Attachment Y Study
Edwards Unit 1: 90 MW Coal
Retirement December 31, 2012

ATTACHMENT Y STUDY REPORT

7/5/2013

PUBLIC / REDACTED

EXECUTIVE SUMMARY

MISO received an Attachment Y Notification of Potential Generation Resource/SCU Change of Status (Attachment Y Notice) from Ameren Energy Marketing (AEM) dated August 9, 2011 to suspend Edwards Unit 1 from February 6, 2012 – February 5, 2015. In an amended Attachment Y to MISO dated December 12, 2012, AEM revised the request to retire Edwards Unit 1 effective December 31, 2012. After being reviewed for power system reliability impacts as provided for under Section 38.2.7 of the MISO's Open Access Transmission, Energy & Operating Reserve Markets Tariff (Tariff), MISO determined that Edwards Unit 1 should enter into a System Support Resource (SSR) Agreement until the necessary transmission upgrades are placed into service.

The necessary transmission improvements include the previously planned upgrades to the Keystone -Edwards 138kV and East Peoria-Flint 138kV and Edwards –Tazewell 138kV circuits, along with the installation of 40Mvar capacitor banks at Fargo 138kV and Keystone 138kV substations, addition of a 150MVA 138/69kV transformer planned for Edwards substation, reconductor of the Edwards-Cat Sub 1 138kV line, Tazewell-Flint 138kV line, and the Latham-Kickapoo 138kV line and the completion of the new Fargo 345/138kV substation and the 20-mile Maple Ridge-Fargo 345kV line.

Contents

I. INTRODUCTION

Ameren Energy Marketing (AEM) submitted an Attachment Y Notice to MISO dated August 9, 2011 to provide notice to MISO of the planned suspension of Edwards Unit 1 effective February 6, 2012 and returning to service on February 5, 2015. AEM later submitted an amended Attachment Y Notice to MISO dated December 12, 2012, and clarified to MISO that they intend to Retire the Edwards Unit 1with an effective date of December 31, 2012.

The Edwards Unit 1 is a 107MVA nameplate unit located in the Peoria Area of Illinois with a currently de-rated capability of 90MW net output. The generation at the Edwards plant consists of generating units 1-3 (760MW) connected to the 138kV and 69kV buses. Edwards Unit 1 is connected to the 69 kV system of the Ameren Transmission Company (Ameren) transmission system.

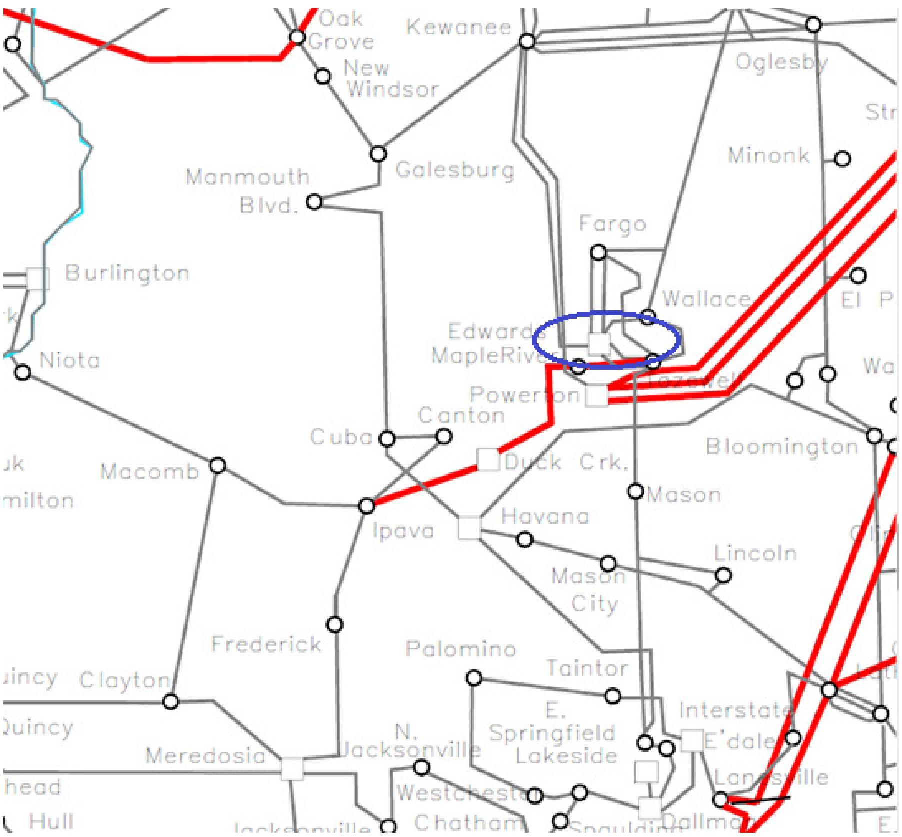

Figure 1: Location of Edwards in the Peoria, Illinois area of Ameren

II. STUDY OBJECTIVES

Under Section 38.2.7 of the MISO Tariff, SSR procedures maintain system reliability by providing a mechanism for MISO to enter into agreements with Market Participants (MP) that own or operate Generation Resources or Synchronous Condenser Units (SCUs) that have requested to either Retire or Suspend, but are required to maintain system reliability.

The principal objective of an Attachment Y study is to determine if the unit(s) for which a change in status is requested is necessary for system reliability based on the criteria set forth in the MISO Business Practices Manuals. The study work included monitoring and identifying the steady state branch/voltage violations on transmission facilities due to the unavailability of the Generation Resource or SCU. The relevant MISO Transmission Owner and/or regional reliability criteria are used for monitoring such violations.

