THE DOE–2 USER NEWS

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DOE-2: THE COMPUTER PROGRAM FOR BUILDING ENERGY SIMULATION

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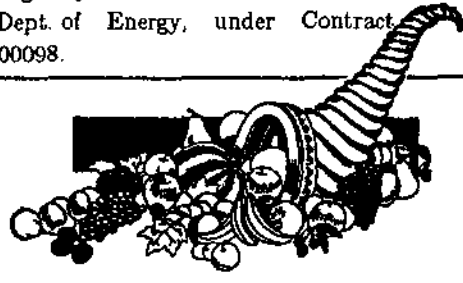

☞ ☞ Hands On ☜ ☜

☞ DOE-2 Workshop Coming Up!

A three-day hands-on workshop, aimed at beginning/intermediate program users, will be held February 7-9 at Pacific Gas & Electric's Energy Center in San Francisco. The workshop, jointly sponsored by PG&E and CABEC, is the first of an ongoing series of educational classes that will feature DOE-2 and other energy software. There will be a modest charge for lab materials and computer rental; enrollment is limited to 40 people. To enroll or get further information, contact Charles Ehrlich at the PG&E Energy Center via fax: (415) 896-1290.

☞ Need DOE-2 Help?? Call Bruce!!

Don't forget that Bruce Birdsall is available to answer user questions. You may call him Monday through Friday, from 10:00 a.m. to 3:00 p.m. (PST), at 510-829-8459. This is a free service, supported by the Simulation Research Group.

☞ You Never Call, You Never Write

PLEASE!!! Phone, FAX or drop us a note when you change your address. Because we use a special low postage rate, the post office doesn't forward the newsletter to your new address; instead, they photocopy the back page and send it to us so we can correct our records. The newsletter itself, addressed to you, is thrown away.

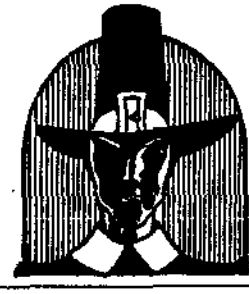

Table of Contents

The User News is produced by Lawrence Berkeley Laboratory's Simulation Research Group. Comments and submittals should be directed to Kathy Ellington.
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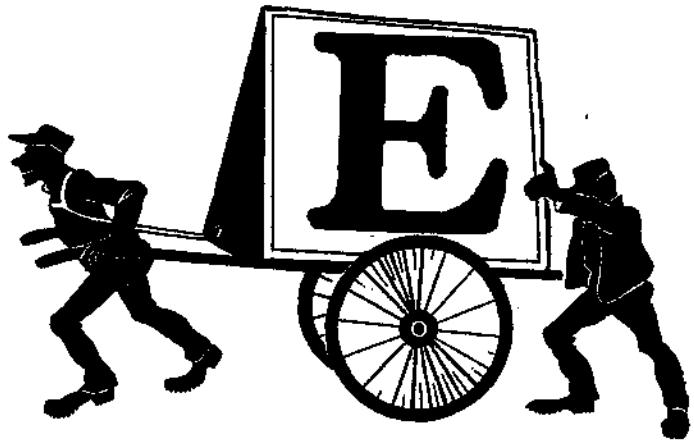
DOE-2 User News, Vol.14, No.3, 1993

Release Of DOE-2.1E



The 2.1E version of DOE-2 has been completed and will soon be available. It replaces DOE-2.1D, which was released in 1989. The new version was developed by the LBL Simulation Research Group with the assistance of Hirsch & Associates. Support was provided by the Department of Energy, Southern California Edison Co., Pacific Gas & Electric Co., the Electric Power Research Institute, the Gas Research Institute (via ElectroCom GARD Ltd.), Pacific Northwest Laboratory, and the International Energy Agency Solar Heating and Cooling Programme.

Here are the major new features in DOE-2.1E, listed by program section. This is followed by a list of other significant enhancements, information on obtaining DOE-2.1E, and a description of future upgrades to DOE-2 that are in the works.

Major New Features

LOADS

- Window Library with solar-optical and thermal properties of 200 currently-available glazings (including low-E, gas fill, heat mirror, and superwindows) and 14 electrochromic glazings. See Fig. 1.

- Option for users to add custom glazings to the Window Library by running the WINDOW-4 program with layer-by-layer input.

- Improved window U-value calculation: the very accurate WINDOW-4 calculation of window conduction and solar gain has been integrated into DOE-2.1E.

- Window frames.

- Switchable glazing. This is glazing whose transmittance can change according to environmental conditions. An example is electrochromic glass that can be switched from a clear to a colored state by changing the applied voltage in response to a control variable such as outside temperature or incident solar radiation. Switchable glazing has the potential for a higher level of solar gain control than is possible with conventional glazing having fixed transmittance.

- Improved outside air film conductance calculation: an improved correlation has been introduced for outside air film conductance that gives a more accurate calculation of conduction through walls, roofs, windows, and doors. In the new correlation, which is based on measurements in the LBL MoWiTT calorimeter, the air film conductance depends on wind speed, wind direction, surface-to-ambient temperature difference, surface temperature, and surface IR emissivity. The old correlation, which overestimated the air film conductance, neglected the effects of wind direction and surface temperature.

