THE DOE–2 USER NEWS

DOE-2: A COMPUTER PROGRAM FOR BUILDING ENERGY SIMULATION

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☞ ☞ HANDS ON ☜ ☜

☞ DOE-2 Basics from N.T.I.S.

The *DOE-2 Basics* manual may be ordered from the National Technical Information Service at a cost of $43/US and $86/foreign. Check out the order form in this issue.

☞ DOE-2 Training in 1993 !!

The Washington State Energy Office will host a series of training sessions (both beginning and advanced) in the Seattle and Portland areas. Tentative 1993 dates are the end of February and early June. Interested users should contact Pete Gonzales at WSEO for details — phone (206) 956-2044.

☞ ACEEE 1992 Proceedings

Proceedings from the *ACEEE 1992 Summer Study on Energy Efficiency in Buildings* are now available. The 11-volume set (plus index) includes 285 peer-reviewed papers and poster abstracts that examine the growing role of energy efficiency in our changing economic and political environment. The proceedings cost $162.00ppd (California residents please add 8¼% sales tax) and may be ordered from

ACEEE
2140 Shattuck Avenue, #202
Berkeley, CA 94704.
Ph: (510) 549-9914 or FAX -9984

☞ MEETINGS ☜

Mar 24-26, 1993 — *Sixth National Demand-Side Management Conference*

to be held in Miami Beach, FL.
Contact: Patrice Ignelzi, Sixth National Demand-Side Management Conference, 1320 Solano Avenue #203, Albany, CA 95706.

May 3-4, 1993 — *Institutional Energy Conservation Programs: Prudent Management*

to be held at the University of Minnesota, Twin Cities Campus.
Contact: David Grimsrud, Minnesota Building Research Center, 330 Wulling Hall, 86 Pleasant Street S.E., Univ. of Minnesota, Minneapolis, MN 55455 — Ph: (612) 626-7419.

■ ■ ■ THE HEAT EXCHANGER ■ ■ ■

"Hot Tips for Cooling Towers"

Question:
Attached is a file containing excerpts from my output file with some of my comments inserted. A colleague has shed some light on some of the output after digging through the manuals, but the major problem remains: the energy consumption for the tower is way too high relative to the centrifugal chiller's consumption!

(User's input and output deleted).

Answer:
As I see it, you had three problems/questions:

1. You input INSTALLED–NUMBER=1 and MAX–NUMBER–AVAIL=1 for the tower in your PLANT–EQUIPMENT command but report PV–A shows that the program gave you four for both.

2. The tower uses too much energy.

3. Report PS–H shows that the operating hours for the cooling tower are greater than for the chiller and are even greater than the number of hours in a year.

These are my explanations:

1. DOE-2 ignores any user input for INSTALLED–NUMBER and MAX–NUMBER–AVAIL for the cooling tower if you tell the program to size the tower (by setting SIZE=-999). There is only one cooling tower, divided into N cells. DOE-2 will calculate N. It likes to make N=4, with the limitation that no cell can be bigger than 15 million Btu and if possible will not be smaller than 1 million Btu (see the *Engineers Manual (2.1A)*, p.V.58). PV–A shows the number of tower cells, not the number of towers. You can input the cell size and cell number using SIZE and INSTALLED–NUMBER. For instance,

   CTOWER=PLANT-EQUIPMENT TYPE=COOLING-TWR SIZE=2.2 INSTALLED-NUMBER=2 ..

   would give a cooling tower with two cells, each of 2.2 million Btu capacity.

2. Cooling towers use more energy than people think. Often they have very bad part load performance, so looking at what the chiller and tower consume at peak load does not give a very clear idea of their energy consumption relative to each other at low part load. I've been told that one of the most cost effective retrofits is to upgrade the fan drive and controls on an old cooling tower.

   The default tower in DOE-2 is very inefficient. The key defaults are TOWER–FAN–CONTROL=ONE–SPEED and TWR–TEMP–CONTROL=FLOAT in the PLANT–PARAMETERS command. It is a one-speed fan and it operates so that it drives the tower water exit temperature (entering chiller condenser temperature) down as far as the ambient wetbulb will allow it (except it won't go below 65°F, the default for MIN-TWR-WTR-T). This low tower water exit temperature can improve the efficiency of the chiller, but it causes the tower to use more energy (more than the chiller saves usually). Note that all the tower cells operate together; that is, they all either have their fans on, or all have them off. The fans go off (and the tower operates by natural convection) only when the part load drops below 0.18 (set by TWR-FAN-OFF-CFM). Thus the default cooling tower in DOE-2 runs full out most of the time there is a cooling load.

