVELOPED BY HONEYWELL
18760C
18770C      CREATION DATE      9/10/78
18780C
18790C*****
18800C
18810      DATA C/0.25/,ONE/1.0/
18820      B = C * X
18830      DEGRAD = ONE - B * (ONE - TF)
18840      RETURN
18850      END
18860      SUBROUTINE CONV2(GAS,OIL,ELE,PEAK)
18870C
18880C*****
18890C
18900C      THIS SUBROUTINE WILL ESTIMATE THE HOURLY GAS, OIL, AND
18910C      ELECTRIC USAGE OF A HEAT PUMP HEATING AND COOLING SYSTEM
18920C      AND AN ELECTRIC HOT WATER SYSTEM
18930C
18940C
18950C      THE SUBROUTINE STATEMENT IS
18960C
18970C      SUBROUTINE CONV2(GAS,OIL,ELE)
18980C
18990C      WHERE
19000C

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19010C   GAS IS THE HOURLY BTU'S SUPPLIED BY THE GAS SYSTEM
19020C
19030C   OIL IS THE HOURLY BTU'S SUPPLIED BY THE OIL SYSTEM
19040C
19050C   ELE IS THE HOURLY BTU'S SUPPLIED BY THE ELETRIC SYSTEM
19060C
19070C   PROJECT      ACES
19080C
19090C   DEVELOPED BY HONEYWELL
19100C
19110C   CREATION DATE      9/10/78
19120C
19130C *****
19140C
19150   DATA ONE/1.0/,OP365/1.365/,ZERO/0.0/,BTUHP/2545./,P7375/0.7375/
19160   DATA TWO/2.0/,SEVTY/70000./
19170   COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCME,SCALE,QHL,
19180   1   QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
19190   1   KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
19200   1   CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
19210   1   SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWW,TQCCW,
19220   1   TQHLMS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
19230   COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
19240   1   WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
19250   REAL KADX
19260   LOGICAL IN,FIRST
19270C
19280   ELE1 = ZERO
19290   ELE2 = ZERO
19300   BU = ZERO
19310   BU1 = ZERO
19320   BU2 = ZERO
19330   AUX1 = ZERO
19340   AUX2 = ZERO
19350   PEAK1 = ZERO
19360   PEAK2 = ZERO
19370   PEAK3 = ZERO
19380   IF(QHL .LE. ZERO) GO TO 20
19390   CALL ATAMP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
19400   QNEED = QHL/(ONE + (FANH - AUX2)/(QCOND + FANH - AUX2))
19410   TF = QNEED/(QCOND + FANH)
19420   IF(ISTRIP .GT. ONE .AND. QNEED .GT. QCOND) GO TO 10
19430   IF(QNEED .GT. QCOND) BU = SIZE
19440   IF(QNEED .GT. QCOND) QNEED = (QHL)/(ONE + (FANH - AUX2)/
19450   1   (QCOND + FANH - AUX2 + SIZE))
19460   IF(BU .GT. ZERO) TF = QNEED/(QCOND + FANH - AUX2 + SIZE)
19470   GO TO 15
19480 10 CONTINUE
19490   BU1 = SIZE/TWO
19500   QNEED = (QHL)/(ONE + (FANH - AUX2)/(QCOND + FANH - AUX2 + BU1))

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19510      TF = QNEED/(QCOND + FANH - AUX2 + BU1)
19520      IF(TF .GT. ONE) BU2 = BU1
19530      IF(TF .GT. ONE) QNEED = (QHL)/(ONE + (FANH - AUX2)/(QCOND + FANH
19540      1      - AUX2 + BU1 + BU2))
19550      IF(TF .GT. ONE) TF = QNEED/(QCOND + FANH - AUX2 + BU1 + BU2)
19560      BU = ZERO
19570  15 CONTINUE
19580      XRZ = 3.
19590      IF(A(196) .LE. ZERO) XRZ = ONE
19600      DTF = TF
19610      IF(A(196) .LE. ZERO) GO TO 333
19620      IF(DTF .GT. ZERO .AND. DTF .LE. .33) DTF = DTF/.33
19630      IF(DTF .GT. .66 .AND. DTF .LE. .66) DTF = (DTF - .33)/.33
19640      IF(DTF .GT. .66) DTF = (DTF - .66)/.34
19650  333 CONTINUE
19660      CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ONE))
19670      HPD = HP/CD
19680      ELE1 = TF * (HPD * BTUHP + FANH + FANE + AUX1 + BU + BU1 + BU2)
19690      CENT = ZERO
19700      IF(TF .LT. .33) CENT = .33
19710      IF(TF .GT. .33 .AND. TF .LT. .66) CENT = .66
19720      IF(TF .GT. .66) CENT = ONE
19730      PEAK1 = CENT * ELE1/TF
19740C
19750  20 IF(QC .LE. ZERO) GO TO 30
19760      CALL ATAMP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
19770      QNEED = QC/(ONE - FANH/QEVAP)
19780      TF = QNEED/QEVAP
19790      XRZ = 3.
19800      IF(A(196) .LE. ZERO) XRZ = ONE
19810      DTF = TF
19820      IF(A(196) .LE. ZERO) GO TO 777
19830      IF(DTF .GT. ZERO .AND. DTF .LE. .33) DTF = DTF/.33
19840      IF(DTF .GT. .66 .AND. DTF .LE. .66) DTF = (DTF - .33)/.33
19850      IF(DTF .GT. .66) DTF = (DTF - .66)/.34
19860  777 CONTINUE
19870      CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ONE))
19880      HPD = HP/CD
19890      ELE2 = TF*(HPD*BTUHP + FANH + FANE)
19900      CENT = ZERO
19910      IF(TF .GT. ZERO .AND. TF .LT. .33) CENT = .33
19920      IF(TF .GT. .33 .AND. TF .LT. .66) CENT = .66
19930      IF(TF .GT. .66) CENT = ONE
19940      PEAK2 = CENT * ELE2/TF
19950C
19960  30 CONTINUE
19970      ELE = ELE1 + ELE2 + QHW
19980      IF(QHW .GT. ZERO) PEAK3 = SEVTY
19990      PEAK = PEAK1 + PEAK2 + PEAK3
20000      GAS = ZERO

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20010      OIL = ZERO
20020      RETURN
20030      END
20040      SUBROUTINE CONV3(GAS,OIL,ELE,PEAK)
20050C
20060C*****
20070C
20080C      THIS SUBROUTINE WILL ESTIMATE THE HOURLY GAS OIL AND ELECTRIC
20090C      USAGE OF AN OIL HEATING SYSTEM, AN ELECTRIC COOLING SYSTEM
20100C      (CENTRAL), AND AN ELECTRIC HOT WATER SYSTEM
20110C
20120C
20130C      THE SUBROUTINE STATEMENT IS
20140C
20150C      SUBROUTINE CONV3(GAS,OIL,ELE)
20160C
20170C      WHERE
20180C
20190C      GAS IS THE HOURLY BTU'S SUPPLIED BY THE GAS SYSTEM
20200C
20210C      OIL IS THE HOURLY BTU'S SUPPLIED BY THE OIL SYSTEM
20220C
20230C      ELE IS THE HOURLY BTU'S SUPPLIED BY THE ELETIC SYSTEM
20240C
20250C      PROJECT      ACES
20260C
20270C      DEVELOPED BY HONEYWELL
20280C
20290C      CREATION DATE      9/10/78
20300C
20310C*****
20320C
20330      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCME,SCALE,QHL,
20340      1      QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
20350      1      KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
20360      1      CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
20370      1      SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTKET,TQHLHW,TQHHWW,TQCCW,
20380      1      TQHLHS,TQHWHHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
20390      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
20400      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
20410      REAL KADX
20420      LOGICAL IN,FIRST
20430      DATA ONE/1.0/,OP365/1.365/,ZERO/0.0/,BTUHP/2545./,P7375/0.7375/
20440      DATA THOU/1000.0/,AUTO/0.0/
20450      DATA SEVTY/70000./
20460C
20470      OIL = ZERO
20480      ELE0 = ZERO
20490      ELE1 = ZERO
20500      ELE2 = ZERO

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20510      TFP = ZERO
20520      PEAK1 = ZERO
20530      PEAK2 = ZERO
20540      PEAK3 = ZERO
20550      IF(QHL .LE. ZERO) GO TO 20
20560      ITYPE = 0
20570      CALL FURN(ITYPE,FANOIL,QHL,QNEED,ETA,TF)
20580      OIL = QNEED/ETA
20590      TFP = TF
20600      ELE0 = TF * FANOIL
20610      PEAK1 = FANOIL
20620C
20630      20 CONTINUE
20640      IF(QC .LE. ZERO) GO TO 30
20650      CALL ATAMP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
20660      QNEED = QC/(ONE - FANH/QEVAP)
20670      TF = QNEED/QEVAP
20680      CD = DEGRAD(TF,ONE)
20690      HPD = HP/CD
20700      ELE1 = TF*(HPD*BTUHP + FANH + FANE)
20710      PEAK2 = ELE1/TF
20720C
20730      30 CONTINUE
20740      ELE2 = QHW
20750      ELE = ELE1 + ELE2 + ELE0
20760      IF(QHW .GT. ZERO) PEAK3 = SEVTY
20770      PEAK = PEAK1 + PEAK2 + PEAK3
20780      GAS = ZERO
20790      PILOT = (ONE - TFP) * THOU * AUTO
20800      OIL = OIL + PILOT
20810      RETURN
20820      END
20830      SUBROUTINE FURN(ITYPE,FAN,QHL,QNEED,ETA,TF)
20840C
20850C*****
20860C
20870C      THIS SUBROUTINE ESTIMATES THE TIME FRACTION, EFFICIENCY AND
20880C      OUTPUT OF A CONVENTIONAL GAS OR OIL FIRED FURNACE
20890C
20900C      GUESS THE EFFICIENCY, THEN USE NEWTON'S METHOD TO SOLVE FOR
20910C      THE REQUIRED FURNACE PARAMETERS
20920C
20930C      THE SUBROUTINE STATEMENT IS
20940C
20950C      SUBROUTINE FURN(ITYPE,SIZE,FAN,QHL,QNEED,ETA,TF)
20960C
20970C      WHERE
20980C
20990C      ITYPE DENOTES THE TYPY OF HEATING SYSTEM
21000C

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21010C      SIZE IS THE OUTPUT CAPACITY OF THE PLANT
21020C
21030C      FAN IS THE BTU'S REJECTED BY THE FAN
21040C
21050C      QHL IS THE HOURLY THERMAL LOAD
21060C
21070C      QNEED IS THE ACTUAL HEAT NEEDED BY THE SPACE
21080C
21090C      ETA IS THE EFFICIENCY OF THE FURNACE
21100C
21110C      TF IS THE TIME FRACTION
21120C
21130C      PROJECT      ACES
21140C
21150C      DEVELOPED BY HONEYWELL
21160C
21170C      CREATION DATE      9/10/78
21180C
21190C*****
21200C
21210      COMMON /DESH/HEATD
21220      DATA P71/0.71/,ZERO/0.0/,ONE/1.0/,P00001/.00001/,P01/.01/
21230      DATA THIRTY/30.0/,P63/0.63/,P005/0.005/
21240C
21250      SUM = ZERO
21260      IF(ITYPE .EQ. 0) ETA = P71
21270      IF(ITYPE .EQ. 1) ETA = P63
21280      QIN = HEATD/ETA
21290      10 QOUT = QIN * ETA
21300      QNEED = QHL/(ONE + FAN/(QOUT + FAN))
21310      TF = QNEED/(QOUT + FAN)
21320      IF(ITYPE .EQ. 0) ETA1 = ETAOIL(TF)
21330      IF(ITYPE .EQ. 1) ETA1 = ETAGAS(TF)
21340      FX = ETA1 - ETA
21350      DEL = P00001*ETA
21360      ETAP = ETA + DEL
21370      QOUT = QIN * ETA
21380      QNEED = QHL/(ONE + FAN/(QOUT + FAN))
21390      TF = QNEED/(QOUT + FAN)
21400      IF(ITYPE .EQ. 0) ETA1 = ETAOIL(TF)
21410      IF(ITYPE .EQ. 1) ETA1 = ETAGAS(TF)
21420      FXD = ETA1 - ETAP
21430      FXP = (FXD - FX)/DEL
21440      ETAN = ETA - FX/FXP
21450      ETA = ETAN
21460      SUM = SUM + ONE
21470      IF(ABS(FX) .GT. P01 .AND. SUM .LT. THIRTY) GO TO 10
21480      IF(SUM .GE. THIRTY .AND. QHL/HEATD .GT. P005) WRITE(9,101)
21490      101 FORMAT('SUBROUTINE FURN HAS NOT CONVERGED')
21500      RETURN

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21510      END
21520      FUNCTION ETAOIL(TF)
21530C
21540C*****
21550C
21560C      THIS FUNCTION WILL DETERMINE THE EFFICIENCY OF AN OIL
21570C      FIRED FURNACE AS A FUNCTION OF THE PERCENT ON TIME
21580C
21590C      THE FUNCTION STATEMENT IS
21600C
21610C      FUNCTION ETAOIL(TF)
21620C
21630C      WHERE TF IS THE TIME FRACTION
21640C
21650C      DEVELOPED BY HONEYWELL
21660C
21670C      CREATION DATE          9/10/78
21680C
21690C*****
21700C
21710      DATA P025/0.025/,P71/0.71/,ONE/1.0/,S4P59/74.59/,P60/0.6/
21720      DATA P11/0.11/,T4P24/24.24/
21730      IF(TF .LE. P025) ETAOIL = P71*(ONE - EXP(-S4P59*TF))
21740      IF(TF .GT. P025) ETAOIL = P60 + P11*(ONE - EXP(-T4P24*(TF -
21750      1                                P025)))
21760      RETURN
21770      END
21780      FUNCTION ETAGAS(TF)
21790C
21800C*****
21810C
21820C      THIS FUNCTION WILL DETERMINE THE EFFICIENCY OF A GAS FIRED
21830C      FURNACE AS A FUNCTION OF THE PERCENT ON TIME
21840C
21850C      THE FUNCTION STATEMENT IS
21860C
21870C      FUNCTION ETAGAS(TF)
21880C
21890C      WHERE TF IS THE TIME FRACTION
21900C
21910C      PROJECT      ACES
21920C
21930C      DEVELOPED BY HONEYWELL
21940C
21950C      CREATION DATE          9/10/78
21960C
21970C*****
21980C
21990      DATA ONE/1.0/,P63/0.63/,T3P3/33.3/
22000      ETAGAS = P63*(ONE - EXP(-T3P3*TF))

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22010      RETURN
22020      END
22030      SUBROUTINE CONV4(GAS,OIL,ELE,PEAK)
22040C
22050C*****
22060C
22070C      THIS SUBROUTINE WILL ESTIMATE THE HOURLY GAS OIL AND ELECTRIC
22080C      USAGE OF A GAS HEATING SYSTEM, AN ELECTRIC COOLING SYSTEM
22090C      (CENTRAL), AND A GAS HOT WATER SYSTEM
22100C
22110C
22120C      THE SUBROUTINE STATEMENT IS
22130C
22140C      SUBROUTINE CONV4(GAS,OIL,ELE)
22150C
22160C      WHERE
22170C
22180C      GAS IS THE HOURLY BTU'S SUPPLIED BY THE GAS SYSTEM
22190C
22200C      OIL IS THE HOURLY BTU'S SUPPLIED BY THE OIL SYSTEM
22210C
22220C      ELE IS THE HOURLY BTU'S SUPPLIED BY THE ELECTRIC SYSTEM
22230C
22240C
22250C      PROJECT      ACES
22260C
22270C      DEVELOPED BY HONEYWELL
22280C
22290C      CREATION DATE      9/10/78
22300C
22310C*****
22320C
22330      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCMEL,SCALE,QHL,
22340      1      QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
22350      1      KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
22360      1      CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
22370      1      SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
22380      1      TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP,
22390      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PH(24),TC(24),TOC(24),
22400      1      WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
22410      REAL KADX
22420      LOGICAL IN,FIRST
22430      DATA ONE/1.0/,OP365/1.365/,ZERO/0.0/,BTUHP/2545./,P7375/0.7375/
22440      DATA P73/0.73/,THOU/1000.0/,AUTO/0.0/
22450C
22460      GAS = ZERO
22470      ELE0 = ZERO
22480      ELE1 = ZERO
22490      TFP = ZERO
22500      PEAK1 = ZERO

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22510     PEAK2 = ZERO
22520     IF(QHL .LE. ZERO) GO TO 20
22530     ITYPE = 1
22540     CALL FURN(ITYPE,FANGAS,QHL,QNEED,ETA,TF)
22550     GAS = QNEED/ETA
22560     TFP = TF
22570     ELE0 = TF*FANGAS
22580     PEAK1 = FANGAS
22590C
22600 20 CONTINUE
22610     IF(QC .LE. ZERO) GO TO 30
22620     CALL ATAMP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
22630     QNEED = QC/(ONE - FANH/QEVAP)
22640     TF = QNEED/QEVAP
22650     CD = DEGRAD(TF,ONE)
22660     HPD = HP/CD
22670     ELE1 = TF*(HPD*BTUMP + FANH + FANE)
22680     PEAK2 = ELE1/TF
22690C
22700 30 CONTINUE
22710     GAS2 = QHW/P73
22720     PILOT = (ONE - TFP) * THOU * AUTO
22730     GAS = GAS + GAS2 + PILOT
22740     OIL = ZERO
22750     ELE = ELE0 + ELE1
22760     PEAK = PEAK1 + PEAK2
22770     RETURN
22780     END
22790     SUBROUTINE ACES(FIRST,GAS,OIL,ELE,ELEBU,PEAK)
22800C
22810C*****
22820C
22830C     THIS SUBROUTINE WILL SIMULATE THE ENERGY USAGE OF A FULL
22840C     MINIMUM UK COST OPTIMIZED ACES. THE MAJOR INPUTS TO THIS
22850C     ROUTINE ARE THE HOURLY LOADS,WEATHER, COLLECTOR SIZE, TANK
22860C     SIZE, CUTOFF OR CHANGE OVER TEMPERATURE, AND PERFORMANCE
22870C     CHARACTERISTICS OF THE VARIOUS COMPONENTS.
22880C
22890C
22900C     THE SUBROUTINE STATEMENT IS
22910C
22920C     SUBROUTINE ACES(FIRST,GAS,OIL,ELE)
22930C
22940C     WHERE
22950C
22960C     GAS IS THE HOURLY BTU'S SUPPLIED BY THE GAS SYSTEM
22970C
22980C     OIL IS THE HOURLY BTU'S SUPPLIED BY THE OIL SYSTEM
22990C
23000C     ELE IS THE HOURLY BTU'S SUPPLIED BY THE ELETRIC SYSTEM

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23010C
23020C FIRST IS AN OPTION DELEMETER
23030C
23040C ELEBU IS THE HOURLY BTU'S SUPPLIED BY THE BACKUP ELECTRIC SYSTEM
23050C
23060C PROJECT ACES
23070C
23080C DEVELOPED BY HONEYWELL
23090C
23100C CREATION DATE 9/10/78
23110C
23120C*****
23130C
23140 COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCMF,SCALE,QHL,
23150 1 QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANDIL,FANGAS,
23160 1 KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,3C,BH,PCT,CPRVT,FANC,
23170 1 CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
23180 1 SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
23190 1 TQHLHS,TQHWHHS,TQCCS,TOTGOL,IMONTH,VOLUME,SIZEE,FANE,ISTRIP
23200 COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
23210 1 WET(24),DRY(24),IYEAR,IDUM1,IOHM2,ICITY
23220 COMMON /ZAP1/ZAP,PEK,PQBU1
23230 INTEGER TIMEON,TIMOFF
23240 REAL KADX
23250 LOGICAL IN,FIRST,DUEL,RUN,G01
23260 DATA ELEVEN/11.0/,OP01/1.01/,P99/0.99/,ZERO/0.0/,ONE/1.0/
23270 DATA P5/0.5/,OP05/1.05/,TWNFOR/24./,OPEM4/1.2131944E-4/,SIX/6.0/
23280 DATA THIRT/30./,SEVFIV/75./,SIX2P4/62.4/,F7P24/57.24/,THIR2/32./
23290 DATA TS45/2545./,TWO/2.0/,P97/.97/,OP05/1.05/,005/105./
23300C
23310C INITIALIZE VARIABLES
23320C
23330 IF(.NOT. FIRST) GO TO 10
23340 DUEL = .TRUE.
23350 TOSAW = A(82)
23360 TZONEW = A(88)
23370 TZONES = A(89)
23380 TTANK = A(146)
23390 CUFT = ZERO
23400 TTANK2 = A(96)
23410 AWALBG = A(65)
23420 THOTW = 005
23430 FNOC = A(97)
23440 DAYON = A(98)
23450 DAYOF = A(108)
23460 XK = (ONE/PF - ONE)
23470 DAYAFT = A(109)
23480 FLAG = ZERO
23490 CHECK = ONE
23500 IDUM = IMONTH

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23510 TIMEON = IFIX(A(100))
23520 TIMOFF = IFIX(A(101))
23530 XRZ = 3.
23540 IF(A(196) .LE. ZERO) XRZ = ONE
23550 TERI = ZERO
23560 STAR = ZERO
23570 BEFO = ZERO
23580 IF((PEK + DAYAFT) .GT. BH) BEFO = ONE
23590 ZUM = BH - ONE
23600 ZIP = ZAP
23610 TEMP = (TZONEN + TZONES)/TWO
23620 RUN = .FALSE.
23630 IF(CUTOFF .GT. TZONEN) DUEL = .FALSE.
23640 VOLUME = HEIGHT*SIDE*SIDE
23650C
23660C SET PARAMETERS AND ESTIMATE LOADS TO BE USED IN CONTROLLING
23670C THE SOLAR PANEL
23680C
23690 TIME = (BH - BC)*TWNFOR
23700 QINL = TOTCOL - TLOSS*TIME
23710 IMONTH = 9
23720 CALL TANKLD(TLOSS,SURFW,TLOSA,TEMP,FIRST)
23730 IMONTH = IDUM
23740 FIRST = .TRUE.
23750 TTLOSS = TLOSS
23760 QINH = TOTCOL - TTLOSS*TIME
23770 QNETI = QINH
23780C
23790 10 CONTINUE
23800 AUX1 = ZERO
23810 AUX2 = ZERO
23820 COP1 = ZERO
23830 COP2 = ZERO
23840 SSS = ZERO
23850 QCOND1 = ZERO
23860 QCOND2 = ZERO
23870 QBU = ZERO
23880 QBU1 = ZERO
23890 HP1 = ZERO
23900 HP2 = ZERO
23910 TEMP = T
23920 PEAK1 = ZERO
23930 PEAK2 = ZERO
23940 PEAK3 = ZERO
23950 PEAK4 = ZERO
23960 PEAK5 = ZERO
23970 IF(J .EQ. 1) ZUM = ZUM + ONE
23980 TERI = TERI + QC
23990 IF(J .NE. 24) GO TO 444
24000 IF(TERI .GT. .99 * ZAP) STAR = ONE

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24010      IF(STAR .GT. ZERO) ZIP = TERI
24020      TERI = ZERO
24030      444 CONTINUE
24040C
24050C      CHECK TO SEE IF THE ACES UTILIZES A DUAL SOURCE EVAPORATOR
24060C      THEN CALL THE REQUIRED HEAT PUMP ROUTINES
24070C
24080      IF(DUEL .AND. TO .GT. CUTOFF .AND. (I .LT. BC .OR. I .GE. BH))
24090      1 CALL ATAMP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
24100      IF(DUEL .AND. TO .GT. CUTOFF .AND. (I .LT. BC .OR. I .GE. BH))
24110      1 SSS = ONE
24120      IF(SSS .LT. ONE) GO TO 445
24130      QCOND2 = QCOND
24140      QEVAP2 = QEVAP
24150      HP2 = HP
24160      COP2 = COP
24170      445 CONTINUE
24180      IF(DUEL .AND. I .GE. BC .AND. I .LT. BH) CALL WAHP(TTANK,T,
24190      1 QCOND,QEVAP,HP)
24200      IF(.NOT. DUEL .OR. TO .LE. CUTOFF) CALL WAHP(TTANK,T,QCOND,
24210      1 QEVAP,HP)
24220      CALL WWHP(TTANK,THOTW,QCOND1,QEVAP1,HP1,COP1)
24230      IF(QHL .LE. ZERO)SSS = TWO
24240      IF(SSS .LT. TWO) GO TO 446
24250      QCOND2 = QCOND1
24260      QEVAP2 = QEVAP1
24270      HP2 = HP1
24280      COP2 = COP1
24290      446 CONTINUE
24300      IF(COP .LE. ZERO)COP = ONE
24310C
24320C      DETERMINE THE DYNAMIC TANK LOSS
24330C
24340      CALL TANKLD(TLOSS,SURFW,TLOSA,TEMP,FIRST)
24350C
24360C      ENERGY FROM THE COLLECTOR
24370C
24380      QINC = QINCI
24390      CALL COLECT(QINC,QCOLL)
24400      QPCC = ZERO
24410      QPAN = ZERO
24420      IF(TTANK .GT. SEVFIV) QCOLL = ZERO
24430      IF(I .GT. BC .AND. I .LT. BH) GO TO 20
24440C
24450C      KEEP TEMPERATURE IN THE TANK 42F OR BELOW IF THERE IS A
24460C      COOLING LOAD
24470C
24480      IF(I.GE.BH .AND. I.LE.ENDC .AND. TTANK.GT.TTANK2) QCOLL = ZERO
24490C
24500C      ESTIMATE WHEN THE PANELS SHOULD BE SHUT OFF OR TURNED ON

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24510C DURING THE WINTER
24520C
24530 IF(I .GT. (PEK + DAYAFT) .AND. I .LT. BH) CHECK = ZERO
24540 IF(BEFO .GT. ZERO .AND. ZUM .GT. (PEK + DAYAFT)) CHECK = ZERO
24550 IF(CUFT .GT. OP05 * PF * VOLUME) QBU = SIZE
24560 PEAK1 = QBU
24570 IF(I .GT. DAYON .AND. I .LT. DAYOF) GO TO 40
24580 IF(CUFT .GE. P99*PF*VOLUME) FLAG = ONE
24590 IF(CUFT .LT. P97*PF*VOLUME .AND. FLAG .GE. ONE) FLAG = ZERO
24600 IF(CHECK .LE. ZERO .AND. FLAG .LT. ONE) QCOLL = ZERO
24610 GO TO 40
24620C
24630C SUMMERTIME OPERATION OF PANELS IF NECESSARY
24640C
24650 20 CONTINUE
24660 IF(CUFT .LE. ZERO) GO TO 30
24670 IF(QINH .GE. PF*VOLUME/OP04) GO TO 30
24680 QNETI = QNETI - (QC - (QHL * (ONE - ONE/COP) + QHW * (ONE -
24690 1 ONE/OP01)) - TLOSS)
24700 DIF = TTLOSS - TLOSS
24710 IF(CUFT/OP04 .LE. (QNETI - DIF)) QCOLL = ZERO
24720 GO TO 40
24730 30 CONTINUE
24740 QCOLL = ZERO
24750C
24760C ENERGY NEEDED TO RUN THE PANEL PUMP
24770C
24780 40 CONTINUE
24790 IF(QCOLL .GT. ZERO) QPCC = PUMP*(ONE - XPER)
24800 IF(QCOLL .GT. ZERO) QPAN = PUMP * XPER
24810C
24820C ELECTRIC ENERGY TO RUN COLLECTOR
24830C
24840 ELESOL = ZERO
24850 IF(QCOLL .GT. ZERO) ELESOL = PUMP
24860C
24870C CALCULATE THE ENERGY NEEDED TO REJECT HEAT FROM COLD STORAGE
24880C DURING THE SUMMER
24890C
24900 QLOW = ZERO
24910 ELENIT = ZERO
24920 ENELOW = ZERO
24930 ENELOT = ZERO
24940 IF(I .LT. BC .OR. I .GE. BH) GO TO 70
24950 OVER = PF * VOLUME * (SIX2P4*XK + F7P24) * (TTANK2 - TTANK) + CUFT
24960 1 / OP04
24970 IF(OVER .LT. ZIP) RUN = .TRUE.
24980 IF(.NOT. RUN .OR. (J .LT. TIMEON .AND. J .GT. TIMOFF)) GO TO 70
24990 IF(CUFT .GE. PF * VOLUME) GO TO 70
25000 CALL WAHP(TTANK,TO,QCOND,QEVAP,HP)

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25010 QLOW = QEVAP
25020 ELENIT = FANH + TS45*HP + PUME
25030 IF(J .LT. TIMEON .AND. J .GE. TIMOFF) RUN = .FALSE.
25040 ENELOW = PUME*XPER
25050 ENELOT = PUME*(ONE - XPER)
25060 PEAK2 = ELENIT
25070 CALL WAHP(TTANK,T,QCOND,QEVAP,HP)
25080C
25090 70 CONTINUE
25100C
25110 GO1 = .FALSE.
25120 IF(TTANK .GT. TTANK2 .AND. (I .GE. HC .AND. I .LT. BH) .AND.
25130 1 (J .LT. TIMEON .AND. J .GT. TIMOFF)) GO1 = .TRUE.
25140 IF(.NOT.GO1) GO TO 781
25150 CALL WAHP(TTANK,T,QCOND,QEVAP,HP)
25160 QLOW = QEVAP
25170 ELENIT = FANH + TS45*HP + PUME
25180 IF(J .GE. TIMOFF) RUN = .FALSE.
25190 ENELOW = PUME*XPER
25200 ENELOT = PUME*(ONE - XPER)
25210 PEAK2 = ELENIT
25220 CALL WAHP(TTANK,T,QCOND,QEVAP,HP)
25230C
25240 781 CONTINUE
25250C
25260C THE TOTAL HEATING LOAD FOR THE HOUR IS
25270C
25280 HEAT = QHL
25290C
25300C IF THERE WERE NO BASEMENT, THE TOTAL HEAT LOAD WOULD BE
25310C
25320 HEATMB = HEAT + BASLOD
25330C
25340C THE ADJUSTED BASEMENT LOAD AS A FUNCTION OF THE REPLACED
25350C SURFACE AREA OF THE TANK
25360C
25370 BASE1 = BASLOD*(ONE - SURFW/AWALBG)
25380C
25390C THE ACTUAL HEAT DEMAND ACCOUNTING FOR THE CORRECTED BASEMENT
25400C SURFACE AREA, THE ADDED FAN HEAT, AND THE HEAT FROM THE
25410C BASEMENT TO THE TANK IS QNEED. QNEED IS EQUAL TO HEAT IF THE
25420C TANK AND THE FAN SYSTEM ARE NOT IN THE HEATED SPACE.
25430C
25440 XX = ONE
25450 IF(DUEL .AND. TO .GT. CUTOFF) XX = ZERO
25460 IF(I .GE. BC .AND. I .LT. RH) XX = ONE
25470 QCOND1 = QCOND1 * XX + QCOND2 * (ONE - XX)
25480 IF(QHL .GT. ZERO) QCOND1 = QCOND1 * XX + QCOND2 * (ONE - XX)
25490 CO = COP1 * XX + COP2 * (ONE - XX)
25500 QNEEDW = QHW/(ONE + (ONE - XPER) * PUMW/(QCOND1 + (ONE - XPER)

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25510      1      * PUMW))
25520      TFW = QNEEDW/(QCON1 + (ONE - XPER) * PUMW)
25530      QNEEDS = (HEATMB - BASE1 + TLOSA - QPAN - TFW*XPER* (PUME*XX
25540      1      + PUMW) - ENELOW)/(ONE + (FANH - AUX2 + XX*PUME*XPER)/
25550      1      (QCOND + FANH - AUX2 + XPER*PUME*XX))
25560      TFS = QNEEDS/(QCOND + FANH - AUX2 + XPER * PUME * XX)
25570      TF = TFS + TFW
25580      IF(QNEEDS .GT. ZERO .AND. QHL .GT. ZERO .AND. XX .GT. ZERO)
25590      1      CO = COP
25600      DTF = TF
25610      IF(A(196) .LE. ZERO) GO TO 377
25620      IF(DTF .GT. ZERO .AND. DTF .LE. .33) DTF = DTF/.33
25630      IF(DTF .GT. .33 .AND. DTF .LE. .66) DTF = (DTF - .33)/.33
25640      IF(DTF .GT. .66) DTF = (DTF - .66)/.34
25650      377 CONTINUE
25660C
25670C      ENERGY OUT OF THE TANK FOR HEATING VIA WATER SOURCE EVAPORATOR
25680C
25690      IF(I .GE. BC .AND. I .LT. BH) GO TO 55
25700      IF(DUEL .AND. TO .GT. CUTOFF) GO TO 50
25710      55 CONTINUE
25720      QPE = PUME*TF*(ONE - XPER)
25730      QOUT = QNEEDS * (ONE - ONE/COP) + QNEEDW * (ONE - ONE/CO)
25740      IF(QHL .LE. ZERO) QOUT = QNEEDW*(ONE - ONE/CO)
25750      IF(QNEEDS .LE. ZERO) QOUT = QNEEDW*(ONE - ONE/CO)
25760      IF(QNEEDS .LE. ZERO) QPE = PUME*TFW*(ONE - XPER)
25770      IF(QOUT .LE. ZERO) QPE = ZERO
25780C
25790C      ELECTRICAL ENERGY DURING HEATING
25800C
25810      CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ZERO))
25820      HPD = HP/CD
25830      COPD = COP * CD
25840      HPD1 = HP1/CD * XX + HP2/CD * (ONE - XX)
25850      COP 1 = CO * CD
25860      ELE1 = TFS * FANH + TF * PUME + QNEEDS/COPD + QNEEDW/COPD1
25870      1      + TFW * PUMW
25880      IF( NEEDS .LE. ZERO) ELE1 = TFW * (PUME + PUMW) + QNEEDW/COPD1
25890      IF( OUT .LE. ZERO) ELE1 = ZERO
25900      PEA = TS45 * HPD + PUMW + PUME + FANE
25910      IF( NEEDS .LE. ZERO) PEA = TS45 * HPD1 + PUME + PUMW
25920      CEN = ELE1/PEA
25930      IF( ENT .GT. ZERO .AND. CENT .LT. .33) CENT=.33
25940      IF( ENT .GT. .33 .AND. CENT .LT. .66) CENT = .66
25950      IF( ENT .GT. .66) CENT = ONE
25960      PEA 3 = CENT * PEA
25970      GO 0 60
25980C
25990C      ELECTRICAL ENERGY NEEDED FOR THE AIR SOURCE EVAPORATOR
26000C

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26010 50 CONTINUE
26020 CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ZERO))
26030 HPD = HP/CD
26040 COPD = COP * CD
26050 HPD1 = HP1/CD * XX + HP2/CD * (ONE - XX)
26060 COPD1 = CO * CD
26070 ELE1 = TFS * FANH + TF * FANE + QNEEDS/COPD + QNEEDW/COPD1
26080 1 + TFW * PUMW + TF * AUX1
26090 IF(QNEEDS .LE. ZERO) ELE1 = TFW * (FANE + PUMW + AUX1)
26100 1 + QNEEDW/COPD1
26110 IF(ELE1 .LE. ZERO) ELE1 = ZERO
26120 IF(QCOND .GT. ZERO .AND. (QNEEDS + QNEEDW) .GT. QCOND) QBU1 =
26130 1 QNEEDS + QNEEDW - QCOND
26140 IF(QBU1 .GT. ZERO) ELE1 = FANH + FANE + QCOND/COPD
26150 QOUT = ZERO
26160 QPE = ZERO
26170 PEA = T545 * HPD + AUX1 + PUMW + FANE + FANH
26180 IF(QNEEDS .LE. ZERO) PEA = T545 * HPD1 + AUX1 + PUMW + FANE
26190 CENT = ELE1/PEA
26200 IF(CENT .GT. ZERO .AND. CENT .LT. .33) CENT = .33
26210 IF(CENT .GT. .33 .AND. CENT .LT. .66) CENT = .66
26220 IF(CENT .GT. .66) CENT = ONE
26230 PEAK3 = CENT * PEA
26240 IF(QBU1 .GT. ZERO) PEAK3 = CENT * PEA + QBU1
26250 60 CONTINUE
26260 IF(ELE1 .LE. ZERO) GO TO 65
26270 ELE1 = ZERO
26280 QPE = ZERO
26290 QOUT = ZERO
26300 65 CONTINUE
26310C THE TOTAL COOLING LOAD FOR THE HOUR
26320C
26330C COOL = QC
26340C
26350C IF THERE IS NO BASEMENT THE TOTAL COOLING LOAD WOULD BE
26360C
26370C COOLMB = COOL - BASLOD
26380C
26390C THE ADJUSTED BASEMENT LOAD AS A FUNCTION OF THE REPLACED WALL
26400C AREA
26410C
26420C BASE2 = BASLOD*(ONE - SURFW/AWALBG)
26430C
26440C THE ACTUAL COOLING DEMAND ACCOUNTING FOR THE CORRECTED
26450C BASEMENT SURFACE AREA, THE ADDED FAN HEAT, AND THE HEAT FLOW
26460C FROM THE BASEMENT TO THE TANK IS QNEED. QNEED IS EQUAL TO
26470C COOL IF THE TANK AND THE FAN SYSTEM ARE NOT IN THE HEATED
26480C SPACE
26490C
26500C

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26510      RATI = (T - TTANK)/(TZONES - THIR2)
26520      QNEED = (COULMB + BASE2 - TLOSA + QPAN + TFW*XPER*(PUME*XX+PUMW)
26530      1 + ENELOW)/(ONE - (FANC + XPER*PUMC)/(RATI*SIZE2))
26540      TF = QNEED/(RATI*SIZE2)
26550C
26560C      ENERGY INTO THE TANK FROM COOLING
26570C
26580      QPC = PUMC*TF*(ONE - XPER)
26590      QIN = QNEED
26600      IF(QC .LE. ZERO) QIN = ZERO
26610      IF(QIN .LE. ZERO) QIN = ZERO
26620      IF(QIN .LE. ZERO) QPC = ZERO
26630C
26640C      ELECTRICAL ENERGY DURING COOLING
26650C
26660      ELECOL = TF*(PUMC + FANC)
26670      IF(QPC .LE. ZERO) ELECOL = ZERO
26680      IF(QPC .GT. ZERO) PEAK4 = PUMC + FANC
26690C
26700C      DETERMINE THE TANK TEMPERATURE OR THE AMOUNT OF ICE IN THE TANK
26710C
26720      QELE = QPCC + QPC + QPE + ENELOT + QBU
26730      Q = ZERO
26740      QI = ZERU
26750      IF(CUFT .GT. ZERO) GO TO 120
26760      TOLD = TTANK
26770      130 CONTINUE
26780      TTANK = TTANK + ONE/(PF*VOLUME*(SIX2P4*XX + F7P24))*(QIN - QOUT
26790      1 + TLOSS + QCOLL - QI + QELE - QLOW)
26800      IF(TTANK .LE. THIR2) Q = PF*VOLUME*(SIX2P4*XX+F7P24)*(TOLD-THIR2)
26810      IF(TTANK .GT. THIR2) GO TO 140
26820      120 TTANK = THIR2
26830      CUOLD = CUFT
26840      CUFT = CUFT + (QOUT-QIN+TLOSS-QCOLL-Q-QELE+QLOW)*OPEM4
26850      IF(CUFT .GT. ZERO) GO TO 150
26860      QI = CUOLD/OPEM4
26870      CUFT = ZERO
26880      GO TO 130
26890      150 CONTINUE
26900      IF(CUFT .GT. PCUFT) PCUFT = CUFT
26910      140 CONTINUE
26920      ELE = ELESOL + ELENIT + ELE1 + ELECOL + QBU + QBU1
26930      GAS = ZERU
26940      QIL = ZERO
26950      ELEBU = QBU + QBU1
26960      PEAK = PEAK1 + PEAK2 + PEAK3 + PEAK4
26970      IF(A(198) .GT. ZERO)WRITE(9,711)I,J,TTANK,CUFT,QNEEDS,QNEED,
26980      1 QNEEDW,QCOLL,ELENIT,ELE1,ELECOL,ELESOL,ELE
26990      711 FORMAT(1X,2(13,1X),2(F7.2,1X),9(F10.2,1X))
27000      RETURN
27010      END

```


**** **** **** ***** *****
* * * * * *
**** **** **** **** **** **** **** ****
* * * * * * * *
* * * * * * * *
**** **** * * *

-- 3 0 -- DATE 08-31-79 TIME 11.931 ID = E1 GCS-AJ

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A-169

ECOMOD

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SNUMB = 3895T
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  XXXX      XXXX      XXXX      XXXXX      XXXXX
  X          X X      X X      X          X
  XXX       XXXX      X X      XXXXX      X
  X         X X      XXXX      X X      X
  X X       X X      X        X X      X
  XXXX      XXXX      X        XXXX      X
  
```

XX
 XXX

SS 3895T ENTERED GCS-AJ AT 11.500 FROM SYSTEM=0 TSS/S 0-08-10

```

0001 S      SNUMB 3895T
0002 S      COMMENT F00648      TSS MEDIA CONVERSION
0003 S      IDENT  F00648-ACES
0004 SS     USERID F00648S
0005 AS     CONVER
0006 S      LIMITS ,,,50000
0007 S      SYSOUT OT,E1
0008 S      MULTI 1-1
0009 S      DATA IN,,COPY,ENDFC
0010 S      ENDCOPY IN
0011 S      ENDJOB
      TOTAL CARD COUNT THIS JOB = 001027
  
```

```

* ACTY=01 SCARD #0005 CONVER 08/31/79 SW=000000000000
  BMC-TTL DATE 771205
S      MULTI 1-1
FILE #000001 TOT 001016 INPUT
INPUT COUNT 001016 OUTPUT COUNT 001016
BLOCKS SKIPPED 000000 IGNORE COUNT 000000
* NORMAL TERMINATION AT 001544 I=2060 SW=000000000000
  
```

START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/HC	MS/HE	ADDRESS	T#/PK#
11.532	11.534	0.000	0.002										
				LINES	1015	PROC	0.0002	I/O	0.001	IU	5	MEMORY	8K
				LIMIT	50000	LIMIT	0.2000	LIMIT		CU	5	M*F	66
				MC R	MSU450 *	22	0	1	1	1	1	0-08-09	
				IN R	MSU450 *	550	0	25	25	25	25	0-08-09	
				OT	SYOUT								
				P*	SYOUT								

