SURREBUTTAL TESTIMONY

OF

DENNIS PATTERSON

UNION ELECTRIC COMPANY

CASE NO. EM-96-149

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. Are you the same Dennis Patterson who submitted direct testimony in this case?

A. Yes, I am

PURPOSE

Q. What is the purpose of your surrebuttal testimony?

A. The purpose of my surrebuttal testimony is twofold. First, I will sponsor two comparisons of monthly average temperatures in the area surrounding St. Louis, Missouri. These comparisons are discussed in the surrebuttal testimony of Staff witness Steve Qi Hu, with respect to his response to the rebuttal testimony of Union Electric Company (UE) witness Mr. Allen Dutcher. Second, I will respond to the rebuttal testimony of UE witness Mr. Richard A. Voytas. The issues arise from the commissioning of the Automated Surface Observing System (ASOS) at the St. Louis Lambert International Airport weather station (STL) that became official on 1 June 1996.

Comparison of Monthly Average Temperatures for the St. Louis, Missouri Area

Q. What are the monthly temperatures that you prepared for Dr. Hu?

A. Two series STL monthly average temperatures were compared to a third series that was calculated as the monthly average over seven nearby stations. The first STL series came from official sources, contained no adjustments, and is called the "reported" series. The second STL series contained the adjustments sponsored by Dr. Hu in his direct testimony, and is called the "corrected" series. The monthly average temperatures from the seven nearby stations were tabulated from the United States Historical Climatology Network (USHCN), a project sponsored by the National Oceanographic and Atmospheric Administration (NOAA). The monthly average of these is called the "comparison" series. A double mass analysis was performed of each STL series relative to the comparison series.

Reported and Corrected Monthly Temperatures

for St. Louis Lambert International Airport

Q. How did you tabulate the reported series of monthly average temperatures for STL?

A. First, I tabulated daily maximum and minimum temperatures for STL for all months from January, 1960 through December, 1998, from official NOAA publications. These were downloaded electronically as a single text file from the Midwest Climate Data Center web site, but may be assembled from a number of alternate

NOAA data sources and publications. Then, I calculated monthly average temperatures from these data.

Q. How did you tabulate the corrected series of monthly average temperatures for STL?

A. First, I tabulated the same daily maximum and minimum temperatures that were used to calculate the reported series just described. Second, I substituted daily maximum and minimum temperatures that the Staff obtained from Dr. Hu, for the period January 1978 through May 1996, which contained the adjustments he sponsors in his direct testimony. Third, I calculated the corrected series of monthly average temperatures from these data. Finally, I examined these results to insure that the differences between the reported and corrected series indeed equaled the adjustments sponsored by Dr. Hu.

Comparison Temperatures from the

United States Historical Climatology Network (USHCN)

Q. What is the United States Historical Climatology Network?

A. The USHCN home page states that "[t]he U.S. Historical Climatology Network (USHCN, Karl et al. 1990) is a high-quality moderate sized data set of monthly averaged maximum, minimum, and mean temperature and total monthly precipitation developed to assist in the detection of regional climate change." The address of the USHCN home page is:

http://www.ncdc.noaa.gov/ol/climate/research/ushcn/ushcn.html.

Q. Why are the temperature data from USHCN different from other official sources of temperature data?

A. The monthly temperature data products from USHCN are based on official sources, but have received adjustments which account for time of observation bias and exposure changes (changes in weather station sensors or location of sensors). They are thus suitable candidates for comparison with STL monthly temperatures, which are calculated from daily maximum and minimum temperatures that were observed on a midnight-to-midnight schedule.

Q. Are USHCN data available for all weather stations?

A. No. They are only available for selected cooperative stations whose histories are long enough to be useful for detection of regional climate change.

Q. Which stations did you select to make up the comparison series?

A. I chose the following USHCN weather stations in Missouri: BOWLING GREEN 2NE; FARMINGTON; WARRENTON 1N; and the following USHCN stations in Illinois: CARLINVILLE; HILLSBORO; SPARTA 3N; and WHITE HALL 1E.

Q. Why did you choose these stations?

A. I chose them because of their proximity to St. Louis Lambert International Airport, and because St. Louis Lambert International Airport is near the center of the area covered by these stations.

Q. What were the results of your comparison?

A. The results of the comparison are illustrated at Schedule 1. To make the comparison, I calculated a double mass analysis of the cumulative differences between monthly average temperatures from the STL reported series and the comparison series. I then plotted this cumulative difference for each month between 1960 and 1997.

