THE DOE–2 USER NEWS

DOE-2: A COMPUTER PROGRAM FOR BUILDING ENERGY SIMULATION

PUB-439
Vol. 10, No. 3
Fall 1989

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☞ ☞ HANDS ON ☜ ☜

☞ ASHRAE Standard 90.1P

From *ASHRAE Insights*, Sept. 89: ASHRAE Standard 90.1P, Energy Efficient Design of New Buildings Except Low-Rise Residential, has been approved for publication by the ASHRAE Board of Directors. This new standard sets energy efficiency requirements for new buildings and serves as a basis for building codes in many states. Under development since 1982, Standard 90.1P is based on extensive parametric analysis with DOE-2.

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

☞ New PC Version of DOE-2.1D

ADM Associates of Sacramento, CA, has recently completed work on a functionally-identical microcomputer version of DOE-2.1D. The original work of porting 2.1D to the microcomputer environment was done by ADM under contract to the California Energy Commission, which is now using the micro version as a research tool in developing its 1991 non-residential energy standards. ADM enhanced the basic program with a menu-driven front end file handling executive used for managing the analysis and saving loads files. In the *Winter* User News we plan to feature a more detailed article on this newest DOE-2 based PC program. In the meantime, contact ADM for price and availability at (916) 363-8383.

☞ Time To Make Travel Plans

Oct 29-Nov 3 — *Conference on Technology for Generation Power in the Twenty-First Century*

to be held in San Francisco, California.
Sponsor: Electric Power Research Institute
Contact: S.B. Alpert, EPRI, P.O. Box 10412, Palo Alto, CA 94303. Phone: (415) 855-2512.

* * * * *

Dec 4-7 — *Thermal Performance of the Exterior Envelopes of Buildings IV*

to be held in Orlando, Florida.
Sponsors: ASHRAE, U.S. Dept. of Energy, Building Thermal Envelope Coordinating Council, and the Chartered Institution of Building Services Engineers. Contact: Gabrielle Coleman, Bldg. 4508, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831-6092.

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DOE – 2.1D

A new version of the DOE-2 program, DOE-2.1D, is now available. It replaces DOE-2.1C, which was released in 1984. DOE-2.1D is "upwardly compatible", so that 2.1C input files will run on 2.1D with no changes. DOE-2.1D will run on a variety of computers, including DEC-VAX, Sun, and IBM-PC compatibles.

NEW FEATURES

Gas-fired cooling equipment • New models for three different types of gas-fired cooling equipment were developed in collaboration with the GARD Division of the Chamberlain Manufacturing Corporation, with support from the Gas Research Institute:

Desiccant cooling system – a small packaged unit (5 to 10 tons, 1800-3600 cfm) that uses a desiccant wheel in conjunction with direct and indirect evaporative cooling, instead of the usual DX coils. A gas-fired hydronic heater is used to regenerate the desiccant and to provide heating.

Direct-fired absorption chiller – a gas- or oil-fired two-stage absorption chiller with optional heating capability. These units are commercially available in sizes ranging from 100 to 150 tons.

Engine-driven chiller – a compression chiller driven by a natural-gas internal combustion engine. Hot water can be recovered from the engine exhaust and coolant to provide space heating or to run an absorption chiller for extra cooling or for greater overall efficiency.

Ice storage simulation • The DOE-2.1D PLANT program contains a new, component-based ice-storage model called CBS/ICE, developed for ASHRAE by the University of Texas Center for Energy Studies. With CBS/ICE users can configure a large variety of static (ice-on-coil) systems by linking together system components such as evaporator, ice tank, compressor, condenser, controller, etc.

Input functions in SYSTEMS • This feature, designed for advanced users only, allows users to modify DOE-2 calculations without recompiling the program. Users may write their own algorithms in a FORTRAN-like language and place these algorithms in the BDL input. The algorithms will then be automatically incorporated into DOE-2 as a supplement to the standard hourly calculation. Previously available in LOADS, this feature has been extended in DOE-2.1D to SYSTEMS. One application of this feature would be to model innovative HVAC control schemes that cannot be simulated by the regular program.

