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Witness:	*Seoung Joun Won*
Sponsoring Party:	*MoPSC Staff*
Type of Exhibit:	*Surrebuttal Testimony*
Case Nos.:	*GR-2017-0215 and GR-2017-0216*
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MISSOURI PUBLIC SERVICE COMMISSION

COMMISSION STAFF DIVISION

TARIFF/RATE DESIGN

SURREBUTTAL TESTIMONY

OF

SEOUNG JOUN WON, PhD

SPIRE MISSOURI, INC., d/b/a SPIRE

LACLEDE GAS COMPANY and MISSOURI GAS ENERGY
GENERAL RATE CASE

CASE NOS. GR-2017-0215 AND GR-2017-0216

Jefferson City, Missouri
November 2017

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

A. I am employed by the Missouri Public Service Commission ("Commission") and my title is Regulatory Economist III in the Tariff/Rate Design Unit of the Operational Analysis Department, Commission Staff Division.

Q. Are you the same Seoung Joun Won who prepared the weather variables section of Staff's Cost of Service Report ("Staff Report") and Rebuttal Testimony?

A. Yes, I am.

EXECUTIVE SUMMARY

Q. What is the purpose of your surrebuttal testimony?

A. The purpose of my surrebuttal testimony is to address issues with the weather variables that Spire Missouri's witness (for both LAC and MGE), Ms. Keri E. Feldman, addressed in her rebuttal testimony.

Q. Which aspects of the weather variables used by Ms. Feldman are you going to address?

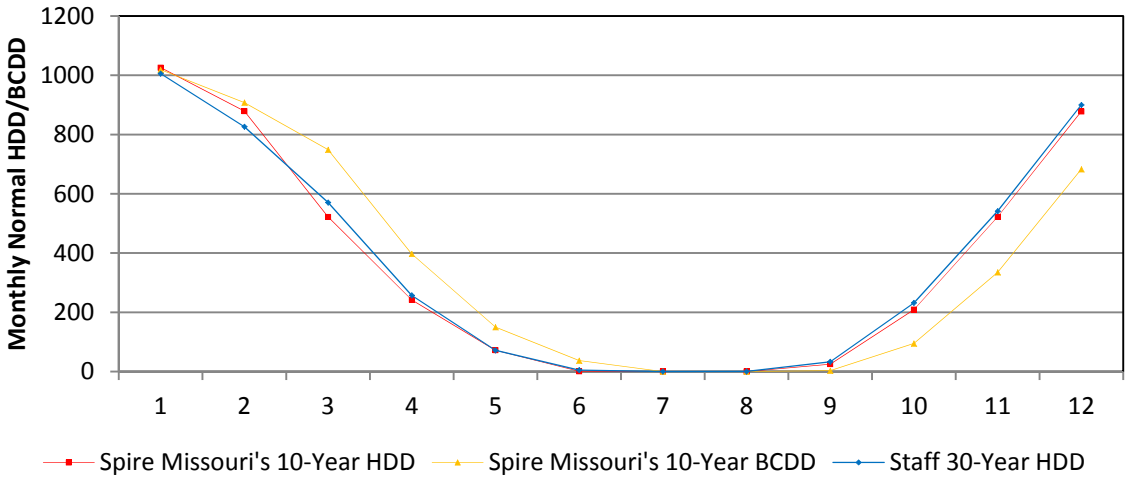
A. I am addressing two issues: (1) the method used to calculate the normal heating degree days ("HDD") and (2) the time period used to define normal weather.

THE METHOD USED TO CALCULATE NORMAL HDD

Q. What is Staff's concern with Ms. Feldman's method used to calculate the normal HDD for weather normalization?

A. Staff's concern is Ms. Feldman's usage of the normal billing cycle HDD ("BCDD"). The BCDD is used for the input data of the normal HDD for Spire Missouri's regression model for weather normalization. The BCDD of a month is calculated by counting the daily HDD in all billing cycles for the given month. In her rebuttal testimony, Ms. Feldman said that the individual monthly HDD variances are driving the significant usage differential. However, there is no significant difference in monthly HDD between Spire Missouri's 10-year normal and Staff's 30-year normal.

