EXHIBIT NO. ___(JAD-9)
DOCKET NO. UE-060266/UG-060267
2006 PSE GENERAL RATE CASE
WITNESS: JEFFREY A. DUBIN

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY, INC.,** **Respondent.**	**Docket No. UE-060266** **Docket No. UG-060267**

FOURTH EXHIBIT (NONCONFIDENTIAL) TO THE PREFILED REBUTTAL TESTIMONY OF JEFFREY A. DUBIN ON BEHALF OF PUGET SOUND ENERGY, INC.

AUGUST 23, 2006

Analysis of Puget Sound Electric Residential Appliance Saturation Survey – Engineering Analysis of Balance Point Temperature Differentials

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I. Introduction

The purpose of this analysis is to determine the likely range of balance point temperatures in single-family residential structures in the Puget Sound Electric (PSE) service area. No additional heating is required when outdoor temperatures are higher than the balance point. Thermostat setting and the insulation properties of the residential shell determine the balance point temperature.[1]

The heat gain from occupants and appliances in a well insulated dwelling may lower the balance point temperature significantly below the thermostat set point. If, for instance, customers set their thermostats at 65 degrees in the winter, then it is possible that no extra energy (electricity or natural gas, etc.) will be required to achieve the 65 degree thermostat setting until outside temperatures drop to 45 to 55 degrees depending on the dwelling and its occupants. A base temperature of 65 degrees used for heating-degree-day measurement would tend to over-estimate the amount of likely energy requirement for heating in such a situation. My weather

[1] For additional discussion of balance point temperatures and the use of engineering thermal models, see Margaret Fels, "PRISM: An Introduction", Energy and Buildings, Volume 9, 1986, pp. 5-18. Huang, Ritschard, Bull, and Chang (1987) report balance point temperatures from 56 degrees F to 65 degrees F depending on the thermal integrity of typical dwellings. Their analysis is similar to the analysis reported here and is based on the DOE-2 energy simulation program. See J. Huang, "Climatic Indicators for Estimating Residential Heating and Cooling Loads," ASHRAE Transactions, Vol. 93, 1987, pp. 72-111.

normalization analysis does not assume any balance point temperatures or thermostat settings because it uses alternative base temperature measurements in a regression analysis[2]. This analysis established the non-linear empirical relationship between temperature conditions and load. However, the present analysis demonstrates the theoretical and empirical link between temperatures below 65 degrees and heating load based on survey evidence and engineering analysis.

To accomplish these goals, I analyzed Puget's RAS 2004 survey. RAS is an acronym for Residential Appliance Saturation. The RAS survey samples individual gas and electric customers on the Puget system and contains detailed information on over 5000 households. I adapted an energy thermal model published in Dubin (1985)[3] to work with the PSE survey. I used information on single-family residence square footage, presence or absence of insulation, the types of storm or glazed windows in the home, and other factors available in the survey as inputs to my model. These factors and matched weather information permitted me to make an engineering prediction of space heating load for each month that would likely occur for each household. The energy load model quantifies the differences between energy used for houses of different sizes. I used this information to calculate the implied balance point temperatures for each dwelling.[4] Balance point temperatures are the external temperatures at which a given household would begin to need space heating in order to maintain an assumed comfort level.

[2] Prefiled Direct Testimony of Jeffrey A. Dubin December 2005.
[3] Jeffrey A. Dubin, Consumer Durable Choice and the Demand for Electricity, Elsevier Publishers, New York: New York, 1985.

II. RAS Survey

Puget Sound Electric (PSE) performed a mail survey of its residential and gas customers in 2004. This survey is the most recent of several previous surveys conducted of PSE's residential customers (1981, 1983, 1986, 1989, 1992, and 1998). The RAS survey was designed to collect detailed and representative data on appliance holdings and customer characteristics. The survey was conducted using a mail survey instrument. The 2004 RAS Survey instrument is attached to this report as Appendix A. The RAS provides information on whether the customer is a gas, electric, or combined customer of PSE. It provides basic information on housing tenure (owning or renting the dwelling and its type), as well as structural characteristics of the dwelling. These physical traits include: square footage, number of floors, and the presence of weatherization (ceiling insulation, wall insulation, duct insulation, weather strip doors, and glazed or storm windows). The survey also provides information on the use of fuels for heating and cooking, type of heating system (gas, electric, oil), and presence of air-conditioning. The RAS also captures information on water heat fuel types and the number of electricity using appliances (stove-top cooking, ovens, clothes dryers and so on). Finally, the survey captures various socio-demographic characteristics, such as education levels, income levels, employment status, and number of household members.

The target population for the survey was all residential customers. Billing recodes established the sampling frame, which was then sampled based on systematic sampling. To insure that all customers would be represented, dwelling type and sorting schedule were used to sort the target population. Following systematic sampling, PSE achieved a sample that was proportionately stratified by dwelling type and billing schedule.

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[4] Balance point temperatures also depend on thermostat settings as I discuss below.

My review of previously conducted RAS surveys suggested that a large enough initial population was sampled in 2004 to achieve a high degree of reliability[5]. The resulting surveys were keypunched and verified. The final survey results were assembled into a SAS database of 5,316 respondents. A sample weighting factor was present to allow extrapolation to population levels. For instance, the 5,316 survey respondents represented 259,205 Gas customers, 552,795 electric customers and 260,400 combined customers for a total of 813,195 electric and 519,605 gas customers in 2004.

I extracted an ASCII data file and record layout rasfinal.sts from the file rasfinal.sas7bdat using Stat-Transfer. I took additional information from the survey instrument and from the file rass formats.sas, which provided value labels for some of the variables contained in the survey. I used SST (Statistical Software Tool 3.0) to read the raw data and prepare it for analysis. The codes in rasfinal.cmd read the ASCII to create an SST saveset. The output from this program, rasfinal.log, is in Appendix B. I further used the program jad.cmd (output of the command file, jad.log, is presented in Appendix B) to process and recode the data. Rasfinal.log has a complete listing of factors contained in the survey, as well as several recoded factors. In processing the raw data for analysis, I determined that there were 2,657 electric customers and 1,286 combined customers in the final RAS survey or 3,943 electric customers in 2004. Over 78 percent of these customers lived in single-family dwellings. I ultimately selected the single-family electric customers for further analysis. These customers constitute 3,089 sampled individuals.

Several factors are necessary inputs to the Dubin-McFadden thermal model. They include (i) house square footage, (ii) number of storm windows, (iii) number of non-storm windows, (iv) presence of wall insulation, (v) inches of attic insulation, (vi) number of rooms,

[5] For instance, detailed information from the 1992 PSE RAS survey found that nearly 70% of customers responded

(vii) number of floors, (viii) weather conditions for system design (summer outdoor daily temperature range, summer degree dry bulb and winter degree design temperature), (ix) normal heating and cooling degree days for estimated system coefficients of performance and (x) heating and cooling degrees days for a test period. To produce these factors, I needed to recode the RAS survey information to eliminate missing values and to check or recode the data for consistency and rationality. The thermal model also post-processes the information to check the values of all key factors.

For instance, I combined household members by age group to create a total number of household members. I further assumed that households with greater than 7 members had exactly 7 members to "top-code" the small number of cases of implausibly large households. I similarly assigned average values to households with missing data or non-response on this factor. The number of household member for which imputation was done was 169, or 5.5 percent, of the 3,089 survey respondents.

Similarly, I recoded the factors for the presence of wall and ceiling insulations. I assumed 12 inches of ceiling insulation for homes with this characteristic. Because dwelling vintage or information about when insulation was upgraded in order to determine the amount of attic insulation was not available, I did not use either piece of information in the analysis. Instead I used the information that insulation had been added to the residence either before or after the current resident had moved in.

To determine the number of rooms in the residence, I combined information on the number of heated rooms and the number of bathrooms; I top-coded heated-rooms above ten to

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to the survey. This response rate is exceptionally high for a mail survey

ten.[6] I then assigned average values to those entries with missing information. I recoded the categorical value for dwellings into a continuous measure, and recoded missing data as discussed above. The number of heated rooms was missing in 835, or 27 percent, of the 3,089 surveyed responses. The number of bathrooms was missing in 658, or 21 percent, of the survey respondents. After recoding missing data, there were, on average, approximately 6.96 heated rooms in the dwellings and 2.26 bathrooms.

I also assigned mean values to houses with missing square footage using the continuously reported square footage variable, the categorical square footage when available, or final based on average imputation when it was available. Square footage was imputed in 333 cases (10.8 percent).

An important factor missing from the RAS survey was the number of windows. Using a sample of 7 homes from the ASHRAE Fundamentals (1982), I ran regressions for the number of windows and floors, square footage, and number of rooms. I found a high correlation (R-squared 81 percent) for a simple regression where the number of windows was determined by the number of floors and the home's square footage. The result was then used to impute the number of windows for RAS respondents. The file, winavg.log, in Appendix C contains the regression outcomes. Next, I used the observed information on percent of double-pane and stormed windows to calculate a percentage of stormed or double-paned windows. I used the combination of percentage and total number of windows to impute a value for the number of stormed and non-stormed windows. Because the thermal model requires a distribution of small, medium and large windows, I assumed that all windows were medium sized.

[6] The number of rooms in the dwelling (number of heated rooms plus number of bathrooms) is only used to determine heating system transmission losses related to the length of piping or ducting used in the heating system. It does not affect the balance point temperature differential.

Using "county of residence," I matched information on normal degree days with a base of 65 degrees in the thermal modeling. Based on matched billing information, I also matched actual heating and cooling degree information and kwh consumption for the three years, 2001-2003. Actual heating and cooling degree days were combined with billing data from PSE's survey contractor using the weather station closest to the address of the survey respondent. For the year 2003, I found that the degree of correlation between cooling degree days measured at the county level and the cooling degree days measured at the closest weather station was quite high (correlation = 0.88). However, the heating degree day correlation was low (correlation = 0.36). SST file county2.log in Appendix C processes the county level normal heating and cooling degree day information. County3.log presented in Appendix C processes the 2003 actual annual heating and cooling degree days at the county level.

Summer design weather conditions and winter design weather were taken from ASHRAE (2005) for Washington state based on the closest weather station for each recorded county of residence. The SST file used for processing this information was weather.cmd and the output from this analysis was weather.log. It is available in Appendix C. Finally, I assumed a winter thermostat setting of 70 degrees and a summer thermostat setting of 75 degrees. As discussed below, these values do not affect the balance point temperature differential. However, they do affect the predicted space and cooling heat load.

I finally restricted the sample to the 2,875 cases for which the survey contractor could ascertain the monthly heating and cooling degree information in 2003. I found that in the full sample of electric and gas customers, 23.1 percent claimed to use electricity for primary heating.

III. Thermal Model Analysis

The Dubin-McFadden thermal model is in Chapter 2 of Dubin (1985), I have reproduced a copy of this chapter in Appendix D. The approach used in the Dubin-McFadden model was to construct an engineering thermal model that is simple enough to use with typical residential survey data. Such data is often much less complete than one would obtain using a detailed energy audit. For the reason mentioned above, the thermal model makes simplifying assumptions when some data is not available. The model assumes operating characteristics of dwellings that are not coded in typical survey data. The model has been successfully applied in several contexts. For example, the thermal model was adapted in Dubin (1985) for analyzing the Pacific Northwest Survey administered under the Bonneville Power Administration. The Dubin-McFadden model also uses summary weather measures, such as temperature means and extremes or heating and cooling degree days measured as alternative base temperatures to fit empirical temperature distributions. These measures are then used to forecast loads.

The basic approach follows ASHRAE engineering principles and conceptualizes the residence as a box with walls of varying thermal resistances to heat conduction. One insight of the modeling analysis is that the temperature load relationship is non-linear. As outside temperature declines, the marginal energy load necessary to maintain an interior temperature is non-constant. This fundamental observation is due to air-infiltration. As the difference between indoor and outdoor temperatures increases, the rate of exchange of the air volume in the house due to infiltration also increases. Each air exchange brings unheated air into the dwelling. That air must be heated to maintain the indoor temperature. This mechanism creates a multiplicative affect where the energy required to maintain a given indoor temperature increases as measured by the product of air infiltration and temperature differential. Because indoor and outdoor

temperatures are proportional to temperature differential, a quadratic relationship exists between indoor and outdoor temperatures and temperature differential.

The quadratic approximation that Dubin-McFadden derived was:

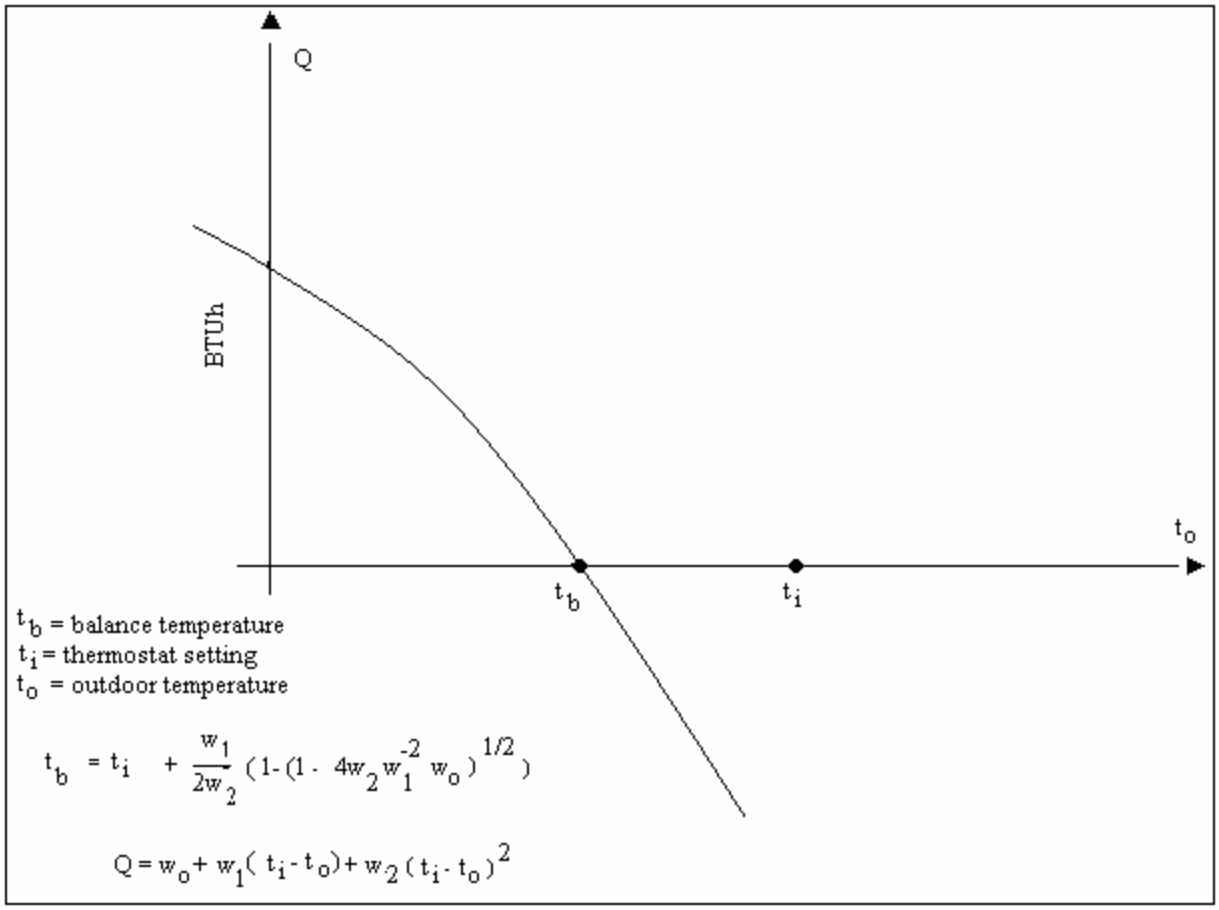
$Q(t_o) = w_0 + w_1 * (t_i - t_o) + w_2 * (t_i - t_o)^2$

where t_o is the outdoor temperature and t_i is the interior temperature. The constants, w_0, w_1, and w_2, are functions of the dwelling's thermal characteristics. They are dependent on the size of the dwelling and its insulation levels, among other factors. The formula provides an estimate of BTU's lost per hour due to the temperature differential.

The presence of sensible heat gain due to occupants and appliances causes the constant, w_0, to be negative in the above expression. Provided that w_0 is negative, there is a balance temperature, t_b. Heat is not required for temperature above this level. After all, the load function $Q(t_o)$ is quadratic in t_o, negative at the point t_i, zero at the point t_b, and decreasing in the range [t_b, t_i]. Heating is not required until temperatures fall below the balance temperature, t_b. For further discussion see Dubin (1985, p. 52, equation (43)). The thermal load function is illustrated in Figure 1.[7]

[7] Inspection of the formula for the balance point temperature differential shows that it is unchanged up to multiplicative scale changes in the thermal load function. Thus inaccuracies in the thermal load function, if present, do not affect the calculation of balance point temperature differentials reported below.

Figure 1: Thermal Load Function



The thermal model is shown in Appendix E. It is in the form of a computer program written in C, which has been modified to accommodate the RAS survey information. As described above, the inputs to this model consist of the design temperature information, monthly normal heating and cooling degree days, heating and cooling degree days by location of residence for the three years 2001-2003 on a monthly basis and the factors taken from the RAS survey described above. These considerations include: square footage, windows, insulation levels, and number of residents. The model processes data inputs for each of the 2,875 households for every month from 2001 through 2003. The output from the model consists of an estimated balance point temperature differential (the difference between the estimated balance point temperature and the assumed indoor thermostat setting). The results also contain the

estimated space heat energy loads for each of the 36 months, assuming that space heat is produced using the efficiency of an all electric space heating system.

To illustrate the methodology, I provide the detailed characteristics for two households from the survey.[8] These are the first and fifth households from the subset 2,875 analyzed by the thermal model. Both households reside in King County where the summer outdoor daily temperature range is 18.2 degrees F, the summer design dry bulb temperature is 84.9 degrees F and the winter design temperature is 28.4 degrees F.[9] Each household has two family members. Neither has wall insulation. Both households have stormed or double-paned windows. The first household has 8 heated rooms, 1 floor, 1,290 square feet, and 11 windows. The second household has 5 heated rooms, 2 floors, 322 square feet, and 15 windows. The first house does not have attic insulation while the second house does have attic insulation (assumed to be 12 inches). The thermal coefficients (w0, w1, and w2) respectively are estimated to be -3719.0, 682.4, and 1.291 for house number 1 and -3719.0, 312.3, and 0.329 for house number 5. The estimated balance temperature differentials are -5.39 and -11.76 degrees F for the households respectively.

The mean balance point temperature was -8.1 degrees for all electric sample of households. The standard deviation of this differential was 3.8 degrees. These calculations are presented in the reg.log shown in Appendix F. They are based on the SST program reg.cmd. Balance point temperatures corresponding to different thermostat settings are easily derived. The mathematics show that the balance point estimate decline one degree for each one degree change in the thermostat setting. Hence, at a thermostat setting of 60 degrees for the interior

[8] These households are selected to illustrate a range of dwelling sizes and are not meant to be representative of all households in the survey.

temperature, the balance point temperature would be roughly 52 degrees. At a thermostat setting of 65 degrees the balance point temperature would be 57 degrees on average.

I show a histogram of balance point temperatures, assuming a 65 degree F thermostat setting, in Appendix F. This distribution has a "fat tail" with many values below the average. Assuming that the thermostat is set at 65 degree (a 15 degree balance point temperature differential), about 5 percent of the sample has a balance point of 50 degrees or less. However, my analysis of thermostat settings on the PSE system reveals that many customers set their thermostat at levels lower than 65 degrees. I have analyzed survey data taken from roughly 400 PSE customers during the last twelve months.[10] Monthly self-reported thermostat information is available by month for each month from April 2005 through March 2006. My analysis of this information reveals a seasonal pattern in average thermostat settings wherein lower thermostat levels are set during summer months. The survey also collected thermostat settings for living and sleeping areas in the home and for three time-periods: day, evening, and night. I found clear variation in thermostat settings by time of day, somewhat less variation in the sleeping versus living area of the home. For instance, average evening thermostat settings are 64.9 degrees in the sleeping area and 66.6 degrees in the living area. By contrast, average nightly thermostat settings are closer to 63.3 degrees. In Appendix F, I show the histogram of thermostat settings. Over 40 percent of the sample has thermostat settings lower than 65 degrees while over 10 percent of the

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[9] Design temperatures are from American Society of Heating, Refrigerating and Air-Conditioning, 2005 Fundamentals, Chapter F28, Climatic Design Information. Design temperatures affect system design capacities but do not affect the estimated balance point temperature differential.

[10] PSE devotes a significant portion of its web page (www.pse.com) to energy efficiency. PSE customers can conduct a free energy self-audit through an online survey. This produces a report with specific and customized energy efficiency recommendations. The thermostat data was collected as part of the online survey process.

sample reported thermostat settings less than 55 degrees.[11] As the RAS survey and the web thermostat surveys are independent and as thermostat settings and balance point temperature differentials may reasonably be assumed to be independent, there are a significant number of customers whose true balance point temperature is quite low.[12] In these households, energy load for heating would not be triggered until the outdoor temperature becomes fairly cold. The relevant measure on a daily basis of such events is based on heating degree days for bases lower than 65 degrees. A single measurement of heating degree days with base 65 does not capture this information. The weather normalization analysis I conducted demonstrates that non-linearity between load and temperature is adequately captured using a measurement at base 45 degrees in conjunction with a measurement of heating degree days at 65 degrees.