RC=00 1015 LINES AT STA. E1

ACTIVITY 01 COST=\$ 0.37
 *CUMULATIVE COST=\$ 0.37

SNUMB = 3895T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 001015

\$ NOTE FILENAME ECOMOD
\$ NOTE LABELS- A,R(E1)
\$ NOTE TABS/SETTINGS- ASIS

```

1000C*****
1010C
1020C          ACES ECONOMIC EVALUCATION PACKAGE
1030C
1040C
1050C          DEVELOPED BY HONEYWELL, INC
1060C          CREATION DATE:  NOVEMBER 17, 1978
1070C
1080C  THIS PROGRAM CAN EITHER CALCULATE THE LIFE CYCLE COST OF A
1090C  SINGLE HVAC SYSTEM IN THE FORM OF ANNUALIZED COSTS OR IT CAN
1100C  COMPARE THE ECONOMIC EFFECTIVENESS OF UP TO FIVE SYSTEMS IN
1110C  TERMS OF ANNUAL COST OF OPERATION, PRESENT VALUE OF NET
1120C  BENEFITS, AND PAYBACK
1130C
1140C*****
1150      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
1160      &      TOTELEC(5),COST(5),PVNB(5),PAYBAK(5),MAINT(5),INS(5),AC(5),
1170      &      PVTD(5),PTAX(5),PVC(5),OETD(5),BRKEV(5)
1180      COMMON /FUEL/TOTGAS(5),TOTOIL(5),OPEU(12,5),PEU(12,5),PDM(12,5),
1190      &      OPDM(12,5)
1200      COMMON /BILL/NCB(4),BLKCBST(4,5),BLKSIZ(4,5)
1210      COMMON /ACES/ETC,IPASS,ACESC(7),IRLDG,DATA(10),IDSYS(5)
1220      COMMON /OUTP/DELTAC(5),DELTOL(5),PVE(5),PVG(5),PVO(5),PVEC(2,5),
1230      &      PVED(2,5)
1240      DIMENSION MARGIN(10),LABEL(10),ESC(3,25),DF(30),NETD(5,25),
1250      &      FCTD(5,25),PTF(25),DEP(5),OP(5),AMP(5)
1260      CHARACTER MARGIN*6,LABEL*6
1270      INTEGER OWNER,FLAGT
1280      REAL MULT,MAINT,INS
1290      DO 1 IW = 1,170
1300      1 EIA(IW) = 0.0
1310C
1320C  READ IN ECONOMIC PARAMETERS ARRAY FROM FILE CODE 14
1330C
1340      REWIND 20
1350      READ(20) (MARGIN(II),II=1,10)
1360      WRITE(10,3000) (MARGIN(II),II=1,10)
1370 3000 FORMAT(10A6)
1380      5 READ(20,3002,END=7) J,EIA(J),(LABEL(JJ),JJ=1,9)
1390 3002 FORMAT(I4,F13.0,9A6)
1400      WRITE(10,3001) J,EIA(J),(LABEL(KK),KK=1,9)
1410 3001 FORMAT(I4,I3,F15.4,5X,9A6)
1420      GO TO 5
1430      7 CONTINUE
1440C
1450C  READ ENERGY USE FILES AND CALCULATE AMOUNT OF EACH ENERGY TYPE
1460C  USED DURING EACH RATE PERIOD DURING THE YEAR
1470C
1480      CALL AMOUNT
1490C
1500C  CALCULATE FIRST YEAR FUEL COSTS FOR EACH SYSTEM

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1510C
1520     CALL FUEL COST
1530C
1540C     CALCULATE EQUIPMENT COSTS FOR ACES
1550C
1560     IF(IDSYS(1) .NE. 1) GO TO 8
1570     CALL ACES COST
1580C
1590C     CALCULATE EQUIPMENT COST FOR OTHER SYSTEMS I=2,5 WHERE
1600C         2 = ALL ELECTRIC
1610C         3 = AIR-TO-AIR HEAT PUMP AND ELECTRIC DHW
1620C         4 = OIL HEAT, ELECTRIC A/C, ELECTRIC DHW
1630C         5 = GAS HEAT, ELECTRIC A/C, GAS DHW
1640C
1650     8 COST(2) = EIA(132) + EIA(134) + EIA(136)
1660     COST(3) = EIA(133) + EIA(136)
1670     COST(4) = EIA(131) + EIA(134) + EIA(136)
1680     COST(5) = EIA(130) + EIA(134) + EIA(135)
1690C
1700C     IDENTIFY TYPE OF OWNER
1710C
1720     OWNER = EIA(1)
1730C
1740C     INITIALIZE ANALYSIS PARAMETERS
1750C
1760     FLAGT = EIA(169)
1770     LAP = EIA(2)
1780     RDR = EIA(3)/100.0
1790     TAXI = EIA(4)/100.0
1800     TAXP = EIA(5)/100.0
1810     MFLAG = EIA(13)
1820     RMORT = EIA(6)/100.0
1830     SALV = EIA(7)/100.0
1840     TDS = EIA(14)
1850     NSYS = EIA(160)
1860     RINT = EIA(15)/100.0
1870     IPASS = 0
1880     NPOINT = EIA(170)
1890     PARAN = (1.0+RDR)
1900     NSEC = 169
1910     DO 900 INDEX=1,NPOINT
1920     NSEC = NSEC + 2
1930     ISTART = EIA(NSEC) + 1
1940     IEND = ISTART + LAP - 1
1950     COST(1) = (ACESC(1)+ACESC(2)+ACESC(3)+ACESC(4)+ACESC(5)+ACESC(6)+
1960     & ACESC(7))*EIA(NSEC+1)
1970     MULT = (PARAN**LAP-1.0)/(RDR*PARAN**LAP)
1980     AMULT = MULT/PARAN**(ISTART - 1)
1990     DO 9 KW=1,NSYS
2000     PVE(KW) = 0.0

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2010     PVG(KW) = 0.0
2020     PVO(KW) = 0.0
2030     MAINT(KW) = 0.0
2040     INS(KW) = 0.0
2050     DO 9 KX=1,2
2060     PVEC(KX,KW) = 0.0
2070     9 PVED(KX,KW) = 0.0
2080C
2090C  CALCULATE TOTAL PRESENT VALUE OF FUEL COSTS
2100C
2110     MFORM = 0
2120     DO 15 M=22,42,10
2130     MFORM = MFORM + 1
2140     NYR = 0
2150     FMULT = (1.0 + EIA(M+1)/100.0)**(ISTART-1)
2160     IF(ISTART .LT. EIA(M+2))GO TO 130
2170     FMULT = FMULT * (1.0+EIA(M+3)/100.0)**(ISTART-EIA(M+2))
2180 130 NEPH = EIA(M)
2190     LOPH = M
2200     LL = 1
2210     DO 15 N=1,NEPH
2220     LOPH = LOPH + 2
2230     LU = EIA(LOPH) + LL -1
2240     IF(ISTART .NE. 1 .AND. N .EQ. 1)LL=ISTART
2250     IF(LU .LT. LL)GO TO 15
2260     DO 13 L=LL,LU
2270     IF(L .GT. IEND)GO TO 15
2280     NYR = NYR + 1
2290     FMULT = FMULT * (EIA(LOPH-1)/100.0 + 1.0)
2300 13 ESC(MFORM,NYR) = FMULT/PARAN**L
2310 15 LL = LU + 1
2320     DO 16 LI=1,LAP
2330     DO 16 M=1,NSYS
2340     PVE(M) = TOTELEC(M)*ESC(1,LI) + PVE(M)
2350     PVG(M) = GASC(M)*ESC(2,LI) + PVG(M)
2360     PVO(M) = OILC(M)*ESC(3,LI) + PVO(M)
2370     FCTD(M,LI) = PVE(M) + PVG(M) + PVO(M)
2380     DO 16 N=1,2
2390     PVEC(N,M) = ELEC(N,M)*ESC(1,LI) + PVEC(N,M)
2400 16 PVED(N,M) = DEMAND(N,M)*ESC(1,LI) + PVED(N,M)
2410C
2420C  CALCULATE PRESENT VALUE OF NET EXPENDITURES TO DATE
2430C
2440     DO 660 NEL=1,LAP
2450     DO 660 IS=1,NSYS
2460     DISC = 1.0/(PARAN**(NEL+ISTART-1))
2470C
2480C  CALCULATE MAINTENANCE AND INSURANCE EXPENSES
2490C
2500     L = 8

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2510 IF(IDSYS(IS) .NE. 1)GO TO 17
2520 RMM = EIA(9)*DISC/100.0
2530 MAINT(1) = MAINT(1) + (ACESC(1)+ACESC(2)+ACESC(5)+ACESC(7))*
2540 & RMM
2550 L = 9
2560 GO TO 18
2570 17 MAINT(IS) = MAINT(IS) + EIA(8)*COST(IDSYS(IS))*DISC/100.0
2580 18 INS(IS) = INS(IS) + EIA(L+2)*COST(IDSYS(IS))*DISC/100.0
2590C
2600C CALCULATE TAX DEDUCTIONS FOR MORTGAGE PAYMENTS
2610C
2620 IF(NEL .GT. 1)GO TO 19
2630 EXPO = EIA(12)*EIA(2)
2640 FACT = RMORT/EIA(12)
2650 RMULT = FACT*(1+FACT)**EXPO/((1+FACT)**EXPO-1.0)
2660 JEND = ISTART + LAP - 1
2670 NPPY = EIA(12)
2680 PVTD(IS) = 0.0
2690 IF(MFLAG .EQ. 0)GO TO 21
2700 OP(IS) = COST(IDSYS(IS))*(1.0-EIA(167)/100.0)
2710 AMP(IS) = OP(IS)*RMULT
2720 19 IW = ISTART + NEL - 1
2730 DO 20 IV=1,NPPY
2740 TOMIP = OP(IS) * FACT
2750 OP(IS) = OP(IS) * (1 + FACT) - AMP(IS)
2760 20 PVTD(IS) = PVTD(IS) + (TOMIP/(PARAN**IW)*TAXI*(-1.0))
2770C
2780C CALCULATE PROPERTY TAX EFFECT
2790C
2800 21 IF(NEL .GT. 1)GO TO 600
2810 IF(IDS .NE. 0)GO TO 522
2820 DO 521 J1=1,LAP
2830 521 DF(J1) = 0.0
2840 GO TO 560
2850 522 IF(IDS .NE. 1)GO TO 524
2860 DO 523 J2=1,LAP
2870 523 DF(J2) = 1/LAP
2880 GO TO 560
2890 524 IF(IDS .NE. 2)GO TO 526
2900 DO 525 J3=1,LAP
2910 525 DF(J3) = 2.0*(LAP-J3+1)/(LAP*(LAP+1))
2920 GO TO 560
2930 526 SSF = RINT/((1+RINT)**LAP-1.0)
2940 DO 527 J4=1,LAP
2950 527 DF(J4) = SSF
2960 560 COST1 = 1.0
2970 COST2 = 1.0
2980 DO 599 K3=1,LAP
2990 COST1 = COST1 - COST2*DF(K3)
3000 599 PTF(K3) = TAXP*COST1/(PARAN**(K3+ISTART-1))

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```

3010      PTAX(IS) = 0.0
3020      600 COSTM = COST(IDSYS(IS))
3030      IF(IS.EQ.1.AND.FLAGT.EQ.0)COSTM = COST(1) - (ACESC(3) +
3040      &      ACESSC(4) + ACESSC(5))*EIA(NSEC+1)
3050      PTAX(IS) = PTAX(IS) + (1.0-TAXI)*COSTM*PTF(NEL)
3060C
3070C      CALCULATE PRESENT VALUE OF CAPITAL INVESTMENT EXPENDITURES
3080C
3090      IF(NEL .GT. 1)GO TO 602
3100      XNUM = 1.0
3110      IF(MFLAG .EQ. 0)GO TO 601
3120      ARATE = (EIA(3) + EIA(166))/100.0
3130      AMQ = 1.0 + ARATE
3140      XNUM = RMULT*EIA(12)
3150      601 DPAY = EIA(167)/100.0
3160      PVC(IS) = DPAY*COST(IDSYS(IS))/(PARAN** (ISTART-1))
3170      602 CDISC = 1.0/(AMQ**NEL)/(PARAN** (ISTART-1))
3180      DM = (1.0-DPAY)*XNUM*CDISC
3190      PVC(IS) = PVC(IS) + COST(IDSYS(IS))*DM
3200      IF(NEL .LT. LAP)GO TO 603
3210      PVC(IS) = PVC(IS) - COST(IDSYS(IS))*SALV/(PARAV**IEND)
3220C
3230C      CALCULATE ENERGY TAX CREDIT
3240C
3250      603 IF(NEL .GT. 1)GO TO 604
3260      ETC = (ACESC(4)+ACESC(5))*EIA(NSEC+1)*EIA(168)/100.0/
3270      &      (PARAN** (ISTART-1))
3280C
3290C      IF A COMMERCIAL BUILDING, CALCULATE TAX DEDUCTION DUE TO
3300C      OPERATING EXPENSES
3310C
3320      604 IF(OWNER .EQ. 2)GO TO 630
3330      OETD(IS) = 0.0
3340      GO TO 650
3350      630 IF(NEL .GT. 1)GO TO 640
3360      OETD(IS) = 0.0
3370      DEP(IS) = 0.0
3380      640 DEP(IS) = DEP(IS) + COST(IDSYS(IS))*DF(NEL)*DISC
3390      OETD(IS) = -(DEP(IS)+MAINT(IS)+PVG(IS)+PVO(IS)+PVE(IS))*TAXI
3400      650 NETD(IS,NEL) = PVC(IS)+PVTD(IS)+MAINT(IS)+INS(IS)+PTAX(IS)+
3410      &      OETD(IS)
3420      IF(IDSYS(IS).EQ.1)NETD(IS,NEL) = NETD(IS,NEL) - ETC
3430      660 CONTINUE
3440C
3450C      CALCULATE TOTAL PRESENT VALUE (TPV) OF SYSTEM AND ANNUAL COST (AC)
3460C
3470      DO 820 I=1,NSYS
3480      TPV = PVC(I)+MAINT(I)+INS(I)+PVE(I)+PVG(I)+PVO(I)+
3490      &      PVTD(I)+PTAX(I)+OETD(I)
3500      IF(I .EQ. 1 .AND. IDSYS(1) .EQ. 1)TPV = TPV - ETC

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3510 820 AC(I) = 1PV/MULT
3520C
3530C CONVERT ALL COST ITEMS TO ANNUAL COSTS
3540C
3550 ETC = ETC/MULT
3560 DO 821 I=1,NSYS
3570 PVC(I) = PVC(I)/MULT
3580 MAINT(I) = MAINT(I)/MULT
3590 INS(I) = INS(I)/MULT
3600 PVE(I) = PVE(I)/MULT
3610 PVG(I) = PVG(I)/MULT
3620 PVO(I) = PVO(I)/MULT
3630 PVT(I) = PVT(I)/MULT
3640 PTAX(I) = PTAX(I)/MULT
3650 OETD(I) = OETD(I)/MULT
3660 DO 821 J=1,2
3670 PVEC(J,I) = PVEC(J,I)/MULT
3680 821 PVED(J,I) = PVED(J,I)/MULT
3690 AM = (AMQ**LAP-1.0)/(ARATE*(AMQ**LAP))
3700 PVCM = (DPAY+(1.0-DPAY)*XNUM*AM)/(PARAN**((ISTART-1))-SALV/
3710 8 (PARAN**IEND)
3720 DIV = PVCM/MULT
3730 DO 822 K=1,7
3740 822 ACESC(K) = ACESC(K)*EIA(NSEC+1)*DIV
3750C
3760C IF THERE IS MORE THAN ONE SYSTEM, CALCULATE PRESENT VALUE OF NET
3770C BENEFITS AND PAYBACK
3780C
3790 IF(NSYS .EQ. 1)GO TO 850
3800 COST1 = PVC(1)+MAINT(1)+INS(1)+PVT(1)+PTAX(1)+OETD(1)
3810 FC1 = PVE(1) + PVG(1) + PVO(1)
3820 DO 825 I=2,NSYS
3830 DELTAC(I) = COST1-PVC(I)-MAINT(I)-INS(I)-PVT(I)-PTAX(I)-OETD(I)
3840 DELTAO(I) = PVE(I)+PVG(I)+PVO(I)-FC1
3850 PVNB(I) = (DELTAO(I) * DELTAC(I))*MULT
3860 DELTAO(I) = DELTAO(I) * MULT
3870 PAYBAK(I) = 0.0
3880 BRKEV(I) = 0.0
3890 DO 823 KX=1,LAP
3900 DELF = FCTD(I,KX) - FCTD(1,KX)
3910 IF(DELFF .LT. 0.0)GO TO 823
3920 DELC = NETD(1,KX) - NETD(I,KX)
3930 IF(DELFF .GE. DELC .AND. BRKEV(I) .LE. 0.0)BRKEV(I)=KX
3940 IF(DELFF .GE. (DELTAO(I)*MULT) .AND. PAYBAK(I) .LT. 1.0)
3950 8 PAYBAK(I) = KX
3960 823 CONTINUE
3970 IF(PAYBAK(1) .LT. 1.0)PAYBAK(1)=999.0
3980 IF(BRKEV(1) .LT. 1.0)BRKEV(1) = 999.0
3990 825 DELTAC(I) = -DELTAC(I)*MULT
4000 850 CRF = 1.0/MULT

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4010      CALL OUTPUT(CRF,REP)
4020      DO 880 K=1,7
4030      880 ACESC(K) = ACESC(K)/DIV/EIA(NSEC+1)
4040      900 CONTINUE
4050      STOP
4060      END
4070C
4080C
4090      SUBROUTINE AMOUNT
4100      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
4110      &      TOTELEC(5),COST(5),PVNB(5),PAYRAK(5),MAINT(5),INS(5),AC(5),
4120      &      PVTG(5),PTAX(5),PVC(5),OETD(5),BRKEV(5)
4130      COMMON /FUEL/TOTGAS(5),TOTOIL(5),OPEU(12,5),PEU(12,5),PDM(12,5),
4140      &      OPDM(12,5)
4150      COMMON /ACES/ETC,IPASS,ACESC(7),IBLDG,DATA(10),IDSYS(5)
4160      INTEGER BSP(2),WPED(2),BHDP(2),EHDP(2),DAY,DAYC
4170      DIMENSION MONTH(13)
4180C
4190C      INITIALIZE PARAMETERS WHERE
4200C      BSP(1) = BEGINNING OF SEASONAL PEAK I
4210C      WPED(1) = WEEKLY PEAK ENDING DAY DURING SEASON I
4220C      BHDP(1) = BEGINNING HOUR OF DAILY PEAK DURING SEASON I
4230C      EHDP(1) = ENDING HOUR OF DAILY PEAK DURING SEASON I
4240C      OPEU(I,J) = OFF-PEAK ELEC USE DURING SEASON I BY SYSTEM J
4250C      PEU(I,J) = PEAK PERIOD ELEC USE, SEASON I BY SYSTEM J
4260C      OPDM(I,J) = MAX OFF-PEAK DEMAND IN MONTH I BY SYSTEM J
4270C      PDM(I,J) = MAX PEAK DEMAND IN MONTH I BY SYSTEM J
4280C
4290      NSYS = EIA(160)
4300      BSP(1) = EIA(102)
4310      BSP(2) = EIA(112)
4320      WPED(1) = EIA(108)
4330      WPED(2) = EIA(118)
4340      BHDP(1) = EIA(109)
4350      EHDP(1) = EIA(110)
4360      BHDP(2) = EIA(119)
4370      EHDP(2) = EIA(120)
4380C
4390C      CALCULATE QUANTITIES DEFINED ABOVE FOR EACH SYSTEM
4400C
4410      NCOUNT = 1
4420      DO 1 KA=161,165
4430      IF(EIA(KA).LE. 0.1)GO TO 1
4440      IDSYS(NCOUNT) = EIA(KA)
4450      NCOUNT = NCOUNT + 1
4460      1 CONTINUE
4470      DO 3 IK=1,10
4480      3 DATA(IK) = 0.0
4490      DO 250 ID=1,NSYS
4500      DAY = EIA(151) - 2.0

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4510     MONTH(1) = 1
4520     MONTH(2) = 32
4530     MONTH(3) = 60
4540     MONTH(4) = 91
4550     MONTH(5) = 121
4560     MONTH(6) = 152
4570     MONTH(7) = 182
4580     MONTH(8) = 213
4590     MONTH(9) = 244
4600     MONTH(10) = 274
4610     MONTH(11) = 305
4620     MONTH(12) = 335
4630     MONTH(13) = 366
4640     IFIRST = 0
4650     ILAST = 0
4660     IFC = 13 + IDSYS(ID)
4670     TOTGAS(ID) = 0.0
4680     TUTOIL(ID) = 0.0
4690     DO 5 KB=1,12
4700         OPEU(KB,ID) = 0.0
4710         PEU(KB,ID) = 0.0
4720         PDM(KB,ID) = 0.0
4730     5 OPDM(KB,ID) = 0.0
4740C
4750C   IF THIS IS AN ACES SYSTEM, IFC=14 AND WE WANT TO READ SOME
4760C   EQUIPMENT SIZE AND TYPE INFORMATION
4770C
4780     READ(IFC) IHLDG
4790     IF(IFC .EQ. 14)GO TO 2
4800     GO TO 6
4810     2 READ(IFC) (DATA(K),K=1,3),DATA(8),DATA(9)
4820C   READ IN THE DAY THAT THE HEATING SEASON BEGINS
4830C
4840     6 READ(IFC) DAY1
4850     NDAY1 = DAY1
4860C
4870C   DETERMINE THE MONTH IN WHICH HEATING BEGINS
4880C
4890     ISUB = 0
4900     20 ISUB = ISUB + 1
4910     IF(NDAY1 .GE. MONTH(ISUB))GO TO 20
4920     MONTH1 = ISUB - 1
4930     LEAPYR = 1
4940     YRCH = AMOD(EIA(150),4,0)
4950     IF(YRCH .GT. 0.0)LEAPYR=0
4960     M1 = ISUB
4970     IF(ISUB .LT. 3)M1 = 3
4980     DO 21 KN=M1,13
4990     21 MONTH(KN) =MONTH(KN) + LEAPYR
5000     LEAPYR = 1

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5010      YRCH = AMOD((EIA(150)+1),4,0)
5020      IF(YRCH .GT. 0.0)LEAPYR=0
5030      IF(M1 .EQ. 3)GO TO 25
5040      M1 = M1 - 1
5050      DO 22 KM=3,M1
5060      22 MONTH(KM) =MONTH(KM) + LEAPYR
5070C
5080C
5090      25 I = 1
5100      J = 2
5110      IF(BSP(1) .LT. HSP(2))GO TO 26
5120      I = 2
5130      J = 1
5140      26 IF(MONTH1 .GE. BSP(I))GO TO 30
5150      MBEG = MONTH1
5160      MEND = BSP(I) - 1
5170      NSEASON = J
5180      GO TO 80
5190      30 IF(MONTH1 .GE. BSP(J))GO TO 40
5200      MBEG = MONTH1
5210      MEND = BSP(J) - 1
5220      NSEASON = I
5230      GO TO 80
5240      40 MBEG = MONTH1
5250      MEND = 12
5260      NSEASON = I
5270      GO TO 80
5280C
5290C READ IN THE ENERGY USE DATA FOR THIS MONTH
5300C
5310      80 DO 155 N1=MBEG,MEND
5320      K = MONTH(N1)
5330      IF(IFIRST .GT. 0)GO TO 90
5340      IFIRST = 1
5350      K = NDAY1
5360      IF(AMOD(EIA(150),4,0) .LE. 0.01)NDAY1 = NDAY1 - 1
5370      90 L = MONTH(N1+1)
5380      IF(ILAST .EQ. 0)GO TO 92
5390      IF(MONTH(N1+1) .LT. NDAY1)GO TO 92
5400      L = NDAY1
5410      92 LMO = L - K
5420C
5430C DAILY DIVISION OF LOAD TO PEAK AND OFF-PEAK
5440C
5450      LDEX = L - 1
5460      DO 100 N2=K,LDEX
5470      DAY = DAY + 1
5480      DAY = MOD(DAY,7) + 1
5490      LL = 1
5500      LU = BHDP(NSEASON)

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5510      IF(DAY .GT. WPED(NSEASON))LU = 24
5520 105 IF(LU .EQ. 1)GO TO 111
5530      DO 110 N3=LL,LU
5540      READ(IFC) GAS,OIL,ELECTR,DMAND
5550      TOTGAS(ID) = TOTGAS(ID) + GAS
5560      TOTOIL(ID) = TOTOIL(ID) + OIL
5570      PEAK = DMAND/3413.0
5580      OPEU(N1,ID) = OPEU(N1,ID) + ELECTR/3413.0
5590 110 IF(OPDM(N1,ID) .LT. PEAK)OPDM(N1,ID) = PEAK
5600      IF(LU .GE. 24)GO TO 100
5610 111 LL2 = EHOP(NSEASON)+1
5620      IF(LL2 .EQ. 2)LL2 = 1
5630      LU2 = EHOP(NSEASON)
5640      DO 120 N4 =LL2,LU2
5650      READ(IFC) GAS,OIL,ELECTR,DMAND
5660      TOTGAS(ID) = TOTGAS(ID) + GAS
5670      TOTOIL(ID) = TOTOIL(ID) + OIL
5680      PEAK = DMAND/3413.0
5690      PEU(N1,ID) = PEU(N1,ID) + ELECTR/3413.0
5700 120 IF(PDM(N1,ID) .LT. PEAK)PDM(N1,ID) = PEAK
5710      IF(LU2 .EQ. 24)GO TO 100
5720      LL = EHOP(NSEASON) + 1
5730      LU = 24
5740      GO TO 105
5750 100 IF(ILAST .NE. 0 .AND. (N2+1) .EQ. NDAY1)GO TO 200
5760 155 CONTINUE
5770      IF(MEND .EQ. 12)GO TO 160
5780      MUNIH1 = MFND + 1
5790      GO TO 25
5800 160 IF(NDAY1 .EQ. 1)GO TO 200
5810      MONTH1 = 1
5820      ILAST = 1
5830      GO TO 25
5840 200 CONTINUEIF
5850      READ(IFC) DUMMY
5860      IF(IFC .EQ. 14)DATA(10) = DUMMY
5870 250 CONTINUE
5880      RETURN
5890      END
5900C
5910C
5920C
5930      SUBROUTINE FULLCOST
5940C
5950C      THIS SUBROUTINE CALCULATES THE TOTAL YEARLY COST OF THE GAS, OIL,
5960C      AND ELECTRICITY USED FOR HEAT, HOT WATER AND AIR CONDITIONING
5970C
5980      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
5990      &      TOTELEC(5),COST(5),PVNR(5),PAYHAK(5),MAINT(5),TVR(5),AC(5),
6000      &      PVTD(5),PTAX(5),PVC(5),OETD(5),BRKEV(5)

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6010      COMMON /FUEL/TOTGAS(5),TOTOil(5),OPEU(12,5),PEU(12,5),PDM(12,5),
6020      &      OPDM(12,5)
6030      COMMON /BILL/NCB(4),BLKCOST(4,5),BLKSIZ(4,5)
6040      COMMON /ACES/ETC,IPASS,ACESC(7),IHLOG,DATA(10),IDSYS(5)
6050      DIMENSION PASS(4),CCPM(2),DMAX(2),PER(2),DMIN(2),PDC(2),OPDC(2),
6060      &      PEC(2),OPEC(2),DDMAX(2)
6070      INTEGER BMSP(2)
6080C
6090C  COMPUTE GAS AND OIL COSTS
6100C
6110      DO 1 IA=1,5
6120      GASC(IA) = TOTGAS(IA)*EIA(31)/EIA(20)/10**6
6130      1 OILC(IA) = TOTOil(IA)*EIA(41)/EIA(21)
6140      NRATE = EIA(19)
6150      NSYS = EIA(160)
6160      DO 400 MX=1,2
6170      DO 400 MY=1,NSYS
6180      DEMAND(MX,MY) = 0.0
6190      400 ELEC(MX,MY) = 0.0
6200C
6210C  COMPUTE ELECTRIC COST
6220C
6230      IF(NRATE .EQ. 2)GO TO 12
6240      NCB(1) = EIA(51)
6250      NCB(2) = EIA(71)
6260      NCB(3) = EIA(61)
6270      NCB(4) = EIA(81)
6280C
6290C  SET UP ENERGY AND DEMAND COST ARRAYS FOR STANDARD RATES
6300C
6310      J = 0
6320      DO 2 IE=51,61,10
6330      LU = IE + 20
6340      DO 2 IB=IE,LU,20
6350      J = J + 1
6360      IU = EIA(IB)
6370      ID = IB
6380      DO 2 IC=1,IU
6390      ID = ID + 1
6400      BLKCOST(J,IC) = EIA(ID)
6410      ID = ID + 1
6420      2 BLKSIZ(J,IC) = EIA(ID)
6430C
6440C  INITIALIZE FOR DEMAND CALCULATIONS
6450C
6460      LDLI = NRATE - 1
6470      DO 3 JA=LDLI,NSYS
6480      DO 3 MON=1,12
6490      3 PDM(MON,JA) = AMAX1(PDM(MON,JA),OPDM(MON,JA))
6500      12 DO 200 JA=1,NSYS

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6510      IF(NRATE .EQ. 2)GO TO 4
6520      IF(NRATE .EQ. 3 .AND. IDSYS(JA) .EQ. 1)GO TO 4
6530      BMSP(1) = EIA(49)
6540      BMSP(2) = EIA(69)
6550      CCPM(1) = EIA(50)
6560      CCPM(2) = EIA(70)
6570      GO TO 5
6580      4 BMSP(1) = EIA(102)
6590      BMSP(2) = EIA(112)
6600      CCPM(1) = EIA(111)
6610      CCPM(2) = EIA(121)
6620      5 DMAX(1) = EIA(90)
6630      DMAX(2) = EIA(91)
6640      PER(1) = EIA(92)/100.0
6650      PER(2) = EIA(93)/100.0
6660      DMIN(1) = DMAX(1)
6670      DMIN(2) = DMAX(2)
6680C
6690C      CALCULATE PEAK DEMAND FOR EACH SEASON
6700C
6710      ISUB = 1
6720      JSUB = 2
6730      IF(BMSP(1) .LT. BMSP(2))GO TO 11
6740      ISUB = 2
6750      JSUB = 1
6760      11 LU = BMSP(ISUB) - 1
6770      IF(BMSP(ISUB) .EQ. 1)GO TO 7
6780      DO 6 JD=1,LU
6790      6 IF(PDM(JB,JA) .GT. DMAX(JSUB))DMAX(JSUB)=PDM(JB,JA)
6800      7 LV = BMSP(JSUB) - 1
6810      DO 8 JC=BMSP(ISUB),LV
6820      8 IF(PDM(JC,JA) .GT. DMAX(ISUB))DMAX(ISUB)=PDM(JC,JA)
6830      DO 9 JD=BMSP(JSUB),12
6840      9 IF(PDM(JD,JA) .GT. DMAX(JSUB))DMAX(JSUB)=PDM(JD,JA)
6850C
6860C      AT THIS POINT THE MAX PEAK DEMAND FOR EACH SEASON HAS BEEN
6870C      DEFINED WHERE SEASON 1 IS THE HIGHEST PEAK
6880C
6890      UDMAX(2) = DMAX(2)
6900      DDMAX(1) = DMAX(1)
6910      IF(NRATE .EQ. 2)GO TO 10
6920      DDMAX(2) = AMAX1(DMAX(1),DMAX(2))
6930C
6940C      NOW CALCULATE BILLING DEMAND
6950C
6960      10 IF(BMSP(ISUB) .EQ. 1)GO TO 17
6970      DO 16 KB = 1,LU
6980      PDM(KB,JA) = AMAX1(PDM(KB,JA),DDMAX(JSUB)*PER(JSUB),DMIN(JSUB))
6990      OPDM(KB,JA) = OPDM(KB,JA) + PDM(KB,JA)
7000      16 IF(OPDM(KB,JA) .LT. 0.0)OPDM(KB,JA) = 0.0

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7010 17 DO 18 KC = BMSP(ISUB),LV
7020   PDM(KC,JA) = AMAX1(PDM(KC,JA),DDMAX(ISUB)*PER(ISUB),DMIN(ISUB))
7030   OPDM(KC,JA) = OPDM(KC,JA) - PDM(KC,JA)
7040 18 IF(OPDM(KC,JA) .LT. 0.1)OPDM(KC,JA) = 0.0
7050   DO 19 KD = BMSP(JSUB),12
7060   PDM(KD,JA) = AMAX1(PDM(KD,JA),DDMAX(JSUB)*PER(JSUB),DMIN(JSUB))
7070   OPDM(KD,JA) = OPDM(KD,JA) - PDM(KD,JA)
7080 19 IF(OPDM(KD,JA) .LT. 0.1)OPDM(KD,JA) = 0.0
7090   IF(NRATE .EQ. 3 .AND. INSYS(JA) .NE. 1)GO TO 25
7100   IF(NRATE .GE. 2)GO TO 302
7110C
7120C NOW CALCULATE DEMAND AND ENERGY BILLS FOR STANDARD RATES
7130C
7140 25 IF(BMSP(ISUB) .EQ. 1)GO TO 27
7150   DO 26 LB=1,LU
7160   PASS(JSUB) = PDM(LB,JA)
7170   PASS(JSUB+2) = PEU(LB,JA) + OPEU(LB,JA)
7180   CALL BILLING(PASS,JSUB)
7190   DEMAND(JSUB,JA) = DEMAND(JSUB,JA) + PASS(JSUB)
7200 26 ELEC(JSUB,JA) = ELEC(JSUB,JA) + PASS(JSUB+2)
7210 27 DO 28 LC=BMSP(ISUB),LV
7220   PASS(ISUB) = PDM(LC,JA)
7230   PASS(ISUB+2) = PEU(LC,JA) + OPEU(LC,JA)
7240   CALL BILLING(PASS,ISUB)
7250   DEMAND(ISUB,JA) = DEMAND(ISUB,JA) + PASS(ISUB)
7260 28 ELEC(ISUB,JA) = ELEC(ISUB,JA) + PASS(ISUB+2)
7270   DO 29 LD=BMSP(JSUB),12
7280   PASS(JSUB) = PDM(LD,JA)
7290   PASS(JSUB+2) = PEU(LD,JA) + OPEU(LD,JA)
7300   CALL BILLING(PASS,JSUB)
7310   DEMAND(JSUB,JA) = DEMAND(JSUB,JA) + PASS(JSUB)
7320 29 ELEC(JSUB,JA) = ELEC(JSUB,JA) + PASS(JSUB+2)
7330   GO TO 330
7340C
7350C SET UP DEMAND AND ENERGY COST MULTIPLIERS FOR PEAK LOAD PRICING
7360C   1 = PRIMARY PEAK SEASON 2 = SECONDARY PEAK SEASON
7370C
7380 302 PDC(1) = EIA(103)
7390   PDC(2) = EIA(113)
7400   OPDC(1) = EIA(104)
7410   OPDC(2) = EIA(114)
7420   PEC(1) = EIA(105)
7430   OPEC(1) = EIA(106)
7440   PEC(2) = EIA(115)
7450   OPEC(2) = EIA(116)
7460C
7470C NOW CALCULATE YEARLY DEMAND AND ENERGY COSTS
7480C
7490   IF(BMSP(ISUB) .EQ. 1)GO TO 327
7500   DO 326 LB=1,LU

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7510     DEMAND(JSUB,JA) = DEMAND(JSUB,JA) + PDM(LH,JA)*PDC(JSUB) +
7520     &      OPDM(LB,JA) * OPDC(JSUB)
7530 326 ELEC(JSUB,JA) = ELEC(JSUB,JA) + PEC(JSUB)*PEU(LB,JA) +
7540     &      OPEC(JSUB)*OPEU(LH,JA)
7550 327 DO 328 LC=BMSP(ISUB),LV
7560     DEMAND(ISUB,JA) = DEMAND(ISUB,JA) + PDM(LC,JA)*PDC(ISUB) +
7570     &      OPDM(LC,JA)*OPDC(ISUB)
7580 328 ELEC(ISUB,JA) = ELEC(ISUB,JA) + PEU(LC,JA)*PEC(ISUB) +
7590     &      OPEU(LC,JA)*OPEC(ISUB)
7600     DO 329 LD=BMSP(JSUB),12
7610     DEMAND(JSUB,JA) = DEMAND(JSUB,JA) + PDM(LD,JA)*PDC(JSUB) +
7620     &      OPDM(LD,JA)*OPDC(JSUB)
7630 329 ELEC(JSUB,JA) = ELEC(JSUB,JA) + PEU(LD,JA)*PEC(JSUB) +
7640     &      OPEU(LD,JA)*OPEC(JSUB)
7650 330 MULT = IABS(BMSP(2) - BMSP(1))
7660     IF(BMSP(1) .GT. BMSP(2))MULT = 12 - MULT
7670     TOTELEC(JA) = DEMAND(1,JA)+DEMAND(2,JA)+ELEC(1,JA)+ELEC(2,JA) +
7680     &      CCPM(1)*MULT + CCPM(2)*(12-MULT)
7690 200 CONTINUE
7700     RETURN
7710     END
7720C
7730C
7740C
7750     SUBROUTINE BILLING(Q,JW)
7760     COMMON /BILL/NCB(4),BLK COST(4,5),BLK SIZ(4,5)
7770     DIMENSION Q(4)
7780     JX = JW + 2
7790     DO 4 JS=JW,JX,2
7800     TCOST = 0.0
7810     LU = NCB(JS) - 1
7820     DO 3 I=1,LU
7830     IF(Q(JS) .GT. BLK SIZ(JS,I))GO TO 2
7840     TCOST = TCOST + BLK COST(JS,I)*Q(JS)
7850     GO TO 4
7860 2 Q(JS) = Q(JS) - BLK SIZ(JS,I)
7870 3 TCOST = TCOST + BLK COST(JS,I)*BLK SIZ(JS,I)
7880     TCOST = TCOST + BLK COST(JS,LU+1)*Q(JS)
7890 4 Q(JS) = TCOST
7900     RETURN
7910     END
7920C
7930C
7940C
7950     SUBROUTINE OUTPUT(CRF,REP)
7960     COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
7970     &      TOTELEC(5),COST(5),PVNB(5),PAYHAK(5),MAINT(5),INB(5),AC(5),
7980     &      PVID(5),PTAX(5),PVC(5),OETO(5),BRKEV(5)
7990     COMMON /FUEL/TOTGAS(5),TOTOIL(5),OPEU(12,5),PEU(12,5),PDM(12,5),
8000     &      OPDM(12,5)

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8010      COMMON /ACES/ETC,IPASS,ACESC(7),IBLDG,DATA(10),IDSYS(5)
8020      COMMON /OUTP/DELTAC(5),DELTAO(5),PVE(5),PVG(5),PVO(5),PVEC(2,5),
8030      &      PVED(2,5)
8040      DIMENSION TITLE(2,5),LAB(2),UNDER(5),MONTH(12),TOTE(5),SUM(5)
8050      CHARACTER UNDER*6,TITLE*4,LAB*6,MONTH*4
8060      REAL MAINT,INS
8070      DATA ((TITLE(J,K),J=1,2),K=1,5)/4H      ,4HACES,4HALL ,4HELEC,
8080      & 4HHEAT,4HPUMP,4H      ,4HOIL ,4HNAT ,4HGAS /
8090      DATA (MONTH(N),N=1,12)/4HJAN ,4HFEB ,4HMAR ,4HAPRL,4HMAY ,4HJUNE,
8100      & 4HJULY,4HAUG ,4HSEPT,4HOCT ,4HNOV ,4HDEC /
8110      DO 10 I=1,5
8120 10 UNDER(I) = 6H-----
8130      IPAGE = 1
8140      NSYS = EIA(160)
8150      IPASS = IPASS + 1
8160C
8170C PRINT OUT ANNUAL COST SUMMARY
8180C
8190      WRITE(10,4000) IPAGE
8200      WRITE(10,4001) (UNDER(J),J=1,4)
8210      WRITE(10,4002) EIA(2),EIA(8)
8220      WRITE(10,4003) CRF,EIA(10)
8230      WRITE(10,4004) EIA(3),EIA(5)
8240      WRITE(10,4005) EIA(7),EIA(4)
8250      WRITE(10,4006) EIA(15)
8260      WRITE(10,4007) EIA(6)
8270      IYEAR = 1978 + EIA(169+2*IPASS)
8280      WRITE(10,4008) IYEAR,(UNDER(J),J=1,5),UNDER(1)
8290      WRITE(10,4009) (TITLE(1,IDSYS(J)),J=1,NSYS)
8300      WRITE(10,4010) (TITLE(2,IDSYS(I)),I=1,NSYS)
8310      WRITE(10,4020) (UNDER(J),J=1,2),(UNDER(1),I=1,NSYS)
8320      WRITE(10,4030) (PVC(I),I=1,NSYS)
8330      IF(IDSYS(1) .NE. 1)GO TO 20
8340      WRITE(10,4110) (ACESC(L),L=1,6)
8350      IF(ACESC(7) .LT. 0.01)GO TO 20
8360      WRITE(10,4310) ACESC(7)
8370 20 WRITE(10,4050)
8380      LAB(1) = 6HMAINT
8390      LAB(2) = 6HNANCE
8400      WRITE(10,4060) (LAB(K),K=1,2),(MAINT(J),J=1,NSYS)
8410      LAB(1) = 6HINSUR
8420      LAB(2) = 6HNCE
8430      WRITE(10,4060) (LAB(K),K=1,2),(INS(J),J=1,NSYS)
8440      WRITE(10,4070)
8450      LAB(1) = 6HNATURA
8460      LAB(2) = 6HNGAS
8470      WRITE(10,4060) (LAB(K),K=1,2),(PVG(J),J=1,NSYS)
8480      LAB(1) = 6HHEATIN
8490      LAB(2) = 6HGOIL
8500      WRITE(10,4060) (LAB(K),K=1,2),(PVO(K),K=1,NSYS)

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8510 LAB(1) = 6HELECTR
8520 LAB(2) = 6HICITY
8530 WRITE(10,4060) (LAB(K),K=1,2),(PVE(M),M=1,NSYS)
8540 NPEAKS = EIA(101)
8550 DO 30 I=1,NPEAKS
8560 LAB(1) = 6HENERGY
8570 LAB(2) = 6H COST
8580 WRITE(10,4040) (LAB(K),K=1,2),(PVEC(I,J),J=1,NSYS)
8590 IF(EIA(52).LE.0.0.AND.IFIX(EIA(19)).EQ.1)GO TO 30
8600 IF(EIA(103).LE.0.0.AND.IFIX(EIA(19)).EQ.2)GO TO 30
8610 LAB(1) = 6HDEMAND
8620 LAB(2) = 6H COST
8630 WRITE(10,4040) (LAB(K),K=1,2),(PVED(I,M),M=1,NSYS)
8640 30 CONTINUE
8650 DO 32 L=1,NSYS
8660 32 SUM(L) = PVG(L) + PVO(L) + PVE(L)
8670 LAB(1) = 6HTOTAL
8680 LAB(2) = 6HFUEL
8690 WRITE(10,4060) (LAB(K),K=1,2),(SUM(M),M=1,NSYS)
8700 WRITE(10,4080)
8710 LAB(1) = 6HMORTGA
8720 LAB(2) = 6HGE DED
8730 WRITE(10,4060) (LAB(K),K=1,2),(PVTD(N),N=1,NSYS)
8740 LAB(1) = 6HPRUPER
8750 LAB(2) = 6HTY TAX
8760 WRITE(10,4060) (LAB(K),K=1,2),(PTAX(L),L=1,NSYS)
8770 IF(EIA(1) .LE. 1)GO TO 35
8780 LAB(1) = 6HOP EXP
8790 LAB(2) = 6H DED
8800 WRITE(10,4060) (LAB(K),K=1,2),(OETO(L),L=1,NSYS)
8810 35 WRITE(10,4062) ETC
8820 WRITE(10,4090) (UNDER(J),J=1,NSYS)
8830 WRITE(10,4100) (AC(M),M=1,NSYS)
8840C
8850C PRINT OUT PRESENT VALUE OF NET BENEFITS AND PAYBACK
8860C
8870 IF(NSY8 .LT. 2)GO TO 40
8880 WRITE(10,4114) (DELTAC(J),J=2,NSYS)
8890 WRITE(10,4115) (DELTAO(N),N=2,NSYS)
8900 WRITE(10,4120) (PVNB(M),M=2,NSYS)
8910 WRITE(10,4130) (BRKEV(J),J=2,NSYS),(PAYBAK(K),K=2,NSYS)
8920 WRITE(10,4135) COST(1)
8930 IF(IPASS .LT. IFIX(EIA(170)))RETURN
8940C
8950C PRINT ENERGY USE SUMMARY
8960C
8970 40 WRITE(10,4140) IPAGE,(UNDER(J),J=1,4)
8980 WRITE(10,4009) (TITLE(1,IDSYS(K)),K=1,NSYS)
8990 WRITE(10,4150) (TITLE(2,IDSYS(M)),M=1,NSYS)
9000 WRITE(10,4020) (UNDER(J),J=1,2),(UNDER(I),I=1,NSYS)

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9010C
9020C  COMPUTE ANNUAL FUEL USAGE IN MILLIONS OF BTU
9030C
9040      DO 45 K=1,NSYS
9050      TOTE(K) = 0.0
9060      DO 44 KZ=1,12
9070  44  TOTE(K) = TOTE(K) + (PEU(KZ,K)+OPEU(KZ,K))*0.003413
9080      TOTGAS(K) = TOTGAS(K)/10**6
9090      TOTOIL(K) = TOTOIL(K)/10**6
9100  45  SUM(K) = TOTE(K) + TOTGAS(K) + TOTOIL(K)
9110      WRITE(10,4160) (TOTGAS(L),L=1,NSYS)
9120      WRITE(10,4170) (TOTOIL(M),M=1,NSYS)
9130      WRITE(10,4180) (TOTE(M),M=1,NSYS)
9140      WRITE(10,4090) (UNDER(J),J=1,NSYS)
9150      WRITE(10,4190) (SUM(M),M=1,NSYS)
9160      NRATE = EIA(19)
9170C
9180C  PRINT MONTHLY ELECTRICAL CONSUMPTION DATA
9190C
9200      WRITE(10,4240) (UNDER(K),K=1,4)
9210      WRITE(10,4009) (TITLE(1,IDSYS(M)),M=1,NSYS)
9220      WRITE(10,4250) (TITLE(2,IDSYS(N)),N=1,NSYS)
9230      WRITE(10,4260)
9240      DO 60 KK=1,12
9250  60  WRITE(10,4270) MONTH(KK),(PEU(KK,I),I=1,NSYS)
9260      IF(NRATE.EQ. 1)GO TO 66
9270      WRITE(10,4280)
9280      DO 65 KL=1,12
9290  65  WRITE(10,4270) MONTH(KL),(OPEU(KL,J),J=1,NSYS)
9300  66  WRITE(10,4290)
9310      DO 70 KM=1,12
9320  70  WRITE(10,4270) MONTH(KM),(PDM(KM,K),K=1,NSYS)
9330      IF(NRATE.EQ. 1)GO TO 75
9340      WRITE(10,4300)
9350      DO 74 KN=1,12
9360  74  WRITE(10,4270) MONTH(KN),(OPDM(KN,M),M=1,NSYS)
9370      75  CONTINUE
9380  4000  FORMAT(I1,/,26X,'ECONOMIC ANALYSIS PARAMETERS')
9390  4001  FORMAT(26X,4A6,4H---,/)
9400  4002  FORMAT(11X,'ANALYSIS PERIOD (YRS)',4X,F3.0,5X,'MAINTENANCE RATE',
9410      &      3X,F4.1,2H %)
9420  4003  FORMAT(11X,'CAPITAL REC FACTOR',5X,F5.3,5X,'INSURANCE RATE',
9430      &      5X,F4.1,1X,1H%)
9440  4004  FORMAT(11X,'REAL DISCOUNT RATE',6X,F4.1,1X,1H%,3X,'PROPERTY TAX',
9450      &      7X,F4.1,2H %)
9460  4005  FORMAT(11X,'SALVAGE VALUE PERCENT',3X,F4.1,2H %,3X,'INCOME TAX',
9470      &      9X,F4.1,2H %)
9480  4006  FORMAT(11X,'RETURN ON INVESTED CAP REC FUNDS',3X,F4.1,2H %)
9490  4007  FORMAT(11X,'MORTGAGE INTEREST RATE',13X,F4.1,2H %)
9500  4008  FORMAT(1X,/,27X,'ANNUAL COST SUMMARY-',I4,1X,'INSTALLATION',/,

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9510      & 27X,6A6,1H-,//,27X,'SYSTEM TYPES BY SOURCE OF SPACE HEAT',/)
9520 4009 FORMAT(30X,A4,5X,A4,5X,A4,5X,A4,5X,A4)
9530 4010 FORMAT(13X,'COST ITEM',8X,4(A4,5X),A4)
9540 4020 FORMAT(9X,2A6,5H-----,5(3X,A6),/)
9550 4030 FORMAT(9X,'EQUIPMENT',10X,F7.0,4(2X,F7.0))
9560 4040 FORMAT(14X,2A6,F7.0,4(2X,F7.0))
9570 4050 FORMAT(9X,'OPERATIONS')
9580 4060 FORMAT(12X,2A6,2X,5(2X,F7.0))
9590 4062 FORMAT(12X,'TAX CREDIT',4X,5(2X,F7.0))
9600 4070 FORMAT(9X,'FUEL')
9610 4080 FORMAT(9X,'TAXES')
9620 4090 FORMAT(29X,A6,4(3X,A6))
9630 4100 FORMAT(9X,'TOTAL ANNUAL COST',5(2X,F7.0))
9640 4110 FORMAT(12X,'HEAT PUMP',5X,F7.0,/,12X,'CONTROL PKG',3X,F7.0,/,
9650      &12X,'E.T.M.',4X,F7.0,/,12X,'SOLAR FIXED',3X,F7.0,/,12X,
9660      &'SOLAR COLLECT',1X,F7.0,/,12X,'STORAGE BIN',3X,F7.0)
9670 4114 FORMAT(1X,/,9X,'PRESENT VALUE OF-',/,11X,'DELTA CAP & OP COSTS',
9680      &4X,4(1X,F8.0))
9690 4115 FORMAT(11X,'DELTA FUEL COSTS',8X,4(1X,F8.0))
9700 4120 FORMAT(11X,'TOTAL NET BENEFITS',6X,4(1X,F8.0))
9710 4135 FORMAT(1X,/,9X,'THE INITIAL CAPITAL COST OF THE ACES WAS $',F12.2)
9720 4130 FORMAT(1X,/,9X,'BREAKEVEN POINT(YRS)',6X,4(2X,F7.0),/,9X,
9730      &'PAYBACK PERIOD (YRS)',6X,4(2X,F7.0))
9740 4140 FORMAT(11,///,27X,'ANNUAL ENERGY USE SUMMARY',/,27X,
9750      &'(UNITS OF 1 MILLION BTU)',/,27X,4A6,1H-,//30X,
9760      &'SYSTEM TYPES BY SOURCE OF SPACE HEAT')
9770 4150 FORMAT(12X,'ENERGY FORM',2X,5(5X,A4))
9780 4160 FORMAT(9X,'NATURAL GAS',6X,5(1X,F8.2))
9790 4170 FORMAT(9X,'HEATING OIL',6X,5(1X,F8.2))
9800 4180 FORMAT(9X,'ELECTRICITY',6X,5(1X,F8.2))
9810 4190 FORMAT(9X,'TOTAL ENERGY USE',1X,5(1X,F8.2),////////)
9820 4200 FORMAT(9X,'MPEU',13X,5(2X,F7.0))
9830 4210 FORMAT(9X,'MOPEU',12X,5(2X,F7.0))
9840 4220 FORMAT(9X,'MPD',14X,5(2X,F7.0))
9850 4230 FORMAT(9X,'MOPD',13X,5(2X,F7.0))
9860 4240 FORMAT(1X,///,28X,'MONTHLY ELECTRICAL DATA',/,28X,4A6,/,
9870      &30X,'SYSTEM TYPES BY SOURCE OF SPACE HEAT')
9880 4250 FORMAT(25X,5(5X,A4))
9890 4260 FORMAT(9X,'PEAK HOUR ENERGY USE',/,9X,'IN KWH PER MONTH')
9900 4270 FORMAT(12X,A4,10X,5(2X,F7.0))
9910 4280 FORMAT(9X,'OFF-PEAK ENERGY USE',/,9X,'IN KWH PER MONTH')
9920 4290 FORMAT(9X,'MAX PEAK DEMAND PER',/,9X,'MONTH IN KW')
9930 4300 FORMAT(9X,'EXCESS OFF-PEAK DEMAND',/,9X,'PER MONTH IN KW')
9940 4310 FORMAT(12X,'AUX HEAT',6X,F7.0)
9950      RETURN
9960      END
9970      SUBROUTINE ACES COST
9980      COMMON/ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
9990      &      TOTELEC(5),COST(5),PVNB(5),PAYBAC(5),MAINT(5),INS(5),AC(5),
10000      &      PVTD(5),PTAX(5),PVC(5),OETD(5),HRKEV(5)

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10010 COMMON/ACES/ETC,IPASS,ACESC(7),IHLDG,DATA(10),IDSYS(5)
10020 DIMENSION CTANK(6),VOL(7),UNITC(4),EVAP(2),PLATE(2,2),ADJ(2)
10030 CHARACTER EVAP*6,PLATE*4,ADJ*6
10040 DATA (EVAP(J),J=1,2)/6H DUAL ,6HWATER /
10050 DATA ((PLATE(N,M),M=1,2),N=1,2)/4HUNGL,4HAZED,4HGLAZ,4HED /
10060 DATA (ADJ(I),I=1,2)/6HDOESNT,6H DUES /
10070 DATA (CTANK(J),J=1,6)/1557.0,2485.0,3237.0,3823.0,4448.0,4940.0/
10080 DATA (UNITC(L),L=1,4)/0.25,4.29,2.33,3.59/
10090 DATA (VOL(N),N=1,7)/0.0,512.0,1056.0,1560.0,2048.0,2592.0,3040.0/
10100 INTEGER ZERO,FLAGSS,FLAGHP,FLAGAH,FLAGFC
10110 DATA ZERO/0/
10120C
10130C CHECK IF THIS IS COMMERCIAL OR RESIDENTIAL BUILDING
10140C
10150 ISUB = 0
10160 LAP = EIA(2)
10170 FLAGFC = 1
10180 FLAGHP = DATA(8)
10190 FLAGSS = DATA(9)
10200 FLAGAH = DATA(10)
10210 IF(DATA(1) .LT. 1.0)FLAGFC = 0
10220 TANK = 0.0
10230 LSUB = IFIX(DATA(8)) + 1
10240 JSUB = IFIX(DATA(9)) + 1
10250 KSUB = IFIX(DATA(10)) + 1
10260C
10270C COMPUTE COST OF HEAT PUMPS
10280C
10290 RHP = EIA(137) * FLAGHP + EIA(138) * (1. - FLAGHP)
10300 CHP = DATA(6)*EIA(145) + DATA(7)*EIA(146)
10310C
10320C COMPUTE COST OF STORAGE TANKS
10330C
10340 IF(DATA(2) .GT. 10.0)GO TO 1
10350 TANK = 0.0
10360 GO TO 4
10370 1 DO 3 K=1,6
10380 IF(DATA(2) .GT. VOL(K) .AND. DATA(2) .LE. VOL(K+1))ISUB=K
10390 3 CONTINUE
10400 IF(ISUB .EQ. 0)GO TO 6
10410 TANK = CTANK(ISUB)*EIA(158)
10420 4 IF(IBLDG .EQ. ZERO)GO TO 5
10430 IF(IBLDG .EQ. 1)GO TO 8
10440 6 DATA(5) = EIA(148)
10450 DATA(3) = SQRT(DATA(2)/DATA(5))
10460 DATA(4) = DATA(3)
10470 8 CLINER = ((DATA(3)+DATA(4))*2.0*DATA(5)+DATA(4)*DATA(3))*UNITC(1)
10480 CWALL = (DATA(3)+DATA(4))*2.0*DATA(5)*UNITC(2)
10490 CSLAB = (DATA(3)+1.0)*(DATA(4)+1.0)*UNITC(3)
10500 CTOP = (DATA(3)+1.0)*(DATA(4)+1.0)*UNITC(4)

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10510      CCOLO = (CLINER + CWALL + CSLAB + CTOP)*EIA(158)
10520      IF(IBLDG .NE. 1)TANK = CCOLD
10530C
10540C      COMPUTE SOLAR SYSTEM VARIABLE COST FRACTION
10550C
10560          5 CMULT = 1.0
10570          IF(FLAGSS .EQ. ZERO)GO TO 12
10580          FLAGSS = 1
10590          GO TO 20
10600      12 RDR = EIA(3)/100.0
10610          IEXP = EIA(149)
10620          CMULT = 1.0
10630      14 IF(IEXP .GE. LAP)GO TO 20
10640          CMULT = CMULT + 1.0/(1+RDR)**IEXP
10650          IEXP = IEXP + EIA(149)
10660          GO TO 14
10670      20 SSCOST = DATA(1)*(EIA(140)*FLAGSS+EIA(141)*(1-FLAGSS)*CMULT)
10680          IF(IBLDG .EQ. 1)GO TO 30
10690C
10700C      ASSIGN RESIDENTIAL SPECIFIC ACES COST COMPONENTS
10710C
10720          ACESC(1) = RHP
10730          CADD = 0.0
10740          ZZ = SQRT(DATA(2)/EIA(148))
10750          IF(EIA(177).GT.0.0)CADD=(ZZ*ZZ*2.+ZZ*EIA(148)*4.)*EIA(178)
10760          ACESC(6) = TANK + CADD
10770          GO TO 50
10780C
10790C      ASSIGN COMMERCIAL SPECIFIC ACES COST COMPONENTS
10800C
10810      30 ACESC(1) = CHP
10820          ACESC(6) = TANK + CCOLO
10830C
10840C      ASSIGN COMMON COST COMPONENTS
10850C
10860          50 ACESC(5) = SSCOST
10870          ACESC(4) = EIA(142) * FLAGFC
10880          ACESC(3) = EIA(144) * FLAGFC
10890          ACESC(2) = EIA(147)
10900          ACESC(7) = EIA(143) * FLAGAH
10910          DO 51 L=1,7
10920      51 COST(1) = COST(1) + ACESC(L)
10930          IF(IBLDG .EQ. 1)GO TO 52
10940          WRITE(10,5000) EVAP(LSUB),DATA(1),(PLATE(JSUB,K),K=1,2),
10950          & DATA(2),ADJ(KSUB)
10960          RETURN
10970      52 CUBIC = DATA(3) * DATA(4) * DATA(5)
10980          WRITE(10,5001) EVAP(LSUB),DATA(1),(PLATE(JSUB,L),L=1,2),DATA(2),
10990          & CUBIC,DATA(6),DATA(7),ADJ(KSUB)
11000      5000 FORMAT(1X,///,AX,'THE ACES SYSTEM HAS A ',A6,'SOURCE EVAPORATOR, ',

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11010      &F7.0,1X,'SQUARE FEET',/,8X,'OF',1X,2A4,1X,'SOLAR COLLECTORS AND',
11020      &F7.0,1X,'CUBIC FEET OF ICE STORAGE.',/,8X,'THE SYSTEM',1X,A6,
11030      &1X,'HAVE AN AUXILIARY HEAT SYSTEM.')
```

5001

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11040      FORMAT(1X,/,8X,'THE ACES SYSTEM HAS A ',A6,'SOURCE EVAPORATOR, ',
11050      &F7.0,1X,'SQUARE FEET',/,8X,'OF',1X,2A4,1X,'SOLAR COLLECTORS,',
11060      &F7.0,1X,'CUBIC FEET OF HOT STORAGE, AND',/,8X,F7.0,1X,
11070      &'CUBIC FEET OF COLD STORAGE. IT HAS',F3.0,1X,'35KW HEAT PUMPS, ',
11080      &/,8X,F3.0,1X,'20KW HEAT PUMPS AND IT',1X,A6,1X,
11090      &'HAVE AUXILIARY HEAT.')
```

```

11100      RETURN
11110      END
```


***** ***** ***** ***** *****
 * * * * *
***** ***** ***** ***** *****
 * * * * *
***** ***** ***** ***** *****
 * * * * *
***** ***** ***** ***** *****
 * * * * *

-- 3 0 -- DATE 08-31-79 TIME 11.837 ID = E1 GCS-AJ

APPENDIX B
TYPICAL INPUTS AND OUTPUTS OF ACESIM

This appendix gives some of the typical inputs needed to run ACESIM as well as some of the outputs generated by the various modules. The first inputs listed are those used to run LODMOD_B. The next listing gives the inputs to run LODMOD_A, or, if desired, DESMOD or SIMMOD. The final input schedule shows the variables needed to run ECOMOD. The first output listing shows typical results generated by LODMOD_A or B. The next listing shows results of DESMOD for the single-family residential Full ACES in Philadelphia. The condensed results of SIMMOD are shown in the next listing for the single-family residential Full ACES in Philadelphia. Finally, the results of ECOMOD are given in the last output listing.

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LODMOD_B INPUT ARRAY

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SNUMB = 4177T
 XXX

```

  XX      X      XXXXXX      XXXXXX      XXXXX
  X X      XX      X      X      X
  X X      X      X      X      X
  XXXXXX      X      X      X      X
  X      X      X      X      X
  X      XXX      X      X      X

```

XX
 XXX

\$\$ 4177T ENTERED GCS-AJ AT 14.507 FROM SYSTEM-0 TSS/S 0-08-24

```

0001 $ SNUMB 4177T
0002 $ COMMENT F00648 TSS MEDIA CONVERSION
0003 $ IDENT F00648-ACES
0004 $$ USERID F00648$
0005 AS CONVER
0006 $ LIMITS ,,,50000
0007 $ SYSOUT OT,E1
0008 $ MULTI 1-1
0009 $ DATA IN,,COPY,ENDFC
0010 $ ENDCOPY IN
0011 $ ENDJOB
TOTAL CARD COUNT THIS JOB = 000188

```

```

* ACTY-01 SCARD #0005 CONVER 08/31/79 SW=000000000000
BMC-TTL DATE 771205
$ MULTI 1-1
FILE #000001 TOT 000177 INPUT
INPUT COUNT 000177 OUTPUT COUNT 000177
BLOCKS SKIPPED 000000 IGNORE COUNT 000000
* NORMAL TERMINATION AT 001544 I=2060 SW=000000000000

```

START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/RC	MS/NE	ADDRESS	TN/PK#
14.838	14.840	0.000	0.002			MC R MSU450 *	22	0	1	1	1	0-08-06	8K
						IN R MSU450 *	154	0	7	7	7	0-08-06	66
						OT SYOUT							
						P* SYOUT							

RC-00 176 LINES AT STA. E1

ACTIVITY 01 COST=\$ 0.07
 *CUMULATIVE COST=\$ 0.07

SNUMB = 41771, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 000176

\$ NOTE FILENAME BKDAT
\$ NOTE LABELS- A,R(E1)
\$ NOTE TABS/SETTINGS- ASIS

10DATA FOR A RESIDENTIAL STRUCTURE IN PHILADELPHIA			
20	1	39.5000	LATITUDE OF INSTALLATION
30	2	75.1000	LONGITUDE OF INSTALLATION
40	3	5.0000	TIME ZONE NUMBER
50	4	365.00	NUMBER OF DAYS TO BE SIMULATED
60	5	0.0000	AZIMUTH ANGLE OF COLLECTORS
70	6	39.5000	TILT OF COLLECTORS
80	7	1.0000	STARTING DAY OF SIMULATION
90	8	365.00	LAST DAY OF SIMULATION
100	9	0.2000	GROUND REFLECTIVITY
110	10	.025	INTEG STEP SIZE
120	11	6.0	HO
130	12	1.85	HI
140	13	.083333	CONDUCTIVITY OF 6 FEET OF EARTH
160	15	0.	
170	16	500.	
180	17	1.0000	CLEARNESS FACTOR
190	18	.06	U KNEE WALL
200	19	1.46	KNEE WALL OUTSIDE FILM COEFF
210	20	6825.	HIF*FLOOR AREA
220	21	.0688	U OF TANK BELOW GRADE
230	22	0.	MODIFY COP OF HEAT PUMP
240	23	0.	IF 0 TANK OUTSIDE ELSE INSIDE OR BG
260	25	750.	BTU/HR REQ'D BY PANEL PUMP
270	26	750.	BTU/HR REQ'D BY EVAPORATOR PUMP
280	27	750.	BTU/HR REQ'D BY COOLING LOOP PUMP
290	28	.8	GROUND CONDUCTIVITY AROUND TANK
300	29	.5	PERCENTAGE OF PUMP ENERGY TO
310	30	136.	SLAB PERIMETER
330	32	.32	U ROOF(1)
340	33	.16	U SLANT ROOF
350	34	.08	U EXTERIOR WALL
360	35	.09	U GARAGE WALL
370	36	1.4	HIC(1)
380	37	39.	TWELL WINTER DESIGN
400	41	.81	SLAB PERIMETER COEFFICIENT
410	45	6.	ROOF OUTSIDE FILM COEFFICIENT
420	46	1.41	ROOF INSIDE FILM COEFFICIENT
430	47	1.85	SLANT ROOF INSIDE FILM COEFFICIENT
440	48	24.	THERMAL CAPACITY(PSF) 12" EARTH
450	50	120,000	DOMESTIC HOT WATER TEMP
460	51	1.8	U CRUSHED ROCK
470	52	294.	AREA NORTH CEILING
480	53	0.3835	U OF DOMESTIC HOT WATER TANK
490	54	.0515	U CEILING
500	55	5.4	U SLAB

520	57	.73	U WINDOW
530	58	.79	U SG DOOR
540	59	.7353	U CARPET
550	60	.32	U ROOF
560	61	.31	U NORTH ATTIC WALL
570	62	27.1	U HOT WATER TANK
580	63	319.2	AREA TOP CEILING
590	64	294.	AREA SOUTH CEILING
610	66	79.	AREA NORTH-GLASS
620	67	31.	AREA EAST GLASS
630	68	48.	AREA SOUTH GLASS
640	69	21.	AREA WEST GLASS
650	70	34.	AREA SOUTH SG DOOR
660	71	1092.	FLOOR AREA
670	72	252.	AREA ROOF(1)
680	73	79.8	AREA SLANT ROOF (2)
690	74	378.	AREA ROOF(3)
700	75	160.5	CFMINF
710	76	4.0000	PEAK NUMBER OF PEOPLE
720	77	4352.0000	PEAK APPLIANCE BTU
730	78	1.0000	PEAK LIGHTING (WATTS/SQ.FT.)
740	79	0.1000	ATTIC VENTILLATION (CFM/SQ.FT.)
750	80	140.0000	ATTIC SUMMER DESIGN TEMPERATURE
760	81	64.8000	WINDOW DESIGN SOLAR GAIN
770	82	-16.0000	OUTSIDE WINTER DESIGN TEMPERATURE
780	83	92.0000	OUTSIDE SUMMER DESIGN TEMPERATURE
790	84	0.0171	OUTSIDE SUMMER DESIGN HUMIDITY RATIO
800	85	0.0103	INSIDE SUMMER DESIGN HUMIDITY RATIO
810	86	1.0000	OVERCAPACITY OF THE HEATING PLANT
820	87	1.0000	OVERCAPACITY OF THE COOLING PLANT
830	88	70.0000	WINTER SET POINT
840	89	78.0000	SUMMER SET POINT
850	90	0.0000	OPTION FOR NIGHT SETBACK (0 = NO SETBACK)
860	91	0.0000	BLANK
870	92	0.0000	OPTION FOR SHADES (0 = NO SHADES)
880	93	0.	COMPUTE DESIGN LOADS
890	94	33000.0	DESIGN HEATING LOAD
900	95	32000.0	DESIGN COOLING LOAD
910	96	320110.0	PEAK DAILY COOLING LOAD
950	100	22.0000	HOOR H-P BEGINS TO RUN DURING COOLING
960	101	5.0000	HOOR H-P STOPS RUNNING DURING COOLING
0970	110	55.83	***INITIAL TEMP SOUTH SLANT ROOF
0980	111	45.78	***INITIAL TEMP SOUTH LOWER ROOF
0990	112	44.99	***INITIAL TEMP TOP EAST ATTIC WALL
1000	113	45.88	***INITIAL TEMP SOUTH EAST ATTIC WALL

1010	114	45.74	***INITIAL TEMP TOP ATTIC AIR
1020	115	47.55	***INITIAL TEMP SOUTH ATTIC AIR
1030	116	57.51	***INITIAL TEMP SOUTH CEILING
1040	117	57.52	***INITIAL TEMP SOUTH KNEE WALL
1050	118	55.85	***INITIAL TEMP GARAGE WALL
1060	125	1.4	HIC
1080	127	45.03	***INITIAL TEMP TOP WEST ATTIC WALL
1090	128	55.85	***INITIAL TEMP NORTH WALL
1100	129	55.89	***INITIAL TEMP EAST WALL
1110	130	55.91	***INITIAL TEMP SOUTH WALL
1120	131	55.93	***INITIAL TEMP WEST WALL
1130	132	45.93	***INITIAL TEMP SOUTH WEST ATTIC WALL
1140	133	44.89	***INITIAL TEMP TOP SOUTH ROOF
1150	134	0.7600	BULK GLASS TRANSMITTANCE
1160	135	0.0000	BUILDING ORIENTATION ANGLE
1170	136	56.60	***INITIAL TEMP TOP CEILING
1180	137	0.	UNUSED SPACE
1190	138	0.	UNUSED SPACE
1200	139	.025	U OF TANK TO AIR
1210	140	8.	HEIGHT OF TANK (FT)
1220	141	.4	VOLUMETRIC PACKING
1230	142	.0001	PERCENT OF TANK ABOVE GROUND
1240	143	9.5904	THERMAL CAPACITY OF TANK (PSF)
1250	144	9.5904	THERMAL CAPACITY OF WALL BG (PSF)
1260	145	1.0	IF SET=1; DESIGN FOR FULL ACES
1270	146	32.0	INITIAL TANK TEMP
1280	147	.84	TAU ALPHA OF SOLAR COLLECTORS
1290	148	.80	U OF COLLECTOR
1300	149	34.	AVERAGE WINTER TEMPERATURE
1310	150	18.0	AREA OF EACH PANEL (SQ FT)
1320	151	36.87	ROOF 123 TILT ANGLE
1330	152	0.0000	ROOF1 AZMITH ANGLE
1340	153	36.87	ROOF 456 TILT ANGLE
1350	154	180.0000	ROOF2 AZMITH ANGLE
1360	155	235.2	AREA N KNEE WALL
1370	156	235.2	AREA S KNEE WALL
1380	157	244.	AREA N WALL
1390	158	267.	AREA E WALL
1400	159	254.	AREA S WALL
1410	160	159.	AREA W WALL
1420	161	120.	AREA GARAGE WALL
1430	162	12.5	AREA ATTIC WALL 1
1440	163	12.5	AREA ATTIC WALL 2
1450	164	19.6	AREA ATTIC WALL 3
1460	165	19.6	AREA ATTIC WALL 4
1470	166	19.6	AREA ATTIC WALL 5
1480	167	19.6	AREA ATTIC WALL 6
1490	168	.77	ABG WALLS
1500	169	1.61	THERMAL CAP PSF EXT WALL

1510	170	1.61	THERMAL CAP ROOF
1520	171	2.17	THERMAL CAP SLANT ROOF PSF
1530	172	1.45	THERMAL CAP PSF CEILING
1540	173	.23	ABS ROOF
1550	174	.17	THERMAL CAP CARPET
1560	175	.975	THERMAL CAP KNEE WALL
1570	176	16.17	THERMAL CAP SLAB
1580	177	7.92	THERMAL CAP CRUSHED ROCK
1590	178	.47	U NORTH DOOR
1600	179	13.	AREA NORTH DOOR
1610	180	430.8843	THERMAL CAP. OF WEST WALL
1620	181	21407.9040	THERMAL CAP. OF SURFACE BELOW GRADE
1630	182	3041.0000	THERMAL CAP. OF INTERNAL MASS
1640	183	2000.0000	MASS
1650	184	343.	THERMAL CAPACITY OF AIR MASS
1660	185	57.50	***INITIAL TEMP NORTH KNEE WALL
1670	186	45.86	***INITIAL TEMP NORTH EAST ATTIC WALL
1680	187	45.91	***INITIAL TEMP NORTH WEST ATTIC WALL
1690	188	0.	UNUSED SPACE
1700	189	44.84	***INITIAL TEMP TOP NORTH ROOF
1710	190	67.49	***INITIAL TEMP SPACE
1720	191	55.82	***INITIAL TEMP NORTH SLANT ROOF
1730	192	66.27	***INITIAL TEMP SLAB
1740	193	65.94	***INITIAL TEMP CRUSHED ROCK
1750	194	47.55	***INITIAL TEMP NORTH ATTIC AIR
1760	195	45.78	***INITIAL TEMP NORTH LOWER ROOF
1770	196	57.48	***INITIAL TEMP NORTH CEILING
1780	197	67.54	***INITIAL TEMP INTERNAL MASS
1790	198	0.	UNUSED SPACE
1800	199	66.	***INITIAL FLOOR TEMPERATURE
1810	200	0.	
1820	-1		
1830	1	30	60 90 120 150 200 230 260 300 320

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SNUMB = 3898T
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  X          X          X          X          X
  XXX        XXXX      X      X      XXXX      X
  X          X          XXXX      X      X      X
  X      X      X      X      X      X      X
  XXXX      XXXX      X      XXXX      X
  
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XX
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SS 3898T ENTERED GCS-AJ AT 11.524 FROM SYSTEM-0 TSS/S 0-08-08

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0001 $ SNUMB 3898T
0002 $ COMMENT F00648 TSS MEDIA CONVERSION
0003 $ IDENT F00648-ACES
0004 $$ USERID F006485
0005 AS CONVER
0006 $ LIMITS ,,,50000
0007 $ SYSOUT OT,E1
0008 $ MULTI 1*1
0009 $ DATA IN,,COPY,ENDFC
0010 $ ENDCOPY IN
0011 $ ENDJOB
  
```

TOTAL CARD COUNT THIS JOB = 000167

* ACTY=01 \$CARD #0005 CONVER 08/31/79 SW=000000000000

BMC-TTL DATE 771205

\$ MULTI 1-1

FILE #000001 TOT 000156 INPUT

INPUT COUNT 000156 OUTPUT COUNT 000156

BLOCKS SKIPPED 000000 IGNORE COUNT 000000

* NORMAL TERMINATION AT 001544 I=2060 SW=000000000000

START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/RC	MS/RE	ADDRESS	T#/PK#
11.551	11.553	0.000	0.002										
MC R MSU450 * 22 0 1 1 1 0-08-16
IN R MSU450 * 132 0 6 6 6 0-08-16
OT SYOUT
P* SYOUT													

RC-00 155 LINES AT STA. E1

ACTIVITY 01 COST=\$ 0.07
 *CUMULATIVE COST=\$ 0.07

B-14

SNUMB = 3898T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 000155

\$ NOTE FILENAME DATA1
\$ NOTE LABELS- A,R(E1)
\$ NOTE TABS/SETTINGS- ASIS

10DATA FOR A RESIDENTIAL STRUCTURE IN MINNEAPOLIS

20	1	44.7000	LATITUDE OF INSTILATION
30	2	93.0000	LONGITUDE OF INSTILATION
40	3	6.0000	TIME ZONE NUMBER
50	4	365.0000	NUMBER OF DAYS TO BE SIMULATED
60	5	0.0000	AZIMUTH ANGLE OF COLLECTORS
70	6	45.0000	TILT OF COLLECTORS
80	7	1.0000	STARTING DAY OF SIMULATION
90	8	365.0000	LAST DAY OF SIMULATION
100	9	0.2000	GROUND REFLECTIVITY
110	10	0.0250	INTEGRATION STEP SIZE (HOURS)
120	11	4.0000	OUTSIDE SURFACE HEAT XFER CDEF.
130	12	2.0000	INSIDE SURFACE HEAT XFER CDEF.
140	13	0.5000	GROUND CONDUCTIVITY (BTU/HR-FT-F)
150	15	0.0000	OPTION FOR ACES OR CONV. SYSTEM (0,1,2,3,4)
160	16	500.0000	HOT WATER PUMPING POWER (BTU/HR)
170	17	1.0000	CLEARNESS FACTOR
180	21	1000.0000	U OF TANK BELOW GRADE
190	22	0.0000	MODIFICATION TO COP OF HEAT PUMP
200	23	0.0000	IF 0 TANK OUTSIDE ELSE INSIDE OR BELOW GROUND
210	24	0.0000	IF 1 TANK IS SIZED FOR BOTH WINTER AND SUMMER
220	25	1200.0000	BTU/HR REQUIRED BY THE PANEL PUMP
230	26	750.0000	BTU/HR REQUIRED BY THE EVAPORATOR PUMP
240	27	750.0000	BTU/HR REQUIRED BY THE COOLING LOOP PUMP
250	28	0.5000	GROUND CONDUCTIVITY AROUND TANK
260	29	0.3500	PERCENTAGE OF PUMP ENERGY TO SPACE
270	31	0.4167	CONVECTOR COEFFICIENT
280	38	-0.1107	CONVECTOR COEFFICIENT
290	50	120.0000	DOMESTIC HOT WATER TEMPERATURE
300	53	0.3835	U OF DOMESTIC HOT WATER TANK
310	54	0.0700	U OF CEILING
320	55	0.0800	U OF NORTH WALL
330	56	0.1468	U OF WALL BELOW GROUND
340	57	0.5800	U OF GLASS
350	58	0.4900	U OF DOOR
360	59	0.0000	U OF FLOOR
370	60	0.4400	U OF ROOF
380	61	0.3400	U OF NORTH ATTIC WALL
390	62	27.1000	AREA OF HOT WATER TANK
400	63	1444.0000	AREA OF CEILING
410	64	380.0000	AREA OF NORTH WALL
420	65	2200.0000	AREA OF WALL BELOW GROUND
430	66	72.0000	AREA OF NORTH GLASS
440	67	36.0000	AREA OF EAST GLASS
450	68	81.0000	AREA OF SOUTH GLASS
460	69	36.0000	AREA OF WEST GLASS
470	70	76.0000	DOOR AREA
480	71	0.0000	FLOOR AREA
490	72	833.0000	AREA OF ROOF
500	73	1.0000	AREA OF NORTH ATTIC WALL

