

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

PUB-439

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

DOE-2 USER NEWS

A COMPUTER PROGRAM FOR BUILDING ENERGY USE ANALYSIS

PUB-439

Vol. 5 No. 1

MAY 17 1984

SPRING 1984

RECEIVED
PUB FILE

Building Energy Simulation Group
Building 90, Room 3147
Telephone: (415) 486-5711
FTS: 451-5711

LBL LIBRARY

Table of Contents

| | |
|---|---|
| Energy Efficiency in Singapore | 1 |
| Documentation Updates | 3 |
| Bugs Discovered and Interim Solutions | 4 |

standards for office buildings. Rapid economic growth and a surge in building construction in those equatorial, hot and humid regions has made energy efficiency a major governmental concern. Singapore was chosen as a base case because of their interest in taking governmental action in response to the findings of the study, and also because of their prior experience with energy standards. Singapore is one of the few countries in the world that has mandatory standards for new office buildings.

DOE-2 was the basic tool used to perform the energy analysis. The LBL team, made up of members from the Energy Analysis Program, the Lighting Systems Research Group, and ourselves, traveled to Singapore where they installed the DOE-2.1B version of the program and provided the necessary training to their Singaporean counterparts. A weather tape was prepared using measured solar data.

An initial study of energy use in Singapore revealed that about 32% of the country's electricity is consumed by commercial buildings, primarily for cooling and lighting. Imported oil is used to generate electricity, and in 1980, 50% of the total oil imported was used to produce electricity. Therefore, even a 10% reduction in energy use in commercial buildings would yield a very substantial energy cost savings, in the neighborhood of \$25 million a year, as well as a concomitant decrease in oil imports. The LBL team was able, at the end of the DOE-2 analysis phase of the study, to predict a potential savings of 40%.

Parametric runs, both for single parameters to identify the most promising measures, and then in combinations to study the performance of a very efficient building, were conducted using a typical Singapore office building. The findings, in order of magnitude of their impact on energy savings, were:

- Daylighting — the combination of efficient lighting systems with photosensors on the lights in the perimeter zones, glare control, and external shades — can reduce energy use by 30% or more.
- The reduction of lighting from the standard 20 watts per square meter to 15 or 16 would result in a 10 to 12.5% reduction in energy use.
- Effective building equipment maintenance policies may lower energy use by 10% or more.

BULLETIN BOARD

Item: The IBM version of DOE-2.1B has recently been released and is available for purchase from NTIS and, to their registrants, from the National Energy Software Center, Argonne National Laboratory, Argonne, IL, (312) 972-7250. At this time, there are no plans to offer a DEC10 version. Please contact NESC if you are in need of that version. If there is enough interest, a DEC10 version will be created.

The back page of this newsletter is a tear-out sheet containing an order form for tapes and documentation.

Item: The latest addition to the roster of DOE-2 commercial computer service bureaus is the Mason and Hanger Company, one of the oldest architectural/engineering consulting firms in the country. For more information, contact:

Elizabeth Boorman
Mason & Hanger Company, Inc.
200 West Vine St.
Lexington, Kentucky 40507
(606) 252-4421

For an otherwise complete list of service bureaus, check the May 1983 issue of the newsletter.

ENERGY EFFICIENCY IN SINGAPORE

Over the last two years, a project team from LBL has been working with the Association of South East Asian Nations (ASEAN) in the analysis and implementation of measures to improve their countries' energy conservation

(Continued on page 2)

