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Witness: Dennis Patterson
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Case No.: GR-2001-292
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MISSOURI PUBLIC SERVICE COMMISSION

UTILITY OPERATIONS DIVISION

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Missouri Public
Service Commission

DIRECT TESTIMONY

OF

DENNIS PATTERSON

MISSOURI GAS ENERGY
A DIVISION OF SOUTHERN UNION COMPANY

CASE NO. GR-2001-292

Jefferson City, Missouri
April, 2001

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Q. Please state your name and business address.

A. My name is Dennis Patterson and my business address is Missouri Public Service Commission, P. O. Box 360, Jefferson City, Missouri, 65102.

Q. What is your present position with the Missouri Public Service Commission (Commission)?

A. I am a Regulatory Economist in the Electric Department of the Utility Operations Division.

Q. Please review your educational background and work experience.

A. I was trained as an officer and aviator in the U.S. Army. I studied economics, math, sciences and languages, receiving a B.A. in Latin American Studies (University of Missouri, 1983) and an M.S. in Agricultural Economics (University of Missouri, 1989). I joined the Staff of the Commission in April, 1986. I established the Staff's centralized weather database, and have continued to maintain and improve it by employing data and methods from reliable sources. I have been employed by the Commission, the Missouri Army National Guard, the University of Missouri, U.S. Army Reserves, and the U.S. Army.

SUMMARY

Q. Please summarize the issues, position, method, process and products that you describe in your written direct testimony.

A. The relevant issue in my direct testimony is the weather variables used for weather normalization of test year natural gas sales for Missouri Gas Energy (MGE) in this rate case, Case No. GR-2001-292.

Temperatures from Kansas City International Airport (KCI) were used to perform weather normalization for the Company's Kansas City and St. Joseph geographical regions. Temperatures from Springfield (SGF) were used to perform the weather normalization for the Company's Joplin geographical. (The official three-letter identifier for Kansas City International Airport is MCI; SGF is now called Springfield-Branson Regional Airport).

In order to perform weather normalization, actual and normal daily heating degree-days (HDD) were tabulated for KCI and for SGF. The time periods of interest were all days in the official normals period (1961-1990), as well as the days relevant to the test year (the period of approximately 13 months that ended in January, 2001). Weather from the days in the period between the normals period and the test year was also tabulated, in order to verify that the normals and actuals were consistent. To ensure that all time periods were addressed, weather data were tabulated for all days between January 1, 1961 and January 15, 2001.

The fundamental weather elements in this analysis are daily maximum temperature and daily minimum temperature. The mean daily temperature is then

defined as the average of the daily maximum and daily minimum temperatures. Finally, daily HDD are calculated as the positive difference between a day's mean temperature and the reference temperature of 65 degrees Fahrenheit (F), and are set to zero if the mean daily temperature is above 65 F. The final data set therefore includes an observation of each day's daily maximum temperature, daily minimum temperature, mean daily temperature and daily HDD for every day in the time periods mentioned above. The daily temperature observations dating from January 1, 1961 through December 31, 1990 were adjusted so that resulting daily temperatures and HDD correspond with published temperature normals from the National Oceanic and Atmospheric Administration (NOAA). The final HDD normals products are based on temperatures for KCI and SGF that contain these adjustments. I furnished these normals products to Staff witnesses Jim Gray and Dan Beck.

Q. Are the methods you applied in this case consistent with those used in previous cases?

A. Yes. The Commission accepted this methodology in the Report and Order for the Missouri Gas Energy rate case, Case No. GR-96-285. I developed the methodology in 1992, well in advance of the 1996 report and order. The Staff has continued to apply it consistently since 1994 for weather normalization in electric, natural gas and water rate cases. A detailed and documented description of the method for gas cases may be found in my direct testimony for the MGE rate case, Case No. GR-98-140.

Q. In the present case, does your analysis of historical daily temperatures with respect to NOAA normals in the present case differ from your analyses in the MGE rate cases, GR-98-140 and GR-96-245?

