DOE-2 Articles from the *Building Energy Simulation User News*

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SOLAR RADIATION DATA

I am working on a research project to evaluate the impact of solar radiation changes on building performance. When varying the solar radiation data, I always get the exact same results every time, which is not what I expected. So I started to explore this issue and have found there may be a serious problem with the DOE-2 weather processor. Whatever solar radiation data are in the original weather file, the weather processor always produces the same output of solar radiation without referemce to the solar data in weather file.

Answer
It sounds like DOE-2 is calculating solar internally rather than using the solar from the weather file. The weather file has a flag value to tell DOE-2 whether there is solar data on the weather file or not (this is a legacy from the days when many weather files such as TRY had no solar data).

To check whether a weather file has the flag set properly generate the ASCII version of the weather file (run wthfmt on the weather file). Look at the first line of the weather data output. The last value on the line should be 5 - this indicates a "solar" file. If this value is 3, it indicates a "normal" (no solar) file. If the file is flagged "normal" but actually has solar data on it, the solar data will be ignored by DOE-2 and the solar data will be calculated internally. In the past, this value was a multipurpose flag; currently, the only values it should ever have are 3 or 5.

If this is confusing, the DOE-2 weather documentation has a detailed explanation.

IRRADIATION ON AN INCLINED PLANE

Regarding the radiation models described in the DOE-2.1A Engineering reference manual … is irradiation on an inclined plane still used in the latest version of DOE-2.1E?

Answer (from Fred Buhl)
If you are asking about the diffuse radiation, the algorithm has changed. Here is the current code:

```
C            PEREZ MODEL FOR DIFFUSE RADIATION ON SLOPED SURFACES.
C            SEE R. PEREZ, R. SEALS, P. INEICHEN, R. STEWART, AND
C            D. MENICUCCI, "A NEW SIMPLIFIED VERSION OF THE PEREZ
C            DIFFUSE IRRADIANCE MODEL FOR TILTED SURFACES", SOLAR
C            ENERGY 39,221-231,1987.  COMMUNICATED BY A. ZELENKA,
C            SWISS METEOROLOGICAL INSTITUTE, ZURICH, VIA ISIDORE
C            MARCUS OF EMPA, DUBENDORF, SWITZERLAND.
C
C            PARAMETER LIST                            DOE-2 VARIABLE
C            --------------                            --------------
C            GH    = GLOBAL HORIZONTAL (MEAS OR CALC)  SOLRAD
C            DH    = DIFFUSE    "        "        "    BSCC
C            COSI  = COS(INCIDENCE ANGLE OF DIR BEAM)  ETA
C            COSA  = COS(SURFACE TILT ANGLE)           GAMMA
C            ZD    = SOLAR ZENITH ANGLE (DEGREES)
C            DB0   = ANNUAL AVERAGE SOLAR CONSTANT (BTUH/SF)
C            AM    = RELATIVE AIRMASS (KASTEN)
C
C
      FFS0 = 0.
      IF(DH.LE.0.) GO TO 7
C
      Z = PIOVR2 - PHSUN
      ZD = 90.0 - PHSUND
      THC = ACOS(COSI)
C
C            RELATIVE AIR MASS (BALTIT/3281 IS BUILDING ALT IN KM)
C
      AMH = 1.0-.1*BALTIT/3281.
      AM  = AMH/COSZ
      IF(ZD.GT.75.) AM = AMH/(COSZ + 0.15*(93.885-ZD)**(-1.235))
C
C            MODEL PARAMETERS
C
      DB = (GH-DH)/COSZ
      EPS = (DB+DH)/DH
      DELT = DH*AM/DB0
C
C            CIRCUMSOLAR (F1P) AND HORIZON (F2P) BRIGHTENING COEFFS
C
      DO 1 K=1,7
      IF(EPS.LT.EPSL(K)) GO TO 2
    1 CONTINUE
    2 F1P = F1(K,1) + F1(K,2)*DELT + F1(K,3)*Z
      F2P = F2(K,1) + F2(K,2)*DELT + F2(K,3)*Z
C
C            GEOMETRY OF (ALSO PARTLY HIDDEN) 25-DEG HELIOS ON SLOPE
C            NOTE: COSI<0 ALLOWED
C
      IF(Z.LT.PIHMAW) THEN
        GHIH=COSZ
        PSIH=1.
```

```
      ELSE
        PSIH=(PIHPAW-Z)/ZWAW
        GHIH=PSIH*SIN(AW*PSIH)
      END IF
C
      IF(THC.GT.PIHPAW) THEN
        GHIC=0.
      ELSE
        IF(THC.GT.PIHMAW) THEN
          PSIC=(PIHPAW-THC)/ZWAW
          GHIC=PSIH*PSIC*SIN(AW*PSIC)
        ELSE
          GHIC=PSIH*COSI
        END IF
      END IF
C
C             SKY FORM FACTOR (WITHOUT SHADING) FOR THIS WALL AND FOR
C             WINDOWS AND DOORS IN THIS WALL
C
c<>   FFS0 = 0.5*(1.+COSA)*(1.-F1P) + GHIC*F1P/GHIH + F2P*<SXSTLT>
      FFS0 = 0.5*(1.+COSA)*(1.-F1P) + GHIC*F1P/GHIH + F2P*AA(MX+31)
C
    7 CONTINUE
C
C             GROUND FORM FACTOR (WITHOUT SHADING)
C
      FFG0 = 0.5*(1.0-GAMMA)
C
C             FORM FACTORS WITH SHADING FOR THIS WALL (FORM FACS FOR
C             WINDOWS AND DOORS W/SHADING CALCD IN CALWIN, CALEXT)
C             HERE, EWSKYFF AND EWGNDFF ARE RATIOS OF SHADED TO
C             UNSHADED INCIDENT RADIATION (SEE SUBR FFDIF)
c<>   FFS = FFS0*ABS(<EWSKYFF>)
      FFS = FFS0*ABS(AA(MX+19))
c<>   FFG = FFG0*ABS(<EWGNDFF>)
      FFG = FFG0*ABS(AA(MX+20))
  320 RDIF   = FFS*BSCC + FFG*BG
C               CALCULATE TOTAL SOLAR ON WALL
      RTOT   = RDIR + RDIF
```

