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Issues: Normal Weather
Witness: Seoung Joun Won
Sponsoring Party: MO PSC Staff
Type of Exhibit: Rebuttal Testimony
Case No.: ER-2012-0166
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MISSOURI PUBLIC SERVICE COMMISSION

REGULATORY REVIEW DIVISION

REBUTTAL TESTIMONY

OF

SEOUNG JOUN WON

UNION ELECTRIC COMPANY d/b/a AMEREN MISSOURI

CASE NO. ER-2012-0166

Jefferson City, Missouri
August 2012

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Increase Its Revenues for Electric Service	)))	Case No. ER-2012-0166

AFFIDAVIT OF SEOUNG JOUN WON

STATE OF MISSOURI)
) **ss**
COUNTY OF COLE)

Seoung Joun Won, of lawful age, on his oath states: that he has participated in the preparation of the following Rebuttal Testimony in question and answer form, consisting of 10 pages of Rebuttal Testimony to be presented in the above case, that the answers in the following Rebuttal 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.

Seoung Joun Won

Subscribed and sworn to before me this 14th day of August, 2012.

SUSAN L. SUNDERMEYER
Notary Public - Notary Seal
State of Missouri
Commissioned for Callaway County
My Commission Expires: October 03, 2014
Commission Number: 10942086

Notary Public

REBUTTAL TESTIMONY

OF

SEOUNG JOUN WON

UNION ELECTRIC COMPANY d/b/a AMEREN MISSOURI

CASE NO. ER-2012-0166

Q. Please state your name and business address.

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

Q. What is your present position?

A. I am a Regulatory Economist in the Economic Analysis Section, Energy Unit, Utility Operation Department of the Missouri Public Service Commission.

Q. Are you the same Seoung Joun Won who provided testimony in Staff's Cost of Service Report?

A. Yes, I am.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to address the Direct Testimony ("testimony") of Union Electric Company d/b/a Ameren Missouri ("Company") witness, Steven M. Wills.

Q. Which part of Mr. Wills' testimony are you going to address?

A. I address the adjustments that Mr. Wills made to the historical temperature data of Lambert - St. Louis International Airport weather station ("STL") in the period of January 1, 1981, through December 31, 2010, used to determine normal weather.

Q. In his direct testimony, does Mr. Wills use a current analysis of the temperature time series for STL from 1981 – 2010 as the basis for his adjustments to the time series to compute normal temperatures?

A. No.

Q. What was the source of the adjustments proposed by Mr. Wills?

A. According to his direct testimony and his responses to data requests, Mr. Wills' adjustments are based on the results of settlement negotiations between the Company and Staff in Case No. EM-96-149 regarding the STL daily temperatures in *"the sharing period of July 1997 - June 1998"* (sic).[1] In that case, both the Company and Staff had employed "double-mass analysis" ("DMA") to determine the magnitude of adjustments to the STL daily temperature time series. In the settlement discussions, the Company and Staff agreed to a set of modified DMA adjustments, which were a compromise between the DMA adjustments of consultants of the Company and Staff.[2]

Q. Do you consider the DMA adjustments from Case No. EM-96-149 made to the STL 1981-2010 record of daily temperature observations by Mr. Wills adequate, appropriate, and based on contemporary statistical methods used in climatology?

A. No.

Q. In what way are Mr. Wills' DMA adjustments not appropriate?

A. The DMA adjustments are not appropriate because Mr. Wills is relying on analysis performed approximately 13 years ago, and they are not adequate because DMA is a subjective methodology that can easily introduce bias.

[1] Mr. Richard A. Voytas, Rebuttal Testimony, Union Electric Company, Case No. EO-96-14, Case No. EM-96-149, April, 1999, p 22.
[2] Ameren Missouri's response to Staff Data Request No. MPSC 0198.

