

DOE-2 USER NEWS PUB-439

DOE-2: A COMPUTER PROGRAM FOR
BUILDING ENERGY SIMULATION

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*** HANDS ON ***

 **Bugged by 2.1C??** To date, over 40 bugs in 2.1C have been fixed. If you would like to "trade-in" your old 2.1C tape for our bug-free version, please call Kathy Ellington at (415) 486-5711 for instructions.

 **PC-DOE Update** — The folks who brought you the PC version of DOE-2.1B have moved! Use their new address and phone number for your PC-DOE inquiries:

Lynda Osborn, P.E.
TRI FUND Research Corporation
Suite 900
1050-17th Street
Denver, CO 80265

Telephone: (303) 595-0610

 **Building Your Energy Reference Library** The American Council for an Energy-Efficient Economy (ACEEE) is a non-profit organization that conducts research and analysis on energy efficiency with the goal of stimulating the adoption of energy conserving technologies and practices. The 11-volume set of proceedings from their 1986 Summer Study Program on Energy Efficiency in Buildings is an impressive compilation of the research papers presented. Some of the topics from the proceedings, which may be of special interest to DOE-2 users, are: Large and Small Building Technologies; Performance Measurement and Analysis; Planning and Forecasting; and Mandatory Conservation/Efficiency Standards.

We feel that ACEEE is an excellent resource for information on energy efficiency in buildings and suggest that you send for its publication list.

Please contact:

The American Council for an
Energy-Efficient Economy
Suite 535
1001 Connecticut Avenue N.W.
Washington, DC 20036

Telephone: (202) 429-8873

 **Let There be Daylight!**

Proceedings are now available from the 1986 International Daylighting Conference held last November in Long Beach, CA. Price of the proceedings is \$36.14 including the cost of postage; it may be ordered from John Cable Associates, Inc., 1508 Emerson Avenue, McLean, VA 22101.

Also available are copies of the Technical Proceedings from the 1983 International Daylighting Conference. Price for the 1983 proceedings is \$10.00 per copy. For more information, contact Marjorie Matthews, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, TN 37831.

[We noted that the January 1987 issue of the **ASHRAE Journal** carried an advertisement for a program called **MICRO-DOE2**, a microcomputer version of **DOE-2.1C**. We contacted Acrosoft International's Gene Tsai, **MICRO-DOE2**'s developer, and requested that he submit a short article on his program. It is printed herewith for your consideration. If you have used the **MICRO-DOE2** program, please let us know your comments or opinions on its capabilities.]

MICRO-DOE2 — DOE-2.1C on a Microcomputer

by

Gene Tsai

Acrosoft International, Inc.

Denver, CO 80227

MICRO-DOE2, version 2.1C, is a microcomputer translation of the mainframe/minicomputer version of the **DOE-2.1C** program. Not a single equation was changed in the process. Therefore, with the exception of floating point round-off due to differences in floating point number representations, the same results will be obtained on a microcomputer when compared to those produced by a mainframe or minicomputer at a fraction of the cost.

Taking advantage of the microcomputer environment, two new features were added to **DOE-2** in order to make **MICRO-DOE2** easier and more pleasant to use.

- **Menu-Driven User Interface** - This interface provides a method of easily controlling **DOE-2**. It provides options to (1) select run-time display headers; (2) specify the **BDL** and weather data file to use for a given simulation; (3) validate the required files for a process; and (4) create "batch" files for automatic executions.
- **Run-Time Status Display** - Since the hour-by-hour simulations take some time to run, progress updates are essential. Information displayed includes the current input line of the **BDL** file, the current day and hour of the simulation, the module that is currently executing, the execution time of each module, and several other useful statistics.

MICRO-DOE2 will do anything from load calculation and equipment sizing to bottom-line economics analysis. It includes all the features necessary to analyze the energy performance of a building, whether it be a single zone residence or a 40-zone high-rise.

Computer System Requirements

Microcomputer	— IBM-PC, -XT, -AT, COMPAQ DESKPRO 386, or true compatibles
Disk Operating System	— PC-DOS or MS-DOS 2.10 or later
Random Access Memory	— 640KB (kilobyte)
Math Co-Processor	— INTEL 8087 or 80287
Hard Disk Drive	— 20MB (megabyte)
Floppy Disk Drive	— 360KB or 1.2MB disk drive (for installation use only)
Monitor	— monochrome (B/W) or color display
Printer	— text printer

Benchmark Execution Times

The execution time of MICRO-DOE2 on a given computer will depend on a number of factors. These include the type of microprocessor, the clock speed and, of course, the size of the BDL input (zones, walls, schedules, etc.).