V. Conclusions

The engineering thermal modeling approach to electric loads in the PSE service territory shows that balance point temperatures may be as low as 45 to 50 degrees for some households. This finding demonstrates that base temperatures of 65 degrees used in weather normalization regression models are not likely to capture the load temperature relationship for a significant number of dwellings. Regression techniques using splines or other non-parametric methods exploring curvature in the load-temperature relationship should rely on multiple base temperature measures of degrees days. The Dubin-McFadden engineering thermal model shows

[11] These results are similar to those obtained from the EIA 2001 Residential Energy Consumption Survey (RECS). The public use micro data file: http://www.eia.doe.gov/emeu/recs/recs2001/publicuse2001.html contains 481 survey respondents in the Pacific region which includes Washington State. I find that thermostat settings range from 45 to 80 degrees with an average of 64 degrees F. Roughly 4 percent of respondents set their thermostats lower than 50 and roughly one-third set their thermostats lower than 60 degrees.

considerable promise in forecasting space heating load. Applied to the RAS data, the model yields practical implications and demonstrates that energy load on the PSE system is not best measured by heating degrees days base 65 degrees because balance point temperatures are significantly lower than comfort levels for a significant fraction of the PSE customer class.

[12] For instance, roughly 5 percent of customers have balance point temperature differentials of 15 degrees or more while roughly one third of customers set their thermostats under 60 degrees. Thus there are at least 1.5 percent of customers whose balance point temperature is 45 degrees or lower.

Appendix A

PSE PUGET SOUND ENERGY

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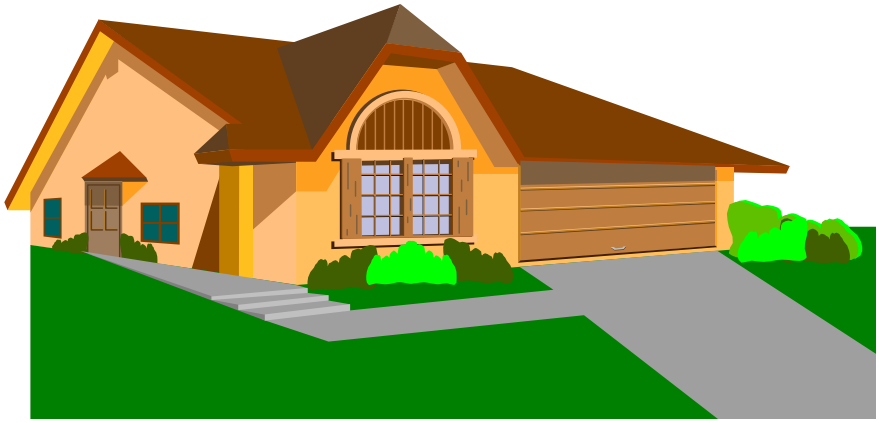

Residential Energy Study

This study is being conducted by Puget Sound Energy to better understand your energy needs. Please help us by taking the time to answer the questions in this booklet. If you wish to comment on a question, please feel free to use the space provided in the margins. You are encouraged to answer every question is this booklet. However, if there is a question to which you would rather not respond, feel free to omit your answer and continue.

Please answer the questions in this booklet for the address shown below.

ID number
Service Address
Service City

Please answer these questions for the address shown on the cover of this booklet.

You are encouraged to answer every question is this booklet. However, if there is a question to which you would rather not respond, feel free to omit your answer and continue.

Circle the number for the most appropriate answer.

THIS RESIDENCE

1. Do you own or rent this residence?
   1 Own or buying
   2 Rent or lease ⇨*Answer 1A below*
   3 Other (*Please describe*)
   4 Don't know

1A. Do you pay the heating bills for this residence, or does your landlord pay them?
   1 We pay the bills to heat our home
   2 We pay for some heating (e.g., portable heaters) and our landlord pays for some.
   3 Our landlord pays for all of our heat (included as part of our rent)
   4 Other (*Please describe*) _____
   5 Don't know

2. How long have you lived in this residence?
   1 1 year or less
   2 2-5 years
   3 6-10 years
   4 11-20 years
   5 More than 20 years
   6 Don't know

3. Which of the following best describes how this residence is occupied?
   1 Year-round, full-time
   2 Seasonal or part-time use
   3 Don't know

4. Which of the following best describes this residence?
   1 Single family detached house (on a separate lot) not connected to other living units
   2 A unit in a condominium or apartment (2 or more attached units) ⇨ *Answer 4A below*

3 Row or townhouse (Adjacent walls to another residence with no units above or below.) ⇨*Answer 4A below*
4 Mobile home or house trailer
5 Other (*Please describe*) _____
6 Don't know

4A. How many living units or apartments are in the building where this residence is located? Please answer only for the building which contains this residence. Do not consider other buildings which may exist in the complex.

1 2 units
2 3 units
3 4 units
4 5 or more units
5 Don't know

5. How many levels or stories are there in this residence? *Do not* include an unfinished attic or basement or other floors not used for living space. (*For a townhouse or multi-family building with two or more living units*, answer only for the portion of the building where this residence is located.) *Please circle only one number.*

1 One story
2 One and a half stories
3 Split-level or two stories
4 Two and a half stories
7 Other (*Please describe*)
5 Tri-level or three stories
6 More than three stories
8 Don't know

6. What is the approximate square footage of *heated* floor space in this residence?

_____ Heated square feet 0 Don't know

If you don't know the actual *heated* floor space, please indicate below the appropriate category.

1 Less than 500 square feet
2 501 to 1000 square feet
3 1001 to 1500 square feet
4 1501 to 2000 square feet
5 2001 to 2500 square feet
6 2501 to 3000 square feet
7 More than 3000 square feet
8 Don't know

10. About what year was this residence built?

01 Before 1980
02 1980 to 1985
03 1986 to 1990
04 1991 to 1995
05 1996 to 2000
06 2001
07 2002
08 2003
09 2004
10 Don't know

11. Have there been any additions to this residence *within the last five years* that have increased the *heated floor space*?

1 Yes ⇨ *Answer 11A below*
2 No
3 Don't know

11A. How much heated floor space was added to this residence in the last five years?

_____ Square feet added 0 Don't know

NATURAL GAS SERVICE

1. Do you have natural gas service at this residence?
   1 Yes → *Answer 1A below*
   2 No
   3 Don't know

   1A. Was natural gas service in this residence at the time it was built or was it added at a later time?
      1 In residence at the time it was built
      2 Added at a later time
      3 Don't know

2. Is natural gas service available in this neighborhood (do any of your close neighbors have natural gas service)?
   1 Yes
   2 No
   3 Don't know

HOME HEATING

1. Does the main heating system serve only this residence or does it serve more than one residence? The main heating system is the one that is used the most.

- ❑ Heating system serves only this residence
- ❑ Heating system serves more than residence → Skip to the WATER HEATING SECTION
- ❑ This residence has no heating system → Skip to the WATER HEATING SECTION
- ❑ Don't know → Skip to the WATER HEATING SECTION

3. What is the main heating system that is used to heat the home? The main heating system is the one that is used the most.

4. What other heating system(s) do you use to heat your home?

	Q3. Main System	Q4. Additional System(s)
Type of Heating System(s)	**Circle the number for the ONE system used most at this residence.**	**Circle the number for ALL other heating systems that are used at this residence.**
Natural Gas Heating		
Central forced air furnace	1	1
Natural gas fireplace	17	17
Other natural gas system	3	3
Electric Heating		
Baseboard, wall heaters (without fans), or ceiling cables	4	4
Wall heaters with fans	5	5
Central forced air furnace	6	6
Heat pump	7	7
Portable heaters	8	8
Other electric system	9	9
Oil Heating:		
Central forced air furnace	10	10
Other oil system	12	12
Bottled Gas Heat: propane, butane, or kerosene		
Central forced air	13	13
Portable heaters	14	14
Other Fuels		
Wood stove	15	15
Wood fireplace	16	16
Solar	18	18
Other System (please describe): _____	19	19

3. Approximately how old is the *main* heating system (the one used most often)?

1 1 year OR LESS→ *Answer 3A below*
3 2 to 5 years
4 6 to 10 years
5 11 to 20 years
6 More than 20 years
7 Don't know

3A. Was the *main* heating system for this residence replaced in 2003?

1 Yes → *Answer 3A1 below*
2 No
3 Don't know

3A1. What was the primary source of heat before the replacement? (C*heck one box only.*)

01 Electric baseboards
02 Electric wall heaters
03 Electric forced air furnace or boiler
04 Heat pump
05 Natural gas forced air furnace or boiler
06 Propane or bottled gas furnace or boiler
07 Oil forced air furnace or boiler
08 Only have wood heating device(s)
09 Other (*Please describe*) _____
10 None
11 Don't know

2. Have you had a service professional repair or perform routine maintenance on your main heating system within the last two years?

1 Yes, repair work was performed within the past two years
2 Yes, routine maintenance was performed within the past two years
3 Yes, repair work **AND** routine maintenance was performed within the past two years
4 No
5 Don't know

5. What type of temperature control is on the main heating system (the one used most often)?

   01 Regular thermostat(s) with temperature settings
   02 Clock or programmable thermostat(s)
   03 Dial control without temperature settings
   04 Simple on/off switch or no temperature control
   05 Other [specify: _____]

6. Which of the following statements best describes how the main heating system is used?

   01 The thermostat(s) is kept at a constant setting or temperature
   02 The thermostat setting changes based on the time of day or night
   03 The heater is turned on only when someone is cold
   04 We rarely use this heating system

WATER HEATING

1. Does the water heater, or the source of the hot water, serve only this residence or does it serve more than one residence?
   - ❑ Water heater(s) serves only this residence
   - ❑ Water heater serves more than residence → Skip to the APPLIANCE SECTION
   - ❑ This residence has no hot water → Skip to the APPLIANCE SECTION
   - ❑ Don't know → Skip to the APPLIANCE SECTION

2. How many water heaters are at this residence?
   - ❑ One
   - ❑ Two
   - ❑ Three or more

The following questions refer to the *primary* or *main* water heater (the one that is used the most).

3. What type of fuel or energy is used to heat the water used in this residence?
   - ❑ Electricity
   - ❑ Natural gas
   - ❑ Propane or bottled gas (LP, propane, butane)
   - ❑ Other [describe: _____]
   - ❑ Don't know

4. Approximately how old is your main water heater?
   - 1 1 year OR LESS→ *Answer 4A below*
   - ❑ 2 to 5 years old
   - ❑ 6 to 10 years old
   - ❑ 11 to 20 years old
   - ❑ More than 20 years old
   - ❑ Don't know

4A. Was the *primary water heater f*or this residence replaced in 2003?
   - 1 Yes → *Answer 4A1 below*
   - 2 No
   - 3 Don't know

4A1. What type of water heater was replaced? (C*heck one box only.*)
   - 12 Electric
   - 13 Natural gas
   - 14 Propane or bottled gas furnace or boiler
   - 15 Other (*Please describe*) _____
   - 16 Don't know

5. Where is your main water heater located?
   - ❑ In a heated area (including a heated basement)
   - ❑ In an unheated area (such as a garage, utility room, or unheated basement)
   - ❑ Don't Know

6. Which of the following items do you have for your main water heater?

   Water heater wrap or insulation blanket on the outside of the water heater

   - ❑ Water heater pipe wrap
   - ❑ Water heater timer
   - ❑ None of these

Please continue to answer these questions for the address shown on the cover of this booklet.

APPLIANCES AND OTHER EQUIPMENT

1. For the following appliances or household equipment, please indicate what fuel or energy source is used at this residence. (Please circle only one answer for each. Do not count appliances or equipment shared by other residences.)

	Don't Have	Electri-city	Natural Gas	Propane	Other	Don't Know
Stove-top cooking*	0	1	2	3	4	5
Conventional oven*	0	1	2	3	4	5
Clothes dryer	0	1	2	3	4	5
Private hot tub or spa	0	1	2	3	4	5
Private swimming pool	0	1	2	3	4	5

**If this residence has a conventional range (i.e., combination cook-top and oven), please answer for both of these appliances*

2. Approximately how old are the following appliances? (Please circle only one answer for each. Do not count appliances or equipment shared by other residences.)

	Don't Have	1 year or less	2 to 5 years	6 to 10 years	11 to 20 years	More than 20 years	Don't Know
Stove-top cooking*	0	1	2	3	4	5	6
Conventional oven*	0	1	2	3	4	5	6
Clothes dryer	0	1	2	3	4	5	6
Private hot tub or spa	0	1	2	3	4	5	6
Private swimming pool	0	1	2	3	4	5	6

**If this residence has a conventional range (i.e., combination cook-top and oven), please answer for both of these appliances*

3. How many of each of the following appliances or household equipment are there in use in this residence? (Please respond for each appliance listed below. If none, please enter "0" or none)

4. Approximately how old is your primary unit? (Please respond for each appliance listed below.)

Appliance/Equipment Type	Q3.. How many installed?	Q4.. Approximately how old is your primary unit?
Dishwasher		
Microwave oven		
Refrigerator		
Separate freezer		
On-demand hot water dispenser		
Central air conditioner		
Room air conditioner		
Electric Blankets		
Televisions		
Video cassette recorders (VCRs) or DVD players		
Home office equipment (Fax, photo copier, etc.)		
Personal computers		
Home stereo systems		

7. Do any of the appliances or equipment in this residence have the ENERGY STAR label on them?

   ❑ Yes → Please list: .....

   .....

   ❑ No

   ❑ Don't know

4. Is there a back-up generator at this residence?
   1 Yes
   2 No
   3 Don't know

7. Is there a home office at this residence from which a business is operated?
   1 Yes
   2 No
   3 Don't know

WEATHERIZATION/EFFICIENT EQUIPMENT AND LIGHTING

In this section, we are gathering information about changes you may have made to you home. Please consider all work you have done ***with or without assistance*** from a contractor or other service personnel.

1. Which of the following energy conservation measures do you have in this residence? If you do have an item, please indicated whether or not it was already there when you moved in, or was something that was done after you moved in.

	Yes, was done…		**No, was never done**	**Don't know**
	…before I moved in	**…after I moved in**		
1. Ceiling or attic insulation	1	2	3	4
2. Wall or floor insulation	1	2	3	4
3. Heating duct insulation	1	2	3	4
4. Caulk or weatherstrip doors or windows	1	2	3	4
5. Low-flow showerheads	1	2	3	4
6. Energy efficient windows	1	2	3	4

2. Compact fluorescent bulbs (CFLs) are small screw-in fluorescent bulbs that fit in regular light bulb sockets. CFLs look different than standard incandescent bulbs. They are often made out of thin tubes of glass bent into loops. Sometimes, they are enclosed in a globe for use in ceiling fans or bathroom vanities. Without any rebates or discounts, compact fluorescent bulbs typically cost from $2 to $13, while regular incandescent bulbs usually cost from $1 to $1.50. Do you have any compact fluorescent bulbs, or CFLs, in your home?

1 Yes → *Answer 2A*
2 No
3 Don't know

2A. Where are your Compact fluorescent bulbs located? Please indicate the number of CFLs installed in the…

_____Bathroom
_____Bedroom
_____Closet
_____Dining room
_____Family room
_____Garage
_____Hallway/entryway
_____Kitchen
_____Living room
_____Home office
_____Utility room
_____Other [Specify:_____]
_____Other [Specify:_____]

_____Outdoors

3. Approximately what percentage of this residence's windows are double or triple-pane?

   1 All (100%)→ *Answer 3A*
   2 Most (75%) → *Answer 3A*
   3 Some (50%) → *Answer 3A*
   4 Few (25%) → *Answer 3A*
   5 None
   6 Don't know

3A. Approximately how old are the double or triple-pane windows in this residence?

   1 1 year or less
   2 2-5 years
   3 6-10 years
   4 11-20 years
   5 more than 20 years
   6 Don't know

4. Approximately what percentage of this residence's windows are equipped with storm windows?

   1 All (100%)
   2 Most (75%)
   3 Some (50%)
   4 Few (25%)
   5 None
   6 Don't know

HOUSEHOLD CHARACTERISTICS

To assist us in analyzing the information gathered in this study, your answers to the following questions will be especially helpful. Please be assured that all of your answers will be confidential and used only to summarize statistics for large groups of customers.

1. Please indicate how many people who usually live in this residence at least six months of the year are in each of the age groups shown below. (If you have none, please enter "0".)

   Number of Persons

   _____ Under 6 years old

   _____ 6 to 18 years old

   _____ 19 to 64 years old

   _____ 65 years and older

Please answer the following questions for the primary wage earner, or the person considered to be the head of the household.

4. What is the highest level of schooling completed by the head of the household?

   1 8^{th} grade or less
   2 High school graduate/GED
   3 Business/technical school
   4 Some college (or 2-year degree)
   5 Graduated college (4-year degree)
   6 Some graduate work
   7 Graduate degree
   8 Don't know

5. What is the employment status of the head of the household?

   1 Employed full-time
   2 Employed part-time
   3 Not employed
   4 Self-employed
   5 Don't know

6. What is the age of the head of the household?

_____ Years
0 Don't know

2. Which of the following categories includes the total yearly income before taxes for the entire household in 1997?

01 Less than $20,000	07 $70,000 - $79,999
02 $20,000 - $29,999	08 $80,000 - $89,999
03 $30,000 - $39,999	09 $90,000 - $99,999
04 $40,000 - $49,999	10 $100,000 - $149,999
05 $50,000 - $59,999	11 $150,000 or more
06 $60,000 - $69,999	12 Don't know

8. PSE plans to collect more detailed information and is conducting short follow-up telephone interviews on a small sample of homes. Would you be interested in participating in a follow-up telephone interview?

- ❑ Yes
- ❑ No

9. PSE plans to collect more detailed information on energy efficient equipment, and is conducting in-persons audits at a small sample of homes. The audits are conducted by professionals, and are simply conducted to look at the presence of energy efficient equipment in households. Participants in the study will also receive [incentive] Would you be interested in participating in this study?

- ❑ Yes
- ❑ No

11. If you indicated 'Yes' to either of the above questions, what is the best number to reach you?

(_____) _____-_____

12. When is the best time to have someone call you to conduct an interview or schedule an appointment?

1. Morning
2. Afternoon
3. Evenings
4. Weekends

Thank you very much for your cooperation and assistance!