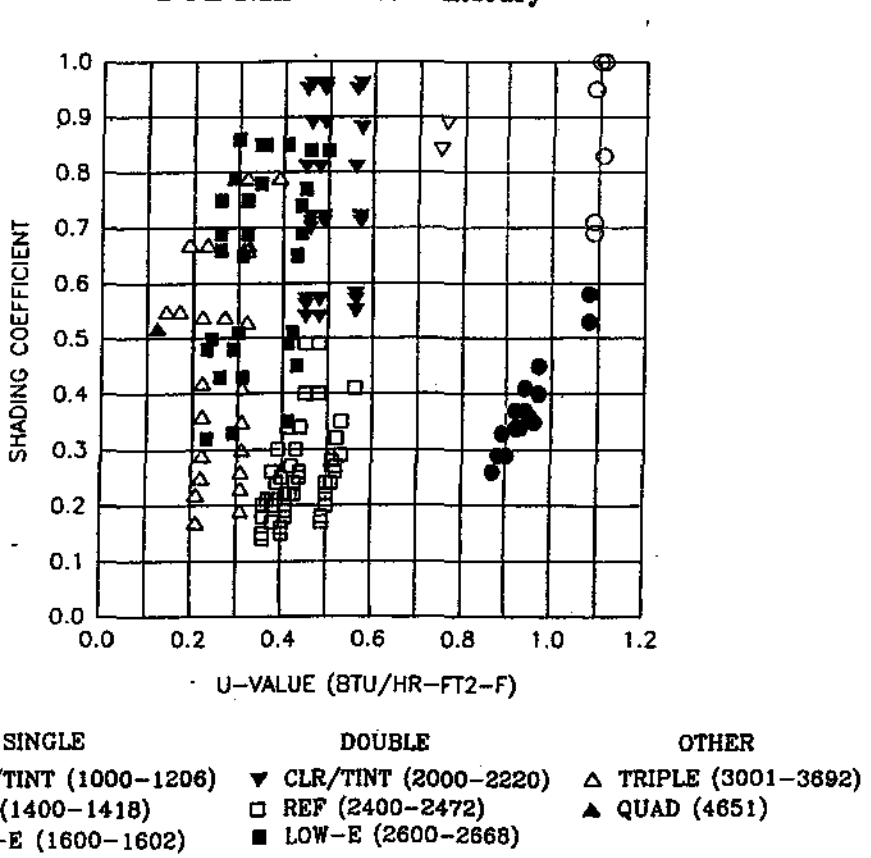


Figure 1: Center-of-glass shading coefficient (ASHRAE summer conditions) vs. center-of-glass U-value (ASHRAE winter conditions) for all glazings in the DOE-2.1E Window Library, except the electrochromic glazings. CLR/TINT is clear or tinted glass; REF is glass with a reflective coating; LOW-E is glass with a low-emissivity coating; SINGLE, DOUBLE, TRIPLE and QUAD refer to the number of panes. Numbers in parentheses give the GLASS-TYPE-CODE range.

SYSTEMS

- Evaporative cooling:
  - stand-alone indirect or indirect/direct evaporative cooling system (see Fig. 2);
  - add-on evaporative pre-cooler for conventional systems;
  - residential direct evaporative cooler.
- Add-on desiccant cooling units:
  - solid desiccant dehumidifier;
  - liquid desiccant dehumidifier;
  - liquid desiccant dehumidifier combined with gas-fired absorption chiller.
- Enhanced water-loop heat pump (HP) model with: variable-speed and scheduled pumping; boiler, and cooling tower in SYSTEMS; units with different performance characteristics on same loop; air-side (and future water-side) economizer. See Fig. 3.

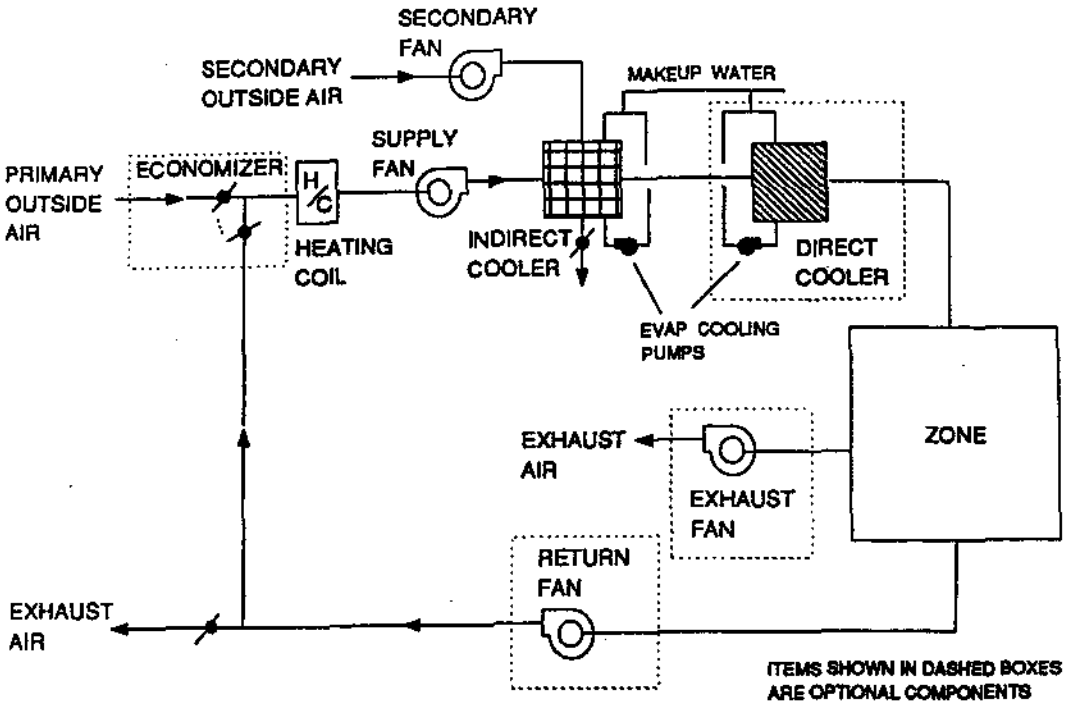


Figure 2: Stand-alone evaporative cooler system (SYSTEM-TYPE=EVAP-COOL)

- Variable-speed electric heat pump with optional waste heat recovery.
- Packaged variable-volume variable-temperature system (PVVT).
- Service hot water heat pump.
- Variable-speed gas heat pump with optional waste heat recovery. See Fig. 4.
- Residential variable-volume variable-temperature system (RESVVT) system with variable-speed electric heat pump, individual zone control, and optional waste heat recovery to domestic hot water.
- Additional air-side economizer options; combined enthalpy/drybulb controller; economizer lockout controls.
- Additional heat pump defrost options: resistive or reverse-cycle defrost with on-demand or timed control.
- Improved coiling coil model: keywords have been added to allow better modeling of moisture removal performance for various configurations of chilled water and DX cooling coils and their controls. The new keywords allow different coil part load control such as "wild coils" with face-and-bypass dampers, different types of chilled water valves and their controls, and multiple series or parallel coil circuits to be modeled. The effect of chilled water reset on coil latent performance (in SYSTEMS only) can also be simulated.
- Sizing enhancements: independent SIZING-RATIOs for heating and cooling; option of design-day vs. weather tape PLANT sizing; summary of design-day SYSTEMS sizing (SS-J design-day report); loads-not-met flags added to SS-J as indicator of undersizing.
- A water-cooled condenser option including a water-side economizer capability for single-duct central packaged systems.
- Evaporatively-cooled condenser for packaged systems.
- Disaggregation and hourly/monthly reporting of electrical and fuel energy consumption by 20 different end uses (area lighting electric, task lighting electric, cooling electric, heating fuel, cooling fuel, etc.). Up to five different electric meters and five different fuel meters and corresponding utility rates can be assigned to the different end uses for energy cost calculations.