PUB-439

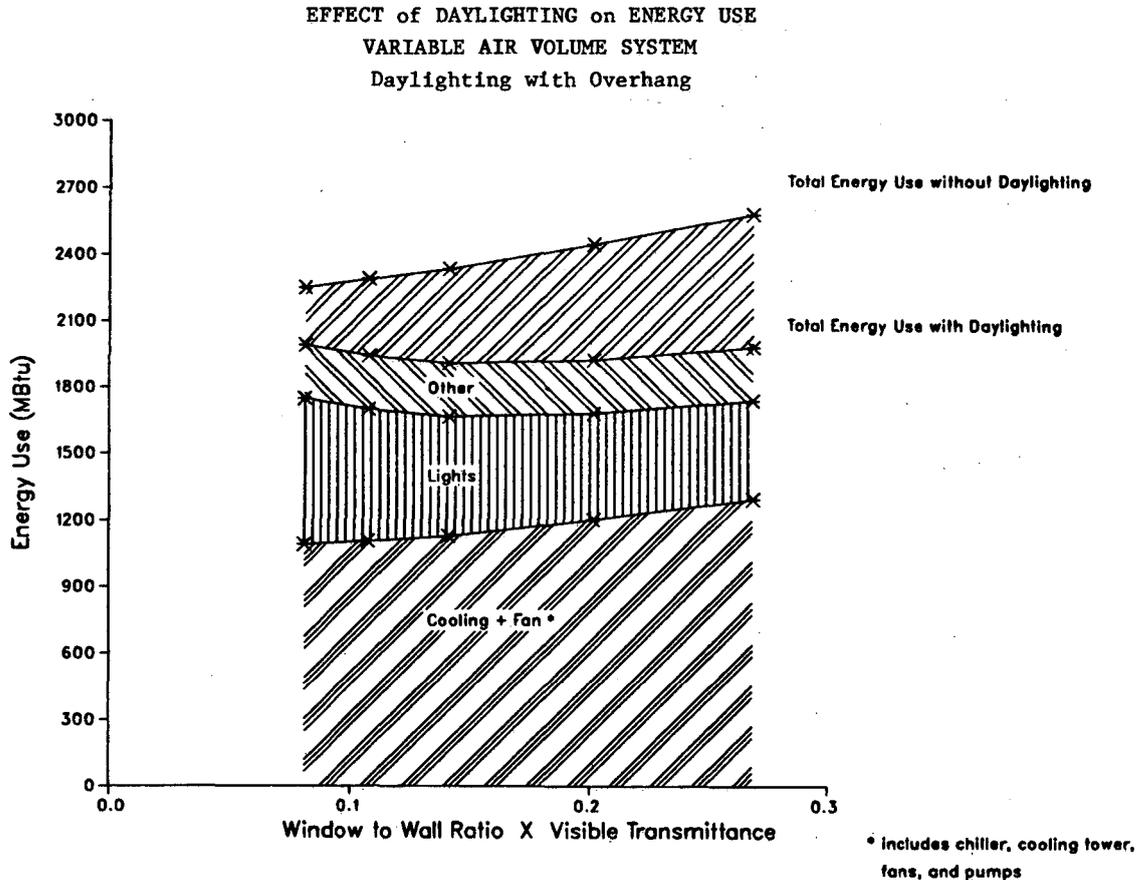
The chart below, which shows the total annual energy use of the typical office building vs. window-to-wall ratio times visible transmittance, exhibits a valuable finding for designers employing daylighting strategies with external shading in Singapore. Notice the flatness of the "Total Energy Use with Daylighting" curve. The effect of increasing the product of window-to-wall ratio * visible transmittance is negligible, whereas, when daylighting is not employed, energy use rises substantially. (It should be emphasized that the shape of the curves shown is both building- and climate-dependent.)

Interestingly, two normally energy-saving strategies were found to be ineffective in the Singaporean climate. Single pane windows are (slightly) more energy efficient than double or triple pane, and precooling, the use of night-time air to cool the building during the predawn hours when neither the internal loads nor the external heat gains are significant, is not a feasible option.

This is not surprising when one realizes that the difference between the average daily minimum and maximum temperatures in Singapore varies from about 4.5 to 6°C throughout the year — a very small range — and that there is very little seasonal variation in dry bulb temperatures. The average daytime temperature, over the entire year, ranges between 25 and 30°C. The average relative humidity is in the high 80's, with peaks in the 95% range at 4:00 AM.

Precooling, therefore, is not a possibility here because of the minimal day-night temperature shift, and more importantly, because the night air is so humid. Single pane windows, on the other hand, facilitate the heat transfer from inside to the outside of the building. During the late afternoon hours after the cooling system is shut down, indoor temperatures typically rise substantially above 30°C, and the net heat flow is from inside the building to the cooler outdoors.

The project's next goal is to use the analysis results to extend and enhance Singapore's energy standards and, finally, to establish a process whereby other ASEAN members (Thailand, Malaysia, Indonesia, and the Philippines) can benefit from the experience in Singapore, including the use of DOE-2.



DOCUMENTATION UPDATES — DOE-2.1B

The following addenda apply to the basic Reference Manual, revised in May 1981, and to the DOE-2 Supplement, which is the DOE-2.1B companion volume to the Reference Manual, dated January 1983. If you do not have the Supplement, consult the NTIS Order Form on the back page for information on the DOE-2.1B Documentation Update package.

Reference Manual

- On page III.49, under the discussions of both SOURCE-SENSIBLE and SOURCE-LATENT, the statement reading:

The sum of SOURCE-SENSIBLE and SOURCE-LATENT must not exceed 1.00 and ...

should be altered to read "... should not exceed 1.00", since the program does not do any check on these values, and one can actually input values that together exceed 1.00.

- On page IV.72, a sentence should be added to the end of the second paragraph reading:

Note that it is not possible to combine a system which requires a chiller with the HP system. If a chiller is specified in PLANT in conjunction with the HP system, the chiller will pick up this rejected heat as a cooling load.