Q. Do the deficiencies in the DMA adjustment process affect Mr. Wills' STL temperature time series?

A. Yes. Mr. Wills implicitly assumes a bias in the STL data series based on a DMA adjustment using a reference station data series that had no documented changes. However, even though there were no documented changes, the relationship between the two temperature data series was still inconsistent because of undocumented changes to the land use or land cover surrounding of the reference station.[3] Climatologists have indicated there is a problem with using methodologies that assume all changes in a reference station time series are accounted for in the official documentation.[4] Even though there are no instrument, location, or elevation changes in the official documentation of historic metadata,[5] there may exist undocumented changes such as nearby construction of buildings and growth or removal of trees. Those undocumented changes will cause significant discontinuities of the temperature data series.[6]

Q. Did Mr. Wills' DMA adjustments to the temperature time series include an adjustment for the conversion of the STL instrumentation to Automated Surface Observing System ("ASOS") in 1996?

A. Yes. According to Mr. Wills' direct testimony and his response to Data Request No. 0198, adjustments were made to account for the 1996 ASOS change. Ameren Missouri used two reference weather stations' daily mean temperature data series for calculating DMA adjustments to STL for the ASOS instrument change in May 1996. One

[3] Menne, M. J., and C. N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.
[4] Hanssen-Bauer, I., and E. J. Førland, (1994) Homogenizing long Norwegian precipitation series. J. Climate, **7**, 1001–1013.
[5] Metadata is data about data. It describes the content, quality, condition and other characteristics of the data. http://www.mpcer.nau.edu/metadata/WhatIsMetadata.htm
[6] Menne, M. J., and C. N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.

weather station is located at the St. Louis Science Center, and the other is in St. Charles. The four-year period of May 15, 1994, through May 15, 1998, was used in the DMA for both sites' daily mean temperature data series. Mr. Wills reported that the amount of the adjustments from the St. Louis Science Center and St. Charles reference weather stations were -1.65°F and -1.73°F, respectively. Mr. Wills used the average of the two amounts, -1.69°F, as the final adjustment.

Q. Does Staff agree with the DMA adjustments used by Mr. Wills to the STL 1981 – 2010 time series of temperatures used to compute the normal temperatures?

A. No. To check Mr. Wills' adjustments, Staff requested the supporting data and detailed procedure of the DMA adjustments from Case No. EM-96-149. The Company's response to Staff's request in DR No. 198.1 was as follows:

> The requested data is not available. The calculations referred to relate to a case 13 years old, and electronic copies of the data underlying the graphs presented in hard copy form for DR No 198 cannot be located.

Staff independently replicated the DMA adjustment calculations using the same time period and reference weather stations indicated in the response to DR No. 198. Staff's analysis showed that the amount of the DMA adjustment using the St. Louis Science Center weather station as a reference station was -1.40°F, which is 24% warmer than Mr. Wills' adjustment of -1.73°F. Staff analysis of the DMA adjustment using the St. Charles weather station was -1.67°F, which is very close (1.2% cooler) but is still different from Mr. Wills' adjustment of -1.65°F. Using the results of Staff's analysis for these two stations, if the Commission were to use the Company's method for adjusting weather, the adjustment that should be made would be -1.54°F instead of the Company's -1.69°F. This difference is compared and presented in Schedule SJW-R1.

Q. Is this difference due to the compromise that you referred to earlier in your testimony?

A. It may be, but without documentation, neither the Staff nor the Company can know why there is a difference.

Q. Did other information in Mr. Wills' direct testimony or response to the data request clarify the methodology and DMA adjustments used by Mr. Wills?

A. No. Mr. Wills' response to Data Request No. 0198 included a document from Case No. EM-96-149 titled '*Methodology*,' which appears to be a portion of a larger document prepared by or under the direction of Ameren Missouri witness Rick Voytas.

In the *Methodology* documentation, six weather stations located within 25 miles of the greater St. Louis metropolitan area served as reference stations for STL. Four of the reference sites were located in Missouri. They include St. Charles, St. Charles 7 SW, St. Louis Science Center, and St. Louis WMCO. The other two sites were in Illinois. They were Alton Lock and Dam and Cahokia.

Mr. Wills, however, only used the St. Louis Science Center and St. Charles' weather stations for the final DMA adjustment of the 1996 ASOS change. Neither Mr. Wills' Direct Testimony nor the Company's response to Data Request No. 0198 include justification for considering only two of the six reference weather stations used in the their methodology document. If all six stations were considered, of course, the results of the Company's DMA adjustment would change.

