Exhibit No.:
Issue(s): Weather Normalization
Witness: Michael S. Proctor
Type of Exhibit: Surrebuttal
Sponsoring Party: MoPSC Staff
Case No.: GR-99-315

MISSOURI PUBLIC SERVICE COMMISSION

UTILITY OPERATIONS DIVISION

SURREBUTTAL TESTIMONY

OF

MICHAEL S. PROCTOR

LACLEDE GAS COMPANY

CASE NO. GR-99-315

Jefferson City, Missouri

August, 1999

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Q. WHAT IS YOUR NAME AND BUSINESS ADDRESS?

A. My name is Michael S. Proctor. My business address is 301 West High St., P.O. Box 360, Jefferson City, Mo. 65102-0360.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by the Missouri Public Service Commission (Commission) as Chief Regulatory Economist in the Electric Department.

Q. WHAT IS YOUR EDUCATION BACKGROUND AND WORK EXPERICENCE?

A. I have Bachelors and Masters of Arts Degrees in Economics from the University of Missouri at Columbia, and a Ph.D. degree in Economics from Texas A&M University. My previous work experience has been as an Assistant Professor of Economics at Purdue University and at the University of Missouri at Columbia. Since June 1, 1977 I have been on the Staff of the Commission and have presented testimony on various issues related to weather normalized energy usage and rate design for both electric and natural gas utilities.

Q. WHICH OF YOUR CURRENT DUTIES RELATE TO THIS INSTANT CASE?

A. I have oversight responsibility for the Staff on issues related to normal weather. Specifically, I supervise the work of Mr. Dennis Patterson and made the decision to contract for the services of Dr. Steve Qui Hu.

Q. WHAT IS THE NATURE OF YOUR SURREBUTTAL TESTIMONY IN THIS INSTANT CASE?

A. My surrebuttal testimony in this instant case is in response to the rebuttal testimony of Laclede Gas Company (LGC or Company) witness Patricia A. Krieger. Specifically, on pages 4 through 8, Ms. Krieger has a section of her rebuttal testimony entitled: "Inconsistency of Staff's Normalization Adjustment." In this section of her rebuttal testimony, Ms. Krieger claims that the Staff's approach to weather normalization has not been consistent, starting with Case No. GR-92-165. The inconsistency claimed is due to the changes in what Staff has proposed for normal heating degree days (HDD) for that case, for GR-94-220, GR-96-193, GR-98-374 and in this current case GR-99-315. Because I have ultimately been responsible for the decisions that led to these changes, I am responding to what I see as a mischaracterization of these changes as demonstrating an inconsistency on the part of the Staff.

Q. DO YOU AGREE WITH MS. KRIEGER'S DESCRIPTION OF THE CHANGES IN NORMAL HDD USED IN THESE CASES?

A. Yes, I agree with Ms. Krieger's description of the basic information about the normal HDD used by the Staff in each of these cases. However, what Ms. Krieger failed to include in her rebuttal testimony is the additional information that was available to LCG at each point in the events that resulted in the Staff's choice for normal HDD. For example, in GR-92-165 the Staff did use a 30-year normal HDD based on a simple

average of NOAA heating degree days for the period ending in 1990. At that time the Staff was not aware of any reason to use other than a simple average without corrections for weather station changes as the St. Louis Lambert International Airport (Lambert Field). The normal HDD, unadjusted for any changes were 4,939.

Q. PRIOR TO FILING IN GR-92-165, HAD THE STAFF CONSULTED WITH THE STATE CLIMATOLOGIST TO DETERMINE WHAT IT SHOULD USE AS THE BASIS FOR NORMAL HDD?

A. Yes, I consulted with Dr. Wayne L. Decker, who at that time was the State Climatologist for Missouri. Dr. Decker pointed out several changes in weather station locations that had occurred over the years and recommended that the Staff file the thirty-year normal period from 1961 through 1990 to "place the Commission in step with the policy of the National Weather Station." Dr. Decker's letter and memo are attached to my Surrebuttal testimony as Schedule 1. I should point out that Dr. Decker did not mention the station change that occurred in 1978 at Lambert Field, and the Staff was not aware of the change at that time.

