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PUB-439

DOE-2 USER NEWS: A COMPUTER PROGRAM FOR BUILDING ENERGY USE ANALYSIS

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Building Energy Simulation Group

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BULLETIN BOARD

Item: Wondering what to expect in the next version of DOE-2? The following is a list of the major new features we have added to the code. DOE-2.1B is now completed and should be released by the end of this year.

- Daylighting (and lighting controls)
- Trombe walls, both vented and unvented
- Simpler, as well as more precise, shades, fins and overhangs
- The Sherman-Grimsrud infiltration method for residential and single zone commercial buildings
- Capability of specifying different interior wall types
- More detailed humidification
- Night-time forced ventilation and auxiliary night fans
- New summary and verification reports
- A metric input and output units option
- Many small but significant improvements to be described later.

Item: The editor wishes to apologize to George Meixel, of the University of Minnesota, and to Zulfikar Cumali, of the Consultants Computation Bureau, for the lack of credit shown them for their work on the simulation of earth-bermed buildings, in the article on DOE-2.1n in the May 1982 issue.

A BLAST/DOE-2 COMPARISON STUDY

This comparison study was conducted by members of the LBL Passive Solar Research and Development Group and Group Q-11, Solar Energy Group, at Los Alamos National Laboratory in conjunction with a Commercial Building Passive Cooling Technology Assessment project for the U.S. Department of Energy where both BLAST and DOE-2 energy analysis programs were used to determine changes in building energy performance due to the utilization of various passive cooling strategies. The comparison was made to insure comparability of results between strategies simulated by one program and those of other strategies simulated by the other program.

Annual comparison runs were made for a 10,000 ft^2, one-story, office building using Phoenix TMY weather to emphasize cooling differences (see Reference 1 for details). The building description inputs for both programs were made to agree as closely as possible within the constraints of the respective program input requirements.

The results of the simulations are shown on the next page in Figures 1 through 3, and described below. Runs in other climates and a more detailed comparison of results will be conducted in the near future.

Figure 1. Monthly and Annual Heating and Cooling Space Energy

This figure shows the monthly heating and cooling energies for the LOADS only portion of the programs. These are the monthly and annual sum of zone sensible loads only. To make this comparison, BLAST was run at a constant temperature of 73°F so a direct comparison could be made between the programs. The BLAST simulation was run with the BLAST zoning arrangement (which is slightly different from the DOE-2 arrangement) but since the runs were made at constant temperature, these zoning differences should not be significant. This figure shows that BLAST predicts heating loads that are larger than those predicted by DOE-2 in all months, resulting in an annual difference of 4%. DOE-2 cooling loads are smaller in winter and slightly higher in summer, but on an annual basis are only 1.6% lower than BLAST.

Ref. 1. W. L. Carroll, et al., "Passive Cooling Technology Assessment: Synthesis Report", LBL and LANL joint technical report, to be published.