As a general rule, if you have an IBM-AT (80286) with a clock speed of 8-MHz, you will need to allocate approximately 10-14 minutes per zone for a full year with an hourly simulation that includes a LOADS-SYSTEMS-PLANT-ECONOMICS analysis. If you are using an IBM-XT (8088) with a clock speed of 4.77-MHz, then you will have to allocate approximately 200% to 230% of the -AT time. If using a COMPAQ DESKPRO 386 (80386) with a clock speed of 16-MHz, then allocate approximately 54% to 57% of the -AT time.

Sample Runs					
Description	No. of Zones	LOADS	BDL Module		
			SYSTEMS	PLANT	ECONOMICS
Test 1	6	1	1	1	1
Test 2	11	1	3	3	3
Test 3	11	1	1	1	1

Test 1 is Sample 1 — Run 3A of DOE-2.1C samples.
 Test 2 is Sample 2 — Runs 1, 2, and 3 of DOE-2.1C samples.
 Test 3 is Sample 3 of DOE-2.1C samples.

Timing Results			
(Units are in Hours:Minutes)			
Model	IBM-AT	IBM-AT	COMPAQ
Processor	80286	8088	DESKPRO 386
Clock Speed	8-MHz	4.77-MHz	80386/16-MHz
Test 1	1:04	2:19	0:35
Test 2	2:57	6:35	1:36
Test 3	2:29	5:01	1:22

Literature and ordering information for MICRO-DOE2 can be obtained by contacting
 Gene Tsai, Telephone: (303) 969-0170
 Acrosoft International, Inc.
 3120 South Wadsworth Blvd., Suite 1
 Denver, CO 80227

ADVANCED SIMULATION: A New Direction For The Simulation Research Group

The Simulation Research Group (SRG) at Lawrence Berkeley Laboratory has the long-term objective of providing the architectural, engineering, and research communities with software tools to assist in the design of significantly more energy efficient and cost effective buildings. The ongoing research of the SRG has two main thrusts: (1) the development and maintenance of DOE-2, the current-generation benchmark program; (2) advanced simulation, the development of the next generation of building performance calculation tools (the Energy Kernel System). Because the readers are already so knowledgeable about the DOE-2 program, this article will focus on the Energy Kernel System (EKS).

The main efforts in the advanced simulation area at this time are the creation of the EKS and the organization of the simulation development community to encourage collaboration. The EKS has three main components:

- **software primitives**, including a component model library and simulation tools;
- a **software harness** to facilitate the construction of simulation programs by allowing general linkage of component models and support models; and
- a **knowledge base** which will contain the rules of simulation development and use so as to allow, at a future time, the construction of expert systems for building performance simulation.

These three aspects of the EKS will provide the basic tools and information to allow the SRG and other groups to develop the simulation programs of the future. They will also provide a mechanism to facilitate exchange of research results and technology advances, and provide a basis for integrating performance simulation into CAD and expert system software.

The SRG and collaborating institutions in the United Kingdom and other countries have formulated a proposal for creating the software tools essential for the next generation of building energy simulation models. The intention of this project is not to develop a single new model but, instead, to provide a kernel system of highly-portable software modules and linking protocols which will enable groups in the public and private sectors to construct a variety of customized programs. The work plan has been developed in the context of the following guiding principles:

- (1) Researchers developing building performance simulation techniques can no longer afford to work as independent groups creating non-interchangeable software. Some mechanism must be found to give all developers access to the developments of others while retaining the flexibility to tailor a simulation system to individual needs.
- (2) As many energy sources become more expensive, and as improved efficiency technologies become more complex, designers of the future will be required to focus more critically on the intimate relationship between design and performance. This will require a quantum jump in the capability and accuracy of the energy simulation techniques then available.
- (3) The private sector of architectural and engineering firms, HVAC equipment manufacturers, and CAD (Computer Aided Design) system vendors does not necessarily support the development of large public domain simulation codes. However, they *will* support developments of the kind proposed, which seek to create and order

the building blocks of energy simulation. Private and public sector organizations can then use the resulting kernel system to construct customized simulation systems which embody an appropriate level of detail, offer wide-ranging application potential, and use the most up-to-date techniques.