Appendix B

rasfinal.log

```
SST Spool File:  rasfinal.log
Thu Mar 30 09:23:46 2006

data fmt[                    \
   id           1-9          \
   sampleid     10-17        \
   county4      18-19        \
   scanid       20-23        \
   ownrent      24-25        \
   payht        26-27        \
   occres       28-29        \
   dwltype      30-31        \
   units        32-33        \
   dwlstr       34-35        \
   sqftact      36-40        \
   sqftcat      41-42        \
   heatroom     43-44        \
   bathroom     45-46        \
   builtyr      47-48        \
   addition     49-50        \
   addsqft      51-54        \
   ngserv       55-56        \
   ngtime       57-58        \
   ngavail      59-60        \
   heatserv     61-62        \
   prihtsys     63-64        \
   htngcnt      65-66        \
   htngfp       67-68        \
   htngoth      69-70        \
   htelbsb      71-72        \
   htelwht      73-74        \
   htelcrh      75-76        \
   htelchp      77-78        \
   htelpth      79-80        \
   hteloth      81-82        \
   htolcnt      83-84        \
   htoloth      85-86        \
   htbgcnt      87-88        \
   htbgpth      89-90        \
   htwdws       91-92        \
   htwdfp       93-94        \
   htslr        95-96        \
   htotsys      97-98        \
   htsysage     99-100       \
   htrepl03     101-102      \
   heatrepl     103-104      \
   repair       105-106      \
   htctlbev     107-108      \
   heatuse      109-110      \
   whsystyp     111-112      \
   whsysnum     113-114      \
   whfuel       115-116      \
   whage        117-118      \
   whrepl03     119-120      \
   whrepl       121-122      \
   whloc        123-124      \
   whwrap       125-126      \
   whpwrap      127-128      \
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   whnone       131-132      \
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   ckovtyp      135-136      \
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pltyp       141-142     \
ckrnage     143-144     \
ckovage     145-146     \
dryage      147-148     \
sphtage     149-150     \
poolage     151-152     \
dishwn      153-154     \
microwvn    155-156     \
refrn       157-158     \
freezern    159-160     \
hwdispn     161-162     \
centacn     163-164     \
roomacn     165-166     \
elblnktn    167-168     \
tvn         169-170     \
vcrdvdn     171-172     \
offeqpn     173-174     \
pcn         175-176     \
stereon     177-178     \
dishwa      179-180     \
microwva    181-182     \
refra       183-184     \
freezera    185-186     \
hwdispa     187-188     \
centaca     189-190     \
roomaca     191-192     \
elblnkta    193-194     \
tva         195-196     \
vcrdvda     197-198     \
offeqpa     199-200     \
pca         201-202     \
stereoa     203-204     \
enrgystr    205-206     \
genrator    207-208     \
homeoffc    209-210     \
ceilins     211-212     \
wallins     213-214     \
htdctins    215-216     \
drwinins    217-218     \
showerhd    219-220     \
eewindws    221-222     \
cfl         223-224     \
cflbthn     225-226     \
cflbedn     227-228     \
cflclstn    229-230     \
cflfamrn    231-232     \
cflgrgen    233-234     \
cflhalln    235-236     \
cflktchn    237-238     \
cfllvrmn    239-240     \
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nr65ovr     261         \
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age          266-267      \
agenr        268-269      \
income       270-271      \
followup     272          \
audits       273          \
phone        274-283      \
besttime     284          \
batchno      285-287      \
nr0_6a       288          \
nr6_18a      289          \
nr19_64a     290          \
nrovr65a     291          \
dwltypex     292          \
custx        293          \
county1      294          \
county2      295          \
numres       296-297      \
name         298-343 (s)  \
mailadd      344-378 (s)  \
mailcity     379-395 (s)  \
mailst       396-397 (s)  \
mailzip      398-402 (s)  \
address      403-441 (s)  \
city         442-458 (s)  \
zip          459-463 (s)  \
pscounty     464-465 (s)  \
ps_egi       466-469 (s)  \
ps_dwl       470-472 (s)  \
ownrntot     473          \
payhtot      474-475      \
occresot     476          \
dwltypot     477-478      \
dwlstrot     479          \
htothr       480          \
htnr         481          \
htprfp       482          \
htpellet     483          \
htrad        484          \
hthwrad      485          \
htflrepo     486-487      \
httempct     488-489      \
whfuelot     490-491      \
whrepot      492          \
whlocot      493-494      \
esac         495-496      \
escd         497-498      \
espc         499-500      \
ecmntr       501-502      \
ecdishw      503-504      \
ecdry        505-506      \
ecdvd        507-508      \
ecfrzr       509-510      \
ecfrnc       511-512      \
ecmicrow     513-514      \
ecprint      515-516      \
ecrefr       517-518      \
ecstereo     519-520      \
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ecvcr        525-526      \
ecwash       527-528      \
ecwh         529-530      \
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cflout      542         \
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mwvncat     547-548     \
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fzrncat     551-552     \
hwdnact     553-554     \
centnact    555-556     \
rmacnact    557-558     \
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tvncat      561-562     \
vcrdvnct    563-564     \
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fzracat     611-612     \
hwdspact    613-614     \
centact     615-616     \
rmacact     617-618     \
blnktact    619-620     \
tvacat      621-622     \
vcrdvact    623-624     \
offeqact    625-626     \
pcacat      627-628     \
streoact    629-630     \
agecat      631-632     \
kwh2001     633-637     \
kwh2002     638-642     \
kwh2003     643-647     \
yrresnum    648-649     \
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nrescat     689-690     \
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   county      712-720 (s) \
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   relwt       739-756     \
   resp1_a     757         \
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   cflbed      760-761     \
   cflclst     762-763     \
   cflfam      764-765     \
   cflgarag    766-767     \
   cflhall     768-769     \
   cflktch     770-771     \
   cflliv      772-773     \
   pcflhoff    774-775     \
   cflout3     776-777     \
   cflutil     778-779     \
   cflot1      780-781     \
   cflot2      782-783     \
   pcflindr    784-785     \
   pcflbath    786-804     \
   pcflbed     805-823     \
   pcflclst    824-842     \
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   pcflhall    862-880     \
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label var[pcn        ] lab[{N OF PERSONAL COMPUTERS - A Q3}       ]
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label var[homeoffc   ] lab[{HOME OFFICE AT RESIDENCE - A Q7}       ]
label var[ceilins    ] lab[{WHEN CEILING INSULATION INSTALLED-C Q1}]
label var[wallins    ] lab[{WHEN WALL INSULATION INSTALLED - C Q1}]
label var[htdctins   ] lab[{WHEN HEAT DUCT INS INSTALLED - C Q1}  ]
label var[drwinins   ] lab[{WHEN WEATHERSTRIP INSTALLED - C Q1}   ]
label var[showerhd   ] lab[{WHEN LOWFLOW SHOWER HD INSTALLED-C Q1}]
label var[eewindws   ] lab[{WHEN EFFICIENT WINDOWS INSTALLED-C Q1}]
label var[cfl        ] lab[{HAS CFLS - C Q2}                       ]
label var[cflbthn    ] lab[{N OF CFLS IN BATHROOM - C Q2a}         ]
label var[cflbedn    ] lab[{N OF CFLS IN BEDROOM - C Q2a}          ]
label var[cflclstn   ] lab[{N OF CFLS IN CLOSET - C Q2a}           ]
label var[cflfamrn   ] lab[{N OF CFLS IN FAMILY ROOM - C Q2a}      ]
label var[cflgrgen   ] lab[{N OF CFLS IN GARAGE - C Q2a}           ]
label var[cflhalln   ] lab[{N OF CFLS IN HALLWAY - C Q2a}          ]
label var[cflktchn   ] lab[{N OF CFLS IN KITCHEN - C Q2a}          ]
label var[cfllvrmn   ] lab[{N OF CFLS IN LIVING ROOM - C Q2a}      ]
label var[cflhoffn   ] lab[{N OF CFLS IN HOME OFFICE EQUIP-C Q2a} ]
label var[cfloutn    ] lab[{N OF CFLS IN OUTDOORS - C Q2a}         ]
label var[cflutiln   ] lab[{N OF CFLS IN UTILITY ROOM - C Q2a}     ]
label var[cfloth1n   ] lab[{N OF CFLS IN OTHER 1 - C Q2a}          ]
label var[cfloth2n   ] lab[{N OF CFLS IN OTHER 2 - C Q2a}          ]
label var[dblpane    ] lab[{PCNT OF DBL PANE WINDOWS - C Q3}       ]
label var[dblpanea   ] lab[{AGE OF DBLE PANE WINDOWS - C Q3a}      ]
label var[pctstrmw   ] lab[{PCNT OF WINDOWS THAT ARE STORM - C Q4}]
label var[nr0_6      ] lab[{N OF PEOPLE UNDER 6 YRS OLD - D Q1}    ]
label var[nr6_18     ] lab[{N OF PEOPLE BTWN 6 AND 18 - D Q1}      ]
label var[nr19_64    ] lab[{N OF PEOPLE BTWN 19 AND 64 - D Q1}     ]
label var[nr65ovr    ] lab[{N OF PEOPLE OLDER 65 YRS OLD - D Q1}   ]
label var[educ       ] lab[{HIGHEST EDUC BY HEAD OF HOUSE - D Q2}  ]
label var[empstat    ] lab[{EMP STATUS OF HEAD OF HOUSE - D Q3}    ]
label var[age        ] lab[{AGE OF HEAD OF HOUSEHOLD - D Q4}       ]
label var[agenr      ] lab[{AGE OF HEAD OF HOUSEHOLD - D Q4}       ]
label var[income     ] lab[{YEARLY INCOME 2003 - D Q5}             ]
label var[followup   ] lab[{FOLLOW UP INTERVIEW - D Q6}            ]
label var[audits     ] lab[{FOLLOW UP AUDIT - D Q7}                ]
label var[phone      ] lab[{BEST PHONE NUMBER - D Q8}              ]
label var[besttime   ] lab[{BEST TIME TO REACJ - D Q9}             ]
label var[batchno    ] lab[{Survey Id}                             ]
label var[nr0_6a     ] lab[{N IN HOUSEHOLD UNDER 6 ANY- D Q1}      ]
label var[nr6_18a    ] lab[{N IN HOUSEHOLD 6-18 ANY- D Q1}         ]
label var[nr19_64a   ] lab[{N IN HOUSEHOLD 19-64 ANY- D Q1}        ]
label var[nrovr65a   ] lab[{N IN HOUSEHOLD OVER 65 ANY- D Q1}      ]
label var[dwltypex   ] lab[{PSE DWELLING TYPE (1=SF,2,3=MF,4=MH)} ]
label var[custx      ] lab[{CUST TYPE (1=GAS,2=ELECTRIC,3=COMBO)} ]
label var[county1    ] lab[{FIRST DIGIT OF COUNTY}                 ]
label var[county2    ] lab[{SECOND DIGIT OF COUNTY}                ]
label var[numres     ] lab[{TOTAL NUMBER OF OCCUPANTS}             ]
label var[name       ] lab[{PSE: CUSTOMER NAME}                    ]
label var[mailadd    ] lab[{PSE: MAILING ADDRESS}                  ]
label var[mailcity   ] lab[{PSE: MAILING CITY}                     ]
label var[mailst     ] lab[{PSE: MAILING STREET}                   ]
label var[mailzip    ] lab[{PSE: MAILING ZIP}                      ]
label var[address    ] lab[{PSE: RESIDENCE ADDRESS}                ]
label var[city       ] lab[{PSE: RESIDENCE CITY}                   ]
label var[zip        ] lab[{PSE: RESIDENCE ZIP}                    ]
label var[pscounty   ] lab[{PSE: RESIDENCE COUNTY}                 ]
label var[ps_egi     ] lab[{PSE: ELECTRIC GAS INDICATOR}           ]
label var[ps_dwl     ] lab[{PSE: DWELLING TYPE}                    ]
label var[ownrntot   ] lab[{OWN OR RENT: OTHER - R Q1}             ]
label var[payhtot    ] lab[{PAY BILL: OTHER - R Q1a}               ]
label var[occresot   ] lab[{OCCUPANT SEASONS: OTHER - R Q3}        ]
label var[dwltypot   ] lab[{DWELLING TYPE: OTHER - R Q4}           ]
label var[dwlstrot   ] lab[{DWELLING STORIES: OTHER - R Q5}        ]
label var[htothr     ] lab[{HEATSYS: OTHER - H Q2}                 ]
```

```
label var[htnr       ] lab[{HEATSYS: DON'T KNOW - H Q2}           ]
label var[htprfp     ] lab[{HEATSYS: PROPANE STOVE - H Q2}        ]
label var[htpellet   ] lab[{HEATSYS: PELLET STOVE - H Q2}         ]
label var[htrad      ] lab[{HEATSYS: RADIANT FLOOR HEAT - H Q2}   ]
label var[hthwrad    ] lab[{HEATSYS: READIANT HOT WATER - H Q2}   ]
label var[htflrepo   ] lab[{PRIOR HEATING SYSTEM: OTHER - H Q4b}  ]
label var[httempct   ] lab[{TEMP CONTROL: OTHER - H Q6}           ]
label var[whfuelot   ] lab[{WATER HTR FUEL: OTHER - W Q3}         ]
label var[whrepot    ] lab[{WATER HTR REPLACED: OTHER - W Q4b}    ]
label var[whlocot    ] lab[{WATER HTR LOCATION: OTHER - W Q5}     ]
label var[esac       ] lab[{HAS ENERGY STR AIR CONDITION - A Q5}  ]
label var[escd       ] lab[{HAS ENERGY STR CD PLAYER - A Q5}      ]
label var[espc       ] lab[{HAS ENERGY STR COMPUTER - A Q5}       ]
label var[ecmntr     ] lab[{HAS ENERGY STR COMPUTER MONITOR-A Q5} ]
label var[ecdishw    ] lab[{HAS ENERGY STR DISHWASHER - A Q5}     ]
label var[ecdry      ] lab[{HAS ENERGY STR DRYER - A Q5}          ]
label var[ecdvd      ] lab[{HAS ENERGY STR DVD PLAYER - A Q5}     ]
label var[ecfrzr     ] lab[{HAS ENERGY STR FREEZER - A Q5}        ]
label var[ecfrnc     ] lab[{HAS ENERGY STR FURNACE - A Q5}        ]
label var[ecmicrow   ] lab[{HAS ENERGY STR MICROWAVE - A Q5}      ]
label var[ecprint    ] lab[{HAS ENERGY STR PRINTER - A Q5}        ]
label var[ecrefr     ] lab[{HAS ENERGY STR REFRIGERATOR - A Q5}   ]
label var[ecstereo   ] lab[{HAS ENERGY STR STEREO - A Q5}         ]
label var[ecstove    ] lab[{HAS ENERGY STR STOVE - A Q5}          ]
label var[ectv       ] lab[{HAS ENERGY STR TV - A Q5}             ]
label var[ecvcr      ] lab[{HAS ENERGY STR VCR - A Q5}            ]
label var[ecwash     ] lab[{HAS ENERGY STR WASHING MACHINE- A Q5} ]
label var[ecwh       ] lab[{HAS ENERGY STR WATER HEATER - A Q5}   ]
label var[ecoth      ] lab[{HAS ENERGY STR OTHER - A Q5}          ]
label var[cfloth1    ] lab[{OTHER LOCATION WITH CFL - C Q2a}      ]
label var[cfloth2    ] lab[{OTHER LOCATION WITH CFL - C Q2a}      ]
label var[cfl1oth    ] lab[{OTHER LOCATION WITH CFL - C Q2a}      ]
label var[cfl2oth    ] lab[{OTHER LOCATION WITH CFL - C Q2a}      ]
label var[cflbasem   ] lab[{CFL IN BASEMENT - C Q2a}              ]
label var[cfldine    ] lab[{CFL IN DINING ROOM - C Q2a}           ]
label var[cfllamp    ] lab[{CFL IN LAMPS - C Q2a}                 ]
label var[cflout     ] lab[{CFL OUTSIDE - C Q2a}                  ]
label var[adsqftct   ] lab[{ADDED HEATED SQUARE FOOTAGE - R Q10a} ]
label var[dwncat     ] lab[{N OF DISHWASHERS - A Q3}              ]
label var[mwvncat    ] lab[{N OF MICROWAVES INSTALLED - A Q3}     ]
label var[refrncat   ] lab[{N OF REFRIGERATORS INSTALLED - A Q3}  ]
label var[fzrncat    ] lab[{N OF SEPARATE FREEZERS INSTALLED-A Q3}]
label var[hwdnact    ] lab[{N OF ONDEMAND H20 DISPENSERS  - A Q3} ]
label var[centnact   ] lab[{N OF CENTRAL AIR CONDITIONERS - A Q3} ]
label var[rmacnact   ] lab[{N OF ROOM ACs INSTALLED - A Q3}       ]
label var[blnktnct   ] lab[{N OF ELECTRIC BLANKETS - A Q3}        ]
label var[tvncat     ] lab[{N OF TELEVISIONS - A Q3}              ]
label var[vcrdvnct   ] lab[{N OF VCR OR DVD PLAYER - A Q3}        ]
label var[offeqnct   ] lab[{N OF HOME OFFICE EQUIP - A Q3}        ]
label var[pcncat     ] lab[{N OF PERSONAL COMPUTERS - A Q3}       ]
label var[sternct    ] lab[{N OF HOME STEREO SYSTEM - A Q3}       ]
label var[cflbtnct   ] lab[{N OF CFLS IN BATHROOM - C Q2a}        ]
label var[cflbdnct   ] lab[{N OF CFLS IN BEDROOM - C Q2a}         ]
label var[cflclnct   ] lab[{N OF CFLS IN CLOSET - C Q2a}          ]
label var[cflfrnct   ] lab[{N OF CFLS IN FAMILY ROOM - C Q2a}     ]
label var[cflganct   ] lab[{N OF CFLS IN GARAGE - C Q2a}          ]
label var[cflhlnct   ] lab[{N OF CFLS IN HALLWAY - C Q2a}         ]
label var[cflktnct   ] lab[{N OF CFLS IN KITCHEN - C Q2a}         ]
label var[cfllvnct   ] lab[{N OF CFLS IN LIVING ROOM - C Q2a}     ]
label var[cflofnct   ] lab[{N OF CFLS IN HOME OFFICE EQUIP-C Q2a} ]
label var[cfoutnct   ] lab[{N OF CFLS IN OUTDOORS - C Q2a}        ]
label var[cflutnct   ] lab[{N OF CFLS IN UTILITY ROOM - C Q2a}    ]
label var[cflo1nct   ] lab[{N OF CFLS IN OTHER 1 - C Q2a}         ]
label var[cflo2nct   ] lab[{N OF CFLS IN OTHER 2 - C Q2a}         ]
```

```
label var[nr0_6cat   ] lab[{N OF PEOPLE UNDER 6 YRS OLD - D Q1}   ]
label var[nr618cat   ] lab[{N OF PEOPLE BTWN 6 AND 18 - D Q1}     ]
label var[n1964ct    ] lab[{N OF PEOPLE BTWN 19 AND 64 - D Q1}    ]
label var[n65ovrct   ] lab[{N OF PEOPLE OLDER 65 YRS OLD - D Q1}  ]
label var[dwacat     ] lab[{AGE OF PRIM DISHWASHERS - A Q4}        ]
label var[mwvacat    ] lab[{AGE OF PRIM MICROWAVE - A Q4}          ]
label var[refracat   ] lab[{AGE OF PRIM REFRIGERATOR - A Q4}       ]
label var[fzracat    ] lab[{AGE OF PRIM SEPARATE FREEZER - A Q4}  ]
label var[hwdspact   ] lab[{AGE PRIM ONDEMAND H20 DISPENSER-A Q4} ]
label var[centact    ] lab[{AGE OF PRIM CENTRAL AC - A Q4}         ]
label var[rmacact    ] lab[{N OF ROOM AC INSTALLED - A Q3}         ]
label var[blnktact   ] lab[{AGE OF PRIM ELECTRIC BLANKET - A Q4}  ]
label var[tvacat     ] lab[{AGE OF PRIM TELEVISION - A Q4}         ]
label var[vcrdvact   ] lab[{AGE OF PRIM VCR OR DVD PLAYER - A Q4} ]
label var[offeqact   ] lab[{AGE OF PRIM HOME OFFICE EQUIP - A Q4} ]
label var[pcacat     ] lab[{AGE OF PRIM PERSONAL COMPUTER - A Q4} ]
label var[streoact   ] lab[{AGE OF PRIM HOME STEREO SYSTEM - A Q4}]
label var[agecat     ] lab[{AGE OF HEAD OF HOUSEHOLD - D Q4}       ]
label var[kwh2001    ] lab[{PSE ANNUAL 2001 KWH}                   ]
label var[kwh2002    ] lab[{PSE ANNUAL 2002 KWH}                   ]
label var[kwh2003    ] lab[{PSE ANNUAL 2003 KWH}                   ]
label var[yrresnum   ] lab[{NUMBER OF YEARS IN RESIDENCE}          ]
label var[roomsq     ] lab[{ROOMS PER SQUARE FOOTAGE}              ]
label var[bathsqr    ] lab[{BATHS PER SQUARE FOOTAGE}              ]
label var[yrs_res    ] lab[{YEARS LIVED IN RESIDENCE}              ]
label var[counter    ] lab[{NUMBER OF MISSING KEY VARIABLES}       ]
label var[nrescat    ] lab[{N OF PEOPLE IN HOUSEHOLD - D Q1}       ]
label var[dwlnew     ] lab[{Dwelling Type}                         ]
label var[housetyp   ] lab[{Housetype}                             ]
label var[custtyp    ] lab[{Custtyp}                               ]
label var[county     ] lab[{County}                                ]
label var[weight     ] lab[{CASE WEIGHT}                           ]
label var[relwt      ] lab[{RELATIVE WEIGHT}                       ]
label var[resp1_a    ] lab[{1 IF IN FINAL SAMPLE}                  ]
label var[cflbath    ] lab[{NUMBER OF CFLS IN BATHROOM- CLEANED}   ]
label var[cflbed     ] lab[{NUMBER OF CFLS IN BEDROOM - CLEANED}   ]
label var[cflclst    ] lab[{NUMBER OF CFLS IN CLOSETS - CLEANED}   ]
label var[cflfam     ] lab[{NUMBER OF CFLS IN FAMILY ROOM-CLEANED}]
label var[cflgarag   ] lab[{NUMBER OF CFLS IN GARAGE - CLEANED}    ]
label var[cflhall    ] lab[{NUMBER OF CFLS IN HALLS - CLEANED}     ]
label var[cflktch    ] lab[{NUMBER OF CFLS IN KITCHENS - CLEANED}  ]
label var[cflliv     ] lab[{NUMBER OF CFLS IN LIVING ROOM-CLEANED}]
label var[pcflhoff   ] lab[{NUMBER OF CFLS IN HOME OFFICE-CLEANED}]
label var[cflout3    ] lab[{NUMBER OF CFLS OUTDOORS - CLEANED}     ]
label var[cflutil    ] lab[{NUMBER OF CFLS IN UTILITY ROOM-CLEANED}]
label var[cflot1     ] lab[{NUMBER OF CFLS IN OTHER RESP 1-CLEANED}]
label var[cflot2     ] lab[{NUMBER OF CFLS IN OTHER RESP 2-CLEANED}]
label var[pcflindr   ] lab[{Number of CFLs Indoors}                ]
label var[pcflbath   ] lab[{PERCENT OF CFLS - BATHROOMS}           ]
label var[pcflbed    ] lab[{PERCENT OF CFLS - BEDROOMS}            ]
label var[pcflclst   ] lab[{PERCENT OF CFLS - CLOSETS}             ]
label var[pcflfam    ] lab[{PERCENT OF CFLS - FAMILY ROOM}         ]
label var[pcflhall   ] lab[{PERCENT OF CFLS - HALLS}               ]
label var[pcflktch   ] lab[{PERCENT OF CFLS - KITCHEN}             ]
label var[pcflliv    ] lab[{PERCENT OF CFLS - LIVING ROOM}         ]
label var[pcflhof2   ] lab[{PERCENT OF CFLS - HOME OFFICE}         ]
label var[pcflutil   ] lab[{PERCENT OF CFLS - UTILITY ROOM}        ]
label var[pcfloth1   ] lab[{PERCENT OF CFLS - OTHER RESP 1}        ]
label var[pcfloth2   ] lab[{PERCENT OF CFLS - OTHER RESP 2}        ]

save file[rasfinal]

quit mem
Memory release complete
```