A. No. The results of this part of my analysis were the same in the present case as they were in these prior rate cases.

Q. Have you performed additional analysis in the present case?

A. Yes. I performed crosschecks to insure that test year daily temperatures were consistent with the normal daily temperatures. This was necessary because Automated Surface Observing System (ASOS) thermometers were commissioned at KCI and SGF in 1995. The results of these crosschecks indicated that the effects of ASOS upon temperature measurements are not statistically significant.

Q. What were the final products that you provided to the witnesses?

A. First, I provided actual daily HDD for every day from January 1, 1999 through January 15, 2001. Second, I provided daily normal HDD for every calendar day of the normal year, from January 1 through December 31, to include February 29. Finally, I provided ranked normal HDD for the average coldest day, the average second coldest day, and so on through the average warmest day of the normal year.

Q. What are the contents of your written direct testimony?

A. I have organized my written direct testimony in the following sections:

I. THE DEFINITION OF NORMAL WEATHER.
II. CONSISTENT WEATHER MEASURES.
III. THE CALCULATION OF DAILY NORMAL HEATING DEGREE-DAYS.
IV. FINAL PRODUCTS.

THE DEFINITION OF NORMAL WEATHER

Q. What are weather normals?

A. Normals have been defined as the arithmetic mean of a climatological element computed over a long time period. (See Climatography of the United States No. 81 Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1961-90, MISSOURI, NOAA, National Climatic Data Center, Asheville, North Carolina) (Monthly Normals). NOAA applies this concept to temperature by calculating thirty-year normal temperatures as monthly average maximum and monthly average minimum temperatures.

Q. What period is used by NOAA in its calculations of its thirty-year temperature normals?

A. NOAA uses the three most recent consecutive decades, which are currently the thirty years ending December 31, 1990. International agreements among members of the World Meteorological Organization, and its predecessor, the International Meteorological Committee, have established that three-decade periods are appropriately long and uniform periods for the calculation of normals. NOAA recalculates thirty-year normals at the end of each decade as a way of dealing with changes in measurement conditions and changes in the climate itself. The 1961-1990 normals were published in early 1992, and it is expected that the 1971-2000 normals will be published in early 2002.

Q. Has the Missouri Public Service Commission (Commission) made any findings with respect to the use of NOAA's thirty-year normal?

A. Yes. The use of the NOAA 30-year normal and 30-year normals period complies with a provision of the Commission's Report and Order in the Missouri Gas Energy rate case, Case No. GR-96-285. At page 18, the Commission's Report and Order states:

> The Commission finds that NOAA's 30-year normals is the more appropriate benchmark . . . In addition, the data upon which Staff's recommendation is based has gone through the processes established by NOAA to ensure the best data possible.

CONSISTENT WEATHER MEASURES

Q. What types of weather stations are maintained at KCI and SGF?

A. Both KCI and SGF have first-order weather stations. A first-order weather station is usually located at a regional or municipal airport, where the temperature instruments are continuously monitored by professional observers. The instruments record hourly observations of temperature and other weather elements. In contrast, cooperative weather stations are usually manned by trained volunteers who record daily maximum and minimum temperatures and other weather elements.

Q. How does NOAA calculate normals for first-order weather stations?

A. When normal monthly temperatures are calculated for first-order stations and selected cooperative stations, NOAA climatologists take special measures to insure that all the years of monthly average maximum and minimum temperatures in the calculations are consistent with the current temperature measurement conditions. To achieve this consistency, NOAA makes adjustments to the historical monthly temperatures for the effects of changes in observation practice, changes in instrument type, and changes in instrument location.

Q. How are monthly temperature normals related to daily temperatures?

A. For first-order and cooperative stations, the original daily temperatures are first subjected to quality checks. When the quality checks are complete, the daily temperatures are deemed official and printed in monthly publications. When the daily temperatures are published, monthly average daily maximum and average daily minimum temperatures are published with them. NOAA eventually calculates normal monthly temperatures from the monthly averages of daily temperature observations, after making adjustments for changes in measurement conditions.

Q. Did the data series for KCI and SGF include any inconsistencies?

A. Yes. At both stations, the weather instruments have been moved and instrument types have been changed in several instances since 1961. These events are documented for KCI in 1999 LOCAL CLIMATOLOGICAL DATA ANNUAL SUMMARY WITH COMPARATIVE DATA, INTERNATIONAL AIRPORT, KANSAS CITY, MISSOURI (MCI), Asheville, North Carolina: National Climatic Data Center, 151 Patton Avenue, Rm 120, Asheville NC 28801-5001 (Annual Summary). They are documented for SGF in the Annual Summary for Springfield, Missouri (SGF).

