Report 2: Analysis of Damper and Furnace Effects

1. Objective of the report

   Wisconsin Power and Light studied the effectiveness of two devices for improving the efficiency of gas home-heating systems. The electric vent damper (EVD) reduces heat loss through the chimney when the furnace is in its off cycle by closing off the vent. It is controlled electrically. The thermally activated vent damper (TVD) is the same as the EVD except it is controlled by the thermal properties of a set of bimetal fins set in the vent. Ninety test houses were used, 40 with EVDs and 50 with TVDs. For each house, energy consumption was measured for a period of several weeks with the vent damper active and for a period with the damper not active. This should help show how effective the vent damper is in each house.

   Both overall weather conditions and the size of a house can greatly affect energy consumption. A simple formula was used to try to adjust for this. Average energy consumed by the house during one period was recorded as (consumption)/[(weather)(house area)], where consumption is total energy consumption for the period, measured in BTU's, weather is measured in number of degree days, and house area is measured in square feet. In addition, various characteristics of the house, chimney, and furnace were recorded for each house. A few observations were missing and recorded as .

   Your report should answer the following questions:

   (a) Is either damper effective? Effectivity is measured by energy consumption; less consumption means more effective. You may use BTUIN-BTUOUT (Change from Baseline) to measure this.

   (b) Is there a difference in effectivity between the two types of dampers? Do any differences depend on type of house? (For instance, you might conclude that ranch houses should have one type of damper while two story houses should have another type of damper. Do any differences depend on chimney area, shape, height, or liner ?

   (c) Is there a difference in energy consumption between the three types of furnaces? Do any differences depend on type of house, chimney area, shape, height, or liner ?

   (d) Does adjusting for age of house affect the analyses? In what way?

2. Suggested Outline

   I. Introduction (Statement of problem, brief description of data)
   II. Methods (Description of statistical methodology)
   III. Results
   IV. Conclusions

3. Aim for 5-15 double-spaced pages. DO NOT submit SAS printouts. You may cut-and-paste portions of the printout into displayed tables and equations.

4. Your report will be evaluated according to

   (a) readability (30%)
      i. did you clearly state your conclusions?
      ii. did you clearly state your justifications?
      iii. did you clearly describe your statistical methods?
      iv. did you make good use of tables and figures?

   (b) strength of conclusions (30%)
      i. did you arrive at reasonable conclusions? (Some decisions are necessarily judgement calls - in these cases the justification is as important as the decision itself.)
      ii. did you miss any important findings?

   (c) statistical correctness (30%)
      i. did you use appropriate tools and models?
      ii. are you interpreting SAS output correctly?

   (d) overall look (neatness, organization, professionalism) (10%)

****

```
Variable                        Description
 1 TYPE           Type of furnace:
                         1 = forced air
                         2 = gravity
                         3 = forced water


 2 CH.AREA        Chimney area


 3 CH.SHAPE       Chimney shape:
                         1 = round
                         2 = square
                         3 = rectangular


 4 CH.HT          Chimney height (in feet)


 5 CH.LINER       Type of Chimney liner:
                         0 = unlined
                         1 = tile
                         2 = metal


 6 HOUSE          Type of house:
                         1 = ranch
                         2 = two-story
```

```
                         3 = tri-level
                         4 = bi-level
                         5 = one and a half stories


   7 AGE            House age in years (99 means 99 or more years)

   8 BTU.IN         Average energy consumption with vent damper in

   9 BTU.OUT        Average energy consumption with vent damper out

  10 DAMPER         Type of damper
                         1 = EVD
                         2 = TVD


-----------------------------------------------------------------
The Data. The following is also posted as a .txt file at
http://www.stat.wmich.edu/naranjo/stat6620/furnacedata.txt


1   28  1  20  2  3   8   7.87    8.25  1
2  144  2  26  0  2  75   9.43    9.66  1
1   80  3  30  1  2  44   7.16    8.33  1
2  100  2  24  0  2  75   8.67    8.82  1
3  168  3  35  1  2  30  12.31   12.06  1
3   28  1  17  2  3   4   9.84    9.67  1
1   64  2  24  1  2  45  16.90   17.51  1
1   64  2  18  1  1  16  10.04   10.79  1
3   96  3  25  1  5  45  12.62   13.59  1
3  108  3  27  1  5  40   7.62    7.99  1
1   64  2  16  1  1  22  11.12   12.64  1
2   63  3  30  1  2  40  13.43   14.42  1
1   42  3  15  1  1  13   9.07    9.25  1
1  117  3  25  0  2  99   6.94    7.79  1
1   64  2  18  1  1  19  10.28   11.29  1
1   28  1  17  2  2  30   9.37   10.26  1
2   64  2  28  0  2  60   7.93    9.46  1
1   64  2  19  1  2  30  13.96   14.77  1
1   28  1  26  2  2  10   6.80    7.21  1
1   80  3  27  0  2  60   4.00    4.29  1
1   28  1  14  2  1  24   8.58    9.81  1
1   28  1  23  2  2  70   8.00    8.41  1
1   64  2  17  1  1  12   5.98    6.78  1
3    .  .  30  .  2  60  15.24   16.30  1
1   64  2  27  0  2  40   8.54    9.01  1
1   64  2  19  1  1  17  11.09   11.41  1
1   50  1  18  1  4  15  11.70   12.37  1
```

