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Issues: Weather Normalization
Witness: Dennis Patterson
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MISSOURI PUBLIC SERVICE COMMISSION

UTILITY OPERATIONS DIVISION

DIRECT TESTIMONY

OF

DENNIS PATTERSON

LACLEDE GAS COMPANY

CASE NO. GR-2001-629

Jefferson City, Missouri
October, 2001

DIRECT TESTIMONY

OF

DENNIS PATTERSON

LACLEDE GAS COMPANY

CASE NO. GR-2001-629

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, MO 65102.

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

A. I am a Regulatory Economist in the Energy 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 at the University of Missouri, receiving an M.S. in Agricultural Economics (1989) and a B.A. in Latin American Studies (1983). I joined the Staff of the Commission in 1986. I established the Staff's centralized weather data base, 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, the U.S. Army Reserves, and the U.S. Army.

I. SUMMARY

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

A. The issues I address are the temperature variables used by other Staff for the weather normalization of test year gas sales for Laclede Gas Company (LGC) in the present rate case. In the absence of consistent temperature data for St. Louis-Lambert International Airport (STL), Staff's position is that a thirty-year history of consistent heating degree-days (HDD) from a group of five St. Louis area weather stations should be used for weather normalization in the present rate case. This process uses adjusted monthly temperatures from the National Oceanic and Atmospheric Administration's (NOAA's) United States Historical Climatology Network (USHCN) for which the temperature data are consistent for a history long enough to establish HDD normals. Daily temperatures from the five stations were then used to calculate a time series of HDD averages that is centered on the service territory of LGC. The Staff's weather data products include actual and normal HDD for every day in the test year (the billing year that ends on 28 February 2001). I have provided both actual and normal HDD to Staff witnesses Dan Beck, Jim Gray and Henry Warren. A summary of HDD results is attached to my direct testimony at Schedule 1. Actual and normal HDD were also calculated using adjusted temperature data from STL. In crosschecking, I found that percentage adjustments from actual HDD to normal HDD were similar between the two data sets.

Q. What degree-day quantities did you provide to the Staff witnesses?

A. I provided daily HDD, as well as peak day HDD. I also provided water-heating degree-days (WHDD) so that the witnesses might explain actual and normal gas usage for water heating.

Q. What are the final products that you provided to the witnesses for use in calculating weather normalized test year gas usage for LGC?

A. The final products are daily normal degree-days for the five-station composite. Test year calendar month actual degree-days and normal degree-days are presented as a summary at Schedule 1-1. The daily HDD for this period are presented at Schedule 1-2, while daily WHDD are presented at Schedule 1-5.

Daily normal HDD (Schedule 1-3) were calculated from daily values for the thirty-year period ending December 31, 1999. Daily normal WHDD (Schedule 1-6) were similarly calculated. The historical daily degree-days were calculated for each of the component weather stations from daily temperatures that had been adjusted with USHCN monthly temperatures. The daily normal degree-days were averaged over the 5 stations, and then tabulated as whole degree-day values for the 365 days in a normal year for LGHC.

I have included NOAA's unadjusted daily temperatures; USHCN adjusted monthly temperatures; and adjusted daily temperatures, HDD and WHDD for the five component weather stations in my working papers

Q. What is the final product that you provided to the witnesses for use in calculating weather normalized test year peak day gas usage for LGC?

A. This final product is a tabulation of the twelve monthly normal peak (coldest) day degree-days and the maximum of these, the annual normal peak day degree-days. Tables of the annual and monthly actual and normal peak values of these quantities are presented in the summary at Schedule 1-1.

Peak day HDD were drawn from the series of ranked normal degree-day values from the calendar years 1961 through 1990. This HDD series is presented at Schedule 1-4, and includes the normal HDD for the coldest day of the year, the second coldest day, the third coldest, and so on down through days with no expected HDD. Peak day normal WHDD and the series of ranked normal WHDD were calculated in the same way, and are presented at Schedule 1-7.

Q. How is your direct testimony organized?

A. First, there are several background explanations involving weather responses, heating degree-days, water heating degree-days and normals. This background section is followed by the primary focus of my direct testimony involving the five USHCN weather stations that were chosen for weather normalization in this case. This is followed by a crosscheck that was performed using adjusted temperatures at STL. The final section is my recommendation for the use of the five USHCN weather station results.

II. BACKGROUND

A. Weather Response

Q. How do gas sales vary in response to weather?

A. The majority of residential and commercial class gas sales are for space heating. Space heating gas sales increase in cold weather, and are analyzed with respect to HDD, the number of degrees accumulated below the threshold temperature of

65 degrees Fahrenheit (65° F). First, the day's mean daily temperature (MDT) is calculated as the average of the maximum and minimum temperatures (TMAX and TMIN). Then, if the MDT for the day is below 65° F, HDD are calculated by subtracting the MDT from 65° F. If the day's MDT is 65° F or warmer, there are no HDD on that day.

A majority of customers also use natural gas for water heating. LGC studies have shown that water heating gas sales vary with inlet water temperature, and that a desired hot water temperature of 140° F works well for the analysis of this end use. Subsequent Staff analysis has shown that Missouri River water temperatures (RWT) serve as a statistically reliable proxy for inlet water temperatures in the St. Louis area. Thus, water-heating degree-days (WHDD) for a day may be specified as 140° F minus daily RWT (140-RWT).

B. Water Heating Degree-Days

Q. What was the Staff's source of RWT data?

A. The Staff acquired RWT for the days from January 1, 1986 through May 31, 2001 from the City of St. Louis.

Q. Were these data sufficient to calculate actual and normal daily WHDD for the present case?

A. No. In order to calculate daily WHDD, an observation for RWT must be available for all days in the 1970-1999 normals period sponsored by the Staff, as well as for all days in the test year. However, the Missouri River water temperature data obtained by the Staff do not begin until January 1, 1986. It was therefore necessary to estimate RWT for the observations that were missing between January 1, 1970 and December 31, 1985.

Q. How were the missing RWT observations estimated?

A. The statistical relationship of daily RWT with lagged MDT and hours of daylight (day length) was estimated using regression analysis of data from the period January 1986 through the present. This estimated relationship was then used to calculate daily RWT for the missing observations. Finally, daily WHDD were calculated from the estimates of daily RWT values (1970-1985) and daily observations (1986-1998) of RWT. The calculation of normal WHDD then proceeded as for normal HDD, using data from the years 1970 through 1999. Actual and normal WHDD for the calendar year ending 28 February 2001 are summarized in Schedule 1-1, attached to my direct testimony.

Q. Were there any statistical issues with the regression between RWT and MDT?

A. Yes, there was the issue of using ordinary least squares regression in the presence of serial correlation. Since the temperature of any large body of water can respond only incrementally to changes in air temperature, the current day's RWT is highly correlated with the previous day's RWT as well as with the current day's values of lagged MDT and day length. This is, identically, first-order serial correlation. I took the standard statistical measures to correct for the effects of serial correlation. The procedure is detailed in my working papers.

Q. How have WHDD varied since 1970?

A. The maximum observed RWT has been 91 degrees F (seen only in the exceptionally warm summers of 1987 and 1988). Since liquid fresh water is not usually observed below 32 degrees F, daily observations of WHDD have therefore ranged between (140-32)=108 degree-days in the winter and (140-91)=49 degree-days in the hottest summer weather.

Q. Are WHDD levels the same every year?

A. No, they vary considerably. Annual total WHDD since 1970 have varied between 28,514 (observed in1998) and 30,029 (observed in 1996), for a range of 1,515 WHDD. This range is 5.16% of the 1970-1999 normal of 29,332 WHDD. The varying annual total is a signal that gas sales for the water heating end use should be weather normalized.

Q. Are WHDD levels the same every summer?

A. No. The sum of July and August WHDD has varied from an observed 3,339 WHDD in the exceptionally hot summer of 1988 to an observed 3745 WHDD in the cool summer of 1992. This is a spread of 406 WHDD over the two summer months, which would add up to 2,436 WHDD when annualized. The annualized summer WHDD would be 8.3 percent of the normal annual level of 29,332 WHDD. This varying summer level of WHDD would indicate that summer gas sales for water heating are not insensitive to weather.

C. Normal Weather

Q. What is normal weather?

A. The National Oceanographic and Atmospheric Administration (NOAA) usually expresses normal weather as the average level of a climatological element over thirty years. "Normals have been defined as the arithmetic mean of a climatological element computed over a long time period." **(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, January, 1992) (Monthly Station Normals). Examples of published normals that are available for Missouri weather stations would be the normal daily average temperature for each month, and the normal annual precipitation.

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 in 1990. International agreement among members of the World Meteorological Organization has established that three decades are the desirable period for the calculation of normals. NOAA recalculates thirty-year normals at the end of each decade, as a way of dealing with climatic and non-climatic changes. However, NOAA's normals for the thirty years ending in 2000 are not yet available. For purposes of this case, the Staff is using the period 1970 through 1999 for the calculation of normal weather variables.

Q. Has the Staff consistently used the NOAA thirty-year normals period, products and procedures to tabulate weather data?

A. Yes, it has, since April of 1994. The importance of using these products and procedures became evident when NOAA replaced the 1951-1980 normals with the 1961-1990 normals in 1992. The narrative portion of NOAA's 1961-1990 Monthly Station Normals disclosed that the normals were calculated from weather data that had been adjusted for inconsistencies. As a result, the Staff devised a data tabulation process that incorporated NOAA's adjusted temperatures.

