

SPP DISIS 2017-001 AFS STUDY REPORT

INTRODUCTION

Associated Electric Cooperative Inc. (AECI), through coordination with the Southwest Power Pool (SPP), has identified generator interconnection requests (GIRs) within the DISIS 2017-001 Study Cycle (the “Study Cycle”) for an Affected System Study (AFS) evaluation on the AECI transmission system (the “Study”). The full list of Study Cycle requests included in the Study is listed in Table 1.

Table 1: Study Cycle Requests Evaluated

Project #	CA	Capacity (MW)	Service Type	Fuel Type	POI	Cluster Group
GEN-2016-037	AEPW	300.0	ER	Wind	Chisholm-Gracemont 345kV	07 - Southwestern Oklahoma
GEN-2016-103	WAPA	240.0	ER	Wind	Fort Thompson-Leland Olds 345kV	15 - Eastern South Dakota
GEN-2016-159	NPPD	427.8	ER	Wind	Turtle Creek 345kV	09 - Nebraska
GEN-2016-172	SWPS	231.0	ER	Wind	Newhart 115kV	06 - South Texas Panhandle/New Mexico
GEN-2017-004	SUNC	201.6	ER	Wind	Elm Creek - Summit 345 kV	04 - Northwest Kansas
GEN-2017-005	WERE	190.0	ER	Wind	Marmaton - Litchfield 161 kV	08 - North Oklahoma/South Central Kansas
GEN-2017-007	SWPS	297.5	ER	Wind	Pleasant Hill 230 kV sub	06 - South Texas Panhandle/New Mexico
GEN-2017-008	NPPD	305.0	ER	Solar	Pauline 345kV Substation	09 - Nebraska
GEN-2017-009	WERE	302.5	ER	Wind	Neosho - Caney River 345 kV	08 - North Oklahoma/South Central Kansas
GEN-2017-010	WAPA	200.1	ER	Wind	Rhame 230 kV Sub	16 - Western North Dakota
GEN-2017-014	WAPA	300.0	ER/NR	Wind	Underwood - Philip Tap 230 kV	17 - Western South Dakota
GEN-2017-018	SUNC	190.0	ER/NR	Solar	Thistle 345 kV sub	03 - Spearville
GEN-2017-022	WERE	65.0	ER/NR	Solar	Altoona- NE Parson 138kV	08 - North Oklahoma/South Central Kansas
GEN-2017-026	SWPS	235.0	ER/NR	Wind	Tolk 230kV	06 - South Texas Panhandle/New Mexico
GEN-2017-027	OKGE	140.0	ER	Wind	Pooleville-Ratliff (Carter County) 138kV	14 - South Central Oklahoma
GEN-2017-030	KCPL	200.0	ER	Wind	Eastown - Iatan 345kV	13 - Northeast Kansas/Northwest Missouri
GEN-2017-033	AEPW	200.0	ER/NR	Wind	Oklunion 345 kV sub	06 - South Texas Panhandle/New Mexico
GEN-2017-039	SWPS	200.1	ER	Wind	Needmore 230 kV sub	06 - South Texas Panhandle/New Mexico
GEN-2017-040	OKGE	200.0	ER	Solar	Canadian River-Muskogee and Muskogee-Seminole 345kV	08 - North Oklahoma/South Central Kansas
GEN-2017-048	BEPC	300.0	ER	Wind	Neset 230 kV Substation	16 - Western North Dakota
GEN-2017-055	LES	228.3	ER/NR	Solar	Wagener 115 kV Sub	09 - Nebraska
GEN-2017-060	EDE	149.4	ER	Wind	LaRussell Energy Center 161kV	12 - Northwest Arkansas
GEN-2017-061	GRDA	101.5	ER/NR	Solar	GRDA1 to CLARMR 5 161kV line	08 - North Oklahoma/South Central Kansas
GEN-2017-064	WAPA	110.0	ER/NR	Solar	Underwood - Wayside 230 kV	17 - Western South Dakota
GEN-2017-065	AEPW	200.3	ER/NR	Solar	Oklunion 345 kV sub	06 - South Texas Panhandle/New Mexico
GEN-2017-071	OKGE	124.7	ER	Solar	Greenwood 138kV sub	08 - North Oklahoma/South Central Kansas
GEN-2017-072	OKGE	52.2	ER	Solar	Greenwood 138kV sub	08 - North Oklahoma/South Central Kansas
GEN-2017-073	GRDA	72.5	ER	Solar	Dry Gulch 161kV sub	08 - North Oklahoma/South Central Kansas
GEN-2017-074	AEPW	72.5	ER	Solar	Pryor Junction 138kV sub	08 - North Oklahoma/South Central Kansas

