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DOE-2 USER NEWS

A COMPUTER PROGRAM FOR BUILDING ENERGY USE ANALYSIS

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Table of Contents

BULLETIN BOARD

Item: Users should be aware that a complete bug list of the current production version of the code is maintained and updated on a weekly basis on the LBL BKY computer. Those users with LBLaccounts may access this file in PSS library DOE21, subset BUGS. Others may request a listing from the DOE-2 User Coordination Office.

Item: The latest in the series of articles by Vladimir Bazjanac appeared in the December 1980 issue of Progressive Architecture. The article contains a DOE-2.1 energy analysis of the new Johnson/Burgee crystal cathedral in Garden Grove, CA.

COMING UP: DOE-2.1A

Although for the majority of the user community DOE-2.1 has been available only for a little over three months, for those of us in the Building Energy Analysis Group at Lawrence Berkeley Laboratory it has been around since last May. In these eight months we have run across a number of bugs and other minor problems which have been fixed in what we call the development version of the program. Many of these bugs have been discovered by those who are making runs in association with determining the Design Energy Budgets for the Building Energy Performance Standards (BEPS). We now think (with fingers crossed!) that the major problems have been corrected and will soon be sending a new version (DOE-2.1A) to the National Energy Software Center for processing. This version will be available to the public sometime this Spring and will be the Standard Evaluation Technique (SET) for BEPS.

Although there will be a small number of new features, the major difference between DOE-2.1 and DOE-2.1A is the correction of the list of bugs mentioned in this and earlier issues of USER NEWS. In fact, we have gathered all the bugs in DOE-2.1 together in this issue and have provided an index for ease of finding the ones that apply to a particular building element, Command, or Keyword.

The greatest change in the program is in SYSTEMS and probably results in the program behaving in a way that the user thought it should have behaved all along. In particular, the meanings of HEAT-TEMP-SCH and COOL-TEMP-SCH have been sharpened in DOE-2.1A. They will refer, in that version of the program, to the center of two control bands in a single thermostat. The lower control band (determined by HEAT-TEMP-SCH and the THROTTLING-RANGE) governs the main heating coil (for central systems), the zone heating coil (for zonal systems), the reheat coil, the baseboards, and the air volume (for THERMOSTAT-TYPE = REVERSE-ACTION). At the bottom of the lower control band there is full heating or, in the case of the air-volume for THERMOSTAT-TYPE = REVERSE-ACTION, full air flow. At the top of the lower control band the heating is off and the air flow is at a minimum. The upper control band (determined by COOL-TEMP-SCH and the THROTTLING-RANGE) governs the main cooling coil (for central systems), the zone cooling coil (for zonal systems), and the air volume for variable volume systems (MIN-CFM-RATIO < 1). At the top of the upper control band there is full cooling and full air volume. At the bottom of the upper control band there is minimum cooling and minimum air volume. In the dead band, if any, the air temperature and the air flow is whatever it is at the bottom of the upper throttling range.

If the system being modeled has no controls corresponding to one of the two control bands, there will be in DOE-2.1A no need to enter the corresponding temperature schedule. Thus, for example, in a constant volume dual duct system with COOL-CONTROL = CONSTANT, only a HEAT-TEMP-SCH is required to determine the center of the control band that controls the damper that regulates the fraction of air going through the hot deck. Above the throttling range all the air passes through the cold deck and the system produces maximum cooling.

You might ask, "If this is what it is going to be in DOE-2.1A, what in the world happens in DOE-2.1?" The answer is that in DOE-2.1, if there is a deadband, the program forces the heat extraction rate to be zero, i.e., it attempts to make the temperature of the air entering the zone to be the same as the zone temperature. This has the effect, for example, of negating the "free" cooling of an economizer in the deadband region and of introducing "ghost" heating. For most systems the effect on predicted energy consumption of this bug is approximately 5 to 10%.

PUB 391

BUGS DISCOVERED IN DOE-2.1 AND FIXED IN DOE-2.1A

The following is a complete listing, to press time, of the bugs discovered in the DOE-2.1 version of the code. They have been fixed in DOE-2.1A, which will soon be available through NTIS. An update package to the documentation to accompany DOE-2.1A will also be published at that time.

CLASSIFIED INDEX

This index is intended to cross-reference bugs by 1) abort routine, 2) system-type affected (except those affecting all systems), 3) report affected, and 4) subject matter, command, and/or keyword.

BDL

[1] The U-value used for interior walls, in a regular LOADS run, is incorrect when the interior wall has a delayed construction. The U-value (taken from the LAYERS command) does not include the INSIDE-FILM-RES on both sides of the wall; it is included on one side only. This problem occurs when the user has made a weighting factor library run and is using the same deck for his/her regular LOADS run. The bug has been cured by recalculating the U-value to include INSIDE-FILM-RES on both sides of the wall.

Interim solution: Alter the deck to make INTERIOR-WALL a quick wall and include I-F-R's in the overall U-VALUE.

[2] If the user inputs the codeword DEFAULT for any of the list in the ASSIGN-SCHEDULE keyword in the LOAD-MANAGEMENT command, the program will abort in subroutine EQUIP.

Interim solution: None; do not use the codeword DEFAULT.

[3] The command SET-DEFAULT has no effect when used in 1) the SYSTEM command and its associated subcommands, 2) the PLANT-ASSIGNMENT command and 3) all of the PLANT commands, including the solar package. The program does not issue an error message if SET-DEFAULT is input for these commands.

Interim solution: None; do not SET-DEFAULT for these commands.

[4] In the CURVE-FIT command, BDL does not pass quadratic, bi-quadratic or cubic curves to the simulator when the data are entered as COEFFICIENTS. Linear and bi-linear curves are unaffected by this bug.

Interim solution: When quadratic, bi-quadratic or cubic curves are desired, input them as data points using the DATA keyword.

[5] The program will abort in routine FMTAP if the user neglects to close a TITLE LINE with a star (*).

Interim solution: Always end TITLE LINEs with a star.

[6] The SCALE option in the DAY-SCHEDULE command does not work when PARAMETER is also input. The program aborts in routine SCANO with no error message.

[7] BDL aborts (rarely and randomly) with memory reference beyond field length in subroutine SPACEO when it is saving interior wall pointers for each space.

Interim solution: Add dummy spaces to increase the field length.

[8] Commands that use another command's tables (synonym commands) can not be used in the SET-DEFAULT command. Therefore, SET-DEFAULT FOR ROOF and SET-DEFAULT FOR UNDERGROUND-FLOOR, will produce ****ERROR -- UNKNOWN COMMAND****.

Interim solution: Instead of SET-DEFAULT FOR ROOF, use SET-DEFAULT FOR EXTERIOR-WALL; instead of SET-DEFAULT FOR UNDERGROUND-FLOOR, use SET-DEFAULT FOR UNDERGROUND-WALL.

[9] The Custom Weighting Factor calculation ignores quick interior surfaces with U > 0.709 since such surfaces give negative convective air film resistance. The most common case where interior surfaces with a high U-value might be used is to model interior walls with open doors; the U-value in this case is often made larger than that of the wall itself in order to approximately account for convective heat transfer through the openings. There is a problem in the program in that these surfaces are not being properly excluded in the calculation of the matrix which gives the radiation exchange factors between pairs of surfaces. This problem occurs whenever there are quick interior walls or floors with U > 0.709 in a LIBRARY-INPUT LOADS run.

Interim solution: There are two alternative solutions; the second solution is the recommended one.
1) Remove the wall entirely from the Custom Weighting Factor calculation input, but leave as is in LOADS input.
2) If large U-value was chosen to account for convection through openings proceed as follows: in the Custom Weighting Factor input, ignore the openings, assign a U-value equal to the actual U-value of the wall (including air film resistances on both sides), and do not include the area of the openings in the wall area. Leave wall as is in the LOADS input. (Note: Rather than use a U-value in the Custom Weighting Factor input, it would be preferable to describe the wall as a delayed surface.)