Input macros • The "input macros" feature, intended for advanced users who are already familiar with preparing Building Description Language (BDL) input increases the flexibility of BDL. For example, "input macros" can be used to

-- Define a block of input (a wall, a schedule, or a space, for example) and associated parameters. The block can then be used repeatedly in the input with different values for the parameters.

-- Selectively accept or skip portions of the input. One could, for example, have BUILDING–LOCATION inputs for ten different cities, but select only the one corresponding to the weather file being used for the run.

-- Perform arithmetic and logical operations. In particular, this allows keywords to be set equal to the result of adding, subtracting, multiplying, or dividing other values.

-- Incorporate external files containing pieces of BDL into the main BDL input stream. This is the basis of the "general library" feature (see below).

General library feature • The "input macro" feature allows the user to merge other files into the BDL input by using the new ##include command. These files could contain previously prepared BDL descriptions of individual building components (walls, windows, schedules, whole spaces, HVAC systems, etc.). An example would be to assemble a set of files, each file containing the lighting, occupancy, and equipment schedules for a particular building type (office, retail, etc.). This would then be a "schedules library" that could be used repeatedly.

Improved window calculation • Because heat gain and loss through windows can have a large impact on energy performance, the window thermal calculation has been improved. This includes

-- Automatic calculation of the shading of *diffuse* solar radiation by neighboring buildings and by architectural elements such as overhangs. Previously, only the shading of direct solar radiation was automatically calculated.

-- Improved calculation of diffuse solar radiation from the sky incident on windows and other exterior surfaces.

-- Improved calculation of infrared radiation loss from windows (and walls and roof) to sky and ground, taking into account hourly-varying atmospheric conditions such as humidity and cloud cover. Blocking of infrared by overhangs, etc., is also taken into consideration.

Enhancements to residential natural ventilation • In DOE-2.1C the user had considerable control over when natural ventilation occurred for the residential system (RESYS), but was forced to guess the air change rate when the windows were open. DOE-2.1D increases the user's ability to control when venting occurs, and, more importantly, adds a calculation of the ventilation rate.

In addition to the above major changes, a number of minor improvements have been made in DOE-2.1D, including:

-- Lower case letters are now allowed in the BDL input.

-- The maximum number of SCHEDULES has been increased from 40 to 60.

-- A new keyword, AREA/PERSON, in SPACE–CONDITIONS eliminates calculating the NUMBER–OF–PEOPLE for each space.

-- To help in sizing thermal energy storage systems, report SS-J now shows the peak integrated cooling load for a 24-hour period and the day of the year that it occurs.

-- An option has been added to write a binary file of hourly report data. This file can then be used as input to a post-processor program (provided by the user — not part

of DOE-2) for graphing, making tables, histogramming, statistical analysis, etc.

DOCUMENTATION

New manuals are:

-- DOE-2.1D BDL Summary

-- DOE-2.1D Supplement

-- DOE-2.1D Sample Run Book

The Supplement describes how to use the new program features in 2.1D as well those added in 2.1B and 2.1C. It is designed for use as a supplement to the DOE-2.1A Reference Manual. (The DOE-2 Engineers Manual and the DOE-2 Users Guide have not been updated for 2.1D.)

OBTAINING DOE-2.1D

Two PC versions are available. For more information on these contact the vendors:

Acrosoft International, Inc.
Suite 230
9745 East Hampden Avenue
Denver, CO 80231

Phone: (303) 368-9225
FAX: (303) 368-5929

— and —

ADM Associates, Inc.
3299 Ramos Circle
Sacramento, CA 95827

Phone: (916) 363-8383

For instructions on how to obtain versions of DOE-2.1D for other machines, or for general information about the program, documentation, etc., contact:

Kathy Ellington — Bldg. 90, Rm. 3147
Simulation Research Group
Lawrence Berkeley Laboratory
Berkeley, CA 94720