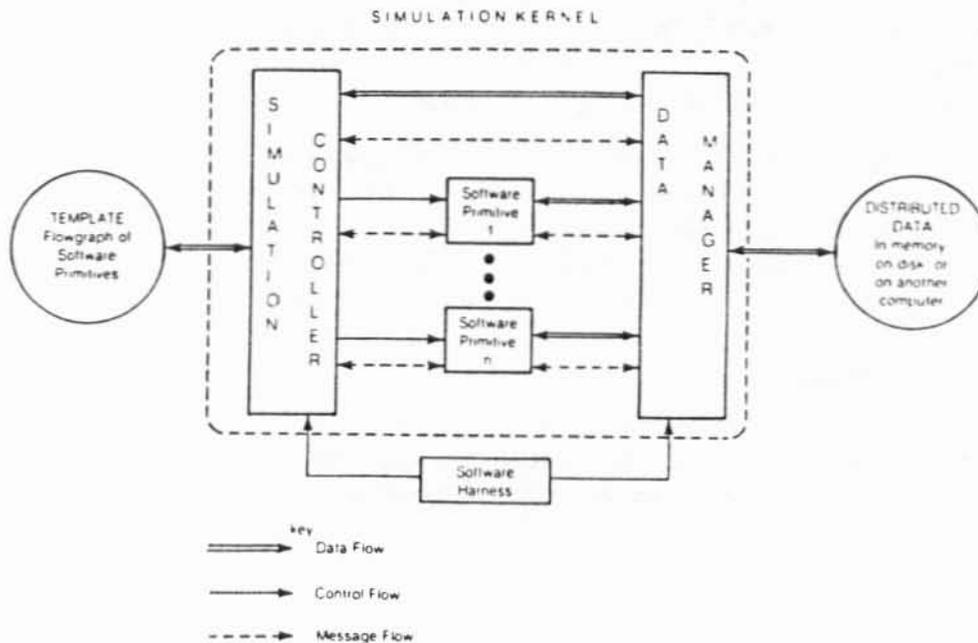
- (4) Increasingly, energy simulation models will form part of a building's operating system, allowing controls to be optimized in real time before being applied to the building.
- (5) The building design profession will increasingly rely on advanced CAD software packages. As systems possessing a drafting function proliferate, a demand will grow for explicit performance appraisal software. Designers will then come to rely on simulation techniques to test alternative hypotheses throughout the design stages and post occupancy. Indeed, CAD system integration is perhaps the most effective mechanism for market penetration of advanced energy analysis systems.
- (6) It is likely that, with the advent of powerful, integrated CAD systems, the design profession will seek to refine the building model and associated performance database beyond the construction phase. One possible scenario is that a client of the future will expect delivery of a computer-based model and performance database, in addition to the building itself. The information regarding building performance is then readily available for inspection. And, of course, the model can be used at any time as the basis for HVAC system maintenance, trouble shooting, and retrofits.

Each of these factors calls for the existence of a modular approach to energy simulation and, it could be argued, would be badly served if only free-standing, monolithic programs continue to be developed.

A model-creation system has been proposed which consists of three main elements:

- a public-domain library of **software primitives**;
- a **software harness**, i.e. executive software for controlling how the primitives are linked into a modeling system, and
- a **knowledge base**, which contains the rules for model construction.

The model-creation system is schematically illustrated below.



The characteristics of these elements and the tasks required to construct them are as follows.

- **Software Primitives**

Many useful models and techniques already exist within contemporary modeling systems. And much additional software continues to emerge as existing codes are extended or new developments pursued. The first task is to divide the useful, existing software into small, logically independent, well-tested units called "software primitives", and place them within a central, public domain library. Each library entry is then a small software module which performs a single task. The library entries will be independent, in the sense that each primitive will have no "knowledge" of any overall data structure. The primitives will obtain data and return results in a standard way, by invoking special primitives which will fetch data from and return data to a central storage area. There will be no attempt to prescribe an overall modeling technology; instead, we hope to allow the free evolution of useful *software tools* for those concerned with developments in building energy simulation. Naturally, portability will be a necessary attribute for all of these tools. The library will have different types of entries: first principle, governing equation generators for building and system components; self-contained algorithmic approaches; data manipulators; software development and management tools; and simulation support modules. By accepting a high level of pluralism it is likely that a rich modeling base can be formed, entirely free of application assumptions.

- **Software Harness**

The second stage addresses the development of harness or executive software which will allow primitives extracted from the library to be combined into an actual modeling system. This software will consist of a *data manager* used to define and control data traffic among the primitives and a *simulation controller* to control the sequence in which the primitives (r groups of primitives) will be executed. Creation of the software harness is analagous to the development of a computer operating system, such as UNIX, where the problems of concurrent processes and communication among processes have already been addressed. Using techniques from this field will facilitate the use of parallel processing at some future point in time. It will also permit the construction of any modeling approach (so long as the necessary software primitives exist), from the establishment and integration of matrix equations representing energy and fluid flow within buildings and their systems, to more pragmatic models which apply simplifications appropriate to the problem in hand.

