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ECONOMIC EVALUATION OF THE ANNUAL CYCLE ENERGY SYSTEM (ACES)

FINAL REPORT

Volume III — Appendices

ENERGY RESOURCES CENTER
HONEYWELL INC.
2600 RIDGWAY PARKWAY
MINNEAPOLIS, MINNESOTA 55413

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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.

$LODMOD_A$

```
  B U R = 3 8 T                    * * * * * * * * * * * * * * * * * * * * * * * * *
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  XXXX              XXXX              XXXX              XXXX              XXXXX
     X             X    X            X    X                X                X
   XXX              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

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


$$    3883T ENTERED GCS-AJ AT 11.413 FROM SYSTEM-0 TSS/S   0-03-12


0001  $       SNUMB   3883T
0002  $       COMMENT F00648          TSS MEDIA CONVERSION
0003  $       IDENT   F00648-ACES
0004  $$      USERID  F00648$
0005 A$       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 11.414       LINES   1604       PROC  0.0003       I/O   0.001     IU  5   MEMORY     8K
      STOP  11.428       LIMIT  50000       LIMIT 0.2000       LIMIT           CU  5   M*T        91
      SWAP   0.011
      LAPSE  0.013 FC D   TYPE      BUSY     IP/AT     FP/RT     IS/#C MS/#E     ADDRESS T#/PK#

                   MC R MSU450 *      22         0         1         1     1     0-08-23
                   IN R MSU450 *     858         0        59        39    59     0-08-23
                   OT     SYOUT
                   P*     SYOUT

       RC-00  1604 LINES AT STA.  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/SETTNGS-  ASIS
```

```
C*********************************************************************
C
C     LOADS PROGRAM FOR RESIDENTIAL ACES
C
C     THIS PROGRAM HAS BEEN DESIGNED TO CALCULATE THE HOURLY LOADS
C     FOR A SINGLE OR MULTI-FAMILY RESIDENCES (ONLY) EQUIPPED WITH AN
C     ACES CONFIGURATION.  THIS PROGRAM IS ONE OF FOUR DISTINCT MODULES.
C     THEY ARE:
C          1.  LOADS PROGRAM
C          2.  DESIGN PROGRAM
C          3.  SIMULATION PROGRAM
C          4.  ECONOMIC ANALYSIS PROGRAM
C     IF THE LOADS HAVE BEEN ALREADY DETERMINED, THIS MODULE CAN BE
C     BYPASSED.
C
C     DEVELOPED BY HONEYWELL
C
C     CREATION DATE: JULY 6, 1978
C
C*********************************************************************
C
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
     1        QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,HPEAK,
     1        THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR,A(200),
     1        NTABLE(20),XTEMP(24,366),BASLOD(24,366)
      COMMON /SOLAR/S(35)
      COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),
     1        TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
      COMMON /SLOAD/QTRAN(5),ABSORB(5)
      COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
      COMMON /YEARLY/TW(4),TAW(4),TR1,TR2,TA,TCE,TIM,TSBG,TG1,TG2,
     1             TG3,TX,TSBGI,TCEI,TWSI(4)
      COMMON/HOURLY/CONDL,XINF,TSR,QINC1,QINC2,ALFW,ALFR
      COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,EFFECT,
     1         WATVEL,WATTMP,CFA,FNCFM1
      DIMENSION MSIZE(12),DAY(24,15),TDAY(15),MONTH(12,15)
      DATA MSIZE/31,28,31,30,31,30,31,31,30,31,30,31/
      DATA ZERO/0./,TWNFOR/24./,ONE/1./,TWNFIV/25./
      REAL MHOTW,MONTH
C
C     INITIALIZE
C
      DO 20 I = 1, 24
         DO 10 J = 1, 366
            QC(I,J) = ZERO
            QHL(I,J) = ZERO
            QHW(I,J) = ZERO
            QINCI(I,J) = ZERO
            XTEMP(I,J) = ZERO
            BASLOD(I,J) = ZERO
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          TOC(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       TTSR = ZERO
10730       IHOUR = 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) MSIZE(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,PB,TC,TDC,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
```

```
      TDAY(14) = TDAY(14)/TWNFOR
      NDAY = NDAY + 1
      IF (K .GT. 20) GO TO 100
      IF (NTABLE(K) .EQ. 0 .OR. NTABLE(K) .NE. TDAY) GO TO 100
      K = K + 1
      WRITE(9,500) NDAY,L
      DO 80 I = 1, 24
         WRITE(9,510) I,(DAY(I,J),J = 1, 8)
         IF (I .EQ. 24) WRITE(9,520) (TDAY(J),J = 1, 8)
80       CONTINUE
      WRITE(9,530)
      DO 90 I = 1, 24
         WRITE(9,510) I,(DAY(I,J),J = 9, 15)
         IF (I .EQ. 24) WRITE(9,520) (TDAY(J), J = 9, 15)
90       CONTINUE
100   CONTINUE
      DO 110 J = 1, 15
         MONTH(L,J) = TDAY(J) + MONTH(L,J)
110      CONTINUE
      GO TO 40
120   CONTINUE
      DO 125 I=1,12
         MONTH(I,14) = MONTH(I,14)/FLOAT(MSIZE(I))
 125     CONTINUE
      WRITE(9,540)
      DO 130 I = 1, 12
         WRITE(9,510)I,(MONTH(I,J), J = 1, 8)
130     CONTINUE
      WRITE(9,530)
      DO 140 I = 1, 12
         WRITE(9,510) I,(MONTH(I,J),J = 9, 15)
140      CONTINUE
      DAYC = ZERO
      PDAYC = ZERO
      DO 150 K=1,366
         IF(DAYC .GT. PDAYC) PDAYC = DAYC
         DAYC = ZERO
         DO 150 J=1,24
         DAYC = DAYC + QC(J,K)
         WRITE(11) QHL(J,K),QHW(J,K),QC(J,K),QINCI(J,K),
     1                 BASLOD(J,K),XTEMP(J,K)
 150     CONTINUE
      WRITE(9,550)THLOAD,TCLOAD,THOTWL,TINF,TTSR,TCONDL,CPEAK,HPEAK
      WRITE(9,560)HEATD,COOLD,SIZE1,SIZE2,FANCFM,FNCFM1,EVPGPM,
     1            EFFECT,WATVEL,WATTMP,CFA,PDAYC
      WRITE(9,570) TCEI,(TWSI(I),I=1,4),TSBGI,(TW(I),I=1,4),
     1             (TAW(I),I=1,4),TA,TCE,TR1,TR2,TIM,TX,TSBG,
     1             TG1,TG2,TG3
      WRITE(13) FANCFM,FNCFM1,SIZE1,SIZE2,HEATD
      ENDFILE 11
```

```
      STOP
C
C     FORMAT STATEMENTS
C
  500 FORMAT(1H1,45X,' HOURLY SUMMARY FOR DAY',I4,' MONTH',I4///11X,
     1 'QHL',11X,'QHW',12X,'QC',10X,'QINCI',9X,'CONDL',10X,'XINF',10X,
     1       'TSR',9X,'QINC1'/)
  510 FORMAT(1X,I2,8(1X,E13.5))
  520 FORMAT(/' DAILY SUMMARY'//3X,8(1X,E13.5))
  530 FORMAT(//10X,'QINC2',8X,'ABSORB(1)',5X,'ABSORB(2)',
     1       5X,'ABSORB(3)',5X,'ABSORB(4)',8X,'XTEMP',7X,'BASLOD'/)
  540 FORMAT(1H1,' MONTHLY SUMMARY'///11X,'QHL',11X,'QHW',12X,'QC',10X,
     1        'QINCI',9X,'CONDL',10X,'XINF',10X,'TSR',9X,'QINC1'/)
  550 FORMAT(1H1,' YEARLY SUMMARY'///5X,'THLOAD',10X,'TCLOAD',10X,
     1        'THOTWL',11X,'TINF',12X,'TTSR',11X,'TCONDL',10X,'CPEAK',
     1        11X,'HPEAK'//8(1X,E15.8))
  560 FORMAT(1H1,' DESIGN PARAMETERS'///1X,'HEATING DESIGN LOAD',
     1       23X,E15.8/1X,'COOLING DESIGN LOAD',23X,E15.8/1X,
     1       'CAPACITY OF HEATING PLANT',17X,E15.8/1X,
     1       'CAPACITY OF COOLING PLANT',17X,E15.8/1X,
     1       'BLOWER CFM FOR COOLING SYSTEM',13X,E15.8/1X,
     1       'BLOWER CFM FOR HEATING SYSTEM',13X,E15.8/1X,
     1       'GAL./MIN. THROUGH EVAPORATOR',14X,E15.8/1X,
     1       'RATED EFFECTIVENESS OF HEAT EXCHANGER',5X,E15.8/1X,
     1       'WATER VELOCITY THROUGH HEAT EXCHANGER',5X,E15.8/1X,
     1       'WATER TEMPERATURE RISE',20X,E15.8/1X,
     1       'COIL FACE AREA',28X,E15.8/1X,'PEAK DAILY COOLING LOAD',
     1       19X,E15.8)
  570 FORMAT(1H1,'   FINAL TEMPERATURES'///1X,'CEILING SURFACE',
     1       10X,F8.2/1X,'WALL SURFACE - NORTH',5X,F8.2/1X,
     1       13X,'- EAST',6X,F8.2/14X,'- SOUTH',5X,F8.2/14X,
     1       '- WEST',6X,F8.2/1X,'BASEMENT SURFACE',9X,F8.2/1X,
     1       'WALL - NORTH',13X,F8.2/6X,'- EAST',14X,F8.2/6X,
     1       '- SOUTH',13X,F8.2/6X,'- WEST',14X,F8.2/1X,
     1       'ATTIC WALL - NORTH',7X,F8.2/12X,'- EAST',8X,F8.2/
     1       12X,'- SOUTH',7X,F8.2/12X,'- WEST',8X,F8.2/1X,
     1       'ATTIC AIR',16X,F8.2/1X,'CEILING',18X,F8.2/1X,
     1       'ROOF #1',18X,F8.2/1X,'ROOF #2',18X,F8.2/1X,
     1       'INTERNAL MASS',12X,F8.2/1X,'SPACE',20X,F8.2/
     1       1X,'SLAB',21X,F8.2/1X,'GROUND #1',16X,F8.2/1X,
     1       'GROUND #2',16X,F8.2/1X,'GROUND #3',16X,F8.2)
C
C     LAST CARD OF MAIN PROGRAM.
C
      END
C
      SUBROUTINE INPUT
C
C*********************************************************************
C
```

```
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/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHN(24,366),
12680      1        QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,HPEAK,
12690      1        THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR,A(200),
12700      1        NTABLE(20),XTEMP(24,366),BASLOD(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,.7,.4,.4,.2,.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,22HWELL 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/
```

```
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(I5,F15.5,10A6)
13090 3000  FORMAT(3H A(,I3,1H),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 HORIZONATAL 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/IHOUR,IDAY,IMONTH,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,TCONDL,TCLOAD,TTSR
13410      1        ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(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      1OPEM6/1.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
```

```
      S(5) = S(5) - TWNFOR
      READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,
     1            ICITY
      IMONTH = IDUM1
      CALL SUN(MODE0)
   10 IHOUR = IFIX(S(5))
      IDAY = IFIX(S(4))
C
C     COMPUTE SOLAR RADIATION COMPONENTS (CLOUD MODIFIED)
C
      CCOVER = TC(IHOUR)
      NYTYPE = IFIX(TOC(IHOUR))
      IF(NYTYPE .LT. 1) CCOVER = CCOVER/TWO
      CCF = ONE - P011 * CCOVER - P00792 * CCOVER ** 2
      CALL SUN(MODE1)
C
C     IF PRECIPITATION IS PRESENT THEN NO DIRECT OR DIFFUSE RADIATION
C
      IF (WET(IHOUR) .LT. OPEM6 .AND. DRY(IHOUR) .LT. OPEM6) GO TO 20
      S(23) = ZERO
      S(24) = ZERO
   20  CONTINUE
C
C     DIRECT NORMAL RADIATION (CLOUD MODIFIED)
C
      DIRN = (ONE - P09 * CCOVER) * S(24)
C
C     DIRECT RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
C
      DIRH = DIRN * S(13)
C
C     TOTAL RADIATION ON A HORIZONTAL SURFACE (CLOUD MODIFIED)
C
      TOTH = CCF * S(23)
C
C     DETERMINE LOADS BY CALLING SUBROUTINE HOUSE
C
      CALL HOUSE
      RETURN
C
C     LAST CARD OF SUBROUTINE TIME
C
      END
      SUBROUTINE HOUSE
C
C*********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE HEATING AND COOLING LOAD
C     FOR A RESIDENTIAL BUILDING.
C
```

```
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE HOUSE
C
C     THIS SUBROUTINE CALCULATES THE FOLLOWING QUANTITIES:
C
C     QHL(IHOUR,IDAY) - HOURLY HEATING LOAD
C     QC(IHOUR,IDAY) - HOURLY COOLING LOAD
C     QHW(IHOUR,IDAY) - HOURLY HOT WATER LOAD
C     BASLOD(IHOUR,IDAY) - HOURLY BASE LOAD
C     QINCI(IHOUR,IDAY) - HOURLY AVAILABLE ENERGY
C     XTEMP(IHOUR,IDAY) - HOURLY GROUND TEMPERATURE
C     CONDL - HOURLY CONDUCTION LOSS
C     XINF - HOURLY INFILTRATION
C     TSR - HOURLY TRANSMITTED SOLAR RADIATION
C     CPEAK - COOLING LOAD PEAK FOR THE PERIOD OF SIMULATION
C     HPEAK - HEATING LOAD PEAK FOR THE PERIOD OF SIMULATION
C     TA - ATTIC TEMPURATURE
C     TX - AIR SPACE TEMPURATURE
C     WALLT(I) - WALL SURFACE TEMP. ON FOUR WALLS
C     TW(I) - ROOM WALL TEMP. ON FOUR WALLS
C     TINF - TOTAL INFILTRATION
C     THOTWL - TOTAL HOT WATER LOAD
C     THLOAD - TOTAL HEATING LOAD
C     TCLOAD - TOTAL COOLING LOAD
C     TCONDL - TOTAL CONDUCTION LOSS
C     TTSR - TOTAL TRANSMITTED SOLAR RADIATION
C
C     DEVELOPED BY HONEYWELL
C
C     PROJECT: ACES
C
C     CREATION DATE: 06/19/78
C
C*****************************************************************
C
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
     1        QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
     1        HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
     1        ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
      COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),P3(24),TC(24)
     1        ,TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
      COMMON /SOLAR/S(35)
      COMMON /SLOAD/QTRAN(5),ABSORB(5)
      COMMON /HTPP/FF
      COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
      COMMON /YEARLY/TW(4),TAW(4),TR1,TR2,TA,TCE,TIM,TSBG,TG1,TG2,
     1         TG3,TX,TSBGI,TCEI,TWSI(4)
      COMMON /HOURLY/CONDL,XINF,TSR,QINC1,QINC2,ALFW,ALFR
      COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,ENPGPM,EFFECT,
```

```
     1          WATVEL,WATTMP,CFA,FNCFM1
      LOGICAL FIRST,COOLIN
      REAL NDYTP,MHOTW,KADX
      DIMENSION UAWI(4),UAWO(4),UAAWO(4),UAAWI(4),CRVAW(4),CRVW(4),
     1          AREAA(4),AREAW(4),HAWI(4),UWALL(4),UATTIC(4),
     1          WALLT(4),HA(4),UAAWX(4),TASS(4),HAW(4),UAWX(4),
     1          UAWXI(4),TASSS(4),XTEMP1(4),XTEMP2(4),XTEMP3(4),
     1         XTEMP4(4),XTEMP5(4),XTEMP6(4),XTEMP7(4)
      DATA FIRST/.TRUE./
      DATA PI/3.414/,TWO/2./,ETP6/83.6/,ONET/1000./,P01/.01/,
     1     ETIN/18./,HUNDRD/100./,P79/.79/,THR3/33./,SIXTY/60./
      DATA OP08/1.08/,THRTWO/32./,ONE/1./,ZERO/0./,P1/.1/,P4/.4/,P5/.5/
     1     ,P8/.8/,TTP32/8.33/,SIXTHR/63./,TFIFTY/250./,FHNDRD/500./
     1     ,FHUNDR/400./,FOURTY/40./,SSX/666./,FOUR90/490./,ETHUND/1800
     1     ./,TEN/10./,P45/.45/,ONET61/1061./,OT75P4/1075.4/,FORP46/4.
     1     46/,P05030/.05030/,THREE/3./,TW25/25./
C
C     FIRST TIME THROUGH, INITIALIZE CONSTANTS FROM 'A' ARRAY. SKIP
C     INITIALIZATION ON SUCCEEDING CALLS.
C
      IF (.NOT. FIRST) GO TO 40
      OLDMTH = ZERO
      TIME = ZERO
      FF = A(22)
      ANG1 = A(6)
      ANG2 = A(5)
      ANG3 = A(151)
      ANG4 = A(152)
      ANG5 = A(153)
      ANG6 = A(154)
      THOTW = A(50)
      UHOTW = A(53)
      UCEIL = A(54)
      UWALL(1) = A(55)
      UWALL(2) = A(155)
      UWALL(3) = A(156)
      UWALL(4) = A(157)
      UWALBG = A(56)
      UGLASS = A(57)
      UDOOR = A(58)
      UFLOOR = A(59)
      UROOF = A(60)
      UATTIC(1) =A(61)
      UATTIC(2) = A(158)
      UATTIC(3) = A(159)
      UATTIC(4) = A(160)
      AHOTW = A(62)
      ACEIL = A(63)
      AREAW(1) = A(64)
      AREAW(2) = A(161)
```

```
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        WINDWG = 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
```

```
15510        SUMUA = (UWALL(1) * AREAW(1) + UWALL(2) * AREAW(2) + UWALL(3) *
15520       1        AREAW(3) + UWALL(4) * AREAW(4)) + UADOOR + UAFLOR +
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        CRVSBG = A(181)
15890        CRVIM = A(182)
15900        CRVX = A(184)
15910        CRVG1 = ETP6 * AWALBG
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
```

```
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        TSBG = A(192)
16180        TG1 = A(193)
16190        TG2 = A(194)
16200        TG3 = A(195)
16210        TSBGI = 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        KADX = TCON * AWALBG/TWO
16320C
16330        IF(ICALC .NE. 0) GO TO 30
16340C
16350C       HEATING DESIGN LOAD
16360C
16370        HEATD = ( SUMUA * (TZONEW - TOSAW) + UACEIL * (TZONEW - TOSAW)
16380       1         + (TZONEW - TWELL(1)) * (ONE/(ONE/UAWBG + THREE/KADX))
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 - XLTEMX)
16460       1        * OVRCPS
16470C
16480  30    CONTINUE
16490C
16500C       HEAT PUMP DESIGN
```

```
16510C
16520       CALL WAHP(THRTWO,TZONEW,QCOND,QEVAP,HP,COP)
16530       CHECK1 = COOLD/QEVAP
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/QEVAP .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/QEVAP
16660       IF(DESL .LE. DESL1) SIZE1 = SF1 * QCOND
16670       SFP = SF1
16680       IB = IFIX((SFP-ONE)*ETHUND*P01)
16690       B = HUNDRD * (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/HUNDRD) + 1) * HUNDRD
16820       SIZE2 = FANCFM * OP08 * (TZONES - THRTWO) * EFFECT
16830       SIZE2 = ONET * FLOAT(IFIX(SIZE2/ONET)) + ONET
16840       CFA = FANCFM/FHUNDR
16850       CFT2 = COOLD/CFA
16860C
16870C      SET P05030 = 1.66/33.
16880C
16890       WATVEL = FOURTY * P05030
16900       WATTMP = COOLD/(FHNDRD * FOURTY)
16910       FIRST = .FALSE.
16920C
16930C      INTERMEDIATE CALCULATION FOR EQUATIONS INSIDE INNER LOOP
16940C
16950       TEMP0 = OP08 * CFMINF
16960       TEMP1 = DT/CRVX
16970       TEMP2 = ONE - TEMP1 * (HAWBG + UAGLAS + HACI + HAWI(1) + HAWI(2)
16980      1        + HAWI(3) + HAWI(4) + HAIM + TEMP0 + UAHOTW + UADOOR)
16990       TEMP4 = OP08 * AVENT * ACEIL
17000       TEMP5 = TEMP4 + UARI1 + UARI2 + UAAWI(1) + UAAWI(2) + UAAWI(3)
```

```
     1          + UAAWI(4) + UACO
      TEMP6 = DT/CRVG1
      TEMP7 = ONE - TEMP6 * TWO * KADX
      TEMP8 = KADX * TWELL(IMONTH)
      TEMP9 = DT/CRVR1
      TEMP10 = DT/CRVR2
      TEMP11 = DT/CRVC
      TEMP12 = DT/CRVIM
      TEMP13 = DT/CRVSBG
      HAR1 = HO * AROOF1
      HAR2 = HO * AROOF2
      UARX1 = ONE/(ONE/UARO1 - ONE/HAR1)
      UARX2 = ONE/(ONE/UARO2 - ONE/HAR2)
      UACX = ONE/(ONE/UACI - ONE/HACI)
      UAWBX = ONE/(ONE/UAWBG - ONE/HAWBG)
      TEMP16 = UARX1 + UARI1
      TEMP17 = UARX2 + UARI2
      TEMP18 = HACI + UACX
      TEMP19 = UACX + UACO
      TEMP20 = HAWBG + UAWBX
      TEMP21 = KADX + UAWBX
      TEMP22 = HAR1 + UARX1
      TEMP23 = HAR2 + UARX2
      DO 35 I = 1, 4
         HA(I) = HO * AREAA(I)
         UAAWX(I) = ONE/(ONE/UAAWO(I) - ONE/HA(I))
         TASS(I) = ALFW * AREAA(I)
         HAW(I) = HO * AREAW(I)
         UAWX(I) = ONE/(ONE/UAWO(I) - ONE/HAW(I))
         UAWXI(I) = ONE/(ONE/UAWI(I) - ONE/HAWI(I))
         TASSS(I) = ALFW * AREAW(I)
         XTEMP2(I) = HA(I) + UAAWX(I)
         XTEMP3(I) = UAAWX(I) + UAAWI(I)
         XTEMP4(I) = HAWI(I) + UAWXI(I)
         XTEMP6(I) = HAW(I) + UAWX(I)
         XTEMP7(I) = UAWX(I) + UAWXI(I)
35       CONTINUE
40    CONTINUE
      J = IHOUR
C
C     CALCULATE INTERNAL PEOPLE, LIGHT, AND APPLIANCE SENSIBLE LOADS
C
      PEOPL = PEOPLE(J) * PEOPMX * TFIFTY
      XLIGT = XLIGHT(J) * XLTEMX
      APPL1 = APPL(J) *APPLMX
C
C     CALCULATE AVAILABLE RADIATION ON COLLECTOR SURFACE
C
      CALL SOLARQ(ANG1,ANG2,QAVAIL)
      QINCI(IHOUR,IDAY) = QAVAIL
```

```
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) *AGLASW)
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)) TZONEW = 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       HGHOTW = MHOTW(J) * TTP32 * (THOTW - TWELL(IMONTH))
17780       TINLOD = PEOPL + XLIGT +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       TTX = 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) * ABSORB(I)
17940          XTEMP5(I) = HAW(I) * DB(J) + TASSS(I) * ABSORB(I)
17950 65       CONTINUE
17960       TEMP3 = DB(J) * (TEMPO + UAGLAS + UADOOR) + UAHOTW * THOTW
17970       TEMP14 = HAR1 * DB(J) + QINC1 * ALFR * AROOF1
17980       TEMP15 = HAR2 * DB(J) + QINC2 * ALFR * AROOF2
17990       TEMP24 = DB(J) * TEMP4
18000C
```

```
18010C      INTEGRATE DIFFERINTIAL 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 TEMPERTURES
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 TEMPERTURE
18370C
18380       TCEI = (HACI * TX + UACX *TCE)/TEMP18
18390       TCE = TCE*(ONE -TEMP11*TEMP19)+TEMP11*(UACO*TA+UACX*TCEI)
18400C
18410C      DETERMINE THE ATTIC TEMPERTURE
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 TEMPERTURES
18480C
18490       DO 80 I=1,4
18500         TEMP = DT/CRVW(I)
```

```
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      DETEMINE THE INTERNAL MASS TEMPERTURE
18580C
18590       TIM =TIM*(ONE -TEMP12*HAIM)+TEMP12*(HAIM*TX+TSR)
18600C
18610C      DETERMINE THE BASEMENT TEMPERTURE(SURFACE TEMPERTURE 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 TEMPERTURE ASSUMING ONE DIRECTIONAL
18690C      HEAT TRANSFER AND THAT THE GROUND TEMPERTURE AT A DISTANCE OF 6
18700C      FEET FROM THE WALL IS AT THE WELL WATER TEMPERTURE
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 = HAWBG * (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
```

```
19010       CLOAD = ZERO
19020       HLOAD = ZERO
19030       GO TO 130
19040   110 CONTINUE
19050C
19060C      CALCULATE COOLING LOADS
19070C
19080       QS = -TBTU
19090       QL = PEOPL*P8
19100       HLOAD = ZERO
19110       TODB = DB(J)
19120       TODP = DP(J)
19130       CALL COIL(TODB,TODP,TWI,QL,QS,CFMINF,FANCFM,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       TTINLD = TTINLD + TINLOD
19270       XINF = TEMPO*(TTX-DB(J))
19280       HLHOTW = UAHOTW * (THOTW - TTX)
19290       CONDL = HLOAD + TSR - XINF + HLHOTW +TINLOD
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,TZONEW,TZONES)
19500C
```

```
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*****************************************************************
19620       COMMON /DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,EFFECT,
19630      1         WATVEL,WATTMP,CFA,FNCFM1
19640       DATA TRH/3./,TRC/1./,ONE/1./,ZERO/0./
19650C
19660       HEAT = (TZONEW - TX)/TRH
19670       IF(HEAT .GT. ONE) HEAT = ONE
19680       IF(HEAT .LT. ZERO) HEAT = ZERO
19690C
19700       COOL = (TX - TZONES)/TRC
19710       IF(COOL .GT. ONE) COOL = ONE
19720       IF(COOL .LT. ZERO) COOL = ZERO
19730C
19740       Q = HEAT * SIZE1 - COOL * SIZE2
19750C
19760       RETURN
19770C
19780C      LAST CARD OF SUBROUTINE TSTAT
19790C
19800       END
19810       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 INICIDENT ON SURFACE (BTU/SQ.FT.)
19990C
20000C      DEVELOPED BY HONEYWELL
```

```
C
C     PROJECT: ACES
C
C     CREATION DATE: 06/21/78
C
C*********************************************************************
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
     1        QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
     1        HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
     1        ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
      COMMON /DIR/DIRH,DIRN,TOTH
      COMMON /SOLAR/S(35)
      DATA POINT/.017453/,ZERO/0./,ONE/1./,TWO/2./
C
C     CALCULATE SURFACE ANGLES
C
      TILT = ANG1 * POINT
      CTILT = COS(TILT)
      STILT = SIN(TILT)
      FTILT = (ONE - CTILT)/TWO
      AZIM = ANG2 * POINT
      CAZIM = COS(AZIM)
      SAZIM = SIN(AZIM)
      RHO = A(9)
C
C     COMPUTE ANGLE OF INCIDENCE WHERE
C        S(13) - THE DIRECTION COSINE WITH RESPECT TO THE SURFACE NORMAL
C        S(14) - THE DIRECTION COSIN WITH RESPECT TO LOCAL EAST
C        S(15) - THE DIRECTION COSINE WITH RESPECT TO LOCAL NORTH
C
      CTHETA = CTILT * S(13) + STILT * SAZIM * S(14) - STILT * CAZIM *
     1         S(15)
      IF (CTHETA .LT. ZERO) CTHETA = ZERO
C
C     COMPUTE DIRECT AND DIFFUSE SOLAR RADIATION IMPINGING ON AN
C     OBLIQUE SURFACE
C
      QDIR = DIRN * CTHETA
      QDIF = (TOTH - DIRH) * (ONE - FTILT) + RHO * TOTH * FTILT
      QAVAIL = QDIR + QDIF
      RETURN
      END
C
      SUBROUTINE SUN(MODE)
C
C*********************************************************************
C
C     THIS SUBROUTINE COMPUTES DECLINATION, EQUATION OF TIME,APPARENT
C     SOLAR CONSTANT, ATMOSPHERIC EXTINCTION COEFFICIENT, SKY DIFFUSE
C     FACTOR, SUN RISE AND SUNSET TIMES ONCE EACH DAY, AND
```

```
C     THE SUN PARAMETERS.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE SUN(MODE)
C
C     WHERE
C
C     MODE IS SET TO 0 AT THE FIRST CALL OF EACH DAY
C
C     S(1)= LATITUDE,DEGREES(+NORTH,-SOUTH)
C     S(2)= LONGITUDE,DEGREES(+WEST,-EAST)
C     S(3)= TIME ZONE NUMBER
C              STANDARD  TIME        DAYLIGHT  SAVING TIME
C      ATLANTIC        4                     3
C      EASTERN         5                     4
C      CENTRAL         6                     5
C      MOUNTAIN        7                     6
C      PACIFIC         8                     7
C     S(4)= DAYS(FROM START OF YEAR)
C     S(5)= TIME,HOUR AFTER MIDNIGHT)
C     S(6)= DAYLIGHT SAVING TIME INDICATOR
C     S(8)= CLEARNESS NUMBER
C     S(11)=SUN RISE TIME  (HOURS AFTER MIDNIGHT)
C     S(12)=SUN SET TIME
C     S(13)=COSZ     DIRECTION COSINES
C     S(14)=COSN     DIRECTION COSINES
C     S(15)=COS(S)   DIRECTION COSINES)
C     S(16)=ALPHA    DIRECTION COSINES NORMAL TO SURFACE
C     S(20)=SOLAR ALTITUDE ANGLE, RADIANS
C     S(21)=SOLAR AZIMUTH ANGLE, RADIANS
C     S(22)=DIFFUSE SKY RADIATION ON HORIZONTAL SURFACE
C     S(23)=TOTAL HORIZONTAL RADIATION ITH
C     S(24)=DIRECT NORMAL RADIATION
C     S(28)=SUN DECLINATION ANGLE DELTA, RADIANS
C     S(29)=EQUATION OF TIME ,HOURS
C     S(30) = SOLAR FACTOR A
C     S(31) = SOLAR FACTOR B
C     S(32) = SOLAR FACTOR C
C     S(35)=SOLAR HOUR ANGLE OMEGA, RADIANS
C
C     DEVELOPED BY HONEYWELL
C
C*********************************************************************
C
      COMMON /SOLAR/ S(35)
      DIMENSION A0(5),A1(5),A2(5),A3(5),B1(5),B2(5),B3(5)
      DATA A0/.302,-.0002,368.44,.1717,.0905/
      DATA A1/-22.93,.4197,24.52,-.0344,-.0410/
      DATA A2/-.229,-3.2265,-1.14,.0032,.0073/
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      DATA A3/-.243,-.0903,-.109,.0024,.0015/
      DATA B1/3.851,-7.351,.58,-.0043,-.0034/
      DATA B2/.002,-9.3912,-.18,0.,.0004/
      DATA B3/-.055,-.3361,.28,.0008,-.0006/
      DATA TWO/2./,THR66/366./,THREE/3./,ONE80/180./,SIXTY/60./
     1     ,FIFTIN/15./,TWELVE/12./,ONE/1./,ZERO/0./,OPEM6/1.E-6/
      DATA RPH/0.261799383/
      REAL LAT,LATD,LONG,MERID,LOND
C
      PI = 3.14159265
      TWOPI = 6.28318531
      IF(MODE .NE. 0) GO TO 20
      X= TWO *PI/THR66*S(4)
      C1=COS(X)
      C2=COS(TWO*X)
      C3=COS(THREE*X)
      S1=SIN(X)
      S2=SIN(TWO*X)
      S3=SIN(THREE*X)
      DO 10 K=1,5
         KS=(K-1)+28
         S(KS)=A0(K)+A1(K)*C1+A2(K)*C2+A3(K)*C3+B1(K)*S1+B2(K)*S2
     1   + B3(K)*S3
10       CONTINUE
      S(28) = S(28)*PI/ONE80
      S(29)=S(29)/SIXTY
      LATD=S(1)
      LONG=S(2)
      MERID=FIFTIN*S(3)
      LOND=LONG-MERID
      Y = S(28)
      YY=LATD*PI/ONE80
      HP=-SIN(Y)/COS(Y)*SIN(YY)/COS(YY)
      TR=TWELVE/PI*ARCOS(HP)
      S(11)=(TWELVE-TR)-S(29)+LOND/FIFTIN
      S(12) = S(11) + TWO*TR
C
C     COMPUTE DAILY CONSTANTS
C
      TYY=SIN(YY)/COS(YY)
      TY=SIN(Y)/COS(Y)
      CY=COS(Y)
      SY=SIN(Y)
      CYY=COS(YY)
      SYY=SIN(YY)
      ACHP=ARCOS(HP)
      HP1 = ARCOS(HP)
      X1=ABS(HP1)
      GO TO 40
C
```

```
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/ONE80
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(TODB,TODP,TWI,QL,QS,CFMINF,FANCFM,TX,TF
21970      1,CLOAD,EFFECT)
21980C
21990C*****************************************************************
22000C
```

```
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       HO= HI - DH
22500C
```

```
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      1        - 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
```

```
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,WO,WIP,QL,TE,TWI,TX,HO,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*WO + QL/ONET96 + TEMP1*WE)/
23320      1    (TEMP0 + TEMP1)
23330C
23340C        DETERMINE QMAX, DH, HI, HO, 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       HO= 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 OMGAIN(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       WGRAIN = SEVENT * W
23850       OMGAIN = X(1) + X(2) * WGRAIN - X(3) * WGRAIN * WGRAIN + X(4)
23860      1          * WGRAIN ** 3 - X(5) * WGRAIN ** 4 + X(6) * WGRAIN ** 5
23870       RETURN
23880C
23890C      LAST CARD OF FUNCTION OMGAIN
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 IN 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/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHN(24,366),
24570       1        QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
24580       1        HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
24590       1        ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(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/,P5/.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        SDNC=DIRN
24790C
24800C       DIRECT RADIATION ON HORIZONTAL SURFCE 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 COORINATES
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 COSNE OF NORMAL TO VERTICAL WALL WITH RESPECT TO
24990C       LOCAL WEST HORIZONTAL.
25000C
```

```
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
```

```
      QTRAN(IWALL) = QSINC * TDR + QDIFS * TDF
C
C     CALCULATE THE INCIDENT RADIATION ON THE WALL SURFACE
C
      ABSORB(IWALL) = QINCIS
C
500     CONTINUE
      RETURN
1000  FORMAT(/,1X,'COSAOI = ',F12.8)
C
C      LAST CARD OF SUBROUTINE WINDOW
C
      END
      SUBROUTINE WAHP(TWI,TAI,QCOND,QEVAP,HP,COP)
C
C*****************************************************************
C       THIS ROUTINE PREDICTS THE PERFORMANCE OF A WATER TO
C       AIR HEAT PUMP AS A FUNCTION OF THE EVAPORATOR AND
C       CONDENSER INLET TEMPERATURES
C
C       DEVELOPED BY HONEYWELL
C
C*****************************************************************
C
      COMMON /HTPP/FF
      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/300./,
     1     P00155/.00155/,P7336/.7336/,T9P23/29.23/,EIGHTY/80./,
     1     F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.414/,
     1     T545/2545./,P00159/.00159/,P6875/.6875/
C
      EET = TWI
      ECT = TAI
      BTU = ONET23 * (EET - THRTWO) + SIXFT - THUND * ECT
      Y = T9P23 * (ECT - EIGHTY) + F569
      XM = (Y - T523)/SIX2P5
      WATTS = XM * (EET - TWP5) + T523
      COP = BTU/(WATTS * PI) + FF
      QCOND = BTU
      BTUM = QCOND/COP
      QEVAP = QCOND - BTUM
      QCOND = QCOND * (P00155 * EET + P7336)
      QEVAP = QEVAP * (P00159 * EET + P6875)
      QMOT = QCOND - QEVAP
      COP = QCOND/QMOT
      HP = QMOT/T545
      RETURN
C
C     LAST CARD OF SUBROUTINE WAHP
C
      END
```

```
*****************************************************************************
*****************************************************************************

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

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

$LODMOD_B$

```
  SNUMB = 3888T                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  XXXX                XXXX                XXXX                XXXX                XXXXX
     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

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


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


0001  $       SNUMB    3888T
0002  $       COMMENT  F00648        TSS MEDIA CONVERSION
0003  $       IDENT    F00648-ACES
0004  $$      USERID   F00648$
0005 A$       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 = 002094


* ACTY-01  $CARD #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 11.476       LINES   2082        PROC  0.0003        I/O    0.001      IU  5    MEMORY    8K
    STOP  11.480       LIMIT  50000        LIMIT 0.2000        LIMIT             CU  5    M*T      149
    SWAP   0.000
    LAPSE  0.004 FC D   TYPE      BUSY     IP/AT      FP/RT     IS/#C MS/#E      ADDRESS TH/PK#

                 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 = 002062

$       NOTE     FILENAME BKACE
$       NOTE     LABELS- A,R(E1)
$       NOTE     TABS/SETTNGS-  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/IHOUR,IDAY,IMONTH,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/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
```

```
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       IHOUR = TWNFOR
10750       DO 23 I = 1, 20
10760          NTABLE(I) = 0
10770 23       CONTINUE
10780       CALL INPUT
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)
```

```
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,DP,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
```

```
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     CONTI UE
11950       WRITE(9, 50)THLOAD,TCLOAD,THOTWL,TINF,TISR,TCONDL,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),
```

```
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',I4///11X,
12090      1 'QHL',11X,'QHW',12X,'QC',10X,'QINCI',9X,'CONDL',10X,'XINF',10X,
12100      1       'TSR',9X,'QINC1'/)
12110 510   FORMAT(1X,I2,8(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,'TTSR',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./MIN. 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      15X,'- SOUTH WALL',13X,F8.2/1X,
12480      1 5X,'- WEST  WALL',13X,F8.2/1X,
12490      1 5X,'- GARAGE WALL',13X,F8.2/1X,
12500      1'ATTIC WALL - TOP EAST',10X,F8.2/1X,
```

```
     1 12X,'-TOP WEST',10X,F8.2/1X,
     1 12X,'-S   EAST',10X,F8.2/1X,
     1 12X,'-S   WEST',10X,F8.2/1X,
     1 12X,'-N   EAST',10X,F8.2/1X,
     1 12X,'-N   WEST',10X,F8.2/1X,
     1 'ATTIC AIR  - TOP ATTIC',9X,F8.2/1X,
     1 8X,'- SOUTH ATTIC',9X,F8.2/1X,
     1 8X,'- NORTH ATTIC',9X,F8.2/1X,
     1 'CEILING - TOP CEILING',9X,F8.2/1X,
     1 8X,'- SOUTH CEILING',9X,F8.2/1X,
     1 8X,'- NORTH CEILING',9X,F8.2/1X,
     1 'ROOF    - TOP SOUTH',11X,F8.2/1X,
     1 6X,'- SOUTH SLANT',11X,F8.2/1X,
     1 6X,'- SOUTH LOWER',11X,F8.2/1X,
     1 6X,'-   TOP NORTH',11X,F8.2/1X,
     1 6X,'- NORTH SLANT',11X,F8.2/1X,
     1 6X,'- NORTH LOWER',11X,F8.2/1X,
     1 'INTERNAL MASS',17X,F8.2/1X,
     1 'SPACE',28X,F8.2/1X,
     1 'SLAB',29X,F8.2/1X,
     1 'CRUSHED ROCK',21X,F8.2)
C  LAST CARD OF MAIN PROGRAM
C
      END
      SUBROUTINE INPUT
C
C*****************************************************************************
C
C     THIS SUBROUTINE READS IN THE FOLLOWING INFORMATION FROM FILE 5 AND
C     PRINTS IT OUT ONE FILE 9:
C
C     1.  TITLE
C     2.  THE INPUT PARAMETERS
C     3.  THE OUTPUT TABLE FOR DAYS LISTED
C
C     THIS SUBROUTINE ALSO CONTAINS THE DATA STATEMENTS FOR
C     WELL WATER DATA, HOT WATER SCHEDULE, OCCUPANCY SCHEDULE,
C     LIGHTING SCHEDULE, AND APPLIANCE SCHEDULE
C     DEVELOPED BY HONEYWELL
C
C*****************************************************************************
C
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,ISTOR,QHL(24,366),QHN(24,366),
     1        QC(24,366),QINCI(24,366),PLOAD,HLOAD,CPEAK,HPEAK,
     1        THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TPLOAD,TTSR,A(200),
     1        NTABLE(20),XTEMP(24,366),PASLOD(24,366)
      COMMON /SCHDL/ TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24)
     1,APPL(24)
      DATA TWELL /35.,42.,40.,39.,41.,45.,51.,55.,57.,57.,55.,50./
      REAL MHOTW
```