jad.log

```
SST Spool File:  jad.log

load file[rasfinal]
set case_num = obsno

match file[ebill1] key[id]
Warning: 1652 observations not matched

freq var[pscounty]


pscounty    {PSE: RESIDENCE COUNTY}
5316 valid observations

                  17          19          27          34          15
                   0           1           2           3           4
           ----------  ----------  ----------  ----------  ----------
Count            1231         263         843         472         242
Percent         23.16        4.95       15.86        8.88        4.55


                  16          18          29          37          21
                   5           6           7           8           9
           ----------  ----------  ----------  ----------  ----------
Count             266         670         220         222         242
Percent          5.00       12.60        4.14        4.18        4.55


                  31
                  10
           ----------
Count             645
Percent         12.13

recode var[pscounty] map[0=17 1=19 2=27 3=34 4=15 5=16 6=18 7=29 8=37 9=21
10=31]
freq var[pscounty]


pscounty    {PSE: RESIDENCE COUNTY}
5316 valid observations


                  15          16          17          18          19
           ----------  ----------  ----------  ----------  ----------
Count             242         266        1231         670         263
Percent          4.55        5.00       23.16       12.60        4.95


                  21          27          29          31          34
           ----------  ----------  ----------  ----------  ----------
Count             242         843         220         645         472
Percent          4.55       15.86        4.14       12.13        8.88


                  37
           ----------
Count             222
Percent          4.18
```

```
freq var[custx]


custx    {CUST TYPE (1=GAS,2=ELECTRIC,3=COMBO)}
5316 valid observations

                    1           2           3
           ----------  ----------  ----------
Count            1373        2657        1286
Percent         25.83       49.98       24.19

calc sum(weight,custx==1)
      2.59205e+005
calc sum(weight,custx==2)
      5.52795e+005
calc sum(weight,custx==3)
      2.60400e+005
calc sum(weight)
      1.07240e+006
set eleccust = (custx == 2) || (custx == 3)

freq var[dwltype]


dwltype    {DWELLING TYPE - R Q4}
5316 valid observations

                    1           2           3           4           5
           ----------  ----------  ----------  ----------  ----------
Count            4288         472         154         276          82
Percent         80.66        8.88        2.90        5.19        1.54


                   97          98
           ----------  ----------
Count               5          39
Percent          0.09        0.73

range if[dwltype==1 & eleccust] rp # Single-family dwellings and ELEC only

set sumths = 75

recode var[sqftcat] map[(97,98)=md]
set sqftc = (sqftcat == 1) * 500 + \
          (sqftcat == 2) * 750 + \
          (sqftcat == 3) *1250 + \
          (sqftcat == 4) *1750 + \
          (sqftcat == 5) *2250 + \
          (sqftcat == 6) *2750 + \
          (sqftcat == 7) *3000
freq var[sqftcat]


sqftcat    {SQUARE FOOTAGE OF HOME - R Q6}
2756 valid observations

                    1           2           3           4           5
           ----------  ----------  ----------  ----------  ----------
Count              69         265         631         769         492
Percent          2.50        9.62       22.90       27.90       17.85


                    6           7
```

```
            ----------  ----------
Count              298         232
Percent          10.81        8.42


recode var[sqftact] map[99999=md]

set sfe = !miss(sqftact) ? sqftact : (!miss(sqftc) ? sqftc : 0)
freq var[(sfe==0)]


(sfe==0)
3089 valid observations

                    0           1
            ----------  ----------
Count            2756         333
Percent         89.22       10.78

recode var[sfe] map[0=$(mean(sfe))]
cova var[sfe]

Variable:      sfe

Mean                    1.88727e+003 Standard deviation      8.34803e+002
Minimum                 2.52000e+002 Skewness                1.71896
Maximum                 8.97500e+003 Kurtosis               10.60412
Valid observations      3089


set nhsldmem = nr0_6 + nr6_18 + nr19_64 + nr65ovr
recode var[nhsldmem] map[(7 thru hi)=7]
freq var[nhsldmem]


nhsldmem
3089 valid observations

                    0           1           2           3           4
            ----------  ----------  ----------  ----------  ----------
Count              169         403        1302         511         463
Percent           5.47       13.05       42.15       16.54       14.99


                    5           6           7
            ----------  ----------  ----------
Count              151          48          42
Percent           4.89        1.55        1.36

recode var[nhsldmem] map[0=$( mean(nhsldmem) )]
freq var[nhsldmem]


nhsldmem
3089 valid observations

                    1           2      2.5021           3           4
            ----------  ----------  ----------  ----------  ----------
Count              403        1302         169         511         463
Percent          13.05       42.15        5.47       16.54       14.99


                    5           6           7
            ----------  ----------  ----------
```

```
Count             151          48          42
Percent          4.89        1.55        1.36


rem Recode wall and Ceiling insulation so that it is yes if was \
    done before or after resident moved in
freq var[wallins]


wallins    {WHEN WALL INSULATION INSTALLED - C Q1}
3089 valid observations

                   1           2           3          97          98
           ----------  ----------  ----------  ----------  ----------
Count            1962         349         228         395         155
Percent         63.52       11.30        7.38       12.79        5.02

recode var[wallins] map[(97,98,99)=0]
set hinwall = (wallins == 1) | (wallins==2)
freq var[hinwall]


hinwall
3089 valid observations

                   0           1
           ----------  ----------
Count             778        2311
Percent         25.19       74.81


freq var[ceilins]


ceilins    {WHEN CEILING INSULATION INSTALLED - C Q
3089 valid observations

                   1           2           3          97          98
           ----------  ----------  ----------  ----------  ----------
Count            2105         451         155         281          97
Percent         68.15       14.60        5.02        9.10        3.14

recode var[ceilins] map[(97,98,99)=0]
set insat1 = 12 * ((ceilins==1)|(ceilins==2))
freq var[insat1]


insat1
3089 valid observations

                   0          12
           ----------  ----------
Count             533        2556
Percent         17.25       82.75


freq var[bathroom]


bathroom    {NUMBER OF BATHROOMS - R Q8}
3089 valid observations

                   1           2           3           4           5
           ----------  ----------  ----------  ----------  ----------
```

Count	7	415	977	821	211
Percent	0.23	13.43	31.63	26.58	6.83

	98
Count	658
Percent	21.30

```
recode var[bathroom] map[0=99,1=0,2=1,3=2,4=3,5=4]  # J227 PSE Questionaire
Layout.doc
recode var[bathroom] map[(97,98,99)=md]
recode var[bathroom] map[(5 thru hi) = 5]
recode var[bathroom] map[md=$( mean(bathroom) )]
set bathroom = floor(bathroom+0.5)
cova var[bathroom]
```

Variable: bathroom {NUMBER OF BATHROOMS - R Q8}

Mean	2.26352	Standard deviation	0.78306
Minimum	0.00000	Skewness	0.32671
Maximum	4.00000	Kurtosis	2.93553
Valid observations	3089		

```
freq var[heatroom]
```

heatroom {NUMBER OF HEATED ROOMS - R Q7}
3089 valid observations

	1	2	3	4	5
Count	10	27	87	179	340
Percent	0.32	0.87	2.82	5.79	11.01

	6	7	8	9	10
Count	472	392	360	181	123
Percent	15.28	12.69	11.65	5.86	3.98

	11	12	13	14	15
Count	46	20	6	4	4
Percent	1.49	0.65	0.19	0.13	0.13

	16	19	98
Count	2	1	835
Percent	0.06	0.03	27.03

```
recode var[heatroom] map[(97,98,99)=md]
cova var[heatroom]
```

Variable: heatroom {NUMBER OF HEATED ROOMS - R Q7}

Mean	6.67569	Standard deviation	2.11035
Minimum	1.00000	Skewness	0.43363
Maximum	19.00000	Kurtosis	4.09770
Valid observations	2254		

```
reg dep[heatroom] ind[(1) sfe] coef[bhr]


********* ORDINARY LEAST SQUARES ESTIMATION *********

Dependent Variable:  heatroom

Independent        Estimated             Standard               t-
 Variable         Coefficient             Error               Statistic

      (1)           3.27800              0.10652              30.77368
      sfe           1.94899e-003         5.74711e-005         33.91253


Number of Observations                2254
R-squared                                0.33805
Corrected R-squared                      0.33775
Sum of Squared Residuals                 6.64198e+003
Standard Error of the Regression         1.71737
Durbin-Watson Statistic                  1.93360
Mean of Dependent Variable               6.67569

set hroom = floor((bhr[1] + bhr[2]*sfe) + 0.5)
cova var[hroom]

Variable:    hroom

Mean                    7.07252      Standard deviation      1.63191
Minimum                 4.00000      Skewness                1.56470
Maximum                21.00000      Kurtosis               10.10877
Valid observations      3089

set heatroom = (!miss(heatroom) ? heatroom : hroom)
recode var[heatroom] map[(12 thru hi) = 12]
cova var[heatroom]

Variable: heatroom     {NUMBER OF HEATED ROOMS - R Q7}

Mean                    6.96698      Standard deviation      2.04045
Minimum                 1.00000      Skewness                0.18984
Maximum                12.00000      Kurtosis                3.11481
Valid observations      3089

recode var[heatroom] map[md=$( mean(heatroom) )]
set heatroom = floor(heatroom+0.5)
cova var[heatroom]

Variable: heatroom     {NUMBER OF HEATED ROOMS - R Q7}

Mean                    6.96698      Standard deviation      2.04045
Minimum                 1.00000      Skewness                0.18984
Maximum                12.00000      Kurtosis                3.11481
Valid observations      3089


set nrooms = heatroom + bathroom
cova var[heatroom bathroom nrooms]

Variable: heatroom     {NUMBER OF HEATED ROOMS - R Q7}

Mean                    6.96698      Standard deviation      2.04045
Minimum                 1.00000      Skewness                0.18984
Maximum                12.00000      Kurtosis                3.11481
Valid observations      3089
```

```
Variable: bathroom     {NUMBER OF BATHROOMS - R Q8}

Mean                     2.26352      Standard deviation      0.78306
Minimum                  0.00000      Skewness                0.32671
Maximum                  4.00000      Kurtosis                2.93553
Valid observations       3089

Variable:   nrooms

Mean                     9.23050      Standard deviation      2.41607
Minimum                  2.00000      Skewness               -6.28123e-002
Maximum                 16.00000      Kurtosis                2.89499
Valid observations       3089


freq var[dwlstr]


dwlstr    {N STORIES IN BLDG - R Q5}
3089 valid observations

                   1           2           3           4           5
            ----------  ----------  ----------  ----------  ----------
Count            1284         220        1285          68         200
Percent         41.57        7.12       41.60        2.20        6.47


                   6           7          97          98
            ----------  ----------  ----------  ----------
Count               9          10           2          11
Percent          0.29        0.32        0.06        0.36

recode var[dwlstr] map[(97,98,99)=0]
set floors = (dwlstr==1)*1 + (dwlstr==2)*1.5 + (dwlstr==3)*2 + (dwlstr==4)*2.5
+ \
           (dwlstr==5)*3 + (dwlstr==6)*3 + (dwlstr==7)*0
freq var[floors]


floors
3089 valid observations

                   0           1         1.5           2         2.5
            ----------  ----------  ----------  ----------  ----------
Count              23        1284         220        1285          68
Percent          0.74       41.57        7.12       41.60        2.20


                   3
            ----------
Count             209
Percent          6.77

recode var[floors] map[0=$(mean(floors))]
freq var[floors]


floors
3089 valid observations

                   1         1.5      1.6125           2         2.5
            ----------  ----------  ----------  ----------  ----------
Count            1284         220          23        1285          68
```

```
Percent          41.57         7.12         0.74        41.60         2.20


                    3
           ----------
Count             209
Percent          6.77


freq var[pscounty]


pscounty    {PSE: RESIDENCE COUNTY}
3089 valid observations


                   15           16           17           18           19
           ----------   ----------   ----------   ----------   ----------
Count              195          219          800          528          202
Percent           6.31         7.09        25.90        17.09         6.54



                   27           29           34           37
           ----------   ----------   ----------   ----------
Count              438          181          371          155
Percent          14.18         5.86        12.01         5.02

match file[county2] by[co_indx] key[pscounty]  # match normals
match file[county3] by[co_indx] key[pscounty]  # match 2003 actuals

set hdd03 = cdd03 = kwh03 = 0
foreach(j ; {25-36}) {
set hdd03 += hdd${j}
set cdd03 += cdd${j}
set kwh03 += kwh${j}
}

set hdd_03 = cdd_03 = 0
foreach(j ; {1-12}) {
set hdd_03 += hdd3_${j}
set cdd_03 += cdd3_${j}
}

cova var[hdd_03 hdd03] cov

Variable:   hdd_03

Mean                    4.61350e+003 Standard deviation      4.56778e+002
Minimum                 4.04378e+003 Skewness                1.32116
Maximum                 5.86865e+003 Kurtosis                4.45074
Valid observations      2875

Variable:    hdd03

Mean                    4.85333e+003 Standard deviation      4.27145e+002
Minimum                 4.21545e+003 Skewness               -0.41649
Maximum                 5.67235e+003 Kurtosis                1.69215
Valid observations      2875

Correlation and Covariance matrix

               hdd_03             hdd03
  hdd_03      2.08573e+005      6.92280e+004
```

```
   hdd03      0.35494           1.82389e+005

cova var[cdd_03 cdd03] cov

Variable:   cdd_03

Mean                    2.30316e+002 Standard deviation      1.17546e+002
Minimum                84.00000      Skewness                0.83659
Maximum                 5.45500e+002 Kurtosis                3.95119
Valid observations      2875

Variable:    cdd03

Mean                    2.37476e+002 Standard deviation      2.13801e+002
Minimum                40.00000      Skewness                2.19794
Maximum                 9.91700e+002 Kurtosis                8.20554
Valid observations      2875

Correlation and Covariance matrix

               cdd_03             cdd03
  cdd_03      1.38122e+004      2.16171e+004
   cdd03      0.86046           4.56951e+004

cova var[kwh2003 kwh03] cov

Variable:  kwh2003     {PSE ANNUAL 2003 KWH}

Mean                    1.13763e+004 Standard deviation      7.47000e+003
Minimum                 0.00000      Skewness                1.61226
Maximum                 7.99130e+004 Kurtosis                8.54331
Valid observations      2875

Variable:    kwh03

Mean                    1.13763e+004 Standard deviation      7.47000e+003
Minimum                 0.00000      Skewness                1.61226
Maximum                 7.99130e+004 Kurtosis                8.54331
Valid observations      2875

Correlation and Covariance matrix

              kwh2003             kwh03
 kwh2003      5.57816e+007      5.57816e+007
   kwh03      1.00000           5.57816e+007


freq var[custx]


custx    {CUST TYPE (1=GAS,2=ELECTRIC,3=COMBO)}
3089 valid observations

                    2           3
            ----------  ----------
Count             1917        1172
Percent          62.06       37.94


rem set win = floor( (2.66 + 8.33 * floors) + 0.5 )
set win = floor( 1.9423 + 6.385*floors + 0.002173*sfe + 0.5)

freq var[dblpane pctstrmw]
```

```
dblpane    {PCNT OF DBL PANE WINDOWS - C Q3}
3089 valid observations

                  1           2           3           4           5
           ----------  ----------  ----------  ----------  ----------
Count           2074         301         100         135         306
Percent        67.14        9.74        3.24        4.37        9.91


                 97          98
           ----------  ----------
Count            123          50
Percent         3.98        1.62


pctstrmw    {PCNT OF WINDOWS THAT ARE STORM - C Q4}
3089 valid observations

                  1           2           3           4           5
           ----------  ----------  ----------  ----------  ----------
Count            290         113          59          86        2077
Percent         9.39        3.66        1.91        2.78       67.24


                 97          98
           ----------  ----------
Count            345         119
Percent        11.17        3.85

recode var[dblpane] map[(97,98,99)=0]
set pctdp  = (dblpane==1)*1.00 + (dblpane==2)*0.75 + (dblpane==3)*0.5 + \
             (dblpane==4)*0.25 + (dblpane==5)*0.00 + (dblpane==6)*0.00

recode var[pctstrmw] map[(97,98,99)=0]
set pctstm = (pctstrmw==1)*1.00 + (pctstrmw==2)*0.75 + (pctstrmw==3)*0.5 + \
             (pctstrmw==4)*0.25 + (pctstrmw==5)*0.00 + (pctstrmw==6)*0.00


set pct = vmax(pctdp,pctstm)

set lwinds = 0
set mwinds = win
set swinds = 0

set nlwind = 0
set nmwind = win * pct
set nswind = 0

set winths = 70

match file[weather] by[co_indx] key[pscounty]  # match design termperatures
rename var[sddr] to[sddb]

range if[!miss(hdd25)] rp
list

---- Variables ----
addition  2875  Thu Mar 30 09:23:47 2006 {ADDITIONS TO HOME - R Q10}
address   2875  Thu Mar 30 09:23:47 2006 {PSE: RESIDENCE ADDRESS}
addsqft   2875  Thu Mar 30 09:23:47 2006 {ADDED HEATED SQUARE FOOTAGE- R Q10a}
adsqftct  2875  Thu Mar 30 09:23:47 2006 {ADDED HEATED SQUARE FOOTAGE- R Q10a}
age       2875  Thu Mar 30 09:23:47 2006 {AGE OF HEAD OF HOUSEHOLD - D Q4}
agecat    2875  Thu Mar 30 09:23:47 2006 {AGE OF HEAD OF HOUSEHOLD - D Q4}
```

