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Issue(s):	LED Street Lighting
Witness:	Kyle F. Shoff
Sponsoring Party:	Union Electric Company
Type of Exhibit:	Rebuttal Testimony
Case No.:	ER-2011-0028
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MISSOURI PUBLIC SERVICE COMMISSION

Case No. ER-2011-0028

REBUTTAL TESTIMONY

OF

KYLE F. SHOFF

ON

BEHALF OF

UNION ELECTRIC COMPANY
d/b/a Ameren Missouri

St. Louis, Missouri
March, 2011

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REBUTTAL TESTIMONY

OF

KYLE F. SHOFF

CASE NO. ER-2011-0028

I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name and business address.

A. My name is Kyle F. Shoff. My business address is One Ameren Plaza, 1901 Chouteau Avenue, St. Louis, Missouri 63103.

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

A. I am a Planning Consultant – Energy Efficiency/Demand Response employed by Ameren Services on behalf of Union Electric Company d/b/a Ameren Missouri ("Ameren Missouri" or "Company") for energy efficiency program design. A statement of my qualifications is attached as Appendix A to this rebuttal testimony.

II. PURPOSE AND SCOPE

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to address the Street and Area Lighting ("SAL") recommendation of Staff Witness Hojong Kang highlighted in Section VII of Missouri Public Service Commission Staff's ("Staff") Rate Design and Class Cost-of-Service Report, pages 32 – 36. I will show why it is not in customers' best interests for the Commission to order the Company to file a proposed Light Emitting Diode ("LED") SAL tariff – at least in the foreseeable future. The Company certainly will continue to share its technical and financial analyses of emerging street lighting technologies with the Commission, Staff and other stakeholders. Should the analyses warrant the development of new SAL tariffs, the Company

will continue to work collaboratively with all stakeholders to proceed in that direction. Ameren Missouri witness Wilbon Cooper also addresses the street lighting tariff issue in his rebuttal testimony.

Q. Please summarize the conclusions of your rebuttal testimony.

A. Research on LED street lighting technology continues to evolve as the industry strives to understand the multitude of operational issues that have been identified with this technology. In addition, there are other efficient street lighting technologies, such as induction lighting, which last longer, have better operating characteristics, and at the present time offer better economics than LEDs. However, none of the new, cutting edge street lighting technologies are cost effective at this time. Ameren Missouri has already taken steps to increase the efficiency of its street lights by beginning the process of converting its old, inefficient mercury vapor ("MV") street lights to more efficient high pressure sodium lights as the MV lights reach the end of their useful lives. Therefore, ample time exists to make an informed assessment of all efficient street lighting technologies before making a commitment to begin a change out with any new street lighting technology – most especially LED technology. It is not in the best interests of customers from financial, reliability and safety perspectives for the Commission to order the Company to issue an LED street lighting tariff(s) in the Staff's recommended time period.

III. DISCUSSION OF STAFF'S RECOMMENDATIONS ON STREET AND AREA LIGHTING

Q. How does Staff witness Hojong Kang characterize the Company's SAL system?

A. Mr. Kang states that Ameren Missouri has approximately 137,000 annual MWh of public street and municipal lighting. Mr. Kang includes a footnote that about 65% of the lamps are high pressure sodium ("HPS") and about 32% are MV.

Q. Do you agree with Mr. Kang's characterization of the Company's SAL system?

A. Yes. I agree that Mr. Kang's characterization of the Company's SAL system is accurate.

Q. What are Mr. Kang's recommendations for SAL?

A. Mr. Kang recommends that the Commission order the Company to complete its evaluation of LED SAL systems, and no later than 12 months following the Commission's Report and Order in this case, file either a proposed LED lighting tariff(s) or an update to the Commission on when it will file a proposed LED lighting tariff(s).

Q. What is the basis for Mr. Kang's recommendations?

A. Mr. Kang states that Pacific Gas and Electric Company and Southern California Edison Company offer LED street light rates.

Q. Is the reference to the two California investor owned utilities the totality of the evidence on which Mr. Kang bases his recommendations?

A. It appears to be. I cannot find any other evidence in Mr. Kang's testimony.

Q. Did Mr. Kang provide Staff's analysis of the state of LED street lighting and/or an economic analysis of LED street lighting technology?