It is important to note that the harness software is designed for use by model *developers* not by model users. It is an efficient way of building appropriate models which can be easily improved as the underlying techniques are refined. Users would continue to use prescribed programs, the only difference being that their architecture would be highly modular and, thus, easy to change.

- **Knowledge Base**

The third important stage consists of setting down the rules which govern model construction and use in a design, educational, or research context. This is essential if it is desired to move to so-called "expert" systems.

Concerning model construction, the rules employed by some contemporary programs will be set down as a first step template. This would include those rules commonly applied to component models, as well as those applicable to overall solving strategies. Normal academic interchange would then serve to modify these templates or to create alternative approaches. Each participant can have his/her say, allowing the more effective templates to become prominent with time.

Model use is a different problem. The intention here is to explain how existing and planned energy simulation systems work. This knowledge is required by those future developers who will construct expert systems in this application area. It is proposed not to develop decision-making software, but simply to organize a database of information in this one area.

SPANK: A Prototype Kernel System

In 1986 the SRG developed new software called the Simulation Problem ANalysis Kernel (SPANK) as a first prototype of the EKS. SPANK views a simulation problem as a network — the nodes represent nonlinear equations, and the lines linking the nodes (called links or arcs) represent variables in the equations. The network representation of a simulation problem is completely equivalent to describing the problem as a set of simultaneous, nonlinear equations. The network representation has the advantage that it allows graph theory techniques to be used to reduce the size of the problem to be solved. The existing version of SPANK only allows algebraic equations, but the next version will handle first-order differential equations.

A simulation problem in SPANK consists of a set of coupled equations. Each equation or relation among variables is known as a "primitive object". Primitive objects may be combined into "macro objects", and primitive and macro objects can be combined into more complex macro objects. Thus, modules (sets of equations) which represent complicated physical processes or entities can be built up from simple components. Once the necessary objects, either simple or complex, are defined, the problem description is completed by "linking" the objects together; i.e., by specifying which variables are common to which equations.

Once the simulation problem is defined, SPANK does the rest. The user does not have to choose a computation sequence (that is, write a procedural algorithm in FORTRAN or some other language) that solves the set of equations. SPANK creates the solution sequence in two steps. First, a particular relationship (equation) has to be selected for each variable and inverted to give a formula for that variable. Selecting a relationship to be used in solving for a particular variable is a classic matching problem from graph theory, and algorithms for performing this matching are well known.

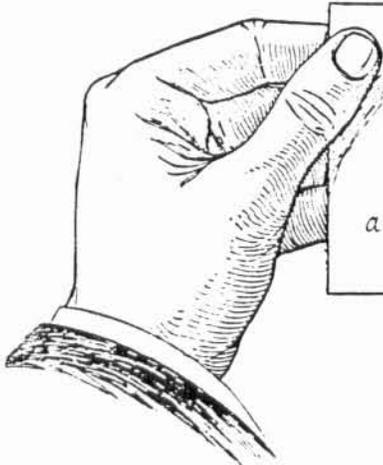
Once the matching has been accomplished, the second step is to find a set of break variables, called a "cut set". These variables become the iteration variables in the solution sequence. That is, initial values are guessed, then used to solve for all the variables using the set of relationships, yielding new values for the cut set variables. Then a scheme such as Newton-Raphson iteration is used for choosing the next guess for the cut set.

Most simulation programs, when faced with solving a system of nonlinear equations, simply iterate on all the variables; i.e., the cut set includes all the variables in the problem. One of SPANK's major contributions is to use graph theory methods to reduce the cut size greatly; thus, the problem size is effectively reduced.

At this time the largest practical problem solved with SPANK is a simulation of a constant volume reheat HVAC system. The model contains 23 equations and 23 variables. The cut set found by SPANK contains 1 variable; a 23 to 1 reduction in problem complexity. The model structure of the SPANK problem description (objects and macro objects) allows a model to be easily comprehended and altered. SPANK inherently allows simultaneity and nonlinearity. Lastly, the use of data flow concepts allow SPANK to take optimal advantage of multiprocessor machines.

International Association

One of the elements of the proposal to develop an Energy Kernel System is the formation of a broadly-based group or association to foster and guide research and development in the building performance simulation field. The first organizational meeting of this group was held January 19, 1986, in San Francisco in conjunction with the 1986 ASHRAE Winter Meeting. At that meeting, an enthusiastic group of supporters selected the name "International Building Performance Simulation Association" (IBPSA), and formally put the organizational process in motion. By the second organizational meeting on June 22, 1986, in Portland, subcommittees had drawn up a draft Mission Statement and initiated the incorporation process. The Mission Statement, which has since been approved by the charter members, defines IBPSA to be an organization "... founded to advance and promote the science of building performance simulation in order to improve the design, construction, operation, and maintenance of new and existing buildings world-wide." Objectives listed include identification of building simulation research and development needs, and the enhancement/transfer of new developments and technology to the user community. IBPSA seeks the participation of building designers, owners, operators, and developers in order to provide a broad base of support and to assure technical input from the entire building community. At a meeting held September 21, 1986, in Washington, these objectives were explained to an international group of attendees of the CIB meeting. The most recent IBPSA meeting was held January 20 in New York in conjunction with the 1987 ASHRAE Winter meeting.