The MISO transmission planning process is a collaborative effort with participation of Transmission Owners and MISO in the development of the study parameters and review of study results. Ameren Transmission Planning conducted the analysis on behalf of MISO and provided the study results to MISO for review and comment.

III. MODELS AND ASSUMPTIONS

The Peoria area load is significantly higher in the summer season than in the winter season and previous system studies of winter peak or off-peak conditions have not identified any thermal loading issues or concerns for low system voltages. Therefore, based on the results of the previous studies, the evaluation of the proposed unavailability of Edwards generator #1 was limited to summer peak conditions only. The models used to perform the impact studies are described below.

Corresponding to the anticipated retirement of Edwards unit 1 the following power system analysis models were used for the study:

- Near term 2012 Summer Peak
- Intermediate term 2016 Summer Peak

a. Model Assumptions

To evaluate the near-term impact of the Attachment Y request, a 2012 summer peak model was used to represent expected near-term conditions. This model was based on the 2010 series ERAG MMWG model with inclusion of more detailed representation of Ameren 34 kV and 69 kV busses connected to the transmission system through transformation. The Medina Valley CTGs (cogeneration facility in the Peoria area that is operated only when the customer needs steam power) were modeled off. Loads and shunt capacitor banks were modeled at the sub-transmission level busses instead of at the transmission busses, and transformer LTCs were modeled to control the sub-transmission bus voltages. The resultant model more accurately reflects the impact on local area reliability as Edwards generating unit #1 is connected to Ameren's Peoria area 69 kV system. This model was one of the models used by Ameren to support its 2011 compliance with the NERC TPL-001 through TPL-004 standards.

To evaluate the intermediate-term impact of the Attachment Y request, a 2016 summer peak model was used. Similar to the 2012 summer peak model, this model was also based on the 2010 series ERAG MMWG model with inclusion of more detailed representation of Ameren 34 kV and 69 kV busses connected to the transmission system through transformation. The Medina Valley CTGs again were modeled off. Loads and shunt capacitors were modeled at the sub-transmission level busses instead of at the transmission busses, and transformer LTCs were modeled to control the sub-transmission bus voltages. This model was also one of the models used to support Ameren's 2011 compliance with the NERC TPL-001 through TPL-004 standards.

For both the near-term and intermediate study models, generation within the AMIL footprint was dispatched such that most of the peaking units were off-line, including the Medina Valley CTGs, Avena CTG #1, Stallings CTGs 1-4, Oglesby CTGs 1-4, and the Tilton Energy Center CTGs 1-4.Units that had previously submitted Attachment Y applications to retire or suspend operations were also modeled off, including Hutsonville units 3&4, Vermilion units 1-3, Meredosia units 1-4, Havana units 1-5, and Wood River units 1-3. Make-up power for the unavailability of Edwards generator #1 was simulated from the Reliant CTGs near Neoga, IL in an attempt to maintain an economic generation dispatch in the AMIL balancing area. The Reliant CTGs were also selected because they are sufficiently far enough away from Peoria that the power flow and reactive support from these units would neither mask nor overstate the reliability impacts of the Edwards generator #1 outage, as measured by the changes on local Peoria area transmission facility loadings and bus voltages.

b. Transmission Projects

Existing transmission projects in the area were included in the 2012 summer peak model and 2016 summer peak model.

IV. STUDY CRITERIA AND METHODOLOGY

Siemens PTI's Power System Simulator for Engineering (PSS/E) was used to perform AC contingency analysis. Contingency analysis is the study of transmission system facility outages. Outages of transmission facilities are applied to a mathematical model of the transmission system in order to calculate the effects on the remainder of the system. The models were solved with automatic control of Load Tap Changers (LTCs), phase shifters, DC taps, switched shunts enabled (regulating), and area interchange disabled. The results are compared to determine if there were any criteria violations due to the change in the status for the unit(s).

a. Ameren Transmission Planning Criteria

2.2.1 General Transmission Planning Criteria

Listed below are long-standing general planning criteria that Ameren has used over the years to plan the transmission system. These planning criteria were developed and used by many companies in the utility industry following the formation of

NERC in the late-1960s, long before the establishment of mandatory NERC Reliability Standards. These criteria have been more or less accepted by the industry and have developed into the NERC TPL-001 through TPL-004 Reliability Standards in their present Version 0 form. A reference to the NERC Reliability Standard is included following each criterion. Items 6, 6.1, and 6.2 below represent a recent clarification to these criteria in regards to the concurrent outage of two transmission elements.

---------------------------------------Description---------------------------------

1. With all facilities in service, the Ameren system shall operate (perform) with all equipment loaded at or below normal ratings and with voltages within acceptable limits. (NERC Standard TPL-001)

2. For the outage of any one transmission circuit, transmission element or generator, the Ameren system shall operate with all equipment loaded at or below emergency ratings and with voltages within acceptable limits. (NERC Standard TPL-002)

3. To account for variations in regional dispatch and/or extended generation outages, the system shall operate with all equipment loaded at or below emergency ratings and with voltages within acceptable limits for the loss of any one transmission circuit coincident with any generator assumed to be out of service. The displaced generation may be replaced with generation inside of the Ameren system or through regional dispatch. (NERC Standard TPL-002)

4. The system shall be able to withstand the loss of all transmission lines on a single right-of-way. The word "withstand" as used here means that the system would not collapse, even though there might be local low voltage conditions and possible transmission line or transformer overloads in some areas. Some redispatch or local load shedding might be required to mitigate loading or voltage issues. (NERC Standard TPL-004)

