ESL-TR-94/12-01

Advanced DOE-2 Calibration Procedures: A Technical Reference Manual

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General Disclaimer

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INTRODUCTION

This manual outlines the procedures to collect data, poll the datalogger, and process the data. The processed data is then used with a calibrated DOE-2 input file using statistical graphing routines for the U.S.D.O.E. Forrestal Child Development Center. Appendix A contains the data processing routines. Appendix B contains the final calibrated input file. Appendix C contains processing and column merging routines. Appendix D contains the SAS graphical routines. Appendix E contains a solar conversion routine that converts data collected at an 18 degree south facing tilt to global horizontal solar data. Appendix F contains information on the channel tables for the loggers located at the Forrestal building and the Forrestal Child Development Center.

Campbell Logger Polling Procedure

The following procedure outlines the Campbell 21X logger polling operations on the personal computer. The Campbell datalogger records several channels of hourly data including AC and DC power generation due to the photovoltaic system, solar radiation measured at a south facing 18° tilt, ambient dry bulb temperature, and solar panel surface temperature. The data are polled weekly by a personal computer and modem as shown below in Figure 1. The reader is also referred to Bou-Saada and Haberl (1994) for a more detailed procedure on polling and processing the Campbell data.

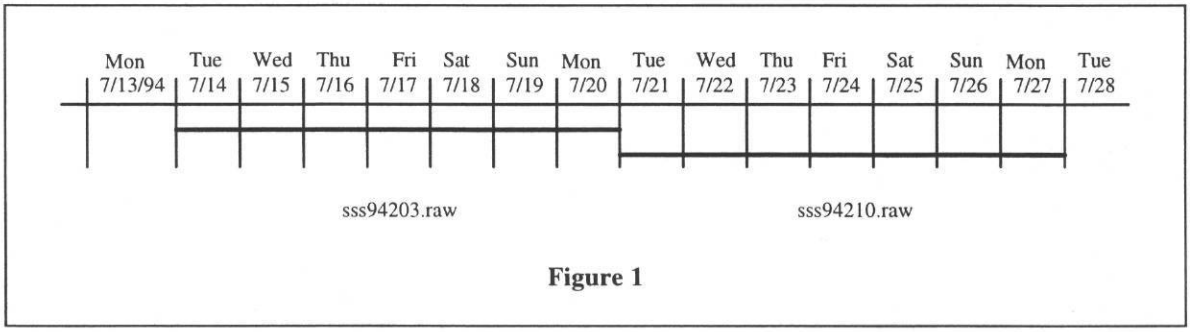

Figure 1

To poll the logger on Monday evening, move into the PC208 directory ***(IT IS STRONGLY RECOMMENDED THAT THE POLLING TIME BE SET TO AFTER 12:00 A.M. AND BEFORE 1:00 A.M. LOCAL SITE TIME ON TUESDAY MORNING TO AVOID MISSING***

RECORDS AND/OR MANUALLY HAVING TO EDIT THE FILE FOR THE PROPER NUMBER OF RECORDS):

```
cd c:\PC208

telcom
```

The configuration files may be edited and/or checked for accuracy at this point (see PC208 documentation (Campbell 1993)). To poll the loggers:

```
forres/w
```

This batch script tells the program to call the Forrestal CDC logger when the pre-programmed wakeup time in the configuration file is reached (directly after midnight on Tuesday morning), polls the logger, and writes the data into a comma delineated datafile in the PC208 directory. A complete manual of this procedure is documented in PlotCDC (Bou-Saada and Haberl 1994).

Screen Output

The following is an example of what is printed to the screen while PC208 is running:

```
Calling Station "forres"

Smartmodem Dialing: DTxxx-xxx-xxxx

ATZ

OK

0TE1QV

ATDTxxx-xxx-xxxx

5

*1A

 R+14772. F+29908. V3 E00 00 M96 A1 L+14772. C2477

*14772G

 A1 L+14772. C1058

*50B

 A1 L+14172. C0887

*512F

88F
```

```
nNext time for "forres" is 11/28/94 23:20:00


Options which may be entered following the station or script file name:
    /E = Edit parameters            /B size = specify Block size
    /C = Call datalogger now        /G = Get all data from datalogger
    /W = Wait for wake up time      /D = unattended Done
    /A port = Answer modem ring     /F name = alternate data file
        To end, press Enter key without a file name


Enter station or script file name:
```

What Is Required to Process Campbell Data

On Tuesday morning:

```
ESC
```

(the ESC function allows the user to return to the DOC prompt). The data is now ready for processing and plotting.

Output file

PC208 creates one output file for the site:

The raw datafile written by PC208 is:

FORRES.DAT

The data will be stored in Campbell's ASCII comma delineated format as seen in Figure 2. See the site-specific channel table located in Appendix A for a detailed description of each field.

```
115,1994,305,0,-.025,18.39,17.98,17.97,.002,.002,2330,304
115,1994,305,100,-.026,18.13,17.68,17.66,.002,.002,29.5,305
115,1994,305,200,-.031,17.95,17.5,17.48,.002,.002,129.5,305
115,1994,305,300,-.034,17.81,17.3,17.28,.002,.002,229.5,305
115,1994,305,400,-.032,17.74,17.14,17.13,.002,.002,329.5,305
115,1994,305,500,-.021,17.74,17.08,17.08,.002,.002,429.5,305
```

Figure 2 Contents of six hours of *.RAW datafile written by PC208.

Create a sequential raw file in the \PLOTS\PROCESS directory:

```
copy forres.dat \process\90794xxx.raw (to xxx, add 7 every week)
```

where 907 is the site number for the Forrestal CDC. 94 is the year and xxx is the day of the year that the data were polled *(Tuesday)*.

Process the data files and plot:

```
\work\util\plotcdc 907 94xxx 90793001
```

The batch routine will format the raw data into a file readable by graphics utilities and then plots summary graphs. `plotcdc` is the master batch routine that processes the data, `907` is the site number, `94xxx` is the data, and `90793001` is the channel table which formats the columnar data with ARCHIVE.EXE. `90793001` is a permanent file and does not change names.

(IT IS STRONGLY RECOMMENDED TO PERMANENTLY ARCHIVE THE *.RAW FILES AND THE *.ACS FILES WEEKLY FOR FUTURE REFERENCE).

What is the polling routine doing?

The flowcharts in Figure 3 show the overall processing procedure. Figure 3 (a) is a flowchart for the data processing during Eastern Standard time and Figure 3 (b) is a flowchart for data processing during Eastern Daylight time.

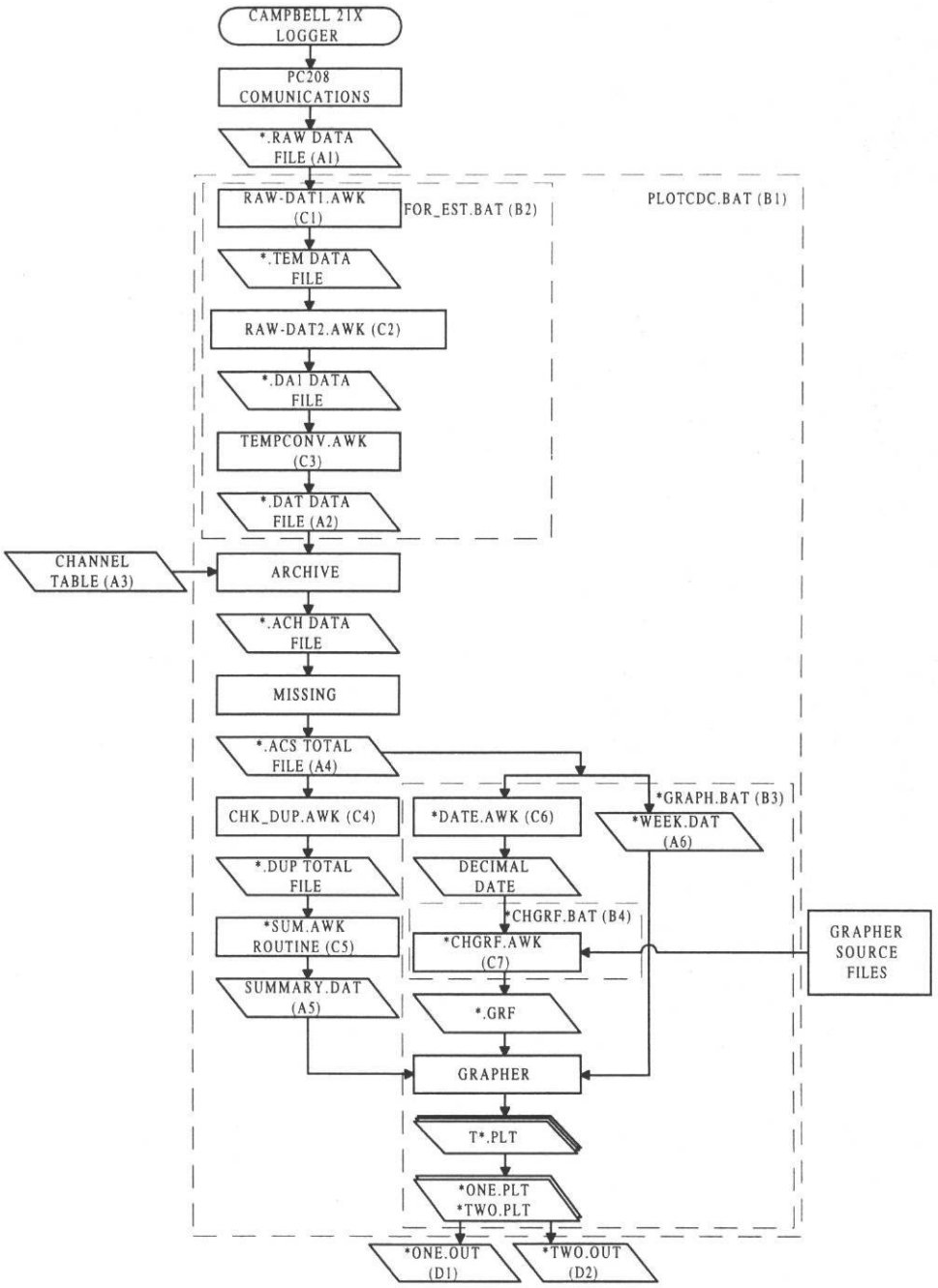

Figure 3 (a) Flowchart for Eastern Standard time processing and plotting.

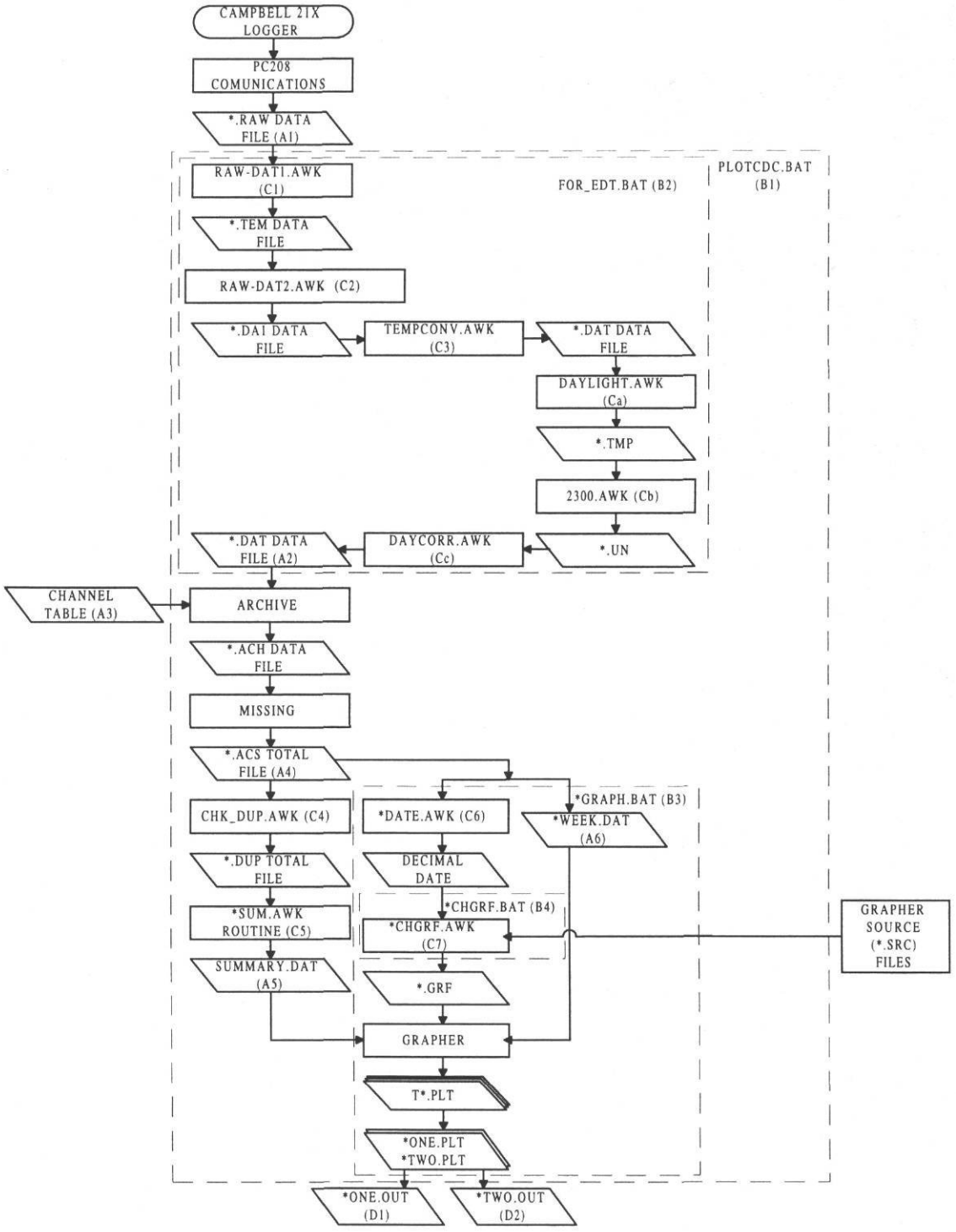

Figure 3 (b) Flowchart for Eastern Daylight Savings time processing and plotting.

The Campbell 21X logger at the daycare center was polled weekly using the PC208 (Campbell 1993) communications package to produce a comma delimited raw file (A1). Bou-Saada and Haberl (1994) contains instructions for polling the Campbell 21X data logger. A master batch script PLOTCDC.BAT (B1). The batch script contains several other batch subroutines, FOR_EST.BAT (B2) (during Eastern Standard Time) and FOR_EDT.BAT (B2) (during Eastern Daylight Time) for the actual data processing, and *GRAPH.BAT (B3) and *CHGRF.BAT (B4) to graph the data. The raw file was converted into a columnar ASCII data file (A2) using RAW-DAT1 (C1) and RAW-DAT2 (C2). A temperature conversion routine TEMPCONV.AWK (C3) converted Celsius temperatures into Fahrenheit temperatures. During daylight savings time, further processing was required. Three daylight savings conversion routines were then used when applicable during daylight savings time DAYLIGHT.AWK (Ca), 2300.AWK (Cb), and DAYCORR.AWK (Cc). The resulting datafile became the ASCII datafile shown in (A2). The data were then processed with ARCHIVE using channel table (A3), scanned for missing data using MISSING.AWK to create the *.ACS (A4) datafile, and checked for duplicate records using CHK_DUP.AWK (C4) to produce a standardized data file that was then added to the LoanSTAR database. SUM.AWK (C5) was used to prepare the final file SUMMARY.DAT (A5) that was used along with *WEEK.DAT (A6) and the Grapher software to plot the data. *DATE.AWK (C6) updated the date every week for plotting. *CHGRF.AWK (C7) copied the new date onto the grapher source files for plotting on the x-axis of each inspection plot. Grapher was then run and the resulting inspection plots can be seen in D1 and D2.

Several steps in addition to this were performed in order to convert the global solar data measured at an 18° south facing tilt into global horizontal solar data and are described in Bou-Saada (1994), however, the solar conversion routine is included in this volume. Weather data was also extracted in order to pack a DOE-2 weather file as well as the extraction of the whole-building electricity data that were used to calibrate the DOE-2 input file as is included in Bou-Saada (1994).

DOE-2 Input File

In order to simulate the case study building with DOE-2, an input file was developed for the USDOE Child Development Center in Washington, D.C. The building is a four zone modular building served by four separate HVAC systems. The input file incorporates all the variables that were used for the LOADS, SYSTEMS, and PLANT sub-programs specific to the building. An economics study was not performed and hence, the ECONOMICS sub-program was omitted. For information on writing a DOE-2 input file, see LBL (1980; 1981; 1982; 1989; 1994). Detailed information on the building and how the model was calibrated to measured whole building electricity data is provided in Bou-Saada (1994). The input file was specified to produce an hourly output file from the PLANT sub-program which included whole-building electricity and outdoor ambient temperature. Simulation was performed in conjunction with nine months of measured weather conditions which include ambient dry bulb temperature, relative humidity, peak wind speed, and global horizontal solar radiation data packed onto an existing Typical Reference Year (TRY 1983) weather tape. The weather data packing procedure may be found in Bronson (1992b). The simulated hourly data were compared to hourly measured data using graphical processing routines described in later sections. The final calibrated DOE-2 input file is included in Appendix B.

Data Processing Routines

All the routines introduced in this section and marked within parantheses may be found in Appendix C. Once a DOE-2 input file has been run without errors, it can be calibrated by specifying an hourly output file from any of the four sub-routines (LOADS, SYSTEMS, PLANT, and ECONOMICS). In the case of the Child Development Center's processing procedure, as shown in Figure 4, the most useful hourly output report contained two variables that were reported from the PLANT sub-program, the DOE-2 simulated whole-building electricity and the outdoor ambient temperature which is read from the site specific packed weather file. The DOE-2 output file was transferred to a UNIX operating system using the file transfer protocol (ftp) for processing due to the hourly datafile's large size. On the UNIX system, a special batch script, MERGE (1), was developed to operate a series of processing routines including those developed

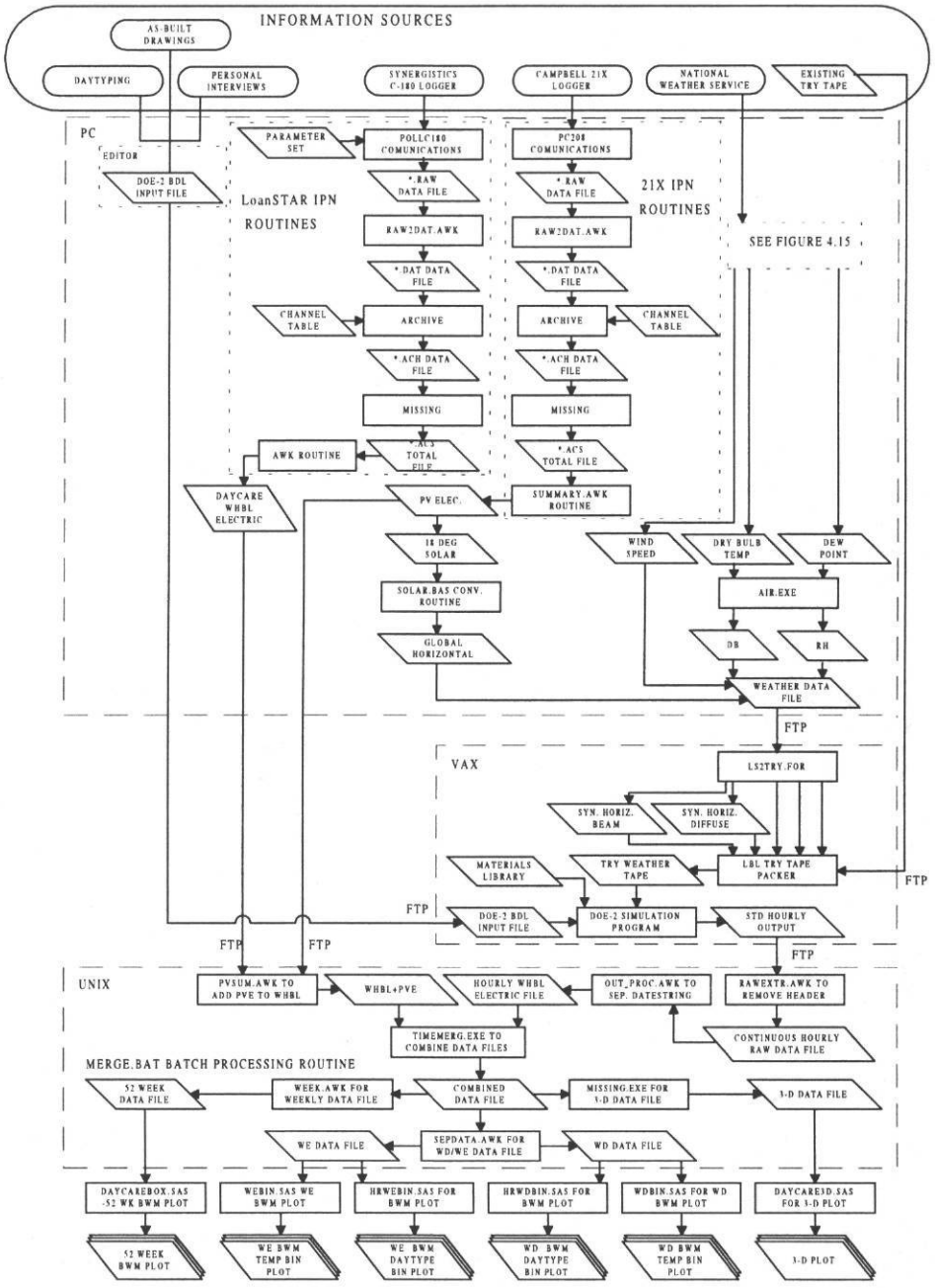

Figure 4 DOE-2 Processing Procedure.

by Bronson (1992a; 1992b) and those developed for this research Bou-Saada (1994). The first routine of the batch script is an existing AWK (Aho 1988) routine, RAWEXTR (Bronson 1992a; 1992b), that extracts the data from the hourly DOE-2 file format and removes the headers and footers from daily reports that each contain 24 individual hours of data. The AWK script merges

each 24 hour period into a contiguous datafile that still must be processed further. Another AWK script, OUT_PROC (Bronson 1992a; 1992b), then calculates a decimal date beginning from 1980, removes the daylight savings shift, and writes the data into a columnar datafile.