Phone: (415) 486-5711 • FAX: (415) 486-5172
E-mail: kathy%gundog@lbl.gov

Graphs From DOE123

by

Ernie Jessup, P.E.
E. Jessup & Associates, Consulting Engineers
19730 Ventura Boulevard, Suite 22
Woodland Hills, CA 91364

Phone: (818) 884-3997

DOE123 is a utility software program that can be used to generate graphs from a DOE-2 file. The process runs under LOTUS123 Version 2, and on IBM-PC compatible microcomputers. Hardware requirements are 640K RAM minimum, a graphics video card and a graphics printer. **DOE123** has been tested on simulation files created with the MICRO–DOE and PC–DOE programs.

When **DOE123** is started, the following menu appears:

RETRIEVE	GRAPH	SAVE	QUIT

Retrieve a DOE-2 report file by moving the cursor to RETRIEVE and press return. You will be prompted for a file name. After entering the file name, **DOE123** retrieves the file, formats the data, and extracts a list of the reports. Move the cursor to GRAPH and press return. The cursor moves to a list of reports (see Fig. 1). Move the cursor within the report list and select a report by pressing return. The cursor will only move to the report that can be graphed. **DOE123** then generates graphs for screen display and saves the graphs in "PIC" files. LOTUS123 PRINTGRAPH can be used to print graphs from the "PIC" files.

Some editing of the generated graphs may be required when numbers or letters overlap. Editing may also be desirable to change the graph type and presentation. The LOTUS123 command, /GRAPH, can be used to edit the graphs.

The worksheet can be saved by using the SAVE command. The QUIT command returns the program to the LOTUS "Ready" mode.

Following Fig. 1 are examples of graphs generated with **DOE123**.