[10] In the Custom Weighting Factor calculation, the effective area of furniture for radiative exchange is different from the corresponding area for convective exchange. This produces a $\leq$ 10% error in the weighted loads when furniture is defined in LIBRARY-INPUT LOADS. This will occur in any space where furniture is defined in the Custom Weighting Factor input.

Interim solution: None; do not specify furniture in Custom Weighting Factor input.

[11] When furniture is specified in the Custom Weighting Factor calculation, the floor area is incorrectly multiplied by 1 - (FURN-FRACTION). This reduces the contribution of the floor to the weighting factors.

Interim solution: None; do not specify furniture in the Custom Weighting factor input.

[12] In the Custom Weighting Factor calculation, high order response factor terms are calculated using a factor proportional to $(\text{common-ratio})^n$. For small common ratio, this may cause underflow [$(\text{common-ratio})^n < 10^{-293}$ on CDC 7600 machines]; on the LBL machine, this will give an error message each time such an underflow occurs. The Custom Weighting Factor calculation is unaffected since the underflow gets set to zero. This bug occurs when the Custom Weighting Factor input contains an extremely light delayed construction, e.g., a wall consisting only of $\frac{1}{2}$" of plywood.

Interim solution: Change from delayed to quick surface (i.e., specify U-value) for very light walls.

[13] The Custom Weighting Factor calculation may fail for spaces of very light construction. The resulting ERROR message is:

> WEIGHTING FACTOR CALCULATION FOR SPACE <u-name>,
> WEIGHTING FACTOR TYPE <k>, FAILED IN DECONVOLUTION, SUBROUTINE WFDECN

This may occur when all the surfaces in a space are of very light construction, e.g., an attic with a light roof and floor.

Interim solution: None; use ASHRAE weighting factors for these spaces (i.e., enter FLOOR-WEIGHT in LOADS input).

[14] In the Custom Weighting Factor calculation, the FURN-WEIGHT keyword has no effect.

Interim solution: None; do not specify furniture in the Custom Weighting Factor input.

[15] In the Custom Weighting Factor calculation, the characteristic weight of heavy furniture is mis-punched as 2.0 lb/ft^2; it should be 20.0. However, this bug has no effect on results, since the characteristic weight is not used in DOE-2.1.

[16] If any surface has zero area or if any window, wall, underground floor, etc, has a MULTIPLIER=0, the Custom Weighting Factor calculation will fail, giving the ERROR message:

> WEIGHTING FACTOR CALCULATION FOR SPACE <u-name>,
> WEIGHTING FACTOR TYPE <k>, FAILED IN DECONVOLUTION, SUBROUTINE WFDECN

Note, however, that LOADS will accept a zero-area surface.

Interim solution: 1) Remove surface from input; or 2) give surface a very small area. Fixed in DOE-2.1A by assigning zero-area surfaces an area of 0.01 ft^2 in the Custom Weighting Factor calculation.

[17] The Custom Weighting Factor calculation fails for a space with quick underground walls or floors. It will also fail if the underground wall or floor is defined with LAYERS, but each of the MATERIALs in the construction is defined by a RESISTANCE rather than by THICKNESS, CONDUCTIVITY, DENSITY and SPECIFIC-HEAT.

Example: the following two underground surface inputs will cause the Custom Weighting Factor calculation to abort in routine WFMATG:

```
[1]  SLAB    =CONSTRUCTION  U-VALUE=0.7                          ..
     FLOOR-1 =UNDERGROUND-FLOOR  CONS=SLAB  AREA=1176
                                 SOLAR=FRACTION=0.7              ..

[2]  CONCRETE =MATERIAL  RESISTANCE=0.5                         ..
     FL-TYPE  =LAYERS    MATERIAL=(CONCRETE)  I-F-R=0.92         ..
     SLAB     =CONSTRUCTION  LAYERS=FL-TYPE                     ..
     FLOOR-1  =UNDERGROUND-FLOOR  CONS=SLAB
                          AREA=1176  SOLAR FRACTION=0.7          ..
```

Interim solution: Make all underground floors and walls delayed. At least one material in the construction must have THICKNESS, CONDUCTIVITY, DENSITY and SPECIFIC-HEAT specified.

[18] If a Custom Weighting Factor creation run is made for a single space and the WEIGHTING-FACTOR keyword is not specified, the results will be meaningless.

Interim solution: Be sure to specify WEIGHTING-FACTOR keyword.

[19] When (a) two spaces are defined in a LIBRARY-INPUT LOADS run; and (b) the first space has WEIGHTING-FACTOR=u-name specified; and (c) the second space is LIKE'd to the first space; and (d) FLOOR-WEIGHT is specified for the second space, then the following will occur: (a) the Custom Weighting Factors requested for the first space will be assigned to the second space; and (b) the first space will end up with all weighting factors equal to zero.

Interim solution: In the above situation, do not LIKE the second space to the first space. The weighting factors will then be correctly calculated for the first space, and none will be calculated for the second space. If the user wants weighting factors calculated for both spaces, WEIGHTING-FACTOR=u-name must be specified for both spaces, with unique u-names for each space.

[20] BDL does not make an appropriate substitution when a parameter is set equal to the u-name of a schedule. A misleading error message reading:

<u-name of SCHEDULE> WAS REFERENCED... BUT WAS NEVER DEFINED

is printed. A similar problem does not arise for the u-names of DAY-SCHEDULEs and WEEK-SCHEDULEs.

Interim solution: None; do not set a parameter equal to the u-name of a SCHEDULE.

[21] The command RUN-PERIOD cannot be parameterized. Error messages are produced for month, day and year that advise the user that the values input are incorrect.

Interim solution: None.

[22] When a command is LIKE'd to itself, the program is supposed to print an error message. It does not. The program will usually abort in routine SYMFIL with a dayfile message reading **SCM BEYOND FLS. This will occur when the sequence <u-name> = command LIKE <u-name> occurs.

Interim solution: Check your input carefully for mistakes of this kind.

[23] A zero wall area error message prints out with no name and zero for the defined line. This will occur whenever EXTERIOR-WALL is unnamed and the window and door area are equal to or greater than the exterior wall area. The above error message does not provide useful information.

Interim solution: Change the input. Find wall(s) which violate the rule and add a small amount to the area.

[24] In the MATERIALS section of the library, the materials IN01, IN02, IN03, IN04, IN05, IN11 and IN12 have the wrong density. They are coded as 6.0 lbs/ft^3. They should actually be 0.6 lbs/ft^3.

Interim solution: Input the above materials in the MATERIAL command with the correct densities.

[25] LIKEing CONSTRUCTION commands causes an abort in subroutine CONSTI.
Interim solution: None.

[26] In the schedule of U.S holidays, the second Monday in October, Columbus Day, has been omitted.
Interim solution: If desired as a holiday, explicitly input the day in all SCHEDULEs.

[27] When the PLENUM-NAMES list has more than one zone in it for a SYSTEM-TYPE for which PLENUM-NAMES is unused, BDL will abort in routine KODER with no error message.
Interim solution: Remove the PLENUM-NAMES keyword and make those zones unconditioned with LIGHT-TO-SPACE=100.

WEATHER FILE

[28] The ground temperatures and clearness numbers on the weather file for Albuquerque (code name ALBUQUE) on the LBL computer are incorrect.
Interim solution: Input the values in the BUILDING-LOCATION command. Correct ground temperatures are:

67.5, 65.3, 65.5, 68.3, 72.8, 78.1, 82.3, 84.7, 84.4, 81.6, 76.9, 71.9.