```
      DATA MHOTW /.4475,0.,0.,0.,0.,1.,.3,.9275,.4475,1.68,1.38,.9,
     1     .72,1.02,.54,.48,.42,.75,1.352,2.32,1.12,1.38,1.09,.9275/
      DATA PEOPLE /1.,1.,1.,1.,1.,1.,1.,.75,.5,.5,.5,.5,.5,
     1             .5,.5,.75,.75,1.,1.,1.,1.,1.,1.,1./
      DATA XLIGHT /0.,0.,0.,0.,0.,0.,.5,.5,.5,.5,.2,.2,.5,.5,.5,
     1             .8,.8,.8,.8,.8,.8,.2,.2,.2/
      DATA APPL /0.,0.,0.,0.,0.,0.,.7,.7,.4,.4,.4,.6,.4,.4,.4,
     1            .5,.75,.9,.9,.75,.75,.25,.25,0./
      DIMENSION LABEL(10),MARGIN(1)
      CHARACTER LABEL*6, MARGIN*6
      MAXA = 0
      READ(5,500) MARGIN
      WRITE(9,1000) MARGIN
  100 READ(5,2000) N, DUM, LABEL
      IF(N .LE. 0) GO TO 200
      IF(N .GT. MAXA) MAXA = N
      A(N) = DUM
      WRITE(9,3000) N, A(N), LABEL
      GO TO 100
  200 READ(5,4000) (NTABLE(I),I = 1, 20)
      WRITE(9,911)
  911 FORMAT(/////)
      WRITE(9,913) TWELL,MHOTW,PEOPLE,XLIGHT,APPL
  913 FORMAT(2X,22HWELL WATER TEMPERATURE,2X,12F8.3/
     12X,22H     HOT WATER SCHEDULE,2X,12F8.3/26X,12F8.3/
     12X,22H     OCCUPANCY SCHEDULE,2X,12F8.3/26X,12F8.3/
     12X,22H     LIGHTING SCHEDULE,2X,12F8.3/26X,12F8.3/
     12X,22H     APPLIANCE SCHEDULE,2X,12F8.3/26X,12F8.3)
      WRITE(9,914) NTABLE
  914 FORMAT(//2X,22H OUTPUT TABLE SCHEDULE,2X,1I8/26X,12I8)
      RETURN
  500 FORMAT(13A6)
 1000 FORMAT(1H1,17H INPUT PARAMETERS,//,13A6//)
 2000 FORMAT(I5,F15.5,10A6)
 3000 FORMAT(3H A(,I3,1H),G15.5,3X,10A6)
 4000 FORMAT(20I4)
C
C     LAST CARD OF SUBROUTINE INPUT
C
      END
      SUBROUTINE TIME
C
C***********************************************************************
C
C     THIS SUBROUTINE COMPUTES THE SOLAR RADIATION COMPONENTS, DIRECT
C     NORMAL RADIATION, DIRECT RADIATION ON A HORIZONTAL SURFACE,
C     TOTAL RADIATION ON A HORIZONATAL SURFACE AND CALLS SUBROUTINE
C     HOUSE WHICH DETERMINES THE LOADS.
C
C     THE SUBROUTINE STATEMENT IS
```

```
13510C
13520C      SUBROUTINE TIME
13530C
13540C      DEVELOPED BY HONEYWELL
13550C
13560C*****************************************************************************
13570C
13580       COMMON /SLOAD/QTRAN(5),ABSORB(5)
13590       COMMON /SOLAR/S(35)
13600       COMMON /DIR/DIRH,DIRN,TOTH
13610       COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),
13620      1         TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
13630       COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
13640      1        QC(24,366),QINCI(24,366),FLOAD,HLOAD,CPEAK,
13650      1        HPEAK,THOTWL,THLS,HHWL,TINF,THLOAD,TCONDL,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 TWNTRE/23./,ONE/1./,TWO/2./,P011/.011/,P00792/.00792/,
13690      1OPEM6/1.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    IHOUR = IFIX(S(5))
13820       IDAY = IFIX(S(4))
13830C
13840C      COMPUTE SOLAR RADIATION COMPONENTS (CLOUD MODIFIED)
13850C
13860       CCOVER = TC(IHOUR)
13870       NYTYPE = IFIX(TOC(IHOUR))
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(IHOUR) .LT. OPEM6 .AND. DRY(IHOUR) .LT. OPEM6) GO TO 20
13950       S(23) = ZERO
13960       S(24) = ZERO
13970 20     CONTINUE
13980C
13990C      DIRECT NORMAL RADIATION (CLOUD MODIFIED)
14000C
```

```
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       TOTH = 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(TX,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 THERMOSTAT 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 TRH/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 SOLARQ(ANG1,ANG2,QAVAIL)
```

```
C
C*****************************************************************************
C
C     THIS SUBROUTINE CALCULATES THE SOLAR LOAD OF A RESIDENTIAL
C     BUILDING.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE SOLARQ(ANG1,ANG2,QAVAIL)
C
C     WHERE
C
C        ANG1     = THE ANGLE THE SURFACE MAKES WITH RESPECT TO
C                   HORIZONTAL
C        ANG2     = THE ANGLE THE SURFACE MAKES WITH RESPECT TO THE
C                   LOCAL AZMITH (DUE SOUTH IS 0. EAST + WEST - )
C        QAVAIL   = ENERGY INICIDENT ON SURFACE (BTU/SQ.FT.)
C
C     DEVELOPED BY HONEYWELL
C
C     PROJECT: ACES
C
C     CREATION DATE: 06/21/78
C
C*****************************************************************************
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
     1        QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
     1        HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
     1        ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
      COMMON /DIR/DIRH,DIRN,TOTH
      COMMON /SOLAR/S(35)
      DATA POINT/.017453/,ZERO/0./,ONE/1./,TWO/2./
C
C     CALCULATE SURFACE ANGLES
C
      TILT = ANG1 * POINT
      CTILT = COS(TILT)
      STILT = SIN(TILT)
      FTILT = (ONE - CTILT)/TWO
      AZIM = ANG2 * POINT
      CAZIM = COS(AZIM)
      SAZIM = SIN(AZIM)
      RHO = A(9)
C
C     COMPUTE ANGLE OF INCIDENCE WHERE
C        S(13) - THE DIRECTION COSINE WITH RESPECT TO THE SURFACE NORMAL
C        S(14) - THE DIRECTION COSIN WITH RESPECT TO LOCAL EAST
C        S(15) - THE DIRECTION COSINE WITH RESPECT TO LOCAL NORTH
C
      CTHETA = CTILT * S(13) + STILT * SAZIM * S(14) - STILT * CAZIM *
```

```
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, RADIANS
15500C      S(21)=SOLAR AZIMUTH ANGLE, RADIANS
```

```
C      S(22)=DIFFUSE SKY RADIATION ON HORIZONTAL SURFACE
C      S(23)=TOTAL HORIZONTAL RADIATION ITH
C      S(24)=DIRECT NORMAL RADIATION
C      S(28)=SUN DECLINATION ANGLE DELTA, RADIANS
C      S(29)=EQUATION OF TIME ,HOURS
C      S(30) = SOLAR FACTOR A
C      S(31) = SOLAR FACTOR B
C      S(32) = SOLAR FACTOR C
C      S(35)=SOLAR HOUR ANGLE OMEGA, RADIANS
C      DEVELOPED BY HONEYWELL
C*********************************************************************
C
       COMMON /SOLAR/ S(35)
       DIMENSION A0(5),A1(5),A2(5),A3(5),B1(5),B2(5),B3(5)
       DATA A0/.302,-.0002,368.44,.1717,.0905/
       DATA A1/-22.93,.4197,24.52,-.0344,-.0410/
       DATA A2/-.229,-3.2265,-1.14,.0032,.0073/
       DATA A3/-.243,-.0903,-.109,.0024,.0015/
       DATA B1/3.851,-7.351,.58,-.0043,-.0034/
       DATA B2/.002,-9.3912,-.18,0.,.0004/
       DATA B3/-.055,-.3361,.28,.0008,-.0006/
       DATA TWO/2./,THR66/366./,THREE/3./,ONE80/180./,SIXTY/60./
     1       ,FIFTIN/15./,TWELVE/12./,ONE/1./,ZERO/0./,OPE-6/1.E-6/
       DATA RPH/0.261799383/
       REAL LAT,LATD,LONG,MERID,LOND
C
       PI = 3.14159265
       TWOPI = 6.28318531
       IF(MODE .NE. 0) GO TO 20
       X= TWO *PI/THR66*S(4)
       C1=COS(X)
       C2=COS(TWO*X)
       C3=COS(THREE*X)
       S1=SIN(X)
       S2=SIN(TWO*X)
       S3=SIN(THREE*X)
       DO 10 K=1,5
          KS=(K-1)+28
          S(KS)=A0(K)+A1(K)*C1+A2(K)*C2+A3(K)*C3+B1(K)*S1+B2(K)*S2
     1    + B3(K)*S3
 10       CONTINUE
       S(28) = S(28)*PI/ONE80
       S(29)=S(29)/SIXTY
       LATD=S(1)
       LONG=S(2)
       MERID=FIFTIN*S(3)
       LOND=LONG-MERID
       Y = S(28)
       YY=LATD*PI/ONE80
       HP=-SIN(Y)/COS(Y)*SIN(YY)/COS(YY)
```

```
16010       TR=TWELVE/PI*ARCOS(HP)
16020       S(11)=(TWELVE-TR)-S(29)+LOND/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)
```

```
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/,ONET96/1096./,ONET61/1061./,P24/.24/,P45/.45/,
16920      1      ZERO/0./,P01/.01/,FIFTIN/15./,ONE/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 + ONET61)
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       TF= 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
```

```
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= TEMP0 * (TEMP2-WIP*(ONET61+P45*TX))
17630       XINF=TEMP0 * (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,TX,HO,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       TEMP0 = FP46 * CFMINF
17930       TEMP1 = FP46 * FANCFM
17940       WX= OMEGA(TWI)
17950       WE= OMEGA(TE)
17960       WI= (TEMP0*WO + QL/ONET96 + TEMP1*WE)/
17970      1     (TEMP0 + TEMP1)
17980C
17990C         DETERMINE QMAX, DH, HI, HO, WIP, AND HOTRY
18000C
```

```
18010       QMAX= EFFECT*(TEMP1*(((P24+P45*WI)*TX+ONET61*WI)-((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       HOTRY= P24*TE + WE*(P45*TE + ONET61)
18080       RETURN
18090C
18100C       LAST CARD OF SUBROUTINE FUNC
18110C
18120       END
18130       FUNCTION OMEGA(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 OMGAIN(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
```

```
      OMGAIN = X(1) + X(2) * WGRAIN - X(3) * WGRAIN * WGRAIN + X(4)
     1         * WGRAIN ** 3 - X(5) * WGRAIN ** 4 + X(6) * WGRAIN ** 5
      RETURN
C
C     LAST CARD OF FUNCTION OMGAIN
C
      END
      SUBROUTINE WINDOW
C
C***********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE SOLAR RADIATION TRANSMITTED
C     PER SQ FT OF GLASS DUE TO CLEAR SKY DIRECT RADIATION
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE WINDOW
C
C     THE EXTERIOR WALLS AND WINDOWS ARE ASSUMED TO BE VERTICAL
C     SURFACES. CALCULATIONS ARE MADE FOR EACH OF THE FOUR VERTICAL
C     EXPOSURES ALLOWING FOR + OR -45 DEGREES ROTATION FROM TRUE NESW.
C     THE DIRECT NORMAL RADIATION IS CALCULATED FROM SUBROUTINE
C     SUN FOR EACH HOUR.  DIRECTION COSINES OF THE SUN'S RAYS WITH
C     RESPECT TO LOCAL VERTICAL, LOCAL WEST AND LOCAL SOUTH ARE
C     ALSO CALCULATED IN SUBROUTINE SUN.  DIRECTION COSINES OF
C     THE NORMAL TO EACH OF THE FOUR WALLS WITH RESPECT TO LOCAL
C     VERTICAL, LOCAL WEST AND LOCAL SOUTH ARE CALCULATED.  THE
C     COSINE OF THE ANGLE OF INCIDENCE IN CALCULATED FOR EACH OF
C     THE WALLS FROM THE DIRECTION COSINES OF THE NORMALS TO THE
C     WALL AND THE SUN'S RAYS.  THE SOLAR RADIATION INCIDENT ON
C     EXTERIOR WALLS AND TRANSMITTED THROUGH THE WINDOWS IS THEN
C     CALCULATED AS A FUNCTION OF THE ANGLE OF INCIDENCE FOR EACH
C     OF THE FOUR EXPOSURES.  THE MEAN ANGLE OF INCIDENCE FOR DIFFUSE
C     SOLAR RADIATION IS ASSUMED TO BE 60 DEGREES.  THE WINDOWS ARE
C     ASSUMED TO BE DOUBLE GLAZED.  INTERNAL AND EXTERNAL SHADING
C     EFFECTS ARE NOT CONSIDERED.
C
C     EXPLANATION OF VARIABLES:
C
C     BOANG IS THE BUILDING ROTATION ANGLE (-45 DEG < BOANG < +45 DEG)
C
C      RHOS IS THE REFLECTANCE OF THE GROUND IN FRONT OF THE WINDOW
C
C     XN IS THE INDEX OF REFRACTION OF GLASS IN AIR
C
C     XK IS THE PRODUCT OF THE EXTINCTION COEFFICIENT AND THE
C        THICKNESS FOR EACH PANE OF GLASS (DIMENSIONLESS)
C
C     TDR IS THE WINDOW TRANSMITTANCE FOR DIRECT SOLAR RADIATION
C         (FUNCTION OF THE INCIDENCE ANGLE)
```

```
C
C     TDF IS THE WINDOW TRANSMITTANCE FOR DIFFUSE SOLAR RADIATION
C         (SKY RADIATION AND DIFFUSELY REFLECTED RADIATION FROM
C         THE GROUND)
C
C     QTRAN(I) IS THE SOLAR RADIATION TRANSMITTED THROUGH GLASS (BTUH/SQ FT)
C
C     ABSORB(I) IS THE SOLAR RADIATION INCIDENT ON EACH EXTERIOR
C                 WALL (BTUH/SQ FT)
C
C                 WHERE
C
C                 I = 1 FOR NORTH EXPOSURE
C                   = 2 FOR EAST EXPOSURE
C                   = 3 FOR SOUTH EXPOSURE
C                   = 4 FOR WEST EXPOSURE
C     DEVELOPED BY HONEYWELL
C
C
C*********************************************************************
C
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
     1       QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
     1       HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TTSR
     1       ,A(200),NTABLE(20),XTEMP(24,366),BASLOD(24,366)
      COMMON /SOLAR/S(35)
      COMMON /SLOAD/QTRAN(5),ABSORB(5)
      COMMON /DIR/DIRH,DIRN,TOTH
      DATA TWO/2./,ONE/1./,P011/.011/,P00792/.00792/,ZERO/0./,THREE/3./
     1     ,P09/.09/,FSP3/57.3/
      DATA PI/3.1416/,XK/0.05/,XN/1.526/,TDF/0.672/,P5/.5/,P999/.999/
C
C     INITIALIZATION
C
      DO 10 I = 1, 5
         QTRAN(I) = ZERO
         ABSORB(I) = ZERO
10       CONTINUE
      RHOS = A(9)
      BOANG = A(135)
C
C     DIRECT NORMAL RADIATION DUE TO CLOUDY SKY
C
      SDNC=DIRN
C
C     DIRECT RADIATION ON HORIZONTAL SURFCE DUE TO CLOUDY SKY
C
      SDRHC=DIRH
C
C     TOTAL RADIATION ON HORIZONTAL SURFACE DUE TO CLOUDY SKY
```

```
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       DO 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 COSNE 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
```

```
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 * TDF
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,'COSAOI = ',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/,TWP5/12.5/,PI/3.414/,
20460      1     T545/2545./,P00159/.00159/,P6875/.6875/
20470C
20480       EET = TWI
20490       ECT = TAI
20500       BTU = ONET23 * (EET - THRTWO) + SIXFT - THUND * ECT
```

```
      Y = T9P23 * (ECT - EIGHTY) + F569
      XM = (Y - T523)/SIX2P5
      WATTS = XM * (EET - TWP5) + T523
      COP = BTU/(WATTS * PI) + FF
      QCOND = BTU
      BTUM = QCOND/COP
      QEVAP = QCOND - BTUM
      QCOND = QCOND * (P00155 * EET + P7336)
      QEVAP = QEVAP * (P00159 * EET + P6875)
      QMOT = QCOND - QEVAP
      COP = QCOND/QMOT
      HP = QMOT/T545
      RETURN
C
C     LAST CARD OF SUBROUTINE WAHP
C
      END
      SUBROUTINE HOUSE
C
C*********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE HEATING AND COOLING LOAD
C     FOR A RESIDENTIAL BUILDING.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE HOUSE
C
C     DEVELOPED BY HONEYWELL
C
C     PROJECT ACES-2 STORY HOUSE ORNL-DWG 78-2174
C
C     CREATION DATE:09/26/78
C
C*********************************************************************
C
      COMMON/BLOCK/IHOUR,IDAY,IMONTH,TSTOR,QHL(24,366),QHW(24,366),
     1      QC(24,366),QINCI(24,366),CLOAD,HLOAD,CPEAK,
     1        HPEAK,THOTWL,THLS,THWL,TINF,THLOAD,TCONDL,TCLOAD,TISR
     1      ,A(200),
     1       NTABLE(20),XTEMP(24,366),BASLOD(24,366)
      LOGICAL FIRST,COOLIN
      COMMON /WEATHER/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24)
     1        ,TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
      REAL NDYTP,MHOTW,KADX
      REAL NINTY
      DIMENSION UWALL(7),UROOF(6),ACE(3),AWALL(7),AAWALL(6),
     1AROOF(6),UAWXI(7),UAWXO(7),HAWI(7),HAWO(7),UAWI(7),UAWO(7),
     2UAAWX(6),HAAWI(6),HAAWO(6),UARX(6),HARO(6),HARI(6),UARI(6),
     3 HIW(7),HIC(3),HACO(3),UACO(3),UACX(3),HOW(7),TAS(6),
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```
     4 TWSI(7),TRI(6),TI(6),TWS(7),HAWS(6),CONS1(6),
     5CONS2(6),CONS4(6),CONS5(6),CONS6(6),CONS7(3),HAWSW(7)
      DIMENSION HAWSW2(7),TCE(3),TCEI(3)
      DIMENSION UAAWO(6),TO(7),UARO(6)
      DIMENSION UACI(3),UARXI(6)
      DIMENSION TRS(6),CONS11(7),CONS3(7),HO(7),
     1QAAA(6),QAA(7),QAR(6),UAAWI(6),HIR(6),HACI(3)
      COMMON /SOLAR/S(35)
      COMMON /SLOAD/QTRAN(5),ABSORB(5)
      COMMON/HTPP/FF
      COMMON /SCHDL/TWELL(12),MHOTW(24),PEOPLE(24),XLIGHT(24),APPL(24)
      COMMON/TEMP/TW(7),TAW(6),TR(6),TA(6),TIM,TFI,TSL,TCR,TTE,
     1            TX,TCE,TWSI,TCEI
      COMMON/DESIGN/HEATD,COOLD,SIZE1,SIZE2,FANCFM,EVPGPM,
     1 EFFECT,WATVEL,WATTMP,CFA,FNCFM1
      COMMON/HOURLY/CONDL,XINF,TSR,QINC1,QINC2,ALFW,ALFR
      COMMON /DIR/DIRH,DIRN,TOTH
      DIMENSION SHDXW(20),SHDXD(20),SHDXSW(20),SHDXNW(20)
      DIMENSION UARXTPH(6),HDQ(6),HDQR(6),DTOCC(3),DTOCN(7)
      DATA FIRST/.TRUE./
      DATA OP08/1.08/,THRTWO/32./,ONE/1./,ZERO/0./,P1/.1/,P4/.4/,P5/.5/
     1      ,P8/.8/,TTP32/33.32/,SIXTHR/63./,TFIFTY/250./,FHNDRD/500./
     1      ,FHUNDR/400./,FOURTY/40./,SSP3/77.3/,FOUR90/490./,ETHUND/1800
     1      ./,TEN/10./,P45/.45/,ONET61/1061./,OT75P4/1075.4/,FORP46/4.
     1      46/,P13833/.13833/
      DATA CHECK/0.0/
      DATA PI/3.1416/
      DATA TWO/2.00/,THOU/1000./,HUND/100./,ET/18./,P79/.79/,
     1 SBM45/33./
      DATA TWEL/12./,FOUR/4.0/,SEVEN/7.0/,FIFT/15.0/,FIVE/5.0/,
     1 EIGHT/8./,THIR775/37.75/,THREE/3./,FRT2/42./,NINTY/90./,
     2 O80/180./,FP25/4.25/,TP414/3.414/,TW2/22./,SIX/6./
      DATA OLDMTH/0.0/
      DATA PS/.58/,PD/.70/,TW25/25./,P01/.01/
      MODEC = ONE
      MODES = ONE
      MODEW = ONE
C
C     FIRST TIME THROUGH, INITIALIZE CONSTANTS FROM 'A' ARRAY. SKIP
C     INITIALIZATION ON SUCCEEDING CALLS.
C
      IF (.NOT. FIRST) GO TO 10
      TIME=ZERO
      THOTW = A(50)
      USTAG = A(51)
      USTHG = A(52)
      UHOTW = A(53)
      UCEIL = A(54)
      UCE=UCEIL
      UWALL(1)=A(18)
```

```
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)=AROOF(1)
21910       AROOF(5)=AROOF(2)
21920       AROOF(6)=AROOF(3)
21930C
21940       CFMINF=A(75)
21950       PEOPMX = A(76)
21960       APPLMX = A(77)
21970       ACEIL=ACE(1)+ACE(2)+ACE(3)
21980       XLTEMX=A(78)*ACEIL*TP414
21990       AVENT = A(79)
22000C SET UP DATA ARRAY FOR SHADING SOUTH WINDOWS,SOUTH WALL
```

```
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(I)=ZERO
22140 1937    SHDXSW(I)=ZERO
22150C
22160C SET UP ARRAY FOR SHADING SOUTH SG DOOR,SOUTH WALL
22170        SHDXD(1)=FR25
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
```

```
22510C
22520C
22530C
22540        ATTICT=A(80)
22550        WINDWG = 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        TZONES = 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 SELECTIND 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       INFA2=OP08*AVENT*ACE(2)
23240       INFA1=OP08*AVENT*ACE(1)
23250       INFA3=OP08*AVENT*ACE(3)
23260       KADX=ONE/TWEL
23270       UAXTTE=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       UCRTTE=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)
```

```
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)*AROOF(I)*TWO
23580       UARI(I)=UARO(I)
23590       HARO(I)=HOR*AROOF(I)
23600       HARI(I)=HIR(I)*AROOF(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+UADOOR
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*AROOF(I)))*(UARX(I)+UARXI(I))
23880       CONS5(I)=(DT/(CRVR*AROOF(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
```

```
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        DTSL=DT/CRVSL
```

```
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       UAFLOR1=UPF*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+UCE*ACE(I)
24790C  ADD SLANT ROOF TO CEILING UA
24800       UACEIL=UACEIL+TWO*UROOF(2)*AROOF(2)
24810       SUMUA=SUMU+UADOOR+UAFLOR1+UAGLAS+OP08*CFMINF
24820C
24830       HEATD = ( SUMUA * (TZONEW - TOSAW) + UACEIL * (TZONEW - TOSAW)
24840      1        +SSP3 * (THOTW - FOURTY)) * OVRCPW
24850       UTTE=A(13)
24860       RT=ONE/UFLOOR+ONE/USL+ONE/UCR+ONE/UTTE
24870       UFT=ONE/RT
24880       UAFLO=UFT*AFLOOR
24890       HEATD=HEATD+UAFLO*(TZONEW-TWW)
24900C      COOLING DESIGN LOAD
24910C
24920       COOLD = -(SUMUA * (TZONES - TOSAS) + UACEIL * (TZONES - ATTICT)
24930      1        + UAHOTW * (TZONES - THOTW) - WINDWG * (AGLASN + AGLASE
24940      1        + AGLASS + AGLASW) - PEOPMX * FOUR90 - APPLMX - XLTEMX)
24950      1        * OVRCPS
24960C
24970  110 CONTINUE
24980C
24990C      HEAT PUMP DESIGN
25000C
```

```
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/(FHNDRD * 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(/////, 'IHOUR    IDAY       QHL        QHW          QC
25490C     1      QINCI        ABSORB(5)                DB(J)    TA   ',/////)
25500C
```

```
25510        FIRST = .FALSE.
25520 10     CONTINUE
25530        J = IHOUR
25540C
25550C       CALCULATE INTERNAL PEOPLE, LIGHT, AND APLIANCE SENSIBLE LOADS
25560C
25570        PEOPL = PEOPLE(J) * PEOPMX * TFIFTY
25580        XLIGT = XLIGHT(J) * XLTEMX
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(IHOUR,IDAY) = 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) * AGLASE
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        TTSR = TTSR + 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        HGHOTW = MHOTW(J) * TTP32 * (THOTW - TWELL(IMONTH))
26160        TINLOD = 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=UP08*CFMINF*DB(J)+UAHOTW*THOTW+UADOOR*DB(J)+TINLOD
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,SHADES)
26450        QAA(5)=ABSORB(3)*AWALL(5)*SHADES*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 DIFFERINTIAL 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,TZONEW,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)=(UARXI(I)*TR(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)+UARXI(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)+DTOCC(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)+DTOCW(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=TSL*OMDT1+DTSL*(TSLI*UAXSL+
27350     1 UAXSL*TCRI)
27360      TCRI=(UAXSL*TSL+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
```

```
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 = PEOPL*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       HOTWL = HGHOTW + HLHOTW
27940       THOTWL = THOTWL + HOTWL
27950       QHL(IHOUR,IDAY) = HLOAD
27960       QC(IHOUR,IDAY) = CLOAD
27970       QHW(IHOUR,IDAY) = HOTWL
27980       XTEMP(IHOUR,IDAY)=TTX
27990       RETURN
28000       END
```

```
28010       SUBROUTINE SHADE(SHDX,PHI,COSZ,SHRAT)
28020C
28030C*************************************************************
28040C    THIS PROGRAM CALCULATES SHADOW CAST BY OVERHANG AND SIDE FINS
28050C    PHI= SOLAR AZIMOUTH 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
```

```
28510        SBETA=COSZ
28520        IF(SBETA) 100,100,152
28530 152    SING=SIN(GAMMA)
28540        IF(SING) 1200,100,1200
28550 1200   CONTINUE
28560        VERT=SBETA/SQRT(1.-SBETA*SBETA)/COSG
28570        HORIZ=ABS(SING)/COSG
28580        TCETA=VERT/HORIZ
28590        IF(GAMMA) 154,154,154
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) 37,37,153
28800 153    T=T1
28810        FM=FM1
28820        AB=B*TCETA
28830        UG=(FL+B)*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))8,8,6
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
```

```
29010 10    AREAO=H*FL+(DE-B)**2*TCETA*0.5
29020       GO TO 37
29030C            HORIZ 3
29040 11    AREAO=FL*(T-A)
29050       L=2
29060       GO TO 24
29070 12    IF(T-(H+A))11,13,13
29080C            HORIZ 2
29090 13    AREAO=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    AREAO=(UG-A)**2/TCETA*0.5
29160       GO TO 37
29170 18    IF(T-(H+A))20,19,19
29180C            HORIZ 5
29190 19    AREAO=H+(FL-(A+0.5*H/TCETA+B)
29200       GO TO 37
29210C            HORIZ 4
29220 20    AREAO=(T-A)*(FL+B-FM*(1.+A/T)*0.5)
29230       L=2
29240C           VERT PROJ "AREA V"
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            VERT5
29480 32    H3=H
29490       GO TO 3700
29500C            VERT 4
```

```
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(AREAO) 73,73,88
29780C           TEST FOR OVERLAP OF FIN AND OVERHANG 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 OH SHADOW-PORTION ABOVE HORIZ EDGE
29910C            NOT IN OVERHUNG SHADOW IS FIN SHADOW
29920 622   AREA1=FL*(T1-A)-AREAO
29930C            RESET TO CALC FIN SHADOW BELOW HORIZ EDGE OF OVERHANG 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
```

```
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)+AREA1
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)*TCETA+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*(CX-(BF+FL/2.)*TCETA)
30410        GO TO 69
30420C             SHORT 4
30430 61     ARSH1=-(CX-AB)**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     ARSH0=-(FM-BF)*(CX-(T+AB)*0.5)
30490 69     GO TO (77,78),K
30500 76     ARSH1=-ARSH1
```

```
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        BBF=BF
30610        BF=FM1-B+BF
30620        IF(BF)186,185,185
30630 186    BF=BBF
30640 185    IF(HT+A-T1-)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             SHADED AREA "ARSHA"
30730 68     ARSHA=AREAO+AREAV+ARSHF+ARSIF
30740        SHRAT=(FL1*H1-ARSHA)/(FL1*H1)
30750        FL=FL1
30760 2000   CONTINUE
30770        RETURN
30780        END
```

```
*****************************************************************************
*****************************************************************************