Cost of **DOE123** is around $40; for more information please contact E. Jessup & Associates directly.

```
Reports that can be graphed using DOE123

  1 REPORT- LS-C BUILDING PEAK LOAD COMPONENTS      WEATHER FILE- TRY  CHICAGO
  2 REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY     WEATHER FILE- TRY  CHICAGO
  3 REPORT- LS-C BUILDING PEAK LOAD COMPONENTS      WEATHER FILE- TRY  CHICAGO
  4 REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY     WEATHER FILE- TRY  CHICAGO
  5 REPORT- LS-A SPACE PEAK LOADS SUMMARY           DESIGN DAY
  6 REPORT- LS-B SPACE PEAK LOAD COMPONENTS         PLENUM-1
  7 REPORT- LS-B SPACE PEAK LOAD COMPONENTS         SPACE1-1
  8 REPORT- LS-B SPACE PEAK LOAD COMPONENTS         SPACE2-1
  9 REPORT- LS-B SPACE PEAK LOAD COMPONENTS         SPACE3-1
 10 REPORT- LS-B SPACE PEAK LOAD COMPONENTS         SPACE4-1
 11 REPORT- LS-B SPACE PEAK LOAD COMPONENTS         SPACE5-1
 12 REPORT- LS-C BUILDING PEAK LOAD COMPONENTS      DESIGN DAY
 13 REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY     DESIGN DAY
 14 REPORT- LS-E  SPACE MONTHLY LOAD COMPONENTS IN MBTU FOR    PLENUM-1
 15 REPORT- LS-E  SPACE MONTHLY LOAD COMPONENTS IN MBTU FOR    SPACE1-1
 16 REPORT- LS-E  SPACE MONTHLY LOAD COMPONENTS IN MBTU FOR    SPACE2-1
 17 REPORT- LS-E  SPACE MONTHLY LOAD COMPONENTS IN MBTU FOR    SPACE3-1
 18 REPORT- LS-E  SPACE MONTHLY LOAD COMPONENTS IN MBTU FOR    SPACE4-1
 19 REPORT- SS-A  SYSTEM MONTHLY LOADS SUMMARY FOR SYST-1
 20 REPORT- SS-B  SYSTEM MONTHLY LOADS SUMMARY FOR SYST-1
 21 REPORT- SS-C  SYSTEM MONTHLY LOAD HOURS FOR    SYST-1
 22 REPORT- SS-H  SYSTEM MONTHLY LOADS SUMMARY FOR SYST-1
 23 REPORT- SS-I  SYSTEM MONTHLY SOURCE-LATENT SUMMARY FOR     SYST-1
 24 REPORT- SS-J  SYSTEM PEAK HEATING AND COOLING DAYS FOR     SYST-1
 25 REPORT- SS-K  SPACE TEMPERATURE SUMMARY                    SYST-1
 26 REPORT- SS-L  FAN ELECTRIC ENERGY                          SYST-1
 27 REPORT- SS-N  HUMIDITY RATIO SCATTER PLOT FOR              SYST-1
 28 REPORT- SS-G  ZONE LOADS SUMMARY IN     SYST-1          FOR SPACE5-1
 29 REPORT- SS-F  ZONE DEMAND SUMMARY  IN   SYST-1          FOR SPACE5-1
 30 REPORT- SS-O  TEMPERATURE SCATTER PLOT  SYST-1          FOR SPACE5-1