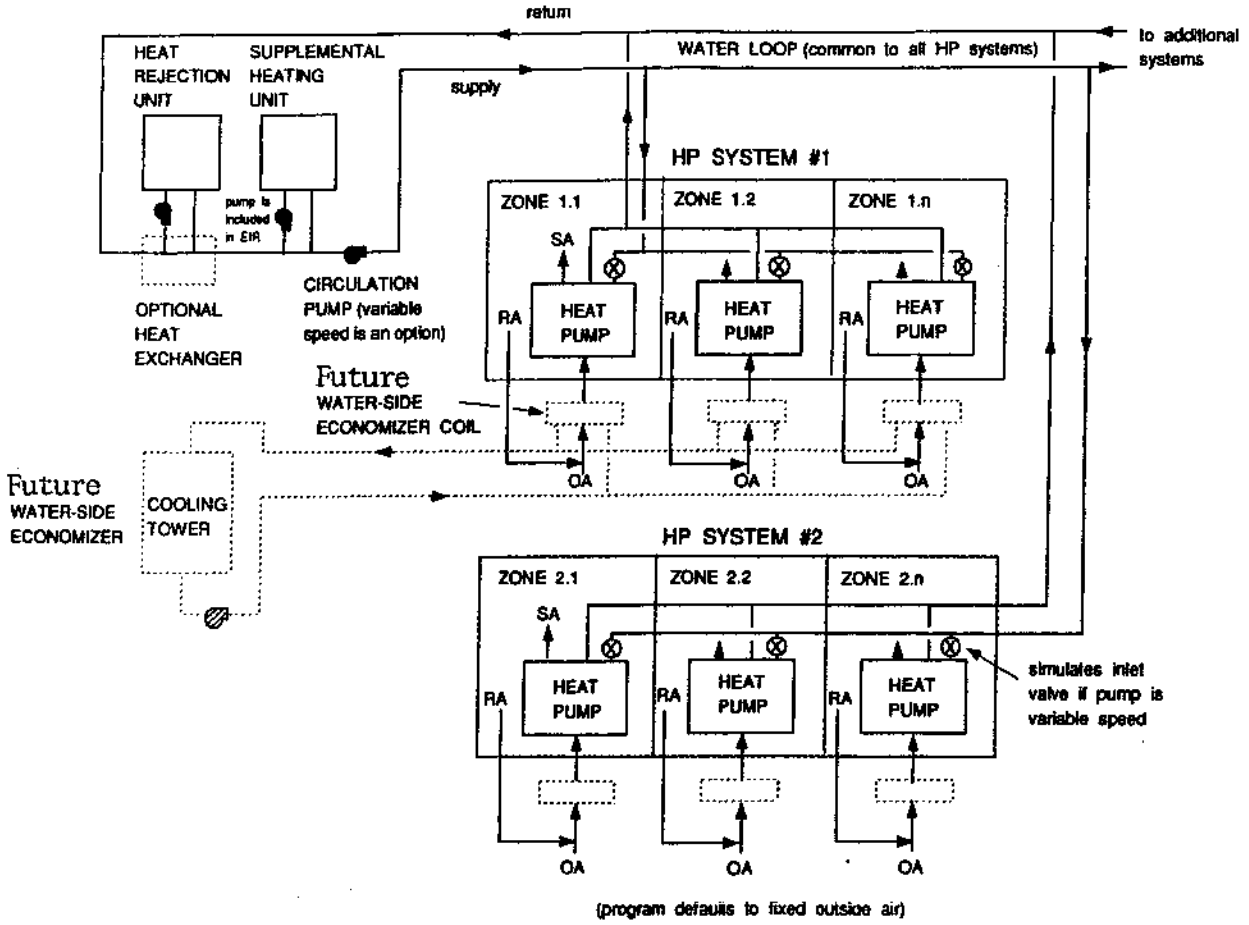


Figure 3: Water Loop Heat Pump System

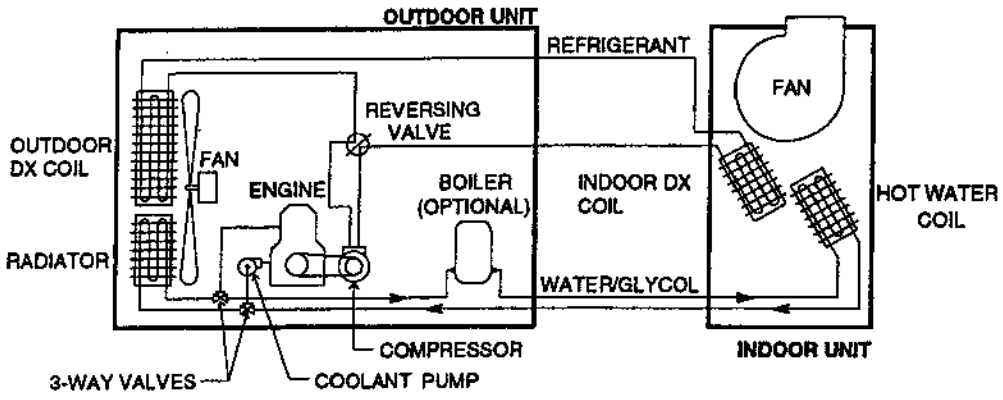


Figure 4: System configuration for a typical packaged system with a gas engine driven heat pump (GHP). The arrangement of blower and coils for the indoor unit depends upon the particular air handling system type. Four-pipe GHP systems have a water/glycol loop with a hot water coil; two-pipe systems do not.

PLANT

- Ice thermal energy storage. System types that can be modeled are ice-on-coil, ice harvester, ice slurry, brine, and eutectic salt. Options include full vs. partial storage, chiller priority vs. storage priority, and demand limiting.
- Improved cooling tower model with variable-speed fan option, more accurate calculation at low wet bulb temperatures, and optional direct-cooling mode (thermo-cycle and strainer cycle).
- Revised circulation pump simulation including variable-speed pumps.

