Exhibit No. 103

Staff – Exhibit 103
Alan J. Bax
Direct Testimony
File No. ER-2022-0337

Exhibit No.:	
Issue(s):	*System Energy Losses* *Line Loss Study* *FAC Voltage Adjustment Factors*
Witness:	*Alan J. Bax*
Sponsoring Party:	*MoPSC Staff*
Type of Exhibit:	*Direct Testimony*
Case No.:	*ER-2022-0337*
Date Testimony Prepared:	*January 10, 2023*

MISSOURI PUBLIC SERVICE COMMISSION

INDUSTRY ANALYSIS DIVISION

ENGINEERING ANALYSIS DEPARTMENT

DIRECT TESTIMONY
Revenue Requirement

OF

ALAN J. BAX

UNION ELECTRIC COMPANY,
d/b/a AMEREN MISSOURI

CASE NO. ER-2022-0337

Jefferson City, Missouri
January 2023

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UNION ELECTRIC COMPANY,
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CASE NO. ER-2022-0337

DIRECT TESTIMONY

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UNION ELECTRIC COMPANY,
d/b/a AMEREN MISSOURI

CASE NO. ER-2022-0337

Q. Please state your name and business address.

A. Alan J. Bax, P.O. Box 360, Jefferson City, Missouri, 65102.

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

A. I am employed by the Missouri Public Service Commission (Commission) as an Associate Engineer in the Engineering Analysis Department of the Industry Analysis Division.

Q. Please describe your educational and work background.

A. My educational and work background is summarized in Schedule AJB-d1.

Q. Are you a member of any professional organizations?

A. Yes, I am a member of the Institute of Electrical and Electronic Engineers (IEEE).

Q. Have you previously filed testimony before the Commission?

A. Yes. My case participation history with the Commission is listed in Schedule AJB-d2.

EXECUTIVE SUMMARY

Q. What is the purpose of your testimony?

A. The purpose of this testimony is to describe my calculations of the following inputs to Staff's direct case:

- System energy line loss factor
- Voltage Adjustment Factors (VAFs).

Q. Please summarize the results of your analyses.

A. I calculated the following system energy line loss factor:

0.0454 of Net System Input ("NSI")[1]

I have determined the following VAFs for the respective voltage levels:

$VAF_{Transmission}$	0.9954
$VAF_{HV\ Primary}$	1.0085
$VAF_{LV\ Primary}$	1.0248
$VAF_{Secondary}$	1.0567

Q. Do you provide the results of these calculations to other Staff witnesses for the development of an issue?

A. Yes. I provided the system energy loss factor to Staff witness Hari K. Poudel, PhD for use in determining weather-normalized loads that were used as an input into Staff's fuel model. I provided the VAFs to Staff witness Amanda C. Conner, who utilized these VAFs in conjunction with the determination of Fuel Adjustment Rates ("FARs") that are reflected in the Fuel Adjustment Clause ("FAC").

SYSTEM ENERGY LOSSES

Q. What are system energy losses?

A. System energy losses largely occur in the electrical equipment (e.g., transmission and distribution lines, transformers, etc.) of Ameren Missouri's system. For example, there are losses realized from each voltage conversion as the voltage is ultimately reduced to 120/240 Volts for residential customer usage. Losses also result from the

[1] Considered to have been calculated at the transmission voltage level, the Load Requirement at Transmission ("LRT"), as described on Page 3.

transmission and distribution of electricity flowing through the associated conductors utilized in its delivery. In addition, small fractional amounts of energy, either stolen (diversion) or unmetered, are included as system energy losses.

Historically, this calculation has represented the amount of losses experienced between Ameren Missouri's generating sources and its customers' meters. However, with its participation in the Midcontinent Independent System Operator ("MISO") market, this system energy loss factor calculation is considered to represent losses experienced between Ameren Missouri's transmission voltage level and its customers' meters as Ameren Missouri sells its generation into the MISO market and subsequently buys from MISO what is to be delivered to its customers' loads, an amount referenced as the Load Requirement at Transmission ("LRT").