Q. How does NOAA calculate adjustments for such inconsistencies?

A. According to documentation published with the normals, these adjustments were calculated with reference to monthly average temperatures at surrounding stations where no exposure changes took place for a sufficient length of time before and after the dates of the exposure changes at the weather station in question.

Q. Does NOAA publish the adjustments they have calculated for the inconsistencies?

A. No, not directly. Instead, NOAA publishes adjusted monthly average temperatures for KCI and SGF in the computer tape deck, TD-9641: 1961-90 SEQUENTIAL TEMPERATURE AND PRECIPITATION, Asheville, North Carolina: National Climatic Data Center, NOAA/NESDIS/NCDC, Federal Building, 37 Battery Park Avenue, Asheville, NC, 28801-2733. The adjustment process is described in an undated narrative that was supplied with the tape deck. I will refer to these 360 observations of adjusted monthly temperature as the "NOAA sequentials" for KCI and SGF.

Q. Do published NOAA normals for KCI and SGF contain adjustments from the corresponding NOAA sequentials?

A. Yes. NOAA's 12 monthly normal temperatures for KCI and SGF are each calculated as the average of the thirty adjusted observations for that month from the NOAA sequentials for the corresponding weather station.

Q. Has NOAA calculated adjustments for all of the inconsistencies that occurred between 1961 and 1990?

A. No, they have not. Some documented changes in temperature measurement conditions did not have significant effects. For example, the HO-83 hygrothermometer was commissioned at KCI in October of 1984, and at SGF in July of 1985. No adjustments were applied for these events.

Q. Which changes were documented for KCI and SGF?

A. For KCI, it appeared that NOAA calculated adjustments for a move from the downtown airport to KCI in 1972, and for a move from one location to another at KCI

in 1979. For SGF, it appeared that NOAA calculated adjustments for instrument moves in 1963 and 1988.

Q. Have instrument moves or type changes occurred at KCI since the 1961-1990 normals were published?

A. Yes. According to the Annual Summary cited above, one more exposure change occurred. The Automated Surface Observing System (ASOS) instrumentation was installed in a new location at KCI on an undocumented date, and commissioned officially in July of 1995.

Q. Have instrument moves or type changes occurred at SGF since the 1961-1990 normals were published?

A. Yes. According to the Annual Summary cited above, two more exposure changes have occurred. First, the SGF weather site was moved from the former Municipal Airport to the Regional Airport on an undocumented date, and commissioned officially at the new location in 1994. Second, the automated ASOS instrumentation was installed at the Regional Airport on an undocumented date, and commissioned officially in November, 1995.

Q. Has NOAA calculated adjustments for the exposure change that occurred in 1994 at SGF, and those that occurred in 1995 at both KCI and SGF?

A. No. NOAA will not address these potential inconsistencies at either station until the 1971-2000 normals are published.

Q. Will the movement of the SGF weather site in 1994 have significant effects on the calculations of normal for SGF?

A. No. I did not use temperatures from this time period in my analysis.

Q. Will the instrument type change from the former HO-83 thermometers to ASOS in 1995 have a significant effect on the calculation of normals at either KCI or SGF?

A. Crosschecks indicated that the effects would be small at both KCI and SGF (-30 HDD and +10 HDD respectively), which were well within the 95% confidence intervals about the respective mean annual HDD ($\pm$ 139 HDD at KCI and $\pm$ 122 HDD at SGF). The details of these crosscheck calculations have been included in my working papers.

CALCULATION OF DAILY NORMAL HEATING DEGREE-DAYS

Q. Do the NOAA monthly HDD normals for a given station contain sufficient detail for weather normalizing gas usage?

A. No, they do not. Monthly normals don't provide enough detail. Daily HDD normals are needed in order to accurately match normal weather to the billing cycle sales data for accurate calculation of test year normalized sales. In addition, an HDD normal for the coldest day of the year is also needed to calculate peak day demands. NOAA does not ordinarily provide such a normals product.