A. No.

Q. What is your assessment of the Staff's recommendation?

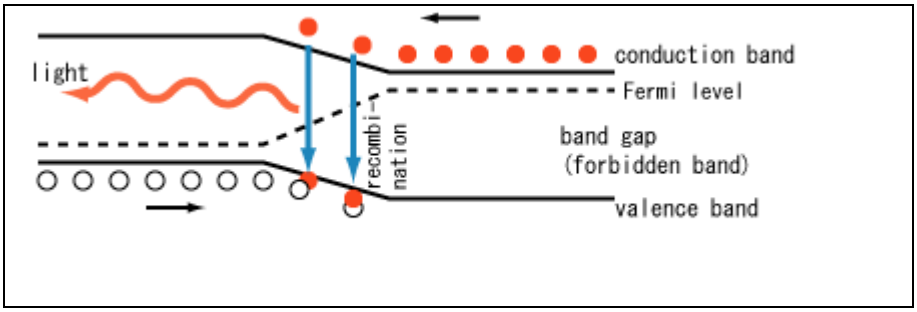
A. While I agree that the Company's street lighting tariff offerings should be re-evaluated whenever there is a material change in lighting technology, Mr. Kang's recommendation to issue new tariffs specifically designed for LED SAL systems without any independent analysis by Staff and other parties is without merit and should be dismissed by the Commission.

IV. LED STREET LIGHTING TECHNOLOGY

Q. What is an LED?

A. Light Emitting Diodes are composed of a semiconducting chip complete with a junction for electrons to move across. As these electrons move across the junction, they release photons, thereby creating light at very high efficiencies. This process can be viewed in the diagram below.

Figure 1: LED Composition



Q. How mature is LED roadway lighting technology?

A. LED roadway lighting technology is in its infancy. It is precisely for this reason that the Company partnered with the Electric Power Research Institute ("EPRI") and eleven other investor-owned utilities (including American Electric Power, Kansas City Power & Light Company, and the Tennessee Valley Authority) to sponsor field demonstrations of LED SAL

systems. It was not until the late 1990s that the first high brightness LEDs were developed in laboratory settings. The U.S. Department of Energy Commercially Available LED Product Evaluation and Reporting ("CALiPER") program supports testing of a wide array of LED products available for general illumination. The pilot phase of CALiPER testing of LEDs began in 2006. Testing continues today, but there is still much research and product testing that needs to be completed in order to determine whether the desired performance can be delivered at competitive prices.

Q. What are some of the more significant technical issues with LED roadway lighting?

A. Significant LED technical issues that are being assessed, quantified and addressed by on-going research include:

- LED light patterns and color variation;
- LEDs fade with time. The severity of this lumen degradation is not yet well understood.
- Quality control – national rating agencies such as the American National Standards Institute, Underwriters Laboratories, and the Institute of Electrical and Electronics Engineers are still refining standards for LED lighting;
- Pole spacing and pole heights – LED SAL systems may require different pole spacing and heights in order to achieve comparable footcandles to conventional lighting technologies. Footcandles are a measure of how much light reaches the ground; one footcandle is equal to one lumen per square foot;
- Power supplies and ballasts vary;
- Safety and customer perception issues exist;

- LED lighting is directional and therefore concentrates light only on the desired roadway reducing spill-over on sidewalks and potentially reducing visibility for pedestrians at night;
- Customers could have negative perceptions of the light quality and the glare from the fixtures.

Q. How is Ameren working to address the technical issues associated with LED street lighting technology?

A. As mentioned, Ameren Missouri has partnered with EPRI and eleven other major investor owned utilities to develop, share and assess field demonstration information for LED street lighting technology. Many LEDs have only been tested in laboratory environments, absent weather, insects, voltage interferences, and a host of other circumstances that are relatively common in the field. It is vital that Ameren Missouri participate in reviews of the technology and determine if LEDs are indeed the next generation luminaire. Ameren Missouri's LED street lighting project was initially started in January 2009, in Ballwin, Missouri. Eleven existing 250 watt HPS lights were replaced with 157 watt LED fixtures. The LED lights themselves were erected in February 2010 and will continue to be in the field until at least the fourth quarter of 2011. Both Ameren Missouri and EPRI felt it was important to include multiple seasonal weather variances within the pilot to gauge and analyze the performance of the LEDs in different scenarios under different conditions.