Q. How are system energy losses determined?

A. The basis for calculating system energy losses is that LRT equals the sum of "Total Sales" (Retail + Wholesale), "Company Use," and "System Energy Losses." This can be expressed mathematically as:

LRT = Total Sales + Company Use + System Energy Losses

LRT, Company Use, and Total Sales are known quantities; therefore, system energy losses may be calculated as follows:

System Energy Losses = LRT – Total Sales – Company Use

The system energy loss factor is the ratio of system energy losses to LRT:

System Energy Loss Factor = (System Energy Losses ÷ LRT)

Q. How is LRT determined?

A. In addition to the relationship expressed in the equation above, LRT is also equal to the sum of Ameren Missouri's net generation and the net interchange, considered determined at the transmission level. Net generation is the total energy output of each generating station minus the energy consumed internally to enable its production of electricity at each plant. The output of each generation plant is continuously monitored and metered. Net interchange is the difference resulting from netting off-system purchases and off-system sales, and is similarly monitored.

Q. What is the resultant system energy loss factor?

A. The system energy line loss factor, based on an evaluation of data provided in conjunction with the test year in this case, April 2021 to March 2022, is as follows:

System Energy Loss Factor - 0.0454

Q. Which Staff witness used your calculated system energy loss factor?

A. I provided my calculated system energy loss factor to Staff witness Hari K. Poudel, PhD. Mr. Poudel utilized this system energy loss factor as an input in his development of weather normalized energy loads that were subsequently reflected in Staff's fuel model.

LOSS STUDY AS IT APPLIES TO THE FUEL ADJUSTMENT CLAUSE

Q. Was a System Energy Line Loss Study ("Loss Study") provided in this case?

A. No.

Q. Why was a Loss Study not provided?

A. Ameren Missouri supplied Staff with a Loss Study in its Response to Staff Data Request No. 0239 in its last general rate increase case (ER-2021-0240). This Loss Study includes analyses based on data collected during calendar year 2018. Therefore, Ameren

Missouri is compliant with the rule that requires a current Loss Study be provided in conjunction with a request to continue a Rate Adjustment Mechanism ("RAM"), i.e. its Fuel Adjustment Clause ("FAC") in the current case, per 20 CSR 4240-20.090(13).[2]

Q. What information are you evaluating in the Loss Study[3]?

A. Included in the analysis of line losses in the Loss Study is a derived loss factor for each of the corresponding operating voltage levels (transmission, high voltage primary, low voltage primary, and secondary) in which Ameren Missouri serves its customers.

Q. What are these voltage level factors ("VAFs") and the results of your calculation at each operating level of Ameren Missouri system?

A. VAFs account for the energy losses experienced in the delivery of electricity from the generation level to the retail customer. Given that the VAFs in the current FAC tariff were determined utilizing data in the same Loss Study, I am recommending no changes be reflected in the VAFs in the revised FAC being proposed in this Case. The current VAFs included in the FAC are as follows:

$VAF_{Transmission}$	0.9954
$VAF_{HV\ Primary}$	1.0085
$VAF_{LV\ Primary}$	1.0248
$VAF_{Secondary}$	1.0567

[2] 20 CSR 4240-20.090(13) Rate Design of the RAM, states in pertinent part... "The design of the RAM rates shall reflect differences in losses incurred in the delivery of electricity at different voltage levels for the electric utility's different rate classes as determined by periodically conducting Missouri jurisdictional system loss studies…When the electric utility seeks to continue or modify its RAM, the end of the twelve- (12-) month period of actual data collected that is used in its Missouri jurisdictional system loss study must end no earlier than four (4) years before the date the utility files the general rate proceeding seeking to continue or modify its RAM."

[3] The "Loss Study" being evaluated is the document provided in Response to Staff Data Request No. 0239 in Case No. ER-2021-0240.

