SPP DISIS-2016-2 AFS EXECUTIVE SUMMARY

INTRODUCTION

Associated Electric Cooperative Inc. (AECI), through coordination with the Southwest Power Pool (SPP), has updated the analysis for generator interconnection requests (GIRs) within the DISIS-2016-2 Study Cycle (the "Study Cycle") for an Affected System Study (AFS) evaluation on the AECI transmission system. The restudy has been conducted to include the following updates:

- Withdraw of GI-059 (Osage County, Oklahoma) from the AECI GI queue
- Inclusion of GI-061 (Nodaway County, MO) and associated network upgrades from the AECI GI queue

The Study Cycle requests under evaluation are shown in Table 1. The results of the analysis, as well as network upgrades assigned, are included in this executive summary.

Table 1: Study Cycle Requests

Project #	TO	Capacity	Service Type	Fuel Type	POI
GEN-2016-149	WERE	302.0	ER	Wind	Stranger Creek 345kV
GEN-2016-150	WERE	302.0	ER	Wind	Stranger Creek 345kV
GEN-2016-157	KCPL	252.0	ER	Wind	West Gardner 345kV
GEN-2016-158	KCPL	252.0	ER	Wind	West Gardner 345kV
GEN-2016-174	WERE	302.0	ER	Wind	Stranger Creek 345kV
GEN-2016-176	WERE	302.0	ER	Wind	Stranger Creek 345kV
GEN-2016-091	AEP	303.6	ER	Wind	Gracemont-Lawton East Side 345kV
GEN-2016-100	OKGE	100.0	ER	Wind	Spring Creek-Sooner 345kV
GEN-2016-101	OKGE	195.0	ER	Wind	Spring Creek-Sooner 345kV
GEN-2016-118	OKGE	288.0	ER	Wind	Dover Switchyard 138 kV Line
GEN-2016-119	OKGE	600.0	ER	Wind	Spring Creek-Sooner 345kV
GEN-2016-128	OKGE	176.0	ER	Wind	Woodring 345kV
GEN-2016-133	AEP	187.5	ER	Wind	Riverside 345kV Substation
GEN-2016-134	AEP	187.5	ER	Wind	Riverside 345kV Substation
GEN-2016-137	AEP	187.5	ER	Wind	Riverside 345kV Substation
GEN-2016-138	AEP	187.5	ER	Wind	Riverside 345kV Substation
GEN-2016-141	AEP	350.0	ER	Wind	Riverside 345kV Substation
GEN-2016-142	AEP	350.0	ER	Wind	Riverside 345kV Substation
GEN-2016-143	AEP	175.0	ER	Wind	Riverside 345kV Substation
GEN-2016-144	AEP	175.0	ER	Wind	Riverside 345kV Substation
GEN-2016-145	AEP	175.0	ER	Wind	Riverside 345kV Substation
GEN-2016-146	AEP	175.0	ER	Wind	Riverside 345kV Substation

Project #	TO	Capacity	Service Type	Fuel Type	POI
GEN-2016-162	WERE	252.0	ER	Wind	Benton 345kV
GEN-2016-163	WERE	252.0	ER	Wind	Benton 345kV

Based on the information and results received from SPP, no AECI facilities were identified as impacts through the SPP study process.

ANALYSIS

Steady state analysis was performed to confirm the reliability impacts on the AECI system under a variety of system conditions and outages. AECI's transmission system must be capable of operating within the applicable normal ratings, emergency ratings, and voltage limits of AECI planning criteria. AECI is a member of SERC, one of eight Electric Reliability Organizations under the North American Electric Reliability Corporation (NERC). As a member of SERC, AECI develops its planning criteria consistent with NERC Reliability Planning Standards and the SERC planning criteria. The NERC TPL-001-4 Planning Standard Table I requires that, for normal and contingency conditions, line and equipment loading shall be within applicable thermal limits, voltage levels shall be maintained within applicable limits, all customer demands shall be supplied (except as noted), and stability of the network shall be maintained.

In evaluating further impacts of the Study Cycle projects, the following thermal and voltage limits were applied to the analysis for P0 or normal system conditions:

- Thermal Limits within Applicable Rating – Applicable Rating shall be defined as the Normal Rating. The thermal limit shall be 100% of Rating A.

- Voltage Limits within Applicable Rating – Applicable Rating shall have the meaning of Nominal Voltage. Voltage limits shall be set at plus or minus five percent (+/- 5%), 0.95 p.u. - 1.05 p.u. for systems operating at 60 kV or above on load serving buses.