agenr	2875	Thu Mar 30 09:23:47 2006	{AGE OF HEAD OF HOUSEHOLD - D Q4}
audits	2875	Thu Mar 30 09:23:47 2006	{FOLLOW UP AUDIT - D Q7}
batchno	2875	Thu Mar 30 09:23:47 2006	{Survey Id}
bathroom	2875	Thu Mar 30 09:23:47 2006	{NUMBER OF BATHROOMS - R Q8}
bathsqr	2875	Thu Mar 30 09:23:47 2006	{BATHS PER SQUARE FOOTAGE}
besttime	2875	Thu Mar 30 09:23:47 2006	{BEST TIME TO REACJ - D Q9}
blnktact	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM ELECTRIC BLANKET - A Q4}
blnktnct	2875	Thu Mar 30 09:23:47 2006	{N OF ELECTRIC BLANKETS - A Q3}
builtyr	2875	Thu Mar 30 09:23:47 2006	{YEAR HOME WAS BUILT - R Q9}
case_num	2875	Fri Apr 28 12:34:55 2006	
cdd03	2875	Fri Apr 28 12:34:57 2006	
cdd1	2875	Fri Apr 28 12:34:55 2006	
cdd10	2875	Fri Apr 28 12:34:55 2006	
cdd11	2875	Fri Apr 28 12:34:55 2006	
cdd12	2875	Fri Apr 28 12:34:55 2006	
cdd13	2875	Fri Apr 28 12:34:55 2006	
cdd14	2875	Fri Apr 28 12:34:55 2006	
cdd15	2875	Fri Apr 28 12:34:55 2006	
cdd16	2875	Fri Apr 28 12:34:55 2006	
cdd17	2875	Fri Apr 28 12:34:55 2006	
cdd18	2875	Fri Apr 28 12:34:55 2006	
cdd19	2875	Fri Apr 28 12:34:55 2006	
cdd2	2875	Fri Apr 28 12:34:55 2006	
cdd20	2875	Fri Apr 28 12:34:55 2006	
cdd21	2875	Fri Apr 28 12:34:55 2006	
cdd22	2875	Fri Apr 28 12:34:55 2006	
cdd23	2875	Fri Apr 28 12:34:55 2006	
cdd24	2875	Fri Apr 28 12:34:55 2006	
cdd25	2875	Fri Apr 28 12:34:55 2006	
cdd26	2875	Fri Apr 28 12:34:55 2006	
cdd27	2875	Fri Apr 28 12:34:55 2006	
cdd28	2875	Fri Apr 28 12:34:55 2006	
cdd29	2875	Fri Apr 28 12:34:55 2006	
cdd3	2875	Fri Apr 28 12:34:55 2006	
cdd30	2875	Fri Apr 28 12:34:55 2006	
cdd31	2875	Fri Apr 28 12:34:55 2006	
cdd32	2875	Fri Apr 28 12:34:55 2006	
cdd33	2875	Fri Apr 28 12:34:55 2006	
cdd34	2875	Fri Apr 28 12:34:55 2006	
cdd35	2875	Fri Apr 28 12:34:55 2006	
cdd36	2875	Fri Apr 28 12:34:55 2006	
cdd3_1	2875	Fri Apr 28 12:34:57 2006	
cdd3_10	2875	Fri Apr 28 12:34:57 2006	
cdd3_11	2875	Fri Apr 28 12:34:57 2006	
cdd3_12	2875	Fri Apr 28 12:34:57 2006	
cdd3_2	2875	Fri Apr 28 12:34:57 2006	
cdd3_3	2875	Fri Apr 28 12:34:57 2006	
cdd3_4	2875	Fri Apr 28 12:34:57 2006	
cdd3_5	2875	Fri Apr 28 12:34:57 2006	
cdd3_6	2875	Fri Apr 28 12:34:57 2006	
cdd3_7	2875	Fri Apr 28 12:34:57 2006	
cdd3_8	2875	Fri Apr 28 12:34:57 2006	
cdd3_9	2875	Fri Apr 28 12:34:57 2006	
cdd4	2875	Fri Apr 28 12:34:55 2006	
cdd5	2875	Fri Apr 28 12:34:55 2006	
cdd6	2875	Fri Apr 28 12:34:55 2006	
cdd7	2875	Fri Apr 28 12:34:55 2006	
cdd8	2875	Fri Apr 28 12:34:55 2006	
cdd9	2875	Fri Apr 28 12:34:55 2006	
cdd_03	2875	Fri Apr 28 12:34:57 2006	
ceilins	2875	Thu Mar 30 09:23:47 2006	{WHEN CEILING INSULATION INSTALLED- C
centaca	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM CENTRAL AC - A Q4}
centacn	2875	Thu Mar 30 09:23:47 2006	{N OF CENTRAL AIR CONDITIONERS- A Q3}
centact	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM CENTRAL AC - A Q4}

```
centnact  2875  Thu Mar 30 09:23:47 2006 {N OF CENTRAL AIR CONDITIONER - A Q3}
cfl       2875  Thu Mar 30 09:23:47 2006 {HAS CFLS - C Q2}
cfl1oth   2875  Thu Mar 30 09:23:47 2006 {OTHER LOCATION WITH CFL - C Q2a}
cfl2oth   2875  Thu Mar 30 09:23:47 2006 {OTHER LOCATION WITH CFL - C Q2a}
cflbasem  2875  Thu Mar 30 09:23:47 2006 {CFL IN BASEMENT - C Q2a}
cflbath   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN BATHROOM- CLEANED}
cflbdnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN BEDROOM - C Q2a}
cflbed    2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN BEDROOM - CLEANED}
cflbedn   2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN BEDROOM - C Q2a}
cflbthn   2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN BATHROOM - C Q2a}
cflbtnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN BATHROOM - C Q2a}
cflclnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN CLOSET - C Q2a}
cflclst   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN CLOSETS - CLEANED}
cflclstn  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN CLOSET - C Q2a}
cfldine   2875  Thu Mar 30 09:23:47 2006 {CFL IN DINING ROOM - C Q2a}
cflfam    2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN FAMILY ROOM- CLEAN
cflfamrn  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN FAMILY ROOM - C Q2a}
cflfrnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN FAMILY ROOM - C Q2a}
cflganct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN GARAGE - C Q2a}
cflgarag  2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN GARAGE - CLEANED}
cflgrgen  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN GARAGE - C Q2a}
cflhall   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN HALLS - CLEANED}
cflhalln  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN HALLWAY - C Q2a}
cflhlnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN HALLWAY - C Q2a}
cflhoffn  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN HOME OFFICE EQUIP- C Q2
cflktch   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN KITCHENS- CLEANED}
cflktchn  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN KITCHEN - C Q2a}
cflktnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN KITCHEN - C Q2a}
cfllamp   2875  Thu Mar 30 09:23:47 2006 {CFL IN LAMPS - C Q2a}
cflliv    2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN LIVING ROOM- CLEAN
cfllvnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN LIVING ROOM - C Q2a}
cfllvrmn  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN LIVING ROOM - C Q2a}
cflo1nct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN OTHER 1 - C Q2a}
cflo2nct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN OTHER 2 - C Q2a}
cflofnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN HOME OFFICE EQUIP- C Q2
cflot1    2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN OTHER RESP 1- CLEA
cflot2    2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN OTHER RESP 2- CLEA
cfloth1   2875  Thu Mar 30 09:23:47 2006 {OTHER LOCATION WITH CFL - C Q2a}
cfloth1n  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN OTHER 1 - C Q2a}
cfloth2   2875  Thu Mar 30 09:23:47 2006 {OTHER LOCATION WITH CFL - C Q2a}
cfloth2n  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN OTHER 2 - C Q2a}
cflout    2875  Thu Mar 30 09:23:47 2006 {CFL OUTSIDE - C Q2a}
cflout3   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS OUTDOORS - CLEANED}
cfloutn   2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN OUTDOORS - C Q2a}
cflutil   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN UTILITY ROOM- CLEA
cflutiln  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN UTILITY ROOM - C Q2a}
cflutnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN UTILITY ROOM - C Q2a}
cfoutnct  2875  Thu Mar 30 09:23:47 2006 {N OF CFLS IN OUTDOORS - C Q2a}
city      2875  Thu Mar 30 09:23:47 2006 {PSE: RESIDENCE CITY}
ckovage   2875  Thu Mar 30 09:23:47 2006 {CONVENTIONAL OVEN  AGE  - A Q2}
ckovtyp   2875  Thu Mar 30 09:23:47 2006 {CONVENTIONAL OVEN FUEL - A Q1}
ckrnage   2875  Thu Mar 30 09:23:47 2006 {STOVETOP COOKING EQUIP AGE- A Q2}
ckrntyp   2875  Thu Mar 30 09:23:47 2006 {STOVETOP COOKING FUEL - A Q1}
co_indx   2875  Fri Apr 28 12:34:57 2006 county index
counter   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF MISSING KEY VARIABLES}
county    2875  Thu Mar 30 09:23:47 2006 {County}
county1   2875  Thu Mar 30 09:23:47 2006 {FIRST DIGIT OF COUNTY}
county2   2875  Thu Mar 30 09:23:47 2006 {SECOND DIGIT OF COUNTY}
county4   2875  Thu Mar 30 09:23:47 2006 {COUNTY CODE}
custtyp   2875  Thu Mar 30 09:23:47 2006 {Custtyp}
custx     2875  Thu Mar 30 09:23:47 2006 {CUST TYPE
(1=GAS,2=ELECTRIC,3=COMBO)}
dblpane   2875  Thu Mar 30 09:23:47 2006 {PCNT OF DBL PANE WINDOWS - C Q3}
dblpanea  2875  Thu Mar 30 09:23:47 2006 {AGE OF DBLE PANE WINDOWS - C Q3a}
```

dishwa	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM DISHWASHERS - A Q4}
dishwn	2875	Thu Mar 30 09:23:47 2006	{N OF DISHWASHERS - A Q3}
drwinins	2875	Thu Mar 30 09:23:47 2006	{WHEN WEATHERSTRIP INSTALLED - C Q1}
dryage	2875	Thu Mar 30 09:23:47 2006	{CLOTHES DRYER AGE - A Q2}
drytyp	2875	Thu Mar 30 09:23:47 2006	{CLOTHES DRYER FUEL - A Q1}
dwacat	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM DISHWASHERS - A Q4}
dwlnew	2875	Thu Mar 30 09:23:47 2006	{Dwelling Type}
dwlstr	2875	Thu Mar 30 09:23:47 2006	{N STORIES IN BLDG - R Q5}
dwlstrot	2875	Thu Mar 30 09:23:47 2006	{DWELLING STORIES: OTHER - R Q5}
dwltype	2875	Thu Mar 30 09:23:47 2006	{DWELLING TYPE - R Q4}
dwltypex	2875	Thu Mar 30 09:23:47 2006	{PSE DWELLING TYPE (1=SF,2,3=MF, 4=MH
dwltypot	2875	Thu Mar 30 09:23:47 2006	{DWELLING TYPE: OTHER - R Q4}
dwncat	2875	Thu Mar 30 09:23:47 2006	{N OF DISHWASHERS - A Q3}
ecdishw	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR DISHWASHER - A Q5}
ecdry	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR DRYER - A Q5}
ecdvd	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR DVD PLAYER - A Q5}
ecfrnc	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR FURNACE - A Q5}
ecfrzr	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR FREEZER - A Q5}
ecmicrow	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR MICROWAVE - A Q5}
ecmntr	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR COMPUTER MONITOR- A Q
ecoth	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR OTHER - A Q5}
ecprint	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR PRINTER - A Q5}
ecrefr	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR REFRIGERATOR - A Q5}
ecstereo	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR STEREO - A Q5}
ecstove	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR STOVE - A Q5}
ectv	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR TV - A Q5}
ecvcr	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR VCR - A Q5}
ecwash	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR WASHING MACHINE- A Q5
ecwh	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR WATER HEATER - A Q5}
educ	2875	Thu Mar 30 09:23:47 2006	{HIGHEST EDUC BY HEAD OF HOUSE- D Q2}
eewindws	2875	Thu Mar 30 09:23:47 2006	{WHEN EFFICIENT WINDOWS INSTALLED - C
elblnkta	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM ELECTRIC BLANKET - A Q4}
elblnktn	2875	Thu Mar 30 09:23:47 2006	{N OF ELECTRIC BLANKETS - A Q3}
eleccust	2875	Fri Apr 28 12:34:56 2006	
empstat	2875	Thu Mar 30 09:23:47 2006	{EMP STATUS OF HEAD OF HOUSE - D Q3}
enrgystr	2875	Thu Mar 30 09:23:47 2006	{ANY APPL ENERGY STAR - A Q5}
esac	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR AIR CONDITION - A Q5}
escd	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR CD PLAYER - A Q5}
espc	2875	Thu Mar 30 09:23:47 2006	{HAS ENERGY STR COMPUTER - A Q5}
floors	2875	Fri Apr 28 12:34:57 2006	
followup	2875	Thu Mar 30 09:23:47 2006	{FOLLOW UP INTERVIEW - D Q6}
freezera	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM SEPARATE FREEZER - A Q4}
freezern	2875	Thu Mar 30 09:23:47 2006	{N OF SEPARATE FREEZERS INSTALLED - A
fzracat	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM SEPARATE FREEZER - A Q4}
fzrncat	2875	Thu Mar 30 09:23:47 2006	{N OF SEPARATE FREEZERS INSTALLED - A
genrator	2875	Thu Mar 30 09:23:47 2006	{BACK UP GENERATOR - A Q6}
hdd03	2875	Fri Apr 28 12:34:57 2006	
hdd1	2875	Fri Apr 28 12:34:55 2006	
hdd10	2875	Fri Apr 28 12:34:55 2006	
hdd11	2875	Fri Apr 28 12:34:55 2006	
hdd12	2875	Fri Apr 28 12:34:55 2006	
hdd13	2875	Fri Apr 28 12:34:55 2006	
hdd14	2875	Fri Apr 28 12:34:55 2006	
hdd15	2875	Fri Apr 28 12:34:55 2006	
hdd16	2875	Fri Apr 28 12:34:55 2006	
hdd17	2875	Fri Apr 28 12:34:55 2006	
hdd18	2875	Fri Apr 28 12:34:55 2006	
hdd19	2875	Fri Apr 28 12:34:55 2006	
hdd2	2875	Fri Apr 28 12:34:55 2006	
hdd20	2875	Fri Apr 28 12:34:55 2006	
hdd21	2875	Fri Apr 28 12:34:55 2006	
hdd22	2875	Fri Apr 28 12:34:55 2006	
hdd23	2875	Fri Apr 28 12:34:55 2006	
hdd24	2875	Fri Apr 28 12:34:55 2006	

hdd25	2875	Fri Apr 28 12:34:55 2006	
hdd26	2875	Fri Apr 28 12:34:55 2006	
hdd27	2875	Fri Apr 28 12:34:55 2006	
hdd28	2875	Fri Apr 28 12:34:55 2006	
hdd29	2875	Fri Apr 28 12:34:55 2006	
hdd3	2875	Fri Apr 28 12:34:55 2006	
hdd30	2875	Fri Apr 28 12:34:55 2006	
hdd31	2875	Fri Apr 28 12:34:55 2006	
hdd32	2875	Fri Apr 28 12:34:55 2006	
hdd33	2875	Fri Apr 28 12:34:55 2006	
hdd34	2875	Fri Apr 28 12:34:55 2006	
hdd35	2875	Fri Apr 28 12:34:55 2006	
hdd36	2875	Fri Apr 28 12:34:55 2006	
hdd3_1	2875	Fri Apr 28 12:34:57 2006	
hdd3_10	2875	Fri Apr 28 12:34:57 2006	
hdd3_11	2875	Fri Apr 28 12:34:57 2006	
hdd3_12	2875	Fri Apr 28 12:34:57 2006	
hdd3_2	2875	Fri Apr 28 12:34:57 2006	
hdd3_3	2875	Fri Apr 28 12:34:57 2006	
hdd3_4	2875	Fri Apr 28 12:34:57 2006	
hdd3_5	2875	Fri Apr 28 12:34:57 2006	
hdd3_6	2875	Fri Apr 28 12:34:57 2006	
hdd3_7	2875	Fri Apr 28 12:34:57 2006	
hdd3_8	2875	Fri Apr 28 12:34:57 2006	
hdd3_9	2875	Fri Apr 28 12:34:57 2006	
hdd4	2875	Fri Apr 28 12:34:55 2006	
hdd5	2875	Fri Apr 28 12:34:55 2006	
hdd6	2875	Fri Apr 28 12:34:55 2006	
hdd7	2875	Fri Apr 28 12:34:55 2006	
hdd8	2875	Fri Apr 28 12:34:55 2006	
hdd9	2875	Fri Apr 28 12:34:55 2006	
hdd_03	2875	Fri Apr 28 12:34:57 2006	
heatrepl	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEM PRIOR TO 2003 - H Q4b}
heatroom	2875	Thu Mar 30 09:23:47 2006	{NUMBER OF HEATED ROOMS - R Q7}
heatserv	2875	Thu Mar 30 09:23:47 2006	{HEATING SYS SERVICE TYPE - H Q1}
heatuse	2875	Thu Mar 30 09:23:47 2006	{HEATING SYS CONTROL BEHAVIOR - H Q7}
hinwall	2875	Fri Apr 28 12:34:56 2006	
homeoffc	2875	Thu Mar 30 09:23:47 2006	{HOME OFFICE AT RESIDENCE - A Q7}
housetyp	2875	Thu Mar 30 09:23:47 2006	{Housetype}
hroom	2875	Fri Apr 28 12:34:57 2006	
htbgcnt	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htbgpth	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htctlbev	2875	Thu Mar 30 09:23:47 2006	{TMP CONTROL ON HEATING SYSTEM- H Q6}
htdctins	2875	Thu Mar 30 09:23:47 2006	{WHEN HEAT DUCT INS INSTALLED - C Q1}
htelbsb	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htelchp	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htelcrh	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
hteloth	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htelpth	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htelwht	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htflrepo	2875	Thu Mar 30 09:23:47 2006	{PRIOR HEATING SYSTEM: OTHER - H Q4b}
hthwrad	2875	Thu Mar 30 09:23:47 2006	{HEATSYS: READIANT HOT WATER - H Q2}
htngcnt	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htngfp	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htngoth	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htnr	2875	Thu Mar 30 09:23:47 2006	{HEATSYS: DON'T KNOW - H Q2}
htolcnt	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htoloth	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htothr	2875	Thu Mar 30 09:23:47 2006	{HEATSYS: OTHER - H Q2}
htotsys	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htpellet	2875	Thu Mar 30 09:23:47 2006	{HEATSYS: PELLET STOVE - H Q2}
htprfp	2875	Thu Mar 30 09:23:47 2006	{HEATSYS: PROPANE STOVE - H Q2}
htrad	2875	Thu Mar 30 09:23:47 2006	{HEATSYS: RADIANT FLOOR HEAT - H Q2}

htrepl03	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEM REPLACED IN 2003- H Q
htslr	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htsysage	2875	Thu Mar 30 09:23:47 2006	{AGE OF HEATING SYSTEM - H Q4}
httempct	2875	Thu Mar 30 09:23:47 2006	{TEMP CONTROL: OTHER - H Q6}
htwdfp	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
htwdws	2875	Thu Mar 30 09:23:47 2006	{HEATING SYSTEMS USED AT HOME - H Q3}
hwdispa	2875	Thu Mar 30 09:23:47 2006	{AGE PRIM ONDEMAND H20 DISPENSER- A Q
hwdispn	2875	Thu Mar 30 09:23:47 2006	{N OF ONDEMAND H20 DISPENSERS - A Q3}
hwdnact	2875	Thu Mar 30 09:23:47 2006	{N OF ONDEMAND H20 DISPENSERS - A Q3}
hwdspact	2875	Thu Mar 30 09:23:47 2006	{AGE PRIM ONDEMAND H20 DISPENSER- A Q
id	2875	Thu Mar 30 09:23:47 2006	{ID NUMBER}
income	2875	Thu Mar 30 09:23:47 2006	{YEARLY INCOME 2003 - D Q5}
insat1	2875	Fri Apr 28 12:34:56 2006	
kwh03	2875	Fri Apr 28 12:34:57 2006	
kwh1	2875	Fri Apr 28 12:34:55 2006	
kwh10	2875	Fri Apr 28 12:34:55 2006	
kwh11	2875	Fri Apr 28 12:34:55 2006	
kwh12	2875	Fri Apr 28 12:34:55 2006	
kwh13	2875	Fri Apr 28 12:34:55 2006	
kwh14	2875	Fri Apr 28 12:34:55 2006	
kwh15	2875	Fri Apr 28 12:34:55 2006	
kwh16	2875	Fri Apr 28 12:34:55 2006	
kwh17	2875	Fri Apr 28 12:34:55 2006	
kwh18	2875	Fri Apr 28 12:34:55 2006	
kwh19	2875	Fri Apr 28 12:34:55 2006	
kwh2	2875	Fri Apr 28 12:34:55 2006	
kwh20	2875	Fri Apr 28 12:34:55 2006	
kwh2001	2875	Thu Mar 30 09:23:47 2006	{PSE ANNUAL 2001 KWH}
kwh2002	2875	Thu Mar 30 09:23:47 2006	{PSE ANNUAL 2002 KWH}
kwh2003	2875	Thu Mar 30 09:23:47 2006	{PSE ANNUAL 2003 KWH}
kwh21	2875	Fri Apr 28 12:34:55 2006	
kwh22	2875	Fri Apr 28 12:34:55 2006	
kwh23	2875	Fri Apr 28 12:34:55 2006	
kwh24	2875	Fri Apr 28 12:34:55 2006	
kwh25	2875	Fri Apr 28 12:34:55 2006	
kwh26	2875	Fri Apr 28 12:34:55 2006	
kwh27	2875	Fri Apr 28 12:34:55 2006	
kwh28	2875	Fri Apr 28 12:34:55 2006	
kwh29	2875	Fri Apr 28 12:34:55 2006	
kwh3	2875	Fri Apr 28 12:34:55 2006	
kwh30	2875	Fri Apr 28 12:34:55 2006	
kwh31	2875	Fri Apr 28 12:34:55 2006	
kwh32	2875	Fri Apr 28 12:34:55 2006	
kwh33	2875	Fri Apr 28 12:34:55 2006	
kwh34	2875	Fri Apr 28 12:34:55 2006	
kwh35	2875	Fri Apr 28 12:34:55 2006	
kwh36	2875	Fri Apr 28 12:34:55 2006	
kwh4	2875	Fri Apr 28 12:34:55 2006	
kwh5	2875	Fri Apr 28 12:34:55 2006	
kwh6	2875	Fri Apr 28 12:34:55 2006	
kwh7	2875	Fri Apr 28 12:34:55 2006	
kwh8	2875	Fri Apr 28 12:34:55 2006	
kwh9	2875	Fri Apr 28 12:34:55 2006	
lwinds	2875	Fri Apr 28 12:34:57 2006	
mailadd	2875	Thu Mar 30 09:23:47 2006	{PSE: MAILING ADDRESS}
mailcity	2875	Thu Mar 30 09:23:47 2006	{PSE: MAILING CITY}
mailst	2875	Thu Mar 30 09:23:47 2006	{PSE: MAILING STREET}
mailzip	2875	Thu Mar 30 09:23:47 2006	{PSE: MAILING ZIP}
microwva	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM MICROWAVE - A Q4}
microwvn	2875	Thu Mar 30 09:23:47 2006	{N OF MICROWAVES INSTALLED - A Q3}
mwinds	2875	Fri Apr 28 12:34:57 2006	
mwvacat	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM MICROWAVE - A Q4}
mwvncat	2875	Thu Mar 30 09:23:47 2006	{N OF MICROWAVES INSTALLED - A Q3}
n1964ct	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE BTWN 19 AND 64 - D Q1}