510	74	160.0000	INFILTRATION CFM
520	75	0.0000	BLANK
530	76	4.0000	PEAK NUMBER OF PEOPLE
540	77	4352.0000	PEAK APPLIANCE BTU
550	78	1.0000	PEAK LIGHTING (WATTS/SQ.FT.)
560	79	0.1000	ATTIC VENTILLATION (CFM/SQ.FT.)
570	80	140.0000	ATTIC SUMMER DESIGN TEMPERATURE
580	81	64.8000	WINDOW DESIGN SOLAR GAIN
590	82	-16.0000	OUTSIDE WINTER DESIGN TEMPERATURE
600	83	92.0000	OUTSIDE SUMMER DESIGN TEMPERATURE
610	84	0.0171	OUTSIDE SUMMER DESIGN HUMIDITY RATIO
620	85	0.0103	INSIDE SUMMER DESIGN HUMIDITY RATIO
630	86	1.0000	OVERCAPACITY OF THE HEATING PLANT
640	87	1.0000	OVERCAPACITY OF THE COOLING PLANT
650	88	70.0000	WINTER SET POINT
660	89	78.0000	SUMMER SET POINT
670	90	0.0000	OPTION FOR NIGHT SETBACK (0 = NO SETBACK)
680	91	0.0000	BLANK
690	92	0.0000	OPTION FOR SHADES (0 = NO SHADES)
700	93	1.0000	OPTION TO INPUT HEATING AND COOLING LOADS
710	94	48000.0000	HEATING DESIGN LOAD
720	95	35000.0000	COOLING DESIGN LOAD
730	96	42.0000	MAXIMUM TANK TEMP. TO PROVIDE COOLING
740	97	290.0000	LAST DAY TO MAINTAIN MINIM. TANK TEMP.
750	98	1.0000	DAY COLLECTORS ON
760	99	10.0000	CUTOFF TEMPERATURE
770	100	22.0000	HOUR HEATPUMP BEGINS TO RUN DURING COOLING
780	101	5.0000	HOUR HEATPUMP STOPS RUNNING DURING COOLING
790	102	0.0000	0 IF COLLECTOR, 1 IF CONVECTOR
800	103	1000.0000	CFM OF OIL FURNACE
810	104	1000.0000	CFM OF GAS FURNACE
820	105	1.0000	STAGES OF STRIP HEAT (1,2)
830	106	15.9900	OPTION TO INPUT TANK SIDE DIMENSION
840	107	1.0000	OPTION TO INPUT COLLECTOR AREA
850	108	0.0000	DAY COLLECTORS OFF
860	109	50.0000	DAY AFTER PEK COLECTORS OFF
870	135	0.0000	BUILDING ORIENTATION ANGLE
880	136	66.5000	INITIAL TEMP. OF CEILING SURFACE
890	137	65.9000	INITIAL TEMP. OF WALL SURFACE
900	138	67.9000	INITIAL TEMP. OF BASEMENT SURFACE
910	139	0.0250	U OF TANK TO AIR
920	140	8.0000	HIGHT OF TANK (FT.)
930	141	0.4000	VOLUMETRIC PACKING FRACTION
940	142	0.0001	PERCENTAGE OF TANK ABOVE GROUND
950	143	9.5904	THERMAL CAPACITANCE OF TANK ON A SQ.FT.
960	144	9.5904	THERMAL CAPACITANCE OF WALBG ON A SQ.FT.
970	145	1.0000	IF SET = 1 DESIGN FOR A FULL ACES
980	146	32.0000	INITIAL TANK TEMPERATURE
990	147	0.8400	TAU ALPHA OF SOLAR COLLECTORS
1000	148	0.8000	U OF COLLECTOR

1010	149	34.0000	AVERAGE OUTDOOR WINTER TEMPERATURE.
1020	150	18.0000	AREA OF EACH PANEL (SQ.FT.)
1030	151	30.0000	ROOF1 TILT ANGLE
1040	152	0.0000	ROOF1 AZMITH ANGLE
1050	153	30.0000	ROOF2 TILT ANGLE
1060	154	180.0000	ROOF2 AZMITH ANGLE
1070	155	0.0800	U OF EAST WALL
1080	156	0.0800	U OF SOUTH WALL
1090	157	0.0800	U OF WEST WALL
1100	158	0.3400	U OF EAST ATTIC WALL
1110	159	0.3400	U OF SOUTH ATTIC WALL
1120	160	0.3400	U OF WEST ATTIC WALL
1130	161	380.0000	AREA OF EAST WALL
1140	162	380.0000	AREA OF SOUTH WALL
1150	163	380.0000	AREA OF WEST WALL
1160	164	833.0000	AREA OF ROOF2
1170	165	208.0000	AREA OF EAST ATTIC WALL
1180	166	1.0000	AREA OF SOUTH ATTIC WALL
1190	167	208.0000	AREA OF WEST ATTIC WALL
1200	168	0.2300	ABSORPTIVITY OF WALLS
1210	169	1.7115	THERMAL CAP. OF NORTH ATTIC WALL
1220	170	356.0000	THERMAL CAP. OF EAST ATTIC WALL
1230	171	1.7115	THERMAL CAP. OF SOUTH ATTIC WALL
1240	172	356.0000	THERMAL CAP. OF WEST ATTIC WALL
1250	173	0.7700	ABSORPTIVITY OF ROOFS
1260	174	1337.0000	THERMAL CAP. OF ROOF1
1270	175	1337.1573	THERMAL CAP. OF ROOF2
1280	176	2877.4500	THERMAL CAP. OF CEILING
1290	177	647.0000	THERMAL CAP. OF NORTH WALL
1300	178	647.0000	THERMAL CAP. OF EAST WALL
1310	179	647.0000	THERMAL CAP. OF SOUTH WALL
1320	180	647.0000	THERMAL CAP. OF WEST WALL
1330	181	20315.0000	THERMAL CAP. OF SURFACE BELOW GRADE
1340	182	3041.0000	THERMAL CAP. OF INTERNAL MASS
1350	183	2000.0000	MASS
1360	184	325.0000	THERMAL CAP. OF AIR MASS
1370	185	36.0000	INITIAL TEMP. OF WALLS
1380	186	6.9000	INITIAL TEMP. OF ATTIC WALLS
1390	187	10.6000	INITIAL TEMP. OF ATTIC AIR
1400	188	41.0000	INITIAL TEMP. OF CEILING
1410	189	6.7700	INITIAL TEMP. OF ROOF1
1420	190	6.7700	INITIAL TEMP. OF ROOF2
1430	191	68.4400	INITIAL TEMP. OF ROOM AIR
1440	192	61.2100	INITIAL SLAB TEMP.
1450	193	56.6000	INITIAL TEMP. OF GROUND1
1460	194	51.5000	INITIAL TEMP. OF GROUND2
1470	195	45.9000	INITIAL TEMP. OF GROUND3
1480	196	0.0000	BUILDING TYPE(0-SING.FAM. 2-M.F.)
1490	197	391000.0000	PEAK DAILY COOLING LOAD
1500	198	0.0000	OPTION TO OUTPUT LOAD HISTORY(0-NO,1-YES)
1510	199		
1520	1	2	3
	4	5	6
	7	8	

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-- 3 0 -- DATE 08-31-79 TIME 11.952 ID = E1 GCS-AJ

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SNUMB = 3901T
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XXXX      XXXX      XXXX      X      XXXXX
X          X X      X X      XX      X
XXX        X X      X X      X      X
X          XXXX      X X      X      X
X X        X      X X      X      X
XXXX      X      XXXX      XXX      X

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33 3901T ENTERED GCS-AJ AT 11.545 FROM SYSTEM-0 TSS/S 0-08-23

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0001 S SNUMB 3901T
0002 S COMMENT F00648 TSS MEDIA CONVERSION
0003 S IDENT F00648-ACES
0004 SS USERID F00648$
0005 AS CONVER
0006 S LIMITS ,,,50000
0007 S SYSOUT OT,E1
0008 S MULTI 1-1
0009 S DATA IN,,COPY,ENDFC
0010 S ENDCOPY IN
0011 S ENDJOB
TOTAL CARD COUNT THIS JOB = 000151

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* ACTY=01 SCARD #0005 CONVER 08/31/79 SW=000000000000
BMC=TTL DATE 771205
S MULTI 1-1
FILE #000001 TOT 000140 INPUT
INPUT COUNT 000140 OUTPUT COUNT 000140
BLOCKS SKIPPED 000000 IGNORE COUNT 000000
* NORMAL TERMINATION AT 001544 I=2060 SW=000000000000

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START	STOP	SWAP	LAPSE	FC	D	TYPE	BUSY	IP/AT	FP/RT	IS/NC	MS/NE	ADDRESS	TW/PK#
11.551	11.560	0.002	0.009			MC R MSU450 *	22	0	1	1	1	0-08-06	
						IN R MSU450 *	110	0	5	5	5	0-08-06	
						OT SYOUT							
						P* SYOUT							

RC=00 139 LINES AT STA. E1

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ACTIVITY 01 COST=$ 0.06
* CUMULATIVE COST=$ 0.06

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SNUMB = 3901T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 000139

\$ NOTE FILENAME ECORESM
\$ NOTE LABELS- A,R(E1)
\$ NOTE TABS/SETTINGS- ASIS

1000ECONOMIC PARAMETERS FILE FOR SINGLE FAMILY MINNEAPOLIS

1010	1	1.0	TYPE OF OWNER (1=PRIVATE,2=LANDLORD)
1020	2	20.	LENGTH OF ANALYSIS PERIOD IN YEARS
1030	3	2.5	REAL DISCOUNT RATE
1040	4	30.	INCOME TAX RATE
1050	5	3.71	PROPERTY TAX RATE
1060	6	10.5	MORTGAGE INTEREST RATE
1070	7	10.0	SALVAGE VALUE (0=100% OF ORIGINAL PRICE)
1080	8	1.	MAINTENANCE COST FOR CONVENTIONAL SYSTEMS
1090	9	1.0	MAINTENANCE COST FOR ACES (% PER YR)
1100	10	0.4	INSURANCE RATE FOR CONVENTIONAL SYSTEMS
1110	11	0.4	INSURANCE RATE FOR ACES SYSTEM
1120	12	12.0	NUMBER OF MORTGAGE PAYMENTS PER YEAR
1125	13	1.0	MORTGAGE USED (0=NO,1=YES)
1130	14	0.0	DEPRECIATION SCHEDULE (0=NONE,1=SL,2=SY,3=SF)
1140	15	3.0	REAL INTEREST RATE FOR SF DEPRECIATION FUNDS
1170	19	2.0	RATE STRUCTURE(1=STAN,2=PLP,3=PLP-STAN)
1180	20	1.0	MILLION BTU PER MCF OF NATURAL GAS
1190	21	139600.	BTU PER GALLON OF HEATING OIL
1200	22	2.0	NUMBER OF PRICE ESCALATION PHASES FOR ELECTRICITY
1210	23	0.600	FIRST PHASE ESCALATION RATE
1220	24	7.0	FIRST PHASE DURATION IN YEARS
1230	25	0.500	SECOND PHASE ESCALATION RATE
1240	26	17.0	SECOND PHASE DURATION IN YEARS
1250	31	2.12	CURRENT PRICE OF NATURAL GAS(\$/MCF)
1260	32	4.0	NUMBER OF PRICE ESCALATION PHASES FOR NAT GAS
1270	33	5.610	FIRST PHASE ESCALATION RATE
1280	34	7.0	FIRST PHASE DURATION IN YEAR
1290	35	5.000	SECOND PHASE ESCALATION RATE
1300	36	5.0	SECOND PHASE DURATION IN YEARS
1301	37	2.170	THIRD PHASE ESCALATION RATE
1302	38	2.0	THIRD PHASE DURATION
1303	39	0.910	FOURTH PHASE ESCALATION RATE
1304	40	10.0	FOURTH PHASE DURATION
1310	41	0.463	CURRENT PRICE OF OIL (\$/GAL)
1320	42	2.0	NUMBER OF PRICE ESCALATION PHASES FOR OIL
1330	43	2.280	FIRST PHASE ESCALATION RATE
1340	44	7.0	FIRST PHASE DURATION IN YEARS
1350	45	0.900	SECOND PHASE ESCALATION RATE
1360	46	17.0	SECOND PHASE DURATION IN YEARS
1362	49	6.0	BEGINNING MONTH, STANDARD SYS PRIM PEAK
1370	50	2.50	MONTHLY CUSTOMER CHARGE FOR ELEC SERVICE, PRI PEAK
1380	51	1.0	NUMBER OF DEMAND CHARGE BLOCKS (UP TO 4)
1390	52	0.0	DEMAND CHARGE FOR FIRST BLOCK (\$/KW)
1400	53		SIZE OF FIRST BLOCK (KW)
1410	54		DEMAND CHARGE FOR SECOND BLOCK (\$/KW)
1420	55		SIZE OF SECOND BLOCK (KW)
1430	56		DEMAND CHARGE FOR THIRD BLOCK (\$/KW)
1440	57		SIZE OF THIRO BLOCK
1450	61	2.0	NUMBER OF ENERGY CHARGE BLOCKS

1460	62	.0430	ENERGY CHARGE FOR FIRST BLOCK (\$/KWH)
1470	63	1000.	SIZE OF FIRST BLOCK (KWH)
1480	64	.0430	ENERGY CHARGE FOR SECOND BLOCK (\$/KWH)
1490	65		SIZE OF SECOND BLOCK (KWH)
1500	66		ENERGY CHARGE FOR THIRD BLOCK (\$/KWH)
1502	69	10.0	BEGINNING MONTH, STANDARD SYS SEC PEAK
1510	70	2.50	MONTHLY CUSTOMER CHARGE FOR ELEC SERVICE, SEC PEAK
1520	71	1.0	NUMBER OF DEMAND CHARGE BLOCKS (UP TO 4)
1530	72	0.0	DEMAND CHARGE FOR FIRST BLOCK (\$/KW)
1540	73		SIZE OF FIRST BLOCK (KW)
1550	74		DEMAND CHARGE FOR SECOND BLOCK (\$/KW)
1560	75		SIZE OF SECOND BLOCK (KW)
1570	76		DEMAND CHARGE FOR THIRD BLOCK (\$/KW)
1580	77		SIZE OF THIRD BLOCK
1590	81	2.0	NUMBER OF ENERGY CHARGE BLOCKS
1600	82	.0390	ENERGY CHARGE FOR FIRST BLOCK (\$/KWH)
1610	83	1000.	SIZE OF FIRST BLOCK (KWH)
1620	84	.0230	ENERGY CHARGE FOR SECOND BLOCK (\$/KWH)
1630	85		SIZE OF SECOND BLOCK (KWH)
1640	86		ENERGY CHARGE FOR THIRD BLOCK (\$/KWH)
1650	90	10.0	MINIMUM BILLING DEMAND FOR SEASON 1
1660	91	10.0	MINIMUM BILLING DEMAND FOR SEASON 2
1670	92	95.0	DEMAND % MULTIPLIER FOR SEASON 1
1680	93	60.0	DEMAND % MULTIPLIER FOR SEASON 2
1690	101	2.0	NUMBER OF SEASONAL PEAKS (1 OR 2)
1700	102	6.0	BEGINNING MONTH OF HIGHEST SEASON PEAK PERIOD*****
1710	103	0.00	ON-PEAK DEMAND CHARGE, PRIMARY PEAK SEASON
1720	104	0.00	OFF-PEAK DEMAND CHARGE, PRIMARY PEAK SEASON
1730	105	0.0743	ON-PEAK ENERGY CHARGE, PRIMARY PEAK SEASON (\$/KWH)
1740	106	0.0214	OFF-PEAK ENERGY CHARGE, PRIMARY PEAK SEASON (\$/KWH)
1750	107	1.0	WEEKDAY BEGINNING WEEKLY PEAK PERIOD
1760	108	5.0	WEEKDAY ENDING WEEKLY PEAK PERIOD
1770	109	9.0	HOUR BEGINNING DAILY PEAK PERIOD
1780	110	21.0	HOUR ENDING DAILY PEAK PERIOD
1782	111	5.500	MONTHLY CUSTOMER CHARGE, PRIM PEAK PLP
1790	112	11.0	BEGINNING MONTH OF SECONDARY SEASON PEAK PERIOD
1800	113	0.00	ON-PEAK DEMAND CHARGE, SECONDARY PEAK SEASON
1810	114	0.00	OFF-PEAK DEMAND CHARGE, SECONDARY PEAK SEASON
1820	115	0.0604	ON-PEAK ENERGY CHARGE, SECONDARY PEAK SEASON (\$/KWH)
1830	116	0.0214	OFF-PEAK ENERGY CHARGE, SECONDARY PEAK SEASON (\$/KWH)
1840	117	1.0	WEEKDAY BEGINNING WEEKLY PEAK PERIOD
1850	118	5.0	WEEKDAY ENDING WEEKLY PEAK PERIOD
1860	119	9.0	HOUR BEGINNING DAILY PEAK PERIOD
1870	120	21.0	HOUR ENDING DAILY PEAK PERIOD
1872	121	5.500	MONTHLY CUSTOMER CHARGE, SEC PEAK PLP
1880	130	820.0	COST OF CONVENTIONAL GAS SPACE HEAT PLANT
1890	131	730.0	COST OF CONVENTIONAL OIL SPACE HEAT PLANT
1900	132	840.0	COST OF CONVENTIONAL ELEC SPACE HEAT PLANT

1910 133	3436.0	COST OF AIR-TO-AIR HEAT PUMP
1920 134	1120.0	COST OF CONVENTIONAL SPACE COOLING EQUIPMENT
1930 135	182.0	COST OF CONVENTIONAL GAS DHW HEATER
1940 136	170.0	COST OF CONVENTIONAL ELEC DHW HEATER
1950 137	4200.0	COST OF ICE MAKER HEAT PUMP
1960 138	4804.0	COST OF ICE MAKER HEAT PUMP WITH OUTSIDE EVAPORATOR
1970 140	19.65	COST OF GLAZED SOLAR PANELS (\$/SQ FT)
1980 141	9.50	COST OF ABSORBER PANELS (\$/SQ FT)
1990 142	1580.0	SOLAR FIXED COST COMPONENT
2000 143	300.0	COST OF BACKUP SYSTEM
2010 144	563.0	NON-SOLAR FIXED COST COMPONENT
2020 145		COST OF LARGE COMMERCIAL SYSTEM HEAT PUMP
2030 146		COST OF SMALL COMMERCIAL SYSTEM HEAT PUMP
2040 147	1150.0	COST OF ACES CONTROL PACKAGE
2045 148	8.0	HEIGHT OF STORAGE TANK (FEET)
2046 149	10.0	LIFE OF THE ABSORBER SOLAR PANELS
2047 150	1957.0	YEAR THAT SIMULATION BEGINS
2048 151	3.0	DAY OF WEEK SIM BEGINS(1=MON,7=SUN)
2050 158	1.005	REGIONAL ACES TANK COST ADJ MULT
2060 159	0.32	SCALE FACTOR EXPONENT FOR HEAT PUMP
2070 160	5.0	NUMBER OF SYSTEMS TO BE ANALYZED
2080 161	1.0	ACES SYSTEM (0=NO,1=YES)
2090 162	2.0	ALL ELECTRIC (0=NO,2=YES)
2100 163	3.0	AIR-TO-AIR HEAT PUMP (0=NO,3=YES)
2110 164	4.0	OIL HEAT (0=NO,4=YES)
2120 165	5.0	NATURAL GAS HEAT (0=NO,5=YES)
2122 166	6.0	ASSUMED AVERAGE INFLATION RATE
2124 167	10.0	DOWNPAYMENT ON MORTGAGE
2125 169	1.0	DOES PROP TAX APPLY TO SOLAR (0=NO,1=YES)
2130 170	3.0	NUMBER OF LEARNING CURVE POINTS
2140 171	0.0	NUMBER OF YRS FROM 1978 TO FIRST POINT
2150 172	1.0	FIRST POINT COST ADJ MULT
2160 173	2.0	NUMBER OF YRS FROM 1978 TO SECOND POINT
2170 174	0.60	SECOND POINT COST ADJ MULT
2180 175	4.0	NUMBER OF YRS FROM 1978 TO THIRD POINT
2190 176	0.48	THIRD POINT COST ADJ MULT
2200 177	0.0	1 IF INSUL 0 IF NOT
2210 178	0.54	COST OF ADD INSUL/FT2

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840.

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-- 3 0 --          DATE 08-31-79    TIME 11.984          ID = E1   GCS-AJ
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LODMOD OUTPUT SUMMARY

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HOURLY SUMMARY FOR DAY 1 MONTH 1

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.25487E 05	0.17780E 04	0.	0.	0.22618E 05	0.44544E 04	0.	0.
2	0.19464E 05	0.53638E 03	0.	0.	0.15559E 05	0.54411E 04	0.	0.
3	0.18527E 05	0.53559E 03	0.	0.	0.14435E 05	0.56276E 04	0.	0.
4	0.18452E 05	0.53554E 03	0.	0.	0.14012E 05	0.59751E 04	0.	0.
5	0.18480E 05	0.53556E 03	0.	0.	0.13867E 05	0.61481E 04	0.	0.
6	0.18411E 05	0.53550E 03	0.	0.	0.13798E 05	0.61491E 04	0.	0.
7	0.15078E 05	0.13322E 04	0.	0.	0.14834E 05	0.63716E 04	0.	0.
8	0.15471E 05	0.30053E 04	0.	0.34496E 02	0.16430E 05	0.68846E 04	0.19658E 04	0.25684E 02
9	0.15519E 05	0.43915E 04	0.	0.12145E 03	0.17962E 05	0.68841E 04	0.50051E 04	0.91316E 02
10	0.14660E 05	0.50105E 04	0.	0.18017E 03	0.17017E 05	0.67233E 04	0.56874E 04	0.13605E 03
11	0.14212E 05	0.42104E 04	0.	0.19480E 03	0.15639E 05	0.69028E 04	0.49369E 04	0.14752E 03
12	0.13548E 05	0.29303E 04	0.	0.15563E 03	0.14678E 05	0.69125E 04	0.37807E 04	0.11809E 03
13	0.13824E 05	0.24508E 04	0.	0.12124E 03	0.14422E 05	0.69082E 04	0.31850E 04	0.91989E 02
14	0.14155E 05	0.32508E 04	0.	0.10265E 03	0.14706E 05	0.69035E 04	0.31329E 04	0.77747E 02
15	0.14760E 05	0.19718E 04	0.	0.71300E 02	0.14589E 05	0.70680E 04	0.25755E 04	0.53798E 02
16	0.12918E 05	0.18102E 04	0.	0.36901E 02	0.14662E 05	0.69221E 04	0.16430E 04	0.27569E 02
17	0.14666E 05	0.16519E 04	0.	0.	0.14101E 05	0.75889E 04	0.	0.
18	0.15424E 05	0.25321E 04	0.	0.	0.15426E 05	0.79252E 04	0.	0.
19	0.16004E 05	0.41373E 04	0.	0.	0.16015E 05	0.79169E 04	0.	0.
20	0.16902E 05	0.67184E 04	0.	0.	0.16274E 05	0.79039E 04	0.	0.
21	0.17754E 05	0.56529E 04	0.	0.	0.16793E 05	0.82383E 04	0.	0.
22	0.21479E 05	0.42168E 04	0.	0.	0.16367E 05	0.83571E 04	0.	0.
23	0.21974E 05	0.34441E 04	0.	0.	0.16868E 05	0.83512E 04	0.	0.
24	0.23657E 05	0.30124E 04	0.	0.	0.17143E 05	0.86732E 04	0.	0.

DAILY SUMMARY

0.41083E 06	0.66186E 05	0.	0.10186E 04	0.37822E 06	0.16723E 06	0.31913E 05	0.76977E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLOD
1	0.	0.	0.	0.	0.	0.63698E 02	0.
2	0.	0.	0.	0.	0.	0.68390E 02	0.
3	0.	0.	0.	0.	0.	0.68466E 02	0.
4	0.	0.	0.	0.	0.	0.68471E 02	0.
5	0.	0.	0.	0.	0.	0.68468E 02	0.
6	0.	0.	0.	0.	0.	0.68474E 02	0.
7	0.	0.	0.	0.	0.	0.68758E 02	0.
8	0.13033E 01	0.32611E 01	0.43280E 02	0.32425E 02	0.32611E 01	0.68717E 02	0.
9	0.44701E 01	0.12377E 02	0.93642E 02	0.93498E 02	0.12377E 02	0.68715E 02	0.
10	0.65539E 01	0.18948E 02	0.89019E 02	0.13801E 03	0.18948E 02	0.68787E 02	0.
11	0.81378E 01	0.23009E 02	0.58111E 02	0.14312E 03	0.23009E 02	0.68822E 02	0.
12	0.78740E 01	0.21273E 02	0.22810E 02	0.11158E 03	0.21273E 02	0.68878E 02	0.
13	0.64246E 01	0.17113E 02	0.17113E 02	0.37265E 02	0.35145E 02	0.68854E 02	0.
14	0.53885E 01	0.14222E 02	0.14222E 02	0.76055E 02	0.48194E 02	0.68826E 02	0.
15	0.36647E 01	0.94703E 01	0.94703E 01	0.36159E 02	0.50822E 02	0.68775E 02	0.
16	0.16435E 01	0.40789E 01	0.40789E 01	0.32336E 02	0.42385E 02	0.68933E 02	0.
17	0.	0.	0.	0.	0.	0.68780E 02	0.
18	0.	0.	0.	0.	0.	0.68721E 02	0.
19	0.	0.	0.	0.	0.	0.68673E 02	0.
20	0.	0.	0.	0.	0.	0.68598E 02	0.
21	0.	0.	0.	0.	0.	0.68527E 02	0.
22	0.	0.	0.	0.	0.	0.68212E 02	0.
23	0.	0.	0.	0.	0.	0.68178E 02	0.
24	0.	0.	0.	0.	0.	0.68036E 02	0.

DAILY SUMMARY

0.45460E 02	0.12375E 03	0.35175E 03	0.77744E 03	0.25541E 03	0.68407E 02	0.

HOURLY SUMMARY FOR DAY 30 MONTH 1

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.16589E 05	0.17268E 04	0.	0.	0.12641E 05	0.54816E 04	0.	0.
2	0.16971E 05	0.53427E 03	0.	0.	0.12856E 05	0.56496E 04	0.	0.
3	0.17337E 05	0.53458E 03	0.	0.	0.13054E 05	0.58177E 04	0.	0.
4	0.17708E 05	0.53490E 03	0.	0.	0.13257E 05	0.59857E 04	0.	0.
5	0.18087E 05	0.53523E 03	0.	0.	0.13468E 05	0.61536E 04	0.	0.
6	0.18476E 05	0.53556E 03	0.	0.	0.13690E 05	0.63214E 04	0.	0.
7	0.15272E 05	0.13324E 04	0.	0.	0.14858E 05	0.65421E 04	0.	0.
8	0.15144E 05	0.30050E 04	0.	0.13753E 02	0.15313E 05	0.65428E 04	0.83413E 03	0.10326E 02
9	0.15934E 05	0.43918E 04	0.	0.36584E 02	0.15347E 05	0.65311E 04	0.16213E 04	0.27696E 02
10	0.15253E 05	0.50110E 04	0.	0.16419E 03	0.17941E 05	0.63683E 04	0.56635E 04	0.12469E 03
11	0.13628E 05	0.42099E 04	0.	0.18502E 03	0.15924E 05	0.62182E 04	0.51227E 04	0.14077E 03
12	0.12026E 05	0.29290E 04	0.	0.19843E 03	0.14960E 05	0.60680E 04	0.47413E 04	0.15107E 03
13	0.11288E 05	0.24486E 04	0.	0.19341E 03	0.14500E 05	0.59050E 04	0.47982E 04	0.14722E 03
14	0.11312E 05	0.32483E 04	0.	0.25856E 02	0.10645E 05	0.55574E 04	0.57171E 03	0.19561E 02
15	0.12394E 05	0.19698E 04	0.	0.19903E 02	0.11751E 05	0.55419E 04	0.57904E 03	0.15018E 02
16	0.10635E 05	0.18082E 04	0.	0.11341E 02	0.12707E 05	0.53948E 04	0.44604E 03	0.85100E 01
17	0.11421E 05	0.16490E 04	0.	0.16159E 01	0.12812E 05	0.57292E 04	0.98648E 02	0.12003E 01
18	0.11312E 05	0.25286E 04	0.	0.	0.13331E 05	0.59045E 04	0.	0.
19	0.11769E 05	0.41337E 04	0.	0.	0.13622E 05	0.60710E 04	0.	0.
20	0.12439E 05	0.67146E 04	0.	0.	0.13650E 05	0.60613E 04	0.	0.
21	0.12579E 05	0.56484E 04	0.	0.	0.13791E 05	0.60595E 04	0.	0.
22	0.15825E 05	0.42119E 04	0.	0.	0.13054E 05	0.60117E 04	0.	0.
23	0.16132E 05	0.34390E 04	0.	0.	0.13364E 05	0.60085E 04	0.	0.
24	0.17125E 05	0.30068E 04	0.	0.	0.13285E 05	0.59939E 04	0.	0.

DAILY SUMMARY

0.34665E 06	0.66087E 05	0.	0.85010E 03	0.32982E 06	0.14392E 06	0.24477E 05	0.64605E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	HASLON
1	0.	0.	0.	0.	0.	0.68624E 02	0.
2	0.	0.	0.	0.	0.	0.68593E 02	0.
3	0.	0.	0.	0.	0.	0.68563E 02	0.
4	0.	0.	0.	0.	0.	0.68532E 02	0.
5	0.	0.	0.	0.	0.	0.68500E 02	0.
6	0.	0.	0.	0.	0.	0.68468E 02	0.
7	0.	0.	0.	0.	0.	0.68741E 02	0.
8	0.69009E 00	0.17315E 01	0.18326E 02	0.11645E 02	0.17315E 01	0.68745E 02	0.
9	0.18294E 01	0.48305E 01	0.29734E 02	0.27244E 02	0.48805E 01	0.68678E 02	0.
10	0.77089E 01	0.21432E 02	0.87949E 02	0.11569E 03	0.21432E 02	0.68739E 02	0.
11	0.91200E 01	0.25319E 02	0.62673E 02	0.12615E 03	0.25319E 02	0.68873E 02	0.
12	0.97771E 01	0.27259E 02	0.34459E 02	0.13383E 03	0.27259E 02	0.69006E 02	0.
13	0.95313E 01	0.26533E 02	0.26533E 02	0.13096E 03	0.50535E 02	0.69066E 02	0.
14	0.34122E 00	0.16278E 01	0.16278E 01	0.18789E 02	0.11006E 02	0.69061E 02	0.
15	0.30965E 00	0.12925E 01	0.12925E 01	0.15143E 02	0.13959E 02	0.68971E 02	0.
16	0.23314E 00	0.76418E 00	0.78418E 00	0.94476E 01	0.12832E 02	0.69123E 02	0.
17	0.80945E-01	0.18595E 00	0.18695E 00	0.15793E 01	0.31172E 01	0.69052E 02	0.
18	0.	0.	0.	0.	0.	0.69063E 02	0.
19	0.	0.	0.	0.	0.	0.69024E 02	0.
20	0.	0.	0.	0.	0.	0.68968E 02	0.
21	0.	0.	0.	0.	0.	0.68957E 02	0.
22	0.	0.	0.	0.	0.	0.68682E 02	0.
23	0.	0.	0.	0.	0.	0.68663E 02	0.
24	0.	0.	0.	0.	0.	0.68579E 02	0.

DAILY SUMMARY

0.39622E 02	0.11105E 03	0.26351E 03	0.59048E 03	0.17207E 03	0.68803E 02	0.

HOURLY SUMMARY FOR DAY 1 MONTH 3

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.18653E 05	0.16838E 04	0.	0.	0.13870E 05	0.63188E 04	0.	0.
2	0.18752E 05	0.53579E 03	0.	0.	0.13971E 05	0.63175E 04	0.	0.
3	0.19078E 05	0.53608E 03	0.	0.	0.14128E 05	0.64861E 04	0.	0.
4	0.19152E 05	0.53614E 03	0.	0.	0.14203E 05	0.64851E 04	0.	0.
5	0.18926E 05	0.53594E 03	0.	0.	0.14147E 05	0.63151E 04	0.	0.
6	0.18921E 05	0.53594E 03	0.	0.	0.14142E 05	0.63151E 04	0.	0.
7	0.15320E 05	0.13024E 04	0.	0.	0.15080E 05	0.63682E 04	0.	0.
8	0.15232E 05	0.29124E 04	0.	0.	0.14742E 05	0.63681E 04	0.	0.
9	0.16355E 05	0.42475E 04	0.	0.	0.14326E 05	0.63516E 04	0.	0.
10	0.17119E 05	0.48447E 04	0.	0.	0.14173E 05	0.63407E 04	0.	0.
11	0.17179E 05	0.40750E 04	0.	0.	0.14233E 05	0.63401E 04	0.	0.
12	0.16520E 05	0.28429E 04	0.	0.	0.14435E 05	0.63499E 04	0.	0.
13	0.16434E 05	0.23811E 04	0.	0.	0.14406E 05	0.63509E 04	0.	0.
14	0.16143E 05	0.31505E 04	0.	0.	0.14284E 05	0.61818E 04	0.	0.
15	0.16092E 05	0.19189E 04	0.	0.	0.14233E 05	0.61624E 04	0.	0.
16	0.13942E 05	0.17631E 04	0.	0.	0.14751E 05	0.62141E 04	0.	0.
17	0.13750E 05	0.16091E 04	0.	0.	0.14557E 05	0.62161E 04	0.	0.
18	0.12956E 05	0.24550E 04	0.	0.	0.14654E 05	0.62278E 04	0.	0.
19	0.12844E 05	0.39994E 04	0.	0.	0.14541E 05	0.62291E 04	0.	0.
20	0.13296E 05	0.64834E 04	0.	0.	0.14347E 05	0.62224E 04	0.	0.
21	0.13297E 05	0.54571E 04	0.	0.	0.14347E 05	0.62226E 04	0.	0.
22	0.16721E 05	0.40747E 04	0.	0.	0.13617E 05	0.63454E 04	0.	0.
23	0.17002E 05	0.33308E 04	0.	0.	0.13901E 05	0.63426E 04	0.	0.
24	0.17972E 05	0.29148E 04	0.	0.	0.13798E 05	0.63284E 04	0.	0.

DAILY SUMMARY

0.39166E 06	0.64127E 05	0.	0.	0.34289E 06	0.15142E 06	0.	0.

HOURLY SUMMARY FOR DAY 31 MONTH 3

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.14621E 05	0.16804E 04	0.	0.	0.10817E 05	0.53365E 04	0.	0.
2	0.15445E 05	0.53296E 03	0.	0.	0.11306E 05	0.56714E 04	0.	0.
3	0.16260E 05	0.53366E 03	0.	0.	0.11787E 05	0.60064E 04	0.	0.
4	0.16809E 05	0.53413E 03	0.	0.	0.12172E 05	0.61719E 04	0.	0.
5	0.17329E 05	0.53458E 03	0.	0.	0.12525E 05	0.63378E 04	0.	0.
6	0.17828E 05	0.53501E 03	0.	0.69136E-01	0.12886E 05	0.65040E 04	0.27605E 02	0.53837E-01
7	0.12770E 05	0.13002E 04	0.	0.57224E 02	0.18087E 05	0.62324E 04	0.54242E 04	0.44495E 02
8	0.10023E 05	0.29078E 04	0.	0.14088E 03	0.17600E 05	0.59239E 04	0.76277E 04	0.10892E 03
9	0.84644E 04	0.42407E 04	0.	0.21696E 03	0.15610E 05	0.54257E 04	0.82548E 04	0.16741E 03
10	0.71800E 04	0.48361E 04	0.	0.27686E 03	0.13368E 05	0.49241E 04	0.77258E 04	0.21343E 03
11	0.62341E 04	0.40656E 04	0.	0.31558E 03	0.11270E 05	0.45908E 04	0.62418E 04	0.24317E 03
12	0.51219E 04	0.28331E 04	0.	0.33014E 03	0.10421E 05	0.42603E 04	0.53047E 04	0.25436E 03
13	0.47762E 04	0.23710E 04	0.	0.31947E 03	0.10722E 05	0.40917E 04	0.57241E 04	0.24616E 03
14	0.38497E 04	0.51399E 04	0.	0.28436E 03	0.11009E 05	0.37586E 04	0.66057E 04	0.21919E 03
15	0.27347E 04	0.19074E 04	0.	0.22748E 03	0.10423E 05	0.34279E 04	0.68053E 04	0.17549E 03
16	0.71591E 02	0.17509E 04	0.	0.15347E 03	0.99313E 04	0.32984E 04	0.61471E 04	0.11861E 03
17	0.36316E 02	0.15969E 04	0.	0.70097E 02	0.82328E 04	0.32983E 04	0.44837E 04	0.54425E 02
18	0.46750E 03	0.24441E 04	0.	0.21534E 01	0.55854E 04	0.32901E 04	0.49364E 03	0.17335E 01
19	0.27143E 04	0.39908E 04	0.	0.	0.68571E 04	0.37737E 04	0.	0.
20	0.51090E 04	0.64764E 04	0.	0.	0.81155E 04	0.42593E 04	0.	0.
21	0.64216E 04	0.54512E 04	0.	0.	0.91010E 04	0.45875E 04	0.	0.
22	0.10386E 05	0.40693E 04	0.	0.	0.89196E 04	0.47029E 04	0.	0.
23	0.11284E 05	0.33259E 04	0.	0.	0.96559E 04	0.48645E 04	0.	0.
24	0.12801E 05	0.29103E 04	0.	0.	0.99350E 04	0.50158E 04	0.	0.

DAILY SUMMARY

0.20874E 06	0.63968E 05	0.	0.23948E 04	0.26634E 06	0.11575E 06	0.70866E 05	0.18475E 04

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLON
1	0.	0.	0.	0.	0.	0.68786E 02	0.
2	0.	0.	0.	0.	0.	0.68718E 02	0.
3	0.	0.	0.	0.	0.	0.68651E 02	0.
4	0.	0.	0.	0.	0.	0.68606E 02	0.
5	0.	0.	0.	0.	0.	0.68563E 02	0.
6	0.29377E-01	0.84395E-01	0.76789E 00	0.36846E-01	0.36846E-01	0.68522E 02	0.
7	0.83022E 01	0.98021E 01	0.14497E 03	0.23723E 02	0.98021E 01	0.68955E 02	0.
8	0.14978E 02	0.17152E 02	0.18565E 03	0.66136E 02	0.17152E 02	0.69175E 02	0.
9	0.20109E 02	0.22634E 02	0.17753E 03	0.10605E 03	0.22634E 02	0.69301E 02	0.
10	0.23912E 02	0.26647E 02	0.14352E 03	0.13780E 03	0.26647E 02	0.69407E 02	0.
11	0.26306E 02	0.29161E 02	0.93553E 02	0.15842E 03	0.29161E 02	0.69485E 02	0.
12	0.27198E 02	0.30094E 02	0.34830E 02	0.16618E 03	0.30094E 02	0.69578E 02	0.
13	0.26544E 02	0.29411E 02	0.29411E 02	0.16049E 03	0.84841E 02	0.69605E 02	0.
14	0.24377E 02	0.27138E 02	0.27138E 02	0.14179E 03	0.13662E 03	0.69683E 02	0.
15	0.20785E 02	0.23352E 02	0.23352E 02	0.11160E 03	0.17364E 03	0.69776E 02	0.
16	0.15860E 02	0.18105E 02	0.18105E 02	0.72692E 02	0.18670E 03	0.70029E 02	0.
17	0.94731E 01	0.11120E 02	0.11120E 02	0.30042E 02	0.15655E 03	0.70028E 02	0.
18	0.76696E 00	0.16459E 01	0.95016E 00	0.95016E 00	0.18698E 02	0.69981E 02	0.
19	0.	0.	0.	0.	0.	0.69771E 02	0.
20	0.	0.	0.	0.	0.	0.69572E 02	0.
21	0.	0.	0.	0.	0.	0.69465E 02	0.
22	0.	0.	0.	0.	0.	0.69131E 02	0.
23	0.	0.	0.	0.	0.	0.69063E 02	0.
24	0.	0.	0.	0.	0.	0.68936E 02	0.

DAILY SUMMARY

0.21864E 03	0.24635E 03	0.89090E 03	0.11759E 04	0.89257E 03	0.69283E 02	0.

HOURLY SUMMARY FOR DAY 30 MONTH 4

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.	0.16327E 04	0.	0.	0.45056E 04	0.23297E 04	0.	0.
2	0.	0.50824E 03	0.	0.	0.45056E 04	0.23297E 04	0.	0.
3	0.	0.51398E 03	0.	0.	0.45056E 04	0.23297E 04	0.	0.
4	0.18938E 02	0.51814E 03	0.	0.	-0.22138E 03	0.17585E 04	0.	0.
5	0.68285E 03	0.52025E 03	0.	0.	0.47481E 03	0.17233E 04	0.	0.
6	0.79036E 03	0.52031E 03	0.	0.12773E 02	0.45135E 04	0.18957E 04	0.40985E 04	0.10930E 02
7	0.72362E 01	0.12587E 04	0.	0.77803E 02	0.11316E 05	0.15571E 04	0.67713E 04	0.61767E 02
8	0.	0.28352E 04	0.	0.15250E 03	0.11316E 05	0.15571E 04	0.78890E 04	0.11948E 03
9	0.	0.41470E 04	0.	0.22008E 03	0.11316E 05	0.15571E 04	0.80491E 04	0.17155E 03
10	0.	0.47324E 04	0.	0.27277E 03	0.11316E 05	0.15571E 04	0.73392E 04	0.21209E 03
11	0.	0.39669E 04	0.	0.30582E 03	0.11316E 05	0.15571E 04	0.59069E 04	0.23751E 03
12	0.	0.27447E 04	0.	0.31649E 03	0.11316E 05	0.15571E 04	0.52294E 04	0.24571E 03
13	0.	0.22854E 04	0.	0.30393E 03	0.11316E 05	0.15571E 04	0.57069E 04	0.23606E 03
14	0.	0.30404E 04	0.	0.26915E 03	0.11316E 05	0.15571E 04	0.64944E 04	0.20931E 03
15	0.	0.18182E 04	0.	0.21504E 03	0.11316E 05	0.15571E 04	0.66717E 04	0.16766E 03
16	0.	0.16528E 04	0.22546E 04	0.14653E 03	0.11316E 05	0.15571E 04	0.62275E 04	0.11488E 03
17	0.	0.14994E 04	0.19233E 04	0.71763E 02	0.11316E 05	0.15571E 04	0.51330E 04	0.57084E 02
18	0.	0.23349E 04	0.30171E 04	0.10222E 02	0.11316E 05	0.15571E 04	0.29184E 04	0.80147E 01
19	0.	0.38599E 04	0.74725E 03	0.	0.11316E 05	0.15571E 04	0.	0.
20	0.	0.63192E 04	0.	0.	0.11316E 05	0.15571E 04	0.	0.
21	0.	0.53164E 04	0.	0.	0.11316E 05	0.15571E 04	0.	0.
22	0.	0.39688E 04	0.	0.	0.11316E 05	0.15571E 04	0.	0.
23	0.	0.32479E 04	0.	0.	0.11316E 05	0.15571E 04	0.	0.
24	0.	0.28500E 04	0.	0.	0.11316E 05	0.15571E 04	0.	0.

DAILY SUMMARY

0.14994E 04	0.62092E 05	0.79423E 04	0.23749E 04	0.22197E 06	0.40394E 05	0.78435E 05	0.18521E 04

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	RASLOD
1	0.	0.	0.	0.	0.	0.71944E 02	0.
2	0.	0.	0.	0.	0.	0.71097E 02	0.
3	0.	0.	0.	0.	0.	0.70544E 02	0.
4	0.	0.	0.	0.	0.	0.70145E 02	0.
5	0.	0.	0.	0.	0.	0.69942E 02	0.
6	0.92687E 01	0.23897E 02	0.94898E 02	0.71501E 01	0.71501E 01	0.69936E 02	0.
7	0.19967E 02	0.20426E 02	0.17003E 03	0.16200E 02	0.16200E 02	0.71983E 02	0.
8	0.27113E 02	0.22740E 02	0.18590E 03	0.46675E 02	0.22740E 02	0.73189E 02	0.
9	0.32406E 02	0.27779E 02	0.17087E 03	0.80331E 02	0.27779E 02	0.73676E 02	0.
10	0.36180E 02	0.31443E 02	0.13577E 03	0.10726E 03	0.31443E 02	0.73997E 02	0.
11	0.38448E 02	0.33667E 02	0.87499E 02	0.12433E 03	0.33667E 02	0.74552E 02	0.
12	0.39167E 02	0.34376E 02	0.34376E 02	0.12987E 03	0.36706E 02	0.75200E 02	0.
13	0.38319E 02	0.33542E 02	0.33542E 02	0.12335E 03	0.91743E 02	0.75530E 02	0.
14	0.35925E 02	0.31197E 02	0.31197E 02	0.10539E 03	0.13922E 03	0.75989E 02	0.
15	0.32029E 02	0.27418E 02	0.27418E 02	0.77778E 02	0.17296E 03	0.76633E 02	0.
16	0.26504E 02	0.22267E 02	0.22267E 02	0.43772E 02	0.18596E 03	0.77924E 02	0.
17	0.19266E 02	0.21764E 02	0.15581E 02	0.15581E 02	0.16676E 03	0.78066E 02	0.
18	0.81041E 01	0.22154E 02	0.62207E 01	0.62207E 01	0.84140E 02	0.78080E 02	0.
19	0.	0.	0.	0.	0.	0.78027E 02	0.
20	0.	0.	0.	0.	0.	0.77253E 02	0.
21	0.	0.	0.	0.	0.	0.76287E 02	0.
22	0.	0.	0.	0.	0.	0.74375E 02	0.
23	0.	0.	0.	0.	0.	0.73074E 02	0.
24	0.	0.	0.	0.	0.	0.71767E 02	0.

DAILY SUMMARY

0.36280E 03	0.35267E 03	0.10156E 04	0.88391E 03	0.10165E 04	0.74134E 02	0.

HOURLY SUMMARY FOR DAY 30 MONTH 5

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.	0.15447E 04	0.	0.	0.89155E 04	0.25640E 04	0.	0.
2	0.	0.50919E 03	0.	0.	0.89155E 04	0.25640E 04	0.	0.
3	0.19127E 02	0.51704E 03	0.	0.	-0.11074E 04	0.25436E 04	0.	0.
4	0.97963E 03	0.52051E 03	0.	0.	-0.85430E 02	0.25855E 04	0.	0.
5	0.19275E 04	0.52132E 03	0.	0.98156E 00	0.12531E 04	0.25722E 04	0.37652E 03	0.76430E 00
6	0.14582E 04	0.52087E 03	0.	0.20480E 02	0.46283E 04	0.24063E 04	0.40556E 04	0.16987E 02
7	0.23883E 02	0.12091E 04	0.	0.78747E 01	0.44366E 04	0.24239E 04	0.73228E 03	0.63422E 01
8	0.	0.26697E 04	0.	0.14602E 02	0.44366E 04	0.24239E 04	0.76897E 03	0.11548E 02
9	0.	0.38751E 04	0.	0.15767E 03	0.44366E 04	0.24239E 04	0.69557E 04	0.12354E 03
10	0.	0.44102E 04	0.	0.25491E 02	0.44366E 04	0.24239E 04	0.67687E 03	0.19941E 02
11	0.	0.37064E 04	0.	0.28502E 02	0.44366E 04	0.24239E 04	0.54015E 03	0.22259E 02
12	0.	0.25801E 04	0.	0.11859E 03	0.44366E 04	0.24239E 04	0.36276E 04	0.92535E 02
13	0.	0.21507E 04	0.	0.28356E 02	0.44366E 04	0.24239E 04	0.52139E 03	0.22146E 02
14	0.	0.28461E 04	0.	0.25211E 02	0.44366E 04	0.24239E 04	0.59991E 03	0.19726E 02
15	0.	0.17233E 04	0.	0.20319E 02	0.44366E 04	0.24239E 04	0.63278E 03	0.15958E 02
16	0.	0.15710E 04	0.	0.14142E 02	0.44366E 04	0.24239E 04	0.61596E 03	0.11193E 02
17	0.	0.14291E 04	0.	0.74091E 01	0.44366E 04	0.24239E 04	0.58248E 03	0.59806E 01
18	0.	0.21954E 04	0.	0.16211E 01	0.44366E 04	0.24239E 04	0.49484E 03	0.13484E 01
19	0.	0.35994E 04	0.	0.87628E-01	0.44366E 04	0.24239E 04	0.24466E 02	0.68265E-01
20	0.	0.58620E 04	0.	0.	0.44366E 04	0.24239E 04	0.	0.
21	0.	0.49351E 04	0.	0.	0.44366E 04	0.24239E 04	0.	0.
22	0.	0.36934E 04	0.	0.	0.44366E 04	0.24239E 04	0.	0.
23	0.	0.30263E 04	0.	0.	0.44366E 04	0.24239E 04	0.	0.
24	0.	0.26581E 04	0.	0.	0.44366E 04	0.24239E 04	0.	0.

DAILY SUMMARY

0.44083E 04	0.58274E 05	0.	0.47134E 03	0.10238E 06	0.59166E 05	0.21205E 05	0.37034E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLOD
1	0.	0.	0.	0.	0.	0.71799E 02	0.
2	0.	0.	0.	0.	0.	0.71006E 02	0.
3	0.	0.	0.	0.	0.	0.70251E 02	0.
4	0.	0.	0.	0.	0.	0.69916E 02	0.
5	0.73560E 00	0.29500E 01	0.55915E 01	0.52488E 00	0.52488E 00	0.69839E 02	0.
6	0.11429E 02	0.29064E 02	0.70719E 02	0.11356E 02	0.11356E 02	0.69882E 02	0.
7	0.26425E 01	0.39468E 01	0.16840E 02	0.18603E 01	0.18603E 01	0.70984E 02	0.
8	0.33307E 01	0.24222E 01	0.17768E 02	0.27537E 01	0.24222E 01	0.71270E 02	0.
9	0.31295E 02	0.37954E 02	0.11132E 03	0.53601E 02	0.37954E 02	0.71986E 02	0.
10	0.41940E 01	0.31677E 01	0.12874E 02	0.80850E 01	0.31677E 01	0.72685E 02	0.
11	0.44076E 01	0.33574E 01	0.83763E 01	0.96100E 01	0.33574E 01	0.73075E 02	0.
12	0.20924E 02	0.27894E 02	0.27894E 02	0.46632E 02	0.28410E 02	0.73728E 02	0.
13	0.43972E 01	0.33483E 01	0.33483E 01	0.95356E 01	0.87172E 01	0.74645E 02	0.
14	0.41736E 01	0.31498E 01	0.31498E 01	0.79439E 01	0.13150E 02	0.75059E 02	0.
15	0.38061E 01	0.28283E 01	0.28283E 01	0.55075E 01	0.16368E 02	0.75370E 02	0.
16	0.32890E 01	0.23875E 01	0.23875E 01	0.25387E 01	0.17796E 02	0.76557E 02	0.
17	0.25851E 01	0.40439E 01	0.18152E 01	0.18152E 01	0.16652E 02	0.76750E 02	0.
18	0.15464E 01	0.42281E 01	0.10372E 01	0.10372E 01	0.11321E 02	0.77073E 02	0.
19	0.55605E-01	0.22064E 00	0.45943E-01	0.45943E-01	0.40054E 00	0.77083E 02	0.
20	0.	0.	0.	0.	0.	0.76618E 02	0.
21	0.	0.	0.	0.	0.	0.76034E 02	0.
22	0.	0.	0.	0.	0.	0.74327E 02	0.
23	0.	0.	0.	0.	0.	0.73436E 02	0.
24	0.	0.	0.	0.	0.	0.72394E 02	0.

DAILY SUMMARY

0.98811E 02	0.13098E 03	0.28600E 03	0.16285E 03	0.17346E 03	0.73407E 02	0.

HOURLY SUMMARY FOR DAY 19 MONTH 7

	QHL	QHW	QC	QINCI	CONDL	XINF	TSH	QINCI
1	0.	0.12510E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
2	0.	0.45101E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
3	0.	0.45590E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
4	0.	0.45972E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
5	0.	0.46411E 03	0.	0.95212E-02	0.98143E 04	0.25278E 04	0.39556E 01	0.74184E-02
6	0.	0.46391E 03	0.	0.18719E 02	0.98143E 04	0.25278E 04	0.48529E 04	0.14532E 02
7	0.	0.98068E 03	0.30099E 03	0.71115E 02	0.98143E 04	0.25278E 04	0.67492E 04	0.57040E 02
8	0.	0.21045E 04	0.31338E 04	0.37130E 02	0.98143E 04	0.25278E 04	0.21672E 04	0.29293E 02
9	0.	0.30397E 04	0.53536E 04	0.15035E 03	0.98143E 04	0.25278E 04	0.68844E 04	0.11830E 03
10	0.	0.34572E 04	0.87818E 04	0.21576E 03	0.98143E 04	0.25278E 04	0.77168E 04	0.16866E 03
11	0.	0.29168E 04	0.10572E 05	0.20874E 03	0.98143E 04	0.25278E 04	0.65967E 04	0.16293E 03
12	0.	0.20530E 04	0.10203E 05	0.29253E 02	0.98143E 04	0.25278E 04	0.48845E 03	0.22827E 02
13	0.	0.17293E 04	0.11653E 05	0.73540E 02	0.98143E 04	0.25278E 04	0.22279E 04	0.57389E 02
14	0.	0.22687E 04	0.11764E 05	0.21329E 03	0.98143E 04	0.25278E 04	0.69790E 04	0.16666E 03
15	0.	0.14045E 04	0.13129E 05	0.19095E 03	0.98143E 04	0.25278E 04	0.70574E 04	0.14961E 03
16	0.	0.12935E 04	0.16728E 05	0.10156E 03	0.98143E 04	0.25278E 04	0.49430E 04	0.79874E 02
17	0.	0.11856E 04	0.15302E 05	0.68852E 02	0.98143E 04	0.25278E 04	0.46576E 04	0.54729E 02
18	0.	0.17794E 04	0.16389E 05	0.20651E 02	0.98143E 04	0.25278E 04	0.29791E 04	0.16921E 02
19	0.	0.28644E 04	0.14824E 05	0.15577E 01	0.98143E 04	0.25278E 04	0.44152E 03	0.12130E 01
20	0.	0.46077E 04	0.12298E 05	0.	0.98143E 04	0.25278E 04	0.	0.
21	0.	0.38886E 04	0.91117E 04	0.	0.98143E 04	0.25278E 04	0.	0.
22	0.	0.29185E 04	0.33718E 04	0.	0.98143E 04	0.25278E 04	0.	0.
23	0.	0.23971E 04	0.13922E 04	0.	0.98143E 04	0.25278E 04	0.	0.
24	0.	0.21055E 04	0.16367E 02	0.	0.98143E 04	0.25278E 04	0.	0.

DAILY SUMMARY

0.	0.46540E 05	0.16432E 06	0.14021E 04	0.23554E 06	0.60666E 05	0.64745E 05	0.11000E 04

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	RASLOD
1	0.	0.	0.	0.	0.	0.77103E 02	0.
2	0.	0.	0.	0.	0.	0.76604E 02	0.
3	0.	0.	0.	0.	0.	0.76133E 02	0.
4	0.	0.	0.	0.	0.	0.75766E 02	0.
5	0.72800E-02	0.31292E-01	0.57541E-01	0.49636E-02	0.49636E-02	0.75343E 02	0.
6	0.12707E 02	0.34893E 02	0.86663E 02	0.10961E 02	0.10961E 02	0.75363E 02	0.
7	0.23543E 02	0.40189E 02	0.13903E 03	0.22045E 02	0.22045E 02	0.77577E 02	0.
8	0.87008E 01	0.10329E 02	0.39069E 02	0.10467E 02	0.10329E 02	0.78077E 02	0.
9	0.30264E 02	0.37143E 02	0.11125E 03	0.51294E 02	0.37143E 02	0.78125E 02	0.
10	0.38844E 02	0.45421E 02	0.11466E 03	0.77607E 02	0.45421E 02	0.78198E 02	0.
11	0.36582E 02	0.46594E 02	0.77493E 02	0.80308E 02	0.46594E 02	0.78261E 02	0.
12	0.44198E 01	0.34866E 01	0.40268E 01	0.10179E 02	0.34866E 01	0.78275E 02	0.
13	0.12836E 02	0.16457E 02	0.16457E 02	0.28469E 02	0.25183E 02	0.78262E 02	0.
14	0.38170E 02	0.46040E 02	0.46040E 02	0.78431E 02	0.10523E 03	0.78293E 02	0.
15	0.36683E 02	0.40834E 02	0.40834E 02	0.63165E 02	0.13496E 03	0.78350E 02	0.
16	0.22868E 02	0.28188E 02	0.28188E 02	0.30950E 02	0.96991E 02	0.78638E 02	0.
17	0.19899E 02	0.32375E 02	0.22463E 02	0.22463E 02	0.10337E 03	0.78631E 02	0.
18	0.10054E 02	0.24665E 02	0.10734E 02	0.10734E 02	0.60294E 02	0.78634E 02	0.
19	0.10334E 01	0.39531E 01	0.83173E 00	0.83173E 00	0.76302E 01	0.78459E 02	0.
20	0.	0.	0.	0.	0.	0.78303E 02	0.
21	0.	0.	0.	0.	0.	0.78239E 02	0.
22	0.	0.	0.	0.	0.	0.78099E 02	0.
23	0.	0.	0.	0.	0.	0.78057E 02	0.
24	0.	0.	0.	0.	0.	0.77980E 02	0.

DAILY SUMMARY

0.29661E 03	0.41062E 03	0.73779E 03	0.49791E 03	0.70964E 03	0.77699E 02	0.

FOURLY SUMMARY FOR DAY 18 MONTH 8

	3HL	QHW	QC	QINCI	CONDL	XINF	TSH	QINC1
1	0.	0.12905E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
2	0.	0.46099E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
3	0.	0.46948E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
4	0.	0.47399E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
5	0.	0.47703E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
6	0.	0.48042E 03	0.	0.61541E 01	0.98143E 04	0.25278E 04	0.12014E 04	0.47889E 01
7	0.	0.10247E 04	0.	0.57539E 02	0.98143E 04	0.25278E 04	0.49137E 04	0.45467E 02
8	0.	0.21837E 04	0.	0.12509E 03	0.98143E 04	0.25278E 04	0.70209E 04	0.97861E 02
9	0.	0.31413E 04	0.	0.18235E 03	0.98143E 04	0.25278E 04	0.78238E 04	0.14253E 03
10	0.	0.35703E 04	0.28869E 04	0.24345E 03	0.98143E 04	0.25278E 04	0.79658E 04	0.18924E 03
11	0.	0.30098E 04	0.63450E 04	0.27527E 03	0.98143E 04	0.25278E 04	0.70818E 04	0.21375E 03
12	0.	0.21134E 04	0.10083E 05	0.24715E 03	0.98143E 04	0.25278E 04	0.65657E 04	0.19240E 03
13	0.	0.17775E 04	0.10352E 05	0.15231E 03	0.98143E 04	0.25278E 04	0.47739E 04	0.11881E 03
14	0.	0.23372E 04	0.93611E 04	0.13737E 03	0.98143E 04	0.25278E 04	0.48216E 04	0.10682E 03
15	0.	0.14414E 04	0.10803E 05	0.17534E 03	0.98143E 04	0.25278E 04	0.66157E 04	0.13679E 03
16	0.	0.13287E 04	0.12564E 05	0.79712E 02	0.98143E 04	0.25278E 04	0.38224E 04	0.62277E 02
17	0.	0.12173E 04	0.11156E 05	0.73037E 01	0.98143E 04	0.25278E 04	0.49835E 03	0.60210E 01
18	0.	0.18333E 04	0.10119E 05	0.13046E 01	0.98143E 04	0.25278E 04	0.27575E 03	0.10930E 01
19	0.	0.29570E 04	0.84363E 04	0.	0.98143E 04	0.25278E 04	0.	0.
20	0.	0.47639E 04	0.63024E 04	0.	0.98143E 04	0.25278E 04	0.	0.
21	0.	0.40178E 04	0.40662E 04	0.	0.98143E 04	0.25278E 04	0.	0.
22	0.	0.30129E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
23	0.	0.24729E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
24	0.	0.21755E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.