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

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

DESMOD

```
  SNUMB = 3892T                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  XXXX            XXXX            XXXX            XXXX            XXXXX
     X           X    X          X    X          X    X             X
   XXX            XXXX           X    X               X             X
      X          X    X           XXXX             XXX              X
 X    X          X    X              X            X                 X
  XXXX            XXXX              X            XXXXXX             X

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


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

0001  $       SNUMB   3892T
0002  $       COMMENT F00648          TSS MEDIA CONVERSION
0003  $       IDENT   F00648-ACES
0004  $$      USERID  F00648$
0005 A$       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 = 001696
```

```
* 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 11.493      LINES   1684      PROC  0.0003       I/O   0.001     IO  5   MEMORY     8K
      STOP  11.496      LIMIT  50000      LIMIT 0.2000      LIMIT             CO  5   M*T       116
      SWAP   0.000
      LAPSE  0.003 FC D   TYPE     BUSY    IP/AT    FP/RT    IS/#C MS/#E    ADDRESS T#/PK#

                   MC R MSU450 *     22        0        1        1     1    0-08-13
                   IN R MSU450 *    902        0       41       41    41    0-08-13
                   OT    SYOUT
                   P*    SYOUT

       RC-00  1684 LINES AT STA.  E1


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




  SNUMB = 3892T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 001684

$       NOTE    FILENAME DESMOD
$       NOTE    LABELS- A,R(E1)
$       NOTE    TABS/SETTNGS-  ASIS
```

```
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      MIMIMUN 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 OVERAL 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.
```

```
C
C     AWALBG IS THE AREA OF WALL BELOW GROUND.
C
C     BH IS THE BEGINNING OF THE HEATING SEASON.
C
C     COP IS THE HEAT PUMP COEFFICIENT OF PERFORMANCE
C
C
C     TQINCW IS THE SOLAR INSOLATION AVAILABLE DURING THE WINTER
C
C     TQINCS IS THE SOLAR INSOLATION AVAILABLE DURING THE SUMMER
C
C     PCT IS THE PERCENTAGE OF THE HEIGHT DIMENSIONS OF THE TANK
C         THAT IS ABOVE GROUND (IF PCT=0, THE TANK IS ASSUMED TO BE
C         COMPLETELY BELOW GROUND).
C
C     DMINQ IS THE TOTAL HEAT NEEDED FOR THE MINIMUM ACES DESIGN
C
C     DMINBL IS THE TOTAL BASEMENT LOAD FOR THE MINIMUM ACES DESIGN
C
C     CPRVT IS THE THERMAL CAPACITANCE OF THE TANK ON A SQ.FT. BAS.
C
C     CPRVW IS THE THERMAL CAPACITANCE OF THE WALL BELOW GROUND
C
C     TAMBA IS THE AMBIENT TEMPERATURE.
C
C     AREAC IS THE AREA OF THE COLLECTOR.
C
C     CK IS THE INTERCEPT OF THE COLLECTOR EFFICIENCY CURVE
C
C     C IS THE SLOPE OF THE COLLECTOR EFFICIENCY CURVE
C
C     FF IS A FACTOR TO ADJUST THE COP OF THE HEATPUMP IF DESIRED
C
C     PUMP IS THE ENERGY NEEDED BY THE PANEL PUMP
C
C     PUME IS THE ENERGY NEEDED BY THE EVAPORATOR PUMP
C
C     PUMC IS THE ENERGY NEEDED BY THE COOLING PUMP
C
C     FANH IS THE ENERGY THE NEEDED BY HEATING BLOWER
C
C     FANC IS THE ENERGY NEEDED BY THE COOLING BLOWER
C
C     IN IS THE OPTION TO PUT THE TANK INSIDE OR OUTSIDE THE HOUSE
C
C*****************************************************************
C
      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UNAL,TTANK,TAVF,TMELA,
     1             TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,
```

```
     1              TBLDCS,THLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,
     1              THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,
     1              CPRVT,CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,
     1              PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN,AA,BH
      COMMON/BLOCK/IHOUR,IDAY,IMONTH,QHL,QHW,QC,
     1              QINCI,BASLOD,XTEMP,A(200),
     1              TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
      COMMON /STOP/ENDC,TTANK2
      COMMON /CPO/COP1
      COMMON /PEK1/PEK
      REAL KADX
      LOGICAL NORTH,FULL,IN,BOTH
      DATA ZERO/0./,ONE/1./,TWO/2./,DELTA/1.365/
      DATA TWELL/45.,42.,40.,39.,41.,45.,51.,55.,57.,57.,55.,50./
      LOGICAL FIRST
C
C     INITIALIZATION
      TQHLHW = ZERO
      TQINCS = ZERO
      TQINCW = ZERO
      TQCCW = ZERO
      TQHWHW = ZERO
      TQHWHS = ZERO
      TQCCS = ZERO
      TQHLHS = ZERO
      TBLD = ZERO
      DAYC = ZERO
      PDAYC = ZERO
      DMINQ1 = ZERO
      DMINQ2 = ZERO
      DMINBL = ZERO
C
C     READ IN INPUT FILES
C
      CALL DINPUT
C
      TZONEW = A(88)
      THOTW = A(50)
      AA = A(31)
      BB = A(38)
      AA = AA * A(102)
      TTANK2 = A(96)
      ENDC = A(97)
      AWALBG = A(65)
      KADX = A(28)/TWO
      UWALBG = A(56)
      HWALBG = A(12)
      UTANKT = A(139)
      HEIGHT = A(140)
      PF = A(141)
```

```
      PCT = A(142)
      UWAL = ONE/(ONE/UWALBG - ONE/HWALBG)
      NDAYS = A(8)
      UTANKA = UTANKT
      UTANKB = A(21)
      UTANKW = UTANKB
      CPRVT = A(143)
      CPRVW = A(144)
      SET = A(145)
      TTANK = A(146)
      CK = A(147)
      C = A(148)
      TAMBA = A(149)
      AREAC = A(150)
      FF = A(22)
      SET2 = A(23)
      SET3 = A(24)
      PUMP = A(25)
      PUME = A(26)
      PUMC = A(27)
      PUMW = A(16)
      FANC = FANCFM * DELTA
      FANH = FNCFM1 * DELTA
      XPER = A(29)
      FULL = .FALSE.
      IF (SET .GT. ZERO) FULL = .TRUE.
      BOTH = .FALSE.
      IN = .FALSE.
      IF (SET2 .GT. ZERO) IN = .TRUE.
      IF (SET3 .GT. ZERO) BOTH = .TRUE.
C
C     DETERMINE THE BEGINNING OF THE COOLING SEASON AND THE BEGINNING OF
C     THE HEATING SEASON.
C
      SCALE = ONE
      CALL WAHP(TTANK,TZONEW,QCOND,QEVAP,HP)
      CALL WWHP(TTANK,THOTW,QCOND1,QEVAP1,HP1,COP1)
      SCALE = SIZE/QCOND
      CALL BEGIN
C
C     DETERMINE THE LOADS DURING THE HEATING SEASON
C
      REWIND(10)
      DO 710 I=1,366
      DO 810 J=1,24
      READ(10)QHL,QHW,QC,QINCI,XX,YY
      TQC = TQC + QC
      TQH = TQH + QHL
      TQW = TQW + QHW
      TQI = TQI + QINCI
```

```
  810 CONTINUE
  710 CONTINUE
      WRITE(9,811)TQC,TQH,TQW,TQI
  811 FORMAT(1X,4(F15.2,4X))
      REWIND(10)
      IBEGIN = 1
      IEND = IFIX(BC - ONE)
10    CONTINUE
      DO 40 I = IBEGIN, IEND
         DO 30 J = 1, 24
            READ(10) QHL,QHW,QC,QINCI,BASLOD,XTEMP
            TQHLHW = TQHLHW + QHL
            TQCCW = TQCCW + QC
            TQHWHW = TQHWHW + QHW
            TBLD = TBLD + BASLOD
            IF(I .LE. 19 .OR. I .GT. 31) GO TO 20
            DMINQ1 = DMINQ1 + QHL
            DMINQ2 = DMINQ2 + QHW
            DMINBL = DMINBL + BASLOD
20          CONTINUE
            TQINCW = TQINCW + QINCI
30          CONTINUE
40       CONTINUE
      IF (IEND .NE. IFIX(BC - ONE)) GO TO 50
C
C     DETERMINE THE LOADS DURING THE COOLING SEASON
C
      CONTINUE
      IBHM1 = IFIX(BH - ONE)
      IBC = IFIX(BC)
      DO 70 I = IBC, IBHM1
         DO 60 J = 1, 24
          READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
           TQHWHS = TQHWHS + QHW
           TQCCS =TQCCS + QC
            TQHLHS = TQHLHS + QHL
            TQINCS = TQINCS + QINCI
            DAYC = DAYC + QC
60          CONTINUE
            IF(DAYC .GT. PDAYC) PDAYC = DAYC
            DAYC = ZERO
70       CONTINUE
      IF(IEND .NE. IFIX(BC - ONE))GO TO 50
      IBEGIN = IFIX(BH)
      IEND = NDAYS
      GO TO 10
C
C     CALCULATE THE TOTAL HEAT LOAD IN THE WINTER.
C
50    QHTOT = TQHWHW + TQHLHW
```

```
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 MIMIMUM 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)
```

```
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)BC,BH,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/IHOUR,IDAY,IMONTH,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)
```

```
      MAXA = 0
      READ(5,500) MARGIN
      WRITE(9,1000) MARGIN
  100 CONTINUE
      READ(5,2000) N,DUM,LABEL
      IF (N .LE. 0) GO TO 200
      IF (N .GT. MAXA) MAXA = N
      A(N) = DUM
      WRITE(9,3000) N,A(N),LABEL
      GO TO 100
  200 CONTINUE
      WRITE(9,913) TWELL
      READ(11)FANCFM,FNCFM1,SIZE,SIZE2,HEATD
      WRITE(9,211)
  211 FORMAT(1X,'     FANCFM          FANCFM1          SIZE1
     1SIZE2          HEATD')
      WRITE(9,212)FANCFM,FNCFM1,SIZE,SIZE2,HEATD
  212 FORMAT(V)
      RETURN
  500 FORMAT(13A6)
 1000 FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6//)
 2000 FORMAT(I5,F15.5,10A6)
 3000 FORMAT(3H A(,I3,1H),G15.5,3X,10A6)
  913 FORMAT(2X,22HWELL WATER TEMPERATURE,2X,12F8.3)
C
C     LAST CARD OF SUBROUTINE DINPUT.
C
      END
      SUBROUTINE BEGIN
C
C*********************************************************************
C
C     THIS SUBROUTINE DETERMINES THE BEGINNING OF THE HEATING SEASON,
C     THE BEGINNING OF THE COOLING SEASON, THE TOTAL HEATING LOAD FOR
C     A WEEK, THE TOTAL COOLING LOAD FOR A WEEK.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE BEGIN
C
C     OTHER VARIABLES USED:
C
C     WTH IS AN OUTPUT PARAMETER WHICH CONTINS THE TOTAL HEATING LOAD
C         FOR THE WEEK WHEN THE HEATING SEASON BEGINS.
C
C     WTC IS AN OUTPUT PARAMETER WHICH CONTAINS THE TOTAL COOLING LOAD
C         FOR THE WEEK WHEN THE COOLING SEASON BEGINS
C
C     PROJECT:  ACES
C
```

```
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,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,TBLDCS,
14090      1       TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,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/IHOUR,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
```

```
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,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,
14740      1              TBLDCS,TBLDHS,TQCCS,AWALBG,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 = ONET23 * (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
```

```
15010C
15020C      LAST CARD OF SUBROUTINE WAHP.
15030C
15040       END
15050       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 STATMENT 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
15410       COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
15420      1         TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,TBLDCS,
15430      1         TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,TCCW,
15440      1         TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,CPRVW,TAMBA,
15450      1  AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN
15460      1 ,AA,BB
15470       COMMON /BLOCK/IHOUR,IDAY,IMONTH,QHL,QHW,
15480      1         QC,QINCI,BASLOD,XTEMP,
15490      1         A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
15500       LOGICAL FIRST,IN
```

```
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        UTNK = UTANKA * XK
15650        UTNK1 = TWO * UTNK
15660        UTNK2 = UTNK1
15670        TEMP1 = ONE/UTANKW + ONE/KADX
15680        UTNKD = ONE/(TEMP1 + AX/UWAL)
15690        UTNKD1 = TWO * UTNKD
15700        UTNKD2 = UTNKD1
15710        UTNKWD = ONE/(TEMP1 + XK/UWAL)
15720        UTKWD1 = TWO * UTNKWD
15730        UTKWD2 = UTKWD1
15740        TA = TEMP
15750        IF(.NOT. IN) TA = TO
15760        TTA = TTANK + (TA - TTANK)/TWO
15770        UD = ONE/(ONE/UTNKD + TWO/KADX)
15780        QD = UD * (TTANK - TWELL(IMONTH))
15790        TTG1 = TTANK - QD/UTNKD1
15800        TTG2 = TTG1 - QD/UTNKD2
15810        TTG3 = TTG2 - QD/KADX
15820        UWD = ONE/(ONE/UTNKWD + 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 = UTNK1 + UTNK2
15890        TEMP4 = ONE/CPRV2
15900        TEMP5 = UTNKD1 + UTNKD2
15910        TEMP6 = ONE/CPRV3
15920        TEMP7 = UTKWD1 + UTKWD2
15930        TEMP8 = ONE/CPRVP
15940        TEMP9 = UTNKD2 + KADX
15950        TEMP10 = TWO * KADX
15960        TEMP11 = UTKWD2 + KADX
15970        TEMP12 = TEMP8 * KADX
15980        FIRST = .FALSE.
15990 10     CONTINUE
16000        TA = TEMP
```

```
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 * UTNK1
16090      1       + TA * UTNK2)
16100       QLOST = (THTSD * PCT + SIDESQ) * UTNK1 * (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 * UTNKD2)
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) * UTNKD1 * (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) * UTNK2 * (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*****************************************************************
```

```
C
C     THIS SUBROUTINE WILL DETEMINE THE AMOUNT OF ENERGY THAT CAN
C     BE COLLECTED FROM A SOLAR PANEL GIVEN THE PANEL PERFORMANCE
C     CHARACTERISTICS, CK , C , AA , AND BB.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE COLECT(QINC,VEL,PANUM,QCOLL)
C
C     WHERE
C
C     QINC IS THE INCIDENT RADIATION.
C
C     PANUM IS THE NUMBER OF PANELS.
C
C     QCOLL IS THE ENERGY COLLECTED
C     VEL IS THE WIND VELOCITY
C
C    PROJECT:  ACES
C
C     DEVELOPED BY HONEYWELL
C
C     CREATION DATE:  8/25/78
C
C*********************************************************************
C
      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
     1         TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,TBLDCS,
     1         TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,
     1     TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,CPRVW,TAMBA,
     1    AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,SCALE,IN
     1 ,AA,BB
      REAL KADX
      LOGICAL IN
      DATA ZERO/0./,FIVE/5./
C
      IF(AA .LE. ZERO) GO TO 20
      ZZ = AA * EXP(BB * VEL * 1.151)
      C = CK/ZZ
   20 CONTINUE
      ETA = ZERO
      IF (QINC .LE. ZERO) GO TO 10
      ETA = CK - C * (TTANK - TAMBA)/QINC
      IF (ETA .LT. ZERO) ETA = ZERO
10    CONTINUE
      Q = ETA *QINC
      IF (Q .LE. ZERO .AND. (TAMBA - FIVE) .GE. TTANK)
     1   Q = -C * (TTANK - TAMBA)
      QCOLL = Q * PANUM * AREAC
      RETURN
```

```
17010C
17020C      LAST CARD OF SUBROUTINE COLECT.
17030C
17040       END
17050       SUBROUTINE TANK2(VOLUME)
17060C
17070*****************************************************************
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/KADX,HEIGHT,PF,UTANKA,UTANKW,UWALL,TTANK,TAVE,TWELA,
17330      1        TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,TBLDCS,
17340      1        TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,TCCW,
17350      1        TQINCW,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/IHOUR,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
```

```
17510C      DETERMINE THE AVERAGE TEMPERATURE OVER THE PERIOD.
17520C
17530       DO 20 I = 1, 12
17540          READ(8) DB,DP,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       QICEI = QOUT * (ONE - ONE/COP)
17750       VOLUME = (QICEI * 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 WWHP(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      1          *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)
```

```
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,TO,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
```

```
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,UWALL,TTANK,TAVE,TWELA,
18810      1              TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,
18820      1              TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,
18830      1      TCCS,THLHS,THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,
18840      1             CPRVT,CPRVW,TAMBA,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/IHOUR,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       VOLUM1 = 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        VOLUM1 = VOLUME
19440        GO TO 5
19450 30     CONTINUE
19460        IF (VOLUM1 .LT. ONE) GO TO 40
19470        IF(VOLUM1 .LT. VOLUME) VOLUME = VOLUM1
19480        IF(VOLUM1 .LE. VOLUME) NORTH = IXIX
19490        IF(VOLUM1 .GT. VOLUME) NORTH = .NOT.IXIX
19500 40     CONTINUE
```

```
      RETURN
C
C     LAST STATEMENT OF SUBROUTINE TANK.
C
      END
      SUBROUTINE NEWTON(NORTH,SIDE,VOLUME)
C
C*********************************************************************
C
C     THIS SUBROUTINE DETERMINES THE SIZE OF A ICE BIN STORAGE TANK
C     BY EQUATING ENERGIES INTO AND OUT OF THE TANK OVER THE SEASON
C     OF INTEREST AND THE CORRECT DIMENSION.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE NEWTON(NORTH,SIDE,VOLUME)
C
C     WHERE
C
C     NORTH IS A LOGICAL VARIABLE.  IF DEFINED AS
C           .TRUE. = THE TANK IS SIZED FOR A NORTHERN CLIMATE.
C          .FALSE. = THE TANK IS SIZED FOR A SOUTHERN CLIMATE.
C
C     SIDE IS THE SIDE DIMENSION OF THE TANK.
C
C     VOLUME IS THE VOLUME OF THE TANK.
C
C     PROJECT:  ACES
C
C   DEVELOPED BY HONEYWELL
C
C     CREATION DATE: 8/22/78
C
C*********************************************************************
C
      COMMON/PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,
     1            TWELA,TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,
     1            TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,
     1            THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,
     1        CPRVT,CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,
     1            FANC,NDAYS,XPER,SCALE,IN,AA,BB
      COMMON /BLOCK/IHOUR,IDAY,IMONTH,QHL,QHW,
     1         QC,QINCI,BASLOD,XTEMP,
     1         A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
      REAL KADX
      LOGICAL IN,NORTH
      DATA P0001/.0001/,ZERO/0./,FIFTIN/15./,ONE/1./,ONEST/150000./
      DATA FIVE/5.0/
C
C
```

```
C
      SUM = ZERO
 10   CONTINUE
      CALL STORAG(NORTH,SIDE,CUFTN,CUFT,PCUFT)
      FX = CUFTN - CUFT
      IF(.NOT.NORTH) FX = PF * HEIGHT * SIDE * SIDE - PCUFT
      DEL = P0001 * SIDE
      SIDP = SIDE + DEL
      CALL STORAG(NORTH,SIDP,CUFTN,CUFT,PCUFT)
      FXD = CUFTN - CUFT
      IF(.NOT.NORTH) FXD = PF * HEIGHT * SIDP * SIDP - PCUFT
      FXP = (FXD - FX)/DEL
      SIDN = SIDE - FX/FXP
      SIDE = SIDN
      SUM = SUM + ONE
C
C
C
      IF(A(145) .GT. ZERO .AND. SIDE .LT. FIVE) GO TO 1111
      WRITE(9,101)SIDE,CUFT,CUFTN,PCUFT,FX,FXD
 101  FORMAT(1X,6(F13.3,3X))
      IF (ABS(FX) .GT. ONE .AND. SUM .LT. FIFTIN) GO TO 10
      IF (SUM .GE. FIFTIN) WRITE(9,1000)
 1000 FORMAT(//' NEWTON METHOD HAS NOT CONVERGED')
      VOLUME = HEIGHT * SIDE * SIDE
      RETURN
 1111 WRITE(9,1011)
 1011 FORMAT(1X,'   WARNING - TANK IS INCAPABLE OF STORING SUFFICIENT',
     1' ICE FOR TOTAL SUMMER OPERATION')
      VOLUME = ONE5T
      RETURN
C
C     LAST CARD OF SUBROUTINE NEWTON.
C
      END
      SUBROUTINE STORAG(NORTH,SIDE,CUFTN,CUFT,PCUFT)
C
C*********************************************************************
C
C     THIS SUBROUTINE DETERMINES THE ICE INVENTORY WITHIN A STORAGE TANK
C     AT THE END OF A GIVEN SEASON.  IT WILL ALSO DETERMINE THE MAXIMUM
C     OR MINIMUM AMOUNT OF ICE THAT CAN BE STORED WITHIN THE TANK.
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE STORAG(NORTH,SIDE,CUFTN,CUFT)
C
C     WHERE
C
C     NORTH IS A LOGICAL VARIABLE.  IF DEFINED AS
```

```
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
20660*************************************************************************
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,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,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./,005/105./
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       IBHM1 = IFIX(BH - ONE)
```

```
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,QEVAP,HP)
21200              CALL WWHP(TTANK,TWI,QCOND1,QEVAP1,HP1,COP1)
21210C
21220C       DETERMINE THE DYNAMIC TANK LOSS.
21230C
21240              CALL TANKLD(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))
```

```
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     1          /COP)
21600          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 (QC  .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
```

```
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(BC - 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
```

```
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
22730       COMMON /PASS/ KADX,HEIGHT,PF,UTANKA,UTANKW,UWALL,TTANK,TAVE,
22740      1        TWELA,TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,
22750      1        TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,
22760      1        TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,CPRVW,
22770      1  TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,NDAYS,XPER,
22780      1 SCALE,IN,AA,BB
22790       COMMON /TRY/QCOLLT
22800       LOGICAL NORTH,IN
22810       REAL KADX
22820       DATA ZERO/0./,ONE/1./,OPEM4/1.2131944E-4/,OP5/1.5/
22830C
22840       IF (.NOT. NORTH) GO TO 10
22850C
22860C      DETERMINE APPROXIMATE SIZE OF COLLECTORS
22870C
22880       QINCT = TQINCW
22890       CALL COLECT(QINCT,ZERO,ONE,QCOLLT)
22900       QMELT = (TQHLHW + TQHWHW) * (ONE - ONE/COP) - TQCCW
22910      1         - PF * VOLUME/OPEM4
22920       NUMPAN = IFIX(QMELT/QCOLLT) + 1
22930       PANUM = FLOAT(NUMPAN) * OP5
22940C
22950C      SIZE FOR THE HEATING SEASON; SECANT METHOD.
22960C
22970       CALL BISCAN(VOLUME,SIDE,PANUM)
22980C
22990C      THE INTEGER NUMBER OF PANELS, NEEDED TO MELT ICE FOR THE
23000C      WINTER IS.....
```

```
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,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,TBLDCS,
23420      1             TBLDHS,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,BB
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/
```

```
      DATA TWO/2.0/,OP5/1.5/,TWENTY/20.0/
C
      ICHECK = 0
      XA = ZERO
      XB = PANUM
      FXA = PF * VOLUME - ((TQHLHW + TQHWHW) * (ONE - ONE/COP) -
     1       TQCCW) * OPEM4
      SUM = ZERO
   10 CONTINUE
      PANUM = (XA + XB)/TWO
      CALL SIZES(PANUM,VOLUME,CUFT,ICHECK,SIDE,PCUFT)
      FX = PF * VOLUME - CUFT
      IF(FXA * FX .LE. ZERO) XB = PANUM
      IF(FXA * FX .GT. ZERO) XA = PANUM
      SUM = SUM + ONE
      WRITE(9,101)FXA,FX,XA,XB,PANUM,CUFT,PCUFT
  101 FORMAT(1X,7(F10.3,3X))
      IF (ABS(FX) .GT. ONE .AND. SUM .LT. TWENTY) GO TO 10
      IF (SUM .GE. TWENTY) WRITE(9,1000)
 1000 FORMAT(1X,'BISCAN IN PANEL HAS NOT CONVERGED')
C
C     CHECK TO SEE THAT THE ICE HAS NOT EXCEEDED HALF THE VOLUME OF
C     THE TANK AT ANY TIME THROUGH THE SEASON.
C
      FLAG = ONE
      SUM = ZERO
      FXN0 = PF * VOLUME - PCUFT
      X0 = PANUM
      XN = X0 * OP5
      PANUM = XN
   20 CALL SIZES(PANUM,VOLUME,CUFT,ICHECK,SIDE,PCUFT)
      FXN = PF * VOLUME - PCUFT
      XNEW = XN - FXN * (XN - X0)/(FXN - FXN0)
      WRITE(9,102)X0,FXN0,XN,FXN,XNEW,CUFT,PCUFT
  102 FORMAT(1X,7(F10.3,3X))
      X0 = XN
      FXN0 = FXN
      XN = XNEW
      PANUM = XN
      SUM = SUM + ONE
      IF(ABS(FXN) .GT. ONE .AND. SUM .LT. FIFTIN) GO TO 20
      IF(SUM .GE. FIFTIN) WRITE(9,1000)
   30 CONTINUE
      NUMPAN = IFIX(PANUM) + 1
      SIZE = FLOAT(NUMPAN) * AREAC
      PEK = ICHECK
      WRITE(9,9999)PEK
 9999 FORMAT(1X,F12.3)
      RETURN
C
```

```
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 STORATE 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/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,
24420      1         TWELA,TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHWHS,TQHLHS,
24430      1        TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,THLHW,
24440      1        TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,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/IHOUR,IDAY,IMONTH,QHL,QHW,
24480      1        QC,QINCI,BASLOD,XTEMP,
24490      1        A(200),TWELL(12),FANCFM,FNCFM1,SIZE,SIZE1,SIZE2
24500       COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),
```

```
     1          TOC(24),WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
      COMMON /STOP/ENDC,TTANK2
      REAL KADX
      LOGICAL FIRST,IN
      DATA ZERO/0./,ONE/1./,SIX2P4/62.4/,THRTWO/32./,OPEM4/1.2131944E-4/
     1          ,F7P24/57.24/,SEVFIV/75.0/,005/105./
C
C     INITIALIZE AND POSITION WEATHER TAPE.
C
      REWIND(8)
      REWIND(10)
      TZONES = A(89)
      THOTWI = 005
      FIRST = .TRUE.
      CUFT = ZERO
      TTANK = A(146)
      TQI=ZERO
      TQNS=ZERO
      TQNW=ZERO
      TQN=ZERO
      PCUFT = ZERO
      WRITE(9,911)BC,BH,ICHECK,ICHEC1,IBEGIN,IEND
  911 FORMAT(1X,2(F6.2,2X),4(I4,2X))
      IBHM1 = IFIX(BH - ONE)
      DO 10 I = 1, IBHM1
         READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IDU1,IMONTH,IDU2,IDU3
         DO 110 IJK = 1,24
            READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
110         CONTINUE
10       CONTINUE
      IBEGIN = IFIX(BH)
      IEND = NDAYS
30    CONTINUE
C
C     READ WEATHER TAPES AND PERFORM HOURLY ENERGY CALCULATIONS
C
      DO 80 I = IBEGIN, IEND
         READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,ICITY
         IMONTH = IDUM1
         IHOURE = 24
         DO 70 J = 1, IHOURE
            T = XTEMP
             READ(10)QHL,QHW,QC,QINCI,BASLOD,XTEMP
            TO = DB(J)
            TWI = THOTWI
            CALL WAHP(TTANK,T,SIZE1,QEVAP,HP)
            CALL WWHP(TTANK,TWI,QCOND1,QEVAP1,HP1,COP1)
C
C     DETERMINE THE DYNAMIC TANK LOSS.
C
```

```
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 COLECT(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       TQI = TQI + 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)
```

```
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 - TLOSA + QPAN + 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 TEMPURATURE 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 *
```

```
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) ICHEC1 = 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
26350        END
26360        SUBROUTINE WWHP(TWIE,TWIC,QCOND1,QEVAP1,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*****************************************************************
```

```
26510C
26520      COMMON /PASS/KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,TAVE,TWELA,
26530     1              TQHLHW,TQHWHW,TBLDHW,TBLDCW,TQCCW,TQHNHS,TQHLHS,
26540     1              TBLDCS,TBLDHS,TQCCS,AWALBG,TIME,BC,BH,COP,TCCS,THLHS,
26550     1           THLHW,TCCW,TQINCW,TQINCS,PCT,DMINQ1,DMINQ2,DMINBL,CPRVT,
26560     1          CPRVW,TAMBA,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,FANH,FANC,
26570     1              NDAYS,XPER,SCALE,IN,AA,BB
26580      REAL KADX
26590      LOGICAL IN
26600      DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,THUND/3000./,
26610     1     P00097/.00097/,P7612/.7612/,T9P23/29.23/,EIGHTY/80./,
26620     1     F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.414/,
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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SIMMOD

```
  SNUMB = 3897T                          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  XXXX              XXXX              XXXX              XXXXXX              XXXXX
     X             X    X            X    X                  X                X
   XXX              XXXX             X    X                X                  X
      X            X    X             XXXX               X                    X
 X    X            X    X               X              X                      X
  XXXX              XXXX               X             X                        X

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


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

0001  $       SNUMB    3897T
0002  $       COMMENT  F00648        TSS MEDIA CONVERSION
0003  $       IDENT    F00648-ACES
0004  $$      USERID   F00648$
0005 A$       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 = 001717


* ACTY-01  $CARD #0005  CONVER   08/31/79   SW=000000000000
  BMC-TTL DATE     771205
$      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=000000000000

      START 11.533      LINES   1705      PROC  0.0003      I/O   0.001     IU  5   MEMORY    8K
      STOP  11.551      LIMIT  50000      LIMIT 0.2000      LIMIT           CU  5   M*T      140
      SWAP   0.014
      LAPSE  0.018 FC D   TYPE      BUSY     IP/AT     FP/RT     IS/#C MS/#E    ADDRESS T#/PK#

                   MC R MSU450 *      22         0         1         1     1    0-08-01
                   IN R MSU450 *     924         0        42        42    42    0-08-01
                   OT    SYOUT
                   P*    SYOUT

       RC-00  1705 LINES AT STA.  E1

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

```
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,FANCME,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,VOLUMEE,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 P84/.84/,005/105./
10480C
10490C      READ INPUT FILES
10500C
```

```
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(105))
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
```

```
      IF(AA .LE. ZERO .AND. CK .LT. P84) FLAG2 = TWO
      ELEBU = ZERO
      TELEBU = ZERO
      FIRST = .TRUE.
C
C     SIZE FAN FOR AIR TO AIR SYSTEM
C
      IF(ICONV .LE. 0) GO TO 5
      SCALE = ONE
      CALL ATAHP(TOSAS,TZONES,QCOND,QEVAP,HP,AUX1,AUX2)
      SCALE = SIZE2/QEVAP
      IB = IFIX((SCALE - ONE)*T8HUN*P01)
      FANCME = FLOAT((IB + 1) + T8HUN*P01)*HUN
      IB = IFIX((SCALE - ONE)*ETHUN*P01)
      FANCMH = FLOAT((IB + 1) + ETHUN*P01)*HUN
      GO TO 8
C
C     SIZE FAN FOR WATER TO AIR SYSTEM
C
    5 SCALE = ONE
      CALL WWHP(TTANK,THOTW,QCOND1,QEVAP1,HP1,COP1)
      CALL WAHP(TTANK,TZONEW,QCOND,QEVAP,HP)
      SCALE = SIZE/QCOND
      SCALE0 = SCALE
      IB = IFIX((SCALE - ONE)*ETHUN*P01)
      FANCMH = FLOAT((IB + 1) + ETHUN*P01)*HUN
      IB = IFIX((SCALE - ONE) * T8HUN * P01)
      FANCME = FLOAT((IB + ONE) + T8HUN * P01) * HUN
      TOTHET = TQHLHW * (ONE - ONE/COP) + TQHWHW * (ONE - ONE/COP1)
      TOTCOL = TQCCS - (TQHLHS * (ONE - ONE/COP) + TQHWHS * (ONE
     1          - ONE/COP1))
C
C     SIZE FAN FOR DUAL SOURCE SYSTEM
C
C     IF(CUTOFF .GT. TZONEW) GO TO 8
C     SCALE1 = (TZONEW - CUTOFF)/(TZONEW - TOSAW)
C     SCALE = ONE
C     QHL = ONE
C     QC = ZERO
C     CALL ATAHP(CUTOFF,TZONEW,QCOND,QEVAP,HP,AUX1,AUX2)
C     SCALE = SCALE1*SIZE/QCOND
C     IF(SCALE .LT. SCALE0) SCALE = SCALE0
C     IF(SCALE .LE. SCALE0) GO TO 8
C     IB = IFIX((SCALE - ONE)*T8HUN*P01)
C     FANCME = FLOAT((IB + 1) + T8HUN*P01)*HUN
C     IB = IFIX((SCALE - ONE) * ETHUN * P01)
C     FANCMH = FLOAT((IB + 1) + ETHUN*P01)*HUN
C
    8 CONTINUE
C
```

```
      FANC = FANCFM*OP365
      FANH = FANCMH*OP365
      FANE = FANCME*P7375
      FANOIL = A(103) * OP365
      FANGAS = A(104) * OP365
      PUMW = A(16)
      PUMP = A(25)
      PUME = A(26)
      PUMC = A(27)
C
C     SIZE AUXILLARY HEAT FOR AIRSOURCE ACES
C
      PQBU1 = ZERO
      QC = ZERO
      QHL = ONE
      IF(CUTOFF .GT. TZONEW .OR. ICONV .GT. 0) GO TO 9
      CALL ATAHP(CUTOFF,TZONEW,QCOND,QEVAP,HP,AUX1,AUX2)
      PQBU1 = SIZE - QCOND
      IF(PQBU1 .LT. ZERO)PQBU1 = ZERO
    9 CONTINUE
C
      FIRST = .TRUE.
      Z=IB
      WRITE(14 + ICONV) IBLDGT
      IF(ICONV .EQ. 0)WRITE(14)SIZEE,VOLUMEE,SCALE,FLAG1,FLAG2
      WRITE(14 + ICONV)BH
C
C     START SIMULATION AT THE BEGINNING OF THE HEATING SEASON
C
      REWIND(8)
      REWIND(10)
      IBHMI = IFIX(BH - ONE)
      IBEGIN = IFIX(BH)
      IEND = NDAYS
C
C     POSITION TAPES
C
        DO 10 I=1,IBHMI
        READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IDU1,IDU2,IDU3,IDU4
          DO 20 K=1,24
          READ(10) QHW,QHW,QC,QINCI,BASLOD,XTEMP
   20     CONTINUE
   10   CONTINUE
C
C     START SIMULATION
C
   70 CONTINUE
        DO 30 I=IBEGIN,IEND
        READ(8) DB,DP,WB,WS,PB,TC,TOC,WET,DRY,IYEAR,IDUM1,IDUM2,
     1          ICITY
```

```
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(IBLDGT .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 = IBHMI
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',
```

```
12510      1' SYSTEM',1X,I1,1X)
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,FANCME,SCALE,QHL,
12850      1     QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,DOP,FANOIL,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,NDAYS,XPER,IN,AA,BB,
12880      1     SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
12890      1     TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,SIZEE,FANE,ISTRIP
12900       COMMON /ZAP1/ZAP,PEK,PQBU1
12910       COMMON /DESH/HEATD
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/,P1/0.1/
12980C
12990       REWIND (8)
13000       REWIND(10)
```

```
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,HEATD
13140       WRITE(9,211)
13150  211  FORMAT(1X,'      FANCFM            FANCFM1           SIZE1
13160      1SIZE2            HEATD')
13170       WRITE(9,212)FANCFM,FNCFM1,SIZE,SIZE2,HEATD
13180  212  FORMAT(V)
13190       READ(13)BC,BH,SIZE,SIZE2,SID,SIZ,TQHLHW,TQHWHW,TQCCW,TQHLHS,
13200      1 TQHWHS,TQCCS,VOLUMEE,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       VOLUMEE = 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,VO_UMEE,SIZEE
13300       RETURN
13310 500   FORMAT(13A6)
13320 1000  FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6//)
13330 2000  FORMAT(I5,F15.5,10A6)
13340 3000  FORMAT(3H A(,I3,1H),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,QEVAP,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,FANCME,SCALE,QHL,
13570      1     QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,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,NDAYS,XPER,IN,AA,BB,
13600      1     SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
13610      1     TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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/3.414/,
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       COP = QCOND/QMOT
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,FANCME,SCALE,QHL,
14080      1    QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,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,BB,
14110      1    SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
14120      1    TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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,IDUM1,IDUM2,ICITY
14150       REAL KADX
14160       LOGICAL IN
14170       DATA ONE/1./,ONET23/1023./,THRTWO/32./,SIXFT/65000./,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/3.414/,
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 ATAHP(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,FANCME,SCALE,QHL,
14550      1     QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
14560      1     KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,ITANK,BC,BH,PCT,CPRVT,FANC,
14570      1     CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
14580      1     SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
14590      1     TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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      P00097/.00097/,P7612/.7612/,T9P23/29.23/,EIGHTY/80./,
14660      1      F569/4569./,T523/2523./,SIX2P5/62.5/,TWP5/12.5/,PI/3.414/,
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))
```

```
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       QEVAP = (S3P36 - P2493 * ECT) * THOU * SCALE
15110       COP = SP9875 - P0415 * ECT
15120       QMOT = QEVAP/COP
15130       HP = QMOT/T545
15140       QCOND = QMOT + QEVAP
15150       AUX1 = ZERO
15160       AUX2 = ZERO
15170       GO TO 20
15180C
15190C      IN DEAD BAND
15200C
15210    30 CONTINUE
15220       QCOND = ZERO
15230       QEVAP = ZERO
15240       COP = ZERO
15250       AUX1 = ZERO
15260       AUX2 = ZERO
15270       HP = ZERO
15280    20 CONTINUE
15290       RETURN
15300C
15310C      LAST CARD OF SUBROUTINE ATAHP
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 STATMENT 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.
```

```
C
C     SURFW IS THE BASEMENT SURFACE AREA THAT THE TANK REPLACES.
C
C     TLOSA IS THE ENERGY LOSS FROM THE TANK TO THE BASEMENT.
C
C     TEMP IS THE BASEMENT TEMPERATURE
C
C     TO IS THE OUTSIDE TEMPERATURE
C
C     FIRST IS A LOGICAL VARIABLE.
C
C     PROJECT:  ACES
C
C     DEVELOPED BY HONEYWELL
C
C     CREATION DATE: 8/25/78
C
C*********************************************************************
C
      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCME,SCALE,QHL,
     1    QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
     1    KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BC,BH,PCT,CPRVT,FANC,
     1    CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
     1    SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHWHW,TQCCW,
     1    TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,SIZEE,FANE,ISTRIP
      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TOC(24),
     1        WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
      LOGICAL FIRST,IN
      REAL KADX
      DATA ZERO/0./,TWO/2./,ONE/1./,ET3P6/83.6/
C
C     INITIALIZATION ON FIRST PASS.
C
      IF (.NOT. FIRST) GO TO 10
      AX = ZERO
      IF (PCT .GE. ONE) AX= ONE
      XK = ZERO
      IF (PCT .GT. ZERO) XK = ONE
      CPRVP = ET3P6
      CPRV2 = CPRVT + CPRVP
      CPRV3 = CPRVT + CPRVP + CPRVW
      UTNK = UTANKA * XK
      UTNK1 = TWO * UTNK
      UTNK2 = UTNK1
      TEMP1 = ONE/UTANKW + ONE/KADX
      UTNKD = ONE/(TEMP1 + AX/UWAL)
      UTNKD1 = TWO * UTNKD
      UTNKD2 = UTNKD1
      UTNKWD = ONE/(TEMP1 + XK/UWAL)
      UTKWD1 = TWO * UTNKWD
```

```
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       1       + 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       1       + TTG2 * UTNKD2)
16450        TTG2 = TTG2 * (ONE - TEMP8 * TEMP9) + TEMP8 * (UTNKD2 * TTG1
16460       1       + KADX * TTG3)
16470        TTG3 = TTG3 * (ONE - TEMP8 * TEMP10) + TEMP12 * (TTG2 +
16480       1       TWELL(IMONTH))
16490        QLOSG = (TWO * THTSD * (ONE - PCT) + SIDESQ) * UTNKD1 * (TTANK -
16500       1 TTG1)
```

```
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) + TEMP8 * (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) * UTNK2 * (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 DETEMINE 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,FANCME,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,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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
```

```
C
C     CREATION DATE            9/10/78
C
C*****************************************************************
C
      DATA F059P/459.688/,TW73P/273.16/,TH73P/373.16/,TW9P/29.921/
      DATA ONEP8/1.8/,ONE/1.0/,TEN/10.0/,ZERO/0.0/
      DIMENSION A(6)/-7.90298,5.02808,-1.3816E-7,11.344,8.1328E-3,
     1           -3.49149/,B(4)/-9.09718,-3.56654,0.876793,0.0060273/
      DIMENSION P(4)
      T = (X + F059P)/ONEP8
      IF(T .LT. TW73P) GO TO 3
      Z = TH73P/T
      P(1) = A(1)*(Z - ONE)
      P(2) = A(2)*ALOG10(Z)
      Z1 = A(4)*(ONE - ONE/Z)
      P(3) = A(3)*(TEN**Z1 - ONE)
      Z1 = A(6)*(Z - ONE)
      P(4) = A(5)*(TEN**Z1 - ONE)
      GO TO 4
    3 Z = TW73P/T
      P(1) = B(1)*(Z - ONE)
      P(2) = B(2)*ALOG10(Z)
      P(3) = B(3)*(ONE - ONE/Z)
      P(4) = ALOG10(B(4))
    4 SUM = ZERO
        DO 5 I=1,4
    5   SUM = SUM + P(I)
      PVSF = TW9P*TEN**SUM
      RETURN
      END
      SUBROUTINE CONV1(GAS,OIL,ELE,PEAK)
C
C*****************************************************************
C
C     THIS SUBROUTINE WILL ESTIMATE THE HOURLY GAS OIL AND ELECTRIC
C     USAGE OF AN ELECTRIC HEATING SYSTEM, AN ELECTRIC COOLING
C     SYSTEM (CENTRAL), AND AN ELECTRIC HOT WATER SYSTEM
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE CONV1(GAS,OIL,ELE)
C
C     WHERE
C
C     GAS IS THE HOURLY BTU'S SUPPLIED BY THE GAS SYSTEM
C
C     OIL IS THE HOURLY BTU'S SUPPLIED BY THE OIL SYSTEM
C
C     ELE IS THE HOURLY BTU'S SUPPLIED BY THE ELETRIC SYSTEM
```

```
C
C     PROJECT    ACES
C
C     DEVELOPED BY HONEYWELL
C
C     CREATION DATE            9/10/78
C
C*****************************************************************
C
C     THE SUBROUTINE STATEMENT IS
C
C     SUBROUTINE CONV1(GAS,OIL,ELE)
C
C     WHERE
C
C     GAS IS THE HOURLY BTUS SUPPLIED BY THE GAS SYSTEM
C
C     OIL IS THE HOURLY BTUS SUPPLIED BY THE OIL SYSTEM
      DATA ONE/1.0/,OP365/1.365/,ZERO/0.0/,BTUHP/2545./,P7375/0.7375/
      DATA SEVTY/70000./,P33/.33/,P66/.66/
      COMMON /PASS/ A(200),SIZE,SIZE2,FANCFM,FANCMH,FANCME,SCALE,QHL,
     1     QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
     1     KADX,HEIGHT,PF,UTANKA,UTANKW,UWAL,TTANK,BCOBH,PCT,CPRVT,FANC,
     1     CPRVW,AREAC,CK,C,FF,PUMP,PUME,PUMC,PUMW,NDAYS,XPER,IN,AA,BB,
     1     SIDE,PANUM,CUTOFF,VEL,I,FANH,J,TOTHET,TQHLHW,TQHNHW,TQCCW,
     1     TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,SIZEE,FANE,ISTRIP
      COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(24),TC(24),TDC(24),
     1        WET(24),DRY(24),IYEAR,IDUM1,IDUM2,ICITY
      REAL KADX
      LOGICAL IN,FIRST
C
      QNEED = ZERO
      TF = ZERO
      IF(QC .LE. ZERO) GO TO 20
      CALL ATAHP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
      QNEED = QC/(ONE - FANH/QEVAP)
      TF = QNEED/QEVAP
      CD = DEGRAD(TF,ONE)
      HPD = HP/CD
C
   20 CONTINUE
      ELE = QHW + QHL + TF*(HPD*BTUHP + FANH + FANE)
      PECO = SEVTY
      IF(QHW .LE. ZERO) PECO = ZERO
      CAP = SIZE
      CENT = ZERO
      PER = QHL/CAP
      IF(PER .GT. ZERO .AND. PER .LT. P33) CENT = P33
      IF(PER .GT. P33 .AND. PER .LT. P66) CENT = P66
      IF(PER .GT. P66) CENT = ONE
```

```
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
```

```
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,TQHWHW,TQCCW,
19220      1    TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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 ATAHP(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))
```

```
      TF = QNEED/(QCOND + FANH - AUX2 + BU1)
      IF(TF .GT. ONE) BU2 = BU1
      IF(TF .GT. ONE) QNEED = (QHL)/(ONE + (FANH - AUX2)/(QCOND + FANH
     1                          - AUX2 + BU1 + BU2))
      IF(TF .GT. ONE) TF = QNEED/(QCOND + FANH - AUX2 + BU1 + BU2)
      BU = ZERO
   15 CONTINUE
      XRZ = 3.
      IF(A(196) .LE. ZERO) XRZ = ONE
      DTF = TF
      IF(A(196) .LE. ZERO) GO TO 333
      IF(DTF .GT. ZERO .AND. DTF .LE. .33) DTF = DTF/.33
      IF(DTF .GT. .66 .AND. DTF .LE. .66) DTF = (DTF - .33)/.33
      IF(DTF .GT. .66) DTF = (DTF - .66)/.34
  333 CONTINUE
      CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ONE))
      HPD = HP/CD
      ELE1 = TF * (HPD * BTUHP + FANH + FANE + AUX1 + BU + BU1 + BU2)
      CENT = ZERO
      IF(TF .LT. .33) CENT = .33
      IF(TF .GT. .33 .AND. TF .LT. .66) CENT = .66
      IF(TF .GT. .66) CENT = ONE
      PEAK1 = CENT * ELE1/TF
C
   20 IF(QC .LE. ZERO) GO TO 30
      CALL ATAHP(TO,T,QCOND,QEVAP,HP,AUX1,AUX2)
      QNEED = QC/(ONE - FANH/QEVAP)
      TF = QNEED/QEVAP
      XRZ = 3.
      IF(A(196) .LE. ZERO) XRZ = ONE
      DTF = TF
      IF(A(196) .LE. ZERO) GO TO 777
      IF(DTF .GT. ZERO .AND. DTF .LE. .33) DTF = DTF/.33
      IF(DTF .GT. .66 .AND. DTF .LE. .66) DTF = (DTF - .33)/.33
      IF(DTF .GT. .66) DTF = (DTF - .66)/.34
  777 CONTINUE
      CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ONE))
      HPD = HP/CD
      ELE2 = TF*(HPD*BTUHP + FANH + FANE)
      CENT = ZERO
      IF(TF .GT. ZERO .AND. TF .LT. .33) CENT = .33
      IF(TF .GT. .33 .AND. TF .LT. .66) CENT = .66
      IF(TF .GT. .66) CENT = ONE
      PEAK2 = CENT * ELE2/TF
C
   30 CONTINUE
      ELE = ELE1 + ELE2 + QHW
      IF(QHW .GT. ZERO) PEAK3 = SEVTY
      PEAK = PEAK1 + PEAK2 + PEAK3
      GAS = ZERO
```

```
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 ELETRIC 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,TOTHET,TQHLHW,TQHWHW,TQCCW,
20380      1    TQHLHS,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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
```

```
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       ELEO = TF * FANOIL
20610       PEAK1 = FANOIL
20620C
20630    20 CONTINUE
20640       IF(QC .LE. ZERO) GO TO 30
20650       CALL ATAHP(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 + ELEO
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
```

```
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
```

```
      END
      FUNCTION ETAOIL(TF)
C
C*********************************************************************
C
C     THIS FUNCTION WILL DETERMINE THE EFFICIENCY OF AN OIL
C     FIRED FURNACE AS A FUNCTION OF THE PERCENT ON TIME
C
C     THE FUNCTION STATEMENT IS
C
C     FUNCTION ETAOIL(TF)
C
C     WHERE TF IS THE TIME FRACTION
C
C     DEVELOPED BY HONEYWELL
C
C     CREATION DATE            9/10/78
C
C*******************************************************************
C
      DATA P025/0.025/,P71/0.71/,ONE/1.0/,S4P59/74.59/,P60/0.6/
      DATA P11/0.11/,T4P24/24.24/
      IF(TF .LE. P025) ETAOIL = P71*(ONE - EXP(-S4P59*TF))
      IF(TF .GT. P025) ETAOIL = P60 + P11*(ONE - EXP(-T4P24*(TF -
     1                          P025)))
      RETURN
      END
      FUNCTION ETAGAS(TF)
C
C*********************************************************************
C
C     THIS FUNCTION WILL DETERMINE THE EFFICIENCY OF A GAS FIRED
C     FURNACE AS A FUNCTION OF THE PERCENT ON TIME
C
C     THE FUNCTION STATEMENT IS
C
C     FUNCTION ETAGAS(TF)
C
C     WHERE TF IS THE TIME FRACTION
C
C     PROJECT     ACES
C
C     DEVELOPED BY HONEYWELL
C
C     CREATION DATE            9/10/78
C
C*******************************************************************
C
      DATA ONE/1.0/,P63/0.63/,T3P3/33.3/
      ETAGAS = P63*(ONE - EXP(-T3P3*TF))
```

```
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 ELETRIC 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,VOLUMEE,SIZEEL,FANE,ISTRIP
22390       COMMON /WEATHR/DB(24),DP(24),WB(24),WS(24),PB(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
```

```
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 ATAHP(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*BTUHP + 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 OR 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
```

```
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,FANCME,SCALE,QHL,
23150      1    QHW,QC,QINCI,BASLOD,XTEMP,TWELL(12),TO,T,COP,FANOIL,FANGAS,
23160      1    KADX,HEIGHT,PF,UTANKA,UTANKW,UWALL,TTANK,BC,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,TQHWHS,TQCCS,TOTCOL,IMONTH,VOLUMEE,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,IDUM2,ICITY
23220       COMMON /ZAP1/ZAP,PEK,PQBU1
23230       INTEGER TIMEON,TIMOFF
23240       REAL KADX
23250       LOGICAL IN,FIRST,DUEL,RUN,GO1
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 T545/2545./,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       ENDC = 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
```

```
      TIMEON = IFIX(A(100))
      TIMOFF = IFIX(A(101))
      XRZ = 3.
      IF(A(196) .LE. ZERO) XRZ = ONE
      TERI = ZERO
      STAR = ZERO
      BEFO = ZERO
      IF((PEK + DAYAFT) .GT. BH) BEFO = ONE
      ZUM = BH - ONE
      ZIP = ZAP
      TEMP = (TZONEW + TZONES)/TWO
      RUN = .FALSE.
      IF(CUTOFF .GT. TZONEW) DUEL = .FALSE.
      VOLUME = HEIGHT*SIDE*SIDE
C
C     SET PARAMETERS AND ESTIMATE LOADS TO BE USED IN CONTROLLING
C     THE SOLAR PANEL
C
      TIME = (BH - BC)*TWNFOR
      QINL = TOTCOL - TLOSS*TIME
      IMONTH = 9
      CALL TANKLD(TLOSS,SURFW,TLOSA,TEMP,FIRST)
      IMONTH = IDUM
      FIRST = .TRUE.
      TTLOSS = TLOSS
      QINH = TOTCOL - TTLOSS*TIME
      QNETI = QINH
C
   10 CONTINUE
      AUX1 = ZERO
      AUX2 = ZERO
      COP1 = ZERO
      COP2 = ZERO
      SSS = ZERO
      QCOND1 = ZERO
      QCOND2 = ZERO
      QBU = ZERO
      QBU1 = ZERO
      HP1 = ZERO
      HP2 = ZERO
      TEMP = T
      PEAK1 = ZERO
      PEAK2 = ZERO
      PEAK3 = ZERO
      PEAK4 = ZERO
      PEAK5 = ZERO
      IF(J .EQ. 1) ZUM = ZUM + ONE
      TERI = TERI + QC
      IF(J .NE. 24) GO TO 444
      IF(TERI .GT. .99 * ZAP) STAR = ONE
```

```
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 ATAHP(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 = QCON1
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
```

```
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/OPEM4) GO TO 30
24680       QNETI = QNETI - (QC - (QHL * (ONE - ONE/COP) + QHW * (ONE -
24690      1         ONE/COP1)) - TLOSS)
24700       DIF = TTLOSS - TLOSS
24710       IF(CUFT/OPEM4 .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        / OPEM4
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)
```

```
25010       QLOW = QEVAP
25020       ELENIT = FANH + T545*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. BC .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,TO,QCOND,QEVAP,HP)
25160       QLOW = QEVAP
25170       ELENIT = FANH + T545*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      SURGACE 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. BH) XX = ONE
25470       QCON1 = QCOND1 * XX + QCOND2 * (ONE - XX)
25480       IF(QHL .GT. ZERO)QCON1 = QCOND * XX + QCOND2 * (ONE - XX)
25490       CO = COP1 * XX + COP2 * (ONE - XX)
25500       QNEEDW = QHW/(ONE + (ONE - XPER) * PUMW/(QCON1 + (ONE - XPER)
```

```
     1          * PUMW))
      TFW = QNEEDW/(QCON1 + (ONE - XPER) * PUMW)
      QNEEDS = (HEATMB - BASE1 + TLOSA - QPAN - TFW*XPER* (PUME*XX
     1           + PUMW) - ENELOW)/(ONE + (FANH - AUX2 + XX*PUME*XPER)/
     1          (QCOND + FANH - AUX2 + XPER*PUME*XX))
      TFS = QNEEDS/(QCOND + FANH - AUX2 + XPER * PUME * XX)
      TF = TFS + TFW
      IF(QNEEDS .GT. ZERO .AND. QHL .GT. ZERO .AND. XX .GT. ZERO)
     1  CO = COP
      DTF = TF
      IF(A(196) .LE. ZERO) GO TO 377
      IF(DTF .GT. ZERO .AND. DTF .LE. .33) DTF = DTF/.33
      IF(DTF .GT. .33 .AND. DTF .LE. .66) DTF = (DTF - .33)/.33
      IF(DTF .GT. .66) DTF = (DTF - .66)/.34
  377 CONTINUE
C
C     ENERGY OUT OF THE TANK FOR HEATING VIA WATER SOURCE EVAPORATOR
C
      IF(I .GE. BC .AND. I .LT. BH) GO TO 55
      IF(DUEL .AND. TO .GT. CUTOFF) GO TO 50
   55 CONTINUE
      QPE = PUME*TF*(ONE - XPER)
      QOUT = QNEEDS * (ONE - ONE/COP) + QNEEDW * (ONE - ONE/CO)
      IF(QHL .LE. ZERO) QOUT = QNEEDW*(ONE - ONE/CO)
      IF(QNEEDS .LE. ZERO) QOUT = QNEEDW*(ONE - ONE/CO)
      IF(QNEEDS .LE. ZERO) QPE = PUME*TFW*(ONE - XPER)
      IF(QOUT .LE. ZERO) QPE = ZERO
C
C     ELECTRICAL ENERGY DURING HEATING
C
      CD = XRZ/(XRZ - ONE + ONE/DEGRAD(DTF,ZERO))
      HPD = HP/CD
      COPD = COP * CD
      HPD1 = HP1/CD * XX + HP2/CD * (ONE - XX)
      COP 1 = CO * CD
      ELE1 = TFS * FANH + TF * PUME + QNEEDS/COPD + QNEEDW/COPD1
     1  + TFW * PUMW
      IF( NEEDS .LE. ZERO) ELE1 = TFW * (PUME + PUMW) + QNEEDW/COPD1
      IF( OUT .LE. ZERO) ELE1 = ZERO
      PEA = T545 * HPD +PUMW + PUME + FANE
      IF( NEEDS .LE. ZERO)PEA = T545 * HPD1 + PUME + PUMW
      CEN  = ELE1/PEA
      IF( ENT .GT. ZERO .AND. CENT .LT. .33) CENT=.33
      IF( ENT .GT. .33.AND. CENT .LT. .66) CENT = .66
      IF( ENT .GT. .66) CENT = ONE
      PEA 3 = CENT * PEA
      GO  O 60
C
C     ELECTRICAL ENERGY NEEDED FOR THE AIR SOURCE EVAPORATOR
C
```

```
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 + PQBU1
26250   60 CONTINUE
26260      IF(ELENIT .LE. ZERO) GO TO 65
26270      ELE1 = ZERO
26280      QPE = ZERO
26290      QOUT = ZERO
26300   65 CONTINUE
26310C
26320C     THE TOTAL COOLING LOAD FOR THE HOUR
26330C
26340      COOL = QC
26350C
26360C     IF THERE IS NO BASEMENT THE TOTAL COOLING LOAD WOULD BE
26370C
26380      COOLMB = COOL - BASLOD
26390C
26400C     THE ADJUSTED BASEMENT LOAD AS A FUNCTION OF THE REPLACED WALL
26410C     AREA
26420C
26430      BASE2 = BASLOD*(ONE - SURFW/AWALBG)
26440C
26450C     THE ACTUAL COOLING DEMAND ACCOUNTING FOR THE CORRECTED
26460C     BASEMENT SURFACE AREA, THE ADDED FAN HEAT, AND THE HEAT FLOW
26470C     FROM THE BASEMENT TO THE TANK IS QNEED.  QNEED IS EQUAL TO
26480C     COOL IF THE TANK AND THE FAN SYSTEM ARE NOT IN THE HEATED
26490C     SPACE
26500C
```

```
      RATI = (T - TTANK)/(TZONES - THIR2)
      QNEED = (COOLMB + BASE2 - TLOSA + QPAN + TFW*XPER*(PUME*XX+PUMW)
     1        + ENELOW)/(ONE - (FANC + XPER*PUMC)/(RATI*SIZE2))
      TF = QNEED/(RATI*SIZE2)
C
C     ENERGY INTO THE TANK FROM COOLING
C
      QPC = PUMC*TF*(ONE - XPER)
      QIN = QNEED
      IF(QC .LE. ZERO) QIN = ZERO
      IF(QIN .LE. ZERO) QIN = ZERO
      IF(QIN .LE. ZERO) QPC = ZERO
C
C     ELECTRICAL ENERGY DURING COOLING
C
      ELECOL = TF*(PUMC + FANC)
      IF(QPC .LE. ZERO) ELECOL = ZERO
      IF(QPC .GT. ZERO) PEAK4 = PUMC + FANC
C
C     DETERMINE THE TANK TEMPERATURE OR THE AMOUNT OF ICE IN THE TANK
C
      QELE = QPCC + QPC + QPE + ENELOT + QBU
      Q = ZERO
      QI = ZERO
      IF(CUFT .GT. ZERO) GO TO 120
      TOLD = TTANK
  130 CONTINUE
      TTANK = TTANK + ONE/(PF*VOLUME*(SIX2P4*XK + F7P24))*(QIN - QOUT
     1        - TLOSS + QCOLL - QI + QELE - QLOW)
      IF(TTANK .LE. THIR2) Q = PF*VOLUME*(SIX2P4*XK+F7P24)*(TOLD-THIR2)
      IF(TTANK .GT. THIR2) GO TO 140
  120 TTANK = THIR2
      CUOLD = CUFT
      CUFT = CUFT + (QOUT-QIN+TLOSS-QCOLL-Q-QELE+QLOW)*OPEM4
      IF(CUFT .GT. ZERO) GO TO 150
      QI = CUOLD/OPEM4
      CUFT = ZERO
      GO TO 130
  150 CONTINUE
      IF(CUFT .GT. PCUFT) PCUFT = CUFT
  140 CONTINUE
      ELE = ELESOL + ELENIT + ELE1 + ELECOL + QBU + QBU1
      GAS = ZERO
      OIL = ZERO
      ELEBU = QBU + QBU1
      PEAK = PEAK1 + PEAK2 + PEAK3 + PEAK4
      IF(A(198) .GT. ZERO)WRITE(9,711)I,J,TTANK,CUFT,QNEEDS,QNEED,
     1 QNEEDW,QCOLL,ELENIT,ELE1,ELECOL,ELESOL,ELE
  711 FORMAT(1X,2(I3,1X),2(F7.2,1X),9(F10.2,1X))
      RETURN
      END
```