On the same graph, I plotted the corresponding cumulative differences between Dr. Hu's corrected STL series and the comparison series. A visual inspection of the graph shows the "corrected" comparison has a more nearly constant slope than the "reported" comparison.

Q. Did you make this analysis available to Dr. Hu?

A. Yes, I did. I made a preliminary version of this analysis available to Dr. Hu shortly after he had made his adjustments to the STL series. This version included actual readings at the seven USHCN stations for 1997, as the adjusted data for 1997 were not yet available at that time. More recently, I updated the comparison series to include USHCN monthly mean temperatures from 1997, which are the most recent available at this time. Dr. Hu will discuss his use of this double mass comparison in his surrebuttal testimony.

Response to the Rebuttal Testimony of Richard A. Voytas

Q. On page 10 of his rebuttal testimony, at lines 10-11, Mr. Voytas states "The Company's approach was a permanent approach to resolve the ASOS issue." Do you agree with this statement?

A. This was UE's intention, but the approach it used should not be permanent. The Staff reviewed the work papers provided by Mr. Voytas, and has found UE's estimate of the correction for the ASOS change to be unreliable. The time period used in UE's analysis is too short, the temperatures are not properly compared by season, and Time of Observation Bias (TOB) was improperly corrected. Issues beyond the single ASOS adjustment are addressed in subsequent questions and answers below.

First, UE's calculations are based on less than four months of temperature data from before the ASOS installation. These are then compared with less than four months of temperature data after the ASOS installation. In his surrebuttal testimony, Dr. Hu recommends that at least one year's data be used before and after an exposure change.

Second, UE bases its temperature difference calculations on a double mass analysis of late winter and early spring seasons for the first half of the data, but on late spring and early summer for the latter half. The results would have been more reliable had each of the four seasons appeared in full on both sides of the exposure change.

Finally, UE's only correction for TOB consists of lagging the comparison data by half a day, a measure which may add more bias than it corrects. Dr. Hu addresses the most reliable method for correcting TOB in his surrebuttal testimony.

Due to these very serious shortcomings, UE's preliminary estimates of the single correction for the ASOS installation should be recalculated using at least one year's daily temperature data before and after the ASOS change, and when comparable data is developed for STL and appropriately determined comparison stations.

Q. On page 11 of his rebuttal testimony, at lines 14 through 19, Mr. Voytas states, "On the basis of Dr. Hu's remarkably – one might even say, appallingly – incomplete work, Mr. Patterson edited the official weather data compiled by the National Climactic [sic] Data Center and recalculated new Lambert Airport normal temperatures. He then invented an analysis that is not mentioned anywhere in the Agreement – that is, he fashioned *his own* normal cooling and heating degree days." Do you agree with these statements?

A. No, I do not. First, given the availability of the data at the time of Dr. Hu's work, it is complete. Dr. Hu addresses this issue in his surrebuttal testimony.

Second, I did not edit official weather data. Dr. Hu furnished me with a file of adjusted daily temperatures that I used to make my calculations of normal temperatures and degree days. As a crosscheck, however, I did compare Dr. Hu's data with NOAA's official history of daily temperatures for STL. During the adjustment period between 1978 and 1996, the only differences that appeared were in fact due to Dr. Hu's adjustments. The only estimate in the file replaces a missing value from 7 November, 1996. This observation occurred after the normals period, where it could have no effect. It had no material effect during the revenue sharing period.

Third, I did not violate the Case No. EM-96-149 Stipulation and Agreement (Agreement). The Agreement specifically allows for the inclusion of new information at the time it becomes available. Moreover, the Agreement makes no provision for UE to unilaterally reject new information.

Finally, I disagree that I or Dr. Hu "invented an analysis." The accepted methodology for making adjustments in preparation for the calculation of normals was carefully developed by respected climatologists and may be quoted as follows: "Several adjustments were made to the data before normals were calculated. These adjustments include estimating missing data, adjusting for time of observation bias, and adjusting for exposure changes (First Order stations, as defined in Section II, only)."

(CLIMATOGRAPHY OF THE UNITED STATES NO. 81, Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1961-1990, MISSOURI, James R. Owenby and D. S. Ezell, January, 1992. U.S.

DEPARTMENT OF COMMERCE, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, North Carolina: Section I, Paragraph 2).