Any readers who would like more information on the Energy Kernel System, SPANK, or IBPSA should contact Kathy Ellington at the address given on the front page of this USER NEWS !!

WEATHER DATA FOR DOE-2

One of the most frequent questions we get asked is this: "What weather data should I use with DOE-2, and where can I obtain it?" Consequently, as a follow up to the article on the DOE-2 weather processor in the Fall, 1986 newsletter, we will discuss the sources for hourly weather data, and the different data sets and formats of weather data that are commonly used with DOE-2.

The primary source for weather data in the United States is the National Climatic Data Center (NCDC), a branch of the National Oceanic and Atmospheric Administration (NOAA). The address for the NCDC is:

National Climatic Data Center
Federal Building
Asheville, North Carolina 28801

Telephone: (704) 259-0682
Federal Telephone System: 672-0683

The NCDC can supply the "typical year" data sets called TMY and TRY (see below) as well as hourly data for specific years for hundreds of locations in the US. This data is available on magnetic tape in a variety of formats. In addition, the NCDC has weather data for many foreign locations. Most of the data for specific locations is not hourly, but rather tri-hourly (data every third hour). The DOE-2 weather processor handles tri-hourly data by interpolating data for the missing hours.

The NCDC also has a large number of publications about weather. One that we use frequently is "Local Climatological Data — Annual Summaries", which contains annual and historic summaries of weather data for hundreds of locations in the U.S. Information about this publication and a list of other publications can be obtained from the Printing and Publications Distribution Section of NCDC.

Secondary sources of hourly weather data include ASHRAE (for WYEC data), the California Energy Commission (for CTZ and RCTZ data), and the U.S. Air Force (for data for air bases). Sometimes local utilities or irrigation districts measure and archive weather data. In most cases, however, the NCDC is the only agency a user will have to contact.

Weather data for use with DOE-2 can be divided into "typical year" data sets, and data specific to a given location and year. Typical year data sets are an attempt to create a single "year" of data for a given location, which will in some sense represent the long term average weather for that location. The available typical year data sets are Test Reference Year (TRY), Typical Meteorological Year (TMY), Weather Year for Energy Calculation (WYEC), and for California, California Thermal Climate Zones (CTZ).

TRY The TRY data set is an early attempt to create a typical year database. A TRY year is data for a real year for the location, selected from the period 1948 to 1975. The selection procedure involves eliminating years in the period of record containing months with extremely high or low mean temperatures until only one year remains (see the *DOE-2 Reference Manual, Volume II*, page

VIII.18). Since the selection procedure has no theoretical statistical validity, TRY years cannot be expected to yield reliable estimates of average annual energy requirements for a building. The data is useful for comparison of different heating and cooling systems, control strategies, envelope features, and so on, but not for realistic estimates of annual energy consumption. TRY data is available for 60 locations in the U.S.; however, it includes no solar data, so DOE-2 calculates insolation from a cloud cover model. In general TRY data should not be used for applications in which solar radiation is expected to be important.

TMY TMY represents a more recent attempt by NCDC to provide a typical year data set for use in energy calculations. The coverage is much better for TMY than for TRY; data for 233 locations is available. TMY years are not real years; rather, they are ersatz years assembled from typical (real) months. The selection method involves statistically comparing 9 indices (daily max, min, and mean for dry bulb and dew point temperatures, daily max and mean wind velocity, and daily global solar radiation) for a candidate month with the same indices for the entire period of record (23 years). In the comparison the indices were given different weights. It is noteworthy that the weighting is 50% solar - 50% all other indices, so TMY's are strongly biased toward "typical" solar data. The statistical comparison was used to select a small group of candidate months; the final selection of the typical month was done subjectively. Twenty-six of the TMY locations contain measured solar radiation data from the SOLMET database; all other locations contain ersatz solar data obtained from models applied to cloud cover observations or measurements of hours of sunshine. This ersatz data is more accurate than the solar radiation calculations done in DOE-2 so, for this reason alone, the TMY data is preferable to the TRY data. In addition the coverage is better and the selection or creation of the typical year is done in a statistically reasonable manner. Unfortunately, the data integrity for TMY is not as good as for TRY. Possible problems include missing data, anomalous temperature changes, bad solar values, etc. Most of these problems can be handled by careful inspection of the weather summaries produced by the DOE-2 weather processor, when the TMY file are packed. However, no compilation of problems with the TMY data has ever been made, so it is definitely a case of "user beware"!