ECOMOD

```
  SNUMB = 3895T                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  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
  XXXX              XXXX                X               XXXX                X

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


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


0001  $        SNUMB    3895T
0002  $        COMMENT F00648         TSS MEDIA CONVERSION
0003  $        IDENT    F00648-ACES
0004  $$       USERID   F00648$
0005 A$        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 = 001027


* ACTY-01  $CARD #0005  CONVER    08/31/79   SW=000000000000
  BMC-TTL DATE     771205
$     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 11.532      LINES   1015      PROC  0.0002       I/O   0.001     IU  5    MEMORY     8K
      STOP  11.534      LIMIT  50000      LIMIT 0.2000       LIMIT             CU  5    M*T        66
      SWAP   0.000
      LAPSE  0.002 FC D   TYPE     BUSY     IP/AT     FP/RT     IS/#C MS/#E    ADDRESS T#/PK#

                   MC R MSU450 *    22        0         1         1     1    0-08-09
                   IN R MSU450 *   550        0        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/SETTNGS=  ASIS
```

```
C*****************************************************************
C
C            ACES ECONOMIC EVALUCATION PACKAGE
C
C
C            DEVELOPED BY HONEYWELL,INC
C            CREATION DATE:  NOVEMBER 17,1978
C
C  THIS PROGRAM CAN EITHER CALCULATE THE LIFE CYCLE COST OF A
C  SINGLE HVAC SYSTEM IN THE FORM OF ANNUALIZED COSTS OR IT CAN
C  COMPARE THE ECONOMIC EFFECTIVENESS OF UP TO FIVE SYSTEMS IN
C  TERMS OF ANNUAL COST OF OPERATION, PRESENT VALUE OF NET
C  BENEFITS, AND PAYBACK
C
C*****************************************************************
      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
     &        TOTELEC(5),COST(5),PVNB(5),PAYBAK(5),MAINT(5),INS(5),AC(5),
     &        PVTD(5),PTAX(5),PVC(5),DETD(5),BRKEV(5)
      COMMON /FUEL/TOTGAS(5),TOTOIL(5),OPEU(12,5),PEU(12,5),PDM(12,5),
     &              OPDM(12,5)
      COMMON /BILL/NCB(4),BLKCOST(4,5),BLKSIZ(4,5)
      COMMON /ACES/ETC,IPASS,ACESC(7),IBLDG,DATA(10),IDSYS(5)
      COMMON /OUTP/DELTAC(5),DELTAO(5),PVE(5),PVG(5),PVO(5),PVEC(2,5),
     &              PVED(2,5)
      DIMENSION MARGIN(10),LABEL(10),ESC(3,25),DF(30),NETD(5,25),
     &          FCTD(5,25),PTF(25),DEP(5),OP(5),AMP(5)
      CHARACTER MARGIN*6,LABEL*6
      INTEGER OWNER,FLAGT
      REAL MULT,MAINT,INS
      DO 1 IW = 1,170
    1 EIA(IW) = 0.0
C
C  READ IN ECONOMIC PARAMETERS ARRAY FROM FILE CODE 14
C
      REWIND 20
      READ(20) (MARGIN(II),II=1,10)
      WRITE(10,3000) (MARGIN(II),II=1,10)
 3000 FORMAT(10A6)
    5 READ(20,3002,END=7) J,EIA(J),(LABEL(JJ),JJ=1,9)
 3002 FORMAT(I4,F13.0,9A6)
      WRITE(10,3001) J,EIA(J),(LABEL(KK),KK=1,9)
 3001 FORMAT(1X,I3,F15.4,5X,9A6)
      GO TO 5
    7 CONTINUE
C
C  READ ENERGY USE FILES AND CALCULATE AMOUNT OF EACH ENERGY TYPE
C  USED DURING EACH RATE PERIOD DURING THE YEAR
C
      CALL AMOUNT
C
C  CALCULATE FIRST YEAR FUEL COSTS FOR EACH SYSTEM
```

```
1510C
1520        CALL FUELCOST
1530C
1540C  CALCULATE EQUIPMENT COSTS FOR ACES
1550C
1560        IF(IDSYS(1) .NE. 1)GO TO 8
1570        CALL ACESCOST
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        IDS = 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
```

```
      PVG(KW) = 0.0
      PVO(KW) = 0.0
      MAINT(KW) = 0.0
      INS(KW) = 0.0
      DO 9 KX=1,2
      PVEC(KX,KW) = 0.0
    9 PVED(KX,KW) = 0.0
C
C CALCULATE TOTAL PRESENT VALUE OF FUEL COSTS
C
      MFORM = 0
      DO 15 M=22,42,10
      MFORM = MFORM + 1
      NYR = 0
      FMULT = (1.0 + EIA(M+1)/100.0)**(ISTART-1)
      IF(ISTART .LT. EIA(M+2))GO TO 130
      FMULT = FMULT * (1.0+EIA(M+3)/100.0)**(ISTART-EIA(M+2))
  130 NEPH = EIA(M)
      LOPH = M
      LL = 1
      DO 15 N=1,NEPH
      LOPH = LOPH + 2
      LU = EIA(LOPH) + LL -1
      IF(ISTART .NE. 1 .AND. N .EQ. 1)LL=ISTART
      IF(LU .LT. LL)GO TO 15
      DO 13 L=LL,LU
      IF(L .GT. IEND)GO TO 15
      NYR = NYR + 1
      FMULT = FMULT * (EIA(LOPH-1)/100.0 + 1.0)
   13 ESC(MFORM,NYR) = FMULT/PARAN**L
   15 LL = LU + 1
      DO 16 LI=1,LAP
      DO 16 M=1,NSYS
      PVE(M) = TOTELEC(M)*ESC(1,LI) + PVE(M)
      PVG(M) = GASC(M)*ESC(2,LI) + PVG(M)
      PVO(M) = OILC(M)*ESC(3,LI) + PVO(M)
      FCTD(M,LI) = PVE(M) + PVG(M) + PVO(M)
      DO 16 N=1,2
      PVEC(N,M) = ELEC(N,M)*ESC(1,LI) + PVEC(N,M)
   16 PVED(N,M) = DEMAND(N,M)*ESC(1,LI) + PVED(N,M)
C
C  CALCULATE PRESENT VALUE OF NET EXPENDITURES TO DATE
C
      DO 660 NEL=1,LAP
      DO 660 IS=1,NSYS
      DISC = 1.0/(PARAN**(NEL+ISTART-1))
C
C  CALCULATE MAINTENANCE AND INSURANCE EXPENSES
C
      L = 8
```

```
      IF(IDSYS(IS) .NE. 1)GO TO 17
      RMM = EIA(9)*DISC/100.0
      MAINT(1) = MAINT(1) + (ACESC(1)+ACESC(2)+ACESC(5)+ACESC(7))*
     &           RMM
      L = 9
      GO TO 18
   17 MAINT(IS) = MAINT(IS) + EIA(8)*COST(IDSYS(IS))*DISC/100.0
   18 INS(IS) = INS(IS) + EIA(L+2)*COST(IDSYS(IS))*DISC/100.0
C
C  CALCULATE TAX DEDUCTIONS FOR MORTGAGE PAYMENTS
C
      IF(NEL .GT. 1)GO TO 19
      EXPO = EIA(12)*EIA(2)
      FACT = RMORT/EIA(12)
      RMULT = FACT*(1+FACT)**EXPO/((1+FACT)**EXPO-1.0)
      JEND = ISTART + LAP -1
      NPPY = EIA(12)
      PVTD(IS) = 0.0
      IF(MFLAG .EQ. 0)GO TO 21
      OP(IS) = COST(IDSYS(IS))*(1.0-EIA(167)/100.0)
      AMP(IS) = OP(IS)*RMULT
   19 IW = ISTART + NEL - 1
      DO 20 IV=1,NPPY
      TDMIP = OP(IS) * FACT
      OP(IS) = OP(IS) * (1 + FACT) - AMP(IS)
   20 PVTD(IS) = PVTD(IS) + (TDMIP/(PARAN**IW)*TAXI*(-1.0))
C
C  CALCULATE PROPERTY TAX EFFECT
C
   21 IF(NEL .GT. 1)GO TO 600
      IF(IDS .NE. 0)GO TO 522
      DO 521 J1=1,LAP
  521 DF(J1) = 0.0
      GO TO 560
  522 IF(IDS .NE. 1)GO TO 524
      DO 523 J2=1,LAP
  523 DF(J2) = 1/LAP
      GO TO 560
  524 IF(IDS .NE. 2)GO TO 526
      DO 525 J3=1,LAP
  525 DF(J3) = 2.0*(LAP-J3+1)/(LAP*(LAP+1))
      GO TO 560
  526 SSF = RINT/((1+RINT)**LAP-1.0)
      DO 527 J4=1,LAP
  527 DF(J4) = SSF
  560 COSTI = 1.0
      COST2 = 1.0
      DO 599 K3=1,LAP
      COSTI = COSTI - COST2*DF(K3)
  599 PTF(K3) = TAXP*COSTI/(PARAN**(K3+ISTART-1))
```

```
      PTAX(IS) = 0.0
  600 COSTM = COST(IDSYS(IS))
      IF(IS.EQ.1.AND.FLAGT.EQ.0)COSTM = COST(1) - (ACESC(3) +
     &     ACESC(4) + ACESC(5))*EIA(NSEC+1)
      PTAX(IS) = PTAX(IS) + (1.0-TAXI)*COSTM*PTF(NEL)
C
C CALCULATE PRESENT VALUE OF CAPITAL INVESTMENT EXPENDITURES
C
      IF(NEL .GT. 1)GO TO 602
      XNUM = 1.0
      IF(MFLAG .EQ. 0)GO TO 601
      ARATE = (EIA(3) + EIA(166))/100.0
      AMQ = 1.0 + ARATE
      XNUM = RMULT*EIA(12)
  601 DPAY = EIA(167)/100.0
      PVC(IS) = DPAY*COST(IDSYS(IS))/(PARAN**(ISTART-1))
  602 CDISC = 1.0/(AMQ**NEL)/(PARAN**(ISTART-1))
      DM = (1.0-DPAY)*XNUM*CDISC
      PVC(IS) = PVC(IS) + COST(IDSYS(IS))*DM
      IF(NEL .LT. LAP)GO TO 603
      PVC(IS) = PVC(IS) - COST(IDSYS(IS))*SALV/(PARAN**IEND)
C
C CALCULATE ENERGY TAX CREDIT
C
  603 IF(NEL .GT. 1)GO TO 604
      ETC = (ACESC(4)+ACESC(5))*EIA(NSEC+1)*EIA(168)/100.0/
     &      (PARAN**(ISTART-1))
C
C IF A COMMERCIAL BUILDING, CALCULATE TAX DEDUCTION DUE TO
C OPERATING EXPENSES
C
  604 IF(OWNER .EQ. 2)GO TO 630
      OETD(IS) = 0.0
      GO TO 650
  630 IF(NEL .GT. 1)GO TO 640
      OETD(IS) = 0.0
      DEP(IS) = 0.0
  640 DEP(IS) = DEP(IS) + COST(IDSYS(IS))*DF(NEL)*DISC
      OETD(IS) = -(DEP(IS)+MAINT(IS)+PVG(IS)+PVO(IS)+PVE(IS))*TAXI
  650 NETD(IS,NEL) = PVC(IS)+PVTD(IS)+MAINT(IS)+INS(IS)+PTAX(IS)+
     &                OETD(IS)
      IF(IDSYS(IS).EQ.1)NETD(IS,NEL) = NETD(IS,NEL) - ETC
  660 CONTINUE
C
C CALCULATE TOTAL PRESENT VALUE (TPV) OF SYSTEM AND ANNUAL COST (AC)
C
      DO 820 I=1,NSYS
      TPV = PVC(I)+MAINT(I)+INS(I)+PVE(I)+PVG(I)+PVO(I)+
     &        PVTD(I)+PTAX(I)+OETD(I)
      IF(I .EQ. 1 .AND. IDSYS(1) .EQ. 1)TPV = TPV - ETC
```

```
3510  820 AC(I) = TPV/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      PVTD(I) = PVTD(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     &        (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)+PVTD(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)-PVTD(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(DELF .LT. 0.0)GO TO 823
3920      DELC = NETD(1,KX) - NETD(I,KX)
3930      IF(DELF .GE. DELC .AND. BRKEV(I) .LE. 0.0)BRKEV(I)=KX
3940      IF(DELF .GE. (DELTAC(I)*MULT) .AND. PAYBAK(I) .LT. 1.0)
3950     &   PAYBAK(I) = KX
3960  823 CONTINUE
3970      IF(PAYBAK(I) .LT. 1.0)PAYBAK(I)=999.0
3980      IF(BRKEV(I) .LT. 1.0)BRKEV(I) = 999.0
3990  825 DELTAC(I) = -DELTAC(I)*MULT
4000  850 CRF = 1.0/MULT
```

```
      CALL OUTPUT(CRF,REP)
      DO 880 K=1,7
  880 ACESC(K) = ACESC(K)/DIV/EIA(NSEC+1)
  900 CONTINUE
      STOP
      END
C
C
      SUBROUTINE AMOUNT
      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
     &        TOTELEC(5),COST(5),PVNB(5),PAYBAK(5),MAINT(5),INS(5),AC(5),
     &        PVTD(5),PTAX(5),PVC(5),DETD(5),BRKEV(5)
      COMMON /FUEL/TOTGAS(5),TOTOIL(5),OPEU(12,5),PEU(12,5),PDM(12,5),
     &        OPDM(12,5)
      COMMON /ACES/ETC,IPASS,ACESC(7),IBLDG,DATA(10),IDSYS(5)
      INTEGER BSP(2),WPED(2),BHDP(2),EHDP(2),DAY,DAYC
      DIMENSION MONTH(13)
C
C  INITIALIZE PARAMETERS WHERE
C     BSP(I) = BEGINNING OF SEASONAL PEAK I
C     WPED(I) = WEEKLY PEAK ENDING DAY DURING SEASON I
C     BHDP(I) = BEGINNING HOUR OF DAILY PEAK DURING SEASON I
C     EHDP(I) = ENDING HOUR OF DAILY PEAK DURING SEASON I
C     OPEU(I,J) = OFF-PEAK ELEC USE DURING SEASON I BY SYSTEM J
C     PEU(I,J) = PEAK PERIOD ELEC USE, SEASON I BY SYSTEM J
C     OPDM(I,J) = MAX OFF-PEAK DEMAND IN MONTH I BY SYSTEM J
C     PDM(I,J) = MAX PEAK DEMAND IN MONTH I BY SYSTEM J
C
      NSYS = EIA(160)
      BSP(1) = EIA(102)
      BSP(2) = EIA(112)
      WPED(1) = EIA(108)
      WPED(2) = EIA(118)
      BHDP(1) = EIA(109)
      EHDP(1) = EIA(110)
      BHDP(2) = EIA(119)
      EHDP(2) = EIA(120)
C
C  CALCULATE QUANTITIES DEFINED ABOVE FOR EACH SYSTEM
C
      NCOUNT = 1
      DO 1 KA=161,165
      IF(EIA(KA) .LE. 0.1)GO TO 1
      IDSYS(NCOUNT) = EIA(KA)
      NCOUNT = NCOUNT + 1
    1 CONTINUE
      DO 3 IK=1,10
    3 DATA(IK) = 0.0
      DO 250 ID=1,NSYS
      DAY = EIA(151) - 2.0
```

```
      MONTH(1) = 1
      MONTH(2) = 32
      MONTH(3) = 60
      MONTH(4) = 91
      MONTH(5) = 121
      MONTH(6) = 152
      MONTH(7) = 182
      MONTH(8) = 213
      MONTH(9) = 244
      MONTH(10) = 274
      MONTH(11) = 305
      MONTH(12) = 335
      MONTH(13) = 366
      IFIRST = 0
      ILAST = 0
      IFC = 15 + IDSYS(ID)
      TOTGAS(ID) = 0.0
      TOTOIL(ID) = 0.0
      DO 5 KB=1,12
      OPEU(KB,ID) = 0.0
      PEU(KB,ID) = 0.0
      PDM(KB,ID) = 0.0
    5 OPDM(KB,ID) = 0.0
C
C IF THIS IS AN ACES SYSTEM, IFC=14 AND WE WANT TO READ SOME
C EQUIPMENT SIZE AND TYPE INFORMATION
C
      READ(IFC) IBLDG
      IF(IFC .EQ. 14)GO TO 2
      GO TO 6
    2 READ(IFC) (DATA(K),K=1,3),DATA(8),DATA(9)
C READ IN THE DAY THAT THE HEATING SEASON BEGINS
C
    6 READ(IFC) DAY1
      NDAY1 = DAY1
C
C DETERMINE THE MONTH IN WHICH HEATING BEGINS
C
      ISUB = 0
   20 ISUB = ISUB + 1
      IF(NDAY1 .GE. MONTH(ISUB))GO TO 20
      MONTH1 = ISUB - 1
      LEAPYR = 1
      YRCH = AMOD(EIA(150),4.0)
      IF(YRCH .GT. 0.0)LEAPYR=0
      M1 = ISUB
      IF(ISUB .LT. 3)M1 = 3
      DO 21 KN=M1,13
   21 MONTH(KN) =MONTH(KN) + LEAPYR
      LEAPYR = 1
```

```
      YRCH = AMOD((EIA(150)+1),4.0)
      IF(YRCH .GT. 0.0)LEAPYR=0
      IF(M1 .EQ. 3)GO TO 25
      M1 = M1 - 1
      DO 22 KM=3,M1
   22 MONTH(KM) =MONTH(KM) + LEAPYR
C
C
   25 I = 1
      J = 2
      IF(BSP(1) .LT. BSP(2))GO TO 26
      I = 2
      J = 1
   26 IF(MONTH1 .GE. BSP(I))GO TO 30
      MBEG = MONTH1
      MEND = BSP(I) - 1
      NSEASON = J
      GO TO 80
   30 IF(MONTH1 .GE. BSP(J))GO TO 40
      MBEG = MONTH1
      MEND = BSP(J) - 1
      NSEASON = I
      GO TO 80
   40 MBEG = MONTH1
      MEND = 12
      NSEASON = I
      GO TO 80
C
C READ IN THE ENERGY USE DATA FOR THIS MONTH
C
   80 DO 155 N1=MBEG,MEND
      K = MONTH(N1)
      IF(IFIRST .GT. 0)GO TO 90
      IFIRST = 1
      K = NDAY1
      IF(AMOD(EIA(150),4.0) .LE. 0.01)NDAY1 = NDAY1 - 1
   90 L = MONTH(N1+1)
      IF(ILAST .EQ. 0)GO TO 92
      IF(MONTH(N1+1) .LT. NDAY1)GO TO 92
      L = NDAY1
   92 LMO = L - K
C
C  DAILY DIVISION OF LOAD TO PEAK AND OFF-PEAK
C
      LDEX = L - 1
      DO 100 N2=K,LDEX
      DAY = DAY + 1
      DAY = MOD(DAY,7) + 1
      LL = 1
      LU = BHDP(NSEASON)
```

```
      IF(DAY .GT. NPED(NSEASON))LU = 24
  105 IF(LU .EQ. 1)GO TO 111
      DO 110 N3=LL,LU
      READ(IFC) GAS,OIL,ELECTR,DMAND
      TOTGAS(ID) = TOTGAS(ID) + GAS
      TOTOIL(ID) = TOTOIL(ID) + OIL
      PEAK = DMAND/3413.0
      OPEU(N1,ID) = OPEU(N1,ID) + ELECTR/3413.0
  110 IF(OPDM(N1,ID) .LT. PEAK)OPDM(N1,ID) = PEAK
      IF(LU .GE. 24)GO TO 100
  111 LL2 = BHDP(NSEASON)+1
      IF(LL2 .EQ. 2)LL2 = 1
      LU2 = EHDP(NSEASON)
      DO 120 N4 =LL2,LU2
      READ(IFC) GAS,OIL,ELECTR,DMAND
      TOTGAS(ID) = TOTGAS(ID) + GAS
      TOTOIL(ID) = TOTOIL(ID) + OIL
      PEAK = DMAND/3413.0
      PEU(N1,ID) = PEU(N1,ID) + ELECTR/3413.0
  120 IF(PDM(N1,ID) .LT. PEAK)PDM(N1,ID) = PEAK
      IF(LU2 .EQ. 24)GO TO 100
      LL = EHDP(NSEASON) + 1
      LU = 24
      GO TO 105
  100 IF(ILAST .NE. 0 .AND. (N2+1) .EQ. NDAY1)GO TO 200
  155 CONTINUE
      IF(MEND .EQ. 12)GO TO 160
      MONTH1 = MEND + 1
      GO TO 25
  160 IF(NDAY1 .EQ. 1)GO TO 200
      MONTH1 = 1
      ILAST = 1
      GO TO 25
  200 CONTINUE
      READ(IFC) DUMMY
      IF(IFC .EQ. 14)DATA(10) = DUMMY
  250 CONTINUE
      RETURN
      END
C
C
C
      SUBROUTINE FUELCOST
C
C  THIS SUBROUTINE CALCULATES THE TOTAL YEARLY COST OF THE GAS, OIL,
C  AND ELECTRICITY USED FOR HEAT, HOT WATER AND AIR CONDITIONING
C
      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
     &        TOTELEC(5),COST(5),PVNB(5),PAYBAK(5),MAINT(5),INS(5),AC(5),
     &        PVTD(5),PTAX(5),PVC(5),DETD(5),BRKEV(5)
```

```
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),IBLDG,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
```

```
      IF(NRATE .EQ. 2)GO TO 4
      IF(NRATE .EQ. 3 .AND. IDSYS(JA) .EQ. 1)GO TO 4
      BMSP(1) = EIA(49)
      BMSP(2) = EIA(69)
      CCPM(1) = EIA(50)
      CCPM(2) = EIA(70)
      GO TO 5
    4 BMSP(1) = EIA(102)
      BMSP(2) = EIA(112)
      CCPM(1) = EIA(111)
      CCPM(2) = EIA(121)
    5 DMAX(1) = EIA(90)
      DMAX(2) = EIA(91)
      PER(1) = EIA(92)/100.0
      PER(2) = EIA(93)/100.0
      DMIN(1) = DMAX(1)
      DMIN(2) = DMAX(2)
C
C  CALCULATE PEAK DEMAND FOR EACH SEASON
C
      ISUB = 1
      JSUB = 2
      IF(BMSP(1) .LT. BMSP(2))GO TO 11
      ISUB = 2
      JSUB = 1
   11 LU = BMSP(ISUB) - 1
      IF(BMSP(ISUB) .EQ. 1)GO TO 7
      DO 6 JB=1,LU
    6 IF(PDM(JB,JA) .GT. DMAX(JSUB))DMAX(JSUB)=PDM(JB,JA)
    7 LV = BMSP(JSUB) - 1
      DO 8 JC=BMSP(ISUB),LV
    8 IF(PDM(JC,JA) .GT. DMAX(ISUB))DMAX(ISUB)=PDM(JC,JA)
      DO 9 JD=BMSP(JSUB),12
    9 IF(PDM(JD,JA) .GT. DMAX(JSUB))DMAX(JSUB)=PDM(JD,JA)
C
C  AT THIS POINT THE MAX PEAK DEMAND FOR EACH SEASON HAS BEEN
C  DEFINED WHERE SEASON 1 IS THE HIGHEST PEAK
C
      DDMAX(2) = DMAX(2)
      DDMAX(1) = DMAX(1)
      IF(NRATE .EQ. 2)GO TO 10
      DDMAX(2) = AMAX1(DMAX(1),DMAX(2))
C
C  NOW CALCULATE BILLING DEMAND
C
   10 IF(BMSP(ISUB) .EQ. 1)GO TO 17
      DO 16 KB = 1,LU
      PDM(KB,JA) = AMAX1(PDM(KB,JA),DDMAX(JSUB)*PER(JSUB),DMIN(JSUB))
      OPDM(KB,JA) = OPDM(KB,JA) - PDM(KB,JA)
   16 IF(OPDM(KB,JA) .LT. 0.0)OPDM(KB,JA) = 0.0
```

```
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. IDSYS(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
```

```
      DEMAND(JSUB,JA) = DEMAND(JSUB,JA) + PDM(LB,JA)*PDC(JSUB) +
     &                  OPDM(LB,JA) * OPDC(JSUB)
  326 ELEC(JSUB,JA) = ELEC(JSUB,JA) + PEC(JSUB)*PEU(LB,JA) +
     &                OPEC(JSUB)*OPEU(LB,JA)
  327 DO 328 LC=BMSP(ISUB),LV
      DEMAND(ISUB,JA) = DEMAND(ISUB,JA) + PDM(LC,JA)*PDC(ISUB) +
     &                  OPDM(LC,JA)*OPDC(ISUB)
  328 ELEC(ISUB,JA) = ELEC(ISUB,JA) + PEU(LC,JA)*PEC(ISUB) +
     &                OPEU(LC,JA)*OPEC(ISUB)
      DO 329 LD=BMSP(JSUB),12
      DEMAND(JSUB,JA) = DEMAND(JSUB,JA) + PDM(LD,JA)*PDC(JSUB) +
     &                  OPDM(LD,JA)*OPDC(JSUB)
  329 ELEC(JSUB,JA) = ELEC(JSUB,JA) + PEU(LD,JA)*PEC(JSUB) +
     &                OPEU(LD,JA)*OPEC(JSUB)
  330 MULT = IABS(BMSP(2) - BMSP(1))
      IF(BMSP(1) .GT. BMSP(2))MULT = 12 - MULT
      TOTELEC(JA) = DEMAND(1,JA)+DEMAND(2,JA)+ELEC(1,JA)+ELEC(2,JA) +
     &              CCPM(1)*MULT + CCPM(2)*(12-MULT)
  200 CONTINUE
      RETURN
      END
C
C
C
      SUBROUTINE BILLING(Q,JW)
      COMMON /BILL/NCB(4),BLKCOST(4,5),BLKSIZ(4,5)
      DIMENSION Q(4)
      JX = JW + 2
      DO 4 JS=JW,JX,2
      TCOST = 0.0
      LU = NCB(JS) - 1
      DO 3 I=1,LU
      IF(Q(JS) .GT. BLKSIZ(JS,I))GO TO 2
      TCOST = TCOST + BLKCOST(JS,I)*Q(JS)
      GO TO 4
    2 Q(JS) = Q(JS) - BLKSIZ(JS,I)
    3 TCOST = TCOST + BLKCOST(JS,I)*BLKSIZ(JS,I)
      TCOST = TCOST + BLKCOST(JS,LU+1)*Q(JS)
    4 Q(JS) = TCOST
      RETURN
      END
C
C
C
      SUBROUTINE OUTPUT(CRF,REP)
      COMMON /ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
     &        TOTELEC(5),COST(5),PVNB(5),PAYBAK(5),MAINT(5),INS(5),AC(5),
     &        PVTD(5),PTAX(5),PVC(5),OETD(5),BRKEV(5)
      COMMON /FUEL/TOTGAS(5),TOTOIL(5),OPEU(12,5),PEU(12,5),PDM(12,5),
     &        OPDM(12,5)
```

```
      COMMON /ACES/ETC,IPASS,ACESC(7),IBLDG,DATA(10),IDSYS(5)
      COMMON /OUTP/DELTAC(5),DELTAO(5),PVE(5),PVG(5),PVO(5),PVEC(2,5),
     &              PVED(2,5)
      DIMENSION TITLE(2,5),LAB(2),UNDER(5),MONTH(12),TOTE(5),SUM(5)
      CHARACTER UNDER*6,TITLE*4,LAB*6,MONTH*4
      REAL MAINT,INS
      DATA ((TITLE(J,K),J=1,2),K=1,5)/4H    ,4HACES,4HALL ,4HELEC,
     & 4HHEAT,4HPUMP,4H    ,4HOIL ,4HNAT ,4HGAS /
      DATA (MONTH(N),N=1,12)/4HJAN ,4HFEB ,4HMAR ,4HAPRL,4HMAY ,4HJUNE,
     & 4HJULY,4HAUG ,4HSEPT,4HOCT ,4HNOV ,4HDEC /
      DO 10 I=1,5
   10 UNDER(I) = 6H------
      IPAGE = 1
      NSYS = EIA(160)
      IPASS = IPASS + 1
C
C  PRINT OUT ANNUAL COST SUMMARY
C
      WRITE(10,4000) IPAGE
      WRITE(10,4001) (UNDER(J),J=1,4)
      WRITE(10,4002) EIA(2),EIA(8)
      WRITE(10,4003) CRF,EIA(10)
      WRITE(10,4004) EIA(3),EIA(5)
      WRITE(10,4005) EIA(7),EIA(4)
      WRITE(10,4006) EIA(15)
      WRITE(10,4007) EIA(6)
      IYEAR = 1978 + EIA(169+2*IPASS)
      WRITE(10,4008) IYEAR,(UNDER(J),J=1,5),UNDER(1)
      WRITE(10,4009) (TITLE(1,IDSYS(J)),J=1,NSYS)
      WRITE(10,4010) (TITLE(2,IDSYS(I)),I=1,NSYS)
      WRITE(10,4020) (UNDER(J),J=1,2),(UNDER(I),I=1,NSYS)
      WRITE(10,4030) (PVC(I),I=1,NSYS)
      IF(IDSYS(1) .NE. 1)GO TO 20
      WRITE(10,4110) (ACESC(L),L=1,6)
      IF(ACESC(7) .LT. 0.01)GO TO 20
      WRITE(10,4310) ACESC(7)
   20 WRITE(10,4050)
      LAB(1) = 6HMAINTE
      LAB(2) = 6HNANCE
      WRITE(10,4060) (LAB(K),K=1,2),(MAINT(J),J=1,NSYS)
      LAB(1) = 6HINSURA
      LAB(2) = 6HNCE
      WRITE(10,4060) (LAB(K),K=1,2),(INS(J),J=1,NSYS)
      WRITE(10,4070)
      LAB(1) = 6HNATURA
      LAB(2) = 6HL GAS
      WRITE(10,4060) (LAB(K),K=1,2),(PVG(J),J=1,NSYS)
      LAB(1) = 6HHEATIN
      LAB(2) = 6HG OIL
      WRITE(10,4060) (LAB(K),K=1,2),(PVO(K),K=1,NSYS)
```

```
      LAB(1) = 6HELECTR
      LAB(2) = 6HICITY
      WRITE(10,4060) (LAB(K),K=1,2),(PVE(M),M=1,NSYS)
      NPEAKS = EIA(101)
      DO 30 I=1,NPEAKS
      LAB(1) = 6HENERGY
      LAB(2) = 6H COST
      WRITE(10,4040) (LAB(K),K=1,2),(PVEC(I,J),J=1,NSYS)
      IF(EIA(52).LE.0.0.AND.IFIX(EIA(19)).EQ.1)GO TO 30
      IF(EIA(103).LE.0.0.AND.IFIX(EIA(19)).EQ.2)GO TO 30
      LAB(1) = 6HDEMAND
      LAB(2) = 6H COST
      WRITE(10,4040) (LAB(K),K=1,2),(PVED(I,M),M=1,NSYS)
   30 CONTINUE
      DO 32 L=1,NSYS
   32 SUM(L) = PVG(L) + PVO(L) + PVE(L)
      LAB(1) = 6HTOTAL
      LAB(2) = 6HFUEL
      WRITE(10,4060) (LAB(K),K=1,2),(SUM(M),M=1,NSYS)
      WRITE(10,4080)
      LAB(1) = 6HMORTGA
      LAB(2) = 6HGE DED
      WRITE(10,4060) (LAB(K),K=1,2),(PVTD(N),N=1,NSYS)
      LAB(1) = 6HPROPER
      LAB(2) = 6HTY TAX
      WRITE(10,4060) (LAB(K),K=1,2),(PTAX(L),L=1,NSYS)
      IF(EIA(1) .LE. 1)GO TO 35
      LAB(1) = 6HOP EXP
      LAB(2) = 6H DED
      WRITE(10,4060) (LAB(K),K=1,2),(OETD(L),L=1,NSYS)
   35 WRITE(10,4062) ETC
      WRITE(10,4090) (UNDER(J),J=1,NSYS)
      WRITE(10,4100) (AC(M),M=1,NSYS)
C
C  PRINT OUT PRESENT VALUE OF NET BENEFITS AND PAYBACK
C
      IF(NSYS .LT. 2)GO TO 40
      WRITE(10,4114) (DELTAC(J),J=2,NSYS)
      WRITE(10,4115) (DELTAO(N),N=2,NSYS)
      WRITE(10,4120) (PVNB(M),M=2,NSYS)
      WRITE(10,4130) (BRKEV(J),J=2,NSYS),(PAYBAK(K),K=2,NSYS)
      WRITE(10,4135) COST(1)
      IF(IPASS .LT. IFIX(EIA(170)))RETURN
C
C  PRINT ENERGY USE SUMMARY
C
   40 WRITE(10,4140) IPAGE,(UNDER(J),J=1,4)
      WRITE(10,4009) (TITLE(1,IDSYS(K)),K=1,NSYS)
      WRITE(10,4150) (TITLE(2,IDSYS(M)),M=1,NSYS)
      WRITE(10,4020) (UNDER(J),J=1,2),(UNDER(I),I=1,NSYS)
```

```
C
C  COMPUTE ANNUAL FUEL USAGE IN MILLIONS OF BTU
C
      DO 45 K=1,NSYS
      TOTE(K) = 0.0
      DO 44 KZ=1,12
   44 TOTE(K) = TOTE(K) + (PEU(KZ,K)+OPEU(KZ,K))*0.003413
      TOTGAS(K) = TOTGAS(K)/10**6
      TOTOIL(K) = TOTOIL(K)/10**6
   45 SUM(K) = TOTE(K) + TOTGAS(K) + TOTOIL(K)
      WRITE(10,4160) (TOTGAS(L),L=1,NSYS)
      WRITE(10,4170) (TOTOIL(M),M=1,NSYS)
      WRITE(10,4180) (TOTE(M),M=1,NSYS)
      WRITE(10,4090) (UNDER(J),J=1,NSYS)
      WRITE(10,4190) (SUM(M),M=1,NSYS)
      NRATE = EIA(19)
C
C  PRINT MONTHLY ELECTRICAL CONSUMPTION DATA
C
      WRITE(10,4240) (UNDER(K),K=1,4)
      WRITE(10,4009) (TITLE(1,IDSYS(M)),M=1,NSYS)
      WRITE(10,4250) (TITLE(2,IDSYS(N)),N=1,NSYS)
      WRITE(10,4260)
      DO 60 KK=1,12
   60 WRITE(10,4270) MONTH(KK),(PEU(KK,I),I=1,NSYS)
      IF(NRATE .EQ. 1)GO TO 66
      WRITE(10,4280)
      DO 65 KL=1,12
   65 WRITE(10,4270) MONTH(KL),(OPEU(KL,J),J=1,NSYS)
   66 WRITE(10,4290)
      DO 70 KM=1,12
   70 WRITE(10,4270) MONTH(KM),(PDM(KM,K),K=1,NSYS)
      IF(NRATE .EQ. 1)GO TO 75
      WRITE(10,4300)
      DO 74 KN=1,12
   74 WRITE(10,4270) MONTH(KN),(OPDM(KN,M),M=1,NSYS)
   75 CONTINUE
 4000 FORMAT(I1,//,26X,'ECONOMIC ANALYSIS PARAMETERS')
 4001 FORMAT(26X,4A6,4H----,/)
 4002 FORMAT(11X,'ANALYSIS PERIOD (YRS)',4X,F3.0,5X,'MAINTENANCE RATE',
     &       3X,F4.1,2H %)
 4003 FORMAT(11X,'CAPITAL REC FACTOR',5X,F5.3,5X,'INSURANCE RATE',
     &       5X,F4.1,1X,1H%)
 4004 FORMAT(11X,'REAL DISCOUNT RATE',6X,F4.1,1X,1H%,3X,'PROPERTY TAX',
     &       7X,F4.1,2H %)
 4005 FORMAT(11X,'SALVAGE VALUE PERCENT',3X,F4.1,2H %,3X,'INCOME TAX',
     &       9X,F4.1,2H %)
 4006 FORMAT(11X,'RETURN ON INVESTED CAP REC FUNDS',3X,F4.1,2H %)
 4007 FORMAT(11X,'MORTGAGE INTEREST RATE',13X,F4.1,2H %)
 4008 FORMAT(1X,///,27X,'ANNUAL COST SUMMARY-',I4,1X,'INSTALLATION',/,
```

```
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(I1,///,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 ACESCOST
9980       COMMON/ECON/EIA(180),GASC(5),OILC(5),ELEC(2,5),DEMAND(2,5),
9990      &       TOTELEC(5),COST(5),PVNB(5),PAYBAK(5),MAINT(5),INS(5),AC(5),
10000      &       PVTD(5),PTAX(5),PVC(5),DETD(5),BRKEV(5)
```

```
      COMMON/ACES/ETC,IPASS,ACESC(7),IBLDG,DATA(10),IDSYS(5)
      DIMENSION CTANK(6),VOL(7),UNITC(4),EVAP(2),PLATE(2,2),ADJ(2)
      CHARACTER EVAP*6,PLATE*4,ADJ*6
      DATA (EVAP(J),J=1,2)/6H DUAL ,6HWATER /
      DATA ((PLATE(N,M),M=1,2),N=1,2)/4HUNGL,4HAZED,4HGLAZ,4HED  /
      DATA (ADJ(I),I=1,2)/6HDOESNT,6H DOES /
      DATA (CTANK(J),J=1,6)/1557.0,2485.0,3237.0,3823.0,4448.0,4940.0/
      DATA (UNITC(L),L=1,4)/0.25,4.29,2.33,3.59/
      DATA (VOL(N),N=1,7)/0.0,512.0,1056.0,1560.0,2048.0,2592.0,3040.0/
      INTEGER ZERO,FLAGSS,FLAGHP,FLAGAH,FLAGFC
      DATA ZERO/0/
C
C  CHECK IF THIS IS COMMERCIAL OR RESIDENTIAL BUILDING
C
      ISUB = 0
      LAP = EIA(2)
      FLAGFC = 1
      FLAGHP = DATA(8)
      FLAGSS = DATA(9)
      FLAGAH = DATA(10)
      IF(DATA(1) .LT. 1.0)FLAGFC = 0
      TANK = 0.0
      LSUB = IFIX(DATA(8)) + 1
      JSUB = IFIX(DATA(9)) + 1
      KSUB = IFIX(DATA(10)) + 1
C
C  COMPUTE COST OF HEAT PUMPS
C
      RHP = EIA(137) * FLAGHP + EIA(138) * (1. - FLAGHP)
      CHP = DATA(6)*EIA(145) + DATA(7)*EIA(146)
C
C  COMPUTE COST OF STORAGE TANKS
C
      IF(DATA(2) .GT. 10.0)GO TO 1
      TANK = 0.0
      GO TO 4
    1 DO 3 K=1,6
      IF(DATA(2) .GT. VOL(K) .AND. DATA(2) .LE. VOL(K+1))ISUB=K
    3 CONTINUE
      IF(ISUB .EQ. 0)GO TO 6
      TANK = CTANK(ISUB)*EIA(158)
    4 IF(IBLDG .EQ. ZERO)GO TO 5
      IF(IBLDG .EQ. 1)GO TO 8
    6 DATA(5) = EIA(148)
      DATA(3) = SQRT(DATA(2)/DATA(5))
      DATA(4) = DATA(3)
    8 CLINER = ((DATA(3)+DATA(4))*2.0*DATA(5)+DATA(4)*DATA(3))*UNITC(1)
      CWALL = (DATA(3)+DATA(4))*2.0*DATA(5)*UNITC(2)
      CSLAB = (DATA(3)+1.0)*(DATA(4)+1.0)*UNITC(3)
      CTOP = (DATA(3)+1.0)*(DATA(4)+1.0)*UNITC(4)
```

```
10510       CCOLD = (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 + CCOLD
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,//,8X,'THE ACES SYSTEM HAS A ',A6,'SOURCE EVAPORATOR, ',
```

```
     &F7.0,1X,'SQUARE FEET',/,8X,'OF',1X,2A4,1X,'SOLAR COLLECTORS AND',
     &F7.0,1X,'CUBIC FEET OF ICE STORAGE.',/,8X,'THE SYSTEM',1X,A6,
     &1X,'HAVE AN AUXILIARY HEAT SYSTEM.')
5001 FORMAT(1X,//,8X,'THE ACES SYSTEM HAS A ',A6,'SOURCE EVAPORATOR, ',
     &F7.0,1X,'SQUARE FEET',/,8X,'OF',1X,2A4,1X,'SOLAR COLLECTORS,',
     &F7.0,1X,'CUBIC FEET OF HOT STORAGE, AND',/,8X,F7.0,1X,
     &'CUBIC FEET OF COLD STORAGE.  IT HAS',F3.0,1X,'35KW HEAT PUMPS, ',
     &/,8X,F3.0,1X,'20KW HEAT PUMPS AND IT',1X,A6,1X,
     &'HAVE AUXILIARY HEAT.')
      RETURN
      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 $LODMOD_{A \text{ or } B}$. 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.

$LODMOD_B$ INPUT ARRAY