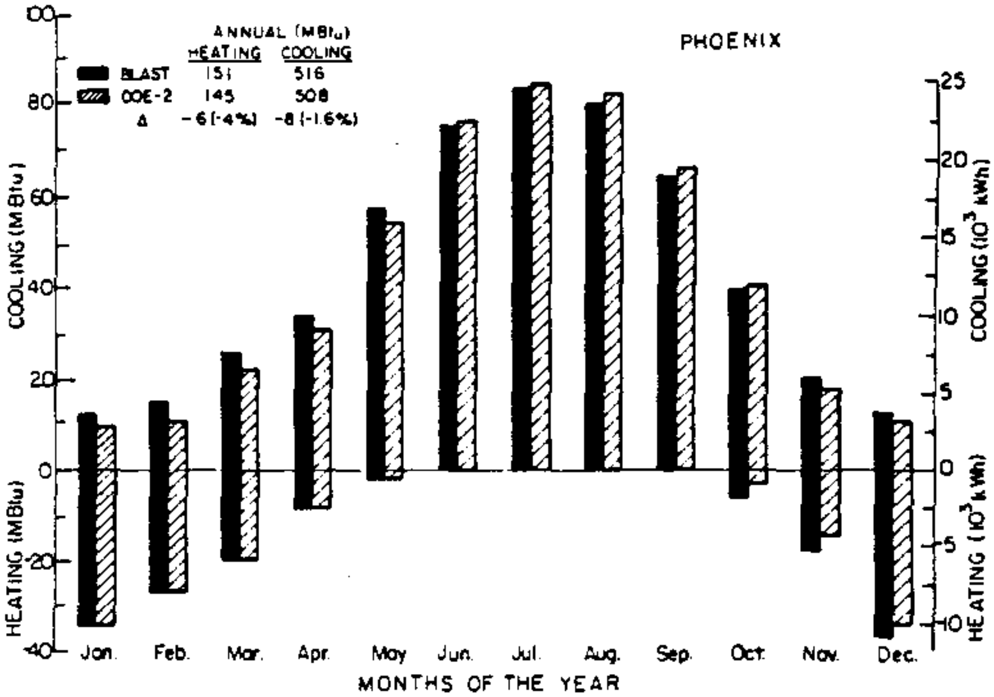

FIG. 1 SPACE ENERGY

XBL 826-5854

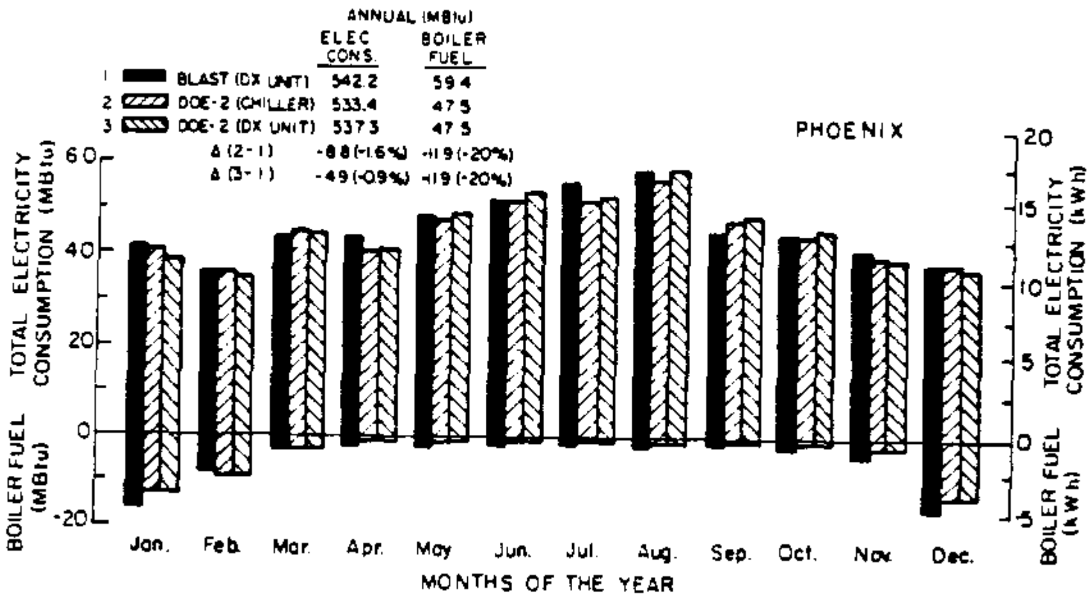

FIG. 2 SITE (BUILDING BOUNDARY) ENERGY CONSUMPTION

XBL 826-5857

Figure 2. Monthly and Annual Heating and Cooling Site Energy Consumption

Total electricity consumption shown on this figure includes primary equipment energy (boilers and chillers), plus energy for fans, lights and equipment, and auxiliary equipment. The differences in total energy use on a monthly and annual basis are less than 10%. Heating is unaffected by the difference between DX and chilled water for DOE-2, and is about 20% smaller than BLAST on an annual basis. The fact that the DOE-2 heating predictions are smaller in the summer, when only hot water loads are present, suggests that there maybe some differences between the boiler algorithms.