Q. Doesn't NOAA calculate daily HDD normals for a given weather station that are consistent with the adjusted monthly HDD normals at that station?

A. Yes. Unfortunately, NOAA's daily normal HDD are calculated from a smooth curve that has been fitted to the monthly HDD normals, by a mathematical splining process that does not regain the lost information about the distribution of extreme days. Although NOAA's daily HDD normals are appropriate for their stated

purpose of averaging normal climatic values over intervals of time, they are not appropriate for the purposes of normalizing test year sales.

Q. Is it possible to calculate daily HDD normals that include information about the distribution of extreme daily HDD?

A. Yes. However, if daily HDD normals are to include the desired information about the distribution of days with extreme HDD, then the daily normals must be calculated from properly adjusted actual daily temperature data that correspond with the NOAA normal temperatures.

Q. How is this correspondence insured?

A. Before daily HDD normals that are consistent with NOAA's monthly normals can be calculated, it is first necessary to calculate properly adjusted daily temperature data for the NOAA normals period. Fortunately, it is possible to calculate the necessary adjustments by referring to the NOAA monthly sequentials for the 1961-1990 normals period. Thus, even though the thirty years of adjusted monthly temperature averages from the NOAA sequentials don't provide the required information about days with extreme temperatures, they do serve a necessary and crucial function as a benchmark for making the daily temperature data consistent over the NOAA normals period.

Q. What information did you use to calculate adjusted daily temperatures at KCI and SGF for the thirty-year NOAA normals period?

A.For each of these weather stations, I used two NOAA data sets to make these calculations. First, I consulted the NOAA sequentials (above). This data set has 30 entries for each of the 12 calendar months, or 360 entries. As stated above, the average

of these 30 adjusted values for each of the 12 months constitute NOAA's 30-year normals. These 360 entries provide the benchmarks for adjusting actual daily temperatures in these months.

Second, I obtained official daily temperature data for the same 30-year time period from NOAA Internet sources such as the Midwest Climate Information Service and the National Climatic Data Center. The daily temperatures may also be compiled from other official NOAA data products and publications. The resulting data set has entries of actual maximum and minimum temperature for each day since January 1, 1961. In this data set, there are a total of 10,957 entries over the 360 months in the 1961-1990 normals period. These are the actual daily temperatures that must be adjusted.

Q. How did you use the monthly sequentials make the adjustments to actual daily temperatures?

A. First, I calculated monthly averages of the actual daily temperatures that had to be adjusted. This provided 360 monthly averages for both actual daily maximum temperature and actual daily minimum temperature, one for each of the twelve months in each of the thirty years.

Second, I calculated temperature adjustments for each month of each of the thirty years. This was done by subtracting each of the 360 monthly averages of actual daily maximum temperature and actual daily minimum temperature that were just calculated, from the corresponding maximum and minimum temperature in the monthly sequentials described above.

Finally, I applied the maximum temperature adjustments and minimum temperature adjustments, just calculated for each of the 360 months in the thirty years, by

adding them to the daily actual maximum temperature and daily actual minimum temperature in the month. These calculations yielded 10,957 adjusted daily observations of maximum and minimum temperature, for the 360 months in the years 1961 through 1990.

Q. How did you crosscheck your results to make sure that the adjusted daily temperatures corresponded to NOAA's normals?

A. For this crosscheck, I first took the monthly averages of the daily maximum and minimum temperatures that were just adjusted. I then verified that the 360 monthly averages of the adjusted daily temperatures were equal to the 360 benchmarks, which are the monthly sequential temperatures that were used by NOAA to calculate its 30-year temperature normals for KCI and SGF. I also verified that the twelve 30-year monthly averages of the adjusted daily temperatures were equal to NOAA's 12 monthly normal temperatures for KCI and SGF. The crosschecks were successful in this case, confirming that the adjusted daily HDD normals products that I supplied to Mr. Gray and Mr. Beck did correspond with the NOAA temperature normals.