Q. WHEN DID THE STAFF BECOME AWARE THAT A CHANGE HAD OCCURRED AT LAMBERT FIELD?

A. I became aware of a change at Lambert Field when the National Oceanic and Atmospheric Administration (NOAA) published its thirty-year normal HDD for the thirty years ending December 31, 1990 and lowered normal HDD to 4,758. This correction was in response to a movement of the weather station at Lambert Field that took place in 1978. In the next LCG Case No. GR-94-220, the Staff used the published NOAA normal HDD. I should note that NOAA uses a statistical estimate of degree days over the thirty-

year period based on adjustments made to monthly mean temperatures and standard deviations of these monthly means observed from the thirty years. This statistical method works well in heating and cooling months, but we have found these estimates to be inaccurate for transition months, and have recalculated the thirty-year NOAA adjusted normal to be 4,815 HDD.

Q. DO YOU AGREE WITH MS. KRIEGER'S CHARACTERIZATION OF THE CHANGE MADE FROM GR-92-165 TO GR-94-220 AS A STAFF CHANGE THAT IS INCONSISTENT?

A. No, I do not. In both cases the Staff was using the best available information in applying the NOAA thirty-year standard for normal weather. This change simply reflects the additional information that there is a difference in weather measurements occurring before and after the station move. In 1978 the weather station was moved from the airfield to a location near an office building, resulting in higher temperature readings than those observed prior to the move. To make the readings observed after the move consistent over the historical thirty-year period, the monthly mean temperatures prior to the station move would have to be adjusted upward. The result is to adjust the HDD downward for those months prior to the move and therefore to adjust downward the estimate of the thirty-year normal HDD.

Q. WHAT WAS THE NEXT CHANGE MADE BY THE STAFF IN ITS CALCULATION OF NORMAL HDD?

A. In GR-96-193, the Staff became aware of another significant change that occurred in terms of movements of the weather station at Lambert Field. The weather station was moved away from the office building and back onto the airfield and a new

measuring instrument was installed. The Staff was in a situation in which it knew that the current data would be inconsistent with the historical data, but there was not sufficient data by which to make the adjustments necessary to have normal and actual HDD being measured on a consistent basis. As an alternative, the Staff chose to use the St. Charles weather station and NOAA's published thirty-year normal as the basis for its weather adjustment in GR-96-193.

Q. DO YOU AGREE WITH MS. KRIEGER'S CHARACTERIZATION OF THE CHANGE MADE FROM GR-94-220 TO GR-96-193 AS A STAFF CHANGE THAT IS INCONSISTENT?

A. No, I do not. As with the previous change, the Staff's decision was based on the best information available at the time. In the true sense of consistency, it would have been inconsistent if the Staff had ignored the significant change at Lambert Field and gone forward with the normal HDD used in GR-94-220. Moreover, the Staff was consistently applying the principle that ***current temperature readings should be on the same measurement basis as the historical readings used to calculate normal temperatures***; i.e., an "apples-to-apples" comparison.

Q. WHAT CHANGE NEXT OCCURRED IN THE CALCULATION OF NORMAL HDD?

A. The Staff had to make a decision as to whether to go forward with the St. Charles weather station or make corrections for the change that had occurred at Lambert Field. At that time, the Staff was communicating with Union Electric Company (UE) on the issue of the change that had occurred in 1996. UE had run comparisons with the St. Charles temperature data that indicated Lambert Field temperature data statistically did a