Figure 1 Comparison of normal HDDs and BCDD at STL



As presented in Figure 1, the comparison of normal HDDs and BCDD at St Louis Lambert International Airport ("STL") illustrates an insignificant difference between the 30-year and the 10-year HDD. However, Spire Missouri's normal BCDD shows significant dissimilarities. The BCDD in December shows only 60% of the BCDD of January and even less than the

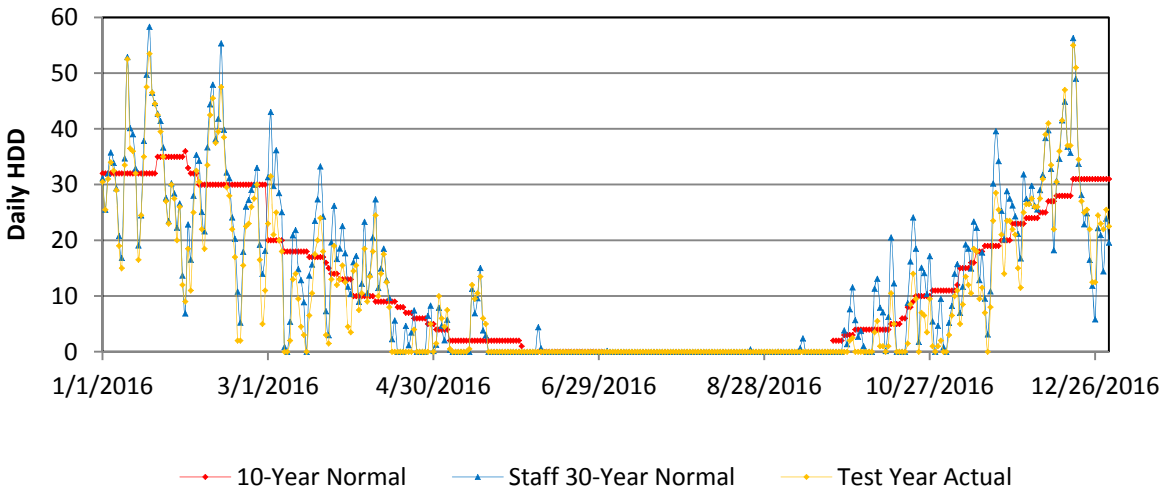
BCDD of March. This abnormal pattern of monthly BCDD variation is not observed in Spire Missouri's service territories.

The reason for this difference is Spire Missouri's method of calculation of normal BCDD. Even though Spire Missouri's 10-year monthly normal HDD closely matches Staff's 30-year monthly normal HDD, this method results in problems with Spire Missouri's normal BCDD showing an irregular pattern. There are two major issues in Spire Missouri's method. One is the method of assigning daily normal HDD, and the other is the way of considering customer numbers in each billing cycle.

Q. What is the issue with the method of assigning the daily normal HDD?

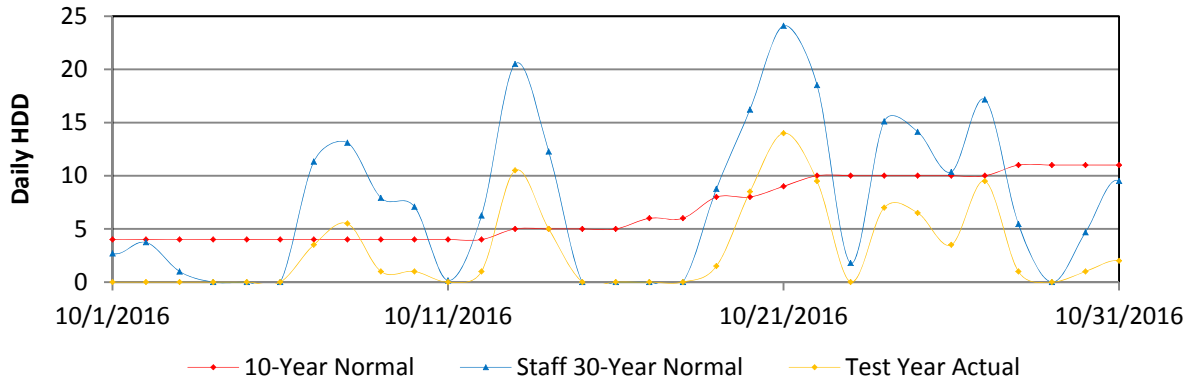
A. The detailed reasons for Staff's concern with Spire Missouri's method of assigning the daily normal HDD have already been addressed in my rebuttal testimony. The most important issue is that Spire Missouri's method of assigning the daily normal HDD is a subjective decision by Spire Missouri personnel.[1]