ECONOMICS

- Revised energy cost calculation to handle utility rate structures that are more complex than could be specified in previous versions of DOE-2. New features include multiple energy meters with separate utility rates; improved scheduling for time of use and real time rates; any number of seasons for energy charges, demand charges, and ratchets; a RATCHET command that allows multiple demand ratchets to be defined for any rate; rate qualifiers that allow the program to select different rates depending on monthly energy and demand thresholds; broader specification of minimum monthly charges; taxes and surcharges; reactive demand calculations; and kWh/kW limits and sum limits in the blocks.

Other Enhancements

BDL

- DOE-2 now accepts "tabs" input using your editor. Previously, the program would give an error message whenever it encountered a tab.
- Both lower and upper case letters are now accepted in all commands, keywords, values, and symbols. Previously, only upper case letters were permitted. However, as before, code-words must still be only upper case.

LOADS

- The number of LOADS commands allowed has been increased to allow inputting more constructions, walls, windows, spaces, schedules, etc. in a single run. It is now possible to have up to 64 constructions, 300 exterior walls, 200 windows, 512 interior walls, and 128 spaces.
- A new command, ALT-HOLIDAY, allows you to change the holidays to correspond to those in other countries. Previously, only U.S. holidays (or no holidays) were allowed.
- The warm-up period has been increased from 3 to 7 days to give better starting values for high-mass buildings.
- A new keyword, OUTSIDE-EMISS, allows you to change the outside surface IR emissivity of walls and roofs.
- A correction to the weather-file wind speed to account for the effects of terrain and space height now gives a more accurate calculation of wind-speed-dependent infiltration and outside air film conductance. Previously, this correction was only applied to the Sherman-Grimsrud infiltration method.

SYSTEMS

The number of SYSTEMS commands allowed has been increased to allow inputting more zones, systems, schedules, etc. in a single run. It is now possible to have up to 128 zones and 100 systems.

Summary Reports

SS-J now summarizes the results of design-day sizing; in addition, it now reports numerous check figures useful in system design, such as sf/ton of peak cooling, peak cooling/sf, peak heating/sf, peak cfm/sf, minimum outside air cfm per person, and outside air fraction at heating and cooling peak.

SS-D now reports the peak integrated daily cooling load.

PS-B now reports energy use by up to five different electric meters and five different fuel meters.

PS-C now reports the energy use of the cooling tower fan and condenser water pump.

There are several new reports, including:

SS-P "Load, Energy, and Part-Load Heating and Cooling In [u-name of system or plant assignment]"

SS-Q "Heat Pump Cooling and Heating Summary In [u-name of system or plant assignment]"

SUPL "System Supplemental Evaporative or Desiccant Cooling"

PS-E "Monthly Energy End Use Summary"

PS-F "Energy Resource Peak Breakdown by End Use"

BEPU "Building Energy Performance Summary (in Resource Units)"; like the BEPS report, but gives energy use in kWh, therms, etc. rather than MBtu.

ES-D "Energy Cost Summary"; summarizes the yearly energy consumption and cost for each utility rate.

ES-E "Summary of Utility Rate"; summarizes the key costs by month for each utility rate.

ES-F "Block Charges and Ratchet Summary"; for each utility rate, summarizes the monthly costs associated with each block charge, and the monthly ratchet values.

Hourly Reports

- The OPTION keyword now allows individual hourly reports to be output to either a binary or formatted file for exporting to post-processor programs for plotting.
- LOADS hourly variables can now be printed in SYSTEMS and PLANT hourly reports. Similarly, SYSTEMS hourly variables can now be printed in PLANT hourly reports.

Sample Runs

The sample run inputs in the *Sample Run Book (2.1E)* and on the release tape have been updated to make them more consistent with current practice. Changes include decreasing the lighting watts/sf, increasing the equipment watts/sf, replacing single with double glazing, and increasing the outside air ventilation rate. In addition, some mispositioned surfaces have been corrected.

Documentation

The DOE-2.1E documentation consists of an updated *Supplement* (designed to be used with the *Reference Manual (2.1A)*), *BDL Summary*, *Sample Run Book*, and *Basics Manual*. The *Reference Manual (2.1A)* and *Engineers Manual (2.1A)* remain unchanged. The *Reference Manual* and *Supplement* will be combined into a single document when the next major version of DOE-2 is released toward the end of 1994.

Availability of DOE-2.1E

DOE-2.1E executables, source code, and documentation for Sun-UNIX and DEC-VAX VMS computers will be available from the Energy Science and Technology Software Center (ESTSC). Contact ESTSC at P.O. Box 1020, Oak Ridge, TN 37831, tel. 615-576-2606, for prices and ordering information. As usual, documentation will also be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, tel. 703-487-4650. However, users should contact Kathy Ellington at LBL for information on how to obtain the new documentation immediately.

IBM-compatible-PC versions of DOE-2.1E are expected to be available from private vendors that currently sell PC versions of DOE-2.1D. A list of these vendors is given under "Microcomputer Versions of DOE-2" in the DOE-2 Directory in this issue. Contact these vendors directly for their prices and ordering information.

Private vendors are also expected to produce versions of DOE-2.1E for other computer platforms. Check the *User News* for announcements of these versions.

What's Next?

Updated Version of DOE-2.1E

Early in 1994, an update to 2.1E will be released that will contain a number of enhancements developed for the California Conservation Inventory Group by Hirsch & Associates. Included will be:

- Improved calculation of duct and piping losses, including (1) the effect of these losses on the heating and cooling loads of the zone(s) into which the loss occurs, and (2) hot and chilled water temperature reset and its effect on piping losses, fluid flows, and chiller efficiency.
- Moving the main hot and chilled water pump simulation from PLANT to SYSTEMS to allow better modeling of variable-speed pumping, with choice of constant or variable head pressure control, as well as two- or three-way coil valves.
- Ability to control exhaust fans separately from supply and return fans.
- The improved energy recovery from relief air allows cool as well as heat recovery, scheduled controls on the recovery system, and electrical consumption by the recovery equipment.
- Residential heating system in which the hot water for the heating coil is supplied by the domestic hot water heater.