DAILY SUMMARY

0.	0.48031E 05	0.10247E 06	0.16928E 04	0.23554E 06	0.60666E 05	0.63381E 05	0.13178E 04

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	TEMP	HASLOD
1	0.	0.	0.	0.	0.	0.76171E 02	0.
2	0.	0.	0.	0.	0.	0.75644E 02	0.
3	0.	0.	0.	0.	0.	0.74826E 02	0.
4	0.	0.	0.	0.	0.	0.74393E 02	0.
5	0.	0.	0.	0.	0.	0.74100E 02	0.
6	0.28504E 01	0.74858E 01	0.24566E 02	0.33715E 01	0.33715E 01	0.73774E 02	0.
7	0.14532E 02	0.20067E 02	0.10590E 03	0.17418E 02	0.17418E 02	0.75267E 02	0.
8	0.23403E 02	0.28031E 02	0.14146E 03	0.44295E 02	0.28031E 02	0.76409E 02	0.
9	0.29364E 02	0.36210E 02	0.13868E 03	0.73066E 02	0.36210E 02	0.77624E 02	0.
10	0.34768E 02	0.40718E 02	0.12718E 03	0.10143E 03	0.40718E 02	0.78088E 02	0.
11	0.37502E 02	0.44321E 02	0.91845E 02	0.11783E 03	0.44321E 02	0.78160E 02	0.
12	0.35549E 02	0.47626E 02	0.50252E 02	0.10878E 03	0.47626E 02	0.78232E 02	0.
13	0.23399E 02	0.34040E 02	0.34040E 02	0.67771E 02	0.52609E 02	0.78240E 02	0.
14	0.21705E 02	0.31309E 02	0.31309E 02	0.59771E 02	0.67940E 02	0.78244E 02	0.
15	0.28380E 02	0.36984E 02	0.36984E 02	0.71797E 02	0.12417E 03	0.78258E 02	0.
16	0.15076E 02	0.20812E 02	0.20812E 02	0.30649E 02	0.78082E 02	0.78332E 02	0.
17	0.18257E 01	0.16659E 01	0.15897E 01	0.15897E 01	0.15958E 02	0.78278E 02	0.
18	0.78556E 00	0.19528E 01	0.67174E 00	0.67174E 00	0.82381E 01	0.78254E 02	0.
19	0.	0.	0.	0.	0.	0.78210E 02	0.
20	0.	0.	0.	0.	0.	0.78148E 02	0.
21	0.	0.	0.	0.	0.	0.78121E 02	0.
22	0.	0.	0.	0.	0.	0.77867E 02	0.
23	0.	0.	0.	0.	0.	0.77754E 02	0.
24	0.	0.	0.	0.	0.	0.77191E 02	0.

DAILY SUMMARY

0.26914E 03	0.35122E 03	0.80530E 03	0.69843E 03	0.56469E 03	0.77066E 02	0.

HOURLY SUMMARY FOR DAY 17 MONTH 9

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.	0.13314E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
2	0.	0.45502E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
3	0.	0.45890E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
4	0.	0.46185E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
5	0.	0.46438E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
6	0.	0.46769E 03	0.	0.	0.98143E 04	0.25278E 04	0.	0.
7	0.	0.10446E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
8	0.	0.22752E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
9	0.	0.32994E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
10	0.	0.37616E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
11	0.	0.31723E 04	0.	0.30369E 02	0.98143E 04	0.25278E 04	0.57471E 03	0.23373E 02
12	0.	0.22239E 04	0.	0.31403E 02	0.98143E 04	0.25278E 04	0.50822E 03	0.24167E 02
13	0.	0.18648E 04	0.	0.29991E 02	0.98143E 04	0.25278E 04	0.56252E 03	0.23083E 02
14	0.	0.24506E 04	0.	0.26237E 02	0.98143E 04	0.25278E 04	0.64043E 03	0.20200E 02
15	0.	0.15043E 04	0.	0.20427E 02	0.98143E 04	0.25278E 04	0.64391E 03	0.15737E 02
16	0.	0.13798E 04	0.38844E 04	0.13041E 02	0.98143E 04	0.25278E 04	0.55801E 03	0.10062E 02
17	0.	0.12616E 04	0.29733E 04	0.49312E 01	0.98143E 04	0.25278E 04	0.34972E 03	0.38199E 01
18	0.	0.19101E 04	0.34139E 04	0.	0.98143E 04	0.25278E 04	0.	0.
19	0.	0.30937E 04	0.11783E 04	0.	0.98143E 04	0.25278E 04	0.	0.
20	0.	0.49969E 04	0.30054E 04	0.	0.98143E 04	0.25278E 04	0.	0.
21	0.	0.42106E 04	0.30608E 04	0.	0.98143E 04	0.25278E 04	0.	0.
22	0.	0.31582E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
23	0.	0.25927E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.
24	0.	0.22796E 04	0.	0.	0.98143E 04	0.25278E 04	0.	0.

DAILY SUMMARY

0.	0.50119E 05	0.17516E 05	0.15640E 03	0.23554E 06	0.60666E 05	0.38375E 04	0.12044E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLOD
1	0.	0.	0.	0.	0.	0.76544E 02	0.
2	0.	0.	0.	0.	0.	0.76218E 02	0.
3	0.	0.	0.	0.	0.	0.75845E 02	0.
4	0.	0.	0.	0.	0.	0.75561E 02	0.
5	0.	0.	0.	0.	0.	0.75318E 02	0.
6	0.	0.	0.	0.	0.	0.74999E 02	0.
7	0.	0.	0.	0.	0.	0.76232E 02	0.
8	0.	0.	0.	0.	0.	0.76528E 02	0.
9	0.	0.	0.	0.	0.	0.76333E 02	0.
10	0.	0.	0.	0.	0.	0.75842E 02	0.
11	0.23432E 01	0.27721E 01	0.80363E 01	0.15712E 02	0.27721E 01	0.75796E 02	0.
12	0.24039E 01	0.28339E 01	0.28339E 01	0.16266E 02	0.32847E 01	0.76257E 02	0.
13	0.23208E 01	0.27494E 01	0.27494E 01	0.15510E 02	0.88635E 01	0.76762E 02	0.
14	0.20976E 01	0.25207E 01	0.25207E 01	0.13502E 02	0.13568E 02	0.77139E 02	0.
15	0.17426E 01	0.21503E 01	0.21503E 01	0.10403E 02	0.16645E 02	0.77402E 02	0.
16	0.12619E 01	0.16288E 01	0.16288E 01	0.64927E 01	0.17016E 02	0.78031E 02	0.
17	0.63312E 00	0.88326E 00	0.88326E 00	0.22999E 01	0.12136E 02	0.78052E 02	0.
18	0.	0.	0.	0.	0.	0.78075E 02	0.
19	0.	0.	0.	0.	0.	0.78066E 02	0.
20	0.	0.	0.	0.	0.	0.78039E 02	0.
21	0.	0.	0.	0.	0.	0.78041E 02	0.
22	0.	0.	0.	0.	0.	0.77159E 02	0.
23	0.	0.	0.	0.	0.	0.76709E 02	0.
24	0.	0.	0.	0.	0.	0.76104E 02	0.

DAILY SUMMARY

0.12803E 02	0.15538E 02	0.20803E 02	0.80186E 02	0.74285E 02	0.76710E 02	0.

HOURLY SUMMARY FOR DAY 27 MONTH 10

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.13615E 05	0.14409E 04	0.	0.	0.97951E 04	0.53510E 04	0.	0.
2	0.13839E 05	0.53157E 03	0.	0.	0.10023E 05	0.53480E 04	0.	0.
3	0.14260E 05	0.53193E 03	0.	0.	0.10277E 05	0.55152E 04	0.	0.
4	0.14684E 05	0.53230E 03	0.	0.	0.10534E 05	0.56825E 04	0.	0.
5	0.14837E 05	0.53242E 03	0.	0.	0.10689E 05	0.56804E 04	0.	0.
6	0.14953E 05	0.53252E 03	0.	0.	0.10807E 05	0.56787E 04	0.	0.
7	0.11393E 05	0.11391E 04	0.	0.32857E 01	0.12040E 05	0.57313E 04	0.25421E 03	0.24643E 01
8	0.11219E 05	0.24145E 04	0.	0.13236E 02	0.12007E 05	0.57324E 04	0.64638E 03	0.10014E 02
9	0.11939E 05	0.34720E 04	0.	0.21066E 02	0.11443E 05	0.55484E 04	0.73288E 03	0.15992E 02
10	0.12326E 05	0.39449E 04	0.	0.26686E 02	0.11014E 05	0.53697E 04	0.66665E 03	0.20291E 02
11	0.11518E 05	0.33344E 04	0.	0.69838E 02	0.11703E 05	0.50351E 04	0.18302E 04	0.53386E 02
12	0.10365E 05	0.23578E 04	0.	0.30512E 02	0.10234E 05	0.48783E 04	0.48830E 03	0.23221E 02
13	0.98101E 04	0.19915E 04	0.	0.28525E 02	0.10141E 05	0.45395E 04	0.55335E 03	0.21699E 02
14	0.91925E 04	0.26007E 04	0.	0.55841E 02	0.10948E 05	0.43751E 04	0.18133E 04	0.42632E 02
15	0.90099E 04	0.16250E 04	0.	0.39675E 02	0.10314E 05	0.45508E 04	0.15385E 04	0.30225E 02
16	0.69358E 04	0.15012E 04	0.	0.82762E 01	0.97606E 04	0.45812E 04	0.38875E 03	0.62401E 01
17	0.76290E 04	0.13799E 04	0.	0.	0.97300E 04	0.49170E 04	0.	0.
18	0.74535E 04	0.20504E 04	0.	0.	0.10281E 05	0.50932E 04	0.	0.
19	0.75803E 04	0.32741E 04	0.	0.	0.10410E 05	0.50913E 04	0.	0.
20	0.84522E 04	0.52424E 04	0.	0.	0.10469E 05	0.52518E 04	0.	0.
21	0.91373E 04	0.44300E 04	0.	0.	0.10818E 05	0.55887E 04	0.	0.
22	0.12737E 05	0.33356E 04	0.	0.	0.10265E 05	0.57093E 04	0.	0.
23	0.13138E 05	0.27464E 04	0.	0.	0.10672E 05	0.57047E 04	0.	0.
24	0.14750E 05	0.24175E 04	0.	0.	0.10874E 05	0.60278E 04	0.	0.

DAILY SUMMARY

0.27077E 06	0.53359E 05	0.	0.29694E 01	0.25525E 06	0.12698E 06	0.89125E 04	0.22616E 03

	DINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	HASLUD
1	0.	0.	0.	0.	0.	0.68870E 02	0.
2	0.	0.	0.	0.	0.	0.68853E 02	0.
3	0.	0.	0.	0.	0.	0.68817E 02	0.
4	0.	0.	0.	0.	0.	0.68782E 02	0.
5	0.	0.	0.	0.	0.	0.68770E 02	0.
6	0.	0.	0.	0.	0.	0.68761E 02	0.
7	0.12544E 00	0.33553E 00	0.64972E 01	0.27976E 01	0.33553E 00	0.69064E 02	0.
8	0.31645E 00	0.11023E 01	0.14676E 02	0.97183E 01	0.11023E 01	0.69071E 02	0.
9	0.38432E 00	0.15969E 01	0.14602E 02	0.14486E 02	0.15969E 01	0.69004E 02	0.
10	0.41485E 00	0.19274E 01	0.11293E 02	0.17760E 02	0.19274E 01	0.68978E 02	0.
11	0.40414E 01	0.10647E 02	0.18661E 02	0.43861E 02	0.10647E 02	0.69048E 02	0.
12	0.55560E 00	0.21467E 01	0.21467E 01	0.19948E 02	0.36595E 01	0.69143E 02	0.
13	0.46656E 00	0.20336E 01	0.20336E 01	0.18814E 02	0.90728E 01	0.69188E 02	0.
14	0.31351E 01	0.85475E 01	0.85475E 01	0.36003E 02	0.30458E 02	0.69240E 02	0.
15	0.22923E 01	0.61140E 01	0.61140E 01	0.26691E 02	0.32427E 02	0.69253E 02	0.
16	0.24407E 00	0.75024E 00	0.75024E 00	0.64561E 01	0.12110E 02	0.69429E 02	0.
17	0.	0.	0.	0.	0.	0.69366E 02	0.
18	0.	0.	0.	0.	0.	0.69383E 02	0.
19	0.	0.	0.	0.	0.	0.69372E 02	0.
20	0.	0.	0.	0.	0.	0.69298E 02	0.
21	0.	0.	0.	0.	0.	0.69241E 02	0.
22	0.	0.	0.	0.	0.	0.68937E 02	0.
23	0.	0.	0.	0.	0.	0.68911E 02	0.
24	0.	0.	0.	0.	0.	0.68774E 02	0.

DAILY SUMMARY

0.11976E 02	0.35202E 02	0.85320E 02	0.19653E 03	0.10334E 03	0.69065E 02	0.

HOURLY SUMMARY FOR DAY 16 MONTH 11

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINCI
1	0.70708E 04	0.15248E 04	0.	0.	0.52317E 04	0.33649E 04	0.	0.
2	0.83577E 04	0.52687E 03	0.	0.	0.60182E 04	0.38663E 04	0.	0.
3	0.90743E 04	0.52747E 03	0.	0.	0.65722E 04	0.40296E 04	0.	0.
4	0.97035E 04	0.52801E 03	0.	0.	0.70376E 04	0.41939E 04	0.	0.
5	0.10287E 05	0.52851E 03	0.	0.	0.74568E 04	0.43589E 04	0.	0.
6	0.11116E 05	0.52923E 03	0.	0.	0.79512E 04	0.46935E 04	0.	0.
7	0.75403E 04	0.11958E 04	0.	0.18858E 00	0.91031E 04	0.45733E 04	0.14979E 02	0.13979E 00
8	0.72570E 04	0.25965E 04	0.	0.10954E 02	0.92678E 04	0.44027E 04	0.54261E 03	0.82187E 01
9	0.77544E 04	0.37578E 04	0.	0.19444E 02	0.87040E 04	0.40486E 04	0.68246E 03	0.14669E 02
10	0.73176E 04	0.42764E 04	0.	0.25313E 02	0.79777E 04	0.33619E 04	0.63576E 03	0.19147E 02
11	0.66637E 04	0.36061E 04	0.	0.28628E 02	0.75319E 04	0.30246E 04	0.50727E 03	0.21680E 02
12	0.50423E 04	0.25331E 04	0.	0.29304E 02	0.72395E 04	0.25283E 04	0.47091E 03	0.22196E 02
13	0.36367E 04	0.21301E 04	0.	0.27314E 02	0.66223E 04	0.18550E 04	0.52853E 03	0.20675E 02
14	0.30030E 04	0.27993E 04	0.	0.22725E 02	0.62035E 04	0.16905E 04	0.57936E 03	0.17171E 02
15	0.21666E 04	0.17270E 04	0.	0.15559E 02	0.56456E 04	0.13559E 04	0.52401E 03	0.11743E 02
16	0.50024E 02	0.15903E 04	0.	0.55606E 01	0.59219E 04	0.14016E 04	0.26303E 03	0.41508E 01
17	0.	0.14553E 04	0.	0.	0.59219E 04	0.14016E 04	0.	0.
18	0.	0.21894E 04	0.	0.	0.59219E 04	0.14016E 04	0.	0.
19	0.	0.35340E 04	0.	0.	0.59219E 04	0.14016E 04	0.	0.
20	0.	0.56979E 04	0.	0.	0.59219E 04	0.14016E 04	0.	0.
21	0.54695E 03	0.48064E 04	0.	0.	0.53902E 04	0.24187E 04	0.	0.
22	0.41919E 04	0.36041E 04	0.	0.	0.48842E 04	0.25385E 04	0.	0.
23	0.51489E 04	0.29575E 04	0.	0.	0.55079E 04	0.28725E 04	0.	0.
24	0.62876E 04	0.25957E 04	0.	0.	0.55761E 04	0.28561E 04	0.	0.

DAILY SUMMARY

0.12222E 06	0.57218E 05	0.	0.18563E 03	0.15953E 06	0.69042E 05	0.47489E 04	0.13979E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	TEMP	BASL00
1	0.	0.	0.	0.	0.	0.69412E 02	0.
2	0.	0.	0.	0.	0.	0.69305E 02	0.
3	0.	0.	0.	0.	0.	0.69247E 02	0.
4	0.	0.	0.	0.	0.	0.69195E 02	0.
5	0.	0.	0.	0.	0.	0.69140E 02	0.
6	0.	0.	0.	0.	0.	0.69077E 02	0.
7	0.68454E-02	0.16156E-01	0.37890E 00	0.19239E 00	0.16156E-01	0.69383E 02	0.
8	0.24632E 00	0.79667E 00	0.12205E 02	0.91509E 01	0.79667E 00	0.69399E 02	0.
9	0.33244E 00	0.13167E 01	0.13482E 02	0.14850E 02	0.13167E 01	0.69356E 02	0.
10	0.36804E 00	0.16540E 01	0.10667E 02	0.18471E 02	0.16540E 01	0.69395E 02	0.
11	0.38320E 00	0.18400E 01	0.59813E 01	0.20451E 02	0.18400E 01	0.69449E 02	0.
12	0.38596E 00	0.18776E 01	0.18776E 01	0.20850E 02	0.32548E 01	0.69586E 02	0.
13	0.37753E 00	0.17666E 01	0.17666E 01	0.19670E 02	0.84547E 01	0.69702E 02	0.
14	0.35397E 00	0.15069E 01	0.15069E 01	0.16896E 02	0.12382E 02	0.69752E 02	0.
15	0.30014E 00	0.10875E 01	0.10875E 01	0.12358E 02	0.13616E 02	0.69822E 02	0.
16	0.15266E 00	0.43007E 00	0.43007E 00	0.50125E 01	0.80679E 01	0.70086E 02	0.
17	0.	0.	0.	0.	0.	0.70194E 02	0.
18	0.	0.	0.	0.	0.	0.70440E 02	0.
19	0.	0.	0.	0.	0.	0.70372E 02	0.
20	0.	0.	0.	0.	0.	0.70093E 02	0.
21	0.	0.	0.	0.	0.	0.69953E 02	0.
22	0.	0.	0.	0.	0.	0.69645E 02	0.
23	0.	0.	0.	0.	0.	0.69572E 02	0.
24	0.	0.	0.	0.	0.	0.69477E 02	0.

DAILY SUMMARY

0.29071E 01	0.12292E 02	0.49383E 02	0.13790E 03	0.51400E 02	0.69627E 02	0.

MONTHLY SUMMARY

	QHL	QHW	QC	QINC1	CONDL	XINF	TSR	QINC1
1	0.12793E 08	0.20505E 07	0.	0.20475E 05	0.11487E 08	0.50733E 07	0.58505E 06	0.15464E 05
2	0.88033E 07	0.18310E 07	0.	0.20142E 05	0.85805E 07	0.36931E 07	0.59802E 06	0.15320E 05
3	0.76408E 07	0.19831E 07	0.	0.31381E 05	0.83398E 07	0.35348E 07	0.10186E 07	0.24110E 05
4	0.36636E 07	0.18885E 07	0.12798E 06	0.33513E 05	0.59729E 07	0.22934E 07	0.11542E 07	0.26020E 05
5	0.88648E 06	0.18058E 07	0.64105E 06	0.38914E 05	0.49401E 07	0.16758E 07	0.14646E 07	0.30366E 05
6	0.69354E 05	0.15857E 07	0.32650E 07	0.33352E 05	0.61223E 07	0.17879E 07	0.14164E 07	0.26216E 05
7	0.	0.14427E 07	0.46026E 07	0.42185E 05	0.73018E 07	0.18806E 07	0.17622E 07	0.33099E 05
8	0.	0.14891E 07	0.29373E 07	0.38224E 05	0.73018E 07	0.18806E 07	0.14294E 07	0.29794E 05
9	0.30459E 06	0.15116E 07	0.16262E 07	0.31283E 05	0.65355E 07	0.19215E 07	0.10206E 07	0.24140E 05
10	0.25326E 07	0.16420E 07	0.65181E 04	0.36015E 05	0.49890E 07	0.21908E 07	0.11174E 07	0.27522E 05
11	0.50154E 07	0.17175E 07	0.	0.25082E 05	0.61265E 07	0.26991E 07	0.71147E 06	0.19007E 05
12	0.85465E 07	0.19021E 07	0.	0.22058E 05	0.85395E 07	0.37824E 07	0.59846E 06	0.16630E 05

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	HASLOD
1	0.64803E 03	0.19733E 04	0.59188E 04	0.15570E 05	0.57657E 04	0.68570E 02	0.
2	0.68164E 03	0.20623E 04	0.64279E 04	0.13557E 05	0.65896E 04	0.68914E 02	0.
3	0.23996E 04	0.40184E 04	0.12106E 05	0.17445E 05	0.11437E 05	0.69275E 02	0.
4	0.45733E 04	0.56248E 04	0.13101E 05	0.14549E 05	0.14175E 05	0.70587E 02	0.
5	0.70200E 04	0.82064E 04	0.17013E 05	0.13922E 05	0.17890E 05	0.73490E 02	0.
6	0.71089E 04	0.91517E 04	0.15789E 05	0.11105E 05	0.15539E 05	0.76419E 02	0.
7	0.86425E 04	0.10984E 05	0.20088E 05	0.14403E 05	0.19545E 05	0.77708E 02	0.
8	0.62237E 04	0.77566E 04	0.17168E 05	0.15213E 05	0.15668E 05	0.77046E 02	0.
9	0.32004E 04	0.46032E 04	0.11245E 05	0.15791E 05	0.12091E 05	0.75545E 02	0.
10	0.18959E 04	0.44014E 04	0.12404E 05	0.22365E 05	0.11828E 05	0.70637E 02	0.
11	0.79842E 03	0.25042E 04	0.75197E 04	0.18053E 05	0.68093E 04	0.85498E 02	0.
12	0.59738E 03	0.18970E 04	0.60947E 04	0.17192E 05	0.55148E 04	0.69054E 02	0.

YEARLY SUMMARY

THLOAD	TCLOAD	THOTWL	TINF	TTSR	TCONDL	CPEAK	HPEAK
0.50255256E 08	0.13206716E 08	0.20849662E 08	0.25155252E 08	0.12876440E 08	0.51525059E 08	0.25492889E 05	0.30651430E 05

DESIGN PARAMETERS

HEATING DESIGN LOAD	0.33000000E 05
COOLING DESIGN LOAD	0.25000000E 05
CAPACITY OF HEATING PLANT	0.36202144E 05
CAPACITY OF COOLING PLANT	0.28000000E 05
BLOWER CFM FOR COOLING SYSTEM	0.70000000E 03
BLOWER CFM FOR HEATING SYSTEM	0.19000000E 04
GAL./MIN. THROUGH EVAPORATOR	0.10555556E 02
RATED EFFECTIVENESS OF HEAT EXCHANGER	0.79000000E 00
WATER VELOCITY THROUGH HEAT EXCHANGER	0.13833000E 01
WATER TEMPERATURE RISE	0.50000000E 01
COIL FACE AREA	0.17500000E 01
PEAK DAILY COOLING LOAD	0.31433455E 06

INITIAL TEMPERATURES

CEILING SURFACES	TOP -	68.05	NORTH -	68.13	SOUTH -	68.12
WALL SURFACE - SOUTH KNEE		68.23				
- NORTH KNEE		68.22				
- NORTH WALL		67.64				
- EAST WALL		67.85				
- SOUTH WALL		67.86				
- WEST WALL		67.86				
- GARAGEWALL		67.69				
FLOOR SURFACE		68.72				
WALL - SOUTH KNEE		57.72				
- NORTH KNEE		57.60				
- NORTH WALL		56.06				
- EAST WALL		56.19				
- SOUTH WALL		56.32				
- WEST WALL		56.28				
- GARAGEWALL		55.96				
ATTIC WALL - TOP EAST		43.98				
- TOP WEST		44.15				
- S EAST		44.96				
- S WEST		45.13				
- N EAST		44.67				
- N WEST		45.04				
ATTIC AIR - TOP ATTIC		44.66				
- SOUTH ATTIC		46.66				
- NORTH ATTIC		46.66				
CEILING - TOP CEILING		56.64				
- SOUTH CEILING		57.67				
- NORTH CEILING		57.55				
ROOF - TOP SOUTH		43.69				
- SOUTH SLANT		56.02				
- SOUTH LOWER		44.66				
- TOP NORTH		43.69				
- NORTH SLANT		55.96				
- NORTH LOWER		44.66				
INTERNAL MASS		69.05				
SPACE		66.96				
SLAB		66.79				
CRUSHED ROCK		66.21				

DESMOD OUTPUT SUMMARY

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WELL WATER TEMPERATURE	40.000	41.000	43.000	44.000	50.000	57.000	66.000	64.000	61.000	59.000	53.000	47.000
FANCFM	FANCFM1	SIZE1	SIZE2	HEATD								
0.70000000E 03	0.19000000E 04	0.3202144E 05	0.28000000E 05	0.33000000E 05								
13206715.63	50255256.00	20849662.00	372531.46									
22.274	-285.916	0.	947.558	246.023								
21.303	111.136	0.	1587.922	-116.881								
21.280	2.521	0.	1452.479	-2.308								
21.280	0.225	0.	1449.327	-0.014								
162.00 274.00	0 0 0 0											
45889074.50	15242837.50	2230640.22	50540708.50	74.93								
-4135.594	1449.018	0.	7.500	749.070								
162.00 274.00	0 0 1 161											
45484222.50	15229978.50	2304293.78	43806656.50	53.13								
-4135.594	1449.018	0.	3.750	1658.241								
162.00 274.00	71 8 1 161											
45330938.00	15223955.88	2417657.97	27044014.50	32.00								
-4135.594	291.975	0.	1.875	2488.704								
162.00 274.00	95 15 1 161											
45239927.50	15220932.88	2464889.54	14336647.88	32.00								
-4135.594	-1183.623	0.938	0.938	3245.811								
162.00 274.00	110 14 1 161											
45282022.50	15222546.75	2445353.31	20896506.75	32.00								
-4135.594	-420.350	1.406	1.406	2807.698								
162.00 274.00	110 14 1 161											
45305699.50	15223312.00	2433454.16	24035378.75	32.00								
-4135.594	-56.778	1.641	1.641	2638.078								
162.00 274.00	95 15 1 161											
45318882.00	15223690.38	2426131.28	25569205.00	32.00								
-4135.594	120.197	1.641	1.758	2560.818								
162.00 274.00	95 15 1 161											
45311848.00	15223503.38	2430349.88	24806159.00	32.00								
-4135.594	32.312	1.641	1.699	2598.847								
162.00 274.00	95 15 1 161											
45309093.50	15223405.13	2431478.13	24420857.75	32.00								
-4135.594	-12.290	1.670	1.699	2618.517								
162.00 274.00	95 15 1 161											
45310711.00	15223453.75	2430635.41	24613415.00	32.00								
-4135.594	9.923	1.670	1.685	2608.770								
162.00 274.00	95 15 1 161											
45309781.50	15223429.00	2431195.94	24517067.50	32.00								
-4135.594	-1.153	1.677	1.677	2613.613								
162.00 274.00	95 15 1 161											
45310249.00	15223441.88	2430915.88	24565483.50	32.00								
-4135.594	4.412	1.677	1.681	2611.165								
162.00 274.00	95 15 1 161											
45310136.00	15223435.38	2430916.81	24541298.00	32.00								
-4135.594	1.594	1.677	1.679	2612.424								
162.00 274.00	95 15 1 161											
45309839.00	15223432.00	2431195.50	24529149.25	32.00								
-4135.594	0.257	1.677	1.678	2612.983								
162.00 274.00	95 15 1 161											

45391545.50	15224777.13	2365636.31	34778200.00	32.00
1.678 -1163.905	2.517	-686.850	3.725 247.114	2135.868
162.00 274.00 91 8 1 161				
45483631.00	15229859.63	2303757.13	43721589.00	58.65
2.517 -686.850	3.725	-217.061	4.283 0.	1636.079
162.00 274.00 71 8 1 161				
45541363.00	15232401.75	2273047.53	45367463.50	63.72
3.725 -217.061	4.283	-39.156	4.406 0.	1438.174
162.00 274.00 71 8 1 161				
45558518.50	15232940.25	2263710.09	45677138.00	64.53
4.283 -39.156	4.406	-2.192	4.413 0.	1451.210
162.00 274.00 71 7 1 161				
45559553.00	15232971.38	2263115.75	45691064.00	64.56
4.406 -2.192	4.413	-0.094	4.414 0.	1449.112
71.000				

ACES COMPONENT SIZES

THE LISTED COMPONENT SIZES ARE FOR THE FULL ACES

THE VOLUME OF THE ACES STORAGE TANK IS 3872.00 CUBIC FEET

THE AREA OF THE COLLECTOR/CONVECTOR ARRAY IS 90.00 SQUARE FEET

THE SIDE DIMENSION OF THE TANK IS 21.28 FEET

THE FRACTIONAL NUMBER OF PANELS NEEDED ARE 4.41

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SIMMOD OUTPUT SUMMARY

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ANNUAL ENERGY USAGE OF THE ACES

THE TOTAL HEATING LOAD EQUALS 50255245.50 BTUS

THE TOTAL HOT WATER LOAD EQUALS 20849667.00 BTUS

THE TOTAL COOLING LOAD EQUALS 13206715.63 BTUS

THE YEARLY BTUS SUPPLIED BY THE GAS SYSTEM ARE 0.

THE YEARLY BTUS SUPPLIED BY THE OIL SYSTEM ARE

0.

THE YEARLY BTUS SUPPLIED BY THE ELECTRIC SYSTEM ARE 24551665.25

THE TOTAL BACKUP ELECTRICITY NEEDED IN BTUS IS

0.

THE DAY THAT ICE WOULD PEAK IN THE TANK IS 71.00

THE HEAT PUMP SCALE FACTOR IS 1.05

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ECOMOD OUTPUT SUMMARY

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ECONOMIC ANALYSIS PARAMETERS

ANALYSIS PERIOD (YRS)	20.	MAINTENANCE RATE	1.0 %
CAPITAL REC FACTOR	0.064	INSURANCE RATE	0.4 %
REAL DISCOUNT RATE	2.5 %	PROPERTY TAX	2.5 %
SALVAGE VALUE PERCENT	10.0 %	INCOME TAX	30.0 %
RETURN ON INVESTED CAP REC FUNDS	3.0 %		
MORTGAGE INTEREST RATE	10.5 %		

ANNUAL COST SUMMARY-1978 INSTALLATION

SYSTEM TYPES BY SOURCE OF SPACE HEAT

| COST ITEM | ACES | ALL
ELEC | HEAT
PUMP | OIL | NAT
GAS |
|---|-------|-------------|--------------|---------|------------|
| EQUIPMENT | 1080. | 116. | 189. | 127. | 115. |
| HEAT PUMP | 275. | | | | |
| CONTROL PKG | 78. | | | | |
| E.T.M. | 38. | | | | |
| SOLAR FIXED | 107. | | | | |
| SOLAR COLLECT | 103. | | | | |
| STORAGE BIN | 478. | | | | |
| OPERATIONS | | | | | |
| MAINTENANCE | 67. | 17. | 28. | 19. | 17. |
| INSURANCE | 64. | 7. | 11. | 7. | 7. |
| FUEL | | | | | |
| NATURAL GAS | 0. | 0. | 0. | 0. | 481. |
| HEATING OIL | 0. | 0. | 0. | 289. | 0. |
| ELECTRICITY | 530. | 1351. | 1033. | 789. | 403. |
| ENERGY COST | 102. | 427. | 417. | 411. | 200. |
| ENERGY COST | 248. | 743. | 436. | 198. | 23. |
| TOTAL FUEL | 530. | 1351. | 1033. | 1078. | 884. |
| TAXES | | | | | |
| MORTGAGE DED | -317. | -34. | -55. | -37. | -34. |
| PROPERTY TAX | 275. | 30. | 48. | 32. | 29. |
| TAX CREDIT | 0. | | | | |
| TOTAL ANNUAL COST | 1700. | 1486. | 1254. | 1226. | 1018. |
| PRESENT VALUE OF- | | | | | |
| DELTA CAP & OP COSTS | | -16118. | -14799. | -15920. | -16140. |
| DELTA FUEL COSTS | | 12788. | 7845. | 8538. | 5509. |
| TOTAL NET BENEFITS | | -3330. | -6954. | -7381. | -10631. |
| BREAKEVEN POINT (YRS) | | 999. | 999. | 999. | 999. |
| PAYBACK PERIOD (YRS) | | 999. | 999. | 999. | 999. |
| THE INITIAL CAPITAL COST OF THE ACES WAS \$ | | | | | 15898.65 |

ECONOMIC ANALYSIS PARAMETERS

ANALYSIS PERIOD (YRS)	20.	MAINTENANCE RATE	1.0 %
CAPITAL REC FACTOR	0.064	INSURANCE RATE	0.4 %
REAL DISCOUNT RATE	2.5 %	PROPERTY TAX	2.5 %
SALVAGE VALUE PERCENT	10.0 %	INCOME TAX	30.0 %
RETURN ON INVESTED CAP REC FUNDS	3.0 %		
MORTGAGE INTEREST RATE	10.5 %		

ANNUAL COST SUMMARY-1980 INSTALLATION

SYSTEM TYPES BY SOURCE OF SPACE HEAT

| COST ITEM | ACES | ALL
ELEC | HEAT
PUMP | OIL | NAT
GAS |
|---|-------|-------------|--------------|---------|------------|
| EQUIPMENT | 617. | 111. | 180. | 121. | 109. |
| HEAT PUMP | 157. | | | | |
| CONTROL PKG | 45. | | | | |
| E.T.M. | 22. | | | | |
| SOLAR FIXED | 61. | | | | |
| SOLAR COLLECT | 59. | | | | |
| STORAGE BIN | 273. | | | | |
| OPERATIONS | | | | | |
| MAINTENANCE | 64. | 16. | 26. | 18. | 16. |
| INSURANCE | 36. | 7. | 11. | 7. | 6. |
| FUEL | | | | | |
| NATURAL GAS | 0. | 0. | 0. | 0. | 481. |
| HEATING OIL | 0. | 0. | 0. | 283. | 0. |
| ELECTRICITY | 509. | 1297. | 993. | 759. | 387. |
| ENERGY COST | 98. | 410. | 401. | 395. | 192. |
| ENERGY COST | 238. | 714. | 419. | 190. | 22. |
| TOTAL FUEL | 509. | 1297. | 993. | 1041. | 868. |
| TAXES | | | | | |
| MORTGAGE DED | -181. | -32. | -33. | -35. | -32. |
| PROPERTY TAX | 157. | 28. | 46. | 31. | 28. |
| TAX CREDIT | 0. | | | | |
| TOTAL ANNUAL COST | 1203. | 1427. | 1202. | 1182. | 996. |
| PRESENT VALUE OF- | | | | | |
| DELTA CAP & OP COSTS | | -8798. | -7543. | -8610. | -8819. |
| DELTA FUEL COSTS | | 12285. | 7536. | 8286. | 5588. |
| TOTAL NET BENEFITS | | 3486. | -7. | -524. | -3231. |
| BREAKEVEN POINT (YRS) | | 7. | 999. | 999. | 999. |
| PAYBACK PERIOD (YRS) | | 14. | 999. | 999. | 999. |
| THE INITIAL CAPITAL COST OF THE ACES WAS \$ | | | | 9539.19 | |

ECONOMIC ANALYSIS PARAMETERS

ANALYSIS PERIOD (YRS)	20.	MAINTENANCE RATE	1.0 %
CAPITAL REC FACTOR	0.064	INSURANCE RATE	0.4 %
REAL DISCOUNT RATE	2.5 %	PROPERTY TAX	2.5 %
SALVAGE VALUE PERCENT	10.0 %	INCOME TAX	30.0 %
RETURN ON INVESTED CAP REC FUNDS	3.0 %		
MORTGAGE INTEREST RATE	10.5 %		

ANNUAL COST SUMMARY-1982 INSTALLATION

SYSTEM TYPES BY SOURCE OF SPACE HEAT

| COST ITEM | ACES | ALL
ELEC | HEAT
PUMP | OIL | NAT
GAS |
|---|-------|-------------|--------------|---------|------------|
| EQUIPMENT | 470. | 105. | 171. | 115. | 104. |
| HEAT PUMP | 120. | | | | |
| CONTROL PKG | 34. | | | | |
| E.T.M. | 17. | | | | |
| SOLAR FIXED | 47. | | | | |
| SOLAR COLLECT | 45. | | | | |
| STORAGE BIN | 208. | | | | |
| OPERATIONS | | | | | |
| MAINTENANCE | 61. | 15. | 25. | 17. | 15. |
| INSURANCE | 28. | 6. | 10. | 7. | 6. |
| FUEL | | | | | |
| NATURAL GAS | 0. | 0. | 0. | 0. | 478. |
| HEATING OIL | 0. | 0. | 0. | 275. | 0. |
| ELECTRICITY | 488. | 1244. | 952. | 727. | 371. |
| ENERGY COST | 94. | 393. | 384. | 378. | 184. |
| ENERGY COST | 229. | 684. | 401. | 182. | 21. |
| TOTAL FUEL | 488. | 1244. | 952. | 1002. | 849. |
| TAXES | | | | | |
| MORTGAGE DED | -138. | -31. | -50. | -34. | -31. |
| PROPERTY TAX | 120. | 27. | 43. | 29. | 27. |
| TAX CREDIT | 0. | | | | |
| TOTAL ANNUAL COST | 1029. | 1367. | 1151. | 1137. | 970. |
| PRESENT VALUE OF- | | | | | |
| DELTA CAP & OP COSTS | | -6506. | -5312. | -6327. | -6526. |
| DELTA FUEL COSTS | | 11776. | 7224. | 8015. | 5619. |
| TOTAL NET BENEFITS | | 5270. | 1912. | 1688. | -908. |
| BREAKEVEN POINT(YRS) | | 3. | 8. | 11. | 999. |
| PAYBACK PERIOD (YRS) | | 10. | 14. | 16. | 999. |
| THE INITIAL CAPITAL COST OF THE ACES WAS \$ | | | | 7631.35 | |

ANNUAL ENERGY USE SUMMARY
(UNITS OF 1 MILLION BTU)

ENERGY FORM	SYSTEM TYPES BY SOURCE OF SPACE HEAT				
	ACES	ALL
ELEC	HEAT
PUMP	OIL	NAT
GAS
NATURAL GAS	0.	0.	0.	0.	105.63
HEATING OIL	0.	0.	0.	68.26	0.
ELECTRICITY	24.55	77.44	50.26	29.11	8.26
TOTAL ENERGY USE	24.55	77.44	50.26	97.37	113.89

MONTHLY ELECTRICAL DATA

	SYSTEM TYPES BY SOURCE OF SPACE HEAT				
	ACES	ALL
ELEC	HEAT
PUMP	OIL	NAT
GAS
PEAK HOUR ENERGY USE
IN KWH PER MONTH					
JAN	574.	1726.	1043.	382.	53.
FEB	397.	1165.	667.	328.	33.
MAR	343.	1005.	608.	343.	26.
APRIL	203.	590.	434.	333.	21.
MAY	122.	389.	367.	353.	66.
JUNE	122.	566.	566.	566.	317.
JULY	127.	666.	666.	666.	437.
AUG	114.	514.	514.	514.	279.
SEPT	107.	427.	421.	417.	169.
OCT	130.	386.	312.	265.	6.
NOV	235.	744.	476.	300.	18.
DEC	396.	1162.	669.	336.	33.
OFF-PEAK ENERGY USE
IN KWH PER MONTH					
JAN	868.	2624.	1634.	362.	90.
FEB	656.	1951.	984.	307.	65.
MAR	616.	1815.	917.	323.	59.
APRIL	354.	1055.	580.	280.	39.
MAY	162.	491.	359.	276.	35.
JUNE	102.	381.	369.	362.	146.
JULY	92.	403.	403.	403.	209.
AUG	86.	332.	332.	332.	131.
SEPT	98.	332.	287.	257.	62.
OCT	269.	838.	476.	246.	24.
NOV	383.	1229.	638.	260.	39.
DEC	635.	1849.	1004.	317.	63.

MAX PEAK DEMAND PER
MONTH IN KW

JAN	10.	10.	10.	10.	10.
FEB	10.	10.	10.	10.	10.
MAR	10.	10.	10.	10.	10.
APRL	10.	10.	10.	10.	10.
MAY	10.	10.	10.	10.	10.
JUNE	10.	10.	10.	10.	10.
JULY	10.	10.	10.	10.	10.
AUG	10.	10.	10.	10.	10.
SEPT	10.	10.	10.	10.	10.
OCT	10.	10.	10.	10.	10.
NOV	10.	10.	10.	10.	10.
DEC	10.	10.	10.	10.	10.

EXCESS OFF-PEAK DEMAND
PER MONTH IN KW

JAN	0.	0.	0.	0.	0.
FEB	0.	0.	0.	0.	0.
MAR	0.	0.	0.	0.	0.
APRL	0.	0.	0.	0.	0.
MAY	0.	0.	0.	0.	0.
JUNE	0.	0.	0.	0.	0.
JULY	0.	0.	0.	0.	0.
AUG	0.	0.	0.	0.	0.
SEPT	0.	0.	0.	0.	0.
OCT	0.	0.	0.	0.	0.
NOV	0.	0.	0.	0.	0.
DEC	0.	0.	0.	0.	0.

APPENDIX C

CACESS COMMERCIAL BUILDING

PROGRAM LISTING

This appendix gives a compiled listing of the CACESS program, a sample execution run, and the program output. The execution run is for the sizing of the commercial components. The simulation run can be executed by rerunning the listed program with the appropriate input flag. The economic evaluation run can be made by utilizing the ECOMOD subroutines found in the residential programs.

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1 C SIMULATION OF A COMMERCIAL ANNUAL CYCLE ENERGY SYSTEM (ACES)
2 C THIS PROGRAM IS DEVELOPED BY HONEYWELL ENERGY RESOURCES
3 C CENTER. THE PROGRAM IS DESIGNED TO FURNISH TWO TASKS,
4 C 1. SIZING THE COMPONENTS NECESSARY FOR AN ACES.
5 C THE GENERAL COMPONENTS IN A COMMERCIAL ACES ARE,
6 C A HOT STORAGE BIN FOR HEATING,
7 C A COLD STORAGE BIN FOR COOLING,
8 C A HEAT PUMP TO TRANSFER HEAT FROM COLD BIN TO HOT
9 C BIN,
10 C A SOLAR COLLECTOR FIELD (IN COLD CLIMATE
11 C REGION) TO ASSIST THE HEATING SEASON
12 C 2. SIMULATE A COMMERCIAL ACES USING ACTUAL WEATHER
13 C DATA AND LOAD PROFILE CALCULATED BY THE NBSLD SOFTWARE FOR
14 C ELEVEN ZONES, WHICH ARE
15 C ZONE 1 BASEMENT
16 C ZONE 2 1ST TO 5TH FLOORS, SOUTH SIDE
17 C ZONE 3 1ST TO 5TH FLOORS, WEST SIDE
18 C ZONE 4 1ST TO 5TH FLOORS, NORTH SIDE
19 C ZONE 5 1ST TO 5TH FLOORS, EAST SIDE
20 C ZONE 6 1ST TO 5TH FLOORS, CENTRAL
21 C ZONE 7 6TH FLOOR, SOUTH SIDE
22 C ZONE 8 6TH FLOOR, WEST SIDE
23 C ZONE 9 6TH FLOOR, NORTH SIDE
24 C ZONE 10 6TH FLOOR, EAST SIDE
25 C ZONE 11 6TH FLOOR, CENTRAL
26 C EACH FLOOR HAS THE GROSS FLOOR AREA OF 10,000 FT2.
27 C THE VARIABLE AIR VOLUME HVAC SYSTEM IS USED TO FURNISH THE
28 C BUILDING HEATING AND COOLING LOADS.
29 C COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
30 C 2 DT, CTHETA, NSTATE, TIME, TSTORC, TSTORN, AREA, INKDAY,
31 C 3 INDRKD, IYEAR, IMONTH, IDAY, INOUR, TAMB, BARP, IMOL
32 C 4 ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
33 C 5 ,UASTH,DEWP,IBUFLG,TCOVER
34 C COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
35 C 1 TZ(11),RH(11), QPFUSE, QMFUSE, QELEG
36 C COMMON /SIZING/ QCOS,QHDS,IMCONS,HDAY,MCOLL,ATOTAL,NROWS,LROW
37 C 1 ,NSERES,LCOLL,QCCONS,QCLCON
38 C REAL LCOLL, LROW
39 C REWIND 8
40 C CALL INPUT
41 C IF(A(12) .EQ. 2.) A(11) = 2.
42 C ISIZNG = IFIX(A(11))
43 C IRTYPE = IFIX(A(12))
44 C IF(A(98) .EQ. 1.) WRITE(9,1111)
45 C 1111 FORMAT(//41X,' THIS RUN IS FOR CONVENTIONAL SYSTEM')
46 C IF(A(98) .EQ. 1.) GOTO 1
47 C IF(IRTYPE .EQ. 1) WRITE(9,170)
48 C IF(IRTYPE .EQ. 2) WRITE(9,180)
49 C IF(IRTYPE .EQ. 2) GOTO 1
50 C IF(ISIZNG .EQ. 1) WRITE(9,190)
51 C IF(ISIZNG .EQ. 2) WRITE(9,195)
52 C 1 CONTINUE
53 C INDEX = IFIX(A(31))

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54      NPOINT = IFIX(A(32))
55      DELTAP = A(33)
56      IF(INDEX .GT. 0) WRITE(9,9970) INDEX
57 9970 FORMAT(//41X,'THE VARIABLE PARAMETER IN THIS RUN IS A(',
58      1      I3,')')
59      DO 9000 IIP = 1, NPOINT
60      IF(IIP .GT. 1) A(INDEX) = A(INDEX) + DELTAP
61      IF(INDEX .EQ. 0) GOTO 9987
62      WRITE(9,9985) IIP, INDEX, A(INDEX)
63 9985 FORMAT(1H1//2X,'RUN NO.',I2,', A( ,I3,') = ',E12.5)
64 9987 CONTINUE
65      HDAY = A(13)
66      NSTEP = IFIX(A(16))
67      TCOVER = A(22)
68      HBLENG = A(37)
69      HBHEIG = A(38)
70      HBAREA = 2.*HBLENG*HBLENG + 4.*HBLENG*HBHEIG
71      UASTH = A(71)*HBAREA
72      RMCSE = 62.4*HBLENG*HBLENG*HBHEIG
73      CHLENG = A(68)
74      CHHEIG = A(69)
75      CHAREA = 2.*CHLENG*CHLENG + 4.*CHLENG*CHHEIG
76      UASTC = A(71)*CHAREA
77      RMCSC = 62.4*CHLENG*CHLENG*CHHEIG
78      NROWS = IFIX(A(63))
79      LROW = A(64)
80      LCOLL = A(65)
81      HCOLL = A(66)
82      ICONV = IFIX(A(98))
83      NSERES=IFIX(A(15))
84      FUDGE = .5
85      FUDGE1 = .5
86      PERCNT = .1
87      ALLOW = A(23)/100.
88      ALLOW1 = .1
89      SERES = FLOAT(NSERES)
90      IF(IRTYPE .EQ. 2) GOTO 2
91      IF(ISIZNG .EQ. 2) GOTO 2
92      IF(A(98) .EQ. 1) GOTO 2
93      LROW = 3.
94      NROW = 1
95      SERES = 1.
96 2 CONTINUE
97      ATOTAL = LROW*HCOLL*FLOAT(NROWS)*SERES
98      AREA=ATOTAL*A(96)
99      FPACK = A(70)
100     QMFUSE = 143.6*RMCSC
101     IF(IRTYPE .EQ. 1) GOTO 3
102     CALL ACESIM
103     GOTO 5000
104 3 CONTINUE
105     IF(ISIZNG .EQ. 2) GOTO 5
106     CALL ACESIM

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107      IF (ICONV .EQ. 1) GOTO 4
108      CALL CSIZE(OCDS,OHDS,OHCONS,OCCONS,HDAY,OCLCON)
109      4 CONTINUE
110      GOTO 5000
111      5 CONTINUE
112      IF (ATOTAL .LE. 0.) GOTO 5000
113      C FIND COLLECTOR AREA USING NEWTON ITERATION METHOD
114      DO 300 II = 1,5
115      DO 20 N = 1, NSTEP
116      DO 10 M = 1,2
117      WRITE(9,9997)
118      9997 FORMAT(/2X,' ITERATION STEP      GRADIENT STEP')
119      WRITE(9,9999) N,M
120      CALL ACESIM
121      FPACK1 = OCFUSE/OMFUSE
122      C IF THE FIRST GUESS IS OUT OF THE BOUND CRITERIA
123      C      FPACK**2 .LT. FPACK1 .LT. SQRT(FPACK)
124      C THEN FIND THE NEW GUESS WITHIN THE BOUND
125      IF (FPACK1.GT.SQRT(FPACK) .OR. FPACK1.LT.FPACK**2) GOTO 100
126      IF (M .EQ. 2) GOTO 10
127      ERROR1 = FPACK1 - FPACK
128      C IF THE FIRST CONSTRAINT IS SATISFIED, GO TO THE BISECTION
129      C METHOD TO REFINE THE ACCURACY OF THE SOLUTION
130      IF (ABS(ERROR1) .LE. (FPACK*ALLD41)) GOTO 1000
131      ATOT = ATOTAL
132      ATOTAL = ATOT * (1.+PERCNT)
133      IF (ERROR1 .LT. 0.) ATOTAL = ATOT*(1.-PERCNT)
134      LROW = ATOTAL/(HCOLL*SERES*VROWS)
135      AREA = ATOTAL * A(96)
136      10 CONTINUE
137      FPACK1 = OCFUSE/OMFUSE
138      ERROR2 = FPACK1 - FPACK
139      SLOPE = (ERROR2-ERROR1)/(ATOTAL*PERCNT)
140      IF (ERROR1 .LT. 0.) SLOPE = -SLOPE
141      DELTA = -ERROR1/SLOPE
142      ATOTAL = ATOT + DELTA
143      LROW = ATOTAL/(HCOLL*SERES*VROWS)
144      AREA = ATOTAL * A(96)
145      WRITE(9,9998)
146      9998 FORMAT(/2X,'*****CONVERGENCE CHECK*****',
147      1      //2X,' FPACK      ERROR1      ERROR2
148      2      ' SLOPE      DELTA      ATOTAL')
149      WRITE(9,9999) FPACK,ERROR1,ERROR2,SLOPE,DELTA,ATOTAL
150      9999 FORMAT(V)
151      20 CONTINUE
152      WRITE(9,30) N
153      30 FORMAT(4X,' CONVERGENCE IS NOT FOUND AFTER',I3,
154      1      ' ITERATIONS FOR COLLECTOR AREA')
155      GOTO 1000
156      100 CONTINUE
157      C INITIAL GUESS FOR COLLECTOR AREA (WHEN NECESSARY) BY
158      C DOUBLING OR HALVING THE PREVIOUS AREA UNTIL IT COMES
159      C WITHIN THE CRITERIA

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160      C          FPACK**2 .LT. FPACK1 .LT. SORT(FPACK)
161      IF(FPACK1 .GT. FPACK*FPACK) GOTO 150
162      ATOTAL = ATOTAL * FUDGE
163      GOTO 200
164      150 CONTINUE
165      ATOTAL = ATOTAL/FUDGE
166      200 LROW = ATOTAL/(HCCLL*SERES*NROWS)
167      AREA = ATOTAL*A(96)
168      NSIGN = 1
169      IF(FPACK1 .LT. FPACK) NSIGN = -1
170      ISIGN = NSIGN + NSLAST
171      IF(II .NE. 1 .AND. ISIGN .EQ. 0) FUDGE1 = FUDGE1/2.
172      IF(II .NE. 1 .AND. ISIGN .EQ. 0) FUDGE = FUDGE + FUDGE1
173      NSLAST = NSIGN
174      300 CONTINUE
175      WRITE(9,9990)
176      9990 FORMAT(/2X,' WARNING, THE: CALCLATION DOES NOT CONVERGE !!!')
177      1000 CONTINUE
178      IF(ABS(ERROR1) .LE. (FPACK*ALLOW)) GOTO 5000
179      C ENTER THE BISECTION METHOD TO REFINE THE ACCURACY OF THE
180      C RESULT. THE EXACTNESS OF THE RESULT MAY NOT BE MEANINGFULL
181      C DUE TO THE NATURE OF THE SYSTEM
182      AT1 = ATOTAL
183      AT2 = ATOTAL*(1.-ALLOW)
184      IF(ERROR1 .GT. 0.) AT2 = ATOTAL * (1.+ALLOW)
185      DO 1030 I = 1, NSTEP
186      ATOTAL = (AT1+AT2)/2.
187      LROW = ATOTAL/(HCCLL*SERES*NROWS)
188      AREA = ATOTAL*A(96)
189      CALL ACESIM
190      FPACK1 = QCFUSE/QMFUSE
191      WRITE(9,9980) ATOTAL, FPACK1, I
192      9980 FORMAT(2X,' ATOTAL =',E12.5,' FPACK =',F6.3,' NSTEP =',I4)
193      ERROR = FPACK1 - FPACK
194      C IF THE SECOND CONSTRAINT IS SATISFIED, JUMP OUT OF THE
195      C LOOP AND STOP
196      IF(ABS(ERROR) .LE. (FPACK*ALLOW)) GOTO 5000
197      C TEST WHETHER F(ERROR1) AND F(ERROR) ARE OF OPPOSITE SIGNS.
198      C RESET VALUES ACCORDINGLY
199      IF(ERROR*ERROR1) 1010,1011,1012
200      1010 AT2 = ATOTAL
201      GOTO 1030
202      1012 AT1 = ATOTAL
203      ERROR1 = ERROR
204      1030 CONTINUE
205      WRITE(9,9915) NSTEP
206      9915 FORMAT(/2X,' DOES NOT CONVERGE AFTER',I4,' STEPS OF'
207      1 ' BISECTION ITERATION')
208      GOTO 5000
209      1011 WRITE(9,9916)
210      9916 FORMAT(' ERROR')
211      5000 CONTINUE
212      IF(ISIZNG .EQ. 1) GOTO 6000

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213      FPMAX = QCFUSE/QMFUSE
214      FPFINL = QMFUSE/QMFUSE
215      WRITE(9,220) FPMAX, CTIME, MCOAY, MONTHC, FPFINL
216      IF(ERTYPE .EQ. 2) GOTO 6000
217      NCOLL = IFIX(ATOTAL/(HCOLL*LCOLL))
218      WRITE(9,165) FPACK1, RMCSC, ATOTAL, NCOLL
219      WRITE(9,160) NROWS, LROW, NSERES
220      6000 CONTINUE
221      9000 CONTINUE
222      STOP
223      165 FORMAT(/2X, ' WITH THE PACKING FACTOR OF', F6.2, ' AND THE STORAGE'
224      1      ' CAPACITY OF', F10.1, ' BTUS/F', /2X, ' THE MINIMUM'
225      2      ' COLLECTOR AREA REQUIREMENT IS', F10.1, ' FT2, OR THE TOTAL'
226      3      ' OF', I5, ' COLLECTORS')
227      160 FORMAT(/2X, ' THE NUMBER OF COLLECTORS IS DIVIDED INTO',
228      1      ' I2, ' ROWS, EACH ROW HAS THE LENGTH OF', F10.1, ' FTS', /2X,
229      2      ' THE COLLECTORS ARE CONNECTED BY', I2, ' IN SERIES')
230      170 FORMAT(/41X, 'THIS RUN IS FOR COMPONENT SIZING')
231      180 FORMAT(/41X, 'THIS RUN IS FOR SYSTEM SIMULATION')
232      190 FORMAT(/41X, 'THIS IS THE FIRST RUN FOR COMPONENT SIZING'
233      1      ' , /41X, 'THE APPROPRIATE OUTPUT SHOULD BE USED IN'
234      2      ' , /41X, 'THE NEXT RUN FOR STORAGE AND COLLECTOR SIZING'
235      3      ' , /41X, ' A(I5), A(37), A(63), A(64), '
236      4      ' , /41X, ' A(65), A(66), A(67), A(68), A(69)')
237      195 FORMAT(/41X, 'THIS IS THE SECOND RUN FOR COMPONENT SIZING', /41X,
238      1      ' THE COLLECTOR AREA & CONFIGURATION ARE PREDICTED BELOW. ')
239      220 FORMAT(/2X, ' MAXIMUM ICE RATIO IS', F6.3, ' AT TIME'
240      1      ' , F6.3, ' ON DAY', I4, ' ( MONTH', I3, ' )', /2X,
241      2      ' THE FINAL ICE RATIO IN STORAGE IS', F6.3)
242      END

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EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .84 LINES/MINUTE 17199

