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Witness: Seoung Joun Won  
Sponsoring Party: MO PSC Staff  
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Case No.: GR-2014-0152  
Date Testimony Prepared: July 30, 2014

**MISSOURI PUBLIC SERVICE COMMISSION**

**REGULATORY REVIEW DIVISION**  
Tariff, Safety, Economic & Engineering Analysis

**REBUTTAL TESTIMONY**

**OF**

**SEOUNG JOUN WON, Ph.D.**

**LIBERTY UTILITIES (MIDSTATES NATURAL GAS) CORP.**  
**d/b/a LIBERTY UTILITIES**

**CASE NO. GR-2014-0152**

*Jefferson City, Missouri*  
*July 2014*

**BEFORE THE PUBLIC SERVICE COMMISSION  
OF THE STATE OF MISSOURI**

In the Matter of Liberty Utilities )  
(Midstates Natural Gas) Corp. d/b/a )  
Liberty Utilities' Tariff Revisions )  
Designed to Implement a General Rate )  
Increase for Natural Gas Service in the )  
Missouri Service Areas of the Company )

File No. GR-2014-0152

**AFFIDAVIT OF SEOUNG JOUN WON**

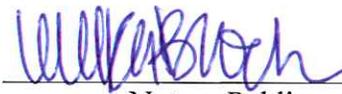
**STATE OF MISSOURI**     )  
  ) ss  
**COUNTY OF COLE**     )

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   9   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   29<sup>th</sup>   day of July, 2014.



  
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Notary Public

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1 **REBUTTAL TESTIMONY**

2 **OF**

3 **SEOUNG JOUN WON, Ph.D.**

4 **LIBERTY UTILITIES (MIDSTATES NATURAL GAS) CORP.**  
5 **D/B/A LIBERTY UTILITIES**

6 **CASE NO. GR-2014-0152**

7 Q. Please state your name and business address.

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

10 Q. Who is your employer and what is your present position?

11 A. I am employed by the Missouri Public Service Commission (“Commission”)  
12 and my title is Regulatory Economist III, Economic Analysis Section, Energy Unit, Utility  
13 Operations, Regulatory Review Division.

14 **CREDENTIALS**

15 Q. What is your educational background and work experience?

16 A. I received my Bachelor of Arts, Master of Arts, and Doctor of Philosophy in  
17 Mathematics from Yonsei University in Seoul, South Korea, and earned my Doctor of  
18 Philosophy in Economics from the University of Missouri - Columbia. Also, I passed several  
19 certificate examinations for Finance Specialist in South Korea, such as Enterprise Resource  
20 Planning Consultant, Financial Risk Management, Derivatives Consultant, and Financial  
21 Planner. Prior to joining the Commission, I taught both undergraduate and graduate level  
22 mathematics at the Korean Air Force Academy and Yonsei University for 13 years. I served  
23 as the director of the Education and Technology Research Center in NeoEdu for 5 years. My  
24 duties at the Commission include managing weather data, calculating normal weather,

1 analyzing revenues, and developing rate designs. A list of my educational background and  
2 work experience is also attached to this testimony as Schedule SJW-1.

3 **EXECUTIVE SUMMARY**

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

5 A. The purpose of my rebuttal testimony is to explain how Staff computed the  
6 weather variables that were used to weather normalize Liberty Utilities' (Midstates Natural  
7 Gas) Corp. ("Liberty" or "Company") sales, to address problems in the weather data that  
8 Company witness Christopher D. Krygier used to perform Liberty's weather normalization  
9 calculations, and to explain why Staff's weather variables are preferable to those used by Mr.  
10 Krygier.

11 Q. Which part of the weather data used by Mr. Krygier are you going to address?

12 A. I am addressing two issues: (1) the time series of temperature observations  
13 used to calculate Liberty's climate normals and (2) the weather station for the WEMO  
14 division.

15 **STAFF'S WEATHER VARIABLES**

16 Q. What is the purpose of calculating weather variables for normalizing test year  
17 sales?

18 A. Natural gas sales and revenues vary from year to year based on weather  
19 conditions. The temperature pattern in the test year is the primary determinant for weather-  
20 sensitive customer gas sales and the Company's revenue in the test year (October 1, 2012 –  
21 September 30, 2013). Each year's weather is unique, so rates for weather-sensitive customer  
22 classes must be based on test year sales and revenues adjusted to a level commensurate with  
23 "normal" weather conditions, rather than actual test year sales and revenues. Therefore, Staff

1 calculates variables of “actual weather” and “climate normals” so that weather-sensitive rate  
2 class sales and revenues can be adjusted to normal weather conditions.