This data tabulation process was first established in November, 1992. A period of internal and external review followed. I used the process exclusively after April, 1994, for all weather data sets developed for weather normalization. However, NOAA's adjustments for the 1961-1990 normals period do not address temperature data inconsistencies that occurred after the end of this normals period and before the current observations. For example, in the case of STL, a major change in both instruments and location occurred in 1996..

Q. Has the Commission made any findings on the use of NOAA's thirty-year normals period?

A. Yes. The use of the NOAA 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 (Report and Order). 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."

Q. How are NOAA's temperature and degree-day normals calculated?

A. NOAA temperature normals are calculated as simple averages by month over 30 years from data that have been adjusted to be consistent. In order to follow this practice in the current case, I adjusted daily TMAX and TMIN at five component weather stations to be consistent with USHCN monthly temperatures. I then calculated observed MDT and HDD for each day in each of the twelve calendar months in the years 1970 through 1999. I then averaged temperatures and HDD for all these days over the five stations to create the time series of daily weather. At this point, using average daily MDT for the five-station composite, I calculated daily WHDD as described in the section of my testimony entitled Water Heating Degree-Days.

With the daily degree-days now available, I calculated daily normal HDD and WHDD for each of the 365 days in the normal year for the five-station composite as the respective average for that month and day over the thirty years in the normals period. I furnished these daily normals to the Staff witnesses. Finally, I added up monthly totals of HDD and WHDD, and then calculated an average total over thirty years for each of the twelve calendar months. As a crosscheck, I used these 12 monthly averages of HDD and WHDD as the benchmark to verify the accuracy of the 365 daily normal degree-day values that I furnished to the Staff witnesses. To provide a crosscheck, I also calculated daily normal MDT, HDD and WHDD in the same way for the single STL weather station.

III. CONSISTENT WEATHER MEASURES FROM A FIVE-STATION COMPOSITE WEATHER STATION

Q. What is the USHCN?

A. The USHCN is a set of weather stations for which continuous monthly temperature data exists from the 19th century through the present. NOAA and the Carbon Dioxide Information Analysis Center (CDIAC) have removed biases from USHCN data so that the entire history of monthly temperatures at each USHCN weather station is as consistent as possible with the present-day location, an unbiased thermometer and an observation time of midnight. The USHCN is well described at the following Internet website:

http://lwf.ncdc.noaa.gov/oa/climate/research/ushcn/ushcn.html.

Q. Why did you choose to us USHCN weather stations as a basis for normalizing weather for LGC?

A. Until NOAA makes adjustments in the historical data from STL for the 1971-2000 period, the current temperature observations at STL will be inconsistent with historical observations. Because NOAA has made such adjustments for the USHCN weather stations, consistency of historical observations is available for data ending in 1999 back for more than the thirty years needed for normals. However, no single weather station in the USHCN database is representative of the LGC service area. Thus, several of the USHCN weather stations were used to be representative for LGC.

Q. How were these representative weather stations chosen?

A. The objective was to center the geographic location of the average of these stations within the LGC service area, while keeping them as close to St. Louis area as possible. Within a 67-mile radius of STL, five USHCN stations with readings available for the test year were chosen. These five USHCN stations have a geographic center at about 38 degrees 40 minutes north latitude and 90 degrees 46 minutes west longitude. This set of coordinates falls within the city limits of St. Louis, Missouri.

Q. How did you insure that the daily normal HDD were consistent with daily temperatures and HDD from the test year?

A. This required that normals period daily temperatures and test year daily temperatures both be indexed to consistent monthly (average TMIN and average TMAX) temperatures in the USHCN database.

Q. How did you insure that normals period temperatures were consistent with USHCN's uniform measurement conditions?

A. The daily observations on TMAX and TMIN represent the distribution over 28 to 31 days (depending on the month) of those temperatures about their respective means (averages). Because of the adjustments made for consistency, the USHCN monthly averages of TMAX and TMIN do not equal the averages of the actual observations. For either TMAX or TMIN, the difference between these two averages is the adjustment made for consistency. In order to maintain the historical distribution of the data about the mean and to yield distributions having the same means (averages) as the USHCN monthly temperature averages, these respective differences are applied to each daily observation of TMAX and TMIN within the month.

Q. How did you insure that test year daily normal HDD were consistent with USHCN's uniform measurement conditions?

A. Because the USHCN data was not available for months after 1999, monthly differences between USHCN monthly temperatures and recorded monthly temperatures were calculated for the latest month where both were available prior to the end of 1999. These differences were then applied to every day of each month during the test year. In this way, the test year daily temperatures for the five component weather stations were made consistent with the historical HSHCN data..

Q. How did you calculate daily HDD and WHDD for the five-station composite?

A. Daily MDT and HDD were calculated at each of the five weather stations. Daily HDD were then averaged over the five stations to yield the daily HDD for the five station composite. The calculation of normal WHDD was based on historical daily MDT averaged over the five weather stations.

Q. Have you recorded your adjustment process and calculations in detail?

A. Yes, I have. The adjustment process is described in Schedule 2. The calculations are found in the spreadsheets provided as part of my working papers. I have furnished these items to the Company.

IV. CROSSCHECK: ADJUSTED TEMPERATURE MEASURES FROM THE STL WEATHER STATION

Q. How did you calculate consistent weather measures for the STL weather station?

A. These calculations are described at Schedule 3. The numeric results are found in spreadsheets that are provided in my working papers.

Q. Could you briefly describe your what you did?

A. Yes. I applied monthly and seasonal adjustments to daily temperatures, where the adjustments corrected readings of TMAX and TMIN that were measured in the past so that they would correspond to readings measured in the present, at the current location and with the current thermometer type. I then calculated daily MDT, HDD and WHDD with the adjusted TMAX and TMIN readings. Finally, I calculated daily normal MDT, HDD and WHDD at STL for the 1970-1999 normals period that would be consistent with daily MDT, HDD and WHDD at STL for the test year ending 28 February 2001.

Q. What events made the adjustments necessary?

A. On various occasions since 1970, the ground temperature measurement site has moved from one location to another at STL. On three of these occasions (1979, 1985 and 1988), the changes caused temperatures measured after the move to be significantly warmer than they would have been had they been measured under the conditions that existed before the move. On a fourth occasion (1996), the change reversed some of the warming bias that had been introduced by prior moves. Such moves are called exposure changes.

Q. In the joint process involving Staff and Laclede, what adjustments were calculated?

A. In 1996, the weather instrument at STL was replaced with the more modern Automated Surface Observing System (ASOS). This new instrument was relocated from near buildings and parking lots to the runway. The combination of these two exposure changes resulted in a significant change in temperature readings. The process involving Staff and LGC was an attempt to come to agreement on appropriate adjustments to make for these exposure changes. NOAA was well aware of the problem and hired Dr. Thomas McKee to investigate and recommend changes. Dr. McKee made seasonal adjustments that are documented in his report to NOAA entitled **"Climate Data Continuity with ASOS, Report for Period April 1996 through June 2000, Climatology Report No. 00-3."** McKee, Thomas B.; Nolan J. Doesken; Christopher A.

Davey and Roger A. Pielke, Sr. Fort Collins, Colorado: Colorado State University, Department of Atmospheric Science. Dr. McKee was contacted by Staff and LGC, and met with us to detail what he was doing to make these adjustments. Upon completion of his study, Dr. McKee provided us with a copy of his report. His approach of applying seasonal adjustments rather than a single annual adjustment addressed a major concern that LGC had with the adjustment proposed by the Missouri state Climatologist. I applied Dr. McKee's adjustments for the period that he recommended,1990 through to the 1996 exposure changes.

Q. Did this resolve all the issues regarding exposure changes at STL?

A. No, it did not. The state Climatologist had also identified exposure changes in the mid and late 1980s that had not previously been corrected by NOAA and which were not a part of the assignment for Dr. McKee.

Q. How did you deal with the exposure changes in the mid and late 1980s?

A. I applied the same methods used by Dr. McKee to calculate seasonal adjustments.

Q. How did you deal with the earlier exposure changes that occurred in 1979?

A. I applied the adjustments made by NOAA to determine normals for the 1961-1990 normals period.

Q. Why didn't NOAA make the adjustments for the changes in the mid and late 1980's in their 1961-1990 normal period?

A. I don't know for certain, but it appears than when exposure changes occur late in the normals period, the methods used by NOAA require more data than are available at the time. For example, an adjustment for the 1979 exposure change did not appear in the 1951-1980 normals, but was included in the 1961-1990 normals.

Q. How did you apply the adjustments?

A. I applied them by month to all daily observations that were read before each of the exposure changes.

Q. After your adjustments were complete, did you compare the differences between actual and normal HDD for the five-station composite and at STL?

A. Yes, I did.

Q. What time period did you use to make the comparison?

A. I used the 12 months ending 28 February 2001.

Q. What were the results of your comparison?

A. For the five station composite, the 12 calendar months ending 28 February 2001 experienced 5266 HDD, while the 1970-1999 annual normal was 5148 HDD. The adjustment from actual HDD to normal HDD would be downward by 188 HDD, which would be an adjustment of –2.23% of actual HDD.

For STL with the adjustments discussed above, the actual HDD for the 12 months ending 28 February 2001 were 4952 HDD, while the 1970-1999 normal HDD were 4785 HDD. This adjustment from actual to normal would also be downward, for and adjustment of –167 HDD, or –3.37% of actual.