THERE WERE 1 DIAGNOSTICS IN ABOVE COMPILATION
 29K WORDS WERE USED FOR THIS COMPILATION


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1      SUBROUTINE ACESIM
2      C THIS ROUTINE DIRECTS ALL THE COMPUTATION OF THE PROGRAM
3      C IT ALSO SAMPLES THE OUTPUT DATA ACCORDING TO THE USER REQUIREMENT
4      COMMON /CTRL/ A(183), NTABLE(20), K(50), XDOT(50), IHTYPE,
5      2      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, IWKDAY,
6      3      IWORKD, IYEAR, IMONTH, IDAY, IHOURL, TAMB, BARP, IHOL
7      4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
8      5      ,UASTH,DEWP,IBUFLG,TCOVER
9      COMMON /HVACS/ HA, HEXIT, HZ(11), JLS(11), QLL(11), NZONE,
10     1      TZ(11),RH(11), QFUSE, QMFUSE, DELEG
11     COMMON /FAN/ PCFMAX, TFMAX, OFMAC
12     COMMON /SIZING/ CCES,QHDS,QHCONS,HJAY,HCOLL,ATOTAL,NROWS,LROW
13     1      ,NSERES,LCOLL,QCCONS,QCLCON
14     DIMENSION NAMET(44),NAME(70),YEAR(1,44),AVERAG(52,44),
15     1      , ANNUAL(366,44)
16     COMMON /PLOTTR/ IYSYMB(5)
17     DIMENSION MONTH(12,44),DAY(24,70)
18     COMMON /SOLAR/ S(35)
19     COMMON /FLOW/ MDOOTCC, MDOOTCS
20     REAL MDOOTCC, MDOOTCS
21     DIMENSION AX(31), AXH(31), EXCL(31)
22     COMMON /WEATHR/ NAMERM,DB(24),DP(24),WB(24),WS(24),PB(24),
23     1      TC(24),TOC(24),WET(24),DRY(24),CALDH(24,11),
24     2      CALRH(24,11),GOLE(24,11),GOLL(24,11),JLIGHT,
25     3      QEQUIP,QROOFO,QPEOPL
26     LOGICAL SUMMER
27     REAL MONTH
28     CHARACTER NAME*6, NAMET*6, NAMERM*(9), IYSYMB*1
29     DATA NPRINT/70/,NSIZE/44/
30     DATA NAME/6H IDNC ,6H IDHC ,6H ITHE ,6HQDIRCT,6HQAVAIL,6HCOLCT,
31     1      6H QCR ,6H QH8 ,6H QDH ,6HQCBTOT,6HQHBTOT,6HQTAMB ,
32     2      6HBACKUP,6H QH1 ,6H QH2 ,6H QH3 ,6H QH4 ,
33     3      6H QH5 ,6H QH6 ,6H QH7 ,6H QH8 ,6H QH9 ,
34     4      6H QH10 ,6H QH11 ,6H QC1 ,6H QC2 ,6H QC3 ,
35     5      6H QC4 ,6H QC5 ,6H QC6 ,6H QC7 ,6H QC8 ,
36     6      6H QC9 ,6H QC10 ,6H QC11 ,6HQCOMPA,6HFPPOWER,
37     7      6H PUMPC,6HQHGA9 ,6HQHDIIL ,6HQELECT,6HQEACES,
38     8      6HQEHCON,6HQECCON,6H TZ1 ,6H TZ2 ,6H TZ3 ,
39     9      6H TZ4 ,6H TZ5 ,6H TZ6 ,6H TZ7 ,6H TZ8 ,
40     1      6H TZ9 ,6H TZ10 ,6H TZ11 ,6H TAMB ,6H TSC ,
41     2      6H TSH ,6H QFUSE,6H RH1 ,6H RH2 ,6H RH3 ,
42     3      6H RH4 ,6H RH5 ,6H RH6 ,6H RH7 ,6H RH8 ,
43     4      6H RH9 ,6H RH10 ,6H RH11 /
44     DIMENSION IPLOT(15)
45     DATA IPLOT/56,57,58,5,6,7,8,9,5,6,7,8,9/
46     DATA IYSYMB/1H.,1H0,1H+,1H-,1H*/
47     DATA X/50*0.0/,XDOT/50*0.0/,DAY/1520*0.0/,YEAR/44*0.0/
48     DATA MONTH/528*0.0/,DB/24*0.0/,WB/24*0.0/,TC/24*0.0/
49     DATA DP/24*0.0/,WS/24*0.0/,F/24*0.0/,CALDH/254*0.0/
50     DATA CALRH/264*0.0/,GOLS/264*0.0/,GOLL/264*0.0/
51     DATA QEQUIP/0.0/,QLIGHT/0.0/,QROOFO/0.0/,QPEOPL/0.0/
52     DATA TOC/24*0.0/,WET/24*0.0/,DRY/24*0.0/,A/183*0.0/
53     DATA ND/0.0/,TIME/0.0/,ITER/0.0/,IDAY/0.0/,IHOURL/24.0/,IMONTH/1.0/

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54      - NDAYS = IFIX(A(4))
55      ISTART = IFIX(A(7))
56      NDAY = ISTART - 1
57      IEND = IFIX(A(8))
58      IESCAP = 120*24*(IEND-ISTART + 1)
59      DT = A(9)
60      TIME = 0.0
61      TSAMPL = A(10)
62      IWRITE = IFIX(A(29))
63      CONV = A(98)
64      IF(CONV .EQ. 0.) GOTO 1112
65      IF(A(32) .LE. 1.) GOTO 1112
66      IWRITE = IWRITE + 1 + A(103)
67 1112 CONTINUE
68      IF(IWRITE .GT. 0) WRITE(9,1113) IWRITE
69 1113 FORMAT(//2X,'THE ENERGY CONSUMPTION IN THIS RUN IS WRITTEN ON'
70      1 ' THE FILE CODE NO.',I3)
71      IFCON = IFIX(A(30))
72      IF(IWRITE .EQ. 0) GOTO 2
73      BUILD = 1.
74      WRITE(IWRITE) BUILD
75      HTVOL = RMCSH/62.4
76      RN4 = A(24)
77      RN6 = A(25)
78      GLAZE = A(35)
79      IF(CONV .EQ. 0.) GOTO 1
80      AREA = 0.
81      ATOTAL = 0.
82      HTVOL = 0.
83      A(68) = 0.
84      A(69) = 0.
85      RN4 = 0.
86      RN6 = 0.
87      GLAZE = 0.
88      1 CONTINUE
89      WRITE(IWRITE) ATOTAL,HTVOL,A(68),A(68),A(69),RN6,RN4,GLAZE
90      DHEAT = A(142)
91      WRITE(IWRITE) DHEAT
92      2 CONTINUE
93      FHACUP = A(146)
94      IF(IRTYPE .EQ. 2) GOTO 5
95      IF(ISIZING .EQ. 2) GOTO 5
96      IF(ISTART .EQ. 1) GOTO 5
97      WRITE(9,3)
98      3 FORMAT(2X,' CHECK INPUT ARRAY',//2X,' TO USE THE SOFTWARE FOR'
99      1 ' COMPONENT SIZING (A(12) = 1.), THE WEATHER TAPE SHOULD',//
100      2 ' 2X,' BE POSITIONED AT THE FIRST DAY (A(7) = 1.)')
101      STOP
102      5 CONTINUE
103      NSTATE = 46
104      JPL0T = IFIX(A(56))
105      NAVG = IFIX(A(62))
106      C COLLECTOR LOOP FLOW RATE, ASSUMING NORMAL FLOW RATE OF 0.5

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107 C GPM PER COLLECTOR
108 MDUTCC = AREA*.5*60.*8.33333/(13.*A(96))
109 C STORAGE FLOW RATE, ASSUMING THAT IT IS EQUAL TO THE COLLECTOR
110 C FLOW RATE
111 MDOTCS = MDUTCC
112 IMUFLG = 0
113 PCFMAX = 0.
114 QHDS = 0.
115 QCDS = 0.
116 QFUSE = 0.
117 QCFUSE = 0.
118 QLIGHT = 0.
119 QEQUIP = 0.
120 QPEOPL = 0.
121 QWDOFO = 0.
122 QCHMAX = 0.
123 QHMAX = 0.
124 QXCLIT = 0.
125 DO 10 J = 1, (NSTATE-2)
126 YEAR(1,J) = 0.
127 DO 7 K = 1, 366
128 ANNUAL(K,J) = 0.
129 7 CONTINUE
130 DO 10 I = 1, 12
131 MONTH(I,J) = 0.
132 10 CONTINUE
133 DO 20 I = 1, NSTATE
134 X(I) = 0.
135 XOUT(I) = 0.
136 20 CONTINUE
137 X(NSTATE-1) = A(27)
138 X(NSTATE) = A(28)
139 TSTORC = X(NSTATE-1)
140 TSTORH = X(NSTATE)
141 IF (TSAMPL .GT. 1.E-06) NSAMPL = 24/TSAMPL + 0.5
142 TPAST1 = DT
143 TPAST2 = DT
144 C INITIALIZE COLLECTOR PARAMETERS
145 CALL COLECT(0.0,0.0,0.0,0.0)
146 C INITIALIZE SUN ARRAY
147 S(1) = A(1)
148 S(2) = A(2)
149 S(3) = A(3)
150 S(4) = A(7) - 1.0
151 S(5) = 24.0
152 S(8) = A(17)
153 NZONE = IFIX(A(84))
154 C POSITION TAPE FOR START OF WEATHER DATA
155 NYRS=IFIX(A(135))
156 NSTARS = IFIX(A(143))
157 NEWDS = IFIX(A(144))
158 IF (NYRS .LT. 1) GO TO 713
159 DO 708 N = 1, NYRS

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160      READ (8) (IDUM,I=1,3),(DUM,I=1,216)
161      DO 708 J = 1,NZONE
162      READ(8) NAMERM,(DUM,K=1,192)
163      708 CONTINUE
164      713 CONTINUE
165      INIT=ISTART-1
166      IF(INIT .EQ. 0) GO TO 750
167      DO 715 N = 1,INIT
168      READ (8) (IDUM,I=1,3),(DUM,I=1,216)
169      DO 715 J = 1,NZONE
170      READ(8) NAMERM,(DUM,K=1,192)
171      715 CONTINUE
172      750 CONTINUE
173      SUMMER = S(4) .GE. NSTARS .AND. S(4) .LT. NENDS
174      IDPST = IDAY
175      IWDPT = IWKDAY
176      IMPST = IMONTH
177      IHPST = IHOL
178      C INTEGRATE OVER TIME STEP DT
179      CALL STEP
180      C FIND THE MAXIMUM HOURLY HEATING LOAD AND THE MAXIMUM
181      C HOURLY COOLING LOAD
182      IF(XDOT(7) .GT. QCHMAX) GOTO 792
183      QCHMAX = XDOT(7)
184      792 IF(XDOT(8) .LT. QHHMAX) GOTO 794
185      QHHMAX = XDOT(8)
186      794 CONTINUE
187      IF(IWRITE .EQ. 0) GOTO 755
188      IF(TIME .GT. 0.) WRITE(IWRITE) XDOT(39), XDOT(40), XDOT(41)
189      1 , XDOT(42), XDOT(43), XDOT(44), IWKDAY, IHOL
190      755 CONTINUE
191      C SAMPLE OUTPUT AT EACH SAMPLE TIME
192      IF(TSAMPL .LT. 1.E-06) GO TO 800
193      760 IF((TIME - TPAST1) .LT. (TSAMPL - 0.0001)) GO TO 800
194      FACTOR = TSAMPL/(TIME - TPAST1)
195      IF(ND .EQ. 0) FACTOR = 1.0
196      IF(ABS(FACTOR-1.) .LT. .001) FACTOR = 1.0
197      TPAST1 = TPAST1 + TSAMPL
198      NDP1 = ND + 1
199      IF(NDP1 .GT. NSAMPL) NDP1 = 1
200      DO 770 K=1,NSIZE
201      DAY(NDP1,K) = DAY(ND,K) + (XDOT(K) - DAY(ND,K))*FACTOR
202      IF(K .EQ. 6 .AND. ISIZNG .EQ. 1) DAY(NDP1,K) = 0.
203      IF(K .EQ. 7) DAY(NDP1,K) = -DAY(NDP1,K)
204      770 CONTINUE
205      DO 780 K = 1,NZONE
206      780 DAY(NDP1,NSIZE+K) = DAY(ND,NSIZE+K)+(TZ(K)-DAY(ND,NSIZE+K))*FACTOR
207      K = NZONE+NSIZE
208      DAY(NDP1,K+1) = DAY(ND,K+1) + (TAMB - DAY(ND,K+1))*FACTOR
209      DAY(NDP1,K+2) = DAY(ND,K+2) + (TSTORC - DAY(ND,K+2))*FACTOR
210      DAY(NDP1,K+3) = DAY(ND,K+3) + (TSTORH - DAY(ND,K+3))*FACTOR
211      DAY(NDP1,K+4) = DAY(ND,K+4) + (DFJSE - DAY(ND,K+4))*FACTOR
212      K = K+5

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213      KEND = K+NZONE-1
214      DO 790 I = K,KEND
215      790 DAY(NDP1,I) = DAY(ND,I) + (RH(1-K+1)-DAY(ND,I))*FACTOR
216      ND = NDP1
217      800 CONTINUE
218      C AT THE END OF EACH DAY RECORD ENERGY FOR YEAREND SUMMARY
219      IF((TIME - TPAST2) .LT. (24.0-.0001) ) GOTO 910
220      TPAST2 = TIME
221      NDAY = NDAY + 1
222      C SEARCH FOR N CONSECUTIVE COLDEST DAYS OF THE YEAR AND
223      C CALCULATE THE NET HEATING LOAD FOR THOSE DAYS
224      C ALSO, SEARCH FOR N CONSECUTIVE HOTTEST DAYS OF THE YEAR AND
225      C CALCULATE THE TOTAL COOLING LOAD FOR THOSE DAYS
226      IF(IRTYPE .EQ. 2) GOTO 819
227      IF(ISIZNG .EQ. 2) GOTO 819
228      XH = X(8)
229      XC = X(7)
230      XCL = X(6)
231      IIDAY = HDAY
232      IF(NDAY .GT. IIDAY) GOTO 810
233      AXH(NDAY) = XH
234      AXCL(NDAY) = XC
235      AXCL(NDAY) = XCL
236      QXHTOT = QXHTOT + XH
237      QXCTOT = QXCTOT + XC
238      QXCLTT = QXCLTT + XCL
239      GOTO 812
240      810 CONTINUE
241      AXH(IIDAY + 1) = XH
242      AXCL(IIDAY + 1) = XC
243      AXCL(IIDAY + 1) = XCL
244      QXHTOT = QXHTOT + XH - AXH(1)
245      QXCTOT = QXCTOT + XC - AXCL(1)
246      QXCLTT = QXCLTT + XCL - AXCL(1)
247      DO 811 I = 1,IIDAY
248      AXH(I) = AXH(I + 1)
249      AXCL(I) = AXCL(I + 1)
250      AXCL(I) = AXCL(I + 1)
251      811 CONTINUE
252      812 IF(QXHTOT .LE. QHCONS) GOTO 814
253      QHCONS = QXHTOT
254      QCCONS = QXCTOT
255      QCLCON = QXCLTT
256      814 CONTINUE
257      IF((-QXCTOT) .LT. QCDS) GOTO 815
258      QCDS = -QXCTOT
259      815 CONTINUE
260      IF(X(8) .LE. QHDS) GOTO 819
261      QHDS = X(8)
262      819 DO 820 I = 1,NSIZE
263      IF(ISIZNG .EQ. 1 .AND. I .EQ. 6) X(I) = 0.
264      NAME(I)=NAME(I)
265      YEAR(1,I) = YEAR(1,I) + X(I)

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266      MONTH(MONTH,I) = MONTH(MONTH,I) + X(I)
267      ANNUAL(MDAY,I) = ANNUAL(MDAY,I) + X(I)
268      IF(ISIZNG .EQ. 2 .AND. QCFUSE .GE. QMFUSE) GOTO 970
269      820 X(I) = 0.
270      C AT THE END OF SELECTED DAYS OUTPUT TABLES AND PLOTS
271      IF(TSAMPL .LT. 1.E-06) GO TO 910
272      DO 930 I = 1,20
273      NOUT = NTABLE(I)
274      IF(MDAY .NE. NOUT) GO TO 900
275      WRITE(9,2000) MDAY, IOPAST, IMPAST
276      IF(INDPST .EQ. 1) WRITE(9,2001)
277      IF(INDPST .EQ. 2) WRITE(9,2002)
278      IF(INDPST .EQ. 3) WRITE(9,2003)
279      IF(INDPST .EQ. 4) WRITE(9,2004)
280      IF(INDPST .EQ. 5) WRITE(9,2005)
281      IF(INDPST .EQ. 6) WRITE(9,2006)
282      IF(INDPST .EQ. 7) WRITE(9,2007)
283      IF(IHPAST .EQ. 1) WRITE(9,2008)
284      CALL CROUTPUT(DAY,1,NSAMPL,NPRINT,NAME)
285      XDELT = TSAMPL
286      XMIN = XDELT
287      YMIN = A(57)
288      YMAX = A(58)
289      IF(JPLOT .EQ. 1) WRITE(9,2200)
290      IF(JPLOT .EQ. 1) CALL LPLOT(09,1,3,NSAMPL,24,61,XDELT,DAY,XMIN,
291      1 YMIN,YMAX,NAME,61,IPLOT,13)
292      YMIN = 0.
293      YMAX = A(59)
294      IF(JPLOT .EQ. 1) WRITE(9,2300)
295      IF(JPLOT .EQ. 1) CALL LPLOT(09,4,5,NSAMPL,24,61,XDELT,DAY,XMIN,
296      1 YMIN,YMAX,NAME,61,IPLOT,13)
297      900 CONTINUE
298      910 ITER = ITER + 1
299      IF(ITER .GT. IESCAP) GO TO 920
300      IF(S(4)-FLOAT(IEND)) 750,750,920
301      920 CONTINUE
302      CALL CROUTPUT(MONTH,1,12,NSIZE,NAMET)
303      CALL CROUTPUT (YEAR,1,1,NSIZE,NAMET)
304      IF(NAVG .EQ. 0) GOTO 970
305      DO 940 NW = 1,52
306      DO 940 I = 1,NSIZE
307      DUMMY = 0.
308      DO 930 ND = 1,NAVG
309      N = (NW-1)*7 + 3 - NAVG/2 + ND
310      IF(N .LE. 0) N = N + NDAYS
311      IF(N .GT. NDAYS) N = N - NDAYS
312      930 DUMMY = DUMMY + ANNUAL(N,I)
313      AVERAG(NW,I) = DUMMY/NAVG
314      IF(I .EQ. 7) AVERAG(NW,I) = -AVERAG(NW,I)
315      IF(I .EQ. 10) AVERAG(NW,I) = -AVERAG(NW,I)
316      940 CONTINUE
317      IF(ISIZNG .EQ. 1) GOTO 960
318      YMIN = 0.

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319      YMAX = 0.
320      DO 950 NW = 1,52
321      IF(AVERAG(NW,5) .LT. YMAX) GOTO 950
322      YMAX = AVERAG(NW,5)*1.1
323 950 CONTINUE
324      IF(JPLOT .EQ. 1) WRITE(9,2400) NAVG
325      XMIN = 1.
326      XDELT = 1.
327      IF(JPLOT .EQ. 1) CALL LPLOT(09,9,2,52,52,35,XDELT,AVERAG,XMIN,
328      1      YMIN,YMAX,NAME,35,JPLOT,13)
329 960 CONTINUE
330      IF(JPLOT .EQ. 1) WRITE(9,2400) NAVG
331      XMIN = 1.
332      XDELT = 1.
333      YMIN = 0.
334      YMAX = A(60)
335      IF(JPLOT .EQ. 1) CALL LPLOT(09,11,3,52,52,35,XDELT,AVERAG,XMIN,
336      1      YMIN,YMAX,NAME,35,JPLOT,13)
337 970 CONTINUE
338      IF(ISIZNG .EQ. 2) WRITE(9,7000) TSTORH,ISTORC
339      WRITE(9,8000) DELIGHT,GENJIP,SPEEDPL
340      WRITE(9,8100) PCFMAX,TFMAX,DFMAX
341      IF(ISIZNG .EQ. 1) GOTO 980
342      IF(MDOTCC .GT. 0.) WRITE(9,8200) MDOTCC
343 980 CONTINUE
344      WRITE(9,8300) QCHMAX,QFHMAY
345      REWIND R
346      IF(IWRITE .EQ. 0) GOTO 990
347      BUFLAG = FHACUP*IRUFLG
348      WRITE(IWRITE) BUFLAG
349      IF(BUFLAG .EQ. 0.) WRITE(9,9900)
350      IF(BUFLAG .EQ. 1.) WRITE(9,9910)
351 990 CONTINUE
352      IF(IWRITE .EQ. 0) GOTO 999
353      REWIND IWRITE
354 999 IF(IECON .EQ. 1) CALL ECONDM
355      RETURN
356 2000 FORMAT(1H1,41X,22H DAILY SUMMARY FOR DAY,I4,2H (.12,4H OF I2,1H))
357 2001 FORMAT(//41X,' THE SAMPLED DAY IS SUNDAY')
358 2002 FORMAT(//41X,' THE SAMPLED DAY IS MONDAY')
359 2003 FORMAT(//41X,' THE SAMPLED DAY IS TUESDAY')
360 2004 FORMAT(//41X,' THE SAMPLED DAY IS WENESDAY')
361 2005 FORMAT(//41X,' THE SAMPLED DAY IS THURSDAY')
362 2006 FORMAT(//41X,' THE SAMPLED DAY IS FRIDAY')
363 2007 FORMAT(//41X,' THE SAMPLED DAY IS SATURDAY')
364 2008 FORMAT(//41X,' IT IS ALSO A HOLIDAY')
365 2200 FORMAT(1H1,40X,38HTEMPERATURE PLOTS (FAHRENHEIT DEGREES)/)
366 2300 FORMAT(1H1,45X,25H ENERGY PLOTS (BTUS/HOUR)/)
367 2400 FORMAT(1H1,32X,15HENERGY PLOTS OF,I3,
368      1      24H DAY AVERAGES (BTUS/DAY))
369 3000 FORMAT(1H1,//2X,'FINAL TEMP. IN HOT STORAGE BIN IS',F6.1,'DEG F',
370      1      /2X,'FINAL TEMP. IN COLD STORAGE BIN IS',F6.1,'DEG F')
371 3000 FORMAT(' YEARLY INTERNAL LOAD GENERATED BY LIGHTS =',E12.5,/,

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372      1      35X,'EQUIPMENT =',E12.5,/,35X,'PEOPLE =',E12.5)
373      8100 FORMAT(/2X,' THE MAXIMUM FAN FLOW RATIO IS',F6.3,' AT TIME',
374      1      F6.2,' ON DAY',F5.0)
375      8200 FORMAT(/2X,' THE COLLECTOR AND STORAGE LOOP THERMAL FLOW RATE'
376      1      ' IS',E12.5,' BTUS/HR F')
377      8300 FORMAT(/2X,' THE MAXIMUM COOLING LOAD IS',E12.5,' BTUS/HR',
378      1      '/2X,' THE MAXIMUM HEATING LOAD IS',E12.5,' BTUS/HR')
379      9900 FORMAT(///41X,' THIS SYSTEM DOES NOT USE BACK-UP HEATING')
380      9910 FORMAT(///41X,' THIS SYSTEM USES BACK-UP HEATING')
381      END
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EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) 1.74 LINES/MINUTE 13100

THERE WERE 1 DIAGNOSTICS IN ABOVE COMPILATION
32K WORDS WERE USED FOR THIS COMPILATION


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1      C
2      SUBROUTINE LP PLOT(IW, ISTART, NPLOTS, NPOINT, NPSM, NRM, XDEL1, RP, XMIN,
3      1      YMIN, YMAX, NAME, NDIM, IPLCT, IMAX)
4      DIMENSION YY(52, 5), YSCALE(11), RP(NPSM, NRM), NAME(NDIM),
5      1      TPLOT(IMAX)
6      DIMENSION ITITLE(5), IBUF(120), IXBUFFA(5), IXBUFFB(10)
7      COMMON /PLOTTR/ IYSYMB(5)
8      CHARACTER NAME*6
9      CHARACTER ITITLE*6
10     CHARACTER IYSYMB*1
11     CHARACTER IBUF*1
12     CHARACTER IBLANK*1
13     CHARACTER IMINUS*1
14     CHARACTER II*1
15     IBLANK = 1H
16     IMINUS = 1H-
17     II = 1HI
18     JJ = ISTART - 1
19     DO 132 J = 1, NPLOTS
20     JJ = JJ + 1
21     JCURVE = IPLOT(JJ)
22     ITITLE(J) = NAME(JCURVE)
23     DO 132 I = 1, NPOINT
24     YY(I, J) = RP(I, JCURVE)
25     IF(YY(I, J) .GT. YMAX) YY(I, J) = YMAX
26     IF(YY(I, J) .LT. YMIN) YY(I, J) = YMIN
27   132 CONTINUE
28     YDEL10 = (YMAX - YMIN)/10
29     XDEL5 = 5.0 * XDEL1
30     YMAX = YMIN + 10.0 * YDEL10
31     WRITE(IW, 600) (ITITLE(J), IYSYMB(J)), J = 1, NPLOTS)
32   600 FORMAT(/19X, 5(A6, 11H SYMBOL = , A1, 3X))
33     DO 680 J = 1, 11
34     YSCALE(J) = YMIN + YDEL10 * FLJAT(J-1)
35     WRITE(IW, 700) YSCALE
36   700 FORMAT(/2X, 11(F10.1))
37     DO 730 J = 1, 10
38     IBUF(J) = IBLANK
39     DO 740 J = 112, 120
40     IBUF(J) = IBLANK
41     DO 750 J = 12, 110
42     IBUF(J) = IMINUS
43     DO 770 J = 11, 111, 10
44     IBUF(J) = II
45     WRITE(IW, 790) IBUF
46   790 FORMAT(2(60A1))
47   820 CONTINUE
48     ILINE = 0
49     IXPRT = 1
50     XSCALE = XMIN
51   890 ILINE = ILINE + 1
52     DO 910 J = 1, 120
53   910 IBUF(J) = IBLANK

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54      IBUF(111)=II
55      DO 1120 J = 1,NPLOTS
56      YQ = YY(ILINE,J)
57      YDIFF = YMAX - YMIN
58      IF(YDIFF.EQ.0.0) YDIFF = 1.00
59      YRAT = 100.0*(YQ - YMIN) / YDIFF
60      IF(YRAT.LT.0.) YRAT=0.
61      IF(YRAT.GT.100.) YRAT=100.
62      IYQ = 11 + IFIX (YRAT + 0.5)
63      IBUF(IYQ) = IYSYMR(J)
64      1120 CONTINUE
65      IBUF (11) = II
66      IF (ILINE .LT. IXPRNT) GO TO 63
67      IF(NPOINT .NE. 52) GO TO 61
68      C
69      C      TIME AXIS FOR ANNUAL PLOTS
70      C
71      IWK = XSCALE
72      WRITE(IW,59) IWK, (IBUF(ISON),ISON=10,120)
73      59 FORMAT(6H WEEK,I3,60A1,51A1)
74      GO TO 62
75      C
76      C      TIME AXIS FOR DAILY PLOTS
77      C
78      61 IHOJR = XSCALE
79      IMIN = IFIX(60*(XSCALE-FLOAT(IHOJR)))
80      IF(IMIN .GE. 10)
81      1 WRITE(IW,66) IHOJR, IMIN, (IBUF(ISON),ISON=10,120)
82      IF(IMIN .LT. 10)
83      1 WRITE(IW,67) IHOJR, IMIN, (IBUF(ISON),ISON=10,120)
84      66 FORMAT(4X,I2,1H ,I2,60A1,51A1)
85      67 FORMAT(4X,I2,2H 0,I1,60A1,51A1)
86      62 IXPRNT = IXPRNT + 5
87      XSCALE = XSCALE + XDELS
88      GO TO 65
89      63 WRITE (IW, 790) IBUF
90      65 IF (ILINE .LT. NPOINT) GO TO.890
91      DO 130 J = 1,10
92      130 IBUF (J) = IBLANK
93      DO 140 J = 112,120
94      140 IBUF (J) = IBLANK
95      DO 150 J = 12, 110
96      150 IBUF (J) = IMINUS
97      DO 170 J = 11, 111, 10
98      170 IBUF (J) = II
99      WRITE (IW, 790) IBUF
100     RETURN
101     END

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6828T 01 03-01-79 10.176

LABEL LPPLOT PAGE 3

ELAPSED TIME (SEC) .43 LINES/MINUTE 13904

THERE WERE 1 DIAGNOSTICS IN ABOVE COMPILATION
27K WORDS WERE USED FOR THIS COMPILATION

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1      SUBROUTINE CSIZE(QCDS,QHDS,QHCONS,QCCONS,HDAY,QCLCON)
2      C THIS SUBROUTINE COMPUTES AND SIZES
3      C THE COMPONENTS, THE STORAGES, AND THE COLLECTOR
4      C AREA BASED ON CERTAIN WORST CONSECUTIVE HEATING DAYS AND MINIMUM
5      C CONSECUTIVE SOLAR ENERGY COLLECTED DAYS, USING NEWTON
6      C ITERATION METHOD.
7      C
8      C          QCDS = LARGEST V CONSECUTIVE DAY COOLING LOAD
9      C          QHDS = LARGEST DAILY HEATING LOAD
10     C          QHCONS = LARGEST NET (HEATING - COOLING) LOAD
11     C                  IN N CONSECUTIVE DAYS
12     C          HDAY = NUMBER OF CONSECUTIVE DAYS FOR COMPONENT SIZING
13     C
14     C
15     COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
16     2      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, INKDAY,
17     3      IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, HARP, IHOL
18     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
19     5      ,UASTH,DEWP,IHUF LG,TCOVER
20     REAL KWHP, KWHP4, KWHP6
21     REAL LCOLL
22     LOGICAL SUMMER
23     DATA SUMMER/.FALSE./
24     TEXTIT = A(18)
25     ISIZNG = A(11)
26     N4 = A(24)
27     N6 = A(25)
28     RMCSC = A(37)
29     IF(RMCSC .LE. 0.) RMCSC = 10000.
30     THMAX = A(43)
31     THMIN = A(44)
32     TENDUR = A(45)
33     NSERES = A(15)
34     HCOLL = A(66)
35     LCOLL = A(65)
36     SSIDE = A(68)
37     SHITE = A(69)
38     SSIDE1 = SSIDE
39     SHITE1 = SHITE
40     SCUBE = 0.
41     FPACK = A(70)
42     USTORC = A(71)
43     TGRDUN = A(72)
44     C COMPUTE THE MAXIMUM POSSIBLE CHARGING HOURS OF HEAT PUMP PER N DAY
45     C PERIOD IN SUMMER
46     HRCHR = 0.
47     NWEK = IFIX(HDAY/7.)
48     NDRES = HDAY - NWEK*7.
49     HRCHR = (NWEK*5.+NDRES)*(24.-(A(39)-A(40)))+NWEK*2.*24.
50     IF(NDRES .GE. 6) HRCHR = HRCHR + (A(39)-A(40))
51     C COMPUTE THE HOT STORAGE SIZE AND THE SLOPE FOR THE HEATING
52     C RESET CONTROLLER
53     QHMAX = QHDS*TENDUR/24.

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54      RMCSC = QHMAX/(THMAX-THMIN)
55      VOLHT = RMCSC/62.4
56      SIDEHT = VOLHT**.333333
57      AREAHT = SIDEHT*SIDEHT*6.
58      UAHT = AREAHT*USTORC
59      DIFF = (THMAX-THMIN)/TEXT
60      C COMPRESSOR RATINGS
61      TEVAP = 20.
62      C RATINGS OF THE 4RA3-2000-TSK MODEL
63      CALL HP(1,0,0.,THMAX,THMAX,32.,QHPC,QHPC,KWHP,0.,30.,SUMMER)
64      QHPC4 = QHPC
65      QHPH4 = QHPH
66      KWHP4 = KWHP
67      COPRT4 = QHPH4/(KWHP4*3413.)
68      C RATINGS OF THE 6RHC-3500-TSK MODEL
69      CALL HP(0,1,0.,THMAX,THMAX,32.,QHPC,QHPC,KWHP,0.,30.,SUMMER)
70      QHPC6 = QHPC
71      QHPH6 = QHPH
72      KWHP6 = KWHP
73      COPRT6 = QHPH6/(KWHP6*3413.)
74      QNMAX = QHCONS*(1.-(N4+N6)/(N4*COPRT4+N6*COPRT6)) + 3CCONS
75      C SIZE THE HEAT PUMP
76      QDSMAX = AMAX1(QNMAX,QCDS)
77      QCSMAX = QDSMAX/HRCFR
78      C DETERMINE THE STORAGE SIZE
79      IF(QNMAX .LE. 0.) GOTO 80
80      DO 60 I = 1,20
81      DO 50 J = 1,2
82      IF(SSIDE .EQ. 0. .AND. SHITE .EQ. 0.) GOTO 30
83      IF(SHITE .EQ. 0.) GOTO 15
84      SSIDE = SQRT(RMCSC/(62.4*SHITE))
85      GOTO 20
86      10 SHITE = RMCSC/(62.4*SSIDE*SSIDE)
87      20 SAREA = 2.*SSIDE*SSIDE+4.*SSIDE*SHITE
88      GOTO 40
89      30 SCUBE = (RMCSC/62.4)**.333333
90      SAREA = SCUBE*SCUBE*6.
91      40 UASTC = USTORC * SAREA
92      OLSC = UASTC*(32.0-TGROU)*24.*HDAY
93      QNET = QNMAX+OLSC
94      RMCSCP = QNET/(143.6*FPACK)
95      IF(J .EQ. 2) GOTO 50
96      ERR1 = RMCSCP-RMCSC
97      IF(ABS(ERR1) .LT. RMCSC*.001) GOTO 80
98      RMCSC1 = RMCSC
99      RMCSC = RMCSC * 1.001
100      50 CONTINUE
101      ERR2 = RMCSCP - RMCSC
102      SLOPE = (ERR2-ERR1)/(RMCSC*.001)
103      DELTA = -ERR1/SLOPE
104      RMCSC = RMCSC1 + DELTA
105      60 CONTINUE
106      WRITE(9,70) 1

```

```

107       70. FORMAT(4X,48H CONVERGENCE IS NOT FOUND FOR STORAGE SIZE AFTER ,
108         1      14,11H ITERATIONS)
109       STOP
110       80 RMCGAL = RMCSC/8.333333
111       C FIRST GLESS FOR COLLECTOR AREA
112       AGUESS = QNMAX/QCLCON
113       C OUTPUT .....
114       WRITE(9,8000) QCMAX, RMCSC, THMAX, DIFF, TENDUR
115       WRITE(9,8005) SSIDEHT, UAHT
116       WRITE(9,8010) QHPC4, QHPH4, KWHP4, THMAX, TEVAP, COPRT4
117       WRITE(9,8020) QHPC6, QHPH6, KWHP6, THMAX, TEVAP, COPRT6
118       WRITE(9,8030) HDAY, QHCONS, QCCONS
119       IF(SSIDE1.EQ. 0. .AND. SHITE1.EQ. 0.) WRITE(9,9000) SCUBE
120       IF(SHITE1.GT. 0.) WRITE(9,9010) SSIDE, SHITE
121       IF(SSIDE1.GT. 0.) WRITE(9,9020) SSIDE, SHITE
122       WRITE(9,9030) RMCSC, RMCGAL, UASTC
123       WRITE(9,9040) HDAY
124       IF(QHMAX.GT. 0.) WRITE(9,9060) AGUESS, LCOLL, HCOLL, NSERES
125       IF(QHMAX.LE. 0.) WRITE(9,9070) HDAY
126       RETURN
127       8000 FORMAT(///2X,' HEAT PUMP COOLING CAPACITY =',E12.5,' BTUS/HR',
128         1      /2X,' BASED ON THIS CAPACITY, THE USER HAS TO SPECIFY THE'
129         2      ' NUMBER OF COMPRESSORS TO BE USED IN THE HEAT PUMP',/2X,
130         3      ' EITHER TYPE 4RA3-2000-TSK OR TYPE 6RHI-3500-TSK OR THE'
131         4      ' COMBINATION. SEE ROUTINE HP IN THIS SOFTWARE FOR DETAIL',
132         5      /2X,' THE HOT STORAGE BIN CAPACITY =',E12.5,' LHS',
133         6      /2X,' THE EQUATION FOR THE TEMPERATURE RESET CONTROLLER'
134         7      ' IN THE STORAGE IS,',/
135         8      /,6X,' TSETH =',F8.1,' -',F6.2,' * TAMB',/2X,
136         9      ' THIS IS BASED ON THE ABILITY TO HEAT THE BUILDING FOR',
137         1     F8.2,' CONSECUTIVE HOURS FROM HOT STORAGE.')
```

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138       8005 FORMAT(///2X,' IF THE HOT STORAGE IS ASSUMED TO BE A CUBE, EACH'
139         1     ' SIDE',F8.2,' FT LONG, THEN THE',/2X,' HEAT TRANSFER'
140         2     ' COEFFICIENT OF THE TANK IS',F8.2,' BTUS/F HR')
```

```

141       8010 FORMAT(///2X,' RATINGS OF THE HEAT PUMP COMPRESSORS',/,/,
142         1     8X,' 4RA3-2000-TSK',/,/16X,
143         2     ' COOLING CAPACITY =',E12.5,' BTUS/HR',/16X,
144         3     ' HEATING CAPACITY =',E12.5,' BTUS/HR',/16X,
145         4     ' COMPRESSOR SIZE =',E12.5,' KW',/16X,
146         5     ' CONDENSOR TEMPERATURE =',F8.2,' F',/16X,
147         6     ' EVAPORATOR TEMPERATURE =',F8.2,' F',/16X,
148         7     ' RATED COP FOR HEATING =',E12.5)
```

```

149       8020 FORMAT(//8X,' 6RHI-3500-TSK',/,/16X,
150         1     ' COOLING CAPACITY =',E12.5,' BTUS/HR',/16X,
151         2     ' HEATING CAPACITY =',E12.5,' BTUS/HR',/16X,
152         3     ' COMPRESSOR SIZE =',E12.5,' KW',/16X,
153         4     ' CONDENSOR TEMPERATURE =',F8.2,' F',/16X,
154         5     ' EVAPORATOR TEMPERATURE =',F8.2,' F',/16X,
155         6     ' RATED COP FOR HEATING =',E12.5)
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156       8030 FORMAT(///2X,' DURING THE',F5.1,' CONSECUTIVE DAYS OF MAXIMUM'
157         1     ' NET HEATING, THE HEATING LOAD IS',E12.5,' BTUS',/2X,
158         2     ' AND THE COOLING LOAD IS',E12.5,' BTUS')
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159       9000 FORMAT(///2X,' THE COLD STORAGE IS (PRESUMED BY THE USER) A CUBE'
```

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160      1      'HAVING THE DIMENSION OF',F7.1,' FT AT EACH SIDE.')
161      9010 FORMAT(///2X,' THE COLD STORAGE HAS THE FOLLOWING DIMENSION',/
162      1      4X,F7.1,' FT AT EACH SIDE (COMPUTED FROM THE SOFTWARE), '
163      2      'AND',/4X,F7.1,' FT HEIGHT (PRESUMED BY THE USER)')
164      9020 FORMAT(///2X,' THE COLD STORAGE HAS THE FOLLOWING DIMENSION',/
165      1      4X,F7.1,' FT AT EACH SIDE (PRESUMED BY THE USER), AND',
166      2      /,4X,F7.1,' FT HEIGHT (COMPUTED FROM THE SOFTWARE)')
167      9030 FORMAT(//2X,' THE COLD STORAGE CAN STORE',F10.1,' LBS OR',F10.1,
168      2      ' GALLONS OF WATER',/4X,' THE STORAGE UA = ',F10.1,
169      3      ' BTUS/HR F')
170      9040 FORMAT(//2X,' THE ABOVE INFORMATION IS BASED ON',F6.1,
171      1      ' CONSECUTIVE DAYS OF WORST HEATING LOAD IN THE YEAR.')
172      9060 FORMAT(//2X,' THE FIRST GUESS FOR COLLECTOR AREA IS',F10.0,
173      1      ' FT2',/2X,' EACH COLLECTOR HAS DIMENSION OF',F6.1,' *',
174      2      'F6.1',F12,' AND THE COLLECTORS ARE PLACED',I3,' IN SERIES',
175      3      '/2X,' THIS INFO. MUST BE PUT IN THIS PROGRAM PROPERLY'
176      2      ' FOR COLLECTOR SIZING')
177      9070 FORMAT(//2X,' IN THIS PARTICULAR RUN, NO COLLECTOR IS NEEDED'
178      1      ' BECAUSE THE NET MAXIMUM NET LOAD',/2X,
179      2      ' FOR',F6.1,' CONSECUTIVE DAYS IS LESS THAN ZERO.')
180      END

```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .66 LINES/MINUTE 16257

THERE WERE 1 DIAGNOSTICS IN ABOVE COMPILATION
 28X WORDS WERE USED FOR THIS COMPILATION

```

1      SUBROUTINE COLLECT(TINLET,QCOLL,QAVAIL,IFLAG)
2      C THIS SUBROUTINE COMPUTE THE FLAT PLATE COLLECTOR EFFICIENCY
3      C AND THE AVAILABLE AND COLLECTED SOLAR ENERGY.
4      DIMENSION ATR(2),HTR(2),CTR(2),TAU040(2)
5      DIMENSION FRP(2),ULU(2),FP(2)
6      COMMON /CTRL/ A(183), VTARLE(20), X(50), XDOT(50), IRTYPE,
7      2      DT, CTHETA, NSTATE, TIME, TSTORC, YSTORH, AREA, IWKDAY,
8      3      IWORKD, IYEAR, IMONTH, IDAY, IHOURL, TAMB, BARP, IHOL,
9      4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
10     5      ,UASTH,DEWP,IBUFLG,TCOVER
11     COMMON /SIZNG/ QCOS,WHDS,RHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
12     1      ,NSERES,LCOLL,JCCONS,QCLCON
13     COMMON /SOLAR/ S(35)
14     COMMON /FLOW/ MDOTCC, MDOTCS
15     REAL MDOTCC, MDOTCS
16     LOGICAL TFIRST
17     DATA TFIRST/.TRUE./
18     DATA ATR/-2.9868,-1.4214/,CTR/-3.7360,-5.7356/
19     DATA CTR/4.3541,5.7723/,TAU040/0.96,0.92/
20     DATA FRP/0.93,0.90/,ULU/0.959,0.567/,FP/0.956,0.919/
21     REAL LCOLL, LSHADE, LROW
22     IF (AREA .EQ. 0.) RETURN
23     IF (.NOT. TFIRST) GO TO 50
24     TFIRST = .FALSE.
25     SERES = FLOAT(NSERES)
26     RAD = 3.14159/180.
27     TANPHI=SIN(A(1)*RAD)/COS(A(1)*RAD)
28     TILT = A(6)*RAD
29     CTILT = COS(TILT)
30     STILT = SIN(TILT)
31     FTILT = (1. - CTILT)/2.
32     AZIM = A(5)*RAD
33     CAZIM = COS(AZIM)
34     SAZIM = SIN(AZIM)
35     RHO = A(20)
36     AA = A(34)
37     XNG = A(35)
38     NG=FIX(XNG)
39     CC = A(36)
40     DIST = A(67)
41     TAU60=EXP(-1.21453*XNG*.0125)*(1.0-EXP((ATR(NG)+
42     1(HTR(NG)+CTR(NG)*0.5)*0.5)*0.5))*(1.0565**NG)
43     RETURN
44     50 TDIFF = TINLET - TAMB
45     C ... COMPUTE COSINE OF ANGLE OF INCIDENCE
46     IF (IFLAG .EQ. 0) GO TO 101
47     CTHETA = CTILT*S(13) + STILT*SAZIM*S(14) - STILT*CAZIM*S(15)
48     IF (CTHETA .LT. 0.0) CTHETA = 0.0
49     C ... COMPUTE SOLAR RADIATION ON TILTED SURFACE
50     QDIR = XDOT(1)*CTHETA
51     QDIF = (XDOT(3)-XDOT(2))*(1.0-FTILT) + RHO*XDOT(3)*FTILT
52     IF (NROWS .EQ. 1) GO TO 150
53     C ... COMPUTE SHADED AREA

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54      LSHADE=0.0
55      HSHADE=0.0
56      CALPHA=COS(S(20))
57      ZZ=COS(S(21)-AZIM)
58      Z77=S(13)*CTILT*STILT*CALPHA*ZZ
59      IF (ABS(Z77).GT.1.E-06) HSHADE=HCOLL*SERES-DIST*S(13)/ZZZ
60      IF (HSHADE.LT.0.) HSHADE=0.0
61      IF (HSHADE.GT.HCOLL*SERES) HSHADE=HCOLL*SERES
62      IF (ABS(ZZ).GT.1.E-06) LSHADE=LROW-(DIST-(HCOLL*SERES-HSHADE)
63      1*CTILT)*SIN(ABS(S(21)-AZIM)),ZZ
64      IF (LSHADE.LT.0.) LSHADE=0.0
65      IF (LSHADE.GT.LROW) LSHADE=LROW
66      150 ASHADE = FLOAT(NROWS-1)*LSHADE*HSHADE
67      QTOT = QDIR + QDIF
68      QAVAIL = QTOT*(ATOTAL - ASHADE)/ATOTAL
69      TAU=0.0
70      IF (CTHETA.LT..0871) GO TO 96
71      IF (QTOT.LT.1.E-06) GO TO 95
72      STHETA=SQRT(1.-CTHETA*CTHETA)
73      STH2=STHETA/1.526
74      COSTH2=SQRT(1.-STH2*STH2)
75      TAU=TAU040(NG)
76      IF (CTHETA.GT..766) GO TO 85
77      TAU=(1.0-EXP(-(ATR(NG)+(UTR(NG)*CTR(NG)*CTHETA)*CTHETA)*CTHETA)
78      1)*(1.0565**NG)
79      86 TAU=QDIR/QTOT*TAU+EXP(-XNG*.0125/COSTH2)
80      TAU=TAU+QDIF/QTOT*TAU60
81      96 ETAF=AA*TAU/TAU040(NG)
82      FR=MDOTCC*SERES/(AREA*ULO(NG))*(1.-EXP(-FP(NG)
83      1*ULO(NG)*AREA/(MDOTCC*SERES)))
84      ETAF=ETAF/FRP(NG)=FR
85      101 CONTINUE
86      C ... COMPUTE ETA FOR FLAT PLATE COLLECTOR
87      DCOLL = QAVAIL*ETAF-CC*FR*TDIF/FRP(NG)
88      500 XDOT(4) = QDIR
89      XDOT(5) = QAVAIL*AREA
90      RETURN
91      END

```

EDIT DATE 03-31-77 **3R4J**

ELAPSED TIME (SEC) .43 LINES/MINUTE 12630

THERE WERE 1 DIAGNOSTICS IN ABOVE COMPILATION
 28K WORDS WERE USED FOR THIS COMPILATION

```

1      C
2      SUBROUTINE DERIV
3      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
4      2      DT, CIPETA, NSTATE, TIME, TSTORC, TSTORH, AREA, IWKDAY,
5      3      IWORKD, IYEAR, IMONTH, IDAY, IHOURL, TAMB, HARP, IHOL
6      4      , RMCS, UASTC, QCFUSE, CTIME, MCDAY, MONTHC, ISIZNG, RMCSH
7      5      , HASTH, DEWP, IBUFLG, TCOVER
8      COMMON /SOLAR/ S(35)
9      COMMON /WEATHR/ NAMERM, DB(24), DP(24), WB(24), WS(24), PB(24),
10     1      TC(24), TOC(24), NET(24), DRY(24), CALDR(24,11),
11     2      CALRH(24,11), QCLS(24,11), QCLL(24,11), QLIGHT,
12     3      QEQUIP, QROOFO, QPEOPL
13     COMMON /SCHDL/ TWELL(12), MHTW(24), PEOPLE(24)
14     COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
15     1      TZ(11), RH(11), QFUSE, QMFUSE, QELED
16     DIMENSION QQLITE(24,11), QEQUP(24,11), QROOF(24,11), QPEOP(24,11)
17     CHARACTER NAMERM*4(9)
18     REAL MHTW
19     NZONE = A(84)
20     C THIS SUBROUTINE COMPUTES FUNCTIONS OF TIME, THEN CALLS THE
21     C SUBROUTINE HVAC THAT COMPUTES THE STATE DERIVATIVES
22     C COMPUTE THE FUNCTIONS OF TIME
23     IF((TIME - OLDTIM) .LT. 1.0 .AND. TIME.GT.1.E-06) GO TO 100
24     OLDTIM = TIME
25     DBOLD = DB(IHOURL)
26     WBOLD = WB(IHOURL)
27     DPOLD = DP(IHOURL)
28     PBOLD = PB(IHOURL)
29     TCOLD = TC(IHOURL)
30     NTYPE = IFIX(TOC(IHOURL))
31     IF(S(5) .LT. 24.0) GO TO 50
32     TCOND1 = 0.
33     S(4) = S(4) + 1.
34     S(5) = S(5) - 24.0
35     READ (8,END=40) IYEAR,IMONTH,IDAY,DB,DP,WB,WS,PB,TC,TOC,WET,DRY
36     DO 23 J = 1, NZONE
37     READ (8,END=40) NAMERM, (CALDR(I,J),I=1,24), (CALRH(I,J),I=1,24),
38     1      (QCLS(I,J),I=1,24), (QCLL(I,J),I=1,24), (QQLITE(I,J),I=1,24),
39     2      (QEQUP(I,J),I=1,24), (QROOF(I,J),I=1,24), (QPEOP(I,J),I=1,24)
40     IF (TIME .GT. 0.) GOTO 23
41     IF (J .EQ. 1) WRITE(9,5) IDAY, IMONTH, IYEAR
42     5 FORMAT(///6X, ' THE SIMULATION STARTED ON DAY', I4, ' MONTH', I3,
43     1      ' OF THE YEAR', I5)
44     IF (J .EQ. 1) WRITE(9,10)
45     WRITE(9,20) J, NAMERM
46     10 FORMAT(///6X, ' ZONE', I4, ' NAME OF ZONE', ///)
47     20 FORMAT(8X, I3, 8X, 9A4)
48     23 CONTINUE
49     40 CALL SUN(0)
50     IWKDAY = WKDAY(IYEAR,IMONTH,IDAY)
51     CALL HOLDDAY(IYEAR,IMONTH,IDAY,IWKDAY,IHOL)
52     50 IWORKD = 1
53     IF(S(5) .LT. A(149) .OR. S(5) .GE. A(150)) IWORKD = 0

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54      IF(IWKDAY.EQ.1.OR.IWKDAY.EQ.7.DR.IHOL.EQ.1) IWORKD = 0
55      HOTW=HNOTW(IHOUR)*IWORKD*8.333*PEOPLE(IHOUR)*A(151)
56      IHOUR = IFIX(S(5)) + 1
57      QELEN = C.
58      DO 75 I=1,NZONE
59      QLS(I) = QQLS(IHOUR,I)
60      QLL(I) = QQLL(IHOUR,I)
61      TZ(I) = CALDH(IHOUR,I)
62      RH(I) = CALRH(IHOUR,I)
63      QLIGHT = QLIGHT + QQLITE(IHOUR,I)
64      QEQUIP = QEQUIP + QQEUUP(IHOUR,I)
65      QROOFD = QROOFD + QQROOF(IHOUR,I)
66      QPEOPL = QPEOPL + QQPEOP(IHOUR,I)
67      QELEN = QELEN + QQLITE(IHOUR,I) + QQEUUP(IHOUR,I)
68      75 CONTINUE
69      100 CONTINUE
70      C    ... INTERPOLATE FOR AMBIENT TEMPERATURE AND CLOUD COVER
71      CCOVER = TCOLD - (TC(IHOUR) - TCOLD)*(TIME - OLDTIM)
72      IF(MTYPE.EQ.0) CCOVER = CCOVER/2.
73      CCF = 1.0 + .011*CCOVER - .0092*CCOVER*CCOVER
74      IF(TIME.LT.1.E-06 .AND. ABS(DBOLD).LT.1.E-06) DBOLD = DB(1)
75      TAMB = DBOLD + (DB(IHOUR) - DBOLD)*(TIME - OLDTIM)
76      IF(TIME.LT.1.E-06 .AND. ABS(WBOLD).LT.1.E-06) WBOLD = WB(1)
77      TWET = WBOLD + (WB(IHOUR) - WBOLD)*(TIME - OLDTIM)
78      IF(TIME.LT.1.E-06 .AND. ABS(DPOLD).LT.1.E-06) DPOLD = DP(1)
79      DEWP = DPOLD + (DP(IHOUR) - DPOLD)*(TIME - OLDTIM)
80      IF(TIME.LT.1.E-06 .AND. ABS(PBOLD).LT.1.E-06) PBOLD = PE(1)
81      HARP = PBOLD + (PB(IHOUR) - PBOLD)*(TIME - OLDTIM)
82      C    COMPUTE SOLAR RADIATION COMPONENTS
83      CALL SUN(1)
84      IF(WET(IHOUR).LT.1.E-06 .AND. DRY(IHOUR).LT.1.E-06) GO TO 120
85      C    ... IF PRECIPITATION PRESENT, THEN NO DIRECT OR DIFFUSE RADIATION
86      S(23) = 0.0
87      S(24) = 0.0
88      C    CLOUD MODIFIED RADIATION .....
89      C    ... DIRECT NORMAL RADIATION (CLOUD MODIFIED)
90      120 XDOT(1) = (1.0 - .09*CCOVER)*S(24)
91      C    ... DIRECT RADIATION ON HORIZONTAL SURFACE (CLOUD MODIFIED)
92      XDOT(2) = XDOT(1)*S(13)
93      C    ... TOTAL RADIATION ON HORIZONTAL SURFACE (CLOUD MODIFIED)
94      XDOT(3) = CCF*S(23)
95      MODEC = 0
96      IF(WET(IHOUR).LT.1.E-06 .AND. DRY(IHOUR).LT.1.E-06 .AND.
97      1 (S(5)-S(11)).GT.-1.E-06 .AND. S(15).LT. S(12)) MODEC = 1
98      CALL HVAC(HOTW,MODEC,MODET)
99      RETURN
100     END

```

C-26

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .52 LINES/MINUTE 11427

6828T 01 03-01-79 10.177

LABEL DERIV PAGE 3

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
28K WORDS WERE USED FOR THIS COMPILATION

```

1      FUNCTION WKDAY(YR,MO,DAY)
2      C
3      C *****
4      C
5      C      WKDAY=1  SUNDAY
6      C      WKDAY=2  MONDAY
7      C      WKDAY=3  TUESDAY
8      C      WKDAY=4  WEDNESDAY
9      C      WKDAY=5  THURSDAY
10     C      WKDAY=6  FRIDAY
11     C      WKDAY=7  SATURDAY
12     C
13     INTEGER YR,DAY,WKDAY,TDAY,FSTDAY
14     DIMENSION FSTDAY(12) /31,59,9C,120,151,181,212,243,273,304,334,
15     *      365/
16     N=YR/4
17     ND=N-485
18     IY=2
19     IF(ND.EQ.0) GO TO 40
20     IF(ND.LT.0) GO TO 10
21     IADD=2
22     GOTO 20
23     C
24     10 ND=-ND
25     IADD=-2
26     20 DO 30 J=1,ND
27     IY=IY-IADD
28     IF(IY.GT.7) IY=IY-7
29     IF(IY.EQ.0) IY=7
30     IF(IY.LT.0) IY=IY+7
31     30 CONTINUE
32     40 ND=YR-N*4
33     IF(MD.EQ.0) IWK=IY
34     IF(MD.EQ.1) IWK=IY+2
35     IF(MD.EQ.2) IWK=IY+3
36     IF(MD.EQ.3) IWK=IY+4
37     IF(IWK.GT.7) IWK=IWK-7
38     IF(MD.NE.1) GO TO 50
39     TDAY=DAY-1
40     GOTO 80
41     C
42     50 DO 60 J=2,12
43     IF(MD.NE.J) GO TO 60
44     TDAY=FSTDAY(J-1)+DAY-1
45     GOTO 70
46     60 CONTINUE
47     70 IF(MD.EQ.0.AND.MO.GT.2) TDAY=TDAY+1
48     80 NIX=TDAY/7
49     NDX=TDAY-7*NIX+IWK
50     IF(NDX.GT.7) NDX=NDX-7
51     WKDAY=NDX
52     KV=YR/100
53     KTEST=YR-KV*100

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6828T 01 03-01-79 10.178

LAHEL WKDAY PAGE 2

```
54      IF(MD.GT.2.OR.KTEST.NE.0) GOTO 90
55      KV=KV-1
56      90  LV=KV/4
57      LTEST=KV-LV*4
58      IF(LTEST.EQ.2) WKDAY=WKDAY+1
59      IF(LTEST.EQ.1) WKDAY=WKDAY+2
60      IF(LTEST.EQ.0) WKDAY=WKDAY+3
61      WKDAY=WKDAY-3*(LV-4)
62      100 IF(WKDAY.LE.0) WKDAY=WKDAY+7
63      IF(WKDAY.LE.0) GOTO 100
64      IF(WKDAY.GT.7) WKDAY=WKDAY-7
65      RETURN
66      C
67      END
```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .29 LINES/MINUTE 13627

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
27K WORDS WERE USED FOR THIS COMPILATION

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1      SUBROUTINE HOLIDAY(YR,MO,DAY,NDAY,HOL)
2      C
3      C *****
4      C
5      INTEGER YR,DAY,HOL,WKDAY
6      NDAY=WKDAY(YR,MO,DAY)
7      HOL=0
8      IF(MO.EQ.1.AND.DAY.EQ.1) HOL=1
9      IF(MO.EQ.12.AND.DAY.EQ.31.AND.NDAY.EQ.6) HOL=1
10     IF(MO.EQ.1.AND.DAY.EQ.2.AND.NDAY.EQ.2) HOL=1
11     IF(MO.EQ.2.AND.DAY.EQ.22) HOL=1
12     IF(MO.EQ.2.AND.DAY.EQ.21.AND.NDAY.EQ.6) HOL=1
13     IF(MO.EQ.2.AND.DAY.EQ.23.AND.NDAY.EQ.2) HOL=1
14     IF(MO.EQ.5.AND.DAY.EQ.30) HOL=1
15     IF(MO.EQ.5.AND.DAY.EQ.29.AND.NDAY.EQ.6) HOL=1
16     IF(MO.EQ.5.AND.DAY.EQ.31.AND.NDAY.EQ.2) HOL=1
17     IF(MO.EQ.7.AND.DAY.EQ.4) HOL=1
18     IF(MO.EQ.7.AND.DAY.EQ.3.AND.NDAY.EQ.6) HOL=1
19     IF(MO.EQ.7.AND.DAY.EQ.5.AND.NDAY.EQ.2) HOL=1
20     IF(MO.EQ.12.AND.DAY.EQ.25) HOL=1
21     IF(MO.EQ.12.AND.DAY.EQ.24.AND.NDAY.EQ.6) HOL=1
22     IF(MO.EQ.12.AND.DAY.EQ.26.AND.NDAY.EQ.2) HOL=1
23     IF(MO.EQ.9.AND.DAY.LT.7.AND.NDAY.EQ.2) HOL=1
24     IF(MO.EQ.11.AND.DAY.GT.24.AND.NDAY.EQ.5) HOL=1
25     RETURN
26     C
27     END

```

ECIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .24 LINES/MINUTE 6612

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
26K MCROS WERE USED FOR THIS COMPILATION

```

1      SUBROUTINE HVAC(HOTW,MODEC,MODET)
2      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
3      2      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, TWKDAY,
4      3      IWORKD, IYEAR, IMONTH, IDAY, IHOOR, TAMH, HARP, IHOL
5      4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
6      5      ,UASTH,DEWP,IBUFLG,TCOVER
7      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
8      1      TZ(11),RH(11), QFUSE, QMFUSE, QLELO
9      COMMON /FAN/ PCFMAX, TFMAX, DFMAX
10     DIMENSION FLOW(11),RMAZ(11),QZONE(11)
11     COMMON /SIZING/ QQDS,QHDS,QHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
12     1      ,NSERES,LCOLL,QCCONS,QCLCON
13     COMMON /SCHOL/ TWELL(12),MHOTN(24),PEOPLE(24)
14     COMMON /SOLAR/ S(35)
15     INTEGER PCOLL
16     REAL KWHP
17     LOGICAL TFIRST, SUMMER
18     DATA TFIRST/.TRUE./
19
20     C THIS SUBROUTINE COMPUTES STATE DERIVATIVES FOR A BUILDING WITH AN
21     C HVAC SYSTEM
22     C HEATING/COOLING SYSTEM SCHEMATIC
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      COLLECTOR FIELD
      HEAT EXCHANGER
      COLD STORAGE
      PUMP
      HEATING LOADS
      HOT STORAGE
      HEATING LOADS

```

THE X VECTOR AND XDOT VECTOR ELEMENTS ARE DEFINED AS FOLLOWS

1 IDNC	2 IDHC	3 ITHC	4 QDIRCT	5 QAVAIL	6 QCOLCT	7 QCB
8 QHB	9 QDHW	10 QCBTOT	11 QHRTOT	12 QTAMB	13 BACKUP	14 QH1
15 QH2	16 QH3	17 QH4	18 QH5	19 QH6	20 QH7	21 QH8
22 QH9	23 QH10	24 QH11	25 QC1	26 QC2	27 QC3	28 QC4
29 QC5	30 QC6	31 QC7	32 QC8	33 QC9	34 QC10	35 QC11
36 QCOMPA	37 FPOWER	38 PUMPC	39 QH3AS	40 QHOIL	41 RELECT	42 QEACES