better job explaining the electric loads on its system. Thus, I made the decision that corrections needed to be made for this most recent change in weather station location at Lambert Field. In order to make those changes, Staff hired Dr. Steve Qi Hu, who had replaced Dr. Decker as the State Climatologist for Missouri. Dr. Hu, investigated the weather station moves at Lambert and found that in addition to the move in 1978 and 1996, there was a significant move that had also occurred in 1988. For Case No. GR-98-374, Dr. Hu made adjustments for the 1978 and 1988 station moves. The purpose for these two adjustments was to make the historical temperature from 1961 through 1990 consistent with readings occurring subsequent to the change in 1996. In theory, the weather station move in 1996 resulted in placing the instruments back onto the field, and these new readings would be consistent with those taken prior to the moves occurring in 1978 and 1988. Thus, the adjustment made was to subtract 0.3° F from each mean temperature reading starting in January of 1978 through January of 1988 and then subtract 0.75° F from each mean temperature reading starting in February of 1988 through June of 1996. The result would be to make the mean temperature readings lower, resulting in a higher calculation of normal HDD. While this raised the normal HDD from NOAA's published normal of 4,758 to 4,976, this increase was warranted by the lower readings that were now being recorded at Lambert Field subsequent to the June 1996 change.

Q. DO YOU AGREE WITH MS. KRIEGER'S CHARACTERIZATION OF THE CHANGE MADE FROM GR-96-193 TO GR-98-374 AS A STAFF CHANGE THAT IS INCONSISTENT?

A. No, I do not. It is important to notice that the weather adjustment is made based on the difference between normal and actual weather. If the measurement of actual weather has decreased due to a movement in the weather station as occurred in 1996, then the normal weather must also be decreased in order to have a consistent measurement of the difference. Thus, while it appears that the Staff is inconsistently increasing normal HDD from 4,758 to 4,976, in fact it would be inconsistent not to do so. LGC was well aware of the problems at Lambert Field, and has yet to propose any adjustments to account for these changes in locations of weather stations.

Q. WHAT WAS THE NEXT CHANGE IN CALCULATIONS OF NORMAL WEATHER MADE WITH RESPECT TO LAMBERT FIELD?

A. Subsequent to GR-98-374, UE raised three objections to the adjustments made by Dr. Hu. First, the adjustments made for the station move in January 1978 should have been made for November 1979. While the weather station was moved in January 1978, the thermometer was not moved until the later date. Second, the adjustment made for this station move should have used at least two reference stations, and Dr. Hu used only one reference station. Third, UE believed that there was a need for an additional adjustment for the station move made in 1996; i.e., that Dr. Hu's original hypothesis (post 1996 and pre 1978 weather measurements are consistent because the weather instrument is located on the airfield for both of these time periods) was not correct.

I asked Dr. Hu to investigate each of the concerns raised by UE. Thus, Dr. Hu made a determination of new reference stations and evaluated all three station moves. The results were for a 0.7° F increase in November 1979, a 0.783° F increase in February 1978 and a 1.875° F decrease in June of 1996. Notice that since the sum of increases in

November 1979 and February 1988 (0.7° + 0.783° = 1.483°) is less than the 1996 decrease (1.875° - 1.483° = 0.392°), the thermometer currently installed at Lambert Field are estimated to be reading cooler than in the period 1961 through 1979 The net effect is to increase the calculation of normal HDD to be consistent with the cooler temperature readings currently being recorded at Lambert Field. Thus, in this instant Case No. GR-99-315, normal HDD are calculated to be 5,101, an increase of 125 HDD over the 4,976 HDD previously calculated from Dr. Hu's adjustments made in GR-98-374.

Q. DO YOU AGREE WITH MS. KRIEGER'S CHARACTERIZATION OF THE CHANGE MADE FROM GR-98-374 TO GR-99-315 AS A STAFF CHANGE THAT IS INCONSISTENT?

A. No, I do not. Ms. Krieger's testimony is that while Dr. Hu performed a double mass analysis in both cases, since results were different, there is an inconsistency. What she fails to point out is that there were valid reasons for making the recalculations.

In addition, Ms. Krieger is in error in stating that in GR-98-374, Dr. Hu found an overall warming bias and in GR-99-315, Dr. Hu found an overall cooling bias. In both cases, Dr. Hu found that measurements taken after the June 1996 movement of the station back to the airfield were cooler than temperatures observed when the weather station was moved from the airfield to a location near an office building. Thus, in both cases, Dr. Hu found that there was a warming bias in readings taken over the period when the thermometer was located near an office building and not located on the airfield.

