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DOE-2: A COMPUTER PROGRAM FOR BUILDING ENERGY SIMULATION

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☞ ☞ HANDS ON ☜ ☜

☞ BDL Summary Corrections

On the last two pages of this newsletter we have reprinted pages 24 and 42 of the 2.1D *BDL Summary*, with corrections noted on each page. Please use these as replacement pages.

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☞ Conferences and Workshops

Mar 11-14, 1991 — *SCOOP-West*

Seminars and Conference in Object-Oriented Programming, to be held in San Jose, CA. Sponsors: Journal of Object-Oriented Programming and the Wang Institute of Boston University. Contact SCOOP-West, Wang Institute of Boston University, 72 Tyng Road, Tyngsboro, MA 01879.

Jun 2-7, 1991 — *Building Systems Automation and Integration*

Symposium presented by the University of Wisconsin-Madison, Madison, WI. Organized by the Thermal Storage Applications Research Center of the University of Wisconsin-Madison. Contact Prof. Charles E. Dorgan, Building Systems Symposium, Thermal Storage Applications Research Center, University of Wisconsin-Madison, 150 E. Gilman Street, Suite 1200, Madison, WI 53703-1493.

Aug 20-22, 1991 — *Building Simulation '91*

in Nice, France. Second World Congress on Technology Improving the Energy Use, Comfort, and Economics of Buildings Worldwide. Sponsor: IBPSA, the International Building Performance Simulation Association. Co-Sponsors: AFME, BAG, BPA, BEPAC, CEC-DGXII, DOE, EPRI, GRI, JRC, NOVEM, USA-CERL, PWC. Contact: Philippe Geril, IBPSA-BS'91, Coupure Links 653, B-9000 Ghent, Belgium. FAX: 32.91.24.40.93. E-MAIL: SCSI@BGERUG51.BITNET

Two Examples of Functional Inputs

by

Gerhard Zweifel

The following two examples of functional inputs were written by Gerhard Zweifel, a visiting researcher in the Simulation Research Group from the Swiss National Laboratory for Materials Testing (EMPA). They were developed at EMPA for special applications according to Swiss requirements and, therefore, use metric inputs. These examples should be of interest to DOE-2 users; their aim and usage is self-explanatory.

Example #1:

```
$ FUNCTION FOR UNDELAYED INTERNAL GAINS FROM EQUIPMENT
$ (100 % CONVECTIVE), GERHARD ZWEIFEL, EMPA, JUNE 21 1990

INPUT LOADS INPUT-UNITS=METRIC    ..
 .
 .
 .
 ......... = SPACE
          .
          .
          FUNCTION = (*NONE*,*EQUIP-DIRECT*)     ..
 .
 .
 .
END ..

FUNCTION NAME = EQUIP-DIRECT    ..

ASSIGN MZ=MZ QSUMW=QSUMW ISCHR=ISCHR    ..

CALCULATE    ..

C     UNDELAYED LOAD FROM EQUIPMENT IN W/M2:
C     CAUTION: VALUE IS TAKEN  I N   A D D I T I O N  TO
C     VALUES OF 'EQUIPMENT-KW' OR 'EQUIPMENT-W/AREA'!
C     INSERT 0 FOR THESE, IF WHOLE EQUIPMENT LOAD TO BE
C     UNDELAYED, BUT EQUIPMENT-SCHEDULE IS USED DESPITE!
C
C       INSERT THE DESIRED VALUE HERE (W/M2)
C
      EQUIP = 8.

C CONVERSION TO BTU/HR*SQF
      EQUIP = EQUIP/3.15248
```

```
C ACCESS TO AREA
      ASP = ACCESS(MZ+16)

C ACCESS TO SCHEDULE VALUE
      INDEX = IACCESS(MZ+44)
      ISCHED = IACCESS(INDEX)+ISCHR
      SCHED = ACCESS(ISCHED)

C MULTIPLICATION WITH AREA AND SCHEDULE, AND ADD
      QEQ = EQUIP*ASP*SCHED
      QSUMW = QSUMW + QEQ

      END

END FUNCTION ..

COMPUTE LOADS ..
----+----1----+----2----+----3----+----4----+----5----+----6----+
```

Example #2:

```
$ FUNCTION FOR CALCULATION OF AN OUTDOOR RESET ZONE TEMPERATURE
$ COOLING SETPOINT  -  GERHARD ZWEIFEL, EMPA, JUNE 1 1990

INPUT SYSTEMS INPUT-UNITS = METRIC   OUTPUT-UNITS = METRIC ..
 .
 .
 .
 ........ = ZONE
                .
            .
        FUNCTION = (*OUT-RES-SETP*,*NONE*)   ..
 .
 .
 .
END ..

FUNCTION NAME = OUT-RES-SETP ..

ASSIGN ZP2=ZP2 ISCHR=ISCHR DBT=DBT ..

CALCULATE ..

C     ACCESS TO THE RIGHT POINTER OF THE ZONE TEMPERATURE SETPOINT:
      INDEX = IACCESS(ZP2+55)
      IC    = IACCESS(INDEX)+ISCHR
```

```
C       EXPLANATION OF THE VARIABLES:
C
C                                       TOUTH
C                                         ^
C                                           ------ TSETH
C                                         /
C                                        /
C                   TSETL -----
C                              ^
C                            TOUTL
C
C        INSERT VALUES FOR BASEL ENERGY REGULATIONS

      TSETH = 28.
      TSETL = 24.
      TOUTH = 32.
      TOUTL = 24.

C CONVERT TO FAHRENHEIT AND CALCULATE
      TSETH = TSETH*9./5.+32.
      TSETL = TSETL*9./5.+32.
      TOUTH = TOUTH*9./5.+32.
      TOUTL = TOUTL*9./5.+32.

      TSET = AMIN(TSETH,TSETL+(TSETH-TSETL)/(TOUTH-TOUTL)*(DBT-TOUTL))
      TSET = AMAX(TSETL,TSET)

C STORE IN AA-ARRAY
      TSET = STORE(TSET,IC)

      END

END-FUNCTION   ..

COMPUTE SYSTEMS     ..

----+----1----+----2----+----3----+----4----+----5----+----6----+
```

Using DOE-2 Input Macros for Enhancing the Treatment of Residential Windows

by

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Input Macros, a capability first appearing in DOE-2.1D, can be used to enhance DOE-2's treatment of residential windows. In the Loads input below, macros are used to improve the SHADING-COEF input so that the impacts of window frames, sashes and mullions are properly considered by DOE-2.

The principal element of the problem is the following. When SHADING-COEF is supplied to DOE-2 by the user, it is most often the shading coefficient of the glass unit, only, and does not consider the opaque frame components. An error develops when DOE-2 applies the entered SHADING-COEF not only to the glass unit, which represents only 73 to 78% of the wall or roof opening, but also to the window sash, mullion and frame, which combined represent the remaining 22 to 27% of the opening. This problem can be remedied by the use of Input Macros, which can be used to develop a shading coefficient representative of the entire window unit: glass plus frame, sash and mullion. It should be noted that this difficulty does not arise when inputting GLASS-CONDUCTANCE. When DOE-2 requests GLASS-CONDUCTANCE, it is seeking a system value which represents the overall conductance of the entire window unit (glass plus frame, sash and mullion). Such an overall GLASS-CONDUCTANCE is not difficult to obtain. It is available either through existing test results or by adjustment of the U-value output of LBL's WINDOW-3.1 public domain program.

In the following Loads input, Input Macros are used to develop "shading coefficients" for window frames (the term "frame" will be used below to mean all of the non-glass portions of a window: the frame, sash and mullion). Then, the frame's "shading coefficient" is combined with the glass shading coefficient, using a weighted average, to yield an overall SHADING-COEF which can be used more accurately by DOE-2 to represent the entire window (glass plus frame).

The numbered paragraphs, below, outline this and several other enhancements which can be made to DOE-2 using Input Macros.