3 Q. How did Staff calculate actual weather variables for Liberty’s rate case?

4 A. Staff obtained weather data from the Midwest Regional Climate Center  
5 (“MRCC”). Kansas City International Airport (“MCI”) weather data was used for the  
6 WEMO division, while the Kirksville (“KIR”) weather data was used for the NEMO division.  
7 The Cape Girardeau Airport (“CGI”) weather data was used for the SEMO division. The  
8 actual weather data sets consist of daily maximum temperature (“Tmax”) and daily minimum  
9 temperature (“Tmin”) observations. Staff used these daily temperatures to develop a set of  
10 mean daily temperature (“MDT”) values.

11 Q. What is a “climate normal”?

12 A. According to the U.S. National Oceanic and Atmospheric Administration  
13 (“NOAA”), a “climate normal” is defined as the arithmetic mean of a climatological element,  
14 such as temperature, computed over three consecutive decades.<sup>1</sup> The most recent U.S.  
15 Climate Normals published by the NOAA (“NOAA 1981-2010 Normals”) is for the period of  
16 January 1, 1981 through December 31, 2010.<sup>2</sup> In developing climate normal temperatures,  
17 the NOAA focusses on the monthly maximum and minimum temperature time series to  
18 produce the serially-complete monthly temperature (“SCMT”) data series.<sup>3</sup>

19 Q. How does Staff calculate climate normals?

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<sup>1</sup> Retrieved on June 27, 2014, <http://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals>.

<sup>2</sup> Retrieved on June 27, 2014, <http://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals/1981-2010-normals-data>.

<sup>3</sup> Retrieved on October 17, 2013, <http://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/source-datasets/>. The SCMT, computed by the NOAA, includes adjustments to make the time series of daily temperatures homogeneous.

1           A.     Staff utilized the SCMT of NOAA 1981-2010 Normals published in July 2011  
2 by the National Climatic Data Center (“NCDC”) of the NOAA. For the purposes of  
3 normalizing the test year gas usage and revenues, Staff used the NOAA’s three consecutive  
4 decade convention of observed  $T_{\max}$  and  $T_{\min}$  daily temperatures for the 30-year period of  
5 January 1, 1981 through December 31, 2010, at MCI, KIR and CGI. This is the same location  
6 and period that NOAA used for its calculation of the SCMT.

7           Q.     Why does Staff use NOAA 1981-2010 Normals for this rate case?

8           A.     Because there may be circumstances under which inconsistencies and biases in  
9 the 30-year time series of daily temperature observations occur, (e.g. such as the relocation,  
10 replacement, or recalibration of the weather instruments). Changes in observation procedures  
11 or in an instrument’s environment may also occur during the 30-year period. The NOAA  
12 accounted for documented and undocumented anomalies in calculating its SCMT. The  
13 meteorological and statistical procedures used in the NOAA’s homogenization for removing  
14 documented and undocumented anomalies from the monthly maximum and minimum  
15 temperature series is explained in a peer-reviewed publication.<sup>4</sup>

16          Q.     What weather variables does Staff use?

17          A.     Natural gas sales are predominantly influenced by “ambient air temperature,”<sup>5</sup>  
18 so MDT and the derivative measure, heating degree days (“HDD”),<sup>6</sup> are the measures of  
19 weather used in adjusting test year natural gas sales. HDDs were originally developed as a  
20 weather measure that could be used to determine the relationship between temperature and  
21 gas usage. HDDs are based on the difference of the MDT from a comfort level of 65°F.

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<sup>4</sup> Menne, M.J., and C.N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.

<sup>5</sup> Ambient air temperature is the outside temperature of the surrounding air without taking into account the humidity or wind in the air.

<sup>6</sup> Where  $MDT < 65^{\circ}F$ ,  $HDD = 65 - MDT$ ; otherwise,  $HDD = 0$ .

1 HDDs are calculated as the difference between 65°F and the MDT when the MDT is below  
2 65°F, and are equal to zero when the MDT is above 65°F.

3 Q. How did Staff calculate its daily normal HDD?

4 A. Staff developed a series of normal MDTs by adjusting the test year's actual  
5 daily average temperature data based on the 30 years of MDTs, such that the monthly average  
6 of the adjusted normal MDTs for a month is consistent with the SCMT of NOAA 1981-2010  
7 Normals. Using these adjusted daily average temperatures, Staff calculated HDDs for each  
8 day of the 30-year period history. Staff calculated daily normal HDDs as the average of the  
9 adjusted daily actual HDD for each calendar date in the test year. For example, Staff  
10 averaged the 30 observations of the adjusted daily actual HDD for January 1 of each year for  
11 years 1981 through 2010, to determine the normal HDD for January 1.

12 Q. How are these variables in Staff' weather data used?

13 A. This information was provided to Staff witnesses Joel McNutt and Kim Cox to  
14 calculate the weather normalization adjustment factor.