FINAL PRODUCTS

Q. What were the final products that you provided to Mr. Gray and Mr. Beck?

A. The final products that I provided were actual daily HDD for the test year, and two calculations of normal daily HDD that corresponded to the calendar months and days of the test year. The normal daily HDD were calculated from the adjusted daily

temperatures that were described above for the years 1961 through 1990. I provided one set of these products for KCI, and one set for SGF.

Q. What were the two daily normals products that you provided to the witnesses?

A. The first normals product was a set of daily normal HDD for each month and day of the test year. These could be used to calculate the number of normal HDD for each billing cycle of a billing month. These daily normals were based on adjusted daily temperatures that had the same monthly averages as the 1961-1990 monthly sequentials from which the NOAA HDD normals were estimated. In crosschecks, it was determined that the monthly sums of these daily HDD normals corresponded closely to NOAA's monthly HDD normal, and that their annual sum corresponded exactly to NOAA's annual normal HDD for the weather station in question. This product is presented at Schedule 1 for KCI, and at Schedule 2 for SGF.

The second normals product was ranked daily normal HDD, which included the normal peak day HDD that would correspond to the coldest day of the test year. These could be used to analyze peak day gas usage. The first rank HDD value of the ranked daily HDD normals was calculated as the average daily HDD of thirty occurrences of the coldest day each year, over the thirty heating years that began with July 1, 1961 and ended with June 30, 1991. The second rank HDD value of the ranked daily HDD normals was calculated as the average of thirty occurrences of the second coldest day each year over the same thirty heating years, while the third and succeeding rank HDD values were calculated similarly. The ranked values were assigned to calendar month and day in a way that gives likely dates of occurrence of the extreme daily HDD, but does not

yield monthly sums that are equivalent to the published normals. Thus, these ranked normal daily HDD would be appropriate for the analysis of peak day sales, but would not be appropriate for the analysis of billing data. However, it was determined in crosschecks that the annual sum of the ranked daily normal HDD corresponded exactly with the average annual sum of daily HDD over the thirty heating years that began with July 1, 1961 and ended with June 30, 1991, for the weather station in question. This product is presented at Schedule 3 for KCI, and at Schedule 4 for SGF.

Q. Does this conclude your direct testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

IN THE MATTER OF MISSOURI GAS ENERGY'S TARIFF FILING FOR GENERAL RATE INCREASE.	)))	Case No. GR-2001-292

AFFIDAVIT OF DENNIS PATTERSON

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Dennis Patterson, of lawful age, on his oath states: that he has participated in the preparation of the foregoing written testimony in question and answer form, consisting of 15 pages of testimony to be presented in the above case, that the answers in the attached written testimony were given by him; that he has knowledge of the matters set forth in such answers; and that such matters are true to the best of his knowledge and belief.

Dennis Patterson

Subscribed and sworn to before me this 11th day of April, 2001.

DAWN L. HAKE
Notary Public – State of Missouri
County of Cole
My Commission Expires Jan 9, 2005

Notary Public

My commission expires

KANSAS CITY INTERNATIONAL AIRPORT NORMAL HEATING DEGREE DAYS (HDD)
1961-1990 DAILY AVERAGES AS ADJUSTED TO CORRESPOND WITH PUBLISHED MONTHLY NORMALS

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	41	37	27	16	10	1	0	0	0	5	13	28	
2	39	39	23	17	10	2	0	0	0	4	15	30	
3	41	41	26	16	8	0	0	0	0	6	16	30	
4	41	39	28	16	6	1	0	0	1	6	19	29	
5	39	40	29	18	6	1	0	0	1	6	19	29	
6	40	41	28	16	5	0	0	0	0	7	18	32	
7	42	40	26	11	4	0	0	0	0	6	17	32	
8	43	39	26	12	4	0	0	0	0	7	17	34	
9	43	38	25	15	7	0	0	0	1	8	18	33	
10	43	34	23	15	6	0	0	0	1	9	21	33	
11	42	35	22	12	5	0	0	0	1	7	20	35	
12	42	33	22	11	6	0	0	0	2	8	22	35	
13	40	33	24	12	5	1	0	0	2	7	21	34	
14	40	33	24	12	4	0	0	0	2	7	21	34	
15	39	34	23	12	4	0	0	0	2	8	20	36	
16	39	34	21	9	4	0	0	0	2	9	21	38	
17	38	31	21	7	4	1	0	0	2	10	21	36	
18	38	30	22	8	3	0	0	0	2	11	22	35	
19	39	31	21	8	4	0	0	1	1	12	24	35	
20	40	30	21	8	3	0	0	0	2	10	24	38	
21	37	29	22	7	3	0	0	0	3	9	25	38	
22	35	31	20	8	3	0	0	0	3	9	24	35	
23	35	31	20	7	3	0	0	0	4	11	25	36	
24	35	31	22	7	2	0	0	1	4	13	25	37	
25	37	30	22	7	2	0	0	0	3	13	23	39	
26	39	29	20	6	2	0	0	0	3	12	24	36	
27	40	26	17	8	3	0	0	1	3	11	31	36	
28	39	27	15	9	2	0	0	1	4	13	32	36	
29	37		17	8	2	0	0	1	3	13	29	37	
30	38		18	7	2	0	0	0	4	11	30	38	
31	37		16		3		0	1		11		39	
TOTALS	1218	946	691	325	135	7	0	6	56	279	657	1073	5393

