Exhibit No.:
Issues: Weather Normalization

Witness: Dennis Patterson
Sponsoring Party: MO PSC Staff
Type of Exhibit: Surrebuttal Testimony
Case No.: GR-2004-0209
Date Testimony Prepared: June 14, 2004

MISSOURI PUBLIC SERVICE COMMISSION

UTILITY OPERATIONS DIVISION

SURREBUTTAL TESTIMONY

OF

DENNIS PATTERSON

MISSOURI GAS ENERGY

CASE NO. GR-2004-0209

Jefferson City, Missouri
June 2004

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the Matter of Missouri Gas Energy's Tariff Sheets Designed to Increase Rates for Gas Service in the Company's Missouri Service Area	))))	Case No. GR-2004-0209

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 following Surrebuttal Testimony in question and answer form, consisting of 7 pages of Surrebuttal Testimony to be presented in the above case, that the answers in the following Surrebuttal 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 9th day of June, 2004.

Notary Public

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

My commission expires

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SURREBUTTAL TESTIMONY

OF

DENNIS PATTERSON

MISSOURI GAS ENERGY

CASE NO. GR-2004-0209

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 Energy Department of the Utility Operations Division.

Q. Are you the same Dennis Patterson who has submitted Direct and Rebuttal Testimony in this case?

A. Yes, I am.

SUMMARY

Q. What is the purpose of your Rebuttal Testimony?

A. I will address the written Rebuttal Testimony of Company witness F. Jay Cummings, PhD on the issue of weather normalization of test year revenues.

Q. What issues in Dr. Cummings' Rebuttal Testimony will you address?

A. I will first address Dr. Cummings' concerns regarding the recommendations of the Staff and the decisions of the Missouri Public Service Commission (Cummings Rebuttal, Page 6, lines 11-16; Page 6, line 23 through Page 7,

line 2). I will then address certain other details of Dr. Cummings' Rebuttal Testimony where he proposes to remove or discard certain years and days of HDD data from the calculation of average annual HDD. As before, I will defer to other Staff witnesses for the calculation of weather adjustments.

STAFF RECOMMENDATIONS

Q. What are the Staff's recommendations for calculating normal weather?

A. The Staff continues to recommend the use of the National Oceanic and Atmospheric Administration (NOAA) normals based on a three-decade time period in rate cases before the Commission. This period is currently the years 1971 through 2000.

Q. Why does the Staff continue to recommend this standard?

A. The three-decade normals period is the international standard that is long enough and recalculated often enough for statistical and practical reasons, and is accepted by national weather agencies whose responsibility is to provide the standards. "A climate normal is defined, by convention, as the arithmetic mean of a climatological element computed over three consecutive decades..." (Climatology of the United States No. 81, Monthly Normals of Temperature, Precipitation and Heating and Cooling Degree Days, 1971-2000, Missouri, in the section entitled "Computational Procedures.)" (Please see Schedule 1-3.) The Staff has also verified that NOAA normals based on the current three-decade time period to be statistically superior to averages based on the shorter time periods, for summer and winter temperatures at the many Missouri weather stations in the regulated utility service areas.

Q. How does the Staff believe that its recommendation should be applied?

A. The Staff believes that the recommendation should apply for regulated electric, gas and water utilities in Missouri, and that the consequences of departing from this reliable standard would be far-reaching.

Q. Have longer time periods been considered?

A. Yes, because there is evidence that a longer time period would be superior statistically to the three-decade period normally used in Missouri. However, it is difficult and costly to maintain consistent historical data for weather stations for long time periods.

Q. Why is this true?

A. The difficulty arises because changes can occur at the stations that are not in control of the Commission, and that NOAA does not address if the changes occur before the standard three-decade normals period: "Ideally, the data record for such a 30-year period should be free of any inconsistencies in observational practices (*e.g.*, changes in station location, instrumentation, time of observation, *etc.*) and be serially complete (*i.e.* no missing values). When present, inconsistencies can lead to a non-climatic bias in one period of a station's record relative to another, yielding an "inhomogeneous" data record." (Please see "Computational Procedures" at Schedule 1-3.)

Q. Is the standard for the calculation of normals restricted to the choice of time period?

A. No. The standard includes numerous crosschecks and addresses unavoidable inconsistencies in temperature data. (Please see "Computational Procedures" at Schedule 1-3.)

Q. In your Rebuttal Testimony, did you conclude that the NOAA methodology using the three-decade time period was superior for the calculation of the HDD normals?