15 **COMPANY'S CLIMATE NORMALS**

16 Q. Did Mr. Krygier calculate normal weather for the Company's service areas  
17 based on the NOAA 1981-2010 Normals?

18 A. No. Mr. Krygier used temperature observations for the 30-year period of  
19 January 1, 1984 through December 31, 2013.

20 Q. Is this calculation consistent with the normal that Staff recommends?

21 A. No. Staff recommends using the NOAA 1981-2010 Normals. The procedure  
22 used by the NOAA in calculating the 1981-2010 normal temperatures includes the removal of  
23 any observation anomalies in the temperature data series, while the 30-year daily temperature

1 data series for the climate normals used by Mr. Krygier did not adjust for observation  
2 anomalies.

3 Q. Are there usually anomalies in the 30-year daily temperature data series of a  
4 weather station?

5 A. Yes, anomalies are inconsistencies and biases in time series of daily  
6 temperature observations that occur when weather instruments are relocated, replaced or  
7 recalibrated. In addition, changes in observation procedures or the instrument's environment  
8 may also cause anomalies. It is common for these anomalies to occur in the 30-year daily  
9 temperature data series of observations for a weather station.

10 Q. Are there any known anomalies in the temperature data series used by Mr.  
11 Krygier?

12 A. Yes. According to the Historical Observing Metadata Repository ("HOMR")  
13 of the NOAA, there were multiple changes of both equipment and location in all three  
14 weather stations used by Mr. Krygier: KIR, CGI, and Kansas City Downtown AP ("KCA").<sup>7</sup>

15 Q. Does the NOAA make adjustments in the time series for these anomalies  
16 documented by the HOMR when the NOAA 1981-2010 Normals was calculated?

17 A. Yes. The NOAA confirmed that the serially-complete monthly minimum and  
18 maximum temperature data sets have been adjusted to remove all inconsistencies and biases  
19 due to changes in the associated historical database.<sup>8</sup> The statistical soundness of NOAA's

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<sup>7</sup> Retrieved on July 10, 2014 from NOAA website, <http://www.ncdc.noaa.gov/homr>.

<sup>8</sup> Retrieved on July 10, 2014 from NOAA website, <http://www1.ncdc.noaa.gov/pub/data/normal/1981-2010/documentation/>.

1 methodology for removing documented and undocumented anomalies is published in the  
2 Journal of Climate.<sup>9</sup>

3 **WEATHER STATIONS**

4 Q. What weather stations did Mr. Krygier use for the WEMO division?

5 A. Mr. Krygier used the KCA weather station located in Charles B. Wheeler  
6 Downtown Airport, Kansas City, Missouri.

7 Q. Does Staff agree with Mr. Krygier's use of the KCA weather station to  
8 determine adjustments to sales and revenues for the WEMO division?

9 A. No. The KCA weather station is not a proper weather station for calculating  
10 climate normals of the WEMO division. The ambient environment of KCA is not consistent  
11 with the ambient environment of customers in the WEMO division. Because of its location in  
12 downtown Kansas City, Missouri, the KCA weather station is exposed to an Urban Heat  
13 Islands ("UHI") effect. The UHI effect alters the observed temperatures at KCA so that the  
14 relationship between weather and natural gas sales in the Liberty West division are distorted.  
15 Because of the UHI effect, the temperature variations observed in KCA are not consistent  
16 with the temperature variations experienced by customers in the WEMO division.

17 Q. What is a UHI effect?

18 A. A UHI is the downtown of a metropolitan area which is significantly warmer  
19 than its surroundings. According to the United State Environmental Protection Agency  
20 ("EPA"), the annual mean air temperature of a city with 1 million people or more can be 1.8–  
21 5.4°F warmer than its surroundings, and in the evening, the difference can be as high as

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<sup>9</sup> Menne, Matthew J., and Claude N. Williams Jr. "Homogenization of temperature series via pairwise comparisons." Journal of Climate 22, no. 7 (2009): 1700-1717.

1 22°F.<sup>10</sup> This temperature difference is usually larger at night than during the day and larger in  
2 winter than in summer.<sup>11</sup> The main causes are changes in the land surface by urban  
3 development along with waste heat generated by energy use. As population centers grow,  
4 they tend to change greater areas of land which then undergo a corresponding increase in  
5 average temperature.

6 Q. Is KCA affected by a UHI effect?

7 A. Yes, it is. KCA is located in downtown Kansas City. The distance between  
8 KCA and the downtown business area of Kansas City is around 1 mile. According to the U.S.  
9 Census Bureau ("CB"), the Kansas City metropolitan area has an area 7,952 square miles with  
10 a population of 2.3 million.<sup>12</sup> Therefore, KCA is located at the downtown of a typical  
11 metropolitan city observed UHI. There are peer reviewed research papers which specifically  
12 investigate the UHI effect of Kansas City.<sup>13</sup> According to research using satellite radiation  
13 data, the maximum UHI effect of Kansas City is 6°F.<sup>14</sup>

14 Q. Is the service territory of the WEMO division affected by a UHI effect?

15 A. No. The service territory of the WEMO is located through Bates, Henry, Cass  
16 and St. Clair counties of Missouri which are more than 40 miles distance from downtown  
17 Kansas City. According to the 2010 Census Urban and Rural Classification of the CB, the  
18 most serviced territory of the WEMO division is categorized as non-urbanized.<sup>15</sup>

19 Q. Is there any other appropriate weather station for the WEMO division?

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<sup>10</sup> Retrieved on July 10, 2014 from EPA website, <http://www.epa.gov/heatisland/>.