```
  SNUMB = 4177T                         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

     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

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


$$    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 A$       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  $CARD #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 14.838      LINES    176      PROC  0.0001      I/O   0.000     IU  5   MEMORY    8K
     STOP  14.840      LIMIT  50000      LIMIT 0.2000      LIMIT           CU  5   M*T       66
     SWAP   0.000
     LAPSE  0.002 FC D   TYPE      BUSY    IP/AT     FP/RT     IS/#C MS/#E     ADDRESS T#/PK#

                  MC R MSU450 *     22       0         1         1     1     0-08-06
                  IN R MSU450 *    154       0         7         7     7     0-08-06
                  OT     SYOUT
                  P*     SYOUT

      RC-00   176 LINES AT STA.  E1

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

```
SNUMB = 4177T, 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              AZIMOUTH 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            OVRECAPACITY 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               HOUR H-P BEGINS TO RUN DURING COOLING
960  101       5.0000              HOUR 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	ABS 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             HAIM
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     44.89                ***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
```

DESMOD AND SIMMOD INPUT ARRAY

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  SNUMB = 3898T                          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  XXXX              XXXX               XXXX               XXXX               XXXXX
     X             X    X             X    X             X    X                X
   XXX              XXXX              X    X              XXXX                 X
      X            X    X              XXXX              X    X                X
 X    X            X    X                X               X    X                X
  XXXX              XXXX                X                 XXXX                 X

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


$$     3898T ENTERED GCS-AJ AT 11.524 FROM SYSTEM-0 TSS/S   0-08-08

0001  $       SNUMB    3898T
0002  $       COMMENT  F00648          TSS MEDIA CONVERSION
0003  $       IDENT    F00648-ACES
0004  $$      USERID   F00648$
0005 A$       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 11.551       LINES    155      PROC  0.0001        I/O    0.000      IU  5    MEMORY    8K
      STOP  11.553       LIMIT  50000      LIMIT 0.2000       LIMIT              CU  5    M*T       70
      SWAP   0.000
      LAPSE  0.002 FC D   TYPE      BUSY     IP/AT     FP/RT     IS/#C MS/#E    ADDRESS T#/PK#

                   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
```

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

$       NOTE     FILENAME DATA1
$       NOTE     LABELS- A,R(E1)
$       NOTE     TABS/SETTNGS-  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          AZIMOUTH 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 COEF.
130   12        2.0000          INSIDE SURFACE HEAT XFER COEF.
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 ROOF1
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	OVRECAPACITY 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          HAIM
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 REMP. 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   -1
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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ECOMOD INPUT ARRAY

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  SNUMB = 3901T                          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

  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

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


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


0001  $       SNUMB    3901T
0002  $       COMMENT F00648        TSS MEDIA CONVERSION
0003  $       IDENT    F00648-ACES
0004  $$      USERID   F00648S
0005 A$       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 = 000151


* ACTY-01  $CARD #0005  CONVER    08/31/79   SW=000000000000
  BMC-TTL DATE     771205
$       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

      START 11.551       LINES     139       PROC  0.0001       I/O    0.000      IU  5    MEMORY     8K
      STOP  11.560       LIMIT  50000        LIMIT 0.2000       LIMIT               CU  5    M*T       271
      SWAP   0.002
      LAPSE  0.009 FC D    TYPE       BUSY      IP/AT     FP/RT     IS/#C MS/#E     ADDRESS T#/PK#

                   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


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

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SNUMB = 5901T, ACTIVITY # = 01, , REPORT CODE = 00, RECORD COUNT = 000139

$       NOTE    FILENAME ECORESM
$       NOTE    LABELS= A,R(E1)
$       NOTE    TABS/SETTNGS=  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 ($/KW)
1440   57             SIZE OF THIRD BLOCK
1450   61        2.0  NUMBER OF ENERGY CHARGE BLOCKS
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1460  62        .0430 ENERGY CHARGE FOR FIRST BLOCK ($/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
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1910 133      3436.0 COST OF AIR-TO-AIR HEAT PUMP
1920 134       1120. COST OF CONVENTIONAL SPACE COOLING EQUIPMENT
1930 135       182.0 COST OF CONVENTIONAL GAS DHW HEATER
1940 136        170. 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
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** 3 0 **          DATE  08-31-79    TIME  11.984       ID = E1   GCS-AJ
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LODMOD OUTPUT SUMMARY

HOURLY SUMMARY FOR DAY 1 MONTH 1

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	QINC1
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	0.53796E 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	0.99498E 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	0.87265E 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	0.56159E 02	0.50822E 02	0.68775E 02	0.
16	0.16435E 01	0.40789E 01	0.40789E 01	0.33336E 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	QINC1
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	BASLOD
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	0.48805E 01	0.29784E 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	0.78418E 00	0.78418E 00	0.94476E 01	0.12832E 02	0.69123E 02	0.
17	0.80945E-01	0.18695E 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	0.26361E 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	QINC1
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	0.61824E 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	QINC1
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	0.31399E 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.	0.21634E 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.	0.23944E 04	0.26634E 06	0.11575E 06	0.70866E 05	0.18475E 04

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLOD
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	QINC1
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.	0.47981E 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	BASLOD
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	0.91793E 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	0.26604E 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	0.26640E 04	0.	0.
2	0.	0.50919E 03	0.	0.	0.89155E 04	0.26640E 04	0.	0.
3	0.19127E 02	0.51704E 03	0.	0.	-0.11074E 04	0.26436E 04	0.	0.
4	0.97963E 03	0.52051E 03	0.	0.	-0.85430E 02	0.25856E 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	0.29084E 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	TSR	QINC1
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.	0.18709E 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	0.37180E 02	0.98143E 04	0.25278E 04	0.21672E 04	0.29293E 02
9	0.	0.30397E 04	0.53536E 04	0.15095E 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	BASLOD
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	0.24685E 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.

HOURLY SUMMARY FOR DAY 18 MONTH 8

	QHL	QHW	QC	QINCI	CONDL	XINF	TSR	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.	0.57559E 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.	0.18295E 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	0.24775E 03	0.98143E 04	0.25278E 04	0.65657E 04	0.19240E 03
13	0.	0.17775E 04	0.10352E 05	0.15291E 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	0.17565E 03	0.98143E 04	0.25278E 04	0.66157E 04	0.13679E 03
16	0.	0.13287E 04	0.12564E 05	0.79702E 02	0.98143E 04	0.25278E 04	0.38224E 04	0.62277E 02
17	0.	0.12173E 04	0.11156E 05	0.76097E 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)	XTEMP	BASLOD
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	QINC1
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)	ABSOR3(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	TSK	QINC1
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 03	0.25525E 06	0.12698E 06	0.89125E 04	0.22616E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLOD
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	0.69009E 02	0.
10	0.41485E 00	0.19279E 01	0.11293E 02	0.17760E 02	0.19279E 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	0.69145E 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	QINC1
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.	0.18898E 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.	0.15599E 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.	0.18503E 03	0.15953E 06	0.69042E 05	0.47489E 04	0.13979E 03

	QINC2	ABSORB(1)	ABSORB(2)	ABSORB(3)	ABSORB(4)	XTEMP	BASLOD
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.	0.69146E 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	0.69363E 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	QINCI	CONDL	XINF	TSR	QINC1
1	0.12793E 08	0.20505E 07	0.	0.20475E 05	0.11487E 08	0.50733E 07	0.58506E 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.	0.31387E 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	0.38814E 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	0.65365E 07	0.19215E 07	0.10206E 07	0.24140E 05
10	0.25326E 07	0.16420E 07	0.65181E 04	0.36016E 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	BASLOD
1	0.64803E 03	0.19733E 04	0.59168E 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	0.69273E 02	0.
4	0.45733E 04	0.56248E 04	0.13101E 05	0.14549E 05	0.14175E 05	0.70687E 02	0.
5	0.70200E 04	0.82064E 04	0.17013E 05	0.13922E 05	0.17890E 05	0.73498E 02	0.
6	0.71089E 04	0.91517E 04	0.15789E 05	0.11106E 05	0.15539E 05	0.76419E 02	0.
7	0.86425E 04	0.10984E 05	0.20088E 05	0.14408E 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	0.75643E 02	0.
10	0.18959E 04	0.44014E 04	0.12404E 05	0.22366E 05	0.11828E 05	0.70637E 02	0.
11	0.79842E 03	0.25042E 04	0.75197E 04	0.18059E 05	0.68093E 04	0.69496E 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	0.23155258E 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		67.84				
- 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		44.87				
-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		68.96				
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  0.36202144E 05  0.28000000E 05  0.33000000E 05
    13206715.63         50255256.00         20849662.00            372531.46
       22.274          -285.916            0.            937.558          286.023          285.916
       21.303           111.136            0.           1587.922         -110.881         -111.136
       21.280             2.521            0.           1452.479           -2.308           -2.521
       21.280             0.225            0.           1449.327           -0.014           -0.225
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          7.500          0.          749.070
162.00  274.00      0      0      1    161
    45484222.50         15229978.50         2304293.78         43806656.50                59.13
 -4135.594      1449.018          0.          3.750          3.750          0.         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          1.875       1157.043      2488.709
162.00  274.00     95     15      1    161
    45239927.50         15220932.88         2464889.34         14336647.88                32.00
 -4135.594     -1183.623          0.938       1.875          0.938       2632.640      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       1.875          1.406       1869.368      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       1.875          1.641       1505.796      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          1.758       1328.821      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          1.699       1416.706      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          1.670       1461.307      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          1.685       1439.095      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       1.685          1.677       1450.171      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          1.681       1444.606      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          1.679       1447.424      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          1.678       1448.761      2612.983
162.00  274.00     95     15      1    161
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45391545.50          15224777.13          2365836.31          34778200.00                32.00
 1.678    -1163.965          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                58.85
 2.517     -686.850          3.725     -217.061          4.283          0.        1666.079
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.        1488.174
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          2263116.75          45691064.00                64.56
 4.406       -2.192          4.413       -0.094          4.414          0.        1449.112
  71.000
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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

SIMMOD OUTPUT SUMMARY

ANNUAL ENERGY USAGE OF THE ACES

THE TOTAL HEATING LOAD EQUALS 50255245.50 BTUS

THE TOTAL COOLING LOAD EQUALS 13206715.63 BTUS

THE YEARLY BTUS SUPPLIED BY THE OIL SYSTEM ARE 0.

THE TOTAL BACKUP ELECTRICITY NEEDED IN BTUS IS 0.

THE HEAT PUMP SCALE FACTOR IS 1.05

THE TOTAL HOT WATER LOAD EQUALS 20849667.00 BTUS

THE YEARLY BTUS SUPPLIED BY THE GAS SYSTEM ARE 0.

THE YEARLY BTUS SUPPLIED BY THE ELECTRIC SYSTEM ARE 24551665.25

THE DAY THAT ICE WOULD PEAK IN THE TANK IS 71.00

ECOMOD OUTPUT SUMMARY

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.	758.	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.	-53.	-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.	-324.	-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.
APRL	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.
APRL	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.	1899.	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.

```
C          SIMULATION OF A COMMERCIAL ANUAL CYCLE ENERGY SYSTEM (ACES)
C  THIS PROGRAM IS DEVELOPED BY HONEYWELL ENERGY RESOURCES
C  CENTER. THE PROGRAM IS DESIGNED TO FURNISH TWO TASKS,
C        1.  SIZING THE COMPONENTS NECESSARY FOR AN ACES.
C            THE GENERAL COMPONENTS IN A COMMERCIAL ACES ARE,
C                    A HOT STORAGE BIN FOR HEATING,
C                    A COLD STORAGE BIN FOR COOLING,
C                    A HEAT PUMP TO TRANSFER HEAT FROM COLD BIN TO HOT
C                        BIN,
C                    A SOLAR COLLECTOR FIELD (IN COLD CLIMATE
C                        REGION) TO ASSIST THE HEATING SEASON
C        2.  SIMULATE A COMMERCIAL ACES USING ACTUAL WEATHER
C            DATA AND LOAD PROFILE CALCULATED BY THE NBSLD SOFTWARE FOR
C            ELEVEN ZONES, WHICH ARE
C                    ZONE  1    BASEMENT
C                    ZONE  2    1ST TO 5TH FLOORS, SOUTH SIDE
C                    ZONE  3    1ST TO 5TH FLOORS, WEST SIDE
C                    ZONE  4    1ST TO 5TH FLOORS, NORTH SIDE
C                    ZONE  5    1ST TO 5TH FLOORS, EAST SIDE
C                    ZONE  6    1ST TO 5TH FLOORS, CENTRAL
C                    ZONE  7    6TH FLOOR, SOUTH SIDE
C                    ZONE  8    6TH FLOOR, WEST SIDE
C                    ZONE  9    6TH FLOOR, NORTH SIDE
C                    ZONE 10    6TH FLOOR, EAST SIDE
C                    ZONE 11    6TH FLOOR, CENTRAL
C            EACH FLOOR HAS THE GROSS FLOOR AREA OF 10,000 FT2.
C  THE VARIABLE AIR VOLUME HVAC SYSTEM IS USED TO FURNISH THE
C  BUILDING HEATING AND COOLING LOADS.
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1               TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      COMMON /SIZING/ QCDS,QHDS,QHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
     1                ,NSERES,LCOLL,QCCONS,QCLCON
      REAL LCOLL, LROW
      REWIND 8
      CALL INPUT
      IF(A(12) .EQ. 2.) A(11) = 2.
      ISIZNG = IFIX(A(11))
      IRTYPE = IFIX(A(12))
      IF(A(98) .EQ. 1.) WRITE(9,1111)
 1111 FORMAT(//41X,' THIS RUN IS FOR CONVENTIONAL SYSTEM')
      IF(A(98) .EQ. 1.) GOTO 1
      IF(IRTYPE .EQ. 1) WRITE(9,170)
      IF(IRTYPE .EQ. 2) WRITE(9,180)
      IF(IRTYPE .EQ. 2) GOTO 1
      IF(ISIZNG .EQ. 1) WRITE(9,190)
      IF(ISIZNG .EQ. 2) WRITE(9,195)
    1 CONTINUE
      INDEX = IFIX(A(31))
```

```
      NPOINT = IFIX(A(32))
      DELTAP = A(33)
      IF(INDEX .GT. 0) WRITE(9,9970) INDEX
 9970 FORMAT(//41X,'THE VARIABLE PARAMETER IN THIS RUN IS A(',
     1        I3,')')
      DO 9000 IIP = 1, NPOINT
      IF(IIP .GT. 1) A(INDEX) = A(INDEX) + DELTAP
      IF(INDEX .EQ. 0) GOTO 9987
      WRITE(9,9985) IIP, INDEX, A(INDEX)
 9985 FORMAT(1H1//2X,'RUN NO.',I2,', A(',I3,') = ',E12.5)
 9987 CONTINUE
      HDAY = A(13)
      NSTEP = IFIX(A(16))
      TCOVER = A(22)
      HBLENG = A(37)
      HBHEIG = A(38)
      HBAREA = 2.*HBLENG*HBLENG + 4.*HBLENG*HBHEIG
      UASTH = A(71)*HBAREA
      RMCSH = 62.4*HBLENG*HBLENG*HBHEIG
      CBLENG = A(68)
      CBHEIG = A(69)
      CBAREA = 2.*CBLENG*CBLENG + 4.*CBLENG*CBHEIG
      UASTC = A(71)*CBAREA
      RMCSC = 62.4*CBLENG*CBLENG*CBHEIG
      NROWS = IFIX(A(63))
      LROW = A(64)
      LCOLL = A(65)
      HCOLL = A(66)
      ICONV = IFIX(A(98))
      NSERES=IFIX(A(15))
      FUDGE = .5
      FUDGE1 = .5
      PERCNT = .1
      ALLOW = A(23)/100.
      ALLOW1 = .1
      SERES = FLOAT(NSERES)
      IF(IRTYPE .EQ. 2) GOTO 2
      IF(ISIZNG .EQ. 2) GOTO 2
      IF(A(98) .EQ. 1) GOTO 2
      LROW = 3.
      NROW = 1
      SERES = 1.
    2 CONTINUE
      ATOTAL = LROW*HCOLL*FLOAT(NROWS)*SERES
      AREA=ATOTAL*A(96)
      FPACK = A(70)
      QMFUSE = 143.6*RMCSC
      IF(IRTYPE .EQ. 1) GOTO 3
      CALL ACESIM
      GOTO 5000
    3 CONTINUE
      IF(ISIZNG .EQ. 2) GOTO 5
      CALL ACESIM
```

```
107          IF(ICONV .EQ. 1) GOTO 4
108          CALL CSIZE(QCDS,QHDS,QHCONS,QCCONS,HDAY,QCLCON)
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 = QCFUSE/QMFUSE
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*ALLOW1)) GOTO 1000
131          ATOT = ATOTAL
132          ATOTAL = ATOT * (1.+PERCNT)
133          IF(ERROR1 .LT.0.) ATOTAL = ATOT*(1.-PERCNT)
134          LROW = ATOTAL/(HCOLL*SERES*NROWS)
135          AREA = ATOTAL * A(96)
136       10 CONTINUE
137          FPACK1 = QCFUSE/QMFUSE
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*NROWS)
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
```

```
C                FPACK**2 .LT. FPACK1 .LT. SQRT(FPACK)
      IF(FPACK1 .GT. FPACK*FPACK) GOTO 150
      ATOTAL = ATOTAL * FUDGE
      GOTO 200
  150 CONTINUE
      ATOTAL = ATOTAL/FUDGE
  200 LROW = ATOTAL/(HCOLL*SERES*NROWS)
      AREA = ATOTAL*A(96)
      NSIGN = 1
      IF(FPACK1 .LT. FPACK) NSIGN = -1
      ISIGN = NSIGN + NSLAST
      IF(II .NE. 1 .AND. ISIGN .EQ. 0) FUDGE1 = FUDGE1/2.
      IF(II .NE. 1 .AND. ISIGN .EQ. 0) FUDGE = FUDGE + FUDGE1
      NSLAST = NSIGN
  300 CONTINUE
      WRITE(9,9990)
 9990 FORMAT(//2X,' WARNING, THE CALCULATION DOES NOT CONVERGE !!!')
 1000 CONTINUE
      IF(ABS(ERROR1) .LE. (FPACK*ALLOW)) GOTO 5000
C  ENTER THE BISECTION METHOD TO REFINE THE ACCURACY OF THE
C  RESULT. THE EXACTNESS OF THE RESULT MAY NOT BE MEANINGFULL
C  DUE TO THE NATURE OF THE SYSTEM
      AT1 = ATOTAL
      AT2 = ATOTAL*(1.-ALLOW1)
      IF(ERROR1 .GT. 0.) AT2 = ATOTAL * (1.+ALLOW1)
      DO 1030 I = 1, NSTEP
      ATOTAL = (AT1+AT2)/2.
      LROW = ATOTAL/(HCOLL*SERES*NROWS)
      AREA = ATOTAL*A(96)
      CALL ACESIM
      FPACK1 = QCFUSE/QMFUSE
      WRITE(9,9980) ATOTAL, FPACK1, I
 9980 FORMAT(2X,' ATOTAL =',E12.5,'FPACK =',F6.3,'NSTEP =',I4)
      ERROR = FPACK1 - FPACK
C  IF THE SECOND CONSTRAINT IS SATISFIED, JUMP OUT OF THE
C  LOOP AND STOP
      IF(ABS(ERROR) .LE. (FPACK*ALLOW)) GOTO 5000
C TEST WHETHER F(ERROR1) AND F(ERROR) ARE OF OPPOSITE SIGNS.
C  RESET VALUES ACCORDINGLY
      IF(ERROR*ERROR1) 1010,1011,1012
 1010 AT2 = ATOTAL
      GOTO 1030
 1012 AT1 = ATOTAL
      ERROR1 = ERROR
 1030 CONTINUE
      WRITE(9,9915) NSTEP
 9915 FORMAT(//2X,' DOES NOT CONVERGE AFTER',I4,'STEPS OF'
     1       ' BISECTION ITERATION')
      GOTO 5000
 1011 WRITE(9,9916)
 9916 FORMAT('     ERROR')
 5000 CONTINUE
      IF(ISIZNG .EQ. 1) GOTO 6000
```

```
      FPMAX = QCFUSE/QMFUSE
      FPFINL = QFUSE/QMFUSE
      WRITE(9,220) FPMAX, CTIME, MCDAY, MONTHC, FPFINL
      IF(IRTYPE .EQ. 2) GOTO 6000
      NCOLL = IFIX(ATOTAL/(HCOLL*LCOLL))
      WRITE(9,165) FPACK1,RMCSC,ATOTAL,NCOLL
      WRITE(9,160) NROWS,LROW,NSERES
 6000 CONTINUE
 9000 CONTINUE
      STOP
  165 FORMAT(//2X,' WITH THE PACKING FACTOR OF',F6.2,'AND THE STORAGE'
     1       ' CAPACITY OF',F10.1,' BTUS/F',/2X,' THE MINIMUM'
     2       ' COLLECTOR AREA REQIREMENT IS',F10.1,' FT2, OR THE TOTAL'
     3       ' OF',I5,' COLLECTORS')
  160 FORMAT(/2X,' THE NUMBER OF COLLECTORS IS DIVIDED INTO',
     1        I2,' ROWS, EACH ROW HAS THE LENGTH OF',F10.1,' FTS',//2X,
     2       ' THE COLLECTORS ARE CONNECTED BY',I2,' IN SERIES')
  170 FORMAT(//41X,'THIS RUN IS FOR COMPONENT SIZING')
  180 FORMAT(//41X,'THIS RUN IS FOR SYSTEM SIMULATION')
  190 FORMAT(//41X,'THIS IS THE FIRST RUN FOR COMPONENT SIZING'
     1       ,/41X,'THE APPROPRIATE OUTPUT SHOULD BE USED IN'
     2      ,/41X,'THE NEXT RUN FOR STORAGE AND COLLECTOR SIZING'
     3       ,/41X,' A(15),A(37),A(63),A(64),'
     4       ,/41X,' A(65),A(66),A(67),A(68),A(69)')
  195 FORMAT(//41X,'THIS IS THE SECOND RUN FOR COMPONENT SIZING',/41X,
     1       'THE COLLECTOR AREA & CONFIGURATION ARE PREDICTED BELOW. ')
  220 FORMAT(//2X,' MAXIMUM ICE RATIO IS',F6.3,'AT TIME'
     1       ,F6.3,' ON DAY',I4,' ( MONTH',I3,' )',/2X,
     2      ' THE FINAL ICE RATIO IN STORAGE IS',F6.3)
       END
```

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

```
      SUBROUTINE ACESIM
C  THIS ROUTINE DIRECTS ALL THE COMPUTATION OF THE PROGRAM
C  IT ALSO SAMPLES THE OUTPUT DATA ACCORDING TO THE USER REQIREMENT
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1                TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      COMMON /FAN/ PCFMAX, TFMAX, DFMAX
      COMMON /SIZING/ QCDS,QHDS,QHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
     1               /,NSERES,LCOLLCCONS,QCLCON
      DIMENSION NAMET(44),NAME(70),YEAR(1,44),AVERAG(52,44),
     1         ANNUAL(366,44)
      COMMON /PLOTTR/ IYSYMB(5)
      DIMENSION MONTH(12,44),DAY(24,70)
      COMMON /SOLAR/ S(35)
      COMMON /FLOW/ MDOTCC, MDOTCS
      REAL MDOTCC, MDOTCS
      DIMENSION AXC(31), AXH(31),AXCL(31)
      COMMON /WEATHR/ NAMERM,DB(24),DP(24),WB(24),WS(24),PB(24),
     1                TC(24),TOC(24),WET(24),DRY(24),CALDB(24,11),
     2                CALRH(24,11),QQLS(24,11),QQLL(24,11),QLIGHT,
     3                QEQUIP,QROOFO,QPEOPL
      LOGICAL SUMMER
      REAL MONTH
      CHARACTER NAME*6, NAMET*6, NAMERM*4(9), IYSYMB*1
      DATA NPRINT/70/,NSIZE/44/
      DATA NAME/6H IDNC ,6H IDHC ,6H ITHC ,6HQDIRCT,6HQAVAIL,6HQCOLCT,
     1          6H QCB  ,6H QHB  ,6H QDHW ,6HQCBTOT,6HQHBTOT,6HQTAMB ,
     2          6HBACKUP,6H QH1  ,6H QH2  ,6H QH3  ,6H QH4  ,
     3          6H QH5  ,6H QH6  ,6H QH7  ,6H QH8  ,6H QH9  ,
     4          6H QH10 ,6H QH11 ,6H QC1  ,6H QC2  ,6H QC3  ,
     5          6H QC4  ,6H QC5  ,6H QC6  ,6H QC7  ,6H QC8  ,
     6          6H QC9  ,6H QC10 ,6H QC11 ,6HQCOMPA,6HFPOWER,
     7          6H PUMPC,6HQHGAS ,6HQHOIL ,6HQELECT,6HQEACES,
     8          6HQEHCON,6HQECCON,6H TZ1  ,6H TZ2  ,6H TZ3  ,
     9          6H TZ4  ,6H TZ5  ,6H TZ6  ,6H TZ7  ,6H TZ8  ,
     1          6H TZ9  ,6H TZ10 ,6H TZ11 ,6H TAMB ,6H TSC  ,
     2          6H TSH  ,6H QFUSE,6H RH1  ,6H RH2  ,6H RH3  ,
     3          6H RH4  ,6H RH5  ,6H RH6  ,6H RH7  ,6H RH8  ,
     4          6H RH9  ,6H RH10 ,6H RH11 /
      DIMENSION IPLOT(13)
      DATA IPLOT/56,57,58,5,6,7,8,9,5,6,7,8,9/
      DATA IYSYMB/1H.,1H0,1H+,1H-,1H*/
      DATA X/50*0.0/,XDOT/50*0.0/,DAY/1680*0.0/,YEAR/44*0.0/
      DATA MONTH/528*0.0/,DB/24*0.0/,WB/24*0.0/,TC/24*0.0/
      DATA DP/24*0.0/,WS/24*0.0/,PB/24*0.0/,CALDB/264*0.0/
      DATA CALRH/264*0.0/,QQLS/264*0.0/,QQLL/264*0.0/
      DATA QEQUIP/0./,QLIGHT/0./,QROOFO/0./,QPEOPL/0./
      DATA TOC/24*0.0/,WET/24*0.0/,DRY/24*0.0/,A/183*0.0/
      DATA ND/0/,TIME/0.0/,ITER/0/,IDAY/0/,IHOUR/24/,IMONTH/1/
```

```
      NDAYS = IFIX(A(4))
      ISTART = IFIX(A(7))
      NDAY = ISTART - 1
      IEND = IFIX(A(8))
      IESCAP =120*24*(IEND-ISTART + 1)
      DT = A(9)
      TIME = 0.0
      TSAMPL = A(10)
      IWRITE = IFIX(A(29))
      CONV = A(98)
      IF(CONV .EQ. 0. ) GOTO 1112
      IF(A(32) .LE. 1.) GOTO 1112
      IWRITE = IWRITE - 1 + A(103)
 1112 CONTINUE
      IF(IWRITE .GT. 0) WRITE(9,1113) IWRITE
 1113 FORMAT(//2X,'THE ENERGY CONSUMPTION IN THIS RUN IS WRITTEN ON'
     1       ' THE FILE CODE NO.',I3)
      IECON = IFIX(A(30))
      IF(IWRITE .EQ. 0) GOTO 2
      BUILD = 1.
      WRITE(IWRITE) BUILD
      HTVOL = RMCSH/62.4
      RN4 = A(24)
      RN6 = A(25)
      GLAZE = A(35)
      IF(CONV .EQ. 0.) GOTO 1
      AREA = 0.
      ATOTAL = 0.
      HTVOL = 0.
      A(68) = 0.
      A(69) = 0.
      RN4 = 0.
      RN6 = 0.
      GLAZE = 0.
    1 CONTINUE
      WRITE(IWRITE) ATOTAL,HTVOL,A(68),A(68),A(69),RN6,RN4,GLAZE
      DHEAT = A(142)
      WRITE(IWRITE) DHEAT
    2 CONTINUE
      FBACUP = A(146)
      IF(IRTYPE .EQ. 2) GOTO 5
      IF(ISIZNG .EQ. 2) GOTO 5
      IF(ISTART .EQ. 1) GOTO 5
      WRITE(9,3)
    3 FORMAT(2X,' CHECK INPUT ARRAY',//2X,' TO USE THE SOFTWARE FOR'
     1       ' COMPONENT SIZING (A(12) = 1.), THE WEATHER TAPE SHOULD',/,
     2        2X,' BE POSITIONED AT THE FIRST DAY (A(7) = 1.)')
      STOP
    5 CONTINUE
      NSTATE = 46
      JPLOT = IFIX(A(56))
      NAVG = IFIX(A(62))
C  COLLECTOR LOOP FLOW RATE, ASSUMING NORMAL FLOW RATE OF 0.5
```

```
C  GPM PER COLLECTOR
      MDOTCC = AREA*.5*60.*8.33333/(18.*A(96))
C  STORAGE FLOW RATE, ASSUMING THAT IT IS EQUAL TO THE COLLECTOR
C  FLOW RATE
      MDOTCS = MDOTCC
      IBUFLG = 0
      PCFMAX = 0.
      QHDS = 0.
      QCDS = 0.
      QFUSE = 0.
      QCFUSE = 0.
      QLIGHT = 0.
      QEQUIP = 0.
      QPEOPL = 0.
      QROOFO = 0.
      QCHMAX = 0.
      QHHMAX = 0.
      QXCLTT = 0.
      DO 10 J = 1,(NSTATE-2)
      YEAR(1,J) = 0.
      DO 7 K = 1,366
      ANNUAL(K,J) = 0.
    7 CONTINUE
      DO 10 I = 1,12
      MONTH(I,J) = 0.
   10 CONTINUE
      DO 20 I = 1,NSTATE
      X(I) = 0.
      XDOT(I) = 0.
   20 CONTINUE
      X(NSTATE-1) =A(27)
      X(NSTATE) = A(28)
      TSTORC = X(NSTATE-1)
      TSTORH = X(NSTATE)
      IF(TSAMPL .GT.1.E-06) NSAMPL = 24/TSAMPL + 0.5
      TPAST1 = DT
      TPAST2 = DT
C     INITIALIZE COLLECTOR PARAMETERS
      CALL COLECT(0.0,0.0,0.0,0)
C     INITIALIZE SUN ARRAY
      S(1) = A(1)
      S(2) = A(2)
      S(3) = A(3)
      S(4) = A(7) - 1.0
      S(5) = 24.0
      S(8) = A(17)
      NZONE = IFIX(A(84))
C     POSITION TAPE FOR START OF WEATHER DATA
      NYRS=IFIX(A(135))
      NSTARS = IFIX(A(143))
      NENDS = IFIX(A(144))
      IF (NYRS .LT. 1) GO TO 713
      DO 708  N = 1,NYRS
```

```
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          IDPAST = IDAY
175          IWDPST = IWKDAY
176          IMPAST = IMONTH
177          IHPAST = IHOL
178    C     INTEGRATE OVER TIME STEP DTI
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) + (QFJSE - DAY(ND,K+4))*FACTOR
212          K = K+5
```

```
      KEND = K+NZONE-1
      DO 790 I = K,KEND
  790 DAY(NDP1,I) = DAY(ND,I) + (RH(I-K+1)-DAY(ND,I))*FACTOR
      ND = NDP1
  800 CONTINUE
C     AT THE END OF EACH DAY RECORD ENERGY FOR YEAREND SUMMARY
      IF((TIME - TPAST2) .LT.(24.0-.0001) ) GOTO 910
      TPAST2 = TIME
      NDAY = NDAY + 1
C  SEARCH FOR N CONSECUTIVE COLDEST DAYS OF THE YEAR AND
C  CALCULATE THE NET HEATING LOAD FOR THOSE DAYS
C  ALSO, SEARCH FOR N CONSECUTIVE HOTTEST DAYS OF THE YEAR AND
C  CALCULATE THE TOTAL COOLING LOAD FOR THOSE DAYS
      IF(IRTYPE .EQ. 2) GOTO 819
      IF(ISIZNG .EQ. 2) GOTO 819
      XH = X(8)
      XC = X(7)
      XCL = X(6)
      IIDAY = HDAY
      IF(NDAY .GT. IIDAY) GOTO 810
      AXH(NDAY) = XH
      AXC(NDAY) = XC
      AXCL(NDAY) = XCL
      QXHTOT = QXHTOT + XH
      QXCTOT = QXCTOT + XC
      QXCLTT = QXCLTT + XCL
      GOTO 812
  810 CONTINUE
      AXH(IIDAY + 1) = XH
      AXC(IIDAY + 1) = XC
      AXCL(IIDAY + 1) = XCL
      QXHTOT = QXHTOT + XH - AXH(1)
      QXCTOT = QXCTOT + XC -AXC(1)
      QXCLTT = QXCLTT + XCL - AXCL(1)
      DO 811 I = 1,IIDAY
      AXH(I) = AXH(I + 1)
      AXC(I) = AXC(I + 1)
      AXCL(I) = AXCL(I + 1)
  811 CONTINUE
  812 IF(QXHTOT .LE. QHCONS) GOTO 814
      QHCONS = QXHTOT
      QCCONS = QXCTOT
      QCLCON = QXCLTT
  814 CONTINUE
      IF((-QXCTOT) .LT. QCDS) GOTO 815
      QCDS = -QXCTOT
  815 CONTINUE
      IF(X(8) .LE. QHDS) GOTO 819
      QHDS = X(8)
  819 DO 820 I = 1,NSIZE
      IF(ISIZNG .EQ. 1 .AND. I .EQ. 6) X(I) = 0.
      NAMET(I)=NAME(I)
      YEAR(1,I) = YEAR(1,I) + X(I)
```

```
      MONTH(IMONTH,I) = MONTH(IMONTH,I) + X(I)
      ANNUAL(NDAY,I) = ANNUAL(NDAY,I) + X(I)
      IF(ISIZNG .EQ. 2 .AND. QCFJSE .GE. QMFUSE) GOTO 970
  820 X(I) = 0.
C     AT THE END OF SELECTED DAYS OUTPUT TABLES AND PLOTS
      IF(TSAMPL .LT.1.E-06) GO TO 910
      DO 900  I = 1,20
      NOUT = NTABLE(I)
      IF(NDAY .NE. NOUT) GO TO 900
      WRITE(9,2000) NDAY, IDPAST, IMPAST
      IF(IWDPST .EQ. 1) WRITE(9,2001)
      IF(IWDPST .EQ. 2) WRITE(9,2002)
      IF(IWDPST .EQ. 3) WRITE(9,2003)
      IF(IWDPST .EQ. 4) WRITE(9,2004)
      IF(IWDPST .EQ. 5) WRITE(9,2005)
      IF(IWDPST .EQ. 6) WRITE(9,2006)
      IF(IWDPST .EQ. 7) WRITE(9,2007)
      IF(IMPAST .EQ. 1) WRITE(9,2008)
      CALL CBOUTPUT(DAY,1,NSAMPL,NPRINT,NAME)
      XDELT = TSAMPL
      XMIN = XDELT
      YMIN = A(57)
      YMAX = A(58)
      IF(JPLOT .EQ. 1) WRITE(9,2200)
      IF(JPLOT .EQ. 1) CALL LPPLOT(09,1,3,NSAMPL,24,61,XDELT,DAY,XMIN,
     1                             YMIN,YMAX,NAME,61,IPLOT,13)
      YMIN = 0.
      YMAX = A(59)
      IF(JPLOT .EQ. 1) WRITE(9,2300)
      IF(JPLOT .EQ. 1) CALL LPPLOT(09,4,5,NSAMPL,24,61,XDELT,DAY,XMIN,
     1                             YMIN,YMAX,NAME,61,IPLOT,13)
  900 CONTINUE
  910 ITER = ITER + 1
      IF(ITER .GT. IESCAP) GO TO 920
      IF(S(4)-FLOAT(IEND)) 750,750,920
  920 CONTINUE
      CALL CBOUTPUT(MONTH,1,12,NSIZE,NAMET)
      CALL CBOUTPUT (YEAR,1,1,NSIZE,NAMET)
      IF(NAVG .EQ. 0) GOTO 970
      DO 940 NW = 1,52
      DO 940 I = 1,NSIZE
      DUMMY = 0.
      DO 930 ND = 1,NAVG
      N = (NW-1)*7 + 3 - NAVG/2 + ND
      IF(N .LE. 0) N = N + NDAYS
      IF(N .GT. NDAYS) N = N - NDAYS
  930 DUMMY = DUMMY + ANNUAL(N,I)
      AVERAG(NW,I) = DUMMY/NAVG
      IF(I .EQ. 7) AVERAG(NW,I) = -AVERAG(NW,I)
      IF(I .EQ. 10) AVERAG(NW,I) = -AVERAG(NW,I)
  940 CONTINUE
      IF(ISIZNG .EQ. 1) GOTO 960
      YMIN = 0.
```