```

54 C 43 NEHCON 44 DECONV 45 TSC 46 TSH
55 C
56 IF(.NOT.TFIRST) GO TO 30
57 TFIRST = .FALSE.
58 C INITIALIZE WITH INPUT PARAMETERS
59 RMBA = A(14)
60 NM4 = A(24)
61 NM6 = A(25)
62 NMAX = NM4+NM6
63 THOT = A(26)
64 OFFPT = A(39)
65 ONPT = A(40)
66 IHPL = 0
67 TSETC = A(41)
68 DELTAT = A(42)
69 THMA = A(43)
70 THMIN = A(44)
71 DTSTAG = A(46)
72 TSUMAX = A(47)
73 TCUTCF = A(48)
74 TSRES = 70.
75 DTHAND = THMA - THMIN
76 ALIM = DTHAND*FLOAT(NMAX)
77 IF(DTSTAG.GT. ALIM)WRITE(9,2) ALIM
78 2 FORMAT(/2X,'LIMIT EXCEEDED, RESET A(46) SMALLER THAN',
79 1 F7.2)
80 IF(DTSTAG.GT. ALIM) STOP
81 QLSH = 0.
82 QLSC = 0.
83 DIFF = A(49)
84 TGRQUN = A(72)
85 QMIN = A(51)
86 FPACK = A(70)
87 PCMIN = A(83)
88 NZONE = A(84)
89 FLWMIN = 0.
90 DO 5 I = 1, NZONE
91 RMAZ(I) = A(82+I)*RMBA*PCMIN
92 5 CONTINUE
93 ICONV = A(98)
94 ETAOIL = A(99)
95 ETAGAS = A(100)
96 FPMAX = A(101)
97 NSTARS = A(143)
98 NENDS = A(144)
99 ELCOIL = A(145)*3413.
100 FBACUP = A(146)
101 TWORK = A(149)
102 30 CONTINUE
103 IF(TIME.GT. 1.E-06) GOTO 32
104 ICMODE = IFIX(A(103))
105 IGAS = 0
106 IOIL = 0

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107       IELECT = 0
108       IF(ICMODE .EQ. 3) IGAS = 1
109       IF(ICMODE .EQ. 2) IOIL = 1
110       IF(ICMODE .EQ. 1) IELECT = 1
111       32 CONTINUE
112       DO 4C I=4,NSTATE
113       40 XDOT(I) = 0.0
114       HACKLP = 0.
115       QTAMIN = 0.
116       QCHP = 0.
117       QCB = 0.
118       QHR = 0.
119       CTHETA = 0.0
120       QHOIL = 0.
121       QHGAS = 0.
122       QCOMP = 0.
123       HECOMC = 0.
124       FLWTOT = 0.
125       QTAMB = 0.
126       PCFLOW = 0.
127       QHPC = 0.
128       QHPH = 0.
129       QLSC = 0.
130       QLSH = 0.
131       KWHP = 0.
132       QCULCT = 0.
133       PIUMPC = 0.
134       TSTORC = X(NSTATE-1)
135       TSTORH = X(NSTATE)
136       SUMMER = S(4) .GE. NSTARS .AND. S(4) .LT. NENDS
137       IPEAK = 0
138       IF(S(5) .LT. OFFPT .AND. S(5) .GE. ONPT) IPEAK = 1
139       IF(IHOL .EQ. 1 .OR. IWKDAY .EQ. 7 .OR. IWKDAY .EQ. 1) IPEAK = 0
140       ICSU-1 = 0
141       IF(SJMMER) ICSUM = 1
142       IF(ISIZNG .EQ. 1) GOTO 39
143       IF(TSTORH .LT. (THMIN-15.)) WRITE(9,33) TSTORH
144       IF(TSTORH .LT. (THMIN-15.)) STOP
145       33 FORMAT(/2X,'HOT STORAGE TEMPERATURE =',F7.2,' RESIZE THE '
146       1 'HOT STORAGE, OR HEAT PUMP, OR A(46)')
147       C COMPUTE THE RESET TEMPERATURE IN THE STORAGE BIN
148       TSETH = THMAX-DIFF*TAMB
149       IF(TSETH .LT. THMIN) TSETH = THMIN
150       IF(S(5) .GT. 11. .AND. S(5) .LT. 13.) TRESET = TSETH
151       IF(TRESET .GE. TSETH) GOTO 35
152       TRESET = TSETH
153       TRSMAX = TRESET + DELTAT
154       35 CONTINUE
155       C COMPUTE THE HEAT PUMP OPERATING STAGE
156       TSTAGE = THMIN
157       DO 38 N = 1,NMAX
158       IF(TRESET .GE. TSTAGE) ISTAGE = N
159       TSTAGE = TSTAGE + DTSTAG

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160      38 CONTINUE
161      N4 = MIN(ISTAGE,NM4)
162      N6 = 1STAGE - N4
163      IF(N6 .LT. 0) N6 = 0
164      IF(SUMMER) N4 = NM4
165      IF(SUMMER) N6 = NM6
166      IF(ICSUM .EQ. C) TRSMAX = AMAX1(THMAX,TRSMAX)
167      C IN SUMMER, COMPUTE THE AMOUNT OF ICE ALLOWED IN COLE STORAGE
168      IF(.NOT. SUMMER) GOTO 39
169      IF(S(5) .GT. 8. .AND. S(5) .LT. 10.) TSRES = TAMH
170      IF(TSRES .GE. TAM4) GOTO 399
171      TSRES = TAMH
172      FPSUM = FPACK*(TSRES - TCUTOF)/(TSUMAX - TCUTOF)
173      IF(FPSUM .LT. 0.) FPSUM = 0.
174      IF(FPSUM .GT. FPACK) FPSUM = FPACK
175      399 CONTINUE
176      39 CONTINUE
177      C
178      IF(ISIZNG .EQ. 2) GOTO 41
179      IF(MODEC .EQ. 1 .OR.
180      1 TAMH .GT. (TSTORC+5.)) CALL CDECT(32.0,QCOLCT,QAVAIL,1)
181      IF(QCOLCT .LT. 0.) QCOLCT = 0.
182      GOTO 42
183      C THIS SUBROUTINE COMPUTES THE ENERGY NEEDED FOR THE BUILDING AS
184      C DETERMINED BY THE AMBIENT TEMPERATURE AND DESIGN LOAD FOR THE BUILDING
185      41 CONTINUE
186      CALL FUSION
187      C COMPUTE STORAGE GAIN OR LOSS
188      QLSG = UASTC*(TSTORC-TGRDUN)
189      QLSH = UASTH*(TSTORH-TGRDUN)
190      IF(MODEC .EQ. 1) CALL CDECT(32.0,QAVAIL,1)
191      IF(SUMMER .AND. TSTORH .GT. TRSMAX) GOTO 42
192      IF(TSTORC .GT. (TSETC-10.)) GOTO 42
193      IF((QAVAIL .GT. QMIN .OR. TAMH .GT. (TSTORC+5.)) .AND. AREA .GT. 0.)
194      1 CALL CHARGE(MODEC,QAVAIL,QCOLCT)
195      PPMAX = 5.
196      IF(ATOTAL .LT. 2232.) PPMAX = 3.
197      IF(ATOTAL .LT. 18.) PPMAX = 0.
198      IF(QCOLCT .GT. 0.) PUMPC = PPMAX*3413.
199      42 CONTINUE
200      C DETERMINE ENERGY REQUIRED FOR HOT WATER
201      QCHW = HOTW*(THOT-TWELL*(MONTH))
202      IF(IGAS .EQ. 1) QCHW = QCHW/ETAGAS
203      CALL ENTHLP
204      C COMPUTE THE VENTILATION AIR FLOW RATE IN EACH ZONE
205      DO 50 I = 1, NZONE
206      QZONE(I) = QLS(I) + QLL(I)
207      FLOW(I) = -QZONE(I)/(HZ(I)-HEXIF)
208      IF(FLOW(I) .LT. RMAZ(I)) FLOW(I) = RMAZ(I)
209      IF(ICNV .EQ. 0. .AND. (.NOT. SUMMER)) FLOW(I) = RMAZ(I)
210      FLOW(I) = FLOW(I)*WORKD
211      FLWTOT = FLWTOT + FLOW(I)
212      C COMPUTE THE TOTAL HEATING LGAD

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213       IF(QZONE(I) .GT. 0.) QHB = QHB + QZONE(I)
214       C COMPUTE THE TOTAL COOLING LOAD
215       IF(QZONE(I) .LT. 0.) QCB = QCB + QZONE(I)
216       C COMPUTE THE NET COOLING CONTRIBUTION FROM AMBIENT AIR
217       QAMB = FLOW(I) * (HZ(I) - HA)
218       QAMIN = RMAZ(I)*(HZ(I)-HA)
219       IF(QAMB .LT. 0..AND.FLOW(I) .GT. RMAZ(I)) QAMB = QAMIN
220       QTAMB = QTAMB + QAMB
221       QTAMIN = QTAMIN+QAMIN
222       50 CONTINUE
223       QCBTOT = QCB
224       QHBTOT = QHB
225       C COMPUTE THE FAN POWER
226       PCFLOW = FLWTOT/RMBA
227       FPOWER = FPMAX * 3413. * (.8 * PCFLOW + .3)
228       IF(PCFLOW .EQ. 0.) FPOWER = 0.
229       C IF THE DAMPER IS SET AT MINIMUM AND THE AMBIENT AIR IS TOO COLD,
230       C ADD THE EXTRA LOAD TO THE HEATING LOAD
231       QCBP = (QCB - FPOWER + QTAMIN) * IWORKD
232       IF(QCBP .GT. 0.) QHB = QHB + QCBP
233       C THIS POWER ADDS HEAT TO THE COOLING LOAD
234       C THE FINAL COOLING LOAD IS
235       QCB = (QCB - FPOWER + QTAMB) * IWORKD
236       IF(QCB .GT. 0.) QCB = 0.
237       IF(PCFMAX .GE. PCFLOW) GOTO 52
238       PCFMAX = PCFLOW
239       IFMAX = S(5)
240       DFMAX = S(4)
241       52 CONTINUE
242       IF(ISIZNG .NE. 2) GOTO 90
243       C OPERATE HEAT PUMP WHEN NECESSARY
244       C
245       C HEAT PUMP CONTROL
246       IF(IPEAK .EQ. 1 .AND. TSTORH .GT. THMIN) GOTO 85
247       IF(TSTORH .GE. TRSMAX .AND. IHPL .EQ. 1) IHPN=0
248       IF(TSTORH .LT. (TRSMAX-DELTAT/2.) .AND. IHPL .EQ. 0) IHPN = 1
249       IF(TSTORC .GT. TSETC) IHPN = 1
250       IHPL = IHPN
251       IF(SUMMER) GOTO 85
252       IF(FRACUP .EQ. 0.) GOTO 55
253       IF((QFUSE/QMFUSE).LE.FPACK .AND. TSTORH.GT.(THMIN-5.)) GOTO 55
254       BACKUP = ELCOIL*IHPN
255       IF(IHPN .EQ. 1) IHJFLG = IHPN
256       IF((QFUSE/QMFUSE) .GT. FPACK) GOTO 86
257       55 CONTINUE
258       IF(IHPN .EQ. 1 .AND. QFUSE .LT. QMFUSE*FPACK)
259       1      CALL HP(N4,N6,TAMB,TRSMAX,TSTORH,TSTORC,QHPH,QHPC,KWHP,
260       2      TCOVER,TSETC,SUMMER)
261       GOTO 86
262       85 IF(QFUSE .GT. (QMFUSE*FPSUM) .AND. IHPN .EQ. 0) GOTO 86
263       IF(IPEAK .EQ. 1 .AND. TSTORC .LE. TSETC) GOTO 86
264       CALL HP(N4,
265       1N6,TAMB,TRSMAX,TSTORH,TSTORC,QHPH,QHPC,KWHP,TCOVER,TSETC,

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```

266      2SUMMER)
267      IF(QFUSE.GT.(QMFUSE*FPACK)) QHPC = 0.
268      IF(IHPN.EQ.0) QHPH = 0.
269      86 CONTINUE
270      C CALCULATE THE ENERGY BALANCE IN THE STORAGE
271      DTSC = (QCOLCT*(1-ICSUM)+PUMPC-QHPC-QLSC-QCB)/RMCSC
272      DTSH = (QCOLCT*ICSUM+QHPH+BACKJP-QLSH-QHB)/RMCSP
273      GOTO 1000
274      90 CONTINUE
275      C CONVENTIONAL SYSTEM SIZING
276      IF(ICONV.NE.1) GOTO 1000
277      QOIL = QHR/ETAOIL
278      QGAS = QHR/ETAGAS
279      IF(QCB.GE.0.) GOTO 1000
280      CALL ACCONV(TAMB,COPCON)
281      QCOMP = -QCB/COPCON
282      1000 CONTINUE
283      QO/S = (QDPW + QCAE)/ICAE
284      QOIL = QOIL*OIL
285      C MISCELLANEOUS ELECTRIC USAGE (LIGHTING, EQUIPMENTS, DHW, ETC.)
286      QELECT = QDHW*(1-IGAS) + FPOWER + PUMPC + QELED
287      C ELECTRIC FOR ACES HEAT PUMP
288      QEACES = KWHP*3413. + BACKUP
289      C ELECTRIC FOR CONVENTIONAL HEATING
290      QEHCON = QHR*ICONV*IELECT
291      C ELECTRIC FOR CONVENTIONAL COOLING
292      QECCON = QCOMP
293      XDOT(6) = QCOLCT
294      XDOT(7) = QCB
295      XDOT(8) = QHR
296      XDOT(9) = QDHW
297      XDOT(10) = QCELOT
298      XDOT(11) = QHETOT
299      XDOT(12) = QTAMB
300      XDOT(13) = BACKUP
301      DO 100 I=1,NZONE
302      IF(QLS(I)+QLLETI).GE.0.) XDOT(13+I)=QLS(I)+QLL(I)
303      IF(QLS(I)+QLLETI).LT.0.) XDOT(24+I)=QLS(I)+QLL(I)
304      100 CONTINUE
305      XDOT(36) = KWHP*3413.
306      XDOT(37) = FPOWER
307      XDOT(38) = PUMPC
308      XDOT(39) = QHGAS
309      XDOT(40) = QHOIL
310      XDOT(41) = QELECT
311      XDOT(42) = QEACES
312      XDOT(43) = QEHCON
313      XDOT(44) = QECCON
314      XDOT(NSTATE-1) = DTSC
315      XDOT(NSTATE) = DTSH
316      RETURN
317      END

```

79267

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ABRAT 01 03-01-79 10.180

LABEL HVAC PAGE 7

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) 1.07 LINES/MINUTE 17715

THERE WERE 1 DIAGNOSTICS IN ABOVE COMPILATION
30K WORDS WERE USED FOR THIS COMPILATION

```
1      SUBROUTINE ACCONV(TAMB,COPCON)
2      C THIS SUBROUTINE COMPUTE THE CONVENTIONAL AIR CONDITIONER COP
3      C BASED ON THE DATA FOR THE BRHI-3500-TSK COMPRESSOR.
4          TCOND = TAMB + 20.
5          WHPC = -2300.*TCOND + 498000.
6          KWHP = .0005*TCOND*TCOND + .031*TCOND + 17.54
7          COPCON = WHPC/(KWHP*3413.)
8      RETURN
9      END
```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .13 LINES/MINUTE 4067

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
26K WORDS WERE USED FOR THIS COMPILATION


```

54      KWHP4 = KWHP4*N4
55      10 CONTINUE
56      IF(N6 .LE. 0) GOTO 100
57      C HEAT PUMP WITH THE 6RHI-3500-TSK COMPRESSOR MODEL, RUNNING WITH
58      C TEVAP = 20 F.
59      QHPC6 = .8333333*TSTORH**3-275.*TSTORH*TSTORH+27666.67*TSTORH
60      1 -580000.
61      KWHP6 = .0005*TSTORH*TSTORH+.031*TSTORH+17.54
62      QHPC6 = QHPC6*N6
63      KWHP6 = KWHP6*N6
64      GOTO 100
65      C HEAT PUMP WITH THE 4R#3-2000-TSK COMPRESSOR MODEL, RUNNING WITH
66      C TEVAP = 35 F.
67      50 CONTINUE
68      IF(N4 .LE. 0) GOTO 60
69      QHPC4 = -.1666667*TSTORH**3+57.85714*TSTORH*TSTORH-8061.905*TSTORH
70      1 +586400.
71      KWHP4 = .12*TSTORH + 2.4
72      QHPC4 = QHPC4*N4
73      KWHP4 = KWHP4*N4
74      60 CONTINUE
75      IF(N6 .LE. 0) GOTO 100
76      C HEAT PUMP WITH THE 6RHI-3500-TSK COMPRESSOR MODEL, RUNNING WITH
77      C TEVAP = 35 F.
78      QHPC6 = .4166667*TSTORH**3-13E.2143*TSTORH*TSTORH+12490.48*TSTORH
79      1 +81600.
80      KWHP6 = .001*TSTORH*TSTORH+.002*TSTORH+17.76
81      QHPC6 = QHPC6*N6
82      KWHP6 = KWHP6*N6
83      GOTO 100
84      70 CONTINUE
85      C IF THE AMBIENT TEMPERATURE IS GREATER THAN THE CHANGE-OVER
86      C TEMPERATURE, OPERATE THE HEAT PUMP WITH THE OUTDOOR EVAPORATOR
87      IF(SUMMER) GOTO 75
88      IF(TSTORC .GT. TSETC) GOTO 75
89      IF(TAMB .GT. TCOVER) GOTO 90
90      C IN THE CASE THAT THE HOT STORAGE BIN TEMPERATURE IS GREATER THAN
91      C LIMIT, USE OUTDOOR AIR COOL CONDENSER. TEVAP = 20 F.
92      75 TCND = TAMB+20.
93      IF(N4 .LE. 0) GOTO 80
94      QHPC4 = -1110.*TCND + 247700.
95      KWHP4 = -.0002857*TCOND*TCOND+.1468571*TCCND+1.26
96      QHPC4 = QHPC4*N4
97      KWHP4 = KWHP4*N4
98      80 CONTINUE
99      IF(N6 .LE. 0) GOTO 100
100     QHPC6 = -2300.*TCND+498000.
101     KWHP6 = .0005*TCND*TCOND+.031*TCOND+17.54
102     QHPC6 = QHPC6*N6
103     KWHP6 = KWHP6*N6
104     GOTO 100
105     90 CONTINUE
106     QHPC = 0.

```

6828T 01 03-01-79 10.182

LABEL HP PAGE 3

```
107 QHPH4 = 3292.86*TAMB + 68532.98
108 QHPH6 = QHPH4*35./20.
109 QHPH = QHPH4*N4 + QHPH6*N6
110 KWHP4 = .08*TAMB+11.04
111 KWHP6 = KWHP4*35./20.
112 KWHP = KWHP4*N4 + KWHP6*N6
113 GO TO 1000
114 100 CONTINUE
115 QHPC = QHPC6+QHPC4
116 KWHP = KWHP6+KWHP4
117 IF (TSORH .LE. TRSMAX) QHPH = QHPC+KWHP*3413.
118 1000 RETURN
119 END
```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .42 LINES/MINUTE 16987

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
27K WORDS WERE USED FOR THIS COMPILATION

C-42

6828T 01 03-01-79 10.182

LABEL ENTHLP PAGE

2

```
54 C COMPUTE THE ENTHALPY OF THE RETURNING DUCTS
55 DO 100 I = 1,NZONE
56 IF(RH(I) .GT. RHMAX) RH(I) = RHMAX
57 PVSZ = PVSF(TZ(I))
58 PVZ = RH(I)*PVSZ/100.
59 WZ = .622*PVZ/(HARP-PVZ)
60 HZ(I) = .24*TZ(I)+(1061.+ .444*TZ(I))*WZ
61 100 CONTINUE
62 C CALCULATE THE AMBIENT AIR ENTHALPY
63 PVA = PVSF(DEWP)
64 WA = .622*PVA/(HARP-PVA)
65 HA = .24*TAMB+(1061.+ .444*TAMB)*WA
66 RETURN
67 END
```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .26 LINES/MINUTE 14906

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
26K WORDS WERE USED FOR THIS COMPILATION

```

1      SUBROUTINE FUSION
2      C THIS ROUTINE COMPUTES THE AMOUNT OF HEAT OF FUSION IN THE STORAGE
3      C AND KEEPS TRACK OF THE ICE BUILT UP AND TEMPERATURE CHANGE
4      C
5      COMMON /CTRL/ A(153), NTABLE(20), X(50), XDOT(50), IRTYPE,
6      2      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, IWKDAY,
7      3      IWORKU, IYEAR, IMONTH, IDAY, IHOOR, TAMH, HARP, IHOL
8      4      ,RMCSC,IASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
9      5      ,UASTH,DEWP,IBUFLD,ICOVER
10     COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
11     1      TZ(11),RH(11), QFUSE, QMFUSE, QELED
12     COMMON /SOLAP/ S(35)
13     QMFUSE = 143.6*RMCSC
14     DTFUSE = 0.
15     C CALCULATE THE HEAT OF FUSION IN THE STORAGE
16     IF(TSTORC .GT. 32.0 .AND. QFUSE .LE. 0.) GOTO 1020
17     IF(TSTORC .LT. 32.0 .AND. QFUSE .GE. QMFUSE) GOTO 1020
18     IF(TSTORC .LT. 32.0) GOTO 1010
19     QXCEED = RMCSC*(TSTORC-32.0)
20     QFUSE = QFUSE - QXCEED
21     IF(QFUSE .GE. 0.) GOTO 1015
22     DTFUSE = QFUSE/RMCSC
23     QFUSE = 0.
24     GOTO 1015
25     1010 QXCEED = RMCSC*(32.0-TSTORC)
26     QFUSE = QFUSE + QXCEED
27     IF(QFUSE .LE. QMFUSE) GOTO 1015
28     DTFUSE = -(QFUSE-QMFUSE)/RMCSC
29     QFUSE = QMFUSE
30     1015 TSTORC = 32.0 + DTFUSE
31     1020 CONTINUE
32     C RESET STORAGE TEMPERATURE FOR OUTPUT PURPOSE
33     X(NSTATE-1) = TSTORC
34     IF(QFUSE .LE. QCFUSE) GOTO 1100
35     QCFUSE = QFUSE
36     CTIME = S(5)
37     MCDAY = S(4)
38     MONTHC = IMONTH
39     1100 CONTINUE
40     RETURN
41     END

```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .20 LINES/MINUTE 11939

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
26K WORDS WERE USED FOR THIS COMPILATION

```

1      SUBROUTINE CHARGE(MODEC,QAVAIL,QCOLCT)
2      COMMON /CTRL/ A(183), NTABLE(20), X(50), XOOT(50), IRTYPE,
3      2      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, IWKDAY,
4      3      IWORKD, IYEAR, IMONTH, IDAY, IHOURL, TAMB, HARP, IHOL
5      4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
6      5      ,UASTH,DEWP,IHUFLE,TCOVER
7      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
8      1      TZ(11),RH(11), RFUSE, QMFUSE, QELEG
9      COMMON /SOLAR/ S(35)
10     COMMON /SIZING/ QCONS,QHQS,Q4CONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
11     1      ,NSERES,LCOLL,JCONS,QCLCON
12     COMMON /FLOW/ MDOTCC, MDOTCS
13     REAL LCOLL,LROW
14     DIMENSION TITER(10),QITER(10)
15     LOGICAL TFIRST
16     DATA TFIRST/.TRUE./
17     REAL MDOTCC,MDOTCS,MCMIN,MCMAX
18     IF(.NOT.TFIRST) GO TO 10
19     TFIRST = .FALSE.
20     E = 4.
21     SERES = FLOAT(NSERES)
22     HOILPT = A(53)
23     MSTEP = A(74)
24     TZERO = A(76)
25     ULPIP1=A(79)
26     ULPIP2=A(80)
27     PLOSS1 = EXP(-ULPIP1/MDOTCC)
28     PLOSS2 = EXP(-ULPIP2/MDOTCC)
29     MCMIN = AMIN1(MDOTCS,MDOTCC)
30     MCMAX = AMAX1(MDOTCS,MDOTCC)
31     QUO = MCMIN/MCMAX
32     UAX = A(55)
33     IF(QUO .GE. 1.) GOTO 5
34     EXPCS = EXP(-(1. - QUO)*UAX/MCMIN)
35     ECS = (1. - EXPCS)/(1. - QUO*EXPCS)
36     GOTO 7
37     5 ECS = UAX/(MCMIN+UAX)
38     7 TCIN1 = TSTORC
39     10 CONTINUE
40     DO 130 N=1,MSTEP
41     DO 120 K=1,2
42     MSTEP1 = N
43     TCIN2 = TAMB + PLOSS1*(TCIN1 - TAMB)
44     QCSOFT = 0.
45     QCOLCT = 0.
46     TITER(1) = TCIN2
47     DO 110 ISERES=1,NSERES
48     CALL COLECT(TITER(ISERES),QCSOFT,QAVAIL,0)
49     QITER(ISERES) = QCSOFT*AREA/SERES
50     TCOUT1 = TITER(ISERES) + (QITER(ISERES)/MDOTCC)
51     TITER(ISERES+1) = TCOUT1
52     110 QCOLCT = QCOLCT + QITER(ISERES)
53     TCOUT2 = TAMB + PLOSS2*(TCOUT1 - TAMB)

```

```

54      IF(TCOUT2 .LT. BOILPT) GO TO 115
55      TCOUT2 = BOILPT
56      115 TPIN1 = TCOUT2 - (MCMIN/MDOTCC)*(TCOUT2 - TSTORC)*ECS
57      IF(K .EQ. 2) GO TO 120
58      ERR1 = TPIN1 - TCIN1
59      IF(ABS(ERR1) .LT. TZERO1 GO TO 150
60      TONE = TCIN1
61      TCIN1 = TCIN1 + E*SIGN(1.0,ERR1)
62      120 CONTINUE
63      ERR2 = TPIN1 - TCIN1
64      SLOPE = (ERR2 - ERR1)/(E*SIGN(1.0,ERR1))
65      DELTA = -ERR1/SLOPE
66      TCIN1 = TONE + DELTA
67      130 CONTINUE
68      WRITE(9,140) S(5),S(4),*STEP
69      140 FORMAT(12H WARNING, AT,F9.4,7H ON DAY,14,6H TCIN1
70      1      24H DOES NOT CONVERGE AFTER,16,11H ITERATIONS)
71      150 TCIN1 = TPIN1
72      QCOLCT = MDOTCC*(TCOUT2 - TCIN1)
73      IF(TCOUT2 .LT. (TSTORC+.5.)) QCOLCT = 0.
74      RETURN
75      END

```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .34 LINES/MINUTE 13042

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
 27K WORDS WERE USED FOR THIS COMPILATION

```

1      C
2      FUNCTION PVSF(X)
3      DIMENSION A(6),B(4),P(4)
4      DATA A /-7.9029A,5.02A08,-1.3816E-7,11.344,A.1328E-3,-3.49149/
5      DATA B /-9.09718,-3.56654,0.876793,0.0060273/
6      T=(X+459.688)/1.8
7      IF (T.LT.273.16) GO TO 10
8      Z=373.16/T
9      P(1)=A(1)*(Z-1.)
10     P(2)=A(2)*ALOG10(Z)
11     Z1=A(4)*(1-1./Z)
12     P(3)=A(3)*(10**Z1-1)
13     Z1=A(6)*(Z-1)
14     P(4)=A(5)*(10.**Z1-1.)
15     GO TO 20
16     10  Z=273.16/T
17     P(1)=B(1)*(Z-1.)
18     P(2)=B(2)*ALOG10(Z)
19     P(3)=B(3)*(1.-1./Z)
20     P(4)=ALOG10(B(4))
21     20  SUM=0
22     DO 30 I=1,4
23     30  SUM=SUM+P(I)
24     PVSF=29.921*10.**SUM
25     RETURN
26     END

```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .19 LINES/MINUTE 8031

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
 26X WORDS WERE USED FOR THIS COMPILATION


```

1      C
2      SUBROUTINE INPUT
3      COMMON /CTRL/ A(143), NTABLE(20), X(50), XDOT(50), IRTYPE,
4      2      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, IWKDAY,
5      3      IWORKC, IYEAR, I-ONTH, IDAY, IHOURL, TAMB, RAMP, IHOL
6      4      ,RMCSC,HASTE,QCFUEE,CTIME,MCOAY,MONTHC,ISIZNG,RMCSH
7      5      ,UASTH,DEWP,IBUFL,TCOVER
8      COMMON /SCHDL/ TWELL(12),MHOTW(24),PEOPLE(24)
9      DIMENSION LAEEL(10),MARGIN(10)
10     REAL MHOTW,LIGHT
11     CHARACTER LAEEL*6, MARGIN*6
12     MAXA = 0
13     READ(5,500) MARGIN
14     WRITE(9,1000) MARGIN
15     100 READ(5,2000) N, DJM, LAEEL
16     IF(N .LE. 0) GO TO 200
17     IF(N .GT. MAXA) MAXA = N
18     A(N) = DJM
19     WRITE(9,3000) N, A(N), LAEEL
20     GO TO 100
21     200 READ(5,20) (TWELL(I),I=1,12)
22     READ(5,20) (MHOTW(I),I=1,24)
23     READ(5,20) (PEOPLE(I),I=1,24)
24     WRITE(9,913) TWELL,MHOTW,PEOPLE
25     913 FORMAT(2X,22H WELLS WATER TEMPERATURE,2X,12F8.3/
26     12X,22H HOT WATER SCHEDULE,2X,12F8.3/26X,12F8.3/
27     22X,22H OCCUPANCY SCHEDULE,2X,12F8.3/26X,12F8.3)
28     READ(5,4000) NTABLE
29     WRITE(9,5000) NTABLE
30     20 FORMAT(V)
31     RETURN
32     500 FORMAT(13A6)
33     1000 FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6,/)
34     2000 FORMAT(15,F15.0,10A6)
35     3000 FORMAT(3H A(,13,1H),G15.5,3X,10A6)
36     4000 FORMAT(20I4)
37     5000 FORMAT(///40H OUTPUT TABLE AND PLOTS FOR DAYS LISTED ,20I4)
38     END

```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .22 LINES/MINUTE 1022

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
 26K WORDS WERE USED FOR THIS COMPILATION

6R28T 01 03-01-79 10.183

LABEL STEP PAGE 1

```
1      C
2      SUBROUTINE STEP
3      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
4      DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA, IWKDAY,
5      IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IMOL
6      , RMCSC, UASTC, OCFUSE, CTIME, MCDAY, MONTHC, ISIZNG, RMCCH
7      , UASTH, DEWP, IRUFLG, TCOVER
8      COMMON /SOLAR/ S(35)
9      CALL DERIV
10     C
11     INTEGRATE STATE VARIABLES
12     IF (TIME.LT..1E-06) GO TO 5
13     DO 300 N=1,NSTATE
14     300 X(N)=X(N)+XDOT(N)*DT
15     5 CONTINUE
16     TIME = TIME + DT
17     S(5) = S(5) + DT
18     RETURN
19     END
```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .14 LINES/MINUTE 7230

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
25% WORDS WERE USED FOR THIS COMPILATION

```

1      C
2      SUBROUTINE CROUTPJT(ARRAY,ISTART,I,J,NAME)
3      DIMENSION ARRAY(I,J), NAME(J)
4      CHARACTER NAME*6
5      M = J/8
6      MLAST = MOD(J,8)
7      IF(MLAST .NE. 0) M = M + 1
8      IF(MLAST .EQ. 0) MLAST = 8
9      DO 200 MM = 1,M
10     J1 = 8*(MM-1) + 1
11     J2 = J1 + 7
12     IF(MM .EQ. M) J2 = J1 + MLAST - 1
13     WRITE(9,1000)(NAME(JJ), JJ = J1,J2)
14     DO 100 NN = ISTART,I
15     IF(ISTART .GT. 1 .OR. I .GT. 1)
16     1 WRITE(9,2000) NN,(ARRAY(NN,JJ), JJ = J1,J2)
17     IF(ISTART .EQ. 1 .AND. I .EQ. 1)
18     1 WRITE(9,3000)(ARRAY(NN,JJ),JJ = J1,J2)
19     100 CONTINUE
20     200 CONTINUE
21     RETURN
22     1000 FORMAT(/,5X,8(4X,A5,3X)/)
23     2000 FORMAT(I4,8(2X,1PE11.4))
24     3000 FORMAT(4X,8(2X,1PE11.4))
25     END

```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .19 LINES/MINUTE 7770

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
 26K WORDS WERE USED FOR THIS COMPILATION

```

1      C
2      SUBROUTINE SUN(MODE)
3      COMMON /SOLAR/ S(35)
4      DIMENSION A0(5),A1(5),A2(5),A3(5),B1(5),B2(5),B3(5)
5      DATA A0/.302,-.0002,368.44,.1717,.0905/
6      DATA A1/-22.93,.4197,24.52,-.0344,-.0410/
7      DATA A2/-229,-3.2265,-1.14,.0032,.0073/
8      DATA A3/-.244,-.0903,-.109,.0024,.0015/
9      DATA B1/3.851,-7.351,.58,-.0043,-.0034/
10     DATA B2/.002,-9.3912,-.18,0.,.0004/
11     DATA B3/-.055,-.3361,.28,.0008,-.0006/
12     REAL LAT,LATD,LONG,MERID,LOND
13     C      S(1)= LATITUDE,DEGREES(+NORTH,-SOUTH)
14     C      S(2)= LONGITUDE,DEGREES(+WEST,-EAST)
15     C      S(3)= TIME ZONE NUMBER
16     C          STANDARD   TIME      DAYLIGHT   SAVING TIME
17     C      ATLANTIC       4          3
18     C      EASTERN        5          4
19     C      CENTRAL        6          5
20     C      MOUNTAIN       7          6
21     C      PACIFIC        8          7
22     C      S(4)= DAYS(FROM START OF YEAR)
23     C      S(5)= TIME, HOUR AFTER MIDNIGHT)
24     C      S(6)= DAYLIGHT SAVING TIME INDICATOR
25     C      S(8)= CLEARNESS NUMBER
26     C      S(11)=SUN RISE TIME (HOURS AFTER MIDNIGHT).
27     C      S(12)=SUN SET TIME
28     C      S(13)=COSZ     DIRECTION COSINES
29     C      S(14)=COSW     DIRECTION COSINES
30     C      S(15)=COS(S)   DIRECTION COSINES)
31     C      S(16)=ALPHA    DIRECTION COSINES NORMAL TO SURFACE
32     C      S(20)=SOLAR ALTITUDE ANGLE, RADIANS
33     C      S(21)=SOLAR AZIMUTH ANGLE, RADIANS
34     C      S(22)=DIFFUSE SKY RADIATION ON HORIZONTAL SURFACE
35     C      S(23)=TOTAL HORIZONTAL RADIATION ITH
36     C      S(24)=DIRECT NORMAL RADIATION
37     C      S(28)=SUN DECLINATION ANGLE DELTA, RADIANS
38     C      S(29)=EQUATION OF TIME ,HOURS
39     C      S(30) = SOLAR FACTOR A
40     C      S(31) = SOLAR FACTOR B
41     C      S(32) = SOLAR FACTOR C
42     C      S(35)=SOLAR HOUR ANGLE OMEGA, RADIANS
43     DATA RPH/0.261799388/
44     PI=3.14159265
45     TWOPI=6.28318531
46     IF(MODE .NE. 0) GO TO 15
47     C      COMPUTE DECLINATION, EQUATION OF TIME, APPARENT SOLAR CONSTANT,
48     C      ATMOSPHERIC EXTINCTION COEFFICIENT, SKY DIFFUSE FACTOR,
49     C      AND SUN RISE AND SUN SET TIMES ONCE EACH DAY.
50     X=2*PI/366.*S(4)
51     C1=COS(X)
52     C2=COS(2*X)
53     C3=COS(3*X)

```

```

54      S1=SIN(X)
55      S2=SIN(2*X)
56      S3=SIN(3*X)
57      DO 10 K=1,5
58      KS=(K-1)+28
59      10 S(KS)=A0(K)+A1(K)*C1+A2(K)*C2+A3(K)*C3+B1(K)*S1+B2(K)*S2
60      1+B3(K)*S3
61      S(28) = S(28)*PI/180.0
62      S(29)=S(29)/60.
63      LATD=S(1)
64      LONG=S(2)
65      MERID=15*S(3)
66      LOND=LONG-MERID
67      Y = S(28)
68      YY=LATD*PI/180.
69      HP=-SIN(Y)/COS(Y)=SIN(YY)/COS(YY)
70      TR=12/PI*ARCOS(-HP)
71      S(11)=(12-TR)-S(29)+LOND/15.
72      S(12) = S(11) + 2.0*TR
73      C  COMPUTE DAILY CONSTANTS
74      TYY=SIN(YY)/COS(YY)
75      TY=SIN(Y)/COS(Y)
76      CY=COS(Y)
77      SY=SIN(Y)
78      CYY=COS(YY)
79      SYY=SIN(YY)
80      ACHP=ARCOS(HP)
81      HP1 = ARCOS(HP)
82      X1=ABS(HP1)
83      GO TO 130
84      C  COMPUTE THE FOLLOWING SUN PARAMETERS ON EACH DT CALL
85      15 CONTINUE
86      C  COMPUTE SOLAR HOUR ANGLE
87      H = -RPH*(S(5)-12+S(3)+S(29)-S(6)) + S(2)*PI/180.0
88      S(35) = H
89      C  IS THE SUN UP
90      X2=ABS(H)
91      IF (X1-X2) 130,20,20
92      C  COMPUTE SOLAR DIRECTION COSINES
93      20 S(13)=SYY*SY+CYY*CY*CCS(H)
94      S(14) = CY*SIN(H)
95      S(15)=-SYY*CY*CCS(H)+CYY*SY
96      C  COMPUTE SOLAR ALTITUDE AND AZIMUTH
97      50 S(20)=ARSTN(S(13))
98      S(21)=(PI-ARCOS(S(15)/COS(S(20))))*SIGN(1.0,H)
99      C  COMPUTE RADIATION INTENSITY
100     CALL FXOPT(89,1,1,0)
101     S(24)=S(30)*S(8)*EXP(-S(31)/S(13))
102     CALL FXOPT(89,1,0,0)
103     S(22)=S(32)*S(24)
104     S(23) = (S(32) + S(13))*S(24)
105     GO TO 150
106     130 S(24)=0.

```

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LABEL SIN PAGE 3