n65ovrct	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE OLDER 65 YRS OLD - D Q1}
n_cdd1	2875	Fri Apr 28 12:34:57 2006	Jan normal cooling days
n_cdd10	2875	Fri Apr 28 12:34:57 2006	Oct normal cooling days
n_cdd11	2875	Fri Apr 28 12:34:57 2006	Nov normal cooling days
n_cdd12	2875	Fri Apr 28 12:34:57 2006	Dec normal cooling days
n_cdd2	2875	Fri Apr 28 12:34:57 2006	Feb normal cooling days
n_cdd3	2875	Fri Apr 28 12:34:57 2006	Mar normal cooling days
n_cdd4	2875	Fri Apr 28 12:34:57 2006	Apr normal cooling days
n_cdd5	2875	Fri Apr 28 12:34:57 2006	May normal cooling days
n_cdd6	2875	Fri Apr 28 12:34:57 2006	Jun normal cooling days
n_cdd7	2875	Fri Apr 28 12:34:57 2006	Jul normal cooling days
n_cdd8	2875	Fri Apr 28 12:34:57 2006	Aug normal cooling days
n_cdd9	2875	Fri Apr 28 12:34:57 2006	Sep normal cooling days
n_hdd1	2875	Fri Apr 28 12:34:57 2006	Jan normal heating day
n_hdd10	2875	Fri Apr 28 12:34:57 2006	Oct normal heating day
n_hdd11	2875	Fri Apr 28 12:34:57 2006	Nov normal heating day
n_hdd12	2875	Fri Apr 28 12:34:57 2006	Dec normal heating day
n_hdd2	2875	Fri Apr 28 12:34:57 2006	Feb normal heating day
n_hdd3	2875	Fri Apr 28 12:34:57 2006	Mar normal heating day
n_hdd4	2875	Fri Apr 28 12:34:57 2006	Apr normal heating day
n_hdd5	2875	Fri Apr 28 12:34:57 2006	May normal heating day
n_hdd6	2875	Fri Apr 28 12:34:57 2006	Jun normal heating day
n_hdd7	2875	Fri Apr 28 12:34:57 2006	Jul normal heating day
n_hdd8	2875	Fri Apr 28 12:34:57 2006	Aug normal heating day
n_hdd9	2875	Fri Apr 28 12:34:57 2006	Sep normal heating day
name	2875	Thu Mar 30 09:23:47 2006	{PSE: CUSTOMER NAME}
ngavail	2875	Thu Mar 30 09:23:47 2006	{NATURAL GAS SERVICE AVAILABLE - N Q2}
ngserv	2875	Thu Mar 30 09:23:47 2006	{HAS NATURAL GAS SERVICE - N Q1}
ngtime	2875	Thu Mar 30 09:23:47 2006	{NATURAL GAS BUILT IN OR ADDED - N Q1a
nhsldmem	2875	Fri Apr 28 12:34:56 2006	
nlwind	2875	Fri Apr 28 12:34:57 2006	
nmwind	2875	Fri Apr 28 12:34:57 2006	
nr0_6	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE UNDER 6 YRS OLD - D Q1}
nr0_6a	2875	Thu Mar 30 09:23:47 2006	{N IN HOUSEHOLD UNDER 6 ANY- D Q1}
nr0_6cat	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE UNDER 6 YRS OLD - D Q1}
nr19_64	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE BTWN 19 AND 64 - D Q1}
nr19_64a	2875	Thu Mar 30 09:23:47 2006	{N IN HOUSEHOLD 19-64 ANY- D Q1}
nr618cat	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE BTWN 6 AND 18 - D Q1}
nr65ovr	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE OLDER 65 YRS OLD - D Q1}
nr6_18	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE BTWN 6 AND 18 - D Q1}
nr6_18a	2875	Thu Mar 30 09:23:47 2006	{N IN HOUSEHOLD 6-18 ANY- D Q1}
nrescat	2875	Thu Mar 30 09:23:47 2006	{N OF PEOPLE IN HOUSEHOLD - D Q1}
nrooms	2875	Fri Apr 28 12:34:57 2006	
nrovr65a	2875	Thu Mar 30 09:23:47 2006	{N IN HOUSEHOLD OVER 65 ANY- D Q1}
nswind	2875	Fri Apr 28 12:34:57 2006	
numres	2875	Thu Mar 30 09:23:47 2006	{TOTAL NUMBER OF OCCUPANTS}
occres	2875	Thu Mar 30 09:23:47 2006	{LIVES IN RESIDENCE: YEAR ROUND- R Q3
occresot	2875	Thu Mar 30 09:23:47 2006	{OCCUPANT SEASONS: OTHER - R Q3}
offeqact	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM HOME OFFICE EQUIP- A Q4}
offeqnct	2875	Thu Mar 30 09:23:47 2006	{N OF HOME OFFICE EQUIP - A Q3}
offeqpa	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM HOME OFFICE EQUIP- A Q4}
offeqpn	2875	Thu Mar 30 09:23:47 2006	{N OF HOME OFFICE EQUIP - A Q3}
ownrent	2875	Thu Mar 30 09:23:47 2006	{OCCUPIED BY OWNER OR RENTER - R Q1}
ownrntot	2875	Thu Mar 30 09:23:47 2006	{OWN OR RENT: OTHER - R Q1}
payht	2875	Thu Mar 30 09:23:47 2006	{PAY FOR SYSTEM - R Q1a}
payhtot	2875	Thu Mar 30 09:23:47 2006	{PAY BILL: OTHER - R Q1a}
pca	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM PERSONAL COMPUTER- A Q4}
pcacat	2875	Thu Mar 30 09:23:47 2006	{AGE OF PRIM PERSONAL COMPUTER- A Q4}
pcflbath	2875	Thu Mar 30 09:23:47 2006	{PERCENT OF CFLS - BATHROOMS}
pcflbed	2875	Thu Mar 30 09:23:47 2006	{PERCENT OF CFLS - BEDROOMS}
pcflclst	2875	Thu Mar 30 09:23:47 2006	{PERCENT OF CFLS - CLOSETS}

```
pcflfam   2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - FAMILY ROOM}
pcflhall  2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - HALLS}
pcflhof2  2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - HOME OFFICE}
pcflhoff  2875  Thu Mar 30 09:23:47 2006 {NUMBER OF CFLS IN HOME OFFICE -
CLEAN
pcflindr  2875  Thu Mar 30 09:23:47 2006 {Number of CFLs Indoors}
pcflktch  2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - KITCHEN}
pcflliv   2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - LIVING ROOM}
pcfloth1  2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - OTHER RESP 1}
pcfloth2  2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - OTHER RESP 2}
pcflutil  2875  Thu Mar 30 09:23:47 2006 {PERCENT OF CFLS - UTILITY ROOM}
pcn       2875  Thu Mar 30 09:23:47 2006 {N OF PERSONAL COMPUTERS - A Q3}
pcncat    2875  Thu Mar 30 09:23:47 2006 {N OF PERSONAL COMPUTERS - A Q3}
pct       2875  Fri Apr 28 12:34:57 2006
pctdp     2875  Fri Apr 28 12:34:57 2006
pctstm    2875  Fri Apr 28 12:34:57 2006
pctstrmw  2875  Thu Mar 30 09:23:47 2006 {PCNT OF WINDOWS THAT ARE STORM - C
Q4
phone     2875  Thu Mar 30 09:23:47 2006 {BEST PHONE NUMBER - D Q8}
pltyp     2875  Thu Mar 30 09:23:47 2006 {SWIMMING POOL FUEL - A Q1}
poolage   2875  Thu Mar 30 09:23:47 2006 {SWIMMING POOL AGE  - A Q2}
prihtsys  2875  Thu Mar 30 09:23:47 2006 {PRIMARY HEATING SYSTEM - H Q2}
ps_dwl    2875  Thu Mar 30 09:23:47 2006 {PSE: DWELLING TYPE}
ps_egi    2875  Thu Mar 30 09:23:47 2006 {PSE: ELECTRIC GAS INDICATOR}
pscounty  2875  Thu Mar 30 09:23:47 2006 {PSE: RESIDENCE COUNTY}
refra     2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM REFRIGERATOR - A Q4}
refracat  2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM REFRIGERATOR - A Q4}
refrn     2875  Thu Mar 30 09:23:47 2006 {N OF REFRIGERATORS INSTALLED - A Q3}
refrncat  2875  Thu Mar 30 09:23:47 2006 {N OF REFRIGERATORS INSTALLED - A Q3}
relwt     2875  Thu Mar 30 09:23:47 2006 {RELATIVE WEIGHT}
repair    2875  Thu Mar 30 09:23:47 2006 {HEATING SYSTEM MAINT SINCE 2003 - H
Q
resp1_a   2875  Thu Mar 30 09:23:47 2006 {1 IF IN FINAL SAMPLE}
rmacact   2875  Thu Mar 30 09:23:47 2006 {N OF ROOM AC INSTALLED - A Q3}
rmacnact  2875  Thu Mar 30 09:23:47 2006 {N OF ROOM ACs INSTALLED - A Q3}
roomaca   2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM ROOM AIR CONDITIONER - A
roomacn   2875  Thu Mar 30 09:23:47 2006 {N OF ROOM AC INSTALLED - A Q3}
roomsq    2875  Thu Mar 30 09:23:47 2006 {ROOMS PER SQUARE FOOTAGE}
sampleid  2875  Thu Mar 30 09:23:47 2006 {SAMPLE ID}
scanid    2875  Thu Mar 30 09:23:47 2006 {SCAN ID}
sddb      2875  Fri Apr 28 12:34:57 2006 SummerDesign Dry Bulb
sfe       2875  Fri Apr 28 12:34:56 2006
showerhd  2875  Thu Mar 30 09:23:47 2006 {WHEN LOWFLOW SHOWER HD INSTALLED - C
sodr      2875  Fri Apr 28 12:34:57 2006 Daily Range
sphtage   2875  Thu Mar 30 09:23:47 2006 {HOT TUB AGE  - A Q2}
sphtf     2875  Thu Mar 30 09:23:47 2006 {HOT TUB FUEL - A Q1}
sqftact   2875  Thu Mar 30 09:23:47 2006 {SQUARE FOOTAGE OF HOME - R Q6}
sqftc     2875  Fri Apr 28 12:34:56 2006
sqftcat   2875  Thu Mar 30 09:23:47 2006 {SQUARE FOOTAGE OF HOME - R Q6}
stereoa   2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM HOME STEREO SYSTEM- A Q4
stereon   2875  Thu Mar 30 09:23:47 2006 {N OF HOME STEREO SYSTEM - A Q3}
sternct   2875  Thu Mar 30 09:23:47 2006 {N OF HOME STEREO SYSTEM - A Q3}
streoact  2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM HOME STEREO SYSTEM- A Q4
sumths    2875  Fri Apr 28 12:34:56 2006
swinds    2875  Fri Apr 28 12:34:57 2006
tva       2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM TELEVISION - A Q4}
tvacat    2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM TELEVISION - A Q4}
tvn       2875  Thu Mar 30 09:23:47 2006 {N OF TELEVISIONS - A Q3}
tvncat    2875  Thu Mar 30 09:23:47 2006 {N OF TELEVISIONS - A Q3}
units     2875  Thu Mar 30 09:23:47 2006 {N UNITS IN BLDG - R Q4a}
vcrdvact  2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM VCR OR DVD PLAYER- A Q4}
vcrdvda   2875  Thu Mar 30 09:23:47 2006 {AGE OF PRIM VCR OR DVD PLAYER- A Q4}
vcrdvdn   2875  Thu Mar 30 09:23:47 2006 {N OF VCR OR DVD PLAYER - A Q3}
vcrdvnct  2875  Thu Mar 30 09:23:47 2006 {N OF VCR OR DVD PLAYER - A Q3}
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w99t       2875  Fri Apr 28 12:34:57 2006 Winter Desing Dry Bulb
wallins    2875  Thu Mar 30 09:23:47 2006 {WHEN WALL INSULATION INSTALLED- C Q1
weight     2875  Thu Mar 30 09:23:47 2006 {CASE WEIGHT}
whage      2875  Thu Mar 30 09:23:47 2006 {WATER HTR AGE - W Q4}
whfuel     2875  Thu Mar 30 09:23:47 2006 {WATER HTR FUEL TYPE - W Q3}
whfuelot   2875  Thu Mar 30 09:23:47 2006 {WATER HTR FUEL: OTHER - W Q3}
whloc      2875  Thu Mar 30 09:23:47 2006 {WATER HTR LOCATION - W Q5}
whlocot    2875  Thu Mar 30 09:23:47 2006 {WATER HTR LOCATION: OTHER - W Q5}
whnone     2875  Thu Mar 30 09:23:47 2006 {WATER HTR ITEMS - W Q6}
whpwrap    2875  Thu Mar 30 09:23:47 2006 {WATER HTR ITEMS - W Q6}
whrepl     2875  Thu Mar 30 09:23:47 2006 {PRI WATER HEATER - W Q4b}
whrepl03   2875  Thu Mar 30 09:23:47 2006 {WATER HTR REPLACED IN 2003 - W Q4a}
whrepot    2875  Thu Mar 30 09:23:47 2006 {WATER HTR REPLACED: OTHER - W Q4b}
whsysnum   2875  Thu Mar 30 09:23:47 2006 {N OF WATER HTRS - W Q2}
whsystyp   2875  Thu Mar 30 09:23:47 2006 {WATER HTR SERVICE TYPE - W Q1}
whtimer    2875  Thu Mar 30 09:23:47 2006 {WATER HTR ITEMS - W Q6}
whwrap     2875  Thu Mar 30 09:23:47 2006 {WATER HTR ITEMS - W Q6}
win        2875  Fri Apr 28 12:34:57 2006
winths     2875  Fri Apr 28 12:34:57 2006
yrresnum   2875  Thu Mar 30 09:23:47 2006 {NUMBER OF YEARS IN RESIDENCE}
yrs_res    2875  Thu Mar 30 09:23:47 2006 {YEARS LIVED IN RESIDENCE}
zip        2875  Thu Mar 30 09:23:47 2006 {PSE: RESIDENCE ZIP}

---- Matrices ----
bhr         2, 1  Fri Apr 28 12:34:57 2006
save file[jad]

write file[jad.dat] var[sodr sddb w99t \
n_hdd{1-12} n_cdd{1-12} hdd{1-36} cdd{1-36} \
sumths nhsldmem \
hinwall insat1 nrooms floors sfe lwinds mwinds swinds \
nlwind nmwind nswind winths case_num] # fmt[114(e15.8,5x)]

print var[sodr sddb w99t \
n_hdd{1-12} n_cdd{1-12} hdd{1-36} cdd{1-36} \
sumths nhsldmem \
hinwall insat1 nrooms floors sfe lwinds mwinds swinds \
nlwind nmwind nswind winths case_num] obs[1,5]

  Obsno          sodr             sddb             w99t
     1:      18.20000          84.90000          28.40000
     5:      18.20000          84.90000          28.40000

  Obsno        n_hdd1           n_hdd2           n_hdd3
     1:       7.53000e+002     7.52000e+002     6.18000e+002
     5:       7.53000e+002     7.52000e+002     6.18000e+002

  Obsno        n_hdd4           n_hdd5           n_hdd6
     1:       5.94000e+002     4.48000e+002     2.85000e+002
     5:       5.94000e+002     4.48000e+002     2.85000e+002

  Obsno        n_hdd7           n_hdd8           n_hdd9
     1:       1.44000e+002     48.00000          40.00000
     5:       1.44000e+002     48.00000          40.00000

  Obsno       n_hdd10          n_hdd11          n_hdd12
     1:       1.35000e+002     3.64000e+002     5.75000e+002
     5:       1.35000e+002     3.64000e+002     5.75000e+002

  Obsno        n_cdd1           n_cdd2           n_cdd3
     1:       0.00000          0.00000          0.00000
     5:       0.00000          0.00000          0.00000
  Obsno        n_cdd4           n_cdd5           n_cdd6
     1:       0.00000          0.00000          4.00000
```

Obsno	n_cdd7	n_cdd8	n_cdd9
1:	10.00000	56.00000	77.00000
5:	10.00000	56.00000	77.00000

Obsno	n_cdd10	n_cdd11	n_cdd12
1:	27.00000	0.00000	0.00000
5:	27.00000	0.00000	0.00000

Obsno	hdd1	hdd2	hdd3
1:	7.06300e+002	6.88900e+002	6.19200e+002
5:	7.15200e+002	7.07700e+002	6.41400e+002

Obsno	hdd4	hdd5	hdd6
1:	5.30600e+002	3.37300e+002	2.42900e+002
5:	5.45200e+002	3.90200e+002	3.00300e+002

Obsno	hdd7	hdd8	hdd9
1:	1.14600e+002	70.20000	1.73000e+002
5:	1.91950e+002	85.30000	1.89400e+002

Obsno	hdd10	hdd11	hdd12
1:	4.44300e+002	5.48200e+002	7.24400e+002
5:	4.53100e+002	5.24200e+002	7.24800e+002

Obsno	hdd13	hdd14	hdd15
1:	7.37400e+002	6.50400e+002	7.28900e+002
5:	7.37800e+002	6.36900e+002	7.44100e+002

Obsno	hdd16	hdd17	hdd18
1:	5.08400e+002	3.91800e+002	1.57925e+002
5:	5.29200e+002	4.45100e+002	2.01775e+002

Obsno	hdd19	hdd20	hdd21
1:	73.20000	71.20000	1.48600e+002
5:	1.38800e+002	1.15500e+002	2.18350e+002

Obsno	hdd22	hdd23	hdd24
1:	4.29100e+002	5.45600e+002	6.78400e+002
5:	4.90500e+002	5.54800e+002	6.99300e+002

Obsno	hdd25	hdd26	hdd27
1:	6.02300e+002	6.51000e+002	5.80800e+002
5:	6.19650e+002	6.71100e+002	6.06400e+002

Obsno	hdd28	hdd29	hdd30
1:	5.04300e+002	3.41600e+002	1.30500e+002
5:	5.30700e+002	3.91500e+002	1.72500e+002

Obsno	hdd31	hdd32	hdd33
1:	29.00000	29.90000	1.23700e+002
5:	77.20000	72.50000	1.56700e+002

Obsno	hdd34	hdd35	hdd36
1:	3.32700e+002	6.73800e+002	7.15200e+002
5:	3.62100e+002	7.17200e+002	7.37300e+002

Obsno	cdd1	cdd2	cdd3
1:	0.00000	0.00000	0.00000
5:	0.00000	0.00000	0.00000

Obsno	cdd4	cdd5	cdd6
1:	0.00000	8.10000	3.40000
5:	0.00000	4.00000	

```
      5:       0.00000           1.00000           0.00000

   Obsno          cdd7              cdd8              cdd9
      1:      12.20000          30.50000           0.40000
      5:       0.00000          14.50000           0.20000

   Obsno         cdd10             cdd11             cdd12
      1:       0.00000           0.00000           0.00000
      5:       0.00000           0.00000           0.00000

   Obsno         cdd13             cdd14             cdd15
      1:       0.00000           0.00000           0.00000
      5:       0.00000           0.00000           0.00000

   Obsno         cdd16             cdd17             cdd18
      1:       0.00000           0.00000          24.30000
      5:       0.00000           0.00000           8.40000

   Obsno         cdd19             cdd20             cdd21
      1:      54.00000          52.30000           4.80000
      5:      16.40000          24.30000           0.00000

   Obsno         cdd22             cdd23             cdd24
      1:       0.00000           0.00000           0.00000
      5:       0.00000           0.00000           0.00000

   Obsno         cdd25             cdd26             cdd27
      1:       0.00000           0.00000           0.00000
      5:       0.00000           0.00000           0.00000

   Obsno         cdd28             cdd29             cdd30
      1:       0.00000           0.10000          62.80000
      5:       0.00000           0.00000          25.90000

   Obsno         cdd31             cdd32             cdd33
      1:      93.10000          44.30000          30.70000
      5:      42.50000           6.20000          14.80000

   Obsno         cdd34             cdd35             cdd36
      1:       0.00000           0.00000           0.00000
      5:       0.00000           0.00000           0.00000

   Obsno        sumths          nhsldmem          hinwall
      1:      75.00000           2.00000           0.00000
      5:      75.00000           2.00000           0.00000

   Obsno         insat1            nrooms            floors
      1:       0.00000           8.00000           1.00000
      5:      12.00000           6.00000           2.00000

   Obsno            sfe             lwinds            mwinds
      1:       1.29000e+003      0.00000          11.00000
      5:       3.22000e+002      0.00000          15.00000

   Obsno         swinds            nlwind            nmwind
      1:       0.00000           0.00000          11.00000
      5:       0.00000           0.00000          15.00000

   Obsno         nswind            winths          case_num
      1:       0.00000          70.00000          11.00000
      5:       0.00000          70.00000          55.00000
quit mem
Memory release complete
```