The difference between the two studies is that Dr. Hu found that: 1) this warming bias did not start until November 1979 rather than January 1978; 2) this warming bias was larger than indicated by his initial measurements; and 3) the measurements after June

1996 were somewhat cooler than those measured from 1961 to the time that the weather station was moved off of the airfield. The revised results are consistent with the previous results, with increased levels for the adjustments needed to make current temperature readings at Lambert Field consistent with historical readings.

Q. DOES IT APPEAR FROM MS. KRIEGER'S REBUTTAL TESTIMONY THAT SHE UNDERSTANDS WHAT ADJUSTMENTS THE STAFF HAS MADE TO MAKE HISTORICAL AND CURRENT TEST YEAR WEATHER CONSISTENT?

A. My reading of Ms. Krieger's rebuttal testimony is that she appears to honestly be confused by the adjustments that Staff has made for the various cases. I have provided Schedule 2 as an attachment to by surrebuttal testimony, which I hope will straighten out any confusion that might exists over these adjustments. For each case I have drawn a time line showing the thirty-year normal period 1961 through 1990. For each case, the graph shows the adjustments made to daily mean temperatures to bring consistency between the historical and temperature measurements during the test year for each case.

What is important to notice on Schedule 2 is the reversal in adjustments that takes place between GR-94-220 and GR-98-374. The test year for GR-94-220 did not include any temperature measurements from the post June 1996 period, and therefore, the current temperature data for that case was considered to be consistent with the measurements that were taken from the location near the office building. However, since the temperature measurements prior to when the station was moved from the airfield would not be consistent (in fact, these temperature measures are too low), they were increased by approximately 1° F by NOAA to bring about the needed consistency.

Data for the test year for GR-98-374 was measured after the June 1996 move of the thermometer back to the airfield. Dr. Hu believed this data was consistent with the measurements from 1961 through 1978 when the thermometer was also located on the airfield. Thus this period does not have an adjustment. But the period after the thermometer was moved from the airfield is reading too high compared to the test year location, and the proper adjustment is to lower the readings for this 1978 through 1990 period.

Data for the GR-99-315 test year was also measured after the June 1996 move of the thermometer back to the airfield. However, Dr. Hu discovered that the adjustments made for GR-98-374 were too small and there was an additional 0.382° F downward adjustment needed for the new type of thermometer being used at Lambert Field.

Q. IN LCG'S REBUTTAL TESTIMONY, DOES IT DENY THAT WEATHER STATION MOVES HAVE OCCURRED AT LAMBERT FIELD?

A. No. While Ms. Krieger uses the adjective "alleged" to describe these changes, neither she nor LCG's outside expert witness deny that these weather station moves have occurred or have resulted in inconsistent measurements between actual and historical temperature readings at Lambert Field.

Q. IN LCG'S REBUTTAL TESTIMONY, IS THERE ANY EVIDENCE PRESENTED THAT THESE MOVES IN THE WEATHER STATION HAVE <u>NOT</u> RESULTED IN INCONSISTENT MEASUREMENTS BETWEEN ACTUAL AND HISTORICAL TEMPERATURE READINGS AT LAMBERT FIELD?

A. No. This is surprising in two respects. First, in its calculation of differences between normal and actual weather, LCG makes no adjustments to account for what is

clearly a significant change that occurred in measurements of temperature at Lambert Field in June 1996. Second, LCG has been aware of this change through its last three rate cases. Specifically, since its last rate case, LCG has been aware of the Staff having hired the state climatologist to make adjustments for this change, and yet LCG has not made any effort to estimate the impact of this change. In this instant case, LCG hired an outside consultant to criticize Dr. Hu's work, but apparently did not ask this consultant to make an estimate of the impacts of the changes that have occurred at Lambert Field. It is always easy to criticize someone else's work, but the real inconsistency is in LCG realizing that there has been a significant change in weather measurements at Lambert Field and failing to have an analysis made of these changes.