```
107      S(22)=C.  
108      S(23)=C.  
109      150 CONTINUE  
110      RETURN  
111      END
```

EDIT DATE 03-31-77 **SR4J**

ELAPSED TIME (SEC) .43 LINES/MINUTE 15169

THERE WERE NO DIAGNOSTICS IN ABOVE COMPILATION
27K WORDS WERE USED FOR THIS COMPILATION

ORIGIN	DATE	MODULE	ENTRY LOCATION	ENTRY LOCATION	ENTRY LOCATION	ENTRY LOCATION	ENTRY LOCATION

SUBPROGRAMS INCLUDED IN DECK.

	\$	OPTION	FORTRAN					
154512 03/01/79		154512						
BLOCK COMMON	.DATA.	154010	SIZING	153774	HVACS	153676	CTRL	153162
150426 03/01/79 ACES	ACESIM	150426						
BLOCK COMMON	.DATA.	077110	WEATHR	074502	FLOW	074500	SOLAR	074434
	SIZING	153774	FAN	074022	HVACS	153676	CTRL	153162
073476 03/01/79 LPPL	LPPLDT	073476						
BLOCK COMMON	.DATA.	072540	PLOTTT	074025				
071500 03/01/79 CSIZ	CSIZE	071500						
BLOCK COMMON	.DATA.	070464	CTRL	153162				
067630 03/01/79 CGLE	COLECT	067640						
BLOCK COMMON	.DATA.	067520	FLOW	074500	SOLAR	074434	SIZING	153774
066432 03/01/79 DERI	DERIV	066442						
BLOCK COMMON	.DATA.	064300	HVACS	153676	SCHDL	064204	WEATHR	074502
	CTRL	153162					SOLAR	074434
063704 03/01/79 WKDA	WKDAY	063704						
	.DATA.	063630						
063324 03/01/79 HOLD	HOLDAY	063324						
	.DATA.	063314						
061450 03/01/79 HVAC	HVAC	061460						
BLOCK COMMON	.DATA.	061200	SOLAR	074434	SCHDL	064204	SIZING	153774
	HVACS	153676	CTRL	153162			FAN	074422
061134 03/01/79 ACCO	ACCOMV	061134						
	.DATA.	061114						
060356 03/01/79 HP	HP	060356						
	.DATA.	060262						
060110 03/01/79 ENTH	ENTHLP	060110						
BLOCK COMMON	.DATA.	060050	SOLAR	074434	HVACS	153676	CTRL	153162
057724 03/01/79 FUSI	FUSION	057724						
BLOCK COMMON	.DATA.	057700	SOLAR	074434	HVACS	153676	CTRL	153162
057326 03/01/79 CHAR	CHARGE	057306						
BLOCK COMMON	.DATA.	057160	FLOW	074500	SIZING	153774	SOLAR	074434
	CTRL	153162					HVACS	153676
057032 03/01/79 PVSF	PVSF	057012						
	.DATA.	056740						
056400 03/01/79 INPU	INPUT	056470						
BLOCK COMMON	.DATA.	056330	SCHDL	064204	CTRL	153162		
056270 03/01/79 STEP	STEP	056270						
BLOCK COMMON	.DATA.	056250	SOLAR	074434	CTRL	153162		
056040 03/01/79 CBOU	CBOUPT	056040						
	.DATA.	055770						
055212 03/01/79 SUN	SUN	055212						
BLOCK COMMON	.DATA.	055060	SOLAR	074434				
052740 03/01/79 ECON	ECONOM	052740						
BLOCK COMMON	.DATA.	052460	DHTP	052402	DMAND	052374	ACES	052342
	FUEL	051674	ECON	051250			BILL	052266
050010 03/01/79 AMOU	AMOUNT	050010						
BLOCK COMMON	.DATA.	047650	DMAND	052374	ACES	052342	FUEL	051674
							ECON	051250

ORIGIN	DATE	MODULE	ENTRY	LOCATION	ENTRY	LOCATION	ENTRY	LOCATION	ENTRY	LOCATION
047552	03/01/79	DCAL	DCALC	047552						
		BLOCK COMMON	.DATA.	047530						
046052	03/01/79	FUEL	FUELCO	046052						
		BLOCK COMMON	.DATA.	045720						
045576	03/01/79	HILL	HILLIN	045576						
		BLOCK COMMON	.DATA.	045550						
043300	03/01/79	OUTP	OUTPUT	043300						
		BLOCK COMMON	.DATA.	042420						
041734	03/01/79	ACES	ACESCO	041734						
		BLOCK COMMON	.DATA.	041500						

SUBPROGRAMS OBTAINED FROM SYSTEM LIBRARY

041312	76/06/11	FWRP	.CE.L.	041373	.FEXIT	041312	.WLITST	041376	.WLEND	041410	.FDSLD	041411
			.ABRT	041371	EXIT	041312						
041134	76/06/11	FALC	.FDSGT	041134	.FDSRL	041244	.FDSCH	041305				
041130	76/06/11	FSIP	.FDSST	041130	FDUMP	041131	FDHUG	041131				
040766	76/01/05	FDXP	.FDXP2	041015	DPW	041015	.FXP5	040766	.FXP6	040770	.FDXP3	041002
			.FXP4	041006								
040554	77/03/14	FDLG	.DLOG	040554	.DLOG2	040576	.DLOG10	040565	.DLG10	040570	.DLOG	040557
			.DLG2	040602								
040360	76/01/05	DEXP	.DEXP	040360	.DEXP2	040372	.DEXP10	040365	.DEXP	040363	.DEXP2	040375
040214	76/09/10	F2XP	.FXP2	040214	.FDXP1	040216						
040102	76/01/05	F3XP	.FXP3	040102	POW	040102						
037750	76/03/22	FSIN	.SIN	037756	.COS	037750	.SIN	037761	.COS	037753	.SIN1	037756
037560	76/01/05	FSQR	.SQRT	037660	.SQRT	037662						
037474	77/03/14	FALG	.ALOG	037474	.ALOG2	037516	.ALOG10	037505	.ALG10	037510	.FALOG	037477
			.ALOG2	037522	.ALOG1	037474						
037236	76/03/22	FASN	.ARSIN	037241	.ARCOS	037236	.ARSIN	037242	.ARCOS	037237	.ASIN	037241
			.ACOS	037236								
037056	76/01/05	FEXP	.EXP	037066	.EXP2	037100	.EXP10	037073	.EXP2	037103	.EXP	037071
			.EXP1	037066								
036752	74/05/19	FSLD	.FSLD	036752	.FSDO	036757	.FSLI	036763	.FSDI	036767	.FSII	036773
			.FSIO	036777	.FSRI	037003	.FSRO	037007	.FS2I	037013	.FS2O	037017
			.FSRI	037027	.FSBO	037033	.FSCI	037037	.FSCO	037037	.FX2I	037023
			.FX2O	037025								
035520	76/10/21	FRDH	.FRDH	036153	.FWRB	035713	.FBLT	036452	.FRDT	036436	.FRLR	036336
			.FWLR	036371	.FRBC	036301	.F3CA	036277	.FBLI	036470	.F3SI	036470
			.FXDI	036470	.FRDI	036472	.FBLD	036474	.FRSO	036474	.FXDO	036474
			.FRDO	036476								
035254	77/03/30	FRDD	.FRDD	035440	.FWRD	035441	.FRUN	035442	.FENC	035443	.FDEC	035444
			.FRCD	035445	.FPRN	035446	.FRTN	035447	.FFIL	035450	.DRCNV	035451
			.BDCNV	035475	.ABLK	035267	.BCOMP	035316	.LNSZ	035326	.A37R	035424
			.PRNIT	035271	.ASTRK	035614	.TC	035273	.POINT	035313	.SIGN	035314
			.FRMTZ	035514	.FRMTZ	035514	.PHINT	035272	.FILL	035324	.A2	035260
			.A7	035322	.A1	035260	.A3	035270	.A4	035320	.A8	035324
			.A9	035327	.A13	035330	.A14	035331	.A15	035332	.A17	035333
			.A18	035260	.A21	035336	.A24	035260	.A30	035313	.A31	035347
			.A27	035344	.A32	035372	.A33	035374	.A34	035374	.A35	035376
			.A37	035420	.A40	035425	.A41	035437	.LPRCH	035262	.CMACH	035263

ORIGIN	DATE	MODULE	ENTRY	LOCATION	ENTRY	LOCATION	ENTRY	LOCATION	ENTRY	LOCATION
031454	77/12/05	FDIO	.ECHR	035264	.UPPRE	035265	.UPPEF	035266	.LWRT	035265
			.OCT60	035261	.A52	035254	.FXWC	035255	.A51	035256
			.FRD	034423	.FWRT	034336	.FPV	034331	.FNC	034552
			.FCD	034423	.FPR	034335	.FEL	034535	.FRT	034514
			.TOS	034271	.LACTF	035161	.EFECF	035244	.FCNVI	032277
			.FCNV2	032372	.SKPBI	032255	.INCR	035246	.CKSTA	032501
			.FMSC2	031505	.FMSC4	031522	.FMSC5	031557	.FMSC6	031531
			.SVRG	031470	.RETI	031503	.GTAFG	034346	.SXIT	031574
			.LNBGN	034632	.SKPBI	032265	.VLST	032212	.CSCFP	031612
			.FEFLT	031664	.FDFLE	031663	.CSESH	034142	.CDCPT	032401
			.CCMMA	031626	.CRPAW	031722	.CLFAR	031666	.LAUFF	035162
			.CKSTP	032462	.CKST	032473	.DATUM	035144	.STCP	032721
			.CCR	033407	.NASTRE	034716	.YASTFK	034721	.CN1	032531
			.FCNV	032456	.STP	032705	.FALD	032315	.FCNVL	032325
			031006	75/09/10	FBST	.FBST	031006			
030732	74/01/11	FEOF	.FEOF	030732						
030556	74/07/22	FSLW	.FSLEW	030566						
030364	75/11/25	FEFT	.FEFT	030364						
030040	09/01/73	FXEM	.FXEM	030051						
026620	77/03/30	FXER	.LSTMS	030350	.FRMT	030371	.FEFTS	030376		
			.FX2	030076	.FXEM	030050	.FXE	030061	.FXMC	030210
			.FX9	030075	.KIND	030164	.BUGE	030163	.MXERR	030052
			.FX6	030151	.FX3	030104	.FX10	030173	.LRG	030120
			.FXM	026640	.CLLR	030314	.EYDEE	030316	.FX4	030106
			.FGERR	027337	.FX7	030200				
			.FUFIN	030032	.FXM	027315	ANYERR	027466	FXOPT	027350
			.MSX	027445	.FXALT	027425	.FXALT	027437	S.REG.	025630
			.FXSW3	027364	.FXDV	030000	.FXDV	027776	FXCODE	027272
			.ETERM	026540	.FXPW	027173	.FXTAC	026735	.FXSW1	027274
			.FOPEN	026007	.ERELK	027474	.FLTER	027476		
			.FID0	025636	.FTERM	026540	.JEXIT	026540	.JEXIT	025540
			.FSLII	025352	.FBAD	026002	.FXDF	026232	.FGTFB	026003
			.FCHMA	025206						
			.FSETU	025104	.FSLIG	025322	.FSLIB	025320	.FXFLG	025354
.FMDR	025074	.FCHM	025210	.FCHP	025211					
025042	75/09/16	FRCD	.ASCB	025042						
024640	03/05/73	FTAR	.GTAR	024640						
024634	75/09/16	FMXN	.MXNO	024634						
024354	74/12/03	GHSR	.GHSR	024354						
024272	01/03/66	GWAI	.SWAIT	024272						
024242	01/03/66	GSTI	.GSTIN	024242						
024130	76/02/12	GSIO	.GSTOT	024130						
024060	07/07/69	GWMC	.SWTRC	024060						
023320	77/05/03	GGTB	.SGTBK	023320						
022454	01/03/66	GPSZ	.GAGET	023322	.GRD01	023324	.GGETR	023312	.GPUTR	023312
			.GUPNR	023312	.GCLSR	023312	.GPTHK	022555	.GPUTR	022555
			.GCOPY	022552	.COPY	022552	.GAPTR	022555	.GAPUT	022560
			.GPT	022560	.GACOP	022552				
			.GPSAV	022563						
			.GPTSZ	022454	.GAPTS	022454	.PUTSZ	022454		

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ORIGIN	DATE	MODULE	ENTRY LOCATION	ENTRY LOCATION	ENTRY LOCATION	ENTRY LOCATION	ENTRY LOCATION
021636	77/04/07	GOPE	.GOPEN 021636	.GAOPE 021636	.GPSZ 022446	.GLPPP 022446	OPEN 021636
021630	04/29/72	GRNT	.GXREA 021630	.GXWRT 021630	.GXLAB 021630	.GXOPN 021631	
021126	77/04/07	GCLD	.GCLSE 021126	.GACLS 021126	.GR185 021240	.GR186 021346	.GR178 021245
			CLOSE 021126	.GHCLS 021126			
021026	07/07/69	GHCL	.GRLSE 021026	.GARLS 021026	RELSE 021026		
020642	73/12/03	G20R	.GR200 020642				
020554	77/04/07	G25R	.GR225 020554				
020476	76/02/12	G50R	.GR250 020476				
020224	75/02/03	G27R	.GR275 020224				
020042	75/02/05	G37R	.GR377 020100	.GR375 020042	.GR37X 020117	.GR390 020137	
020020	74/12/03	G60R	.GR960 020025	.GABTB 020020			
017424	77/07/11	G80R	.GR980 017424	.GR979 017527	.GR99X 017430	.GR984 017475	.GR985 017527
			.GR999 017443	ASCII 017525	ASCRPT 017532	WORRP 020012	
017372	75/04/11	G90R	.GR990 017372	.GR991 017413			
016516	77/04/07	GLAB	.GINHD 016523	.GOUTH 016522	.GINTL 016521	.GOUTL 016520	.GUSWH 016517
			.GOVRL 016524	.GLREA 016624	.GRCVY 016516	.GRPRV 016556	
016514	03/07/66	GINI	.GINID 016514				

	RANGE	SIZE
ALLOCATED CORE	000000 THRU 155777	156000
RELOCATABLE	016514 THRU 155777	137254
\$ TAPE9	08,X10,,63345,,LOADS	
\$ DATA	05	
\$ DATA	20	
\$ SYSOUT	09,ORG	
\$ SYSOUT	10,ORG	

FCB AND BUFFER SPACE		
AVAILABLE	000101 THRU 016513	016413
FILE CTRL BLKS	016206 THRU 016513	000306
MAXIMUM BUFFER SPACE REQUIRED		004307

51K, IS THE MINIMUM MEMORY NEEDED TO LOAD THIS ACTIVITY WITH ALL FILES OPEN 770310 4/J
 001674 LOCATIONS REQUIRED FOR LOAD TABLE
 EXECUTION PROGRAM ENTERED AT 154512 THROUGH .FSETU

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SNUMB = 68281, ACTIVITY # = 02, , REPORT CODE = 11, RECORD COUNT = 000261

INPUT PARAMETERS

MINNEAPOLIS, MN.

A(1)	44.700	LATITUDE OF INSTALLATION*
A(2)	93.000	LONGITUDE OF INSTALLATION*
A(3)	6.0000	TIME ZONE*
A(4)	365.00	NUMBER OF DAYS IN YEAR*
A(5)	0.	AZIMUTH OF COLLECTORS (DEGREE)*
A(6)	44.700	TILT OF COLLECTORS (DEGREE)*
A(7)	1.0000	STARTING DAY FOR SIMULATION*
A(8)	365.00	LAST DAY FOR SIMULATION*
A(9)	1.0000	INTEGRATION STEP SIZE (HRS)*
A(10)	0.	SAMPLE TIME (HRS)
A(11)	1.0000	SIZING TYPE (1=OTHERS, 2=COLLECTOR)*
A(12)	1.0000	RUN TYPE(1=COMPONENT SIZING, 2=SIMULATION)*
A(13)	12.000	NO. OF CONSECUTIVE DAYS FOR COMPONENT SIZING*
A(14)	0.26000E 06	FLOW RATE OF AIR IN BUILDING (LBS PER HR)
A(15)	1.0000	NUMBER OF COLLECTORS PER ROW IN SERIES
A(16)	10.000	NO. OF ITERATION STEPS ALLOWED IN COLLECTOR SIZING*
A(17)	0.90000	CLEARNESS FACTOR FOR HOUSE LOCATION*
A(18)	55.000	DESIGN SUPPLY AIR TEMPERATURE FOR HVAC (F)*
A(19)	95.000	DESIGN SUPPLY AIR HUMIDITY FOR HVAC*
A(20)	0.20000	GROUND REFLECTANCE (RHO)*
A(21)	55.000	MAXIMUM HUMIDITY IN BUILDING*
A(22)	80.000	CHANGEOVER TEMPERATURE FOR HP AIRSIDE CONDENSOR
A(23)	5.0000	ERROR PERCENTAGE ALLOWED IN COLLECTOR SIZING
A(24)	2.0000	NO. OF 4RHI-2000-TSK TYPE COMPRESSORS FOR H.P.
A(25)	2.0000	NO. OF 6RHI-3500-TSK TYPE COMPRESSORS FOR H.P.
A(26)	140.00	MAXIMUM DOMESTIC HOT WATER TEMPERATURE (F)
A(27)	32.000	INITIAL TEMPERATURE IN COLD STORAGE (F)
A(28)	120.00	INITIAL TEMPERATURE IN HOT STORAGE (F)
A(29)	0.	FILE CODE FOR R/W (0.= NO R/W)*
A(30)	0.	ECONOMIC ANALYSIS INCLUDED: (1=YES, 0=NO)*
A(31)	0.	A ARRAY INDEX FOR VARIABLE INPUT*
A(32)	1.0000	NUMBER OF INCREMENTAL POINTS FOR VARIABLE INPUT*
A(33)	0.	DELTA INCREMENT FOR VARIABLE INPUT*
A(34)	0.84000	FRTA FOR FLAT PLATE COLLECTOR (NORMAL INCIDENCE)*
A(35)	1.0000	NUMBER OF GLASS COVERS (1 OR 2)*
A(36)	0.80000	FRUL FOR FLAT PLATE COLLECTOR*
A(37)	10.990	LENGTH OF HOT STORAGE BIN
A(38)	10.990	HEIGHT OF HOT STORAGE BIN*
A(39)	21.000	START OF OFF PEAK TIME FOR ELECTRIC USAGE
A(40)	9.0000	START OF ON PEAK TIME FOR ELECTRIC USAGE
A(41)	50.000	MAX. ALLOWABLE TEMP. IN COLD STORAGE (F)
A(42)	10.000	DELTA DEAD BAND FOR HOT STORAGE CHARGING (F)
A(43)	130.00	MAXIMUM TEMPERATURE FOR RESET HEATING (F)*
A(44)	90.000	MINIMUM TEMPERATURE FOR RESET HEATING (F)*
A(45)	8.0000	TIME ENDURANCE FOR HEATING OF HOT TANK (HRS)*
A(46)	10.000	TEMPERATURE DIFFERENCE FOR HEATING STAGE RESET
A(47)	90.000	DESIGN SUMMER TEMPERATURE FOR THE LOCATION
A(48)	78.000	AMB. AIR TEMP. AT WHICH NO ICE IS NEEDED IN STORAGE
A(49)	0.73000	SLOPE FOR THE RESET TEMPERATURE CONTROL EQ.
A(51)	10.000	MIN. INSOLATION TO TURN COLLE. ON (BTUS/FT2 HR)
A(53)	205.00	MAXIMUM COLLECTOR OUTLET TEMPERATURE (F)

A(55)	18000.	UA HEAT EXCHANGER - COLLECTOR/STORAGE (BTUS/HR F)
A(56)	0.	OUTPUT ALSO IN GRAPHIC FORM (0=NO,1=YES)
A(57)	-20.000	MINIMUM TEMPERATURE FOR PLOTTING OUTPUT
A(58)	200.00	MAXIMUM TEMPERATURE FOR PLOTTING OUTPUT
A(59)	0.15000E 07	MAXIMUM ENERGY FOR PLOTTING OUTPUT (BTUS/HR)
A(60)	0.50000E 07	MAXIMUM ENERGY FOR YEARLY PLOT (BTUS/DAY)
A(62)	30.000	NUMBER OF DAYS FOR PLOTTING AVERAGE
A(63)	1.0000	FLAT PLATE SHADING NUMBER OF ROWS
A(64)	0.	FLAT PLATE SHADING LENGTH OF COLLECTOR ROW
A(65)	3.0000	FLAT PLATE SHADING LENGTH OF COLLECTOR
A(68)	36.000	WIDTH OF COLD STORAGE (IF A(64)=0.) (FT)*
A(69)	12.000	HEIGHT OF COLD STORAGE (IF A(64)=0.) (FT)*
A(70)	0.40000	PACKING FACTOR OF ICE IN COLD STORAGE*
A(71)	0.10000	AVERAGE U VALUE AT STORAGE SURFACE (BTUS/FT2 HR F)*
A(72)	42.000	GROUND TEMPERATURE AT STORAGE SIZING TIME (F)*
A(74)	10.000	NUMBER OF ITERATION STEPS IN THE FLOW LOOP
A(76)	0.25000	TEMPERATURE CONVERGENCE CRITERIA IN COLL. LOOP (F)
A(79)	50.000	UL OF PIPE GOING TO COLLECTOR INLET (BTUS/HR F)
A(80)	50.000	UL OF PIPE COMING TO HOUSE OR STORAGE (BTUS/HR F)
A(83)	0.10000	MINIMUM FRACTION OF AMBIENT AIR FOR VENTILATION*
A(84)	11.000	NUMBER OF HEATING/COOLING ZONES IN BLDG.*
A(85)	0.	FRACTION OF VENT. AIR THRU ZONE 1*
A(86)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 2*
A(87)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 3*
A(88)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 4*
A(89)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 5*
A(90)	0.53333	FRACTION OF VENT. AIR THRU ZONE 6*
A(91)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 7*
A(92)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 8*
A(93)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 9*
A(94)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 10*
A(95)	0.10667	FRACTION OF VENT. AIR THRU ZONE 11*
A(96)	0.05500	COLLECTOR GROSS TO APERTURE AREA RATIO*
A(98)	0.	FLAG FOR ACES OR CONVENTIONAL SYSTEM (0=ACES,1=C)*
A(99)	0.75000	OIL FIRED FURNACE EFFICIENCY*
A(100)	0.65000	GAS FIRED FURNACE EFFICIENCY*
A(101)	45.000	DESIGN POWER CONSUMPTION OF CIRCULATION FAN (HP)*
A(103)	1.0000	HEATING MODE (3=GAS,2=OIL,1=ELECTRIC&ACES)*
A(135)	0.	NO. OF DAYS TO SKIP FOR PRELIM. WEATHER TAPE POS.*
A(142)	274.00	START HEATING SEASON (COUNTING FROM JAN. 1)
A(143)	182.00	BEGIN OF COOLING SEASON*
A(144)	366.00	END OF COOLING SEASON*
A(145)	230.00	BACK UP COIL CAPACITY (KW)
A(146)	0.	FLAG FOR BACK UP MODE (0.=NO,1.=YES)
A(149)	8.0000	BEGINNING WORKING HOUR*
A(150)	17.000	END OF WORKING HOUR*
A(151)	540.00	MAXIMUM PEOPLE IN THE BUILDING*
A(183)	0.	REMARK, INDICATOR * MEANS INPUT REQUIRED WHEN A(11)=1.

WELL WATER TEMPERATURE	45.000	42.000	40.000	39.000	41.000	45.000	51.000	55.000	57.000	57.000	55.000	50.000
HOT WATER SCHEDULE	0.	0.	0.	0.	0.	0.063	0.063	0.063	0.063	0.063	0.063	0.063
	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.	0.	0.
OCCUPANCY SCHEDULE	0.	0.	0.	0.	0.	0.100	0.100	0.200	1.000	1.000	1.000	1.000
	0.800	1.000	1.000	1.000	1.000	0.800	0.400	0.100	0.100	0.	0.	0.

OUTPUT TABLE AND PLOTS FOR DAYS LISTED 5 6 7 8 9 10 11 12 13 14 15 16 17 0 0 0 0 0 0 0

THIS RUN IS FOR COMPONENT SIZING

THIS IS THE FIRST RUN FOR COMPONENT SIZING
 THE APPROPRIATE OUTPUT SHOULD BE USED IN
 THE NEXT RUN FOR STORAGE AND COLLECTOR SIZING
 A(15),A(37),A(53),A(64),
 A(65),A(66),A(67),A(68),A(69)

THE SIMULATION STARTED ON DAY 1 MONTH 10 OF THE YEAR 1957

ZONE	NAME OF ZONE
1	BASEMENT
2	SO. SIDE ZONE, 1ST TO 5TH FLOORS
3	WE. SIDE ZONE, 1ST TO 5TH FLOORS
4	NO. SIDE ZONE, 1ST TO 5TH FLOORS
5	EA. SIDE ZONE, 1ST TO 5TH FLOORS
6	CENTRAL ZONE, 1ST TO 5TH FLOORS
7	SO. SIDE ZONE, 6TH FLOOR
8	WE. SIDE ZONE, 6TH FLOOR
9	NO. SIDE ZONE, 6TH FLOOR
10	EA. SIDE ZONE, 6TH FLOOR
11	CENTRAL ZONE, 6TH FLOOR

	IONC	IDHC	ITHC	QDIRCT	QAVAIL	QCOLCT	QCR	QHR
1	4.3624E 04	2.6272E 04	3.7152E 04	2.9329E 04	6.1114E 05	0.	-1.1702E 06	2.0734E 08
2	3.5979E 04	2.3535E 04	3.5646E 04	2.1939E 04	5.1294E 05	0.	-6.7897E 06	1.2428E 08
3	4.7199E 04	3.1977E 04	5.0152E 04	2.7112E 04	6.7884E 05	0.	-1.7962E 07	8.7198E 07
4	4.1400E 04	2.7576E 04	4.3443E 04	2.4252E 04	6.0146E 05	0.	-1.3703E 07	4.0249E 07
5	3.3020E 04	2.0697E 04	3.5012E 04	2.0865E 04	5.2515E 05	0.	-2.3070E 07	1.2864E 07
6	2.9914E 04	1.6475E 04	2.8522E 04	2.1503E 04	5.0222E 05	0.	-9.3476E 07	2.9165E 05
7	3.3608E 04	1.5574E 04	2.3984E 04	2.6146E 04	5.2379E 05	0.	-1.7520E 08	9.9941E 04
8	2.7134E 04	9.6939E 03	1.5767E 04	2.1633E 04	4.1990E 05	0.	-1.4734E 08	1.1448E 05
9	2.6718E 04	7.8649E 03	1.2041E 04	2.1356E 04	3.8900E 05	0.	-2.8489E 07	4.4688E 06
10	2.0080E 04	6.2577E 03	1.0119E 04	1.5959E 04	3.0095E 05	0.	-6.5743E 07	2.7881E 07
11	1.7078E 04	6.7698E 03	1.1619E 04	1.3313E 04	2.7390E 05	0.	-1.7151E 07	7.8858E 07
12	3.4825E 04	1.7669E 04	2.7082E 04	2.5628E 04	5.3038E 05	0.	-5.3686E 06	1.2337E 08

	QDHW	QCHTOT	QHBTOT	QTAMB	BACKUP	QH1	QH2	QH3
1	4.7286E 06	-1.3848E 08	1.7932E 08	1.2821E 08	0.	5.2561E 06	3.0294E 07	3.7873E 07
2	4.2160E 06	-1.2795E 08	1.1572E 08	9.6823E 07	0.	4.8657E 06	1.9565E 07	2.4211E 07
3	4.9849E 06	-1.5519E 08	8.1994E 07	1.0151E 08	0.	5.2516E 06	1.3894E 07	1.6929E 07
4	4.8102E 06	-1.7739E 08	3.8908E 07	2.0627E 08	0.	5.1307E 06	6.7436E 06	7.0467E 06
5	4.9440E 06	-2.0304E 08	1.2784E 07	1.5456E 08	0.	5.2516E 06	1.6132E 06	1.4282E 06
6	4.5334E 06	-2.2065E 08	2.9165E 05	7.0935E 07	0.	2.3778E 05	1.7306E 04	5.9393E 03
7	4.2387E 06	-2.5993E 08	9.9941E 04	3.3154E 05	0.	9.9940E 04	2.8236E-01	2.6764E-01
8	4.4428E 06	-2.4952E 08	1.1448E 05	3.8140E 07	0.	1.0401E 05	1.6454E 03	5.5775E 02
9	3.7647E 06	-2.0116E 08	4.4688E 06	1.3822E 03	0.	9.3699E 04	8.0071E 05	8.8959E 05
10	4.1412E 06	-1.7224E 08	2.7202E 07	6.5294E 07	0.	4.9257E 06	4.0053E 06	4.8763E 06
11	4.0437E 06	-1.3712E 08	7.5434E 07	8.6870E 07	0.	5.1258E 06	1.2310E 07	1.5464E 07
12	4.0822E 06	-1.3127E 08	1.1382E 08	9.7006E 07	0.	5.5269E 06	1.8916E 07	2.3713E 07

	QH4	QH5	QH6	QH7	QH8	QH9	QH10	QH11
1	4.1021E 07	3.5858E 07	0.	6.0595E 06	7.5747E 06	8.2043E 06	7.1716E 06	0.
2	2.6433E 07	2.2170E 07	0.	3.9130E 06	4.8421E 06	5.2865E 06	4.4339E 06	0.
3	1.8620E 07	1.4505E 07	0.	2.7755E 06	3.3959E 06	3.7240E 06	2.9011E 06	0.
4	7.9868E 06	6.3710E 06	0.	1.3487E 06	1.4093E 06	1.5974E 06	1.2742E 06	0.
5	1.7490E 06	1.4864E 06	0.	3.2263E 05	2.8563E 05	3.4979E 05	2.9727E 05	0.
6	1.0713E 04	1.0934E 04	0.	3.4612E 03	1.1879E 03	2.1426E 03	2.1868E 03	0.
7	2.3033E-01	2.5230E-01	0.	5.6473E-02	5.3528E-02	4.6066E-02	5.0461E-02	0.
8	3.7819E 03	2.7357E 03	0.	3.2907E 02	1.1155E 02	7.5638E 02	5.4714E 02	0.
9	1.0692E 06	8.8645E 05	0.	1.6014E 05	1.7792E 05	2.1383E 05	1.7729E 05	0.
10	5.3889E 06	4.2963E 06	0.	7.9719E 05	9.7526E 05	1.0778E 06	8.5927E 05	0.
11	1.5721E 07	1.4096E 07	0.	2.4620E 06	3.0927E 06	3.3441E 06	2.8192E 06	0.
12	2.5423E 07	2.2193E 07	0.	3.7833E 06	4.7425E 06	5.0845E 06	4.4385E 06	0.

	QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
1	-1.7245E 04	-7.5582E 06	-3.6767E 05	-4.2156E 02	-3.3149E 05	-1.0713E 08	-1.5116E 06	-7.3534E 04
2	-1.4910E 04	-9.1112E 06	-2.2761E 06	-2.5050E 04	-1.3969E 06	-9.3807E 07	-1.8222E 06	-4.5522E 05
3	-1.7296E 04	-1.1728E 07	-4.4662E 06	-3.3274E 05	-5.6544E 06	-1.0713E 08	-2.3455E 06	-8.9325E 05
4	-1.6450E 04	-1.6091E 07	-1.1704E 07	-4.6321E 06	-1.2699E 07	-1.0269E 08	-3.2181E 06	-2.3409E 06
5	-1.7296E 04	-1.6909E 07	-1.7807E 07	-9.2423E 06	-1.8095E 07	-1.0713E 08	-3.3817E 06	-3.5614E 06
6	-1.8596E 06	-1.9008E 07	-2.2599E 07	-1.4252E 07	-2.5948E 07	-1.0269E 08	-3.8896E 06	-4.0797E 06
7	-1.9455E 06	-2.7358E 07	-4.1552E 07	-2.1009E 07	-3.1354E 07	-1.0374E 08	-5.4717E 06	-6.3104E 06
8	-2.1383E 06	-2.7220E 07	-2.5109E 07	-1.6029E 07	-2.7275E 07	-1.1052E 08	-5.4440E 06	-5.0218E 06
9	-1.8549E 06	-2.4281E 07	-1.5208E 07	-7.8244E 06	-1.8434E 07	-1.0034E 08	-4.8563E 06	-3.0415E 06
10	-1.9799E 04	-1.7242E 07	-7.8975E 06	-3.4484E 06	-8.8394E 06	-1.0608E 08	-3.4680E 06	-1.5795E 06
11	-1.6450E 04	-7.9957E 06	-1.6174E 05	-2.7031E 05	-1.6780E 06	-1.0269E 08	-1.5991E 06	-3.2348E 05
12	-1.5604E 04	-7.9219E 06	-5.1799E 05	-3.9047E 04	-5.5450E 05	-1.0034E 08	-1.5844E 06	-1.0360E 05

	QC9	QC10	QC11	QCOMP	FPDWER	PUMPC	QH GAS	QHOIL
1	-8.4312E 01	-6.6299E 04	-2.1426E 07	0.	1.1556E 07	0.	0.	0.
2	-5.0100E 03	-2.7938E 05	-1.8761E 07	0.	9.9800E 06	0.	0.	0.
3	-6.6549E 04	-1.1309E 06	-2.1426E 07	0.	1.1556E 07	0.	0.	0.
4	-9.2642E 05	-2.5398E 06	-2.0538E 07	0.	1.5715E 07	0.	0.	0.
5	-1.8485E 06	-3.6191E 06	-2.1426E 07	0.	1.6977E 07	0.	0.	0.
6	-2.8504E 06	-4.7896E 06	-2.0538E 07	0.	1.6861E 07	0.	0.	0.
7	-4.2018E 06	-6.2668E 06	-2.0747E 07	0.	1.7579E 07	0.	0.	0.
8	-3.2057E 06	-5.4550E 06	-2.2104E 07	0.	1.8865E 07	0.	0.	0.
9	-1.5649E 06	-3.6868E 06	-2.0069E 07	0.	1.5507E 07	0.	0.	0.
10	-6.8968E 05	-1.7679E 06	-2.1215E 07	0.	1.1556E 07	0.	0.	0.
11	-5.4061E 04	-3.3560E 05	-2.0538E 07	0.	1.1030E 07	0.	0.	0.
12	-7.8094E 03	-1.1090E 05	-2.0069E 07	0.	1.0505E 07	0.	0.	0.

	QSELECT	QEACES	QEHCON	QECCON
1	9.4316E 07	0.	0.	0.
2	8.2843E 07	0.	0.	0.
3	9.4572E 07	0.	0.	0.
4	9.5429E 07	0.	0.	0.
5	9.9852E 07	0.	0.	0.
6	9.6298E 07	0.	0.	0.
7	9.7845E 07	0.	0.	0.
8	1.0344E 08	0.	0.	0.
9	9.3195E 07	0.	0.	0.
10	9.2704E 07	0.	0.	0.
11	8.9978E 07	0.	0.	0.
12	8.8411E 07	0.	0.	0.

IDNC	IDHC	ITHC	QDIRECT	QAVAIL	QCOLCT	QCB	QHB
3.9058E 05	2.1036E 05	3.3054E 05	2.6903E 05	5.8697E 06	0.	-5.9546E 08	7.0702E 08

QDHW	QCRTOT	QHBTOT	QTAMB	BACKUP	QH1	QH2	QH3
5.2931E 07	-2.1740E 09	6.5015E 08	1.1971E 09	0.	4.1869E 07	1.0817E 08	1.3244E 08

QH4	QH5	QH6	QH7	QH8	QH9	QH10	QH11
1.4443E 08	1.2188E 08	0.	2.1630E 07	2.6487E 07	2.8885E 07	2.4375E 07	0.

QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
-7.9322E 06	-1.9246E 08	-1.4092E 08	-7.7104E 07	-1.5024E 08	-1.2443E 09	-3.8512E 07	-2.8183E 07

QC9	QC10	QC11	QCOMP	FPOWER	PUMPC	QHGAS	QH0IL
-1.5421E 07	-3.0248E 07	-2.4886E 08	0.	1.6779E 08	0.	0.	0.

QSELECT	QEACES	QEHCON	QECCON
1.1289E 09	0.	0.	0.

YEARLY INTERNAL LOAD GENERATED BY LIGHTS = 0.75805E 09
 EQUIPMENT = 0.15019E 09
 PEOPLE = 0.11153E 09

THE MAXIMUM FAN FLOW RATIO IS 0.499 AT TIME 15.00 ON DAY 291.

THE MAXIMUM COOLING LOAD IS -0.16063E 07 BTUS/HR
 THE MAXIMUM HEATING LOAD IS 0.73969E 08 BTUS/HR

HEAT PUMP COOLING CAPACITY = 0.53934E 06 BTUS/HR
 BASED ON THIS CAPACITY, THE USER HAS TO SPECIFY THE NUMBER OF COMPRESSORS TO BE USED IN THE HEAT PUMP
 EITHER TYPE 4RA3-2000-TSK OR TYPE 6RHI-3500-TSK OR THE COMBINATION. SEE ROUTINE HP IN THIS SOFTWARE FOR DETAIL
 THE HOT STORAGE BIN CAPACITY = 0.82881E 05 LBS
 THE EQUATION FOR THE TEMPERATURE RESET CONTROLLER IN THE STORAGE IS,

TSETH = 130.0 - 0.73 * TAMB
 THIS IS BASED ON THE ABILITY TO HEAT THE BUILDING FOR 8.00 CONSECUTIVE HOURS FROM HOT STORAGE.

IF THE HOT STORAGE IS ASSUMED TO BE A CUBE, EACH SIDE 10.99 FT LONG, THEN THE
 HEAT TRANSFER COEFFICIENT OF THE TANK IS 72.50 BTUS/F. HR

RATINGS OF THE HEAT PUMP COMPRESSORS,

4RA3-2000-TSK

COOLING CAPACITY = 0.10399E 06 BTUS/HR
HEATING CAPACITY = 0.15697E 06 BTUS/HR
COMPRESSOR SIZE = 0.15523E 02 KW
CONDENSOR TEMPERATURE = 130.00 F
EVAPORATOR TEMPERATURE = 20.00 F
RATED COP FOR HEATING = 0.29628E 01

6RHI-3500-TSK

COOLING CAPACITY = 0.20006E 06 BTUS/HR
HEATING CAPACITY = 0.30246E 06 BTUS/HR
COMPRESSOR SIZE = 0.30020E 02 KW
CONDENSOR TEMPERATURE = 130.00 F
EVAPORATOR TEMPERATURE = 20.00 F
RATED COP FOR HEATING = 0.29520E 01

DURING THE 12.0 CONSECUTIVE DAYS OF MAXIMUM NET HEATING, THE HEATING LOAD IS 0.90089E 08 BTUS
AND THE COOLING LOAD IS 0.95707E 03 BTUS

THE COLD STORAGE HAS THE FOLLOWING DIMENSION
36.8 FT AT EACH SIDE (COMPUTED FROM THE SOFTWARE), AND
12.0 FT HEIGHT (PRESUMED BY THE USER)

THE COLD STORAGE HAS THE FOLLOWING DIMENSION
36.8 FT AT EACH SIDE (PRESUMED BY THE USER), AND
12.0 FT HEIGHT (COMPUTED FROM THE SOFTWARE)

THE COLD STORAGE CAN STORE 1015079.4 LBS OR 121809.5 GALLONS OF WATER
THE STORAGE UA = 447.9 BTUS/HR F

THE ABOVE INFORMATION IS BASED ON 12.0 CONSECUTIVE DAYS OF WORST HEATING LOAD IN THE YEAR.

THE FIRST GUESS FOR COLLECTOR AREA IS 6104.5 FT²
EACH COLLECTOR HAS DIMENSION OF 3.0 * 6.0 FT², AND THE COLLECTORS ARE PLACED 1 IN SERIES
THIS INFO. MUST BE PUT IN THIS PROGRAM PROPERLY FOR COLLECTOR SIZING

INPUT PARAMETERS

MINNEAPOLIS, MN.

A(1)	44.700	LATITUDE OF INSTALLATION*
A(2)	93.000	LONGITUDE OF INSTALLATION*
A(3)	6.0000	TIME ZONE*
A(4)	365.00	NUMBER OF DAYS IN YEAR*
A(5)	0.	AZIMUTH OF COLLECTORS (DEGREE)*
A(6)	44.700	TILT OF COLLECTORS (DEGREE)*
A(7)	1.0000	STARTING DAY FOR SIMULATION*
A(8)	182.00	LAST DAY FOR SIMULATION*
A(9)	1.0000	INTEGRATION STEP SIZE (HRS)*
A(10)	0.	SAMPLE TIME (HRS)
A(11)	2.0000	SIZING TYPE (1=OTHERS, 2=COLLECTOR)*
A(12)	1.0000	RUN TYPE(1=COMPONENT SIZING, 2=SIMULATION)*
A(13)	12.000	NO. OF CONSECUTIVE DAYS FOR COMPONENT SIZING*
A(14)	0.26000E 06	FLOW RATE OF AIR IN BUILDING (LBS PER HR)
A(15)	1.0000	NUMBER OF COLLECTORS PER ROW IN SERIES
A(16)	10.000	NO. OF ITERATION STEPS ALLOWED IN COLLECTOR SIZING*
A(17)	0.90000	CLEARNESS FACTOR FOR HOUSE LOCATION*
A(18)	55.000	DESIGN SUPPLY AIR TEMPERATURE FOR HVAC (F)*
A(19)	95.000	DESIGN SUPPLY AIR HUMIDITY FOR HVAC*
A(20)	0.20000	GROUND REFLECTANCE (RHO)*
A(21)	55.000	MAXIMUM HUMIDITY IN BUILDING*
A(22)	80.000	CHANGEOVER TEMPERATURE FOR HP AIRSIDE CONDENSOR
A(23)	5.0000	ERROR PERCENTAGE ALLOWED IN COLLECTOR SIZING
A(24)	2.0000	NO. OF 4RHI-2000-TSK TYPE COMPRESSORS FOR H.P.
A(25)	2.0000	NO. OF 6RHI-3500-TSK TYPE COMPRESSORS FOR H.P.
A(26)	140.00	MAXIMUM DOMESTIC HOT WATER TEMPERATURE (F)
A(27)	32.000	INITIAL TEMPERATURE IN COLD STORAGE (F)
A(28)	120.00	INITIAL TEMPERATURE IN HOT STORAGE (F)
A(29)	0.	FILE CODE FOR R/W (0.= NO R/W)*
A(30)	0.	ECONOMIC ANALYSIS INCLUDED (1=YES, 0=NO)*
A(31)	0.	A ARRAY INDEX FOR VARIABLE INPUT*
A(32)	1.0000	NUMBER OF INCREMENTAL POINTS FOR VARIABLE INPUT*
A(33)	0.	DELTA INCREMENT FOR VARIABLE INPUT*
A(34)	0.84000	FRTA FOR FLAT PLATE COLLECTOR (NORMAL INCIDENCE)*
A(35)	1.0000	NUMBER OF GLASS COVERS (1 OR 2)*
A(36)	0.80000	FRUL FOR FLAT PLATE COLLECTOR*
A(37)	10.990	LENGTH OF HOT STORAGE BIN
A(38)	10.990	HEIGHT OF HOT STORAGE BIN*
A(39)	21.000	START OF OFF PEAK TIME FOR ELECTRIC USAGE
A(40)	9.0000	START OF ON PEAK TIME FOR ELECTRIC USAGE
A(41)	50.000	MAX. ALLOWABLE TEMP. IN COLD STORAGE (F)
A(42)	10.000	DELTA DEAD BAND FOR HOT STORAGE CHARGING (F)
A(43)	130.00	MAXIMUM TEMPERATURE FOR RESET HEATING (F)*
A(44)	90.000	MINIMUM TEMPERATURE FOR RESET HEATING (F)*
A(45)	8.0000	TIME ENDURANCE FOR HEATING OF HOT TANK (HRS)*
A(46)	10.000	TEMPERATURE DIFFERENCE FOR HEATING STAGE RESET
A(47)	90.000	DESIGN SUMMER TEMPERATURE FOR THE LOCATION
A(48)	78.000	AMB. AIR TEMP. AT WHICH NO ICE IS NEEDED IN STORAGE
A(49)	0.73000	SLOPE FOR THE RESET TEMPERATURE CONTROL EQ.
A(51)	10.000	MIN. INSOLATION TO TURN COLL. ON (BTUS/FT2 HR)
A(53)	205.00	MAXIMUM COLLECTOR OUTLET TEMPERATURE (F)

A(55)	18000.	UA HEAT EXCHANGER - COLLECTOR/STORAGE (BTUS/HR F)
A(56)	0.	OUTPUT ALSO IN GRAPHIC FORM (0=NO,1=YES)
A(57)	-20.000	MINIMUM TEMPERATURE FOR PLOTTING OUTPUT
A(58)	200.00	MAXIMUM TEMPERATURE FOR PLOTTING OUTPUT
A(59)	0.15000E 07	MAXIMUM ENERGY FOR PLOTTING OUTPUT (BTUS/HR)
A(60)	0.50000E 07	MAXIMUM ENERGY FOR YEARLY PLNT (BTUS/DAY)
A(62)	30.000	NUMBER OF DAYS FOR PLOTTING AVERAGE
A(63)	1.0000	FLAT PLATE SHADING NUMBER OF ROWS
A(64)	1029.0	FLAT PLATE SHADING LENGTH OF COLLECTOR ROW
A(65)	1.0000	FLAT PLATE SHADING LENGTH OF COLLECTOR
A(66)	6.0000	FLAT PLATE SHADING HEIGHT OF COLLECTOR
A(67)	12.000	FLAT PLATE SHADING DISTANCE BETWEEN ROWS
A(68)	36.400	WIDTH OF COLD STORAGE (IF A(69)=0.) (FT)*
A(69)	12.000	HEIGHT OF COLD STORAGE (IF A(68)=0.) (FT)*
A(70)	0.40000	PACKING FACTOR OF ICE IN COLD STORAGE*
A(71)	0.10000	AVERAGE U VALUE AT STORAGE SURFACE (BTUS/FT2 HR F)*
A(72)	42.000	GROUND TEMPERATURE AT STORAGE SIZING TIME (F)*
A(74)	10.000	NUMBER OF ITERATION STEPS IN THE FLOW LOOP
A(76)	0.25000	TEMPERATURE CONVERGENCE CRITERIA IN COLL. LOOP (F)
A(79)	50.000	UL OF PIPE GOING TO COLLECTOR INLET (BTUS/HR F)
A(80)	50.000	UL OF PIPE COMING TO HOUSE OR STORAGE (BTUS/HR F)
A(83)	0.10000	MINIMUM FRACTION OF AMBIENT AIR FOR VENTILATION*
A(84)	11.000	NUMBER OF HEATING/COOLING ZONES IN BLDG.*
A(85)	0.	FRACTION OF VENT. AIR THRU ZONE 1*
A(86)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 2*
A(87)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 3*
A(88)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 4*
A(89)	0.75000E-01	FRACTION OF VENT. AIR THRU ZONE 5*
A(90)	0.53333	FRACTION OF VENT. AIR THRU ZONE 6*
A(91)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 7*
A(92)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 8*
A(93)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 9*
A(94)	0.15000E-01	FRACTION OF VENT. AIR THRU ZONE 10*
A(95)	0.10667	FRACTION OF VENT. AIR THRU ZONE 11*
A(96)	0.85500	COLLECTOR GROSS TO APERTURE AREA RATIO*
A(98)	0.	FLAG FOR ACES OR CONVENTIONAL SYSTEM(0=ACES,1=C)*
A(99)	0.75000	OIL FIRED FURNACE EFFICIENCY*
A(100)	0.65000	GAS FIRED FURNACE EFFICIENCY*
A(101)	45.000	DESIGN POWER CONSUMPTION OF CIRCULATION FAN (HP)*
A(103)	1.0000	HEATING MODE (3=GAS,2=OIL,1=ELECTRIC&ACES)*
A(135)	0.	NO. OF DAYS TO SKIP FOR PRELIM. WEATHER TAPE POS.*
A(142)	274.00	START HEATING SEASON (COUNTING FROM JAN. 1)
A(143)	182.00	BEGIN OF COOLING SEASON*
A(144)	366.00	END OF COLLING SEASON*
A(145)	230.00	BACK UP COIL CAPACITY (KW)
A(146)	0.	FLAG FOR BACK UP MODE (0.=NO,1.=YES)
A(149)	8.0000	BEGINNING WORKING HOUR*
A(150)	17.000	END OF WORKING HOUR*
A(151)	540.00	MAXIMUM PEOPLE IN THE BUILDING*
A(183)	0.	REMARK, INDICATOR * MEANS INPUT REQUIRED WHEN A(11)=1.

WELL WATER TEMPERATURE	45.000	42.000	40.000	39.000	41.000	45.000	51.000	55.000	57.000	57.000	55.000	50.000
HOT WATER SCHEDULE	0.	0.	0.	0.	0.	0.053	0.053	0.063	0.063	0.063	0.063	0.063
	0.063	0.063	0.063	0.063	0.063	0.053	0.053	0.063	0.063	0.	0.	0.
OCCUPANCY SCHEDULE	0.	0.	0.	0.	0.	0.100	0.100	0.200	1.000	1.000	1.000	1.000
	0.800	1.000	1.000	1.000	1.000	0.800	0.400	0.100	0.100	0.	0.	0.

OUTPUT TABLE AND PLOTS FOR DAYS LISTED 5 6 7 8 9 10 11 12 13 14 15 16 17 0 0 0 0 0 0 0

THIS RUN IS FOR COMPONENT SIZING

THIS IS THE SECOND RUN FOR COMPONENT SIZING
THE COLLECTOR AREA & CONFIGURATION ARE PREDICTED BELOW.

ITERATION STEP GRADIENT STEP
 1 1

THE SIMULATION STARTED ON DAY 1 MONTH 10 OF THE YEAR 1957

79267

ZONE	NAME OF ZONE
1	BASEMENT
2	SO. SIDE ZONE, 1ST TO 5TH FLOORS
3	WE. SIDE ZONE, 1ST TO 5TH FLOORS
4	NO. SIDE ZONE, 1ST TO 5TH FLOORS
5	EA. SIDE ZONE, 1ST TO 5TH FLOORS
6	CENTRAL ZONE, 1ST TO 5TH FLOORS
7	SO. SIDE ZONE, 6TH FLOOR
8	WE. SIDE ZONE, 6TH FLOOR
9	NO. SIDE ZONE, 6TH FLOOR
10	EA. SIDE ZONE, 6TH FLOOR
11	CENTRAL ZONE, 6TH FLOOR

C-68

	IDNC	IDHC	ITHC	QDIRCT	QAVAIL	QCOLCT	QCB	QHB
1	4.3624E 04	2.6272E 04	3.7152E 04	3.2763E 04	2.5378E 08	1.2072E 08	-1.1702E 06	2.0734E 08
2	3.5979E 04	2.3535E 04	3.5646E 04	2.4038E 04	2.0275E 08	8.7572E 07	-6.7897E 06	1.2428E 08
3	4.7199E 04	3.1977E 04	5.0152E 04	2.8504E 04	2.5305E 08	4.3498E 07	-1.7962E 07	8.7198E 07
4	9.1021E 01	5.1669E 01	2.0402E 02	3.8461E 01	1.0077E 06	1.9711E 05	0.	2.2444E 06
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	2.0080E 04	6.2577E 03	1.0119E 04	1.5959E 04	1.0323E 08	5.1100E 06	-6.5743E 07	2.7881E 07
11	1.7078E 04	6.7698E 03	1.1619E 04	1.5516E 04	1.1216E 08	2.8463E 07	-1.7151E 07	7.8858E 07
12	3.4825E 04	1.7669E 04	2.7082E 04	2.7673E 04	1.9934E 08	7.3953E 07	-5.3686E 06	1.2337E 08

	QDHW	QCHTOT	QHBTOT	QTAMB	BACKUP	QH1	QH2	QH3
1	4.7286E 06	-1.3848E 08	1.7932E 08	1.2821E 08	0.	5.2561E 06	3.0298E 07	3.7873E 07
2	4.2160E 06	-1.2795E 08	1.1572E 08	9.6823E 07	0.	4.8657E 06	1.9565E 07	2.4211E 07
3	4.9849E 06	-1.5519E 08	8.1994E 07	1.0151E 08	0.	5.2516E 06	1.3898E 07	1.6929E 07
4	0.	-1.2582E 06	2.2444E 06	0.	0.	2.6585E 05	2.9720E 05	4.2620E 05
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	4.1412E 06	-1.7224E 08	2.7202E 07	6.5294E 07	0.	4.9257E 06	4.0053E 06	4.8763E 06
11	4.0437E 06	-1.3712E 08	7.5434E 07	8.6870E 07	0.	5.1258E 06	1.2310E 07	1.5464E 07
12	4.0622E 06	-1.3127E 08	1.1382E 08	9.7006E 07	0.	5.5269E 06	1.8916E 07	2.3713E 07

	QH4	QH5	QH6	QH7	QH8	QH9	QH10	QH11
1	4.1021E 07	3.5858E 07	0.	6.0595E 06	7.5747E 06	8.2043E 06	7.1716E 06	0.
2	2.6433E 07	2.2170E 07	0.	3.9130E 06	4.8421E 06	5.2865E 06	4.4339E 06	0.
3	1.8620E 07	1.4505E 07	0.	2.7795E 06	3.3859E 06	3.7240E 06	2.9011E 06	0.
4	5.3853E 05	3.8695E 05	0.	5.9440E 04	8.5240E 04	1.0771E 05	7.7370E 04	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	5.3889E 06	4.2963E 06	0.	7.9719E 05	9.7526E 05	1.0778E 06	8.5927E 05	0.
11	1.6721E 07	1.4096E 07	0.	2.4620E 06	3.0927E 06	3.3441E 06	2.8192E 06	0.
12	2.5423E 07	2.2193E 07	0.	3.7833E 06	4.7425E 06	5.0845E 06	4.4385E 06	0.

	QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
1	-1.7245E 04	-7.5582E 06	-3.6767E 05	-4.2156E 02	-3.3149E 05	-1.0713E 08	-1.5116E 06	-7.3534E 04
2	-1.4910E 04	-9.1112E 06	-2.2761E 06	-2.5050E 04	-1.3969E 06	-9.3807E 07	-1.8222E 06	-4.5522E 05
3	-1.7296E 04	-1.1728E 07	-4.4662E 06	-3.3274E 05	-5.6544E 06	-1.0713E 08	-2.3455E 06	-8.9325E 05
4	0.	-6.3324E-03	0.	0.	-7.0190E-03	-1.0485E 06	-1.2665E-03	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	-1.9799E 04	-1.7242E 07	-7.8975E 06	-3.4484E 05	-8.3394E 06	-1.0608E 08	-3.4680E 06	-1.5795E 06
11	-1.6450E 04	-7.9957E 06	-1.6174E 06	-2.7031E 05	-1.6780E 06	-1.0269E 08	-1.5991E 06	-3.2348E 05
12	-1.5604E 04	-7.9219E 06	-5.1799E 05	-3.9047E 04	-5.5450E 05	-1.0034E 08	-1.5844E 06	-1.0360E 05

	QC9	QC10	QC11	QCOMP	FPOWER	PUMPC	OHGAS	OHAIL
1	-8.4312E 01	-6.6299E 04	-2.1426E 07	8.0158E 07	1.1556E 07	5.3925E 06	0.	0.
2	-5.0100E 03	-2.7938E 05	-1.8761E 07	4.3281E 07	9.9800E 06	4.2151E 06	0.	0.
3	-6.6549E 04	-1.1309E 06	-2.1426E 07	2.7928E 07	1.1556E 07	2.3720E 06	0.	0.
4	0.	-1.4038E-03	-2.0969E 05	1.7152E 06	0.	1.7065E 04	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	-6.8968E 05	-1.7679E 06	-2.1215E 07	1.6022E 07	1.1556E 07	1.3652E 05	0.	0.
11	-5.4061E 04	-3.3560E 05	-2.0538E 07	2.5443E 07	1.1030E 07	2.6963E 06	0.	0.
12	-7.8094E 03	-1.1090E 05	-2.0069E 07	4.2307E 07	1.0505E 07	3.9250E 06	0.	0.

	DELECT	DEACES	DEHCON	DECCON
1	9.9708E 07	8.0158E 07	0.	0.
2	8.7058E 07	4.3281E 07	0.	0.
3	9.6944E 07	2.7928E 07	0.	0.
4	1.0410E 06	1.7152E 06	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	9.2841E 07	1.6022E 07	0.	0.
11	9.2674E 07	2.5443E 07	0.	0.
12	9.2336E 07	4.2307E 07	0.	0.

IDNC
1.9888E 05	IDHC
1.1253E 05	ITHC
1.7198E 05	QDIRCT
1.4449E 05	QAVAIL
1.1253E 09	QCOLCT
3.5951E 08	QCB
-1.1418E 08	QHB
6.5118E 08
QDHW
2.6197E 07	QCHTOT
-6.6351E 08	QHBTOT
5.9573E 08	QTAM3
5.7571E 08	BACKUP
0.	QH1
3.1218E 07	QH2
9.9289E 07	QH3
1.2349E 08
QH4
1.3414E 08	QH5
1.1350E 08	QH5
0.	QH7
1.9854E 07	QH8
2.4699E 07	QH9
2.6829E 07	QH10
2.2701E 07	QH11
0.
QC1
-1.0130E 05	QC2
-6.1557E 07	QC3
-1.7143E 07	QC4
-4.1160E 06	QC5
-1.8455E 07	QC6
-6.1822E 08	QC7
-1.2331E 07	QC8
-3.4286E 06
QC9
-8.2319E 05	QC10
-3.6909E 06	QC11
-1.2364E 08	QCOMPA
2.3685E 08	FPOWER
6.6183E 07	PUMPC
1.8754E 07	QH GAS
0.	QHOIL
0.
QSELECT
5.6260E 08	QEACES
2.3685E 08	QEHCON
0.	QECCON
0.				

FINAL TEMP. IN HOT STORAGE BIN IS 119.50 DEG F
 FINAL TEMP. IN COLD STORAGE BIN IS 32.00 DEG F
 YEARLY INTERNAL LOAD GENERATED BY LIGHTS = 0.37590E 09
 EQUIPMENT = 0.74617E 09
 PEOPLE = 0.57459E 08

THE MAXIMUM FAN FLOW RATIO IS 0.100 AT TIME 8.00 ON DAY 1.

THE COLLECTOR AND STORAGE LOOP THERMAL FLOW RATE' IS 0.85750E 05 BTUS/HR F

THE MAXIMUM COOLING LOAD IS -0.93999E 06 BTUS/HR
 THE MAXIMUM HEATING LOAD IS 0.73969E 06 BTUS/HR

ITERATION STEP. GRADIENT STEP
 1 1

THE SIMULATION STARTED ON DAY 1 MONTH 10 OF THE YEAR 1957

ZONE	NAME OF ZONE
1	BASEMENT
2	SO. SIDE ZONE, 1ST TO 5TH FLOORS
3	WE. SIDE ZONE, 1ST TO 5TH FLOORS
4	NO. SIDE ZONE, 1ST TO 5TH FLOORS
5	EA. SIDE ZONE, 1ST TO 5TH FLOORS
6	CENTRAL ZONE, 1ST TO 5TH FLOORS
7	SO. SIDE ZONE, 6TH FLOOR
8	WE. SIDE ZONE, 6TH FLOOR
9	NO. SIDE ZONE, 6TH FLOOR
10	EA. SIDE ZONE, 6TH FLOOR
11	CENTRAL ZONE, 6TH FLOOR

	IDNC	IDHC	ITHC	QDIRCT	QAVAIL	QCOLCT	QCB	QHR
1	4.3624E 04	2.6272E 04	3.7152E 04	3.4896E 04	1.3447E 08	7.6861E 07	-1.1702E 06	2.0734E 08
2	3.5979E 04	2.3535E 04	3.5646E 04	2.4498E 04	1.0545E 08	6.7294E 07	-6.7897E 06	1.2428E 08
3	4.7199E 04	3.1977E 04	5.0152E 04	3.1431E 04	1.4452E 08	9.7592E 07	-1.7962E 07	8.7198E 07
4	9.1021E 01	5.1669E 01	2.0402E 02	3.8461E 01	5.0385E 05	0.	0.	2.2444E 06
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	2.0080E 04	6.2577E 03	1.0119E 04	1.5995E 04	5.1819E 07	3.1960E 06	-6.5743E 07	2.7881E 07
11	1.7078E 04	6.7698E 03	1.1619E 04	1.5671E 04	5.6675E 07	2.0038E 07	-1.7151E 07	7.8858E 07
12	3.4825E 04	1.7669E 04	2.7082E 04	2.8192E 04	1.0186E 08	6.7617E 07	-5.3686E 06	1.2337E 08

	QUMW	QCBTOT	QHBTOT	QTAMH	BACKUP	QH1	QH2	QH3
1	4.7286E 06	-1.3848E 08	1.7932E 08	1.2821E 08	0.	5.2561E 06	3.0298E 07	3.7873E 07
2	4.2160E 06	-1.2795E 08	1.1572E 08	9.6823E 07	0.	4.8657E 06	1.9565E 07	2.4211E 07
3	4.9849E 06	-1.5519E 08	8.1994E 07	1.0151E 08	0.	5.2516E 06	1.3898E 07	1.6929E 07
4	0.	-1.2582E 06	2.2444E 06	0.	0.	2.6585E 05	2.9720E 05	4.2620E 05
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	4.1412E 06	-1.7224E 08	2.7202E 07	6.5294E 07	0.	4.9257E 06	4.0053E 06	4.8763E 06
11	4.0437E 06	-1.3712E 08	7.5434E 07	8.6870E 07	0.	5.1258E 06	1.2310E 07	1.5464E 07
12	4.0822E 06	-1.3127E 08	1.1382E 08	9.7006E 07	0.	5.5269E 06	1.8916E 07	2.3713E 07

	QH4	QH5	QH6	QH7	QH8	QH9	QH10	QH11
1	4.1021E 07	3.5858E 07	0.	6.0595E 06	7.5747E 06	8.2043E 06	7.1716E 06	0.
2	2.6433E 07	2.2170E 07	0.	3.9130E 06	4.8421E 06	5.2865E 06	4.4339E 06	0.
3	1.8620E 07	1.4505E 07	0.	2.7795E 06	3.3859E 06	3.7240E 06	2.9011E 06	0.
4	5.3853E 05	3.8685E 05	0.	5.9440E 04	8.5240E 04	1.0771E 05	7.7370E 04	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	5.3889E 06	4.2963E 06	0.	7.9719E 05	9.7526E 05	1.0778E 06	8.5927E 05	0.
11	1.6721E 07	1.4096E 07	0.	2.4620E 06	3.0927E 06	3.3441E 06	2.8192E 06	0.
12	2.5423E 07	2.2193E 07	0.	3.7833E 06	4.7425E 06	5.0845E 06	4.4385E 06	0.

	QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
1	-1.7245E 04	-7.5582E 06	-3.6767E 05	-4.2156E 02	-3.3149E 05	-1.0713E 08	-1.5116E 06	-7.3534E 04
2	-1.4910E 04	-9.1112E 06	-2.2761E 05	-2.5050E 04	-1.3969E 06	-9.3807E 07	-1.8222E 06	-4.5522E 05
3	-1.7296E 04	-1.1728E 07	-4.4662E 05	-3.3274E 05	-5.6544E 06	-1.0713E 08	-2.3455E 06	-8.9325E 05
4	0.	-6.3324E-03	0.	0.	-7.0190E-03	-1.0485E 06	-1.2665E-03	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	-1.9799E 04	-1.7242E 07	-7.8975E 06	-3.4484E 06	-8.9394E 06	-1.0508E 08	-3.4680E 06	-1.5795E 06
11	-1.6450E 04	-7.9957E 05	-1.6174E 06	-2.7031E 05	-1.6780E 06	-1.0269E 08	-1.5991E 06	-3.2348E 05
12	-1.5604E 04	-7.9219E 06	-5.1799E 05	-3.9047E 04	-5.5450E 05	-1.0034E 08	-1.5844E 06	-1.0360E 05

	QC9	QC10	QC11	QCJMPA	FPOWER	PUMPC	QH GAS	QH OIL
1	-8.4312E 01	-6.6299E 04	-2.1426E 07	8.0651E 07	1.1556E 07	5.4096E 06	0.	0.
2	-5.0100E 03	-2.7938E 05	-1.8761E 07	4.3214E 07	9.9800E 06	5.4267E 06	0.	0.
3	-6.6549E 04	-1.1309E 06	-2.1426E 07	3.0091E 07	1.1556E 07	5.5700E 06	0.	0.
4	0.	-1.4038E-03	-2.0969E 05	1.7152E 05	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	-6.8968E 05	-1.7679E 06	-2.1215E 07	1.5683E 07	1.1556E 07	1.7065E 05	0.	0.
11	-5.4061E 04	-3.3560E 05	-2.0538E 07	2.5465E 07	1.1030E 07	2.3038E 06	0.	0.
12	-7.8094E 03	-1.1090E 05	-2.0069E 07	4.3432E 07	1.0505E 07	5.3243E 06	0.	0.

	QELECT	QEACES	QEHCON	QECCON
1	9.9725E 07	8.0661E 07	0.	0.
2	8.8270E 07	4.3214E 07	0.	0.
3	1.0114E 08	3.0091E 07	0.	0.
4	1.0239E 06	1.7152E 06	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	9.2875E 07	1.5683E 07	0.	0.
11	9.2281E 07	2.5465E 07	0.	0.
12	9.3735E 07	4.3432E 07	0.	0.

IONC
1.9498E 05	IDMC
1.1253E 05	ITMC
1.7198E 05	QDIRCT
1.5072E 05	QAVAIL
5.9530E 08	QCOLCT
3.3260E 08	QCB
-1.1418E 08	QCH
6.5118E 08
QCHW
2.6197E 07	QCHTOT
-8.6351E 08	QCHTOT
5.9573E 06	QTAMB
5.7571E 08	BACKUP
0.	QH1
3.1218E 07	QH2
9.9289E 07	QH3
1.2349E 08
QH4
1.3414E 08	QH5
1.1350E 08	QH6
0.	QH7
1.9854E 07	QH8
2.4699E 07	QH9
2.6829E 07	QH10
2.2701E 07	QH11
0.
QC1
-1.0130E 05	QC2
-6.1557E 07	QC3
-1.7143E 07	QC4
-4.1160E 06	QC5
-1.8455E 07	QC6
-6.1822E 08	QC7
-1.2331E 07	QC8
-3.4286E 06
QC9
-8.2319E 05	QC10
-3.6909E 06	QC11
-1.2364E 08	QCOMP
2.4026E 08	POWER
6.6183E 07	PUMPC
2.5205E 07	QHGAS
0.	QHOILI
0.
QSELECT
5.6905E 08	QEACES
2.4026E 08	QEHCON
0.	QECCON
0.				

FINAL TEMP. IN HOT STORAGE BIN IS 119.40E3 F
FINAL TEMP. IN COLD STORAGE BIN IS 32.00E3 F
YEARLY INTERNAL LOAD GENERATED BY LIGHTS = 0.37690E 09
EQUIPMENT = 0.74617E 08
PEOPLE = 0.57459E 08

THE MAXIMUM FAN FLOW RATIO IS 0.100 AT TIME 8.00 ON DAY 1.

THE COLLECTOR AND STORAGE LOOP THERMAL FLOW RATE IS 0.42875E 05 BTUS/HR F

THE MAXIMUM COOLING LOAD IS -0.93999E 06 BTUS/HR
THE MAXIMUM HEATING LOAD IS 0.73969E 06 BTUS/HR

MAXIMUM ICE RATIO IS 0.404 AT TIME 12.000 ON DAY 147 (MONTH 2)
THE FINAL ICE RATIO IN STORAGE IS 0.009

WITH THE PACKING FACTOR OF 0.40 AND THE STORAGE CAPACITY OF 1014054.9 BTUS/F
THE MINIMUM COLLECTOR AREA REQUIREMENT IS 3087.0 FT², OR THE TOTAL OF 171 COLLECTORS

THE NUMBER OF COLLECTORS IS DIVIDED INTO 1 ROWS, EACH ROW HAS THE LENGTH OF 514.5 FTS

THE COLLECTORS ARE CONNECTED BY 1 IN SERIES

APPENDIX D

TYPICAL WEATHER YEAR

SELECTION REQUIREMENTS

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PROCEDURE FOR SELECTING A TEST YEAR OF WEATHER DATA

RECOMMENDED BY ASHRAE

The term "test year" means a selected calendar year whose actual hourly weather observations are to be used for comparing the computed energy requirements of different buildings in the same municipality or different heating and air conditioning systems in the same building. The weather in the test year is not to be considered sufficiently typical to yield reliable estimates of average energy requirements over several years.

All the desired weather data are readily available only for about ten years at most stations. The problem is to select one test year from among these ten, basing the selection on the 120 values of the monthly mean temperatures for the ten years. The principle of selection is to eliminate years containing months with extremely high or low mean temperatures until only one year remains.

To do this the extreme months must be arranged in order of their importance for energy comparisons. Hot Julys and cold Januarys are assumed to be the most important. All the months are ranked by alternating between the warm half (May to October) and the cold half (November to April) of the year, with the months closest to late July or late January given priority. The resulting order is given in the center column. If, in addition, it assumed that hot summer months and cold winter months are more important than cool summer or mild winter months, then the order of extreme months will be down the first column from "Hottest July" to "Coolest April" and then down the last column from "Coolest July" to "Warmest April."

Hottest	July	Coolest
Coldest	January	Mildest
Hottest	August	Coolest
Coldest	February	Mildest
Hottest	June	Coolest

Coldest	December	Mildest
Hottest	September	Coolest
Coldest	March	Mildest
Warmest	May	Coolest
Coolest	November	Warmest
Warmest	October	Coolest
Coolest	April	Warmest

The first step is to mark all 24 extreme months and to count the number of marked months in each year.

If there is one and only one year remaining without any marked month, then this is the test year.

If there are two or more years remaining without any marked month then continue marking months starting with next-to-the-hottest July, then next-to-the-coldest January and so on down the first column above until only one year remains without any marked month.

If there is no year without a marked month and only one year with only one marked month, then this is the test year.

If there are two or more years with only one marked month, then note these months and whether they are hottest or coldest. Starting at the bottom of the right hand column of the table move upwards until you find one of the extreme months noted. This month is presumed less important than those higher in the table and the year containing it is the test year.

Similar rules could be followed when all years have two or more marked months but this will occur only rarely.

APPENDIX E

BUILDING CHARACTERISTICS

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INTRODUCTION

This appendix summarizes the building characteristics used to determine the heating, cooling, and hot water loads for the three building types in the three geographic locations. For the selected buildings, the following data is attached:

- Construction characteristics
- Construction resistances and capacitances
- Floor plan and elevation
- People load schedule
- Lighting load schedule
- Appliance load schedule
- Hot water use schedule

The internal loads have a set schedule but can have different peaks in various situations. Therefore, the basic schedule is presented in terms of a percent of maximum. The maximum internal loads are summarized in Table E-1. The internal loads given in this volume are taken from two major references. They are

- Single- and Multi-family Housing Final Report, June 1974. Prepared for the Department of Housing and Urban Development, Hittman Associates, Inc.
- Fuel Conservation, Economics and Public Policy. Prepared for the National Science Foundation, Rand Corporation, R-1498-NSF, May 1974, James J. Mutch.

Table E-1. Maximum Internal Load Characteristics

Building Type	Occupancy				
	Sensible
Btu/Hr.	Latent
Btu/Hr.	Peak
People	Lighting
Watts/ft ²	Appliances
Btu/Hr.
Single Family	250	200	4	1.0	4352
Multi-Family	250	200	24	1.0	43,000
Commercial	250	200	300	3.0	----

SINGLE-FAMILY RESIDENCE

