Exhibit No.:	
Issues:	Weather Normal Variables
Witness:	Seoung Joun Won
Sponsoring Party:	MO PSC Staff
Type of Exhibit:	Surrebuttal Testimony
Case No.:	ER-2012-0166
Date Testimony Prepared:	September 7, 2012

MISSOURI PUBLIC SERVICE COMMISSION

REGULATORY REVIEW DIVISION

SURREBUTTAL TESTIMONY

OF

SEOUNG JOUN WON

UNION ELECTRIC COMPANY
d/b/a AMEREN MISSOURI

CASE NO. ER-2012-0166

Jefferson City, Missouri
September 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 Surrebuttal Testimony in question and answer form, consisting of 12 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.

Seoung Joun Won

Subscribed and sworn to before me this 7th day of September, 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

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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, Regulatory Review Division 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 Surrebuttal testimony?

A. The purpose of my Surrebuttal testimony is to address the Rebuttal Testimony ("testimony") of Union Electric Company d/b/a Ameren Missouri ("Company") witnesses, Steven M. Wills and Allan Dutcher.

Response to the Rebuttal Testimony of Steven Wills

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

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

Q. In his testimony, does Mr. Wills use the same adjustment of the temperature time series for STL from 1981 – 2010 as in his direct testimony?

A. No.

Q. What was the change in the adjustment proposed by Mr. Wills?

A. In his direct testimony, he did not account for an instrument change in 2002. In his rebuttal testimony, he accounted for the instrument change in 2002.

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

A. In its direct testimony, Staff proposed an adjustment for an instrument change in 2002 based on information provided by the National Climatic Data Center ("NCDC"). Mr. Wills reviewed the analysis of the U.S. National Oceanic and Atmospheric Administration ("NOAA") for a 2002 adjustment and then asked Mr. Dutcher to analyze the Lambert Field temperature records from that time period. Mr. Dutcher indentified a discontinuity in the data.

Q. In his testimony, Mr. Wills states, "The Staff witness in this case, Dr. Won, is simply mistaken when he contends that the reason or one of the reasons the Staff is changing course in this case is that this is the "first time" NOAA has accounted for station move." Is this statement accurate?

A. No.

Q. Do you have any evidence Mr. Wills is incorrect?

A. Yes. Staff did not state this in its testimony. According to his response to DR 0493, Mr. Wills is simply mistaken in his understanding of the context of Staff's words. The following is the paragraph in Staff's direct testimony that Mr. Wills cites in his rebuttal testimony.

> This is the first Ameren Missouri rate case in which Staff has used NOAA's normal weather based on the 30-year period of 1981-2010. In Ameren Missouri's previous four electric cases, Staff and Ameren Missouri agreed to adjust temperature data from NOAA in the 30-year period (January 1, 1971 – December 31, 2000) for the St. Louis Lambert Airport weather station based on a merger and complaint case agreement in Case No. EM-96-149 and Case No. EC-2002-1. The adjustments agreed to were necessary because NOAA's previous normals did not take into account a 1996 instrumentation change.

When the adjustment was made for Case No. EM-96-149, NOAA's normal period was 1961-1990, which would not be able to account for the Automated Surface Observation System ("ASOS") change in 1996. In addition, during the deposition on August 6, 2012, I said the last NOAA normals time period 1971-2000 accounted for the instrument change to the ASOS in 1996.

Q. According to Mr. Wills' testimony, since in the previous four Ameren Missouri rate cases Company and Staff used the adjustments from an agreement in Case No. EM-96-149, the Commission should adopt the adjustments consistent with the agreement in Case No. EM-96-149. Do you agree?

A. No. The 30-year normal period was 1971-2000 for the previous four Ameren Missouri rate cases. However, for the current Ameren Missouri rate case, Company and Staff used the normal period of 1981-2010, so the adjustments used in the previous four Ameren Missouri rate cases have been superseded for the current rate case. Furthermore, there was no ongoing agreement between Company and Staff to continue to use the adjustments in subsequent cases.

Q. According to Mr. Wills' testimony, the Commission should accept Mr. Dutcher's analysis of the 2002 temperature data. Do you agree?

A. Yes. However, I want to note that Staff has some concerns with Mr. Dutcher's Double Mass Analysis ("DMA"). These concerns are presented in the section of "Response to the testimony of Allen Dutcher."