A more reasonable input for the tower looks like

```
CTOWER=PLANT-EQUIPMENT  TYPE=COOLING-TWR  SIZE=-999 ..
PLANT-PARAMETERS
    TWR-FAN-CONTROL=TWO-SPEED
    TWR-TEMP-CONTROL=FIXED
    TWR-WTR-SET-POINT=75 ..
```

This allows the fan to vary its speed, and the tower operates to hold an exit water set-point of 75°F rather than trying to make it colder if the ambient wetbulb allows it. The set point is colder than the rating point (80°F) and this permits some increase of efficiency at the chiller without causing the tower to expend too much energy. Unfortunately DOE-2 does not have a variable-speed-drive fan option (or variable-speed pumps!) for the cooling tower. Your PS-C report shows that you have a very large number of hours where the chiller part load is below 10%. Changing to a two-speed fan and a fixed tower exit water set point should dramatically lower your tower electricity consumption.

3. The operating hours reported in PS-H are total cell operating hours, not tower operating hours. That is, they are the number of cells operating each hour summed over the all hours in which there is a cooling load. In this case where there are four cells, the maximum this number could be is four times the number of chiller operating hours.

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This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Technologies, Building Systems and Materials Division of the U.S. Dept. of Energy, under Contract No. DE-AC03-76SF00098.

Guidelines for Energy Simulation of Commercial Buildings[1]

by

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Introduction

Energy Edge, a large-scale research and demonstration project funded by the Bonneville Power Administration, used DOE-2.1C to test energy conservation methods in commercial buildings. The Energy Edge project was initiated to determine whether commercial buildings could be designed and constructed to use at least 30% less energy than is mandated by the current regional model energy code. Secondary objectives were to determine the incremental costs and energy savings of a wide variety of energy conservation measures (ECMs) and to compare the predictive accuracy of design-phase models with models that are calibrated with monitored building data. Twenty-eight commercial buildings were selected to participate in Energy Edge; all but two were new construction. The result of the Energy Edge study was the development of a set of guidelines, called "Guidelines for Energy Simulation of Commercial Buildings"[2] (KAP 92a), hereafter called Guidelines. The Guidelines consists of two main parts: modeling from the perspective of the conservation program manager, and detailed technical guidelines for modelers. The appendices provide several technical aids for the modeler, such as a table of U-values for walls and roofs (corrected for framing), tables of EUI values by end-use for various building types, recommended default occupancy schedules for various building types, and sample controls sequences and performance specifications.

In the area of research, special attention was given to the methods for determining *actual* energy savings. Typically, design-phase computer analysis must deal with relatively little information about the reality of a specific building and its operation. Energy Edge expanded the present limits of energy modeling by monitoring the selected buildings in great detail and then using the monitored data to ground the models in reality. As a result of Energy Edge, Bonneville has incorporated the Guidelines into the design and operation of its Energy Smart Design (ESD) program, the primary vehicle for realizing energy savings from commercial buildings in the Pacific Northwest.

Simulation Input – Loads

In this section we discuss a few of the major topics of simulation input covered in the Guidelines; however, these are condensations. The Guidelines covers each of these topics in much greater detail, as well as including the other topics mentioned previously.

Zoning

A major goal of any simulation is to take something that is extremely complex (a building) and to model it as simply as possible yet as accurately as necessary. One of the

1. This paper is a condensed version of that presented at the "ACEEE 1992 Summer Study on Energy Efficiency in Buildings", held August 1992, in Asilomar, CA. Complete conference proceedings are available from the American Council for an Energy Efficient Economy (ACEEE), 2140 Shattuck Avenue #202, Berkeley, CA 94704; (510) 549-9914.

2. The report, "Guidelines for Energy Simulation of Commercial Buildings" [No. DOE/BP-26683-2 (May 1992)], is available from the Bonneville Power Administration, Public Information Dept., 905 N.E. 11th Avenue, Portland, OR 97232.

most critical steps is the zoning of the building. The more complex the building, the more important this step becomes. One approach to zoning a building is to start with the entire building as one zone and then subdivide that zone as needed. If a single-zone model is sufficient for the needs of a project, then there is no need to go any further in zoning the building. There are many different criteria which may be used to determine additional zone boundaries; five basic criteria are usage, type of controls, solar gains, perimeter or interior location, and fan system type. These five characteristics are sufficient to define almost all of the necessary zone boundaries, yet there may often be special conditions which require additional zones to be created. The Guidelines provides specific examples and criteria for optimum zoning.