The MERGE (1) script then uses PVSUM (2) to add the photovoltaic power from the building's roof mounted solar panels to the whole-building electricity load, thus representing the power that the building actually consumes. The measured and DOE-2 simulated data are then combined into one columnar datafile using an AWK routine for use with SAS plotting routines described in the next section. When the combined datafile is produced, MISSING (Sparks et al. 1992) fills in missing data with "-99" until the end of the year is reached if less than one year is being simulated. This is necessary because the particular SAS routine used here requires a full year of data for the three-dimensional plots.

To run the MERGE (1) processing batch script, edit the file and insert the DOE-2 output filename on the third line, save the script and exit. Then on the command line type **merge.** All commands used for this processing are case sensitive when running on the UNIX operating system. Therefore, the command must be typed in lower case letters.

A separate AWK script (WEEK), developed by Abbas (1993), is used to bin the data by week so that it may be used with the 52-week box-whisker-mean routines described in the next section. To run the WEEK routine from the UNIX command line, type:

nawk -f week.awk plant.dat > plantwk.dat

with *plant.dat* being the datafile that contains the measured and simulated data and *plantwk.dat* being the same file that was binned by the week of the simulation period.

Another AWK script, WD_WE_SEP (3), was developed that divides the data into weekday and weekend datafiles to be used with the SAS routines described later. To run the routine from the UNIX command line, type:

nawk -v var1=# -v var2=we.dat -v var3=wd.dat -f wd_we_sep.awk plant.dat

where # requires an alphanumeric number for the day of the week that January 1 of the simulation period begins (SUN=0, MON=1, TUE=2, WED=3, THU=4, FRI=5, SAT=6). For example, the simulation for this research took place in 1993. Therefore, January 1, which was a Friday has the value of 5. WE.DAT is the weekend datafile and WD.DAT is the weekday datafile and. WD_WE_SEP.AWK is the AWK routine and PLANT.DAT is the entire simulated and measured datafile.

SAS Plot Processing Routines

Several Statistical Analysis Software SAS (SAS 1989) source code routines are described in this section and included in Appendix D. They include source codes for three-dimensional plots (DAYCARE3D) (A), 52-week box-whisker-mean plots (DAYCAREBOX) (B), temperature bin box-whisker-mean plots (WDBIN (C), WEBIN (D)), and 24-hour weather daytype plots (scatter plots and box-whisker-mean plots HRWDBIN (E), HRWEBIN (F), HRWDBOX (G), HRWEBOX (H), HRWDOBIN (I), HRWDUBIN (J), HRWDOBOX (K), HRWDUBOX (L)). A graphical example of each of these plots and how each was applied to the calibration procedure are detailed in Bou-Saada (1994).

The DAYCARE3D SAS (A) routine plots two three-dimensional graphs, one of the measured data and one of the DOE-2 simulated data. These plots are similar to the 52-week box-whisker-mean plots produced by DAYCAREBOX (B). DAYCAREBOX plots the data in a weekly binned format with the measured mean superimposed onto the simulated graph for comparison. WDBIN (C) and WEBIN (D), respectively, plot the weekday and weekend data in a temperature bin format with the top two graphs being scatter plots of the measured and simulated data and the bottom two graphs being the measured and simulated temperature bin box-whisker-mean plots. HRWDBIN (E) and HRWEBIN (F) plot the weather dependent data in a 24 hour scatter plot format with the top row of graphs being the measured data and the bottom row of graphs being the simulated data. The routine sorts the data into weather dependent graphs with the two graphs on the left being data below 45° F for the heating season, the two graphs in the

middle being the data between 45° F and 75° F for the intermediate season, and the two graphs on the right being the data above 75° F for the cooling season.

HRWDBOX (G) and HRWEBOX (H) show the weekday and weekend data in a 24 hour binned format with the top row of graphs being the measured data and the bottom row of graphs being the simulated data. The routine sorts the data into weather dependent graphs with the two graphs on the left being data below 45° F for the heating season, the two graphs in the middle being the data between 45° F and 75° F for the intermediate season, and the two graphs on the right being the data above 75° F for the cooling season. All the SAS routines are run as follows:

The remaining routines HRWDOBIN (I), HRWDUBIN (J), HRWDOBOX (K), and HRWDUBOX (L) plot the same data. The difference is that they separate the data into occupied and unoccupied plots with HRWDOBIN (I) graphing the occupied box-whisker-mean plots, HRWDUBIN (J) graphing the unoccupied box-whisker-mean plots, HRWDOBOX (K) graphing the occupied scatter plots, and HRWDUBOX (L) graphing the unoccupied scatter plots.

To use the SAS routines, an input file must be created according to the input format included in the SAS code (site, month, day, year, julian date, decimal date, hour, measured data, temperature data, simulated data). On the command line using the UNIX operating system, type in lower case letters:

sas filename

where the filename refers to any of the SAS routines described in this section.

Solar Processing Routine

The routine shown in Appendix E is the source code for the solar conversion used to convert solar radiation data collected at an 18° south facing tilt to global horizontal solar radiation.

Channel Tables

The final section of this report in Appendix F includes the channel table used in the Forrestal building (site 906). The whole-building electricity energy was measured on three legs (channels 8, 9, and 10) in the Forrestal builing's A vault and is included here for reference.

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APPENDIX A DATA PROCESSING ROUTINES

115,1994,305,0,-.025,18.39,17.98,17.97,.002,.002,2330,304
115,1994,305,100,-.026,18.13,17.68,17.66,.002,.002,29.5,305
115,1994,305,200,-.031,17.95,17.5,17.48,.002,.002,129.5,305
115,1994,305,300,-.034,17.81,17.3,17.28,.002,.002,229.5,305
115,1994,305,400,-.032,17.74,17.14,17.13,.002,.002,329.5,305
115,1994,305,500,-.021,17.74,17.08,17.08,.002,.002,429.5,305
115,1994,305,600,-.028,18,17.36,17.35,.002,.002,529.5,305
115,1994,305,700,.911,18.12,17.49,17.52,.002,.002,629.5,305
115,1994,305,800,22.37,18.39,17.96,17.99,.004,.041,730,305
115,1994,305,900,44.33,18.76,18.62,18.54,.006,.098,830,305
115,1994,305,1000,21,18.37,18.01,17.98,.005,.037,930,305
115,1994,305,1100,112,18.3,18.52,18.16,.007,.308,1030,305
115,1994,305,1200,224.3,18.45,20.3,19.92,.007,.727,1130,305
115,1994,305,1300,142.8,20.01,22.11,21.66,.006,.412,1230,305
115,1994,305,1400,30.5,16.05,15.91,15.69,.004,.069,1330,305
115,1994,305,1500,84.8,11.3,11,11.06,.006,.23,1430,305
115,1994,305,1600,69.57,11.23,10.8,10.86,.006,.193,1530,305
115,1994,305,1700,59.08,10.8,10.58,10.76,.005,.205,1630,305
115,1994,305,1800,1.296,10.03,8.38,8.59,.001,.002,1730,305
115,1994,305,1900,-.052,9.7,8.17,8.42,.001,.001,1830,305
115,1994,305,2000,-.044,9.47,8.16,8.4,.001,.001,1930,305
115,1994,305,2100,-.046,8.54,6.709,6.904,.001,.001,2030,305
115,1994,305,2200,-.045,8.39,6.88,6.904,.001,.002,2130,305
115,1994,305,2300,-.046,8.99,7.82,7.8,.001,.002,2230,305

Figure A1: Example of raw output file from PC208 communication.

```
11 1 94 0 0 -.025 65.102 64.364 64.346 .002 .002
11 1 94 1 0 -.026 64.634 63.824 63.788 .002 .002
11 1 94 2 0 -.031 64.31 63.5 63.464 .002 .002
11 1 94 3 0 -.034 64.058 63.14 63.104 .002 .002
11 1 94 4 0 -.032 63.932 62.852 62.834 .002 .002
11 1 94 5 0 -.021 63.932 62.744 62.744 .002 .002
11 1 94 6 0 -.028 64.4 63.248 63.23 .002 .002
11 1 94 7 0 .911 64.616 63.482 63.536 .002 .002
11 1 94 8 0 22.37 65.102 64.328 64.382 .004 .041
11 1 94 9 0 44.33 65.768 65.516 65.372 .006 .098
11 1 94 10 0 21 65.066 64.418 64.364 .005 .037
11 1 94 11 0 112 64.94 65.336 64.688 .007 .308
11 1 94 12 0 224.3 65.21 68.54 67.856 .007 .727
11 1 94 13 0 142.8 68.018 71.798 70.988 .006 .412
11 1 94 14 0 30.5 60.89 60.638 60.242 .004 .069
11 1 94 15 0 84.8 52.34 51.8 51.908 .006 .23
11 1 94 16 0 69.57 52.214 51.44 51.548 .006 .193
11 1 94 17 0 59.08 51.44 51.044 51.368 .005 .205
11 1 94 18 0 1.296 50.054 47.084 47.462 .001 .002
11 1 94 19 0 -.052 49.46 46.706 47.156 .001 .001
11 1 94 20 0 -.044 49.046 46.688 47.12 .001 .001
11 1 94 21 0 -.046 47.372 44.0762 44.4272 .001 .001
11 1 94 22 0 -.045 47.102 44.384 44.4272 .001 .002
11 1 94 23 0 -.046 48.182 46.076 46.04 .001 .002
```

Figure A2: Example of datafile before ARCHIVE.

Date MM/DD/YY (YY DDD)	Time HH:mm	Raw-Data lin pos	coln pos	Arch coln pos	Name of Channel	Archive Units	Arch Format	Conv'n Code	Conv'n Constants	Error Code	Error Constants	Channel Description
#												
03/01/93	00:00	1	0	0	Begin							
03/01/93	00:00	1	1	1	Bldg. #	xx	I3	2	0 907	0		Building Number
03/01/93	00:00	1	1	2	Mon-Raw	MM	I3	1		0		Month
03/01/93	00:00	1	2	3	Mon-Raw	DD	I3	1		0		Day
03/01/93	00:00	1	3	4	Mon-Raw	YY	I3	1		0		Year
03/01/93	00:00	1	3	5	Greg-Jul	MMDDYY	I5	24	1 2	0		Gregorian Date to Julian
03/01/93	00:00	1	4	7	Time	HH mm	I5	16	5	0		Time
03/01/93	00:00	1	3	6	Greg-Dec	DDD.frac	F10.4	28		0		Gregorian Date to Jul.Decimal
03/01/93	00:00	1	6	8	Irrad	W/m^2	F9.3	1		1	-5 99999	Hr ave Plane Irrad
03/01/93	00:00	1	7	9	db Temp	deg C	F9.3	1		1	-5 99999	Hr ave amb Temp
03/01/93	00:00	1	8	10	mod Tem1	deg C	F9.3	1		1	-5 99999	Hr ave module Temp 1
03/01/93	00:00	1	9	11	mod Tem2	deg C	F9.3	1		1	-5 99999	Hr ave module Temp 2
03/01/93	00:00	1	10	12	Pwr Str1	kW	F9.3	1		1	-5 99999	Hr ave DC Pwr String 1
03/01/93	00:00	1	11	13	Pwr Str2	kW	F9.3	1		1	-5 99999	Hr ave DC Pwr String 2
03/01/93	00:00	1	12	14	Pwr Str3	kW	F9.3	1		1	-5 99999	Hr ave DC Pwr String 3
03/01/93	00:00	1	13	15	Pwr Str4	kW	F9.3	1		1	-5 99999	Hr ave AC Pwr String 4
03/01/93	00:00	1	14	16	AC Pwr 1	kW	F9.3	1		1	-5 99999	Hr ave AC Pwr 1
03/01/93	00:00	1	15	17	AC Pwr 2	kW	F9.3	1		1	-5 99999	Hr ave AC Pwr 2
04/29/99	23:00	1	0	0	End							

Figure A3: Forrestal CDC ARCHIVE channel table.

907	11	1	94	94305	5418.0000	0	-0.025	65.102	64.364	64.346	0.002	0.002
907	11	1	94	94305	5418.0417	100	-0.026	64.634	63.824	63.788	0.002	0.002
907	11	1	94	94305	5418.0833	200	-0.031	64.310	63.500	63.464	0.002	0.002
907	11	1	94	94305	5418.1250	300	-0.034	64.058	63.140	63.104	0.002	0.002
907	11	1	94	94305	5418.1667	400	-0.032	63.932	62.852	62.834	0.002	0.002
907	11	1	94	94305	5418.2083	500	-0.021	63.932	62.744	62.744	0.002	0.002
907	11	1	94	94305	5418.2500	600	-0.028	64.400	63.248	63.230	0.002	0.002
907	11	1	94	94305	5418.2917	700	0.911	64.616	63.482	63.536	0.002	0.002
907	11	1	94	94305	5418.3333	800	22.370	65.102	64.328	64.382	0.004	0.041
907	11	1	94	94305	5418.3750	900	44.330	65.768	65.516	65.372	0.006	0.098
907	11	1	94	94305	5418.4167	1000	21.000	65.066	64.418	64.364	0.005	0.037
907	11	1	94	94305	5418.4583	1100	112.000	64.940	65.336	64.688	0.007	0.308
907	11	1	94	94305	5418.5000	1200	224.300	65.210	68.540	67.856	0.007	0.727
907	11	1	94	94305	5418.5417	1300	142.800	68.018	71.798	70.988	0.006	0.412
907	11	1	94	94305	5418.5833	1400	30.500	60.890	60.638	60.242	0.004	0.069
907	11	1	94	94305	5418.6250	1500	84.800	52.340	51.800	51.907	0.006	0.230
907	11	1	94	94305	5418.6667	1600	69.570	52.214	51.440	51.548	0.006	0.193
907	11	1	94	94305	5418.7083	1700	59.080	51.440	51.044	51.368	0.005	0.205
907	11	1	94	94305	5418.7500	1800	1.296	50.054	47.084	47.462	0.001	0.002
907	11	1	94	94305	5418.7917	1900	-0.052	49.460	46.706	47.156	0.001	0.001
907	11	1	94	94305	5418.8333	2000	-0.044	49.046	46.688	47.120	0.001	0.001
907	11	1	94	94305	5418.8750	2100	-0.046	47.372	44.076	44.427	0.001	0.001
907	11	1	94	94305	5418.9167	2200	-0.045	47.102	44.384	44.427	0.001	0.002
907	11	1	94	94305	5418.9583	2300	-0.046	48.182	46.076	46.040	0.001	0.002

Figure A4: *.ACS datafile from ARCHIVE.

```
5418.0000 -0.025 65.102 64.355 0 0.004
5418.0417 -0.026 64.634 63.806 0 0.004
5418.0833 -0.031 64.310 63.482 0 0.004
5418.1250 -0.034 64.058 63.122 0 0.004
5418.1667 -0.032 63.932 62.843 0 0.004
5418.2083 -0.021 63.932 62.744 0 0.004
5418.2500 -0.028 64.400 63.239 0 0.004
5418.2917 0.911 64.616 63.509 0 0.004
5418.3333 22.370 65.102 64.355 0 0.045
5418.3750 44.330 65.768 65.444 0 0.104
5418.4167 21.000 65.066 64.391 0 0.042
5418.4583 112.000 64.940 65.012 0 0.315
5418.5000 224.300 65.210 68.198 0 0.734
5418.5417 142.800 68.018 71.393 0 0.418
5418.5833 30.500 60.890 60.44 0 0.073
5418.6250 84.800 52.340 51.854 0 0.236
5418.6667 69.570 52.214 51.494 0 0.199
5418.7083 59.080 51.440 51.206 0 0.21
5418.7500 1.296 50.054 47.273 0 0.003
5418.7917 -0.052 49.460 46.931 0 0.002
5418.8333 -0.044 49.046 46.904 0 0.002
5418.8750 -0.046 47.372 44.2515 0 0.002
5418.9167 -0.045 47.102 44.4055 0 0.003
5418.9583 -0.046 48.182 46.058 0 0.003
```

Figure A5: SUMMARY.DAT datafile.

907	11	1	94	94305	5418.0000	0	-0.025	65.102	64.364	64.346	0.002	0.002
907	11	1	94	94305	5418.0417	100	-0.026	64.634	63.824	63.788	0.002	0.002
907	11	1	94	94305	5418.0833	200	-0.031	64.310	63.500	63.464	0.002	0.002
907	11	1	94	94305	5418.1250	300	-0.034	64.058	63.140	63.104	0.002	0.002
907	11	1	94	94305	5418.1667	400	-0.032	63.932	62.852	62.834	0.002	0.002
907	11	1	94	94305	5418.2083	500	-0.021	63.932	62.744	62.744	0.002	0.002
907	11	1	94	94305	5418.2500	600	-0.028	64.400	63.248	63.230	0.002	0.002
907	11	1	94	94305	5418.2917	700	0.911	64.616	63.482	63.536	0.002	0.002
907	11	1	94	94305	5418.3333	800	22.370	65.102	64.328	64.382	0.004	0.041
907	11	1	94	94305	5418.3750	900	44.330	65.768	65.516	65.372	0.006	0.098
907	11	1	94	94305	5418.4167	1000	21.000	65.066	64.418	64.364	0.005	0.037
907	11	1	94	94305	5418.4583	1100	112.000	64.940	65.336	64.688	0.007	0.308
907	11	1	94	94305	5418.5000	1200	224.300	65.210	68.540	67.856	0.007	0.727
907	11	1	94	94305	5418.5417	1300	142.800	68.018	71.798	70.988	0.006	0.412
907	11	1	94	94305	5418.5833	1400	30.500	60.890	60.638	60.242	0.004	0.069
907	11	1	94	94305	5418.6250	1500	84.800	52.340	51.800	51.908	0.006	0.230
907	11	1	94	94305	5418.6667	1600	69.570	52.214	51.440	51.548	0.006	0.193
907	11	1	94	94305	5418.7083	1700	59.080	51.440	51.044	51.368	0.005	0.205
907	11	1	94	94305	5418.7500	1800	1.296	50.054	47.084	47.462	0.001	0.002
907	11	1	94	94305	5418.7917	1900	-0.052	49.460	46.706	47.156	0.001	0.001
907	11	1	94	94305	5418.8333	2000	-0.044	49.046	46.688	47.120	0.001	0.001
907	11	1	94	94305	5418.8750	2100	-0.046	47.372	44.076	44.427	0.001	0.001
907	11	1	94	94305	5418.9167	2200	-0.045	47.102	44.384	44.427	0.001	0.002
907	11	1	94	94305	5418.9583	2300	-0.046	48.182	46.076	46.040	0.001	0.002

Figure A6: *WEEK.DAT datafile.

PLOTCDC.BAT


```
@echo off
cls
echo using plotcdc.bat
rem checking for proper input format
if "%1"=="" goto error
if "%2"=="" goto error
if "%3"=="" goto error

echo cd \plots\process
cd \plots\process

rem WHEN CHANGING FROM STANDARD TIME TO DAYLIGHT SAVINGS TIME OR
rem VICE VERSA:

rem IN APRIL:
rem Make appropriate manual adjustments to the 200 hour on Sunday (rename
rem 200 to 300, 300 to 400 etc. until the end of the raw file).
```

```
rem After the changes, treat the file as if it is still standard time in
rem April for that week only.
rem Next week, use daylight savings routine.

rem IN OCTOBER:
rem Begin .raw file from 2300 and end with 2200.  In .raw file,
rem cut all hours from Sunday @ 200 to the end of the file and paste
rem onto the 100 hour above.  Run as if still in daylight savings time
rem for that week only.  Next week, use standard time routine.

rem During standard time, begin the raw file with 0 and end with 2300.
rem During daylight savings time, begin raw file with 2300 and end with 2200.

rem USE THIS FILE DURING DAYLIGHT SAVINGS TIME
rem if "%1"=="907" call \plots\util\for_edt %1 %2

rem USE THIS FILE DURING STANDARD TIME
if "%1"=="907" call \plots\util\for_est %1 %2

if not exist %3.cht echo •[1;5m%3.cht does not exist!•[0m

rem Using Archive to put into Loanstar format
echo archive %1%2.dat %3.cht

archive \plots\process\%1%2.dat %3.cht

echo cd \plots\process
cd \plots\process

if not exist %1%2.dat echo 1;5m%1%2.dat does not exist!

rem Checking for missing data
echo missing %1%2.ach %1%2.acs
missing %1%2.ach %1%2.acs

rem Checking for duplicate records
gawk -f \plots\util\chk_dup.awk %1%2.acs > %1%2.dup

gawk -f \plots\util\%1sum.awk %1%2.dup > \temp\summary.dat

list %1%2.dup

echo calling on \plots\util\%1graph %1 %2
call \plots\util\%1graph %1 %2
```

```
goto done

:error
echo          #1      #2      #3
echo Usage: plotcdc site_num YYDDD YYDDD(channel)
goto done

:error2
echo ERROR - %1%2.raw does not exist

:done
```

Figure B1: PLOTCDC.BAT master batch file.