Appendix C

winavg.log

```
SST Spool File:  winavg.log

load file [winavg] dbase

reg dep[wind] ind[(1) sqft]

********* ORDINARY LEAST SQUARES ESTIMATION *********

Dependent Variable:      wind

Independent        Estimated             Standard               t-
 Variable         Coefficient             Error               Statistic

      (1)           8.13629              3.23307               2.51658
     sqft           3.98637e-003         1.75880e-003          2.26653


Number of Observations                    7
R-squared                                 0.50677
Corrected R-squared                       0.40812
Sum of Squared Residuals                 83.70891
Standard Error of the Regression          4.09167
Durbin-Watson Statistic                   1.85635
Mean of Dependent Variable               14.57143

reg dep[wind] ind[(1) sqft room flr]


********* ORDINARY LEAST SQUARES ESTIMATION *********

Dependent Variable:      wind

Independent        Estimated             Standard               t-
 Variable         Coefficient             Error               Statistic

      (1)           1.21906              4.86290               0.25068
     sqft           1.69202e-003         2.60635e-003          0.64919
     room           0.31186              1.33321               0.23392
      flr           5.90656              3.50477               1.68529


Number of Observations                    7
R-squared                                 0.81702
Corrected R-squared                       0.63405
Sum of Squared Residuals                 31.05369
Standard Error of the Regression          3.21733
Durbin-Watson Statistic                   1.22536
Mean of Dependent Variable               14.57143

reg dep[wind] ind[(1) room]


********* ORDINARY LEAST SQUARES ESTIMATION *********

Dependent Variable:      wind

Independent        Estimated             Standard               t-
 Variable         Coefficient             Error               Statistic

      (1)           1.27143              4.67083               0.27221
     room           1.90000              0.63987               2.96937
```

Number of Observations	7
R-squared	0.63813
Corrected R-squared	0.56576
Sum of Squared Residuals	61.41429
Standard Error of the Regression	3.50469
Durbin-Watson Statistic	1.95704
Mean of Dependent Variable	14.57143

reg dep[wind] ind[(1) flr]

********* ORDINARY LEAST SQUARES ESTIMATION *********

Dependent Variable: wind

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
(1)	2.66667	3.67575	0.72548
flr	8.33333	2.43128	3.42755

Number of Observations	7
R-squared	0.70146
Corrected R-squared	0.64175
Sum of Squared Residuals	50.66667
Standard Error of the Regression	3.18329
Durbin-Watson Statistic	0.66228
Mean of Dependent Variable	14.57143

reg dep[wind] ind[(1) flr sqft]

********* ORDINARY LEAST SQUARES ESTIMATION *********

Dependent Variable: wind

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
(1)	1.94235	3.27990	0.59220
flr	6.38493	2.48734	2.56697
sqft	2.17294e-003	1.39988e-003	1.55223

Number of Observations	7
R-squared	0.81369
Corrected R-squared	0.72053
Sum of Squared Residuals	31.62008
Standard Error of the Regression	2.81159
Durbin-Watson Statistic	1.23718
Mean of Dependent Variable	14.57143

quit

county2.log

```
SST Spool File:  county2.log
Tue Apr 25 12:45:59 2006

load file[county2.dbf] dbase
recode var[*] map[-999=md]

label var   [co_indx]   lab   [county index]
label var   [n_hdd1 ]   lab   [Jan normal heating day]
label var   [n_hdd2 ]   lab   [Feb normal heating day]
label var   [n_hdd3 ]   lab   [Mar normal heating day]
label var   [n_hdd4 ]   lab   [Apr normal heating day]
label var   [n_hdd5 ]   lab   [May normal heating day]
label var   [n_hdd6 ]   lab   [Jun normal heating day]
label var   [n_hdd7 ]   lab   [Jul normal heating day]
label var   [n_hdd8 ]   lab   [Aug normal heating day]
label var   [n_hdd9 ]   lab   [Sep normal heating day]
label var   [n_hdd10]   lab   [Oct normal heating day]
label var   [n_hdd11]   lab   [Nov normal heating day]
label var   [n_hdd12]   lab   [Dec normal heating day]
label var   [n_cdd1 ]   lab   [Jan normal cooling days]
label var   [n_cdd2 ]   lab   [Feb normal cooling days]
label var   [n_cdd3 ]   lab   [Mar normal cooling days]
label var   [n_cdd4 ]   lab   [Apr normal cooling days]
label var   [n_cdd5 ]   lab   [May normal cooling days]
label var   [n_cdd6 ]   lab   [Jun normal cooling days]
label var   [n_cdd7 ]   lab   [Jul normal cooling days]
label var   [n_cdd8 ]   lab   [Aug normal cooling days]
label var   [n_cdd9 ]   lab   [Sep normal cooling days]
label var   [n_cdd10]   lab   [Oct normal cooling days]
label var   [n_cdd11]   lab   [Nov normal cooling days]
label var   [n_cdd12]   lab   [Dec normal cooling days]
label var   [co_indx]   val   [15 island 16 jefferso 17 king 18 kitsap \
19 kittitas 21 lewis 27 pierce 29 skagit 31 snohomis 34 thurston 37 whatcom]

freq var[co_indx]

co_indx    county index
11 valid observations

               island    jefferso        king      kitsap    kittitas
                   15          16          17          18          19
             ----------  ----------  ----------  ----------  ----------
Count                1           1           1           1           1
Percent           9.09        9.09        9.09        9.09        9.09


                 lewis      pierce      skagit    snohomis    thurston
                    21          27          29          31          34
             ----------  ----------  ----------  ----------  ----------
Count                1           1           1           1           1
Percent           9.09        9.09        9.09        9.09        9.09


               whatcom
                    37
             ----------
Count                1
Percent           9.09


save file[county2.sav]
```

```
quit mem
Memory release complete
```

county3.log

```
SST Spool File:  county3.log
Tue Apr 25 12:46:03 2006

load file[county3] dbase # 2003 HDD/CDD for Washington Counties in RASFINAL

list
---- Variables ----
cdd1         11  Tue Apr 25 12:46:03 2006
cdd10        11  Tue Apr 25 12:46:03 2006
cdd11        11  Tue Apr 25 12:46:03 2006
cdd12        11  Tue Apr 25 12:46:03 2006
cdd2         11  Tue Apr 25 12:46:03 2006
cdd3         11  Tue Apr 25 12:46:03 2006
cdd4         11  Tue Apr 25 12:46:03 2006
cdd5         11  Tue Apr 25 12:46:03 2006
cdd6         11  Tue Apr 25 12:46:03 2006
cdd7         11  Tue Apr 25 12:46:03 2006
cdd8         11  Tue Apr 25 12:46:03 2006
cdd9         11  Tue Apr 25 12:46:03 2006
co_indx      11  Tue Apr 25 12:46:03 2006
hdd1         11  Tue Apr 25 12:46:03 2006
hdd10        11  Tue Apr 25 12:46:03 2006
hdd11        11  Tue Apr 25 12:46:03 2006
hdd12        11  Tue Apr 25 12:46:03 2006
hdd2         11  Tue Apr 25 12:46:03 2006
hdd3         11  Tue Apr 25 12:46:03 2006
hdd4         11  Tue Apr 25 12:46:03 2006
hdd5         11  Tue Apr 25 12:46:03 2006
hdd6         11  Tue Apr 25 12:46:03 2006
hdd7         11  Tue Apr 25 12:46:03 2006
hdd8         11  Tue Apr 25 12:46:03 2006
hdd9         11  Tue Apr 25 12:46:03 2006


foreach(j ; {1-12} ) {
rename var[hdd${j} cdd${j}] to[hdd3_${j} cdd3_${j}]
}

list
---- Variables ----
cdd3_1       11  Tue Apr 25 12:46:03 2006
cdd3_10      11  Tue Apr 25 12:46:03 2006
cdd3_11      11  Tue Apr 25 12:46:03 2006
cdd3_12      11  Tue Apr 25 12:46:03 2006
cdd3_2       11  Tue Apr 25 12:46:03 2006
cdd3_3       11  Tue Apr 25 12:46:03 2006
cdd3_4       11  Tue Apr 25 12:46:03 2006
cdd3_5       11  Tue Apr 25 12:46:03 2006
cdd3_6       11  Tue Apr 25 12:46:03 2006
cdd3_7       11  Tue Apr 25 12:46:03 2006
cdd3_8       11  Tue Apr 25 12:46:03 2006
cdd3_9       11  Tue Apr 25 12:46:03 2006
co_indx      11  Tue Apr 25 12:46:03 2006
hdd3_1       11  Tue Apr 25 12:46:03 2006
hdd3_10      11  Tue Apr 25 12:46:03 2006
hdd3_11      11  Tue Apr 25 12:46:03 2006
hdd3_12      11  Tue Apr 25 12:46:03 2006
hdd3_2       11  Tue Apr 25 12:46:03 2006
hdd3_3       11  Tue Apr 25 12:46:03 2006
hdd3_4       11  Tue Apr 25 12:46:03 2006
hdd3_5       11  Tue Apr 25 12:46:03 2006
hdd3_6       11  Tue Apr 25 12:46:03 2006
```

```
hdd3_7      11  Tue Apr 25 12:46:03 2006
hdd3_8      11  Tue Apr 25 12:46:03 2006
hdd3_9      11  Tue Apr 25 12:46:03 2006

save file[county3]

quit mem
Memory release complete
```

weather.log

```
SST Spool File:  weather.log
Tue Apr 25 12:46:24 2006

load file [weather.dbf] dbase

label var   [co_indx  ] lab   [County Index Number]
label var   [sodr     ] lab   [Daily Range]
label var   [sddr     ] lab   [SummerDesign Dry Bulb ]
label var   [w99t     ] lab   [Winter Desing Dry Bulb]

save file[weather.sav]

quit mem
Memory release complete
```

Appendix D

Appendix E

Thermal Model

```
#include "stdio.h"
#include "stdlib.h"

void main(argc, argv)
int argc;
char **argv;
{
int     i;
float   w0g,w0i,w1,w2,s0,s1,s2,copg,copo,cophp,copac,sheatp,sheatd,sheatn;
float   shuce,shucg,shuco,shude,shudg,shudo,shupe,shupg,shupo,shuchp;
float   dshuce,dshucg,dshuco,dshude,dshudg,dshudo,acheat;
float   dshupe,dshupg,dshupo,dshuchp,shuec,dshuec,acuec,dacuec;
float   hdda,cdda;

int     N, j, y, k;

float   dtp[3];
float   hdd[36], n_hdd[12]; /* Assumes three years of heating degree day data
*/
float   cdd[36], n_cdd[12]; /* Assumes three years of cooling degree day data
*/
float   hse[14];
float   sumths;
float   winths;
float   **X;
float   xlamc_out, xlamh_out;
float   case_num;
float   shuec_out[36];

FILE *fpin;
FILE *fpout;
extern FILE *fopen();

/* NUMBER OF DAYS IN EACH CALANDER MONTH */
static  float   xdays[] = { 31.,28.,31.,30.,31.,
                            30.,31.,31.,30.,31.,30.,31. };

if (argc != 4) {
      printf("Usage: thermal N file_name_in file_name_out\n");
      exit(1);
}

N = atoi( argv[1] );

if((fpin = fopen(argv[2],"r"))==NULL) {
      printf("unable to open input file %s\n",argv[2]);
      exit(1);
      }

if((fpout = fopen(argv[3],"w"))==NULL) {
      printf("unable to open output file %s\n",argv[3]);
      exit(1);
      }


X = (float **)calloc( 114, sizeof(float *) );
if (X == NULL) {printf("could not allocate array X\n"); exit(1);}

for ( j = 0; j < 114; j++ ) {
      X[j] = (float *)calloc(N, sizeof(float));
      if( X[j] == NULL ) {printf("could not allocate array X[%d] of size
%d\n", j, N); exit(1);}
```

```
      }

for(i = 0; i < N; i++) {
      for(j = 0; j < 114; j++)
            {
            if (fscanf(fpin,"%f",&(X[j][i])) != 1) {
                  printf("Error: reading observation %d\n",i+1);
                  exit(1);
                  }
            }
      }

for( i = 0; i < N; i++ ) {

      for(j = 0; j< 3; j++)  dtp[j]   = X[ 0+j][i];
      for(j = 0; j<12; j++)  n_hdd[j] = X[ 3+j][i];   /* normal monthly hdd */

      for(j = 0; j<12; j++)  n_cdd[j] = X[ 15+j][i];  /* normal monthly cdd */
      for(j = 0; j<36; j++)  hdd[j]   = X[ 27+j][i];  /* 2001-2003 monthly hdd
*/
      for(j = 0; j<36; j++)  cdd[j]   = X[ 63+j][i];  /* 2001-2003 monthly cdd
*/
      for(j = 0; j<14; j++)  hse[j]   = X[ 99+j][i];
    case_num = X[113][i];


/* PASADENA, CALIFORNIA */
/*static  float   dtp[] = { 29.,95.,32. };
static  float   hdd[] = { 418.,332.,342.,241.,141.,48.,2.,
                          2.,13.,77.,241.,385. };
static  float   cdd[] = { 2.,2.,4.,7.,27.,89.,
                  218.,228.,165.,55.,9.,2. };

/* TEST CASE #1  1510 ONTARIO AVE.
static  float   hse[] = { 75.,2.,0.,4.,3.,1.,
                  1650.,4.,10.,1.,0.,0.,0.,70. };*/

sumths = *(hse);
winths = *(hse+13);

/* Design Conditions */
building(n_hdd,n_cdd,hse,dtp,&w0g,&w0i,&w1,&w2,&s0,&s1,&s2,
         &copg,&copo,&cophp,&copac,&sheatp,&sheatd,&sheatn,
         &acheat,&hdda,&cdda);

for (y=0; y<3; y++) {
      for (j=0; j<12; ++j) {
      k = y*12 + j;
    therm(sumths,winths,w0g,w0i,w1,w2,s0,s1,s2,*(hdd+k),

*(cdd+k),*(xdays+j),&shuec,&dshuec,&acuec,&dacuec,&xlamc_out,&xlamh_out);
      shuec_out[k] = shuec;

    /*hvac(shuec,dshuec,&acuec,&dacuec,copg,copo,
         cophp,copac,sheatp,sheatd,sheatn,
         &shuce,&shucg,&shuco,&shude,&shudg,&shudo,
         &shupe,&shupg,&shupo,&shuchp,
         &dshuce,&dshucg,&dshuco,&dshude,&dshudg,&dshudo,
         &dshupe,&dshupg,&dshupo,&dshuchp);*/
      }
}

fprintf(fpout,"%4d %8.0f %15.8f", i+1, case_num, xlamh_out);
for (y=0; y<3; y++) {
```

```
      for (j=0; j<12; ++j) {
      k = y*12 + j;
    fprintf(fpout," %15.8f", shuec_out[k]);
      }
}

fprintf(fpout,"\n");
}
fclose(fpin);
fclose(fpout);
}

building(hdd,cdd,hse,dtp,w0g,w0i,w1,w2,s0,s1,s2,
         copg,copo,cophp,copac,sheatp,sheatd,sheatn,
         acheat,hdda,cdda)

float   *hdd,*cdd,*hse,*dtp,*hdda,*cdda;
float   *w0g,*w0i,*w1,*w2,*s0,*s1,*s2,*acheat;
float   *copg,*copo,*cophp,*copac,*sheatp,*sheatd,*sheatn;
{

extern  float   min1(),max1();
extern  double  pow(),exp();
int     i;

float   sflwinds,sfmwinds,sfswinds,sflstrm,sfmstrm,sfsstrm;
float   sfwi,sfstrm,sfnstrm,sflnstrm,sfceil,sfwall,beta,b,vol,reg,duct;
float   pipe,rinsceil,rinswall,sdtempd,wdtempd,reswall,resceilw,ueff1;
float   ueff2,zglass,zglasrw,infil1,infil2,intern;
float   radhlf,radelf,tight;

float   sodr=dtp[0];      /*summer outdoor daily temp range     */
float   sddb=dtp[1];      /*summer design temperature           */
float   w99t=dtp[2];      /*winter design temperature           */

float   sumths=  hse[ 0]; /*summer thermostat setting           */
float   nhsldmem=hse[ 1]; /*total number of residents           */
float   hinwall= hse[ 2]; /*have ext wall insul                 */
float   insat1=  hse[ 3]; /*inches of attic insul.              */
float   nrooms=  hse[ 4]; /*number of rooms in living space     */
float   floors=  hse[ 5]; /*total number of floors              */
float   sfe=     hse[ 6]; /*square feet of dwelling             */
float   lwinds=  hse[ 7]; /*number of large windows             */
float   mwinds=  hse[ 8]; /*number of medium windows            */
float   swinds=  hse[ 9]; /*number of small windows             */
float   nlwind=  hse[10]; /*number large storm win              */
float   nmwind=  hse[11]; /*number medium storm win             */
float   nswind=  hse[12]; /*number small storm win              */
float   winths=  hse[13]; /*winter thermostat setting           */

/*annual heating and cooling degree days*/

*hdda = *cdda =0.;
for (i=0; i<12; ++i)
        {
        *hdda += *(hdd+i);
        *cdda += *(cdd+i);
        }

/*transformations and redefinitions */

insat1 = min1( 17., max1( 0., insat1 ) );      /*inches attic insulation*/
sflwinds=45.*lwinds;
sfmwinds=25.*mwinds;
```

```
sfswinds=8. *swinds;
sflstrm= 45.*nlwind;
sfmstrm= 25.*nmwind;
sfsstrm= 8.*nswind;
sfwi=sflwinds+sfmwinds+sfswinds;
sfstrm=sflstrm+sfmstrm+sfsstrm;
sfnstrm =max1( 0., (sfwi-sfstrm) );
sflnstrm=max1( 0., (sflwinds-sflstrm) );

/*ceiling and wall square feet from regressions on typical houses*/

sfceil=.96*pow((double) floors,-.815)*pow((double) sfe,1.006); /*sf ceiling*/
sfceil=min1(10000.,max1(100.,sfceil)); /*square feet ceiling*/
sfwall=19.1*pow( (double) floors,.92)*pow( (double) sfe,.57);
sfwall=min1(4000.,max1(320.,sfwall));
beta=(sfwi/sfwall);
b=max1(.03,min1(.7,beta));
sfwi=b*sfwall;           /*number of square feet of all windows*/
sfwall *=(1.-b);         /*sf wall excluding windows*/
b=max1(beta/b,1.);
sflstrm  /=b;   /*square feet of large storm windows,doors*/
sflnstrm /=b;   /*square feet of large non-storm windows*/
sfstrm   /=b;   /*square feet of stormed windows*/
sfnstrm  /=b;   /*square feet of non-stormed windows*/

/*cubic feet*/

vol=8.94*pow((double) floors,.8)*pow((double) sfceil,.98);
vol=min1(90000.,max1(800.,vol));              /*volume in cubic feet      */

/*pipe, duct, and chimney*/

reg=2.55+1.07*nrooms+.003*sfe;                /*number registers          */
duct=3.89*reg+.067*sfe;                       /*lf duct                   */
pipe=0.142* pow( (double) sfe,1.03);          /*lf pipe                   */

/*insulation r-values*/

rinsceil=max1(.85,3.*insat1);                        /* ceiling insulation r-
value */
/* rinswall=max1(.94,(1.+.001* *hdda)*hinwall);*/    /* wall insulation r-
value    */
rinswall=max1(.94,19*hinwall);                                    /* wall
insulation r-value    */

tight=1;

sdtempd=sddb-sumths;
wdtempd=winths-w99t;

/*resistences*/

reswall=(2.85+rinswall)/(.9394+.0138*rinswall);
resceilw=3.834+.943*rinsceil;
ueff1=(0.3769+0.00636*rinsceil)/(2.097+0.608*rinsceil);
ueff2=(0.17389+0.00293*rinsceil)/(2.097+0.608*rinsceil);
zglass=((sflstrm/1.32)+(sflnstrm/.88));
zglasrw=(sfstrm-sflstrm)/2.78+(sfnstrm-sflnstrm)/.98;
infil1=tight*(1.14-.28*(sfstrm)/sfwi);
infil2=.00833*infil1;
infil1=.575*infil1;
intern= 3083 + 318.0 * nhsldmem; /* sensible heat gain Anderson (1973) */

/*heat loss and gain coefficients*/
```

```
*w0g=sfceil*(3.88 -0.0299*w99t);
*w0i = - intern;
*w1=(sfwall/reswall)+(sfceil/resceilw)+zglasrw
    +zglass+.018*vol*infil1;
*w2=.018*vol*infil2;

*s0=(sfwall/reswall)*(26.27+0.3196*sodr);
*s0 +=  sfceil*ueff1*(25.35+0.2820*sodr);
*s0= ( *s0 + intern + 30*(sfwi-sflstrm) + 27*sflstrm )*1.25;
*s1=1.0050*(sfwall/reswall) + sfceil*ueff1*0.9958 + sfceil*ueff2;
*s1 = ( *s1 +  0.8*(sfwi-sflstrm) + 0.6*sflstrm + 0.007423*vol )*1.25;
*s2=0.00015*vol*1.25;

/*design capacities*/

*sheatn=(*w0g+wdtempd*(*w1+wdtempd* *w2))/1000.;
*sheatp= *sheatn+.01128*pipe;
*sheatd= *sheatn+.0249*duct;
*acheat=(*s0+sdtempd*(*s1+sdtempd* *s2))/1000.;

/* cooling uec calculation */
*s0 = (sfwall/reswall)*(362.1-0.9638*sodr)/24;
*s0 +=  sfceil*ueff1*(355.6- 1.032*sodr)/24;
*s0 = (*s0  +  intern + 30*(sfwi-sflstrm) + 27*sflstrm)*1.25;
*s1 = 22.67*(sfwall/reswall)/24 + sfceil*ueff1*22.66/24 + sfceil*ueff2/24;
*s1 = (*s1 + 0.8*(sfwi-sflstrm)+0.6*sflstrm+0.007423*vol)*1.25;
*s2 = 0.00015*vol*1.25;

/* necessary size of distribution system */

radhlf= *sheatn / .645;
radelf= *sheatn / .6394;

 /*seasonal heating efficiencies*/

*copg=.46+.0146* *hdda/365.;
*copo=.404+.013* *hdda/365.;
*cophp=1.94 + 1040.25/ *hdda + 350.4/ *cdda;
*cophp +=  - .000126* *hdda - .000222* *cdda;
*copac= 3.44 + 271.56/ *hdda + 448.95/ *cdda;
*copac +=  - .0000986* *hdda - .0001041* *cdda;

}

therm(sumths,winths,w0g,w0i,w1,w2,s0,s1,s2,hdd,cdd,
        xdays,shuec,dshuec,acuec,dacuec,xlamc_out,xlamh_out)
float   sumths,winths;
float   w0g,w0i,w1,w2,s0,s1,s2,hdd,cdd,xdays;
float   *shuec,*dshuec,*acuec,*dacuec;
float   *xlamc_out, *xlamh_out;
{

extern  double  sqrt(), exp();
extern  float   max1(), min1();
float   xlamc,s0a,s1a,s2a,xlamh,w0a,w1a,w2a,apar,bpar,w0;
float   xxlamh,ph,xxlamc,pc,tmean,xd;
float   toler=1.e-4;
int     hmeth,cmeth;

/* calculate summer thermal coeffiecients */

xlamc=sqrt( (double) (1.-4.*s2*min1(s0,0.)/(s1*s1)) );
xlamc=s1*(1.-xlamc)/(2.*s2);
```

```
*xlamc_out = xlamc;
s0a=max1(s0,0.);
s1a= (s1 + 2.*s2*(-1.0*xlamc))*(-1.0);
s2a=s2;

/*calculate heating uec.  first a balance inside-outside temperature */
/*differential  lam  is calculated.  this quantity is independent of */
/*the thermostat setting.  then w1 and w0 coeffieients are redefined */
/*so heat gives the average of  q  over the temperature distribution */
/*up to the balance temperature.  note that the energy cost of a one */
/*degree thermostat increase is simple to compute because balance    */
/*temperature rises one degree, balance differential is unchanged.   */

/*calculate winter thermal coeffiecients                             */
/*do not include heat loss to ground                                 */

w0 = w0i;
xlamh=sqrt( (double) (1.-4.*w2*min1( w0 ,0.)/(w1*w1)) );
xlamh=w1*(1.-xlamh)/(2.*w2);
*xlamh_out = xlamh;
w0a=max1( w0 ,0.);
w1a= (w1 + 2.*w2*(-1.0*xlamh));
w2a=w2;

hdd /=xdays;
cdd /=xdays;

/* choose calculation mode; 1-normal 0-mean  */

hmeth=cmeth=1;

if ((hdd!=0.0) && (cdd!=0.0))   /*  estimate temperature distribution */
        {
        coef(hdd,cdd,&apar,&bpar);
        /*  check estimated temperature distribution through bpar */
        if (bpar != 1.0)           /* calculate xlamh,xlamc,ph,pc */
                {
                /* heating */
                xxlamh=apar+bpar*( winths + xlamh);
                ph=1.0/(1.0+exp( (double) -xxlamh));
                if ( (ph <= toler) || ( (1.0 - ph) <= toler ) ) hmeth=0;
                /* cooling */
                xxlamc=apar+bpar*( sumths - xlamc);
                pc=1.0/(1.0+exp( (double) -xxlamc));
                if ((pc <= toler ) || ( (1.0 - pc ) <= toler ) ) cmeth=0;
                }
        }
else    {
        hmeth=cmeth=0;
        }

/* calculate mean temperature */

if (hdd<cdd) { tmean=65.+cdd; } else { tmean=65.-hdd; }
if ( (hmeth) || (cmeth) ) tmean= - apar/bpar;

/* go to correct method */

if (hmeth && cmeth)
        {
        heat1(xxlamh,w0a,w1a,w2a,bpar,shuec,dshuec);
        acc1(xxlamc,s0a,s1a,s2a,apar,bpar,sumths,acuec,dacuec);
        }
else    if (hmeth && !(cmeth))
```

```
        {
        heat1(xxlamh,w0a,w1a,w2a,bpar,shuec,dshuec);
        acc2(cdd,acuec,dacuec);
        }
else    if (!(hmeth) && cmeth)
        {
        heat2(w0,w1,w2,winths,tmean,shuec,dshuec);
        acc1(xxlamc,s0a,s1a,s2a,apar,bpar,sumths,acuec,dacuec);
        }
else    {
        heat2(w0,w1,w2,winths,tmean,shuec,dshuec);
        acc2(cdd,acuec,dacuec);
        }

xd=xdays*24.0/1000.;
*shuec  *= xd;
*dshuec *= xd;
*acuec  *= xd;
*dacuec *= xd;
}

coef(h65,c65,a,b)
float   h65,c65,*a,*b;
{
float btop,bbot,g;
int     i;
extern  double  log(),exp();

btop=1.;
bbot=0.;
*b=1.;
for (i=1; i<=30; ++i)
        {
        g=1. - exp( (double) - *b * h65) - exp( (double) - *b * c65);
        if ( (g==0.) || ((btop-bbot)<.0001) ) break;
        if (g<0.) {bbot= *b;} else {btop= *b;}
        *b = (btop+bbot)/2.;
        }
*b = (btop+bbot)/2.;
*a = *b * (h65-65.)+log( (double) (1.-exp( (double) - *b * h65 )) );
return;
}

float   gamma(rrr)
float   rrr;
{
float   temp1,temp2,ggg;
extern  float   max1();
extern  double  exp();

temp1=max1(0.,rrr);
temp2=exp( (double) -temp1);
ggg=temp2*.00643169  *(exp( (double) 5.*rrr)-1.);
ggg=temp2*(-.03401569*(exp( (double) 4.*rrr)-1.)+ggg);
ggg=temp2*(.09649159 *(exp( (double) 3.*rrr)-1.)+ggg);
ggg=temp2*(-.24595448*(exp( (double) 2.*rrr)-1.)+ggg);
ggg=temp2*(.99949556 *(exp( (double)    rrr)-1.)+ggg);
ggg=(temp1*temp1/2.)+.82246703+ggg;
return(ggg);
}


float   heat(rrr1,c0,c1,c2,bpar)
float   rrr1,c0,c1,c2,bpar;
```

```
{
extern  double  exp(),log();
extern  float   gamma();
float   hhh;

hhh =  c0/(1.0+exp( (double) -rrr1));
hhh += c1*(log( (double) 1.0+exp( (double) rrr1)))/bpar;
hhh += 2.0*c2*gamma(rrr1)/(bpar*bpar);
return(hhh);
}


heat1(xxlamh,w0a,w1a,w2a,bpar,shuec,dshuec)
float   xxlamh,w0a,w1a,w2a,bpar,*shuec,*dshuec;
{
extern  float   heat();
*shuec  = heat(xxlamh,w0a,w1a,w2a,bpar);
xxlamh  +=bpar;
*dshuec = heat(xxlamh,w0a,w1a,w2a,bpar) - *shuec;
return;
}

heat2(w0,w1,w2,winths,tmean,shuec,dshuec)
float   *shuec,*dshuec,w0,w1,w2,winths,tmean;
{
extern  float   max1();
*shuec  = max1((w0 + w1*( winths-tmean) +
          w2*(winths-tmean)*(winths-tmean)),0.0);
*dshuec = max1((w0 + w1*(winths+1.-tmean) +
          w2*(winths+1.-tmean)*(winths+1.-tmean)),0.0) - *shuec;
return;
}

acc1(xxlamc,s0a,s1a,s2a,apar,bpar,sumths,acuec,dacuec)
float   xxlamc,s0a,s1a,s2a,apar,bpar,sumths,*acuec,*dacuec;
{
extern  double  pow();
*acuec =  s0a+s1a*( sumths - (-1.*apar/bpar))+
          s2a* pow( sumths - (- apar/bpar) , 2. );
*acuec += s2a*(3.289868)/(bpar*bpar) - heat(xxlamc,s0a,s1a,s2a,bpar);
xxlamc += -bpar;
*dacuec = s0a+s1a*( sumths -1. - (-1.*apar/bpar))+
          s2a* pow( sumths -1. - (-1.*apar/bpar),2.);
*dacuec += s2a*(3.289868)/(bpar*bpar) - heat(xxlamc,s0a,s1a,s2a,bpar)
           - *acuec;
return;
}

acc2(cdd,acuec,dacuec)
float   *acuec, *dacuec, cdd;
{
if (cdd==0.0) {*acuec=0.0;}  else { *acuec= -99.;}
*dacuec=0.;
return;
}

hvac(shuec,dshuec,acuec,dacuec,copg,copo,cophp,copac,sheatp,sheatd,sheatn,
     shuce,shucg,shuco,shude,shudg,shudo,shupe,shupg,shupo,shuchp,
     dshuce,dshucg,dshuco,dshude,dshudg,dshudo,dshupe,dshupg,dshupo,dshuchp)

float   shuec,dshuec,*acuec,*dacuec,copg,copo,cophp,copac,sheatp;
float   sheatd,sheatn;
float   *shuce,*shucg,*shuco,*shude,*shudg,*shudo,*shupe;
float   *shupg,*shupo,*shuchp;
```

```
float   *dshuce,*dshucg,*dshuco,*dshude,*dshudg,*dshudo,*dshupe;
float   *dshupg,*dshupo,*dshuchp;

{
*shuce=shuec;
*shucg=shuec/copg;
*shuco=shuec/copo;

*shude= *shuce * sheatd/sheatn;
*shudg= *shucg * sheatd/sheatn;
*shudo= *shuco * sheatd/sheatn;

*shupe = *shuce * sheatp/sheatn;
*shupg = *shucg * sheatp/sheatn;
*shupo = *shuco * sheatp/sheatn;

*shuchp=(shuec/cophp);
*acuec /= copac;

*dshuce=dshuec;
*dshucg=dshuec/copg;
*dshuco=dshuec/copo;

*dshude = *dshuce * sheatd/sheatn;
*dshudg = *dshucg * sheatd/sheatn;
*dshudo = *dshuco * sheatd/sheatn;

*dshupe = *dshuce * sheatp/sheatn;
*dshupg = *dshucg * sheatp/sheatn;
*dshupo = *dshuco * sheatp/sheatn;

*dshuchp=dshuec/cophp;
*dacuec /= copac;
}

float   min1(x,y)
float   x,y;
{
return(x>=y ? y : x);
}

float   max1(x,y)
float   x,y;
{
return(x>=y ? x : y);
}

output121(fp,i,j,xlamc_out, xlamh_out,
                sheatp,sheatd,sheatn,acheat,
                shuce,shucg,shuco,shude,shudg,shudo,
                  shupe,shupg,shupo,dshuce,dshucg,
                  dshuco,dshude,dshudg,dshudo,dshupe,dshupg,dshupo,
                  shuchp,dshuchp,acuec,dacuec)
FILE    *fp;
int     i,j;
float   xlamc_out, xlamh_out;
float   sheatp,sheatd,sheatn,acheat;
float   shuce,shucg,shuco,shude,shudg,shudo,shupe,shupg,shupo;
float   dshuce,dshucg,dshuco,dshude,dshudg,dshudo;
float   dshupe,dshupg,dshupo;
float   shuchp,dshuchp,acuec,dacuec;
{
/* CASE NUMBER, MONTH NUMBER,
BALANCE TEMP Cool, Heat,
```