The Staff realizes that there can be differences among experts in choices of methods, data, reference stations and adjustments required to make data comparable between reference stations and Lambert Field. It is our hope that as these differences surface, we can bring experts together to reach agreement on such issues. Until this happens with LCG, the Commission should find the Staff's weather normalization to be reasonable, and certainly more reasonable than the Company's approach, which ignores a significant change at Lambert Field.

Q. DOES THIS COMPLETE YOUR SURREBUTTAL 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-99-315

AFFIDAVIT OF MICHAEL S. PROCTOR

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Michael S. Proctor, 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 _____ 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.

Michael S Proctor
Michael S. Proctor

Subscribed and sworn to before me this 19th day of August, 1999.

Joyce C. Neuner
Notary Public

Joyce C. Neuner
Notary Public, State of Missouri
County of Osage
My Commission Exp. 06/18/2001

My commission expires _____

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May 27, 1992

Mr. Michael Proctor
Public Service Commission
Truman State Office Building
Room 530
PO Box 360
Jefferson City, MO 65102

Dear Mr. Proctor:

I have reviewed the testimony sent to me and I am enclosing my remarks concerning the issues raised. I hope that you will find them useful. If there are questions concerning the comments or should you need further evaluation, please let me know.

If it is your desire to have the content of the report transferred into testimony for the Commission, I would be pleased to make my self available. I should tell you, however, that I will be away from the Campus and out of the State between June 17 and July 1 and between July 10 and July 28.

Very truly yours,

Wayne

Wayne L. Decker
Professor and State Climatologist

Preliminary Remarks on the Heating Degree Day Testimony
Public Service Commission

Professor Wayne L. Decker
State Climatologist for Missouri
Department of Atmospheric Science
University of Missouri-Columbia

Comparison between the Observations at Lambert Field and St. Louis City Location:

The techniques for the comparison used in the testimony of Mr. Proctor, Mr. Lei and Mr. Boyle appear to be valid. The 15 year period extending from 1934-35 heating season through the 1948-49 season used to establish the relationship between the City observations and the temperature measurements at Lambert Field does not include the entire period of duplicate observations. The published data from NOAA has comparisons for the period running from the 1930-1931 season through the 1964-65 season for a total of 34 comparisons. The City observing station was not closed until 1969 and the records should be available through the National Climate Data Center, so 38 years of comparison would have been possible.

A quick review of the longer published comparison shows that the difference between the downtown location and the Airport was little less than for the shorter record used in the testimony. The downtown locations had about 5 % fewer degree days for the 15 year period and 3% fewer degree days for the longer period.

The regression equation for the more complete record could quite easily be computed.

Discontinuities in the St Louis Weather Records:

When one interprets climate data over an extended period it is very important to review the history of the weather station locations and the type of instrumentation used. Attached to this report is a summary prepared by NOAA of the Downtown and Lambert Field locations and instrumentation.

The Downtown temperature observations were taken roof-top at about 200 feet above the surface from 1903 onward until the closing of the observing station in 1968. Prior to 1903 the roof-top station was located at about 100 feet above the street.

Unless one carefully reviews the station location descriptions, it would appear that the Lambert Field Station did not experience much of a change since it was established in 1929. There are, however, two discontinuities in the Lambert Field observations requiring analysis.

In November 1943 the site of the temperature measurement was moved from a position away from the building (in an instrument shelter at 5 feet above the ground) to a roof-top location on the second floor of the Administration Building. This position allowed the dark roofing and the vents from the first floor to provide a less than ideal location for documenting the climate of the area. A review of the graphs from Michael Proctor's testimony shows this

period (1943 through September 1957) as one with low heating degree day totals at the Lambert Field Observing Station. The average degree days from the period extending from the 1943-44 season through the 1956-57 season is some 6% lower than the "standing mean" of 4838 reported in the Testimony. It is very likely that the warmer temperatures were, at least in part, due to heat added by the roof exposure.