A. Yes, I did, using Kansas City as an example. I showed in my Rebuttal Testimony that normals calculated from shorter time periods were not superior because they are not as accurate and because they changed more from one year to the next. This result is general for Missouri weather stations whose annual HDD values vary around a constant or slowly changing average over many years. That is, normals calculated from three decades of data on a 10-year update schedule are more accurate and vary less than the alternatives presented by Dr. Cummings.

Q. If it could be shown conclusively that a different time period were superior to the Staff's proposed three-decade period, would the Staff change its recommendation?

A. Yes, if the costs were not prohibitive and consistent data were available.

Q. Would such a time period be shorter than 30 years?

A. Not under current climatic conditions, where annual HDD values appear to vary about a constant average for Missouri stations. The shorter time period could be superior only if the weather patterns in Missouri began to change quite drastically, beyond the limits illustrated in my Rebuttal Testimony for Kansas City.

DETAILS OF DR CUMMINGS' REBUTTAL TESTIMONY

Q. In his Rebuttal Testimony, did Dr. Cummings show that his 20-year time period was superior to the three-decade time period that NOAA uses to calculate weather normals?

A. No. Under the objective statistical criteria of accuracy and stability, I don't believe that he has.

Q. What did Dr. Cummings establish in his Rebuttal Testimony?

A. He appeared to try to establish that HDD normals from shorter time periods ending in 2003 resulted in a smaller number of HDD than the HDD normal from the 30-year time period ending in 2000 (Cummings Rebuttal Testimony, page 9, lines 3-19). Dr. Cummings then appeared to suggest that the Company might therefore merit the concession of a higher revenue requirement based on the suggestion that the distribution of warm and cold years in the normals period was not balanced between early and later years (Cummings Rebuttal, page 10, lines 1-8). He also appeared to establish that a select group of jurisdictions had approved the use of shorter time periods in the past as another basis for the desired concession (Cummings Rebuttal, all of pages 7 and 8). Finally, he appeared to favor calculations where extreme high and low annual or daily HDD values were discarded before normals would be calculated (Cummings Rebuttal, page 8, lines 7-9 and page 12, lines 4-14). The universal effect of these alternatives would be to reduce the influence of annual HDD values from certain years in the 1970s and 1980s by excluding one or more of them from the calculations of average annual HDD.

Q. Has Dr. Cummings presented any statistical evidence that would justify a departure from NOAA's established standard of three-decade normals calculated from data that had been made consistent, in favor of alternatives that discard selected annual HDD values or daily HDD values?

A. No. The Staff sees no statistical reason to adopt any of these alternatives, because the universal effect would be to discard valuable information that should be included in the calculation of average annual HDD.

Q. What would persuade the Staff to discard certain annual HDD or daily HDD observations?

A. Staff members are not climatologists, and are therefore not necessarily qualified to discard HDD observations. However, the Staff recognizes that HDD observations that were several standard deviations away from the average value for the year, month or day (as appropriate) should be considered for elimination or estimation. Similarly, HDD observations that were greatly different from those at neighboring stations would be suspect.

Q. Has anyone reviewed the temperature and HDD data in this case for such departures?

A. Yes. NOAA climatologists have already performed the necessary quality control to insure that the data are statistically acceptable.

Q. When do NOAA climatologists perform the quality control procedures?

A. NOAA performs such procedures twice: first, at the time the daily temperature and HDD data are archived and published, and again when the HDD normals are calculated from the archived data.

With regard to daily HDD, the underlying daily temperature data are extensively reviewed: "**Historical cooperative station index**. Cooperative stations are U.S. stations operated by local observers, which generally report max/min temperatures and precipitation. National Weather Service (NWS) data are also included in this dataset.

The data receive extensive automated +(*sic.*) manual quality control." (National Climatic Data Center (NCDC) Inventories website, page 1.) (Please see Schedule 2, attached to my Surrebuttal Testimony) I have provided a text version of the electronic document as working papers for my Surrebuttal Testimony.

With regard to NOAA normals products: "Each monthly observation is evaluated using a modified quality control procedure ... where station observation departures are computed, compared with neighboring stations, and then flagged and estimated where large differences with neighboring values exist." (Schedule 1-3.)