WinDOE

DOE-2.1E will be the basis of the next major upgrade of DOE-2, tentatively called WinDOE, which is expected to be available towards the end of 1994. WinDOE is currently under development by the Simulation Research Group, Hirsch & Associates, Regional Economic Research and The Southern Company, with support from the Department of Energy and the Electric Power Research Institute and its member utilities. The first version of WinDOE will feature a graphical user interface running under Microsoft Windows that will make DOE-2 easier to use. Later versions will feature CAD input, integrated LOADS-SYSTEMS-PLANT calculation, link to the SPARK program for modeling new HVAC technologies, and link to the Energy Design Advisor (an expert system that will provide architectural and engineering design guidance). Reports on the progress of WinDOE development will appear in future issues of the *User News*.

SPARK

Under development is the Simulation Problem Analysis and Research Kernel (SPARK), an object-oriented program that allows users to quickly build models of complex building systems by connecting calculation modules from a library. SPARK will allow users to simulate advanced building envelope, lighting, HVAC and control technologies without having to write computer code. The main elements of SPARK are an interactive graphical editor, an object library containing calculation modules for physical components (such as wall, windows, lamps, fans, coils, chillers, and controllers), and a solver for solving the set of simultaneous algebraic and differential equations that correspond to the system being simulated. A graphical editor will enable users to add their own objects to the library, modify existing objects, combine objects into large objects, and link the objects into networks that represent a building energy system. In 1994 a beta-test version of SPARK will be made available as a stand-alone program. Later, SPARK will be integrated into WinDOE and allow users to analyze the whole-building performance of innovative technologies. SPARK is being developed by the LBL Simulation Research Group with the assistance of Ayres-Sowell Associates and Groupe Informatique et Systemes Energetiques (Ecole Nationale des Ponts et Chaussees, France).

*This section on the gas heat pump calculations in DOE-2.1E should be put in the Systems section of the DOE-2 Engineers Manual (2.1A).**

CALCULATIONS FOR GAS HEAT PUMP

by

J. J. Hirsch
Hirsch & Associates
Camarillo, CA

OPERATING CAPACITIES IN THE HEATING MODE

Total Capacity:

QHT = HEATING-CAPACITY * (HEAT-CAP-FT@DBT,MAT)
* (HEAT-CAP-FRPM@maxRPM,DBT) * (1.0-DFM1)

where

DFM1 = DEFROST-FRAC-FT@outside WBT, outside DBT
DBT = outdoor dry bulb temperature
MAT = dry bulb temperature of the mixed air entering the unit coils
maxRPM = first value of HEAT-RPM-LIMITS

Defrost Load (extra heating load):

QHGDFR = DCAP * DFM2 * DFM1

where

DFM2 = LOAD/QHT
DCAP = QHM1 * (HEAT-CAP-FRPM@maxRPM,DBT) * COOL-SH-CAP

and then

HLOAD = LOAD + QHGDFR (new load on unit in defrost mode)
PLRH = HLOAD/QHT (new unit PLRH in defrost mode)

Total capacity at part load:

QHT * (HEAT-CAP-FRPM@,RPM,DBT)
GRPM = RPM operating/maxRPM

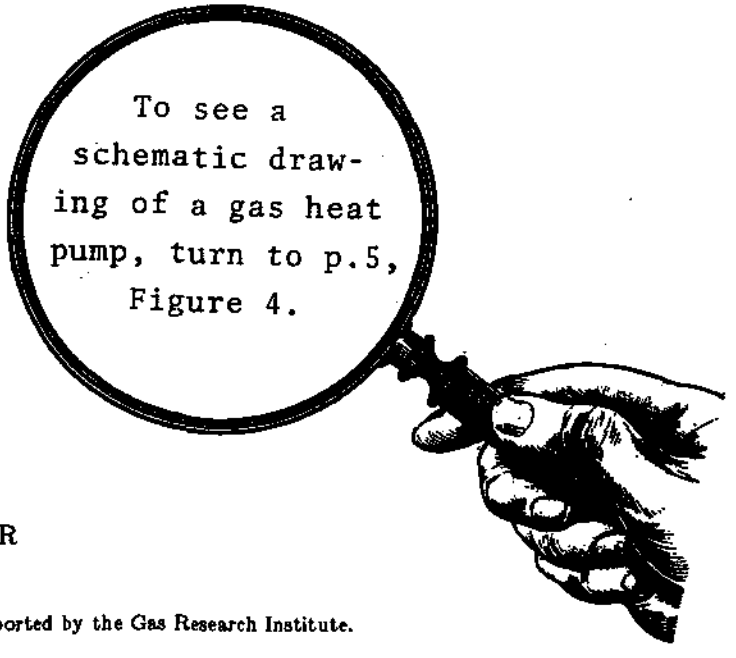
Gas and Power Consumption:

Gas Input

QHGAS = (-QHT) * EIR + QHDFRG
EIR = HEATING-EIR * EIRM1 * EIRM2
EIRM1 = HEAT-EIR-FT@DBT,MAT
EIRM2 = HEAT-EIR-FRPM@GRPM,DBT

Defrost Mode Gas Consumption:

QHDFRG = DFM3 * DCAP * DFM2 * DFM1
DFM3 = EIRM1 * EIRM2 * COOLING-EIR



Development of the DOE-2.1E gas heat pump model was supported by the Gas Research Institute.

Electric Auxilliaries:

QHAUX = Outside fan + pump + aux (all converted to Btu's)
Outside fan = <OUTSIDE-FAN-ELEC> * <COOLING-CAPACITY>
* 0.001 * (OUTSIDE-FAN-HFLT@PLRH,DBT) * PCTON
Pump = <UNIT-PUMP-ELEC> * <COOLING-CAPACITY> * 0.001 * PCTON
Aux = <UNIT-AUX-KW> all hours

Waste Heat Generated:

QHWAS = QHGAS * HEAT-WASTE-HEAT
* (HEAT-WH-FT@DBT,MAT) * (HEAT-WH-FRPM@GRPM,DBT)

If the unit is cycling, meaning HLOAD < QHT * (HEAT-CAP-FRPM@minRPM,DBT) where minRPM = HEAT-RPM-LIMITS second value, then modify the above values for cycling operation as follows:

CLPLR = HLOAD, max of HLOAD/(QHT recalculated with HEAT-CAP-FRPM@minRPM,DBT)

CLOSS = HEAT-CLOSS-FPLR@CLPLR

PCTON = minimum of 1.0 and CLPLR/CLOSS
QHGAS = QHGAS *PCTON
QHWAS= QHWAS *PCTON

Supplemental Heating:

If outside DBT is less than MAX-HSUPP-T, then supplemental part load is

PLRSUP = QHGSLD/SUPP-HEAT-CAP

where QHGSLD is the amount the heating load plus the defrost load that exceeds the capacity.