5. The system shall be able to survive the loss of an entire power plant and switchyard or an entire substation or switching station. Survive in this case indicates that the disturbance would remain local, and that the system would neither collapse nor separate into islands. Some local load and/or generation would probably be lost for these conditions. (NERC Standard TPL-004)

6 System conditions covered in NERC Reliability Standard TPL-003 include the concurrent outage of any two transmission elements (transmission line, transformer, etc.), an outage to a bus section, or failure of a breaker. The Standard requires all remaining system elements to be within applicable thermal and voltage limits but allows operator initiated system adjustments where applicable and also allows loss of demand (load shedding). The Standard also states that the event should not cause cascading outages. Ameren has parsed the allowance of “loss of demand” in the Standard into two categories. In the first category, load is shed via automatic or operator-initiated actions following the loss of two

transmission elements in order to keep the loading of system elements within established ratings and system voltages within established limits. Loadings should be within short-term ratings (either explicitly calculated or based on good utility practice) due to conditions associated with the concurrent outage of two transmission elements. Note that, due to issues of safety, short-term emergency ratings are typically not available for sag limited transmission lines. A capital project would be initiated to address situations where a sag-limited transmission line could be subjected to loading beyond its emergency rating. Load shedding is allowed to reduce equipment loadings below longer-term ratings. In the second category, supply to a defined pocket of load is lost as the direct consequence of the system topology and/or the natural response of the system. An example of the second category would be a substation which serves distribution load and has only two supplies. The concurrent outage of both supplies will result in the load at that substation being lost/dropped. Another example of the second category would be a substation which has three supplies, but if two supplies are outaged, the substation experiences a local voltage collapse and the load is lost/dropped.

6.1For the concurrent outage of any two transmission elements (transmission line, transformer, etc.), an outage to a bus section, or failure of a breaker, and including operator-initiated system adjustments where applicable, the controlled shedding of system load as an emergency operational procedure is allowed but with a limit on the magnitude of load exposed. The amount of load exposed to being shed shall be less than 100 MW. This load shedding includes automatic actions or operator-initiated actions expected to be taken to reduce the loading of transmission elements or to return voltages to acceptable levels. *The 100 MW level for load shedding represents the threshold of a NERC reportable event under NERC Standard EOP-004 and also the threshold for the DOE Energy Emergency Incident and Disturbance Reporting Requirement per Form EIA-417.* Corrective action should be investigated and implemented as soon as practicable to eliminate the projected exposure to automatic or operator-initiated shedding of 100 MW or more of load associated with the concurrent outage of any two transmission elements.

6.2 For the concurrent outage of any two transmission elements (transmission line, transformer, etc.), an outage to a bus section, or failure of a breaker, and including operator-initiated system adjustments where applicable, the loss of load for more than 15 minutes due to system topology and/or the natural response of the system is allowed but with a limit on the magnitude of load exposed. The amount of load exposed to being dropped due to system topology and/or the natural response of the system shall be less than 300 MW. *The 300 MW level for loss of load due to equipment failures represents the threshold of a NERC reportable event under NERC Standard EOP-004 and also the threshold for the DOE Energy Emergency Incident and Disturbance Reporting Requirement per Form EIA-417.* Corrective action should be investigated and implemented as soon as practicable to eliminate the projected exposure to loss of load of 300 MW or more related to system topology and/or the natural response of the system associated with the concurrent outage of any two transmission elements.

b. Steady State Thermal Criteria

Category B contingency performance was evaluated based on the following conditions as specified by the Midwest ISO BPM:
Branch loading was increased by at least 1 MVA due to a change in the requested generation.

Increase in branch loading was more than 3% of total reduction in generation MW for post-contingency thermal violations and 5% of total change in generation MW for pre-contingency thermal violations. For example, for the study of a hypothetical unit with a total of100MW, the increased branch loading cut-off for post-contingency thermal violations is100 MW * 3% = 3 MW, and the increased branch loading cut-off is 100 MW * 5% =5 MW) for pre-contingency thermal violations.

c. Steady State Voltage Criteria

Steady state bus voltage criteria as specified in Ameren's Transmission Planning Criteria and Guidelines was used in determining steady state voltage violations. Transmission bus voltages less than 95% were flagged for further analysis and corrective action. All 100 kV and above post contingency voltages are assessed after automatic transformer tap changes and shunt capacitor switching, if any, have been performed. This analysis also included steady state post contingency voltage assessment at the low-sides of the 34kV and69kV of bulk substation transformers in the general area of the plants being studied.

d. MISO Transmission Planning BPM - SSR Criteria

As specified in MISO BPM-020-r7, the SSR criteria for determining if an identified facility is impacted by the generator's change of status will be:

- Under system intact and contingent events, branch thermal violations are only valid if the flow increase on the element in the "after" retirement scenario is equal to or greater than:
  a) 5% of the "to-be-retired" unit(s) MW amount (i.e. 5% Power Transfer Distribution Factor (PTDF)) for a "base" violation compared with the "before" retirement scenario, or
  b) 3% of the "to-be-retired" unit(s) amount (i.e. 3% Outage Transfer Distribution Factor (OTDF)) for a "contingency" violation compared with the "before" retirement scenario.
- Under system intact and contingent events, high and low voltage violations are only valid if the change in voltage is greater than 1% as compared to the "before" retirement voltage calculation.

e. Contingencies

A subset of the MISO Transmission Expansion Plan (MTEP) contingencies was used for AC contingency analysis based on the results of other pre-screening and assessment studies. This set included select Category B and select Category C contingencies in AMIL balancing area.