1. **Representation of window frame in SHADING-COEF input.**
   A "shading coefficient" is developed for the window frame and combined with the shading coefficient for the glass unit using a weighted average based on fraction of total wall or roof opening. The frame "shading coefficient" is developed using input values from lines 194, 197, and 198. (In line 198, absorptance must

be entered. Thus, the color of the frame is considered in the calculation of the frame's "shading coefficient.") These values are manipulated in lines 246, 247, and 248, to yield a frame "shading coefficient" in line 249. See Note 6, line 341, and the ASHRAE reference within this note for more information on the calculation of SolAir Temperature. The shading coefficient for the glass, input in line 191, and the "shading coefficient" for the frame, available on line 249, are weighted according to their decimal fractions of the total opening on lines 250 and 251, respectively, and are combined as keyword inputs on lines 262, 266, 270, 274, 278, 282, 286, and 290. The macro-names up_s crn_sc_test and lo_scrn_sc_test refer to the shading coefficients of insect screens covering respectively, the upper half of the window and the lower half of the window. They will be explained in the next section. [Some macro-names are concluded with the abbreviations "test" and others with "ctrl." In the experimental design for which this file was developed, window characteristics were varied (tested) on the front of the building, but kept constant (controlled) as single pane, aluminum-frame windows on all other sides. For more information on the experimental design, contact the author.]

2. **Impacts of insect screens on SHADING–COEF and GLASS–CONDUCTANCE.** Through inputs on lines 199, 201, and 212 and through their "evaluations" on lines 262, 266, 274, 282, and 290, the impacts of insects screens are assessed. Note that the shading coefficients of the insect screens modify only the shading coefficients of the glass portions of the windows, not the frames. The U-value and GLASS–CONDUCTANCE of the windows are altered by the insect screens, through input on lines 200, 202, and 213 and through their "evaluations" on lines 263, 267, 275, 283, and 291. Only one shading coefficient for the screen may be entered. This limitation reduces accuracy somewhat, since the angular-dependence, and therefore the angular-variation, of the screen's solar transmittance is not considered. The shading coefficient chosen in this example is the shading coefficient occurring when the solar incidence is 30 degrees to normal. Macros could be developed, however, to vary the screen's shading coefficient for each orientation or for each window; but, through macros, shading coefficients cannot be varied according to the position of the sun as it changes by time-of-day and by season, throughout the simulation run. At various angles of solar incidence the shading coefficients for insect screens are the following:

	Angle of Solar Incidence	Shading Coefficient
Fibreglas insect screen	0°	0.67
	15°	0.66
	25°	0.63
	30°	0.62
	40°	0.60
	45°	0.58
Aluminum insect screen	0°	0.76
	15°	0.75
	25°	0.74
	30°	0.73
	40°	0.70
	45°	0.67

3. **GLASS–CONDUCTANCE can be derived automatically from WINDOW-3.1 output.**
   On lines 193 and 206, winter U-value, an output of LBL's WINDOW-3.1 program, is entered, then converted to GLASS–CONDUCTANCE, a required DOE-2 input, in lines 263, 267, 271, 275, 279, 283, 287, and 291.

4. **Window air leakage considered.**
   The FRAC–LEAK–AREA, line 177, of the Sherman-Grimsrud air infiltration model in DOE-2 is adjusted by macros, so that the impacts of window air leakage can be assessed. The inputs in lines 126 through 135 are used in the macros on lines 142 through 157 to calculate the total window leak area fraction (tot_win_frac) in line 159, the total leakage area in square feet of all windows and skylights divided by the conditioned floor area of the building. Refer to the notes on the right-hand sides of these lines for further information on the progression from cfm_lf_test in line 127 to tot_win_frac in line 159.

5. **GLASS–CONDUCTANCE adjusted for Non-vertical glass.**
   The winter U-value of a glass unit, and therefore its GLASS–CONDUCTANCE, is affected by its slope. Macros in lines 312 through 316 adjust the U-value of non-vertical windows and skylights, entered on line 303, to the appropriate GLASS–CONDUCTANCE for the slope of the roof in which the window or skylight resides. (Note that, because all of a ##set1 command, including the complete macro-name and the complete macro-text, must be placed on one line, a lengthy linear equation, which would not fit on one line, must be segmented into two parts, on lines 314 and 315.) WINDOW-3.1 also adjusts a window's U-value based on slope. So, if the entered U-value has already been adjusted for slope, the user should respond with a "1" (yes) on line 304, which on line 316 will cause the WINDOW-3.1-developed U-value to be used by DOE-2 and the macro-adjusted U-value to be ignored.

6. **Use of macros to aid calculation of overhang height.**
Using roof slope on line 299 as a variable, macros use this input to calculate roof height (called "rafter length") on line 377, overhang height on line 374 (given overhang depth on line 369), side wall height on line 375 (when there are cathedral ceilings), and house volume on line 376 (given floor area on line 370).

Finally, you will note that on lines 181, 293, and 452 the macro command ##clear appears. The PC versions of DOE-2 (I use MICRO-DOE2 prepared by ACROSOFT International, Inc.) are limited somewhat by the memory available for Input Macros. The regular DOS version of MICRO-DOE2 makes 2k available. The 2k limitation is overcome by designing the input file so that the macros are used as keyword inputs before the 2k limit is reached; then, they are cleared using the ##clear command. You will know when the macros have exceeded 2k; the run will abort, and an error message will appear in the BDL echo, indicating that the 2k limit has been exceeded.

Since all macros up to ##clear line will be deleted from memory, it is important that the user make use of these macros as keyword inputs before the ##clear line. The best way to explain the meaning of "make use of these macros as keyword inputs" is by example. Note that the macro-text 1700 of ##set1 floor_area 1700 in line 9 is used as an input for the keyword GROSS-AREA in line 26. It is also used in lines 151, 154 and 157. Macro-text 1700 is also used in other lines beginning with line 376. But, by line 181 the 2k limit has been reached, so the 2k memory allocated for macros must be cleared at this line. (##set1 floor_area 1700 has to be re-entered on line 370 for use on line 376 and beyond.)

In another example, a chain of input macros, beginning with lines 9 and 126 and ending with line 159, develops a macro-text which is used as input for the keyword FRAC-LEAK-AREA on line 177. Then, the macros are cleared on line 181.

The Extended DOS version of ACROSOFT's MICRO-DOE2 (requiring a 386 processor with 3 Meg of RAM) and the mainframe version of DOE-2 do not have the 2k limitation, so all macros can be located conveniently at the beginning of the input file, without any need for re-entering or repeating macros later.

The Extended DOS version of MICRO-DOE2 has 200k of memory allocated for Input Macros, and more space is easily made available, according to ACROSOFT manager Gene Tsai.

Please refer to the 2.1D *Supplement*, pp.1-32, for more information on Input Macros.