Supplemental Gas:

QHGSUP = -SUPP-HEAT-CAP * FURNACE-HIR * (FURNACE-HIR-FPLR@PLRSUP)

Supplemental Auxilliary Electrical:

PLRSUP*(FURNACE-AUX-KW + pump power)

where

pump power = UNIT-PUMP-ELEC * COOLING-CAPACITY * 0.001 (if GHP is not operating and the supplemental source is GAS-HYDRONIC boiler)

Supplemental Auxilliary Gas:

(1.-PLRSUP) * FURNACE-AUX

OPERATING CAPACITIES IN THE COOLING MODE

Total Capacity:
QCT = COOLING-CAPACITY*(QCM1) * (COOL-CAP-FRPM@maxRPM,EDB)
where

QCM1 = COOL-CAP-FT@MATW,EDB
MATW = mixed air wet bulb temperature entering the unit coils
maxRPM = COOL-RPM-LIMIT first value

EDB (Entering Cond T) = outside DBT or PCCEDT if
CONDENSER-TYPE = EVAP-PRECOOLED

Sensible Capacity:
QCS = COOL-SH-CAP * (COOL-SH-FT@MATW,EDB)

Total Capacity at Part Load:
QCT * (COOL-CAP-FRPM@RPM,EDB)
GRPM = RPM operating/maxRPM

Gas and Power Consumption:
Gas Input

QCGAS = QCT * EIR

where

EIR = ECRM1 * COOLING-EIR * (COOL-EIR-FRPM@GRPM,EDB)
EIRM1 = (COOL-EIR-FT@MATW,EDB)

Electric Auxilliaries:

QHAUX = Outside fan + pump + aux (all converted to BTU's)
Outside fan = <OUTSIDE-FAN-ELEC> * <COOLING-CAPACITY> * 0.001
* (OUTSIDE-FAN-CFLT@PLRC,EDB) + <EVAP-PCC-ELEC>
* <COOLING-CAPACITY> * 0.001 (if evap is on) * PCTON
Pump = <UNIT-PUMP-ELEC> * <COOLING-CAPACITY> * 0.001 * PCTON
Aux = <UNIT-AUX-KW> all hours

Waste Heat Generated:

QCWAS = QCGAS * COOL-WASTE-HEAT * (COOL-WH-FT@MATW,EDB)
* (COOL-WH-FRPMT@GRPM,EDB)
If unit is cycling, meaning LOAD < QCT * (COOL-CAP-FRPMT@minRPM,EDB),
where minRPM = COOL-RPM-LIMIT second value,
then modify the above values for cycling operation as follows:
CLPLR = max of LOAD/(QCT recalculated with COOL-CAP-FRPM@minRPM,EDB)
and COOL-CLOSS-MIN
CLOSS = COOL-CLOSS-FPLR@CLPLR
PCTON = minimum of 1.0 and CLPLR/CLOSS
QCGAS = QCGAS * PCTON
QCWAS = QCWAS *PCTON

A new LBL report (LBL-32617) discusses improvements to existing algorithms for modeling switchable glazings. Copies are available from the Building Technologies Program at LBL; please fax your request to Pat Ross at (510) 486-4089, and be sure to give the report number.

Switchable Window Modeling

by
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Berkeley, CA 94720

Background

Switchable glazing, or smart glazing, have variable optical properties. The lenses in sunglasses that become darker as the surroundings become lighter are one common example of switchable glazing. The switching material incorporated into the glazing is known as a chromogenic device. There are electrochromic, thermochromic, and photochromic devices whose properties vary from a high transmittance "bleached" state to a low transmittance "colored" state. The optical properties of electrochromic devices change with applied current, those of thermochromic devices change with temperature, and those of photochromic devices change with the amount of incident radiation. Ineffective control of the amount of incoming solar radiation and visible light can render a space practically uninhabitable. Shading systems and sun control glazing have been developed to avoid excessive solar gains without excluding the daylight completely. These systems have led to a strong interest in the development of switchable glazing which combine the attributes of shading systems and sun control glazing into a single glazing element. Some switchable glazing have the additional advantage of preserving the view through the window while responding to the varying environmental conditions.

Abstract

The purpose of this report is to review and improve upon existing algorithms for modeling switchable glazings. In evaluating the performance of switchable windows in buildings, the thermal and optical properties of the window itself must be known. The switchable windows may be single-pane or multi-pane. Multi-pane windows may be necessary with some of the switchable glazing technologies to protect them from the surroundings or to provide adequate control over their response to environmental conditions. The importance of modeling switchable glazing in building energy simulation programs lies in the need to predict the energy savings potential of this technology in buildings, and to formulate performance guidelines to aid researchers in their development efforts. This requires an hourly simulation model that accurately accounts for thermal, solar optical and daylighting impacts of the switchable glazings. The guidelines need to address questions concerning the switching range and behavior of the switching material, the angular dependence of the optical properties, and how each of these relate to building design issues such as window size and orientation and lighting requirements.

Section II reviews current approaches for modeling switchable window glazings in terms of window performance and building energy performance.

Section III looks at proposed algorithms for modeling switchable window glazings in terms of window performance and building energy performance.

Appendix A specifies models for electrochromic and thermochromic windows used as functions in the DOE-2 building energy simulation program.

Appendix B describes the switchable window incorporated into DOE-2.1E.

For related information, request LBL-32616 "Optical Properties Database for High Performance Glazings".