 31 REPORT- SS-G  ZONE LOADS SUMMARY IN     SYST-1          FOR SPACE1-1
 32 REPORT- SS-F  ZONE DEMAND SUMMARY  IN   SYST-1          FOR SPACE1-1
 33 REPORT- SS-O  TEMPERATURE SCATTER PLOT  SYST-1          FOR SPACE1-1
 34 REPORT- SS-G  ZONE LOADS SUMMARY IN     SYST-1          FOR SPACE2-1
 35 REPORT- SS-F  ZONE DEMAND SUMMARY  IN   SYST-1          FOR SPACE2-1
 36 REPORT- SS-O  TEMPERATURE SCATTER PLOT  SYST-1          FOR SPACE2-1
 37 REPORT- SS-G  ZONE LOADS SUMMARY IN     SYST-1          FOR SPACE3-1
 38 REPORT- SS-F  ZONE DEMAND SUMMARY  IN   SYST-1          FOR SPACE3-1
 39 REPORT- PV-A  EQUIPMENT SIZES
 40 REPORT- PV-B  COST REFERENCE DATA (USED FOR DEFAULT COSTS)
 41 REPORT- PV-C  EQUIPMENT COSTS
 42 REPORT- PV-E  EQUIPMENT LOAD RATIOS
 43 REPORT- PV-G  EQUIPMENT QUADRATICS
 44 REPORT- PV-G  EQUIPMENT QUADRATICS
 45 REPORT- PS-A  PLANT ENERGY UTILIZATION SUMMARY
 46 REPORT- PS-B  MONTHLY PEAK AND TOTAL ENERGY USE
 47 REPORT- PS-B  MONTHLY PEAK AND TOTAL ENERGY USE
 48 REPORT- PS-C  EQUIPMENT PART LOAD OPERATION
 49 REPORT- PS-D  PLANT LOADS SATISFIED
 50 REPORT- PS-D  PLANT LOADS SATISFIED
 51 REPORT- PS-G  ELECTRICAL LOAD SCATTER PLOT
 52 REPORT- PS-H  EQUIPMENT USE STATISTICS
 53 REPORT- PS-I  EQUIPMENT LIFE CYCLE COSTS
 54 REPORT- BEPS  ESTIMATED BUILDING ENERGY PERFORMANCE
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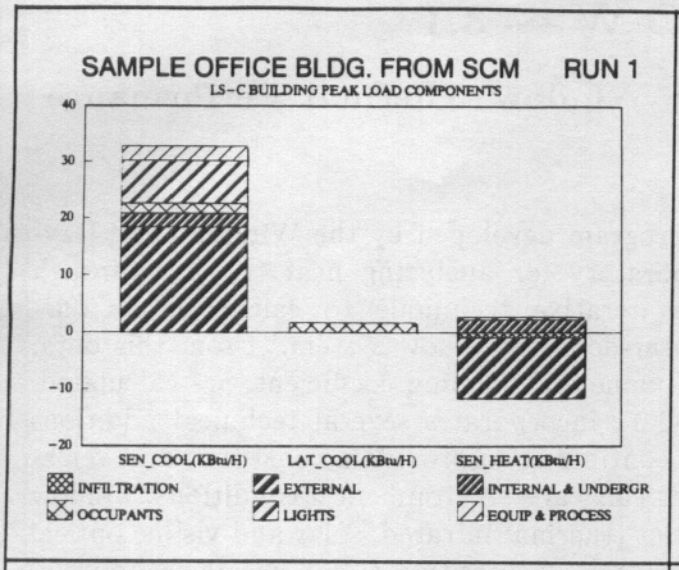
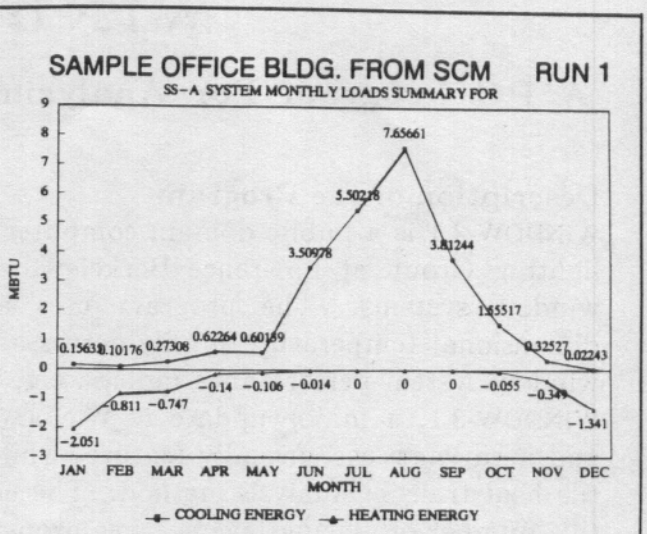
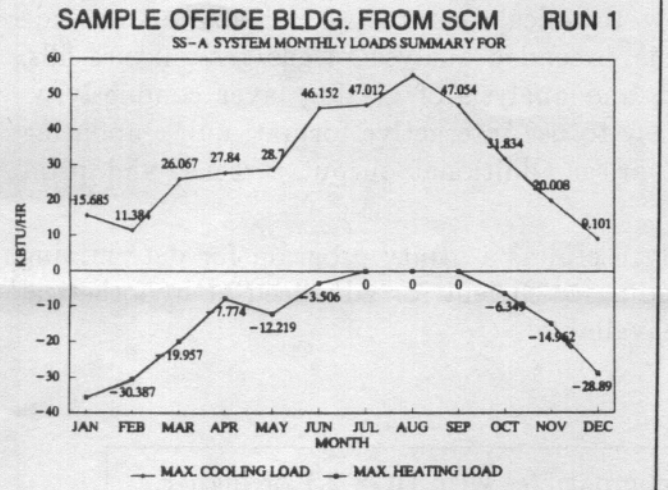
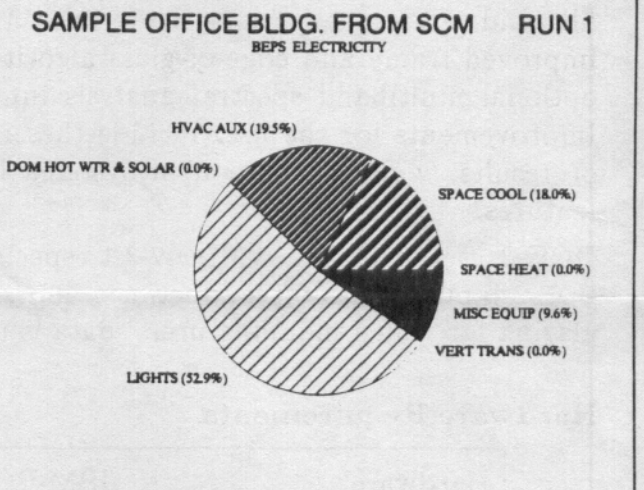
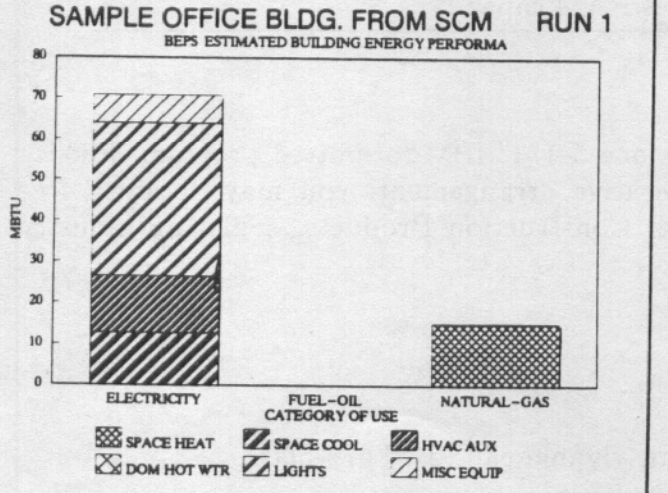
Figure 1: For the Sample Office Building

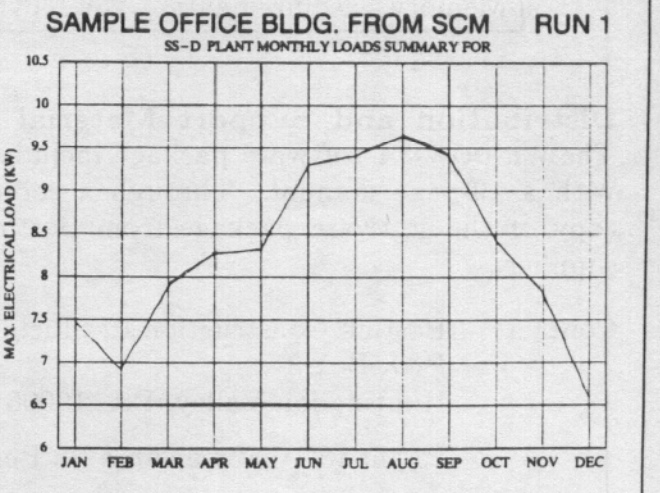












Example of graphs from **DOE123**

WINDOW — 3.1

A PC Program For Analyzing Window Thermal Performance

Description of the Program

WINDOW-3.1 is a public-domain computer program developed by the Windows and Daylighting Group at Lawrence Berkeley Laboratory for analyzing heat transfer through window systems. The program uses an iterative technique to calculate the one-dimensional temperature profile across a user-defined window system. From this data, window system performance indices, e.g. U-value and shading coefficient, are calculated. WINDOW-3.1, a major update to