Q. What Staff member used these VAFs?

A. These VAFs were provided to Staff witness Amanda C. Conner for utilization in calculating respective FARs that are reflected in the FAC. These FARs will be applied to the individual voltage service classification of a particular customer should the Commission authorize Ameren Missouri to continue utilizing its FAC and associated tariff.

Q. Does this conclude your direct 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 Adjust Its Revenues for Electric Service	)))	Case No. ER-2022-0337

AFFIDAVIT OF ALAN J. BAX

STATE OF MISSOURI	)	
	)	ss.
COUNTY OF COLE	)	

COMES NOW ALAN J. BAX and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing *Direct Testimony of Alan J. Bax*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

ALAN J. BAX

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 5th day of January 2023.

D. SUZIE MANKIN
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: April 04, 2025
Commission Number: 12412070

Notary Public

ALAN J. BAX

I graduated from the University of Missouri - Columbia with a Bachelor of Science degree in Electrical Engineering in December 1995. Concurrent with my studies, I was employed as an Engineering Assistant in the Energy Management Department of the University of Missouri – Columbia from the Fall of 1992 through the Fall of 1995. Prior to this, I completed a tour of duty in the United States Navy, completing a course of study at the Navy Nuclear Power School and a Navy Nuclear Propulsion Plant. Following my graduation from the University of Missouri - Columbia, I was employed by The Empire District Electric Company as a Staff Engineer until August 1999, at which time I began my employment with the Staff of the Missouri Public Service Commission. My current position is an Engineer in the Engineering Analysis Department, within the Industry Analysis Division. I presented in a Peer Review of Power Quality Regulations in the National Association of Regulatory Utility Commissioners' (NARUC) outreach program with the Public Utilities Commission of Sri Lanka (PUCSL), supported by the Bureau of Energy Resources (ENR) at the United States Department of State. I am a member of the Institute of Electrical/Electronic Engineers (IEEE).

TESTIMONY AND REPORTS
BEFORE THE MISSOURI PUBLIC SERVICE COMMISSION

BY ALAN J. BAX

COMPANY	CASE NUMBER
Aquila Networks – MPS	ER-2004-0034
Union Electric Company d/b/a AmerenUE	EO-2004-0108
Empire District Electric Company	ER-2002-0424
Kansas City Power and Light Company	EA-2003-0135
Union Electric Company d/b/a AmerenUE	EO-2003-0271
Aquila Networks – MPS	EO-2004-0603
Union Electric Company d/b/a AmerenUE	EC-2002-0117
Three Rivers and Gascosage Electric Coops	EO-2005-0122
Union Electric Company d/b/a AmerenUE	EC-2002-1
Aquila Networks – MPS	EO-2001-0384
Empire District Electric Company	ER-2001-299
Aquila Networks – MPS	EA-2003-0370
Union Electric Company d/b/a AmerenUE	EW-2004-0583
Union Electric Company d/b/a AmerenUE	EO-2005-0369
Trigen Kansas City	HA-2006-0294
Union Electric Company d/b/a AmerenUE	EC-2005-0352
Missouri Public Service	ER-2001-672
Aquila Networks – MPS	EO-2003-0543
Kansas City Power and Light Company	ER-2006-0314
Macon Electric Coop	EO-2005-0076
Aquila Networks – MPS	EO-2006-0244
Union Electric Company d/b/a AmerenUE	EC-2004-0556
Union Electric Company d/b/a AmerenUE	EC-2004-0598
Empire District Electric Company	ER-2004-0570
Union Electric Company d/b/a AmerenUE	EC-2005-0110
Union Electric Company d/b/a AmerenUE	EC-2005-0177
Union Electric Company d/b/a AmerenUE	EC-2005-0313
Empire District Electric Company	EO-2005-0275
Aquila Networks – MPS	EO-2005-0270
Union Electric Company d/b/a AmerenUE	EO-2006-0145
Empire District Electric Company	ER-2006-0315
Aquila Networks – MPS	ER-2005-0436