Sample Loads Input Incorporating Input Macros

```
          $ THIS INPUT FILE COPYRIGHTED (C) 1990 BY PHILIP WEMHOFF AND ASSOCIATES $

INPUT LOADS ..

$ FIRST PARAMETRIC RUN; HOUSE FRONT FACES NORTH $

          PARAMETER     AZIM  = 180  ..

##set1  floor_area  1700        $ Footprint dimensions: 50.5 feet x 33.6666 feet, 1:1.5 aspect $

TITLE     LINE-1 = *????????.INP = FILE NAME *
          LINE-2 = *PHILIP WEMHOFF & ASSOCIATES JACKSONVL FL*
          LINE-3 = *INPUT FILE COPYRIGHT 1990 PHILIP WEMHOFF*
          LINE-4 = *?????? PANE ?????, ALUM FRAME NO T-BREAK*
          LINE-5 = *LOAD 1=N 2=NE 3=E 4=SE 5=S 6=SW 7=W 8=NW*  ..


                          $ -----HEADING----- $

          ABORT                ERRORS ..
          DIAGNOSTIC           NO-ECHO .. $ "COMMENTS" FOR DEFAULTS AND INFO MESSAGES; RM II.17 $
          RUN-PERIOD           JAN 1 1991 THRU DEC 31 1991 ..
          BUILDING-LOCATION    LAT=30.30  LON=81.42  T-Z=5
                               AZIMUTH = AZIM  $ IF AZIM=0, FRONT OF BLDG FACES S; ANGLE BET Y & N $
                               GROSS-AREA=floor_area[]  $ BEPS REPORT NEEDS WHEN NON-COND SPACE $
                               SHIELDING-COEF=0.24      $ MODERATE LOCAL SHIELDING $
                               TERRAIN-PAR1=0.85        $ RURAL, LOW BLDGS, TREES $
                               TERRAIN-PAR2=0.20        $ RURAL, LOW BLDGS, TREES $
                               WS-TERRAIN-PAR1=0.85     $ RURAL, LOW BLDGS, TREES $
                               WS-TERRAIN-PAR2=0.20     $ RURAL, LOW BLDGS, TREES $
                               WS-HEIGHT=20             $ HEIGHT ABOVE GROUND OF WIND INSTRUMENT $
                               HOLIDAY=YES
                               DAYLIGHT-SAVINGS=YES ..

          LOADS-REPORT         VERIFICATION=(LV-A)
                               SUMMARY=(LS-B,LS-F)  ..


                          $ -----SCHEDULE----- $

OC-WD     =DAY-SCHEDULE        (1,8)     (1.)      (9,15)    (0.33)
                               (16,18)   (0.67)    (19,24)   (1.) ..
OC-WEH    =DAY-SCHEDULE        (1,24)    (1.)  ..
PEOPLE    =WEEK-SCHEDULE       (WD)  OC-WD     (WEH)  OC-WEH   ..
OCCUP     =SCHEDULE            THRU DEC 31  PEOPLE     ..
DAYINTSCH =DAY-SCHEDULE           (1)    (.024)     (2)    (.022)
                                 (3,5)   (.021)     (6)    (.026)
                                  (7)    (.038)     (8)    (.059)
                                  (9)    (.056)    (10)    (.060)
```

```
                                     (11)   (.059)   (12)   (.046)
                                     (13)   (.045)   (14)   (.030)
                                     (15)   (.028)   (16)   (.031)
                                     (17)   (.057) (18,19)  (.064)
                                     (20)   (.052)   (21)   (.050)
                                     (22)   (.055)   (23)   (.044)
                                     (24)   (.027) ..
INTLDSCH   =SCHEDULE              THRU DEC 31 (ALL) DAYINTSCH ..
DHW-1      =DAY-SCHEDULE           (1,5)    (.1)      (6,9)   (.17,.22,.44,.26)
                                 (10,11)   (.16)    (12,14)   (.20,.15,.13)
                                 (15,16)   (.13)    (17,19)   (.19,.21,.23)
                                 (20,24)   (.07) ..
HW-LDS-1   =SCHEDULE             THRU DEC 31 (ALL) DHW-1 ..


                        $ -----MATERIALS----- $

2.8FOAM-BD=MAT       TH=.0560 COND=.0200 DENS=1.8 S-H=.29 .. $ 1/2-IN R-2.8 INSULATION PANEL $
4.2FOAM-BD=MAT       TH=.0840 COND=.0200 DENS=1.8 S-H=.29 .. $ 3/4-IN R-4.2 INSULATION PANEL $
5.6FOAM-BD=MAT       TH=.1120 COND=.0200 DENS=1.8 S-H=.29 .. $ 1-IN R-5.6 INSULATION PANEL $
14.6POLYST=MAT       TH=.2917 COND=.0200 DENS=1.8 S-H=.29 .. $ 3.5-IN EXPAND POLYSTY R-4.16/IN $
11BATT-INS=MAT       TH=.2957 COND=.0250 DENS=.6  S-H=.2  .. $ R-11 BATT INSULATION, NOT COMP $
17.8-BATT =MAT       TH=.4450 COND=.0255 DENS=.6  S-H=.2  .. $ R-19 BATT COMP FROM 6.25 TO 5.5 IN $
19BATT-INS=MAT       TH=.5108 COND=.0250 DENS=.6  S-H=.2  .. $ R-19 BATT INSULATION, NOT COMP $
30BATT-INS=MAT       TH=.8065 COND=.0250 DENS=.6  S-H=.2  .. $ R-30 BATT INSULATION, NOT COMP $
FIB-SHEATH=MAT       TH=.0417 COND=.0316 DENS=18  S-H=.31 .. $ 1/2-IN FIBERBOARD SHEATHING $
WD-PANEL-1=MAT       TH=.0417 COND=.0667 DENS=34  S-H=.29 .. $ 1/2-IN WOOD PANEL SHEATHING $
WD-PANEL-2=MAT       TH=.0625 COND=.0667 DENS=34  S-H=.29 .. $ 3/4-IN WOOD PANEL SHEATHING $
2X4-STUD-1=MAT       TH=.2917 COND=.0667 DENS=32  S-H=.33 .. $ 2X4 STUD $
4X2-TRUS-1=MAT       TH=.1250 COND=.0667 DENS=32  S-H=.33 .. $ 2X4 CHORD, WIDE SIDE PRESENTED $
2X6-STUD-1=MAT       TH=.4583 COND=.0667 DENS=32  S-H=.33 .. $ 2X6 STUD $
GYP-BOARD =MAT       TH=.0417 COND=.0926 DENS=50  S-H=.2  .. $ 1/2-IN GYPSUM WALLBOARD $
T111-SIDE =MAT       TH=.0521 COND=.0667 DENS=34  S-H=.29 .. $ 5/8-IN T-111 WOOD PANEL SIDING $
ASPH-SHG-1=MAT       TH=.0208 COND=.0473 DENS=70  S-H=.30 .. $ ASPHALT SHINGLES $
ATTC-AIR-1=MAT       RES=3.1                              .. $ SEE 1989 ASHRAE FUND P. 22.11 $
CONCRETE-1=MAT       TH=.3333 COND=.7576 DENS=140 S-H=.2  .. $ 4-IN CONCRETE $
CONC-BLK-1=MAT       TH=.6667 COND=.6060 DENS=69  S-H=.2  .. $ 8-IN HEAVY WT BLOCK $
STUCCO-1/2=MAT       TH=.0417 COND=.4167 DENS=166 S-H=.2  .. $ 1/2-IN STUCCO FOR BLOCK $
CARP+PAD-1=MAT       RES=2.08                             .. $ W/FIBR PAD, 1.23 W/RUBBER $



                      $ -----CONSTRUCTIONS----- $

LAY-1      =LAYERS              MAT=(T111-SIDE,WD-PANEL-1,11BATT-INS,GYP-BOARD) ..
WALL-INSUL=CONS                 LAYERS=LAY-1  RO=2  ABS=0.75 ..     $ ROUGHNESS OF BRICK OR PLASTER $
                                $ ABSORPTANCE OF LIGHT GRAY OIL PAINT.  REFERENCE MANUAL P III.83-84 $

LAY-2      =LAYERS              MAT=(T111-SIDE,WD-PANEL-1,2X4-STUD-1,GYP-BOARD) ..
WALL-STUD =CONS                 LAYERS=LAY-2  RO=2  ABS=0.75 ..     $ REFERENCE MANUAL P III.83-84 $

LAY-3      =LAYERS              MAT=(ASPH-SHG-1,WD-PANEL-1,ATTC-AIR-1,19BATT-INS,
                                GYP-BOARD)  I-F-R=0.61 ..           $ FOR CEILINGS; .68 FOR WALLS $
ROOF-INSUL=CONS                 LAYERS=LAY-3  ABS=0.86 ..
```

```
LAY-4      =LAYERS            MAT=(ASPH-SHG-1,WD-PANEL-1,2X4-STUD-1,ATTC-AIR-1,
                              2X4-STUD-1,GYP-BOARD)  I-F-R=0.92 .. $ FOR FLOORS; .68 FOR WALLS $
ROOF-TRUSS=CONS               LAYERS=LAY-4  ABS=0.86 ..

LAY-5      =LAYERS            MAT=(CONCRETE-1,CARP+PAD-1)
                              I-F-R=0.92 ..
SLAB-1     =CONS              LAYERS=LAY-5 ..
DOOR-1     =CONS              U=0.629  ABS=0.78  ROUGHNESS=4 ..    $ REFERENCE MANUAL P III.83-84 $

LAY-6      =LAYERS            MAT=(GYP-BOARD,2X4-STUD-1,GYP-BOARD) ..
IN-WAL-STD=CONS               LAYERS=LAY-6 ..

LAY-7      =LAYERS            MAT=(GYP-BOARD,GYP-BOARD) ..
IN-WAL-CAV=CONS               LAYERS=LAY-7 ..


                  $ -----SPACE DESCRIPTION----- $

          $ MACRO INPUTS FOR WINDOW AND SKYLIGHT AIR LEAKAGE $
$ NOTE UNDER FRONT-RF-1=ROOF THAT SKYLIGHTS MAY BE DISABLED BY DOLLAR SIGN IN LEFT COLUMN $

##set1  gls_frac_test     0.7766 $ >>WARNING<<: ENTER HERE AND UNDER GLAZING; NOTE 4 $
##set1  cfm_lf_test       0.20   $ CFM PER LINEAR FOOT AT 25 MPH; FLORIDA CODE MIN = 0.34 $
##set1  num_sash_test     1      $ 1 FOR SINGLE HUNG, 2 FOR DOUBLE HUNG, 0 FOR FIXED $