There were two single-family residences modeled for this study: one used for the Philadelphia and Atlanta results, and one used for the Minneapolis results. The Philadelphia and Atlanta house is shown in Figures E-1 through E-3. The characteristics of this house are shown in Tables E-2 through E-12. The Minneapolis house is shown in Figure E-4. The characteristics of this house are shown in Tables E-13 through E-19. Figures E-5 through E-8 show the internal loads of the single-family residence.

Figure E-1. Elevation of Philadelphia and Atlanta Single-Family Residences

Figure E-2. First Floor Plan of Philadelphia and Atlanta Single-Family Residences

Figure E-3. Second Floor Plan of Philadelphia and Atlanta Single-Family Residences

Table E-2. Composition - North, East, South, and West Walls to Outside

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall, ext. wall
2	0.330	0.034	2.53	0.670	-----	2 x 4 stud 16 in. OC, 4 in. ins R-11
3	0.042	0.032	10.00	0.010		1/8 in. Sheathing Board
4	0.008	0.065	19.20	0.700	-----	3/32 in. Building Paper
5	0.010	0.100	55.00	0.200	-----	1/8 in. Asbestos Siding

Thermal Conductance, $U = 0.08627 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-3. Composition - West Wall (sheltered by garage)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall Garage
2	0.330	0.034	2.53	0.670	-----	2 x 4 stud, 16 in. Oc, 4 in. ins R-11.
3	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall

Thermal Conductance, $U = 0.09636 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-4. Composition - Roof Above Attic

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.000	0.000	0.00	0.000	0.70	Air Film Resistance Roof
2	0.070	0.066	34.00	0.290	0.00	1/2 in. Plywood plus rafters
3	0.008	0.065	19.20	0.700	0.00	3/32 in. Building Paper
4	0.030	0.070	77.00	0.350	0.00	3/8 in. Asphalt Shingles

Thermal Conductance, $U = 0.43218 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-5. Composition - Floor (slab-on-grade)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.060	0.050	8.33	0.340	-----	Carpet, 3/4 in. with Pad
2	0.330	1.800	140.00	0.350	-----	4 in. Concrete Slab
3	0.333	0.600	120.00	0.200	-----	4 in. Crushed Stone

Thermal Conductance, $U = 0.25391 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-6. Composition - Second Floor Slant Roof/Ceiling

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall Roof 2
2	0.128	0.033	1.69	0.670	-----	4 in. Insulation plus Rafters
3	0.052	0.067	34.00	0.290	-----	1/2 in. Plywood plus Rafters
4	0.008	0.065	19.20	0.700	-----	3/32 in. Building Paper
5	0.030	0.070	76.80	0.350	-----	3/8 in. Asphalt Shingles

Thermal Conductance, $U = 0.17963 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-7. Composition - Floor/Ceiling Between First and Second Stories

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.060	0.050	8.33	0.340	-----	3/4 in. Carpet and Pad
2	0.102	0.066	34.00	0.290	-----	3/4 in. Plywood plus Joists
3	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall

Thermal Conductance, $U = 0.32401 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-8. Composition - Non-Actual Division Wall

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall - int. wall
2	0.333	0.318	2.53	0.670	-----	2 x 4 Studs and Air (R = 0.97)
3	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall

Thermal Conductance, $U = 0.57434 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-9. Composition - Floor/Ceiling Between First and Second Stories

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall - Ceiling
2	0.102	0.066	34.00	0.290	-----	3/4 in. Plywood plus Joists
3	0.060	0.050	8.33	0.340	-----	3/4 in. Carpet and Pad

Thermal Conductance, $U = 0.32401 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-10. Composition - Second Floor Knee Wall
(Leading to Unconditioned Attic Space)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	-----	1/2 in. Dry Wall- Attic Wall
2	0.333	0.023	1.69	0.670	-----	2 x 4 Joist and 4 in. ins.

Thermal Conductance, $U = 0.06762 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-11. Composition - Insulated Ceilings (First and Second Floors)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	0.120	55.00	0.259	0.347	1/2 in. Plaster Board
2	-----	-----	-----	-----	15.044	6 in. R-19 Insulation plus Joists 24 in. Centered

Thermal Conductance, $U = 0.05542 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-12. Parameter Values of Non-Component Structures

| Component | Area
(ft ²) | U
(Btu/hr-ft ² -°F) | Density
lbm/ft ³ | Thermal
Capacitance
(Btu/°F) |
|-----------------------------|----------------------------|-----------------------------------|--------------------------------|------------------------------------|
| South Glass Door | 34 | 0.73 | ----- | ----- |
| South Windows | 48 | 0.79 | ----- | ----- |
| West Windows | 21 | 0.79 | ----- | ----- |
| North Windows | 79 | 0.79 | ----- | ----- |
| East Windows | 31 | 0.79 | ----- | ----- |
| Door | 73 | 0.47 | ----- | ----- |
| Ground/ft ² Node | --- | 0.25 | 83.600 | ----- |
| Internal Mass | 2041 | 0.98 | ----- | 3041 |
| Air Mass | --- | ----- | .075 | 343 |

Figure E-4. Minneapolis Single-Family Residence

Table E-13. Composition - North, East, South, and West Walls to Outside

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.042	-----	55.00	0.300	.45	1/2 in. Gypsum Board
2	0.330	-----	2.53	0.670	10.51	Studs + 3 1/2 in. Insulation
3	0.042	-----	18.00	0.310	1.32	1/2 in. Sheathing
4	0.008	-----	19.00	0.700	0.12	Building Paper
5	0.010	-----	55.00	0.200	0.100	Siding

Thermal Conductance, $U = .08 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-14. Composition - Ceiling to Attic

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.420	-----	55.00	0.30	.45	Gypsum Board
2	0.052	-----	34.00	0.29	.77	Plywood plus rafters
3	0.500	-----	1.69	0.67	13.00	Insulation

Thermal Conductance, $U = .07 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-15. Composition - Roof to Outside

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.070	-----	34.00	0.29	1.510	Plywood plus rafters
2	0.008	-----	19.20	0.70	0.125	Building Paper
3	0.030	-----	77.00	0.35	0.628	Shingles

Thermal Conductance, $U = .44 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-16. Composition - Attic Wall to Outside

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.042	-----	55.00	0.259	0.450	1/2 in. Dry Wall
2	0.102	-----	34.00	0.290	2.250	3/4 in. Plywood plus Joists
3	0.008	-----	19.20	0.700	0.125	Building Paper
4	0.010	-----	55.00	0.200	0.100	Siding

Thermal Conductance, $U = .34 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-17. Composition - Basement Floor to Earth

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	.250	-----	140	.20	1.60	Concrete Block
2	.062	-----	-----	-----	3.00	Insulated Pad

Thermal Conductance, $U = .15 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-18. Composition - Wall Below Ground to Earth

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.0420	-----	55	.259	0.45	Gypsum Board
2	0.0625	-----	-----	-----	3.00	Styrofoam
3	1.0000	-----	45	.200	1.90	Concrete Block

Thermal Conductance, $U = .14 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-19. Parameter Values of Non-Composite Structures

| Component | Area
(ft ²) | U
(Btu/hr-ft ² -°F) | Density
lbm/ft ³ | Thermal
Capacitance
(Btu/°F) |
|-------------------------------|----------------------------|-----------------------------------|--------------------------------|------------------------------------|
| North Window | 71.68 | .58 | ----- | ----- |
| East Window | 35.84 | .58 | ----- | ----- |
| South Window | 80.64 | .58 | ----- | ----- |
| West Window | 35.84 | .58 | ----- | ----- |
| Door | 76.00 | .27 | ----- | ----- |
| Ground/ft ² · Node | ----- | .25 | 83.600 | ----- |
| Internal Mass | 1143 | 1.75 | ----- | 3041 |
| Air Mass | ----- | ----- | .075 | 325 |

Figure E-5. Single-Family Residence People Load Schedule

Figure E-6. Single-Family Residence Lighting Load Schedule

Figure E-7. Single-Family Residence Appliance Schedule

Figure E-8. Single-Family Residence Hot Water Schedule

MULTI-FAMILY RESIDENCE

The floor plan and elevation of the multi-family residence is shown in Figure E-9. The characteristics of the building are shown in Tables E-20 through E-26. Figures E-10 through E-13 show the internal loads for the multi-family residence.

Figure E-9. Elevation and Floor Plan of the Multi-Family Residence

Table E-20. Composition - North, East, South, and West Walls to Outside

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft ² -°F)	Density (lb/ft ³)	Specific Heat (Btuh/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.042	-----	55.00	0.03	.45	1/2 in. GVP. Bd.
2	0.330	-----	2.53	0.67	10.51	Studs & 3 1/2 in. ins.
3	0.042	-----	18.00	0.31	1.32	1/2 in. Fiberboard Sheath.
4	0.333	-----	130.00	0.19	.44	4 in. face brick

Thermal Conductance = .08 Btu/ft²-°F-hr

Table E-21. Composition - Ceiling to Attic

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft ² -°F)	Density (lb/ft ³)	Specific Heat (Btuh/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.420	-----	55.00	0.30	.45	Gypsum Board
2	0.052	-----	34.00	0.29	.77	Plywood plus rafters
3	0.500	-----	1.69	0.67	13.00	Insulation

Thermal Conductance, U = .07 Btu/ft²-°F-hr

Table E-22. Composition - Roof to Outside

Layer No.	Thickness (ft.)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btuh/lb - °F)	Thermal Resistance (ft ² - °F/Btuh)	Description of Layers
1	0.070	-----	34.00	0.29	1.510	Plywood plus rafters
2	0.008	-----	19.20	0.70	0.125	Building paper
3	0.030	-----	77.00	0.35	0.628	Shingles

Thermal Conductance, U = .44 Btu/ft²-°F-hr

Table E-23. Composition - Attic Wall to Outside

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btuh/lb - °F)	Thermal Resistance (ft ² - °F/Btuh)	Description of Layers
1	0.042	-----	55.00	0.259	0.450	1/2 in. dry wall
2	0.102	-----	34.00	0.290	2.250	3/4 in. plywood plus joists
3	0.008	-----	19.20	0.700	0.125	Building paper
4	0.010	-----	55.00	0.200	0.100	Siding

Thermal Conductance, U = .34 Btu/ft²-°F-hr

Table E-24. Composition - Basement Floor to Earth

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btuh/lb - °F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	.250	-----	140	.20	1.60	Concrete Block
2	.062	-----	-----	-----	3.00	Styrofoam

Thermal Conductance, $U = .15 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

Table E-25. Composition - Wall Below Ground to Earth

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btuh/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	.0420	-----	55	.259	.45	Gypsum Board
2	.0625	-----	-----	-----	3.00	Styrofoam
3	1.0000	-----	45	.200	1.90	Concrete Block

Thermal Conductance, $U = .14 \text{ Btu/ft}^2\text{-}^\circ\text{F-hr}$

SUBROUTINE
TANK 2

TAVE	AVERAGE BASEMENT TEMPERATURE FOR SIZING OF THE MINIMUM ACES
TOAVE	AVERAGE AIR TEMPERATURE SURROUNDING TANK FOR SIZING THE MINIMUM ACES
QICEI	INITIAL GUESS ON REQUIRED ICE VOLUME
VOLUME	SIZE OF ICE STORAGE TANK FOR THE MINIMUM ACES
SIDE	SIDE DIMENSION OF THE TANK
QNEED2	HEAT REQUIRED FOR HOT WATER DURING THE SIZING OF THE MINIMUM ACES
TF2	PERCENT ON TIME OF HOT WATER SYSTEM DURING THE SIZING OF THE MINIMUM ACES
QINEED1	HEAT REQUIRED FOR SPACE HEATING DURING THE SIZING OF THE MINIMUM ACES
TF1	PERCENT ON TIME OF THE SPACE HEATING PLANT DURING THE SIZING OF THE MINIMUM ACES
QOUT	ENERGY REMOVED FROM THE TANK DURING THE SIZING OF THE MINIMUM ACES
CUFT	ICE GENERATED DURING THE PERIOD
CUFTN	ICE CAPABILITY OF THE TANK BASED ON GUESSED TANK SIZE
TF	TIME FRACTION
FX	}
DEL	}
SIDP	}
FXD	}
FXP	}
SIDN	}

PARAMETERS USED IN NEWTON SOLUTION ROUTINE

SUBROUTINE
TANK

IXIX	LOGIC VARIABLE
NORTH	LOGIC VARIABLE DESIGNATING TYPE OF DESIGN
CONSTRAINTS
QICEI	INITIAL GUESS OF LATENT HEAT OF ICE WITHIN
TANK
VOLUMI	INITIAL GUESS OF VOLUME OF TANK
ICHECK	LOGIC VARIABLES
BOTH	LOGIC VARIABLE TO DESIGN TANK
VOLUME	VOLUME OF THE TANK
AREA	WALL AREA OF TANK
SIDE	SIDE DIMENSION OF TANK

SUBROUTINE
NEWTON

FX	}	
DEL	}	
SIDP	}	
FXD	}	PARAMETERS IN NEWTON SOLUTION ROUTINE
FXP	}	
SIDN	}	
SIDE		SOLUTION TO NEWTON ROUTINE GIVING SIDE
DIMENSION OF TANK

SUBROUTINE
STORAGE

TZONES	SUMMER SET POINT
THOTWI	HOT WATER SET POINT
TTANK	TANK TEMPERATURE
PCUFT	PEAK ICE VOLUME
VOLUME	VOLUME OF STORAGE BIN
IBEGIN	BEGINNING OF HEATING SEASON
IEND	END OF SIMULATION
IBHMI	LAST DAY OF COOLING SEASON
T	SPACE TEMPERATURE
TC	OUTDOOR AIR TEMPERATURE
TWI	ENTERING CONDENSER WATER TEMPERATURE
HEAT	HOURLY HEATING LOAD
HEATMB	HOURLY HEATING LOAD MINUS THE BASEMENT LOAD
BASE 1	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
QNEEDW	TOTAL ENERGY NEEDED FOR HOT WATER PURPOSES
TFW	TIME FRACTION FOR HOT WATER SYSTEM
QNEEDS	TOTAL ENERGY NEEDED FOR SPACE HEAT
TFS	TIME FRACTION FOR SPACE HEAT
COOL	HOURLY COOLING LOAD
COOLMB	COOLING LOAD MINUS THE BASEMENT LOAD
BASE 2	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
RHT1	EFFECTIVENESS OF COOLING HEAT EXCHANGER
QNEED	TOTAL ENERGY NEEDED FOR COOLING PURPOSES
TF	TIME FRACTION (HEATING OR COOLING)
QPC	COOLING PUMP ENERGY
QULE	ELECTRIC ENERGY INTO TANK

SUBROUTINE
PANEL

QINCT	TOTAL AVAILABLE INCIDENT RADIATION
QMELT	BTUS REQUIRED TO MELT ICE WITHIN TANK
NUMPAN	NUMBER OF PANELS
SIZE	SIZE OF THE COLLECTOR ARRAY

SUBROUTINE
BISCAN

ICHECK	LOGIC VARIABLE
XA	LOWER LIMIT ON PANEL CONSTRAINT
XB	FIRST GUESS ON PANEL AREA
FX }	
FXA }	
XA }	
XB }	PARAMETERS NEEDED TO SOLVE FOR THE SIZE OF
THE COLLECTOR USING THE BISECTION METHOD
CUFT }	
PCUFT }	
PANUM }	
FLAG	LOGIC VARIABLE
SUM	COUNTER
FXNO }	
XO }	PARAMETERS NEEDED TO SOLVE FOR THE SIZE OF THE
COLLECTOR
XN }	

Table E-27. Composition - Outside Wall
* (Minneapolis)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	0.3300	-----	130.00	0.19	0.44	Face Brick
2	0.0833	-----	-----	-----	4.00	Rigid Insulation
3	0.6667	-----	61.00	0.22	2.00	Concrete Block
4	0.0420	-----	55.00	0.30	0.45	Gypsum Board

Thermal Conductance, $U = .1451 \text{ Btu/ft}^2\text{-°F-hr}$

*Double glazed (1/2" air gap) door/windows have R-Value of $0.96 \text{ ft}^2\text{-°F/Btu}$

Table E-28. Composition - Roof (Minneapolis)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	.0312	-----	70.00	0.35	0.33	Built-up Roof
2	.2081	-----	-----	0.29	6.95	Roof Insulation
3	.0050	-----	170.00	0.21	0	Metal Deck

Thermal Conductance, $U = 0.1374 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-29. Composition - Floor (Minneapolis)

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.6667	1.35	61.00	0.22	0.96	Concrete

Thermal Conductance, $U = 1.041 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-30. Composition - Outside Wall*
(Philadelphia and Atlanta)

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btuh)	Description of Layers
1	0.333	-----	130.00	0.19	0.44	Face Brick
2	0.666	-----	61.00	0.22	2.00	Concrete Block
3	0.042	-----	55.00	0.30	0.45	Prefinished Gypsum Board

Thermal Conductance, $U = 0.3460 \text{ Btu/ft}^2\text{-°F-hr}$

*Double glazed (1/2" air gap) doors/windows have R-value of $0.96 \text{ ft}^2\text{-°F-Btuh}$

Table E-31. Composition - Roof (Philadelphia and Atlanta)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	.166	-----	1.80	0.29	5.56	Rigid Insulation
2	-----	-----	130.00	0.22	0.33	Pitch and Gravel
3	.005	-----	170.00	0.21	0	Metal Deck

Thermal Conductance, $U = 0.1697 \text{ Btu/ft}^2\text{-°F-hr}$

Table E-32. Composition - Floor (Philadelphia and Atlanta)

Layer No.	Thickness (ft)	Thermal Conductivity (Btu/ft-°F)	Density (lb/ft ³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft ² -°F/Btu)	Description of Layers
1	.6667	-----	61.00	0.22	0.96	Concrete

Thermal Conductance, $U = 1.041 \text{ Btu/ft}^2\text{-°F-hr}$

Figure E-15. Commercial Building People Load Schedule

Figure E-16. Commercial Building Lighting Load Schedule

Figure E-17. Commercial Building Hot Water Schedule

APPENDIX F

LIST OF THE MAJOR VARIABLES
USED IN THE COMPUTER PROGRAMS

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LIST OF MAJOR VARIABLES BY
SUBROUTINE FOR THE RESIDENTIAL
PROGRAM MODULES
LODMOD

MAIN PROGRAM

QC	HOURLY COOLING LOAD
QHL	HOURLY HEATING LOAD
QHW	HOURLY HOT WATER LOAD
QINCI	HOURLY INCIDENT RADIATION ON COLLECTOR SURFACE
XTEMP	HOURLY AVERAGED SPACE TEMPERATURE
BASLOD	HOURLY BASEMENT LOAD
DB	HOURLY DRY BULB TEMPERATURE
WB	HOURLY WET BULB TEMPERATURE
DP	HOURLY DEW POINT
WS	HOURLY WIND SPEED
PB	HOURLY BAROMETRIC PRESSURE
TC	HOURLY CLOUD COVER FACTOR
TOC	HOURLY CLOUD COVER FACTOR
WET	HOURLY WET PRECIPITATION
DRY	HOURLY DRY PRECIPITATION
CLOAD	HOURLY COOLING LOAD
HCOND	HOURLY CONDUCTION LOAD
HPEAK	PEAK HEATING LOAD
CPEAK	PEAK COOLING LOAD
THOTWL	CUMULATIVE HOT WATER LOAD
THLS	CUMULATIVE HEATING LOAD
THWL	CUMULATIVE HOT WATER LOAD
TINF	CUMULATIVE INFILTRATION LOAD
THLOAD	TOTAL HEATING LOAD
TCLOAD	TOTAL COOLING LOAD
TCONDL	TOTAL CONDUCTION LOAD

MAIN PROGRAM

ITSR	TOTAL TRANSMITTED SOLAR RADIATION
IHOUR	HOUR OF THE DAY
IDAYS	NUMBER OF DAYS TO BE SIMULATED
ISTART	STARTING DAY OF SIMULATION
IDAY	DAY OF THE YEAR
IEND	LAST DAY OF SIMULATION
IESCAP	VARIABLE TO POSITION WEATHER TAPE
MONTH	MONTH OF THE YEAR
A(X)	INPUT VARIABLE X
S(X)	SUN VARIABLE X
ABSORB (X)	INCIDENT RADIATION ON SURFACE (X)
HEATD	DESIGN HEATING LOAD
COOLD	DESIGN COOLING LOAD
SIZE 1	SIZE OF HEATING PLANT
SIZE 2	SIZE OF COOLING PLANT
FANCFM	BLOWER CFM FOR THE HEATING PLANT
FNCFM1	BLOWER CFM FOR THE COOLING PLANT
EVPGPM	EVAPORATOR FLOW RATE
EFFECT	HEAT EXCHANGER EFFECTIVENESS
WATVEL	WATER VELOCITY THROUGH HEAT EXCHANGER
WATTMP	WATER DESIGN DELTA T ACROSS HEAT EXCHANGER
CFA	COIL FACE AREA
PDAYC	PEAK DAILY COOLING LOAD
TCEI (X)	INITIAL TEMPERATURE OF CEILING SLAB/SURFACE X
TWSF (X)	INITIAL TEMPERATURE OF WALL SURFACE X
TFLI	INITIAL TEMPERATURE OF FLOOR SURFACE
TW (X)	INITIAL TEMPERATURE OF WALL SLAB X
TAW (X)	INITIAL TEMPERATURE OF ATTIC SLAB X
TA (X)	INITIAL TEMPERATURE OF ATTIC AIR X

TCE (X)	INITIAL TEMPERATURE OF CEILING SLAB X
TIM	INITIAL TEMPERATURE OF INTERNAL MASS
TX	INITIAL SPACE TEMPERATURE
TSC (X)	INITIAL TEMPERATURE OF SLAB X
TCR	INITIAL TEMPERATURE OF CRUSHED ROCK

SUBROUTINE
INPUT

TWELL	WELL WATER TEMPERATURE
MHOTW	COEFFICIENT FOR DETERMINING HOT WATER LOAD
PEOPLE	PERCENT OF MAXIMUM PEOPLE IN RESIDENCE
XLIGHT	PERCENT OF MAXIMUM LIGHTING LOAD
APPL	PERCENT OF MAXIMUM APPLIANCE LOAD
A(N)	N INPUT PARAMETERS

SUBROUTINE
TIME

MODE 0	FLAG USED IN CALLING SUBROUTINE SUN
MODE 1	FLAG USED IN CALLING SUBROUTINE SUN
S(5)	HOUR OF THE DAY
S(4)	DAY OF THE YEAR
CCOVER	CLOUD COVER
NYTYPE	TYPE OF CLOUD
DIRN	DIRECT NORMAL INCIDENT RADIATION (CLOUD MODIFIED)
DIRH	DIRECT RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
TOTH	TOTAL RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)

SUBROUTINE
TSTAT

TZONEW	WINTER SET POINT
TX	INSTANTANEOUS SPACE TEMPERATURE
TRH	STEADY STATE DROOP (HEATING)
HEAT	INSTANTANEOUS PERCENT ON TIME DURING HEATING
TZONES	SUMMER SET POINT
TRC	STEADY STATE DROOP (COOLING)
COOL	INSTANTANEOUS PERCENT ON TIME DURING COOLING
SIZE 1	HEATING CAPACITY
SIZE 2	COOLING CAPACITY
Q	INSTANTANEOUS HEAT OR "COOLTH" DEFERRED TO PLENUM

SUBROUTINE
SOLAR Q

TILT	TILT ANGLE OF SURFACE ABSORBING SOLAR RADIATION
C TILT	COSINE OF THE TILT ANGLE
S TILT	SINE OF THE TILT ANGLE
F TILT	FUNCTION OF THE TILT ANGLE
AZIM	AZIMUTH ANGLE OF SURFACE ABSORBING SOLAR RADIATION
CAZIM	COSINE OF THE AZIMUTH ANGLE
SAZIM	SINE OF THE AZIMUTH ANGLE
RHO	GROUND REFLECTIVITY
S(13)	} DIRECTION COSINES
S(14)	
S(15)	
CTHETA	ANGLE OF INCIDENCE
QDIR	DIRECT RADIATION IMPINGENT ON AN OBLIQUE SURFACE
(CLOUD MODIFIED)
QDIF	DIFFUSE RADIATION IMPINGENT ON AN OBLIQUE SURFACE
(CLOUD MODIFIED)
QAVAIL	TOTAL AVAILABLE RADIATION IMPINGENT ON AN OBLIQUE
SURFACE

SUBROUTINE
SUN

S(1)		LATITUDE
S(2)		LONGITUDE
S(3)		TIME ZONE
S(4)		DAY
S(5)		HOURL
S(6)		DAYLIGHT SAVINGS TIME FLAG
S(8)		CLEARNESS NUMBER
S(11)		SUN RISE TIME
S(12)		SUNE SET TIME
S(13)	}	
S(14)	}	
S(15)	}	DIRECTION COSINES
S(16)		DIRECTION COSINES NORMAL TO A SURFACE
S(20)		SOLAR ALTITUDE ANGLE
S(21)		SOLAR AZIMUTH ANGLE
S(22)		DIFFUSE SKY RADIATION ON A HORIZONTAL SURFACE
S(23)		TOTAL HORIZONTAL RADIATION
S(24)		DIRECT NORMAL RADIATION
S(28)		SUN DECLINATION ANGLE
S(29)		EQUATION OF TIME
S(35)		SOLAR HOUR ANGLE
II		3(35)

SUBROUTINE
COIL

TODB	OUTDOOR AIR DRYBULB TEMPERATURE
TODP	OUTDOOR AIR DEWPOINT TEMPERATURE
TWI	INLET WATER TEMPERATURE TO THE COOLING COIL
QL	LATENT LOAD IN THE SPACE
QS	SENSIBLE LOAD IN THE SPACE
CFMINF	INFILTRATION CFM
FANCFM	COOLING COIL FROM CFM
TX	INDOOR AIR DRYBULB TEMPERATURE
TF	TIME FRACTION THE COOLING COIL IS ON
CLOAD	TOTAL COOLING LOAD FOR THE HOUR
WO	OUTDOOR HUMIDITY RATIO
WI	INDOOR HUMIDITY RATIO
HI	INLET ENTHALPY
HO	OUTLET ENTHALPY
DH	CHANGE IN ENTHALPY
HOTRY	GUESS AT OUTLET ENTHALPY
FX	}
DEL	}
TEP	}
FXD	}
TEN	}
TE	}

PARAMETERS USED IN NEWTON SOLUTION ROUTINE

SUBROUTINE
FUNC

WX	HUMIDITY RATIO AT INLET WATER CONDITIONS
WE	HUMIDITY RATIO AT EXIT WATER CONDITIONS
QMAX	MAXIMUM COOLING CAPACITY OF COOLING COIL

FUNCTION
OMEGA

OMEGA	HUMIDITY RATIO AS A FUNCTION OF THE SATURATION TEMPERATURE

FUNCTION
OMGAIN

WGRAIN	GRAIN OF WATER/POUND OF DRY AIR
OMGAIN	SATURATION TEMPERATURE AS A FUNCTION OF THE HUMIDITY RATIO

SUBROUTINE
WINDOW

BOANG	BUILDING ROTATION ANGLE
RHOS	REFLECTANCE OF THE SOUND IN FRONT OF THE WINDOW
XN	INDEX OF REFRACTION OF GLASS IN AIR
XK	PRODUCT OF THE EXTINCTION COEFFICIENT AND THE THICKNESS FOR EACH PANE OF GLASS
TDR	WINDOW TRANSMITTANCE FOR DIRECT SOLAR RADIATION
TDF	WINDOW TRANSMITTANCE FOR DIFFUSE (SKY AND GROUND REFLECTED) RADIATION
QIRAN(X)	RADIATION TRANSMITTED THROUGH WINDOW X
ABSORB(X)	INCIDENT RADIATION ON WALL X
WA	WALL AZIMUTH ANGLE
BETA	DIRECTION COSINE OF NORMAL TO VERTICAL WALL (WEST)
GAMA	DIRECTION COSINE OF NORMAL TO VERTICAL WALL (SOUTH)
COSAOI	COSINE OF ANGLE OF INCIDENCE
QSINC	DIRECT RADIATION
QINCIS	TOTAL RADIATION
AOI	ANGLE OF INCIDENCE
AOR	ANGLE OF REFLECTANCE

SUBROUTINE
WAHP

TWI	ENTERING WATER TEMPERATURE TO THE EVAPORATOR
TAI	ENTERING AIR TEMPERATURE TO THE CONDENSER
EET	TWI
ECT	TAI
QEVAP	HEAT ABSORBED INTO THE EVAPORATOR
QCOND	HEAT REFLECTED THROUGH THE CONDENSER AND
DESUPERHEATER
QMOT	ENERGY REQUIRED BY THE MOTOR DURING THE
COMPRESSOR
HP	INPUT HORSEPOWER
COP	COEFFICIENT OF PERFORMANCE (COMPRESSOR ONLY)

SUBROUTINE
HOUSE

THOTW	SET POINT OF WATER HEATER
USTAG	U OF STORAGE TANK ABOVE GROUND
USTBG	U OF STORAGE TANK BELOW GROUND
UHOTW	U OF HOT WATER TANK
U CEIL	OVERALL U OF CEILING
U WALL(X)	U OF WALL/ NODE X
U GLASS	OVERALL U OF GLASS
U DOOR	OVERALL U OF DOOR
U ROOF(X)	U OF ROOF/ NODE X
ACE(X)	AREA OF CEILING X
AWALL(X)	AREA OF WALL X
AAWALL(X)	AREA OF ATTIC WALL X
AROOF(X)	AREA OF ROOF X
CFMINF	INFILTRATION CFM
PEOPMX	MAXIMUM PEOPLE DENSITY
APPLMX	MAXIMUM APPLIANCE LOAD DENSITY
XLTEMX	MAXIMUM LIGHTING DENSITY
SHDXXX	SHADING PARAMETERS TO CALCULATE SHADOW GEOMETRY
ATTICTX	SUMMER ATTIC DESIGN TEMPERATURE
WINDWG	SUMMER DESIGN WINDOW SOLAR GAIN
TOSAS	SUMMER OUTSIDE DESIGN TEMPERATURE
TOSAW	WINTER OUTSIDE DESIGN TEMPERATURE
WOSAS	SUMMER DESIGN HUMIDITY RATIO
WINTS	WINTER DESIGN HUMIDITY RATIO
OVRCPW	OVERCAPACITY OF HEATING PLANT
OVRCPs	OVERCAPACITY OF COOLING PLANT
NSB	NIGHT SETBACK OPTION (NOT TO BE USED IN HEAT PUMP APPLICATION)
SHADES	OPTION TO USE WINDOW SHADES

SUBROUTINE
HOUSE (CONT)

HEATD	HEATING DESIGN LOAD
COOLD	COOLING DESIGN LOAD
CRVXXXX	THERMAL CAPACITANCE OF NODE XXXX
UAYY(X)	CONDUCTIVITY OF NODE X SURFACE YY
ALFW	ABSORPTIVITY OF WALLS
ALFR	ABSORPTIVITY OF ROOFS
HO(X)	CONVECTIVE HEAT TRANSFER COEFFICIENT OF OUTSIDE SURFACE X
HIX	CONVECTIVE HEAT TRANSFER COEFFICIENT OF INSIDE SURFACE X
HAIM	HEAT TRANSFER COEFFICIENT OF INTERNAL MASS
ADOOR	AREA OF DOOR
AHOTW	AREA OF HOT WATER TANK
AGLASX	AREA OF GLASS SURFACE X
UND	U OF NORTH DOOR
AND	AREA OF NORTH DOOR
INFAX	INFILTRATION OF ATTIC X
UAXXX	CONDUCTIVITY OF MODE XX IN CRUSHED ROCK
HAXX	SURFACE HEAT TRANSFER COEFFICIENT (SURFACE XX)
DT	STEP SIZE FOR INTEGRATING DIFFERENTIAL EQUATIONS
TR(X)	NODAL TEMPERATURES OF ROOF
TAW(X)	NODAL TEMPERATURES OF ATTIC WALL
TA(X)	ATTIC AIR TEMPERATURES
TCE(X)	NODAL TEMPERATURES OF CEILING
TSL	NODAL SLAB TEMPERATURES
TF	NODAL FLOOR TEMPERATURES
TW(X)	NODAL WALL TEMPERATURES
TIM	TEMPERATURE OF INTERNAL MASS
TX	SPACE TEMPERATURE
XKCON	GROUND CONDUCTIVITY

SUBROUTINE
HOUSE (CONT)

TWW	WINTER WELL WATER DESIGN TEMPERATURE
PEOPL	SENSIBLE OCCUPANT LOAD
XLIGHT	LIGHTING LOAD
APPL1	APPLIANCE LOAD
ANG1	TILT ANGLE OF COLLECTOR
ANG2	AZIMUTH OF COLLECTORS
ANGX	TILT OR AZIMUTH ANGLE OF SURFACE X
HGHOTW	HOT WATER LOAD
TINLOD	INTERNAL LOAD
QAXXX	SOLAR GAIN SURFACE XXX
TAS(X)	EXTERIOR SURFACE TEMPERATURE X
TWSX(X)	SURFACE TEMPERATURE Y OF NODE X
TCRX	NODAL TEMPERATURES OF CRUSHED ROCK
TTEX	NODAL TEMPERATURES OF EARTH
BTU	INSTANTANEOUS LOAD
TTX	CUMULATIVE TEMPERATURE
TBTU	CUMULATIVE BTUS
TIME	CUMULATIVE TIME
QS	SENSIBLE HOURLY LOAD
QL	LATENT HOURLY LOAD

SUBROUTINE
SHADE

PHI	SOLAR AZIMUTH ANGLE
COSZ	COSINE OF SOLAR ZENITH ANGLE
SHRAT	SHADE RATIO OF SUNLIT AREA TO TOTAL AREA
HT	WINDOW HEIGHT
FL	WINDOW LENGTH
FP	DEPTH OF OVERHANG
AW	DISTANCE FROM TOP OF WINDOW TO OVERHANG
BWL	DISTANCE OF OVERHANG EXTENDED BEYOND LEFT EDGE
OF WINDOW
D	DEPTH OF VERTICAL PROJECTION AT END OF OVERHANG
FPI	DEPTH OF LEFT FIN
AI	DISTANCE OF LEFT FIN EXTENDED ABOVE TOP OF WINDOW
BI	DISTANCE FROM LEFT EDGE OF WINDOW TO LEFT FIN
CI	DISTANCE OF LEFT FIN STOP SHORT ABOVE BOTTOM OF
WINDOW
FP2	DEPTH OF RIGHT FIN
A2	DISTANCE OF RIGHT FIN EXTENDED ABOVE TOP OF WINDOW
B2	DISTANCE FROM RIGHT EDGE OF WINDOW TO RIGHT FIN
C2	DISTANCE OF THE RIGHT FIN STOP SHORT ABOVE BOTTOM
OF WINDOW
WAZI	WINDOW AZIMUTH ANGLE

DESMOD

MAIN PROGRAM

KADX	THERMAL CONDUCTIVITY OF THE GROUND AROUND TANK
HEIGHT	HEIGHT OF THE STORAGE TANK
PF	VOLUMETRIC PACKING FRACTION
UTANKA	THERMAL CONDUCTIVITY OF THE TANK FROM THE WATER TO AIR SURFACE
UTANKW	THERMAL CONDUCTIVITY OF THE TANK FROM THE WATER TO THE OUTSIDE SURFACE OF THE TANK
UWAL	THERMAL CONDUCTIVITY OF THE BASEMENT WALL BELOW GROUND LEVEL
TTANK	TEMPERATURE OF THE TANK
TAVE	AVERAGE SPACE TEMPERATURE
TQHLHW	TOTAL WINTER SPACE HEATING LOAD
TQHWHW	TOTAL WINTER HOT WATER LOAD
TQHWHS	TOTAL SUMMER HOT WATER LOAD
TQHCHS	TOTAL SUMMER SPACE HEATING LOAD
TQCCS	TOTAL COOLING LOAD DURING THE SUMMER
BC	BEGINNING OF THE COOLING SEASON
BH	BEGINNING OF THE HEATING SEASON
CCP	COEFFICIENT OF PERFORMANCE
TQINCW	TOTAL SOLAR INSOLATION AVAILABLE DURING THE WINTER
TQINCS	TOTAL SOLAR INSOLATION AVAILABLE DURING THE SUMMER
PCT	PERCENTAGE OF THE HEIGHT DIMENSION THAT THE TANK IS ABOVE GROUND
DMINQ	TOTAL HEAT NEEDED FOR THE MINIMUM ACES DESIGN
DMINBL	TOTAL BASEMENT LOAD FOR THE MINIMUM ACES DESIGN
CPRVT	THERMAL CAPACITANCE OF THE TANK ON A NODAL BASIS PER FT ²
CPRVW	THERMAL CAPACITANCE OF THE BASEMENT WALL ON A NODAL BASIS PER FT ²

TAMBA	AMBIENT TEMPERATURE
AREAC	AREA OF SOLAR COLLECTOR/CONVECTOR
CK	INTERCEPT OF THE COLLECTOR EFFICIENCY CURVE
C	SLOPE OF THE COLLECTOR EFFICIENCY CURVE
FF	COP ADJUSTMENT FACTOR IF DESIRED (CURRENTLY SET = 0)
PUMP	ENERGY NEEDED BY THE PANEL PUMP
PUME	ENERGY NEEDED BY THE EVAPORATOR PUMP
PUMC	ENERGY NEEDED BY THE COOLING LOOP PUMP
FANH	ENERGY NEEDED BY THE HEATING BLOWER
FANC	ENERGY NEEDED BY THE COOLING BLOWER
IN	OPTION TO PUT THE TANK INSIDE OR OUTSIDE THE HOUSE
PDAYC	PEAK DAILY COOLING LOAD
DAYC	DAY THAT THE PEAK COOLING LOAD OCCURS
AA	} COEFFICIENT USED IN DESCRIBING THE CONVECTOR PANEL
BB	
TTANK2	MAXIMUM ALLOWABLE WATER TEMPERATURE TO PROVIDE COOLING
ENDC	DAY THAT THE TANK TEMPERATURE IS ALLOWED TO EXCEED TTANK2
IUDAYS	NUMBER OF DAYS TO BE SIMULATED
BOTH	OPTION TO SIZE TANK FOR BOTH SUMMER AND WINTER
FULL	OPTION TO SIZE THE FULL OR MINIMUM ACES SYSTEM
XPER	PERCENTAGE OF PUMP ENERGY TO SPACE
SCALE	RATIO OF HEAT PUMP NEEDED TO ACTUAL HEAT PUMP
TQC	TOTAL COOLING LOAD
TQH	TOTAL HEATING LOAD
TQW	TOTAL HOT WATER LOAD
TQI	TOTAL AVAILABLE RADIATION PER FT ² OF COLLECTOR AREA
SID	SIDE DIMENSION OF ICE STORAGE TANK
VOLUME	VOLUME OF THE ICE STORAGE TANK
SIZ	AREA OF COLLECTOR/CONVECTOR ARRAY

SUBROUTINE
INPUT

TWELL	WELL WATER TEMPERATURE ARRAY
FANCFM	BLOWER CFM OF HEAT PUMP
FNCFMI	BLOWER CFM OF COOLING SYSTEM
SIZE	DESIGN HEATING CAPACITY
SIZE 2	DESIGN COOLING CAPACITY
A(X)	INPUT VARIABLE X

SUBROUTINE
BEGIN

BH	BEGINNING OF THE HEATING SEASON
BC	BEGINNING OF THE COOLING SEASON
DAY	DAY OF THE YEAR
WTH	WEEKLY HOT WATER AND HEATING ENERGY REMOVED
FROM TANK
WTC	WEEKLY COOLING ENERGY REJECTED TO THE TANK

SUBROUTINE
WAHP

TWI	ENTERING WATER TEMPERATURE TO THE EVAPORATOR
TAI	ENTERING AIR TEMPERATURE TO THE CONDENSER
EET	TWI
ECT	TAI
QEVAP	HEAT ABSORBED INTO THE EVAPORATOR
QCOND	HEAT REFLECTED THROUGH THE CONDENSER AND
DESUPERHEATER
QMOT	ENERGY REQUIRED BY THE MOTOR DURING THE
COMPRESSOR
HP	INPUT HORSEPOWER
COP	COEFFICIENT OF PERFORMANCE (COMPRESSOR ONLY)

SUBROUTINE
TANKLD

SIDE	SIDE DIMENSION OF TANK
TLOSS	TOTAL TANK HEAT LOSS OR GAIN
SURFW	THE BASEMENT WALL SURFACE AREA THAT THE TANK REPLACES
TLOSA	TANK LOSS TO SURROUNDING AIR
TEMP	BASEMENT TEMPERATURE
TO	OUTSIDE TEMPERATURE
AX	} LOGIC VARIABLES
XK	
CPRXX	THERMAL CAPACITANCE OF NODE XX
UTNXX	THERMAL CONDUCTIVITY OF NODE XX
TTU	TEMPERATURE IN FIRST NODE IN COVER OF TANK
QLOST	HEAT TRANSFERRED TO OR FROM WATER TO FIRST NODE
TTGX	TEMPERATURE OF NODE X
TTGWX	TEMPERATURE OF NODE X IF THERE IS A WALL BETWEEN THE TANK AND THE SURROUNDING GROUND
QLOSG	HEAT TRANSFERRED BETWEEN THE GROUND AND WATER
QLUSGW	HEAT TRANSFERRED BETWEEN THE GROUND AND WATER WITH A WALL BETWEEN THE TANK AND THE GROUND

SUBROUTINE
COLLECT

QINC	INCIDENT RADIATION
PANUM	NUMBER OF COLLECTOR PANELS
QCOLL	ENERGY COLLECTED
VEL	WIND VELOCITY
ETA	PANEL EFFICIENCY
Q	BTUS COLLECTED PER FT ²
TTANK	INLET FLUID TEMPERATURE
TAMBA	AMBIENT TEMPERATURE

SUBROUTINE
TANK 2

TAVE	AVERAGE BASEMENT TEMPERATURE FOR SIZING OF THE MINIMUM ACES
TOAVE	AVERAGE AIR TEMPERATURE SURROUNDING TANK FOR SIZING THE MINIMUM ACES
QICEI	INITIAL GUESS ON REQUIRED ICE VOLUME
VOLUME	SIZE OF ICE STORAGE TANK FOR THE MINIMUM ACES
SIDE	SIDE DIMENSION OF THE TANK
QNEED2	HEAT REQUIRED FOR HOT WATER DURING THE SIZING OF THE MINIMUM ACES
TF2	PERCENT ON TIME OF HOT WATER SYSTEM DURING THE SIZING OF THE MINIMUM ACES
QINEED1	HEAT REQUIRED FOR SPACE HEATING DURING THE SIZING OF THE MINIMUM ACES
TFI	PERCENT ON TIME OF THE SPACE HEATING PLANT DURING THE SIZING OF THE MINIMUM ACES
QOUT	ENERGY REMOVED FROM THE TANK DURING THE SIZING OF THE MINIMUM ACES
CUFT	ICE GENERATED DURING THE PERIOD
CUFTN	ICE CAPABILITY OF THE TANK BASED ON GUESSED TANK SIZE
TF	TIME FRACTION
FX	}
DEL	}
SIDP	}
FXD	}
FXP	}
SIDN	}

PARAMETERS USED IN NEWTON SOLUTION ROUTINE

SUBROUTINE
TANK

IXIX	LOGIC VARIABLE
NORTH	LOGIC VARIABLE DESIGNATING TYPE OF DESIGN CONSTRAINTS
QICEI	INITIAL GUESS OF LATENT HEAT OF ICE WITHIN TANK
VOLUMI	INITIAL GUESS OF VOLUME OF TANK
ICHECK	LOGIC VARIABLES
BOTH	LOGIC VARIABLE TO DESIGN TANK
VOLUME	VOLUME OF THE TANK
AREA	WALL AREA OF TANK
SIDE	SIDE DIMENSION OF TANK

SUBROUTINE
NEWTON

FX	}	
DEL	}	
SIDP	}	
FXD	}	PARAMETERS IN NEWTON SOLUTION ROUTINE
FXP	}	
SIDN	}	
SIDE		SOLUTION TO NEWTON ROUTINE GIVING SIDE DIMENSION OF TANK

SUBROUTINE
STORAGE

TZONES	SUMMER SET POINT
THOTWI	HOT WATER SET POINT
TTANK	TANK TEMPERATURE
PCUFT	PEAK ICE VOLUME
VOLUME	VOLUME OF STORAGE BIN
IBEGIN	BEGINNING OF HEATING SEASON
IEND	END OF SIMULATION
IBHMI	LAST DAY OF COOLING SEASON
T	SPACE TEMPERATURE
TC	OUTDOOR AIR TEMPERATURE
TWI	ENTERING CONDENSER WATER TEMPERATURE
HEAT	HOURLY HEATING LOAD
HEATMB	HOURLY HEATING LOAD MINUS THE BASEMENT LOAD
BASE 1	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
QNEEDW	TOTAL ENERGY NEEDED FOR HOT WATER PURPOSES
TFW	TIME FRACTION FOR HOT WATER SYSTEM
QNEEDS	TOTAL ENERGY NEEDED FOR SPACE HEAT
TFS	TIME FRACTION FOR SPACE HEAT
COOL	HOURLY COOLING LOAD
COOLMB	COOLING LOAD MINUS THE BASEMENT LOAD
BASE 2	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
RHT1	EFFECTIVENESS OF COOLING HEAT EXCHANGER
QNEED	TOTAL ENERGY NEEDED FOR COOLING PURPOSES
TF	TIME FRACTION (HEATING OR COOLING)
QPC	COOLING PUMP ENERGY
QULE	ELECTRIC ENERGY INTO TANK

SUBROUTINE
PANEL

QINCT	TOTAL AVAILABLE INCIDENT RADIATION
QMELT	BTUS REQUIRED TO MELT ICE WITHIN TANK
NUMPAN	NUMBER OF PANELS
SIZE	SIZE OF THE COLLECTOR ARRAY

SUBROUTINE
BISCAN

ICHECK	LOGIC VARIABLE
XA	LOWER LIMIT ON PANEL CONSTRAINT
XB	FIRST GUESS ON PANEL AREA
FX }	
FXA }	
XA }	
XB }	PARAMETERS NEEDED TO SOLVE FOR THE SIZE OF
THE COLLECTOR USING THE BISECTION METHOD
CUFT }	
PCUFT }	
PANUM }	
FLAG	LOGIC VARIABLE
SUM	COUNTER
FXNO }	
XO }	PARAMETERS NEEDED TO SOLVE FOR THE SIZE OF THE
COLLECTOR
XN }	

PANUM	}	
FXN	}	USING THE MODIFIED SECANT METHOD
XNEW	}	
NUMPAN		SOLUTION TO THE NUMERICAL ROUTINES
SIZE		AREA OF THE SOLAR COLLECTOR
PEK		DAY THAT THE ICE PEAKED

SUBROUTINE
SIZES

TZONES		SUMMER SET POINT
THOTWI		HOT WATER SET POINT
COFT		ICE VOLUME
PCUFT		PEAK ICE VOLUME
TTANK		TANK TEMPERATURE
TQI	}	
TQNS	}	ENERGY COUNTERS
TQWW	}	
TQN	}	
IBEGIN		BEGINNING OF HEATING SEASON
IEND		END OF SIMULATION
IBHMI		LAST DAY OF COOLING SEASON
T		SPACE TEMPERATURE
TO		OUTDOOR TEMPERATURE
TWI		ENTERING CONDENSER WATER TEMPERATURE
VEL		WIND VELOCITY
TAMBA		TO
QINC		INCIDENT SOLAR RADIATION
QCOL		COLLECTED ENERGY FROM SOLAR PANEL
QPCC		ENERGY FROM PANEL PUMP TO FLOWSTREAM
QPAN		ENERGY FROM PANEL PUMP TO SPACE

HEAT	HOURLY HEATING LOAD
HEATMB	HOURLY HEATING LOAD MINUS THE BASEMENT LOAD
BASE 1	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
QNEEDW	TOTAL ENERGY NEEDED FOR HOT WATER PURPOSES
TFW	TIME FRACTION FOR HOT WATER SYSTEM
QNEEDS	TOTAL ENERGY NEEDED FOR SPACE HEAT
TFS	TIME FRACTION FOR SPACE HEATING
COOL	HOURLY COOLING LOAD
COOLMB	COOLING LOAD MINUS THE BASEMENT LOAD
BASE 2	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
RAT1	EFFECTIVENESS OF COOLING HEAT EXCHANGER
QNEED	TOTAL ENERGY NEEDED FOR COOLING PURPOSES
TF	TIME FRACTION FOR HEATING OR COOLING
QPC	COOLING PUMP ENERGY
QELE	DISSIPATION ENERGY FROM ALL PUMPS TO THE TANK

SIMMOD

MAIN PROGRAM

TZONEW	WINTER SET POINT
TZONES	SUMMER SET POINT
TOSAW	WINTER OUTSIDE DESIGN TEMPERATURE
TOSAS	SUMMER OUTSIDE DESIGN TEMPERATURE
AWALBG	AREA OF WALL BELOW GROUND
KADA	THERMAL CONDUCTIVITY OF GROUND
UWALBG	U OF WALL BELOW GROUND
HWALBG	H OF WALL BELOW GROUND
UTANK	CONDUCTIVITY OF TANK
HEIGHT	HEIGHT OF TANK
PF	VOLUMETRIC PACKING FRACTION
PCT	PERCENT OF TANK ABOVE GROUND
NDAYS	NUMBER OF DAYS TO BE SIMULATED
UTANKX	CONDUCTIVITY OF TANK SECTION X
CPRVX	THERMAL CAPACITANCE OF NODE X
TTANK	TEMPERATURE OF TANK
CUTOFF	CHANGEOVER TEMPERATURE
CK	COLLECTOR CONSTANT
C	COLLECTOR CONSTANT
TAMBA	OUTDOOR TEMPERATURE
AREAC	AREA OF EACH COLLECTOR
FF	COLLECTOR CONSTANT
XPER	PERCENTAGE OF PUMP ENERGY TO FLOWSTREAM
SET2	LOGIC VARIABLE FOR SIZING TANK
ISTRIP	NUMBER OF STAGES OF STRIP HEAT
IN	LOGIC VARIABLE FOR LOCATION OF TANK
ICONV	SYSTEM DESCRIPTOR (ACES OR CONVENTIONAL SYSTEM)

AA	COLLECTOR CONSTANT
BB	COLLECTOR CONSTANT
IBLDGT	BUILDING TYPE
SIDE	SIDE DIMENSION OF TANK
PANUM	NUMBER OF SOLAR PANELS
SCALE	SCALE FACTOR FOR THE HEAT PUMP
QC	COOLING LOAD
AHL	HEATING LOAD
FLAG1	LOGIC VARIABLE
FLAG2	LOGIC VARIABLE
ELEBU	ELECTRIC ENERGY REQUIRED AS SUPPLEMENTAL HEAT
TELEBU	TOTAL ELEBU
FIRST	LOGIC VARIABLE
FANCME	FAN CFM FOR EVAPORATOR
FANCMH	FAN CFM FOR CONDENSER
FANC	COOLING FAN ENERGY INPUT
FANH	CONDENSER FAN ENERGY INPUT
FANE	EVAPORATOR FAN ENERGY INPUT
FANOIL	OIL BURNER FAN ENERGY INPUT
FANGAS	GAS BURNER FAN ENERGY INPUT
PUMW	ENERGY INPUT TO HOT WATER PUMP
PUMP	ENERGY INPUT TO PANEL PUMP
PUME	ENERGY INPUT TO EVAPORATOR PUMP
PUMC	ENERGY INPUT TO COOLING LOOP PUMP
I BEGIN	BEGINNING OF THE HEATING SEASON
IBHMI	LAST DAY OF THE COOLING SEASON
IEND	LAST DAY OF SIMULATION
TQHC	CUMULATIVE HEATING LOAD
TQHW	CUMULATIVE HOT WATER LOAD
TQC	CUMULATIVE COOLING LOAD
GAST	CUMULATIVE GAS CONSUMPTION
OILT	CUMULATIVE OIL CONSUMPTION
ELET	CUMULATIVE ELECTRICITY CONSUMPTION
TELEBU	CUMULATIVE ELEBU

SUBROUTINE
D INPUT

TWELL	WELL WATER TEMPERATURE ARRAY
FANCFM	BLOWER CFM OF HEAT PUMP
FNCFM1	BLOWER CFM OF COOLING SYSTEM
SIZE	DESIGN HEATING CAPACITY
SIZE2	DESIGN COOLING CAPACITY
A(X)	INPUT VARIABLE X
BC	BEGINNING COOLING SEASON
BH	BEGINNING HEATING SEASON
SID	SIDE DIMENSION OF TANK
SIZ	AREA OF COLLECTOR ARRAY
TQZZZ	TOTAL ENERGY FOR ZZZ
VOLUME	VOLUME OF TANK (NEAREST FT ³)
SIZEE	SIZE OF COLLECTOR ARRAY (NEAREST FT ²)
ZAP	DAY OF THE PEAK COOLING LOAD
PEK	THE PEAK COOLING LOAD

SUBROUTINE
WAHP

TWI	ENTERING WATER TEMPERATURE TO THE EVAPORATOR
TAI	ENTERING AIR TEMPERATURE TO THE CONDENSER
EET	TWI
ECT	TAI
QEVAP	HEAT ABSORBED INTO THE EVAPORATOR
QCOND	HEAT REFLECTED THROUGH THE CONDENSER AND
DESUPERHEATER
QMOT	ENERGY REQUIRED BY THE MOTOR DURING THE
COMPRESSOR
HP	INPUT HORSEPOWER
COP	COEFFICIENT OF PERFORMANCE (COMPRESSOR ONLY)

SUBROUTINE
WWHP

TWI	ENTERING WATER TEMPERATURE TO THE EVAPORATOR
TAI	ENTERING AIR TEMPERATURE TO THE CONDENSER
EET	TWI
ECT	TAI
QEVAP	HEAT ABSORBED INTO THE EVAPORATOR
QCOND	HEAT REFLECTED THROUGH THE CONDENSER AND
DESUPERHEATER
QMOT	ENERGY REQUIRED BY THE MOTOR DURING THE
COMPRESSOR
HP	INPUT HORSEPOWER
COP	COEFFICIENT OF PERFORMANCE (COMPRESSOR ONLY)

SUBROUTINE
ATAHP

EET	TEMPERATURE OF AIR ENTERING THE EVAPORATOR
ECT	TEMPERATURE OF AIR ENTERING THE CONDENSER
TAC	EET
TAE	ECT
QCOND	HEAT REJECTED THROUGH THE CONDENSER
QEVAP	HEAT ABSORBED INTO THE EVAPORATOR
COP	COEFFICIENT OF PERFORMANCE (COMPRESSOR ONLY)
QMOT	ENERGY REQUIRED BY THE MOTOR DRIVING THE COMPRESSOR
HP	INPUT HORSE POWER
T1	DEWPOINT TEMPERATURE
T2	TAE
PV	PARTIAL PRESSURE OF VAPOR SATURATION AIR AT T1
PG	PARTIAL PRESSURE OF VAPOR SATURATION AIR AT T2
RH	RELATIVE HUMIDITY
DMAX	MAXIMUM NUMBER OF DEFROST CYCLES
DEFPH	ACTUAL NUMBER OF DEFROST CYCLES
AUX1	ENERGY NEEDED FOR DEFROST
AUX2	ENERGY REMOVED FROM CONDENSER DURING DEFROST

SUBROUTINE
TANKLD

SIDE	SIDE DIMENSION OF TANK
TLOSS	TOTAL TANK HEAT LOSS OR GAIN
SURFW	THE BASEMENT WALL SURFACE AREA THAT THE TANK REPLACES
TLOSA	TANK LOSS TO SURROUNDING AIR
TEMP	BASEMENT TEMPERATURE
TO	OUTSIDE TEMPERATURE
AX	} LOGIC VARIABLES
XK	
CPRXX	THERMAL CAPACITANCE OF NODE XX
UTNXX	THERMAL CONDUCTIVITY OF NODE XX
TTU	TEMPERATURE IN FIRST NODE IN COVER OF TANK
QLOST	HEAT TRANSFERRED TO OR FROM WATER TO FIRST NODE
TTGX	TEMPERATURE OF NODE X
TTGWX	TEMPERATURE OF NODE X IF THERE IS A WALL BETWEEN THE TANK AND THE SURROUNDING GROUND
QLOSG	HEAT TRANSFERRED BETWEEN THE GROUND AND WATER
QLUSGW	HEAT TRANSFERRED BETWEEN THE GROUND AND WATER WITH A WALL BETWEEN THE TANK AND THE GROUND

SUBROUTINE
COLLECT

QINC	INCIDENT RADIATION
PANUM	NUMBER OF COLLECTOR PANELS
QCOLL	ENERGY COLLECTED
VEL	WIND VELOCITY
ETA	PANEL EFFICIENCY
Q	BTUS COLLECTED PER FT ²
TTANK	INLET FLUID TEMPERATURE
TAMBA	AMBIENT TEMPERATURE

FUNCTION
PVSF

T	TEMPERATURE
P(X)	PRESSURE
PVSF	PARTIAL PRESSURE OF MOISTURE SATURATED AIR
AT TEMPERATURE T

SUBROUTINE
CONVL

QNEED	REQUIRED ENERGY NEEDED FOR COOLING
TF	TIME FRACTION FOR COOLING
CD	DEGRADATION COEFFICIENT DUE TO CYCLING
HPD	ACTUAL INPUT POWER TO COOLING SYSTEM
ELE	TOTAL ELECTRICAL ENERGY CONSUMED
CAP	CAPACITY OF HEATING SYSTEM
PER	PERCENT LOAD
PEAK	DEMAND
CAS	HOURLY GAS CONSUMPTION
OIL	HOURLY OIL CONSUMPTION

FUNCTION
DEGRAT

B	COEFFICIENT
DEGRAD	DEGRADATION COEFFICIENT DUE TO CYCLING

SUBROUTINE
CONV 2

ELEX	ELECTRICAL ENERGY CONSUMPTION ASSOCIATED WITH
STAGE X
BUX	SUPPLEMENTAL HEAT ASSOCIATED WITH STAGE X
AUX1	ENERGY CONSUMED DURING CYCLING
AUX2	ENERGY REMOVED FROM THE CONDENSER DURING CYCLING
PEAK X	DEMAND ASSOCIATED WITH STAGE X
QNEED	ENERGY REQUIRED FOR HEATING PURPOSES
TF	TIME FRACTION
XRZ	LOGIC VARIABLES
CD	DEGRADATION COEFFICIENT
HTD	INPUT ENERGY TO PLANT ACCOUNTING FOR CYCLING
ELE	HOURLY ENERGY CONSUMED BY THE ELECTRIC SYSTEM
OIL	HOURLY ENERGY CONSUMED BY THE OIL SYSTEM
GAS	HOURLY ENERGY CONSUMED BY THE GAS SYSTEM

SUBROUTINE
CONV 3

ELEX	ELECTRIC CONSUMPTION ASSOCIATED WITH
COMPONENT X
TFP	TIME FRACTION OF PILOT IF ONE EXISTS
PEAKX	DEMAND ASSOCIATED WITH STAGE X
ITYE	LOGICAL DESIGNATOR FOR OIL OR GAS SYSTEM
OIL	HOURLY OIL CONSUMPTION
QNEED	ENERGY REQUIRED FOR SPACE COOLING
TF	TIME FRACTION OF COOLING SYSTEM
CD	DEGRADATION COEFFICIENT
HPD	INPUT ENERGY TO PLANT ACCOUNTING FOR CYCLING
ELE	HOURLY ENERGY CONSUMED BY THE ELECTRIC SYSTEM
OIL	HOURLY ENERGY CONSUMED BY THE OIL SYSTEM
GAS	HOURLY ENERGY CONSUMED BY THE GAS SYSTEM

SUBROUTINE
FURN

QIN	INPUT ENERGY TO FURNACE
QOUT	OUTPUT ENERGY FROM FURNACE
QNEED	REQUIRED ENERGY FOR HEATING PURPOSES
TF	TIME FRACTION
FX	}
DEL	}
FXD	}
FXP	}
ETA	FURNACE EFFICIENCY

FUNCTION
ETA OIL

ETA OIL

EFFICIENCY OF OIL FURNACE AS A FUNCTION OF THE
PERCENT ON TIME

FUNCTION
ETA GAS

ETA GAS

EFFICIENCY OF GAS FURNACE AS A FUNCTION OF THE
PERCENT ON TIME

SUBROUTINE
CONV 4

ELEX

ELECTRIC CONSUMPTION ASSOCIATED WITH COMPONENT

TFP

TIME FRACTION OF PILOT IF ONE EXISTS

PEAK X

DEMAND ASSOCIATED WITH STAGE X

ITYE

LOGICAL DESIGNATOR FOR OIL OR GAS SYSTEM

OIL

HOURLY OIL CONSUMPTION

QNEED

ENERGY REQUIRED FOR SPACE COOLING

TF

TIME FRACTION OF COOLING SYSTEM

CD

DEGRADATION COEFFICIENT

HPD

INPUT ENERGY TO PLANT ACCOUNTING FOR CYCLING

ELE

HOURLY ENERGY CONSUMED BY THE ELECTRIC SYSTEM

OIL

HOURLY ENERGY CONSUMED BY THE OIL SYSTEM

GAS

HOURLY ENERGY CONSUMED BY THE GAS SYSTEM

SUBROUTINE
ACES

DUAL	LOGICAL VARIABLES FOR THE DUAL SOURCE EVAPORATOR
TSOAW	WINTER DESIGN DRYBULB TEMPERATURE
TZONEW	WINTER SET POINT
TZONES	SUMMER SET POINT
TTANK	TANK TEMPERATURE
CUFT	VOLUME OF ICE WITHIN TANK
TTANK2	MAXIMUM TEMPERATURE OF TANK TO PROVIDE FULL COOLING
LOAD
AWALBG	AREA OF WALL BELOW GROUND
THOTW	HOT WATER SET POINT
ENDC	END OF TANK COOLING REQUIREMENTS
DAYON	DAY COLLECTOR ON
DAYOF	DAY COLLECTOR OFF
DAYAFT	DAY AFTER COLLECTOR OFF
FLAG	LOGICAL VARIABLES
CHECK	
TIMON	TIME WHEN HEAT PUMP BEGINS RUNNING DURING COOLING
SEASON
TIMOF	TIME WHEN HEAT PUMP STOPS RUNNING DURING COOLING
SEASON
TERI	
STAR	VARIABLES USED TO INSURE MINIMUM USE OF HEAT
PUMP DURING SUMMER OPERATION
BEFO	
VOLUME	SIZE OF TANK
SSS	LOGIC VARIABLE
XXXX1	REFERS TO WATER-TO-AIR HEAT PUMP
XXXX2	REFERS TO AIR-TO-AIR HEAT PUMP
QCONDX	ENERGY REJECTED THROUGH CONDENSER X
QBU	SUPPLEMENTAL HEAT
HPX	HORSE POWER OF HEAT PUMP X

PEAKX	DEMAND ASSOCIATED WITH STAGE X
EVAPX	ENERGY ABSORBED THROUGH EVAPORATOR X
QEVAPX	ENERGY ABSORBED THROUGH EVAPORATOR X
COPX	COP OF HEAT PUMP X
QINC	INCIDENT RADIATION
QCOL	ENERGY COLLECTED FROM SOLAR PANEL
QPCC	ENERGY FROM PANEL PUMP TO SPACE
QPAN	ENERGY FROM PANEL PUMP TO TANK
ELESOL	ENERGY TO RUN THE PANEL PUMP
QLOW	HOURLY EVAPORATIVE ENERGY NEEDED TO REJECT HEAT FROM COLD STORAGE
ELENIT	ENERGY CONSUMED BY HEAT PUMP TO REJECT HEAT FROM COLD STORAGE
ELELOT	PARASITIC ENERGY NEEDED TO REJECT HEAT FROM COLD STORAGE
ELELOW	PARASITIC ENERGY NEEDED TO REJECT HEAT FROM COLD STORAGE
HEAT	HOURLY HEATING LOAD
HEATMB	HOURLY HEATING LOAD MINUS THE BASEMENT LOAD
BASE1	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
QNEEDW	TOTAL ENERGY NEEDED FOR HOT WATER PURPOSES
TFW	TIME FRACTION FOR HOT WATER SYSTEM
QNEEDS	TOTAL ENERGY NEEDED FOR SPACE HEAT
TFS	TIME FRACTION FOR SPACE HEATING
CD	DEGRADATION COEFFICIENT FOR HEAT PUMP 1 OR 2
HPD	INPUT HORSEPOWER FOR PUMP 1 OR 2
COPD	COP OF HEAT PUMP 1 OR 2
ELE1	ENERGY CONSUMED BY SYSTEM 1 OR 2
COOL	HOURLY COOLING LOAD
COOLMB	COOLING LOAD MINUS THE BASEMENT LOAD
BASE 2	ADJUSTED BASEMENT LOAD IF TANK IS IN BASEMENT
RAT1	EFFECTIVENESS OF COOLING HEAT EXCHANGER
QNEED	TOTAL ENERGY NEEDED FOR COOLING PURPOSES
TF	TIME FRACTION FOR HEATING OR COOLING

QPC	COOLING PUMP ENERGY
QELE	DISSIPATION ENERGY FROM ALL PUMPS TO THE TANK
ELE	HOURLY ENERGY CONSUMED BY THE ELECTRIC SYSTEM
OIL	HOURLY ENERGY CONSUMED BY THE OIL SYSTEM
GAS	HOURLY ENERGY CONSUMED BY THE GAS SYSTEM

ECOMOD

MAIN PROGRAM

COST (X)	INSTALLED EQUIPMENT COST OF COMPONENT X
FLAGT	FLAG FOR PROPERTY TAX ON SOLAR SYSTEM
LAP	LENGTH OF ANALYSIS PERIOD
RDR	REAL DISCOUNT RATE
TAXI	INCOME TAX RATE
TAXP	PROPERTY TAX RATE
RMORT	MORTGAGE TAX RATE
MFLAG	FLAG FOR TYPE OF MORTGAGE
SALV	SALVAGE VALUE
IDS	DEPRECIATION SCHEDULE
NSYS	NUMBER OF SYSTEMS TO BE ANALYZED
RINT	REAL INTEREST RATE
PVE(X)	PRESENT VALUE OF ELECTRICITY OF SYSTEM X
PVG(X)	PRESENT VALUE OF GAS OF SYSTEM X
PVO(X)	PRESENT VALUE OF OIL OF SYSTEM X
PVEC(X)	PRESENT VALUE OF ELECTRICITY CONSUMPTION OF SYSTEM X
PVED(X)	PRESENT VALUE OF DEMAND COSTS OF SYSTEM X
MAINT(X)	PRESENT VALUE OF MAINTENANCE COST OF SYSTEM X
INS(X)	PRESENT VALUE OF INSURANCE COSTS OF SYSTEM X
PVTD(X)	PRESENT VALUE OF TAX DEDUCTION OF SYSTEM X
PTAX(X)	PROPERTY TAX EFFECT
PVC(X)	PERCENT VALUE OF ALL CAPITAL INVESTMENTS FOR SYSTEM X
ETC	ENERGY TAX CREDIT
OETP	TAX DEDUCTION DUE TO OPERATING EXPENSES
TPV	TOTAL PRESENT VALUE
AC	ANNUAL COST
ACESC(X)	ACES COST OF COMPONENT X

DELTAC	DELTA ANNUAL COSTS
DELTOC	DELTA OPERATING COSTS
PUNB	PRESENT VALUE OF NET BENEFITS
PAYBAK	PAYBACK DURATION
BRKEV	BREAKEVEN DURATION

SUBROUTINE
AMOUNT

BSP	BEGINNING OF SEASONAL PEAK
WPED(X)	WEEKLY PEAK ENDING DAY SEASON (X)
BHDP(X)	BEGINNING HOUR OF DAILY PEAK DURING SEASON (X)
EHDP(X)	ENDING HOUR OF DAILY PEAK DURING SEASON (X)
OPEU(X,Y)	OFF-PEAK ELECTRIC USE, SEASON X BY SYSTEM Y
PEU(X,Y)	PEAK PERIOD ELECTRIC USE, SEASON X BY SYSTEM Y
OPDM(X,Y)	MAXIMUM OFF-PEAK DEMAND IN MONTH X BY SYSTEM Y
PDM(X,Y)	MAXIMUM PEAK DEMAND IN MONTH X BY SYSTEM Y

SUBROUTINE
FUEL COST

OILC(X)	FIRST YEAR OIL COSTS OF SYSTEM X
GASC(X)	FIRST YEAR GAS COSTS OF SYSTEM X
DEMAND(X,Y)	DEMAND FOR SEASON X BY SYSTEM Y
ELEC(X,Y)	ENERGY COST FOR SEASON X BY SYSTEM Y
BLKCOST	BLOCK COSTS FOR STANDARD RATES
BLKSIZ	BLOCK SIZE FOR STANDARD RATES
DMAX(X)	PEAK DEMAND FOR SEASON X
PDC(X)	ON-PEAK DEMAND CHARGE SEASON X
OPDC(X)	OFF-PEAK DEMAND CHARGE SEASON X
PEC(X)	PEAK ENERGY CHANGE SEASON X
OPEC(X)	OFF-PEAK ENERGY CHANGE SEASON X

SUBROUTINE
BILLING

TCOST	CUMULATIVE COST OF BLOCK X
Q(X)	TOTAL COST OF BLOCK X

SUBROUTINE
OUTPUT

This routine is merely used to output all cost information

SUBROUTINE
ACESCOST

FLAGHP	FLAG DESIGNATOR FOR HEAT PUMP
FLAGSS	FLAG DESIGNATOR FOR SOLAR SYSTEM
RHP	COST OF RESIDENTIAL HEAT PUMP
CHP	COST OF COMMERCIAL HEAT PUMP
CLINER	COST OF TANK LINER
CWALL	COST OF TANK WALL
CSLAB	COST OF TANK SLAB
CTOP	COST OF TANK TOP
TANK	COST OF TANK
CADD	COST OF ADDITIONAL TANK INSULATION
SSCOST	SOLAR SYSTEM VARIABLE COST
ACESC(X)	COST OF ACES COMPONENT X

APPENDIX G

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