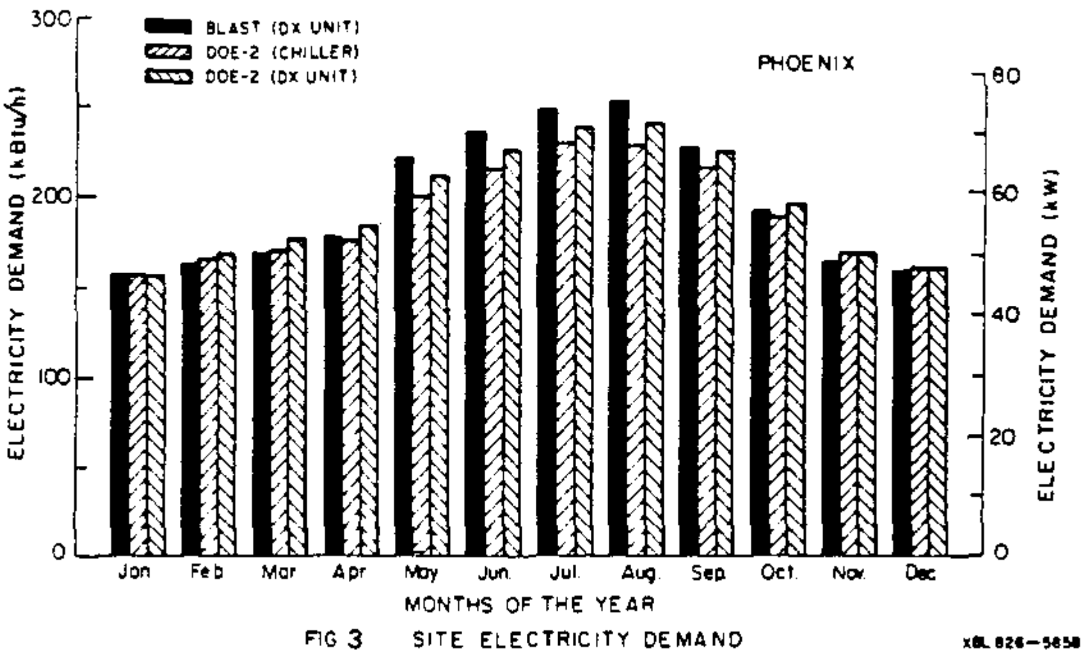

Figure 3. Monthly Site Electricity Demand

The demand shown here is the total monthly peak electricity demand for the building. There are no differences greater than about 10%. Demand charges computed with results from both programs would show about the same equivalence.

* * * * *

BUGS DISCOVERED IN DOE-2.1A AND INTERIM SOLUTIONS

The following three new bugs have been discovered in the program since the last issue of the newsletter. The first and last are in BDL, the second is in SYSTEMS.

[33] The program will give erroneous results if LIGHTING-TYPE = REC-FLUOR-NV has been specified in a space for which custom weighting factors are desired.

Interim solution: Use LIGHTING-TYPE = SUS-FLUOR.

[34] In a CBVAV system, when the following four conditions are met simultaneously, then the supply temperature may be incorrectly calculated (on the high side): 1) the presence of a fixed economizer, 2) the fans were off the previous hour, 3) outside air is relatively cold, and 4) mixed air is being passed to spaces.

Interim solution: None.

[35] If custom weighting factors are requested for a zone with INTERIOR-WALLs NEXT-TO an UNCONDITIONED or PLENUM zone, then a bug in BDL will result in energy disappearing from the building. The amount of energy lost depends upon the fraction of wall surface contiguous with the unconditioned zone.

Interim solution: In LOADS, define all zones as CONDITIONED. In SYSTEMS, define plenums and unconditioned zones appropriately. Do not allow SYSTEMS to size variable air volume systems from peak loads, if there is a single system for the entire building.