Figure 2 Actual HDD and Normals of Daily HDD in 2016 at STL



[1] In Data Request No. 0121.2, Staff requested an explanation of the pattern used for allocating each day's normal HDD from monthly normal. The response is as follows: "It is based on the judgement of the analyst and their cumulative experience working with such data over a number of years."

Figure 3 Actual HDD and Normals of Daily HDD in October 2016 at STL



As presented in Figure 2 and Figure 3, Staff's 30-year normal daily HDD using Staff's ranking method preserves the variation of actual test year HDD, but Spire Missouri's normal daily HDD ignores the pattern of actual HDD variation in the test year. This demonstrates that Staff's statistical ranking method is a better way to minimize potential modeling errors in the regression analysis for appropriate weather normalization.

Ms. Feldman criticizes Staff's method as "cumbersome." Staff's method is more complex, but the complexity is necessary to provide a more accurate and reasonable analysis and to prevent unreasonable consequences. Staff's ranking method has been willingly used by many other Missouri utilities such as Ameren Missouri and Kansas City Power & Light. The detailed explanation of the benefit in using Staff's ranking method is addressed in a paper published in the premier field journal for Energy Economics.[2]

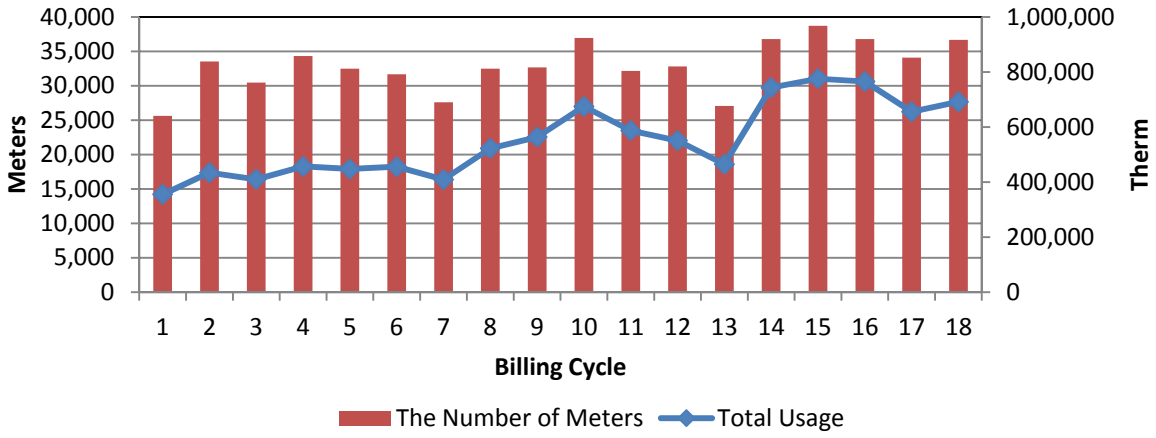
Q. What is the issue with Spire Missouri's way of considering customer numbers in each billing cycle to calculate the BCDD?

A. The issue is that Spire Missouri overlooks the differences in customer numbers in billing cycles when they calculate their BCDD. When the BCDD is calculated the number

[2] Won, S. J., Wang, X. H., & Warren, H. E. (2016). Climate normals and weather normalization for utility regulation. Energy Economics, 54, 405-416.

of days is counted for each billing cycle and then the total daily HDD of billing cycles are aggregated. If each billing cycle has the same number of customers, the BCDD can be calculated with a simple average of total HDD in all of the days of billing cycles. However, each billing cycle has a different number of customers so that the BCDD should be calculated with a weighted average based on the number of customers in each cycle. In other words, if customer numbers are not properly weighted when the BCDD is calculated, the relationship between BCDD and gas usage is distorted.