COMPANY	CASE NUMBER
Union Electric Company d/b/a AmerenUE	EO-2006-0096
West Central Electric Cooperative	EO-2006-0339
Kansas City Power and Light Company	ER-2006-0314
Union Electric Company d/b/a AmerenUE	EO-2008-0031
Union Electric Company d/b/a AmerenUE	EC-2009-0193
Empire District Electric Company	ER-2008-0093
Missouri Rural Electric Cooperative	EO-2008-0332
Grundy Electric Cooperative	EO-2008-0414
Osage Valley Electric Cooperative	EO-2009-0315
Union Electric Company d/b/a AmerenUE	EO-2009-0400
Union Electric Company d/b/a AmerenUE	EO-2008-0310
Aquila Networks – MPS	EA-2008-0279
West Central Electric Cooperative	EO-2008-0339
Empire District Electric Company	EO-2009-0233
Union Electric Company d/b/a/ AmerenUE	EO-2009-0272
Empire District Electric Company	EO-2009-0181
Union Electric Company d/b/a AmerenUE	ER-2008-0318
Kansas City Power and Light Company	ER-2009-0089
Kansas City Power and Light – GMO	ER-2009-0090
Union Electric Company d/b/a AmerenUE	ER-2010-0036
Empire District Electric Company	ER-2010-0130
Laclede Electric Cooperative	EO-2010-0125
Union Electric Company d/b/a AmerenUE	EC-2010-0364
Union Electric Company d/b/a AmerenUE	EO-2011-0052
Kansas City Power and Light Company	ER-2010-0355
Union Electric Company d/b/a AmerenUE	EO-2010-0263
Kansas City Power and Light – GMO	EO-2011-0137
Kansas City Power and Light – GMO	ER-2010-0356
Union Electric Company d/b/a AmerenUE	ER-2011-0028
Kansas City Power and Light – GMO	EO-2012-0119
Kansas City Power and Light Company	EO-2011-0137
Union Electric Company d/b/a AmerenUE	ER-2012-0121
Union Electric Company d/b/a/ Ameren Missouri	EX-2012-0332
Empire District Electric Company	EO-2011-0085
Empire District Electric Company	EO-2012-0192
Empire District Electric Company	EO-2013-0313
Union Electric Company d/b/a AmerenUE	ER-2012-0180
Union Electric Company d/b/a AmerenUE	EO-2013-0418

COMPANY	CASE NUMBER
City Utilities of Springfield	EO-2012-0441
Kansas City Power and Light – GMO	EO-2012-0367
Empire District Electric Company	ER-2011-0004
Union Electric Company d/b/a/ Ameren Missouri	ER-2012-0166
Kansas City Power and Light Company	ER-2012-0174
Union Electric Company d/b/a/ Ameren Missouri	ER-2013-0044
Kansas City Power and Light – GMO	ER-2012-0175
Central Missouri Electric Cooperative	EO-2015-0137
Empire District Electric Company	ER-2012-0345
Kansas City Power and Light Company	EO-2012-0367
Boone Electric Cooperative	EO-2015-0012
Transource Missouri, LLC	EA-2013-0098
Black River Electric Cooperative	EO-2015-0096
Union Electric Company d/b/a/ Ameren Missouri	EW-2012-0369
Empire District Electric Company	ER-2014-0351
Union Electric Company d/b/a/ Ameren Missouri	EO-2014-0044
Union Electric Company d/b/a/ Ameren Missouri	EO-2013-0418
Union Electric Company d/b/a/ Ameren Missouri	EE-2013-0511
Union Electric Company d/b/a/ Ameren Missouri	EO-2015-0017
Union Electric Company d/b/a/ Ameren Missouri	EO-2016-0087
Union Electric Company d/b/a/ Ameren Missouri	EO-2014-0009
Kansas City Power and Light Company	EO-2014-0128
Union Electric Company d/b/a/ Ameren Missouri	EO-2017-0358
Empire District Electric Company	EO-2016-0192
Empire District Electric Company	EO-2017-0217
Union Electric Company d/b/a/ Ameren Missouri	EO-2014-0296
Union Electric Company d/b/a/ Ameren Missouri	EO-2015-0328
Union Electric Company d/b/a/ Ameren Missouri	ER-2014-0258
Union Electric Company d/b/a/ Ameren Missouri	EX-2017-0153
Union Electric Company d/b/a/ Ameren Missouri	EO-2019-0391
Empire District Electric Company	EO-2018-0118
Empire District Electric Company	ER-2016-0023
Ozark Electric Cooperative Inc.	EO-2020-0163
Union Electric Company d/b/a/ Ameren Missouri	EC-2016-0235
Union Electric Company d/b/a/ Ameren Missouri	EO-2018-0058
Union Electric Company d/b/a/ Ameren Missouri	EE-2019-0395
Kansas City Power and Light – GMO	ER-2016-0156
Kansas City Power and Light – GMO	EO-2019-0061