FOR_EST.BAT

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```
@echo entering Forrestal processing (standard time)
@echo off

echo site #%1
echo file #%2
if "%2"=="" goto error

echo using gawk with the raw data . . .

if not exist \plots\util\raw-dat1.awk echo \plots\util\raw-dat1.awk doesn't exist!
if not exist %1%2.raw echo %1%2.raw exists

echo gawk -f \plots\util\raw-dat1.awk %1%2.raw [to] %1%2.tem
gawk -f \plots\util\raw-dat1.awk %1%2.raw > %1%2.tem

if not exist \plots\util\raw-dat2.awk echo \plots\util\raw-dat2.awk doesn't exist!
if exist %1%2.tem echo %1%2.tem exists
```

```
echo gawk -f raw-dat2.awk %1%2.tem [to] %1%2.dat
gawk -f \plots\util\raw-dat2.awk %1%2.tem > %1%2.da1

echo converting Celsius to Fahrenheit
gawk -f \plots\util\tempconv.awk %1%2.da1 > %1%2.dat
del %1%2.da1

del %1%2.tem

cd \plots\util
goto done

:error
echo USAGE: process filename(YYDDD)
:done

echo leaving Forrestal processing
```

Figure B2: FOR_EST.BAT Forrestal CDC Eastern Standard Time data processing batch file.

FOR_EDT.BAT

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```
@echo entering Forrestal processing (daylight savings time)
@echo off

echo site #%1
echo file #%2
if "%2"=="" goto error

echo Using gawk on the raw data . . .

if not exist \plots\util\raw-dat1.awk echo \plots\util\raw-dat1.awk doesn't exist!
if not exist %1%2.raw echo %1%2.raw exists

rem Removing the commas from the raw file
echo gawk -f \plots\util\raw-dat1.awk %1%2.raw [to] %1%2.tem
gawk -f \plots\util\raw-dat1.awk %1%2.raw > %1%2.tem

if not exist \plots\util\raw-dat2.awk echo \plots\util\raw-dat2.awk doesn't exist!
```

```
if exist %1%2.tem echo %1%2.tem exists

rem Preparing the data for Archive
echo gawk -f raw-dat2.awk %1%2.tem [to] %1%2.dat
gawk -f \plots\util\raw-dat2.awk %1%2.tem > %1%2.da1

echo converting Celsius to Fahrenheit
gawk -f \plots\util\tempconv.awk %1%2.da1 > %1%2.dat

del %1%2.da1

echo converting to daylight savings time
gawk -f \plots\util\daylight.awk %1%2.dat > %1%2.tmp

del %1%2.dat

echo converting 2400 hours to 0 hours
gawk -f \plots\util\2300.awk %1%2.tmp > %1%2.un
gawk -f \plots\util\daycorr.awk %1%2.un > %1%2.dat

del %1%2.tmp
del %1%2.un

del %1%2.tem

cd \plots\util
goto done

:error
echo USAGE: process filename(YYDDD)
:done

echo leaving Forrestal processing
```

Figure B2: FOR_EDT.BAT Forrestal CDC Eastern Daylight Time data processing batch file.

*GRAPH.BAT

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```
@echo off
echo entering 907graph.bat

echo Processing data for Forrestal CDC Campbell datalogger
rem Checks for proper input variables
if "%1"=="" goto error
if "%2"=="" goto error

cd \plots\process

echo copy \plots\process\%1%2.acs %1week.dat
copy \plots\process\%1%2.acs \temp\%1week.dat > nul

rem Updates the batch file with the new week
echo gawk -f \plots\util\%1date.awk %1%2.acs [to] \plots\util\%1chgrf.bat
gawk -f \plots\util\%1date.awk %1%2.acs > \plots\util\%1chgrf.bat
```

```
if not exist \plots\util\%1chgrf.bat echo \plots\util\%1chgrf.bat not exist!!!!!

rem Copies the Grapher source files to .GRF files for use by Grapher
copy \plots\util\grfsrc\t%1*.src \temp\*.*

cd \temp

rem Changing the date on each graph
call \plots\util\%1chgrf t%1_01
call \plots\util\%1chgrf t%1_02
call \plots\util\%1chgrf t%1_03
call \plots\util\%1chgrf t%1_04
call \plots\util\%1chgrf t%1_05
call \plots\util\%1chgrf t%1_06
call \plots\util\%1chgrf t%1_07
call \plots\util\%1chgrf t%1_08
call \plots\util\%1chgrf t%1_09
call \plots\util\%1chgrf t%1_10
copy \plots\util\grfsrc\t%1_11.src \temp\t%1_11.grf
call \plots\util\%1chgrf t%1_12
call \plots\util\%1chgrf t%1_13a
copy \plots\util\grfsrc\t%1_14.src \temp\t%1_14.grf
copy \plots\util\grfsrc\t%1_15.src \temp\t%1_15.grf
call \plots\util\%1chgrf t%1_16a
copy \plots\util\grfsrc\t%1_17.src \temp\t%1_17.grf
call \plots\util\%1chgrf t%1_21
copy \plots\process\45.dat \temp\45.dat
echo ------------------------------------------------------------------------
echo Generating plot files

grapher t%1_01.grf
echo.
grapher t%1_02.grf
echo.
grapher t%1_03.grf
echo.
grapher t%1_04.grf
echo.
grapher t%1_05.grf
echo.
grapher t%1_06.grf
echo.
grapher t%1_07.grf
echo.
grapher t%1_08.grf
```

```
echo.
grapher t%1_09.grf
echo.
grapher t%1_10.grf
echo.
grapher t%1_11.grf
echo.
grapher t%1_12.grf
echo.
grapher t%1_13a.grf
echo.
grapher t%1_14.grf
echo.
grapher t%1_15.grf
echo.
grapher t%1_16a.grf
echo.
grapher t%1_17.grf
echo.
grapher t%1_21.grf
echo.

rem This positions the graphs on one page
copy \plots\util\a.plt + t%1_01.plt + \plots\util\b.plt + t%1_02.plt %1temp1.plt >nul
copy \plots\util\b.plt + t%1_03.plt + \plots\util\c.plt + t%1_04.plt %1temp2.plt >nul
copy \plots\util\b.plt + t%1_05.plt + \plots\util\b.plt + t%1_06.plt %1temp3.plt >nul
copy %1temp1.plt + %1temp2.plt + %1temp3.plt %1plot1.plt > nul

copy \plots\util\c.plt + t%1_07.plt + \plots\util\b.plt + t%1_08.plt %1temp4.plt >nul
copy \plots\util\b.plt + t%1_09.plt + \plots\util\c.plt + t%1_10.plt %1temp5.plt >nul
copy %1temp4.plt + %1temp5.plt %1plot2.plt > nul

copy %1plot1.plt + %1plot2.plt %1one.plt > nul

rem doing summary plot page . . .
copy \plots\util\a.plt + t%1_11.plt + \plots\util\b.plt + t%1_12.plt %1temp1a.plt >nul
copy \plots\util\b.plt+t%1_13a.plt+\plots\util\c.plt + t%1_14.plt %1temp2a.plt >nul
copy \plots\util\b.plt + t%1_15.plt + \plots\util\b.plt + t%1_16a.plt %1temp3a.plt >nul

copy %1temp1a.plt + %1temp2a.plt + %1temp3a.plt %1plot1a.plt > nul

copy \plots\util\c.plt + t%1_17.plt + \plots\util\b.plt + \plots\util\b.plt %1temp4a.plt >nul
copy \plots\util\c.plt + \plots\util\b.plt+ \plots\util\b.plt +t%1_21.plt %1temp5a.plt >nul
copy %1temp4a.plt + %1temp5a.plt %1plot2a.plt > nul
```

```
copy %1plot1a.plt + %1plot2a.plt %1two.plt > nul

echo Complete
echo ------------------------------------------------------------------------

echo Creating Postscript file #1

view %1one.plt
view %1two.plt

cls
echo Do you want to plot %1one.plt?  CTRL+C for "no"...
pause > nul

rem Plotting the files
plot %1one.plt /b

echo Do you want to plot %1two.plt?  CTRL+C for "no"...
pause > nul
plot %1two.plt /b

echo Cleaning...
cd \temp

del %1plot?.* > nul
del %1temp?.plt > nul
del t%1*.plt > nul
del t%1*.grf > nul
del \plots\process\%1%2.ach > nul

goto done

:error
echo Usage: 907graph site# YYDDD

:done

echo Processing completed for the Forrestal CDC
cd \plots\process
del 907*.dat
del 907*.dup
del *.tem
del *.ach
del 907*.log
del dup.log
```

```
del missing.log

cd \temp
del *.src
del *.dat
del *.plt
cls
dir
```

Figure B3: *GRAPH.BAT graphing batch file.

907CHGRF..BAT

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```
gawk -v var1=11-1-1994 -v var2=5418 -f \plots\util\907chgrf.awk  %1.src  > %1.grf
```

Figure B4: Weekly time-series time stamp update batch file.

RAW-DAT1.AWK


```
{

gsub(/,/, " ",$0);

print $0;
}
```

Figure C1: RAW-DAT1.AWK to remove commas from .RAW file.

RAW-DAT2.AWK


```
{
y=$2-1900
hr=$4/100

# converting day of year to month
 if($3 <=31){
  m="1"}
 if($3 >=32 && $3 <=59){
  m="2"}
 if($3 >=60 && $3 <=90){
  m="3"}
 if($3 >=91 && $3 <=120){
  m="4"}
 if($3 >=121 && $3 <=151){
  m="5"}
 if($3 >=152 && $3 <=181){
  m="6"}
```

```
 if($3 >=182 && $3 <=212){
  m="7"}
 if($3 >=213 && $3 <=243){
  m="8"}
 if($3 >=244 && $3 <=273){
  m="9"}
 if($3 >=274 && $3 <=304){
  m="10"}
 if($3 >=305 && $3 <=334){
  m="11"}
 if($3 >=335 && $3 <=365){
  m="12"}

# converting day of year to day of month
 if($3 <=31){
  d=$3}
 if($3 >=32 && $3 <=59){
  d=$3-31}
 if($3 >=60 && $3 <=90){
  d=$3-59}
 if($3 >=91 && $3 <=120){
  d=$3-90}
 if($3 >=121 && $3 <=151){
  d=$3-120}
 if($3 >=152 && $3 <=181){
  d=$3-151}
 if($3 >=182 && $3 <=212){
  d=$3-181}
 if($3 >=213 && $3 <=243){
  d=$3-212}
 if($3 >=244 && $3 <=273){
  d=$3-243}
 if($3 >=274 && $3 <=304){
  d=$3-273}
 if($3 >=305 && $3 <=334){
  d=$3-304}
 if($3 >=335 && $3 <=365){
  d=$3-334}

print m,d,y,hr,"0",$5,$6,$7,$8,$9,$10,$11,$12,$13,$14;
}
```

Figure C2: RAW-DAT2.AWK Forrestal CDC date calculation.

TEMPCONV.AWK


```
{
tempa = ($7*9/5)+32

tempb = ($8*9/5)+32

tempc = ($9*9/5)+32

print $1,$2,$3,$4,$5,$6,tempa,tempb,tempc,$10,$11,$12,$13,$14,$15;
}
```

Figure C3: TEMPCONV.AWK to convert temperature from Celsius to Fahrenheit.

DAYLIGHT.AWK


```
{
time=$4+1;

print $1,$2,$3,time,$5,$6,$7,$8,$9,$10,$11,$12,$13,$14,$15;
}
```

Figure Ca: DAYLIGHT.AWK

2300.AWK


```
{
if ($4 == 24) time1=0
  else time1 =$4;
day = $2
if (time1 == 0) day=day+1
  else day = $2

print $1,day,$3,time1,$5,$6,$7,$8,$9,$10,$11,$12,$13,$14,$15;
}
```

Figure Cb: 2300.AWK

DAYCORR.AWK


```
{
mo=$1
day=$2
 if($1 == 1 && $2 == 32){
   mo = 2; day = 1}
 if($1 == 2 && $2 == 29){
   mo = 3; day = 1}
 if($1 == 3 && $2 == 32){
   mo = 4; day = 1}
 if($1 == 4 && $2 == 31){
   mo = 5; day = 1}
 if($1 == 5 && $2 == 32){
   mo = 6; day = 1}
 if($1 == 6 && $2 == 31){
   mo = 7; day = 1}
 if($1 == 7 && $2 == 32){
   mo = 8; day = 1}
```

```
 if($1 == 8 && $2 == 32){
   mo = 9; day = 1}
 if($1 == 9 && $2 == 31){
   mo = 10; day = 1}
 if($1 == 10 && $2 == 32){
   mo = 11; day = 1}
 if($1 == 11 && $2 == 31){
   mo = 12; day = 1}
 if($1 == 12 && $2 == 32){
   mo = 1; day = 1}

print mo,day,$3,$4,$5,$6,$7,$8,$9,$10,$11,$12,$13,$14,$15;
}
```

Figure Cc: DAYCORR.AWK

CHK_DUP.AWK


```
BEGIN{
        flag = 0;
}

NF==0{
next;
}

flag==0{
        prev_time=$7;
        print$0;
        flag++;
}

flag!=0{
        curr_time=$7;
        if(prev_time==curr_time){
```

```
            print($6) > "dup.log";
            prev_time = curr_time;
            next;
        }

        print$0;
        prev_time = curr_time;
}
```

Figure C4: CHK_DUP.AWK to check for duplicate records.

907SUM.AWK

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```
{
dec = $6
solar = $8
temp = $9
modave = ($10+$11)/2
acelec = $16+$17
print dec,solar,temp,modave,acelec;
}
```

Figure C5: 907SUM.AWK to organize columns for plotting.

907DATE.AWK


```
/* This awk script get the date string (mm-dd-yyyy) and decimal date (xxxx) */
/*  from the *.acs file */
/* The output from this file is a command string which will change the date */
/*  in X-Axis label and also change the starting value */

NR == 1 {
  var1 = $2"-"$3"-19"$4;
  var2 = " \\plots\\util\\907chgrf.awk ";
  var3 = " %1.src ";
  var4 = " > %1.grf ";
  printf("gawk -v var1=%s -v var2=%d -f %s %s %s\n",var1,$6,var2,var3,var4);
}
```

Figure C6: 907DATE.AWK to calculate date string.

907CHGRF.AWK

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```
{
 gsub(/Site 907 Beginning/,"Site 907 Beginning " var1);
 if (NR == 12) printf("%f %f %s %s %s \n",var2,var2+7,$3,$4,$5);
 else print$0;
}
```

Figure C7: 907CHGRF.AWK writes datestring into GRAPHER source file.

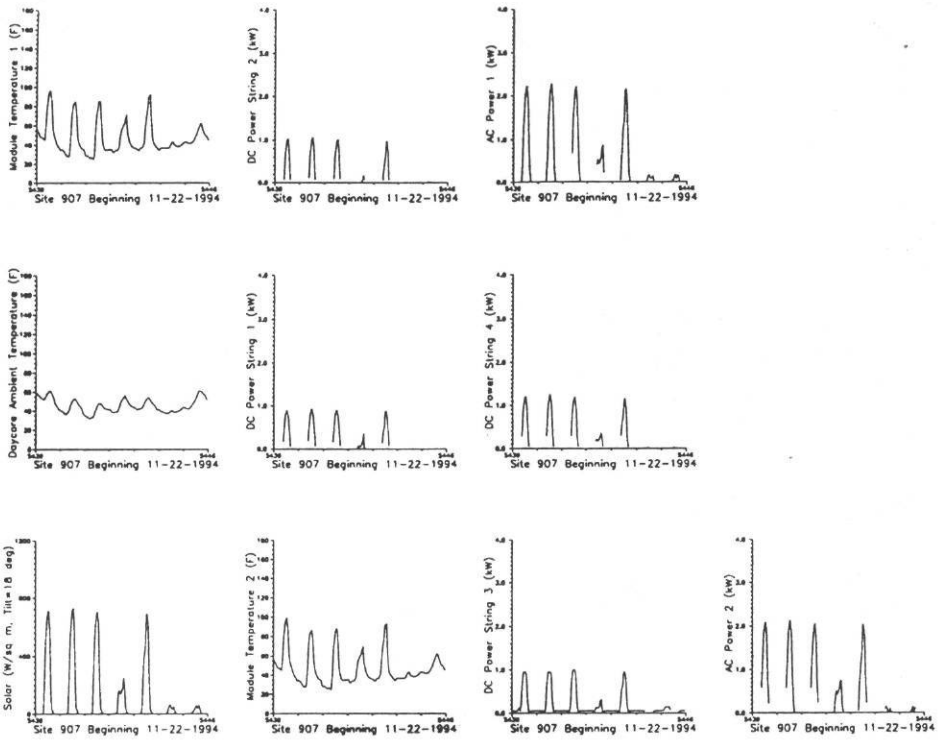


Figure D1: Plot of each logger channel.

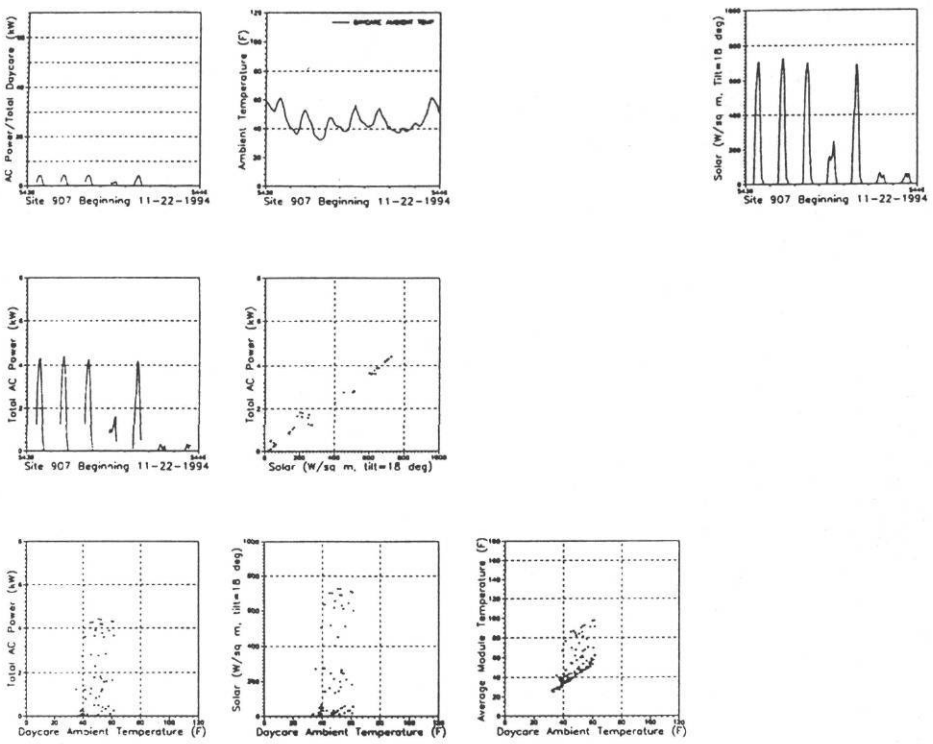


Figure D2: (a) USDOE Summary plot.

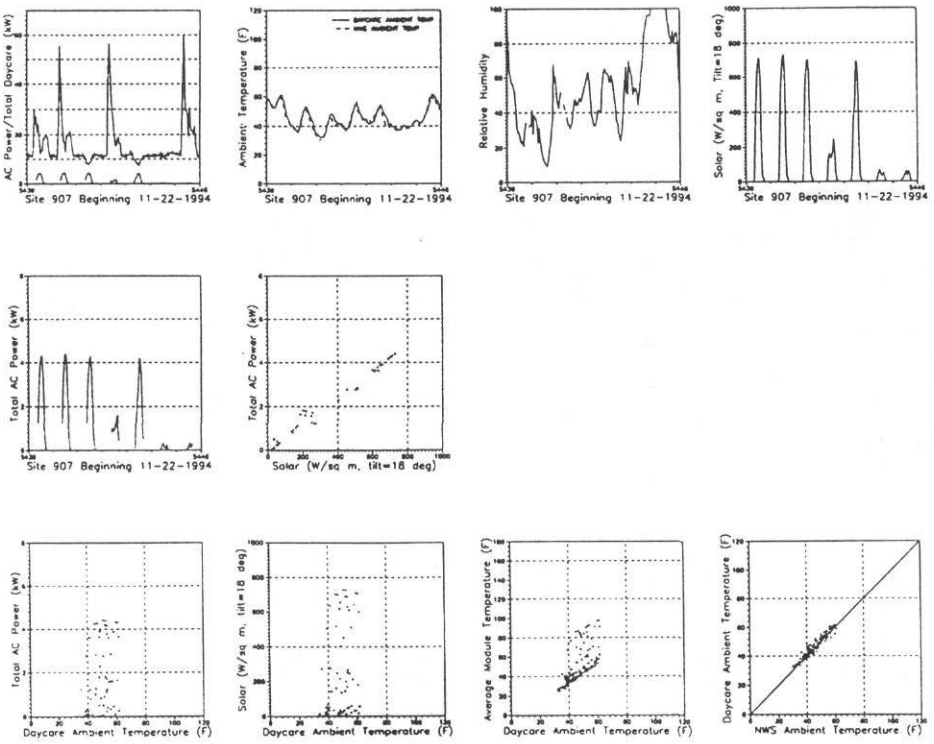


Figure D2: (b) Summary plot.

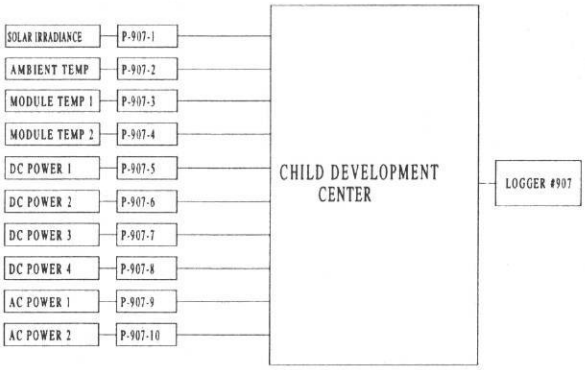
Field	Description	Unit
1	Record ID	
2	Year	
3	Julian Date	
4	Time	HHmm
5	Hourly average plane of array irradiance	W/m2
6	Hourly average ambient temperature	°C
7	Hourly average module temperature 1	°C
8	Hourly average module temperature 2	°C
9	Hourly average DC power string 1	kW
10	Hourly average DC power string 2	kW
11	Hourly average DC power string 3	kW
12	Hourly average DC power string 4	kW
13	Hourly average AC power 1	kW
14	Hourly average AC power 2	kW
15	Time field (used internally by datalogger)	
16	Date field (used internally by datalogger)	

Figure E1 (a) Forrestal CDC parameter set.

Field	Description	Unit
1	Record ID	
2	Year	
3	Julian Date	
4	Time	HHmm
5	Hourly average plane of array irradiance	W/m2
6	Hourly average ambient temperature	°C
7	Hourly average module temperature 1	°C
8	Hourly average module temperature 2	°C
9	Hourly average DC power string 1	kW
10	Hourly average DC power string 2	kW
11	Time field (used internally by datalogger)	
12	Date field (used internally by datalogger)	

Figure E1 (b) Germantown CDC parameter set.