The following North American Electric Reliability Corporation (NERC) Categories of contingencies were evaluated:

1. Category A when the system is under normal conditions.
2. Category B contingencies resulting in the loss of a single element.
3. Category C contingencies resulting in the loss of two or more (multiple) elements.

V. STUDY RESULTS

a. Thermal Analysis

For both the 2012 summer and the 2016 summer models that were used in the analyses, a few thermal issues were identified for the suspension of operations at Edwards unit #1, as noted below. Thermal loadings in excess of 100% of applicable ratings would be considered as a violation of Ameren Transmission Planning Criteria.

For conditions with all other transmission facilities in service (NERC Category A), no transmission overloads were identified for Edwards unit #1 off in either the 2012 summer peak or 2016 summer peak models.

For conditions with a single generator out of service or a single line/transformer/branch out of service (NERC Category B), no transmission overloads were identified for Edwards unit #1 off in either the 2012 summer peak or 2016 summer peak models.

1. 2012 Summer Peak Branch Results (Appendix A Table 1a)

Several transmission thermal loading issues were identified for coincident line and generator outages (NERC Category C3 and Ameren Transmission Planning Criteria) in the 2012 summer peak model.

2. 2016 Summer Peak Results Branch Results (Appendix A Table 1b)

Thermal loading issues for coincident line and generator outages (NERC Category C3 and Ameren Transmission Planning Criteria) were more severe in the 2016 summer peak model with additional thermal overload identified. The 2016 summer peak model also identified overloads as result of a coincident generator outage.

b. Voltage Analysis

For both the 2012 summer and the 2016 summer models that were used in the analyses, several voltage issues were identified for the plants studied. Bus voltages less than 95% of nominal would be considered as a violation of Ameren Transmission Planning Criteria.

For conditions with all other transmission facilities in service (NERC Category A), no transmission system voltages were not identified for Edwards unit #1 off, in either the 2012 summer peak or 2016 summer peak models.

For conditions with a single generator out of service or a single line/transformer/branch out of service (NERC Category B), low transmission system voltages were not identified for Edwards unit #1 off, in either the 2012 summer peak or 2016 summer peak models.

1. 2012 Summer Peak Voltage Results (Appendix A Table 1c)

For the coincident outage of generators (NERC Category C3 and Ameren Transmission Planning Criteria), low voltages would occur in the Peoria area for 2012 summer peak conditions with Edwards unit #1 off. The unavailability of Edwards unit #1 reduces the transmission bus voltages in the Peoria area by approximately 3.8-5.0% in 2012 model

2. 2016 Summer Peak Voltage Results (Appendix A, Table 1d)

Low voltage concerns emerge for coincident line and generator outages (NERC Category C3 and Ameren Transmission Planning Criteria) by 2016 summer or for higher than forecast load in the Peoria area with Edwards unit #1 off. Voltages changes up to 3.1% are indicated, but a voltage change of 1.5% is more typical for most contingencies.

For the coincident outage of generators (NERC Category C3 and Ameren Transmission Planning Criteria), the low voltage conditions are made worse in the summer peak conditions with Edwards unit 1 off. The unavailability of Edwards unit #1 reduces the transmission bus voltages in the Peoria area by approximately 2.8-4.6% in 2016.

VI. CONCLUSIONS

The existing Ameren transmission system in the Peoria area is not adequate to withstand the suspension of operations of Edwards generating unit #1 because the system could be subjected to overloads and low voltages for several NERC Category C contingency events involving the coincident outage of generators or the coincident outage of transmission line or transformer and generator. Transmission and subtransmission system reinforcements are needed in the Peoria area to meet Ameren planning criteria and provide adequate system reliability prior to Edwards unit #1 retirement.

VII. SSR AGREEMENT COST ALLOCATION

MISO utilizes a load shed methodology to determine the reliability benefits to each MISO Local Balancing Area (LBA) of operation, without the SSR unit(s). Although load shed is not permitted for NERC Category A or B events, this methodology determines the load shed amount needed to relieve all Category B reliability issues and the most severe Category C reliability issues identified, as a proxy for the reliability benefit of the SSR unit operation. The SSR

Agreement LBA shares that were calculated for this Attachment Y study are included below in Table 2.

Table 2: SSR Agreement LBA Shares

LBA	Load Shed (MW)	LBA Share
AMIL	1588	100%

VIII. ANALYSIS OF ALTERNATIVES

a. New Generation or Generation Redispatch

No new dispatchable generation is currently planned for the impacted region. Coordination of generation dispatch along the MISO-PJM seam would help to relieve some Peoria area transmission facility loadings for multiple outage events. The dispatch of Duck Creek and Powerton generation has some impact on the loadings on some area facilities, and particularly the Tazewell 345/138 kV transformers. However, with limited generation in the Peoria area redispatch does not provide effective relief for all constraints.

b. System Reconfiguration and Operation Guidelines

Currently no operating procedures are available that would address specific contingency events to maintain the Peoria area transmission loadings within ratings until the new facilities can be built. Moreover, reconfiguration would not provide necessary mitigation for the voltage issues that were identified.

c. Demand Response or Load Curtailment

In the interim period, before the transmission system reinforcements can be completed, dropping load could mitigate some of these multiple contingency events, including coincident line and generator outages. Because the unavailability of Edwards generating unit #1 adds to the transmission loading concerns, up to 150 MW of additional Peoria area load (worst case) would be subjected to curtailment in the near-term planning horizon for a Tazewell 345/138 kV transformer outage. Although dropping load to avert transmission overloads and low voltages for multiple outage events does not violate NERC reliability standards, it does not meet Ameren Transmission Planning criteria and is therefore not a recommended plan of action. From a planning perspective, the Ameren transmission system cannot reliably support the proposed suspension of operations of Edwards unit #1 until additional transmission facilities are constructed, and these additions and upgrades cannot be completed until 2016 based on present schedules. It is instead recommended that Edwards unit #1 remain available and should be operated for the outage of either of the other Edwards generating units and for the coincident outage of key Peoria area transmission facilities.