On a percentage basis, the adjustment for the five station composite is 1.14% greater than the adjustment for STL. This comparison is presented at Schedule 4.

V. RECOMMENDATIONS

Q. Why do you believe that using HDD from the five-station composite is preferable to using HDD from the STL weather station in the present case?

A. Until NOAA makes adjustments in the historical data from STL for the thirty-year period 1971-2000, the current temperature observations at STL will be inconsistent with historical observations. In the last LGC rate case, Case No. GR-99-315, LGC objected to the adjustments made by the state Climatologist on behalf of the Staff. Subsequent to that case, the Staff and LGC have been working on a set of adjustments on which we can both agree. Unfortunately, this is a complex issue involving not only changes that occurred in 1996, but also changes that occurred in the latter half of the 1980s. Thus, the Staff and LGC have yet to reach agreement on adjustments required to arrive at a recent data history of thirty years to be used as the basis for normals at STL. Given this lack of agreement regarding adjustments to STL, the next best alternative would be a set of temperature data that NOAA has determined is consistent, from a set of weather stations that is representative of the LGC service area. The Staff therefore selected USHCN data that has been adjusted by NOAA to be a consistent set of data over a very long time period.

Q. Do you recommend the five station composite as a strong candidate for use in weather normalization for LGC?

A. Yes, I do.

Q. Why do you sponsor the 1970-1999 normals period, given the Commission's findings in GR-1996-285?

A. I believe this normals period best meets the intent of these findings. First, due to thermometer replacements and ground temperature site relocations, NOAA's 1961-1990 monthly station normals for STL are no longer consistent with test year weather. Second, the 1961-1990 normals period will be outdated soon because NOAA is expected to publish updated 1971-2000 normals in early 2002. Finally, NOAA's USHCN adjustments, which were used by the Staff to tabulate weather for the five-station composite, have already been calculated through the year 1999. The Staff therefore sponsors the use of the most recent thirty years of consistent NOAA data, from the years 1970 through 1999, for the calculation of normal HDD and WHDD in the present case.

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 Laclede Gas Company's)
Tariff to Revise Natural Gas Rate Schedules) Case No. GR-2001-629

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 direct testimony in question and answer form, consisting of 18 pages of direct testimony to be presented in the above case, that the answers in the foregoing direct 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
Dennis Patterson

Subscribed and sworn to before me this 10th day of October, 2001.

Dawn L. Hake
Notary Public

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

My commission expires __________

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
ACTUAL AND NORMAL WEATHER VARIABLES FOR 1 MARCH 2000 -- 28 FEBRUARY 2001
HEATING DEGREE-DAYS (HDD) AND WATER HEATING DEGREE-DAYS (WHDD)

MONTHS: AVERAGES AND SUMS

ACTUALS: OBSERVED DEGREE-DAYS FOR CALENDAR YEAR ENDING FEB 28 2001

		SUMS	
YEAR	MONTH	HDD	WHDD
2000	3	543.6	2723
2000	4	353.2	2437
2000	5	57.1	2115
2000	6	17.2	1854
2000	7	0.4	1751
2000	8	0.0	1703
2000	9	83.0	1822
2000	10	229.2	2322
2000	11	738.5	2673
2000	12	1363.2	3244
2001	1	1124.5	3224
2001	2	848.4	2851
ACTUAL 12 MONTHS ENDING FEB 28 2001		**5358.2**	**28719**

NORMALS: 1970-1999 AVERAGE DEGREE-DAYS BY MONTH

		SUMS	
YEAR	MONTH	HDD	WHDD
---	3	660.1	2933
---	4	331.3	2524
---	5	113.3	2272
---	6	11.8	1908
---	7	1.1	1768
---	8	2.7	1791
---	9	70.6	1922
---	10	291.4	2359
---	11	635.0	2666
---	12	987.7	3092
---	1	1150.4	3233
---	2	892.7	2863
NORMAL TOTAL 12 MO. ENDING FEB 28		**5148.0**	**29332**

ADJUSTMENTS: NORMAL DEGREE-DAYS LESS ACTUAL DEGREE-DAYS FOR CALENDAR YEAR ENDING FEB 28 2001

		SUMS	
YEAR	MONTH	HDD	WHDD
2000	3	116.5	209.9
2000	4	-21.9	86.8
2000	5	56.1	156.8
2000	6	-5.4	54.3
2000	7	0.8	17.0
2000	8	2.7	88.2
2000	9	-12.4	100.8
2000	10	62.2	37.3
2000	11	-103.5	-6.7
2000	12	-375.4	-152.1
2001	1	25.9	9.2
2001	2	44.2	11.8
12-MONTH TOTAL DEGREE-DAYS ADJUSTMENT		**-210.2**	**613.4**
12-MONTH TOTAL PERCENT ADJUSTMENT		**-3.92%**	**2.1%**

PEAK DAYS: MINIMUMS AND MAXIMUMS

ACTUALS: OBSERVED MAXIMUM DAILY DEGREE-DAYS FOR CALENDAR YEAR ENDING FEB 28 2001

		MAXIMUMS	
YEAR	MONTH	HDD	WHDD
2000	3	33.4	91.8
2000	4	22.6	84.6
2000	5	10.9	75.6
2000	6	7.5	64.8
2000	7	0.1	64.8
2000	8	0.0	57.6
2000	9	18.3	72.0
2000	10	26.6	79.2
2000	11	41.5	100.8
2000	12	56.1	108.0
2001	1	56.7	108.0
2001	2	47.0	106.2
PEAK DAY IN 12 MONTHS ENDING FEB 28 2001		**56.7**	**108.0**

NORMALS: 1970-1999 RANKED AVERAGE DAILY DEGREE-DAYS ASSIGNED BY MONTH AND DAY

		MAXIMUMS	
YEAR	MONTH	HDD	WHDD
---	3	39.5	100.4
---	4	27.1	91.0
---	5	13.6	79.9
---	6	3.4	68.8
---	7	0.2	61.3
---	8	0.8	61.5
---	9	12.0	71.3
---	10	23.9	82.9
---	11	38.7	95.7
---	12	53.4	104.9
---	1	61.9	107.1
---	2	56.6	106.2
NORMAL PEAK DAY 12 MO. ENDING FEB 28		**61.9**	**107.1**

ADJUSTMENTS: NORMAL MAXIMUM DAILY DEGREE-DAYS LESS ACTUAL MAXIMUM DEGREE-DAYS FOR CALENDAR YEAR ENDING FEB 28 2001

		MAXIMUMS	
YEAR	MONTH	HDD	WHDD
2000	3	6.1	8.6
2000	4	4.5	6.4
2000	5	2.7	4.3
2000	6	-4.0	4.0
2000	7	0.1	-3.5
2000	8	0.8	3.9
2000	9	-6.3	-0.7
2000	10	-2.6	3.7
2000	11	-2.9	-5.1
2000	12	-2.7	-3.2
2001	1	5.2	-0.9
2001	2	9.6	0.0
PEAK DAY DEGREE-DAYS ADJUSTMENT		**5.2**	**-0.9**
PEAK DAY PERCENT ADJUSTMENT		**9.23%**	**-0.9%**

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
ACTUAL WEATHER VARIABLES FOR 1 MARCH 2000 -- 28 FEBRUARY 2001
HEATING DEGREE-DAYS (HDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	13.3	14.4	0.7	0.0	0.0	0.0	0.0	0.9	0.1	29.1	53.2	33.7	
2	21.3	10.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	31.4	56.7	47.0	
3	25.2	10.7	0.2	0.4	0.0	0.0	0.0	0.0	6.4	38.0	52.8	43.4	
4	26.8	18.6	0.0	0.4	0.0	0.0	0.0	0.0	13.5	35.7	42.0	30.0	
5	19.0	20.7	0.0	0.7	0.0	0.0	0.0	5.3	17.0	32.9	34.7	27.9	
6	13.5	8.6	0.0	7.5	0.0	0.0	0.7	14.3	11.6	40.9	32.8	25.5	
7	4.7	7.5	0.0	5.6	0.0	0.0	0.0	25.3	12.7	37.7	30.0	26.0	
8	0.0	17.2	0.0	0.8	0.0	0.0	0.0	26.6	21.5	25.1	36.5	15.6	
9	7.4	22.6	0.3	0.0	0.0	0.0	0.0	25.0	25.2	34.5	44.9	12.3	
10	26.6	13.2	5.7	0.0	0.0	0.0	0.0	21.8	31.0	30.9	39.6	32.1	
11	28.9	12.1	2.4	0.0	0.0	0.0	0.0	17.6	28.7	28.9	33.2	39.4	
12	33.4	20.0	0.0	0.0	0.0	0.0	0.0	12.9	23.8	43.3	32.3	31.8	
13	24.1	19.0	2.1	0.0	0.0	0.0	0.2	5.8	25.0	51.8	30.4	25.3	
14	20.4	12.9	10.9	0.0	0.0	0.0	0.0	0.1	30.4	46.5	28.0	20.7	
15	14.2	8.3	7.7	0.0	0.0	0.0	0.7	0.7	31.1	46.4	27.7	25.7	
16	12.2	2.3	1.6	0.0	0.0	0.0	7.5	7.3	27.3	39.2	32.5	35.3	
17	26.8	8.6	0.0	0.4	0.0	0.0	7.1	9.3	34.3	48.6	33.4	42.9	
18	25.3	17.1	0.0	1.4	0.0	0.0	1.8	11.7	36.9	54.9	35.6	43.0	
19	22.1	8.1	0.7	0.0	0.0	0.0	0.0	8.8	31.6	50.1	34.6	32.4	
20	23.2	0.0	9.2	0.0	0.0	0.0	0.0	5.2	30.6	56.1	40.4	19.4	
21	22.2	10.8	8.4	0.0	0.1	0.0	5.6	3.1	41.5	51.6	43.1	31.9	
22	15.7	13.9	2.3	0.0	0.1	0.0	7.8	2.0	38.4	54.5	36.3	38.0	
23	11.1	10.3	0.0	0.0	0.0	0.0	0.0	2.8	31.0	53.6	34.1	35.2	
24	4.1	10.0	0.0	0.0	0.0	0.0	1.8	0.0	26.4	47.0	31.9	25.6	
25	6.0	13.5	0.0	0.0	0.1	0.0	8.4	0.0	24.9	55.1	38.7	17.4	
26	10.3	12.1	0.0	0.0	0.0	0.0	18.3	0.0	24.9	52.2	39.8	26.6	
27	9.2	10.1	0.8	0.0	0.0	0.0	9.9	0.4	28.8	45.6	30.8	27.4	
28	18.7	10.1	0.2	0.0	0.0	0.0	5.1	3.6	28.8	51.4	36.5	37.5	
29	23.1	6.3	3.0	0.1	0.0	0.0	5.3	9.7	24.7	51.6	30.2		
30	17.9	5.3	0.5	0.0	0.0	0.0	3.1	7.6	29.9	49.3	21.9		
31	16.5		0.0		0.0	0.0		2.3		50.0	30.5		
TOTALS	**543.6**	**353.2**	**57.1**	**17.2**	**0.4**	**0.0**	**83.0**	**229.2**	**738.5**	**1363.2**	**1124.5**	**848.4**	**5358.2**