FORRESTAL MONITORING DIAGRAM



GERMANTOWN MONITORING DIAGRAM

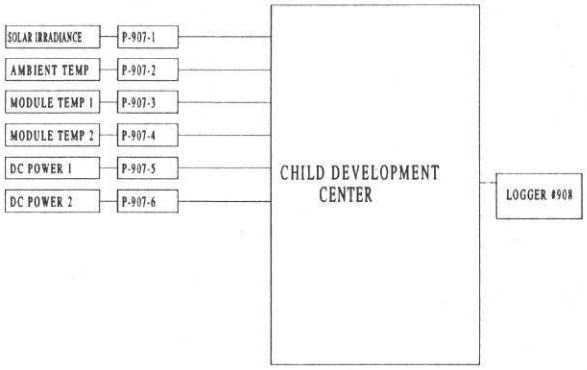


Figure E2: CDC monitoring diagrams.

APPENDIX B CALIBRATED DOE-2 INPUT FILE

```
INPUT LOADS ..

TITLE   LINE-1 * ANALYSIS OF ENERGY CONSERVATION OPTIONS *
        LINE-2 * U.S.D.O.E. FORRESTAL CHILD DEVELOPMENT CENTER *
        LINE-3 * WASHINGTON, D.C. *
        LINE-4 * TEXAS A&M UNIVERSITY, TAREK BOU-SAADA * ..

       ABORT          ERRORS ..
       DIAGNOSTIC     CAUTIONS ..
       RUN-PERIOD     APR 1 1993 THRU DEC 21 1993 ..
       BUILDING-LOCATION LATITUDE=38.85   LONGITUDE=77.03
                         ALTITUDE=33      GROSS-AREA=8088
                         HOLIDAY=YES      DAYLIGHT-SAVINGS=YES
                         TIME-ZONE=5      AZIMUTH=0
                         GROUND-T= (53,53,53,54,54,55,55,55,54,54,53,53)
..

      LOADS-REPORT
      VERIFICATION=(LV-C,LV-D,LV-H,LV-I)
      SUMMARY=(LS-C) ..

$ INTERIOR EQUIPMENT LOADS SCHEDULE
$ ----------------------------------------------------------

SCH-1     =DAY-SCHEDULE (1,7) (.4) (8,12) (.3) (13) (.3) (14) (.2) (15,16) (.2)
            (17,20) (.2) (21) (.5) (22) (.45) (23,24) (.4) ..
SCH-2     =DAY-SCHEDULE (1) (.4) (2,6) (.55) (7,18) (.8) (19,24) (.35) ..
SCH-3     =DAY-SCHEDULE (1,6) (.4) (7,20) (.7) (21) (.5) (22) (.4) (23,24) (.35) ..
SCH-4     =DAY-SCHEDULE (1,5) (.25) (6,16) (.1) (17,20) (.2) (21,24) (.25) ..

INT-LDS-1  =SCHEDULE THRU SEP 15  (MON,FRI) SCH-4
                                  (WEH) SCH-3
                          THRU DEC 31 (MON,FRI) SCH-1
                                  (WEH) SCH-2 ..

$ INFILTRATION SCHEDULE
$ ------------------------------------
INF-SCH-1  =DAY-SCHEDULE (1,6) (.2) (7,21) (.2) (22,24) (.2) ..
INF-SCH-3  =DAY-SCHEDULE (1,24) (.25) ..

INFIL-SCH-1 =SCHEDULE THRU DEC 27 (MON,FRI) INF-SCH-1
                                  (WEH) INF-SCH-3
                          THRU DEC 31 (ALL) INF-SCH-3 ..

$ HOT WATER SCHEDULE
$ ---------------------------------
HT-WTR-1   =DAY-SCHEDULE (1,6) (.2) (7,18) (.1) (19,24) (.2) ..
HT-WTR-2   =DAY-SCHEDULE (1,6) (.3) (7,18) (.55) (19,24) (.3) ..
HT-WTR-3   =DAY-SCHEDULE (1,6) (.25) (7,13) (.3) (14,18) (.25) (19,21) (.2)
                         (22,24) (.1) ..

HOT-WATER-1 =SCHEDULE    THRU APR 15 (MON,FRI) HT-WTR-3
                                  (WEH) HT-WTR-2
                         THRU DEC 31 (MON,FRI) HT-WTR-1
                                  (WEH) HT-WTR-2 ..
$ LIGHTS SCHEDULE
$ -------------------------
LSCH-1     =DAY-SCHEDULE (1,6) (.2) (7) (.3) (8,12) (.45) (13) (.35) (14) (.3) (15)
             (.35) (16,18) (.5) (19) (.3) (20) (.25) (21) (.2) (22) (.2) (23,24) (.2) ..
LSCH-2     =DAY-SCHEDULE (1,24) (.2) ..
LSCH-3     =DAY-SCHEDULE (1,6) (.2) (7) (.4) (8,12) (.45) (13) (.45) (14) (.35) (15)
             (.3) (16,19) (.35) (20,24) (.2) ..
LSCH-4     =DAY-SCHEDULE (1,24) (0) ..

INT-LIGHT-1 =SCHEDULE THRU SEP 15 (MON,FRI) LSCH-1
                                  (WEH) LSCH-2
                          THRU DEC 26 (MON,FRI) LSCH-3
                                  (WEH) LSCH-2 ..

$ BASED ON SUNRISE/SUNSET TIMES $
EXT-LIGHT-1 =SCHEDULE THRU JAN 31 (ALL) (1,7) (1) (8,17) (0) (18,24) (1)
                      THRU FEB 28 (ALL) (1,7) (1) (8,17) (0) (18,24) (1)
                      THRU MAR 31 (ALL) (1,6) (1) (7,18) (0) (19,24) (1)
                      THRU APR 30 (ALL) (1,5) (1) (6,19) (0) (20,24) (1)
                      THRU MAY 31 (ALL) (1,5) (1) (6,19) (0) (20,24) (1)
                      THRU JUN 30 (ALL) (1,5) (1) (6,19) (0) (20,24) (1)
                      THRU JUL 31 (ALL) (1,5) (1) (6,19) (0) (20,24) (1)
                      THRU AUG 31 (ALL) (1,5) (1) (6,19) (0) (20,24) (1)
                      THRU SEP 30 (ALL) (1,5) (1) (6,19) (0) (20,24) (1)
                      THRU OCT 31 (ALL) (1,5) (1) (6,18) (0) (19,24) (1)
                      THRU NOV 30 (ALL) (1,7) (1) (8,18) (0) (19,24) (1)
                      THRU DEC 31 (ALL) (1,7) (1) (8,17) (0) (18,24) (1) ..

$ OCCUPANCY SCHEDULE BASED ON INTERVIEWS $
D-1     =DAY-SCHEDULE    (1,6) (0) (7) (.1) (8,19) (.85) (20) (.05) (21,24) (0) ..
D-2     =DAY-SCHEDULE    (1,24) (0) ..

PEOPLE-WEEK=SCHEDULE   THRU DEC 31 (MON,FRI) D-1
                                  (WEH) D-2 ..

$ ROOF MATERIALS
$ -------------------------
RF-MEMB-1    =MAT TH=.0050 COND=.830 DENS=55   S-H=.40 ..
RF-RIGID-INS-1=MAT TH=.0833 COND=.020 DENS=1.8  S-H=.29 ..
PL-RIGID-INS-1=MAT TH=.1667 COND=.020 DENS=1.8  S-H=.29 ..
RF-MTL-DECK-1 =MAT TH=.0052 COND=28  DENS=488.6 S-H=.12 ..
RF-BATT-INS-1 =MAT RES=30 ..

$ CEILING MATERIALS
$ ----------------------------
RF-CEIL-TILE-1=MAT TH=.0625 COND=.033 DENS=18   S-H=.32 ..

$ WALL MATERIALS
$ -------------------------
WL-BRICK-1   =MAT TH=.0417 COND=.4167 DENS=130 S-H=.22 ..
WL-GYP-OUT-1 =MAT TH=.0521 COND=.0667 DENS=34 S-H=.29 ..
WL-BATT-INS-1 =MAT RES=13 ..
WL-GYP-IN-1  =MAT TH=.0521 COND=.0667 DENS=34 S-H=.29 ..

$ FLOOR MATERIALS
$ --------------------------
FL-CARP/PAD-1 =MAT RES=2.08 ..
FL-CONC-1 =MAT TH=.3333 COND=.0751  DENS=30 S-H=.2 ..
FL-INS-1 =MAT RES=15.4 ..

$ CRAWLSPACE MATERIALS
$ ------------------------------------
FL-GRAVEL-1  =MAT TH=.5 COND=.8340 DENS=55 S-H=.4 ..
WL-RIGID-INS-1 =MAT TH=.2500 COND=.020 DENS=1.8  S-H=.29 ..

$ GLAZING
$ ------------
GT-WIN-1  =GLASS-TYPE  PANES=2  S-C=.71 ..
GT-WIN-2  =GLASS-TYPE  PANES=2  S-C=.82 ..

$ CONSTRUCTIONS
$ -------------------------
LAY-1 =LAYERS    MAT=(RF-BATT-INS-1) I-F-R=.68 ..
RF-1 =CONS       LAYERS=LAY-1  ABS=.5 ..
LAY-2 =LAYERS    MAT=(RF-CEIL-TILE-1) I-F-R=.68 ..
CLG-1 =CONS      LAYERS=LAY-2 ..
LAY-3 =LAYERS    MAT=(WL-BRICK-1,WL-GYP-OUT-1,WL-  BATT-INS-1,WL-
                  GYP-IN-1) I-F-R=.68 ..
BK-1 =CONS       LAYERS=LAY-3 ROUGHNESS=2 ABS=.85 ..
LAY-4 =LAYERS    MAT=(FL-CARP/PAD-1,FL-CONC-1,FL-INS-1) I-F-R=0.92 ..
FLR-1 =CONS      LAYERS=LAY-4 ..
LAY-5 =LAYERS    MAT=(FL-GRAVEL-1) I-F-R=.92 ..
CRWLSP-FL-1 =CONS LAYERS=LAY-5 ..
LAY-6 =LAYERS    MAT=(WL-RIGID-INS-1) I-F-R=.68 ..
CRWLSP-WL-1=CONS LAYERS=LAY-6 ..
LAY-7 =LAYERS    MAT=(WL-BRICK-1,WL-GYP-OUT-1, PL-RIGID-INS-1) I-F-
                  R=.68 ..
PL-WL-1 =CONS    LAYERS=LAY-7 ..
DR-1 =CONS       U=.4 ABS=.78 ROUGHNESS=5 ..

$ SHADE SCHEDULE
$ -------------------------
TREESHADE=SCHEDULE   THRU MAR 31 (ALL) (1,24) (.8)
                     THRU SEP 30 (ALL) (1,24) (.2)
                     THRU DEC 31 (ALL) (1,24) (.8) ..

$ BUILDING SHADE
$ ------------------------

SLRPNLS-1=BUILDING-SHADE        X=54  Y=75  Z=13.1
                                H=6.667  W=52.25
                                AZ=0  TILT=162 ..

SLRPNLS-2=BUILDING-SHADE        X=54  Y=82  Z=13.1
                                H=6.667  W=52.25
                                AZ=0  TILT=162 ..

SLRPNLS-3=BUILDING-SHADE        X=54  Y=89  Z=13.1
                                H=6.667  W=52.25
                                AZ=0  TILT=162 ..

SRTSHADE-1=BUILDING-SHADE       X=48.281  Y=-4  Z=6.667
                                H=4  W=20
                                AZ=180  TILT=0 ..

SLTSHADE-1=BUILDING-SHADE       X=3.281  Y=-4  Z=6.667
                                H=4  W=20
                                AZ=180  TILT=0 ..

WESTWALL-1=BUILDING-SHADE       X=-15  Y=-30  Z=0
                                H=4  W=181
                                AZ=90 TILT=90 ..

CENTPLANT=BUILDING-SHADE        X=-150  Y=40  Z=0
                                H=50  W=120
                                AZ=90  TILT=90 ..
```

```
OFFICE-W=BUILDING-SHADE          X=290 Y=460 Z=0
                                 H=100 W=330
                                 AZ=270 TILT=90 ..

OFFICE-S=BUILDING-SHADE          X=290 Y=130 Z=0
                                 H=100 W=290
                                 AZ=180 TILT=90 ..

CAFETERIA=BUILDING-SHADE         X=-50 Y=200 Z=0
                                 H=30 W=120
                                 AZ=180 TILT=90 ..

FORRESTAL=BUILDING-SHADE         X=-130 Y=540 Z=0
                                 H=75 W=620
                                 AZ=180 TILT=90 ..

POSTOFFICE=BUILDING-SHADE        X=0 Y=-330 Z=0
                                 H=160 W=120
                                 AZ=180 TILT=90 ..

WEST-TREES=BUILDING-SHADE        X=-20 Y=50 Z=0
                                 H=20 W=150
                                 AZ=90 TILT=90
                                 SHADE-SCHEDULE=TREESHADE ..

SOUTH-TREES=BUILDING-SHADE       X=-20 Y=-30 Z=0
                                 H=20 W=130
                                 AZ=180 TILT=90
                                 SHADE-SCHEDULE=TREESHADE ..

EAST-TREES=BUILDING-SHADE        X=110 Y=-30 Z=0
                                 H=20 W=70
                                 AZ=90 TILT=90
                                 SHADE-SCHEDULE=TREESHADE ..

$ ZONE-1 SPACE DESCRIPTION
$ ----------------------------------------

COND-1   =SPACE-CONDITIONS  FLOOR-WEIGHT=30
                 LIGHTING-SCHEDULE=INT-LIGHT-1
                 LIGHTING-TYPE=REC-FLUOR-RV
                 LIGHTING-KW=2.764
                 LIGHT-TO-SPACE=0.80
                 TASK-LIGHT-SCH=INT-LIGHT-1
                 TASK-LIGHTING-KW=.238
                 PEOPLE-SCHEDULE=PEOPLE-WEEK
                 PEOPLE-HG-SENS=250
                 PEOPLE-HG-LAT=200
                 NUMBER-OF-PEOPLE=10
                 TEMPERATURE=(75)
                 EQUIP-SCHEDULE=INT-LDS-1
                 EQUIPMENT-KW=0.5
                 INF-METHOD=AIR-CHANGE
                 AIR-CHANGES/HR=.6
                 INF-SCHEDULE=INFIL-SCH-1 ..

ZONE-1  =SPACE           A=1998 V=23967 S-C=COND-1 ..

FRONT-WL-1A=E-W          H=13.333 W=27 X=45 Y=0
                         AZ=180 CONS=BK-1 ..

 W-8    =WI              H=4 W=4 X=19.281 Y=2.667 G-T=GT-WIN-1 ..
 W-9    =WI              LIKE W-8 X=15.281 ..
 W-10   =WI              LIKE W-8 X=11.281 ..
 W-11   =WI              LIKE W-8 X=7.281 ..
 W-12   =WI              LIKE W-8 X=3.281 ..

FRONT-WL-1B=E-W          H=7.833 W=9 X=36 Y=0
                         AZ=180 CONS=BK-1 ..

RIGHT-WL-1=E-W           H=13.333 W=21 X=72 Y=0
                         AZ=90 CONS=BK-1 ..

 W-7    =WI              H=4 W=5.33
                         X=11.583 Y=2.667 G-T=GT-WIN-1 ..

RIGHT-WL-2=E-W           H=7.833 W=13.5 X=72 Y=21
                         AZ=90 CONS=BK-1 ..

 D-19   =DOOR            H=6.67 W=3 X=8.67 Y=0 CONS=DR-1 ..
 W-4D   =WI              H=4.167 W=2.33 X=9 Y=1.25 G-T=GT-WIN-1 ..
 W-5D   =WI              H=4.167 W=2.33 X=5.67 Y=1.25 G-T=GT-WIN-1 ..
 D-20   =DOOR            H=6.67 W=3 X=5.33 Y=0 CONS=DR-1 ..

RIGHT-WL-3=E-W           H=13.333 W=21 X=72 Y=34.5
                         AZ=90 CONS=BK-1 ..

 W-6    =WI              H=4 W=5.33 X=4.083 Y=2.667 G-T=GT-WIN-1 ..

BACK-WL-1A =E-W          H=2.917 W=27 X=72 Y=21 Z=10.42
                         AZ=0 CONS=BK-1 ..

 CW-1   =WI              H=1.5 W=4 X=19.281 Y=1.667 G-T=GT-WIN-2 ..
 CW-1A  =WI              LIKE CW-1 X=15.281 ..
 CW-2   =WI              LIKE CW-1 X=11.281 ..
 CW-2A  =WI              LIKE CW-1 X=7.281 ..
 CW-3   =WI              LIKE CW-1 X=3.281 ..

FRONT-WL-1D = E-W        H=2.917 W=27 X=45 Y=34.5 Z=10.42
                         AZ=180 CONS=BK-1 ..

BACK-WL-1D =E-W          H=2.917 W=3 X=48 Y=55.5 Z=10.42
                         AZ=0 CONS=BK-1 ..

BACK-WL-1DD =E-W         H=13.333 W=24 X=72 Y=55.5
                         AZ=0 CONS=BK-1 ..

 W-3    =WI              H=4 W=4 X=19.281 Y=2.667 G-T=GT-WIN-1 ..
 W-4    =WI              LIKE W-3 X=11.281 ..
 W-5    =WI              LIKE W-3 X=3.281 ..
 CW-7   =WI              H=1.5 W=7 X=3.281 Y=11.667 G-T=GT-WIN-2 ..
 CW-8   =WI              LIKE CW-7 W=4 X=11.281 ..
 CW-9   =WI              LIKE CW-7 X=16.281 ..

$ ZONE-2 SPACE DESCRIPTION
$ ----------------------------------------

COND-2   =SPACE-CONDITIONS  LIKE COND-1
                 LIGHTING-KW=3.101
                 TASK-LIGHTING-KW=.282
                 EQUIPMENT-KW=0.75 ..

ZONE-2  =SPACE           A=1998 V=23967 S-C=COND-2 ..

FRONT-WL-2A=E-W          H=13.333 W=27 X=0 Y=0
                         AZ=180 CONS=BK-1 ..

 W-13   =WI              H=4 W=4 X=19.281 Y=2.667 G-T=GT-WIN-1 ..
 W-14   =WI              LIKE W-13 X=15.281 ..
 W-15   =WI              LIKE W-13 X=11.281 ..
 W-16   =WI              LIKE W-13 X=7.281 ..
 W-17   =WI              LIKE W-13 X=3.281 ..

FRONT-WL-2B=E-W          H=7.833 W=9 X=27 Y=0
                         AZ=180 CONS=BK-1 ..

LEFT-WL-1 =E-W           H=13.333 W=21 X=0 Y=21
                         AZ=270 CONS=BK-1 ..

 W-18   =WI              H=4 W=5.33 X=4.083 Y=2.667 G-T=GT-WIN-1 ..

LEFT-WL-2 =E-W           H=7.833 W=13.5 X=0 Y=34.5
                         AZ=270 CONS=BK-1 ..

 D-29   =DOOR            H=6.67 W=3 X=2 CONS=DR-1 ..
 W-6D   =WI              H=4.167 W=2.33 X=2.33 Y=1.5 G-T=GT-WIN-1 ..
 W-7D   =WI              H=4.167 W=2.33 X=7.67 Y=1.5 G-T=GT-WIN-1 ..
 D-30   =DOOR            H=6.67 W=3 X=7.33 Y=0 CONS=DR-1 ..

LEFT-WL-3 =E-W           H=13.333 W=21 X=0 Y=55.5
                         AZ=270 CONS=BK-1 ..

 W-19   =WI              H=4 W=5.33 X=11.583 Y=2.667 G-T=GT-WIN-1 ..

BACK-WL-2A =E-W          H=2.917 W=27 X=27 Y=21 Z=10.42
                         AZ=0 CONS=BK-1 ..

 CW-4   =WI              H=1.5 W=4 X=19.281 Y=1.667 G-T=GT-WIN-2 ..
 CW-4A  =WI              LIKE CW-4 X=15.281 ..
 CW-5   =WI              LIKE CW-4 X=11.281 ..
 CW-5A  =WI              LIKE CW-4 X=7.281 ..
 CW-6   =WI              LIKE CW-4 X=3.281 ..

FRONT-WL-2D =E-W         H=2.917 W=27 X=0 Y=34.5 Z=10.42
                         AZ=180 CONS=BK-1 ..

BACK-WL-2D =E-W          H=2.917 W=27 X=27 Y=55.5 Z=10.42
                         AZ=0 CONS=BK-1 ..

 CW-10  =WI              H=1.5 W=4 X=17.75 Y=1.667 G-T=GT-WIN-2 ..
 CW-10A =WI              LIKE CW-10 X=11.75 ..
 CW-10B =WI              LIKE CW-10 X=7.75 ..
 CW-11  =WI              LIKE CW-10 X=3.75 ..

$ ZONE-3 SPACE DESCRIPTION
$ ----------------------------------------

COND-3   =SPACE-CONDITIONS  LIKE COND-1
                 LIGHTING-KW=4.794
                 TASK-LIGHTING-KW=.91
                 EQUIPMENT-KW=5.1
```

```
                EQUIP-SENSIBLE=.89
                EQUIP-LATENT=.11 ..

ZONE-3  =SPACE          A=2988 V=23406 S-C=COND-3 ..

FRONT-WL-3A=E-W         H=7.833 W=7 X=48 Y=65.5
                        AZ=180 CONS=BK-1 ..

 D-11   =DOOR           H=6.67 W=3.5 X=.5 Y=0 CONS=DR-1 ..
 W-2D   =WI             H=.833 W=.833 X=1.5 Y=4 G-T=GT-WIN-1 ..

RIGHT-WL-4=E-W          H=7.833 W=10 X=48 Y=55.5
                        AZ=90 CONS=BK-1 ..
 D-12   =DOOR           H=6.67 W=2.5 X=2 Y=0 CONS=DR-1 ..

RIGHT-WL-5=E-W          H=7.833 W=36 X=55 Y=65.5
                        AZ=90 CONS=BK-1 ..

 W-1    =WI             H=6 W=4 X=27.042 Y=1 G-T=GT-WIN-1 ..
 W-2    =WI             LIKE W-1 X=7.25 ..

RIGHT-WL-6=E-W          H=7.833 W=11 X=48 Y=101.5
                        AZ=90 CONS=BK-1 ..

 W-29   =WI             H=4 W=4 X=.75 Y=2.667 G-T=GT-WIN-1 ..

LEFT-WL-4 =E-W          H=7.833 W=57 X=0 Y=112.5
                        AZ=270 CONS=BK-1 ..

 W-20   =WI             H=3.33 W=4 X=37.5 Y=3 G-T=GT-WIN-1 ..
 W-21   =WI             H=4 W=4.67 X=17.5 Y=2.667 G-T=GT-WIN-1 ..
 D-42   =DOOR           H=6.67 W=3 X=49.33 Y=0 CONS=DR-1 ..
 W-8D   =WI             H=.833 W=.833 X=50.33 Y=4 G-T=GT-WIN-1 ..
 D-46   =DOOR           H=6.67 W=2.83 X=11.33 Y=0 CONS=DR-1 ..

BACK-WL-3A =E-W         H=7.833 W=7 X=55 Y=101.5
                        AZ=0 CONS=BK-1 ..

 D-1A   =DOOR           H=6.67 W=3 X=.5 Y=0 CONS=DR-1 ..
 W-1D   =WI             H=6 W=2.33 X=.67 Y=.67 G-T=GT-WIN-1 ..

$ ZONE-4 SPACE DESCRIPTION
$ ----------------------------------------
COND-4  =SPACE-CONDITIONS  LIKE COND-1
                LIGHTING-KW=1.670
                TASK-LIGHTING-KW=.120
                EQUIPMENT-KW=1.35 ..

ZONE-4  =SPACE          A=1104 V=14720 S-C=COND-4 ..

FRONT-WL-4A=E-W         H=2.917 W=40 X=0 Y=112.5 Z=10.42
                        AZ=180 CONS=BK-1 ..

FRONT-WL-4B=E-W         H=2.917 W=8 X=40 Y=112.5 Z=10.42
                        AZ=180 CONS=BK-1 ..

RIGHT-WL-7=E-W          H=13.333 W=23 X=48 Y=112.5
                        AZ=90 CONS=BK-1 ..

 W-27   =WI             H=4 W=4 X=13.5 Y=2.667 G-T=GT-WIN-1 ..
 W-28   =WI             LIKE W-27 X=1.5 ..

LEFT-WL-5 =E-W          H=13.333 W=23 X=0 Y=135.5
                        AZ=270 CONS=BK-1 ..

 W-22   =WI             H=4 W=4 X=18.25 Y=2.667 G-T=GT-WIN-1 ..
 W-23   =WI             LIKE W-22 X=7.25 ..

BACK-WL-4A =E-W         H=13.333 W=40 X=40 Y=135.5
                        AZ=0 CONS=BK-1 ..

 W-24   =WI             H=4 W=4 X=22.5 Y=2.667 G-T=GT-WIN-1 ..
 W-24A  =WI             LIKE W-24 X=14 ..
 W-25   =WI             H=2 W=4 X=14 Y=.667 G-T=GT-WIN-1 ..
 W-26   =WI             LIKE W-24 X=5.5 ..
 CW-12  =WI             H=1.5 W=4 X=22.5 Y=11.667 G-T=GT-WIN-2 ..
 CW-13  =WI             LIKE CW-12 W=8.83 X=12.5 ..
 CW-14  =WI             LIKE CW-12 W=5.67 X=5.5 ..
 D-56   =DOOR           H=6.67 W=3 X=32.33 Y=0 CONS=DR-1 ..
 W-10D  =WI             H=.833 W=.833 X=33.33 Y=4 G-T=GT-WIN-1 ..

BACK-WL-4B =E-W         H=13.333 W=8 X=48 Y=135.5
                        AZ=0 CONS=BK-1 ..

 D-59   =DOOR           H=6.67 W=3 X=5 Y=0 CONS=DR-1 ..
 W-11D  =WI             H=.833 W=.833 X=5 Y=0 G-T=GT-WIN-1 ..

$ PLENUM DESCRIPTION
$ --------------------------------

COND-5  =SPACE-CONDITIONS  ZONE-TYPE=UNCONDITIONED
                TEMPERATURE = (110) ..

PL-1A   =SPACE          ZONE-TYPE=UNCONDITIONED
                        A=567 V=945 S-C=COND-5 ..

FRPLE-WL-1A =E-W        H=1.667 W=27 X=45 Y=0 Z=13.333
                        AZ=180 CONS=BK-1 ..

BKPLE-WL-1A =E-W        H=1.667 W=27 X=72 Y=21 Z=13.333
                        AZ=0 CONS=BK-1 ..

RTPLE-WL-1 =E-W         H=1.667 W=21 X=72 Y=0 Z=13.333
                        AZ=90 CONS=BK-1 ..

CLG-1A  =I-W            AREA=567 CONS=RF-1
                        NEXT-TO=PL-1A TILT=0 ..

ROOF-1A =ROOF           H=21 W=27 X=45 Y=0 Z=15
                        AZ=180 TILT=0 CONS=RF-1 ..

PL-1B   =SPACE          LIKE PL-1A A=189 V=1355 ..

FRPLE-WL-1B =E-W        H=7.167 W=9 X=36 Y=0 Z=7.833
                        AZ=180 CONS=BK-1 ..

BKPLE-WL-1B =E-W        H=4.583 W=9 X=45 Y=21 Z=10.42
                        AZ=0 CONS=BK-1 ..

CLG-1B  =I-W            LIKE CLG-1A AREA=189
                        NEXT-TO=PL-1B ..

ROOF-1B =ROOF           LIKE ROOF-1A
                        W=9 X=36 ..

PL-1C   =SPACE          LIKE PL-1A A=486 V=3483 ..

CLG-1C  =I-W            LIKE CLG-1A AREA=486
                        NEXT-TO=PL-1C ..

ROOF-1C =ROOF           LIKE ROOF-1A
                        H=13.5 W=36 X=36 Y=21 Z=10.42 ..

RTPLE-WL-2 =E-W         H=2.59 W=13.5 X=72 Y=21 Z=7.833
                        AZ=90 CONS=BK-1 ..

RTRF-WL-1  =E-W         LIKE RTPLE-WL-2 H=4.58 Z=10.42
                        AZ=90 CONS=BK-1 ..

PL-1D   =SPACE          LIKE PL-1A ..

CLG-1D  =I-W            LIKE CLG-1A
                        NEXT-TO=PL-1D ..

ROOF-1D =ROOF           LIKE ROOF-1A
                        Y=34.5 ..

RTPLE-WL-3 =E-W         H=1.667 W=21 X=72 Y=34.5 Z=13.333
                        AZ=90 CONS=BK-1 ..

BKPLE-WL-1D =E-W        H=1.667 W=3 X=48 Y=55.5 Z=13.333
                        AZ=0 CONS=BK-1 ..

BKPLE-WL-1DD=E-W        H=1.667 W=24 X=72 Y=55.5 Z=13.333
                        AZ=0 CONS=BK-1 ..

PL-1E   =SPACE          LIKE PL-1B ..

CLG-1E  =I-W            LIKE CLG-1B
                        NEXT-TO=PL-1E ..

ROOF-1E =ROOF           LIKE ROOF-1B
                        X=36 Y=34.5 ..

FRPLE-WL-1D =E-W        H=1.667 W=27 X=45 Y=34.5 Z=13.333
                        AZ=180 CONS=BK-1 ..

FRPLE-WL-1E =E-W        H=4.583 W=9 X=36 Y=34.5 Z=10.42
                        AZ=180 CONS=BK-1 ..

BKPLE-WL-1E =E-W        H=4.583 W=9 X=45 Y=55.5 Z=10.42
                        AZ=0 CONS=BK-1 ..

PL-2A   =SPACE          LIKE PL-1A ..

CLG-2A  =I-W            LIKE CLG-1A
                        NEXT-TO=PL-2A ..

ROOF-2A =ROOF           LIKE ROOF-1A
                        X=0 ..

FRPLE-WL-2A =E-W        H=1.667 W=27 X=0 Y=0 Z=13.333
```

```
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-2A =E-W    H=1.667 W=27 X=27 Y=21 Z=13.333
                    AZ=0 CONS=BK-1 ..

LEPLE-WL-1 =E-W     H=1.667 W=21 X=0 Y=21 Z=13.333
                    AZ=270 CONS=BK-1 ..

PL-2B    =SPACE     LIKE PL-1B ..

CLG-2B   =I-W       LIKE CLG-1B
                    NEXT-TO=PL-2B ..

ROOF-2B  =ROOF      LIKE ROOF-1B
                    X=27 ..

FRPLE-WL-2B =E-W    H=7.167 W=9 X=27 Y=0 Z=7.833
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-2B =E-W    H=4.583 W=9 X=36 Y=21 Z=10.42
                    AZ=0 CONS=BK-1 ..

PL-2C    =SPACE     LIKE PL-1C ..

CLG-2C   =I-W       LIKE CLG-1C
                    NEXT-TO=PL-2C ..

ROOF-2C  =ROOF      LIKE ROOF-1C
                    X=0 ..

LEPLE-WL-2 =E-W     H=2.59 W=13.5 X=0 Y=34.5 Z=7.833
                    AZ=270 CONS=BK-1 ..

LERF-WL-1  =E-W     LIKE LEPLE-WL-2 H=4.58 Z=10.42
                    AZ=270 CONS=BK-1 ..

PL-2D    =SPACE     LIKE PL-1D ..

CLG-2D   =I-W       LIKE CLG-1D
                    NEXT-TO=PL-2D ..

ROOF-2D  =ROOF      LIKE ROOF-1D
                    X=0 ..

LEPLE-WL-3 =E-W     H=1.667 W=21 X=0 Y=55.5 Z=13.333
                    AZ=270 CONS=BK-1 ..

FRPLE-WL-2D =E-W    H=1.667 W=27 X=0 Y=34.5 Z=13.333
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-2D =E-W    H=1.667 W=27 X=27 Y=55.5 Z=13.333
                    AZ=0 CONS=BK-1 ..

PL-2E    =SPACE     LIKE PL-1E ..

CLG-2E   =I-W       LIKE CLG-1E
                    NEXT-TO=PL-2E ..

ROOF-2E  =ROOF      LIKE ROOF-1E
                    X=27 ..

FRPLE-WL-2E =E-W    H=4.583 W=9 X=27 Y=34.5 Z=10.42
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-2E =E-W    H=4.583 W=9 X=36 Y=55.5 Z=10.42
                    AZ=0 CONS=BK-1 ..

PL-3A    =SPACE     LIKE PL-1A A=2736 V=19608 ..

CLG-3A   =I-W       LIKE CLG-1A AREA=2736
                    NEXT-TO=PL-3A ..

ROOF-3A  =ROOF      H=57 W=48 X=0 Y=55.5 Z=10.42
                    AZ=180 TILT=0 CONS=RF-1 ..

RTPLE-WL-4 =E-W     H=2.59 W=10 X=48 Y=55.5 Z=7.833
                    AZ=90 CONS=BK-1 ..

RTRF-WL-4  =E-W     LIKE RTPLE-WL-4 H=4.58 Z=10.42
                    AZ=90 CONS=BK-1 ..

RTPLE-WL-6 =E-W     H=2.59 W=11 X=48 Y=101.5 Z=7.833
                    AZ=90 CONS=BK-1 ..

RTRF-WL-6  =E-W     LIKE RTPLE-WL-6 H=4.58 Z=10.42
                    AZ=90 CONS=BK-1 ..

LEPLE-WL-4 =E-W     H=2.59 W=57 X=0 Y=112.5 Z=7.833
                    AZ=270 CONS=BK-1 ..

LERF-WL-4  =E-W     LIKE LEPLE-WL-4 H=4.58 Z=10.42
                    AZ=270 CONS=BK-1 ..

PL-3B    =SPACE     LIKE PL-1A A=252 V=1806 ..

CLG-3B   =I-W       LIKE CLG-1A AREA=252
                    NEXT-TO=PL-3B ..

ROOF-3B  =ROOF      LIKE ROOF-3A
                    H=36 W=7 X=48 Y=65.5 ..

FRPLE-WL-3A =E-W    H=2.59 W=7 X=48 Y=65.5 Z=7.833
                    AZ=180 CONS=BK-1 ..

FRRF-WL-3A  =E-W    LIKE FRPLE-WL-3A H=4.58 Z=10.42
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-3A =E-W    H=2.59 W=7 X=55 Y=101.5 Z=7.833
                    AZ=0 CONS=BK-1 ..

BKRF-WL-3A  =E-W    LIKE BKPLE-WL-3A H=4.58 Z=10.42
                    AZ=0 CONS=BK-1 ..

RTPLE-WL-5 =E-W     H=2.59 W=36 X=55 Y=65.5 Z=7.833
                    AZ=90 CONS=BK-1 ..

RTRF-WL-5  =E-W     LIKE RTPLE-WL-5 H=4.58 Z=10.42
                    AZ=90 CONS=BK-1 ..

PL-4A    =SPACE     LIKE PL-1A A=921 V=1535 ..

CLG-4A   =I-W       LIKE CLG-1A AREA=921
                    NEXT-TO=PL-4A ..

ROOF-4A  =ROOF      H=23 W=40 X=0 Y=112.5 Z=15
                    AZ=180 TILT=0 CONS=RF-1 ..

FRPLE-WL-4A =E-W    H=1.667 W=40 X=0 Y=112.5 Z=13.333
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-4A =E-W    H=1.667 W=40 X=40 Y=135.5 Z=13.333
                    AZ=0 CONS=BK-1 ..

LEPLE-WL-5 =E-W     H=1.667 W=23 X=0 Y=135.5 Z=13.333
                    AZ=270 CONS=BK-1 ..

PL-4B    =SPACE     LIKE PL-1A A=183 V=1312 ..

CLG-4B   =I-W       LIKE CLG-1A AREA=183
                    NEXT-TO=PL-4B ..

ROOF-4B  =ROOF      LIKE ROOF-4A
                    H=23 W=8 X=40 ..

RTPLE-WL-7 =E-W     H=1.667 W=23 X=48 Y=112.5 Z=13.333
                    AZ=90 CONS=BK-1 ..

FRPLE-WL-4B =E-W    H=1.667 W=8 X=40 Y=112.5 Z=13.333
                    AZ=180 CONS=BK-1 ..

BKPLE-WL-4B =E-W    H=1.667 W=8 X=48 Y=135.5 Z=13.333
                    AZ=0 CONS=BK-1 ..

$ FLOOR DESCRIPTION
$ ----------------------------

FLR-1A   =U-F       AREA=567 CONS=FLR-1 TILT=180 ..
FLR-1B   =U-F       AREA=189 CONS=FLR-1 TILT=180 ..
FLR-1C   =U-F       AREA=486 CONS=FLR-1 TILT=180 ..
FLR-1D   =U-F       AREA=567 CONS=FLR-1 TILT=180 ..
FLR-1E   =U-F       AREA=189 CONS=FLR-1 TILT=180 ..
FLR-2A   =U-F       AREA=567 CONS=FLR-1 TILT=180 ..
FLR-2B   =U-F       AREA=189 CONS=FLR-1 TILT=180 ..
FLR-2C   =U-F       AREA=486 CONS=FLR-1 TILT=180 ..
FLR-2D   =U-F       AREA=567 CONS=FLR-1 TILT=180 ..
FLR-2E   =U-F       AREA=189 CONS=FLR-1 TILT=180 ..
FLR-3A   =U-F       AREA=2736 CONS=FLR-1 TILT=180 ..
FLR-3B   =U-F       AREA=252 CONS=FLR-1 TILT=180 ..
FLR-4A   =U-F       AREA=921 CONS=FLR-1 TILT=180 ..
FLR-4B   =U-F       AREA=183 CONS=FLR-1 TILT=180 ..

$ EXTERIOR LIGHTS
$ -------------------------

BUILDING-RESOURCE   ELEC-SCHEDULE=EXT-LIGHT-1
                    ELEC-KW=4.9
                    HW-SCHEDULE=HOT-WATER-1
                    HOT-WATER=81888 ..

END ..
COMPUTE LOADS ..
```