```
      YMAX = 0.
      DO 950 NW = 1,52
      IF(AVERAG(NW,5) .LT. YMAX) GOTO 950
      YMAX = AVERAG(NW,5)*1.1
  950 CONTINUE
      IF(JPLOT .EQ. 1) WRITE(9,2400) NAVG
      XMIN = 1.
      XDELT = 1.
      IF(JPLOT .EQ. 1) CALL LPPLOT(09,9,2,52,52,35,XDELT,AVERAG,XMIN,
     1                             YMIN,YMAX,NAME,35,IPLOT,13)
  960 CONTINUE
      IF(JPLOT .EQ. 1) WRITE(9,2400) NAVG
      XMIN = 1.
      XDELT = 1.
      YMIN = 0.
      YMAX = A(60)
      IF(JPLOT .EQ. 1) CALL LPPLOT(09,11,3,52,52,35,XDELT,AVERAG,XMIN,
     1                             YMIN,YMAX,NAME,35,IPLOT,13)
  970 CONTINUE
      IF(ISIZNG .EQ. 2) WRITE(9,7000) TSTORH,TSTORC
      WRITE(9,8000) QLIGHT,QEQJI3,QPEOPL
      WRITE(9,8100) PCFMAX, TFMAX, DFMAX
      IF(ISIZNG .EQ. 1) GOTO 980
      IF(MDOTCC .GT. 0.) WRITE(9,8200) MDOTCC
  980 CONTINUE
      WRITE(9,8300) QCHMAX, QHHMAX
      REWIND 8
      IF(IWRITE .EQ. 0) GOTO 990
      BUFLAG = FRACUP*IBUFLG
      WRITE(IWRITE) BUFLAG
      IF(BUFLAG .EQ. 0.) WRITE(9,9900)
      IF(BUFLAG .EQ. 1.) WRITE(9,9910)
  990 CONTINUE
      IF(IWRITE .EQ. 0) GOTO 999
      REWIND IWRITE
  999 IF(IECON .EQ. 1) CALL ECONOM
      RETURN
 2000 FORMAT(1H1,41X,22H DAILY SUMMARY FOR DAY,I4,2H (,I2,4H OF I2,1H))
 2001 FORMAT(//41X,'  THE SAMPLED DAY IS SUNDAY')
 2002 FORMAT(//41X,'  THE SAMPLED DAY IS MONDAY')
 2003 FORMAT(//41X,'  THE SAMPLED DAY IS TUESDAY')
 2004 FORMAT(//41X,'  THE SAMPLED DAY IS WENESDAY')
 2005 FORMAT(//41X,'  THE SAMPLED DAY IS THURSDAY')
 2006 FORMAT(//41X,'  THE SAMPLED DAY IS FRIDAY')
 2007 FORMAT(//41X,'  THE SAMPLED DAY IS SATURDAY')
 2008 FORMAT(//41X,'  IT IS ALSO A HOLIDAY')
 2200 FORMAT(1H1,40X,38HTEMPERATURE PLOTS (FAHRENHEIT DEGREES)/)
 2300 FORMAT(1H1,45X,25H ENERGY PLOTS (BTUS/HOUR)/)
 2400 FORMAT(1H1,32X,15HENERGY PLOTS OF,I3,
     1        24H DAY AVERAGES (BTUS/DAY))
 7000 FORMAT(1H1,//2X,'FINAL TEMP. IN HOT STORAGE BIN IS',F6.1,'DEG F',
     1    /2X,'FINAL TEMP. IN COLD STORAGE BIN IS',F6.1,'DEG F')
 8000 FORMAT(' YEARLY INTERNAL LOAD GENERATED BY LIGHTS =',E12.5,/,
```

```
     1        35X,'EQUIPMENT =',E12.5,/,35X,'PEOPLE =',E12.5)
8100 FORMAT(/2X,' THE MAXIMUM FAN FLOW RATIO IS',F6.3,' AT TIME',
     1        F6.2,' ON DAY',F5.0)
8200 FORMAT(//2X,' THE COLLECTOR AND STORAGE LOOP THERMAL FLOW RATE'
     1        ' IS',E12.5,' BTUS/HR F')
8300 FORMAT(//2X,' THE MAXIMUM COOLING LOAD IS',E12.5,' BTUS/HR',
     1        /2X,' THE MAXIMUM HEATING LOAD IS',E12.5,' BTUS/HR')
9900 FORMAT(///41X,' THIS SYSTEM DOES NOT USE BACK-UP HEATING')
9910 FORMAT(///41X,' THIS SYSTEM USES BACK-UP HEATING')
      END
```

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

```
C
      SUBROUTINE LPPLOT(IW,ISTART,NPLOTS,NPOINT,NPSM,NRM,XDEL1,RP,XMIN,
     1                  YMIN,YMAX,NAME,NDIM,IPLOT,IMAX)
      DIMENSION YY(52,5), YSCALE(11), RP(NPSM,NRM), NAME(NDIM),
     1              IPLOT(IMAX)
      DIMENSION ITITLE(5), IBUF(120),IXBUFA(5),IXBUFB(10)
      COMMON /PLOTTR/ IYSYMB(5)
      CHARACTER NAME*6
      CHARACTER ITITLE*6
      CHARACTER IYSYMB*1
      CHARACTER IBUF*1
      CHARACTER IBLANK*1
      CHARACTER IMINUS*1
      CHARACTER II*1
      IBLANK = 1H
      IMINUS = 1H-
      II     = 1HI
      JJ = ISTART - 1
      DO 132  J = 1,NPLOTS
      JJ = JJ + 1
      JCURVE = IPLOT(JJ)
      ITITLE(J) = NAME(JCURVE)
      DO 132 I=1,NPOINT
      YY(I,J)=RP(I,JCURVE)
      IF(YY(I,J) .GT. YMAX) YY(I,J) = YMAX
      IF(YY(I,J) .LT. YMIN) YY(I,J) = YMIN
  132 CONTINUE
      YDEL10 = (YMAX-YMIN)/10
      XDEL5 = 5.0 * XDEL1
      YMAX = YMIN + 10.0 * YDEL10
      WRITE(IW,600) ((ITITLE(J), IYSYMB(J)), J = 1,NPLOTS)
  600 FORMAT(/19X,5(A6,11H  SYMBOL = ,A1,3X))
      DO 680 J = 1,11
  680 YSCALE (J) = YMIN + YDEL10 * FLOAT(J-1)
      WRITE (IW, 700)  YSCALE
  700 FORMAT(/2X,11(F10.1))
      DO 730 J = 1,10
  730 IBUF (J) = IBLANK
      DO 740 J = 112,120
  740 IBUF (J) = IBLANK
      DO 750  J = 12, 110
  750 IBUF (J) = IMINUS
      DO 770  J = 11, 111, 10
  770 IBUF (J) = II
      WRITE (IW, 790)  IBUF
  790 FORMAT (2(60A1))
  820 CONTINUE
      ILINE = 0
      IXPRNT = 1
      XSCALE = XMIN
  890 ILINE = ILINE + 1
      DO 910  J = 1, 120
  910 IBUF (J) = IBLANK
```

```
      IBUF(111)=II
      DO 1120  J = 1,NPLOTS
      YQ = YY(ILINE,J)
      YDIFF = YMAX - YMIN
      IF(YDIFF.EQ.0.0) YDIFF = 1.00
      YRAT = 100.0*(YQ - YMIN) / YDIFF
      IF(YRAT.LT.0.) YRAT=0.
      IF(YRAT.GT.100.) YRAT=100.
      IYQ = 11 + IFIX (YRAT + 0.5)
      IBUF(IYQ) = IYSYMB(J)
 1120 CONTINUE
      IBUF (11) = II
      IF (ILINE .LT. IXPRNT)  GO TO 63
      IF(NPOINT .NE. 52) GO TO 61
C
C     TIME AXIS FOR ANNUAL PLOTS
C
      IWEEK = XSCALE
      WRITE(IW,59)  IWEEK, (IBUF(ISON),ISON=10,120)
   59 FORMAT(6H  WEEK,I3,60A1,51A1)
      GO TO 62
C
C     TIME AXIS FOR DAILY PLOTS
C
   61 IHOUR = XSCALE
      IMIN = IFIX(60*(XSCALE-FLOAT(IHOUR)))
      IF(IMIN .GE. 10)
     1 WRITE(IW,66) IHOUR, IMIN,(IBUF(ISON),ISON=10,120)
      IF(IMIN .LT. 10)
     1 WRITE(IW,67) IHOUR, IMIN,(IBUF(ISON),ISON=10,120)
   66 FORMAT(4X,I2,1H ,I2,60A1,51A1)
   67 FORMAT(4X,I2,2H 0,I1,60A1,51A1)
   62 IXPRNT = IXPRNT + 5
      XSCALE = XSCALE + XDELS
      GO TO 65
   63 WRITE (IW, 790)  IBUF
   65 IF (ILINE .LT. NPOINT)  GO TO 890
      DO 130 J = 1,10
  130 IBUF (J) = IBLANK
      DO 140 J = 112,120
  140 IBUF (J) = IBLANK
      DO 150  J = 12, 110
  150 IBUF (J) = IMINUS
      DO 170  J = 11, 111, 10
  170 IBUF (J) = II
      WRITE (IW, 790)  IBUF
      RETURN
      END
```

```
      SUBROUTINE CSIZE(QCDS,QHDS,QHCONS,QCCONS,HDAY,QCLCON)
C  THIS SUBROUTINE COMPUTES AND SIZES
C  THE COMPONENTS, THE STORAGES, AND THE COLLECTOR
C  AREA BASED ON CERTAIN WORST CONSECUTIVE HEATING DAYS AND MINIMUM
C  CONSECUTIVE SOLAR ENERGY COLLECTED DAYS, USING NEWTON
C  ITERATION METHOD.
C
C                    QCDS = LARGEST N CONSECUTIVE DAY COOLING LOAD
C                    QHDS = LARGEST DAILY HEATING LOAD
C                    QHCONS = LARGEST NET (HEATING - COOLING) LOAD
C                             IN N CONSECUTIVE DAYS
C                    HDAY = NUMBER OF CONSECUTIVE DAYS FOR COMPONENT SIZING
C
C
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, QARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      REAL KWHP, KWHP4, KWHP6
      REAL LCOLL
      LOGICAL SUMMER
      DATA SUMMER/.FALSE./
      TEXIT = A(18)
      ISIZNG = A(11)
      N4 = A(24)
      N6 = A(25)
      RMCSC = A(37)
      IF(RMCSC .LE. 0.) RMCSC = 10000.
      THMAX = A(43)
      THMIN = A(44)
      TENDUR = A(45)
      NSERES = A(15)
      HCOLL = A(66)
      LCOLL = A(65)
      SSIDE = A(68)
      SHITE = A(69)
      SSIDE1 = SSIDE
      SHITE1 = SHITE
      SCUBE = 0.
      FPACK = A(70)
      USTORC = A(71)
      TGROUN = A(72)
C  COMPUTE THE MAXIMUM POSSIBLE CHARGING HOURS OF HEAT PUMP PER N DAY
C  PERIOD IN SUMMER
      HRCHR = 0.
      NWEEK = IFIX(HDAY/7.)
      NDRES = HDAY - NWEEK*7.
      HRCHR = (NWEEK*5.+NDRES)*(24.-(A(39)-A(40)))+NWEEK*2.*24.
      IF(NDRES .GE. 6) HRCHR = HRCHR + (A(39)-A(40))
C  COMPUTE THE HOT STORAGE SIZE AND THE SLOPE FOR THE HEATING
C  RESET CONTROLLER
      QHMAX = QHDS*TENDUR/24.
```

```
      RMCSH = QHMAX/(THMAX-THMIN)
      VOLHT = RMCSH/62.4
      SIDEHT = VOLHT**.333333
      AREAHT = SIDEHT*SIDEHT*6.
      UAHT = AREAHT*USTORC
      DIFF = (THMAX-THMIN)/TEXIT
C  COMPRESSOR RATINGS
      TEVAP = 20.
C  RATINGS OF THE 4RA3-2000-TSK MODEL
      CALL HP(1,0,0.,THMAX,THMAX,32.,QHPH,QHPC,KWHP,0.,30.,SUMMER)
      QHPC4 = QHPC
      QHPH4 = QHPH
      KWHP4 = KWHP
      COPRT4 = QHPH4/(KWHP4*3413.)
C  RATINGS OF THE 6RHI-3500-TSK MODEL
      CALL HP(0,1,0.,THMAX,THMAX,32.,QHPH,QHPC,KWHP,0.,30.,SUMMER)
      QHPC6 = QHPC
      QHPH6 = QHPH
      KWHP6 = KWHP
      COPRT6 = QHPH6/(KWHP6*3413.)
      QNMAX = QHCONS*(1.-(N4+N6)/(N4*COPRT4+N6*COPRT6)) + QCCONS
C  SIZE THE HEAT PUMP
      QDSMAX = AMAX1(QNMAX,QCDS)
      QCMAX = QDSMAX/HRCHR
C  DETERMINE THE STORAGE SIZE
      IF(QNMAX .LE. 0.) GOTO 80
      DO 60 I = 1,20
      DO 50 J = 1,2
      IF(SSIDE .EQ. 0. .AND. SHITE .EQ. 0.) GOTO 30
      IF(SHITE .EQ. 0.) GOTO 10
      SSIDE = SQRT(RMCSC/(62.4*SHITE))
      GOTO 20
   10 SHITE = RMCSC/(62.4*SSIDE*SSIDE)
   20 SAREA = 2.*SSIDE*SSIDE+4.*SSIDE*SHITE
      GOTO 40
   30 SCUBE = (RMCSC/62.4)**.33333333
      SAREA = SCUBE*SCUBE*6.
   40 UASTC = USTORC * SAREA
      QLSC = UASTC*(32.0-TGROUN)*24.*HDAY
      QNET = QNMAX+QLSC
      RMCSCP = QNET/(143.6*FPACK)
      IF(J .EQ. 2) GOTO 50
      ERR1 = RMCSCP-RMCSC
      IF(ABS(ERR1) .LT. RMCSC*.001) GOTO 80
      RMCSC1 = RMCSC
      RMCSC = RMCSC * 1.001
   50 CONTINUE
      ERR2 = RMCSCP - RMCSC
      SLOPE = (ERR2-ERR1)/(RMCSC*.001)
      DELTA = -ERR1/SLOPE
      RMCSC = RMCSC1 + DELTA
   60 CONTINUE
      WRITE(9,70) I
```

```
   70 FORMAT(4X,48H CONVERGENCE IS NOT FOUND FOR STORAGE SIZE AFTER ,
     1       I4,11H ITERATIONS)
      STOP
   80 RMCGAL = RMCSC/8.333333
C  FIRST GUESS FOR COLLECTOR AREA
      AGUESS = QNMAX/QCLCON
C  OUTPUT ..............................................................
      WRITE(9,8000) QCMAX, RMCSH, THMAX, DIFF, TENDUR
      WRITE(9,8005) SIDEHT, UAHT
      WRITE(9,8010) QHPC4,QHPH4,KWHP4,THMAX,TEVAP,COPRT4
      WRITE(9,8020) QHPC6,QHPH6,KWHP6,THMAX,TEVAP,COPRT6
      WRITE(9,8030) HDAY, QHCONS, QCCONS
      IF(SSIDE1 .EQ. 0. .AND. SHITE1 .EQ. 0.) WRITE(9,9000) SCUBE
      IF(SHITE1 .GT. 0.) WRITE(9,9010) SSIDE, SHITE
      IF(SSIDE1 .GT. 0.) WRITE(9,9020) SSIDE, SHITE
      WRITE(9,9030) RMCSC, RMCGAL, UASTC
      WRITE(9,9040) HDAY
      IF(QNMAX .GT. 0.) WRITE(9,9060) AGUESS,LCOLL,HCOLL,NSERES
      IF(QNMAX .LE. 0.) WRITE(9,9070) HDAY
      RETURN
 8000 FORMAT(///2X,' HEAT PUMP COOLING CAPACITY =',E12.5,' BTUS/HR',
     1       /2X,' BASED ON THIS CAPACITY, THE USER HAS TO SPECIFY THE'
     2      ' NUMBER OF COMPRESSORS TO BE USED IN THE HEAT PUMP',/2X,
     3      ' EITHER TYPE 4RA3-2000-TSK OR TYPE 6RHI-3500-TSK OR THE'
     4      ' COMBINATION. SEE ROUTINE HP IN THIS SOFTWARE FOR DETAIL',
     5       /2X,' THE HOT STORAGE BIN CAPACITY =',E12.5,' LBS',
     6       /2X,' THE EQUATION FOR THE TEMPERATURE RESET CONTROLLER'
     7      ' IN THE STORAGE IS,',/
     8       /,6X,'TSETH =',F8.1,' -',F6.2,' * TAMB',/2X,
     9      ' THIS IS BASED ON THE ABILITY TO HEAT THE BUILDING FOR',
     1       F8.2,' CONSECUTIVE HOURS FROM HOT STORAGE.')
 8005 FORMAT(//2X,' IF THE HOT STORAGE IS ASSUMED TO BE A CUBE,EACH'
     1      ' SIDE ',F8.2,' FT LONG, THEN THE',/2X,'HEAT TRANSFER'
     2      ' COEFFICIENT OF THE TANK IS',F8.2,'BTUS/F HR')
 8010 FORMAT(///2X,' RATINGS OF THE HEAT PUMP COMPRESSORS,',//,
     1       8X,' 4RA3-2000-TSK',//16X,
     2      ' COOLING CAPACITY =',E12.5,' BTUS/HR',/16X,
     3      ' HEATING CAPACITY =',E12.5,' BTUS/HR',/16X,
     4      ' COMPRESSOR SIZE  =',E12.5,' KW',/16X,
     5      ' CONDENSOR TEMPERATURE =',F8.2,' F',/16X,
     6      ' EVAPORATOR TEMPERATURE =',F8.2,' F',/16X,
     7      ' RATED COP FOR HEATING =',E12.5)
 8020 FORMAT(//8X,' 6RHI-3500-TSK',//16X,
     1      ' COOLING CAPACITY =',E12.5,' BTUS/HR',/16X,
     2      ' HEATING CAPACITY =',F12.5,' BTUS/HR',/16X,
     3      ' COMPRESSOR SIZE  =',E12.5,' KW',/16X,
     4      ' CONDENSOR TEMPERATURE =',F8.2,' F',/16X,
     5      ' EVAPORATOR TEMPERATURE =',F8.2,' F',/16X,
     6      ' RATED COP FOR HEATING =',E12.5)
 8030 FORMAT(//2X,' DURING THE ',F6.1,' CONSECUTIVE DAYS OF MAXIMUM'
     1      ' NET HEATING, THE HEATING LOAD IS',E12.5,' BTUS',/2X,
     2      ' AND THE COOLING LOAD IS',E12.5,' BTUS')
 9000 FORMAT(///,2X,' THE COLD STORAGE IS (PRESUMED BY THE USER) A CUBE'
```

```
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,'FT2, 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
   28K  WORDS WERE USED FOR THIS COMPILATION
```

```
      SUBROUTINE COLECT(TINLET,QCOLL,QAVAIL,IFLAG)
C  THIS SUBROUTINE COMPUTE THE FLAT PLATE COLLECTOR EFFICIENCY
C  AND THE AVAILABLE AND COLLECTED SOLAR ENERGY.
      DIMENSION ATR(2),BTR(2),CTR(2),TAU040(2)
      DIMENSION FRP(2),ULO(2),FP(2)
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /SIZING/ QCOS,QHDS,QHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
     1                ,NSERES,LCOLL,QCCONS,QCLCON
      COMMON /SOLAR/ S(35)
      COMMON /FLOW/ MDOTCC, MDOTCS
      REAL MDOTCC, MDOTCS
      LOGICAL TFIRST
      DATA TFIRST/.TRUE./
      DATA ATR/-2.9868,-1.4214/,BTR/-3.7360,-5.7356/
      DATA CTR/4.3541,5.7723/,TAU040/0.96,0.92/
      DATA FRP/0.93,0.90/,ULO/0.859,0.567/,FP/0.956,0.919/
      REAL LCOLL, LSHADE, LROW
      IF(AREA .EQ. 0.) RETURN
      IF(.NOT.TFIRST) GO TO 50
      TFIRST = .FALSE.
      SERES = FLOAT(NSERES)
      RAD = 3.14159/180.
      TANPHI=SIN(A(1)*RAD)/COS(A(1)*RAD)
      TILT = A(6)*RAD
      CTILT = COS(TILT)
      STILT = SIN(TILT)
      FTILT = (1. - CTILT)/2.
      AZIM = A(5)*RAD
      CAZIM = COS(AZIM)
      SAZIM = SIN(AZIM)
      RHO = A(20)
      AA = A(34)
      XNG = A(35)
      NG=IFIX(XNG)
      CC = A(36)
      DIST = A(67)
      TAU60=EXP(-1.21453*XNG*.0125)*(1.0-EXP((ATR(NG)+
     1(BTR(NG)+CTR(NG)*0.5)*0.5)*0.5))*(1.0565**NG)
      RETURN
   50 TDIFF = TINLET - TAMB
C     ... COMPUTE COSINE OF ANGLE OF INCIDENCE
      IF(IFLAG .EQ. 0) GOTO 101
      CTHETA = CTILT*S(13) + STILT*SAZIM*S(14) - STILT*CAZIM*S(15)
      IF(CTHETA .LT. 0.0) CTHETA = 0.0
C     ... COMPUTE SOLAR RADIATION ON TILTED SURFACE
      QDIR = XDOT(1)*CTHETA
      QDIF = (XDOT(3)-XDOT(2))*(1.0-FTILT) + RHO*XDOT(3)*FTILT
      IF(NROWS .EQ. 1) GO TO 150
C     ... COMPUTE SHADED AREA
```

```
      LSHADE=0.0
      HSHADE=0.0
      CALPHA=COS(S(20))
      ZZ=COS(S(21)-AZIM)
      ZZZ=S(13)*CTILT+STILT*CALPHA*ZZ
      IF(ABS(ZZZ).GT.1.E-06) HSHADE=HCOLL*SERES-DIST*S(13)/ZZZ
      IF(HSHADE.LT.0.) HSHADE=0.0
      IF(HSHADE.GT.HCOLL*SERES) HSHADE=HCOLL*SERES
      IF(ABS(ZZ).GT.1.E-06) LSHADE=LROW-(DIST-(HCOLL*SERES-HSHADE)
     1*CTILT)*SIN(ABS(S(21)-AZIM))/ZZ
      IF(LSHADE.LT.0.) LSHADE=0.0
      IF(LSHADE.GT.LROW) LSHADE=LROW
  150 ASHADE = FLOAT(NROWS-1)*LSHADE*HSHADE
      QTOT = QDIR + QDIF
      QAVAIL = QTOT*(ATOTAL - ASHADE)/ATOTAL
      TAU=0.0
      IF(CTHETA.LT..0871) GO TO 96
      IF(QTOT.LT.1.E-06) GO TO 96
      STHETA=SQRT(1.-CTHETA*CTHETA)
      STH2=STHETA/1.526
      COSTH2=SQRT(1.-STH2*STH2)
      TAU=TAU040(NG)
      IF(CTHETA.GT..766) GO TO 86
      TAU=(1.0-EXP((ATR(NG)+(BTR(NG)+CTR(NG)*CTHETA)*CTHETA)*CTHETA)
     1)*(1.0565**NG)
   86 TAU=QDIR/QTOT*TAU*EXP(-XNG*.0125/COSTH2)
      TAU=TAU+QDIF/QTOT*TAU60
   96 ETAF=AA*TAU/TAU040(NG)
      FR=MDOTCC*SERES/(AREA*ULO(NG))*(1.-EXP(-FP(NG)
     1*ULO(NG)*AREA/(MDOTCC*SERES)))
      ETAF=ETAF/FRP(NG)*FR
  101 CONTINUE
C     ... COMPUTE ETA FOR FLAT PLATE COLLECTOR
       QCOLL = QAVAIL*ETAF-CC*FR*TDIFF/FRP(NG)
  500 XDOT(4) = QDIR
      XDOT(5) = QAVAIL*AREA
      RETURN
      END
```

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

ELAPSED TIME (SEC) .43 LINES/MINUTE 12630

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

```
C
      SUBROUTINE DERIV
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /SOLAR/ S(35)
      COMMON /WEATHR/ NAMERM,DB(24),DP(24),WB(24),WS(24),PB(24),
     1                TC(24),TOC(24),WET(24),DRY(24),CALDB(24,11),
     2                CALRH(24,11),QQLS(24,11),QQLL(24,11),QLIGHT,
     3                QEQUIP,QROOFO,QPEOPL
      COMMON /SCHDL/ TWELL(12),MHOTW(24),PEOPLE(24)
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1               TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      DIMENSION QQLITE(24,11),QQEQUP(24,11),QQROOF(24,11),QQPEOP(24,11)
      CHARACTER NAMERM*4(9)
      REAL MHOTW
      NZONE = A(84)
C     THIS SUBROUTINE COMPUTES FUNCTIONS OF TIME, THEN CALLS THE
C     SUBROUTINE  HVAC THAT COMPUTES THE STATE DERIVATIVES
C     COMPUTE THE FUNCTIONS OF TIME
      IF((TIME - OLDTIM) .LT. 1.0 .AND. TIME.GT.1.E-06) GO TO 100
      OLDTIM = TIME
      DBOLD = DB(IHOUR)
      WBOLD = WB(IHOUR)
      DPOLD = DP(IHOUR)
      PBOLD = PB(IHOUR)
      TCOLD = TC(IHOUR)
      NTYPE = IFIX(TOC(IHOUR))
      IF(S(5) .LT. 24.0) GO TO 50
      TCOND1 = 0.
      S(4) = S(4) + 1.
      S(5) = S(5) - 24.0
      READ (8,END=40) IYEAR,IMONTH,IDAY,DB,DP,WB,WS,PB,TC,TOC,WET,DRY
      DO 23 J = 1, NZONE
      READ (8,END=40) NAMERM,(CALDB(I,J),I=1,24),(CALRH(I,J),I=1,24),
     1     (QQLS(I,J),I=1,24),(QQLL(I,J),I=1,24),(QQLITE(I,J),I=1,24),
     2    (QQEQUP(I,J),I=1,24),(QQROOF(I,J),I=1,24),(QQPEOP(I,J),I=1,24)
      IF(TIME .GT. 0.) GOTO 23
      IF(J .EQ. 1) WRITE(9,5) IDAY, IMONTH, IYEAR
    5 FORMAT(///6X,' THE SIMULATION STARTED ON DAY',I4,' MONTH',I3,
     1       ' OF THE YEAR',I5)
      IF(J .EQ. 1) WRITE(9,10)
      WRITE(9,20) J, NAMERM
   10 FORMAT(///6X,' ZONE            NAME OF ZONE',//)
   20 FORMAT(8X,I3,8X,9A4)
   23 CONTINUE
   40 CALL SUN(0)
      IWKDAY = WKDAY(IYEAR,IMONTH,IDAY)
      CALL HOLDAY(IYEAR,IMONTH,IDAY,IWKDAY,IHOL)
   50 IWORKD = 1
      IF(S(5) .LT. A(149) .OR. S(5) .GE. A(150)) IWORKD = 0
```

```
      IF(IWKDAY.EQ.1.OR.IWKDAY.EQ.7.OR.IHOL.EQ.1) IWORKD = 0
      HOTW=MHOTW(IHOUR)*IWORKD*0.333*PEOPLE(IHOUR)*A(151)
      IHOUR = IFIX(S(5)) + 1
      QELEQ = 0.
      DO 75 I=1,NZONE
      QLS(I) = QQLS(IHOUR,I)
      QLL(I) = QQLL(IHOUR,I)
      TZ(I) = CALDB(IHOUR,I)
      RH(I) = CALRH(IHOUR,I)
      QLIGHT = QLIGHT + QQLITE(IHOUR,I)
      QEQUIP = QEQUIP + QQEQUP(IHOUR,I)
      QROOFO = QROOFO + QQROOF(IHOUR,I)
      QPEOPL = QPEOPL + QQPEOP(IHOUR,I)
      QELEQ = QELEQ + QQLITE(IHOUR,I) + QQEQUP(IHOUR,I)
   75 CONTINUE
  100 CONTINUE
C     ... INTERPOLATE FOR AMBIENT TEMPERATURE AND CLOUD COVER
      CCOVER = TCOLD + (TC(IHOUR) - TCOLD)*(TIME - OLDTIM)
      IF(NTYPE .EQ. 0) CCOVER = CCOVER/2.
      CCF = 1.0 + .011*CCOVER - .00792*CCOVER*CCOVER
      IF(TIME.LT.1.E-06 .AND. ABS(DBOLD).LT.1.E-06) DBOLD = DB(1)
      TAMB = DBOLD + (DB(IHOUR) - DBOLD)*(TIME - OLDTIM)
      IF(TIME.LT.1.E-06.AND.ABS(WBOLD)).LT.1.E-06) WBOLD = WB(1)
      TWET = WBOLD+(WB(IHOUR)-WBOLD)*(TIME-OLDTIM)
      IF(TIME.LT.1.E-06 .AND. ABS(DPOLD)).LT.1.E-06) DPOLD = DP(1)
      DEMP = DPOLD + (DP(IHOUR) - DPOLD)*(TIME - OLDTIM)
      IF(TIME.LT.1.E-06.AND.ABS(PBOLD).LT.1.E-06) PBOLD = PB(1)
      BARP = PBOLD+(PB(IHOUR)-PBOLD)*(TIME-OLDTIM)
C     COMPUTE SOLAR RADIATION COMPONENTS
      CALL SUN(1)
      IF(WET(IHOUR).LT.1.E-06 .AND. DRY(IHOUR).LT.1.E-06) GO TO 120
C     ... IF PRECIPITATION PRESENT, THEN NO DIRECT OR DIFFUSE RADIATION
      S(23) = 0.0
      S(24) = 0.0
C    CLOUD MODIFIED RADIATION ..........
C     ... DIRECT NORMAL RADIATION (CLOUD MODIFIED)
  120 XDOT(1) = (1.0 - .09*CCOVER)*S(24)
C     ... DIRECT RADIATION ON HORIZONTAL SURFACE (CLOUD MODIFIED)
      XDOT(2) = XDOT(1)*S(13)
C     ... TOTAL RADIATION ON HORIZONTAL SURFACE (CLOUD MODIFIED)
      XDOT(3) = CCF*S(23)
      MODEC = 0
      IF(WET(IHOUR).LT.1.E-06 .AND. DRY(IHOUR).LT.1.E-06 .AND.
     1 (S(5)-S(11)).GT.-1.E-06.AND. S(5) .LT. S(12)) MODEC = 1
      CALL HVAC(HOTW,MODEC,MODET)
      RETURN
      END
```

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

ELAPSED TIME (SEC) .52 LINES/MINUTE 11427

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

```
      FUNCTION WKDAY(YR,MO,DAY)
C
C     ****************************************************************
C
C       WKDAY=1  SUNDAY
C       WKDAY=2  MONDAY
C       WKDAY=3  TUESDAY
C       WKDAY=4  WEDNESDAY
C       WKDAY=5  THURSDAY
C       WKDAY=6  FRIDAY
C       WKDAY=7  SATURDAY
C
      INTEGER YR,DAY,WKDAY,TDAY,FSTDAY
      DIMENSION FSTDAY(12) /31,59,90,120,151,181,212,243,273,304,334,
     *                      365/
      N=YR/4
      ND=N-485
      IY=2
      IF(ND.EQ.0) GOTO 40
      IF(ND.LT.0) GOTO 10
      IADD=2
      GOTO 20
C
   10 ND=-ND
      IADD=-2
   20 DO 30 J=1,ND
      IY=IY-IADD
      IF(IY.GT.7) IY=IY-7
      IF(IY.EQ.0) IY=7
      IF(IY.LT.0) IY=IY+7
   30 CONTINUE
   40 MO=YR-N*4
      IF(MO.EQ.0) IWK=IY
      IF(MO.EQ.1) IWK=IY+2
      IF(MO.EQ.2) IWK=IY+3
      IF(MO.EQ.3) IWK=IY+4
      IF(IWK.GT.7) IWK=IWK-7
      IF(MO.NE.1) GOTO 50
      TDAY=DAY-1
      GOTO 80
C
   50 DO 60 J=2,12
      IF(MO.NE.J) GOTO 60
      TDAY=FSTDAY(J-1)+DAY-1
      GOTO 70
   60 CONTINUE
   70 IF(MO.EQ.0.AND.MO.GT.2) TDAY=TDAY+1
   80 NTX=TDAY/7
      NDX=TDAY-7*NTX+IWK
      IF(NDX.GT.7) NDX=NDX-7
      WKDAY=NDX
      KV=YR/100
      KTEST=YR-KV*100
```

```
      IF(MO.GT.2.OR.KTEST.NE.0) GOTO 90
      KV=KV-1
   90 LV=KV/4
      LTEST=KV-LV*4
      IF(LTEST.EQ.2) WKDAY=WKDAY+1
      IF(LTEST.EQ.1) WKDAY=WKDAY+2
      IF(LTEST.EQ.0) WKDAY=WKDAY+3
      WKDAY=WKDAY-3*(LV-4)
  100 IF(WKDAY.LE.0) WKDAY=WKDAY+7
      IF(WKDAY.LE.0) GOTO 100
      IF(WKDAY.GT.7) WKDAY=WKDAY-7
      RETURN
C
      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

```
      SUBROUTINE HOLDAY(YR,MO,DAY,NDAY,HOL)
C
C     ****************************************************************
C
      INTEGER YR,DAY,HOL,WKDAY
      NDAY=WKDAY(YR,MO,DAY)
      HOL=0
      IF(MO.EQ.1.AND.DAY.EQ.1) HOL=1
      IF(MO.EQ.12.AND.DAY.EQ.31.AND.NDAY.EQ.6) HOL=1
      IF(MO.EQ.1.AND.DAY.EQ.2.AND.NDAY.EQ.2) HOL=1
      IF(MO.EQ.2.AND.DAY.EQ.22) HOL=1
      IF(MO.EQ.2.AND.DAY.EQ.21.AND.NDAY.EQ.6) HOL=1
      IF(MO.EQ.2.AND.DAY.EQ.23.AND.NDAY.EQ.2) HOL=1
      IF(MO.EQ.5.AND.DAY.EQ.30) HOL=1
      IF(MO.EQ.5.AND.DAY.EQ.29.AND.NDAY.EQ.6) HOL=1
      IF(MO.EQ.5.AND.DAY.EQ.31.AND.NDAY.EQ.2) HOL=1
      IF(MO.EQ.7.AND.DAY.EQ.4) HOL=1
      IF(MO.EQ.7.AND.DAY.EQ.3.AND.NDAY.EQ.6) HOL=1
      IF(MO.EQ.7.AND.DAY.EQ.5.AND.NDAY.EQ.2) HOL=1
      IF(MO.EQ.12.AND.DAY.EQ.25) HOL=1
      IF(MO.EQ.12.AND.DAY.EQ.24.AND.NDAY.EQ.6) HOL=1
      IF(MO.EQ.12.AND.DAY.EQ.26.AND.NDAY.EQ.2) HOL=1
      IF(MO.EQ.9.AND.DAY.LT.7.AND.NDAY.EQ.2) HOL=1
      IF(MO.EQ.11.AND.DAY.GT.24.AND.NDAY.EQ.5) HOL=1
      RETURN
C
      END
```