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
ACTUAL WEATHER VARIABLES FOR 1 MARCH 2000 -- 28 FEBRUARY 2001
HEATING DEGREE-DAYS (HDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	13.3	14.4	0.7	0.0	0.0	0.0	0.0	0.9	0.1	29.1	53.2	33.7	
2	21.3	10.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	31.4	56.7	47.0	
3	25.2	10.7	0.2	0.4	0.0	0.0	0.0	0.0	6.4	38.0	52.8	43.4	
4	26.8	18.6	0.0	0.4	0.0	0.0	0.0	0.0	13.5	35.7	42.0	30.0	
5	19.0	20.7	0.0	0.7	0.0	0.0	0.0	5.3	17.0	32.9	34.7	27.9	
6	13.5	8.6	0.0	7.5	0.0	0.0	0.7	14.3	11.6	40.9	32.8	25.5	
7	4.7	7.5	0.0	5.6	0.0	0.0	0.0	25.3	12.7	37.7	30.0	26.0	
8	0.0	17.2	0.0	0.8	0.0	0.0	0.0	26.6	21.5	25.1	36.5	15.6	
9	7.4	22.6	0.3	0.0	0.0	0.0	0.0	25.0	25.2	34.5	44.9	12.3	
10	26.6	13.2	5.7	0.0	0.0	0.0	0.0	21.8	31.0	30.9	39.6	32.1	
11	28.9	12.1	2.4	0.0	0.0	0.0	0.0	17.6	28.7	28.9	33.2	39.4	
12	33.4	20.0	0.0	0.0	0.0	0.0	0.0	12.9	23.8	43.3	32.3	31.8	
13	24.1	19.0	2.1	0.0	0.0	0.0	0.2	6.8	25.0	51.8	30.4	25.3	
14	20.4	12.9	10.9	0.0	0.0	0.0	0.0	0.1	30.4	46.5	28.0	20.7	
15	14.2	8.3	7.7	0.0	0.0	0.0	0.7	0.7	31.1	46.4	27.7	25.7	
16	12.2	2.3	1.6	0.0	0.0	0.0	7.5	7.3	27.3	39.2	32.6	35.3	
17	26.8	8.6	0.0	0.4	0.0	0.0	7.1	9.3	34.3	48.6	33.4	42.9	
18	25.3	17.1	0.0	1.4	0.0	0.0	1.8	11.7	36.9	54.9	35.6	43.0	
19	22.1	8.1	0.7	0.0	0.0	0.0	0.0	8.8	31.6	50.1	34.6	32.4	
20	23.2	0.0	9.2	0.0	0.0	0.0	0.0	5.2	30.6	56.1	40.4	19.4	
21	22.2	10.8	8.4	0.0	0.1	0.0	5.6	3.1	41.5	51.6	43.1	31.9	
22	15.7	13.9	2.3	0.0	0.1	0.0	7.8	2.0	38.4	54.5	36.3	38.0	
23	11.1	10.3	0.0	0.0	0.0	0.0	0.0	2.8	31.0	53.6	34.1	35.2	
24	4.1	10.0	0.0	0.0	0.0	0.0	1.8	0.0	26.4	47.0	31.9	25.6	
25	6.0	13.5	0.0	0.0	0.1	0.0	8.4	0.0	24.9	55.1	38.7	17.4	
26	10.3	12.1	0.0	0.0	0.0	0.0	18.3	0.0	24.9	52.2	39.8	26.6	
27	9.2	10.1	0.8	0.0	0.0	0.0	9.9	0.4	28.8	45.6	30.8	27.4	
28	18.7	10.1	0.2	0.0	0.0	0.0	5.1	3.6	28.8	51.4	36.5	37.5	
29	23.1	6.3	3.0	0.1	0.0	0.0	5.3	9.7	24.7	51.6	30.2		
30	17.9	5.3	0.5	0.0	0.0	0.0	3.1	7.6	29.9	49.3	21.9		
31	16.5		0.0		0.0	0.0		2.3		50.0	30.5		
TOTALS	**543.6**	**353.2**	**57.1**	**17.2**	**0.4**	**0.0**	**83.0**	**229.2**	**738.5**	**1363.2**	**1124.5**	**848.4**	**5358.2**

Schedule 1-2

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
1970-1999 NORMAL WEATHER VARIABLES FOR 1 MARCH -- 28 FEBRUARY
HEATING DEGREE-DAYS (HDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	25.9	16.2	7.7	1.8	0.0	0.1	0.2	4.2	11.4	26.3	37.6	34.6	
2	24.8	16.6	8.5	0.8	0.0	0.0	0.3	5.3	13.8	26.2	37.0	35.4	
3	24.7	15.2	7.5	0.6	0.0	0.0	0.5	6.3	16.9	25.4	35.9	36.4	
4	25.4	14.6	7.1	0.8	0.0	0.0	0.9	6.4	17.7	27.5	37.0	37.3	
5	25.0	16.6	6.0	1.4	0.2	0.0	0.8	6.3	18.8	26.9	39.3	37.3	
6	23.8	17.5	5.0	0.8	0.2	0.1	0.6	7.4	19.4	28.4	37.9	38.8	
7	24.3	14.7	5.3	0.5	0.1	0.2	0.5	8.2	19.1	30.3	38.2	39.2	
8	24.9	12.6	4.7	0.1	0.0	0.1	0.7	6.9	19.2	30.0	41.1	38.2	
9	25.0	14.3	5.1	0.5	0.0	0.1	0.7	7.4	17.9	31.4	41.3	38.7	
10	25.6	15.6	4.9	0.3	0.0	0.1	0.6	8.9	19.3	31.7	41.4	34.5	
11	23.5	13.3	3.7	0.4	0.0	0.0	0.9	8.7	22.4	31.0	40.1	32.2	
12	22.1	10.5	3.6	0.7	0.0	0.1	0.7	7.5	22.6	30.3	39.1	33.7	
13	20.6	10.0	4.1	0.4	0.1	0.0	1.2	8.3	20.9	30.9	37.8	34.4	
14	22.2	10.9	3.3	0.2	0.1	0.1	2.0	8.5	19.8	30.4	38.7	31.7	
15	22.4	11.5	4.1	0.1	0.1	0.3	2.3	8.0	20.6	29.8	38.6	31.2	
16	21.7	10.4	3.8	0.3	0.0	0.2	2.2	7.9	21.8	32.4	37.5	32.2	
17	20.9	10.3	2.8	0.4	0.0	0.0	2.2	9.2	21.8	34.0	36.4	31.7	
18	19.7	8.9	2.2	0.2	0.0	0.0	2.2	10.8	19.5	35.0	36.4	28.3	
19	20.4	7.7	2.3	0.1	0.0	0.0	2.4	13.1	18.7	34.2	38.7	27.4	
20	20.1	8.3	2.6	0.0	0.0	0.1	2.5	12.4	20.3	34.1	38.0	27.1	
21	19.4	7.9	1.9	0.1	0.0	0.0	3.8	11.5	23.3	36.5	37.4	24.4	
22	19.0	8.7	1.5	0.3	0.0	0.0	5.2	10.6	24.9	35.3	34.4	24.8	
23	19.6	8.5	1.4	0.3	0.0	0.0	6.0	10.8	24.4	33.1	33.1	26.1	
24	21.0	8.1	1.1	0.3	0.0	0.0	6.1	11.9	26.0	34.7	32.2	27.6	
25	20.3	7.7	1.6	0.2	0.0	0.0	4.2	12.6	26.0	37.2	33.0	28.8	
26	19.1	6.4	2.6	0.1	0.0	0.1	4.3	13.0	23.6	36.5	35.8	27.8	
27	17.2	6.3	2.5	0.0	0.0	0.1	4.7	12.0	23.8	33.5	35.4	26.6	
28	15.2	7.6	2.1	0.0	0.0	0.4	4.2	11.8	26.9	33.0	34.3	26.3	
29	14.5	7.6	1.3	0.0	0.0	0.4	3.9	12.0	27.9	33.5	35.3		
30	16.2	7.1	1.6	0.0	0.1	0.2	4.2	12.1	26.2	33.4	35.5		
31	15.6		1.6		0.1	0.0		11.5		35.3	36.1		
TOTALS	660.1	331.3	113.3	11.8	1.1	2.7	70.6	291.4	635.0	987.7	1150.4	892.7	5148.0