##set1  gls_frac_ctrl     0.7766 $ >>WARNING<<: ENTER HERE AND UNDER GLAZING; NOTE 4 $
##set1  cfm_lf_ctrl       0.20   $ CFM PER LINEAR FOOT AT 25 MPH; FLORIDA CODE MIN = 0.34 $
##set1  num_sash_ctrl     1      $ 1 FOR SINGLE HUNG, 2 FOR DOUBLE HUNG, 0 FOR FIXED $

##set1  num_sky           4      $ NUMBER OF 24x48 SKYLIGHTS; 0 TO MAX OF 10 $
##set1  gls_frac_sky      1      $ >>WARNING<<: ENTER HERE AND UNDER SKYLIGHT; NOTE 4 $
##set1  cfm_lf_sky        0      $ CFM PER LINEAR FOOT AT 25 MPH; FLORIDA CODE MIN = 0.34 $

##set1  hous_frac         0.0005 $ TIGHT: 0.0003; AVERAGE: 0.0005; LOOSE: 0.0010 $


       $ DO NOT ALTER THE FOLLOWING MACROS; THEY ARE INTERMEDIATE STEPS $

##set1  crack_per_test  #[#[0.209712 * #[gls_frac_test[] * 15]] + 7.900]  $ CRACK LF FOR EACH TEST WIN $
##set1  tot_crack_test  #[num_sash_test[] * #[6.6666 * crack_per_test[]]] $ TOT CRACK LF, 6.7 TEST WIN $
##set1  crack_per_ctrl  #[#[0.209712 * #[gls_frac_ctrl[] * 15]] + 7.900]  $ CRACK LF FOR EACH CTRL WIN $
##set1  tot_crack_ctrl  #[num_sash_ctrl[] * #[9.4666 * crack_per_ctrl[]]] $ TOT CRACK LF, 9.5 CTRL WIN $
##set1  crack_per_sky   #[#[0.383047 * #[gls_frac_sky[] * 8]] + 8.992]    $ CRACK LF FOR EACH SKYLITE  $
##set1  tot_crack_sky   #[num_sky[] * crack_per_sky[]]                     $ TOT CRACK LF, ALL SKYLITES $

##set1  tot_cfm_test    #[tot_crack_test[] * cfm_lf_test[]] $ COMBINED CFM LEAKAGE OF ALL TEST WINDOWS $
##set1  leak_area_test  #[#[0.020661157 * tot_cfm_test[]] / 25] $ CONVERT CFM @ 25 MPH TO SF LEAK AREA $
##set1  win_frac_test   #[leak_area_test[] / floor_area[]]  $ TEST WIN LEAK AREA DIVIDED BY FLOOR AREA $
##set1  tot_cfm_ctrl    #[tot_crack_ctrl[] * cfm_lf_ctrl[]] $ COMBINED CFM LEAKAGE OF ALL CTRL WINDOWS $
##set1  leak_area_ctrl  #[#[0.020661157 * tot_cfm_ctrl[]] / 25] $ CONVERT CFM @ 25 MPH TO SF LEAK AREA $
##set1  win_frac_ctrl   #[leak_area_ctrl[] / floor_area[]]  $ CTRL WIN LEAK AREA DIVIDED BY FLOOR AREA $
##set1  tot_cfm_sky     #[tot_crack_sky[] * cfm_lf_sky[]]   $ COMBINED CFM LEAKAGE OF ALL SKYLIGHTS    $
##set1  leak_area_sky   #[#[0.020661157 * tot_cfm_sky[]] / 25]  $ CONVERT CFM @ 25 MPH TO SF LEAK AREA $
##set1  sky_frac        #[leak_area_sky[] / floor_area[]]    $ SKYLIGHT LEAK AREA DIVIDED BY FLOOR AREA $

##set1  tot_win_frac    #[#[win_frac_test[] + win_frac_ctrl[]] + sky_frac[]]
```

```
COND-1    =SPACE-CONDITIONS   TEMPERATURE=(75)      $ BETWEEN 70-75 FOR REPORTS LS-D, LS-F $
                              PEOPLE-SCHEDULE=OCCUP
                              PEOPLE-HEAT-GAIN=350  $ BTUH PER PERSON $
                              NUMBER-OF-PEOPLE=3
                              SOURCE-SCHEDULE=INTLDSCH
                              SOURCE-TYPE=PROCESS   $ "PROCESS" ADDS NO ENERGY USE $
                              SOURCE-BTU/HR=58180   $ BTUH=8.415x(FLOOR AREA)+43873 $
                              SOURCE-SENSIBLE=1
                              SOURCE-LATENT=0.2101  $ LATENT=-0.0000302(FLOOR AREA)+0.26143 $
                              FLOOR-WEIGHT=0
                              FURNITURE-TYPE=LIGHT
                              FURN-FRACTION=0.29
                              FURN-WEIGHT=3.30
                              INF-METHOD=S-G
                              HOR-LEAK-FRAC=0.4     $ 0.3, IF FEW CEILING PENETRATIONS $
                              NEUTRAL-LEVEL=0.5     $ DEFAULT VALUE $
                              FRAC-LEAK-AREA=#[hous_frac[] + tot_win_frac[]] ..



##clear  $ Clears all macros defined up to this line, so full 2k memory is available again $



                         $ -----GLAZING----- $

                  $ GLASS AND WINDOWS INPUT MACROS $

            $ MACRO INPUTS FOR WINDOW CONDUCTED AND SOLAR LOADS $

##set1  sc_gls_test       1.016  $ SHAD COEF OF THE TEST GLASS UNIT, EXCL FRAME $
##set1  panes_test        1      $ NUMBER OF PANES OF GLASS IN THE TEST GLASS UNIT $
##set1  u_win_test        1.290  $ WINTER U OF COMBINED TEST GLASS AND FRAME $
##set1  gls_frac_test     0.7766 $ >>WARNING<<: ENTER HERE AND UNDER SPACE DESC; NOTE 4 $
##set1  cfm_lf_test              $ >>WARNING<<: ENTER THIS ONLY UNDER SPACE DESCRIPTION $
##set1  num_sash_test            $ >>WARNING<<: ENTER THIS ONLY UNDER SPACE DESCRIPTION $
##set1  w_u_frm_test      1.90   $ WINTER U-FRAME; CONVERTED TO SUMMER U; NOTE 2 $
##set1  absorp_frm_test   0.80   $ ABSORPTANCE OF FRAME, ALONE; SEE NOTE 3, BELOW $
##set1  lo_scrn_sc_test   0.62   $ FBR GLS: 0.62; ALUM: 0.73; SOLAR:0.39; NONE:1.0; NOTE 8 $
##set1  lo_scrn_r_test    0.0615 $ NO SCRN: 0.0; EXTERIOR: 0.0615; INTERIOR: 0.1709; NOTE 9 $
##set1  up_scrn_sc_test   1.00   $ FBR GLS: 0.62; ALUM: 0.73; SOLAR:0.39; NONE:1.0; NOTE 8 $
##set1  up_scrn_r_test    0.0    $ NO SCRN: 0.0; EXTERIOR: 0.0615; INTERIOR: 0.1709; NOTE 9 $

##set1  sc_gls_ctrl       1.016  $ S COEF OF THE CONTROL GLASS UNIT, EXCL FRAME $
##set1  panes_ctrl        1      $ NUMBER OF PANES OF GLASS IN THE CONTROL GLASS UNIT $
##set1  u_win_ctrl        1.290  $ WINTER U OF COMBINED CONTROL GLASS AND FRAME $
##set1  gls_frac_ctrl     0.7766 $ >>WARNING<<: ENTER HERE AND UNDER SPACE DESC; NOTE 4 $
##set1  cfm_lf_ctrl              $ >>WARNING<<: ENTER THIS ONLY UNDER SPACE DESCRIPTION $
##set1  num_sash_ctrl            $ >>WARNING<<: ENTER THIS ONLY UNDER SPACE DESCRIPTION $
##set1  w_u_frm_ctrl      1.90   $ WINTER U-FRAME; CONVERTED TO SUMMER U; NOTE 2 $
##set1  absorp_frm_ctrl   0.80   $ ABSORPTANCE OF FRAME, ALONE; SEE NOTE 3, BELOW $
##set1  scrn_sc_ctrl      0.62   $ FBR GLS: 0.62; ALUM: 0.73; SOLAR:0.39; NONE:1.0; NOTE 8 $
##set1  scrn_r_ctrl       0.0615 $ NO SCRN: 0.0; EXTERIOR: 0.0615; INTERIOR: 0.1709; NOTE 9 $
```

```
$ Note 1. The length of sash-frame crack per single-hung window is L = (2W + H - 3.5F)/12; $
$         where L is in feet, and W, H and F are in inches.  The coorelation coef r for $
$         the expression above is 1.0, a highly reliable coorelation. $
$         For skylights without mullions the length of sash-frame crack per skylight is $
$         L = [2(W + H) - 4F]/12; or L = (1 - gls_frac_sky) * (W * H)/(F * 12). $
$ Note 2. Winter U-values for frames, from Window3.1 (from 1989 ASHRAE Fundamentals): $
$         Aluminum, no thermal break: 1.90 (1.90); Aluminum, thermal break: 1.00 (1.00); $
$         Wood with or without cladding: 0.40 (0.40); PVC-Vinyl: 0.30 (0.40). $
$ Note 3. For Dark Brown Semi-Gloss use 0.88; Brown Gloss: 0.80; Medium Yellow Semi- $
$         Gloss: 0.57; White Semi-Gloss and Aluminum Paint: 0.30; White Gloss & Silver $
$         Paint: 0.25; Reference Manual p III.83 $
$ Note 4. Single and Double Hung Windows $
$           For a 36-in x 60-in window with one horiz mullion having frame and mullion width F: $
$           If F = 1.90 (typical for fixed glass), glass fraction = 0.8095 (0.1905 frm_frac) $
$           If F = 2.00, glass fraction = 0.8000 (0.2000 frm_frac) $
$           If F = 2.25 (typical for aluminum frame), glass fraction = 0.7766 (0.2234 frm_frac) $
$           If F = 2.50, glass fraction = 0.7535 (0.2465 frm_frac) $
$           If F = 2.75 (typical for wood and PVC-vinyl frames), glass fraction = 0.7307 $
$           (0.2693 frm_frac).  The area of the frame including one mullion = F(3W + 2H) - 6F*F; $
$           F = width of the frame and mullion; W and H are the outermost dimensions of the $
$           window including the window frame. $
$         Skylights $
