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**MISSOURI PUBLIC SERVICE COMMISSION**

**Case No. ER-2012-0166**

# REBUTTAL TESTIMONY

**OF**

**ALLEN L. DUTCHER**

**ON**

**BEHALF OF**

**UNION ELECTRIC COMPANY**
**d/b/a Ameren Missouri**

**St. Louis, Missouri**
**August, 2012**

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# REBUTTAL TESTIMONY

# OF

# ALLEN L. DUTCHER

# CASE NO. ER-2012-0166

## I. INTRODUCTION AND SUMMARY

**Q. Please state your name and business address.**

A. My name is Allen L. Dutcher. My business address is 724 Hardin Hall, 3310 Holdredge Street, Lincoln, Nebraska.

**Q. By whom and in what capacity are you employed?**

A. I am employed by the University of Nebraska Lincoln ("UNL").

**Q. Please describe your employment history with the University of Nebraska Lincoln.**

A. I began my employment with the University of Nebraska-Lincoln in June of 1989 as an Operations Climatologist in the High Plains Regional Climate Center. I was promoted to State Climatologist in November of 1991. I continue to serve in that capacity.

**Q. Please describe your duties and responsibilities as State Climatologist.**

A. I am responsible for monitoring climatic conditions that can have a direct impact on Nebraska's economy. My typical duties include answering and responding to public requests for climate data, climate data reconstruction, drought monitoring, soil moisture monitoring, weather/climate forecasting, agricultural weather risk assessment, and climate product development.

In an average year, I participate in approximately 250 media interviews and respond to an additional 400 climate data requests, I have undergone weather/climate product training at the

National Climatic Data Center (“NCDC”), which is a division of the United States National Oceanic and Atmospheric Administration ("NOAA"). In addition, I am chairman of the Water Availability and Outlook Committee, which is one of three subcommittees that are part of the governor’s Climate Assessment and Response Committee. I also provide weekly agricultural weather forecasts for UNL’s Market Journal and KRVN Radio – Lexington. I am also a contributing author for UNL’s CropWatch, a multidisciplinary newsletter that addresses topics that may have a direct impact on agricultural producer yields and net profit.

**Q. Please describe your qualifications.**

A. I received my B.S. at Iowa State University in 1985 with a major in Meteorology and a M.S. in Agricultural Climatology from Iowa State University in 1989. During graduate school, I was the Teaching Assistant for Introductory Meteorology and developed my research program on the topic of average time of observation bias corrections for long-term cooperative weather sites in Iowa.

After being hired at the University of Nebraska in 1989, I have worked on soil moisture modeling, thermal tracking of insect development, weather risk assessment, climate data reconstruction, automated weather data network station quality control techniques, developing drought monitoring tools, and answering climate data inquiries.

**Q. What is the purpose of your rebuttal testimony?**

A. The purpose of my rebuttal testimony is to respond to the direct testimony of Missouri Public Service Commission Staff (“Staff”) witness Dr. Seoung Joun Won, and specifically his analysis of normal weather to use for weather normalization calculations. There is a long history of making specific weather adjustments as part of the weather normalization

process for the purposes of establishing rates for Ameren Missouri, as is explained in the rebuttal testimony of Ameren Missouri witness Steven Wills.

**Q. What are your primary conclusions?**

A. I conclude that the Missouri Public Service Commission should continue to apply two weather corrections (1988 and 1996) that had previously been applied by both Ameren Missouri and Staff. Also, I recommend an additional weather correction for 2002. Finally, I conclude that Staff's new methodology for determining normal temperatures cannot be replicated and relies upon estimated data and so must be rejected at this time.

## II. STAFF'S APROACH

**Q. Did Dr. Won use a different methodology for setting normal weather than had been used in previous Ameren Missouri rate cases?**

A. Yes, as Dr. Won testified, he relied upon normal temperatures for the period 1981 through 2010 published by the NCDC in July of 2011. Dr. Won did not apply the adjustments to that data that had been agreed upon in previous rate cases (these adjustments stemmed from a Double Mass analysis performed specifically for the weather station for Ameren Missouri's load, which I provided in an earlier Ameren Missouri case.)[1] As Company witness Steven Wills discusses in his rebuttal testimony, and as I also explain below, historically, the Staff had agreed to the adjustments I developed and has used them in every Ameren Missouri rate proceeding since they were initially developed. Instead of continuing to make these adjustments, Dr. Won changed the Staff's approach and relied on a "homogenization" procedure used by NCDC.