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

ELAPSED TIME (SEC) .24 LINES/MINUTE 6612

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

```
      SUBROUTINE HVAC(HOTW,MODEC,MODET)
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1               TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      COMMON /FAN/ PCFMAX, TFMAX, DFMAX
      DIMENSION FLOW(11),RMAZ(11),QZONE(11)
      COMMON /SIZING/ QCDS,QHDS,QHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
     1                ,NSERES,LCOLL,QCCONS,QCLCON
      COMMON /SCHDL/ TWELL(12),MHOTW(24),PEOPLE(24)
      COMMON /SOLAR/ S(35)
      INTEGER PCOLL
      REAL KWHP
      LOGICAL TFIRST, SUMMER
      DATA TFIRST/.TRUE./
C
C THIS SUBROUTINE COMPUTES STATE DERIVATIVES FOR A BUILDING WITH AN
C HVAC SYSTEM
C  HEATING/COOLING SYSTEM SCHEMATIC
C
C
C                          /-   ------
C                         / I   I    I
C                        /  I   I    I
C                     /\/   I   I    I
C                    /  \   -----  ----------    ----    ----------
C                   /   /   I   I  I        I    I  I    I        I
C                  /   /    I   I  I        I----I  I----I        I
C   COLLECTOR     /   /  HEAT   I  I  COLD  I----I  I----I   HOT  I
C      FIELD     /   / EXCHANGERI  ISTORAGE I    I  I    I STORAGEI
C               /   /         I   I  I        I    ----    I        I
C              /   /          I   I  I        I    HEAT    I        I
C              \  /           -----  ----------    PUMP    ----------
C              /\/            I   I    I  I  I                I  I
C             /               I   I    I  I  I                I  I
C            /---------------   ------  I  I                I  I
C                                        I  I                I  I
C                                     COOLING              HEATING
C                                       LOADS                LOADS
C
C
C
C     THE X VECTOR AND XDOT VECTOR ELEMENTS ARE DEFINED AS FOLLOWS
C
C   1 IDNC    2 IDHC    3 ITHC    4 QDIRCT  5 QAVAIL  6 QCOLCT  7 QCB
C   8 QHB     9 QDHW   10 QCBTOT 11 QHBTOT 12 QTAMB  13 BACKUP 14 QH1
C  15 QH2    16 QH3    17 QH4    18 QH5    19 QH6    20 QH7    21 QH8
C  22 QH9    23 QH10   24 QH11   25 QC1    26 QC2    27 QC3    28 QC4
C  29 QC5    30 QC6    31 QC7    32 QC8    33 QC9    34 QC10   35 QC11
C  36 QCOMPA 37 FPOWER 38 PUMPC  39 QHGAS  40 QHOIL  41 QELECT 42 QEACES
```

```
C  43 QERCON 44 QECCON 45 TSC    46 TSH
C
      IF(.NOT.TFIRST) GO TO 30
      TFIRST = .FALSE.
C     INITIALIZE WITH INPUT PARAMETERS
      RMBA = A(14)
      NM4 = A(24)
      NM6 = A(25)
      NMAX = NM4+NM6
      THOT = A(26)
      OFFPT = A(39)
      ONPT = A(40)
      IHPL = 0
      TSETC = A(41)
      DELTAT = A(42)
      THMAX = A(43)
      THMIN = A(44)
      DTSTAG = A(46)
      TSUMAX = A(47)
      TCUTOF = A(48)
      TSRES = 70.
      DTBAND = THMAX - THMIN
      ALIM = DTBAND/FLOAT(NMAX)
      IF(DTSTAG .GT. ALIM)WRITE(9,2) ALIM
    2 FORMAT(//2X,'LIMIT EXCEEDED, RESET A(46) SMALLER THAN',
     1       F7.2)
      IF(DTSTAG .GT. ALIM) STOP
      QLSH = 0.
      QLSC = 0.
      DIFF = A(49)
      TGROUN = A(72)
      QMIN = A(51)
      FPACK = A(70)
      PCMIN = A(83)
      NZONE = A(84)
      FLWMIN = 0.
      DO 5 I = 1, NZONE
      RMAZ(I) = A(84+I)*RMBA*PCMIN
    5 CONTINUE
      ICONV = A(98)
      ETAOIL = A(99)
      ETAGAS = A(100)
      FPMAX = A(101)
      NSTARS = A(143)
      NENDS = A(144)
      ELCOIL = A(145)*3413.
      FBACUP = A(146)
      TWORK = A(149)
   30 CONTINUE
      IF(TIME .GT. 1.E-06) GOTO 32
      ICMODE = IFIX(A(103))
      IGAS = 0
      IOIL = 0
```

```
      IELECT = 0
      IF(ICMODE .EQ. 3) IGAS = 1
      IF(ICMODE .EQ. 2) IOIL = 1
      IF(ICMODE .EQ. 1) IELECT = 1
   32 CONTINUE
      DO 40 I=4,NSTATE
   40 XDOT(I) = 0.0
      BACKUP = 0.
      QTAMIN = 0.
      QCBP = 0.
      QCB = 0.
      QHB = 0.
      CTHETA = 0.0
      QHOIL = 0.
      QHGAS = 0.
      QCOMPC = 0.
      HECONC = 0.
      FLWTOT = 0.
      QTAMB = 0.
      PCFLOW = 0.
      QHPC = 0.
      QHPH = 0.
      QLSC = 0.
      QLSH = 0.
      KWHP = 0.
      QCULCT = 0.
      PUMPC = 0.
      TSTORC = X(NSTATE-1)
      TSTORH = X(NSTATE)
      SUMMER = S(4) .GE. NSTARS .AND. S(4) .LT. NENDS
      IPEAK = 0
      IF(S(5) .LT. OFFPT .AND. S(5) .GE. ONPT) IPEAK = 1
      IF(IHOL .EQ. 1 .OR. IWKDAY .EQ. 7 .OR. IWKDAY .EQ. 1) IPEAK = 0
      ICSUM = 0
      IF(SUMMER) ICSUM = 1
      IF(ISIZNG .EQ. 1) GOTO 39
      IF(TSTORH .LT. (THMIN-15.)) WRITE(9,33) TSTORH
      IF(TSTORH .LT. (THMIN-15.)) STOP
   33 FORMAT(//2X,'HOT STORAGE TEMPERATURE =',F7.2,' RESIZE THE '
     1       'HOT STORAGE, OR HEAT PUMP, OR A(46)')
C  COMPUTE THE RESET TEMPERATURE IN THE STORAGE BIN
      TSETH = THMAX-DIFF*TAMB
      IF(TSETH .LT. THMIN) TSETH = THMIN
      IF(S(5) .GT. 11. .AND. S(5) .LT. 13.) TRESET = TSETH
      IF(TRESET .GE. TSETH) GOTO 35
      TRESET = TSETH
      TRSMAX = TRESET + DELTAT
   35 CONTINUE
C  COMPUTE THE HEAT PUMP OPERATING STAGE
      TSTAGE = THMIN
      DO 38 N = 1,NMAX
      IF(TRESET .GE. TSTAGE) ISTAGE = N
      TSTAGE = TSTAGE + DTSTAG
```

```
   38 CONTINUE
      N4 = MIN(ISTAGE,NM4)
      N6 = ISTAGE - N4
      IF(N6 .LT. 0) N6 = 0
      IF(SUMMER) N4 = NM4
      IF(SUMMER) N6 = NM6
      IF(ICSUM .EQ. 0) TRSMAX = AMAX1(THMAX,TRSMAX)
C  IN SUMMER, COMPUTE THE AMOUNT OF ICE ALLOWED IN COLD STORAGE
      IF(.NOT. SUMMER) GOTO 39
      IF(S(5) .GT. 8. .AND. S(5) .LT. 10.) TSRES = TAMB
      IF(TSRES .GE. TAMB) GOTO 399
      TSRES = TAMB
      FPSUM = FPACK*(TSRES - TCUTOF)/(TSUMAX -TCUTOF)
      IF(FPSUM .LT. 0.) FPSUM = 0.
      IF(FPSUM .GT. FPACK) FPSUM = FPACK
  399 CONTINUE
   39 CONTINUE
C
      IF(ISIZNG .EQ. 2) GOTO 41
      IF(MODEC .EQ. 1 .OR.
     1 TAMB .GT. (TSTORC+5.)) CALL COLECT(32.0,QCOLCT,QAVAIL,1)
      IF(QCOLCT .LT. 0.) QCOLCT = 0.
      GOTO 42
C THIS SUBROUTINE COMPUTES THE ENERGY NEEDED FOR THE BUILDING AS
C DETERMINED BY THE AMBIENT TEMPERATURE AND DESIGN LOAD FOR THE BUILDING
   41 CONTINUE
      CALL FUSION
C  COMPUTE STORAGE GAIN OR LOSS
      QLSC = UASTC*(TSTORC-TGROUN)
      QLSH = UASTH*(TSTORH-TGROUN)
      IF(MODEC .EQ. 1) CALL COLECT(32.,0.,QAVAIL,1)
      IF(SUMMER .AND. TSTORH .GT. TRSMAX) GOTO 42
      IF(TSTORC .GT. (TSETC-10.)) GOTO 42
      IF((QAVAIL.GT.QMIN .OR. TAMB.GT.(TSTORC+5.)) .AND. AREA.GT.0.)
     1 CALL CHARGE(MODEC,QAVAIL,QCOLCT)
      PPMAX = 5.
      IF(ATOTAL .LT. 2232.) PPMAX = 3.
      IF(ATOTAL .LT. 18.) PPMAX = 0.
      IF(QCOLCT .GT. 0.) PUMPC = PPMAX*3413.
   42 CONTINUE
C  DETERMINE ENERGY REQUIRED FOR HOT WATER
      QDHW = HOTW*(THOT-TWELL(IMONTH))
      IF(IGAS .EQ. 1) QDHW = QDHW/ETAGAS
      CALL ENTHLP
C  COMPUTE THE VENTILATION AIR FLOW RATE IN EACH ZONE
      DO 50 I = 1, NZONE
      QZONE(I) = QLS(I) + QLL(I)
      FLOW(I) = -QZONE(I)/(HZ(I)-HEXIT)
      IF(FLOW(I) .LT. RMAZ(I)) FLOW(I) = RMAZ(I)
      IF(ICONV.EQ.0..AND.(.NOT.SUMMER)) FLOW(I) = RMAZ(I)
      FLOW(I) = FLOW(I)*IWORKD
      FLWTOT = FLWTOT + FLOW(I)
C  COMPUTE THE TOTAL HEATING LOAD
```

```
      IF(QZONE(I) .GT. 0.) QHB = QHB + QZONE(I)
C  COMPUTE THE TOTAL COOLING LOAD
      IF(QZONE(I) .LT. 0.) QCB = QCB + QZONE(I)
C  COMPUTE THE NET COOLING CONTRIBUTION FROM AMBIENT AIR
      QAMB = FLOW(I) * (HZ(I) - HA)
      QAMIN = RMAZ(I)*(HZ(I)-HA)
      IF(QAMB .LT. 0..AND.FLOW(I) .GT. RMAZ(I)) QAMB = QAMIN
      QTAMB = QTAMB + QAMB
      QTAMIN = QTAMIN+QAMIN
   50 CONTINUE
      QCRTOT = QCB
      QHBTOT = QHB
C COMPUTE THE FAN POWER
      PCFLOW = FLWTOT/RMBA
      FPOWER = FPMAX * .5413. * (.8 * PCFLOW + .3)
      IF(PCFLOW .EQ. 0.) FPOWER = 0.
C  IF THE DAMPER IS SET AT MINIMUM AND THE AMBIENT AIR IS TOO COLD,
C  ADD THE EXTRA LOAD TO THE HEATING LOAD
      QCBP = (QCB - FPOWER + QTAMIN) * IWORKD
      IF(QCBP .GT. 0.) QHB = QHB + QCBP
C THIS POWER ADDS HEAT TO THE COOLING LOAD
C  THE FINAL COOLING LOAD IS
      QCB = (QCB - FPOWER + QTAMB) * IWORKD
      IF(QCB .GT. 0.) QCB = 0.
      IF(PCFMAX .GE. PCFLOW) GOTO 52
      PCFMAX = PCFLOW
      TFMAX = S(5)
      DFMAX = S(4)
   52 CONTINUE
      IF(ISIZNG .NE. 2) GOTO 90
C  OPERATE HEAT PUMP WHEN NECESSARY
C
C  HEAT PUMP CONTROL
      IF(IPEAK .EQ. 1 .AND. TSTORH .GT. THMIN) GOTO 85
      IF(TSTORH .GE. TRSMAX .AND. IHPL .EQ. 1) IHPN=0
      IF(TSTORH .LT. (TRSMAX-DELTAT/2.) .AND. IHPL .EQ. 0) IHPN = 1
      IF(TSTORC .GT. TSETC) IHPN = 1
      IHPL = IHPN
      IF(SUMMER) GOTO 85
      IF(FBACUP .EQ. 0.) GOTO 55
      IF((QFUSE/QMFUSE).LE.FPACK .AND. TSTORH.GT.(THMIN-5.)) GOTO 55
      BACKUP = ELCOIL*IHPN
      IF(IHPN .EQ. 1) IBUFLG = IHPN
      IF((QFUSE/QMFUSE) .GT. FPACK) GOTO 86
   55 CONTINUE
      IF(IHPN .EQ. 1 .AND. QFUSE .LT. QMFUSE*FPACK)
     1      CALL HP(N4,N6,TAMB,TRSMAX,TSTORH,TSTORC,QHPH,QHPC,KWHP,
     2              TCOVER,TSETC,SUMMER)
      GOTO 86
   85 IF(QFUSE .GT. (QMFUSE*FPSUM) .AND. IHPN .EQ. 0) GOTO 86
      IF(IPEAK .EQ. 1 .AND. TSTORC .LE. TSETC) GOTO 86
      CALL HP(N4,
     1N6,TAMB,TRSMAX,TSTORH,TSTORC,QHPH,QHPC,KWHP,TCOVER,TSETC,
```

```
          2SUMMER)
            IF(QFUSE .GT. (QMFUSE*FPACK)) QHPC = 0.
            IF(IHPN .EQ. 0) QHPH = 0.
         86 CONTINUE
      C  CALCULATE THE ENERGY BALANCE IN THE STORAGE
            DTSC = (QCOLCT*(1-ICSUM)+PUMPC-QHPC-QLSC-QCB)/RMCSC
            DTSH = (QCOLCT*ICSUM+QHPH+BACKUP-QLSH-QHB)/RMCSH
            GOTO 1000
         90 CONTINUE
      C  CONVENTIONAL SYSTEM SIZING
            IF(ICONV .NE. 1) GOTO 1000
            QOIL = QHB/ETAOIL
            QGAS = QHB/ETAGAS
            IF(QCB .GE. 0.) GOTO 1000
            CALL ACCONV(TAMB,COPCON)
            QCOMPC = -QCB/COPCON
       1000 CONTINUE
            QHGAS = (QDHW + QCAS)*IGAS
            QHOIL = QOIL*IOIL
      C  MISCELLANEOUS ELECTRIC USAGE (LIGHTING, EQUIPMENTS, DHW, ETC.)
            QELECT = QDHW*(1-IGAS) + FPOWER + PUMPC + QELEQ
      C  ELECTRIC FOR ACES HEAT PUMP
            QEACES = KWHP*3413. + BACKUP
      C  ELECTRIC FOR CONVENTIONAL HEATING
            QEHCON = QHB*ICONV*IELECT
      C  ELECTRIC FOR CONVENTIONAL COOLING
            QECCON = QCOMPC
            XDOT(6) = QCOLCT
            XDOT(7) = QCB
            XDOT(8) = QHB
            XDOT(9) = QDHW
            XDOT(10) = QCBTOT
            XDOT(11) = QHBTOT
            XDOT(12) = QTAMB
            XDOT(13) = BACKUP
            DO 100 I=1,NZONE
            IF(QLS(I)+QLL(I) .GE. 0.) XDOT(13+I)=QLS(I)+QLL(I)
            IF(QLS(I)+QLL(I) .LT. 0.) XDOT(24+I)=QLS(I)+QLL(I)
        100 CONTINUE
            XDOT(36) = KWHP*3413.
            XDOT(37) = FPOWER
            XDOT(38) = PUMPC
            XDOT(39) = QHGAS
            XDOT(40) = QHOIL
            XDOT(41) = QELECT
            XDOT(42) = QEACES
            XDOT(43) = QEHCON
            XDOT(44) = QECCON
            XDOT(NSTATE-1) = DTSC
            XDOT(NSTATE) = DTSH
            RETURN
            END
```

79267

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   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
```

```
      SUBROUTINE ACCONV(TAMB,COPCON)
C  THIS SUBROUTINE COMPUTE THE CONVENTIONAL AIR CONDITIONER COP
C  BASED ON THE DATA FOR THE 6RHI-3500-TSK COMPRESSOR.
      TCOND = TAMB + 20.
      QHPC = -2300.*TCOND + 498000.
      KWHP = .0005*TCOND*TCOND + .031*TCOND + 17.54
      COPCON = QHPC/(KWHP*3413.)
      RETURN
      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

```
      SUBROUTINE HP(N4,N6,TAMB,TRSMAX,TSTORH,TSTORC,QHPH,QHPC,KWHP,
     1              TCOVER,TSETC,SUMMER)
C
C  THIS SUBROUTINE COMPUTES THE ENERGY FLOW IN/OUT OF A HEAT PUMP IN AN
C  ACES. DATA IS CURVE FITTED FROM HARRY FISCHER'S, ACES CONSULTANT,
C  PHONE (305) 632 5092.
C
C
C
C
C                 I\/\/I AIR SIDE                 I\/\/I AIR SIDE
C                 I    I EVAPORATOR               I    I CONDENSOR
C                 I    I                          I    I
C                 I    I       OUTDOOR            I    I
C----------------I----I--------------------------I----I-----------------
C----------------I----I--------------------------I----I-----------------
C                 I    I       INDOOR             I    I
C                 I    I                          I    I
C  COLD STORAGE   I    I                          I    I  HOT STORAGE
C-------------I   I    I      I--------I          I    I  I--------------
C             I   I    I      I        I          I    I  I
C       ----------I----I------I  HEAT  I----------I----I----------
C       \     I       I      I  PUMP  I               I  I      /
C       /     I       I      I        I               I  I      \
C       \     I       I      I        I               I  I      /
C       /     I       I      I        I               I  I      \
C       ---------------I------I        I--------------I----------
C             I              I        I                  I
C             I              I        I                  I
C-------------I              I--------I                  I--------------
C
C
      REAL KWHP, KWHP4, KWHP6
      LOGICAL SUMMER
      QHPC4 = 0.
      QHPC6 = 0.
      QHPH = 0.
      QHPC = 0.
      KWHP4 = 0.
      KWHP6 = 0.
      KWHP = 0.
      IF(TSTORH .GT. TRSMAX) GOTO 70
      IF(SUMMER) GOTO 5
      IF(TSTORC .LE. TSETC .AND. TAMB .GT. TCOVER) GOTO 70
    5 IF(TSTORC .GT. 40.) GOTO 50
      IF(N4 .LE. 0) GOTO 10
C  HEAT PUMP WITH THE 4RA3-2000-TSK COMPRESSOR MODEL, RUNNING WITH
C  TEVAP = 20 F.
      QHPC4 = TSTORH*(-.0833333*TSTORH**3+36.66665*TSTORH*TSTORH-
     1        6011.664*TSTORH+434133.1) - 1.1492E7
      KWHP4 = -.0002857*TSTORH*TSTORH+.1468571*TSTORH+1.26
      QHPC4 = QHPC4*N4
```

```
      KWHP4 = KWHP4*N4
   10 CONTINUE
      IF(N6 .LE. 0) GOTO 100
C  HEAT PUMP WITH THE 6RHI-3500-TSK COMPRESSOR MODEL, RUNNING WITH
C  TEVAP = 20 F.
      QHPC6 = .8333333*TSTORH**3-275.*TSTORH*TSTORH+27666.67*TSTORH
     1        -580000.
      KWHP6 = .0005*TSTORH*TSTORH+.031*TSTORH+17.54
      QHPC6 = QHPC6*N6
      KWHP6 = KWHP6*N6
      GOTO 100
C  HEAT PUMP WITH THE 4RA3-2000-TSK COMPRESSOR MODEL, RUNNING WITH
C  TEVAP = 35 F.
   50 CONTINUE
      IF(N4 .LE. 0) GOTO 60
      QHPC4 = -.1666667*TSTORH**3+57.85714*TSTORH*TSTORH-8061.905*TSTORH
     1        +586400.
      KWHP4 = .12*TSTORH + 2.4
      QHPC4 = QHPC4*N4
      KWHP4 = KWHP4*N4
   60 CONTINUE
      IF(N6 .LE. 0) GOTO 100
C  HEAT PUMP WITH THE 6RHI-3500-TSK COMPRESSOR MODEL, RUNNING WITH
C  TEVAP = 35 F.
      QHPC6 = .4166667*TSTORH**3-138.2143*TSTORH*TSTORH+12490.48*TSTORH
     1        +81600.
      KWHP6 = .001*TSTORH*TSTORH+.002*TSTORH+17.76
      QHPC6 = QHPC6*N6
      KWHP6 = KWHP6*N6
      GOTO 100
   70 CONTINUE
C  IF THE AMBIENT TEMPERATURE IS GREATER THAN THE CHANGE-OVER
C  TEMPERATURE, OPERATE THE HEAT PUMP WITH THE OUTDOOR EVAPORATOR
      IF(SUMMER) GOTO 75
      IF(TSTORC .GT. TSETC) GOTO 75
      IF(TAMB .GT. TCOVER) GOTO 90
C  IN THE CASE THAT THE HOT STORAGE BIN TEMPERATURE IS GREATER THAN
C  LIMIT, USE OUTDOOR AIR COOL CONDENSER. TEVAP = 20 F.
   75 TCOND = TAMB+20.
      IF(N4 .LE. 0) GOTO 80
      QHPC4 = -1110.*TCOND + 247700.
      KWHP4 = -.0002857*TCOND*TCOND+.1468571*TCOND+1.26
      QHPC4 = QHPC4*N4
      KWHP4 = KWHP4*N4
   80 CONTINUE
      IF(N6 .LE. 0) GOTO 100
      QHPC6 = -2300.*TCOND+498000.
      KWHP6 = .0005*TCOND*TCOND+.031*TCOND+17.54
      QHPC6 = QHPC6*N6
      KWHP6 = KWHP6*N6
      GOTO 100
   90 CONTINUE
      QHPC = 0.
```

```
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          GOTO 1000
114      100 CONTINUE
115          QHPC = QHPC6+QHPC4
116          KWHP = KWHP6+KWHP4
117          IF(TSTORH .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

```
      SUBROUTINE ENTHLP
C  THIS ROUTINE COMPUTES THE ENTHALPIES OF THE STATE POINTS AT THE
C  ECONOMIZER
C
C
C
C                                                   EXHAUST
C                              I           I           I     I
C                              I           I           I     I
C          OUTDOOR             I           I           I     I
C---------------------------I           I----------I     I-----------------
C---------------------------I           I----------I     I-----------------
C          INDOOR              I           I           I     I
C                              I TAMB      I           I     I
C                              I (HAMB)    I           I     I
C                              I           I  DAMPER   I     I
C                              I//////////I---***----I////I
C                              I           I   ***     I     I---------
C                              I           I    I      I
C                              I           I    I      I     I---------
C        -------------------I           I----I-----I     I
C          IIIII   II                           /           I---------
C          IFANI T II                           /                     TZ(I)
C           III  E II                           /           I---------
C            I   X II HUMIDIFIER OR             /   TMIX    I
C           III  I II DEHUMIDIFIER              /  (HMIX)   I---------
C          IIIII T II                           /
C          IIIII   II                           /           I---------
C        ---------------------------------------------I
C
C
C
      COMMON /CTRL/ A(193), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2        DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3        IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4       ,RMCSC,UASIC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5       ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1                TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      COMMON /SOLAR/ S(35)
      LOGICAL IFIRST
      DATA IFIRST/.TRUE./
      IF(.NOT.IFIRST) GOTO 10
      IFIRST = .FALSE.
C  CALCULATE THE DESIGN FAN EXIT ENTHALPY
      TEXIT = A(18)
      RHEXIT = A(19)
      RHRMAX = A(21)
      PVSE = PVSF(TEXIT)
      PVE = RHEXIT*PVSE/100.
      WE = .622*PVE/(BARP-PVE)
      HEXIT = .24*TEXIT+(1061.+.444*TEXIT)*WE
   10 CONTINUE
```

```
C  COMPUTE THE ENTHALPY OF THE RETURNING DUCTS
      DO 100 I = 1,NZONE
      IF(RH(I) .GT. RHBMAX) RH(I) = RHBMAX
      PVSZ = PVSF(TZ(I))
      PVZ = RH(I)*PVSZ/100.
      WZ = .622*PVZ/(BARP-PVZ)
      HZ(I) = .24*TZ(I)+(1061.+.444*TZ(I))*WZ
  100 CONTINUE
C  CALCULATE THE AMBIENT AIR ENTHALPY
      PVA = PVSF(DEWP)
      WA = .622*PVA/(BARP-PVA)
      HA = .24*TAMB+(1061.+.444*TAMB)*WA
      RETURN
      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

```
      SUBROUTINE FUSION
C  THIS ROUTINE COMPUTES THE AMOUNT OF HEAT OF FUSION IN THE STORAGE
C  AND KEEPS TRACK OF THE ICE BUILT UP AND TEMPERATURE CHANGE
C
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEWP,IBUFLG,TCOVER
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1               TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      COMMON /SOLAR/ S(35)
      QMFUSE = 143.6*RMCSC
      DTFUSE = 0.
C  CALCULATE THE HEAT OF FUSION IN THE STORAGE
      IF(TSTORC .GT. 32.0 .AND. QFUSE .LE. 0.) GOTO 1020
      IF(TSTORC .LT.32.0 .AND. QFUSE .GE. QMFUSE) GOTO 1020
      IF(TSTORC .LT. 32.0) GOTO 1010
      QXCEED = RMCSC*(TSTORC-32.0)
      QFUSE = QFUSE -QXCEED
      IF(QFUSE .GE. 0.) GOTO 1015
      DTFUSE = QFUSE/RMCSC
      QFUSE = 0.
      GOTO 1015
 1010 QXCEED = RMCSC*(32.0-TSTORC)
      QFUSE = QFUSE + QXCEED
      IF(QFUSE .LE. QMFUSE) GOTO 1015
      DTFUSE =-(QFUSE-QMFUSE)/RMCSC
      QFUSE = QMFUSE
 1015 TSTORC = 32.0 +DTFUSE
 1020 CONTINUE
C  RESET STORAGE TEMPERATURE FOR OUTPUT PURPOSE
      X(NSTATE-1) = TSTORC
      IF(QFUSE .LE. QCFUSE) GOTO 1100
      QCFUSE = QFUSE
      CTIME = S(5)
      MCDAY = S(4)
      MONTHC = IMONTH
 1100 CONTINUE
      RETURN
      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

```
      SUBROUTINE CHARGE(MODEC,QAVAIL,QCOLCT)
      COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
     2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
     3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
     4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
     5      ,UASTH,DEXP,IHUFLG,TCOVER
      COMMON /HVACS/ HA, HEXIT, HZ(11), QLS(11), QLL(11), NZONE,
     1               TZ(11),RH(11), QFUSE, QMFUSE, QELEQ
      COMMON /SOLAR/ S(35)
      COMMON /SIZING/ QCDS,QHDS,QHCONS,HDAY,HCOLL,ATOTAL,NROWS,LROW
     1               ,NSERES,LCOLL,QCCONS,QCLCON
      COMMON /FLOW/ MDOTCC, MDOTCS
      REAL LCOLL,LROW
      DIMENSION TITER(10),QITER(10)
      LOGICAL TFIRST
      DATA TFIRST/.TRUE./
      REAL MDOTCC,MDOTCS,MCMIN,MCMAX
      IF(.NOT.TFIRST) GO TO 10
      TFIRST = .FALSE.
      E = 4.
      SERES = FLOAT(NSERES)
      BOILPT = A(53)
      MSTEP = A(74)
      TZERO = A(76)
      ULPIP1=A(79)
      ULPIP2=A(80)
      PLOSS1 = EXP(-ULPIP1/MDOTCC)
      PLOSS2 = EXP(-ULPIP2/MDOTCC)
      MCMIN = AMIN1(MDOTCS,MDOTCC)
      MCMAX = AMAX1(MDOTCS,MDOTCC)
      QUO = MCMIN/MCMAX
      UAX = A(55)
      IF(QUO .GE. 1.) GOTO 5
      EXPCS = EXP(-(1. - QUO)*UAX/MCMIN)
      ECS = (1. - EXPCS)/(1. - QUO*EXPCS)
      GOTO 7
    5 ECS = UAX/(MCMIN+UAX)
    7 TCIN1 = TSTORC
   10 CONTINUE
      DO 130 N=1,MSTEP
      DO 120 K=1,2
      MSTEP1 = N
      TCIN2 = TAMB + PLOSS1*(TCIN1 - TAMB)
      QCSQFT = 0.
      QCOLCT = 0.
      TITER(1) = TCIN2
      DO 110 ISERES=1,NSERES
      CALL COLECT(TITER(ISERES),QCSQFT,QAVAIL,0)
      QITER(ISERES) = QCSQFT*AREA/SERES
      TCOUT1 = TITER(ISERES) + (QITER(ISERES)/MDOTCC)
      TITER(ISERES+1) = TCOUT1
  110 QCOLCT = QCOLCT + QITER(ISERES)
      TCOUT2 = TAMB + PLOSS2*(TCOUT1 - TAMB)
```

```
      IF(TCOUT2 .LT. BOILPT) GO TO 115
      TCOUT2 = BOILPT
  115 TPIN1 = TCOUT2 - (MCMIN/MDOTCC)*(TCOUT2 - TSTORC)*ECS
      IF(K .EQ. 2) GO TO 120
      ERR1 = TPIN1 - TCIN1
      IF(ABS(ERR1) .LT. TZERO) GO TO 150
      TONE = TCIN1
      TCIN1 = TCIN1 + E*SIGN(1.0,ERR1)
  120 CONTINUE
      ERR2 = TPIN1 - TCIN1
      SLOPE = (ERR2 - ERR1)/(E*SIGN(1.0,ERR1))
      DELTA = -ERR1/SLOPE
      TCIN1 = TONE + DELTA
  130 CONTINUE
      WRITE(9,140) S(5),S(4),MSTEP
  140 FORMAT(12H WARNING, AT,F9.4,7H ON DAY,I4,6H TCIN1
     1       24H DOES NOT CONVERGE AFTER,I6,11H ITERATIONS)
  150 TCIN1 = TPIN1
      QCOLCT = MDOTCC*(TCOUT2 - TCIN1)
      IF(TCOUT2 .LT. (TSTORC+3.)) QCOLCT = 0.
      RETURN
      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
```

```
      C
            FUNCTION PVSF(X)
            DIMENSION A(6),B(4),P(4)
            DATA A/-7.90298,5.02808,-1.3816E-7,11.344,8.1328E-3,-3.49149/
            DATA B /-9.09718,-3.56654,0.876793,0.0060273/
            T=(X+459.688)/1.8
            IF (T.LT.273.16) GO TO 10
            Z=373.16/T
            P(1)=A(1)*(Z-1.)
            P(2)=A(2)*ALOG10(Z)
            Z1=A(4)*(1-1/Z)
            P(3)=A(3)*(10**Z1-1)
            Z1=A(6)*(Z-1)
            P(4)=A(5)*(10.**Z1-1.)
            GO TO 20
      10     Z=273.16/T
            P(1)=B(1)*(Z-1.)
            P(2)=B(2)*ALOG10(Z)
            P(3)=B(3)*(1.-1./Z)
            P(4)=ALOG10(B(4))
      20     SUM=0
            DO 30 I=1,4
      30     SUM=SUM+P(I)
            PVSF=29.921*10.**SUM
            RETURN
            END
```

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

ELAPSED TIME (SEC) .19 LINES/MINUTE 8031

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

```
      C
            SUBROUTINE INPUT
            COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
           2        DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
           3        IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
           4       ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
           5       ,UASTH,DEWP,IBUFLG,TCOVER
            COMMON /SCHDL/ TWELL(12),MHOTW(24),PEOPLE(24)
            DIMENSION LABEL(10),MARGIN(13)
            REAL MHOTW,LIGHT
            CHARACTER LABEL*6, MARGIN*6
            MAXA = 0
            READ(5,500) MARGIN
            WRITE(9,1000) MARGIN
        100 READ(5,2000) N, DUM, LABEL
            IF(N .LE. 0) GO TO 200
            IF(N .GT. MAXA) MAXA = N
            A(N) = DUM
            WRITE(9,3000) N, A(N), LABEL
            GO TO 100
        200 READ(5,20) (TWELL(I),I=1,12)
            READ(5,20) (MHOTW(I),I=1,24)
            READ(5,20) (PEOPLE(I),I=1,24)
            WRITE(9,913) TWELL,MHOTW,PEOPLE
        913 FORMAT(2X,22HWELL WATER TEMPERATURE,2X,12F8.3/
           12X,22H     HOT WATER SCHEDULE,2X,12F8.3/26X,12F8.3/
           22X,22H     OCCUPANCY SCHEDULE,2X,12F8.3/26X,12F8.3)
            READ(5,4000) NTABLE
            WRITE(9,5000) NTABLE
         20 FORMAT(V)
            RETURN
        500 FORMAT(13A6)
       1000 FORMAT(1H1,17H INPUT PARAMETERS,4X,13A6//)
       2000 FORMAT(I5,F15.0,10A6)
       3000 FORMAT(3H A(,I3,1H),G15.5,3X,10A6)
       4000 FORMAT(20I4)
       5000 FORMAT(///40H OUTPUT TABLE AND PLOTS FOR DAYS LISTED ,20I4)
            END
```

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

ELAPSED TIME (SEC) .22 LINES/MINUTE 10224

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

```
      C
            SUBROUTINE STEP
            COMMON /CTRL/ A(183), NTABLE(20), X(50), XDOT(50), IRTYPE,
           2       DT, CTHETA, NSTATE, TIME, TSTORC, TSTORH, AREA,IWKDAY,
           3       IWORKD, IYEAR, IMONTH, IDAY, IHOUR, TAMB, BARP, IHOL
           4      ,RMCSC,UASTC,QCFUSE,CTIME,MCDAY,MONTHC,ISIZNG,RMCSH
           5      ,UASTH,DEWP,IBUFLG,TCOVER
            COMMON /SOLAR/ S(35)
            CALL DERIV
      C     INTEGRATE STATE VARIABLES
            IF (TIME.LT.1.E-06) GO TO 5
            DO 300 N=1,NSTATE
        300 X(N)=X(N)+XDOT(N)*DT
          5 CONTINUE
            TIME = TIME + DT
            S(5) = S(5) + DT
            RETURN
            END
```

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

ELAPSED TIME (SEC) .14 LINES/MINUTE 7230

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

```
      C
            SUBROUTINE CBOUTPUT(ARRAY,ISTART,I,J,NAME)
            DIMENSION ARRAY(I,J), NAME(J)
            CHARACTER NAME*6
            M = J/8
            MLAST = MOD(J,8)
            IF(MLAST .NE. 0) M = M + 1
            IF(MLAST .EQ. 0) MLAST = 8
            DO 200  MM = 1,M
            J1 = 8*(MM-1) + 1
            J2 = J1 + 7
            IF(MM .EQ.M) J2 = J1 + MLAST - 1
            WRITE(9,1000)(NAME(JJ), JJ = J1,J2)
            DO 100  NN = ISTART,I
            IF(ISTART .GT. 1 .OR. I .GT. 1)
           1              WRITE(9,2000) NN,(ARRAY(NN,JJ), JJ = J1,J2)
            IF(ISTART .EQ. 1 .AND. I .EQ. 1)
           1              WRITE(9,3000)(ARRAY(NN,JJ),JJ = J1,J2)
        100 CONTINUE
        200 CONTINUE
            RETURN
       1000 FORMAT(//5X,8(4X,A6,3X)/)
       2000 FORMAT(I4,8(2X,1PE11.4))
       3000 FORMAT(4X,8(2X,1PE11.4))
            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

```
C
      SUBROUTINE SUN(MODE)
      COMMON /SOLAR/ S(35)
      DIMENSION A0(5),A1(5),A2(5),A3(5),B1(5),B2(5),B3(5)
      DATA A0/.302,-.0002,368.44,.1717,.0905/
      DATA A1/-22.93,.4197,24.52,-.0344,-.0410/
      DATA A2/-.229,-3.2265,-1.14,.0032,.0073/
      DATA A3/-.243,-.0903,-.109,.0024,.0015/
      DATA B1/3.851,-7.351,.58,-.0043,-.0034/
      DATA B2/.002,-9.3912,-.18,0.,.0004/
      DATA B3/-.055,-.3361,.28,.0008,-.0006/
      REAL LAT,LATD,LONG,MERID,LOND
C     S(1)= LATITUDE,DEGREES(+NORTH,-SOUTH)
C     S(2)= LONGITUDE,DEGREES(+WEST,-EAST)
C     S(3)= TIME ZONE NUMBER
C              STANDARD  TIME        DAYLIGHT  SAVING TIME
C      ATLANTIC        4                     3
C      EASTERN         5                     4
C      CENTRAL         6                     5
C      MOUNTAIN        7                     6
C      PACIFIC         8                     7
C     S(4)= DAYS(FROM START OF YEAR)
C     S(5)= TIME,HOUR AFTER MIDNIGHT)
C     S(6)= DAYLIGHT SAVING TIME INDICATOR
C     S(8)= CLEARNESS NUMBER
C     S(11)=SUN RISE TIME  (HOURS AFTER MIDNIGHT)
C     S(12)=SUN SET TIME
C     S(13)=COSZ    DIRECTION COSINES
C     S(14)=COSN    DIRECTION COSINES
C     S(15)=COS(S)  DIRECTION COSINES)
C     S(16)=ALPHA   DIRECTION COSINES NORMAL TO SURFACE
C     S(20)=SOLAR ALTITUDE ANGLE, RADIANS
C     S(21)=SOLAR AZIMUTH ANGLE, RADIANS
C     S(22)=DIFFUSE SKY RADIATION ON HORIZONTAL SURFACE
C     S(23)=TOTAL HORIZONTAL RADIATION ITH
C     S(24)=DIRECT NORMAL RADIATION
C     S(28)=SUN DECLINATION ANGLE DELTA, RADIANS
C     S(29)=EQUATION OF TIME ,HOURS
C     S(30) = SOLAR FACTOR A
C     S(31) = SOLAR FACTOR B
C     S(32) = SOLAR FACTOR C
C     S(35)=SOLAR HOUR ANGLE OMEGA, RADIANS
      DATA  RPH/0.261799388/
      PI=3.14159265
      TWOPI=6.28318531
      IF(MODE .NE. 0) GO TO 15
C     COMPUTE DECLINATION, EQUATION OF TIME, APPARENT SOLAR CONSTANT,
C     ATMOSPHERIC EXTINCTION COEFFICIENT, SKY DIFFUSE FACTOR,
C     AND SUN RISE AND SUN SET TIMES ONCE EACH DAY.
      X=2*PI/366.*S(4)
      C1=COS(X)
      C2=COS(2*X)
      C3=COS(3*X)
```

```
      S1=SIN(X)
      S2=SIN(2*X)
      S3=SIN(3*X)
      DO 10 K=1,5
      KS=(K-1)+28
   10 S(KS)=A0(K)+A1(K)*C1+A2(K)*C2+A3(K)*C3+B1(K)*S1+B2(K)*S2
     1+B3(K)*S3
      S(28) = S(28)*PI/180.0
      S(29)=S(29)/60.
      LATD=S(1)
      LONG=S(2)
      MERID=15*S(3)
      LOND=LONG-MERID
      Y = S(28)
      YY=LATD*PI/180.
      HP=-SIN(Y)/COS(Y)*SIN(YY)/COS(YY)
      TR=12/PI*ARCOS(HP)
      S(11)=(12-TR)-S(29)+LOND/15.
      S(12) = S(11) + 2.0*TR
C     COMPUTE DAILY CONSTANTS
      TYY=SIN(YY)/COS(YY)
      TY=SIN(Y)/COS(Y)
      CY=COS(Y)
      SY=SIN(Y)
      CYY=COS(YY)
      SYY=SIN(YY)
      ACHP=ARCOS(HP)
      HP1 = ARCOS(HP)
      X1=ABS(HP1)
      GO TO 130
C     COMPUTE THE FOLLOWING SUN PARAMETERS ON EACH DT CALL
   15 CONTINUE
C    COMPUTE SOLAR HOUR ANGLE
      H = -RPH*(S(5)-12+S(3)+S(29)-S(6)) + S(2)*PI/180.0
      S(35) = H
C    IS THE SUN UP
      X2=ABS(H)
      IF (X1-X2) 130,20,20
C    COMPUTE SOLAR DIRECTION COSINES
   20 S(13)=SYY*SY+CYY*CY*COS(H)
      S(14) = CY*SIN(H)
      S(15)=-SYY*CY*COS(H)+CYY*SY
C     COMPUTE SOLAR ALTITUDE AND AZIMUTH
   50 S(20)=ARSIN(S(13))
      S(21)=(PI-ARCOS(S(15)/COS(S(20))))*SIGN(1.0,H)
C     COMPUTE RADIATION INTENSITY
      CALL FXOPT(89,1,1,0)
      S(24)=S(30)*S(8)*EXP(-S(31)/S(13))
      CALL FXOPT(89,1,0,0)
      S(22)=S(32)*S(24)
      S(23) = (S(32) + S(13))*S(24)
      GO TO 150
  130 S(24)=0.
```

```
107          S(22)=0.
108          S(23)=0.
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     PLOTTR 074426
                      SIZING  153774     FAN    074422     HVACS  153676     CTRL   153162
073476 03/01/79 LPPL LPPLOT  073476
      BLOCK COMMON    .DATA.  072540     PLOTTR 074426
071500 03/01/79 CSIZ CSIZE   071500
      BLOCK COMMON    .DATA.  070464     CTRL   153162
067640 03/01/79 COLE COLECT  067640
      BLOCK COMMON    .DATA.  067520     FLOW   074500     SOLAR  074434     SIZING 153774     CTRL   153162
066442 03/01/79 DERI DERIV   066442
      BLOCK COMMON    .DATA.  064300     HVACS  153676     SCHDL  064204     WEATHR 074502     SOLAR  074434
                      CTRL    153162
063704 03/01/79 WKDA WKDAY   063704
                      .DATA.  063630
063324 03/01/79 HOLD HOLDAY  063324
                      .DATA.  063314
061460 03/01/79 HVAC HVAC    061460
      BLOCK COMMON    .DATA.  061200     SOLAR  074434     SCHDL  064204     SIZING 153774     FAN    074422
                      HVACS   153676     CTRL   153162
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
057306 03/01/79 CHAR CHARGE  057306
      BLOCK COMMON    .DATA.  057160     FLOW   074500     SIZING 153774     SOLAR  074434     HVACS  153676
                      CTRL    153162
057012 03/01/79 PVSF PVSF    057012
                      .DATA.  056740
056470 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 CBOUTP  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     OUTP   052402     DMAND  052374     ACES   052342     BILL   052266
                      FUEL    051674     ECON   051250
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    ENTRY LOCATION

047552 03/01/79 DCAL DCALC  047552
       BLOCK COMMON  .DATA. 047530     DMAND  052374     ECON   051250
046052 03/01/79 FUEL FUELCO 046052
       BLOCK COMMON  .DATA. 045720     ACES   052342     BILL   052266     FUEL   051674     ECON   051250
045576 03/01/79 BILL BILLIN 045576
       BLOCK COMMON  .DATA. 045550     BILL   052266
043300 03/01/79 OUTP OUTPUT 043300
       BLOCK COMMON  .DATA. 042420     OUTP   052402     ACES   052342     FUEL   051674     ECON   051250
041734 03/01/79 ACES ACESCO 041734
       BLOCK COMMON  .DATA. 041500     ACES   052342     ECON   051250

                          SUBPROGRAMS OBTAINED FROM SYSTEM LIBRARY

041312 76/06/11 FWRP .CE.L. 041373     .FEXIT 041312     .WLIST 041376     .WLEND 041410     .FDSLD 041411
                     .ABRT  041371     EXIT   041312
041134 76/06/11 FALC .FDSGT 041134     .FDSRL 041244     .FDSCH 041305
041130 76/06/11 FSTP .FDSET 041130     FDUMP  041131     FDEBUG 041131
040766 76/01/05 FDXP .FDXP2 041015     DPOW   041015     .FXP5  040766     .FXP6  040770     .FDXP3 041002
                     .FXP4  041006
040554 77/03/14 FDLG DLOG   040554     DLOG2  040576     DLOG10 040565     .DLG10 040570     .DLOG  040557
                     .DLOG2 040602
040360 76/01/05 FDEX DEXP   040360     DEXP2  040372     DEXP10 040365     .DEXP  040363     .DEXP2 040375
040214 75/09/10 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
037660 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
037066 76/01/05 FEXP EXP    037066     EXP2   037100     EXP10  037073     .EXP2  037103     .EXP   037071
                     .EXP1  037066
036752 74/05/19 FSLO .FSLO. 036752     .FSDO. 036757     .FSLI. 036763     .FSDI. 036767     .FSII. 036773
                     .FSIO. 036777     .FSRI. 037003     .FSRO. 037007     .FS2I. 037013     .FS2O. 037017
                     .FSBI. 037027     .FSBO. 037033     .FSCI. 037037     .FSCO. 037037     .FX2I. 037023
                     .FX2O. 037025
035520 76/10/21 FRDB .FRDB. 036153     .FWRB. 035713     .FBLT. 036452     .FBDT. 036436     .FRLR. 036336
                     .FWLR. 036371     .FBBC. 036301     .FBBCA 036277     .FBLI. 036470     .FBSI. 036470
                     .FXDI. 036470     .FBDI. 036472     .FBLO. 036474     .FBSO. 036474     .FXDO. 036474
                     .FBDO. 036476
035254 77/03/30 FRDD .FRDD. 035440     .FWRD. 035441     .FPUN. 035442     .FENC. 035443     .FDEC. 035444
                     .FRCD. 035445     .FPRN. 035446     .FRTN. 035447     .FFIL. 035450     .DBCNV 035451
                     .BDCNV 035475     ..ABLK 035267     .DCOMP 035316     ..LNSZ 035326     ..A37R 035424
                     .PRNIT 035271     .ASTRK 035614     ..TC   035273     .POINT 035313     .SIGN  035314
                     .FRMTR 035514     .FRMTZ 035514     .PUINT 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  035513     ..A31  035347
                     ..A27  035344     ..A32  035372     ..A33  035374     ..A34  035375     ..A35  035376
                     ..A37  035420     ..A40  035425     ..A41  035437     .LPRCH 035262     .CMACH 035263
```

ORIGIN	DATE	MODULE	ENTRY LOCATION		ENTRY LOCATION		ENTRY LOCATION		ENTRY LOCATION		ENTRY LOCATION	
			.ECHR	035264	.UPPRT	035265	.UPPRF	035266	.LWRT	035265	.LWRF	035266
			.OCT60	035261	..A52	035254	.FXMC.	035255	..A51	035256	.RCMIB	035346
031464	77/12/05	FDIO	.FRD	034423	.FWRT	034336	.FPN	034331	.FNC	034552	.FDC	034604
			.FCD	034423	.FPR	034335	.FFL	034535	.FRT	034514	.IO1	034157
			.IO5	034271	.LBCTR	035161	.EFDBC	035244	.FCNVI	032277	.FCNVR	032306
			.FCNV2	032372	.SKPB1	032256	.INCTR	035246	.CKSTA	032501	.FMSC1	031517
			.FMSC2	031505	.FMSC4	031522	.FMSC5	031557	.FMSC6	031531	.EFFLG	035245
			.SVRG	031470	.RETIN	031503	.GTARG	034346	.SXIT	031574	.INIT2	034413
			.LNBGN	034632	.SKPB0	032265	.VLIST	032212	.CSCFP	031612	.CFFXD	031602
			.FEFLT	031664	.FDFLT	031663	.CSLSH	034142	.CDCPT	032401	.CSCFM	031610
			.CCMMA	031626	.CRPAR	031722	.CLPAR	031666	.LBUFF	035162	.SKPB3	032273
			.CKSTP	032462	..CKST	032473	.DATUM	035144	..STOP	032721	.VCOMA	033374
			..CCR	033407	NASTRK	034716	YASTRK	034721	.CM1	032531	.FWSZ	035233
			.FCNV.	032356	.STP	032705	.FCNVD	032315	.FCNVL	032325	.FCNVC	032334
031006	75/09/10	FBST	.FBST.	031006								
030732	74/01/11	FEOF	.FEOF.	030732								
030566	74/07/22	FSLW	.FSLEW	030566								
030364	75/11/25	FEFT	.FEFT.	030364	.FRWT.	030371	.FEFTS	030376				
030040	09/01/73	FXEM	FXEM	030051	.FXEM.	030050	.F.XE	030061	F.XMC	030210	.TAB1	030340
			.LSTMS	030350	.KIND	030164	.BUGG	030163	.MXERR	030052	..FX1	030054
			..FX2	030076	..FX3	030104	..FX10	030173	.LRG	030120	..FX8	030104
			..FX9	030075	.CLLR	030314	.EYDEE	030316	..FX4	030106	..FX5	030105
			..FX6	030151	..FX7	030200						
026620	77/03/30	FXER	.FXM.	026640	F.XM	027315	ANYERR	027466	FXOPT	027350	FXDVCK	027410
			.FGERR	027337	FXALT	027425	.FXALT	027437	S.REG.	026630	.FERTN	027314
			.FUFIN	030032	FXDV	030000	FXFDV	027776	FXCODE	027272	.TSMS	027441
			.MSX	027445	.FXPNT	027173	.FXTRC	026735	.FXSW1	027274	.FXSW2	027300
			.FXSW3	027304	ERRLK	027474	.FLTPR	027476				
025540	76/02/27	FXIT	.FTERM	026540	FTERM	026540	JEXIT	026540	.JEXIT	026540		
025760	76/02/10	FOPE	.FOPEN	026007	.FBAD.	026002	.FXOP.	026232	.FGTFB	026003	.FJOV.	026005
025522	07/04/65	FOPT	.FIOO.	025636								
025320	75/09/10	FSLI	.FSLII	025352	.FSLIO	025322	.FSLIB	025320	.FXFLG	025354		
025202	03/28/72	FCHA	.FCHMA	025206	.FCHM.	025210	.FCHM	025211				
025052	75/09/10	FSTU	.FSETU	025104	.SETU.	025104	.RCOV	025073	.FBFTB	025062	FPARAM	025052
			.FMDR.	025074	.FTL	025102	.FLTX1	025102	.LINSZ	025075		
025042	75/09/16	FBCD	.ASCB.	025042	.ASCB	025042						
024640	03/05/73	FTAB	.GTAB.	024640								
024634	75/09/16	FMXN	.MXNO	024634	.NMXNO	024635	.GFLG	024636	.FRENT	024637		
024354	74/12/03	GBSR	.GBSRC	024354	.GABSR	024354	BSREC	024354				
024272	01/03/66	GWAI	.GWAIT	024272	.GAWAI	024272	WAIT	024272				
024242	01/03/66	GSTI	.GSTIN	024242	SETIN	024242						
024130	76/02/12	GSTO	.GSTOT	024130	SETOUT	024130						
024060	07/07/69	GWRC	.GWTRC	024060	.GAWTR	024060	WTREC	024060				
023320	77/05/03	GGTB	.GGTBK	023320	GETBK	023320	.GGET	023322	GET	023322	.GAGTB	023320
			.GAGET	023322	.GR001	023324						
023312	07/07/69	GRMT	.GOPNR	023312	.GCLSR	023312	.GGETR	023312	.GPUTR	023312		
022552	77/07/11	GPTB	.GCOPY	022552	COPY	022552	.GPTBK	022555	PUTBK	022555	.GPUT	022560
			PUT	022560	.GACOP	022552	.GAPTB	022555	.GAPUT	022560	.GFR67	023265
			.GPSAV	022563								
022454	01/03/66	GPSZ	.GPTSZ	022454	.GAPTS	022454	PUTSZ	022454				

79267

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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 GCLO .GCLSE 021126     .GACLS 021126     .GR185 021240     .GR186 021346     .GR178 021245
                     CLOSE  021126     .GBCLS 021126
021026 07/07/69 GREL .GRLSE 021026     .GARLS 021026     RELSE  021026
020642 73/12/03 G20R .GR200 020642
020554 77/04/07 G25R .GR225 020554
020476 75/02/12 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     NORRPT 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      137264
                     $       TAPE9   08,X1D,,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 = 6828†, 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	DELTAT 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 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)	36.800	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 APERATURE 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.	0.063	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 TAHLE 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(63),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	QCB	QHB
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	QCBTOT	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	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	1.6456E 08	0.	5.2516E 06	1.6132E 06	1.4282E 06
6	4.5336E 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 06	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 08	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.	2.7795E 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	1.6721E 07	1.4096E 07	0.	2.4620E 06	3.0987E 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	-1.8546E 06	-1.9048E 07	-2.2594E 07	-1.4252E 07	-2.3948E 07	-1.0269E 08	-3.8096E 06	-4.0787E 06
7	-1.9455E 06	-2.7358E 07	-3.1552E 07	-2.1009E 07	-3.1334E 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 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	QCOMPA	FPOWER	PUMPC	QHGAS	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.	1.6877E 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.