The following thermal and voltage limits were applied to the analysis for contingency conditions P1 planning events:

- Thermal Limits within Applicable Rating – Applicable Rating shall be defined as the Emergency Rating. The thermal limit shall be 100% of Rating B.

- Voltage Limits within Applicable Rating – Applicable Rating shall have the meaning of Nominal Voltage. Voltage limits shall be set at plus five percent to minus ten percent (+5%/-10%), 0.90 p.u. – 1.05 p.u. for systems operating at 60 kV or above on load serving buses.

In order for the Study Cycle projects to have a thermal impact on the system, the Projects must cause a thermal violation and have a three percent (3%) or greater increase in flow on the facility based upon the rating of the facility.

RESULTS

Steady state analysis results showed new thermal violations on eleven (11) facilities due to the addition of the Study Cycle projects as shown in Table 2. Ten (10) of these facilities are AECI owned facilities.

Table 2: Steady State Results

Monitored Facility	Zone Name	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)
300097 5MARYVL 161.00 652560 CRESTON5 161.00 1	NW/WAPA-IA	22L	208	90.2	101.8
300120 5THMHILB1 161.00 300172 2TMHILL 69.000 2	CENTRAL	27S	150	99.4	102.9
300132 5THMHLB2 161.00 300172 2TMHILL 69.000 1	CENTRAL	27S	150	99.4	103.0
300179 2HAMBRG 69.000 300184 2NORTHB 69.000 1	NW	22H	35	98.0	103.9
		22S	35	98.6	105.5
300181 2LINDEN 69.000 300185 2PHELPS 69.000 1	NW	27S	35	92.5	101.0
300185 2PHELPS 69.000 300186 2ROCKPT 69.000 1	NW	22H	35	99.3	107.0
		22S	35	97.7	106.8
300387 2BEVIER 69.000 300400 2MACNLK 69.000 1	NORTHEAST	22W	51	95.6	103.9
		27W	51	96.1	104.5
300388 2AXTELL 69.000 300400 2MACNLK 69.000 1	NORTHEAST	22H	46	97.0	106.3
		22S	46	93.0	103.8
300388 2AXTELL 69.000 300401 2MACNTP 69.000 1	NORTHEAST	22H	46	90.9	100.1
		27S	46	97.4	107.9
300748 2NEOSAC 69.000 300758 2SWTWT 69.000 1	KAMO-MO	27S	44	94.8	100.8
300763 2WASHBRN 69.000 300824 2SELIGM 69.000 1	KAMO-MO	27S	51	95.4	100.4

The Maryville to Creston 161 kV line was reported as a new impact in the 2022 Light Load cases for the loss of the Maryville AECI/KCPL tie. The Maryville to Creston line is a tie-line with KCPL and is not owned by AECI; as a result, no mitigations are required.

The Thomas Hill 69/161 kV transformers #1 and #2 were reported as new impacts in the 2027 Summer Peak case for the loss of the other. Adjusting the transformer taps mitigates these overloads; as a result, no upgrades are required.

The Hamburg to Northboro 69 kV line was reported as a new impact in the 2022 Shoulder and 2022 Summer Peak case for the loss of the Rockport to Atchison 69 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Rebuild the 18-mile-long Hamburg to Northboro 69 kV line to 336 ACSR.

The Phelps to Rockport 69 kV line was reported as a new impact in the 2022 Shoulder case as well as the 2022 Summer Peak case for the loss of the Hamburg to Northboro 69 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Rebuild the 4.4-mile-long Phelps to Rockport 69 kV line to 336 ACSR.

The Linden to Phelps 69 kV line was reported as a new impact in the 2027 Summer Peak case for the loss of the Hamburg to Northboro 69 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Rebuild the 11.4-mile-long Linden to Phelps 69 kV line to 336 ACSR.

The Bevier to Macon Lake 69 kV line was reported as a new impact in the 2022 and 2027 Winter cases for the loss of the Thomas Hill to McCredie 345 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Rebuild the 4.136-mile-long Bevier to Macon Lake 69 kV line to 477 ACSR.

The Macon Lake to Axtell to Macon Tap 69 kV line was reported as a new impact in the 2022 Shoulder, as well as the 2022 and 2027 Summer Peak cases, for the loss of the Thomas Hill to Adair 161 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Rebuild the 2.2-mile-long Macon Lake to Axtell to Macon Tap 69 kV line to 477 ACSR.