$           For a 24-in x 48-in skylight with no mullions having frame width F: $
$           If F = 1.90 (typical for fixed glass), glass fraction = 0.7750 (0.2250 frm_frac) $
$           If F = 2.25 (typical for aluminum frame), glass fraction = 0.7363 (0.2637 frm_frac) $
$           If F = 2.75 (typical for wood and PVC-vinyl frames), glass fraction = 0.6825 $
$           (0.3175 frm_frac).  F*L*12 = (1 - gls_frac_sky) * W*H $


       $ DO NOT ALTER THE FOLLOWING MACROS; THEY ARE INTERMEDIATE STEPS $

##set1  s_u_frm_test     #[1 / #[#[#[1 / w_u_frm_test[]] - 0.2233] + 0.3397]] $ WINT U CONV TO SUMR U $
##set1  frm_frac_test    #[1 - gls_frac_test[]]                          $ FRAME'S FRAC OF WINDOW AREA  $
##set1  sol_air_t_test   #[89 + #[#[absorp_frm_test[] / 4] * 248.28]] $ CALC OF SOLAIR TEMP, NOTE 6   $
##set1  sc_frm_test      #[#[#[sol_air_t_test[] - 75] * s_u_frm_test[]] / 211] $ SHAD COEF OF FRAME   $
##set1  wt_sc_gls_test   #[sc_gls_test[] * gls_frac_test[]]              $ WEIGHT AV SHAD COEF OF GLASS $
##set1  wt_sc_frm_test   #[sc_frm_test[] * frm_frac_test[]]              $ WEIGHT AV SHAD COEF OF FRAME $

##set1  s_u_frm_ctrl     #[1 / #[#[#[1 / w_u_frm_ctrl[]] - 0.2233] + 0.3397]] $ WINT U CONV TO SUMR U $
##set1  frm_frac_ctrl    #[1 - gls_frac_ctrl[]]                          $ FRAME'S FRAC OF WINDOW AREA  $
##set1  sol_air_t_ctrl   #[89 + #[#[absorp_frm_ctrl[] / 4] * 248.28]] $ CALC OF SOLAIR TEMP, NOTE 6   $
##set1  sc_frm_ctrl      #[#[#[sol_air_t_ctrl[] - 75] * s_u_frm_ctrl[]] / 211] $ SHAD COEF OF FRAME   $
##set1  wt_sc_gls_ctrl   #[sc_gls_ctrl[] * gls_frac_ctrl[]]              $ WEIGHT AV SHAD COEF OF GLASS $
##set1  wt_sc_frm_ctrl   #[sc_frm_ctrl[] * frm_frac_ctrl[]]              $ WEIGHT AV SHAD COEF OF FRAME $

FR-GLS-NOSN=GLASS-TYPE $ U-NAME MEANS: FRont GLaSs, NO insect ScreeN; upper half of vert slider $
        P= panes_test[]
        S-C=#[#[up_scrn_sc_test[] * wt_sc_gls_test[]] + wt_sc_frm_test[]]      $ NOTE 8 $
        G-C=#[1 / #[#[#[1 / u_win_test[]] - 0.2233] + up_scrn_r_test[]]]  ..  $ NOTE 7 $
FR-GLS-SN  =GLASS-TYPE $ U-NAME MEANS: FRont GLaSs, w/ insect ScreeN; lower half of vert slider $
        P=panes_test[]
        S-C=#[#[lo_scrn_sc_test[] * wt_sc_gls_test[]] + wt_sc_frm_test[]]      $ NOTE 8 $
        G-C=#[1 / #[#[#[1 / u_win_test[]] - 0.2233] + lo_scrn_r_test[]]]  ..  $ NOTE 9 $
```

```
RS-GLS-NOSN=GLASS-TYPE $ U-NAME MEANS: Right Side GLaSs, NO insect ScreeN; upper half of vert slider $
          P=panes_ctrl[]
        S-C=#[wt_sc_gls_ctrl[] + wt_sc_frm_ctrl[]]
        G-C=#[1 / #[#[1 / u_win_ctrl[]] - 0.2233]]  ..
RS-GLS-SN  =GLASS-TYPE $ U-NAME MEANS: Right Side GLaSs, W/ insect ScreeN; lower half of vert slider $
          P=panes_ctrl[]
        S-C=#[#[scrn_sc_ctrl[] * wt_sc_gls_ctrl[]] + wt_sc_frm_ctrl[]]
        G-C=#[1 / #[#[#[1 / u_win_ctrl[]] - 0.2233] + scrn_r_ctrl[]]]  ..
RE-GLS-NOSN=GLASS-TYPE $ U-NAME MEANS: REar GLaSs, NO insect ScreeN; upper half of vert slider $
          P=panes_ctrl[]
        S-C=#[wt_sc_gls_ctrl[] + wt_sc_frm_ctrl[]]
        G-C=#[1 / #[#[1 / u_win_ctrl[]] - 0.2233]]  ..
RE-GLS-SN  =GLASS-TYPE $ U-NAME MEANS: REar GLaSs, W/ insect ScreeN; lower half of vert slider $
          P=panes_ctrl[]
        S-C=#[#[scrn_sc_ctrl[] * wt_sc_gls_ctrl[]] + wt_sc_frm_ctrl[]]
        G-C=#[1 / #[#[#[1 / u_win_ctrl[]] - 0.2233] + scrn_r_ctrl[]]]  ..
LS-GLS-NOSN=GLASS-TYPE $ U-NAME MEANS: Left Side GLaSs, NO insect ScreeN; upper half of vert slider $
          P=panes_ctrl[]
        S-C=#[wt_sc_gls_ctrl[] + wt_sc_frm_ctrl[]]
        G-C=#[1 / #[#[1 / u_win_ctrl[]] - 0.2233]]  ..
LS-GLS-SN  =GLASS-TYPE $ U-NAME MEANS: Left Side GLaSs, W/ insect ScreeN; lower half of vert slider $
          P=panes_ctrl[]
        S-C=#[#[scrn_sc_ctrl[] * wt_sc_gls_ctrl[]] + wt_sc_frm_ctrl[]]
        G-C=#[1 / #[#[#[1 / u_win_ctrl[]] - 0.2233] + scrn_r_ctrl[]]]  ..

##clear      $ Clears all macros defined up to this line, so full 2k memory is available again $


            $ MACRO INPUTS FOR SKYLIGHT CONDUCTED AND SOLAR LOADS $
$ NOTE UNDER FRONT-RF-1=ROOF THAT SKYLIGHTS MAY BE DISABLED BY DOLLAR SIGN IN LEFT COLUMN $

##set1  r_slope        0.50   $ ROOF SLOPE EXPRESSED AS DECIMAL; 6/12 = 0.50; 5/12 = 0.416666 $
##set1  num_sky        4      $ NUMBER OF 24x48 SKYLIGHTS; 0.00005 TO MAX OF 10 $
##set1  sc_sky         0.98   $ SHAD COEF OF THE SKYLIGHT, EXCLUDING FRAME $
##set1  panes_sky      1      $ NUMBER OF PANES OF GLASS OR PLASTIC IN THE SKYLIGHT $
##set1  u_sky          1.20   $ WINTER U OF COMBINED TEST GLASS AND FRAME $
##set1  t_adj?         0      $ 1 IF ENTERED U HAS BEEN ADJ FOR NON-VERT TILT, 0 FOR MACRO TO ADJ $
##set1  gls_frac_sky   1      $ >>WARNING<<: ENTER HERE AND UNDER SPACE DESC; NOTE 4 $
##set1  cfm_lf_sky            $ >>WARNING<<: ENTER THIS ONLY UNDER SPACE DESCRIPTION $
##set1  w_u_frm_sky    1.90   $ WINTER U-FRAME; CONVERTED TO SUMMER U; NOTE 2 $
##set1  absorp_frm_sky 0.80   $ ABSORPTANCE OF FRAME, ALONE; SEE NOTE 3, ABOVE $

      $ DO NOT ALTER THE FOLLOWING MACROS; THEY ARE INTERMEDIATE STEPS $

##set1  u_sky_0         #[#[1.05934 * u_sky[]] + 0.08231] $ CONVERTS U AT 90 TO U AT 0 (HORIZ) NOTE 5 $
##set1  u_sky_45        #[#[1.07912 * u_sky[]] + 0.03385] $ CONVERTS U AT 90 (VERT) TO U AT 45 NOTE 5 $
##set1  b               #[#[u_sky_0[] - u_sky_45[]] / -45]    $ THE b of u_slope = b*slope + u_sky_0   $
##set1  u_slope         #[#[b[] * #[atan of r_slope[]]] + u_sky_0[]]  $ REST OF LIN EQ FROM PREV LINE $
##set1  u_sky_adj       #[#[t_adj?[] * u_sky[]] + #[#[1 - t_adj?[]] * u_slope[]]]  $ ONE U IS CHOSEN  $
##set1  s_u_frm_sky     #[1 / #[#[#[1 / w_u_frm_sky[]] - 0.2233] + 0.3397]]    $ WINT U CONV TO SUMR U $
##set1  frm_frac_sky    #[1 - gls_frac_sky[]]                          $ FRAME'S FRAC OF WINDOW AREA  $
##set1  sol_air_t_sky   #[96 + #[#[absorp_frm_sky[] / 4] * 248.28]]    $ CALC OF SOLAIR TEMP, NOTE 6  $
##set1  sc_frm_sky      #[#[#[sol_air_t_sky[] - 75] * s_u_frm_sky[]] / 211] $ SHAD COEF OF FRAME CALC $
##set1  wt_sc_sky       #[sc_sky[] * gls_frac_sky[]]                   $ WEIGHT AV SHAD COEF OF GLASS $
##set1  wt_sc_frm_sky   #[sc_frm_sky[] * frm_frac_sky[]]               $ WEIGHT AV SHAD COEF OF FRAME $
```

```
RF-GLS-NOSN=GLASS-TYPE $ U-NAME MEANS: RooF GLaSs, typically NO insect ScreeN $
          P=panes_sky[]
        S-C=#[wt_sc_sky[] + wt_sc_frm_sky[]]
        G-C=#[1 / #[#[1 / u_sky_adj[]] - 0.2233]]  ..


$ Note 5. The U-Value increases as the lite is tilted from 90 degrees $
$         (vertical) to 0 degrees (horizontal).  Adjustment in this U-value $
$         is base on Table 13, Part B, page 27.17 1989 ASHRAE Fundamentals $
$         Table of U-Values and Shading Coefficients, Acrylic and Polycarbonate $
$                                     Winter U(a)     Shading Coefficient(a) $
$         Single Dome Clear           1.20                    0.98(b) $
$                     Bronze          1.20                    0.53 $
$         Double Dome Clear (Outer)   0.70                    0.89 $
$                     Bronze (Outer)  0.70                    0.43 $
$         (a) Data from Leslie Locke, Plasteco, Inc., and Bristoline Products $
$         (b) SC Data for Single Dome Clear, 1989 ASHRAE Fundamentals, p 27.30 $
$ Note 6. The SC for the window frame is the Q/A entering the building through $
$         the frame divided by 211 BTU/H-SF, the Q/A for 1/8-in clear glass. $