Project #	CA	Capacity (MW)	Service Type	Fuel Type	POI	Cluster Group
GEN-2017-075	OKGE	200.0	ER	Solar	Hugo-Sunnyside 345 kV	14 - South Central Oklahoma
GEN-2017-076	AEPW	52.2	ER	Solar	Chamber Springs 161kV sub	12 - Northwest Arkansas
GEN-2017-077	AEPW	124.7	ER	Solar	Explorer Claremore Tap EXCLART4	08 - North Oklahoma/South Central Kansas
GEN-2017-078	SWPS	220.0	ER/NR	Wind	Eddy County-Tolk (Crossroads) 345kV	06 - South Texas Panhandle/New Mexico
GEN-2017-080	SWPS	525.0	ER	Solar	Tolk 230 kV substation	06 - South Texas Panhandle/New Mexico
GEN-2017-082	EDE	149.4	ER	Wind	Asbury Plant 161 kV	12 - Northwest Arkansas
GEN-2017-086	WERE	150.0	ER/NR	Wind	Viola 345kV	08 - North Oklahoma/South Central Kansas
GEN-2017-090	KCPL	150.0	ER	Solar	Adrian 161 kV sub	13 - Northeast Kansas/Northwest Missouri
GEN-2017-092	OKGE	200.0	ER	Solar	Canadian River-Muskogee and Muskogee-Seminole 345kV	08 - North Oklahoma/South Central Kansas
GEN-2017-094	WAPA	200.0	ER/NR	Wind	Fort Thompson-Huron 230 kV	15 - Eastern South Dakota
GEN-2017-097	WAPA	128.0	ER	Solar	Underwood 115 kV Sub	17 - Western South Dakota
GEN-2017-104	SWPS	240.0	ER/NR	Solar	Hobbs 230kV Substation	06 - South Texas Panhandle/New Mexico

The following key assumptions were included in the basis of the Study.

- AECI GI-083 network upgrades
 - Upgrade Kingdom City 161/69 kV transformers #2 and #3 to 84/96 MVA units
 - Rebuild Kingdom City – Williamsburg 161 kV, 11.89 miles, utilize 1590 ACSR conductor to be designed for 100°C
 - Rebuild Williamsburg – Montgomery City 161 kV, 17.84 miles, utilize 1590 ACSR conductor to be designed for 100°C
 - Upgrade Thomas Hill 345/161 kV transformer #4 to 625/712 MVA unit
 - Thomas Hill – Bevier area upgrades:
 - Move Thomas Hill – Meadville 161 kV line to Thomas Hill Bus #3
 - Move Thomas Hill – Salisbury 161 kV line to Thomas Hill Bus #4
 - Add Thomas Hill Bus #2 – Bevier 161 kV line
 - Add Bevier 161/69 kV transformer rated for 112/127 MVA
 - Remove Thomas Hill – Bevier 69 kV line
 - Rebuild Reform-Chamois 69kV, 4.00 miles, utilize 795 ACSR conductor to be designed for 100°C
 - Rebuild Bevier - Macon Lake 69 kV, 4.14 miles, utilize 477 ACSR conductor to be designed for 100°C (Contingent facility)