The Neosho to Sweetwater 69 kV line was reported as a new impact in the 2027 Summer Peak cases for the loss of the Washburn to Seligman 69 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Upgrade 10.92-mile section of Neosho to Sweetwater 69 kV line to 336 ACSR.

The Washburn to Seligman 69 kV line was also reported as a new impact in the 2027 Summer Peak cases for the loss of the Neosho to Sweetwater 69 kV line. The following upgrade was evaluated in order to mitigate the overload:

- Add 0.08 p.u. series reactor on Washburn to Seligman 69 kV line

All upgrades listed above were able to mitigate the new impacts caused by the addition of the Study Cycle projects as shown in Table 3.

Table 3: Steady State Results with Upgrades

Monitored Facility	Zone Name	Season	Upgrades Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)	Upgrades Loading (%MVA)
300179 2HAMBRG 69.000 300184 2NORTHB 69.000 1	NW	22H	70	98.0	103.9	54.9
		22S	70	98.6	105.5	55.8
300181 2LINDEN 69.000 300185 2PHELPS 69.000 1	NW	27S	70	92.5	101.0	53.0
300185 2PHELPS 69.000 300186 2ROCKPT 69.000 1	NW	22H	70	99.3	107.0	55.7
		22S	70	97.7	106.8	55.4
300387 2BEVIER 69.000 300400 2MACNLK 69.000 1	NORTHEAST	22W	107	95.6	103.9	51.3
		27W	107	96.1	104.5	51.6
300388 2AXTELL 69.000 300400 2MACNLK 69.000 1	NORTHEAST	22H	88	97.0	106.3	58.2
		22S	88	93.0	103.8	56.9
300388 2AXTELL 69.000 300401 2MACNTP 69.000 1	NORTHEAST	22H	88	90.9	100.1	55.1
		27S	88	97.4	107.9	59.5
300748 2NEOSAC 69.000 300758 2SWTWT 69.000 1	KAMO-MO	27S	70	94.8	100.8	64.1
300763 2WASHBRN 69.000 300824 2SELIGM 69.000 1	KAMO-MO	27S	51	95.4	100.4	91.1

No additional constraints were reported with the inclusion of the identified upgrade. As a result, no additional upgrades were identified for the Study Cycle projects from steady state analysis.

Cost allocations for each of the remaining impacted facilities is discussed in the Cost Allocation section below.

COST ALLOCATION

Network upgrade costs were allocated to each of the Study Cycle projects based on the MW impact each project had on the constraint under the conditions reported as described in the steps below:

1. Determine the MW impact each Study Cycle project had on each constraint using the size of each request:

$$Project\ X\ MW\ Impact\ on\ Constraint\ 1 = DFAX\ (X) * MW\ (X) = X1$$

$$Project\ Y\ MW\ Impact\ on\ Constraint\ 1 = DFAX\ (Y) * MW\ (Y) = Y1$$

$$Project\ Z\ MW\ Impact\ on\ Constraint\ 1 = DFAX\ (Z) * MW\ (Z) = Z1$$

2. Determine the cost allocated to each Study Cycle project for each upgrade using the total cost of a given upgrade:

$$Project\ X\ Upgrade\ 1\ Cost\ Allocation\ (\$) = \frac{Network\ Upgrade\ 1\ Cost\ (\$) * X1}{X1 + Y1 + Z1}$$

AECI developed non-binding, good faith estimates of the timing and cost estimates for upgrades needed as a result of the addition of the Study Cycle projects as shown in Table 4.

Table 4: Network Upgrade Costs

ID	Option / Description		Cost*
1	Rebuild the 18-mile-long Hamburg to Northboro 69 kV line to 336 ACSR		$7,434,000
2	Rebuild the 4.4-mile-long Phelps to Rockport 69 kV line to 336 ACSR		$1,817,000
3	Rebuild the 11.4-mile-long Linden to Phelps 69 kV line to 336 ACSR		$4,708,000
4	Rebuild the 4.136-mile-long Bevier to Macon Lake 69 kV line to 477 ACSR		$2,938,000
5	Rebuild the 2.2-mile-long Macon Lake to Axtell to Macon Tap 69 kV line to 477 ACSR		$1,562,000
6	Upgrade the 10.92-mile section of Neosho to Sweetwater 69 kV line to 336 ASCR		$6,273,000
7	Add 0.08 p.u. series reactor on Washburn to Seligman 69 kV line		$675,000
	*Includes engineering and contingencies	Total Cost:	$25,407,000

The associated cost allocation of the network upgrades to each of the Study Cycle projects is provided below.