$         For vertical frames the frame Q/A = the summer U-value of the frame $
$         times (T_SolAir - T_Indoor).  For horizontal frames add 7 degrees; $
$         so that 89 degrees is replaced by 96.  Refer to page 26-3, 1989 $
$         ASHRAE Fundamentals for T_SolAir calculation method. $
$ Note 7. The GLASS-CONDUCTANCE requested of DOE 2.1D should be derived from the $
$         winter U-value of Window3.1, with the outside winter film coefficient $
$         (resistance) of 0.2233 (1/4.4777) removed.  Refer to LBL paper LBL-27534 $
$         for methodology.  The summer film coefficient is 0.3397 (1/2.9440) $
$ Note 8. The shading coefficient correction factor for insect screens (Fiber- $
$         glass Silver Gray: 0.62; Brite Kote Aluminum: 0.73; Solar Screen White: $
$         0.45, Antique White: 0.44, Chaqua: 0.38, Bronze: 0.37, Charcoal: 0.39, $
$         Silver Gray: 0.38, Gold: 0.38) comes from testing performed for Phifer $
$         Wire Products, Inc by Matrix, Inc., dated April 12, 1977.  It is assumed $
$         that the solar transmittance resulting from a solar incidence angle of $
$         30 deg (from normal) would likely be the most representative single value. $
$ Note 9. The winter R-value additive for insect screen (R_added = 0.0615) comes $
$         from a consensus by engineers at a prominent laboratory which performs $
$         window testing.  Contact the author for more details.


$ MACRO INPUTS WHICH CALC ROOF SLOPE-DEPENDENT VALUES: HOUSE VOLUME, ROOF AREA, O/HANG HEIGHT $

                    $ -----BUILDING SHADE: 16-IN OVERHANGS----- $
        $ NOTE.  DOE2.1D CONSIDERS DIFFUSE SKY RADIATION; NEITHER SKY-FORM-FACTOR $
                $ NOR GND-FORM-FACTOR NEED BE SPECIFIED IN EXPOSED-WALL $

##set1  o_hang      1.3333    $ Overhang depth in feet: 16-in = 1.3333-ft $
##set1  floor_area  1700      $ Footprint dimensions: 50.5 feet x 33.6666 feet, 1:1.5 aspect $
```

```
        $ DO NOT ALTER THE FOLLOWING MACROS; THEY ARE INTERMEDIATE STEPS $

##set1  ht_o_hang    #[8 - #[o_hang[] * r_slope[]]]
##set1  side_wal_ht #[#[#[r_slope[] * 16.8333] / 2] + 8]
##set1  hous_vol     #[side_wal_ht[] * floor_area[]]
##set1  raftr_lnth  #[#[sqrt of #[#[r_slope[] * r_slope[]] + 1]] * 16.8333]

           BUILDING-SHADE      X=0  Y=0  Z=ht_o_hang[]  H=o_hang[]       $FRONT O/HANG $
                               W=50.5  AZ=180  TILT=180 ..  $ FACES S WHEN AZ=0 IN BUILDING-LOCATION $
           BUILDING-SHADE      X=0  Y=33.66  Z=ht_o_hang[]  H=o_hang[]  $REAR O/HANG $
                               W=50.5  AZ=180  TILT=0 ..    $ FACES N WHEN AZ=0 IN BUILDING-LOCATION $


HOUSE-1      =SPACE            A=floor_area[]  V=hous_vol[]  S-C=COND-1 ..

FRONT-WL-1  =EXTERIOR-WALL     H=8  W=41.88  AZ=180  CONS=WALL-INSUL          $ NON-STUD SECTION $
                               GND-REFLECTANCE=0.22  ..                       $ SPARSE GRASS $
    WIN-1-SN     =WI           G-T=FR-GLS-SN  X=7  Y=2  H=2.5  W=20.0  ..     $ VERT SLIDER BOT, 50 SF $
    WIN-1-NOSN   =WI           G-T=FR-GLS-NOSN  X=7  Y=4.5  H=2.5  W=20.0 ..  $ VERT SLIDER TOP, 50 SF $
    FRONT-DOOR-1=DOOR          H=6.67  W=3  CONS=DOOR-1  X=30.0  Y=0  ..      $ DOOR, 20 SF $
FRONT-WL-2  =EXTERIOR-WALL     H=8  W=8.62  AZ=180  CONS=WALL-STUD            $ STUD SECTION $
                               GND-REFLECTANCE=0.22  ..                       $ SPARSE GRASS $
                               $ FRAME IS 17% OF 2X4, 16-IN OC WALL $

RIGHT-WL-1  =EXTERIOR-WALL     H=side_wal_ht[]  W=27.92  X=50.5  Y=0          $ NON-STUD SECTION $
                               AZ=90  CONS=WALL-INSUL  G-R=0.22  ..           $ SPARSE GRASS $
    WIN-2-SN     =WI           G-T=RS-GLS-SN  X=6  Y=2  H=2.5  W=3.0  ..      $ VERT SLIDER BOT, 7.5 SF $
    WIN-2-NOSN   =WI           G-T=RS-GLS-NOSN  X=6  Y=4.5  H=2.5  W=3.0  ..  $ VERT SLIDER TOP, 7.5 SF $
    WIN-3-SN     =WI           G-T=RS-GLS-SN  X=15 Y=5  H=2.0  W=1.5  ..      $ HORZ SLIDER L SIDE, 3 SF $
    WIN-3-NOSN   =WI           G-T=RS-GLS-NOSN  X=16.5 Y=5  H=2.0  W=1.5  ..  $ HORZ SLIDER R SIDE, 3 SF $
RIGHT-WL-2  =EXTERIOR-WALL     H=side_wal_ht[]  W=5.75  X=50.5  Y=0           $ STUD SECTION $
                               AZ=90  CONS=WALL-STUD  G-R=0.22  ..            $ SPARSE GRASS $

REAR-WL-1   =EXTERIOR-WALL     LIKE FRONT-WL-1  W=14.0  X=50.5  Y=33.66
                               AZ=0  GND-REFLECTANCE=0.32 ..                  $ CONC PATIO @ GLS DOOR $
    WIN-4-SN     =WI           G-T=RE-GLS-SN  X=7  Y=0  H=6.667  W=3.0  ..    $ GLASS DOOR R SIDE, 20 SF $
    WIN-4-NOSN   =WI           G-T=RE-GLS-NOSN  X=4  Y=0  H=6.667  W=3.0  ..  $ GLASS DOOR L SIDE, 20 SF $
REAR-WL-2   =EXTERIOR-WALL     LIKE FRONT-WL-1  W=27.88  X=50.5  Y=33.66
                               AZ=0  GND-REFLECTANCE=0.22 ..                  $ SPARSE GRASS $
    WIN-5-SN     =WI           G-T=RE-GLS-SN  X=21  Y=2  H=2.5  W=12.0  ..    $ VERT SLIDER BOT, 30 SF $
    WIN-5-NOSN   =WI           G-T=RE-GLS-NOSN  X=21  Y=4.5  H=2.5  W=12.0 .. $ VERT SLIDER TOP, 30 SF $
REAR-WL-3   =EXTERIOR-WALL     LIKE FRONT-WL-2  W=8.62  X=50.5  Y=33.66
                               AZ=0  GND-REFLECTANCE=0.22  ..                 $ SPARSE GRASS $

LEFT-WL-1   =EXTERIOR-WALL     LIKE RIGHT-WL-1  X=0    Y=33.66  AZ=270        $ NON-STUD SECTION $
                               GND-REFLECTANCE=0.22 ..                        $ SPARSE GRASS $
    WIN-6-SN     =WI           G-T=LS-GLS-SN  X=6  Y=2  H=2.5  W=3.0  ..      $ VERT SLIDER BOT, 7.5 SF $
    WIN-6-NOSN   =WI           G-T=LS-GLS-NOSN  X=6  Y=4.5  H=2.5  W=3.0  ..  $ VERT SLIDER TOP, 7.5 SF $
    WIN-7-SN     =WI           G-T=LS-GLS-SN  X=15 Y=5  H=2.0  W=1.5  ..      $ HORZ SLIDER L SIDE, 3 SF $
    WIN-7-NOSN   =WI           G-T=LS-GLS-NOSN  X=16.5 Y=5  H=2.0  W=1.5  ..  $ HORZ SLIDER R SIDE, 3 SF $
LEFT-WL-2   =EXTERIOR-WALL     LIKE RIGHT-WL-2  X=0    Y=33.66  AZ=270        $ STUD SECTION $
                               GND-REFLECTANCE=0.22 ..                        $ SPARSE GRASS $
```

```
FRONT-RF-1=ROOF                H=raftr_lnth[]  W=45.45  Z=8  AZ=180          $ NON-TRUSS SECTION $
                               TILT=#[atan of r_slope[]]  CONS=ROOF-INSUL  ..
$     SKY-8-NOSN  =WI           G-T=RF-GLS-NOSN  X=20  Y=8
$                               H=4  W=#[num_sky[] * 2]  ..
FRONT-RF-2=ROOF                H=raftr_lnth[]  W=5.05  Z=8  AZ=180           $ TRUSS SECTION $
                               TILT=#[atan of r_slope[]]  CONS=ROOF-TRUSS  ..
                               $ FRAME IS 10% OF 2X4, 24-IN OC TRUSS ROOF $
REAR-RF-1 =ROOF                LIKE FRONT-RF-1  X=50.5  Y=33.66  AZ=0  ..    $ NON-TRUSS SECTION $
REAR-RF-2 =ROOF                LIKE FRONT-RF-2  X=50.5  Y=33.66  AZ=0  ..    $ TRUSS SECTION $
UNDERGROUND-FLOOR              CONS=SLAB-1  A=1700                           $ PERIMETER = 168.2 LF $
                               U-EFFECTIVE = .0217  TILT = 180 ..
PART-STUD =INTERIOR-WALL       CONS=IN-WAL-STD  INT-WALL-TYPE=INTERNAL
                               AREA=#[#[176.75 * 0.17] * side_wal_ht[]] ..
PART-CAV  =INTERIOR-WALL       CONS=IN-WAL-CAV  INT-WALL-TYPE=INTERNAL
                               AREA=#[#[176.75 * 0.83] * side_wal_ht[]] ..
BUILDING-RESOURCE  HW-SCHEDULE=HW-LDS-1  HOT-WATER=5000  ..
##clear  $ Clears all macros defined up to this line, so full 2k memory is available again $
END ..
COMPUTE LOADS ..
```