IBPSA CONFERENCE 1993

The International Building Performance Simulation Association (IBPSA) held its third international conference in Adelaide, Australia, this past August. Below we present a sampling of some of the papers that featured DOE-2. Write or email (ibpsa@fland.rug.ac.be) Philippe Geril for cost of the proceedings:

Philippe Geril
IBPSA Secretariat
Dept of Math, Biometrics and Process Control
University of Ghent
Coupure Links 653
9000, Ghent BELGIUM

- **Development of a Simple Model to Relate Heating and Cooling Energy to Building Envelope Thermal Characteristics** by Daniel Sander, Steve Cornick, Guy Newsham, and Drury Crawley.
  Abstract: A new energy efficiency code for non-residential buildings is being developed in Canada. This code will have three compliance paths for building envelope requirements: simple prescriptive tables, a tradeoff procedure, and whole-building energy performance modeling. A simple means of estimating the relationship between building envelope characteristics and energy consumption was needed both for economic analysis to select prescriptive envelope values, and as the basic energy model for tradoff compliance software. A simplified energy model has been derived from a database of 5,400 DOE-2 simulations for 25 Canadian locations. Correlations developed from this database allow prediction of annual heating and cooling energy loads based on location, building envelope characteristics (area, wall and fenestration U-values, and shading coefficients), and internal gains (people, light, and equipment). This paper describes the development of the energy database and the correlation equations, and compares the correlations' predictions of heating and cooling energy with those of the original DOE-2 simulations.

- **Development of a Commercial Sector Load Aggregation and DSM Impact Assessment Methodology** by Curt Hepting, Norm Weaver, and Gifford Jung.
  Abstract: BC Hydro and their consultant have devised a method for aggregating hourly results from DOE-2 energy models to simulate sector-wide impacts of commercial demand-side mangement (DSM) programs. This process assists in the analysis of DSM program impacts on projected utility system load profiles. With this process, BC Hydro can estimate how DSM programs may influence load shape changes and specify programs which best benefit British Columbia. By having a complete energy model of their commercial sector, BC Hydro can simulate the introduction of various DSM programs to study their influence on electricity requirements. The significance of this process is that it provides hourly end-use data which is accessed quickly to show how certain programs influence coincident demand and energy use. Additionally, it provides a model for commercial end-use load projections. Since this aggregation model is calibrated to existing commercial electricity requirements, the utility can see how new construction and demolition rates will impact future commercial electricity requirements. This provides a valuable basis for making program design decisions, refining the evaluation process, and performing integrated resource planning. Moreover, it establishes a demand-side resource planning tool which may be refined through further load monitoring and research efforts.

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 DEC-VAX, Order #159-D6220-00 **DOE-2.1C** (Source Code) For IBM-3083, Order #158-I3083-00 For DEC-VAX11, 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 Versions of DOE-2

* **ADM-DOE2** 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 greater accuracy and detail than is possible with handbook methods or simplified analysis. [See *User News* Vol.7, No.2, p.6 for more information]	ADM Associates, Inc. 3239 Ramos Circle Sacramento, CA 95827 Contact: Marla Sullivan, Sales Kris Krishnamurti, Support Phone: (916) 363-8383 FAX: (916) 363-1788
* **CECDOEDC (Version 1.0A)** A microcomputer version of DOE-2.1D integrated with a pre- and post-processing system designed strictly for compliance use within the State of California. It generates some of the standard compliance forms as output. Order P40091009 for the CECDOEDC Program with Manuals. Order 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

* *Caveat*: We list third-party DOE-2-related products and services for the convenience of DOE-2 users, with the understanding that the Simulation Research Group does not have the resources to check the DOE-2 program adaptations and utilities for accuracy or reliability.

Microcomputer Versions of DOE-2 (continued)

* "DOE-24/Comply-24" 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 Hawley Phone: (510) 428-0803 FAX: (510) 428-0324
* DOE-Plus™ 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]	ITEM Systems P.O. Box 5218 Berkeley, CA 94705-0218 Contact: Steve Byrne Phone: (510) 549-1444 FAX: (510) 549-1778
* FTI-DOEv2.1D 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
* MICRO-DOE2 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]	ERG International, Inc. 1626 Cole Boulevard #250 Golden, CO 80401-3306 Contact: Gene Tsai, P.E. Phone: (303) 233-4453 FAX: (303) 233-4234
* PRC-DOE2 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 [See *User News* Vol.13, No.4, p.11 for information]	Partnership for Resource Conservation 140 South 34th Street Boulder, CO 80303 Contact: Paul Reeves Phone or FAX: (303) 499-8611

DOE-2 User News, Vol.14, No.2

Pre- and Post-Processors for DOE-2

* **DOE123** Uses Lotus 1-2-3 to graphically display DOE-2 output as barcharts, pie charts, and line graphs. [See *User News* Vol.10, No.3, p.5 for information]	Ernie Jessup 4977 Canoga Avenue Woodland Hills, CA 91364 Phone: (818) 884-3997
* **DrawBDL** Graphic debugging and drawing tool for DOE-2 building geometry. DrawBDL reads your BDL input and makes a rotatable 3-D drawing of your building with walls, windows and building shades shown in different colors for easy identification. Runs on PC's under Microsoft Windows. [See *User News* Vol.14, No.1, p.5 for information]	Joe Huang & Associates 6720 Potrero Avenue El Cerrito CA 94530 Contact: Joe Huang Phone: (510) 559-9067 Fax: (510) 236-9238
* **Graphs for DOE-2** 2-D, 3-D, hourly, daily, and psychrometric plots [See *User News* Vol.13, No.1, p.5 for information]	Energy Systems Laboratory Texas A&M University College Station, TX 77843-3123 Contact: Jeff Haberl Phone : (409) 845-6065 FAX: (409) 862-2762
* **PRC-TOOLS** A set of PC 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 math pre-processor for BDL.	Nick Luick 19030 State Street Corona, CA 91719 Phone: (714) 278-3131
* **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 Systems P.O. Box 5218 Berkeley, CA 94705-0218 Contact: Steve Byrne Phone: (510) 549-1444 FAX: (510) 549-1778

RESOURCES

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
Help Desk – Bruce Birdsall Call our help desk if you have a question about advanced modeling techniques. If you need to fax an example of your problem, please use the Simulation Research Group's fax number (510-486-4089) and it will be forwarded to Bruce. This service is supported by the Simulation Research Group.	Bruce Birdsall Ph: (510) 829-8459. Hours: Monday through Friday 10:00 a.m. to 3:00 p.m. Pacific Time
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 Takes you step-by-step in DOE-2 input preparation and output interpretation.	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

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Enermodal Engineering
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Denver, CO 80218 (303) 861-2070

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EMPA, Section 175
8600 Dubendorf Switzerland