**Q. Please explain the approach taken by Dr. Won in the Staff's direct case.**

A. The methodology that Dr. Won employed in his attempt to determine the impacts of station moves and/or sensor changes for St. Louis Lambert International Airport weather

[1] Case No. EM-96-149

station ("Lambert Field") uses homogeneity techniques undertaken by the NCDC in their calculations of the 1981-2010 normal temperatures. This technique uses a "pairwise" comparison between available weather stations within close proximity to identify data discontinuities due to station moves and/or sensor changes at Lambert Field. These available stations include official NOAA weather stations and "cooperative" sites.[2] Pairwise comparison, in short, is a process where temperatures from one station are compared against surrounding stations, filtered to remove stations with low correlations, examined to identify when station discontinuities occur, and adjusted with a correction factor that accounts for the discontinuity.

The overall goal of the NCDC homogenization analysis was to develop an automated technique that identified change points[3] that impact the way a weather observation station records observations in relation to a large number of widespread neighboring weather observation stations. To understand why NCDC took this approach, one must understand the NCDC's dilemma. NCDC is required to develop 30-year normal temperatures for over 15,000 stations every 10 years and this work must be completed within a window of just 18 months. Manual inspection of data comparisons would be impossible due to time constraints, so NCDC had to develop a more expeditious computational method for identifying change points.

Compare that approach to the previous Double Mass analysis that I performed on the Lambert Field weather station. As a part of that work, I spent over 60 hours on data analysis to

[2] 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.

[3] With the Double Mass analysis, one accumulates the differences of the weather readings between the target station and the reference station. That result is graphed. If there are no discontinuities between the two weather stations, the graph will contain a straight line. If there is a break in the line, then a change point or discontinuity has been identified. In order to have accurate comparisons of weather readings before and after the point in time when the discontinuity is identified, a correction must be applied to weather readings prior to the change point.

develop accumulated difference curves and associated regression results. Another 70 hours were spent documenting my findings. If the NCDC used a similar approach, it would require 900,000 (60 hours x 15,000 stations) man-hours to develop and analyze accumulated temperature difference curves. Given the NCDC's time constraints, they needed to devise a computer simulation method that could quickly identify major discontinuity shifts at all 15,000 weather stations. NCDC simply does not have time to perform at every weather station the type of analysis that I performed to identify and quantify the discontinuities at the Lambert Field station.

**Q. Are the two methodologies similar?**

A. The major difference between the two techniques is that the Double Mass analysis that I used accumulates the Delta T units (i.e., differences in temperature) over time using actual daily data and searches for a pivot point that indicates a relationship change (slope change) between two stations. The NCDC technique plots individual Delta T monthly values over time to identify a point in time where there is a relationship change.

It is important to note that the NCDC uses the daily Historical Climate Network ("HCN") to determine these break points by examining how Delta T behaves between comparison stations. I believe the NCDC homogeneity calculation is a valid technique for identifying major discontinuity events, but the correction factors Staff applied to the Lambert Field weather station do not match up with my findings. This is a significant red flag, because as I noted, my findings were based upon a specific examination of the Lambert Field station, as opposed to the more expeditious homogenization technique applied to 15,000 stations. That the correction factors used by the Staff do not match up is likely because NCDC used daily data to identify discontinuity events, but chose to use monthly HCN data to develop their correction factors.

**Q. Why would this be a concern?**

A. Because the monthly HCN data set that was used by the NCDC contains both homogeneity adjustments and time of observation adjustments, and thus their adjustments have been calculated using estimated data. It is more appropriate that, once discontinuity events are identified using the Double Mass technique, correction factors are determined by examining the actual physical temperature records and not through the use of estimates.

There are many similarities between the NCDC technique and the Double Mass technique that I have used in my current analysis and in my prior analysis. Both methods look at identifying abrupt changes in Delta T by identifying when distinct periods of temperature consistency between a target and comparison station abruptly change. The homogeneity pairwise method looks at daily data to identify discontinuities then uses the monthly HCN to develop adjustment corrections. The Double Mass analysis also uses daily data for pairwise comparison, but uses the same daily data to determine the appropriate correction to account for identified discontinuity events. With the Double Mass technique, potential discontinuity points are identified when the accumulated difference plot of comparison stations versus the target station indicates that a slope change has occurred on the same calendar date.