Figure 4 Residential Meters and Usage of Billing Cycles in October 2016



As presented in Figure 4, residential customer numbers in each billing cycle are significantly different. However, Spire Missouri did not properly consider the difference in customer numbers when they calculated their BCDD. Staff witness, Michelle A. Bocklage addresses the problems of customer number weighting to calculate BCDD and weather normalization in more detail.

THE TIME PERIOD USED TO DEFINE NORMAL HDD

Q. What is the difference between Spire Missouri and Staff with regard to the time period used to calculate normal weather?

A. Spire Missouri used the most recent 10-year time period, 2007-2016, and Staff used the most recent 30-year time period, 1987-2016.

Q. Why does Staff use the 30-year time period instead of the 10-year time period used by Ms. Feldman?

A. As explained in my rebuttal testimony, Staff consistently uses a 30-year time period for gas and electric utility rate cases for a variety of reasons. As explained in the testimony below, Staff has performed a series of statistical analyses that demonstrate the 30-year time period performs better than the 10-year time period when calculating normal weather. In addition, Spire Missouri was unable to provide any analysis or evidence to support their contention that a 10-year normal is better than a 30-year normal.[3] For this rate case, Staff concludes that there is currently no evidence that warrants replacement of the 30-year time period with a 10-year time period for the normal weather calculations.

Q. Why is the 30-year normal statistically more appropriate?

A. There are many reasons, but it can be summarized using the following four statistical criteria: (1) sample size, (2) trend recognition, (3) variation stability, and (4) data reliability.

Q. Why is the 30-year normal is better than the 10-year normal in terms of sample size?

A. The reason is that a bigger sample size will give a higher confidence level of estimation if all other things are equal. In 1956, the World Meteorological Organization ("WMO") officially recommended use of the most recent available period of 30 years for calculating normal weather. The National Oceanic and Atmospheric Administration ("NOAA") updates their climatological normals at the completion of each decade, with the

[3] Spire Missouri's response to Staff's Data Request No. 0220.

latest covering the time period 1981-2010.[4] NOAA states on their website the following for introducing climate normals:

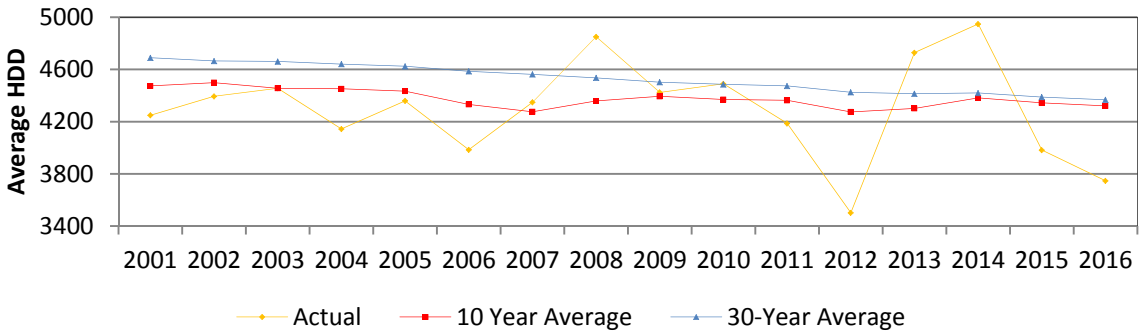
> A general rule in statistics says that you need at least 30 numbers to get a reliable estimate of their mean or average.[5]

Staff's 30-year normal represents a larger sample size than Spire Missouri's 10-year normal as recommended by WMO and NOAA and therefore provides a more reliable and statistically qualified estimate of normal weather conditions.