CONCLUSIONS

Q. Please summarize your Surrebuttal Testimony.

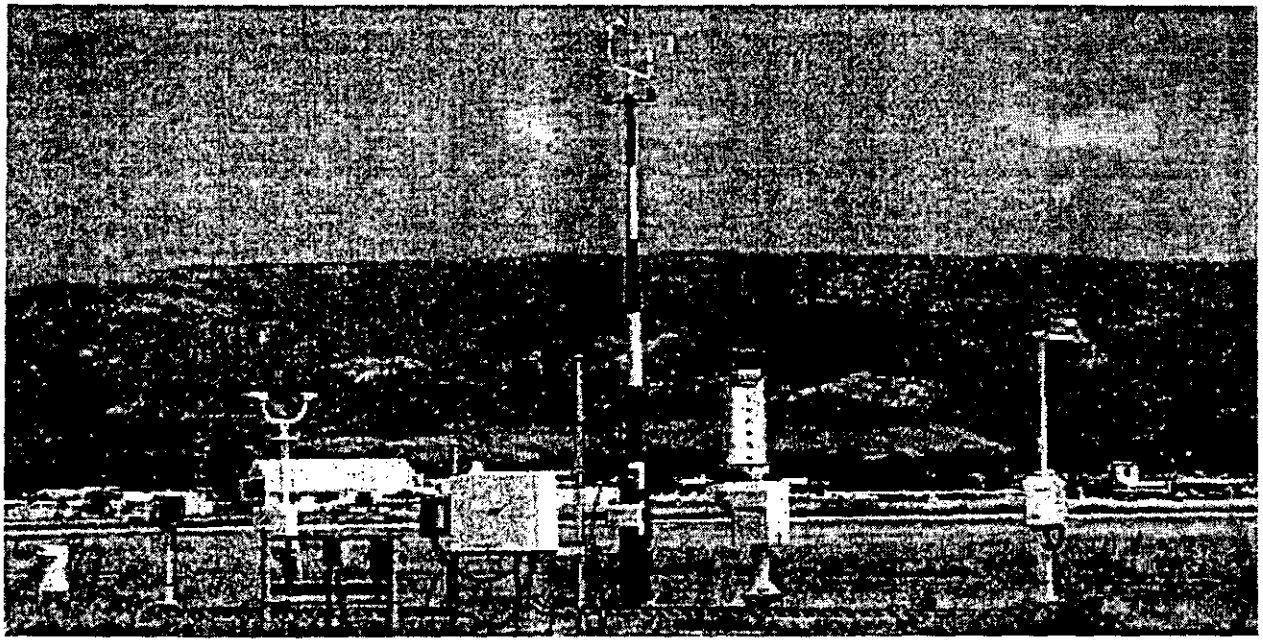
A. First, in response to the legitimate concerns voiced in Dr. Cummings' Rebuttal Testimony, I have attempted to illustrate that the three-decade time period used by NOAA is part of a carefully crafted set of climatology standards that should not be abandoned arbitrarily. Second, in response to the several alternative calculations that were supported in Dr. Cummings' Rebuttal Testimony, I have attempted to show that there is no valid statistical reason for removing selected years or days from the temperature and HDD data that are used to calculate average annual HDD for the Kansas City and Joplin service areas of the Company. For these reasons, the Staff continues to recommend that the current 1971-2000 edition of NOAA's Monthly Station Normals be used as the basis for weather normalization in the present MGE rate case.

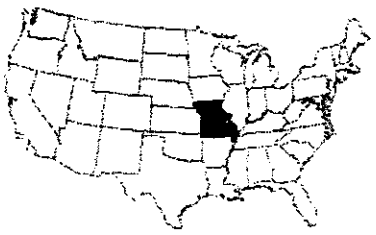
Q. Does this conclude your Surrebuttal Testimony?

A. Yes, it does.

CLIMATOGRAPHY OF THE UNITED STATES NO. 81

Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971 - 2000





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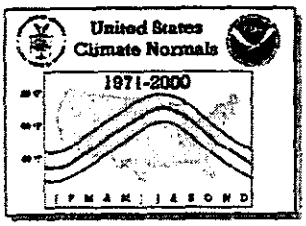
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, NC

Schedule 1-1



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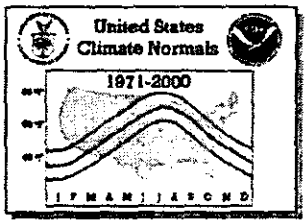


CLIMATOGRAPHY OF THE UNITED STATES NO. 81

Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days
1971-2000

MISSOURI

NOTES

Product Description:
This Climatography includes 1971-2000 normals of monthly and annual maximum, minimum, and mean temperature (degrees F), monthly and annual total precipitation (inches), and heating and cooling degree days (base 65 degrees F). Normals stations include both National Weather Service Cooperative Network and Principal Observation (First-Order) locations in the 50 states, Puerto Rico, the Virgin Islands, and Pacific Islands.