Correct clearness numbers are:

1.05, 1.05, 1.05, 1.05, 1.15, 1.15, 1.15, 1.15, 1.15, 1.15, 1.05, 1.05.

[29] The TRY weather file for Salt Lake City has erroneous data for windspeed and cloud type for the first six months of the year. This is reflected in the weather summary in the Reference Manual.
Interim solution: None; do not use the Salt Lake City weather file.

WEATHER PROCESSOR

[30] In the Weather Processor, the minimum drybulb temperatures reported by the STAT option should agree with the minimum temperatures reported in the monthly summaries of the LIST option. When the value is negative, however, the value in the STAT option is different by one degree due to incorrect rounding.
Interim solution: Ignore the STAT figures for minimum drybulb temperatures; rely on the figures reported in the LIST option.

[31] The EDIT option with the Weather Processor does not work properly when changes are attempted for two different days within the same month. A change is made only for the first day; the second day is left unchanged.
Interim solution: Make two separate EDIT runs, changing one day per month at a time.

[32] Attempting to do a STAT of a solar file without a preceding LIST will cause the program to abort in subroutine MONTHS.
Interim solution: Precede a STAT command with a LIST command when dealing with a solar file.

LOADS

[33] The light energy sent to the plenum in LOADS is incorrect. As an example, suppose LIGHT-TO-SPACE = .80. Then 80% of the light energy goes to the space, as it should. However, (80%)(20%) = 16% is sent to the plenum, instead of the correct 20%. The missing 4% disappears.

Interim solution: None.

[34] The calculations for the pressure due to the wind velocity and to the stack effect in LOADS are being changed slightly. The constant used in the formula for PTWV will be changed from 0.0006407849 to 0.000638. The constant used in the formula for PSE will be changed from 0.25532 to 0.255.

Interim solution: None.

[35] In the LV-J Report the u-names of shading surfaces are not reported. No change is anticipated.

[36] If AREA=0.0 is input in the SPACE command, the program will abort in routine TEMDEV.

Interim solution: Add a very small amount to the value of AREA.

[37] The defaults for LIGHT-TO-SPACE are 1.0, 0.8, 0.8, and 1.0 for SUS-FLUOR, REC-FLUOR-RV, REC-FLUOR-RSV, and INCAND, respectively. If the user attempts to SET-DEFAULT SUS-FLUOR or INCAND to 0.8, the program will still use 1.0 as the default.

Interim solution: Increase the value in SET-DEFAULT to 0.801.

[38] When a wall is too massive, the program aborts in subroutine WRITEN because the response factor common ratio cannot be reached in 100 terms, which is the maximum the program stores.

Interim solution: None; use less massive walls. Three feet of dirt (density=60) is definitely too massive. The lower limit is presently unknown.

[39] Door loads are not multiplied by the exterior wall multiplier. The infiltration through the door is also not multiplied by the exterior wall multiplier. The portion of the space conductance due to doors and windows does not include the effect of the exterior wall multiplier. This occurs whenever the keyword MULTIPLIER is used in the EXTERIOR-WALL command and the EXTERIOR-WALL has doors or windows. This will affect the extraction rate calculated by SYSTEMS, e.g., Report SS-D.

Interim solution: Use only MULTIPLIER = 1 in EXTERIOR-WALL command when there are windows or doors.

[40] TIME ZONE and BUILDING AZIMUTHs are not printed out on the LOADS Verification Report LV-A.

Interim solution: None.

[41] Failure to input both SKY-FORM-FACTOR and GND-FORM-FACTOR allows the program to substitute -66666. for GND-FORM-FACTOR, producing absurd solar loads through the roof. This will occur whenever SKY-FORM-FACTOR is specified but GND-FORM-FACTOR is not.

Interim solution: Input both SKY-FORM-FACTOR and GROUND-FORM-FACTOR or neither, as the documentation indicates.

[42] This modification changes the sunup check and adjusts the hour angle calculation for those hourly bins in which sunrise and sunset occur. Previously the hour angle was always calculated at the midpoint of the hourly bin. For bins containing the sunrise or sunset a yes-no decision was made on whether or not the sun was up for the entire bin, and the hour angle of the sun was set to the bin mid-point. This results, for solar calculated in LOADS, in either underestimating or overestimating the solar energy for the day, depending on which decision was made. For the whole year, the effect should average out. For measured solar data, however, the check would always result in throwing solar data away, and thus underestimating the solar gain. The new check sets the sunup flag to yes if the sun is up at any point in the hourly bin. The hour angle is set to a value midway between sunrise or sunset and the bin edge nearest to noon. For calculated solar, the solar energy for the hour is multiplied by the fraction of the hour the sun is up.

Interim solution: None.

SYSTEMS

[43] The headings in Reports SS-B, SS-F, and SS-H are unclear. In SS-B and SS-H, the headings for the MAXIMUMs should read LOADS, not ENERGY. In Report SS-F, the first two columns should read ENERGY, not LOAD, and the MAXIMUM BASEBOARD should be a LOAD.

Interim solution: None.

[44] Whenever the ALTITUDE, in the BUILDING-LOCATION command in LOADS or on the weather file, is non-zero, the SYSTEMS design routine appropriately computes an ALTITUDE MULTIPLIER (see the SV-A Report) by which all standard cfms are multiplied to obtain the actual cfms. Unfortunately, the program uses the actual cfm and not the standard cfm to compute the fan energy for supply, return, and exhaust fans as well as the temperature rise across the supply and return fans. The effect is to overestimate the fan electric energy by a factor ALTITUDE MULTIPLIER and also to overestimate cooling energy and to underestimate heating energy.

Interim solution: Specify SUPPLY-KW, RETURN-KW, and EXHAUST-KW by dividing the actual kW/cfm by the ALTITUDE MULTIPLIER. If SUPPLY-DELTA-T or RETURN-DELTA-T are specified, divide the actual delta T by the ALTITUDE MULTIPLIER.

[45] It was intended that the user could specify EXHAUST-KW in place of both EXHAUST-STATIC and EXHAUST-EFF to describe the electrical consumption of zone exhaust fans. At present, the EXHAUST-KW option works only if EXHAUST-EFF is specifically set equal to 0.0.

Interim solution: Use either EXHAUST-STATIC with EXHAUST-EFF or set EXHAUST-EFF to 0.0 when using EXHAUST-KW.

[46] In UHT, UVT, TPFC, FPFC, FPH, and PTAC systems, when HEAT-SOURCE=GAS-FURNACE or OIL-FURNACE, the fuel input is overestimated by an extra addition of FURNACE-AUX.

Interim solution: None.

[47] The program uses the "sun" hour rather than the local time (including daylight savings) to report the time of peaks.

Interim solution: None.

[48] The program aborts with a "divide by zero" (infinite result) error message in UNITH. This occurs, very rarely, for UHT systems when no heating is available.

Interim solution: None, except to schedule heating always available.

[49] The program aborts in routine TEMDEV with an infinite result. This will occur whenever MIN-CFM-RATIO is less than MIN-OUTSIDE-AIR or MIN-AIR-SCH has a value of > 1.0.

Interim solution: Correct input.

[50] Whenever MIN-AIR-SCH is used in a UVT system, the program aborts in routine UNITV.

Interim solution: None; do not use MIN-AIR-SCH in a UVT system.

[51] In the RESYS and PTAC systems, the air-to-air heatpumps overestimate the contribution to capacity change from the inside temperature variences from 70 degrees.

Interim solution: Contruct a new bi-linear or bi-quadratic curve for HEAT-CAP-FT in which the first variable is the outside drybulb temperature and the second variable is the inside drybulb temperature.