WINDOW-2.0*, incorporates several technical additions and many new user-friendly features while continuing to provide a consistent and versatile heat transfer analysis method. The user can vary environmental conditions, window tilt, number of glazing layers, layer properties (thermal infrared, solar and visible optical properties, and thermal conductance), gap widths, composition of gap gas or gas mixture fill, and spacer and frame materials. New technical features of WINDOW-3.1 include improved frame and edge-of-glass algorithms, extended analysis of gas/gas-mixture fills, optional multiband spectral analysis input, and analysis of glazing layer conductivity. Improvements for the user include these: easy to use interactive format, quick updating of results, window component/systems libraries, additional output screens, and print features.

DOE-2 users will find WINDOW-3.1 especially useful as a utility program for determining DOE-2 input values of conductance and shading coefficient for advanced or hypothetical glazing for which manufacturers' data is unavailable.

Hardware Requirements

Hardware:	IBM-PC compatibles with DOS 2.1 or higher. A math co-processor decreases calculation time.
Memory Requirement:	256 Kbytes RAM capacity

Distribution and Support Material

The WINDOW-3.1 software package includes one 5-1/4" IBM-formatted program diskette with a 19-page manual. Through a cooperative arrangement, you may obtain a free copy of the software package from Bostick Construction Products, a glazing industry supplier.

Contact: Bostick Construction Products
P.O. Box 8
Huntingdon Valley, PA 19006

Phone (800) 523-6530 • in Pennsylvania call (215) 674-5600

* see Vol. 8, No. 4 of the *USER NEWS* for an article on WINDOW-2.0.

Related Publications

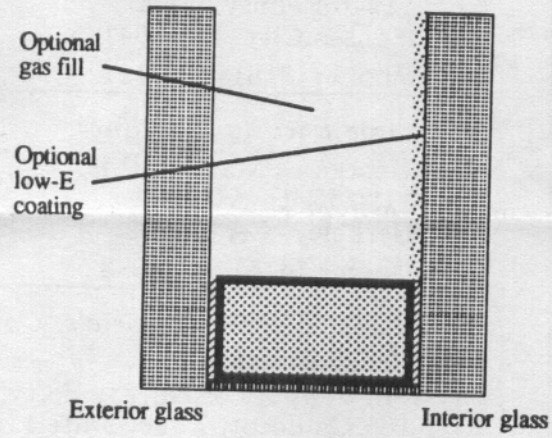
These reports offer further information on analyzing the thermal performance of windows. Contact Ms. Pat Ross, Windows and Daylighting Group 90-3111, Lawrence Berkeley Laboratory, Berkeley, CA 94720 to order the reports.

LBL—25184 • *WINDOW-3.1: A Computer Tool for Analyzing Window Thermal Performance*, by S. Reilly, and D. Arasteh, May 1988