**Q. If the two methodologies are similar, why is the Double Mass technique superior?**

A. There are two major reasons why I feel that the Double Mass technique is superior to Staff's (meaning, NCDC's) technique. First, the Double Mass technique is simple to compute and the computation methodology remains static. Second, data derived from the Double Mass methodology will be consistent over time since the calculation methodology doesn't change. The same things cannot be said with regard to the NCDC homogeneity calculations, as history has shown that their monthly HCN data set has already undergone three

revisions and it will likely be revised in the future. In contrast, the Double Mass analysis uses temperature data that the NCDC has determined to be official, with no further revisions required. This means that future analysis runs can replicate past findings without concern that historical observations will be altered in the future and subsequently eliminates the need of for recalculating previous results. The ability to be able to replicate results is critical. Otherwise, one cannot have a high degree of confidence in the methodology that was used.

While the NCDC homogeneity methodology can be used to identify significant station discontinuities, it is unlikely to properly identify or correct for smaller changes because they have not been documented within the sub-station history files. My technique (Double Mass) identifies "all'' impacts, documented or undocumented, by accumulating temperature differences over time between the target station and a comparison station. If the target station shows duplicate accumulated temperature unit changes with a second nearby station, then a discontinuity point has been identified and the resultant change in the temperature relationship between the two stations can be quantified. These discontinuity points are only valid when the Double Mass analysis performed between comparison stations **do not** show the same slope change at the discontinuity dates identified when performing the same analysis on the target and comparison stations. In summary, the Double Mass approach produces a more accurate representation of temperature relationships between Lambert Field and surrounding comparison stations because it uses actual climate observations at each step of the calculation process and does not rely on estimated data – as does the homogenization approach -- to determine an appropriate correction factor.

**Q. Does Dr. Won's direct testimony explain why Staff prefers the pairwise technique?**

A. It does not. Dr. Won is simply relying upon an assumption that the NCDC 1981-2010 normals (homogeneity) process is valid. Dr. Won agreed in his deposition that he could not duplicate NCDC's analysis and that he was relying upon the accuracy of NCDC adjustments.[4] Based upon that unproven assumption, the Staff has essentially decided to discard the previous Double Mass analysis that was performed by my office and the Missouri State Climatologist, and the subsequent agreement which allowed both sides to reanalyze the data to insure that a mutually agreeable temperature adjustment could be reached. Neither the Staff's workpapers, testimony, nor their responses to discovery in this case demonstrate that this homogenization approach is superior to the Double Mass analysis previously employed by both sides in Case No EM-96-149 and in every Ameren Missouri rate case thereafter. For the reasons discussed in my testimony, it is my opinion that the homogenization approach is inferior.

**Q. Do you know how NCDC's comparison technique works?**

A. From what can be discerned based on publicly available data, NCDC communications with the Staff, and my own contacts at NCDC, once data discontinuity points were identified, temperature data from the NCDC's monthly HCN data set was used to develop the discontinuity adjustments. The NCDC monthly HCN data set currently in operation is Version 3. That alone should be a warning flag to anyone using the data. Multiple revisions of data sets are typically a signal that some issue(s) arose in prior data sets and additional computations were needed to address those specific issues.

**Q. Should Staff's use of monthly HCN data cause the Commission to doubt Dr. Won's results?**

A. Yes. Because the monthly HCN data set was used by Staff, I have serious reservations about the validity of the Staff's calculations. This data set not only contains station

[4] Deposition of Dr. Won, August 6, 2012, p. 55, l. 5-10 and p. 61, l. 7-9.

discontinuity adjustments, it also contains time of observation adjustments (adjusting all temperature records from individual stations to midnight regardless of when the observations were actually made). This was done so that climate trend analysis across broad areas could be conducted after observation time discontinuities between stations had been addressed.

The monthly HCN data set used to develop monthly and daily normals by Staff contains time of observation adjustments to cooperative stations, as well as quality control estimates for missing and suspect data. In short, stations used for comparison against Lambert Field were cooperative sites that take morning or afternoon observations. The subsequent data set contains multiple adjustments that were used in the creation of monthly and daily normals. In simple layman's terms, adjustment **estimates** have been incorporated into the monthly HCN data set, including from cooperative stations which as noted earlier have inherent limitations due to the manner in which the data is collected.