Infiltration

Infiltration can be one of the most significant energy drivers in a building simulation. This is also the simulation parameter about which the modeler is likely to have the least information. Modelers often assume that infiltration air falls to zero during periods of HVAC operation. This assumption rests on the assumption that system operation will result in building pressurization. However, this presumes a well-designed, well-balanced, and properly operated air distribution system. It also presumes the absence of other infiltration-related effects such as tall building stack-effect, a high frequency of occupant or customer entry and egress, normally-open loading docks, and so forth. The presence of any of these effects should prompt the modeler to reconsider infiltration input. The Guidelines recommends that the ASHRAE Standard 90.1 mandated value for infiltration during hours of no HVAC operation, 0.038 CFM/ft^2, is a reasonable beginning assumption (ASH 89).

Window Unit U-Values

In most commercial buildings, the window units have a much greater effect on building heating and cooling loads than do the exterior walls; however, modelers often are comparatively careless with their input of window unit characteristics. Window units have U-value and shading coefficient characteristics that can differ significantly from those of the glazing only. Glazing characteristics must be adjusted to account for the opaque frame area. If modelers have knowledge of the specific window types to be installed, then we recommend that they use the manufacturer's rated window unit U-values (and shading coefficients) as a first preference. If these are not available, or are suspect, then the modeler should either refer to the ASHRAE Fundamentals Handbook (1989), Chapter 27, Table 13, or use the Lawrence Berkeley Laboratory WINDOW program.

Thermal Mass

The Guidelines discusses at some length the implication of building mass on energy behavior. Thermal mass affects the timing of cooling loads as well as energy storage behavior. Thus, inputs describing mass can be important in estimating cooling load shapes and coincident peak demand in buildings of heavy construction. Accurate building weight simulation improves the accuracy of night setback and night flushing savings estimates, as well as the effects of solar gain on HVAC loads. DOE-2 uses precalculated weighting factors and custom weighting factors as methods for dealing with transient heat gains in a space.

Internal Loads

The objects located in a building affect the energy consumption of the building in two ways: they may consume energy directly, and they may affect the amount of energy consumed for HVAC. People and hot food are examples of objects which affect HVAC consumption without consuming energy directly; equipment and lighting generally affect consumption both ways. Simulation programs draw on several different sources to compute both the direct energy consumption of internal loads and the effect of these loads on HVAC operation. It is critical that the modeler carefully select input values for maximum hourly energy consumption and daily consumption profiles (i.e. hourly schedules). The Guidelines recommends values for both types of input for several different building types. The modeler must also carefully consider what portion of the internal loads become sensible or latent cooling loads to the HVAC equipment. Program defaults are often inappropriate, especially for cooking equipment, certain process equipment, and lighting.

Simulation Input – System Selection

All energy simulation programs offer the modeler some latitude in HVAC system selection. Our work and the work of others has shown that selection of the HVAC system type is one of the strongest drivers of simulated energy consumption in a building (COR 90). The modeler should carefully question the default simulation of system type; questions to consider might include these:

-- What control options are available for each system type?

-- Does the system type allow outside air ventilation?

-- Does the program default for part-load efficiency represent the actual equipment performance?

-- Is reheat being assigned automatically if multiple zones are assigned to a "single" zone system?

-- Are the supply fans on continuously, on only during occupied hours, or cycling on and off at all times?

-- Is the reheat source electric or gas? A competent modeler will think of many other questions that must be asked when selecting system type and developing system inputs.

Controls

Controls are one of the most important factors in the simulation of energy consumption. Theoretical savings for control energy conservation measures (ECMs) are easily overestimated. Accurate predictions of energy savings can only be achieved if control ECMs are defined by a sequence of operations common to the model, the installed system, and the use of the system once it has been installed. Although general terms like "optimum start", "intelligent recovery", and "cold deck reset" are often thrown about as though their definitions were clear-cut, that is not the case. The energy savings from any one of these strategies depends on the details of how it is achieved. A modeler cannot accurately model any of these functions unless a sequence of operations has been established. Information about specific control components (e.g. thermostats, sensors, actuators) is best obtained by talking with the manufacturer's design engineers at their central office. Information about the sequence of operations, though, is best obtained, often with difficulty, from either the bid documents or from the controls contractor. Communication between the analyst and the other parties in any project involving controls is important to achieving consistency between estimated and actual energy savings.