WYEC Recently, work was completed on the ASHRAE-funded development of the WYEC typical year data set. The coverage is sparser than TMY (51 locations), but 5 locations in Canada are included. Like TMY, the WYEC "year" is composed of typical months of real data, including solar data. These months were chosen so that the mean monthly dry bulb temperature and the mean global solar radiation for the month were near the long term means. The candidate month was then altered by substituting days from the same month in other years to bring the monthly averages for dry bulb temperature and global insolation into very close agreement with the long term averages. In addition, the wet bulb temperatures during the months June to September were adjusted to match the long term recorded means. The data integrity of the WYEC files is good. For information on obtaining WYEC weather tapes, call ASHRAE at (404) 636-8400.

CTZ The CTZ data was generated by Loren Crow for the California Energy Commission in 1976. California was divided into 16 climate zones, and a representative year for each zone was created from long term local weather data. The CTZ weather files do not include solar radiation data. Consequently, just as for the TRY data, the DOE-2 cloud cover model is used to calculate insolation during a simulation. For information or to obtain the CTZ data, contact Bruce Maeda at the CEC, (916) 324-3399.

When a typical year is needed, we recommend that TMY or WYEC be used. TMY and WYEC data for the same location are very similar, and results from DOE-2 using TMY or WYEC are virtually indistinguishable. Use of TRY data should be phased out, both because TRY does not represent a typical year in any readily definable sense, and because solar data is not included, necessitating the use of the less accurate DOE-2 cloud cover model. When solar data generated by the DOE-2 cloud cover model is compared with TMY or WYEC data, it is evident that the DOE-2 algorithm considerably underestimates the beam (direct) radiation on partly cloudy days, although the total radiation is fairly close. Generally this is not going to make much difference in the overall building load, but data sets that include solar should be preferred.

In many cases the DOE-2 user will not want to use a typical year, but rather a specific historical year at a given location. In this case the user has only to order the desired year or years from the NCDC. The data can be provided in a variety of formats. The DOE-2 weather processor can handle data in TRY, TD1440, CTZ, TMY, SOLMET, WYEC, CD144, and TD9685 formats. In this case (data for a real, historical year) the TRY or CD144 formats are preferable, since they have 80 character records and therefore can be easily examined on a terminal. Note that "TRY" can refer to either a data format or to a typical year — a source of much confusion. In general, solar data is not available for a given year and location. The exception is the SOLMET data base, which has multi-year meteorological and measured data for 27 locations in the U.S. There tend to be many gaps in the solar data on SOLMET, however. Tapes of SOLMET data can be obtained from the NCDC.

Our last topic involves the transfer of packed weather files from one computer system to another. The weather files used by DOE-2 are packed, binary files; therefore, they cannot be transferred from computer to computer, unless the computers and operating systems are exactly the same. Frequently the original raw data used to produce the packed files has been lost or discarded. When a new computer system is installed, or when it is necessary to do runs at another site, a method is needed to preserve and transfer the data contained in the packed files. To do this, we run a small program WTHFMT, which reads a packed, binary weather file and writes out an ASCII file containing the same information. The ASCII file can then be written to tape, along with a program FMTWTH, which can reverse the process; i.e., read an ASCII weather file and output a packed, binary DOE-2 compatible file suitable for the new computer system. The tape recipient then just has to read the tape, compile FMTWTH, and execute it with the ASCII weather file as input. Both WTHFMT and FMTWTH are in FORTRAN, and will compile and execute on a VAX. For other systems the code may need minor changes (to the OPEN statements, for instance). The programs and instructions for use follow this article.

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The ASCII weather file can be examined and edited on a terminal, using the local editor. This means that this technique can be used when it is desired to make changes to a packed weather file, instead of using the rather clumsy batch editing process contained in the weather processor. The format of the ASCII file has been chosen to be easily human readable.

With reference to the programs that follow, FMTWTH reads a one-line input file (INPUT.TMP on the VAX) in addition to the file containing the weather data. INPUT.TMP tells FMTWTH what type of packed binary file to produce. Note that only the first line is used, the subsequent lines are explanatory. The numbers on the first line must be in columns 13 and 31, respectively.