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
1970-1999 NORMAL WEATHER VARIABLES CALCULATED BY RANK WITHIN YEAR, THEN ASSIGNED TO MONTHS AND DAYS
HEATING DEGREE-DAYS (HDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	39.5	25.3	10.6	2.1	0.0	0.0	0.0	0.0	3.6	17.8	38.3	37.0	
2	28.8	19.8	13.6	0.0	0.0	0.0	0.0	0.1	5.6	15.8	35.5	38.0	
3	32.0	15.2	11.9	0.3	0.0	0.0	0.0	0.3	7.6	13.4	31.7	39.3	
4	30.6	21.1	9.3	1.3	0.0	0.0	0.0	1.2	9.5	21.3	35.0	41.0	
5	29.9	27.1	8.2	3.4	0.1	0.0	0.0	0.8	12.9	19.5	50.6	43.6	
6	26.9	23.0	5.7	0.1	0.2	0.0	0.0	1.8	16.9	22.4	40.6	51.6	
7	28.0	17.4	7.1	0.0	0.0	0.0	0.0	5.4	14.1	27.3	42.4	56.6	
8	37.6	14.8	6.7	0.0	0.0	0.0	0.0	1.6	15.0	24.9	54.8	45.7	
9	35.2	16.5	5.2	0.7	0.0	0.0	0.0	2.5	10.9	30.4	59.2	48.2	
10	33.1	18.9	4.4	0.0	0.0	0.0	0.0	8.6	16.1	31.2	61.9	36.1	
11	25.7	14.0	1.5	0.0	0.0	0.0	0.0	7.9	24.4	29.7	52.4	31.6	
12	22.2	11.1	2.2	0.0	0.0	0.0	0.0	3.3	25.1	26.2	49.0	33.6	
13	24.5	9.8	3.0	0.0	0.0	0.0	0.0	6.2	21.8	29.1	40.3	34.5	
14	24.2	12.2	2.7	0.0	0.0	0.0	0.0	6.9	19.1	28.1	46.5	30.8	
15	20.6	12.6	3.8	0.0	0.0	0.1	0.6	4.7	20.7	24.1	44.1	28.4	
16	23.1	10.4	1.8	0.0	0.0	0.0	0.2	3.9	23.5	31.9	37.3	32.8	
17	21.5	9.1	1.2	0.0	0.0	0.0	0.5	9.0	22.8	36.7	34.3	29.5	
18	16.6	5.1	0.4	0.0	0.0	0.0	0.1	10.7	17.6	41.4	33.3	26.4	
19	17.0	2.8	0.2	0.0	0.0	0.0	1.0	23.9	11.6	39.0	45.2	23.3	
20	13.2	2.0	0.9	0.0	0.0	0.0	1.4	18.3	20.2	37.8	41.8	22.6	
21	18.0	7.4	0.1	0.0	0.0	0.0	1.7	13.1	26.5	49.5	36.5	12.7	
22	15.6	6.5	0.0	0.0	0.0	0.0	8.8	10.0	30.2	44.5	26.7	15.9	
23	11.5	8.4	0.0	0.0	0.0	0.0	10.2	11.3	29.2	33.0	23.7	18.2	
24	18.5	5.9	0.0	0.0	0.0	0.0	12.0	14.5	31.3	39.9	18.7	24.8	
25	19.3	4.1	0.1	0.0	0.0	0.0	4.9	20.0	32.4	53.4	20.9	27.6	
26	14.3	0.6	0.5	0.0	0.0	0.0	6.1	22.0	27.5	47.2	31.0	26.0	
27	9.6	0.0	1.1	0.0	0.0	0.0	7.2	15.4	28.3	34.8	28.7	21.7	
28	4.6	1.4	0.1	0.0	0.0	0.8	3.2	13.8	35.7	32.2	25.5	20.3	
29	2.4	1.0	0.0	0.0	0.0	0.4	2.3	16.3	38.7	35.9	27.8	24.1	
30	8.0	0.3	0.0	0.0	0.0	0.0	4.3	17.3	34.1	33.8	30.0		
31	6.4		0.0		0.0	0.0		12.4		43.0	32.6		
MAXIMUMS	**39.5**	**27.1**	**13.6**	**3.4**	**0.2**	**0.8**	**12.0**	**23.9**	**38.7**	**53.4**	**61.9**	**56.6**	**61.9**
TOTALS	658.4	323.7	102.1	7.8	0.3	1.3	64.3	283.1	632.7	994.9	1176.1	903.7	5148.4

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
ACTUAL WEATHER VARIABLES FOR 1 MARCH 2000 -- 28 FEBRUARY 2001
WATER HEATING DEGREE-DAYS (WHDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	88.2	84.6	75.6	64.8	64.8	57.6	50.4	68.4	73.8	100.8	108.0	104.4	
2	86.4	84.6	73.8	61.2	63.0	57.6	50.4	72.0	73.8	100.8	108.0	104.4	
3	90.0	84.6	73.8	61.2	63.0	55.8	50.4	68.4	73.8	100.8	108.0	106.2	
4	86.4	84.6	70.2	61.2	61.2	55.8	50.4	68.4	73.8	100.8	108.0	106.2	
5	91.8	84.6	72.0	61.2	59.4	55.8	50.4	70.2	73.8	100.8	108.0	106.2	
6	91.8	84.6	68.4	64.8	59.4	55.8	57.6	70.2	73.8	100.8	108.0	104.4	
7	88.2	84.6	68.4	64.8	57.6	55.8	57.6	73.8	73.8	102.6	106.2	102.6	
8	86.4	84.6	70.2	63.0	59.4	55.8	59.4	75.6	73.8	100.8	106.2	100.8	
9	86.4	84.6	68.4	61.2	55.8	55.8	57.6	77.4	81.0	100.8	104.4	99.0	
10	86.4	82.8	68.4	61.2	54.0	57.6	57.6	77.4	84.6	100.8	104.4	97.2	
11	86.4	82.8	68.4	59.4	52.2	55.8	57.6	79.2	86.4	100.8	104.4	99.0	
12	88.2	82.8	66.6	61.2	52.2	54.0	55.8	77.4	86.4	100.8	104.4	100.8	
13	88.2	82.8	66.6	59.4	52.2	54.0	57.6	77.4	88.2	100.8	104.4	102.6	
14	88.2	82.8	66.6	59.4	61.2	52.2	55.8	77.4	91.8	100.8	102.6	104.4	
15	86.4	82.8	66.6	61.2	52.2	52.2	57.6	77.4	91.8	106.2	102.6	104.4	
16	88.2	79.2	66.6	61.2	50.4	52.2	61.2	77.4	93.6	106.2	100.8	102.6	
17	88.2	79.2	66.6	61.2	52.2	50.4	63.0	75.6	93.6	106.2	100.8	102.6	
18	88.2	79.2	66.6	61.2	54.0	50.4	63.0	77.4	95.4	108.0	100.8	102.6	
19	90.0	77.4	66.6	61.2	54.0	54.0	61.2	77.4	95.4	108.0	100.8	104.4	
20	90.0	79.2	68.4	61.2	54.0	55.8	61.2	77.4	95.4	108.0	102.6	102.6	
21	90.0	79.2	68.4	61.2	54.0	55.8	64.8	75.6	99.0	108.0	104.4	99.0	
22	90.0	79.2	66.6	61.2	57.6	57.6	66.6	75.6	100.8	108.0	104.4	97.2	
23	90.0	77.4	66.6	61.2	57.6	55.8	64.8	75.6	99.0	108.0	102.6	100.8	
24	90.0	79.2	66.6	63.0	57.6	55.8	64.8	75.6	99.0	108.0	102.6	100.8	
25	86.4	79.2	64.8	64.8	55.8	55.8	68.4	75.6	100.8	108.0	102.6	100.8	
26	86.4	79.2	64.8	63.0	55.8	57.6	72.0	75.6	100.8	108.0	102.6	99.0	
27	86.4	77.4	66.6	61.2	55.8	57.6	72.0	73.8	100.8	108.0	102.6	97.2	
28	86.4	77.4	68.4	61.2	55.8	55.8	72.0	73.8	99.0	108.0	102.6	99.0	
29	84.6	79.2	68.4	61.2	55.8	54.0	70.2	73.8	99.0	108.0	102.6		
30	84.6	77.4	68.4	64.8	57.6	52.2	70.2	75.6	100.8	108.0	100.8		
31	84.6		66.6		55.8	50.4		75.6		108.0	102.6		
TOTALS	2723.4	2437.2	2115.0	1854.0	1751.4	1702.8	1821.6	2322.0	2673.0	3243.6	3223.8	2851.2	28719.0