Simulation of Multiple Zone Systems

Simulation of single zone systems is usually relatively straightforward. Assuming that the modeler did a competent job of zoning the building, the simulation is more or less forced to account for heating and cooling load appropriately. However, when a single system serves multiple zones, there is ample opportunity for errors in heating and cooling load accounting. Simulation of simultaneous heating and cooling where none actually occurs (and vice-versa) is a common problem. Other common problems are inappropriate reset control, inaccurate part-load simulation, and erroneous system linkage with central plant equipment. The Guidelines discusses in detail the inputs for multi-zone, dual duct, variable air volume, and water-loop heat pump systems.

Fan Schedules
Fan schedules and supply CFM are important in determining heating and cooling consumption because they are closely linked to outside air ventilation HVAC loads, the amount of reheat or mixing of hot and cold air that takes place in multiple-zone systems, central plant equipment operation, and, of course, fan motor energy consumption. In computer simulations, the fan operation during unoccupied periods is typically designated as either off, cycling on only as necessary to maintain heating and cooling setpoints, or on continuously. Even during occupied periods, many building operators allow their fans to cycle to meet load. The amount of time the fan is off has a dramatic effect on energy consumption. Modelers should take care in their assumptions about fan schedule and fan mode of operation during both occupied and unoccupied periods. If the minimum ventilation air is input as a percent of the total supply CFM, the supply CFM becomes important in determining the outside air loads on the HVAC system. For both new and existing buildings, the modeler should check that the input for design supply CFM/ft2 looks reasonable. If audit or design information is available, these should be used. If not, rules of thumb in the Guidelines can be used.

Simulation Input — Systems HVAC: Exterior and "Hidden" Energy Users
Modelers often overlook either energy-using equipment outside the building or equipment within the building that does not contribute to HVAC heating or cooling loads. External loads might include such things as car washes, laundries, swimming pools, exterior lighting, gas pumps, water pumps, and sidewalk heating systems. Non-HVAC driving interior loads might include elevators, process equipment, and so forth. If the modeling intent is to estimate the actual utility bills that the owner will be paying, then it is imperative that the modeler try to calculate or simulate these loads. However, if the modeling intent is to estimate either HVAC system performance or the incremental savings of ECMs that influence the HVAC systems, then it is less important to simulate the hidden energy users. Another "hidden" internal load that is easily missed but that can strongly drive building energy use and HVAC performance is a large mainframe computer system. Such systems can have an annual energy use index (EUI) on the order of 2.0 kWh/ft2-yr for large office buildings (PRA 90). The modeler should specifically ask the owner and design team whether they plan such a computer system for the building in question. Since these systems are typically served by a stand-alone air conditioning system, the modeler may decide that the purpose of the design-phase modeling can be met without considering the computer center and its supporting equipment.

The Baseline Building
We cannot over-stress the importance of the baseline building model. The Energy Edge project attempted to comprehensively define baseline for the range of building types encountered in the project. However, one of the lessons learned from the project was that it is impossible to cover all of the building aspects in a baseline definition. Nevertheless, it is possible to state a hierarchy of sources for definition. These might include local building or energy codes, national standards (e.g., ASHRAE 90.1), an independently compiled definition of

common construction practice, and existing conditions (retrofit projects). In addition to these sources, Energy Edge provided modelers with a list of parameters to be held constant between the baseline and energy efficient design unless an ECM directly addresses one of the parameters. These parameters include weather, occupancy and function, lighting usage schedules, zoning, internal equipment schedules and loads, ventilation air schedules and amounts, heating and cooling system schedules, thermostat setpoints and schedules, floor and wall area, energy source (no fuel switching), external shading, and infiltration.

Conclusions

The Energy Edge project provides one of the most comprehensive "real world" experiences to date with respect to modeling commercial buildings. We have learned much about the sources of model errors and their impacts on model accuracy. Although this project has been a fertile ground for modeling lessons, much research work remains. There is much we don't know about the reliability of computer simulation for ECM savings estimates. We believe the Guidelines will serve as a valuable tool for conservation program managers and commercial building modelers. The Guidelines will help assure the appropriate use of building simulation models and improve the accuracy of model outputs, with special respect to energy saving estimates for ECMs. We also believe that modelers have an important role to play in helping assure that the ECMs they recommend actually deliver the energy savings that were estimated.

References

ASH 89 — ASHRAE 1989. Standard 90.1. *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.* American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, 1989.

COR 90 — Gale C. Corson Engineering. *A Comparative Evaluation of Commercial Building Energy Simulation Software.* Bonneville Power Administration, Portland, OR, 1990.