Q. Why is the 30-year normal better than the 10-year normal in terms of trend recognition?

A. Based on the HDD moving average analysis,[6] the 30-year normal HDD data series shows the trend of weather variations but the 10-year normal HDD data series does not show any trends. Staff compared the actual and 10-year moving average and the 30-year moving average data series in Figure 5 and Figure 6 for STL and Kansas City International Airport ("MCI"), respectively.

Figure 5 Actual HDD and Moving Average of HDD at STL

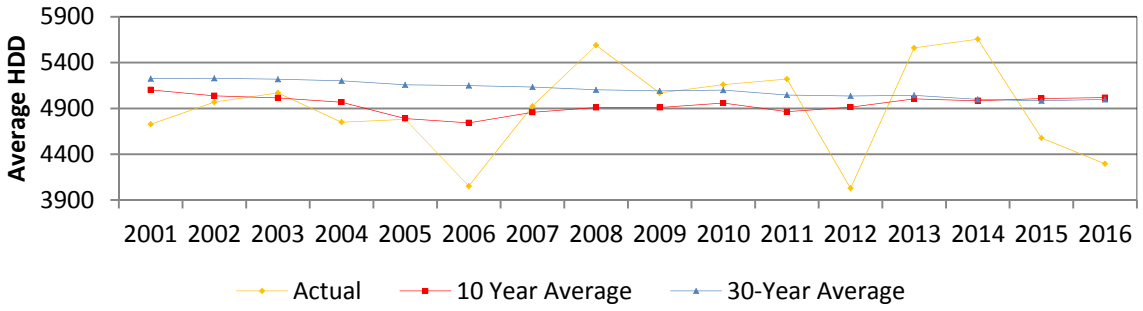


[4] Retrieved on August 22, 2017, https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals.

[5] Retrieved on August 22, 2017, https://www.ncdc.noaa.gov/news/defining-climate-normals-new-ways.

[6] Moving average analysis is a time series analysis technique for investigating trends over a given time period. For instance, 30-year average at 2010 in the HDD moving average data series is the average of HDD for the years 1981 through 2010.

Figure 6 Actual HDD and Moving Average of HDD at MCI



In the figures, the 30-year moving average data series illustrates a downward trend. However, it is hard to identify any trends in the 10-year moving average data series. This is due to the 10-year average data series changing without any trend being revealed. Consequently, there is no reason to think that more recent data should be used for normal HDD if the10-year average is used for normal weather. On the contrary, the 30-year average data series shows a clear downward trend. Therefore, the more recent data is better than older data. Because of this reason, Staff decided to use the most recent 30-year normals 1987-2016 instead of NOAA normals 1981-2010.

Q. Why is the 30-year normal better than the 10-year normal in terms of variation stability?

A. The reason is that the 30-year normal shows a more stable variation. If each year's moving average in HDD has a bigger variation then there is a possibility of unstable rate changes. A lower normal HDD value allows a higher gas rate and a higher normal HDD value allows a lower gas rate. If there is a greater difference in normal HDD values from year-to-year, the possibility of producing a larger rate change will increase. In other words, there will be a more rate changes if a 10-year normal is used. This is because weather extremes in the years immediately preceding the filing of a rate case are given a greater

weight in a 10-year normal. The use of a 30-year normal would prevent a handful of unusually warm or cold years from improperly skewing gas rates too high or too low.