Q. Are there any other concerns with Mr. Wills' testimony?

A. Yes. Mr. Dutcher recommended a range of temperature adjustments for both 1996 and 2002. However, Mr. Wills accepted only Mr. Dutcher's analysis of the 2002 temperature data. In his testimony, Mr. Wills states,

> After reviewing NOAA's analysis that suggests the need for a 2002 adjustment, the Company asked Mr. Dutcher to analyze the Lambert Field temperature records from that time period. He identified and quantified a discontinuity in the data. Based on the results of Mr. Dutcher's analysis, the Company believes that it is appropriate to adjust the temperatures prior to January 18, 2002. Mr. Dutcher identified a change in the maximum temperature in the range of 0.57 to 0.63 degrees, and a change in the minimum temperature of 0 to 0.909 degrees. I have used the midpoint of each range identified to calculate the normal temperatures on which my updated weather normalized sales are based.

First of all, Mr. Wills' upper boundary of the minimum temperature adjustment range in 2002, 0.909, is not right. According to Mr. Dutcher's testimony and Staff's analysis of Mr. Dutcher's workpaper, the number should be 0.09.

Furthermore, Mr. Wills did not consistently use Mr. Dutcher's analysis in his revised adjustment recommendation. For consistency, Mr. Wills should also accept Mr. Dutcher's analysis of the 1996 temperature adjustment, along with the methodology for calculating the adjustment.

Response to the Rebuttal Testimony of Allen Dutcher

Q. What is your concern with Allen Dutcher's analysis?

A. Mr. Dutcher's analysis of temperature data does not resolve the inconsistency and bias of DMA.

Q. Why does Mr. Dutcher's DMA not resolve inconsistency and bias?

A. Mr. Dutcher's DMA adjustment is dependent on the selection of reference weather stations and the selection of the time periods around the station anomaly. In other words, adjustment values vary depending on the analyst's choices. In addition, Mr. Dutcher incorrectly concluded that the temperature series of three reference stations he used have no discontinuities or anomalies. This is not true.

Q. What is the list of reference weather stations used in Mr. Dutcher's DMA?

A. In his testimony, Mr. Dutcher states he used St. Charles, St. Charles 7SW and St. Louis Science Center. However, based on Staff's investigation, currently no weather station with the name St. Charles 7SW is listed as a NOAA cooperative weather station in the St. Charles, Missouri, area. According to Mr. Dutcher's Schedule ALD-ER1, NOAA's Multi-Network Metadata System, he retrieved the information of St. Charles 7SSW. Therefore, Staff concludes Mr. Dutcher mistakenly used the name "St. Charles 7SW" for what is actually St. Charles 7 SSW. Therefore, the list of reference weather stations used in Mr. Dutcher's DMA is St. Charles (City Water Plant), St. Charles 7 SSW (Missouri American Water Plant, Chesterfield), and the St. Louis Science Center.

Q. Are there any characteristics for the qualification of reference weather stations for DMA?

A. Yes. First, the temperature data series of reference weather stations should be highly correlated to the temperature data series of the target station, STL. Second, the

temperature data series should not have any discontinuity during the time frame of the DMA. If there is a discontinuity, the result of the DMA is not correct.

Q. In his testimony, Mr. Dutcher asserted, "My technique (Double Mass) indentifies 'all' impacts, documented or undocumented. . . ." Does Mr. Dutcher provide any evidence that the temperature series of the three reference stations he used has no discontinuity?

A. No. For documented changes, interestingly, Mr. Dutcher provided the evidence that there are more than ten documented changes in three weather stations during the time frame he used in his Schedule ALD-ER1. For undocumented changes, he did not provide any evidence in response to Staff DR 0489. However, he provided the evidence in his workpapers that there are undocumented changes. In his workpapers, Mr. Dutcher provided his chart analysis and the regression results of his DMA. If there is no undocumented change in the temperature data series, then the associated cumulative temperature difference graph should be a straight line except for documented changes. In addition, if there is no discontinuity during the time frame he used, the associated R-square should be "1" in the regression result. However, all of his regression results showed less than one R-square value. This result implies there are unexplained discontinuities during the time frame Mr. Dutcher used in his DMA. Because he used reference stations that include documented and undocumented changes, Mr. Dutcher's DMA result is necessarily biased.

Q. Are there inconsistencies in the calculations of the DMA adjustment according to the reference station used by Mr. Dutcher?