Measuring the photometric performance of the LEDs is a challenge. EPRI has pioneered a unique methodology to quickly and accurately measure the luminance levels of the new lights. EPRI has developed a mobile metering device capable of capturing up to 10,000 different data points for both scotopic and photopic vision spectrums. Scotopic vision is the vision of the

human eye under low light conditions, whereas photopic vision is the vision of the eye in well-lit conditions. This feature is coupled with functionality to link to software and generate a photometric plot of the test fixture. This type of data is cutting edge for the market space and will allow large quantities of data to be stored and analyzed to further enhance Ameren Missouri's decision making with regard to LEDs.

Q. Will all of the utilities complete the project at the same time?

A. No. Each utility had a different starting point as there were frequent delays with product procurement, contracting, and other project details. A majority of the testing will be completed by the second quarter of 2012.

Q. How does the cost of an LED compare to conventional HPS street lighting technology?

A. LED lighting facilities are typically three to five times the price of an equivalent HPS street lighting facility.

Q. When factoring in the potential energy savings of LEDs relative to HPS street lighting technology, do the benefits exceed the costs?

A. No, currently the energy savings benefits do not exceed the costs.

V. DISCUSSION OF OTHER ROADWAY LIGHTING TECHNOLOGIES

Q. What other roadway lighting technologies exist?

A. There are several other lighting technologies that can be, or already are, utilized by utilities and municipalities. Legacy lighting technologies include HPS, Metal Halide, and the less efficient MV. All of these technologies are in mature stages of development, have reliable performance (and efficacies), and are some of the least-cost roadway lighting options for utilities and municipal customers alike.

Induction lighting, which is not a new technology, is another alternative lighting source that is promising for several reasons – one of which is an all-in price approximately one-half that of LEDs. Induction lighting utilizes magnetic coils to move electrons, which excite Phosphor particles and emit light. Induction lighting has been available for decades, allowing the technology and design aspects to be tested and proven.

Induction lighting has unique advantages in that the technology is mature, experiences long life (100,000+ burn hours), and can provide higher color rendering indices than conventional technologies while still producing similar light dispersion to conventional technologies. As mentioned previously, the all-in cost of induction lighting, including lower maintenance costs due to the extended life, is a fraction of the all-in cost of LED technology.

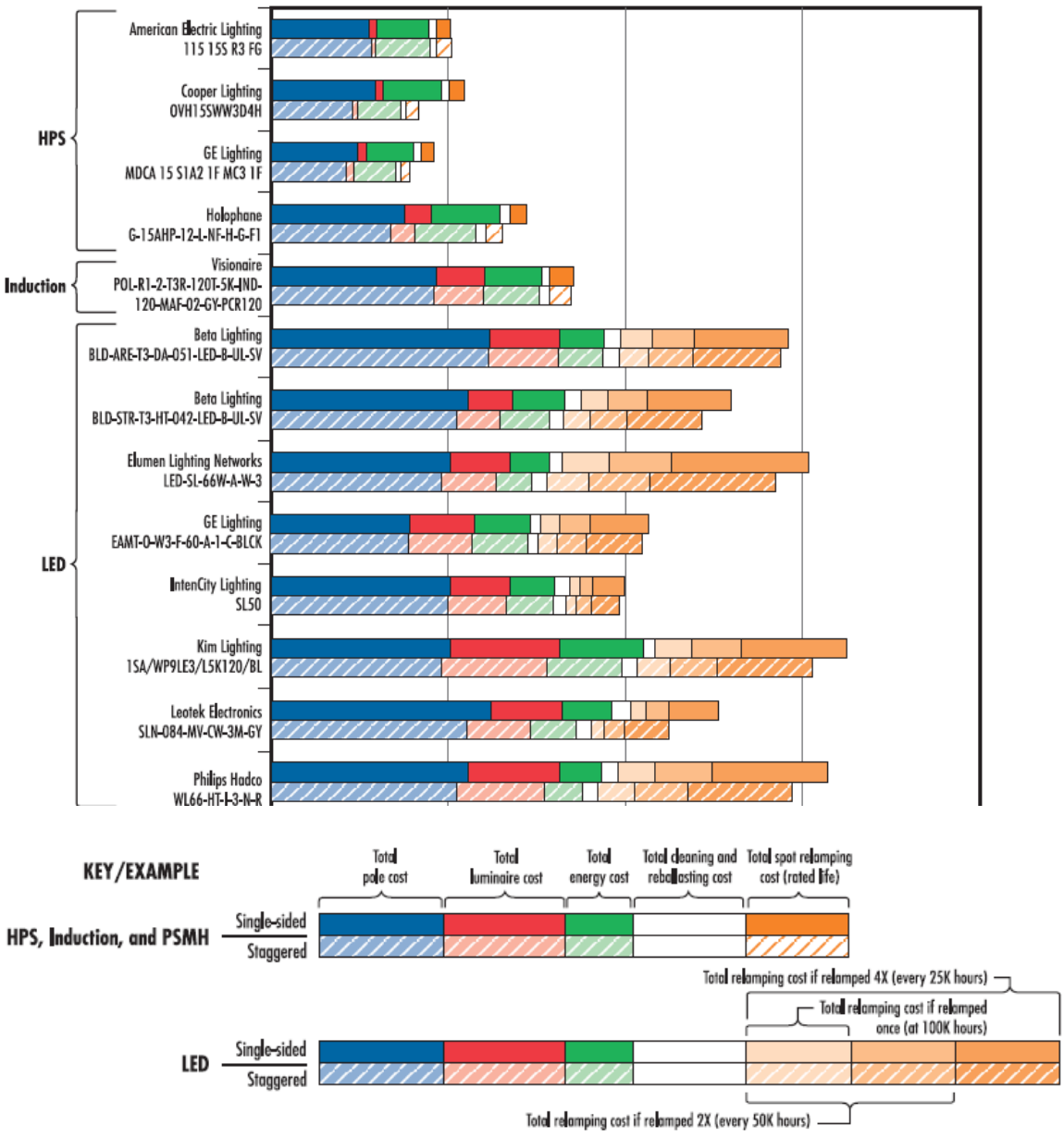
Q. Given the benefits of induction lighting, is the Company proposing an induction street lighting tariff?