Study Cycle Project	POI	MW	Cost Allocation per Upgrade ID ($)							Total Cost
			1	2	3	4	5	6	7	
GEN-2016-149	Stranger Creek 345kV	302	$824,476	$200,821	$496,607	$251,368	$132,221	$0	$0	**$1,905,492**
GEN-2016-150	Stranger Creek 345kV	302	$824,476	$200,821	$496,607	$251,368	$132,221	$0	$0	**$1,905,492**
GEN-2016-157	West Gardner 345kV	252	$528,799	$129,793	$327,655	$236,319	$126,091	$0	$0	**$1,348,657**
GEN-2016-158	West Gardner 345kV	252	$528,799	$129,793	$327,655	$236,319	$126,091	$0	$0	**$1,348,657**
GEN-2016-174	Stranger Creek 345kV	302	$824,476	$200,821	$496,607	$251,368	$132,221	$0	$0	**$1,905,492**
GEN-2016-176	Stranger Creek 345kV	302	$824,476	$200,821	$496,607	$251,368	$132,221	$0	$0	**$1,905,492**
GEN-2016-091	Gracemont-Lawton East Side 345kV	303.6	$174,137	$42,867	$116,102	$77,828	$41,582	$281,032	$33,740	**$767,288**
GEN-2016-100	Spring Creek-Sooner 345kV	100	$69,826	$16,943	$47,165	$32,553	$16,740	$120,934	$12,155	**$316,316**
GEN-2016-101	Spring Creek-Sooner 345kV	195	$136,161	$33,040	$91,971	$63,478	$32,643	$235,821	$23,702	**$616,816**
GEN-2016-118	Dover Switchyard 138 kV Line	288	$188,638	$46,086	$128,492	$87,892	$45,289	$318,190	$32,006	**$846,594**
GEN-2016-119	Spring Creek-Sooner 345kV	600	$418,958	$101,660	$282,989	$195,315	$100,440	$725,602	$72,931	**$1,897,896**
GEN-2016-128	Woodring 345kV	176	$124,626	$30,649	$85,254	$58,009	$29,016	$189,194	$17,929	**$534,676**
GEN-2016-133	Riverside 345kV Substation	187.5	$129,450	$31,769	$86,044	$62,562	$35,672	$358,322	$41,675	**$745,494**
GEN-2016-134	Riverside 345kV Substation	187.5	$129,450	$31,769	$86,044	$62,562	$35,672	$358,322	$41,675	**$745,494**
GEN-2016-137	Riverside 345kV Substation	187.5	$129,450	$31,769	$86,044	$62,562	$35,672	$358,322	$41,675	**$745,494**
GEN-2016-138	Riverside 345kV Substation	187.5	$129,450	$31,769	$86,044	$62,562	$35,672	$358,322	$41,675	**$745,494**
GEN-2016-141	Riverside 345kV Substation	350	$241,640	$59,302	$160,615	$116,782	$66,588	$668,868	$77,793	**$1,391,588**
GEN-2016-142	Riverside 345kV Substation	350	$241,640	$59,302	$160,615	$116,782	$66,588	$668,868	$77,793	**$1,391,588**
GEN-2016-143	Riverside 345kV Substation	175	$120,820	$29,651	$80,308	$58,391	$33,294	$334,434	$38,896	**$695,794**
GEN-2016-144	Riverside 345kV Substation	175	$120,820	$29,651	$80,308	$58,391	$33,294	$334,434	$38,896	**$695,794**
GEN-2016-145	Riverside 345kV Substation	175	$120,820	$29,651	$80,308	$58,391	$33,294	$334,434	$38,896	**$695,794**
GEN-2016-146	Riverside 345kV Substation	175	$120,820	$29,651	$80,308	$58,391	$33,294	$334,434	$38,896	**$695,794**
GEN-2016-162	Benton 345kV	252	$240,896	$59,302	$163,827	$113,719	$53,091	$146,733	$2,334	**$779,902**
GEN-2016-163	Benton 345kV	252	$240,896	$59,302	$163,827	$113,719	$53,091	$146,733	$2,334	**$779,902**
Total Cost		**6028.6**	**$7,434,000**	**$1,817,000**	**$4,708,000**	**$2,938,000**	**$1,562,000**	**$6,273,000**	**$675,000**	**$25,407,000**