SCHEDULE 1

SCHEDULE 2

SPRINGFIELD REGIONAL AIRPORT NORMAL HEATING DEGREE DAYS (HDD)
1961-1990 DAILY AVERAGES AS ADJUSTED TO CORRESPOND WITH PUBLISHED MONTHLY NORMALS

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	35	31	24	13	9	1	0	0	0	5	10	24	
2	34	34	21	14	9	1	0	0	0	5	14	24	
3	34	35	21	13	6	0	0	0	0	5	15	24	
4	36	32	23	14	7	0	0	0	1	6	16	26	
5	33	33	24	16	5	0	0	0	0	6	17	25	
6	33	36	24	14	3	1	0	0	1	7	16	28	
7	37	35	23	10	2	0	0	0	0	6	15	27	
8	38	34	21	11	4	0	0	0	0	6	14	28	
9	38	35	21	13	6	0	0	0	0	6	15	29	
10	38	30	20	13	5	0	0	0	0	8	17	27	
11	38	30	18	11	4	0	0	0	1	7	18	29	
12	36	30	17	8	4	0	0	0	1	6	19	30	
13	36	28	20	11	4	0	0	0	1	7	19	30	
14	35	27	20	10	3	0	0	0	2	6	18	30	
15	33	28	20	11	4	1	0	0	1	7	17	31	
16	32	29	17	8	4	0	0	0	1	7	19	32	
17	34	27	18	6	3	0	0	0	2	9	19	31	
18	34	26	18	7	2	0	0	0	2	10	19	30	
19	34	28	18	7	3	0	0	0	1	11	20	29	
20	35	25	18	6	2	0	0	0	1	9	20	32	
21	32	26	18	6	2	0	0	0	2	8	22	33	
22	30	26	19	6	2	0	0	0	2	9	22	31	
23	31	26	19	7	2	0	0	0	4	10	21	31	
24	31	29	19	7	2	1	0	0	3	11	23	34	
25	32	26	19	6	1	0	0	0	3	12	19	35	
26	33	26	18	7	2	0	0	0	2	10	20	32	
27	34	24	15	6	3	0	0	0	3	9	25	30	
28	33	24	12	8	2	0	0	0	3	12	29	31	
29	31		14	5	1	0	0	0	3	11	27	31	
30	31		15	6	2	0	0	0	3	9	25	33	
31	30		15		2		0	0		9		34	
TOTALS	1051	820	589	280	110	5	0	0	43	249	570	921	4638

KANSAS CITY INTERNATIONAL AIRPORT NORMAL HEATING DEGREE DAYS (HDD)
JULY, 1961 - JUNE, 1991 RANKED DAILY AVERAGE HDD AND SELECTED PEAK DAY HDD