Q. On page 14, lines 5 through 10 of his rebuttal testimony, Mr. Voytas states, "It is an insurmountable task to go back 40 years and accurately adjust historical temperature data for every sensor change, station move, and other temperature occurrences to attempt to align historical temperatures on an equivalent basis to current temperatures. By contrast, there are straightforward techniques that quantify the difference between temperatures recorded by a new temperature sensor versus a prior temperature sensor." Do you agree with these statements?

A. I do not agree with the overall implications of these statements. First, NOAA keeps very good records of "every sensor change, station move and other temperature occurrences…". Dr. Hu has access to this information and used it in his work. (Hu Direct, Schedule 1-6).

Second, as Mr. Voytas states, the techniques for adjusting current data for the latest exposure change are indeed "straightforward." Therefore, they should certainly serve for the next most recent exposure change as well, and so on back to the earliest in the period of years needed to calculate normals. If the objective is to have earlier data align with current readings, the application of the "straightforward techniques" does not change.

Q. On page 16 of his rebuttal testimony, Mr. Voytas states that he compared the "NCDC cooling degree days to the straight average of cooling degree days based on the daily observations taken at Lambert." Do you agree with Mr. Voytas'

conclusion that since both calculations were "very close," that NCDC did not make any exposure changes like those advocated by the Staff?

A. When this conclusion is put together with Mr. Voytas' statement on page 5, lines 4-5, that "[t]here is very little difference between the Company's 70-year normal, and NCDC's 30-year normal," I disagree with the implications Mr. Voytas appears to be drawing from these conclusions. First, it is coincidental, but irrelevant that "the straight average of cooling degree days" from reported data for the 1930-1996 period is approximately, or even exactly, equal to the same "straight average" calculated from reported data for any other period.

Second, NOAA does address exposure changes in the calculation of normals. The STL NOAA normals for 1961-1990 include an adjustment for an exposure change that occurred in 1978, although they do not include an adjustment for the 1988 exposure change addressed by Dr. Hu. NOAA does not always address recent exposure changes in the calculation of normals. It is important to note that in the 1951 through 1980 STL normals published by NOAA, corrections had not yet been made for the 1978 exposure change. Users of NOAA normals need to review them to determine if corrections have been made for the more recent exposure changes that have occurred in the thirty-year time period.

Q. On page 20 of his rebuttal testimony, Mr. Voytas states, "Thus Dr. Hu urges adjustments to compensate for what he contends are biases in the historical record-adjustments that he claims are necessary to make weather normalization more accurate-but Dr. Hu's adjustments themselves are smaller than the inherent accuracy of the sensors that record the temperatures in the first place." Do you agree with this statement?

A. No, I cannot. I will show that the standard deviation of an average calculated from ASOS readings is quite small, certainly less than 1/10 of a degree, and certainly much smaller than the adjustments proposed by Dr. Hu.

First, Mr. Voytas' statement confuses the accuracy that might be expected from ASOS for a single observation with an estimate of the variability around the difference between an estimate of the mean ASOS reading drawn from a sample and the true temperature. The standard deviation of the distribution around the true mean would certainly be less than the maximum error of +/- 0.9 degrees F (Dutcher Rebuttal, p. 4, line 3). Over a thirty day period (one month), the difference between the mean measured by ASOS and the true mean would have a standard deviation less than (+/- 0.9/30) degrees F, or 0.03 degrees F. Then, using Student's "t" distribution, the 95% confidence limit measuring the variability of the distribution of the mean would be less than +/- 2.045*0.03 = +/- 0.06135 degrees F. This means that more than 95% of the probability distribution for the mean lies in this very small interval. From a statistical perspective, based on a sample size of only thirty, this is the maximum variability that should have been used in Mr. Voytas' comparison.

Q. On page 22 of his rebuttal testimony, in the sentence beginning at line 22, Mr. Voytas states, "In fashioning his untested methodology, Mr. Patterson independently decided which months of the sharing period should be weather normalized and which should not." Do you agree with this statement?

A. No, I do not. Mr. Voytas' statement indicates his misunderstanding of the fact that my analysis is a correction to the weather adjustments already performed by UE. In months where the corrections to UE's adjustments were not materially different

from zero, i.e., where UE's adjustment appeared to be the correct one, I simply did not apply any corrections. Thus, in part, Mr. Voytas' criticism appears to be that I accepted UE's adjustments.