- Rebuild Axtell - Macon Lake 69 kV, 1.15 miles, utilize 477 ACSR conductor to be designed for 100°C (Contingent facility)
- Rebuild Axtell - Macon Tap 69 kV, 1.05 miles, utilize 477 ACSR conductor to be designed for 100°C (Contingent facility)
- MISO J1488 and J1490 preliminary network upgrade
 - New J1145 – Montgomery 345 kV double circuit (2 and 3, Ameren facilities)

The listed network upgrades assigned to GI-083, J1488, and J1490 were included in the Study models to resolve convergence issues for outage conditions near and at their interconnection point on the system in order to determine the impact of the Study Cycle on the AECI system. These network upgrade assumptions and their associated impacts to later queue requests will be revisited in the next iteration of analysis based on the status of GI-083, J1488, and/or J1490 within their respective queues.

The results of the analysis for the Study Cycle, as well as network upgrades assigned, are included below.

INPUTS AND ASSUMPTIONS

Each of the SERC member transmission planners is responsible for submitting system modeling data to SERC for development of the power flow models. Power flow analysis utilized the latest Long-Term Working Group (LTWG) models as developed by SERC Reliability Corporation (SERC). Each of the power flow models for the steady state analysis was modified to include appropriate higher-queued generation interconnection requests at the level of dispatch consistent with requirements of the service type requested as defined in AECI's GI Study Guidelines document. Modeling parameters in the SPP DISIS 2017-001 steady state models were referenced for each of the Study Cycle requests.

Full details of the inputs and assumptions are provided in Appendix A.

METHODOLOGY

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 the 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 under P1 and P2EHV 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 negative impact (i.e. criteria violation) on the system, the Study Cycle 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.

In order for the Project to have a negative voltage impact on the system, the Project must cause a voltage violation and have a two percent (2%) or greater change in the voltage.

System upgrades are required for constraints resulting from the addition of the Study Cycle under P0, P1, P2.1, P2.2 (EHV only), and P2.3 (EHV only) system conditions. All improvements were developed and studied in coordination with AECEI.

STEADY STATE ANALYSIS RESULTS

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

Table 2: Steady State Constraints for the Study Cycle

Constraint ID	Event	Monitored Facility	Contingency	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)	
NU01	P1	300203 2KIDDER 69.000 300215 2MABELTP 69.000 1	FROM BUS 300107 [5OSBORN 161.00] TO BUS 301564 [5FAIRPTB1 161.00] CKT 1	25H	35	87.7	101.2	
NU02		300206 2MABEL 69.000 300215 2MABELTP 69.000 1		25H	35	87.6	100.9	
NU03		300260 2MIDWAY 69.000 300264 2SAVANH 69.000 1	FROM BUS 300073 [5GENTRY 161.00] TO BUS 300076 [5FAIRPTB2 161.00] CKT 1	25L	35	98.7	101.9	
NU08		300251 2FLGGSP 69.000 300257 2KINGCT 69.000 1*		25L	35	97.2	100.6	
NU09		300251 2FLGGSP 69.000 300264 2SAVANH 69.000 1*		25L	35	99.4	102.8	
NU07		301251 2VANDSR 69.000 301255 2MORLEY 69.000 1	FROM BUS 300075 [5ESSEX 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT 1 FROM BUS 345588 [5RCHLND 1 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT 1 FROM BUS 345790 [5STODDARD 1 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT Z	25S	35	99.3	103.0	
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 300038 [7ESSEX 345.00] CKT 1 FROM BUS 300075 [5ESSEX 161.00] TO BUS 505434 [IDALIA 5 161.00] CKT 1 FROM BUS 300075 [5ESSEX 161.00] TO BUS 301533 [5ESSEXGSU1 161.00] CKT 1 FROM BUS 300075 [5ESSEX 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT 1	30S	35	105.4	110.4	
NU04		P2EHV	300121 5MORLEY 161.00 301255 2MORLEY 69.000 1	FROM BUS 300038 [7ESSEX 345.00] TO BUS 301407 [7WNWMADRID1A345.00] CKT 1 FROM BUS 300038 [7ESSEX 345.00] TO BUS 344974 [7LUTESVIL 345.00] CKT 1 FROM BUS 301407 [7WNWMADRID1A345.00] TO BUS 301416 [7WNWMADRID1B345.00] CKT Z1	25S	56	110.3	115.4
				FROM BUS 300075 [5ESSEX 161.00] TO BUS 300038 [7ESSEX 345.00] CKT 1 FROM BUS 300075 [5ESSEX 161.00] TO BUS 505434 [IDALIA 5 161.00] CKT 1	30S	56	101.2	106.4
	FROM BUS 300075 [5ESSEX 161.00] TO BUS 301533 [5ESSEXGSU1 161.00] CKT 1			30W	63	96.0	101.2	