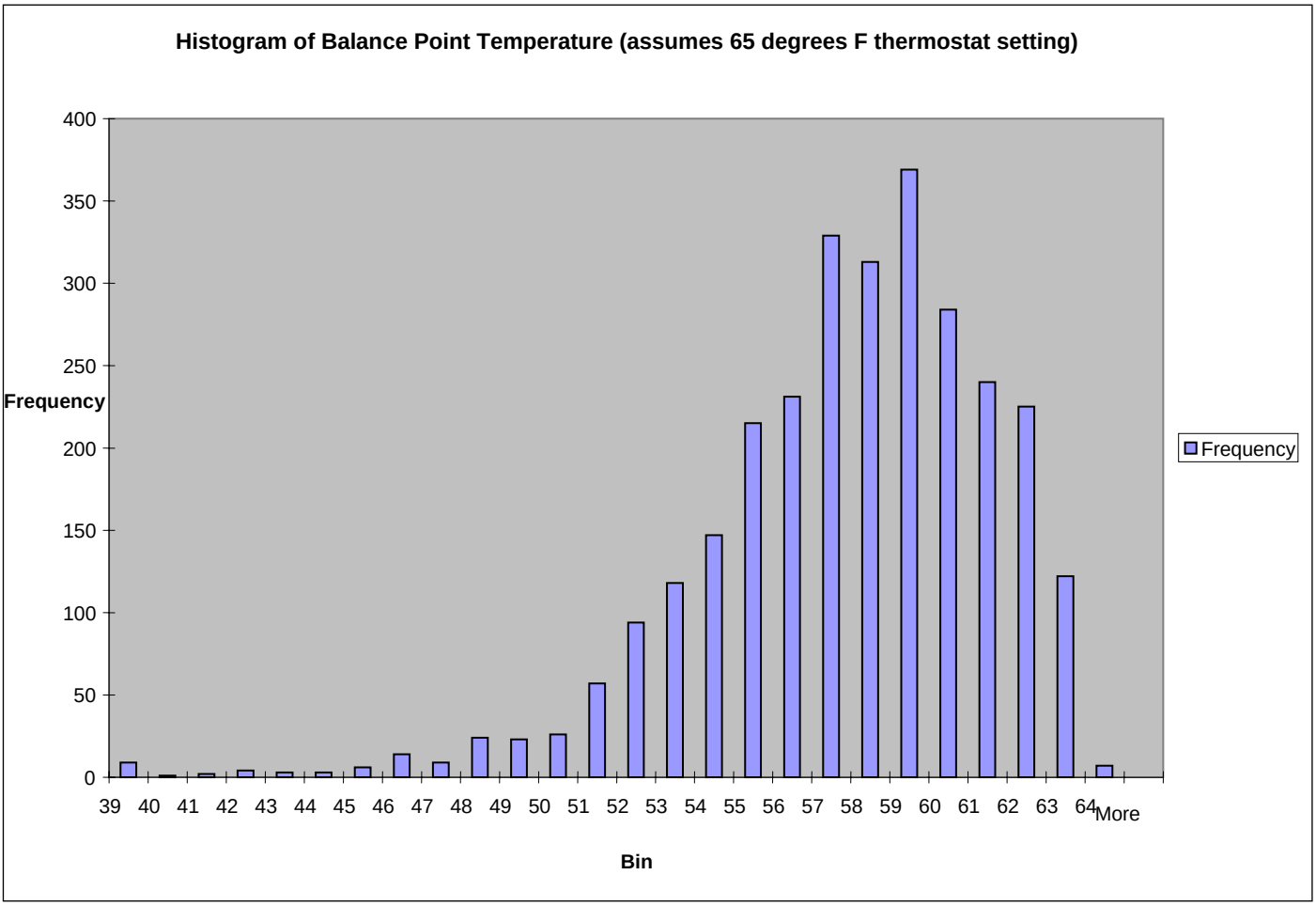
```
CAPACITY UTILIZATION non-central duct, duct, hot-water, air-cond (BTUS's Hour)
NON-CENTRAL SYSTEMS elec, gas, oil,
CENTRAL DUCT SYSTEMS elec, gas, oil,
HOT-WATER DELIVARY elec, gas, oil,
HEAT-PUMP SYSTEM,
AIR-CONDITIONING */

fprintf(fp,"%4d %4d %15.8f %15.8f ", i+1,j+1,xlamc_out,xlamh_out);

fprintf(fp,"%15.8f %15.8f %15.8f %15.8f \
            %15.8f %15.8f %15.8f %15.8f %15.8f %15.8f \
            %15.8f %15.8f %15.8f %15.8f %15.8f %15.8f \
            %15.8f %15.8f %15.8f %15.8f %15.8f %15.8f \
            %15.8f %15.8f %15.8f %15.8f",
            sheatn,sheatd,sheatp,acheat,
            shuce,dshuce,shucg,dshucg,shuco,dshuco,
            shude,dshude,shudg,dshudg,shudo,dshudo,
            shupe,dshupe,shupg,dshupg,shupo,dshupo,
            shuchp,dshuchp,acuec,dacuec);

fprintf(fp,"\n");
}
```

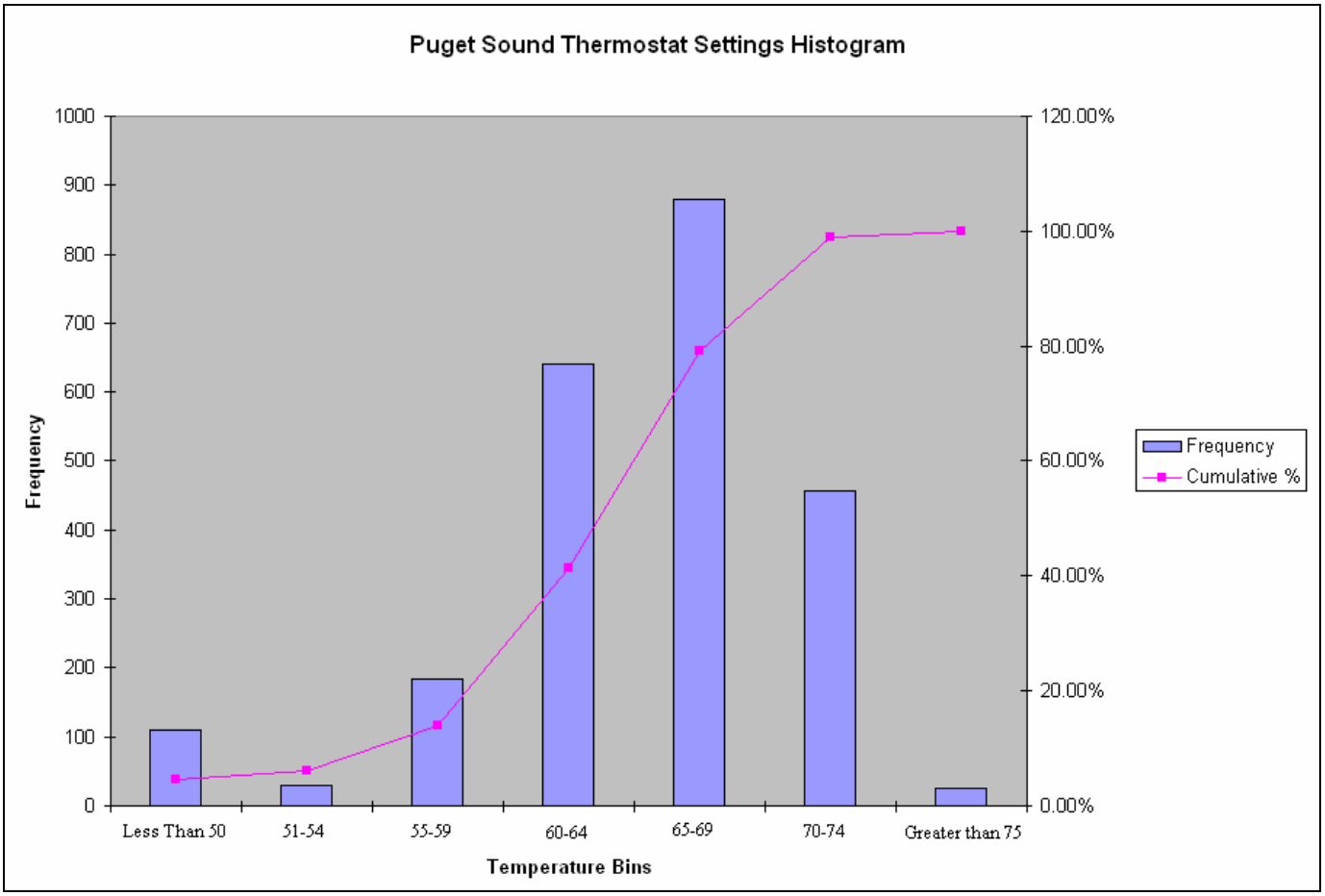
Appendix F

Reg.log

```
SST Spool File:  reg.log


read to[case case_num xlamh shuce{1-36}] file[jad.out]

cova var[xlamh]

Variable:    xlamh

Mean                    -8.11150      Standard deviation
3.80298
Minimum                -39.75851      Skewness                -
1.35748
Maximum                 -1.64159      Kurtosis
7.35549
Valid observations       2875


save file[reg.sav] var[case case_num shuce{1-36} xlamh]
save file[reg.dbf] var[case case_num shuce{1-36} xlamh] dbase

match file[jad] key[case_num] var[weight]
calc sum(xlamh*weight)/sum(weight)
     -7.86989

quit
```

Histogram


Histogram of Balance Point Temperature (assumes 65 degrees F thermostat setting)
Frequency
400
350
300
250
200
150
100
50
0
39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 More
Bin
Frequency


Puget Sound Thermostat Settings Histogram
Frequency
1000
900
800
700
600
500
400
300
200
100
0
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Less Than 50
51-54
55-59
60-64
65-69
70-74
Greater than 75
Temperature Bins
Frequency
Cumulative %