GLAZING OPTIMIZATION STUDY

In collaboration with the Windows and Daylighting Group, a study was undertaken by the Building Energy Simulation Group in which annual energy consumption in an office building module was modeled parametrically with DOE-2 for a wide range of glazing properties in three different climates. Some highlights of this study are presented here; the full report was published as Glazing Optimization Study for Energy Efficiency in Commercial Office Buildings, R. Johnson, S. Selkowitz, F. Winkelmann, and M. Zentner, October 1981, Lawrence Berkeley Laboratory Report LBL-12764. A primary objective was to develop results that could be readily generalized and applied to optimize glazing in a wide variety of design considerations.

Values for thermal conductance, shading coefficient, and visible transmittance were parametrically varied through representative ranges. Annual energy use in a prototypical module of an office building was calculated as a function of glazing material properties, glazing area, orientation, and climate. A module configuration, representative of commercial office building construction, was evolved through a series of sensitivity studies as the basis for a building-block approach for calculations. The 200 ft by 200 ft building module, which can be considered as a single floor in a multistory building, contains four identical perimeter zones, each 30 ft deep, surrounding a core zone. The windows are furnished with drapes having a shading coefficient multiplier of 0.6. There is an 80 percent probability that the drapes are closed when direct solar transmission exceeds 20 Btu/ft^2-hr.

Annual energy consumption was modeled with DOE-2.1, which was modified to improve the analysis of fenestration performance. Glass conductance was varied from 1.1 Btu/ft^2-hr (single glazing) to 0.32 Btu/ft^2-hr (triple glazing). Shading coefficient was varied from 0 to 1.0 and window-to-wall ratio was varied from 0 to 90 percent. Cities were chosen to represent a wide range of climatic conditions. Selected were Bismarck, North Dakota, with a northern heating-dominated climate; New York City, with significant heating and cooling requirements; and Miami, Florida, characterized by low latitude and a cooling-dominated climate.

An example of results for New York City is shown in Figure 1.

From over 250 DOE-2.1 energy analyses, four general conclusions were drawn:

1. Glazing of a perimeter zone office will have a major impact on energy consumption for both heating and cooling. The relationship of energy consumption to glazing is a complex function of glazing size, orientation, and climate.
2. In all climate zones and on all orientations, a glazed wall with properly selected glazing can usually provide equivalent or better energy performance than an unglazed wall. Energy efficiency can be achieved while retaining the desirable architectural qualities of windows.
3. Net annual performance can be fully understood only by examining the component loads in detail and by accounting for the performance of heating and cooling equipment and building operation schedules.
4. No rule of thumb consistently allows for selecting optimal glazing properties. In most cases, if a desired energy budget is chosen, several glazing-system approaches will be available to the building designer, providing flexibility in the design of energy efficient solutions without compromising other design requirements.

In future work, this study will be expanded to include the performance of window systems with a variety of fixed and operable shading devices. The Building Energy Simulation and the Windows and Daylighting groups are currently developing improved algorithms to model the thermal, solar gain, and daylight transmittance properties of such devices.