On April 18, 1958 the system of measuring temperatures employed by the National Weather Service in St. Louis was changed. This change consisted of discontinuing the use of liquid thermometers mounted in the white instrument shelter in favor of electrical thermometers exposed in a reflective cylinder over the grass areas between the runways. The observations from these instruments are recorded on indicators in the National Weather Service Office. This new system was installed at all Airport observing stations of the National Weather Service at about this same time. Since the instruments were located away from the buildings and paved tarmac the temperatures are typically cooler than those previously reported from exposures near the buildings. This system has continued in use for the past three decades. One must note that using the Figures in Mr. Proctor's testimony that the heating degree days in recent years (since 1960) are markedly higher suggesting that the new location is giving a slightly cooler climate for the Lambert Field area. Even when one includes the degree day totals for the warmer most recent decade (through 1990-91 season) the 32 year average (1958-59 through 1990-91) is very close to the value suggested for the "standing mean".

Climate Change as a Factor in Considering Heating Requirements

Global Change and the associated temperature trends is a current topic of concern in the scientific community. Indeed, there is not complete agreement between scientist concerning the validity of a suggested temperature change on a global scale, and there have been few attempts to interpret the global aspects in terms of "local" and seasonal temperature changes. However, the fact that there is serious and scientifically documented evidence of temperature change, it is a basis for an argument against using "long-term" averages as a base for operational decisions.

"Greenhouse warming" is a factor in global temperature trends. It is occurring because of the well documented increase in certain trace gases in the atmosphere. These gases include carbon dioxide, methane, chlorofluorocarbons, among others. If the atmosphere world-wide is warming then the effect should also be noted in regional analysis. The fact that these trends are nor detectable when reviewing local records is attributed to the masking of the warming trend by discontinuities in observational techniques and random variabilities.

The "urban heat island" is a well documented phenomenon which notes that the urban temperatures are warmer than the nearby rural temperatures, particularly at night. This temperature difference is related to size of the city (area and population). The center of warming and the extent of warming depends on the configuration of the city. In the case of St louis there have been some documentation of the urban effect from detailed studies in the 60's.

It appears that the center of development in St. Louis has been away from the river, and the urbanization of the area around Lambert Field is apparent. The opportunity for an urban climate change in the Lambert Field weather records, although not documented, is certainly present.

A Rational Approach to Selection of a "Base -Period" in Climatology

Clearly a period long enough to be "representative" of the climate of the region is required. The period should not be so long that it measures a condition that has already past and no longer valid for the climatological time series. This problem of defining a base period for the "normal" climate has plagued climatologist for many years. The World Meteorological Organization (a UN agency which coordinates National programs in meteorology and climatology) and the National Weather Service in the U.S. have adopted the policy of using the most recent 30 year period as the average for comparison purposes. Under their policy the average is "rolled over" at the beginning of each decade. The newly established "normals" are then used for the next ten years.

It appears that the use of a ninety year average does not account for the known and possible time trends in temperature data series. The equal weighing of reported climate events of nearly a century ago with those of more recent periods, places the Commission in a shaky position at best.

The use of a period as short as a decade for the base of operational calculations is not a good choice. A review of the time series will show that there have been many times during the past 100 years that the temperatures in St. Louis have depart from the normal for periods as long as a decade only to reverse itself in a subsequent decade. The following values can be used as examples of three ten year periods:

1929-30 through 1938-39 4633 degree days
1960-61 through 1969-70 4971 degree days
1980-81 through 1990-91 4633 degree days.

When compared with the with the "standing mean" these departures are -6%, +3% and -4% respectively.