Further confusing the issue of reference weather station selection is an email exchange between Company's witness Al Dutcher and Rick Voytas included in the Company's response to Data Request No. 0198. In the email, Mr. Dutcher discusses using only St.

Charles 7 SSW as a reference station, which again would change the resulting adjustment from DMA. No attempt to put the conversation in context was made by the Company in its DR response.

To get a sense of the significance of reference weather station selection, the DMA-related results for the stations are presented in Schedule SJW-R1. For instance, if we chose only the St. Charles 7 SSW as reference station and use the four-year period May 15, 1994, through May 15, 1998, then the DMA adjustment is -2.43°F, which is different from the -1.65°F measured at the St. Louis Science Center during the same four-year period.

Q. Are there other objections Staff has concerning the reliability of Mr. Wills' DMA adjustments?

A. Yes. In addition to the influence of the reference station selection on the DMA adjustment, another fundamental problem is the dependence of the DMA adjustment on the length of time series used. For instance, if we chose the six-month period February 15, 1996, through August 15, 1996, of the St. Louis Science Center, the DMA adjustment is -2.36°F in comparison to the -1.65°F used for the four-year period May 15, 1994, through May 15, 1998, by the Company. Schedule SJW-R1 provides examples of how the selection of reference weather stations and time period affects the adjustment resulting from DMA.

Q. Do you agree with Mr. Wills' assumptions about the reference stations used to derive the DMA adjustments?

A. No. An implicit assumption in Mr. Wills' DMA adjustments is that there is some spatial correlation inherent to an unspecified area around STL. In other words, the assumption is that weather stations that are in close proximity have more similar variations in daily temperature. Based on this assumption, Mr. Wills further assumed that a bias in the

STL temperature data series can be removed using a DMA adjustment based on the temperature data series of neighboring weather stations that have no documented instrument changes. A necessary condition for this reasoning to be valid is that all changes in the neighboring stations are actually documented. Other climate researchers have found that it is common for stations to have undocumented changes.[7]

Q. Have climate researchers demonstrated that undocumented changes in the reference stations affect the DMA adjustments?

A. Yes. When the bias of a temperature series is adjusted by using a reference temperature series, the reference temperature series should have no bias. However, bias may occur by both documented and undocumented changes in instruments and surrounding conditions.[8] Due to the potential for undocumented changes, just comparing two data series is not the best practice for removing bias. Consequently, the diagnosis and removal of discontinuities in temperature series using DMA adjustments have been brought into question in climate research.[9]

Q. Are there methodologies for identifying and adjusting time series of meteorological observations that are an improvement over DMA adjustments?

A. Yes. Climatologists have developed a process called *homogenization*[10] *of temperature series via a pairwise comparison algorithm* to resolve the problems inherent in the assumptions of DMA.

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[7] Menne, M. J., and C. N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.

[8] Hanssen-Bauer, I., and E. J. Førland, (1994) Homogenizing long Norwegian precipitation series. *J. Climate*, **7**, 1001–1013.

[9] Slonosky, V. C., P. D. Jones, and T. D. Davies, (1999) Homogenization techniques for European monthly mean surface pressure series. *J. Climate*, **12**, 2658–2672.

[10] Homogenization is the act of making something homogeneous or uniform in composition. http://wordnetweb.princeton.edu/perl/webwn?s=homogenization

Q. Does the pairwise comparison algorithm avoid the problem of undetected discontinuities in the reference station?

A. Yes. Researchers have demonstrated that by using the pairwise comparison algorithm, undocumented changes can be identified directly, that is, without first testing the reference series or assuming it is homogenous. The National Climatic Data Center ("NCDC") of the National Oceanic and Atmospheric Administration ("NOAA") has developed an automated *pairwise comparison algorithm* that was used in computing the temperature time series for the new normal temperatures for STL.[11]

Q. Are there any additional shortcomings of Mr. Wills' proposed DMA adjustments?

A. Yes. Mr. Wills' analysis does not include an adjustment for the elevation change in ASOS on January 18, 2002, which is reported by NCDC. According to NCDC's historical metadata report for STL, on January 18, 2002, the elevation of the ASOS instruments changed from 568 feet to 531 feet above sea level.[12]

Q. Does Mr. Wills report any instrument relocation or adjustment to the time series of temperatures used for the computation of the normal temperatures for the 2002 elevation change?

