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Witness: Seoung Joun Won
Sponsoring Party: MO PSC Staff
Type of Exhibit: Rebuttal Testimony
Case No.: GR-2018-0013
Date Testimony Prepared: April 13, 2018

MISSOURI PUBLIC SERVICE COMMISSION

COMMISSION STAFF DIVISION

TARIFF/RATE DESIGN

REBUTTAL TESTIMONY

OF

SEOUNG JOUN WON, Ph.D.

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

CASE NO. GR-2018-0013

Jefferson City, Missouri
April 2018

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1 **REBUTTAL TESTIMONY**

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5 **D/B/A LIBERTY UTILITIES**

6 **CASE NO. GR-2018-0013**

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 in the Tariff/Rate Design Unit of the Operational
13 Analysis Department, Commission Staff Division

14 Q. Are you the same Seoung Joun Won who prepared the Weather Variables
15 section of Staff's Cost of Service Report ("Staff Report")?

16 A. Yes, I am.

17 **EXECUTIVE SUMMARY**

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

19 A. The purpose of my rebuttal testimony is to address issues with the weather
20 variables that Liberty Utilities' (Midstates Natural Gas) Corp. ("Liberty Midstates - MO" or
21 "Company") witness Mr. Charlie Evans used to calculate weather normalization adjustments.

22 Q. Which aspects of the weather variables used by Mr. Evans are you going
23 to address?

1 A. I am addressing two issues: (1) the weather station used for the WEMO
2 division and (2) the time series of temperature observations weather data used to calculate
3 Liberty Midstates - MO's weather normalization.

4 **WEATHER STATIONS**

5 Q. What weather stations did Mr. Evans use for the WEMO division?

6 A. Mr. Evans used the KCA weather station located at Charles B. Wheeler
7 Downtown Airport, Kansas City, Missouri.

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

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

19 Q. What is a UHI effect?

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

1 as 22°F.¹ This temperature difference is usually larger at night than during the day and larger
2 in winter than in summer.² 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.³ 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.⁴ According to research using satellite radiation
13 data, the maximum UHI effect of Kansas City is 6°F.⁵

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

15 A. No. The service territory of WEMO is located through Bates, Henry, Cass and
16 St. Clair counties of Missouri which are more than 40 miles away from downtown Kansas
17 City. According to the 2010 Census Urban and Rural Classification of the CB, the most
18 serviced territory of the WEMO division is categorized as non-urbanized.⁶

¹ Retrieved on March 12, 2018 from EPA website, <http://www.epa.gov/heatisland/>.

² 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.

³ Retrieved on July 10, 2014 from CB website, <http://www.census.gov/>.

⁴ 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.

⁵ 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.

⁶ Retrieved on July 10, 2014 from CB website, <https://www.census.gov/geo/reference/urban-rural.html>.

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

2 A. Yes. MCI is a first-order weather station.⁷ Because MCI is not located in the
3 urban area of Kansas City, the UHI effect is weaker than that of KCA. According to the
4 Missouri Census Data Center, MCI is classified as a rural area by the CB even if MCI is
5 within the city limits.⁸ In addition, the distance between MCI and KCA is around 15 miles.

6 **WEATHER DATA**

7 Q. What is Staff's concern in Mr. Evans' weather data used to calculate weather
8 normalization?

9 A. According to his direct testimony, Mr. Evans used daily heating degree days
10 ("HDDs") reported by the National Oceanic and Atmospheric Administration ("NOAA"). To
11 calculate HDDs, NOAA used the actual weather data sets consisting of daily maximum
12 temperature ("Tmax") and daily minimum temperature ("Tmin") observations and developed
13 a set of mean daily temperature ("MDT") values which consist of the average of Tmax and
14 Tmin for each day. HDDs are based on the difference of the MDT from a comfort level of
15 65°F. HDDs are calculated as the difference between 65°F and the MDT when the MDT is
16 below 65°F, and are equal to zero when the MDT is above 65°F.

17 Mr. Evans used raw data sets without considering missing data and other observation
18 anomalies in the temperature time series for the 30-year period of January 1, 1987 through
19 December 31, 2016 and the test year 12 months ending June 30, 2017. Generally, there are
20 inconsistencies and biases in the time series data of daily temperature observations (e.g. such

⁷ 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>.