[52] The WARMEST and COLDEST codewords for COOL-CONTROL and HEAT-CONTROL are not very accurrate. New algorithms will be added to simultaneously vary temperature and volume.

Interim solution: None.

[53] The program does not print a warning, nor does it reset ASSIGNED-CFM, if the user has input an ASSIGNED-CFM less than EXHAUST-CFM. This can result in a negative return airflow rate and incorrect mixed air temperatures.

Interim solution: Do not input ASSIGNED-CFM less than EXHAUST-CFM.

[54] This bug covers several small problems in the design routine.

1) The sizing of the PTAC system ignores COOL-FT-MIN.

2) When COOLING-CAPACITY is entered by the user but COOL-SH-CAP is not defined, the program may incorrectly override the zone cfms input by the user.

3) When the HEATING-CAPACITY is not entered by the user, the computed heating capacity for variable air volume systems is underestimated, when there is outside air specified.

4) When computing the mixed air temperature for the main air-handler cooling capacity, the program ignores SUPPLY-DELTA-T.

Interim solution: None. Most are not significant.

[55] In HVSYS systems, DUCT-DELTA-T always results in a heat loss (and thus an additional energy consumption), even when the ambient temperature is comparable to the supply temperature.

Interim solution: None; omit DUCT-DELTA-T.

[56] When a large fraction of zone supply air is also zone exhausted from the zone, the return air humidity is incorrectly calculated. This will result in a maximum-humidity error message, even though MAX-HUMIDITY was not input.

Interim solution: None. Ignore the error message; the simulation is correct.

[57] When there are thermostatic baseboards in systems with outside air and when the zone temperature is in the deadband between heating and cooling, under some conditions the baseboards may come on and the heating energy will be overestimated. There is no estimate for the magnitude of this effect.

Interim solution: None.

[58] When only baseboards are available, it is necessary to schedule cooling and fans off and heating on. This is not, however, always being simulated correctly. One can sometimes get phantom heating or cooling, especially if outdoor reset baseboards are used.

Interim solution: None.

[59] For the RESYS system, Report SS-F may indicate underheating, when, in fact, there was no under heating. This anomoly occurs when no cooling is required in the hour and natural ventilation is not used because outside conditions were not appropriate, e.g., the outside temperature exceeded the cooling set-point.

Interim solution: Ignore report. The simulation is otherwise correct.

[60] The heating coil load for UVT systems is greatly underestimated, since only the outside air load is being computed.

Interim solution: None; do not use UVT system.

[61] If SYSTEM-TYPE = UHT and HEAT-SOURCE = GAS-FURNACE, the program will abort in routine FURNAC.

Interim solution: Do not use HEAT-SOURCE = GAS-FURNACE with UHT. Rather, let HEAT-SOURCE default to HOT-WATER and enter a gas furnace in PLANT.

[62] The FPH system does not work correctly under any circumstances. Zero heating energy is reported.

Interim solution: None.

[63] In a RESYS system, the program sometimes aborts in routine CVAL. This occurs when fans are scheduled off, but cooling or heating is scheduled on.

Interim solution: None.

[64] In systems requiring a control zone (SZRH, RESYS, PSZ), if the first zone (which is taken as the control zone) is not a conditioned zone, the program will either abort or will produce meaningless results.

Interim solution: Correct input. The first zone listed in ZONE-NAMES must be the control zone.

[65] The SS-F Report shows cooling and heating energy expended for a plenum zone. This will occur whenever the SS-F Report is requested in a system with a plenum zone.

Interim solution: Ignore this report for the plenum(s). The simulation is correct and the data reported here are junk.

[66] When NIGHT-CYCLE-CTRL=CYCLE-ON-FIRST or CYCLE-ON-ANY and there is a cooling demand, heating energy is used to maintain the cooling set-point in those zones which are below the cooling set-point. NIGHT-CYCLE-CTRL should operate only to maintain the heating set-point.

Interim solution: Set cooling set-point during setup conditions to high value so that NIGHT-CYCLE-CTRL is not invoked.

[67] The airflow rate to a zone in a variable air volume system can go above the design flow rate for that zone, if the main air-handler fan is sized above the sum of the design flow rates for all the zones. This can occur only if SUPPLY-CFM times MAX-FAN-RATIO is greater than the sum of the design flow-rates. It will not happen if the main fan is sized for the coincident load.

Interim solution: If the user does not explicitly specify zone air-flow rates and does not specify SUPPLY-CFM, the SV-A Report should be examined to ensure that the above condition does not apply. If it does, design zone air-flow rates must be specified explicitly.

[68] In TPFC and FPFC systems, when the exhaust air quantity exceeds the outside air quantity, the program ignores the extra required make-up air.

Interim solution: Ensure that the minimum outside air flow rate is greater than or equal to the exhaust air-flow rate.

[69] In TPFC and FPFC systems, a cooling load is often reported in the winter, because no outside air is being simulated and thus the mixed air temperature is incorrectly calculated. This problem occurs whenever the outside air is specified by keywords other than MIN-OUTSIDE-AIR.

Interim solution: For these systems, specify MIN-OUTSIDE-AIR when ventilation air is desired.

[70] The sensible cooling load in the RESYS system is independent of the user-input for DUCT-DELTA-T.

Interim solution: None.

[71] When a zone has zero net loads in any hour, the program simulates heating to maintain the zone temperature. This results from a bug in the algorithm which currently attempts under these conditions to maintain a zero extraction rate. It should supply heat only when the zone temperature falls into or below the heating throttling range.

Interim solution: None.

[72] When the zone temperature is between the heating and cooling throttling ranges, the program attempts to maintain a zero extraction rate. Depending upon the system type it should maintain the extraction rate at the bottom of the cooling throttling range throughout the dead band.

Interim solution: None.

[73] The WARMEST and COLDEST options for COOL-CONTROL and HEAT-CONTROL, respectively, cause a reset of the supply air temperature to the average over all zones of the DESIGN-COOL-T or DESIGN-HEAT-T, respectively. It should set the upper supply air temperature limit for COLDEST and the lower limit for WARMEST to the mixed air temperature passed when the outside air dampers are in their minimum position or to the preheat coil exit temperature.

Interim solution: None; do not use WARMEST and COLDEST codewords.

[74] The COLDEST option for the HEAT-CONTROL keyword is reset based upon the COOL-TEMP-SCH rather than the HEAT-TEMP-SCH.

Interim solution: None; do not use HEAT-CONTROL=COLDEST.

[75] When HEAT-CONTROL=COLDEST, the supply temperature is reset to a value which supplies only 0.75 of the full heating capacity, even when full capacity is requested by zones. This will result in loads-not-met even through the system is adequately sized.

Interim solution: None; do not use HEAT-CONTROL=COLDEST.

[76] In the hourly reports there may appear negative sensible heat capacitites and mixed air humidity ratios larger than 1.0. This will occur for that hour immediately following one in which there is no infiltration and no outside air.

Interim solution: Make sure there is a negligible but non-zero amount of outside air or infiltration at all hours.

[77] In dual duct systems (MZS, PMZS and DDS), the hot supply air temperature is occasionally higher than design by twice the DUCT-DELTA-T. This occurs when heating is off and mixed air is being passed or when HEAT-CONTROL=COLDEST and no zones are asking for heating.

Interim solution: Ignore the hourly reports for the hot supply air temperature under these conditions. There is no effect upon the energy reported.

[78] For VAVS, PVAVS, RHFS and CBVAV systems, the automatic sizing routine uses MAX-SUPPLY-T for the design maximum air temperature, if HEAT-SET-T is not specified and COOL-CONTROL=CONSTANT. This introduces a main heating coil, even when the user does not desire one.

Interim solution: Specify HEAT-SET-T to a low value, when no main heating coil is desired.