A. No. Mr. Wills does not discuss the 2002 instrument elevation change in his direct testimony, and no adjustments were made to the temperature time series that he provided in his workpapers to account for it.

Q. In light of these deficiencies and omissions mentioned above, do you consider Mr. Wills' DMA adjusted STL normal temperatures to be reliable?

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[11] Menne, J. M. and C. N. Jr. Williams. (2009). Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22** 1700–1717.

[12] Retrieved in the website, http://www.ncdc.noaa.gov/homr/.

A. No. Mr. Wills' DMA adjustments are based on incorrect assumptions. Furthermore, Mr. Wills did not consider the ASOS changes in STL during 2002 in his DMA adjustments. Mr. Wills did not consider updated information on STL or use best practices developed by the climatology community. Therefore, from a scientific perspective, both the methodology and process employed in Mr. Wills' DMA adjustment are unsound and inconsistent.

Q. Would you summarize why the Commission should use the normal weather as calculated by Staff?

A. Staff calculated the normal weather based on the adjustments provided by NCDC. The DMA adjustments in Mr. Wills' testimony do not consider either updated information on STL instrument changes or a better methodology used by the climatology community to adjust for inconsistencies due to location or instrumentation changes in meteorological observation time series.

In addition, the Commission, in its Report and Order issued in Case No. GR-2006-0422 on March 22, 2007, stated:

> The Commission continues to use the 30-year normal and finds that it should be consistent when applying a method of weather normalization between utilities. In the absence of more convincing evidence that this methodology should be changed, the commission will continue to adopt the 30-year weather normalization as proposed by Staff.

The use of NOAA's normal weather will allow consistency when applying a method of weather normalization between utilities. With the introduction of the new normal temperatures and the analysis conducted by NCDC to make sure that the data is consistent across the thirty-year time period, the need for the DMA adjustments agreed to by the Company and Staff in the Case EM-96-149 has ended.

Q. Do you know the revenue impact of the difference between Staff and the Company on this issue?

A. Yes, according to Staff's calculations, all other things being equal, the Company would show an additional expected revenue shortfall of $11 million per year using the adjustment proposed by Mr. Wills instead of Staff's adjustment confirmed with NCDC's 1981-2010 normals. Thus, to make up for the shortfall, the revenue requirement increase would be $11 million per year higher if the Commission adopts the Company's method of calculating normal weather.

Q. Does that complete your testimony?

A. Yes, it does

Double Mass Analysis - Results

Average Daily Temperature Reports Quantifying
the Discontinuity in the Average Temperature Readings
Subsequent to the Initial installation of ASOS Instrument Adjustment
Lambert – St Louis International Airport (STL) May 16, 1996

Reference Station	St. Louis Science Center (SSC)			St. Charles (STC)			St. Charles 7 SSW (SC7)		
	Staff	Staff	Ameren Missouri	Staff	Staff	Ameren Missouri	Staff	Staff	Ameren Missouri
Time Period	6 Months 2/15/96 – 8/15/96	4 Years 5/15/94 – 5/15/98	4 Years 5/15/94 – 5/15/98	6 Months 2/15/96 – 8/15/96	4 Years 5/15/94 – 5/15/98	4 Years 5/15/94 – 5/15/98	6 Months 2/15/96 – 8/15/96	4 Years 5/15/94 – 5/15/98	N/A
Measurement Method	Regression	Regression	Unknown	Regression	Regression	Unknown	Regression	Regression	Unknown
Slope Before 5/16/96	1.68°F/D	0.99°F/D	0.95° F/D	4.07°F/D	3.52°F/D	2.82° F/D	4.17°F/D	4.94°F/D	N/A
Slope After 5/16/96	-0.68° F/D	-0.41°F/D	-0.70° F/D	2.33° F/D	1.85° F/D	1.09° F/D	2.09° F/D	2.51°F/D	N/A
DMA Adjustment Amount	-2.36° F/D	-1.40° F/D	-1.65° F/D	-1.74° F/D	-1.67° F/D	-1.73° F/D	-2.08° F/D	-2.43°F/D	N/A

Schedule SJW-R1