COMPANY	CASE NUMBER
Kansas City Power and Light Company	ER-2014-0370
Union Electric Company d/b/a/ Ameren Missouri	EO-2017-0044
Kansas City Power and Light Company	ER-2016-0285
Empire District Electric Company	EO-2019-0381
Union Electric Company d/b/a/ Ameren Missouri	EE-2019-0395
Union Electric Company d/b/a/ Ameren Missouri	ER-2016-0179
Union Electric Company d/b/a/ Ameren Missouri	EO-2018-0278
Union Electric Company d/b/a/ Ameren Missouri	EO-2020-0315
Union Electric Company d/b/a/ Ameren Missouri	EO-2017-0127
Kansas City Power and Light Company	ER-2018-0145
Kansas City Power and Light Company – GMO	ER-2018-0146
Evergy Missouri West LLC	EO-2021-0388
Gridliance High Plains, LLC	EM-2022-0156
Union Electric Company d/b/a/ Ameren Missouri	EO-2021-0305
Union Electric Company d/b/a/ Ameren Missouri	EM-2021-0309
Union Electric Company d/b/a/ Ameren Missouri	ER-2019-0335
Union Electric Company d/b/a/ Ameren Missouri	EE-2019-0383
Osage Valley Electric Cooperative, LLC	EO-2022-0073
Osage Valley Electric Cooperative, LLC	EO-2023-0126
Ozark Border Electric Cooperative, LLC	EO-2022-0264
Evergy Missouri West LLC	EO-2021-0339
Union Electric Company d/b/a/ Ameren Missouri	EE-2021-0086
Union Electric Company d/b/a/ Ameren Missouri	EM-2022-0292
Liberty Utilities-Empire	EO-2021-0389
Laclede Electric Cooperative	EO-2022-0143
Empire District Electric Company	ER-2019-0374
Union Electric Company d/b/a/ Ameren Missouri	ET-2021-0082
Union Electric Company d/b/a/ Ameren Missouri	ER-2021-0240
Union Electric Company d/b/a/ Ameren Missouri	EO-2022-0226
Union Electric Company d/b/a/ Ameren Missouri	EO-2022-0190
Union Electric Company d/b/a/ Ameren Missouri	EO-2022-0332
NextEra Energy Transmission Southwest, LLC	EA-2022-0234
Evergy Missouri Metro	ER-2022-0129
Evergy Missouri West LLC	ER-2022-0130
Evergy Missouri West LLC	EO-2022-0320
Missouri Joint Municipal Utility Electric Commission	EM-2022-0156
Liberty Utilities-Empire	EO-2022-0226
Liberty Utilities-Empire	EC-2022-0291

COMPANY	CASE NUMBER
Union Electric Company d/b/a/ Ameren Missouri	EO-2021-0401
Union Electric Company d/b/a/ Ameren Missouri	EM-2022-0094
Union Electric Company d/b/a/ Ameren Missouri	EO-2022-0102
Liberty Utilities-Empire	EO-2022-0132
Liberty Utilities-Empire	ER-2021-0312