Constraint ID	Event	Monitored Facility	Contingency	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT 1				
NU05		300740 7SPORTSMAN 345.00 300741 5SPORTSMAN 161.00 1	FROM BUS 300741 [5SPORTSMAN 161.00] TO BUS 300740 [7SPORTSMAN 345.00] CKT 2	25H	500	97.1	101.8
			FROM BUS 300739 [7BLACKBERRY 345.00] TO BUS 300740 [7SPORTSMAN 345.00] CKT 1	25L	500	101.5	106.2
NU06		300740 7SPORTSMAN 345.00 300741 5SPORTSMAN 161.00 2	FROM BUS 300739 [7BLACKBERRY 345.00] TO BUS 300740 [7SPORTSMAN 345.00] CKT 1	25H	500	97.1	101.8
			FROM BUS 300741 [5SPORTSMAN 161.00] TO BUS 300740 [7SPORTSMAN 345.00] CKT 1	25L	500	101.5	106.2
NU07		301251 2VANDSR 69.000 301255 2MORLEY 69.000 1	FROM BUS 300038 [7ESSEX 345.00] TO BUS 301407 [7WNWMADRID1A345.00] CKT 1	25S	35	106.0	113.6
			FROM BUS 300038 [7ESSEX 345.00] TO BUS 344974 [7LUTESVIL 345.00] CKT 1				
			FROM BUS 301407 [7WNWMADRID1A345.00] TO BUS 301416 [7WNWMADRID1B345.00] CKT Z1				
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 300038 [7ESSEX 345.00] CKT 1	30S	35	118.1	125.5
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 505434 [IDALIA 5 161.00] CKT 1				
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 301533 [5ESSEXGSU1 161.00] CKT 1				
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT 1				
			FROM BUS 300075 [5ESSEX 161.00] TO BUS 345791 [5STODDARD 2 161.00] CKT 1				
NU10	P1	300293 2CAMRNJ 69.000 300312 2TURNEY 69.000 1*	FROM BUS 300107 [5OSBORN 161.00] TO BUS 301310 [5REX 161.00] CKT 1	25H	35	83.4	100.2
NU11		300101 5MORGAN 161.00 300782 2MORGAN 69.000 1	FROM BUS 300774 [2EUDORA 69.000] TO BUS 300788 [2SLAGLE 69.000] CKT 1	25L	56	105.2	108.3

*Adverse impact with the inclusion of the first round of network upgrades applied for the Project

CONTINGENT FACILITY RESULTS

Contingent Facilities are those facilities identified that are the responsibility of higher-queued generators or are included in the Transmission Provider’s transmission expansion plan and that if not included in the Study would otherwise be the responsibility of the Study Cycle requests as necessary to interconnect to the transmission system.

Twelve (12) facilities were reported as Contingent Facilities with the addition of the Study Cycle requests. The most severe constraints are shown in Table 3.