**Q. How does this compare to the stations you reviewed as part of your analysis?**

A. The Double Mass analysis I used looks at the rate of accumulated temperature differences over time between two official stations. No data adjustment techniques (similar to the NCDC undertaking) are necessary. We are trying to measure the direct impacts of a station move or sensor change by using the highest correlated stations that are within close proximity of the target site (Lambert Field). As long as the comparison station doesn't undergo a discontinuity issue during the time period prior to and after a suspected move at the target station, a specific rate of change between the two stations can be identified and quantified without the use of estimates.

**Q. Is the Double Mass technique commonly accepted and used by climatologists?**

A. In one form or another, yes it is. Even NCDC's pairwise methodology is a form of a Double Mass analysis. The term "Double Mass" was brought to my attention by my former boss, Dr. Ken Hubbard, who found the technique in an engineering text book. We initiated the first attempt at the technique with a similar analysis for Lincoln Electric System ("LES") in 1993 when NOAA commissioned the new Automated Surface Observing System ("ASOS") site at the Lincoln Airport. NOAA's load models were failing and they needed to identify the cause of failure. We found a significant change in way temperatures were measured by the new ASOS sensor compared to the replaced Model HO83 sensor. By using nearby locations, we were able to successfully identify the rate of change and recommend the appropriate adjustments to the data. LES was able to apply that correction to their weather records and successfully account for the ASOS adjustment in their load models. Our results were documented and published in "Tripod," a former automated weather data network publication issued by the High Plains Regional Climate Center.

Other climatologists use the Double Mass technique. For example, the Double Mass technique was employed by Thomas B. McKee, State Climatologist for the state of Colorado, hired by the National Weather Service, Office of Meteorology under a NOAA grant, to investigate the difference between how the new ASOS sensors then being installed by NOAA measured temperatures in comparison to the old HO83 sensors that were to be replaced.[5] He examined a total of 76 stations using side-by-side comparisons and plotting the accumulated temperature differences between the new ASOS sensors and the old HO83 sensors from 1994-1995. He found that the majority of sites had a cool bias when the new ASOS sensor was compared to the old HO83 sensor, with an average cooling of 0.3 C (0.53 F). Of the 76 stations,

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

only nine were found to have a warm bias. In addition, he found that the ASOS sites were cooler than their former locations because the stations were relocated to more open areas that allowed for better air flow through the temperature sensor shield.

The third variation of the Double Mass technique is the NCDC pairwise comparison, which examines the temperature differences between stations to identify when temperature discontinuities occur. Their Double Mass method plots the daily differences to identify discontinuities, as opposed to my Double Mass technique which accumulates those differences to identify the same discontinuities and examine whether periods of discontinuity are occurring within the particular month.

**Q. Did NCDC's methodology identify changes in both the maximum and minimum temperatures?**

A. Staff has stated that its (NCDC's) analysis indicated no adjustment was necessary to maximum temperatures due to the 1996 ASOS installation. That is, they say that there was no discernible trend change for maximum temperatures when the station was relocated and the new ASOS sensor was installed. This is at odds with McKee's study of 76 ASOS stations which found that nearly 90% of the new ASOS stations were cooler (meaning their maximum temperatures do need to come down).

While Staff recommends no changes for maximum temperatures, they advocate for three minimum temperature adjustments. The first minimum temperature adjustment is for a 2002 St. Louis Lambert Field discontinuity and results in a recommended adjustment upwards of 0.7 degrees F from 1981 to the discontinuity date in 2002. Staff also found a 1996 ASOS installation required a cooling adjustment of 1.6 degrees F for minimum temperature from 1981

to the ASOS installation date in 1996. The third adjustment was for the 1989 discontinuity was 1.2 degrees F from 1981 to the discontinuity date in 1989.

**Q. Have you conducted a new Double Mass analysis respecting Lambert Field?**

A. Yes, I have. The results of that analysis are reflected in Schedule ALD-ER1.

**Q. Did your new analysis find discontinuities that should be addressed?**

A. 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. The analysis for the 1989 discontinuity event is incomplete due to time constraints required since the Staff's direct case was only filed about 6 weeks ago.

**Q. Staff's advocates that the 3 homogeneity points identified through their analysis require no adjustment to maximum temperatures. Is this theoretically possible when minimum temperatures required two large warming adjustments (>1 degree F) and one cooling adjustment (1.6 degrees F) for the identified discontinuities?**

A. Not in my opinion. Let's be generous and say that 5% of the locations analyzed across the U.S. needed no adjustment to maximum temperatures for a recognized discontinuity. The odds that this could occur three consecutive times (for all three of the Lambert Field station changes) would be 5% x 5% x 5%, or 1.25 chances out of 10,000 -- .000125, or barely more than one-hundredth of one percent. It is possible by random chance that the three discontinuity events

would indicate that no significant adjustments to maximum temperatures were necessary as advocated by Staff, but the statistics would indicate that it is extremely improbable.