LBL—24903 • *The Design and Testing of a Highly Insulating Glazing System for Use with Conventional Window Systems*, by D. Arasteh, S. Selkowitz, and J. Wolfe, November 1988

LBL—21576 • *Experimental Verification of a Model of Heat Transfer through Windows*, by D. Arasteh, J. Hartmann, and M. Rubin, December 1986

LBL—20543 • *Solar-Optical Properties of Multilayer Fenestration Systems*, by K. Papamichael and F. Winkelmann, November 1986

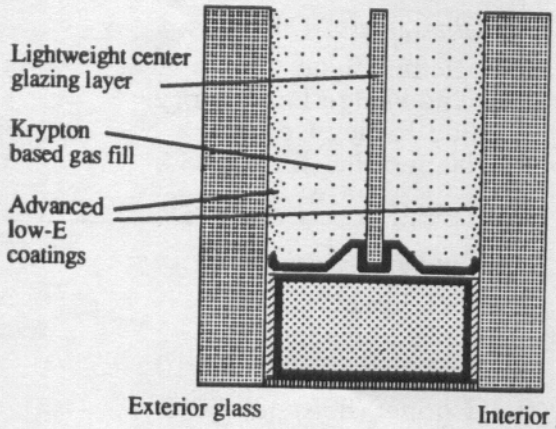


Today's Window Design

R-2 Double Glazing

R-3 Double Glazing with low-E coating

R-4 Double Glazing with low-E coating and gas fill



Tomorrow's Window Design

R-6 to R-10 High-R Glazing

Example:

R-8 Insulating Glass (center) using two low-E coatings (E=.06) and 90% Krypton/10% Argon gases

■ ■ ■ ■ DOE-2 DIRECTORY ■ ■ ■ ■

Program Related Software and Services

■■VIDEO■■

DOE-2 Instructional Video and Manual
Karen George, Program Development
Joint Center for Energy Management
University of Colorado at Boulder
Campus Box 428
Boulder, CO 80309-0428

■■SOFTWARE■■

DOE-2.1D for Micros (MICRO-DOE2)
Gene Tsai, Suite #230
Acrosoft International
9745 East Hampden Avenue
Denver, CO 80231
Phone: (303) 368-9225

■■ UTILITY PROGRAMS ■■

Pre- and Post-Processor Software
James Trowbridge
Trowbridge Software Engineering
4884-D Sunset Terrace
Fair Oaks, CA 95628
Phone: (916) 962-3001

Graphs from DOE-2
Ernie Jessup
E. Jessup & Associates
4977 Canoga Avenue
Woodland Hills, CA 91364
Phone: (818) 884-3997

■■ CONSULTANTS ■■

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Burns & McDonnell Engineers
8055 E. Tufts Avenue – #330
Denver, CO 80237
Phone: (303) 721-9292

Computer-Aided Mechanical Engineering
Mike Roberts
Roberts Engineering Co.
11946 Pennsylvania
Kansas City, MO 64145
Phone: (816) 942-8121

Large Facility Modeling
George F. Marton, P.E.
1129 Keith Avenue
Berkeley, CA 94708
Phone: (415) 841-8083

Master Classes, Tutorials, Consulting
Bruce Birdsall
"In Support of Energy Software"
166 Caldecott Lane, Suite 113
Oakland, CA 94618
Phone: (415) 841-2050

Classes and Consulting
Richard Kuo
Knowledge Laboratory
362 Ripley Court
Naperville, IL 60565
Phone: (312) 416-1696

Consulting and Training
Jeff Hirsch
2138 Morongo
Camarillo, CA 93010
Phone: (805) 482-5515

■ ■ ■ ■ DOE-2 PROGRAM DOCUMENTATION ■ ■ ■ ■