Table 3: Steady State Contingent Constraints for the Study Cycle

Constraint ID	Event	Monitored Facility	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)	Contingent Generator(s)
CF01	P2EHV	300042 7HUBEN 345.00 300088 5HUBEN 161.00 1	25S	392	100.8	105.8	GI-085
			25W	446	99.7	104.0	GI-085
			30S	392	104.6	108.9	GI-085
			30W	446	106.0	110.1	GI-085
CF02		300045 7MORGAN 345.00 301622 5MORGANXF2 161.00 2	25H	400	108.5	113.8	GI-085
			25S	400	104.2	107.4	GI-085
			25W	456	102.4	108.9	GI-085
			30W	456	107.7	113.1	GI-085
CF03	P1	300126 5MOBTAP 161.00 345221 5MOBERLY 1 161.00 Z1	25S	372	108.9	112.4	GI-092
CF04		P2EHV	300173 2GOBKNOB 69.000 301218 2PBSOUTH 69.000 1	25L	35	109.3	115.3
	25L			35	110.6	116.4	MISO DPP 2019
CF05	P1	300193 2AVLON 69.000 300199 2HALE 69.000 1	25S	35	111.0	115.9	MISO DPP 2019
CF06		300194 2CHILLI 69.000 300195 2CHILLR 69.000 1	25S	35	100.3	104.8	MISO DPP 2019
			30S	35	102.4	106.0	MISO DPP 2019
CF07		P2EHV	300199 2HALE 69.000 300201 2INGROV 69.000 1	25S	35	123.5	127.4
	25S			35	97.1	100.2	MISO DPP 2019
CF08	P1	300327 2ELM 69.000 300336 2HOLDEN 69.000 1	25S	51	105.5	110.2	MISO DPP 2019
			30S	51	109.0	113.2	MISO DPP 2019
CF09	P0	300774 2EUDORA 69.000 300788 2SLAGLE 69.000 1	25H	51	106.3	110.4	GI-088
			25S	51	102.3	107.3	GI-088
			30S	51	102.4	106.9	GI-088
	P2EHV		25H	51	132.8	138.8	GI-088
			25L	51	119.0	127.3	GI-088
			25S	51	115.1	121.3	GI-088
			25W	72	96.4	102.5	GI-088
			30S	51	115.6	121.1	GI-088

Constraint ID	Event	Monitored Facility	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)	Contingent Generator(s)
			30W	72	98.3	104.3	GI-088
CF10	P1	301168 2MANSFL 69.000 301174 2SEYMOR 69.000 1	25L	35	117.1	123.1	GI-085
	P2EHV		25L	35	96.0	101.2	GI-085
CF11	P1	301209 2HARVEL 69.000 301218 2PBSOUTH 69.000 1	25L	35	105.4	111.3	GI-084
	P2EHV		25L	35	106.6	112.5	GI-084
CF12	P1	300115 5STFRANB2 161.00 338202 5JIM HILL% 161.00 1	25S	247	126.3	129.9	MISO DPP 2019
			30S	247	124.2	128.1	MISO DPP 2019
			30W	302	111.8	115.6	MISO DPP 2019
	P2EHV		25S	247	126.3	129.9	MISO DPP 2019
			30S	247	124.2	128.1	MISO DPP 2019
			30W	302	111.8	115.6	MISO DPP 2019

NETWORK UPGRADES

Transmission upgrades were evaluated to mitigate the impacts reported from the analyses as a result of the Study Cycle projects. The upgrades shown in Table 4 were evaluated in order to mitigate the reported steady state constraints for the Study Cycle as listed in Table 2.