In addition, it is important to remember that the location of the weather recording station prior to the ASOS installation at Lambert Field was several miles away and located within close proximity (< 25 feet) to a parking lot. The subsequent move to the open area between runways at the airport would strongly suggest that an abrupt change in the climatic conditions had occurred. Staff's recommendation for a minimum temperature correction of 1.6 degrees F matches the correction factor I recommend in the previous case which addressed this matter. With such a substantial change occurring to the minimum temperature, I can't reconcile how maximum temperatures could not be impacted. To put it simply, the weather station move in 1996 (from a parking lot to a grass surface) must have had an impact on maximum temperatures, typically a cooling effect.

**Q. Did you examine the Staff's adjustments to see if they were properly calculated and applied?**

A. Yes, I did. I ran Staff's adjusted Lambert Field daily maximum and minimum temperature adjustments against St. Charles daily maximum and minimum temperatures. If Staff's proposed corrections had been properly calculated and applied, then the Double Mass accumulation plots between Lambert Field and comparison locations should result in a linear plot through the entire 30 year period, without any significant slope change. This is because the discontinuity would have been addressed and the adjustment would have brought it back to the linear trend..

Schedule ALD-ER1 contains Double Mass plots of my technique applied to three comparison sites in close proximity to Lambert Field, St Charles, St Charles 7 SW, and St Louis

Science Center. Also included is a Double Mass plot of the Staff's corrected Lambert Field daily data ran against the raw weather records for St Charles. If you overlay the plots of the minimum temperature (corrected vs. uncorrected), the 1996 correction proposed by Staff appears to eliminate the discontinuity due to the station and sensor change that occurred when the ASOS site was installed at the airport.

However, further examination of the 2002 discontinuity event reveals that Staff's minimum temperature adjustment results in an identical plot of the accumulated temperature units as the uncorrected plot. In short, Staff's correction does not appear to correct for the discontinuity associated with the 2002 event.

Further comparison of the both St Charles and St Charles 7 SW uncorrected minimum temperature accumulation plots against Lambert Field reveal that three (3) linear slope changes from 2001 through 2010 occurred at similar dates. This indicates that Lambert Field's temperature sensor may have been having measurement issues and needs to be investigated to see if additional adjustments are necessary.

Not surprisingly, the Double Mass plot of corrected maximum temperatures for Lambert Field was identical to the uncorrected plot for the same plot. We would expect this result because Staff indicated that their pairwise homogeneity analysis found that the three discontinuity dates had no significant temperature change and they didn't need to apply any corrections to adjust historical observations to current maximum temperature observations.

Both Double Mass plots of uncorrected accumulations of maximum temperature units reveals that both St Charles and St Charles 7 SW had a distinct slope change immediately in regard to the 1996 ASOS installation. With both stations indicating a significant slope change near the same date, I can confidently state that there was indeed a discontinuity at Lambert

Field, it can be measured, and the resultant change was significantly greater than zero. The Staff's conclusion that it was zero is simply not borne out by the facts, or this analysis.

**Q. Do you have any other concerns with the use of NCDC's technique?**

A. At this point in time, there is no option available to compare how the derivation of the new 1981-2010 normals compare to the 1971-2000 normals when using the same technique employed with the most recent normals' calculation. The NCDC has stated on their web-site that an internal consistency test has been run, but they have not made their results available to the public. Until they release this analysis to the scientific community, there is no way to know whether their new techniques used in the creation of the 1981-2010 normals is superior to the previous calculations employed in the creation of the 1971-2000 normals that became operational at the beginning of 2002.

**Q. How did NCDC change their process for identifying discontinuities?**

A. The calculation of daily normals by the NCDC during previous thirty-year normal period (1971 – 2000) used the monthly mean minimum and maximum temperatures and spline fit[6] a curve to that data to come up with **estimates** for daily normals. In short, monthly averages (Jan, Feb, …, Dec) were placed at the mid-point of each month, then a curve was fit to the data. Daily normals were derived by determining the intersection point for each of the 365 days of the year based upon the spline curve. Again, NCDC was relying upon estimates, as opposed to actual analysis specific to Lambert Field used in my analyses.