MODELING A DOMED ROOF WITH DOE-2

I am developing a DOE-2 model for a building with a large domed roof. Do you have any suggestions for approximating roof geometry – i.e. how many facets should I use for reasonable solar gain and conduction results?

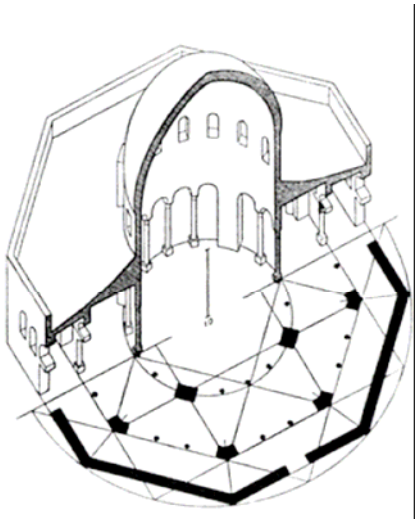
Joe Huang Answers:
A few years ago, I wrote an AWK script that generated DOE-2.1E input based on the input dome diameter and the specified number of arc segments (horizontal rows) desired. The generated script produces a series of polygons to model the dome in any detail. However, h ere are some caveats:

(1) the dome is hemispherical,

(2) the model, of course, does nothing about air stratification or other thermal effects,

(3) one can easily be entranced by the representational accuracy of the script and transform the dome to hundreds of polygons - clearly geometrical overkill - but it looks good in drawings.

The description of the procedure is described in the Sept/Oct 2002 issue of the USER NEWS. Here's a link to "Adapting DOE-2 to meet the needs of the Egyptian Housing and Building Research Center" and "Modeling Domes with DOE-2." The article includes the AWK script and a sample input.



The Ancient Dome of the Rock is a good example of a Domed Building:

HOURLY REPORT FOR SLAB-ON-GRADE

I am trying to get an hourly report for a slab-on-grade for a recreation center building, but the QUGF (underground floor load) variable under the SPACE variable type list doesn't give me a realistic number; it is constant throughout the 24hour cycle. Does this mean that it's not set up correctly?

$ 5" Concrete Underground Slab Floor $

```
 Floor-60-LAYERS = LAYERS   INSIDE-FILM-RES = 0.92
             MAT= (MAT-148,MAT-77,)
             TH= (1.0000,0.4167,) ..
```

I would like to get both the floor temperature and load (in Btuh) from the slab-on-grade. Are there any other variables available for a report value? Thanks,

Answer: (from Joe Huang (YJHuang@lbl.gov)
The underground flow model in DOE-2 is constant not only through the 24-hour cycle, but for an entire month. In a nutshell, the heat flow through an underground surface is simply the input U-value of the floor layer multiplied by the difference between the room temperature (which is constant in LOADS) and the ground temperature (which is constant for each month of the year). DOE-2 does not calculate inside surface temperatures, and even if it did, I would not give it much credence for the floor slab for the reasons given above. Bear in mind that QUGF is a LOADS variable, which is the heat flow calculated at the constant LOADS temperature (input as TEMPERATURE=(XX) in the SPACE-CONDITIONS command), rather than at the actual zone temperature calculated in SYSTEMS.

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