The analysis included an evaluation of the potential curtailment of 100MW of industrial load in the area to determine if it could provide the necessary relief for the thermal and voltage issues. While the demand response addressed the thermal constraints, low voltages could not be completely eliminated at all transmission buses. Tables 2a and 2b show the results of the analysis of the impact of load curtailment and other options evaluated.

d. Transmission Projects

Ameren has planned projects to address the terminal equipment loading concerns on the Edwards-Keystone 138 kV line 1397, the line conductor loading concerns on the East Peoria-Flint section of 138 kV line 1374, and the line conductor loading concerns on the Edwards-Tazewell 138 kV line 1373. In addition, the table shows that relief for the Tazewell 345/138 kV transformers would not be provided until late 2016. Ameren has a planned project to install a 345/138 kV 560 MVA transformer at its Fargo 345/138 kV Substation, supplied from a 20-mile extension (Maple Ridge-Fargo 345 kV supply line) to its existing Duck Creek-Tazewell 345 kV line. The projected overloads on the Tazewell 345/138 kV transformers would double with Edwards unit #1 unavailable, as indicated in Tables 1a and 1b, and extended emergency ratings for the Tazewell 345/138 kV transformers would need to be pursued in the interim period until the new transformer and supply line can be constructed

However, the unavailability of Edwards generating unit #1 would create three new facility loading concerns for the Ameren system as shown Tables 1a and 1b. Table 1a (based on the analysis of the 2012 summer peak model) shows a need to reconductor the Edwards-Cat Sub-1 138 kV line 1374, while Table 1b (based on the analysis of the 2016 summer peak model) shows the needs to reconductor the Tazewell-Flint section of 138 kV line 1353 and the Latham-Kickapoo 138 kV line 1346 to support the generation retirement request. Note that all of these projects would likely not be completed until 2015.

IX. SUMMARY OF SELECTED SOLUTION

The following previously approved facilities would allow for the retirement of Edwards Unit 1 without reliability criteria violations:

- Install 40Mvar capacitor banks at Fargo 138kV (MTEP Project 2299) and Keystone 138kV (MTEP Project 4391) – ISD:6/1/2014
- Install 150MVA 138/69kV transformer at Edwards - ISD:6/1/2015
- Edwards – Keystone upgrade – ISD:12/1/2013
- Reconductor Edwards – Cat Sub1 138kV line 1374 (MTEP Project 3374) – ISD:6/1/2014
- East Peoria - Flint 138kV upgrade (complete)
- Reconductor Tazewell - Flint section of 138kV line 1353 (MTEP Project 4063) – ISD:6/1/2015
- Reconductor Edwards-Tazewell 138kV line 1373 – ISD:10/1/2013
- Reconductor – Latham – Kickapoo section of 138kV line 1346 (MTEP Project 1536) – ISD:6/1/2015
- Fargo 345/161kV Substation and Maple Ridge – Fargo 345kV line (MTEP Project 2472) - ISD:12/1/2016

The completion of all the proposed system upgrades including the Maple Ridge – Fargo 345kV line in December 2016 will eliminate any issues resulting from the retirement of Edwards unit 1. In the 2015-2016 period prior to completion of the Maple Ridge – Fargo project, the generator is still required to be operational but with other system reinforcements in place by summer 2015, the unit output could be limited to maximum of 75 MW to remain within emissions limits and avoid capital upgrades of emissions control equipment.

X. APPENDICES

Appendix A: Steady-State AC Contingency Results

Table 1a: 2012 Branch Results

Line Outage:	Generator Outage:	Facility Loadings (%) with Edwards Gen #1 On	Facility Loadings (%) with Edwards Gen #1 Off
REDACTED	REDACTED	Edwards-Keystone 138 kV – 99.3%	Edwards-Keystone 138 kV – 110.8%
REDACTED	REDACTED	Edwards-Cat Sub 1 138 kV – 96.9%	Edwards-Cat Sub 1 138 kV – 111.4%
REDACTED	REDACTED	East Peoria-Flint 138 kV – 95.7%	East Peoria-Flint 138 kV – 110.0%
REDACTED	REDACTED	Edwards-Tazewell 138 kV line 1373 – 124.2%	Edwards-Tazewell 138 kV line 1373 – 132.5%
REDACTED	REDACTED	Tazewell 345/138 kV Xfmr #1 – 115.9%	Tazewell 345/138 kV Xfmr #1 – 131.5%
REDACTED	REDACTED	Tazewell 345/138 kV Xfmr #2 – 115.7%	Tazewell 345/138 kV Xfmr #2 – 131.3%