[79] The program uses the value of 1st hour's variables (temperatures, extraction rates, etc.) to estimate this hour's values for these variables. This can produce unrealistic temperatures and extraction rates when the zone temperatures change radically during an hour, e.g., immediately following a night set-back or set-up. A better estimate should be made under these circumstances.

Interim solution: None.

[80] The SYSTEMS program does not pass the peak domestic hot water load (BUILDING-RESOURCE command) to PLANT so that boilers or domestic hot water heaters can be appropriately sized.

Interim solution: None; do not allow PLANT to size boilers or domestic hot water heaters, when domestic hot water heaters are present.

[81] In SYSTEMS reports the value of the wetbulb and drybulb temperatures at peak heating loads are incorrectly reported when they are negative.

Interim solution: None.

[82] The outside air as specified in the ZONE command (or ZONE-AIR) is ignored for TPIU and FPIU systems.

Interim solution: Use MIN-OUTSIDE-AIR command in the SYSTEM command (or SYSTEM-AIR command) to specify outside air for these systems.

[83] The recovery of heat through the RECOVERY-EFF keyword does not take into account the value of DUCT-AIR-LOSS.

Interim solution: None.

[84] The SS-F Report provides the maximum and minimum zone temperatures only during those hours that the fans are running. Thus, when baseboards are providing heating, but the fans are off, these temperatures are not correct. There is no affect on the energy calculation from this bug in the report.

Interim solution: None.

[85] The drybulb temperature dependence of the coil bypass factor is incorrectly modeled. The program uses the entering drybulb rather than the outside drybulb.

Interim solution: None.

[86] The latent load on the system coils is overpredicted when the cfm is very small.

Interim solution: None.

[87] The return air temperature is calculated incorrectly for the CBVAV system, whenever the zone MULTIPLIER is different from 1.

Interim solution: None; do not use MULTIPLIER different from 1 for zones in a CBVAV system.

[88] The program will abort with a "divide by zero" error in routine DESIGN whenever the calculated SUPPLY CFM for a zone is less than 5 cfm.

Interim solution: Input an ASSIGNED-CFM of 10 cfm for any zone which has peak heating and cooling loads which are both very low.

[89] The main air handler supply temperature in the TPIU system is set incorrectly, when the terminals are in the cooling mode. The program at present assumes that heating is turned off.

Interim solution: None.

[90] The average coil surface temperature for packaged DX systems (PSZ, PMZS, PVAVS, RESYS and PTAC) increases, rather than decreases, during compressor cycling (Part-Load-Ratio < MIN-HGB-RATIO).

Interim solution: None. This should not produce a large energy effect.

[91] The program simulates dehumidification, with its additional energy use, even when the airflow over the cooling coil is zero. This may cause an abort with a "divide by zero" error in routine DDSF or SDSF. This occurs only, and rarely, for dual duct systems.
Interim solution: None. This should not produce a large energy effect.

[92] There is a slight error in the hourly reported values for the supply and return fan kW, when the cooling coil temperature is depressed for humidity control. The total fan energy is correct. No change is anticipated.

[93] The MIN-AIR-SCH keyword is not effective for the TPFC and the FPFC systems.
Interim solution: None.

[94] Multizone RESYS simulation will not work properly.
Interim solution: None; model only single zone residential systems.

[95] In SZCI systems, the induction air temperature calculation does not take into account the zone exhaust. This will underestimate the heating and cooling done by the system, if there is exhaust in the zone.
Interim solution: None; do not have zone exhaust with this system type.

[96] The program will abort with a "divide by zero" error in routine WBFS, if it should happen that the wetbulb and drybulb temperatures, entering the coil, are equal. This should be an extremely rare occurrence.
Interim solution: None.

[97] When using the HP system, the program may abort in routine HTPUMP under the following simultaneous conditions: No outside air, fans on, and cooling scheduled off.
Interim solution: Schedule fans off when cooling is off and on when cooling is on.

[98] The program will abort in routine DDSF for DDS, MZS or PMZS systems, if there is no outside air, no infiltration and all the air is going through the hot duct.
Interim solution: Schedule at least a small amount of outside air at all times using the keyword MIN-AIR-SCH. E.g.,

```
ALL-AIR = SCHEDULE  THRU DEC 31 (ALL) (1,24) (0.0001) ..

MIN-AIR-SCH = ALL-AIR ..
```

PLANT/SOLAR SIMULATOR

[99] No heat is recovered from the gas turbine.
Interim solution: None.

[100] In Report PV-D, the energy source codewords are truncated to eight characters.
Interim solution: None.

[101] When the number of DESIGN-DAY commands is equal to the number of RUN-PERIOD intervals, and the user has both SYSTEMS and PLANT input, the size of the equipment in SYSTEMS is given in the SV-A Report and the sizes of the equipment in PLANT are given in the PV-A Report. If the user has chosen design day parameters that do not produce both peak heating and cooling loads and the number of RUN-PERIOD intervals is greater than the number of DESIGN-DAY commands, the program may abort in routine PLANT with an infinite result. This occurs because one of the pieces of plant equipment has been given a zero size (there being no load for that piece of equipment) and at some point the program wants to divide by the size.
Interim solution: Always be sure that the design days chosen will produce both heating and cooling loads, if both heating and cooling equipment are defined in PLANT.

[102] If process-heat is hooked as a demand to the DBUN-CHLR (as a supply) in the HEAT-RECOVERY command, there may not be any heat recovered. This is because only a space heating load or scheduled tank charging can cause the DBUN-CHLR to go into the heat-recovery mode.
Interim solution: Input a small tank charging rate, approximately 2 Btu/hr, for a 20000 Btu tank scheduled for the same time as the process load to ensure that the tank is in the recovery mode.

[103] The default values for ELEC-INPUT-RATIO are too high for equipment types STM-BOILER, HW-BOILER, and FURNACE.

Interim solution: Input a value for ELEC-INPUT-RATIO of 0.0063 for boilers and 0.00 for furnaces.

[104] Output for the code-number 11 in the hourly report block VARIABLE-TYPE = PLANT is meaningless.

Interim solution: Do not request code-number 11.

[105] The energy needed to keep the cold tank from freezing is either lost or accounted for improperly in the BEPS Report.

Interim solution: None.

[106] Overloads are carried past end of day or even if the respective heating or cooling schedule in SYSTEMS is turned off.

Interim solution: None; do not undersize equipment.

[107] When a cold storage tank is to be simulated for a building with no cooling load, the program aborts in subroutine PLANT.

Interim solution: Do not simulate a cold storage tank when a building does not need cooling.

[108] If solar is input together with another source of heat in the HEAT-RECOVERY command, double counting of solar energy in the BEPS Report will result.

Interim solution: None.

[109] CBS will meet only the systems coil loads; the loop losses will be met only by the boiler. This causes the boiler to operate a large number of hours at an extremely low efficiency when the solar system should be able to meet the entire load.

Interim solution: When using the solar simulator, do not simulate loop losses, i.e., set HCIRC-LOSS and HCIRC-HEAD to zero.

[110] When heating loop loss is less than pump heat gain, more pump heat is allowed into the heating loop than there is loop loss by conduction. This can result in negative heating loads.

Interim solution: Do not use the keyword HCIRC-LOSS, or make sure that the pumping heat (from HCIRC-HEAD and HCIRC-IMPELLER-EFF) is less than loss.

[111] The program will abort in subroutine READSP if a domestic hot water heater is not explicitly sized.

Interim solution: Always specify the size of domestic hot water heaters.

[112] The tower fan cycling algorithm is incorrect. This bug will sometimes cause the tower to be cycled on longer than one hour each hour, or to cycle a negative period of time. This will occur when the cooling tower has a small cooling load. Its effect is much worse on hourly/peak electric load than on total load.