Figure 7 Difference between Moving Averages of HDD at STL

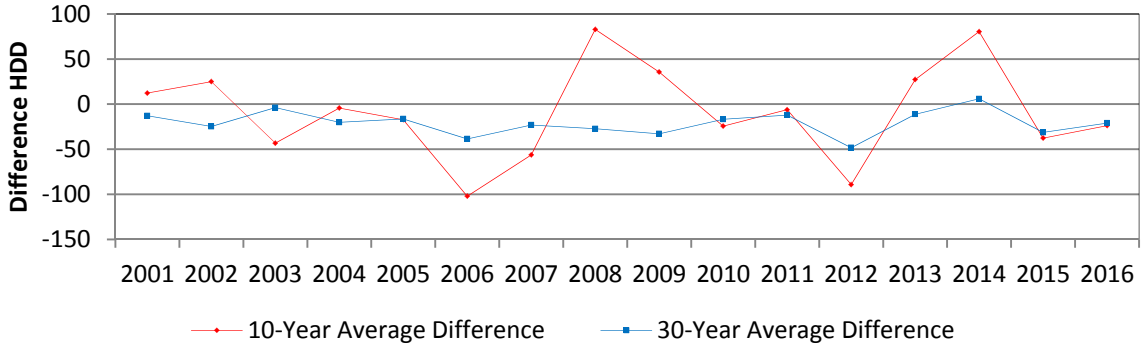


Figure 8 Difference between Moving Averages of HDD at MCI

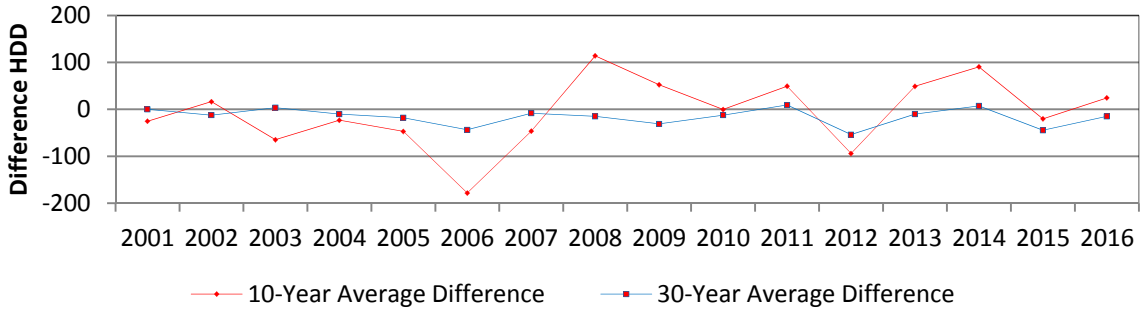


Figure 7 and Figure 8 further illustrate the first difference of moving average analysis. The differences in the 10-year moving average data series have a much bigger variation than the 30-year moving average.[7]

This was the main reason identified in the Commission decision to use the 30-year normal instead of the 10-year normal in MGE's rate case, Case No. GR-96-285. Page 18 of the Commission's Report and Order states:

[7] The first difference of a time series is the series of changes from one period to the next. For instance, the first difference of the 30-year HDD moving average at 2010 is the difference between average HDD 1981 through 2010 and average HDD 1980 through 2009.

> The Commission finds that NOAA's 30-year normals is the more appropriate benchmark. The ten-year moving average would needlessly cause frequent rate changes based on the introduction of new data every year. If one takes MGE's argument to its logical extreme, the Commission would use the most recent years' experience in MGE's service territory and re-set the rate each year. This could lead to serious financial problems for MGE if its rates were set after a record setting cold year.

Q. Why is the 30-year normal better than 10-year normal in terms of data reliability?

A. Staff's 30-year normal is affected less by time series data inconsistencies than Spire Missouri's 10-year normal. There are inconsistencies and biases in the weather time series data. This is especially the case if there are changes at a weather station such as instruments being relocated, replaced, or recalibrated. Changes in observation procedures or in an instrument's environment may also occur during the time period for normal weather. NOAA accounted for these anomalies in calculating the normal temperatures it has published.[8]

According to NOAA's Historical Observing Metadata Repository, the location of the weather station at STL changed on February 20, 2012, and the equipment at the MCI weather station was changed on November 20, 2011.[9] Since Spire Missouri used a 10-year normal of 2007-2016, these changes occurred in the middle of the normal period causing weather data series inconsistencies.

None of the data used by Spire Missouri to produce its 10-year normal has been adjusted by NOAA to account for inhomogeneity of station changes and other data record

[8] 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.

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

errors.[10] In the period from 1987 to 2010, Staff utilized NOAA records that have been homogenized for exposure changes and missing data. Because of the current downward trend of HDD data, Staff used the part of data in the period 2011-2016. Therefore, Staff's HDD data is the available best quality for the most recent 30-year period.