Abbreviations:

No. = Station Number in State Map
COOP ID = Cooperative Network ID (1:2=State ID, 3:6=Station Index)
WBAN ID = Weather Bureau Army Navy ID, if assigned
Elements = Input Elements (X=Maximum Temperature, N=Minimum Temperature, P=Precipitation)
Call = 3-Letter Station Call Sign, if assigned
MAX = Normal Maximum Temperature (degrees Fahrenheit)
MEAN = Average of MAX and MIN (degrees Fahrenheit)
MIN = Normal Minimum Temperature (degrees Fahrenheit)
HDD = Total Heating Degree Days (base 65 degrees Fahrenheit)
CDD = Total Cooling Degree Days (base 65 degrees Fahrenheit)

Latitude = Latitude in degrees, minutes, and hemisphere (N=North, S=South)
Longitude = Longitude in degrees, minutes, and hemisphere (W=West, E=East)
Elev = Elevation in feet above mean sea level
Flag 1 = * If a published *Local Climatological Data* station
Flag 2 = + if WMO Fully Qualified (see *Note* below)

HIGHEST MEAN/YEAR = Maximum Mean Monthly Value/Year, 1971-2000
MEDIAN = Median Mean Monthly Value/Year, 1971-2000
LOWEST MEAN/YEAR = Minimum Mean Monthly Value/Year, 1971-2000
MAX OBS TIME ADJUSTMENT = Add to MAX to Get Midnight Obs. Schedule
MIN OBS TIME ADJUSTMENT = Add to MIN to Get Midnight Obs. Schedule

Note: In 1989, the World Meteorological Organization (WMO) prescribed standards of data completeness for the 1961-1990 WMO Standard Normals. For full qualification, no more than three consecutive year-month values can be missing for a given month or no more than five overall values can be missing for a given month (out of 30 values). Stations meeting these standards are indicated with a '+' sign in Flag 2. Otherwise, stations are included in the normals if they have at least 10 year-month values for each month and have been active since January 1999 or were a previous normals station.

Map Legend: Numbers correspond to 'No.' in Station Inventory; Shaded Circles indicate Temperature and Precipitation Stations, Triangles (Point Up) indicate Precipitation-Only Stations, Triangles (Point Down) indicate Temperature-Only Stations, and Hexagons indicate stations with Flag 1 = *.

Computational Procedures:

A climate normal is defined, by convention, as the arithmetic mean of a climatological element computed over three consecutive decades (WMO,1989). Ideally, the data record for such a 30-year period should be free of any inconsistencies in observational practices (*e.g.*, changes in station location, instrumentation, time of observation, *etc.*) and be serially complete (*i.e.*, no missing values). When present, inconsistencies can lead to a non-climatic bias in one period of a station's record relative to another, yielding an "inhomogeneous" data record. Adjustments and estimations can make a climate record "homogeneous" and serially complete, and allow a climate normal to be calculated simply as the average of the 30 monthly values.

The methodology employed to generate the 1971-2000 normals is not the same as in previous normals, as it addresses inhomogeneity and missing data value problems using several steps. The technique developed by Karl *et al.* (1986) is used to adjust monthly maximum and minimum temperature observations of conterminous U.S. stations to a consistent midnight-to-midnight schedule. All monthly temperature averages and precipitation totals are cross-checked against archived daily observations to ensure internal consistency. Each monthly observation is evaluated using a modified quality control procedure (Peterson *et al.*,1998), where station observation departures are computed, compared with neighboring stations, and then flagged and estimated where large differences with neighboring values exist. Missing or discarded temperature and precipitation observations are replaced using a weighting function derived from the observed relationship between a candidate's monthly observations and those of up to 20 neighboring stations whose observations are most strongly correlated with the candidate site. For temperature estimates, neighboring stations were selected from the U.S. Historical Climatology Network (USHCN; Karl *et al.* 1990). For precipitation estimates, all available stations were potential neighbors, maximizing station density for estimating the more spatially variable precipitation values.

Peterson and Easterling (1994) and Easterling and Peterson (1995) outline the method for adjusting temperature inhomogeneities. This technique involves comparing the record of the candidate station with a reference series generated from neighboring data. The reference series is reconstructed using a weighted average of first difference observations (the difference from one year to the next) for neighboring stations with the highest correlation with the candidate. The underlying assumption behind this methodology is that temperatures over a region have similar tendencies in variation. If this assumption is violated, the potential discontinuity is evaluated for statistical significance. Where significant discontinuities are detected, the difference in average annual temperatures before and after the inhomogeneity is applied to adjust the mean of the earlier block with the mean of the latter block of data. Such an evaluation requires a minimum of five years between discontinuities. Consequently, if multiple changes occur within five years or if a change occurs very near the end of the normals period (*e.g.*, after 1995), the discontinuity may not be detectable using this methodology.