KAP 92a — Kaplan Engineering. *Guidelines for Energy Simulation of Commercial Buildings.* DOE/BP-26683-2, Bonneville Power Administration, Portland, OR, 1992.

KAP 92b — Kaplan Engineering and Portland Energy Conservation, Inc. *Evergreen Plaza Simulation Tuning* (draft report). Bonneville Power Administration, Portland, OR, 1992.

LBL 80 — Lawrence Berkeley Laboratory and Los Alamos National Laboratory. DOE-2 *Reference Manual (2.1A), Part 1*, LBL-8706, Rev.2. National Technical Information Service, Springfield, VA, 1980.

PRA 90 — Pratt, R., M. Williamson, E. Richman, and N. Miller. *Commercial Equipment Loads.* DOE/BP-13795-26, Bonneville Power Administration, Portland, OR, 1990.

TAY 89 — Taylor, Z., and R. Pratt. *Description of Electric Energy Use in Commercial Buildings in the Pacific Northwest.* DOE/BP-13795-22, Bonneville Power Administration, Portland, OR, 1989.

IBPSA

**INTERNATIONAL
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Preliminary Notice

BUILDING SIMULATION '93

ADELAIDE

AUSTRALIA

16-18 AUGUST 1993

If you would like to receive more information please contact:

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Australia**

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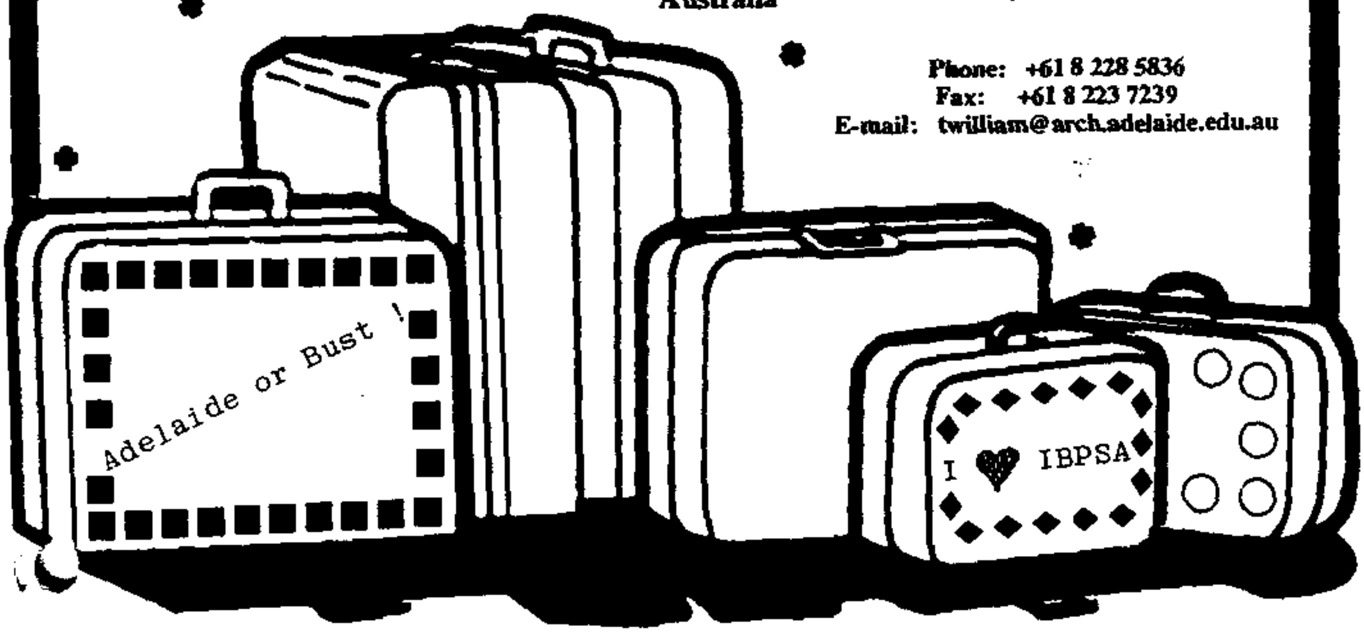
E-mail: twilliam@arch.adelaide.edu.au



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■ ■ ■ ■ DOE-2 DIRECTORY ■ ■ ■ ■