1	50	1	18	1	1	18	12.71	13.28	1
1	50	1	18	1	1	4	6.78	7.24	1
1	28	1	16	2	1	5	9.82	10.55	1
1	80	3	26	0	2	75	12.91	13.89	1
1	50	1	18	1	1	14	10.35	10.72	1
1	28	1	15	2	1	8	9.60	9.22	1
1	100	2	31	0	2	99	9.58	10.61	1
1	28	1	16	2	1	99	9.83	10.04	1
1	50	1	20	1	1	34	9.52	10.20	1
1	108	3	25	0	2	80	18.26	20.55	1
1	64	2	25	0	2	99	10.64	11.75	1
1	36	2	26	0	2	99	6.62	7.08	1
1	28	1	16	2	4	6	5.20	5.50	1
1	49	2	32	1	2	50	12.28	13.07	2
1	38	1	16	2	1	10	7.23	7.60	2
1	28	1	18	2	3	2	2.97	3.20	2
1	64	2	20	1	2	99	8.81	9.28	2
1	72	3	31	1	2	15	9.27	9.73	2
1	70	3	39	1	2	45	11.29	11.73	2
1	28	1	15	2	1	1	8.29	9.67	2
1	72	3	32	0	2	30	9.96	10.76	2
1	96	3	25	0	2	40	10.30	11.05	2
1	49	2	21	1	2	50	16.06	17.63	2
1	100	2	23	0	5	60	14.24	15.58	2
3	49	2	20	1	1	12	11.43	12.53	2
1	38	1	16	2	1	6	10.28	11.87	2
1	28	1	17	2	1	9	13.60	14.19	2
1	38	1	31	1	2	99	5.94	6.84	2
1	72	3	27	0	2	90	10.36	11.89	2
1	28	1	14	2	1	3	6.85	7.41	2
1	84	3	29	1	2	55	6.72	7.42	2
1	28	1	17	2	1	14	10.21	10.83	2
1	64	2	16	1	1	12	8.61	9.44	2
1	64	2	28	0	2	55	11.62	12.94	2
1	64	2	19	1	1	28	11.21	13.15	2
1	28	1	17	2	1	12	10.95	11.69	2
1	64	2	29	0	2	80	7.62	7.73	2
1	28	1	17	2	1	19	10.40	11.94	2
1	80	3	20	1	1	32	12.92	13.62	2
1	80	3	22	0	1	99	15.12	17.07	2
1	64	2	33	0	2	60	13.47	14.66	2
2	64	2	30	0	2	65	8.47	9.56	2
1	50	1	18	1	4	15	11.70	12.37	2
1	50	1	19	1	2	55	7.73	8.33	2
1	28	1	15	2	4	7	8.37	8.67	2

```
1    50  1  18  1  4  13   7.29  11.27  2
1    50  1  18  1  1  10  10.49  11.67  2
1    50  1  15  1  2   6   8.69   9.37  2
1    50  1  16  1  1   5   8.26   8.93  2
1    28  1  17  2  1   5   7.69   8.41  2
1    28  1  15  2  1   8  12.19  12.85  2
1    28  1  14  2  4   5   5.56   5.27  2
3   144  2  30  1  1  50   9.76  10.02  2
1    28  1  17  2  1  10   7.15   7.87  2
1    49  2  18  2  1  14  12.69  11.82  2
1   100  2  27  1  1  40  13.38  14.42  2
1   144  2  22  0  1  70  13.11  13.69  2
1   144  1  30  0  2  85  10.50  10.77  2
2   100  2  24  0  2  70  14.35  15.26  2
2    96  1  17  0  1  40  13.42  14.53  2
1   100  2  20  1  2  99   6.35   6.84  2
1   100  2  20  1  1  14   9.83  10.92  2
1    28  1  28  1  2  55  12.16  13.05  2
****************************************************************************
```