A. No. However, Ameren Missouri is currently working to develop more roadway lighting pilot projects focused on evaluation of other lighting technologies. While Ameren Missouri is still in the early stages of this pilot development, the Company has met with several vendors and begun to evaluate potential sites to install the lighting systems. The Company is hoping to integrate induction lighting into the list of roadway lighting technologies to be evaluated.

Q. How does the cost of an induction street light compare to conventional HPS street lighting technology and to LED technology?

A. Induction street lights require large up-front capital investments similar to LEDs. Due to their extended life, however, the life-cycle cost of an induction fixture is below the cost of most LEDs and only slightly higher than an HPS, which can be seen in the graphic below.[1]

Figure 2: Life Cycle Costs



[1] Streelights for Collector Roads. National Lighting Product Information Program. September 2010.

Q. When factoring in the potential energy savings of induction lights relative to HPS street lighting technology, do the benefits exceed the costs?

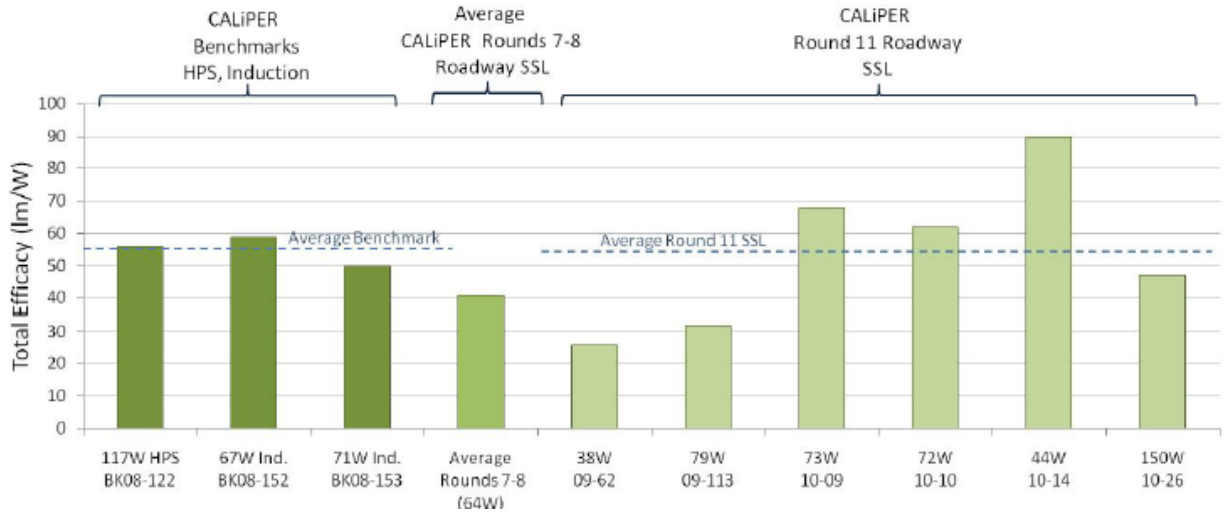
A. No, not yet.