The monthly normals for maximum and minimum temperature and precipitation are computed simply by averaging the appropriate 30 values from the 1971-2000 record. The monthly average temperature normals are computed by averaging the corresponding monthly maximum and minimum normals. The annual temperature normals are calculated by taking the average of the 12 monthly normals. The annual precipitation and degree day normals are the sum of the 12 monthly normals. Trace precipitation totals are shown as zero. Precipitation totals include rain and the liquid equivalent of frozen and freezing precipitation (*e.g.*, snow, sleet, freezing rain, and hail). For many NWS locations, indicated with an '*' next to 'HDD' and 'CDD' in the degree day table, degree day normals are computed directly from daily values for the 1971-2000 period. For all other stations, estimated degree day totals are based on a modification of the rational conversion formula developed by Thom (1966), using daily spline-fit means and standard deviations of average temperature as inputs.

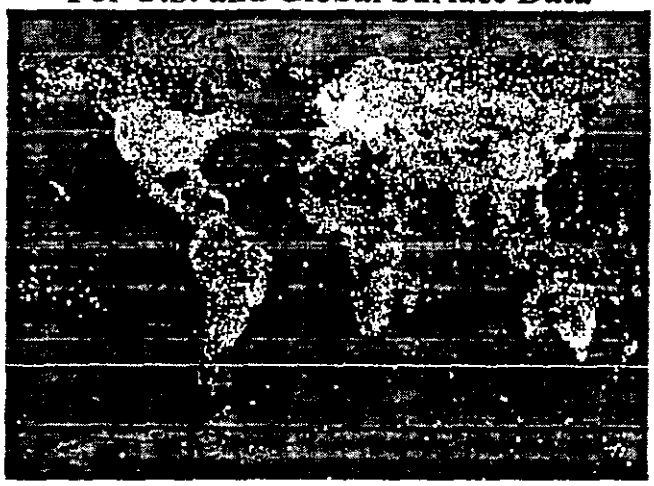
References:

Easterling, D.R, and T.C. Peterson, 1995: A new method for detecting and adjusting for undocumented discontinuities in climatological time series. *Intl. J. Clim.*, **15**, 369-377.
Karl, T.R., C.N. Williams, Jr., P.J. Young, and W.M. Wendland,1986: A model to estimate the time of observation bias associated with monthly mean maximum, minimum, and mean temperatures for the United States. *J. Clim. Appl. Met.*, **25**, 145-160.
Peterson, T.C., and D.R. Easterling, 1994: Creation of homogeneous composite climatological reference series. *Intl. J. Clim.*, **14**, 671-679.
Peterson,T.C., R. Vose, R. Schmoyer, and V. Razuvaev, 1998: Global Historical Climatology Network (GHCN) quality control of monthly temperature data. *Intl. J. Clim.*, **18**, 1169-1179.
Thom, H.C.S., 1966: Normal degree days above any base by the universal truncation coefficient, *Month. Wea. Rev.*, **94**, 461-465.
World Meteorological Organization, 1989: Calculation of Monthly and Annual 30-Year Standard Normals, WCDP-No. 10, WMO-TD/No. 341, Geneva: World Meteorological Organization.

Release Date: December 1, 2001 **National Climatic Data Center/NESDIS/NOAA, Asheville, North Carolina**

Inventories/Station Lists

For U.S. and Global Surface Data



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Introduction

Quick access to NCDC inventories and information is provided below (just click on any file listed below to download). Instructions are also provided at the bottom of this page for accessing these files through anonymous ftp. Some of these files are rather large so special attention to the size is recommended before accessing them through your browser. Additional notes are also available, along with utility software for uncompressing files, etc.

Surface Data Inventories & Station Lists

ASOS STATION LIST

ftp://ftp.ncdc.noaa.gov/pub/data/inventories/ASOSLST.XLS (200.0Kbytes)
MS Excel File--A list of all U.S. ASOS stations for which NCDC receives and processes data.

COOPERATIVE STATIONS INDEX

ftp://ftp.ncdc.noaa.gov/pub/data/inventories/COOP.TXT **(13Mbytes)**
Historical cooperative station index. Cooperative stations are U.S. stations operated by local observers which generally report max/min temperatures and precipitation. National Weather Service (NWS) data are also included in this dataset. The data receive extensive automated + manual quality control. The index includes a county

Schedule 2