The NCDC has modified their calculations for the 1981-2010 normals period by dropping the spline fit methodology and creating "true" daily normals based upon actual daily data. Using information that has been provided by Staff in regard to their calculation of daily

[6] Spline fit methodology finds a curve for a set of data points. NCDC takes the monthly normal temperatures and put a value at the midpoint of each month and then fits a curve to those data points. They take the curve that is generated and find a daily normal derived from the intersection point of that day on the curve.

normals, it appears that Staff applied a uniform correction factor to daily data based upon monthly corrections. Staff's methodology is not consistent with previous renditions undertaken the NCDC that used the spline fit technique or their current methodology of calculating true daily normals.

**Q. Have you been able to verify Staff's calculations?**

A. I can't be certain as to the exact methodology that Staff employed in the calculation of daily normals, since they offered little written evidence in regard to their methodology in the initial analysis submission report or in response to subsequent discovery requests. When asked to provide this information, Staff did nothing more than provide a spreadsheet which fails to provide any evidence that they have accurately depicted the total impact of station moves and sensor changes at Lambert Field. In fact, Staff's entire weather analysis was summed up in five paragraphs, with one of them dedicated to introducing the topic.

**Q. Is it appropriate to rely upon methodologies that cannot be replicated or reviewed by peers in the field?**

A. No, it is not. Standard protocol at academic institutions and other reputable research institutions is that analysis is only valid if it can be defended to a panel of peers and replicated. The problem must be defined and analyzed, and then a solution to it must be found. The research process must be fully described from beginning to end, results must be detailed, and then the reason(s) why the results are relevant and/or superior must be given. This is required so that anyone attempting to duplicate the procedures used in the study can replicate the results of the researcher performing the analysis. The five paragraph description of Staff's techniques and adjustments is grossly insufficient.

**Q. What additional information would need to be provided in order to review Staff's analysis?**

A. The following information has not been provided in regard to their temperature adjustment calculations:

1. An average homogeneity adjustment plot has been supplied for maximum and minimum temperatures, yet individual station adjustment rates used to calculate the average adjustments can't be found. Therefore, it is impossible to determine the variability (spread) of the final correction adjustments. This significantly undermines the Staff's results because the more narrow the variability of the range, the more confidence one can have in the correction value proposed. Without this information, I cannot have confidence in these adjustments.
2. Staff indicates that it verified NCDC's adjustments through direct communication and its own review of daily observations. However, Dr. Won admitted twice in his deposition that he was unable to replicate or duplicate NCDC's analysis.[7] Dr. Won indicated that he "verified" the results by checking the consistency of the NCDC research, asking them to re-do the calculation and by looking for published papers on NCDC's homogenization pairwise comparison process.[8] While that type of verification might be appropriate in some settings, it is not sufficient to label something as "verified" in the scientific community. For the type of analysis being done to find normal weather, verification means replication of methodology, something Dr. Won did not do. Accordingly, there is no evidence that Staff's review of daily observations verifies NCDC's adjustments.

[7] Deposition of Dr. Won, p. 54, l. 5-10 and p. 60, l. 20 through p. 61, l. 1.
[8] Id, p. 61, l. 10 – 21.

3. Staff indicates NCDC provided a peer review paper that describes their homogenization procedure for removing discontinuities. Staff has provided no evidence that indicates the NCDC adjustments have been verified as valid by outside agencies (non NOAA affiliated). This is important because the NCDC does not have an independent advisory panel that insures their computational technique(s) and subsequent results are valid.
4. Staff has failed to describe in detail (writing) each step of their process they took in deriving their adjustments, despite being asked.
5. It is virtually impossible to replicate an analysis if you are lacking detailed information on how each step of the process has been handled. That Staff can't provide it means that the Commission cannot have confidence in it nor can they rely upon it for the purposes of this case.
6. Staff has not produced any evidence explaining why their technique improves on the previous Double Mass analysis performed by both sides in the earlier case where the adjustments were agreed upon, and as noted, have been used for several cases.
7. Staff has failed to explain how they will handle future discontinuity issues when they arise. How will they employ their proposed methodology to identify future discontinuity issues? Can their procedure be duplicated by other parties? How much time will be required to calculate discontinuity adjustments when they arise in the future?
8. Staff has failed to provide a logical explanation as to why no adjustments were necessary for maximum temperature at the three discontinuity points identified in the Staff Report, but yet minimum temperatures were adjusted in both positive and negative directions. At a bare minimum, I would expect that Staff could provide supporting evidence of why a station can move several miles without showing a need for a maximum temperature

adjustment, especially when minimum temperatures have shown that an adjustment is necessary to account for discontinuities. Second, is it even theoretically possible that minimum temperatures require three distinct adjustments, while maximum temperatures are not impacted and require no adjustment? The answer, in my opinion, is no.