VI. BENEFITS TO CUSTOMERS OF WAITING TO FILE NEW STREET LIGHTING TARIFFS

Q. What benefits will customers realize by Ameren postponing adopting a new street lighting tariff?

A. Given the relatively immature market and the rapid levels of product evolution, it would behoove the Company, and customers, to delay the development of a tariff specifically geared toward LEDs. The chart below identifies efficacy levels for various lighting technologies and wattages. As can be seen, there are several instances where the old, average technology has higher efficacies than its replacement. There are, however, obvious instances where the new LEDs offer superior efficacies to the legacy technology. This inconsistency points to an immature market. Customers will not want to receive a product with a manufacturer's claim of 100 lumens/watt only to find their actual operating performance being in the 40 – 50 lumens/watt range. This would defeat the purpose of the new tariff and likely deter customers from adopting this promising future technology.

Figure 3: Efficacies of Street Lighting Technologies



Q. Are there other benefits in not rushing to file street lighting tariffs for LEDs?

A. Yes. Another benefit would be to make sure there are appropriate standards to accurately measure LED lighting. As I discussed previously, LEDs, by nature, do not put out the same initial lumens as conventional sodium vapor technologies, and therefore are somewhat difficult to measure on a one-to-one basis. In order to meet the best-practice roadway lighting design, Illuminating Engineering Society of North America ("IESNA") RP-8, there is a considerable amount of design work that must take place. As LEDs are directional light sources, they need to be configured to illuminate the desired area in a method compliant to lumen ratios identified by the IESNA. Another important aspect is that IESNA has not yet incorporated scotopic luminance levels (vision under low light conditions) into its standards, which is critical to facilitating wide-scale LED adoption.[2]

[2] Illuminating Engineering Society. IES Position Statement (PS-02-10) "Use of Spectral Weighting Functions for Compliance with IES Recommendations." 08/21/2010.

Q. Can LED street lights replace existing street lights one for one?

A. We do not know. The research is on-going and the answer to this question is very site-specific. As mentioned earlier, in most cases, LED roadway lights are not a one-for-one replacement with existing lighting units, due in part to their lower initial light output. Properly matching existing lighting requirements requires analysis and measurement of the existing lighting scheme, coordination with lighting designers/manufacturers, and the integration of utility engineers and any customer (municipal, most likely) officials. A key cost consideration is pole spacing. Since LEDs do not put out the same level of initial light, they may require different pole spacing than the existing set-up, normally at a large expense. A study conducted in 2009 by the National Lighting Product Information Program placed LED, HPS, and Metal Halide technologies in similar scenarios to create an equal comparison of the lighting technologies. The desired lighting specification was IESNA RP-8, but none of the LEDs met the minimum lumen ratios. Consequently, pole spacing was adjusted and the lighting levels were then satisfactory, but not without significant detrimental effect on the payback calculation of LED roadway lighting.[3]

In the chart below, various lighting technologies are compared to a baseline HPS 150 watt system. While all the LED and induction options use less energy, there are some interesting items to note. The initial lumens are much lower, uniformity is much more erratic, and few of the LEDs have energy savings outweighing the percentage in light reduction.

[3] http://www.lrc.rpi.edu/programs/nlpip/publicationDetails.asp?id=927&type=1

Figure 4: Performance Analysis of Lighting Systems

Calculations for retrofit of a somewhat overlit 24-foot wide 2-lane street with 27-foot high HPS luminaires set back 6-foot and spaced 170-foot on center (based on initial performance, not end of life). Other installation configurations (e.g., street widths, mounting heights, and pole spacing) may render significantly different results.