-----1-----2-----3-----4-----5-----6-----7--

```
WORD SIZE = 2      FILE TYPE = 2
WORD SIZE = 1 MEANS 60-BIT, 2 MEANS 30-BIT
FILE TYPE = 1 MEANS OLD, 2 MEANS NORMAL (NO SOLAR DATA), AND 3
MEANS THE DATA HAS SOLAR
```

PROGRAM FMTWTH

```
C
C THIS PROGRAM READS THE FORMATTED WEATHER FILE PRODUCED BY
C WTHFMT (WEATHER.FMT) AND RECONVERTS IT TO A PACKED BINARY
C DOE2 WEATHER FILE (NEWTH.TMP)
C
C DIMENSION CLN(12),GT(12),MDAYS(12),IDAT(1536),IWDID(5)
C
C DATA MDAYS / 31,28,31,30,31,30,31,31,30,31,30,31 /
C
C OPEN(UNIT=12,FILE='INPUT.TMP')
C OPEN(UNIT=11,FILE='WEATHER.FMT')
C OPEN(UNIT=10,FILE='NEWTH.TMP',FORM='UNFORMATTED')
C REWIND 12
C READ (12,9001) IWSZ,IFTYP
9001 FORMAT(12X,I1,17X,I1)
C REWIND 11
C READ (11,9002) (IWDID(I),I=1,5),IWYR,WLAT,WLONG,IWTZN,IWSOL
9002 FORMAT(5A4,I5,2F8.2,2I5)
C IWSOL = IWSZ + (IFTYP-1)*2 - 1
C READ (11,9003) (CLN(I),I=1,12)
C READ (11,9004) (GT(I),I=1,12)
9003 FORMAT(12F6.2)
9004 FORMAT(12F6.1)
C DO 1000 IM=1,12
C IDE = MDAYS(IM)
C DO 1000 ID=1,IDE
C IRECXO = IM*2 + (ID-1)/16 - 1
C IDXO = MOD(ID-1,16) + 1
C DO 500 IH=1,24
C READ (11,9005) KMON, KDAY, KH, WBT, DBT, PATM, CLDAMT, ISNOW,
1 IRAIN, IWNDDR, HUMRAT, DENSTY, ENTHAL, SOLRAD,
2 DIRSOL, ICLDTY, WNDSPD
```

```

9005 FORMAT(3I2,2F5.0,F6.1,F5.0,2I3,I4,F7.4,F6.3,F6.1,2F7.1,I3,F5.0)
ISOL = INT(SOLRAD + .5)
IDN = INT(DIRSOL + .5)
IWET = INT(WBT+99.5)
IDRY = INT(DBT+99.5)
IPRES = INT(PATM*10.-149.5)
ICLDAM = INT(CLDAMT)
IWNDSP = INT(WNDSPD+0.5)
IHUMRT = INT(HUMRAT*10000.+0.5)
IDENS = INT(DENSTY*1000.-19.5)
IENTH = INT(ENTHAL*2.0+60.5)
IP1 = (IDXO-1)*96 + IH*4 - 3
IDAT(IP1) = IPRES*65536 + IWET*256 + IDRY
IDAT(IP1+1) = ISOL*1048576 + IDN*1024 +
1 ICLDAM*64 + ISNOW*32 + IRAIN*16 + IWNDSP
IDAT(IP1+2) = IHUMRT*128 + IDENS
IDAT(IP1+3) = IENTH*2048 + ICLDTY*128 + IWNDSP
500 CONTINUE
IF ((ID .NE. 16) .AND. (ID .NE. IDE)) GO TO 1000
WRITE (10) IWDID,IWYR,WLAT,WLONG,IWTZN,IWRECXO,IDE,CLN(IM) ,
1 GT(IM) , IWSOL, IDAT
1000 CONTINUE
END

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-----1-----2-----3-----4-----5-----6-----7--

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PROGRAM WTHEMT

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C
C THIS PROGRAM READS A PACKED BINARY DOE-2 WEATHER FILE AND
C CREATES A FORMATTED WEATHER FILE AS OUTPUT. THE INPUT
C FILE IS TAPE10, THE OUTPUT FILE IS TAPE11.
C
C DIMENSION CLN(12),GT(12),MDAYS(12),IDAT30(1536),
C IWDID(5),IWTH(14)
C DIMENSION XMASK(16,2),CALC(16)
C INTEGER IDUM
C
C DATA MDAYS / 31,28,31,30,31,30,31,31,30,31,30,31 /
C DATA IWDID /5*4H /
C DATA XMASK / -99.,-99.,15.,0.,0.,0.,0.,0.,.02,-30.,0.,
1 .0.,.0.,.0.,.0,10.,
2 1.,1.,.1,1.,1.,1.,1.,.0001,.001,.5,
3 1.,1.,1.,1.,0.,0. /
C
C OPEN (UNIT=11,FILE='WEATHER.FMT')
C OPEN (UNIT=10,FILE='WEATHER.BIN',FORM='UNFORMATTED')