A. Yes. In lines 6-12, on page 12 of his testimony, Mr. Dutcher stated:

> Yes. My findings are based upon a Double Mass analysis using St. Charles, St Charles 7 SW, and the St Louis Science Center weather stations. The results

> indicate that the 2002 minimum temperature adjustment was between 0.00 degrees F and 0.09 degrees F, while the maximum temperature adjustment ranged from 0.57 degrees F to 0.63 degrees F. For the 1996 ASOS installation and Lambert Field station move, preliminary analysis indicates that minimum temperatures cooled 1.6 degrees F to 2.16 degrees F, while maximum temperature cooled 0.80 degrees F to 0.97 degrees F.

Because the DMA adjustment is dependent on the reference stations, Mr. Dutcher presented a range for the adjustments instead of giving a single adjustment value. If his results were consistent, Mr. Dutcher's DMA would have produced only one adjustment for three weather stations. In other words, the DMA adjustment values are different for each of the three reference weather stations. This result implies if Mr. Dutcher chose weather stations other than St. Charles, St. Charles 7 SSW, and the St. Louis Science Center, he would have different DMA adjustment values.

Q. Are there anomalies in the reference stations' actual temperature data?

A. Yes. In the real world, all actual temperature series of every weather station have anomalies because of instrument changes and observation biases. For instance, documented instrument changes such as the relocation, replacement, and recalibration of an instrument existed during the normal period 1981-2010 in all four weather stations Mr. Dutcher considered in his testimony. The relocation and replacement history is documented by NCDC. Actually, Mr. Dutcher also recognized this fact and provided part of the published instrument change history in Schedule ALD-ER1 of his testimony. According to National Weather Service (NWS) technicians, ASOS instruments are recalibrated quarterly and are repaired occasionally. Other non-ASOS instruments are also periodically serviced and may be repaired or recalibrated.

Undocumented changes, such as changes in local environment, contribute to anomalies in the station's temperature series. Locations of the instruments Mr. Dutcher

considered are: 1) the STL ASOS located between Lambert runways, 2) the St. Louis Science Center where the temperature sensors are between trees and the building, 3) the St. Charles City Water Plant where the temperature sensor is beside an open reservoir, and 4) at the Missouri American Water Company where the temperature sensor is on a road in Chesterfield. All of these temperature sensors are substantially influenced by non-meteorological influences in their local environment.

Observation biases are other major source of anomalies. In his testimony, Mr. Dutcher stated,

> A cooperative station is a station at which observations are taken or other services rendered by private citizens, institutions, etc. Services rendered usually consist of taking instrumental or visual observations and transmitting reports. Data from cooperative stations is generally less reliable than that recorded at other weather stations.

Interestingly, all three reference weather stations Mr. Dutcher used in his DMA are cooperative stations with a Maximum-Minimum Temperature System ("MMTS"). At the two water plants, observers are employees who, as part of their duties, are assigned to read and record the MMTS once a day. Observers in cooperative stations have their primary job and scheduled time off. Even though observers' colleagues help them in reading and reporting daily maximum and minimum temperature in the observer's absence, procedures are manually conducted and are not guaranteed to be error free.

Furthermore, there are systematic observation biases such as Time of Observation Bias ("TOB"). In a cooperative weather station, an observer is supposed to read daily maximum and minimum temperatures every 24 hours and to reset equipment. The problem is the observation time is not usually 12:00 a.m. (midnight). For instance, the observation time of the reference weather stations Mr. Dutcher used is between 7:00 a.m. and 11:00 a.m. This means the maximum temperature stored in the display unit at 8:00 a.m. of the observation day

may not actually be the maximum temperature of the observation day – it may be a temperature from the previous day. Climatologists estimate the annual averages of the effects of TOB on recorded temperatures can be more than $1^{o}F$.[1]

Q. Is there any way to reduce these biases?

A. Yes. Climatologists have developed an adjustments estimation method of TOB[2] and a statistical adjustment procedure of the Homogenization Pairwise Algorithm ("HPA")[3] using monthly mean maximum and minimum temperature data.

Q. Are there any adjustments that accounted for TOB and used HPA?

A. Yes. NOAA 1981-2010 normals produced by NCDC accounted for TOB and used HPA using monthly mean maximum and minimum temperature data.