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	45.26	39.02	34.02	19.61	12.06	3.20	0.00	0.00	0.00	0.00	4.25	17.88	
2	37.64	48.53	29.83	21.21	14.45	1.50	0.00	0.00	0.00	0.00	6.83	22.10	
3	47.97	51.67	36.58	22.67	10.57	0.58	0.00	0.00	0.00	0.00	9.71	23.35	
4	50.72	42.93	43.20	26.90	6.13	0.10	0.00	0.00	0.00	0.07	15.09	19.88	
5	42.10	46.78	39.36	25.05	4.61	0.00	0.02	0.00	0.00	0.00	15.93	13.86	
6	46.32	59.32	32.16	17.48	7.79	0.00	0.00	0.00	0.00	2.74	13.54	25.70	
7	56.33	53.77	35.17	12.78	5.63	0.00	0.00	0.00	0.00	0.33	8.35	24.46	
8	57.56	44.64	31.07	15.52	3.35	0.00	0.00	0.00	0.00	0.88	11.29	27.60	
9	63.07	41.30	28.58	18.87	9.02	0.00	0.00	0.00	0.00	7.70	12.21	28.41	
10	66.39	35.54	26.51	16.89	2.33	0.00	0.00	0.00	0.00	7.02	19.22	26.71	
11	53.05	36.31	19.41	11.93	4.06	0.00	0.00	0.00	0.00	3.73	17.24	30.44	
12	54.41	33.14	24.79	10.91	7.19	0.00	0.00	0.00	0.00	6.49	23.19	31.29	
13	49.93	30.88	27.80	14.62	2.85	0.00	0.00	0.00	0.66	5.76	20.09	32.37	
14	40.97	31.76	25.53	16.25	1.94	0.00	0.00	0.00	0.51	1.59	20.93	29.44	
15	35.79	37.92	23.76	13.40	1.22	0.00	0.00	0.00	0.02	4.83	16.43	38.65	
16	36.73	34.49	20.75	1.79	1.14	0.00	0.00	0.00	0.27	8.19	21.89	44.10	
17	33.61	28.98	17.10	0.00	0.24	0.00	0.00	0.00	0.00	10.72	18.20	40.73	
18	30.65	21.49	16.60	5.40	0.02	0.00	0.00	0.00	0.00	16.09	24.25	37.08	
19	39.85	24.65	15.66	10.06	0.76	0.00	0.00	0.00	0.00	17.66	26.32	33.36	
20	43.67	20.48	18.45	2.54	0.04	0.00	0.00	0.00	0.14	12.39	28.01	55.37	
21	30.01	22.85	23.06	6.28	0.37	0.00	0.00	0.00	1.35	9.92	30.20	47.33	
22	22.47	25.87	11.49	8.01	0.00	0.00	0.00	0.00	3.03	9.41	27.27	35.00	
23	24.10	28.22	14.83	7.34	0.00	0.00	0.00	0.00	5.98	14.06	32.62	38.10	
24	19.03	29.60	22.29	4.47	0.00	0.00	0.00	0.00	9.19	20.25	31.52	45.72	
25	26.06	27.12	21.30	0.16	0.00	0.00	0.00	0.00	2.08	21.70	25.30	52.27	
26	34.74	23.61	12.99	0.00	0.00	0.00	0.00	0.00	5.03	16.78	29.20	42.35	
27	38.38	18.05	6.66	3.56	0.00	0.00	0.00	0.00	3.92	13.18	37.35	36.08	
28	31.97	14.24	2.19	8.76	0.00	0.00	0.00	0.83	11.09	23.96	40.36	34.25	
29	28.78	27.62	8.60	1.05	0.00	0.00	0.00	0.00	7.55	18.62	35.38	41.70	
30	32.85		10.34	0.44	0.00	0.00	0.00	0.00	12.58	15.33	33.85	49.15	
31	27.49		5.28		0.00		0.00	0.03		11.67		60.86	
MAXIMUMS	66.39	59.32	43.20	26.90	14.45	3.20	0.02	0.83	12.58	23.96	40.36	60.86	66.39
TOTALS	1247.90	980.78	685.36	323.95	95.77	5.38	0.02	0.86	63.40	281.07	656.02	1085.59	5426.10

SCHEDULE 3

SPRINGFIELD REGIONAL AIRPORT NORMAL HEATING DEGREE DAYS (HDD)
JULY, 1961 - JUNE, 1991 RANKED DAILY AVERAGE HDD AND SELECTED PEAK DAY HDD