Program Related Software and Services

Mainframe Versions of DOE-2

DOE-2.1D (Source Code) For DEC-VAX mainframe or SUN-4 mini-computer; contact the Simulation Research Group for directions on obtaining the program.	Simulation Research Group Bldg. 90, Room 3147 Lawrence Berkeley Laboratory Berkeley, CA 94720 Contact: Kathy Ellington Phone: (510) 486-5711 FAX: 486-4089/5172
DOE-2.1D (Source Code) For DECVAX, Order #159-D6220-00 **DOE-2.1C** (Source Code) For IBM3083, Order #158-I3083-00 For DECVAX11, Order #158-DVX11-00 For a complete listing of the software available from ESTSC order their "Software Listing" catalog ESTSC-2.	Energy Science and Technology Software Center P.O. Box 1020 Oak Ridge, TN 37831-1020 Contact: Phone: (615) 576-2606 FAX: (615) 576-2865
FTI-DOEv2.1D (Source Code) This is a highly optimized and basically platform independent version of the DOE-2.1D source code. Will compile for most computing systems. The original LBL 2.1D source code is also available in a variety of distribution formats. Site licenses and educational discounts are available. Also available is the full set of program documentation as distributed by NTIS and weather files (TMY and TRY) in a variety of distribution formats. [See *User News* Vol.12, No.4, p.16 for more information]	Finite Technologies, Inc 821 N Street, #102 Anchorage, AK 99501 Contact: Scott Henderson Phone: (907) 272-2714 FAX: (907) 274-5379

Microcomputer and Pre- and Post-Processor Versions of DOE-2

PRC-DOE2 (For Microcomputers) A fast, robust and up-to-date PC version of DOE-2.1D. Runs in extended memory, is compatible with any VCPI compliant memory manager and includes its own disk caching. 377 weather data files available (TMY, TRY, WYEC, CTZ) for the U.S. and Canada **PRC-TOOLS** A set of programs that aids in extracting, analyzing and formatting hourly DOE-2 output. Determines energy use, demand, and cost for any number of end-uses and periods. Automatically creates 36-day load shapes. Custom programs also available.	Partnership for Resource Conservation 140 South 34th Street Boulder, CO 80303 Contact: Paul Reeves Phone or FAX: (303) 499-8611
Pre-DOE (A BDL math pre-processor)	Nick Luick 19030 State Street Corona, CA 91719 Phone: (714) 278-3131

Microcomputer and Pre- and Post-Processor Versions of DOE-2
(continued)

MICRO-DOE2 (For Microcomputers) MICRO-DOE2 (DOE-2.1D) has been in use since 1987; it is an enhanced PC version of the DOE-2 program (over 500 users world-wide). Two versions of MICRO-DOE2 are available: a regular DOS version for all IBM-PC compatibles and an extended DOS version for 386 or 486 computers only. [See *User News* Vol.7, No.4, p.2 and Vol.11, No.1, p.2 for more information]	Acrosoft International, Inc. Suite 230 9745 East Hampden Avenue Denver, CO 80231 Contact: Gene Tsai, P.E. Phone: (303) 368-9225 FAX: (303) 368-5929
ADM-DOE2 (For Microcomputers) ADM-DOE2 (DOE-2.1D) is for professional energy analysts who require a state-of-the-art simulation tool for building energy use. It performs a detailed, zone-by-zone hourly simulation and includes a wide array of modeling features that make it possible to simulate "real buildings". These capabilities offer much grater accuracy and detail than is possible with handbook methods or simplified analysis.	ADM Associates, Inc. 3239 Ramos Circle Sacramento, CA 95827 Contact: Marla Sullivan, Sales Kris Krishnamurti, Support Phone: (916) 363-8383 FAX: (916) 363-1788
DOE-Plus™ (For Microcomputers) DOE-Plus is used to interactively input a building description, run DOE-2, and plot graphs of simulation results. Features include interactive error checking, context-sensitive help for all DOE-2 keywords, a 3-D view of the building that can be rotated, and several useful utilities. DOE-Plus is a complete implementation of DOE-2. [See *User News* Vol.11, No.4, p.4 and Vol.13, No.2, p.54 for more information] **Prep™** Prep is a batch preprocessor that enables conditional text substitution, expression evaluation, and spawning of other programs. Prep is ideal for large parametric studies that require dozens or even thousands of DOE-2 runs.	ITEM Software P.O. Box 5218 Berkeley, CA 94705-0218 Contact: Steve Byrne Phone: (510) 549-1444 FAX: (510) 549-1778
"DOE-24/Comply-24" (For Microcomputers) DOE-24 is a special DOE-2 release which is both a California-approved compliance program for the state's 1992 non-residential energy standards, and a stand-alone version of DOE-2.1D which includes a powerful yet easy-to-use input preprocessor. A free demonstration program is available upon request. [See *User News* Vol.12, No.2, p.2 for more information]	Gabel Dodd Associates 1818 Harmon Street Berkeley, CA 94703 Contact: Rosemary Howley Phone: (510) 428-0803 FAX: (510) 428-8324
FTI-DOEv2.1D (For Microcomputers) Highly optimized version of DOE-2.1D available for the following operating systems: DOS, VMS, ULTRIX, SCO UNIX, RS/6000 (AIX), NeXT and SUN Sparc. Call for more information. [See *User News* Vol.12, No.4, p.16 for more information]	Finite Technologies, Inc 821 N Street, #102 Anchorage, AK 99501 Contact: Scott Henderson Phone: (907) 272-2714 FAX: (907) 274-5379
Graphs from DOE-2 (For Microcomputers)	Ernie Jessup 4977 Canoga Avenue Woodland Hills, CA 91364 Phone: (818) 884-3997