<sup>11</sup> Rizwan, Ahmed Memon, Leung YC Dennis, and Chunho Liu. "A review on the generation, determination and mitigation of Urban Heat Island." *Journal of Environmental Sciences* 20, no. 1 (2008): 120-128.

<sup>12</sup> Retrieved on July 10, 2014 from CB website, <http://www.census.gov/>.

<sup>13</sup> Jones, T. Stephen, Arthur P. Liang, Edwin M. Kilbourne, Marie R. Griffin, Peter A. Patriarca, Steven G. Fite Wassilak, Robert J. Mullan et al. "Morbidity and mortality associated with the July 1980 heat wave in St Louis and Kansas City, Mo." *Jama* 247, no. 24 (1982): 3327-3331.

<sup>14</sup> Matson, Michael, E. Paul McClain, David F. McGinnis Jr, and John A. Pritchard. "Satellite detection of urban heat islands." *Monthly Weather Review* 106, no. 12 (1978): 1725-1734.

<sup>15</sup> Retrieved on July 10, 2014 from CB website, <https://www.census.gov/geo/reference/urban-rural.html>.

Rebuttal Testimony of  
Seoung Joun Won, Ph.D.

1           A.     Yes. MCI is a first-order weather station.<sup>16</sup> Because MCI is not located in the  
2 urban area of Kansas City, the UHI effect is weaker than that of KCA. According to the  
3 Missouri Census Data Center, MCI is classified as a rural area by the CB even if MCI is  
4 within the city limits.<sup>17</sup> In addition, the distance between MCI and KCA is around 15 miles.

5           Q.     Does this conclude your rebuttal testimony?

6           A.     Yes, it does.

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<sup>16</sup> First-Order refers to weather stations that are professionally maintained, primarily through the National Weather Service or Federal Aviation Administration. <http://www.ncdc.noaa.gov/faqs/climfaq25.html>.

<sup>17</sup> Retrieved on July 10, 2014, <http://mcdc.missouri.edu/TenThings/urbanrural.shtml>

## **Credentials and Background of**

### **Seoung Joun Won**

I am currently employed as a Regulatory Economist III in the Energy Economic Analysis Section, Utility Operation Department, Regulatory Review Division of the Missouri Public Service Commission. I have been employed at the Missouri Public Service Commission since May 2010.

I received my Bachelor of Arts, Master of Arts, and Doctor of Philosophy in Mathematics from Yonsei University in Seoul, South Korea, and earned my Doctor of Philosophy in Economics from the University of Missouri - Columbia. Also, I passed several certificate examinations for Finance Specialist in South Korea such as Enterprise Resource Planning Consultant, Financial Risk Management, Derivatives Consultant, and Financial Planner.

Prior to joining the Commission, I taught both undergraduate and graduate level mathematics in the Korean Air Force Academy and Yonsei University for 13 years. I served as the director of the Education and Technology Research Center in NeoEdu for 5 years.

My duties in the Commission include managing weather data, calculating normal weather, and analyzing revenues and rate designs.

## **List of Previous Testimony Filed**

### **Seoung Joun Won**

<b>Case/File Number</b>	<b>Company</b>	<b>Issue</b>
ER-2010-0355	Kansas City Power & Light Co.	Normal Weather Revenue
ER-2010-0356	KCP&L Greater Missouri Operations Co.	Normal Weather
GR-2010-0363	Union Electric Co. d/b/a Ameren Missouri	Normal Weather
ER-2011-0028	Union Electric Co. d/b/a Ameren Missouri	Normal Weather Revenue
ER-2011-0004	Empire District Electric Co.	Normal Weather Revenue
HR-2011-0028	Veolia Energy Kansas City, Inc	Normal Weather
ER-2012-0166	Union Electric Co. d/b/a Ameren Missouri	Normal Weather Revenue
ER-2012-0174	Kansas City Power & Light Co	Normal Weather Revenue
ER-2012-0175	KCP&L Greater Missouri Operations Co.	Normal Weather
ER-2012-0345	Empire District Electric Co.	Normal Weather Revenue
GR-2013-0171	Laclede Gas Co.	Normal Weather
GR-2014-0007	Missouri Gas Energy	Normal Weather