Interim solution: None.

[113] A storage tank is counted as operating in Report PS-C anytime it stores or gives out heat. It should be counted only when giving out heat.

Interim solution: The HOURS AT PERCENT PART LOAD RATIO portion of Report PS-C should be disregarded for storage tanks. The simulation is unaffected by this bug.

[114] The heat recovered from the diesel or gas turbine exhaust gas is less than it should be when a solar absorption chiller is used. This occurs when a user specifies a solar absorption chiller and heat recovery from diesel or gas turbine exhaust, but does not input steam pressure, in which case the program sets the steam pressure to 150 psi.

Interim solution: Explicitly input STM-PRES.

[115] For an oil furnace, there should be no energy use when the furnace is off. The program, however, uses the keyword FURNACE-AUX to calculate energy consumption of spark ignition systems, even when the furnace is off.

Interim solution: When FURNACE-FUEL=FUEL-OIL is used in the PLANT-PARAMETER command, set FURNACE-AUX=0.

[116] When the value for INSTALLED-NUMBER in the PLANT-EQUIPMENT command is greater than one, the annual maintenance cost is calculated incorrectly. The program ignores the number of units and calculates the maintenance cost for one unit only.

Interim solution: Specify the keyword MAINTENANCE as the total number of maintenance hours for all units.

[117] The value reported in the BEPS Report in PLANT for NATURAL-GAS used for heating is incorrectly inflated by the amount of the gas used for any purpose in LOADS. This occurs whenever SOURCE-TYPE=GAS in the SPACE-CONDITIONS command or when the GAS-THERMS keyword is used in the BUILDING-RESOURCE command.

Interim solution: In the BEPS report, subtract the value reported under NATURAL-GAS for MISC EQUIP from that reported for SPACE-HEAT to obtain the correct value for SPACE-HEAT.

DOCUMENTATION UPDATES

BDL Summary

- On page BDL-5 LOADS, under command DIAGNOSTIC, add two new codewords:

LIMITS, NO-LIMITS	LIMITS
LIBRARY-CONTENTS†	No listing of library

The box labelled LIST, LIBRARY-CONTENTS should be eliminated and the note reading "To be used only ..." should be appended to the codeword LIBRARY-CONTENTS above.

- On page BDL-9 LOADS, under the SPACE command, a note should be added to the keyword MULTIPLIER, reading:

‡ Must equal MULTIPLIER in SYSTEMS for corresponding ZONE.

- On page BDL-12 LOADS, under command UNDERGROUND-WALL, keyword SOLAR-FRACTION, remove one set of parentheses, as follows:

SOLAR FRACTION (S-F) (0.0; 0.0 to 1.0)‡

- On page BDL-13 LOADS, and also on page BDL-21 SYSTEMS, reverse the order of the two boxes labelled STOP and SAVE-FILES.

- The SET-DEFAULT command is used neither in the SYSTEM command and its subcommands, PLANT-ASSIGNMENT, nor in any of the PLANT commands. Therefore, on pages 17 through 20 of the BDL Summary, add a note to the commands SYSTEM-CONTROL, SYSTEM-AIR, SYSTEM-FANS, SYSTEM-TERMINAL, SYSTEM-FLUID, SYSTEM-EQUIPMENT, SYSTEM, and PLANT-ASSIGNMENT reading:

[Note: SET-DEFAULT command not allowed]

Please note that the DOE-2.1 version of the program does not issue an error message if this rule is violated. See BDL Bug above.

- On page BDL-24, -53, and -55 SYSTEMS, under command SYSTEM, keyword ZONE-NAMES for system types SZRH, RESYS, and PSZ, add a line after the • (bullet) reading:

(First listed must be control zone)

- On page BDL-48 SYSTEMS, under the command ZONE-CONTROL, strike the keyword COOL-TEMP-SCH.

- On pages BDL-65 and -66 PLANT, strike the box labelled SET-DEFAULT and re-number the CURVE-FIT box "P3b".

- On page BDL-70 PLANT, under keywords DIESEL-STACK-FU and GTURB-STACK-FU, strike the words "linear or".

Users Guide

- In Section 9, on page 9-8, add to the table of DIAGNOSTIC Defaults and Options, LIMITS, NO-LIMITS, and LIBRARY-CONTENTS. To the discussion that follows, append these paragraphs:

  The codeword NO-LIMITS allows the user to enter keyword values outside of the published allowable ranges. The program will issue CAUTION messages rather than ERROR messages in this case. Since some of the algorithms produce meaningful results only when the keyword values are within the published limits, the NO-LIMITS codeword should be used with caution.

  The codeword LIBRARY-CONTENTS causes the contents of the library attached to the job to be printed out. This will be either the standard DOE-2 library, the user-created library, or a combination of the two, depending on the user's prior library-building activities. (See Section 10.) Be advised that LIBRARY-CONTENTS can produce many pages of output.

Reference Manual

- In the Reference Manual, page II.19, add a new rule reading:

  6. The SYSTEM command and its associated subcommands, PLANT-ASSIGNMENT, and none of the PLANT commands may not be set under SET-DEFAULT.

  Again, note that, at present, the program does not issue an error message if this rule is violated. See BDL Bug above.

- On page III.6, at the bottom of the Limitations table, change the maximum number for U-names from 450 to 352.

- On page III.27, change the first sentence of Rule 1 to read:

  One and only one BUILDING-LOCATION instruction must be entered for each separate LOADS progrm run.

- On page III.30, the following sentence should be appended to the end of the first paragraph on BUILDING-SHADE:

  Diffuse solar radiation from the sky and from the ground is not affected by BUILDING-SHADE.

The following discussion should be added to page III.49.

The conductance given in glass manufacturers' data sheets usually includes the outside air film resistance for a windspeed of 7.5 mph (summer) or 15 mph (winter). The following equation can be used to obtain the corresponding value of GLASS-CONDUCTANCE:

$$\text{GLASS-CONDUCTANCE} = \left(\frac{1}{U} - R_{film}\right)^{-1},$$

where U is the overall conductance in Btu/ft^2-h-^{o}F and R_{film} is the outside air film resistance in ft^2-h-^{o}F/Btu. R_{film} can be obtained from:

$$R_{film} = 1/(-0.001661 * v^2 + 0.302 * v + 1.45),$$

where v is the windspeed in knots. For example, let U = 0.64 for a windspeed of 7.5 mph. Then v = 7.5/1.15 = 6.52 knots, and

$$R_{film} = 1/(-0.001661 * 42.51 + 0.302 * 6.52 + 1.45)$$

$$= 0.30,$$

which gives

$$\text{GLASS-CONDUCTANCE} = \left(\frac{1}{0.64} - 0.30\right)^{-1}$$

$$= 0.79$$

On page III.60, under NEUTRAL-ZONE-HT, the description of the method of calculating values contains some inaccuracies. In fact, the measurement is the vertical distance from the present zone to the neutral zone. It is plus for zones below the neutral zone, and negative for zones above it.

On page III.72, under the keyword SOLAR-FRACTION, remove the set of parentheses and the words "list of 1".

On page III.75, change Note (None) 2 to read:

> Note 2: The first fraction is for the side of the wall in this SPACE. The second fraction is for the opposite side of the same wall, in the NEXT-TO SPACE. If an entry is omitted for all surfaces in the SPACE, SOLAR-FRACTION will be apportioned to the opaque surfaces in proportion to their areas.

On page III.88, under DESIGN-DAY, the last sentence of the paragraph should be replaced by:

> In this case, the peak heating and cooling loads afor sizing calculations in SYSTEMS and PLANT are taken from the peaks generated during the DESIGN-DAYSs RUN-PERIODS. If no DESIGN-DAYs have been specified, then the peak heating and cooling loads are taken from the weather file RUN-PERIODs.