Microcomputer and Pre- and Post-Processor Versions of DOE-2
(continued)

CEDDOEDC (For Microcomputers) CEDDOEDC (Version 1.0A) is a microcomputer version of DOE-2.1D, integrated with a pre- and post-processing system that was designed strictly for compliance use within the State of California. It generates some of the standard compliance forms as output. Refer to Pub. No. P40091009 for the CECDOEDC Program with Manuals. Refer to Pub. No. P40091010 for the DOE-2.1 California Compliance Manual. [See *User News* Vol.12, No.4, p.13 for more information]	Publication Office California Energy Commission P.O. Box 944295 Sacramento, CA 94244-2950

R E S O U R C E S

DOE-2 User News Sent without charge to DOE-2 users, the newsletter prints documentation updates and changes, bug fixes, inside tips on using the program more effectively, and articles of special interest to program users. Regular features include a directory of program-related software and services and an order form for documentation. In the summer issue an alphabetical listing is printed of all commands and keywords in DOE-2, and where they are found in the documentation. The winter issue features an index of articles printed in all the back issues.	Simulation Research Group Bldg. 90, Room 3147 Lawrence Berkeley Laboratory Berkeley, CA 94720 Contact: Kathy Ellington Phone: (510) 486-5711 FAX: (510) 486-4089 or -5172 e-mail: kathy%gundog@lbl.gov
DOE-2 Training DOE-2 courses for beginning and advanced users.	Energy Simulation Specialists 64 East Broadway, Suite 230 Tempe, AZ 85282 Contact: Marlin Addison Phone: (602) 967-5278
Instructional DOE-2 Video and Manual	JCEM/U. Colorado Campus Box 428 Boulder, CO 80309-0428 Contact: Prof. Jan Kreider Phone: (303) 492-3915
Weather Tapes TMY (Typical Meteorological Year) TRY (Test Reference Year)	National Climatic Data Center Federal Building Asheville, North Carolina 28801 (704) 259-0871 climate data (704) 259-0682 main number
CTZ (California Thermal Climate Zones)	California Energy Commission Bruce Maeda, MS-25 1516-9th Street Sacramento, CA 95814-5512 1-800-772-3300 Energy Hotline
WYEC (Weather Year for Energy Calculation)	ASHRAE 1791 Tullie Circle N.E. Atlanta, GA 30329 (404) 636-8400

■ ■ DOE–2 ENERGY CONSULTANTS ■ ■

Consulting Engineers Craig Cattelino Burns & McDonnell Engineers 8055 E. Tufts Avenue, Suite 330 Denver, CO 80237 (303) 721-9292	**Consultant** Greg Cunningham Cunningham + Associates 512 Second Street San Francisco, CA (415) 495-2220
Microcomputer DOE-2 for European Users Werner Gygli Informatik Energietechnik Weiherweg 19 CH-8604 Volketswil Switzerland	**Consultant** Jeff Hirsch 2138 Morongo Camarillo, CA 93010 (805) 482-5515
Large Facility Modeling George F. Marton, P.E. 1129 Keith Avenue Berkeley, CA 94708 (510) 841-8083	**Computer-Aided Mechanical Engineering** Mike Roberts Roberts Engineering Co. 11946 Pennsylvania Kansas City, MO 64145 (816) 942-8121
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Pacific Northwest Laboratory's Building Energy Standards Program publishes a quarterly newsletter called "*BESP ... Setting the Standard*". We urge *User News* readers get on the *BESP* mailing list and receive information about standards-related activities, compliance strategies, training, etc. Reprinted below is a sample article from *BESP* that mentioned DOE-2. Contact the editor, Rosalind Schrempf, MSIN-K6-86, PNL, P.O. Box 999, Richland, WA 99352 to receive the newsletter.