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$###########################################################$
$###########################################################$

INPUT SYSTEMS ..

SYSTEMS-REPORT
            VERIFICATION=(ALL-VERIFICATION)
            SUMMARY=(SS-A) ..

$ EQUIPMENT SCHEDULES
$ ---------------------------------

C-SCH1 = SCHEDULE  THRU DEC 31 (MON,FRI) (1,5) (83) (6) (74) (7) (75) (8,12)
                                         (75) (13,18) (75) (19) (75) (20)
                                         (77) (21) (78) (22) (79) (23,24)
                                         (83)
                                 (WEH)   (1,6) (90) (7,18) (87) (19,24) (90)
..

H-SCH1 = SCHEDULE  THRU APR 30 (MON,FRI) (1,5) (55) (6) (80) (7,8) (80)
                                         (9,11) (79) (12,14) (76) (15,19)
                                         (72) (20,21) (55) (22,24) (55)
                                 (WEH)   (1,24) (55)
                           THRU DEC 15 (MON,FRI) (1,5) (55) (6) (80) (7,8) (78) (9)
                                         (77) (10) (76) (11) (75) (12,14)
                                         (73) (15,20) (70) (21) (55) (22,24)
                                         (55)
                                 (WEH)   (1,24) (55)
                           THRU DEC 26 (MON,FRI) (1,5) (55) (6) (80) (7,8) (78)
                                         (9,11) (73) (12,14) (71) (15,19)
                                         (69) (20,21) (55) (22,24) (55)
                                 (WEH)   (1,24) (55)
                           THRU DEC 31 (MON,FRI) (1,5) (55) (6) (70) (7,8) (70)
                                         (9,11) (70) (12,14) (69) (15,19)
                                         (60) (20,21) (55) (22,24) (55)
                                 (WEH)   (1,24) (55) ..

C-SCH2 = SCHEDULE  THRU DEC 31 (ALL)     (1,24) (1) ..

H-SCH2 = SCHEDULE  THRU APR 14 (MON,FRI) (1,5) (0) (6,19) (1) (20,24) (0)
                                 (WEH)   (1,24) (0)
                           THRU SEP 15 (ALL)     (1,24) (0)
                           THRU DEC 15 (MON,FRI) (1,6) (0) (7,19) (1) (20,24) (0)
                                 (WEH)   (1,24) (0)
                           THRU DEC 26 (MON,FRI) (1,6) (0) (7,19) (1) (20,24) (0)
                                 (WEH)   (1,24) (0)
                           THRU DEC 31 (MON,FRI) (1,6) (0) (7,19) (1) (20,24) (0)
                                 (WEH)   (1,24) (0) ..

S-FAN1 = SCHEDULE  THRU APR 14 (MON,FRI) (1,5) (0) (6,20) (1) (21,24) (0)
                                 (WEH)   (1,24) (0)
                           THRU DEC 26 (MON,FRI) (1,6) (0) (7,20) (1) (21,24) (0)
                                 (WEH)   (1,24) (0)
                           THRU DEC 31 (MON,FRI) (1,6) (0) (7,20) (1) (21,24) (0)
                                 (WEH)   (1,24) (0) ..

Z-C-1 = ZONE-CONTROL   DESIGN-HEAT-T= 72
            HEAT-TEMP-SCH= H-SCH1
            DESIGN-COOL-T= 75
            COOL-TEMP-SCH= C-SCH1
            THERMOSTAT-TYPE= TWO-POSITION
            THROTTLING-RANGE= 2 ..

Z-AIR-1 = ZONE-AIR     ASSIGNED-CFM= 2381
            RATED-CFM= 2400
            OUTSIDE-AIR-CFM= 580
            EXHAUST-CFM=585
            EXHAUST-KW=.0009 ..

ZONE-1 = ZONE        ZONE-CONTROL= Z-C-1
            ZONE-AIR= Z-AIR-1
            ZONE-TYPE= CONDITIONED
            COOLING-CAPACITY=90000
            HEATING-CAPACITY=-85000
            SIZING-OPTION=ADJUST-LOADS
            COOL-SH-CAP= 43000 ..

Z-C-2 = ZONE-CONTROL   LIKE Z-C-1 ..

Z-AIR-2 = ZONE-AIR     ASSIGNED-CFM= 2582
            RATED-CFM= 2400
            OUTSIDE-AIR-CFM= 500
            EXHAUST-CFM=490
            EXHAUST-KW=.0007 ..

ZONE-2 = ZONE        ZONE-CONTROL=Z-C-2
            ZONE-AIR=Z-AIR-2
            ZONE-TYPE= CONDITIONED
            HEATING-CAPACITY= -85000
            COOLING-CAPACITY=90000
            SIZING-OPTION=ADJUST-LOADS
            COOL-SH-CAP= 40000 ..

Z-C-3 = ZONE-CONTROL   LIKE Z-C-1 ..

Z-AIR-3 = ZONE-AIR     ASSIGNED-CFM= 2985
            RATED-CFM= 2800
            OUTSIDE-AIR-CFM= 700
            EXHAUST-CFM=591
            EXHAUST-KW=.0013 ..

ZONE-3 = ZONE        ZONE-CONTROL=Z-C-3
            ZONE-AIR=Z-AIR-3
            ZONE-TYPE= CONDITIONED
            HEATING-CAPACITY=-85000
            COOLING-CAPACITY=90000
            SIZING-OPTION=ADJUST-LOADS
            COOL-SH-CAP= 55000 ..

Z-C-4 = ZONE-CONTROL   LIKE Z-C-1
            BASEBOARD-CTRL=OUTDOOR-RESET ..

Z-AIR-4 = ZONE-AIR     ASSIGNED-CFM= 1645
            RATED-CFM= 1600
            OUTSIDE-AIR-CFM= 315
            EXHAUST-CFM=345
            EXHAUST-KW=.0011 ..

ZONE-4 = ZONE        ZONE-CONTROL=Z-C-4
            ZONE-AIR=Z-AIR-4
            ZONE-TYPE= CONDITIONED
            BASEBOARD-RATING= -7504
            HEATING-CAPACITY= -42000
            COOLING-CAPACITY= 46000
            SIZING-OPTION=ADJUST-LOADS
            COOL-SH-CAP= 32700 ..