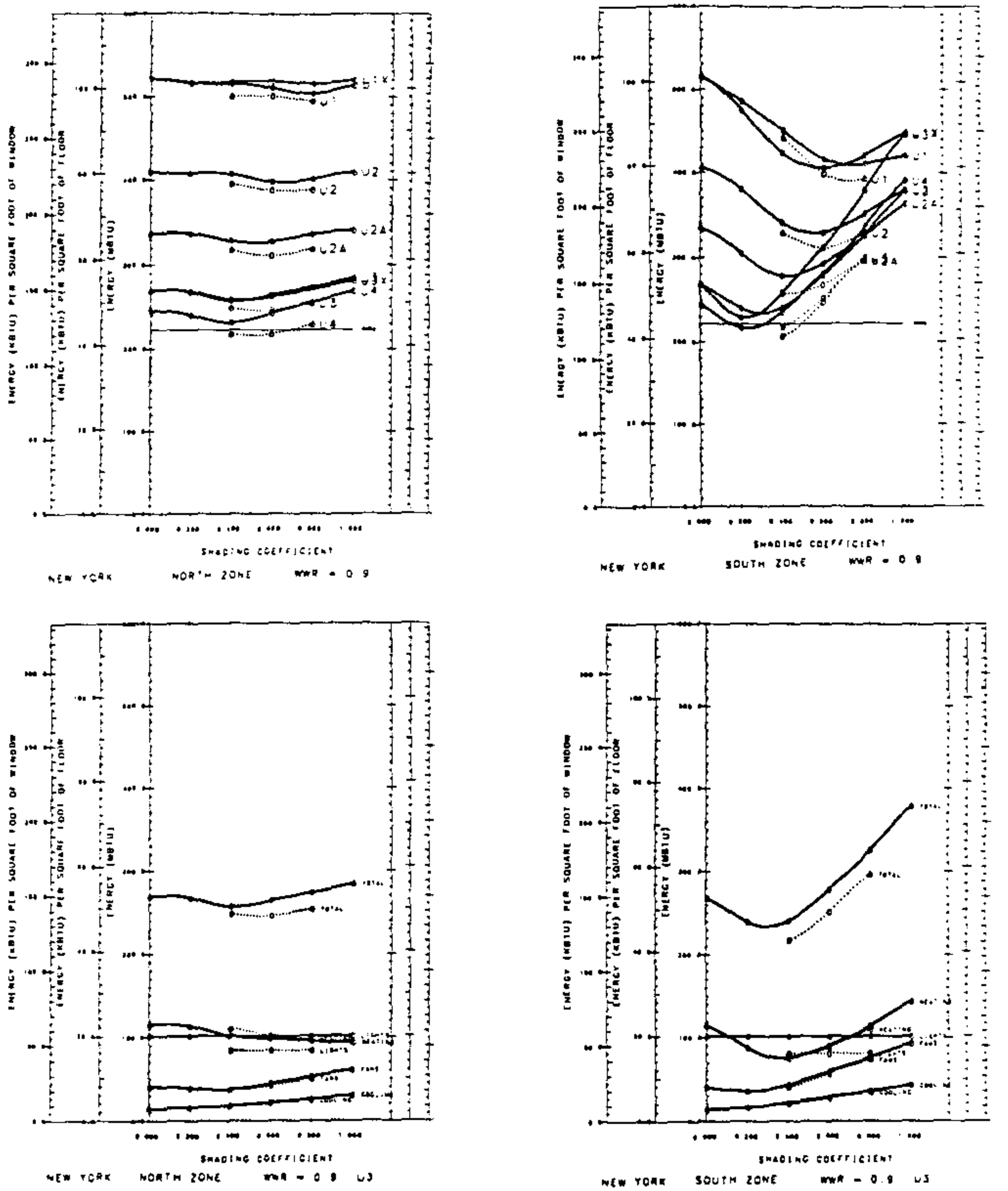

Figure 1. Sample glazing optimization results for a prototype office building located in New York City. The curves, obtained with DOE-2, show how the annual energy use and the energy-use components of a south-facing perimeter zone depend on the shading coefficient of the glazing. The zone has single-pane glass and a window-to-wall ratio of 90%.

U1 = Normal single glazing, nominal 1.1 Btu/hr-ft^2-°F
U2 = Single glazing, low emissivity, nominal .76 Btu/hr-ft^2-°F
U2A = Normal double glazing, nominal .49 Btu/hr-ft^2-°F
U3 = Normal triple glazing, nominal .32 Btu/hr-ft^2-°F

Suffix X = No drapes deployed as a shading device.
Solid line = Energy use with no utilization of daylighting.
Broken line = Energy use with utilization of daylighting.

INDEX TO THE DOE-2 USER NEWS

On this second anniversary of the newsletter, a two-year subject/title index has been prepared.

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