This Space Available

Consultant
Werner Gygli
Informatik Energietechnik
Weiherweg 19
CH-8604 Volketswil Switzerland

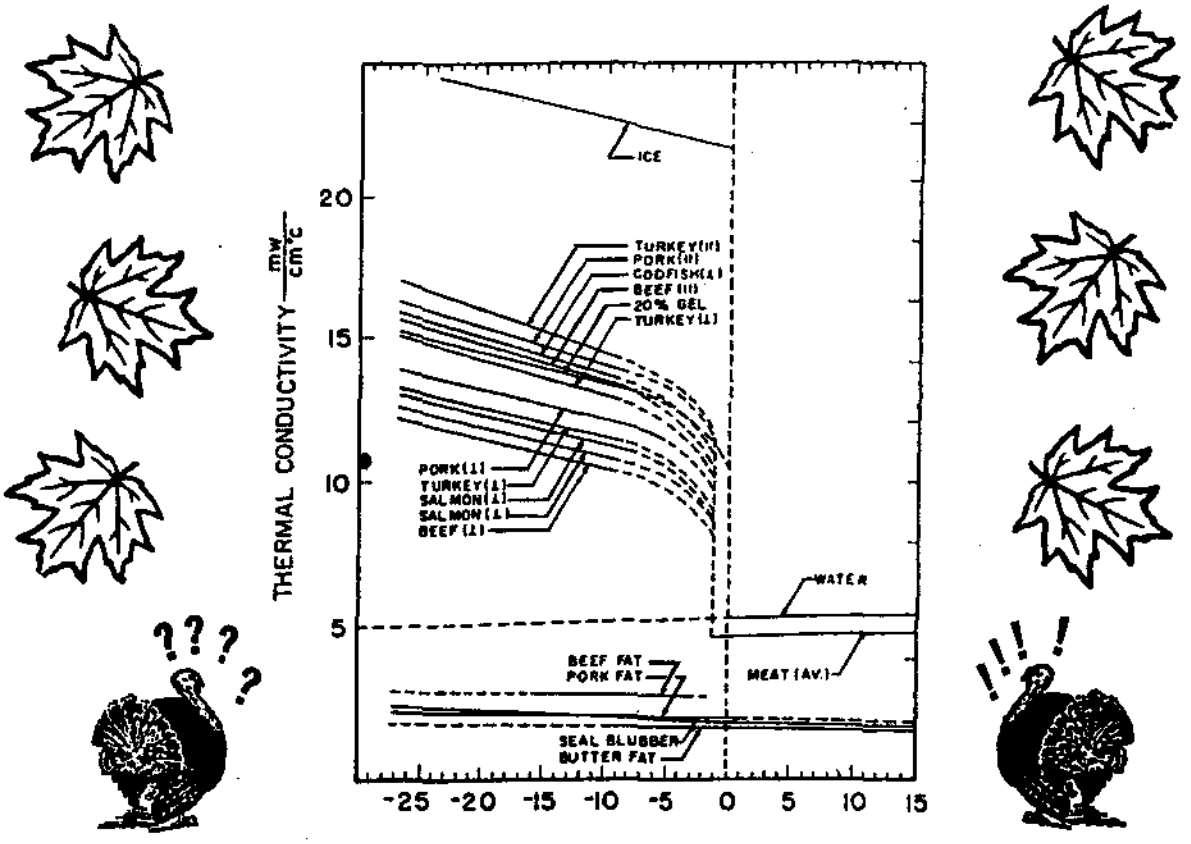
Consultant, Distributor for FTI-DOEv2.1D
Andre Dewint
rue de Livourne 103/12
B-1050 BRUXELLES
BELGIUM

Aunt Kathy's Kitchen Korner

When the frost is on the pumpkin and the autumn leaves start to fall, our thoughts here in the Simulation Research Group naturally turn to Holiday Cookery. However, the holiday table can be fraught with danger from improperly prepared food! So, before you tackle that Thanksgiving Turkey, Christmas Ham, or Norwegian Lutefisk, it is important that you understand the thermal conductivity of the food you're cooking. We think this attractive ASHRAE chart is an invaluable kitchen reference and suggest you paste it to your refrigerator door. Just remember that the simple formula of 1 Btu/hr-ft-°F $\simeq$ 17.3 mw/cm-°C works equally well if the heat flow is parallel *OR* perpendicular to the structure of the fiber!

Happy Holidays from the Simulation Research Group: Fred, Fred, Bruce, Ender and Kathy

Thermal Properties of Food*



Thermal Conductivity of Meats, Fats, Gelatin Gel, and Water

[∥ indicates heat flow *parallel* to fiber structure; ⊥ indicates heat flow *perpendicular* to fiber structure]

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* (c) 1989 ASHRAE, Inc., Atlanta, GA. Used by permission from the ASHRAE 1989 Handbook of Fundamentals.

Special thanks to Jeff Kessel of UCB (the original *"Aunt Fan"*).

DOE-2 Program Documentation

Document	Order Number	Price
DOE-2 Basics Manual (2.1D)	DE-920-07955	46.00*
BDL Summary (2.1D)	DE-890-17726	29.00*
Sample Run Book (2.1D)	DE-890-17727	69.00*
Reference Manual (2.1A)	LBL-8706, Rev.2	119.00*
Supplement (2.1D)	DE-890-17728	65.00*
Engineers Manual (2.1A) [algorithm descriptions]	DE-830-04575	55.00*

* Prices shown are approximate; call NTIS for update. Note that for shipment to foreign countries, double the U.S. prices are doubled.

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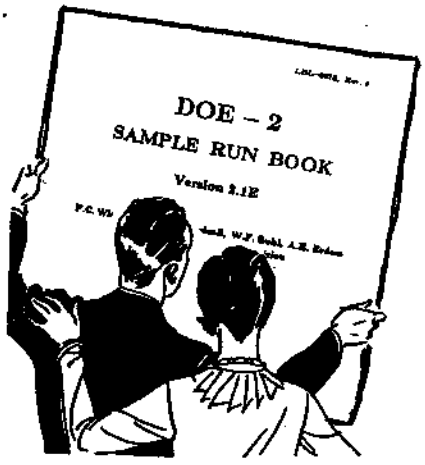

Oh, honey! It's so BEAUTIFUL!! Let's read it together!

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