On page III.90, add a new rule reading:

> A PLANT run is possibe only if the number of RUN-PERIOD intervals is greater than the number of DESIGN-DAY commands.

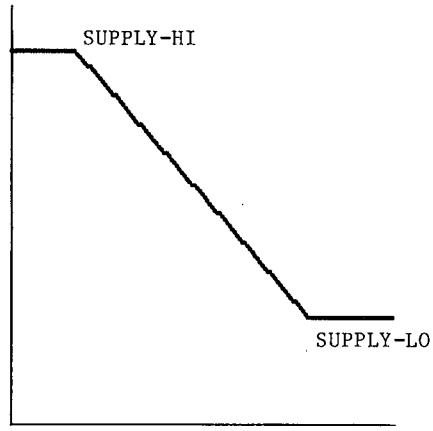
On page III.92, under keyword CLEARNESS, change the minimum in the range from 0. to .5.

On page III.125, in the middle of the page, change the line "and the ceiling .5." to "and the ceiling .05.".

- On page IV.9, add to the end of the list of SDL Commands and Maximun Number:

  U-names 180

- On page IV.12, the tails of the graphs in both figures should be extended in both directions as follows:



- On page IV.35, a footnote to the discussion of zonal systems should be added reading:

  * If described in the system command, each zone in the system is assumed to have those same capacities unless for a particular zone those capacities are overridden by capacities entered in the zone command.

- On page IV.48, in the second line from the top, change the underlined word "all" to "any of".

- On page IV.113, add the following to Number 8, Variable QCZ:

  Note: For SYSTEM-TYPE=RESYS this is the total of mechanical cooling and cooling by natural ventilation.

  And on page IV.114, Number 46, Variable SKWQH, strike the words "for RESYS".

- On page IV.116, Number 75, Variable PCH, the values for RESYS venting are reversed. The value of 1 indicates venting and the value of 0 indicates no venting.

- On page IV.185, under the command ZONE-CONTROL, strike the keyword COOL-TEMP-SCH.

- On page IV.215, change the last sentence on the page to read:

  To size a heating/cooling system, the following quantites must be determined:

- On page IV.219, strike the second sentence from the top of the page reading - "Thus, if the user .... as well as SUPPLY-CFM."

A new page, V.7.1, should be added to furnish the list of limitations in the PLANT subprogram, as follows:

Limitations

For DOE-2, the maximum number of PDL instructions that can be used for specifying the required data for the PLANT program is as follows:

Instruction	Maximum Number
DAY-SCHEDULE	60
WEEK-SCHEDULE	40
SCHEDULE	40
PARAMETER*	50
SET-DEFAULT*	100
TITLE*	5
PLANT-EQUIPMENT	6 for each equipment type
PART-LOAD-RATIO	1 for each equipment type
PLANT-PARAMETERS	1
EQUIPMENT-QUAD	1
LOAD-ASSIGNMENT	50
LOAD-MANAGEMENT	1
HEAT-RECOVERY	1
ENERGY-STORAGE (hot tank)	1
ENERGY-STORAGE (cold tank)	1
ENERGY-COST	5
REFERENCE-COSTS	25
PLANT-COSTS	1
PLANT-ASSIGNMENT	40**
PLANT-REPORT	1 command
HOURLY-REPORT	16
REPORT-BLOCK	64
U-names	118***
Solar Simulator	
SOLAR-EQUIPMENT	1
COMPONENT	40
CONNECT	No. of components
ITERATIONS	1
SYSTEM	1
TRACE	No. of components
DAY-SCHEDULE	20
WEEK-SCHEDULE	20
SCHEDULE	20

* This maximum number refers to the number of keyword values, not the number of instructions.

** This maximum number refers to the total number of different PLANT runs allowed in a single submittal. Only one PLANT-ASSIGNMENT is allowed for each PLANT simulation.

*** Note that the use of advanced scheduling techniques (described in Chapter II) will result in the use of at least three of these U-names internal to the PLANT program. Also, specification of code-words for PLANT-REPORTs, other than the defaults, count as U-names.

- On page V.38, under the (-STACK-FU) keyword, replace the words "a linear or quadratic function" with "an exponential function". Also, replace the last line with "or $z = ax^b$".

  In addition, on page V.45, under keyword DIESEL-STACK-FU, replace the words "a linear or quadratic equation" with:

  > the coefficients, a and b, of the equation $z = ax^b$. The user must use TYPE=QUADRATIC in the CURVE-FIT instruction and enter the coefficients as (a, b, 0).

  Under keyword GTURB-STACK-FU, change "a linear or quadratic" to "an exponential". On page V.50, under the DIESEL-STACK-FU and GTURB-STACK-FU keywords, delete the words "linear or".

- On page V.43, Table V.6, under keyword HW-BOILER-HIR-FPLR, the default value for the third independent variable, c, should read -0.079361.

- On page V.61, delete the third paragraph from the bottom reading "Note that the predicted ... the LOAD-MANAGEMENT instruction."

- On page V.93, it would be helpful to add that the units for c_1 are dollars, and that the units for s_1 are Btu/hr.

- In Table V.16, page V.104, item 11 for the PLANT report block is described incorrectly. It should read:

Variable List	Fortran Variable	Description
11	—	—

  Note that output for that variable may be specified under VARIABLE-TYPE = COOLING-TWR, VARIABLE-LIST = 1, i.e., Cooling tower load, Btu. See Table V.23.

- On page V.112, strike the command SET-DEFAULT from the list of BDL COMMAND WORDS used by the Solar Simulator.

- On page VII.57, add the following sentence to Number 3, COOLING ENERGY:

  > (If SYSTEM-TYPE=RESYS, the value reported here does not include cooling by natural ventilation.)

THE HEAT EXCHANGER

This section is devoted to common questions from users and responses from the DOE-2 User Coordination Office. Your questions and comments are most welcome.

* * * * *

Question: In a recent DOE-2.1 run my input received an error message reading "SYMBOL TABLE FILLED". What does that mean and how do I avoid it?

Answer: The symbol table is the means by which BDL keeps track of code-words and user-defined u-names. Each time the user defines a u-name it is added to the symbol table at the end of the list of program-defined code-words. The error message that you received indicates that you have defined too many u-names. The limit on the number of u-names (see DOCUMENTATION UPDATES in this issue) is 352 for LOADS, 180 for SYSTEMS, 118 for PLANT, and 87 for ECONOMICS. Counting the number of u-names you have created is straight-forward with one exception. When one uses an implicit definition of a DAY-SCHEDULE by incorporating the data within a WEEK-SCHEDULE command, one has used up an entry in the symbol table. In effect the program has defined a u-name for you. A similar situation exists when a WEEK-SCHEDULE is implicitly defined in a SCHEDULE command. Thus, the following SCHEDULE command will take up 7 entries in the symbol table:

```
HEAT-SCH=SCHEDULE
       THRU APR 30 (ALL) (1,7) (55) (8,18) (68) (19,24) (55)
       THRU SEP 30 (ALL) (1,24) (0)
       THRU DEC 31 (ALL) (1,7) (55) (8,18) (68) (19,24) (55) ..
```

since it is really shorthand for the following set of commands:

```
DAY-1   =DAY-SCHEDULE   (1,7) (55) (8,18) (68) (19,24) (55)  ..
DAY-2   =DAY-SCHEDULE   (1,24) (0)                           ..
DAY-3   =DAY-SCHEDULE   (1,7) (55) (8,18) (68) (19,24) (55)  ..
WEEK-1  =WEEK-SCHEDULE  (ALL)  DAY-1                         ..
WEEK-2  =WEEK-SCHEDULE  (ALL)  DAY-2                         ..
WEEK-3  =WEEK-SCHEDULE  (ALL)  DAY-3                         ..
HEAT-SCH=SCHEDULE  THRU APR 30 WEEK-1  THRU SEP WEEK-2
                   THRU DEC 31 WEEK-3                        ..
```

BDL is not smart enough to recognize that DAY-1 is the same as DAY-3!