Table 1b: 2016 Branch Results

Line Outage:	Generator Outage:	Facility Loadings (%) with Edwards Gen #1 On	Facility Loadings (%) with Edwards Gen #1 Off
REDACTED	REDACTED	Edwards-Keystone 138 kV – 103.5%	Edwards-Keystone 138 kV – 116.2%
REDACTED	REDACTED	Edwards-Cat Sub 1 138 kV – 102.0%	Edwards-Cat Sub 1 138 kV – 116.1%
REDACTED	REDACTED	East Peoria-Flint 138 kV – 99.4%	East Peoria-Flint 138 kV – 113.8%
REDACTED	REDACTED	Tazewell-Flint 138 kV – 91.5%	Tazewell-Flint 138 kV – 103.2%
REDACTED	REDACTED	Edwards-Tazewell 138 kV line 1373 – 124.2%	Edwards-Tazewell 138 kV line 1373 – 132.5%
REDACTED	REDACTED	Tazewell 345/138 kV Xfmr #1 – 115.9%	Tazewell 345/138 kV Xfmr #1 – 132.1%
REDACTED	REDACTED	Tazewell 345/138 kV Xfmr #2 – 115.7%	Tazewell 345/138 kV Xfmr #2 – 131.9%
REDACTED	REDACTED	Latham-Kickapoo 138 kV line 1346 – 93.1%	Latham-Kickapoo 138 kV line 1346 – 105.1%
Generator Outage:	**Generator Outage:**	**Facility Loadings (%) with Edwards Gen #1 On**	**Facility Loadings (%) with Edwards Gen #1 Off**
REDACTED	REDACTED	No Overloads	East Peoria-Flint 138 kV – 103.6%

Table 1c: 2012 Voltage Results

Generator Outage:	Generator Outage:	Bus Voltages (p.u.) with Edwards Gen #1 On	Bus Voltages (p.u.) with Edwards Gen #1 Off
REDACTED	REDACTED	Edwards 3 138 kV - .979	Edwards 3 138 kV - .937
REDACTED	REDACTED	Keystone 138 kV - .976	Keystone 138 kV - .932
REDACTED	REDACTED	R. S. Wallace 138 kV - .974	R. S. Wallace 138 kV - .924
REDACTED	REDACTED	Cat Sub 1 138 kV - .974	Cat Sub 1 138 kV - .924
REDACTED	REDACTED	Cat Sub 2 138 kV - .985	Cat Sub 2 138 kV - .947
REDACTED	REDACTED	Hines 138 kV - .985	Hines 138 kV - .943
REDACTED	REDACTED	Eastern 138 kV - .996	Eastern 138 kV - .940
REDACTED	REDACTED	Cat Mapleton 138 kV - .971	Cat Mapleton 138 kV - .928
REDACTED	REDACTED	Fargo 138 kV - .976	Fargo 138 kV - .929
REDACTED	REDACTED	Radnor 138 kV - .977	Radnor 138 kV - .931
REDACTED	REDACTED	Pioneer 138 kV - .980	Pioneer 138 kV - .935
REDACTED	REDACTED	Alta 138 kV - .978	Alta 138 kV - .931
REDACTED	REDACTED	Cat Mossville 138 kV - .982	Cat Mossville 138 kV - .937
REDACTED	REDACTED	Hallock 138 kV - .992	Hallock 138 kV - .947
REDACTED	REDACTED	Spring Bay 138 kV - .983	Spring Bay 138 kV - .938
REDACTED	REDACTED	East Peoria 138 kV - .975	East Peoria 138 kV - .926
REDACTED	REDACTED	Flint 138 kV - .985	Flint 138 kV - .945

Table 1d: 2016 Voltage Results

Line Outage:	Generator Outage:	Bus Voltages (p.u.) with Edwards Gen #1 On	Bus Voltages (p.u.) with Edwards Gen #1 Off
REDACTED	REDACTED	Keystone 138 kV - > .96	Keystone 138 kV - .935
REDACTED	REDACTED	R. S. Wallace 138 kV - > .96	R. S. Wallace 138 kV - .940
REDACTED	REDACTED	Cat Sub 1 138 kV - > .96	Cat Sub 1 138 kV - .943
REDACTED	REDACTED	East Peoria 138 kV - > .96	East Peoria 138 kV - .943
REDACTED	REDACTED	Cat Mossville 138 kV - .948	Cat Mossville 138 kV - .925
REDACTED	REDACTED	Hallock 138 kV - .956	Hallock 138 kV - .925
REDACTED	REDACTED	Alta 138 kV - .948	Alta 138 kV - .931
REDACTED	REDACTED	Spring Bay 138 kV - .943	Spring Bay 138 kV - .936
REDACTED	REDACTED	Fargo 138 kV - .948	Fargo 138 kV - .936
REDACTED	REDACTED	R. S. Wallace - .946	R. S. Wallace - .938
REDACTED	REDACTED	Cat Sub 1 138 kV - .946	Cat Sub 1 138 kV - .938
REDACTED	REDACTED	Radnor 138 kV - .952	Radnor 138 kV - .941
REDACTED	REDACTED	Cat Mapleton 138 kV - .947	Cat Mapleton 138 kV - .932
REDACTED	REDACTED	Cat Sub 1 138 kV - .948	Cat Sub 1 138 kV - .933
REDACTED	REDACTED	R. S. Wallace 138 kV - .948	R. S. Wallace 138 kV - .933
REDACTED	REDACTED	East Peoria 138 kV - .949	East Peoria 138 kV - .934
REDACTED	REDACTED	Fargo 138 kV - .952	Fargo 138 kV - .936
REDACTED	REDACTED	Alta 138 kV - .954	Alta 138 kV - .937
REDACTED	REDACTED	Keystone 138 kV - .952	Keystone 138 kV - .937
REDACTED	REDACTED	Cat Mossville 138 kV - .960	Cat Mossville 138 kV - .938
REDACTED	REDACTED	Radnor 138 kV - .955	Radnor 138 kV - .940
REDACTED	REDACTED	Edwards 3 138 kV - .955	Edwards 3 138 kV .940
REDACTED	REDACTED	Spring Bay 138 kV - .961	Spring Bay 138 kV - .943
REDACTED	REDACTED	Pioneer 138 kV - .959	Pioneer 138 kV - .945