Table 4: Network Upgrades for the Study Cycle Constraints

Constraint ID	Monitored Facility	Network Upgrade
NU01	300203 2KIDDER 69.000 300215 2MABELTP 69.000 1	Rebuild 4.4-mile-long Kidder to Mabel Tap 69 kV line to 336 ACSR at 100C
NU02	300206 2MABEL 69.000 300215 2MABELTP 69.000 1	Rebuild 5.06-mile-long Mabel to Mabel Tap 69 kV line to 336 ACSR at 100C
NU03	300260 2MIDWAY 69.000 300264 2SAVANH 69.000 1	Rebuild 9.6-mile-long Midway to Savannah 69 kV line to 336 ACSR at 100C
NU04	300121 5MORLEY 161.00 301255 2MORLEY 69.000 1	Replace Morley 69/161 kV transformer with 84/95 MVA transformer
NU05	300740 7SPORTSMAN 345.00 300741 5SPORTSMAN 161.00 1	Replace Sportsman 161/345 kV transformer #1 with 625/712 MVA transformer
NU06	300740 7SPORTSMAN 345.00 300741 5SPORTSMAN 161.00 2	Replace Sportsman 161/345 kV transformer #2 with 625/712 MVA transformer
NU07	301251 2VANDSR 69.000 301255 2MORLEY 69.000 1	Rebuild 2.9-mile-long Vanduser-Morley 69 kV line to 336 ACSR at 100C
NU08	300251 2FLGGSP 69.000 300257 2KINGCT 69.000 1	Rebuild 9.76-mile-long Flag Springs-King City 69 kV line to 336 ACSR at 100C
NU09	300251 2FLGGSP 69.000 300264 2SAVANH 69.000 1	Rebuild 6.69-mile-long Flag Springs-Savannah 69 kV line to 336 ACSR at 100C
NU10	300293 2CAMRNJ 69.000 300312 2TURNEY 69.000 1	Rebuild 7.68-mile-long Cameron-Turney 69 kV line to 336 ACSR at 100C
NU11	300101 5MORGAN 161.00 300782 2MORGAN 69.000 1	Adjustment of transformer taps able to mitigate overload, no upgrade evaluated

The upgrades shown in Table 6 were evaluated in order to mitigate the reported steady state contingent constraints for the Study Cycle as listed in Table 3.

Table 5: Network Upgrades for the Study Cycle Contingent Constraints

Constraint ID	Monitored Facility	Network Upgrade
CF01	300042 7HUBEN 345.00 300088 5HUBEN 161.00 1	Contingent on GI-085 Reconfigure Morgan 345 kV to breaker-and-a-half
CF02	300045 7MORGAN 345.00 301622 5MORGANXF2 161.00 2	Contingent on GI-085 Reconfigure Morgan 345 kV to breaker-and-a-half
CF03	300126 5MOBTAP 161.00 345221 5MOBERLY 1 161.00 Z1	Contingent on GI-092 Rebuild 0.02 mile-long line to double bundle 1192 ACSR at 100C
CF04	300173 2GOBKNOB 69.000 301218 2PBSOUTH 69.000 1	Contingent on MISO DPP 2019 Rebuild 4.36 mile-long line to 336 ACSR at 100C
CF05	300193 2AVLON 69.000 300199 2HALE 69.000 1	Contingent on MISO DPP 2019 Rebuild 10.23 mile-long line to 336 ACSR at 100C
CF06	300194 2CHILLI 69.000 300195 2CHILLR 69.000 1	Contingent on MISO DPP 2019 Rebuild 2.05 mile-long line to 336 ACSR at 100C
CF07	300199 2HALE 69.000 300201 2INGROV 69.000 1	Contingent on MISO DPP 2019 Rebuild 10.9 mile-long 4/0 segment of line to 336 ACSR at 100C
CF08	300327 2ELM 69.000 300336 2HOLDEN 69.000 1	Contingent on MISO DPP 2019 Use of Holden Operating Guide unable to mitigate overload Uprate 3.1 mile-long segment to 336 ACSR from 75C to 100C
CF09	300774 2EUDORA 69.000 300788 2SLAGLE 69.000 1	Contingent on GI-088 Rebuild 9.9 mile-long line to 795 ACSR at 100C