Q. On page 23 of his rebuttal testimony, at lines 3-5, Mr. Voytas states, "Clearly, then, ASOS played no role in the Staff's concern for biases in the historical temperature record. Indeed, Mr. Patterson admits this. (p. 5, lines 1-3.)" Do you agree with these statements?

A. No, I do not. Mr. Voytas' interpretation of my direct testimony is wrong. At page 5, lines 1-3 of my direct testimony, I state, "Since 1994, the Staff's approach to constructing a consistent time series of daily temperatures has been to adjust historical temperatures to be consistent with the current readings." This statement says nothing about making or not making an adjustment for ASOS. The Staff's position on making an adjustment for ASOS is presented in the surrebuttal testimony of Dr. Hu.

Q. On page 23 of his rebuttal testimony, at lines 19-22, Mr. Voytas states, "Rather than use the output of the Helm model to determine the annual weather-normalized credit, Mr. Patterson established totally new measures, MWh per heating degree days("HDD") for heating months and MWh per cooling degree day ("CDD") for cooling months to calculate adjustments." Do you agree with this statement?

A. No, I do not. Mr. Voytas' statement indicates his misunderstanding of the fact that my analysis is a correction to the weather adjustment already performed by UE using the Helm model. I used the weather adjustments from UE's Helm model as the basis for making corrections to the output from that model for differences in weather inputs. My analysis assumed that UE's weather adjustments were correct, given the

weather data which it used in the Helm model. In the very few instances where that assumption appears to be wrong, I took the corrective measures that are described in my direct testimony. Using the Helm output weather adjustments as the basis, I then calculated corrections to those weather adjustments for the differences between UE's weather data and the Staff's weather data. Therefore, these corrections are consistent with the weather adjustments from the Helm model.

Q. On page 24 of his rebuttal testimony, at lines 4-6, Mr. Voytas states, "In addition, this methodology completely ignored the rate classes specified in the Agreement to be weather normalized and used his own independent analysis to determine the rate classes to be weather normalized." At lines 13-15, Mr. Voytas also states, "In his calculations, Mr. Patterson simply dismissed two of these classes in the weather normalization process he invented." Do you agree with these statements?

A. No, I do not. Again, Mr. Voytas' statements indicate his misunderstanding of the fact that my analysis is a correction to the weather adjustment already performed by UE. UE made the initial weather adjustments for the specified classes. I then corrected UE's results, leaving out none of the classes for which UE had already made weather adjustments.

I calculated corrections to UE's weather adjustments due to changes in weather assumptions. In months where large adjustments are otherwise indicated by the weather data, but UE's weather adjustments for a particular class were small, it is logical to assume that the weather responses for that class were also small. For a given class, where UE's adjustment was so small that weather appeared not to have been a factor, there was no need to make a correction. I confirmed this very reasonable assumption by

calculating traditional weather normalizations using UE's billing data, first with UE's weather data and then with the Staff's weather data. "Finally, I made no heating month corrections for either the Large Primary of Small Primary Commercial classes, since an independent analysis showed that neither class was sensitive to changes in HDD." (Patterson Direct, page 13, lines 21-23).

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does, unless there is a need for supplemental surrebuttal. After Michael S. Proctor, Dr. Hu, and I reviewed UE's rebuttal testimony on weather, data requests were written and submitted to UE. The Staff has not yet received responses. Once UE responds, there may be a need to supplement my surrebuttal testimony.

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the matter of the Application of Union Electric Company for an order authorizing: (1) certain merger transactions involving Union Electric Company; (2) the transfer of assets, real estate, leased property, easements and contractual agreements to Central Illinois Public Service Company; and (3) in connection therewith, certain other related transactions.	)))))))	Case No. EM-96-149

AFFIDAVIT OF DENNIS PATTERSON

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Dennis Patterson, of lawful age, on his oath states: that he has participated in the preparation of the foregoing written testimony in question and answer form, consisting of 13 pages of testimony to be presented in the above case, that the answers in the attached written testimony were given by him; that he has knowledge of the matters set forth in such answers; and that such matters are true to the best of his knowledge and belief.

Dennis Patterson

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

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

Notary Public

My commission expires

Schedule 1

ST LOUIS LAMBERT TEMPERATURES VERSUS AVERAGES OF CONSISTENT AREA TEMPERATURES FROM US HISTORICAL CLIMATOLOGY NETWORK FILNET DATA
CUMULATIVE DIFFERENCE (DEG F)
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