REDACTED	REDACTED	Hallock 138 kV - .971	Hallock 138 kV - .946
REDACTED	REDACTED	Flint 138 kV - .961	Flint 138 kV - .947
REDACTED	REDACTED	Cat Mapleton 138 kV - .946	Cat Mapleton 138 kV - .936
REDACTED	REDACTED	Cat Sub 1 138 kV - .947	Cat Sub 1 138 kV - .936
REDACTED	REDACTED	R. S. Wallace 138 kV - .947	R. S. Wallace 138 kV - .936
REDACTED	REDACTED	East Peoria 138 kV - .948	East Peoria 138 kV - .937
REDACTED	REDACTED	Keystone 138 kV - .950	Keystone 138 kV - .940
REDACTED	REDACTED	Edwards 3 138 kV - .953	Edwards 3 138 kV - .943
REDACTED	REDACTED	Spring Bay 138 kV - .967	Spring Bay 138 kV - .949
REDACTED	REDACTED	Flint 138 kV - .958	Flint 138 kV - .949
REDACTED	REDACTED	Fargo 138 kV - .951	Fargo 138 kV - .941
REDACTED	REDACTED	Pioneer 138 kV - .958	Pioneer 138 kV - .948
REDACTED	REDACTED	Radnor 138 kV - .954	Radnor 138 kV - .944
REDACTED	REDACTED	Alta 138 kV - .954	Alta 138 kV - .944
Generator Outage:	Generator Outage:	Bus Voltages (p.u.) with Edwards Gen #1 On	Bus Voltages (p.u.) with Edwards Gen #1 Off
REDACTED	REDACTED	Edwards 3 138 kV - .952	Edwards 3 138 kV - .922
REDACTED	REDACTED	Keystone 138 kV - .948	Keystone 138 kV - .916
REDACTED	REDACTED	R. S. Wallace 138 kV - .942	R. S. Wallace 138 kV - .907
REDACTED	REDACTED	Cat Sub 1 138 kV - .943	Cat Sub 1 138 kV - .908
REDACTED	REDACTED	Cat Sub 2 138 kV - .963	Cat Sub 2 138 kV - .930
REDACTED	REDACTED	Hines 138 kV - .964	Hines 138 kV - .924
REDACTED	REDACTED	Eastern 138 kV - .966	Eastern 138 kV - .924
REDACTED	REDACTED	Cat Mapleton 138 kV - .945	Cat Mapleton 138 kV - .913
REDACTED	REDACTED	Fargo 138 kV - .949	Fargo 138 kV - .911
REDACTED	REDACTED	Radnor 138 kV - .951	Radnor 138 kV - .913
REDACTED	REDACTED	Pioneer 138 kV - .956	Pioneer 138 kV - .917
REDACTED	REDACTED	Alta 138 kV - .952	Alta 138 kV - .912
REDACTED	REDACTED	Cat Mossville 138 kV - .958	Cat Mossville 138 kV - .914
REDACTED	REDACTED	Hallock 138 kV - .969	Hallock 138 kV - .923
REDACTED	REDACTED	Spring Bay 138 kV - .958	Spring Bay 138 kV - .921
REDACTED	REDACTED	East Peoria 138 kV - .944	East Peoria 138 kV - .910
REDACTED	REDACTED	Flint 138 kV - .958	Flint 138 kV - .930

Table 2a – Analysis of Alternatives on Thermal Issues - 2016 Summer Peak Case with System Upgrades

Transmission Outage:	Generator Outage:	System without Ameren Upgrades with Edwards Gen #1 On	System without Ameren Upgrades with Edwards Gen #1 Off	System with Ameren Upgrades with Edwards Gen #1 On	System with Ameren Upgrades with Edwards Gen #1 Off	System with Ameren Upgrades with Edwards Gen #1 Off and Load Response of approximately 100 MW	System with Ameren Upgrades with Edwards Gen #1 at 75 MW net	System with Ameren Upgrades with Edwards Gen #1 at 75 MW net and Load Response of approximately 100 MW
REDACTED	REDACTED	Tazewell-Flint 138 kV – 91.5%	Tazewell-Flint 138 kV – 103.2%	Tazewell - Flint reconductor 6/2015				
REDACTED	REDACTED	Latham-Kickapoo 138 kV line 1346 – 93.1%	Latham-Kickapoo 138 kV line 1346 – 105.1%	Latham - Kickapoo reconductor 6/2015				
REDACTED	REDACTED	Tazewell 345/138 kV Xfmr #1 - 115.9%	Tazewell 345/138 kV Xfmr #1 - 132.1%	Tazewell 345/138 kV Xfmr #1 - 114.4%	Tazewell 345/138 kV Xfmr #1 - 129.6%	Tazewell 345/138 kV Xfmr #1 - 116.5%	Tazewell 345/138 kV Xfmr #1 - 119.6%	Tazewell 345/138 kV Xfmr #1 - 106.7%
REDACTED	REDACTED	Tazewell 345/138 kV Xfmr #2 - 115.7%	Tazewell 345/138 kV Xfmr #2 - 131.9%	Tazewell 345/138 kV Xfmr #2 - 114.2%	Tazewell 345/138 kV Xfmr #2 - 129.4%	Tazewell 345/138 kV Xfmr #2 - 116.2%	Tazewell 345/138 kV Xfmr #2 - 119.4%	Tazewell 345/138 kV Xfmr #2 - 106.4%