S-CONT-1 = SYSTEM-CONTROL  MAX-SUPPLY-T= 100
            MIN-SUPPLY-T= 65
            HEATING-SCHEDULE= H-SCH2
            COOLING-SCHEDULE= C-SCH2 ..

S-AIR-1 = SYSTEM-AIR     RATED-CFM= 2400
            SUPPLY-CFM=2381
            RETURN-CFM=1801
            MIN-OUTSIDE-AIR= .244 ..

S-FAN-1 = SYSTEM-FANS     SUPPLY-DELTA-T=.5
            SUPPLY-STATIC=.75
            SUPPLY-KW=0.000698
            RETURN-DELTA-T=.5
            RETURN-STATIC=.25
            RETURN-KW=.00055
            FAN-SCHEDULE= S-FAN1
            NIGHT-CYCLE-CTRL=CYCLE-ON-ANY
            FAN-CONTROL=CONSTANT-VOLUME ..

S-EQ-1 = SYSTEM-EQUIPMENT  HP-SUPP-SOURCE=ELECTRIC
            MAX-HP-SUPP-T=55
            MIN-HP-T=35
            DEFROST-T=30
            COOL-SH-CAP=65000
            COOLING-EIR=.323
            HEATING-EIR=.333
            HP-SUPP-HT-CAP=-34120 ..

SYS-1 = SYSTEM          SYSTEM-TYPE=PSZ
            ZONE-NAMES=(ZONE-1,PL-1A,PL-1B,PL-1C,PL-1D,
                  PL-1E)
            SYSTEM-CONTROL=S-CONT-1
            SYSTEM-AIR=S-AIR-1
            SYSTEM-FANS=S-FAN-1
            SYSTEM-EQUIPMENT=S-EQ-1
            HEAT-SOURCE=HEAT-PUMP
            BASEBOARD-SOURCE= ELECTRIC ..

S-CONT-2 = SYSTEM-CONTROL  LIKE S-CONT-1 ..

S-AIR-2 = SYSTEM-AIR     RATED-CFM= 2400
            SUPPLY-CFM=2582
            RETURN-CFM=2082
            MIN-OUTSIDE-AIR= .194 ..

S-FAN-2 = SYSTEM-FANS     LIKE S-FAN-1
            SUPPLY-STATIC=.80
            SUPPLY-KW=0.000708
            RETURN-STATIC=.35
            RETURN-KW=.00052 ..

S-EQ-2 = SYSTEM-EQUIPMENT  LIKE S-EQ-1
            HP-SUPP-HT-CAP=-34120 ..
```

```
SYS-2 = SYSTEM          LIKE SYS-1
                ZONE-NAMES=(ZONE-2,PL-2A,PL-2B,PL-2C,PL-2D,
                    PL-2E)
                SYSTEM-CONTROL=S-CONT-2
                SYSTEM-AIR=S-AIR-2
                SYSTEM-FANS=S-FAN-2
                SYSTEM-EQUIPMENT=S-EQ-2 ..

S-CONT-3 = SYSTEM-CONTROL  LIKE S-CONT-1 ..

S-AIR-3 = SYSTEM-AIR      RATED-CFM= 2800
                SUPPLY-CFM=2985
                RETURN-CFM=2285
                MIN-OUTSIDE-AIR= .235 ..

S-FAN-3 = SYSTEM-FANS     LIKE S-FAN-1
                SUPPLY-STATIC=.95
                SUPPLY-KW=0.00056
                RETURN-STATIC=.30
                RETURN-KW=.00044 ..

S-EQ-3 = SYSTEM-EQUIPMENT  LIKE S-EQ-1
                HP-SUPP-HT-CAP=-34120 ..

SYS-3 = SYSTEM          LIKE SYS-1
                ZONE-NAMES=(ZONE-3,PL-3A,PL-3B)
                SYSTEM-CONTROL=S-CONT-3
                SYSTEM-AIR=S-AIR-3
                SYSTEM-FANS=S-FAN-3
                SYSTEM-EQUIPMENT=S-EQ-3 ..

BASE-DAY-1 = DAY-RESET-SCH SUPPLY-HI=1.0
                SUPPLY-LO=0.0
                OUTSIDE-HI=60
                OUTSIDE-LO=50 ..

BASE-DAY-2 = DAY-RESET-SCH SUPPLY-HI=0.0
                SUPPLY-LO=0.0
                OUTSIDE-HI=55
                OUTSIDE-LO=45 ..

BASE-SCHED-1=RESET-SCHEDULE THRU APR 15 (MON,FRI) BASE-DAY-1
                    (WEH)    BASE-DAY-2
                THRU SEP 30 (ALL)    BASE-DAY-2
                THRU DEC 26 (MON,FRI) BASE-DAY-1
                    (WEH)    BASE-DAY-2
                THRU DEC 31 (MON,FRI) BASE-DAY-2
                    (WEH)    BASE-DAY-2 ..

S-CONT-4 = SYSTEM-CONTROL  LIKE S-CONT-1
                BASEBOARD-SCH=BASE-SCHED-1 ..

S-AIR-4 = SYSTEM-AIR      RATED-CFM=1600
                SUPPLY-CFM=1645
                RETURN-CFM=1330
                MIN-OUTSIDE-AIR= .191 ..

S-FAN-4 = SYSTEM-FANS     LIKE S-FAN-1
                SUPPLY-STATIC=.675
                SUPPLY-KW=0.00056
                RETURN-STATIC=.25
                RETURN-KW=.00038 ..

S-EQ-4 = SYSTEM-EQUIPMENT  LIKE S-EQ-1
                COOLING-EIR=.385
                COOL-SH-CAP=32000
                HEATING-EIR=.34
                HP-SUPP-HT-CAP=-34120 ..

SYS-4 = SYSTEM  LIKE SYS-1
                ZONE-NAMES=(ZONE-4,PL-4A,PL-4B)
                SYSTEM-CONTROL=S-CONT-4
                SYSTEM-AIR=S-AIR-4
                SYSTEM-FANS=S-FAN-4
                SYSTEM-EQUIPMENT=S-EQ-4 ..

PL-1A = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-1B = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-1C = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-1D = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-1E = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-2A = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-2B = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-2C = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-2D = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-2E = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-3A = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-3B = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-4A = ZONE            ZONE-TYPE=UNCONDITIONED ..
PL-4B = ZONE            ZONE-TYPE=UNCONDITIONED ..

HVAC=PLANT-ASSIGNMENT  SYSTEM-NAMES=(SYS-1,SYS-2,SYS-3,SYS-4) ..

END ..
COMPUTE SYSTEMS ..

$###########################################################$
$###########################################################$

INPUT PLANT ..

PLANT-REPORT      SUMMARY=(BEPS) ..

HVAC=PLANT-ASSIGNMENT ..

CHIL-1  =PLANT-EQUIPMENT  TYPE=HERM-CENT-CHLR  SIZE=0.09
            HOURS-USED=3100 ..

CHIL-2  =PLANT-EQUIPMENT  TYPE=HERM-CENT-CHLR  SIZE=0.09
            HOURS-USED=3100 ..

CHIL-3  =PLANT-EQUIPMENT  TYPE=HERM-CENT-CHLR  SIZE=0.09
            HOURS-USED=3100 ..

CHIL-4  =PLANT-EQUIPMENT  TYPE=HERM-CENT-CHLR  SIZE=0.048
            HOURS-USED=3100 ..

$ HOURLY REPORT

RP-3=SCHEDULE THRU DEC 21 (ALL) (1,24) (1) ..

BLOCK-3-1 = REPORT-BLOCK
            VARIABLE-TYPE=PLANT
            VARIABLE-LIST=(10) ..

BLOCK-3-2 = REPORT-BLOCK
            VARIABLE-TYPE = GLOBAL
            VARIABLE-LIST = (1) ..

HR-3=HOURLY-REPORT
      REPORT-SCHEDULE=RP-3
      REPORT-BLOCK=(BLOCK-3-1,BLOCK-3-2) ..

END ..
COMPUTE PLANT ..
STOP ..
```

APPENDIX C PROCESSING AND MERGING ROUTINES

```
#MERGE.BAT

echo
echo using rawextr.awk to create HR-3 . . .
nawk -f rawextr.awk daycar35.out HR-3 xxxx xxxx xxxx

echo
echo using out_proc.awk to process DOE-2 plant data . . .
nawk -f out_proc.awk HR-3.out 1 93 94 304 2 .0002931 plant.tmp

echo
echo adding in the photovoltaic effects to whole building data . . .
nawk -f pvsum.awk 6motot.acs >6motot.1

timemerg "dayelec.raw -t=6 1-9" "6motot.1 -t=1 2" >6motot.2
nawk -f strip5.awk 6motot.2 > dayelec.dat

echo
echo creating plant datafile combining measured and simulated
data. . .
timemerg "dayelec.dat -t=6 1-9" "plant.tmp -t=5 7" >plant.tmp1
nawk -f strip9.awk plant.tmp1 >plant.dat

echo
echo making 3d datafile for 3D plots
cat begindate.dat plant.dat >plant2.dat
missing plant2.dat plant3d.dat

echo
rm plant.tmp plant.tmp1
rm plant2.dat
rm HR-3.out
rm 6motot.1 6motot.2 dayelec.dat
echo
echo DONE . . .
```

1: MERGE.BAT Main Processing Batch File.

```
# PVSUM.AWK
{
a= $16
b=$17
if($16 <0 || $17<0)  a=0
if($17 <0 || $16<0)  b=0
print $6,a+b;
}
```

2: PVSUM.AWK Used to Create SUMMARY.DAT

```
#WD_WE_SEP.AWK

# This separates wkday, wkend, wkday occupied, and wkday
unoccupied data
# To Run: nawk -v var1=# -v var2=we.dat -v var3=wd.dat -v
var4=wkocc.dat -v var5=wdunocc.dat -f  datafile
# var1: SUN=0, MON=1, TUE=2, WED=3, THU=4, FRI=5,
SAT=6 (first day of the year)
BEGIN{
     first_day_of_year = var1;
     weekend_file = var2;
     weekday_file = var3;
     weekday_occ_file = var4;
     weekday_unocc_file = var5;
}
{
     julian = $5;
     hour = $7;

     day_of_week = (julian - 1000*int(julian/1000) +
first_day_of_year - 1) % 7;


if(((day_of_week==6)&&(hour>=100))||((day_of_week==1)&&(ho
ur==0))||(day_of_week==0)){
          print $0 > weekend_file;
     }else{
          print $0 > weekday_file;
          if ((hour>=700)&&(hour<=1800))
          {print $0 > weekday_occ_file}
          else
          {print $0 > weekday_unocc_file}
     }
}
```

3: WD_WE_SEP.AWK

APPENDIX D SAS SOURCE CODES

```
/*DAYCARE3D.SAS*/

filename gsasfile 'daycare3d.ps';
data hourly;
infile 'plant3d.dat';
input site mo day yr jul frac time meas temp plant;
m+1;
greg = -int(frac);
run;
run;
data one;
set hourly;
if frac >= 4839.0417 and frac <= 5113;
data two;
set hourly;
if frac >= 4839.0417 and frac <= 5113;
run;

goptions
        device = psl
        gaccess = gsasfile
        htext = 0.25 in
        ftext = triplex
        gsfmode = replace
        nodisplay;
data anno;
length function $8 style $8 color $8 text $25;
retain hsys ysys '3' xsys '1'function 'label' color 'black';
text = '31 DEC'; y = 1.2; x = 77;style = triplex;output;
text = '30 SEP'; y = 1.8; x = 57;output;
text = '1 JUL'; y = 2.4; x = 37;output;
text = '1 APR'; y = 3.0; x = 15;output;
text = '0'; size = 2;y = 3; x = 84;output;
text = '6'; y = 12; x = 86.0;output;
text = '12'; y = 23; x = 87.7;output;
text = '18'; y = 32.5; x = 89;output;
text = '20'; y = 21; size = 2.6;x = 10;output;
text = '40'; y = 35; x = 10;output;
text = '60'; y = 49; x = 10;output;
text = '(kWh/h)'; angle = 90; size = 3.0; x = 4; y = 30;output;
text = name; angle = 0;size = 5; style = triplexb;x = 50;y =
405;output;
run;

proc g3d data = one;
plot greg * time = meas /
                grid
                tilt = 55
                rotate = 85
                ctop = black
                nolabel
                side
                zmax = 60
                zmin = 0
                yticknum = 4
                zticknum = 4
                xticknum = 24
                annotate = anno
                xytype = 1;
```

```
title1;
title2 height = 4 'Measured Data';
title3 height = 2;
title4 height = 3 '(a)';

proc g3d data = two;
plot greg * time = plant /
                                grid
                                tilt = 55
                                rotate = 85
                                ctop = black
                                nolabel
                                side
                                zmax = 60
                                zmin = 0
                                yticknum = 4
                                zticknum = 4
                                xticknum = 24
                                annotate = anno
                                xytype = 1;
title1;
title2 height = 4 'DOE-2 Simulated Data';
title3 height = 2;
title4 height = 3 '(b)';
```

```
proc greplay  igout = work.gseg
              tc = work.gseg
              nofs;
goptions display;
list igout;
tdef newfour des = 'Four squares of equal size'
 1/llx = 15  lly = 15
  ulx = 15  uly = 50
  urx = 90  ury = 50
  lrx = 90  lry = 15
  scaley = 1
  scalex = 1
  color = white
 2/llx = 15  lly = 55
  ulx = 15  uly = 90
  urx = 90  ury = 90
  lrx = 90  lry = 55
  scalex = 1
  scaley = 1
  color = white;
template newfour;
treplay  2:g3d
         1:g3d1;
quit;
```

A: DAYCARE3D.SAS

```
/*DAYCAREBOX.SAS*/

filename gsasfile 'daycarebox.ps';
data simul;
infile 'plantwk.dat';
input site mon day yr jul dec time meas temp plant week;
if plant < 0 then plant= ".";
if meas < 0 then meas= ".";
run;
goptions
        device=psl
        gaccess= gsasfile
        htext=0.25 in
        text=triplex
        gsfmode= replace
        nodisplay;

proc means data = simul;
var meas plant;
class week;
output out = dayout mean = mmeas mplant;
data simul1;
merge simul dayout (rename=(week=mweek));
proc print data = dayout;
run;

axis1   order = (0 to 40 by 4)
        minor = (number = 3)
        label = (height = .4 in justify =center 'Week Number
for Apr. - Dec. 1993')
        offset = (0.5,0.5);
axis2   order = (0 to 60 by 10)
        minor = (number = 4)
        value = (height = 3)
        label = (height = .4 in angle = 90 justify=center
'(kWh/h)')
        offset = (0,0);
axis3   order = (0 to 60 by 10)
        minor = (number = 4)
        value = (height = 3)
        label = none
        offset = (0,0);
symbol1 interpol = box10 value = plus color = black;
symbol2 interpol = none  value = none color=black ;
symbol3 interpol = join color = black;
symbol4 interpol = join color = black line=2;

proc gplot data=simul1;
plot    meas*week = 1
        meas*week = 2 / overlay
        skipmiss
        frame
        lvref = 2
        vref = 20 40
        haxis = axis1
        vaxis = axis2;
plot2   meas*week = 1
        meas*week = 2  mmeas*mweek = 3 / overlay
```

```
            skipmiss
            haxis = axis1
            vaxis = axis3;
title1;
title2 height = 4 'Measured Data';
title3 height = 2;
title4 height = 3 '(a)';

proc gplot data = simul1;
plot        plant*week = 1
            plant*week = 2  mplant*mweek = 3 / overlay
            skipmiss
            frame
            lvref=2
            vref = 20 40
            haxis = axis1
            vaxis = axis2;
plot2       plant*week = 1
            plant*week = 2  mmeas*mweek = 4 / overlay
            skipmiss
            haxis = axis1
            vaxis = axis3;
title1;
title2 height = 4 'DOE-2 Simulated Data';
title3 height = 2;
title4 height = 3 '(b)';
```

```
proc greplay  igout = work.gseg
            tc = work.gseg
            nofs;
goptions display;
list igout;
tdef newfour des = 'Four squares of equal size'
 1/llx = 15 lly = 15
  ulx = 15 uly = 50
  urx = 90 ury = 50
  lrx = 90 lry = 15
  scalex = 1
  scaley = 1
  color = white
 2/llx = 15 lly = 55
  ulx = 15 uly = 90
  urx = 90 ury = 90
  lrx = 90 lry = 55
  scalex = 1
  scaley = 1
  color = white;
template newfour;
treplay  2:gplot
         1:gplot1;
run;
quit;
```

B: 52-Week Source Code DAYCAREBOX.SAS

```
/*WDBIN.SAS*/

filename gsasfile 'wdbin.ps';
data bos;
infile 'wd.dat';
input site mo day yr jul frac hour meas temp tot;

tempgrpd = round(temp, 10);
ta1 = tempgrpd;
if temp <0 then temp = ".";
if meas <0 then meas = ".";
if tot <0 then tot = ".";
run;

goptions
                device = psl
                ftext = triplex
                rotate = landscape
                gaccess = gsasfile
                gsfmode = replace
                nodisplay;

axis1   minor = none
        label = (height = 4 'Outside Air Temperature (F)')
        value = (height = 3)
        offset = (5.5,0)
        order = (20 to 110 by 10);

axis2   order = (0 to 60 by 10)
        value = (height = 3)
        minor = (number = 4)
        label = (height = 4 angle = 90 justify = center
'(kWh/h)')
        offset = (0,0);

axis3   order = (0 to 60 by 10)
        minor = (number = 4)
        value = (height = 3)
        label = none
        offset = (0,0);

symbol1 interpol = box10 value = plus ci = black;
symbol2 value = plus color = black;
symbol3 value = diamond color = black;
symbol4 interpol = join color = black;
symbol5 interpol = join color = black line = 2;

proc means data = bos;
var tot meas;
class ta1;
output out = testa mean = mtot mmeas;
proc print data = testa;
run;

data bos1 (drop = ta1);
  set bos;

data boxa;
merge bos1
      testa;
```

```
proc gplot data = boxa;
 plot mmeas*ta1 = 5  /
            frame
            lvref = 2
            vref = 20 40
            haxis = axis1
            vaxis = axis2;
 plot2 mtot*ta1 = 4 tot*tempgrpd = 1 /overlay
            haxis = axis1
            vaxis = axis3;
title1  height = 5 'DOE-2 Weekday Whole Building Electricity';
title2  height = 3;
title3  height = 3 '(d)';

proc gplot data = boxa;
 plot tot*temp = 2      /
            frame
            lvref = 2
            ref = 20 40
            haxis = axis1
            vaxis = axis2;
 plot2 tot*temp = 2 /
            haxis = axis1
            vaxis = axis3;
title1  height = 3;
title2  height = 5 'DOE-2 Weekday Whole Building Electricity';
title3  height = 3;
title4  height = 3 '(c)';

proc gplot data = boxa;
 plot mmeas*ta1 = 4 meas*tempgrpd = 1 / overlay
            frame
            lvref=2
            vref = 20 40
            haxis = axis1
            vaxis = axis2 ;
 plot2 mmeas*ta1 = 4 meas*tempgrpd = 1 / overlay
            haxis = axis1
            vaxis = axis3;
title1  height = 5 'Measured Weekday Whole Building Electricity';
title2  height = 3;
title3  height = 3 '(b)';

proc gplot data = boxa;
 plot meas*temp = 2  /
            frame
            lvref = 2
            vref = 20 40
            haxis = axis1
            vaxis = axis2 ;
 plot2 meas*temp = 2  /
            haxis = axis1
            vaxis = axis3 ;
title1  height = 3;
title2  height = 5 'Measured Weekday Whole Building Electricity';
title3  height = 3;
title4  height = 3 '(a)';

proc greplay  igout = work.gseg
          tc = work.gseg
          nofs;
goptions display;
list igout;
 tdef newfour des = 'Four squares of equal size'

 1/llx = 10 lly = 20
  ulx = 10 uly = 50
  urx = 45 ury = 50
  lrx = 45 lry = 20
  scalex = .95
  scaley = .95
  color = white
 2/llx =10 lly = 55
  ulx = 10 uly = 85
  urx = 45 ury = 85
  lrx = 45 lry = 55
  scalex = .95
  scaley = .95
  color = white
 3/llx = 55 lly = 20
  ulx = 55 uly = 50
  urx = 90 ury = 50
  lrx = 90 lry = 20
  scalex = .95
  scaley = .95
  color = white
 4/llx = 55 lly = 55
  ulx = 55 uly = 85
  urx = 90 ury = 85
  lrx = 90 lry = 55
  scalex = .95
  scaley = .95
  color = white;

  template newfour;
  treplay 1:gplot2
          2:gplot3
          3:gplot
          4:gplot1;
goptions nodisplay;
quit;
```

C: Weekday Temperature Bin Source Code WDBIN.SAS