Standards compliance achievable without sacrificing design

Can a building be aesthetically pleasing and still comply with DOE's energy standards? Or must architects and designers avoid innovative design features to make sure that a building meets the criteria?

A recent research program demonstrated that compliance with DOE's interim energy conservation standards for new commercial buildings (10 CFR Part 435, Subpart A) need not compromise the architectural integrity and intent of a building design.

An unusual and architecturally pleasing building design was chosen as the demonstration example. The two-story, 38,000-ft^2 office building, to be sited in Los Angeles, featured a 34-ft-high large central atrium made almost entirely of glass. The atrium enclosed a skybridge and an elevator tower for access to the second floor. The focal point of the entire building, the atrium lent an inviting atmosphere to the interior spaces. At the same time, though, it challenged the heating, ventilating, and air-conditioning (HVAC) system to keep the building comfortable.

Researchers initially tried for compliance by using the two simplest methods available in the standards--the prescriptive path and the system performance path. The building design easily met the prescriptive lighting criteria. However, it failed to satisfy the envelope requirements of both the prescriptive and system performance paths because of the high window-to-wall ratio and the percentage of roof area as skylights (the atrium).

It was obvious to the researchers that the building would meet the criteria of the system performance compliance path if the atrium were removed and replaced with a more conventional roof configuration. But, instead of changing the design and losing the architectural intent of the building, the researchers attempted compliance with one of the simulation methods.

They assumed that a designer confronted with this problem would choose the most expeditious means for proving a design's compliance. For this reason, they used the Building Energy Cost Compliance (cost) Alternative instead of the Building Energy Compliance (energy) Alternative because the cost alternative does not require a full life-cycle cost analysis.

Using the Lawrence Berkeley Laboratory DOE-2 program (Version 2.1D), researchers modeled the building design, making iterative runs to ensure the most efficient design. Information from the iterative runs suggested some changes to the original design: adding a second HVAC system (to serve the atrium exclusively); adding an exhaust fan to the atrium; and adding reflective coating to the exterior glazing.

These three changes had no effect on either the interior floor plan or the exterior elevations.

Researchers then created a prototype building design embodying features stipulated in the standards. Using DOE-2, they modeled the prototype, then compared the two designs on the basis of predicted energy costs.

They found that, overall, the original building design outperformed the prototype in terms of both dollar and energy savings. Primarily because of conduction losses in the atrium, the original building design needed 85% more energy for heating than the prototype. Because the original design specified using natural gas for heating, the estimated consumption of natural gas was also 85% higher. However, these levels were offset by the very efficient lighting systems that not only lowered the direct consumption for lighting (66% less than the prototype) but also reduced the amount of energy required to cool the building because of the decreased internal gains from the lights (20% less than the prototype). The reduced electricity consumption allowed the designer to essentially trade off the added heating consumption stemming from the atrium with reductions in lighting and cooling. This trade-off becomes especially favorable because of the cost difference between natural gas and electricity in Los Angeles.

The bottom line? At least in this one case, DOE's interim standards appear to give commercial building designers enough flexibility to exercise their creativity and still meet the energy efficiency criteria for the building under design.

A full report documenting this research program is scheduled to be issued this spring. Watch for its announcement in the next issue of . . . *Setting the Standard*.

Comments, questions, or other requests for information about the Building Energy Standards Program at Pacific Northwest Laboratory should be directed to

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Documentation Update

[Change the table on p.2.58 of the DOE-2 *Supplement (2.1D)*]

Christian Gueymard of the Florida Solar Energy Center points out that the turbidity values for Miami too high by about a factor of two (reason: problems with the original measurements by the National Climatic Center). The old values over-estimated the availability of daylight from the clear part of the sky. He suggests for Miami daylighting simulations that the following better values be used (from M. Iqbal, "An Introduction to Solar Radiation", Academic Press, 1983, p.120).

Improved Values for Monthly Average Atmospheric Turbidity for Miami

	J	F	M	A	M	J	J	A	S	O	N	D
Old Value	.19	.29	.30	.31	.36	.54	.51	.55	.40	.33	.31	.24
New Value	.13	.14	.16	.21	.24	.24	.23	.24	.25	.19	.19	.14

So, ATM-TURBIDITY = (.13,.14,.16,.21,.24,.24,.23,.24,.25,.19,.20,.14)

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