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	41.35	34.60	31.41	15.01	11.91	2.09	0.00	0.00	0.00	0.00	1.61	12.87	
2	36.74	38.67	26.72	18.11	13.30	0.81	0.00	0.00	0.00	0.00	3.60	9.46	
3	37.99	40.86	25.74	19.18	10.24	0.27	0.00	0.00	0.00	0.00	6.14	17.12	
4	42.58	36.41	35.70	25.95	8.51	0.00	0.00	0.00	0.00	0.00	10.53	18.31	
5	34.30	37.28	39.15	22.89	4.57	0.00	0.10	0.00	0.00	0.00	12.53	15.31	
6	33.51	52.92	33.70	21.32	0.90	0.00	0.00	0.00	0.00	1.82	11.64	19.56	
7	47.16	48.57	30.35	10.73	2.75	0.00	0.00	0.00	0.00	0.23	8.13	21.66	
8	51.89	46.14	29.14	14.30	6.61	0.00	0.00	0.00	0.00	2.62	5.11	24.12	
9	50.80	43.12	27.75	16.91	7.26	0.00	0.00	0.00	0.00	4.79	9.25	23.30	
10	60.98	29.31	23.92	16.42	5.31	0.00	0.00	0.00	0.00	6.97	14.49	21.02	
11	56.81	33.27	10.09	9.35	1.46	0.00	0.00	0.00	0.00	3.43	15.17	25.08	
12	47.97	31.82	17.98	9.02	3.73	0.00	0.00	0.00	0.00	0.99	20.67	29.57	
13	44.66	26.14	24.48	12.03	3.26	0.00	0.00	0.00	0.00	5.69	15.94	30.49	
14	40.37	24.71	21.78	13.02	2.21	0.00	0.00	0.00	0.00	0.56	17.80	28.06	
15	31.98	31.22	20.16	11.30	1.72	0.00	0.00	0.00	0.17	4.08	13.49	32.97	
16	28.70	30.12	17.55	1.98	0.41	0.00	0.00	0.00	0.00	6.80	18.53	38.19	
17	30.70	27.34	11.08	0.00	0.12	0.00	0.00	0.00	0.07	9.73	19.94	32.24	
18	32.70	16.16	13.16	1.22	0.05	0.00	0.00	0.00	0.00	12.68	23.50	26.89	
19	35.47	25.45	8.69	6.43	0.66	0.00	0.00	0.00	0.00	17.71	24.24	26.26	
20	39.61	17.32	15.62	2.96	0.00	0.00	0.00	0.00	0.02	13.69	25.25	40.10	
21	25.55	19.76	20.82	4.96	0.00	0.00	0.00	0.00	0.47	7.79	28.28	42.05	
22	14.02	23.64	12.33	0.00	0.00	0.00	0.00	0.00	1.33	8.27	26.50	33.97	
23	20.45	21.12	16.53	7.11	0.00	0.00	0.00	0.00	10.44	14.84	27.53	31.64	
24	16.67	28.48	19.06	7.96	0.00	0.00	0.00	0.00	3.14	20.26	29.69	45.36	
25	19.42	22.10	22.56	3.96	0.00	0.00	0.00	0.00	0.68	22.73	21.48	54.71	
26	27.89	18.62	14.72	0.05	0.00	0.00	0.00	0.00	5.56	16.83	22.35	37.01	
27	29.92	9.92	4.26	0.33	0.00	0.00	0.00	0.00	4.39	11.49	32.47	28.92	
28	27.11	13.90	1.09	5.94	0.00	0.00	0.00	0.18	7.45	18.85	37.60	35.96	
29	21.94	24.29	6.26	0.00	0.00	0.00	0.00	0.02	2.46	15.78	34.85	35.26	
30	24.91		7.65	0.00	0.00	0.00	0.00	0.00	12.21	10.94	30.91	43.96	
31	23.07		2.36		0.00		0.00	0.00		8.88		49.52	
MAXIMUMS	60.98	52.92	39.15	25.95	13.30	2.09	0.10	0.18	12.21	22.73	37.60	54.71	60.98
TOTALS	1077.22	853.26	591.81	278.44	84.98	3.17	0.10	0.20	48.39	248.45	569.22	930.94	4686.18

SCHEDULE 4