**Q. For future cases, do you have a recommendation for the Commission?**

A. Based upon past history, potential discontinuities will arise with regard to Lambert Field temperature records in the future due to station relocation and/or sensor changes/replacement. The parties need to find a mutually agreeable methodology for addressing the impacts of these discontinuities. The methodology needs to be simple enough that it can be replicated by both sides or it should be run independently with both sides agreeing on the final correction results.

I advocate the continued use of the Double Mass approach since it is able to isolate "all" suspected discontinuity points. The initial development of the meteorological data base will require a thorough analysis of Lambert Field against surrounding stations to insure that any suspected discontinuity points are the result of a change at Lambert and not a comparison station. Discontinuities can then be adjusted in the historical daily weather data file that is used by both sides for weather normalization and load forecasting.

Once the historical data has been adjusted to the mutual satisfaction of both sides, the only requirement will be to address future discontinuities that will eventually arise at Lambert Field. In essence, the Double Mass analysis will need to be run on a periodic basis to identify the discontinuity date and the subsequent correction factor that needs to be applied to historical records to calibrate them to the current temperature recordings.

If the analysis is set up properly, periodic Double Mass analysis runs should be easily to complete within a one to two day time frame. The overall benefit would be that both sides would not have to spend valuable resources coming up with new ways to adjust data every time a question arises as to whether historical temperature records are adequately reflecting the way Lambert Field is reporting daily maximum and minimum temperatures.

**Q. For purposes of this case, do you have a recommendation on which methodology should be used in the weather normalization process, and why?**

A. Yes, I do. The Commission should adopt the results of my Double Mass analysis, for several reasons.

1. My Double Mass analysis is a more rigorous analysis than NCDC could possibly preform on all of its weather stations. It is a thorough statistical analysis that focuses many hours of effort in identifying and quantifying the parameters of the discontinuities at Lambert Field. NCDC cannot afford to do this at every weather station and doesn't really need to do so for its purposes.

2. The NCDC homogeneity process uses estimated data as part of its corrections for observation bias while my Double Mass methodology is based upon actual daily temperature data, making it inherently more accurate.

3. NCDC's homogeneity analysis cannot be replicated. Without replication, it cannot be scientifically validated and should not be relied upon to make adjustments in this case.

4. The data set used to adjust the normal temperatures has been revised three times and is likely to be revised in the future, whereas the data underlying my Double Mass analysis is final and very unlikely to change.

5. NCDC's homogeneity analysis also causes the illogical result that three measured discontinuity events would impact minimum temperatures but have no impact on maximum temperatures.

In short, the Double Mass analysis results in an answer that is scientifically sound and is capable of being reproduced and verified. The same cannot be said of the NCDC's homogeneity process, which makes it inappropriate for the Commission to rely upon it in this case.

**Q. Does this conclude your rebuttal testimony?**

A. Yes, it does.

**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 Annual Revenues for Electric Service. | ) ) ) | File No. ER-2012-0166 |

**AFFIDAVIT OF ALLEN L. DUTCHER**

**STATE OF NEBRASKA**

**COUNTY OF LANCASTER**

Allen L. Dutcher, being first duly sworn on his oath, states:

1. My name is Allen L. Dutcher and my office is located in Lincoln, Nebraska and I am State Climatologist for the School of Natural Resources at the University of Nebraska Lincoln.

2. Attached hereto and made a part hereof for all purposes is my Rebuttal Testimony on behalf of Union Electric Company, d/b/a Ameren Missouri, consisting of 21 pages and Schedule(s) N/A, all of which have been prepared in written form for introduction into evidence in the above-referenced docket.

3. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded are true and correct.

Allen L. Dutcher

Subscribed and sworn to before me this 13th day of August, 2012.

Shellie J. Hanneman
Notary Public

My commission expires:

GENERAL NOTARY - State of Nebraska
SHELLIE J. HANNEMAN
My Comm. Exp. April 1, 2016