Q. Does Ms. Feldman give a reason why Spire Missouri did not use Staff's 30-year normal?

A. Not exactly. Most of her testimony is an objection to the use of NOAA's 30-year normals, 1981-2010. Ms. Feldman said that "the traditional 30-year normal as published by NOAA is not intended to predict future weather experience" and also said "therefore 30-year normals are not appropriate benchmarks to establish rates for the future." First of all, this statement is directed only against NOAA's 30-year normal timeframe of 1981-2010, and not against Staff's, because Staff used the most recent 30-year period 1987-2016 that includes Spire Missouri's normal period 2007-2016.

More importantly, Ms. Feldman's argument is based on false reasoning because of her misunderstanding of the principles of the Commission's rate case procedure. Missouri utility rates are not decided by the prediction or forecasting of future events. In rate cases filed at the Commission, neither the utilities nor Staff uses a "future test year." Both the utilities and Staff utilize the "historical test year." In other words, the rate case is not based on prediction or forecasting but is based on historical, actual data with consideration of known and measureable events. Therefore, Ms. Feldman's reason to use 10-year normal is inadequate.

Q. Does NOAA or any reliable weather agency publish or recommend the usage of a 10-year normal HDD for St. Louis weather stations?

[10] Inhomogeneity and NOAA's homogenization procedure are explained in Staff's Report and a published paper, Menne, M.J., and C.N. Williams, Jr., (2009) Homogenization of temperature series via pairwise comparisons. *J. Climate*, **22**, 1700-1717.

A. No. There is no published 10-year normal HDD for St. Louis area weather stations. NOAA's National Centers for Environmental Information ("NCEI") provides only 2001-2010 supplementary normals of monthly average maximum temperature and monthly average minimum temperature for STL. The truth is that it is impossible to produce normal HDD using these 10-year supplementary normals and they are inappropriate to use for a rate case.[11] Furthermore, NOAA and other reliable agencies do not recommend any specific normal time period such as 5, 10, 15, 20, or 30 year normals for rate cases.

Q. Does Spire Missouri provide any evidence the 10-year normal is better than any other normals?

A. No. According to the response of Staff's Data Request No. 0490, Spire Missouri has not conducted any comparison analysis of which time period for normal is appropriate for this rate case. As a result, Staff has no evidence that Spire Missouri's 10-year normal is better than other normals.

CONCLUSION

Q. What is the difference between Spire Missouri and Staff with regard to normal HDD of weather variables?

A. For a regular year at STL, the HDD difference between Spire Missouri's 10-year normal and Staff's 30-year normal is only about 1.2%.[12] Therefore, weather normalized revenue and usage differences are not explained by differences with normal HDD of weather variable. To find the real source of the difference in weather normalization adjustment, an individual could examine how normal HDD and other weather variables are used as input data and what regression models are implemented for the

[11] It is impossible to calculate HDD if you have only monthly average temperatures. For instance, monthly average temperature is 65F^{o} does not mean that the average HDD of the month is zero.

[12] The non-leap year normal HDD of Spire Missouri and Staff is 4,377 and 4,431 respectively.

regression model of weather normalization. Staff witness Michelle A. Bocklage will address this in her surrebuttal testimony.

Q. What is your conclusion of this Surrebuttal testimony?

A. Staff recommends that the Commission order the parties to utilize Staff's 30-year normal with ranking method to calculate proper normal HDD. If any method other than a 30-year normal is used for a rate case, the stability of the utility rates would be impaired by the speculation of using an alternative normal time period for biased individual interests. For the just and reasonable rates, each method of ratemaking procedure should be standardized and appropriate. According to current analysis and findings, Spire Missouri's BCDD and 10-year normal time period should not be used for utility rate cases.

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the Matter of Laclede Gas Company's Request to Increase Its Revenues for Gas Service	)))	Case No. GR-2017-0215
In the Matter of Laclede Gas Company d/b/a Missouri Gas Energy's Request to Increase Its Revenues for Gas Service	)))	Case No. GR-2017-0216

AFFIDAVIT OF SEOUNG JOUN WON, PhD

STATE OF MISSOURI)
) ss.
COUNTY OF COLE)

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 Surrebuttal 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 20th day of November, 2017.

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