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
1970-1999 NORMAL WEATHER VARIABLES FOR 1 MARCH -- 28 FEBRUARY
WATER HEATING DEGREE-DAYS (WHDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	99.1	89.0	78.4	68.3	59.2	56.7	59.1	70.4	81.9	95.4	103.2	103.6	
2	98.6	89.0	78.4	68.1	59.0	56.8	59.5	70.8	82.0	95.8	103.4	103.3	
3	98.2	88.6	78.2	67.7	58.8	56.8	59.7	71.0	82.9	96.0	103.8	103.2	
4	97.9	88.3	78.1	67.5	58.5	56.8	59.8	71.4	83.6	96.2	103.8	103.3	
5	97.8	88.1	77.6	67.5	58.3	57.0	60.3	71.8	84.3	96.2	103.9	103.5	
6	97.4	88.1	77.1	67.0	58.0	57.0	60.4	72.4	85.0	96.6	103.9	103.4	
7	97.2	87.9	77.0	66.7	57.8	57.4	60.6	72.8	85.5	97.2	104.2	103.6	
8	97.1	87.4	76.6	66.3	57.8	57.7	60.7	73.3	86.0	97.3	104.2	103.8	
9	96.9	87.1	76.0	65.7	57.6	57.4	61.0	73.6	86.3	98.0	104.4	103.9	
10	97.0	86.9	75.9	65.4	57.4	57.5	61.3	74.1	86.8	98.4	104.5	103.9	
11	96.4	86.6	75.3	65.1	57.3	57.5	61.6	74.4	87.2	98.8	104.6	103.7	
12	96.3	85.7	75.0	65.1	57.3	57.5	61.9	74.5	87.9	99.0	104.9	103.5	
13	95.8	85.3	74.4	64.7	57.1	57.6	62.2	74.7	88.2	99.1	104.9	103.3	
14	95.2	85.2	73.8	64.1	56.9	57.8	62.8	75.2	88.6	99.4	105.0	103.0	
15	95.1	84.9	73.5	63.7	56.9	57.9	63.4	75.6	89.0	99.6	105.1	102.9	
16	94.6	84.5	73.3	63.3	56.9	57.9	63.8	75.9	89.5	99.9	105.1	102.9	
17	94.3	84.0	73.0	62.8	56.8	58.1	64.3	76.3	90.1	100.3	104.9	102.8	
18	94.1	83.4	72.7	62.5	56.7	58.0	64.8	76.7	90.1	100.6	104.6	102.5	
19	93.8	82.8	72.2	62.1	56.8	57.9	65.2	77.2	90.3	100.8	104.5	102.1	
20	93.6	82.2	71.5	61.7	56.3	58.0	65.6	77.8	90.4	101.2	104.6	101.7	
21	93.2	81.8	70.9	61.3	56.0	58.4	66.1	78.3	90.7	101.4	104.7	101.0	
22	92.7	81.5	70.5	60.9	55.9	58.1	66.7	78.6	91.1	101.6	104.6	100.7	
23	92.5	81.0	70.1	60.9	55.8	58.0	67.3	78.8	91.9	101.8	104.4	100.2	
24	92.5	80.7	69.8	60.7	56.0	58.3	68.2	79.1	92.5	102.0	104.1	99.7	
25	92.3	80.1	69.5	60.5	56.0	58.2	68.6	79.4	93.1	102.3	104.0	99.7	
26	92.0	79.7	69.4	60.2	56.1	58.2	69.1	79.9	93.4	102.7	104.0	99.6	
27	91.4	79.1	69.2	59.9	56.0	58.3	69.3	80.2	93.7	102.8	104.0	99.4	
28	90.7	78.4	69.0	59.8	56.3	58.5	69.6	80.9	94.2	102.7	103.9	99.1	
29	90.2	78.4	68.7	59.6	56.3	58.5	69.7	81.2	94.8	102.8	103.9		
30	89.8	78.5	68.6	59.3	56.3	58.5	70.0	81.4	95.1	102.8	103.9		
31	89.4		68.5		56.5	58.7		81.6		102.8	103.8		
TOTALS	**2933.3**	**2524.0**	**2271.8**	**1908.3**	**1768.4**	**1791.0**	**1922.4**	**2359.3**	**2666.3**	**3091.5**	**3233.0**	**2863.0**	**29332.4**

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629
01/1970 THROUGH 03/2001 FIVE-STATION COMPOSITE WEATHER SERIES
1970-1999 NORMAL WEATHER VARIABLES CALCULATED BY RANK WITHIN YEAR, THEN ASSIGNED TO MONTHS AND DAYS
WATER HEATING DEGREE-DAYS (WHDD)

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	ANNUAL
1	100.4	91.0	79.9	68.8	61.3	53.9	57.9	69.3	81.1	93.8	100.8	105.4	
2	100.0	90.2	79.3	68.2	60.8	55.3	58.4	70.1	82.0	94.4	101.2	104.4	
3	99.7	89.6	78.9	67.7	60.4	54.3	58.7	70.8	83.0	95.0	102.5	103.5	
4	99.3	89.2	78.1	67.2	59.9	54.8	59.2	71.5	83.4	96.1	101.7	104.2	
5	98.9	89.0	77.4	66.7	59.6	55.7	59.8	72.1	83.9	95.6	102.7	104.8	
6	98.6	87.9	76.7	66.5	59.0	55.5	60.1	72.2	84.4	96.3	103.9	104.6	
7	98.3	87.5	76.3	66.2	58.8	56.0	60.5	72.7	84.8	96.8	105.0	105.2	
8	97.9	87.1	75.9	65.9	58.5	57.1	61.0	73.1	85.2	97.1	105.2	105.8	
9	97.6	86.5	75.8	65.5	58.3	55.9	61.4	73.5	85.6	97.4	105.7	106.2	
10	96.8	86.2	75.2	65.1	57.8	56.5	61.8	74.0	85.7	98.0	105.9	106.1	
11	96.6	85.9	74.8	64.9	57.3	56.3	61.9	74.2	86.0	98.4	106.4	105.5	
12	96.2	85.5	74.4	64.5	57.6	56.7	62.5	74.6	86.7	98.7	106.7	104.9	
13	95.8	84.9	74.1	64.2	57.2	56.9	62.5	74.7	87.4	99.1	106.8	103.7	
14	95.3	84.7	73.8	63.9	57.2	57.2	63.2	75.0	88.2	99.2	106.9	103.1	
15	95.1	84.3	73.6	63.8	56.7	57.3	63.5	75.4	88.8	99.6	107.1	102.5	
16	94.6	84.1	73.2	63.3	57.0	57.5	64.1	75.6	89.5	99.9	106.9	102.8	
17	94.1	83.7	72.9	63.0	56.6	58.5	64.4	76.1	90.0	100.1	106.8	102.3	
18	93.5	83.3	72.8	62.7	56.2	57.8	64.7	76.6	90.4	100.5	106.5	101.9	
19	93.3	82.6	72.4	62.3	56.4	57.5	65.4	77.1	90.8	101.0	105.8	101.5	
20	93.0	82.3	71.9	62.1	55.7	58.0	65.7	77.6	91.4	101.4	106.5	101.2	
21	92.7	81.5	71.8	61.6	53.8	60.0	66.1	78.3	91.8	101.6	106.6	100.7	
22	92.4	80.9	71.1	61.5	53.2	58.6	66.3	78.6	92.3	101.8	106.4	100.3	
23	92.1	80.5	70.6	61.2	53.0	58.1	66.8	79.1	92.5	102.2	105.4	99.8	
24	91.9	80.2	70.0	60.9	53.5	59.3	67.4	79.6	92.8	102.6	104.7	99.5	
25	91.5	79.7	69.6	60.3	54.1	59.1	68.0	80.1	93.2	102.9	104.0	98.8	
26	91.2	79.4	69.1	59.8	54.6	58.8	68.6	80.4	93.4	103.4	104.4	98.2	
27	90.7	78.5	68.5	59.5	54.5	59.7	69.7	80.7	93.6	104.1	104.6	97.7	
28	89.3	76.5	67.8	59.0	55.0	60.7	70.3	81.2	94.1	103.6	103.6	97.2	
29	88.4	77.9	67.5	58.7	55.5	61.1	71.1	81.6	94.7	103.8	103.2	97.1	
30	87.7	77.2	67.1	58.1	55.4	60.2	71.3	82.4	95.7	104.9	103.0		
31	87.0		67.0		56.1	61.5		82.9		104.5	102.1		
MAXIMUMS	**100.4**	**91.0**	**79.9**	**68.8**	**61.3**	**61.5**	**71.3**	**82.9**	**95.7**	**104.9**	**107.1**	**106.2**	**107.1**
TOTALS	2929.7	2517.7	2267.0	1903.1	1761.0	1785.8	1921.9	2360.8	2662.3	3093.6	3249.1	2895.9	29347.9

Schedule 1-7

Weather Measures From Five Weather Stations
Surrounding the St. Louis Area

Summary: Daily temperatures from five component weather stations were used to build a data set containing consistent daily average heating degree-days (HDD) for an area around St. Louis-Lambert Airport, Missouri.