C REWIND 10
C DO 100 IM1=1,12
C READ (10) (IWDID(I),I=1,5),IWYR,WLAT,WLONG,IWTZN,LRECX,NUMDAY,
C CLN(IM1),GT(IM1),IWSOL
C READ (10) IDUM
100 CONTINUE
C REWIND 10
C LRECX = 0
C WRITE (11,9001) (IWDID(I),I=1,5),IWYR,WLAT,WLONG,IWTZN,IWSOL
C WRITE (11,9002) (CLN(I),I=1,12)
C WRITE (11,9003) (GT(I),I=1,12)
9001 FORMAT(5A4,I5,2F8.2,2I5)
9002 FORMAT(12F6.2)

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DOE-2 USER NEWS

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9003 FORMAT(12F6.1)
DO 1000 IM2=1,12
IDE = MDAYS(IM2)
DO 1000 ID=1,IDE
DO 1000 IH=1,24
105 IRECX = IM2*2 + (ID-1)/16 - 1
IDX = MOD(ID-1,16) + 1
IF (IRECX-LRECX) 200,400,300
200 IDIF = LRECX - IRECX + 1
DO 220 I=1,IDIF
BACKSPACE 10
220 CONTINUE
300 READ (10) IWDID,IWYR,WLAT,WLONG,IWTZN,LRECX,NUMDAY,CLRNES,
TGRND,IDUM,IDAT30
CO TO 105
400 CONTINUE
IP1 = 96*(IDX-1) + 4*IH - 3
IWITH(3) = IDAT30(IP1)/65536
IWITH(1) = MOD(IDAT30(IP1),65536)/256
IWITH(2) = MOD(IDAT30(IP1),256)
IWITH(11) = IDAT30(IP1+1)/1048576
IWITH(12) = MOD(IDAT30(IP1+1),1048576)/1024
IWITH(4) = MOD(IDAT30(IP1+1),1024)/64
IWITH(5) = MOD(IDAT30(IP1+1),64)/32
IWITH(6) = MOD(IDAT30(IP1+1),32)/16
IWITH(7) = MOD(IDAT30(IP1+1),16)
IWITH(8) = IDAT30(IP1+2)/128
IWITH(9) = MOD(IDAT30(IP1+2),128)
IWITH(10) = IDAT30(IP1+3)/2048
IWITH(13) = MOD(IDAT30(IP1+3),2048)/128
IWITH(14) = MOD(IDAT30(IP1+3),128)
DO 500 I=1,14
CALC(I) = FLOAT(IWITH(I))*XMASK(I,2) + XMASK(I,1)
500 CONTINUE
ISNOW = INT(CALC(5) + .01)
IRAIN = INT(CALC(6) + .01)
IWNDDR = INT(CALC(7) + .01)
ICLDTY = INT(CALC(13) + .01)
C
C          IM2          MONTH          (1-12)
C          ID           DAY OF MONTH
C          IH           HOUR OF DAY
C          CALC(1)      WET BULB TEMP      (DEG F)
C          CALC(2)      DRY BULB TEMP      (DEG F)
C          CALC(3)      PRESSURE           (INCHES OF HG)
C          CALC(4)      CLOUD AMOUNT       (0 - 10)
C          ISNOW        SNOW FLAG          (1 = SNOWFALL)
C          IRAIN        RAIN FLAG          (1 = RAINFALL)
C          IWNDDR       WIND DIRECTION     (0 - 15; 0=N, 1=NNE, ETC)
C          CALC(8)      HUMIDITY RATIO     (LB H2O/LB AIR)
C          CALC(9)      DENSITY OF AIR     (LB/CU FT)
C          CALC(10)     SPECIFIC ENTHALPY  (BTU/LB)
C          CALC(11)     TOTAL HOR. SOLAR   (BTU/HR-SQFT)
C          CALC(12)     DIR. NORMAL SOLAR (BTU/HR-SQFT)
C          ICLDTY      CLOUD TYPE         (0 - 2)
C          CALC(14)     WIND SPEED         KNOTS
C
C WRITE (11,9005) IM2, ID, IH, CALC(1), CALC(2), CALC(3), CALC(4),
1 ISNOW, IRAIN, IWNDDR, CALC(8), CALC(9), CALC(10),
2 CALC(11), CALC(12), ICLDTY, CALC(14)
9005 FORMAT(3I2,2F5.0,F6.1,F5.0,2I3,I4,F7.4,F6.3,F6.1,2F7.1,I3,F5.0)
1000 CONTINUE
ENDDFILE 11
END

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