	QELECT	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	QDIRCT	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	QCBTOT	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	QCOMPA	FPOWER	PUMPC	QHGAS	QHOIL
-1.5421E 07	-3.0048E 07	-2.4886E 08	0.	1.6779E 08	0.	0.	0.

QELECT	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 72.50BTUS/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 = 0.20000E 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 6184. FT2
EACH COLLECTOR HAS DIMENSION OF: 3.0 * 6.0FT2, AND THE COLLECTORS ARE PLACED 1 IN SERIES
THIS INFO. MUST BE PUT IN THIS PROGRAM PROPERLY' FOR COLLECTOR SIZING

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 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             DELTAT 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)
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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)	1029.0	FLAT PLATE SHADING LENGTH OF COLLECTOR ROW
A(65)	5.0000	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)	36.000	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 APERATURE 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=ELECTRICACES)*
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.	0.063	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 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	NE. 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	NE. 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	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	QCBTOT	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	4.0822E 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 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 06	-8.8394E 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	QCOMPA	FPOWER	PUMPC	QHGAS	QHOIL
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.

	QELECT	QEACES	QEHCON	QECCON
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	IDHC	ITHC	QDIRCT	QAVAIL	QCOLCT	QCB	QHB
1.9888E 05	1.1253E 05	1.7198E 05	1.4449E 05	1.1253E 09	3.5951E 08	-1.1418E 08	6.5118E 08

QDHW	QCBTOT	QHBTOT	QTAM3	BACKUP	QH1	QH2	QH3
2.6197E 07	-8.6351E 08	5.9573E 08	5.7571E 08	0.	3.1218E 07	9.9289E 07	1.2349E 08

QH4	QH5	QH6	QH7	QH8	QH9	QH10	QH11
1.3414E 08	1.1350E 08	0.	1.9854E 07	2.4699E 07	2.6829E 07	2.2701E 07	0.

QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
-1.0130E 05	-6.1557E 07	-1.7143E 07	-4.1160E 06	-1.8455E 07	-6.1822E 08	-1.2331E 07	-3.4286E 06

QC9	QC10	QC11	QCOMPA	FPOWER	PUMPC	QHGAS	QHOIL
-8.2319E 05	-3.6909E 06	-1.2364E 08	2.3685E 08	6.6183E 07	1.8754E 07	0.	0.

QELECT	QEACES	QEHCON	QECCON
5.6260E 08	2.3685E 08	0.	0.

```
 FINAL TEMP. IN HOT STORAGE BIN IS 119.5DEG F
 FINAL TEMP. IN COLD STORAGE BIN IS  32.0DEG 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 0.85750E 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	QHB
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

	QDHW	QCBTOT	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.	
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 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 06	-8.8394E 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	QCOMPA	FPOWER	PUMPC	QHGAS	QHOIL
1	-8.4312E 01	-6.6299E 04	-2.1426E 07	8.0661E 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	6.5700E 06	0.	0.
4	0.	-1.4038E-03	-2.0969E 05	1.7152E 06	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.

IDNC	IDHC	ITHC	QDIRCT	QAVAIL	QCOLCT	QCB	QHB
1.9898E 05	1.1253E 05	1.7198E 05	1.5072E 05	5.9530E 08	3.3260E 08	-1.1416E 08	6.5118E 08

QDHA	QCBTOT	QHBTOT	QTAMB	BACKUP	QH1	QH2	QH3
2.6197E 07	-8.6551E 08	5.9573E 08	5.7571E 08	0.	3.1218E 07	9.9289E 07	1.2349E 08

QH4	QH5	QH6	QH7	QH8	QH9	QH10	QH11
1.3414E 08	1.1350E 08	0.	1.9854E 07	2.4699E 07	2.6829E 07	2.2701E 07	0.

QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
-1.0130E 05	-6.1557E 07	-1.7143E 07	-4.1160E 06	-1.8455E 07	-6.1822E 08	-1.2331E 07	-3.4286E 06

QC9	QC10	QC11	QCOMPA	FPOWER	PUMPC	QHGAS	QHOILI
-8.2319E 05	-3.6909E 06	-1.2364E 08	2.4026E 08	6.6183E 07	2.5205E 07	0.	0.

QELECT	QEACES	QEHCON	QECCON
5.6905E 08	2.4026E 08	0.	0.

```
 FINAL TEMP. IN HOT STORAGE BIN IS 119.6DEG F
 FINAL TEMP. IN COLD STORAGE BIN IS  32.0DEG 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 0.404AT TIME12.000 ON DAY 147 ( MONTH  2 )
  THE FINAL ICE RATIO IN STORAGE IS 0.009

  WITH THE PACKING FACTOR OF  0.40AND THE STORAGE' CAPACITY OF 1014054.9 BTUS/F
  THE MINIMUM' COLLECTOR AREA REQIREMENT 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

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

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.

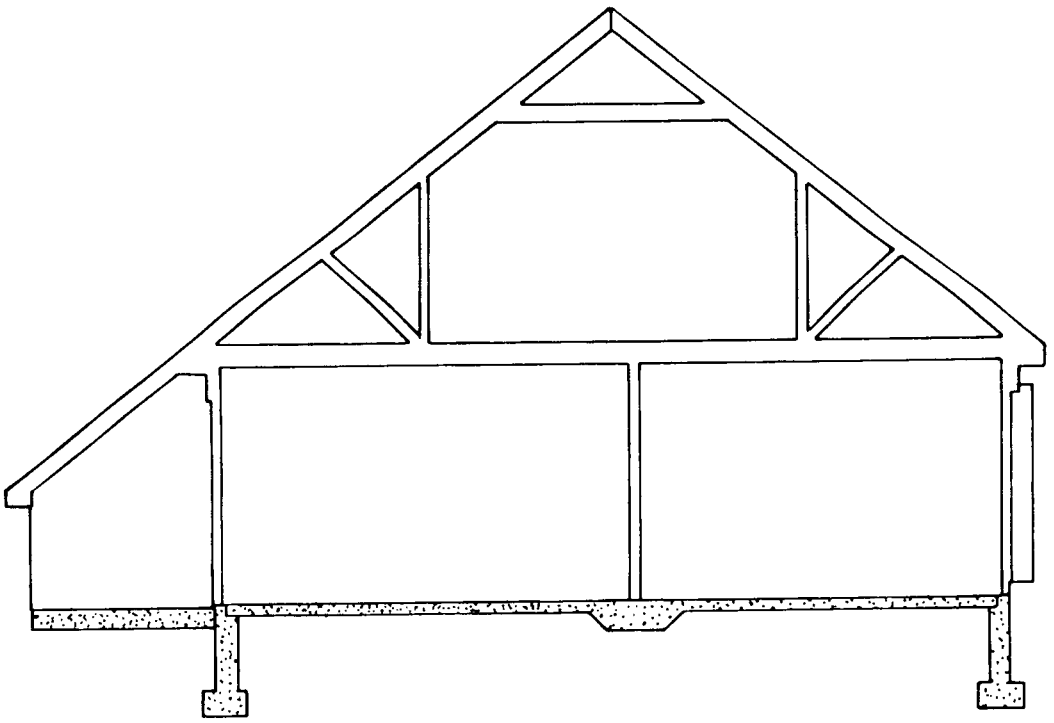

Figure E-1. Elevation of Philadelphia and Atlanta Single-Family Residences

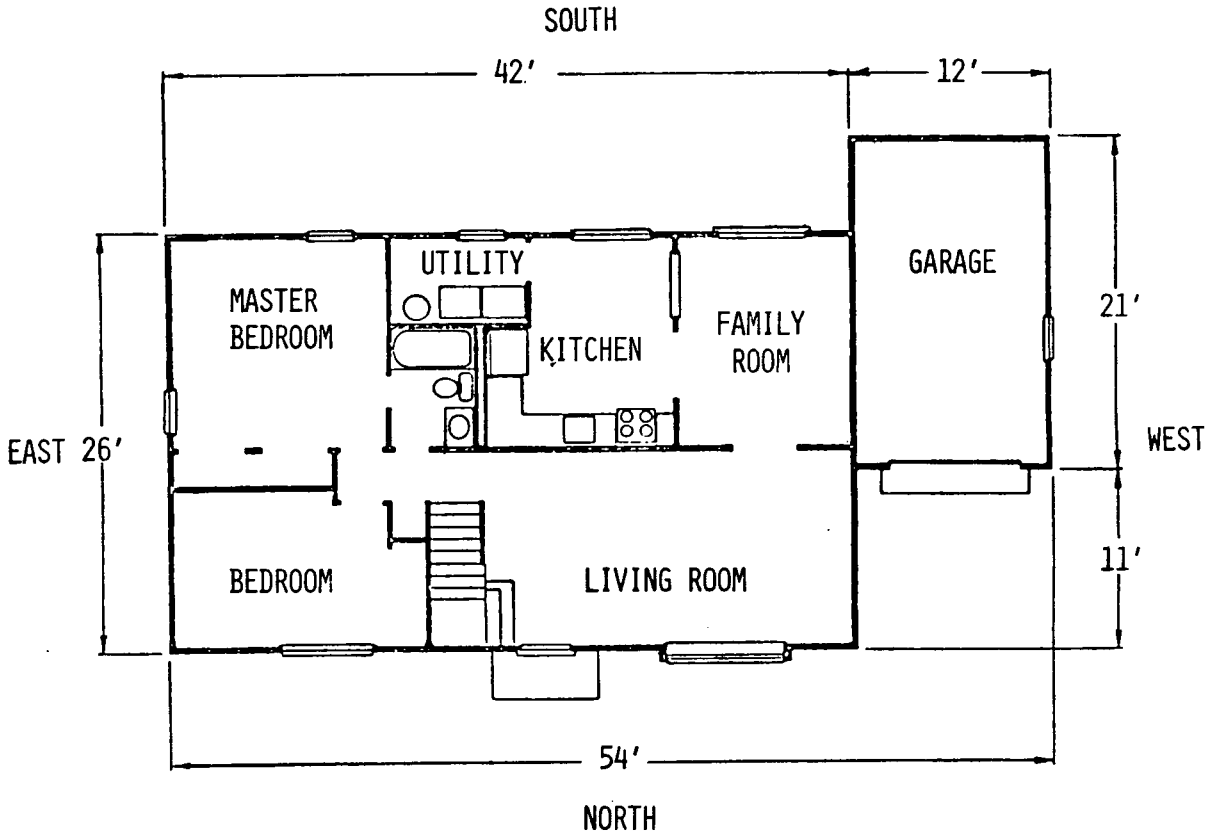

Figure E-2. First Floor Plan of Philadelphia and Atlanta Single-Family Residences

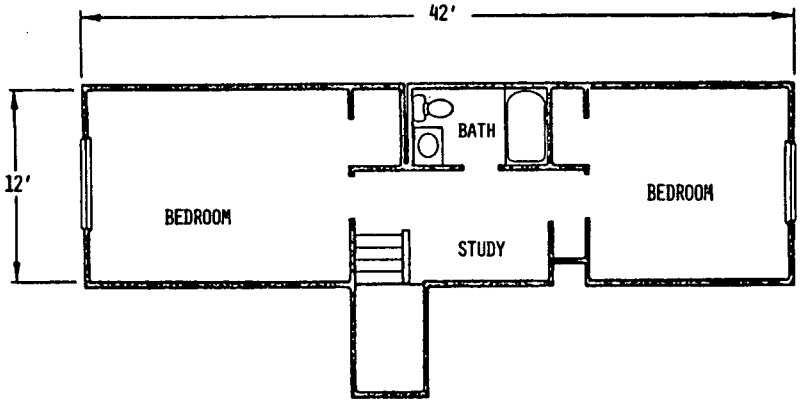

Figure E-3. Second Floor Plan of Philadelphia and Atlanta Single-Family Residences

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

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft^3)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft^2-°F/Btuh)	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	18.00	0.310	-----	1/2 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 Btu/ft^2-°F-hr

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

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	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 Btu/ft^2-°F-hr

Table E-4. Composition - Roof Above 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	0.000	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 Btu/ft^2-°F-hr

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

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	0.060	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 Btu/ft^2-°F-hr

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

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	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 Btu/ft^2-°F-hr

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

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	0.060	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 Btu/ft^2-°F-hr

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

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	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 Btu/ft^2-°F-hr

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

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	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 Btu/ft^2-°F-hr

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

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	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 Btu/ft^2-°F-hr

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

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	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 Btu/ft^2-°F-hr

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

Component	Area (ft^2)	U ($Btu/hr\text{-}ft^2\text{-}^oF$)	Density lbm/ft^3	Thermal Capacitance ($Btu/^oF$)
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

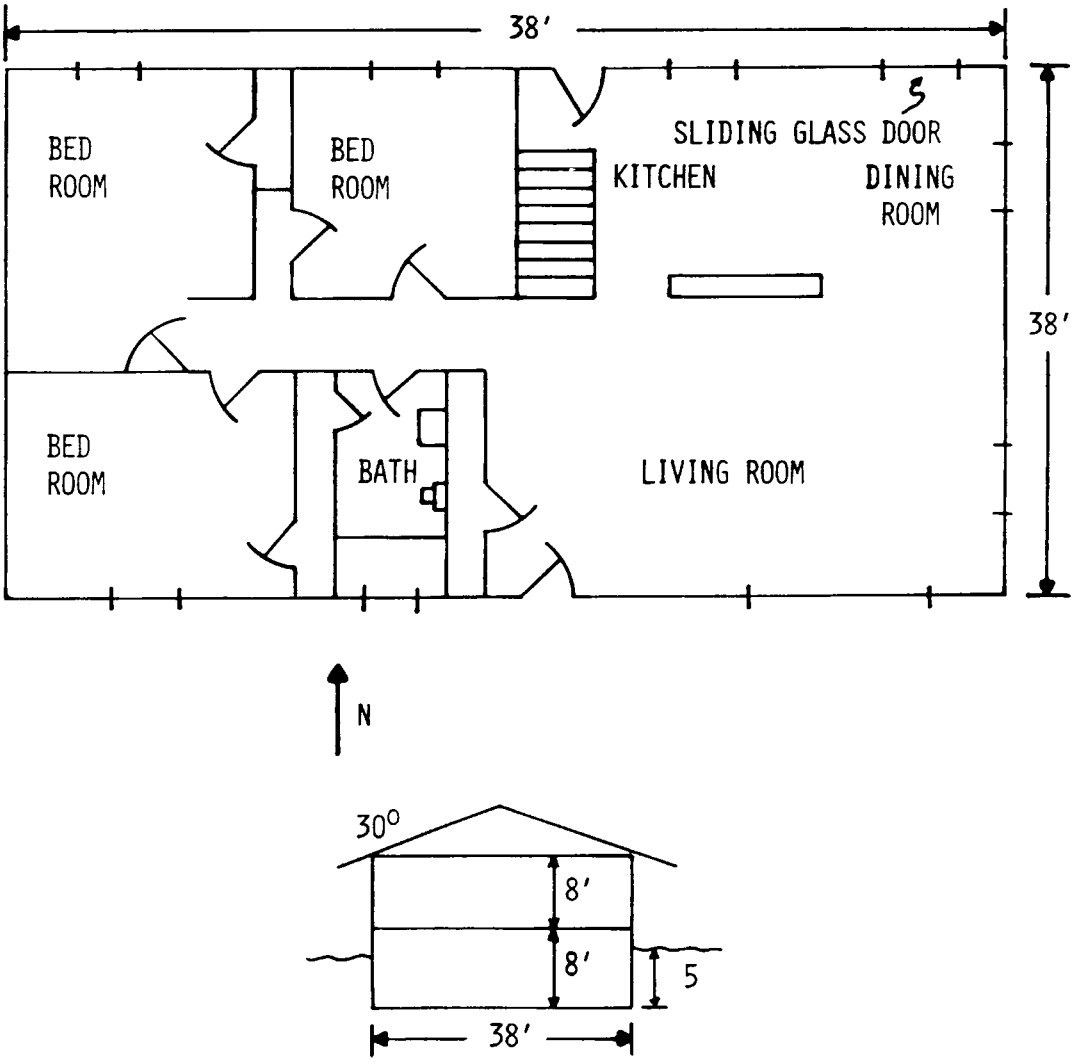

Figure E-4. Minneapolis Single-Family Residence

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 Btu/ft^2-°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 Btu/ft^2-°F-hr

Table E-15. Composition - Roof 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	0.070	-----	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/ft^2-°F-hr

Table E-16. Composition - Attic Wall 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	0.259	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/ft^2-°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 Btu/ft^2-°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 Btu/ft^2-°F-hr

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

Component	Area (ft^2)	U ($Btu/hr\text{-}ft^2\text{-}^oF$)	Density lbm/ft^3	Thermal Capacitance ($Btu/^oF$)
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

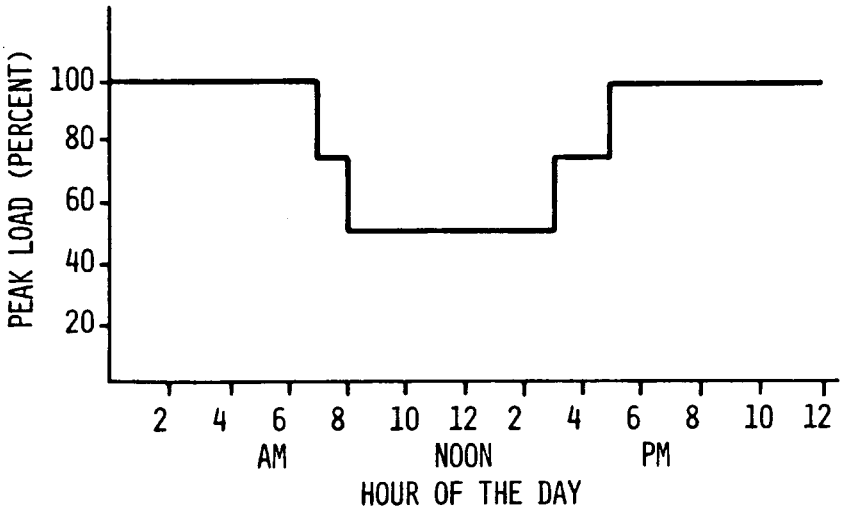

Figure E-5. Single-Family Residence People Load Schedule

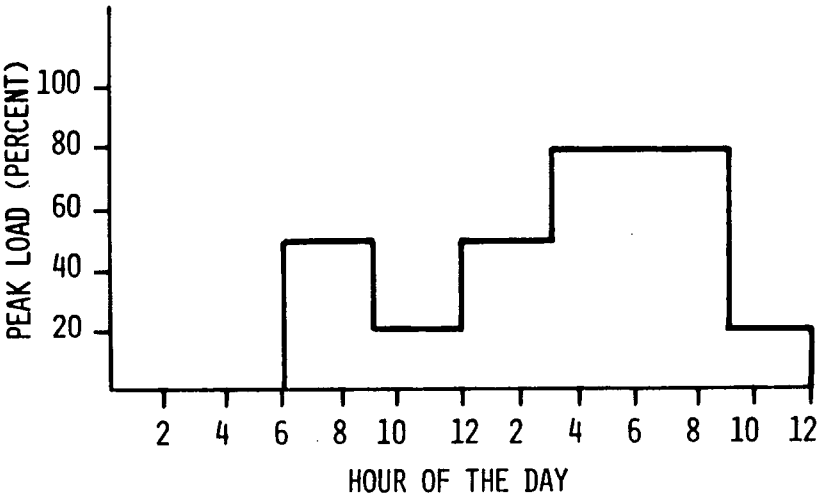

Figure E-6. Single-Family Residence Lighting Load Schedule

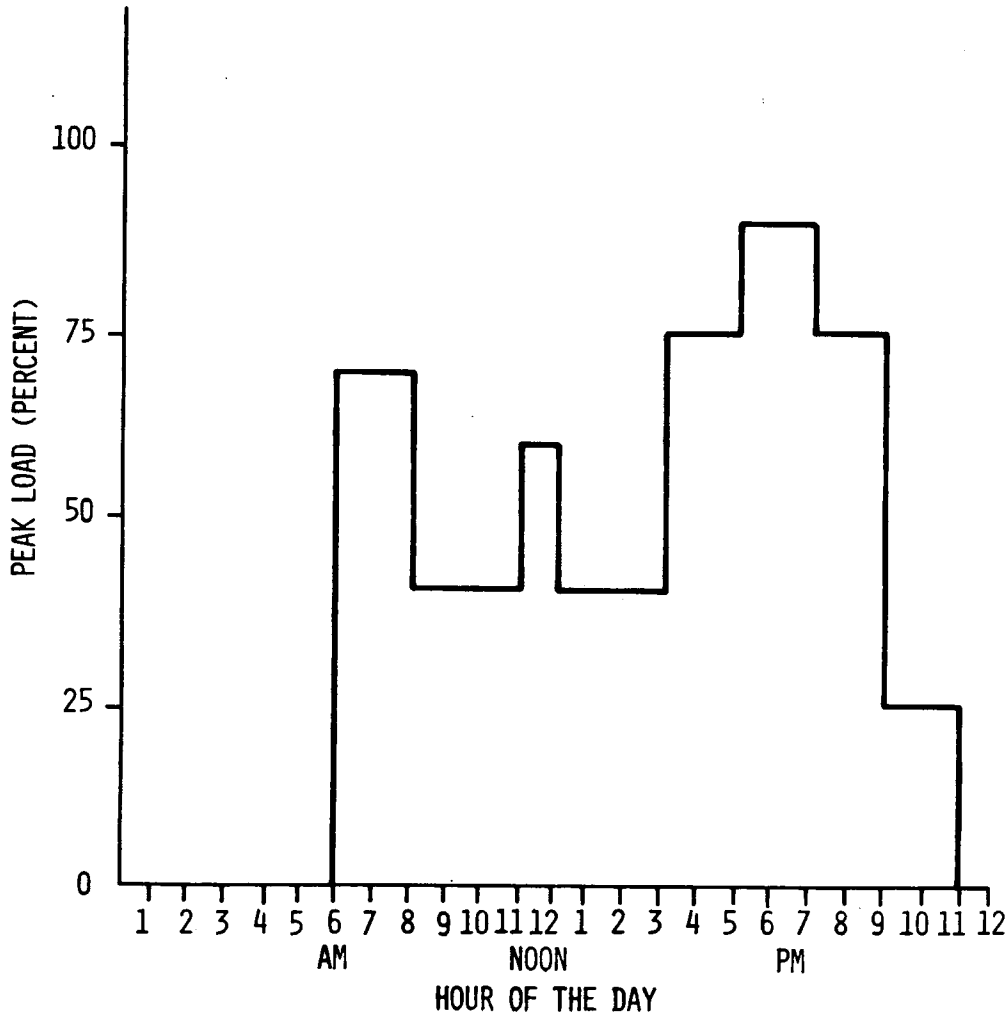

Figure E-7. Single-Family Residence Appliance Schedule

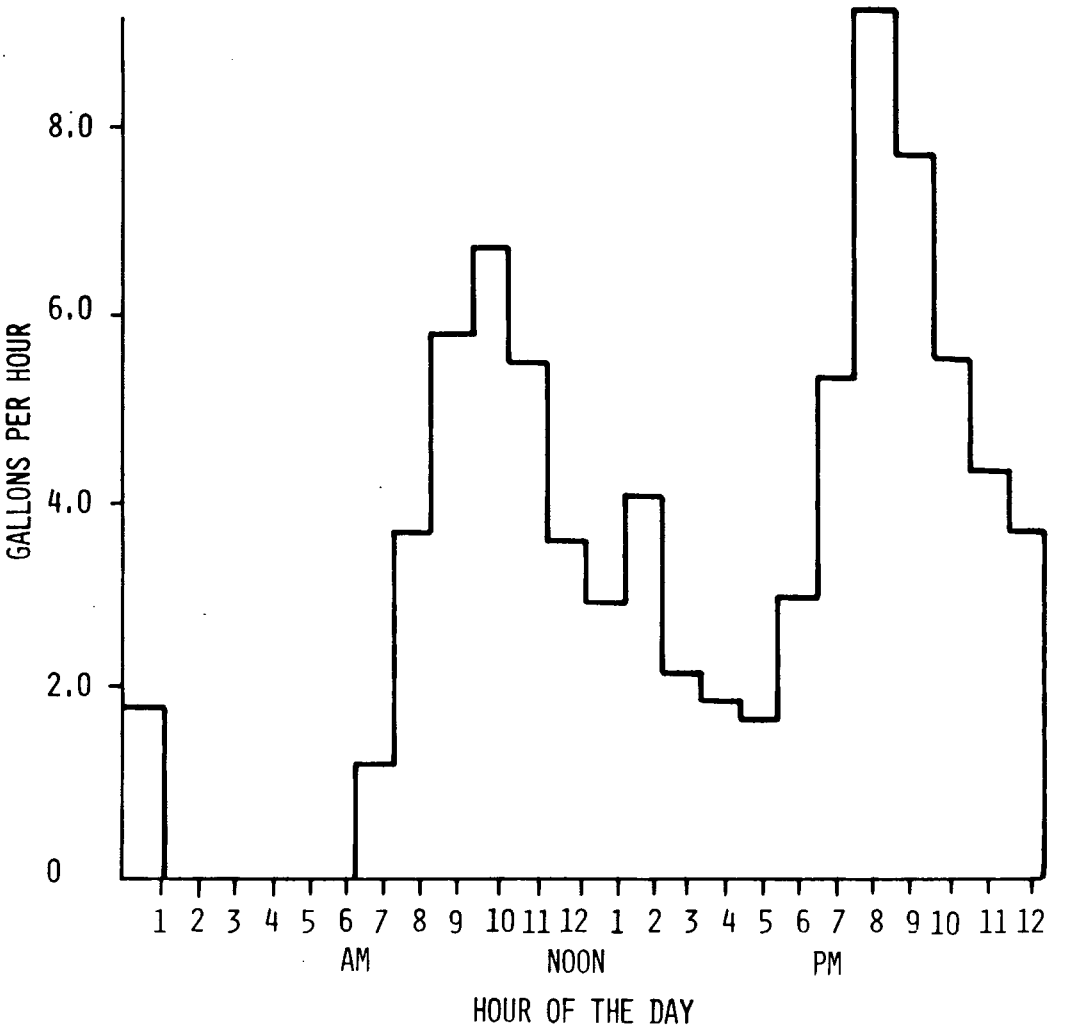

Figure E-8. Single-Family Residence Hot Water Schedule

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.

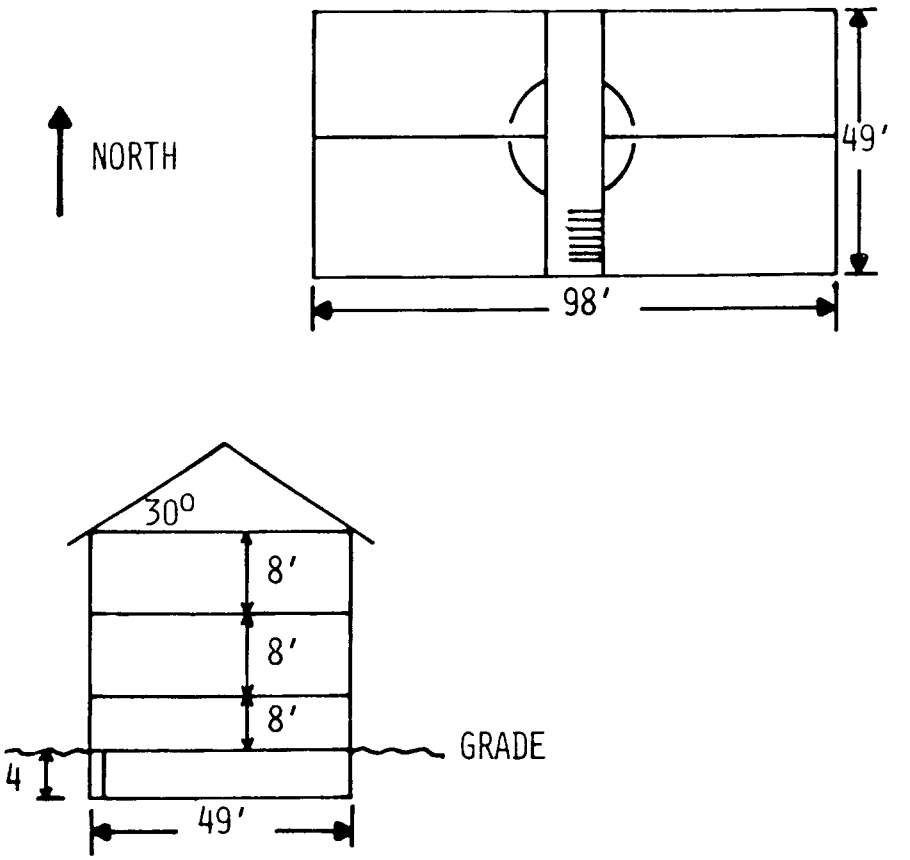

Figure E-9. Elevation and Floor Plan of the Multi-Family Residence

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

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft - °F)	Density (lb/ft³)	Specific Heat (Btuh/lb-°F)	Thermal Resistance (ft²-°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 - °F)	Density (lb/ft³)	Specific Heat (Btuh/lb - °F)	Thermal Resistance (ft²- °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/ft^2-°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/ft^2-°F-hr

Table E-24. Composition - Basement Floor to Earth

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft- °F)	Density (lb/ft³)	Specific Heat (Btuh/lb - °F)	Thermal Resistance (ft²- °F /Btuh)	Description of Layers
1	.250	------	140	.20	1.60	Concrete Block
2	.062	------	----	----	3.00	Styrofoam

Thermal Conductance, U = .15 Btu/ft²-°F-hr

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

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft²)	Specific Heat (Btuh/lb-°F)	Thermal Resistance (ft²- °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 Btu/ft²-°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
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 }	PARAMETERS USED IN NEWTON SOLUTION ROUTINE
FXD }	
FXP }	
SIDN }	

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 }	PARAMETERS IN NEWTON SOLUTION ROUTINE
FXD }	
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 (Btuh/ft-^{o}F)	Density (lb/ft^{3})	Specific Heat (Btu/lb-^{o}F)	Thermal Resistance (ft^{2}-^{o}F/Btuh)	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 Btu/ft^{2}-^{o}F-hr

*Double glazed (1/2" air gap) door/windows have R-Value of 0.96 ft^{2}-^{o}F/Btuh

Table E-28. Composition - Roof (Minneapolis)

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-^{o}F)	Density (lb/ft^{3})	Specific Heat (Btu/lb-^{o}F)	Thermal Resistance (ft^{2}-^{o}F/Btuh)	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 Btu/ft^{2}-^{o}F-hr

Table E-29. Composition - Floor (Minneapolis)

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft²-°F/Btuh)	Description of Layers
1	0.6667	1.35	61.00	0.22	0.96	Concrete

Thermal Conductance, U = 1.041 Btu/ft²-°F-hr

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

Layer No.	Thickness (ft)	Thermal Conductivity (Btuh/ft-°F)	Density (lb/ft³)	Specific Heat (Btu/lb-°F)	Thermal Resistance (ft²-°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 Btu/ft²-°F-hr

*Double glazed (1/2" air gap) doors/windows have R-value of 0.96 ft²-°F-Btuh

Table E-31. Composition - Roof (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	.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 Btu/ft^2-°F-hr

Table E-32. Composition - Floor (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	.6667	------	61.00	0.22	0.96	Concrete

Thermal Conductance, U = 1.041 Btu/ft^2-°F-hr

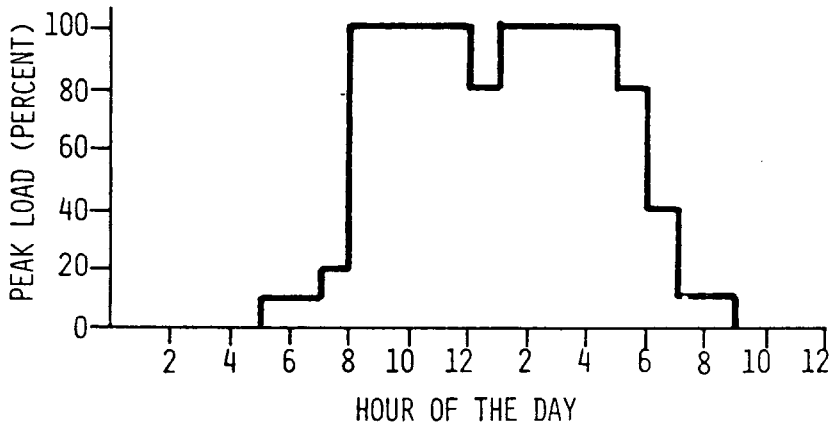

Figure E-15. Commercial Building People Load Schedule

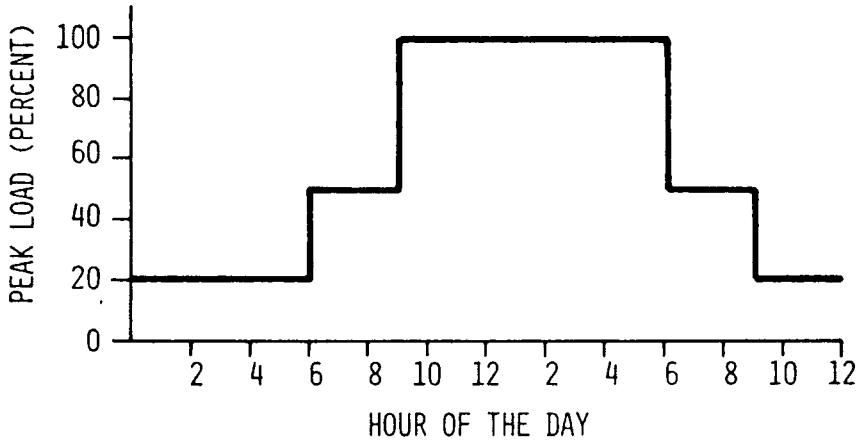

Figure E-16. Commercial Building Lighting Load Schedule

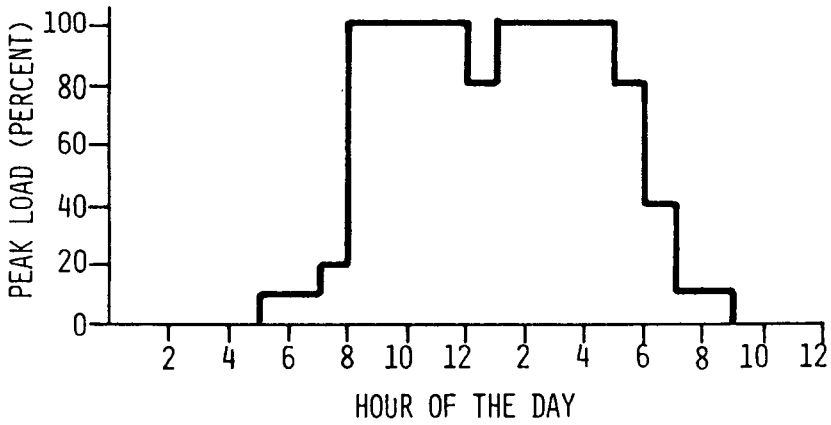

Figure E-17. Commercial Building Hot Water Schedule

APPENDIX F

LIST OF THE MAJOR VARIABLES USED IN THE COMPUTER PROGRAMS

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)	DIRECTION COSINES
S(15)	DIRECTION COSINES
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)		HOUR
S(6)		DAYLIGHT SAVINGS TIME FLAG
S(8)		CLEARNESS NUMBER
S(11)		SUN RISE TIME
S(12)		SUNE SET TIME
S(13)	}	
S(14)	}	DIRECTION COSINES
S(15)	}	
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
H		S(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
XLIGT	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 } BB }	COEFFICENT USED IN DESCRIBING THE CONVECTOR PANEL
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 }	PARAMETERS USED IN NEWTON SOLUTION ROUTINE
FXD }	
FXP }	
SIDN }	

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 }	PARAMETERS IN NEWTON SOLUTION ROUTINE
FXD }	
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
IBHM1		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
VOLUMEE	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
CONV1

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
GAS	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 ENERY 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 }	VARIABLES NEEDED FOR NEWTON ITERATION
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 }	VARIABLES USED TO INSURE MINIMUM USE OF HEAT PUMP DURING SUMMER OPERATION
STAR }	
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 CHARGE 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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BIBLIOGRAPHY

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