The five stations were chosen from those cooperative stations published by the United States Historical Climatology Network (USHCN) as being as free as possible from discontinuities caused by changes in location, instrumentation, local environment, observation time and population growth. To achieve data consistency, discontinuities in actual observations of monthly average temperatures were removed by the National Oceanic and Atmospheric Administration (NOAA) and the Carbon Dioxide Information and Analysis Center (CDIAC). The USHCN is described at the following Internet website:

http://lwf.ncdc.noaa.gov/oa/climate/research/ushcn/ushcn.html

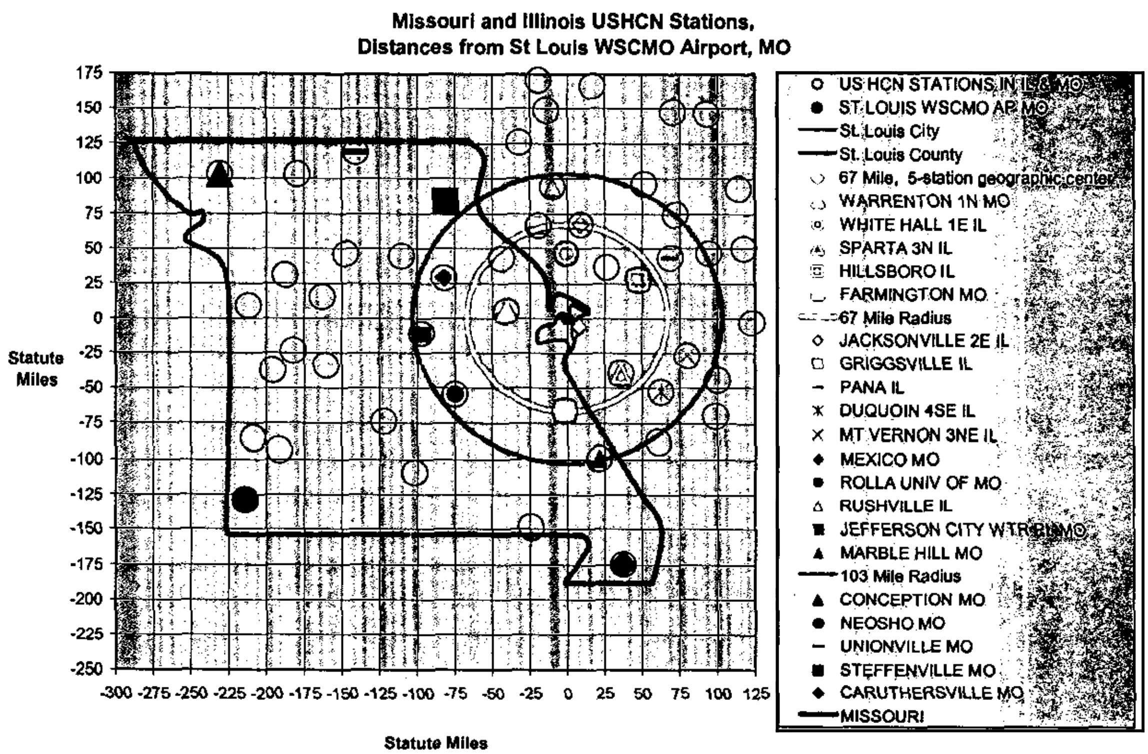
- The time period of the data sets included a test year ending 28 February 2001, as well as a thirty-year normals period containing the years 1970 through 1999.
- The series of daily average HDD from the five component stations were chosen in such a way as to represent a composite weather station with a geographic center as near to St. Louis-Lambert International Airport as possible.
- The daily temperatures for each of the component weather stations were calculated by setting the means of their respective monthly distributions to be equal to adjusted monthly temperatures published for that station by the USHCN.
  - The benchmarking process for adjusting the daily temperatures was based on the one that the Staff has used since the 1995 Missouri Gas Energy rate case, Case No. GR-96-285. In that case and subsequent ones, daily temperatures were made consistent with the adjusted monthly temperatures that NOAA used to calculate 1961-1990 normals.
  - Adjusted monthly averages of daily maximum temperature (TMAX) and daily minimum temperature (TMIN), published by the USHCN, provide the mean values to be sued as benchmarks for consistent daily temperatures at each of the component weather stations. Daily HDD were then calculated from the adjusted daily temperatures.

Selection of component weather stations. Selection was loosely based on a station's distance from St. Louis-Lambert International Airport (the selection radius). A station could be selected if the following criteria were met:

1. The station was operational during all months of the test year.
2. The station was near St. Louis, Missouri, yet its inclusion did not shift the group's geographic center to far away from the St. Louis airport.

3. The station was included in the USHCN from January 1970 through December 1999, the last month for which USHCN data were published.
4. The station experienced no documented changes in observation times after 1999.
5. Official weather data for the station were sufficiently continuous from January 1970 through February 2001.

The weather stations whose data and histories met the criteria were Farmington and Warrenton in Missouri, and Hillsboro, Sparta and White Hall in Illinois. The geographic center of the final group of five stations appears to have fallen within the city limits of St. Louis, less than 10 miles east-southeast of St. Louis-Lambert International Airport. Since it was judged that five component stations were sufficient, the selection radius was not extended beyond Farmington (MO), at about 66 miles. The stations are represented in the following graphic.



Rejection. Carlinville (IL) and Bowling Green (MO) were located within the selection radius, but were rejected for lack of continuous data during the test year. Griggsville (IL) and Jacksonville (IL) were at about the same distance as Farmington (MO), but were not examined because their inclusion would have shifted the geographic center too far northward.

Normals Period. Since publication of the NOAA normals for 1971 through 2000 is expected in early 2002, an appropriate normals period for this analysis would ordinarily have been the same thirty years. However, the normals period 1970 through1999 was chosen because USHCN data were not yet available beyond 1999.

Benchmark calculations where USHCN temperature data were available. The purpose of these calculations is to adjust daily observations for discontinuities to match the adjustments made to monthly values in the USHCN database.

1. The time series of adjusted monthly average TMAX and TMIN for the time period 1970 through 1999 were available from USHCN data products for each of the component stations, giving 360 adjusted monthly observations (12 for each year from 1970 through 1999).
2. Monthly average TMAX and TMIN for the period 1970 through 1999 were calculated from official daily observations at each component station. This yielded 360 unadjusted monthly observations.
3. Within each month and at each component station, the differences between the USHCN monthly averages and the monthly averages calculated from daily observations are calculated as the adjustments made for discontinuities.
4. Within each month and at each component station, the monthly average adjustments for discontinuities are added to the daily observations within each month. This yields 30 years of adjusted daily temperatures that have the same mean values as the USHCN adjusted monthly TMAX and TMIN, and the same distribution within the month as the official daily observations.

Adjustments to temperature data for years after 1999. The purpose of these calculations is to make current (test year) data consistent with historical data that has been adjusted for discontinuities.

1. First, at each component station and for 1999 (or 1998 when 1999 observations were not available), temperature adjustments were calculated by month as the USHCN adjusted average TMAX and TMIN minus the unadjusted averages of official daily TMAX and TMIN respectively. This calculated adjustment would be the most recently made adjustment to observations for historical discontinuities.
2. At each of the component stations and for each month after December 1999 through February 28, 2001, the discontinuity adjustments calculated above were added to the official daily observations of TMAX and TMIN respectively. This results in adjusted daily TMAX and TMIN observations through the test year that ended February 28, 2001. These adjustments to the most recent observations are valid under two assumptions.
    a. *Instruments have not changed, observation times had not changed, and the component stations had not moved since 1999.* Examination of records at the Midwest Climate Center website showed no such events at the component stations, indicating that this assumption was reasonable.
    b. *USHCN adjustments would be the same for each month from one year to the next for at least a short run of years.* Examination of the seasonal pattern of USHCN temperature adjustments that were calculated over all available years showed that this was also a reasonable assumption. Except for the occasional months where official observations were missing, the seasonal adjustment patterns have been consistent for about a decade.

Calculation of averages over component stations. The purpose of these calculations is simply to calculate an average over the five stations.

1. For each day between January 1, 1970 through February 28, 2001, and at each component station, adjusted mean daily temperature (MDT) was calculated as the average of the adjusted daily TMAX and TMIN at that station.
2. Adjusted daily HDD were then calculated as 65 degrees F minus the adjusted daily MDT where the latter was less than 65, and were set to zero otherwise.
3. For each date, adjusted daily HDD at the composite station were calculated as the average of adjusted daily HDD for that date at the five component stations. Average adjusted daily TMAX and TMIN and MDT were also calculated for the composite station as a check for reasonableness.

Consistent Weather Measures at
The St. Louis International Airport Weather Station

Background

An exposure change is said to have occurred where the environment around a weather station changes, where the measurement instrument is exchanged for a new one of a different type, where the observation time changes, or where the station itself is moved to a new location. Temperature measurements taken after an exposure change are not consistent with temperature measurements taken before, making historical observations used for weather normals inconsistent over periods in which such changes have occurred. It is necessary to make adjustments for exposure changes in order to achieve consistency. In this analysis, adjustments were made to observations that occurred before an exposure change to make them consistent with observations that occurred after the change.

Exposure Changes at STL

Temperature data from the National Oceanographic and Atmospheric Administration (NOAA) for St. Louis International Airport (STL) were compared to observations from a number of surrounding stations for the years 1970 through the present. Cumulative sums of temperature differences (double mass analysis) were used to compare STL temperatures with temperatures at a group of its neighbors. STL exposure changes that were easily seen in the temperature comparisons occurred in 1979, 1985, 1988 and 1996.

- NOAA has documented the 1979, 1985 and 1996 changes in its Local Climatological Data publication for St. Louis.
- Previously, the Staff retained the State Climatologist to investigate exposure changes, and annual adjustments were developed. The State Climatologist documented an additional change for 1988 during his contribution to the Staff's analysis in Case No. GR-99-315.
- More recently, Laclede Gas Company (LGC) and Staff together retained Dr. Thomas McKee from Colorado State University to investigate the 1996 exposure change. Dr. McKee calculated seasonal adjustments.