Table 2b Analysis of Alternatives on Voltage Issues – 2016 Summer Peak Case with System Upgrades

Generator Outage:	Generator Outage:	System without Ameren Upgrades with Edwards Gen #1 On	System without Ameren Upgrades with Edwards Gen #1 Off	System with Ameren Upgrades with Edwards Gen #1 On	System with Ameren Upgrades with Edwards Gen #1 Off	System with Ameren Upgrades with Edwards Gen #1 Off and Load Response of approximately 100 MW	System with Ameren Upgrades with Edwards Gen #1 at 75 MW net	System with Ameren Upgrades with Edwards Gen #1 at 75 MW net and Load Response of approximately 100 MW
REDACTED	REDACTED	Edwards 3 138 kV - .952	Edwards 3 138 kV - .922	Edwards 3 138 kV - .961	Edwards 3 138 kV - .940	Edwards 3 138 kV - .947	Edwards 3 138 kV - .960	Edwards 3 138 kV - .962
REDACTED	REDACTED	Keystone 138 kV - .948	Keystone 138 kV - .916	Keystone 138 kV - .960	Keystone 138 kV - .939	Keystone 138 kV - .946	Keystone 138 kV - .959	Keystone 138 kV - .961
REDACTED	REDACTED	R. S. Wallace 138 kV - .942	R. S. Wallace 138 kV - .907	R. S. Wallace 138 kV - .953	R. S. Wallace 138 kV - .932	R. S. Wallace 138 kV - .939	R. S. Wallace 138 kV - .952	R. S. Wallace 138 kV - .954
REDACTED	REDACTED	Cat Sub 1 138 kV - .943	Cat Sub 1 138 kV - .908	Cat Sub 1 138 kV - .953	Cat Sub 1 138 kV - .932	Cat Sub 1 138 kV - .939	Cat Sub 1 138 kV - .952	Cat Sub 1 138 kV - .954
REDACTED	REDACTED	Cat Sub 2 138 kV - .963	Cat Sub 2 138 kV - .930	Cat Sub 2 138 kV - .974	Cat Sub 2 138 kV - .955	Cat Sub 2 138 kV - .961	Cat Sub 2 138 kV - .972	Cat Sub 2 138 kV - .975
REDACTED	REDACTED	Hines 138 kV - .964	Hines 138 kV - .924	Hines 138 kV - .979	Hines 138 kV - .956	Hines 138 kV - .963	Hines 138 kV - .977	Hines 138 kV - .980
REDACTED	REDACTED	Eastern 138 kV - .966	Eastern 138 kV - .924	Eastern 138 kV - .973	Eastern 138 kV - .951	Eastern 138 kV - .957	Eastern 138 kV - .971	Eastern 138 kV - .974
REDACTED	REDACTED	Cat Mapleton 138 kV - .945	Cat Mapleton 138 kV - .913	Cat Mapleton 138 kV - .954	Cat Mapleton 138 kV - .933	Cat Mapleton 138 kV - .940	Cat Mapleton 138 kV - .953	Cat Mapleton 138 kV - .955
REDACTED	REDACTED	Fargo 138 kV - .949	Fargo 138 kV - .911	Fargo 138 kV - .967	Fargo 138 kV - .945	Fargo 138 kV - .952	Fargo 138 kV - .966	Fargo 138 kV - .968
REDACTED	REDACTED	Radnor 138 kV - .951	Radnor 138 kV - .913	Radnor 138 kV - .969	Radnor 138 kV - .946	Radnor 138 kV - .953	Radnor 138 kV - .967	Radnor 138 kV - .969
REDACTED	REDACTED	Pioneer 138 kV - .956	Pioneer 138 kV - .917	Pioneer 138 kV - .972	Pioneer 138 kV - .950	Pioneer 138 kV - .957	Pioneer 138 kV - .971	Pioneer 138 kV - .973
REDACTED	REDACTED	Alta 138 kV - .952	Alta 138 kV - .912	Alta 138 kV - .969	Alta 138 kV - .947	Alta 138 kV - .954	Alta 138 kV - .968	Alta 138 kV - .970
REDACTED	REDACTED	Cat Mossville 138 kV - .958	Cat Mossville 138 kV - .914	Cat Mossville 138 kV - .974	Cat Mossville 138 kV - .952	Cat Mossville 138 kV - .959	Cat Mossville 138 kV - .972	Cat Mossville 138 kV - .975
REDACTED	REDACTED	Hallock 138 kV - .969	Hallock 138 kV - .923	Hallock 138 kV - .984	Hallock 138 kV - .963	Hallock 138 kV - .970	Hallock 138 kV - .983	Hallock 138 kV - .985
REDACTED	REDACTED	Spring Bay 138 kV - .958	Spring Bay 138 kV - .921	Spring Bay 138 kV - .969	Spring Bay 138 kV - .949	Spring Bay 138 kV - .955	Spring Bay 138 kV - .968	Spring Bay 138 kV - .970
REDACTED	REDACTED	East Peoria 138 kV - .944	East Peoria 138 kV - .910	East Peoria 138 kV - .954	East Peoria 138 kV - .933	East Peoria 138 kV - .940	East Peoria 138 kV - .953	East Peoria 138 kV - .955
REDACTED	REDACTED	Flint 138 kV - .958	Flint 138 kV - .930	Flint 138 kV - .966	Flint 138 kV - .949	Flint 138 kV - .955	Flint 138 kV - .965	Flint 138 kV - .967