Recommendations for Preparation for the Laclede Gas Hearing

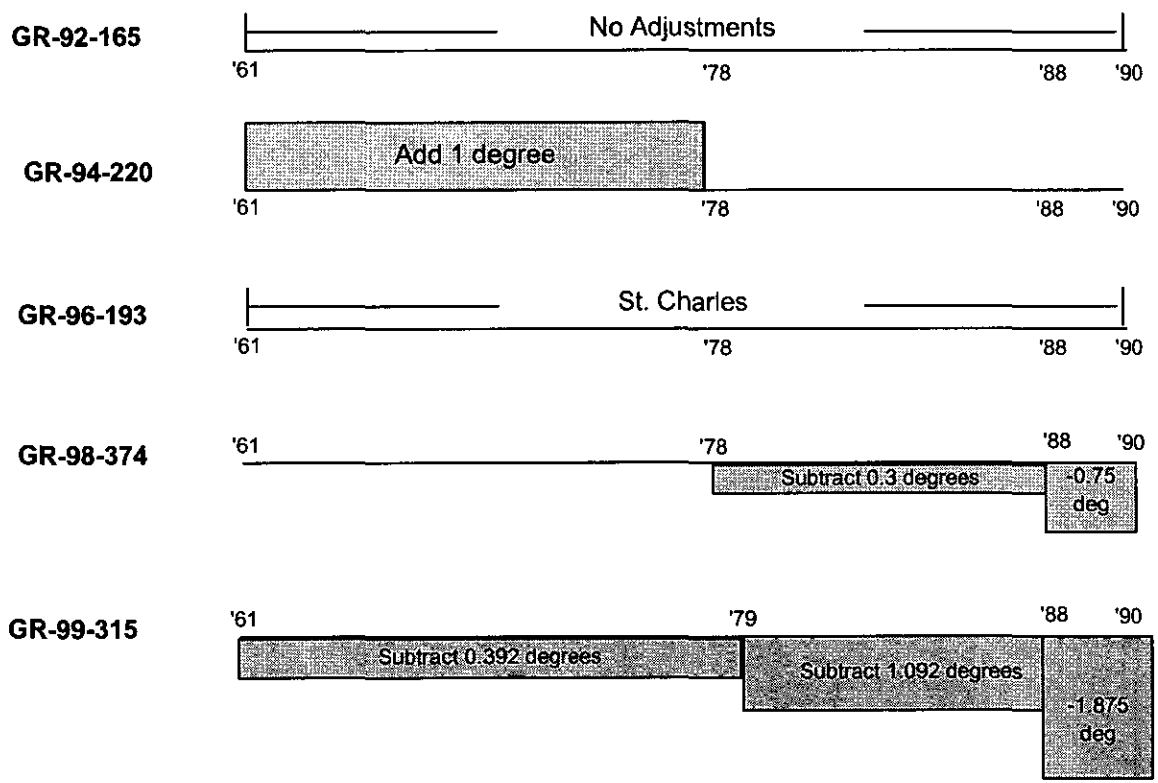
1. The Commission should adopt a policy of using the 30 year period as the "normal" for degree day calculations. It is recommended that the period 1961-62 through 1990-1991 be used for the next ten years and that it be "rolled over" in 2000-01. This would place the Commission in step with the policy of the National Weather Service.

2. If the decision is made to continue the use of the "standing mean", there should be a reanalysis of the relationship between the St. Louis City Records and the Lambert Field Records to include all of the years with overlapping records (1930-1968).

3. The Commission sponsor a study to ascertain the "change" due to global change and urbanization in Missouri and the impacts which such changes have on utility rate policy in the State. Such a study should include (but not be limited to) St. Louis, Kansas City, Springfield and Columbia-Jefferson City.

4. The Commission should instigate a study of the effects of current instrumentation changes at official weather observing points on rate policies. The National Weather Service is (1990 onward) instigating widespread changes in the instrumentation at both Commissioned (Federal professional observers) and Cooperative (non-paid observers) weather stations. In the next decade or so the changes introduced by the new instrumentation system are going to offer many problems and sources of conflict between the Commission and the utility companies. It appears that anticipation of the problem would assist in rational decisions on rate structures in the future.

STAFF'S ADJUSTMENTS TO MAKE HISTORICAL TEMPERATURES CONSISTENT WITH ACTUAL TEMPERATURES FOR EACH CASE



Schedule 2