* * * * *

Question: In Report SS-F in the month of May the MAXIMUM ZONE TEMP is given as $0^{o}F$, while the MINIMUM ZONE TEMP is given as $200^{o}F$. What does this mean?

Answer: The SYSTEMS program initializes the maximum zone temperature as $0^{o}F$ and the minimum as $200^{o}F$ at the beginning of each month. Whenever the maximum temperature for a given day, when the fans are on, is greater than the value stored under maximum zone temperature, the value is changed to the new maximum. Similarly for the minimum temperature. When the fans are off, this part of the program does not operate. When the fans are off for an entire month, the initialization values are printed. These values were chosen as being sufficiently absurd that there would be no chance of their being confused with actual temperatures. My bet is that you have scheduled the fans to be off in May.

* * * * *

Question: I prepared an input deck that included both LOADS and SYSTEMS. I finally got rid of all error messages and the program ran fine. I then stored the LOADS output in preparation for doing a number of SYSTEMS runs with the same LOADS configuration. In accordance with the instructions in the manuals, I removed the LOADS portion of my input deck and tried to run a series of runs with my SYSTEMS deck, after attaching the old LOADS output to the job. My run stopped with a statement that there were 8 ABORT-LEVEL DIAGNOSTICS. What went wrong?

Answer: My guess is that you had no ABORT command in your SYSTEMS input and so the ABORT-LEVEL reverted to the default, namely, CAUTIONS. In addition to seven CAUTIONS you had in your original "successful" run, the program issued a CAUTION message, when it did not see a LOADS deck, to the effect that it is assuming that you will be attaching an old LOADS output. This accounts for there being 8 ABORT-LEVEL DIAGNOSTICS. To avoid this problem, add an ABORT ERRORS or ABORT WARNINGS to the beginning of your SYSTEMS deck.

* * * * *

Question: How do I account for the energy consumed by a domestic hot water heater?

Answer: There are two methods by which the user can enter a load for a domestic hot water heater to be simulated in PLANT. Which method you should choose depends upon whether the use of the domestic hot water adds to a space cooling load. If there is no contribution to space cooling loads from the use of domestic hot water, under the BUILDING-RESOURCE command in LOADS enter the peak energy demand (in Btus) as the value of the keyword HOT-WATER and provide a schedule u-name for the hourly profile as the value of the keyword HW-SCHEDULE.

If the use of the domestic hot water does contribute to the space cooling load, enter under the SPACE command values for the following keywords. Set SOURCE-TYPE = HOT-WATER; enter the peak energy demand as the value of SOURCE-BTU/HR; enter the usage profile under SOURCE-SCHEDULE; determine the fraction of the energy consumed that shows up as a sensible cooling load and assign that fraction to SOURCE-SENSIBLE; determine the fraction of the energy consumed that shows up as a latent cooling load and assign that to SOURCE-LATENT.

The peak energy demand of the domestic hot water heater can be estimated from the following formula:

$$\text{Peak Energy Demand (Btu/hr)} = 480 \times GP \times C \times (T_{supply} - T_{ave.\ inlet})$$

where GP is the peak flow rate in gallons of water per minute, C = 1.0 Btu/lb-^{o}F = the specific heat of water, T_{supply} is the temperature (in degrees Fahrenheit) of the hot water supplied, and $T_{ave.\ inlet}$ is the average temperature of the inlet water to the heater (often the ground temperature).

* * * * *

Question: Although it is often convenient when designing a system for a building to have the DOE-2.1 program perform the system sizing, there are times when I want to find out how a particular system behaves. Unfortunately, DOE-2.1 is so aggressive in its urge to size that my input usually gets overridden. How can I avoid this?

Answer: DOE-2.1 assumes that, when the user inputs ASSIGNED-CFM for a zone, that value is not being estimated, but is known. It does not override the values of ASSIGNED-CFM, and, thus, you should specify this keyword for all conditioned zones. The SUPPLY-CFM keyword describing the air flow through the central fan should be allowed to default for constant volume systems. It will be calculated by the program from the sum of the zone cfms with corrections for DUCT-AIR-LOSS and, in the case of induction units, for INDUCTION-RATIO. For variable-air-volume systems, especially when there is night setup or setback, the user should specify SUPPLY-CFM, using his or her best judgement. Otherwise, the program will compute a SUPPLY-CFM from the coincident building peak load, if there is only one system in the PLANT-ASSIGNMENT, or from the sum of the zone cfms, if there are more than one system in the PLANT-ASSIGNMENT. The fan energy and fan heat are calculated from SUPPLY-CFM, either using the pair of SUPPLY-STATIC and SUPPLY-EFF or the pair of SUPPLY-KW and SUPPLY-DELTA-T.

A return fan is assumed not to exist, unless the user inputs one or the other of the pair RETURN-STATIC and RETURN-EFF or the pair RETURN-KW and RETURN-DELTA-T. The value of RETURN-CFM should be allowed to default, so that the program can properly account for the actual SUPPLY-CFM and the total exhausted air.

The outside air quantity will be forced by the program to excede the amount of air exhausted as specified by the sum of values of the EXHAUST-CFM keyword for each zone, regardless of the user-input for OUTSIDE-AIR-CFM, OA-CHANGES, OA-CFM/PER, MIN-OUTSIDE-AIR, or MIN-AIR-SCH. If the outside air quantity is specified at the zone level, then the sum of those values divided by SUPPLY-CFM will override the value of MIN-OUTSIDE-

AIR, if that keyword is also specified. Consequently, the user should enter a consistent set of values for exhaust and outside air and, if this is done, the program will simulate what is input.

In DOE-2.1, the MIN-CFM-RATIO must exceed the value of MIN-OUTSIDE-AIR as input by the user or as reset as described above. In DOE-2.1A, if MIN-CFM-RATIO < MIN-OUTSIDE-AIR, the program will allow the flow rate to fall below that determined from MIN-OUTSIDE-AIR (but not less than that determined from the zone exhaust) and will simulate 100% outside air in that situation. This latter feature was introduced to allow 100% outside air variable volume systems.

Having described the airflow characteristics, the user must now fix the system's heating and cooling capacities. The firmest way to do this is to specify HEATING-CAPACITY, COOLING-CAPACITY, and COOL-SH-CAP, along with their several performance curves. Since there is a relationship between cfm, capacity, and design temperatures, obviously they may not all be specified independently. In DOE-2.1, if the air quantities and capacities are specified by the user, the MAX-SUPPLY-T and MIN-SUPPLY-T are overridden, if they are not compatible with them.

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The DOE-2 User Coordination Office encourages users to forward questions and comments to:

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Lawrence Berkeley Laboratory
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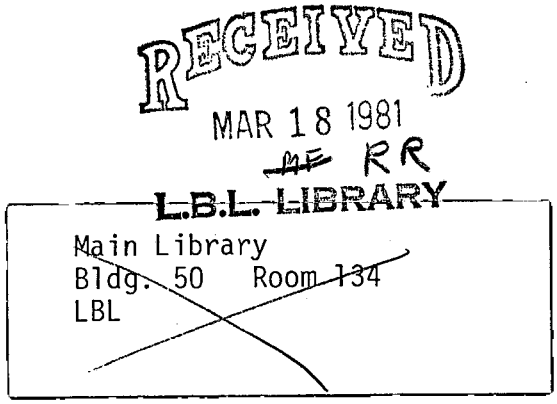

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