⁸ Retrieved on July 10, 2014, <http://mcdc.missouri.edu/TenThings/urbanrural.shtml>

1 as the relocation, replacement, or recalibration of the weather instruments). In addition,
2 changes in observation procedures or in an instrument's environment had also occurred.

3 Q. What are the missing observations in the data sets used by Mr. Evans?

4 A. According to the observation record of NOAA, the daily temperature data is
5 missing more than one year period, November 1993 through December 1994, which is in the
6 30-year year period of the Company's normal HDDs of KCA used for WEMO division. The
7 Company's workpapers provide for the HDDs from January through December, 1994, but
8 provide no explanation for how the Company made those estimates. Therefore, Staff cannot
9 confirm that missing observations are properly estimated in the Company's weather
10 normalization procedure for KCA weather station.

11 Furthermore, according to the direct workpaper provided by Mr. Evans, the monthly
12 HDDs of WEMO divisions are still missing in November and December 1993, so that these
13 missing HDDs are disregarded in Mr. Evans' analysis. Staff's recommended use of the data
14 from MCI weather station avoids this problem. There is no missing data in the 30-year
15 historical observations at MCI, so there is no need to estimate HDDs for any given period.

16 Q. Are there any other known anomalies in the temperature data series used by
17 Mr. Evans?

18 A. According to NOAA's Historical Observing Metadata Repository, the location
19 of the weather station at KCA changed on November 13, 1997, and the equipment was
20 changed on October 2, 1996, November 13, 2009, and December 31, 2013.⁹ However, these
21 anomalies are disregarded in the Company's weather normalization procedure.

⁹ Retrieved on August 22, 2017, <https://www.ncdc.noaa.gov/homr/>.

1 Q. How does NOAA recognize and eliminate these anomalies?

2 A. NOAA recognizes that there are inconsistencies and biases in the weather time
3 series data. This is especially the case if there are changes at a weather station such as
4 instruments being relocated, replaced, or recalibrated. Changes in observation procedures or
5 in an instrument's environment may also occur during the time period for normal weather.
6 NOAA accounted for these anomalies in calculating the normal temperatures it has
7 published.¹⁰ NOAA confirmed that the serially-complete monthly minimum and maximum
8 temperature data sets have been adjusted to remove all inconsistencies and biases due to
9 changes in the associated historical database.¹¹ The statistical soundness of NOAA's
10 methodology for removing documented and undocumented anomalies is published in the
11 Journal of Climate.¹²

12 **CONCLUSION**

13 Q. What is the conclusion of Staff's rebuttal testimony?

14 A. With consideration of UHI effect and observation anomalies in KCA, Staff
15 recommends the Commission to utilize MCI as the weather station for WEMO division
16 weather normalization.

17 Q. Does this conclude your rebuttal testimony?

18 A. Yes, it does.

¹⁰ Arguez, A., I. Durre, S. Applequist, R. S. Vose, M. F. Squires, X. Yin, R. R. Heim, Jr., and T. W. Owen, 2012: NOAA's 1981-2010 U.S. Climate Normals: An Overview. Bulletin of the American Meteorological Society, 93, 1687-1697.

¹¹ Retrieved on July 10, 2014 from NOAA website, <http://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/documentation/>.

¹² Menne, Matthew J., and Claude N. Williams Jr. "Homogenization of temperature series via pairwise comparisons." Journal of Climate 22, no. 7 (2009): 1700-1717.

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)

Case No. GR-2018-0013

AFFIDAVIT OF SEOUNG JOUN WON, PhD

STATE OF MISSOURI)
)
COUNTY OF COLE) ss.

COMES NOW SEOUNG JOUN WON, PhD and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing Rebuttal Testimony and that the same is true and correct according to his best knowledge and belief.

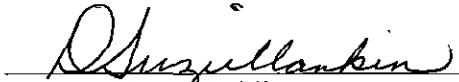
Further the Affiant sayeth not.


SEOUNG JOUN WON, PhD

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 11th day of April 2018.

D. SUZIE MANKIN
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: December 12, 2020
Commission Number: 12412070


Notary Public