National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22121

	NTIS Order No.	Shipments Within The U.S.	Shipments Outside The U.S.
[ ] Complete 2.1C Documentation [includes PB-852-11431]	PB-852-11449	$303.00	$606.00
[ ] 2.1C Update Package	PB-852-11431	$ 92.00	$184.00
[ ] Engineers Manual [not included with PB-852-11449]	DE-830-04575	$ 42.50	$ 85.00
To Order by Separate Titles:			
[ ] BDL Summary [2.1C]	DE-850-12580	$ 15.95	$ 31.90
[ ] Users Guide [2.1A]	LBL-8689, Rev.2.	$ 49.95	$ 99.90
[ ] Sample Run Book [2.1C]	DE-850-12582	$ 55.95	$111.90
[ ] Reference Manual [2.1A]	LBL-8706, Rev.2	$ 97.95	$195.90
[ ] DOE-2 Supplement [2.1C Update]	DE-850-12581	$ 28.95	$ 57.90

For rush shipments: (703) 487-4650 -- Visa/MC
Overnight Express — 24-hr in-house processing — $22 surcharge **per title**
First Class Mail — 24-hr in-house processing — $12 surcharge **per title**

■ ■ Weather Tapes ■ ■

To order TMY or TRY tapes:
National Climatic Data Center
Federal Building
Asheville, North Carolina 28801
Phone: (704) 259-0682

To order CTZ tapes:
California Energy Commission
Attn: Bruce Maeda, MS-25
1516-9th Street
Sacramento, CA 95814-5512
Phone: (404) 636-8400

To order WYEC tapes:
ASHRAE
1791 Tullie Circle N.E.
Atlanta, GA 30329
Phone: (404) 636-8400

■ ■ User News ■ ■

To be put on the newsletter distribution list, to submit articles, corrections or updates to documentation, or for DOE-2 program questions, please call or write:

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Simulation Research Group
Bldg. 90, Room 3147
Lawrence Berkeley Laboratory
Berkeley, CA 94720
Phone: (415) 486-5711
FAX: (415) 486-5172
electronic mail: kathy%gundog@lbl.gov

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c/o National Energy Software Center
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439 U.S.A.

TEXAS A&M UNIVERSITY
ATTN: JEFF HABER
ENERGY SYSTEMS GROUP
MECHANICAL ENGINEERING
COLLEGE STATION, TX 77843-3123

300/10-89 This work was supported by the Assistant Secretary, Conservation and Renewable Energy, Office of Building and Community Systems, Building Systems Division, US Dept of Energy, Contract DE-AC03-76SF00098; Lawrence Berkeley Laboratory is an equal opportunity employer.