DOE-2 DIRECTORY
Program Related Software and Services

Source Code

(2.1D VAX and SUN-4 Only)
Simulation Research Group
Bldg. 90, Room 3147
Lawrence Berkeley Laboratory
Berkeley, CA 94720

(2.1C and 2.1D Mainframe Only)
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

PC VERSIONS

DOE-2.1D for Micros (MICRO-DOE2)
Acrosoft International
9745 East Hampden Avenue
Denver, CO 80231

DOE-2.1D for Micros (ADM-DOE2)
ADM Associates, Inc.
3299 Ramos Circle
Sacramento, CA 95827

Utility Programs

Pre- and Post-Processor (DOE-Plus™)
Building Blocks Software
P.O. Box 5218
Berkeley, CA 94705-0218

Graphs from DOE-2
Ernie Jessup
4977 Canoga Avenue
Woodland Hills, CA 91364

VIDEO

DOE-2 Instructional Video and Manual
Prof. Jan Kreider
Joint Center for Energy Management
University of Colorado at Boulder
Campus Box 428
Boulder, CO 80309-0428

Consultants

Mainframe Versions
Joerg Tscherry
Section 175
EMPA
8600 Dubendorf
Switzerland

Microcomputer Versions
Werner Gygli
Informatik Energietechnik
Weiherweg 19
CH-8604 Volketswil
Switzerland