Constraint ID	Monitored Facility	Network Upgrade
CF10	301168 2MANSFL 69.000 301174 2SEYMOR 69.000 1	Contingent on GI-085 Reconductor 4.2 mile-long line to 336 ACSR at 75C
CF11	301209 2HARVEL 69.000 301218 2PBSOUTH 69.000 1	Contingent on GI-084 Uprate 2.34 mile-long 4/0 segment of line to 100C
CF12	300115 5STFRANB2 161.00 338202 5JIM HILL% 161.00 1	Contingent on MISO DPP 2019 Use of St. Francis Operating Guide unable to mitigate overload Rebuild 9.93 mile-long line to 1192 ACSR at 100C Replace jumpers at St. Francis with 1192 ACSR at 100C Replace disconnect switches at St. Francis 161 kV bus

Simulations were performed on each of the scenarios with the identified network upgrade and contingent network upgrades included. Results from the simulations found that the network upgrades were able to mitigate the reported overload conditions as shown in Table 6 below.

Table 6: Steady State Results with Upgrades

Constraint ID	Event	Monitored Facility	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)	Mitigation Loading (%MVA)	
NU01	P1	300203 2KIDDER 69.000 300215 2MABELTP 69.000 1	25H	35	87.7	101.2	51.1	
NU02		300206 2MABEL 69.000 300215 2MABELTP 69.000 1	25H	35	87.6	100.9	51.1	
NU03		300260 2MIDWAY 69.000 300264 2SAVANH 69.000 1	25L	35	98.7	101.9	52.8	
NU08		300251 2FLGGSP 69.000 300257 2KINGCT 69.000 1*	25L	35	97.2	100.6	53.6	
NU09		300251 2FLGGSP 69.000 300264 2SAVANH 69.000 1*	25L	35	99.4	102.8	54.3	
NU07		301251 2VANDSR 69.000 301255 2MORLEY 69.000 1	25S	35	99.3	103.0	60.8	
			30S	35	105.4	110.4	64.7	
NU04		300121 5MORLEY 161.00 301255 2MORLEY 69.000 1	25S	56	110.3	115.4	81.9	
			30S	56	101.2	106.4	88.8	
		30W	63	96.0	101.2	77.2		
NU05	P2EHV	300740 7SPORTSMAN 345.00 300741 5SPORTSMAN 161.00 1	25H	500	97.1	101.8	83.4	
			25L	500	101.5	106.2	86.9	
NU06		300740 7SPORTSMAN 345.00 300741 5SPORTSMAN 161.00 2	25H	500	97.1	101.8	83.4	
			25L	500	101.5	106.2	86.9	
NU07		301251 2VANDSR 69.000 301255 2MORLEY 69.000 1	25S	35	106.0	113.6	66.4	
			30S	35	118.1	125.5	73.2	
NU10		P1	300293 2CAMRNJ 69.000 300312 2TURNEY 69.000 1*	25H	35	83.4	100.2	52.3
NU11		P1	300101 5MORGAN 161.00 300782 2MORGAN 69.000 1	25L	56	105.2	108.3	91.5
CF01		P2EHV	300042 7HUBEN 345.00 300088 5HUBEN 161.00 1	25S	392	100.8	105.8	88.9
	25W			446	99.7	104.0	91.0	
	30S			392	104.6	108.9	90.5	
	30W			446	106.0	110.1	96.0	
CF02	300045 7MORGAN 345.00 301622 5MORGANXF2 161.00 2		25H	400	108.5	113.8	67.5	
			25S	400	104.2	107.4	72.9	