```
/*WEBIN.SAS*/

filename gsasfile 'webin.ps';
data bos;
infile 'we.dat';
input site mo day yr jul frac hour meas temp tot;

tempgrpd = round(temp, 10);
ta1 = tempgrpd;
if temp <0 then temp = ".";
if meas <0 then meas = ".";
if tot <0 then tot = ".";
run;

goptions
                device = psl
                ftext = triplex
                rotate = landscape
                gaccess = gsasfile
                gsfmode = replace
                nodisplay;

axis1   minor = none
        label = (height = 4 'Outside Air Temperature (F)')
        value = (height = 3)
        offset = (5.5,0)
        order = (20 to 110 by 10);

axis2   order = (0 to 60 by 10)
        value = (height = 3)
        minor = (number = 4)
        label = (height=4 angle = 90 justify = center '(kWh/h)')
        offset = (0,0);

axis3   order = (0 to 60 by 10)
        minor = (number = 4)
        value = (height = 3)
        label = none
        offset = (0,0);

symbol1 interpol = box10 value = plus ci = black;
symbol2 value = plus color = black;
symbol3 value = diamond color = black;
symbol4 interpol = join color = black;
symbol5 interpol = join color = black line = 2;

proc means data = bos;
var tot meas;
class ta1;
output out = testa mean = mtot mmeas;
proc print data = testa;
run;

data bos1 (drop = ta1);
  set bos;

data boxa;
merge bos1
      testa;
```

```
proc gplot data = boxa;
 plot mmeas*ta1 = 5  /
            frame
            lvref = 2
            vref = 20 40
            haxis = axis1
            vaxis = axis2;
 plot2 mtot*ta1 = 4 tot*tempgrpd = 1 /overlay
            haxis = axis1
            vaxis = axis3;
title1  height = 5 'DOE-2 Weekend Whole Building Electricity';
title2  height = 3;
title3  height = 3 '(d)';

proc gplot data = boxa;
 plot tot*temp = 2      /
            frame
            lvref = 2
            vref = 20 40
            haxis = axis1
            vaxis = axis2;
 plot2 tot*temp = 2 /
            haxis = axis1
            vaxis = axis3;
title1  height = 3;
title2  height = 5 'DOE-2 Weekend Whole Building Electricity';
title3  height = 3;
title4  height = 3 '(c)';

proc gplot data = boxa;
 plot mmeas*ta1 = 4 meas*tempgrpd = 1 / overlay
            frame
            lvref = 2
            vref = 20 40
            haxis = axis1
            vaxis = axis2 ;
 plot2 mmeas*ta1 = 4 meas*tempgrpd = 1 / overlay
            haxis = axis1
            vaxis = axis3;
title1  height = 5 'Measured Weekend Whole Building Electricity';
title2  height = 3;
title3  height = 3 '(b)';

proc gplot data = boxa;
 plot meas*temp = 2  /
            frame
            lvref = 2
            vref = 20 40
            haxis = axis1
            vaxis = axis2 ;
 plot2 meas*temp = 2  /
            haxis = axis1
            vaxis = axis3 ;
title1  height = 3;
title2  height = 5 'Measured Weekend Whole Building Electricity';
title3  height = 3;
title4  height = 3 '(a)';

proc greplay  igout = work.gseg
            tc = work.gseg
            nofs;
goptions display;
list igout;
tdef newfour des = 'Four squares of equal size'

 1/llx = 10 lly = 20
  ulx = 10 uly = 50
  urx = 45 ury = 50
  lrx = 45 lry = 20
  scalex = .95
  scaley = .95
  color = white
 2/llx = 10 lly = 55
  ulx = 10 uly = 85
  urx = 45 ury = 85
  lrx = 45 lry = 55
  scalex = .95
  scaley = .95
  color = white
 3/llx = 55 lly = 20
  ulx = 55 uly = 50
  urx = 90 ury = 50
  lrx = 90 lry = 20
  scalex = .95
  scaley = .95
  color = white
 4/llx = 55 lly = 55
  ulx = 55 uly = 85
  urx = 90 ury = 85
  lrx = 90 lry = 55
  scalex = .95
  scaley = .95
  color = white;

  template newfour;
  treplay 1:gplot2
            2:gplot3
            3:gplot
              4:gplot1;
goptions nodisplay;
quit;
```

D: Weekend Temperature Bin Source Code WEBIN.SAS

```
/*HRWDBIN.SAS*/

filename gsasfile 'hrwdbin.ps';
data daily;
infile 'wd.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
time = ranuni(0) * 50 + time;
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;

goptions    device = psl
            ftext = triplex
            gsfmode = replace
            rotate = landscape
            gaccess = gsasfile;

symbol1 value = plus color = black;

axis1       order = (0 to 60 by 10)
            minor = (number = 4)
            label = none
            offset = (0,0)
            value = (height = 4);

axis2       order = (0 to 2400 by 400)
            minor = (number = 3)
            label = (height = 4 'Time of Day')
            offset = (0,0)
            value = (height = 4);

axis3       order = (0 to 60 by 10)
            minor = (number = 4)
            label = (height = 5 angle = 90 justify = center 'DOE-2
(kWh/h)')
            offset = (0,0)
            value = (height = 4);

axis4       order = (0 to 60 by 10)
            minor = (number = 4)
            label = (height = 5 angle = 90 justify = center
'Measured (kWh/h)')
            offset = (0,0)
            value = (height = 4);

proc gplot data = low;
```

```
plot plant * time /
        frame
        lvref = 3
        vref = 0 20 40
        haxis = axis2
        vaxis = axis3;

plot2 plant * time /
        haxis = axis2
        vaxis = axis1;
title1 height = 5 'Weekday Temperatures < 45 F';
title2;
title3 height = 3 '(b)';
title4;

proc gplot data = low;
plot  meas * time /
        frame
        lvref = 3
        vref = 0 20 40
        haxis = axis2
        vaxis = axis4;
plot2 meas * time /
        haxis = axis2
        vaxis = axis1;
title1 height = 5 'Weekday Temperatures < 45 F';
title2;
title3 height = 3 '(a)';
title4;

proc gplot data = med;
plot plant * time /
        frame
        lvref = 3
        vref = 0 20 40
        haxis = axis2
        vaxis = axis3;
plot2 plant * time /
        haxis = axis2
        vaxis = axis1;
title1 height = 5 ' Weekday Temperatures 45 F-75 F';
title2;
title3 height = 3 '(d)';
title4;

proc gplot data = med;
plot meas * time /
        frame
        lvref = 3
        vref = 0 20 40
        haxis = axis2
        vaxis = axis4;
plot2 meas * time /
        haxis = axis2
        vaxis = axis1;
title1 height = 5 ' Weekday Temperatures 45 F-75 F';
title2;
title3 height = 3 '(c)';
title4;

proc gplot data = high;
plot plant * time /
        frame
        lvref = 3
        vref = 0 20 40
        haxis = axis2
        vaxis = axis3;
plot2 plant * time /
        haxis = axis2
        vaxis = axis1;
title1 height = 5 'Weekday Temperatures > 75 F';
title2;
title3 height = 3 '(f)';
title4;

proc gplot data = high;
plot meas * time /
        frame
        lvref = 3
        vref = 0 20 40
        haxis = axis2
        vaxis = axis4;
plot2 meas * time /
        haxis = axis2
        vaxis = axis1;
title1 height = 5 'Weekday Temperatures > 75 F';
title2;
title3 height = 3 '(e)';
title4;

proc greplay igout = work.gseg
        tc = work.gseg
        nofs;
goptions display;
list igout;
 tdef newfour des = 'Four squares of equal size'

 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
     scaley = .91
     scalex = .91
     color = white
 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
     scaley = .91
     scalex = .91
     color = white
 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
     scaley = .91
     scalex = .91
     color = white
 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
     scaley = .91
     scalex = .91
     color = white
 5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
     scaley = .91
     scalex = .91
     color = white
 6/llx = 65 lly = 50
  ulx = 65 uly = 85
  urx = 94 ury = 85
  lrx = 94 lry = 50
```

```
      scaley = .91
      scalex = .91
      color = white;

template newfour;
treplay 1:gplot
        2:gplot1
                                        3:gplot2
                                        4:gplot3
                                        5:gplot4
                                        6:gplot5;
run;
quit;
```

E: WD 24-Hour Daytype Box-whisker-mean Plot Source Code HRWDBIN.SAS

```
/*HRWEBIN.SAS*/

filename gsasfile 'hrwebin.ps';
data daily;
infile 'we.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
time = ranuni(0) * 50 + time;
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;

goptions    device = psl
            ftext = triplex
            gsfmode = replace
            rotate = landscape
            gaccess = gsasfile;

symbol1 value = plus color = black;

axis1 order = (0 to 60 by 10)
            minor = (number = 4)
            label = none
            offset = (0,0)
            value = (height = 4);

axis2 order = (0 to 2400 by 400)
            minor = (number = 3)
            label = (height = 4 'Time of Day')
            offset = (0,0)
            value = (height = 4);

axis3 order = (0 to 60 by 10)
            minor = (number = 4)
            label = (height = 5 angle = 90 justify = center 'DOE-2
(kWh/h)')
            offset = (0,0)
            value = (height = 4);

axis4 order = (0 to 60 by 10)
            minor = (number = 4)
            label = (height = 5 angle = 90 justify = center
'Measured (kWh/h)')
            offset = (0,0)
            value = (height = 4);

proc gplot data = low;
```

```
plot plant * time /
            frame
            lvref = 3
            vref = 0 20 40
            haxis = axis2
            vaxis = axis3;

plot2 plant * time /
            haxis = axis2
            vaxis = axis1;
title1 height = 5 'Weekend Temperatures < 45 F';
title2;
title3 height = 3 '(b)';
title4;

proc gplot data = low;
plot  meas * time /
            frame
            lvref = 3
            vref = 0 20 40
            haxis = axis2
            vaxis = axis4;

plot2 meas * time /
            haxis = axis2
            vaxis = axis1;
title1 height = 5 'Weekend Temperatures < 45 F';
title2;
title3 height = 3 '(a)';
title4;

proc gplot data = med;
plot plant * time /
            frame
            lvref = 3
            vref = 0 20 40
            haxis = axis2
            vaxis = axis3;

Plot2 plant * time /
            haxis = axis2
            vaxis = axis1;
title1 height = 5 ' Weekend Temperatures 45 F-75 F';
title2;
title3 height = 3 '(d)';
title4;

proc gplot data = med;
plot meas * time /
            frame
            lvref = 3
            vref = 0 20 40
            haxis = axis2
            vaxis = axis4;

plot2 meas * time /
            haxis = axis2
            vaxis = axis1;
title1 height = 5 ' Weekend Temperatures 45 F-75 F';
title2;
title3 height = 3 '(c)';
title4;

proc gplot data = high;
plot plant * time /
            frame
            lvref = 3
            vref = 0 20 40
            haxis = axis2
            vaxis = axis3;

plot2 plant * time /
            haxis = axis2
            vaxis = axis1;
title1 height = 5 'Weekend Temperatures > 75 F';
title2;
title3 height = 3 '(f)';
title4;

proc gplot data = high;
plot meas * time /
            frame
            lvref = 3
            vref = 0 20 40
            haxis = axis2
            vaxis = axis4;

plot2 meas * time /
            haxis = axis2
            vaxis = axis1;
title1 height = 5 'Weekend Temperatures > 75 F';
title2;
title3 height = 3 '(e)';
title4;

proc greplay igout = work.gseg
          tc = work.gseg
          nofs;
goptions display;
list igout;
tdef newfour des = 'Four squares of equal size'

 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
     scaley = .91
     scalex = .91
     color = white
 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
     scaley = .91
     scalex = .91
     color = white
 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
     scaley = .91
     scalex = .91
     color = white
 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
     scaley = .91
     scalex = .91
     color = white
 5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
     scaley = .91
     scalex = .91
```

```
    color = white
6/llx = 65 lly = 50
 ulx = 65 uly = 85
 urx = 94 ury = 85
 lrx = 94 lry = 50
    scaley = .91
    scalex = .91
    color = white;
```

```
template newfour;
treplay 1:gplot
        2:gplot1
        3:gplot2
        4:gplot3
        5:gplot4
        6:gplot5;
run;
quit;
```

F: WE 24-Hour Daytype Box-whisker-mean Plot Source Code HRWEBIN.SAS

```
/*HRWDBOX.SAS*/

filename gsasfile 'hrwdbox.ps';
data daily;
infile 'wd.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;

goptions    device = psl
          ftext = triplex
          sfmode = replace
          rotate = landscape
             gaccess = gsasfile;

proc means data = low;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data low1;
merge low dayout;
proc print data = dayout;
run;

proc means data = med;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data med1;
merge med dayout;
proc print data = dayout;
run;

proc means data = high;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data high1;
merge high dayout;
proc print data = dayout;
run;
quit;

symbol1 interpol = box10 value = plus color = black;
```

```
symbol2 interpol = none  value = none color = black;
symbol3 interpol = join  color = black;
symbol4 interpol = join  color = black line=2;

axis1 order = (0 to 60 by 10)
      minor = (number = 4)
      label = none
      offset = (0,0)
      value = (height = 4);

axis2 order = (0 to 2400 by 400)
      minor = (number = 3)
      label = (height = 4 'Time of Day')
      offset = (0,0)
      value = (height = 4);

axis3 order = (4869 to 4900 by 10)
      label = (height = 3 '5/1/93 - 5/31/93')
      offset = (0,0)
      value = (height = 4);

axis4 order = (4900 to 4930 by 10)
      label = (height = 4 '6/1/93 - 6/30/93')
      offset = (0,0)
      value = (height = 4);

axis5 order = (0 to 60 by 10)
      minor = (number = 4)
      label = (height = 5 angle = 90 justify = center 'DOE-2
(kWh/h)')
      offset = (0,0)
      value = (height = 4);

axis6 order = (0 to 60 by 10)
      minor = (number = 4)
      label = (height = 5 angle = 90 justify = center 'Measured
(kWh/h)')
      offset = (0,0)
      value = (height = 4);

proc gplot data = low1;
plot  plant * time = 1
     plant * time = 2  mplant * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis5;
plot2  plant * time = 1
       plant * time = 2 mmeas * time = 4 / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 'Weekday Temperatures < 45 F';
title2;
title3 height = 3 '(b)';
title4;

proc gplot data = low1;
plot   meas * time = 1
      meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis=axis6;
plot2  meas * time = 1
       meas * time = 2  / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 'Weekday Temperatures < 45 F';
title2;
title3 height = 3 '(a)';
title4;

proc gplot data = med1;
plot   plant * time = 1
      plant * time = 2 mplant * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis5;
plot2  plant * time = 1
       plant * time = 2 mmeas * time = 4 / overlay
                haxis = axis2
                vaxis = axis1;
title1 height=5 ' Weekday Temperatures 45 F-75 F';
title2;
title3 height = 3 '(d)';
title4;

proc gplot data = med1;
plot   meas * time = 1
      meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis6;
plot2  meas * time = 1
       meas * time = 2  / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 ' Weekday Temperatures 45 F-75 F';
title2;
title3 height = 3 '(c)';
title4;

proc gplot data = high1;
plot   plant * time = 1
      plant * time = 2 mplant * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis5;
plot2  plant * time = 1
     plant * time = 2  mmeas * time = 4 / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 'Weekday Temperatures > 75 F';
title2;
title3 height = 3 '(f)';
title4;

proc gplot data = high1;
plot   meas * time = 1
      meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis6;
plot2   meas * time = 1
        meas * time = 2 / overlay
                haxis = axis2
```

```
                vaxis = axis1;
title1 height = 5 'Weekday Temperatures > 75 F';
title2;
title3 height = 3 '(e)';
title4;

proc greplay igout = work.gseg
          tc = work.gseg
          nofs;
goptions display;
list igout;
tdef newfour des = 'Four squares of equal size'

 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
      scaley = .91
      scalex = .91
      color = white

 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
      scaley = .91
      scalex = .91
      color = white

 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
      scaley = .91
      scalex = .91
      color = white

 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
      scaley = .91
      scalex = .91
      color = white

 5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
      scaley = .91
      scalex = .91
      color = white

 6/llx = 65 lly = 50
  ulx = 65 uly = 85
  urx = 94 ury = 85
  lrx = 94 lry = 50
      scaley = .91
      scalex = .91
      color = white;

template newfour;
treplay 1:gplot
          2:gplot1
          3:gplot2
          4:gplot3
          5:gplot4
          6:gplot5;
run;
quit;
```

G: Weekday 24-Hour Daytype Scatter Box Plot Source Code HRWDBOX.SAS

```
/*HRWEBOX.SAS*/

filename gsasfile 'hrwebox.ps';
data daily;
infile 'we.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;
goptions    device = psl
          ftext = triplex
          gsfmode = replace
             rotate = landscape
             gaccess = gsasfile;
proc means data = low;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data low1;
merge low dayout;
proc print data = dayout;
run;

proc means data = med;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data med1;
merge med dayout;
proc print data = dayout;
run;

proc means data = high;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data high1;
merge high dayout;
proc print data = dayout;
run;
quit;

symbol1 interpol = box10 value = plus color = black;
symbol2 interpol = none  value = none color = black;
symbol3 interpol = join  color = black;
symbol4 interpol = join  color = black line = 2;
```

```
axis1 order = (0 to 60 by 10)
      minor = (number = 4)
      label = none
      offset = (0,0)
      value = (height = 4);

axis2 order = (0 to 2400 by 400)
      minor = (number = 3)
      label = (height = 4 'Time of Day')
      offset = (0,0)
      value = (height = 4);

axis3 order = (4869 to 4900 by 10)
      label = (height = 3 '5/1/93 - 5/31/93')
      offset = (0,0)
      value = (height = 4);

axis4 order = (4900 to 4930 by 10)
      label = (height = 4 '6/1/93 - 6/30/93')
      offset = (0,0)
      value = (height = 4);

axis5 order = (0 to 60 by 10)
      minor = (number = 4)
      label = (height = 5 angle = 90 justify = center 'DOE-2
(kWh/h)')
      offset = (0,0)
      value = (height = 4);

axis6 order = (0 to 60 by 10)
      minor = (number = 4)
      label = (height = 5 angle = 90 justify = center 'Measured
(kWh/h)')
      offset = (0,0)
      value = (height = 4);

proc gplot data = low1;
plot  plant * time = 1
     plant * time = 2  mplant * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis5;

plot2  plant * time = 1
       plant * time = 2 mmeas * time = 4 / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 'Weekend Temperatures < 45 F';
title2;
title3 height = 3 '(b)';
title4;

proc gplot data = low1;
plot  meas * time = 1
      meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis=axis6;

plot2  meas * time = 1
       meas * time = 2  / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 'Weekend Temperatures < 45 F';
title2;
title3 height = 3 '(a)';
title4;

proc gplot data = med1;
plot  plant * time = 1
      plant * time = 2 mplant * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis5;

plot2  plant * time = 1
       plant * time = 2 mmeas * time = 4 / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 ' Weekend Temperatures 45 F-75 F';
title2;
title3 height = 3 '(d)';
title4;

proc gplot data = med1;
plot  meas * time = 1
      meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis6;
plot2  meas * time = 1
       meas * time = 2  / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 ' Weekend Temperatures 45 F-75 F';
title2;
title3 height = 3 '(c)';
title4;

proc gplot data = high1;
plot  plant * time = 1
      plant * time = 2 mplant * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis5;
plot2  plant * time = 1
       plant * time = 2 mmeas * time = 4 / overlay
                haxis = axis2
                vaxis = axis1;
title1 height = 5 'Weekend Temperatures > 75 F';
title2;
title3 height = 3 '(f)';
title4;

proc gplot data = high1;
plot  meas * time = 1
      meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref = 3
                vref = 0 20 40
                haxis = axis2
                vaxis = axis6;
plot2  meas * time = 1
       meas * time = 2 / overlay
                haxis = axis2
```

```
                vaxis = axis1;
title1 height = 5 'Weekend Temperatures > 75 F';
title2;
title3 height = 3 '(e)';
title4;

proc greplay igout = work.gseg
          tc = work.gseg
          nofs;
goptions display;
list igout;
tdef newfour des = 'Four squares of equal size'
 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
      scaley = .91
      scalex = .91
      color = white
 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
      scaley = .91
      scalex = .91
      color = white
 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
      scaley = .91
      scalex = .91
      color = white
 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
      scaley = .91
      scalex = .91
      color = white
 5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
      scaley = .91
      scalex = .91
      color = white
 6/llx = 65 lly = 50
  ulx = 65 uly = 85
  urx = 94 ury = 85
  lrx = 94 lry = 50
      scaley = .91
      scalex = .91
      color = white;

template newfour;
treplay 1:gplot
        2:gplot1
        3:gplot2
        4:gplot3
        5:gplot4
        6:gplot5;
run;
quit;
```

H: Weekend 24-Hour Daytype Scatter Plot Source Code HRWEBOX.SAS

General Disclaimer


```
/*HRWDOBIN.SAS*/

filename gsasfile 'hrwdoccbin.ps';
data daily;
infile 'wdocc.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
time= ranuni(0) * 50 + time;
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;

goptions   device = psl
           ftext = triplex
           gsfmode = replace
           rotate = landscape
           gaccess = gsasfile;

/*proc print data = daily;
proc print data = low;*/
symbol1 value = plus color=black;
axis1 order=(0 to 60 by 10)
    minor = (number = 4)
    label=none
    offset=(0,0)
    value=(height=4);

axis2 order=(0 to 2400 by 400)
    minor = (number = 3)
    label=(height=4 'Time of Day')
    offset=(0,0)
    value=(height=4);

axis3 order=(4869 to 4900 by 10)
    label=(height=3 '5/1/93 - 5/31/93')
    offset=(0,0)
    value=(height=4);

axis4 order=(4900 to 4930 by 10)
    label=(height=4 '6/1/93 - 6/30/93')
    offset=(0,0)
    value=(height=4);

axis5 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'DOE-2 (kWh/h)')
```

```
    offset=(0,0)
    value=(height=4);

axis6 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'Measured (kWh/h)')
    offset=(0,0)
    value=(height=4);

proc gplot data = low;
plot plant * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;

plot2 plant * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures < 45 F';
title2;
title3 height=3 '(b)';
title4;

proc gplot data = low;
plot  meas * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                 vaxis=axis6;
plot2 meas * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures < 45 F';
title2;
title3 height=3 '(a)';
title4;

proc gplot data = med;
plot plant * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2 plant * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Occupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(d)';
title4;

proc gplot data = med;
plot meas * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2 meas * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Occupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(c)';
title4;

proc gplot data = high;
plot plant * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2 plant * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures > 75 F';
title2;
title3 height=3 '(f)';
title4;

proc gplot data = high;
plot meas * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2 meas * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures > 75 F';
title2;
title3 height=3 '(e)';
title4;

proc greplay igout = work.gseg
          tc=work.gseg
          nofs;
goptions display;
list igout;
 tdef newfour des = 'Four squares of equal size'

 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
     scaley =.91
     scalex =.91
     color = white

 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
     scaley = .91
     scalex = .91
     color = white

 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
     scaley = .9
     scalex = .9
     color = white

 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
     scaley = .91
```

```
      scalex = .91
      color = white

 5/llx = 65 lly = 15
   ulx = 65 uly = 50
   urx = 94 ury = 50
   lrx = 94 lry = 15
      scaley = .91
      scalex = .91
      color = white

 6/llx = 65 lly = 50
   ulx = 65 uly = 85
   urx = 94 ury = 85
   lrx = 94 lry = 50
      scaley = .91
      scalex = .91
      color = white;

template newfour;
treplay 1:gplot
      2:gplot1
      3:gplot2
      4:gplot3
      5:gplot4
      6:gplot5;
run;
quit;
```

I: WD 24-Hour Occupied Daytype Box-whisker-mean Plot Source Code HRWDOBIN.SAS