- On page VII.57, under the description of Report SS-A, a clarifying note should be added:

With the hydronic heat pump (HP) system, the relationship between the heating and cooling energy and peaks in the SS-A Report and SS-D Report differs from other system types. Normally, for all systems with a hot water heat source, the SS-D Report reports the sum of the SS-A energies for all systems on a given PLANT-ASSIGNMENT.

For the HP system, the SS-A Report contains the heating and cooling energy required at the air side coil of the heat pump, summed for all the units on that system. However, the SS-D Report for cooling is the sum of the heat rejected to the cooling tower by the units, and for heating is the supplemental heating required from plant boilers. Both of these values reflect the energy needed to maintain the hydronic loop temperature within its limits.

A similar statement should appear on page VII.63, under the SS-D Report description, or at least a reference to this new note under SS-A.

DOE-2 Supplement

- At the end of the article on "Trombe Walls", page 2-44, there should be a paragraph stating the following warning:

Use of the vented Trombe wall should be avoided in combination with systems which use the COOL-CONTROL = WARMEST or HEAT-CONTROL = COLDEST option. In the warmest/coldest calculations, the thermal gains from the vented Trombe wall are not included. This could cause the hot or cold duct supply temperatures to be incorrectly set, resulting in excess energy consumption, or overheated or undercooled zones. The system types involved are MZS, DDS, SZCI, HVSYS, TPIU, FPIU, VAVS, RHFS, CBVAV, PMZS, and PVAVS. This problem will not occur in these systems if other control methods are used.

BUGS DISCOVERED IN DOE-2.1B AND INTERIM SOLUTIONS

The following is a complete list of bugs discovered to date in the code. We encourage users to document suspected bugs, and report them to their computer service bureau, or to us. If you wish to receive a paper copy of the tape modifications needed to correct the bugs, please drop us a line.

CLASSIFIED INDEX

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

ABORT ROUTINE

DKTEMP: 14
 FMTAP: 1
 LOADS: 2
 OPELEC: 17
 SHDWS: 6
 WTW: 18

SYSTEM-TYPE

PTAC: 13
 VAVS: 11

REPORTS

LS-L: 5
 LV-B: 4
 LV-D: 3
 LV-L: 10
 PS-D: 19
 SS-O: 12
 Hourly
 Reports: 2, 18

SUBJECT/COMMAND/KEYWORD

| | |
|--------------------------|-------------------------|
| CONSTRUCTION: 2 | LOAD-ASSIGNMENT: 16, 17 |
| CURVE-FIT: 15 | Metric option: 3, 4 |
| Daylighting: 5, 6 | PLANT-EQUIPMENT: 16, 17 |
| DESIGN-DAY: 8 | SHADE-SCHEDULE: 6 |
| EQUIPMENT-QUAD: 15 | SYSTEM-EQUIPMENT: 15 |
| Extraction rates: 11, 13 | TITLE: 1 |
| FIXED-SHADE: 7 | Trombe walls: 8 |
| GLASS-CONDUCTANCE: 9 | Weather Processor: 20 |

BDL

- [1] The program will abort in routine FMTAP if the user neglects to close a TITLE LINE with an asterisk (*).
 Interim solution: Always end each TITLE LINE with an asterisk, and the whole command, as usual, with a terminator.
- [2] If hourly reports are requested, there must be at least one CONSTRUCTION command entered in LOADS. Failure to do so may result in an abort in LOADS.
 Interim solution: Create a CONSTRUCTION command, even a dummy one, if hourly reports are desired.
- [3] In Report LV-D, the FLOOR and ROOF designations are reversed. Also, if metric output is requested, the values for AREA of WALL and for U-VALUE of the combined WALL + GLASS are incorrect.
 Interim solution: For the first problem, read the designations in reverse. For the last two, none.
- [4] In Report LV-B, the breakdown of AREA and VOLUME by SPACE is not reported. In an English input deck, the building totals are reported correctly. However, if INPUT-UNITS = METRIC the totals are also incorrect. Additionally, the PEOPLE total in a metric deck is incorrect.
 Interim solution: For the breakdown of AREA and VOLUME, request the LV-C report, which does report the values correctly. For metric runs, none for the building totals problems.