Calculation of Adjustments

NOAA's adjustments for 1979 were calculated by the Staff as the difference between NOAA's adjusted monthly temperatures and the unadjusted reported temperatures. Staff's adjustments and Dr. McKee's adjustments were calculated as the change in differences between STL temperatures and temperatures at selected neighboring stations, before and after each exposure change. Cumulative sums of differences (double mass analysis) and least squares regression were the tools used in these calculations.

- **1979.** A new hygrothermometer of the type in use at the time was commissioned in a new location at STL in November of 1979. Installation, acceptance and evaluation of the new set of instruments probably took place over a number of months before that date. Accordingly, NOAA calculated adjusted TMAX and TMIN at STL for all months from January, 1961 through December of 1977. Separate adjustments were calculated for TMAX and TMIN, and separate adjustments were calculated for each of the 12 calendar months. Adjusted temperatures were significantly warmer than the recorded ones, and TMIN adjustments were much larger than TMAX adjustments. TMAX adjustments were larger in September, October and November than they were in the remaining months. The aggregate effect of the adjustments was about +1.1 degrees for each of the years 1961 through 1977.

- **1985.** A new type of hygrothermometer (the HO-83) replaced the old, and was commissioned in a new but nearby location at STL in March of 1985 (after a "minor move"). In Case No.GR-99-315, the State Climatologist found that a significant exposure change had resulted and calculated a positive adjustment, but did not calculate exposure change adjustments by season. In the current case, following Dr. McKee's seasonal classification, the Staff calculated adjustments for four seasons: December, January & February (DJF); March, April & May (MAM); June, July & August (JJA); and September, October & November (SON). The neighboring stations used in Staff's 1985 analysis were St. Charles 7SSW (MO) and Jerseyville (IL). The seasonal adjustments to prior years for the 1985 exposure change were generally positive for TMAX but mixed for TMIN. The aggregate effect of Staff's seasonal adjustments for 1985 was about 0.7 degrees in mean daily temperature over one year. The effects of the combined NOAA and Staff adjustments would be about +1.8 degrees for years prior to 1979, and about +0.7 degrees for years prior to 1985.

- **1988.** From STL station records, the State Climatologist noted a minor move of the ground temperature instruments, but from a relatively open location to a more protected one, in November of 1988. He also calculated a positive year-around or non-seasonal adjustment for this move in the course of GR-99-315. In the current case, the Staff has also calculated seasonal adjustments for 1988 using Dr. McKee's seasonal classification. The neighboring stations used in Staff's 1988 analysis were St. Charles (MO) and Carlinville (IL). The adjustments were generally positive throughout, and varied considerably by season. Aggregate TMAX adjustments (at about 1.15 degrees over all seasons) were somewhat larger than TMIN adjustments (at about 0.8 degrees over all seasons). The aggregate effect of the Staff's adjustments for 1988 was about 0.96 degrees over all seasons. At this stage, the effects of the combined NOAA and Staff adjustments would be about +2.8 degrees for years prior to 1979, about +1.7 degrees for years prior to 1985, and about +0.96 degrees for years prior to 1988.

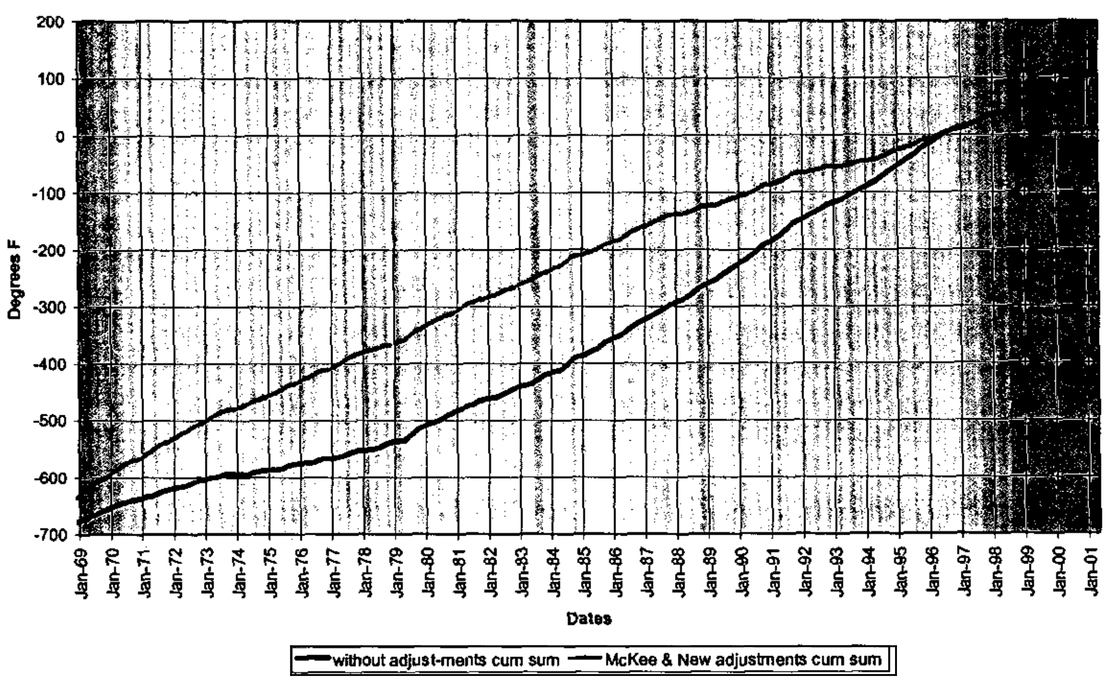
- **1996.** Automated Surface Observing System (ASOS) instruments replaced the former HO-83 ground temperature instruments at STL in 1996. STL's ASOS was commissioned in a new well-exposed runway location at in mid-May of that year. Laclede Gas Company and the Staff retained Dr. McKee to examine the effects of this change. Dr. McKee used a seasonal analysis, and employed temperatures from St. Charles (MO) and Jerseyville (IL) to calculated his adjustments. Dr. McKee's report contained seasonal adjustments for this exposure change that were generally negative, that were about –1.0 degrees in the aggregate for TMAX, and that were about –2.1 degrees in the aggregate for TMIN. The direction of these adjustments was not unexpected because the former HO-83 site had been protected by heated office buildings, and had been warmed in some seasons by an asphalt parking lot. In addition, the HO-83 thermometer was itself known to have a warming bias of about 0.5 degrees. The aggregate effect of Dr. McKee's adjustments for 1996 was about –1.53 degrees over all seasons. The combined and aggregated effects of NOAA's adjustments, Staff's adjustments and Dr. McKee's adjustments would be about +1.17 degrees for years prior to 1979, about +0.12 degrees for years prior to 1985, about –0.56 degrees for years prior to 1988, and about –1.53 degrees for years prior to 1996.

Crosschecks

In a separate analysis, the Staff constructed a set of adjusted daily temperatures by using United States Historical Climatology Network adjusted monthly temperatures as benchmarks, for five weather stations in the St. Louis area. The new St. Louis adjusted temperatures were compared the set of USHCN temperatures in two ways.

1. **Temperatures.** First, cumulative sums of monthly temperature differences (double mass analysis) were used to visually check the consistency of the adjusted St. Louis temperatures with respect to USHCN monthly temperatures. The cumulative sums of differences between the two sets of temperatures exhibited the same slope before each of the exposure changes addressed above as was exhibited after each. Moreover, except for short periods that compensated one another, the slope was relatively constant from 1970 all the way through early 2001.

St. Louis Lambert Airport Temperatures Cumulative Sum of Differences
(St. Louis Temp less Composite Temp)



2. **Degree-days.** Second, normals were calculated for both daily time series for the years 1970 through 1999, and the HDD adjustments from actual to normal were compared for the 12 calendar months ending with February, 2001. The HDD adjustments thus calculated were different by 1.14 percent.

LACLEDE GAS COMPANY RATE CASE NO. GR-2001-629 FIVE-STATION COMPOSITE WEATHER SERIES VERSUS ST. LOUIS-LAMBERT WEATHER SERIES ACTUAL AND NORMAL HEATING DEGREE-DAYS (HDD) FOR THE PERIOD 1 MARCH 2000 – 28 FEBRUARY 2001				
Stations	1970-1999 Normal HDD	Actual HDD: 12 months ending Feb 2001	Difference, Normal-Actual	Difference, Percent of Actual
Five -Station Composite	5148	5266	-118	-2.23%
St. Louis With Adjustments	4785	4952	-167	-3.37%
Difference: Five-Station Composite Minus St. Louis With Adjustments	363	313	49	1.14%

3. **Implications.** The results imply first that the set of adjusted STL temperatures described above are consistent with a set of USHCN monthly temperature data. Since the USHCN temperatures have themselves been made consistent by NOAA and the Carbon Dioxide Information and Analysis Center, the results imply that the adjusted STL temperatures are themselves consistent. Finally, the results imply that actual HDD calculated over a test year ending February, 2001 would be consistent with normal HDD calculated over the years 1970 through 1999, for the adjusted St. Louis temperature time series.

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FIVE-STATION COMPOSITE WEATHER SERIES VERSUS ST. LOUIS-LAMBERT WEATHER SERIES
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FOR THE PERIOD 1 MARCH 2000 -- 28 FEBRUARY 2001

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Schedule 4