CALiPER test source type	08-122 HPS	08-152 Ind.	08-153 Ind.	09-62 LED	09-113 LED	10-09 LED	10-10 LED	10-14 LED	10-26 LED
Input watts	117	67	71	38	42	73	72	44	150
Energy reduction	-	43%	39%	68%	64%	38%	38%	62%	-28%
Initial average illuminance	0.66	0.25	0.23	0.07	0.14	0.57	0.42	0.32	0.50
Initial light reduction	-	62%	65%	89%	79%	14%	36%	52%	24%
Avg:min uniformity	5.5	12.5	11.5	7.0	2.8	5.7	7.0	16.0	16.67
Avg:min uniformity < 6:1	yes	no	no	no	yes	yes	no	no	no
Avg initial illuminance > 0.4	yes	no	no	no	no	yes	yes	no	yes
Initial %energy reduction greater than %light reduction	-	no	no	no	no	yes	yes	yes	no

It should be noted that many of these inconsistencies could be reduced with appropriate lighting design and/or if the replacement technologies were in new installations, where appropriate pole spacing could be designed to meet the necessary requirements. This speaks to the necessity of lighting design when incorporating LED roadway lighting into the utility system or a customer site.

VII. POTENTIAL TARIFF CONSIDERATIONS

Q. Please describe potential tariff possibilities.

A. Again, Mr. Cooper discusses street lighting tariff issues in his rebuttal testimony. Suffice it to say there are several considerations to take into account when developing a street lighting tariff. Considering the infancy and related uncertainty of operating performance of both LED and induction lighting, the Company should not add either of these to its non-metered standard street and outdoor lighting tariff offerings at this time. Rather, customers desiring to install their own LED or induction lighting systems should be granted service under the metered option of the Company's Service Classification No. 6 – Street and Outdoor Area Lighting – Customer Owned.

VIII. CONCLUSION

Q. Please summarize your conclusions.

A. While LED roadway lighting represents a new, promising technology, proposing a tariff by 2012 is premature for the reasons stated in my testimony. Ameren Missouri continues to proactively monitor and evaluate future roadway lighting technologies in hopes of offering customers the most efficient, reliable lighting options. The EPRI LED pilot as well as the future pilot plans will provide invaluable primary market data that will inform business decisions moving forward. While a new tariff for LEDs is not out of the realm of possibility at some point in the future, Ameren Missouri is acting in customers' best interest by undertaking the due diligence necessary to ensure customers will receive quality street lighting products at the most economic rates.

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 AmerenUE for Authority to File Tariffs Increasing Rates for Electric Service Provided to Customers In the Company's Missouri Service Area.	)))))	Case No. ER-2011-0028

AFFIDAVIT OF KYLE F. SHOFF

STATE OF MISSOURI)
) **ss**
CITY OF ST. LOUIS)

Kyle F. Shoff, being first duly sworn on his oath, states:

1. My name is Kyle F. Shoff. I work in the City of St. Louis, Missouri, and I am employed by Ameren Services as a Planning Consultant for Demand Side Management on behalf of Ameren Missouri.

2. Attached hereto and made a part hereof for all purposes is my Rebuttal Testimony on behalf of Ameren Missouri consisting of 14 pages, and Appendix 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.

Kyle F. Shoff

Subscribed and sworn to before me this 25 day of March, 2011.

Amanda Tesdall
Notary Public

My commission expires:

Amanda Tesdall - Notary Public
Notary Seal, State of
Missouri - St. Louis County
Commission #07158967
My Commission Expires 7/29/2011

APPENDIX A

STATEMENT OF QUALIFICATIONS

Kyle F. Shoff

My name is Kyle F. Shoff. My business address is One Ameren Plaza, 1901 Chouteau Avenue, St. Louis, Missouri, 63103. My current title is Planning Consultant – DSM for Ameren Services Company.

My educational background consists of a Bachelor's of Science degree in Business Administration from Saint Louis University in 2008. I am currently pursuing a Master's in Business Administration at Washington University in St. Louis, Missouri.

Beginning in May of 2008, I worked as Planning Consultant – DSM in Ameren's Energy Efficiency/Demand Response team, supporting DSM efforts for our companies in both Illinois and Missouri. My duties included the following: energy efficiency/demand response policy and planning, mass market implementation planning, commercial and industrial market implementation planning, cost-effectiveness analysis and modeling, and tracking of new technologies and DSM industry developments.

In 2009, I was chosen to project manage the EPRI street lighting pilot program. My duties for this specific project include product selection oversight, photometric measurement, interfacing with customers and EPRI, and acting as corporate spokesman for the project.