LOADS

- [5] In Report LS-L, the figures reported under the column labelled "NUMBER OF HOURS MANAGEMENT WOULD BE EMPLOYED" are incorrect since they can include night-time hours. This is problematic only when DAYLIGHTING = YES.
Interim solution: None.
- [6] On CDC machines only, if DAYLIGHTING = YES, and a shading surface transmittance schedule is defined with SHADE-SCHEDULE in either the BUILDING-SHADE or FIXED-SHADE command, then the program will abort in subroutine SHDWS.
Interim solution: Use window management-related keywords instead of SHADE-SCHEDULE to simulate the effects of changing transmittance, if running on a CDC machine.
- [7] The new FIXED-SHADE command is not operable; the program does not respond to the input at all, and there is no warning message.
Interim solution: None.
- [8] Using Trombe walls in a run with one or more DESIGN-DAYS followed by a normal run period from the weather file will cause an abort or erroneous results.
Interim solution: Use Trombe walls with only design days, or only weather-file run periods, but not a combination of the two.
- [9] The default GLASS-CONDUCTANCE for the second and any later GLASS-TYPE commands in a deck is picked up from the first GLASS-TYPE command and is therefore determined by the value of PANES for the first command. This is only a problem if (a) there is more than one GLASS-TYPE command and also (b) the value of PANES for the second and later commands is different from that of the first command.
Interim solution: Specify GLASS-CONDUCTANCE rather than allow the program to choose a default value.
- [10] The window y-coordinate in the daylighting report LV-L is calculated incorrectly. No simulation results are affected.
Interim solution: None.

SYSTEMS

- [11] When the program calculates the maximum and minimum extraction rates and these turn out to be equal, the count of hours undercooled will be underestimated. This situation can occur for VAVS system type, for example, if the MIN-CFM-RATIO is 1.0 and no heating is allowed.
Interim solution: None.
- [12] SS-0 Report, the Temperature Scatter Plot, will contain all zeros unless the user also requests the printing of at least one of the following reports: SS-B, SS-C, SS-H, SS-I, SS-J, SS-K, SS-L, SS-N.
Interim solution: Include at least one of the above reports when requesting SS-0.
- [13] In the PTAC system, the sensible load used to select high- or low-speed ratio should be the net zone extraction minus the extraction done by mixed air. The current calculation incorrectly sums the two values. The error can be significant in runs with large fractions of outside air coincident with high values of zone-to-outside-air-temperature difference combined with small low-speed ratios.
Interim solution: Avoid large outside air quantities with small low-speed ratios in the PTAC system.

- [14] If the COOL-CONTROL or HEAT-CONTROL is specified as RESET, and the corresponding COOL- or HEAT-RESET-SCH references a DAY-SCHEDULE rather than a DAY-RESET-SCH, then the program will abort in subroutine DKTEMP with a "divide by zero" error without printing an ERROR message.
Interim solution: Correct input; use properly defined reset schedules.
- [15] If COEFFICIENTS are specified in the CURVE-FIT command in SYSTEMS or PLANT to enter coefficients for a SYSTEMS-EQUIPMENT or EQUIPMENT-QUAD curve, the results will be incorrect. The program currently transposes the values entered, producing a meaningless curve.
Interim solution: None; use DATA points instead of COEFFICIENTS.

PLANT

- [16] In the LOAD-ASSIGNMENT command, if the first and last PLANT-EQUIPMENTS in a LOAD-RANGE are not both set equal to UTILITY, and the capacity is defined by keyword NUMBER = a value which is less than the peak demand calculated by the program, then any intervening PLANT-EQUIPMENT assignments will be ignored and the entire load is given to the utility.
Interim solution: Correct input. Use the LOAD-MANAGEMENT command when trying to simulate a peak-shaving strategy. See the Reference Manual, page V.61, Example 3.
- [17] If, in the PLANT-EQUIPMENT command, a steam turbine is specified, but no diesel or gas turbine, and if the LOAD-ASSIGNMENT is allowed to default, then the program will abort in subroutine OPELEC.
Interim solution: Always specify, in this case, a LOAD-ASSIGNMENT.
NOTE: The steam turbine simulation is intended for use only with a gas turbine or diesel engine, to generate electricity when there is no other use for the waste heat from these prime movers; it is a very inefficient device for producing electricity and would not ordinarily be used except in a combined-cycle plant.
- [18] The program will abort in subroutine WTW if, in PLANT only, REPORT-BLOCKS are specified but no HOURLY-REPORTS are requested.
Interim solution: Delete (or comment out) the REPORT-BLOCK command in PLANT if no hourly reported are desired.
- [19] The energy performance of hot and cold storage tanks is not reported out in Report PS-D. No simulation results are affected.
Interim solution: None.

Weather Processor

- [20] The design temperatures reported in the statistical summary of the Weather Processor are meaningless.
Interim solution: None.

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
Springfield, Va. 22161

AN EQUAL OPPORTUNITY EMPLOYER

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-211



OFFICIAL BUSINESS
Penalty for Private Use, \$300

PRINTED MATTER

Library

50-134

350/4-84 This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Energy Research and Development, Buildings Systems Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

Lawrence Berkeley Laboratory is an equal opportunity employer.