Mech. Engs., Consulting, Training
Marlon Addison, Suite #230
Energy Simulation Specialists
64 East Broadway
Tempe, AZ 85282

Consulting Engineers
Craig Cattelino
Burns & McDonnell Engineers
8055 E. Tufts Ave. -- #330
Denver, CO 80237

Computer-Aided Mechanical Engineering
Mike Roberts
Roberts Engineering Co.
11946 Pennsylvania
Kansas City, MO 64145

Consulting
Philip Wemhoff
1512 South McDuff Avenue
Jacksonville, FL 32205

Large Facility Modeling
George F. Marton, P.E.
1129 Keith Avenue
Berkeley, CA 94708

Master Classes, Tutorials, Consulting
Bruce Birdsall
"In Support of Energy Software"
166 Caldecott Lane, Suite 113
Oakland, CA 94618

Consulting
Jeff Hirsch
2138 Morongo
Camarillo, CA 93010

■ ■ ■ ■ DOE-2 PROGRAM DOCUMENTATION ■ ■ ■ ■

National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

	NTIS Order No.	Shipments Within The U.S.	Shipments Outside The U.S.
[ ] 2.1C source code*	DE-830-48782	$2,490.00	$4,980.00
[ ] Complete 2.1D Documentation [includes PB-901-43074]	PB-852-11449	319.00	635.00
[ ] 2.1D Update Package	PB-901-43074	112.50	225.00
[ ] Engineers Manual (2.1A) [not included with PB-852-11449]	DE-830-04575	45.00	90.00
To Order by Separate Titles:			
[ ] BDL Summary [2.1D]	DE-890-17726	23.00	46.00
[ ] Users Guide [2.1A]	LBL-8689, Rev.2.	53.00	106.00
[ ] Sample Run Book [2.1D]	DE-890-17727	53.00	106.00
[ ] Reference Manual [2.1A]	LBL-8706, Rev.2	109.00	218.00
[ ] DOE-2 Supplement [2.1D]	DE-890-17728	55.95	111.90

* 2.1C and 2.1D Source Code may be also be ordered from the National Energy Software Center in Argonne, IL. Phone Ms. Margaret Butler at (708) 972-7250 for details on obtaining DOE-2 and NESC's Software Purchase plan.

For phone orders using Visa or Mastercard (703) 487-4650 or FAX (703) 321-8547
Overnight Express — 24-hr in-house processing — $22 surcharge per title
First Class Mail — 24-hr in-house processing — $12 surcharge per title

■ ■ Weather Tapes ■ ■

To order TMY or TRY tapes:
National Climatic Data Center
Federal Building
Asheville, North Carolina 28801
Phone: (704) 259-0682

To order CTZ tapes:
California Energy Commission
Attn: Bruce Maeda, MS-25
1516-9th Street
Sacramento, CA 95814-5512
Phone: (404) 636-8400

To order WYEC tapes:
ASHRAE
1791 Tullie Circle N.E.
Atlanta, GA 30329
Phone: (404) 636-8400

■ ■ User News ■ ■

To be put on the newsletter distribution list, to submit articles, corrections or updates to documentation, or for DOE-2 program questions, please call or write:

Kathy Ellington
Simulation Research Group
Bldg. 90, Room 3147
Lawrence Berkeley Laboratory
Berkeley, CA 94720
Phone: (415) 486-5711
FAX: (415) 486-5172
electronic mail: kathy%gundog@lbl.gov

= **SYSTEM–FANS**(S–FANS,20)

FAN–SCHEDULE(F–SCH) u-name
FAN–CONTROL(F–C)(†;CONSTANT–VOLUME,SPEED,INLET,
DISCHARGE,CYCLING,TWO–SPEED,FAN–EIR–FPLR)

SUPPLY–STATIC(S–S)(†;0.0 to 15.0 in of WG)
and
SUPPLY–EFF(S–E)(†;0.1 to 1.0)
or
SUPPLY–DELTA–T(SUP–D–T)(†;0.0 to 30.0°F)
and
SUPPLY–KW(S–KW)(†;0.0 to 0.0 kW/cfm)

SUPPLY–MECH–EFF(S–M–E)(†;0.1 to 1.0)
MOTOR–PLACEMENT(M–P)(**IN–AIRFLOW**;IN–AIRFLOW,OUTSIDE–AIRFLOW)
FAN–PLACEMENT(F–P)(**DRAW–THROUGH**;DRAW–THROUGH,
BLOW–THROUGH)

RETURN–STATIC(R–S)(†;0.0 to 10.0 in of WG)
and
RETURN–EFF(R–E)(†;0.1 to 1.0)
or
RETURN–DELTA–T(RET–D–T)(†;0.0 to 30.0°F)
and
RETURN–KW(R–KW)(†;0.0 to 0.01 kW/cfm)

NIGHT–CYCLE–CTRL(N–C–C)(†;STAY–OFF,CYCLE–ON–ANY,
CYCLE–ON–FIRST, ZONE–FANS–ONLY*) [*Used only for PIU systems]

NIGHT–VENT–CTRL(N–V–C)(**NOT–AVAILABLE**;NOT–AVAILABLE,NIGHT–FAN,
NIGHT–FAN+REVERT,WHEN–SCHEDULED,SCHEDULED+DEMAND)
NIGHT–VENT–SCH(NT–V–SCH) u-name††
NIGHT–VENT–DT(N–V–D)(**5.0**;0.0 to 30.0°F)
NIGHT–VENT–RATIOS(N–V–R)((‡‡);0.0 to 5.0) (list of 6)
MAX–FAN–RATIO(MAX–F–R)(**1.1**;1.0 to 1.5)
MIN–FAN–RATIO(MIN–F–R)(**0.3**;0.1 to 1.0)
LOW–SPEED–RATIOS(L–S–R)((‡;0.0 to 1.0) (list of 4) [‡ Defaults are (1.0,1.0,1.0,1.0).]
FAN–EIR–FPLR(F–E–FPLR) u-name of linear, quadratic or cubic

† System-dependent; see page 46, **Index of System Types**, for default values
†† Required if NIGHT–VENT–CTRL = WHEN–SCHEDULED or SCHEDULED+DEMAND.
‡‡ Required if NIGHT–VENT–CTRL ≠ NOT–AVAILABLE.

Correct the abbreviation for keyword NIGHT-VENT-SCH from (N-V-SCH) to (NT-V-SCH). 10/22/90

ECONOMICS SUMMARY

INPUT ECONOMICS
Required for Economics input

PARAMETRIC–INPUT ECONOMICS
Replaces INPUT ECONOMICS for parametric runs

TITLE
See LOADS

ABORT
(Only needed when overriding LOADS input)

DIAGNOSTIC(LIST)
(Only needed when overriding LOADS input)

PARAMETER(DEFINE)
See LOADS

= **DAY–CHARGE–SCH**(D–C–SCH,80)

[Note: Accepts a list of hourly values and up to two u-names of CHARGE–ASSIGNMENTs for each set of values.]

In both the 2.1C and 2.1D BDL Summary, this
▼command incorrectly read WEEK-SCH 10/22/90

= **WEEK–SCHEDULE**(W–SCH,60)
See LOADS

= **SCHEDULE**(SCH,60)
See LOADS

ENERGY–COST(E–C,5)

- **RESOURCE**(R)(—;ELECTRICITY,DIESEL–OIL,NATURAL–GAS, FUEL–OIL,STEAM,CHILLED–WATER,LPG,COAL,METHANOL,BIOMASS)

UNIT(U)(†;0.+ to 10^8 Btu/unit)
UNIFORM–COST(U–C)(†;0.0 to 10^5 \$/unit)
ESCALATION(E)(†;0.0 to 100.0 %/yr)
MIN–MONTHLY–CHG(M–M–C)(**0.0**;0.0 to 10^5 \$/month)
FIXED–MONTH–CHG1(F–M–C1)(**0.0**;0.0 to 10^5 \$/month)
FIXED–MONTH–CHG2(F–M–C2)(**0.0**;0.0 to 10^5 \$/month)
RATE–LIMITATION(R–L)(**10000.0**;0.0 to 10^5 \$/units
ASSIGN–CHARGE(A–C) u-name of up to two CHARGE–ASSIGNMENTs††
ASSIGN–SCHEDULE(A–SCH) u-name of schedule

† See Supplement for default values.
†† Maximum of two per ENERGY–COST command.