```
/*HRWDUBIN.SAS*/

filename gsasfile 'hrwdunoccbin.ps';
data daily;
infile 'wdunocc.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
time= ranuni(0) * 50 + time;
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;

goptions   device = psl
           ftext = triplex
                       gsfmode = replace
                       rotate = landscape
                       gaccess = gsasfile;

symbol1 value = plus color=black;
axis1 order=(0 to 60 by 10)
    minor = (number = 4)
    label=none
    offset=(0,0)
    value=(height=4);

axis2 order=(0 to 2400 by 400)
    minor = (number = 3)
    label=(height=4 'Time of Day')
    offset=(0,0)
    value=(height=4);

axis3 order=(4869 to 4900 by 10)
    label=(height=3 '5/1/93 - 5/31/93')
    offset=(0,0)
    value=(height=4);

axis4 order=(4900 to 4930 by 10)
    label=(height=4 '6/1/93 - 6/30/93')
    offset=(0,0)
    value=(height=4);

axis5 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'DOE-2 (kWh/h)')
    offset=(0,0)
    value=(height=4);
```

```
axis6 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'Measured (kWh/h)')
    offset=(0,0)
    value=(height=4);

proc gplot data = low;
plot plant * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;

plot2 plant * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures < 45 F';
title2;
title3 height=3 '(b)';
title4;

proc gplot data = low;
plot  meas * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2 meas * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures < 45 F';
title2;
title3 height=3 '(a)';
title4;

proc gplot data = med;
plot plant * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2 plant * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Unoccupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(d)';
title4;

proc gplot data = med;
plot meas * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2 meas * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Unoccupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(c)';
title4;

proc gplot data = high;
plot plant * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2 plant * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures > 75 F';
title2;
title3 height=3 '(f)';
title4;

proc gplot data = high;
plot meas * time /
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2 meas * time /
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures > 75 F';
title2;
title3 height=3 '(e)';
title4;

proc greplay igout = work.gseg
          tc=work.gseg
          nofs;
goptions display;
list igout;
 tdef newfour des = 'Four squares of equal size'

1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
     scaley =.91
     scalex =.91
     color = white

2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
     scaley = .91
     scalex = .91
     color = white

3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
     scaley = .9
     scalex = .9
     color = white

4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
     scaley = .91
     scalex = .91
     color = white
```

```
5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
     scaley = .91
     scalex = .91
     color = white

6/llx = 65 lly = 50
  ulx = 65 uly = 85
  urx = 94 ury = 85
  lrx = 94 lry = 50
     scaley = .91
     scalex = .91
     color = white;

template newfour;
treplay 1:gplot
     2:gplot1
     3:gplot2
     4:gplot3
     5:gplot4
     6:gplot5;
run;
quit;
```

J: WD 24-Hour Unoccupied Daytype Box-whisker-mean Plot Source Code HRWDUBIN.SAS

```
/*HRWDOBOX.SAS*/

filename gsasfile 'hrwdoccbox.ps';
data daily;
infile 'wdocc.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
run;

data low;
set daily;
if temp <= 45;

data med;
set daily;
if temp > 45 and temp <= 75;

data high;
set daily;
if temp > 75;
run;

goptions   device = psl
           ftext = triplex
         gsfmode = replace
                   rotate = landscape
                   gaccess = gsasfile;

proc means data = low;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data low1;
merge low dayout;
run;

proc means data = med;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data med1;
merge med dayout;
run;

proc means data = high;
var meas plant;
class time;
output out = dayout mean = mmeas mplant;
data high1;
merge high dayout;
run;
quit;

symbol1 interpol = box10 value = plus color = black;
symbol2 interpol = none  value = none color = black;
symbol3 interpol = join  color = black;
symbol4 interpol = join  color = black line=2;
```

```
axis1 order=(0 to 60 by 10)
    minor = (number = 4)
    label=none
    offset=(0,0)
    value=(height=4);

axis2 order=(0 to 2400 by 400)
    minor = (number = 3)
    label=(height=4 'Time of Day')
    offset=(0,0)
    value=(height=4);

axis3 order=(4869 to 4900 by 10)
    label=(height=3 '5/1/93 - 5/31/93')
    offset=(0,0)
    value=(height=4);

axis4 order=(4900 to 4930 by 10)
    label=(height=4 '6/1/93 - 6/30/93')
    offset=(0,0)
    value=(height=4);

axis5 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'DOE-2 (kWh/h)')
    offset=(0,0)
    value=(height=4);

axis6 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'Measured (kWh/h)')
    offset=(0,0)
    value=(height=4);

proc gplot data = low1;
plot  plant * time = 1
    plant * time = 2  mplant * time = 3 / overlay
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;

plot2  plant * time = 1
     plant * time = 2 mmeas * time = 4 / overlay
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures < 45 F';
title2;
title3 height=3 '(b)';
title4;

proc gplot data = low1;
plot   meas * time = 1
     meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2  meas * time = 1
     meas * time = 2  / overlay
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures < 45 F';
title2;
title3 height=3 '(a)';
title4;

proc gplot data = med1;
plot   plant * time = 1
     plant * time = 2 mplant * time = 3 / overlay
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2  plant * time = 1
     plant * time = 2 mmeas * time = 4 / overlay
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Occupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(d)';
title4;

proc gplot data = med1;
plot   meas * time = 1
     meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2  meas * time = 1
     meas * time = 2  / overlay
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Occupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(c)';
title4;

proc gplot data = high1;
plot   plant * time = 1
     plant * time = 2 mplant * time = 3 / overlay
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2  plant * time = 1
     plant * time = 2 mmeas * time = 4 / overlay
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures > 75 F';
title2;
title3 height=3 '(f)';
title4;

proc gplot data = high1;
plot   meas * time = 1
     meas * time = 2  mmeas * time = 3 / overlay
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2   meas * time = 1
      meas * time = 2 / overlay
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Occupied Temperatures > 75 F';
title2;
title3 height=3 '(e)';
```

```
title4;

proc greplay igout = work.gseg
          tc=work.gseg
          nofs;
goptions display;
list igout;
 tdef newfour des = 'Four squares of equal size'

 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
      scaley =.91
      scalex =.91
      color = white

 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
      scaley = .91
      scalex = .91
      color = white

 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
      scaley = .91
      scalex = .91
      color = white

 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
      scaley = .91
      scalex = .91
      color = white

 5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
      scaley = .91
      scalex = .91
      color = white

 6/llx = 65 lly = 50
  ulx = 65 uly = 85
  urx = 94 ury = 85
  lrx = 94 lry = 50
      scaley = .91
      scalex = .91
      color = white;

template newfour;
treplay 1:gplot
      2:gplot1
      3:gplot2
      4:gplot3
      5:gplot4
      6:gplot5;
run;
quit;
```

K: Weekday 24-Hour Occupied Daytype Scatter Box Plot Source Code HRWDOBOX.SAS

```
/*HRWDUBOX.SAS*/

filename gsasfile 'hrwdunoccbox.ps';
data daily;
infile 'wdunocc1.dat';
input site mon day yr jul dec time meas temp plant;
if meas < 0 then meas = ".";
if temp < 0 then temp = ".";
if plant < 0 then plant = ".";
run;

data lowus;
set daily;
if temp <= 45;
proc sort data = lowus out = low;
by time;
run;

data medus;
set daily;
if (temp > 45 and temp <= 75) or temp = ".";
proc sort data = medus out = med;
by time;
run;

data highus;
set daily;
if temp > 75 or temp = ".";
proc sort data = highus out = high;
by time;
run;

goptions   device = psl
           ftext = triplex
                   gsfmode = replace
                   rotate = landscape
                   gaccess = gsasfile;

proc means data = low;
var meas plant;
class time;
output out = dayout1 mean = mmeas mplant;
proc print data = dayout1;
data low1;
merge low dayout1 (rename=(time=mtime));
proc print data = low1;
run;

symbol1 interpol = box10 value = plus color = black;
symbol2 interpol = none value = none color = black;
symbol3 interpol = join  color = black;
symbol4 interpol = join  color = black line=2;

axis1 order=(0 to 60 by 10)
    minor = (number = 4)
    label=none
    offset=(0,0)
    value=(height=4);
```

```
axis2 order=(0 to 2400 by 400)
    minor = (number = 3)
    label=(height=4 'Time of Day')
    offset=(0,0)
    value=(height=4);

axis3 order=(4869 to 4900 by 10)
    label=(height=3 '5/1/93 - 5/31/93')
    offset=(0,0)
    value=(height=4);

axis4 order=(4900 to 4930 by 10)
    label=(height=4 '6/1/93 - 6/30/93')
    offset=(0,0)
    value=(height=4);

axis5 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'DOE-2 (kWh/h)')
    offset=(0,0)
    value=(height=4);

axis6 order=(0 to 60 by 10)
    minor = (number = 4)
    label=(height=5 angle=90 justify=center 'Measured (kWh/h)')
    offset=(0,0)
    value=(height=4);

proc gplot data = low1;
plot  plant * time = 1
    plant * time = 2  mplant * mtime = 3 / overlay
                skipmiss
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5
                ;

plot2  plant * time = 1
     plant * time = 2 mmeas * mtime = 4 / overlay
                skipmiss
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures < 45 F';
title2;
title3 height=3 '(b)';
title4;

proc gplot data = low1;
plot   meas * time = 1
     meas * time = 2  / overlay
                skipmiss
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2  meas * time = 1
     meas * time = 2  mmeas * mtime = 3 / overlay
                skipmiss
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures < 45 F';
title2;
title3 height=3 '(a)';
title4;

proc means data = med;
var meas plant;
class time;
output out = dayout2 mean = mmeas mplant;
data med1;
merge med dayout2 (rename=(time=mtime));
proc print data = med1;
run;

proc gplot data = med1;
plot   plant * time = 1
     plant * time = 2 mplant * mtime = 3 / overlay
                skipmiss
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2  plant * time = 1
     plant * time = 2 mmeas * mtime = 4 / overlay
                skipmiss
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Unoccupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(d)';
title4;

proc gplot data = med1;
plot   meas * time = 1
     meas * time = 2  / overlay
                skipmiss
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2  meas * time = 1
     meas * time = 2  mmeas * mtime = 3 / overlay
                skipmiss
                haxis=axis2
                vaxis=axis1;
title1 height=5 ' Weekday Unoccupied Temperatures 45 F-75 F';
title2;
title3 height=3 '(c)';
title4;

proc means data = high;
var meas plant;
class time;
output out = dayout3 mean = mmeas mplant;
data high1;
merge high dayout3 (rename=(time=mtime));
run;

proc gplot data = high1;
plot   plant * time = 1
     plant * time = 2 mplant * mtime = 3 / overlay
                skipmiss
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis5;
plot2  plant * time = 1
     plant * time = 2 mmeas * mtime = 4 / overlay
                skipmiss
                haxis=axis2
```

```
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures > 75 F';
title2;
title3 height=3 '(f)';
title4;

proc gplot data = high1;
plot   meas * time = 1
     meas * time = 2  / overlay
                skipmiss
                frame
                lvref=3
                vref=0 20 40
                haxis=axis2
                vaxis=axis6;
plot2   meas * time = 1
      meas * time = 2 mmeas * mtime = 3 / overlay
                skipmiss
                haxis=axis2
                vaxis=axis1;
title1 height=5 'Weekday Unoccupied Temperatures > 75 F';
title2;
title3 height=3 '(e)';
title4;

proc greplay igout = work.gseg
          tc=work.gseg
          nofs;
goptions display;
list igout;
 tdef newfour des = 'Four squares of equal size'

 1/llx =  5 lly = 15
  ulx =  5 uly = 50
  urx = 35 ury = 50
  lrx = 35 lry = 15
      scaley = .91
      scalex = .91
      color = white

 2/llx =  5 lly = 50
  ulx =  5 uly = 85
  urx = 35 ury = 85
  lrx = 35 lry = 50
      scaley = .91
      scalex = .91
      color = white

 3/llx = 35 lly = 15
  ulx = 35 uly = 50
  urx = 65 ury = 50
  lrx = 65 lry = 15
      scaley = .91
      scalex = .91
      color = white

 4/llx = 35 lly = 50
  ulx = 35 uly = 85
  urx = 65 ury = 85
  lrx = 65 lry = 50
      scaley = .91
      scalex = .91
      color = white

 5/llx = 65 lly = 15
  ulx = 65 uly = 50
  urx = 94 ury = 50
  lrx = 94 lry = 15
      scaley = .91
      scalex = .91
      color = white

 6/llx = 65 lly = 50
  ulx = 65 uly = 85
  urx = 94 ury = 85
  lrx = 94 lry = 50
      scaley = .91
      scalex = .91
      color = white;

template newfour;
treplay 1:gplot
      2:gplot1
      3:gplot2
      4:gplot3
      5:gplot4
      6:gplot5;
run;
quit;
```

L: Weekday 24-Hour Unoccupied Daytype Scatter Box Plot Source Code HRWDUBOX.SAS

Appendix E SOLAR CONVERSION ROUTINE

```
REM SOLAR.BAS ROUTINE TO CONVERT 18° SOLAR RADIATION TO GLOBAL HORIZONTAL
REM RADIATION

DEFSNG A-Z
CLS
CONST L = 38.8, PI = 3.141592, BETA = 18, ISC = 1367, RHO = .2, R = PI / 180
LST = 75
LLOC = 77
OPEN "18deg.inp" FOR INPUT AS #1
OPEN "0deg.out" FOR OUTPUT AS #2
LATCOS = COS(L * R)
LATSIN = SIN(L * R)

DO WHILE NOT EOF(1)
 INPUT #1, SITE, MON, DOM, YR, JUL, DEC, TIME, IT

REM DEFINING 1993
 DAY = JUL - 93000

REM SOLAR DECLINATION
 LAMBDA = 23.45 * SIN(2 * PI * ((284 + DAY) / 365))

REM CALIBRATION PERIOD DAY OF YEAR
```

```
 IF DAY >= 91 AND DAY <= 365 THEN
 PRINT DAY

REM DEFINING 24 HOUR DAY
  FOR j = 1 TO 24
   HOUR1 = FIX(TIME / 100) - .5

REM EQUATION OF TIME
   B = (360 * (DAY - 81)) / 364 * R
   E = 9.87 * SIN(2 * B) - 7.53 * COS(B) - 1.5 * SIN(B)

REM SOLAR TIME
   HOUR = HOUR1 + (4 * (LST - LLOC) + E) / 60

REM REMOVING NEGATIVE NIGHTTIME PYRANOMETER VALUES
      IF IT <= 0 THEN
        IT = 0
        K = 0
        IDBYI = 0
        K1 = 0
      END IF

REM CORRECTING FOR EARLY AND LATE ROUTINE CALCULATION
REM PROBLEMS
   IF HOUR1 <= 7 OR HOUR1 >= 16 THEN
   WRITE #2, SITE, MON, DOM, YR, JUL, DEC, TIME, IT, K2, IDBYI1
   END IF

REM HOUR ANGLE
   OMEGA = (HOUR - 12) * 15

REM STEP FUNCTION FOR ASSUMED K VALUES
   FOR K = 0.1 TO .95 STEP .025

REM ANGLE OF INCIDENCE ON HORIZONTAL PLANE (ZENITH ANGLE)
 CO2=(LATCOS * COS(LAMBDA*R) * COS(OMEGA* R)) + (SIN(LAMBDA* R) * LATSIN)

REM ANGLE OF INCIDENCE ON SOLAR COLLECTOR
 CO=(COS(R*(L-BETA))*COS(LAMBDA*R)*COS(OMEGA*R))+(SIN(LAMBDA*R)*SIN(R*(L-
      BETA)))

REM TILT FACTOR
     RBT = CO / CO2

REM EXTRATERESTRIAL RADIATION
IO=ISC*(1+.033*COS(360*DAY/365*R))*((LATSIN*SIN(LAMBDA*R))+(LATCOS*COS(LAMBDA*R)*COS(
OMEGA*R)))

REM ERBS EQUATION
   IF K <= .22 THEN IDBYI = 1 - (.09 * K)
   IF K > .22 AND K <= .8 THEN IDBYI =.9511-.1604*K+4.388*K^2-16.638*K^3+12.336*K^4
   IF K > .8 THEN IDBYI = .165

REM EQ 4.7
   ITBYI = RBT - IDBYI * (RBT - .5 - (.5 * COS(BETA * R))) + .5 * RHO * (1 - COS(BETA * R))
```

```
    I = IT / ITBYI
    K1 = I / IO
     IF K1 >= .95 THEN
         I = IT
     END IF

REM ERBS EQUATION TO VERIFY INITIAL K ASSUMPTION
    IF K1 <= .22 THEN IDBYI1 = 1 - (.09 * K1)
    IF K1>.22 AND K1<=.8 THEN IDBYI1 =.9511-.1604*K1+4.388*K1^2-16.638*K1^3+12.336*K1^4
    IF K1 > .8 THEN IDBYI1 = .165

REM EQ 4.7
ITBYI1 = RBT - IDBYI1 * (RBT - .5 - (.5 * COS(BETA * R))) + .5 * RHO * (1 - COS(BETA * R))
       I1 = IT / ITBYI1
       K2 = I1 / IO

       IF K2 >= .95 THEN
        I1 = IT
       END IF

REM CHECKING IF CALCULATIONS FALL IN DAYTIME AND VERIFYING TOLERANCE
 IF HOUR1 > 7 AND HOUR1 < 16 THEN
       IF ABS(K - K1) < .025 THEN
         IF IT < 0 THEN
            I = 0
         END IF

REM IF WITHIN TOLERANCE, PRINT TO FILE
          WRITE #2, SITE, MON, DOM, YR, JUL, DEC, TIME, I, K2, IDBYI1
          EXIT FOR
          WRITE #2, SITE, MON, DOM, YR, JUL, DEC, TIME, I, K2, IDBYI1
       END IF
 END IF
 NEXT K
 IF TIME <> 2300 THEN
    INPUT #1, SITE, MON, DOM, YR, JUL, DEC, TIME, IT
 END IF
  NEXT j
END IF
LOOP
CLOSE
```

APPENDIX F FORRESTAL BUILDING CHANNEL TABLES

Date MM/DD/YY (YY DDD)	Time HH:mm	Raw-Data lin pos	coln pos	Arch coln pos	Name of Channel	Archive Units	Arch Format	Conv'n Code	Conv'n Const	Error Code	Error Constants	Channel Description
#												
03/12/90	00:00	1	0	0	Begin	DOE/Vlt C						Beg date
03/12/90	00:00	1	1	1	Site	-	I3	2	0 906	0		Site #
03/12/90	00:00	1	1	2	Mon-Raw	MM	I3	1		0		Month
03/12/90	00:00	1	2	3	Mon-Raw	DD	I3	1		0		Day
03/12/90	00:00	1	3	4	Mon-Raw	YY	I3	1		0		Year
03/12/90	00:00	1	3	5	Greg-Jul	MMDDYY	I5	24	1 2	0		Greg-Jul
03/12/90	00:00	1	4	7	Time	HH mm	I5	16	5	0		Time
03/12/90	00:00	1	3	6	Greg-Dec	DDD.frac	F10.4	28		0		Greg-Dec
03/12/90	00:00	1	6	8	DayCareA	F9.3	F9.3	1		1	-90 2000	DC Ph A (kWh/h)
03/12/90	00:00	1	7	9	DayCareB	F9.3	F9.3	1		1	-90 2000	DC Ph B (kWh/h)
03/12/90	00:00	1	8	10	DayCareC	F9.3	F9.3	1		1	-90 2000	DC Ph C (kWh/h)
03/12/90	00:00	1	9	11	Lights A	F9.3	F9.3	1		1	-90 2000	Lite Ph A (kWh/h)
03/12/90	00:00	1	10	12	Lights B	F9.3	F9.3	1		1	-90 2000	Lite Phase B (kWh/h)
03/12/90	00:00	1	11	13	MCC9 A	F9.3	F9.3	1		1	-90 2000	MCC 9 Phase A (kWh/h)
03/12/90	00:00	1	12	14	MCC9 B	F9.3	F9.3	1		1	-90 2000	MCC 9 Phase B (kWh/h)
03/12/90	00:00	1	13	15	MCC9 C	F9.3	F9.3	1		1	-90 2000	MCC 9 Phase C (kWh/h)
03/12/90	00:00	1	14	16	DayCarAv	F9.3	F9.3	1		1	-90 2000	Day Care Phase A (kVA/h)
03/12/90	00:00	1	15	17	DayCarBv	F9.3	F9.3	1		1	-90 2000	Day Care Phase B (kVA/h)
03/12/90	00:00	1	16	18	DayCarCv	F9.3	F9.3	1		1	-90 2000	Day Care Phase C (kVA/h)
03/12/90	00:00	1	17	19	Lights A	F9.3	F9.3	1		1	-90 2000	Lights Phase A (kVA/h)
03/12/90	00:00	1	18	20	Lights B	F9.3	F9.3	1		1	-90 2000	Lights Phase B (kVA/h)
03/12/90	00:00	1	19	21	MCC9 Av	F9.3	F9.3	1		1	-90 2000	MCC 9 Phase A (kVA/h)
03/12/90	00:00	1	20	22	MCC9 Bv	F9.3	F9.3	1		1	-90 2000	MCC 9 Phase B (kVA/h)
03/12/90	00:00	1	21	23	MCC9 Cv	F9.3	F9.3	1		1	0 100000	MCC 9 Phase C (kVA/h)
03/12/90	00:00	1	22	24	ChW Btus	F9.3	F9.3	2	1.197 -12.098	1	0 100000	ChW Energy (MBtu)
03/12/90	00:00	1	23	25	ChW Flow	F9.3	F9.3	2	1 -3.66	1	0 100000	Chilled Water Flow (kgal)
03/12/90	00:00	1	24	26	Steam	F9.3	F9.3	2	10 -12.4	1	0 100000	Steam Use (klbs)
03/11/99	23:00	1	0	0	End	DOE/Vault C						

Logger #906 Synergistic C-180 Channel Table.