Q. Is there any evidence TOB in NOAA 1981-2010 normals is properly adjusted?

A. Yes. According to an abstract of a peer-reviewed paper provided by NCDC, the U.S. Historical Climatology Network ("HCN") database contains statistical adjustments that address historical changes in observation time at each observing station in the network. The paper concludes that the HCN station history information is reasonably complete and that the TOB adjustments in HCN appear to be robust.[4]

Q. Is there any evidence HPA is a proper method to resolve bias due to documented and undocumented changes?

[1] Retrieved from http://www.john-daly.com/tob/TOBSUM.HTM
[2] Karl T.R., C.N.Williams, P.J. Young (1986) A model to estimate the time of observation bias associated with monthly mean maximum, minimum and mean temperatures for the United States. *J Climate Appl. Meteorol.*, **25**, 145–160.
[3] Menne, M. J., and C. N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.
[4] Vose, R. S., C. N. Williams Jr., T. C. Peterson, T. R. Karl, and D. R. Easterling (2003), An evaluation of the time of observation bias adjustment in the U.S. Historical Climatology Network, *Geophys. Res. Lett.*, **30(20)**, 2046, doi:10.1029/2003GL018111.

A. HPA was introduced in the peer-reviewed paper "Homogenization of temperature series via pairwise comparisons," which was reviewed and published in 2009 by the American Meteorological Society official journal - "*Journal of Climate*"[5] - which was the world's top ranked journal in the field of Atmospheric Science in 2009 by SCImago Journal and Country Rank.[6] According to the paper, "all possible change points are identified before estimates of their magnitudes are made" and "potential adjustments can then be calculated for all undocumented and documented shifts at the same time." The paper also cited more than 49 published papers in peer-reviewed journals.[7]

Q. According to his testimony, Mr. Dutcher states "there is no evidence that Staff's review of daily observations verifies NCDC's adjustment." Is this true?

A. No. First, Staff provided the process of daily adjustment for the normal period 1981-2010 using NCDC's adjustment to Mr. Wills on September 23, 2011, and the updated version in the Staff's response to Ameren Missouri DR 003. Second, in response to questions about the Staff's review process, Staff provided all email communications with NCDC, including detailed data evidence and supporting published papers, in its response to Ameren Missouri DR 004 and DR 005.

Q. In his testimony, Mr. Dutcher asserts the DMA technique is commonly accepted and used by climatologists. Mr. Dutcher stated, "For example the Double Mass technique was employed by Thomas B. McKee" and used in Dr. McKee's research in 1996. Do you think this is a proper example?

[5] Menne, M. J., and C. N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.
[6] Retrieved in August 21, 2012 from, http://www.scimagojr.com/journalrank.php.
[7] Retrieved in August 21, 2012 from http://scholar.google.com/scholar?cites=4804384233386057349&as_sdt=5,26&sciodt=0,26&hl=en

A. No. Dr. McKee used "Seasonal Accumulated Temperature Difference Plots" in his research in 1996.[8] Even Dr. McKee used accumulative temperature series. Mr. Dutcher has made an elementary logical error: if part of a methodology is the same, then the whole method is the same.

Q. In his testimony, Mr. Dutcher asserted, "Our results were documented and published in "*Tripod*," a former automated weather data network publication issued by the High Plains Regional Climate Center." Do you think "*Tripod*" is a reliable peer-reviewed academic journal?

A. No. "*Tripod*" is "News & Notes about Automated Weather Station Applications"[9] published by the Institute of Agriculture and National Resources at the University of Nebraska-Lincoln, where Mr. Dutcher is a faculty member.

Q. Do you agree with Mr. Dutcher's concern about NCDC's adjustment for maximum temperature series?

A. Yes. Even though NCDC's methodology is theoretically correct, Staff is aware of a bug in the actual implementation of the temperature adjustment in STL. According to NCDC, HPA finds more statistically significant break points and makes more adjustments in minimum temperature series than in maximum temperature series. In addition, NCDC recommended that it would be valuable to examine paired differences between STL monthly mean maximum temperature series and neighbor weather stations to see if there is evidence of shift at the times in question.

Q. Based on NCDC's recommendation and Mr. Dutcher's finding, what is Staff's recommendation for the Commission?

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[8] Temperature Data Continuity with the Automated Surface Observing System. Alison D. Schrumpf and Thomas B. McKee, *Climatology Report* No. 96-2. June, 1996.

[9] Al Dutcher and Ken Hubbard, (1994) "What's wrong with the data?" *The Tripod*.

A. NCDC's adjustments for mean daily temperature for 1996 and 2002, on which Staff based its direct testimony, are within the ranges of Mr. Dutcher's adjustment calculation. However, in consideration of everything described above and for the purposes of this rate case, Staff recommends the Commission approve adjustments to the 1981-2010 temperature time series based on the mid-points of Mr. Dutcher's adjustment ranges for 1996 and 2002. Staff will work with Ameren Missouri after this rate case to develop a weather data series that both parties can agree on.

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does.