Constraint ID	Event	Monitored Facility	Season	Rating (MVA)	Base Loading (%MVA)	Project Loading (%MVA)	Mitigation Loading (%MVA)	
			25W	456	102.4	108.9	66.9	
			30W	456	107.7	113.1	73.4	
CF03	P1	300126 5MOBTAP 161.00 345221 5MOBERLY 1 161.00 Z1	25S	372	108.9	112.4	85.2	
CF04		P2EHV	300173 2GOBKNOB 69.000 301218 2PBSOUTH 69.000 1	25L	35	109.3	115.3	60.1
				25L	35	110.6	116.4	60.7
CF05	P1	300193 2AVLON 69.000 300199 2HALE 69.000 1	25S	35	111.0	115.9	70.3	
CF06		P1	300194 2CHILLI 69.000 300195 2CHILLR 69.000 1	25S	35	100.3	104.8	52.5
				30S	35	102.4	106.0	53.1
CF07	P2EHV	300199 2HALE 69.000 300201 2INGROV 69.000 1	25S	35	123.5	127.4	74.8	
				25S	35	97.1	100.2	59.1
CF08	P1	300327 2ELM 69.000 300336 2HOLDEN 69.000 1	25S	51	105.5	110.2	81.4	
				30S	51	109.0	113.2	83.6
CF09	P0	300774 2EUDORA 69.000 300788 2SLAGLE 69.000 1	25H	51	106.3	110.4	48.9	
				25S	51	102.3	107.3	47.4
				30S	51	102.4	106.9	47.2
	P2EHV			25H	51	132.8	138.8	56.0
				25L	51	119.0	127.3	48.9
				25S	51	115.1	121.3	51.6
				25W	72	96.4	102.5	50.0
				30S	51	115.6	121.1	51.5
	30W	72	98.3	104.3	51.0			
CF10	P1 P2EHV	301168 2MANSFL 69.000 301174 2SEYMOR 69.000 1	25L	35	117.1	123.1	92.8	
		25L	35	96.0	101.2	76.6		
CF11	P1 P2EHV	301209 2HARVEL 69.000 301218 2PBSOUTH 69.000 1	25L	35	105.4	111.3	88.7	
		25L	35	106.6	112.5	89.6		
CF12	P1	300115 5STFRANB2 161.00 338202 5JIM HILL% 161.00 1	25S	247	126.3	129.9	87.8	
				30S	247	124.2	128.1	86.5
				30W	302	111.8	115.6	77.9
	P2EHV			25S	247	126.3	129.9	87.8
				30S	247	124.2	128.1	86.5
				30W	302	111.8	115.6	77.9

*Adverse impact with the inclusion of network upgrades from the new Project impacts

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 7.

Table 7: Network Upgrade Costs

ID	Option / Description	Current Cost	Year In Service
NU01	Rebuild 4.4-mile-long Kidder to Mabel Tap 69 kV line to 336 ACSR at 100C	\$2,042,000	2025
NU02	Rebuild 5.06-mile-long Mabel to Mabel Tap 69 kV line to 336 ACSR at 100C	\$2,348,000	2025
NU03	Rebuild 9.6-mile-long Midway to Savannah 69 kV line to 336 ACSR at 100C	\$4,455,000	2025
NU04	Replace Morley 69/161 kV transformer with 84/95 MVA transformer	\$2,929,000	2025
NU05	Replace Sportsman 161/345 kV transformer #1 with 625/712 MVA transformer	\$6,500,000	2025
NU06	Replace Sportsman 161/345 kV transformer #2 with 625/712 MVA transformer	\$6,500,000	2025
NU07	Rebuild 2.9-mile-long Vanduser-Morley 69 kV line to 336 ACSR at 100C	\$1,022,000	2025
NU08	Rebuild 9.76-mile-long Flag Springs-King City 69 kV line to 336 ACSR at 100C	\$4,530,000	2025
NU09	Rebuild 6.69-mile-long Flag Springs-Savannah 69 kV line to 336 ACSR at 100C	\$3,105,000	2025
NU10	Rebuild 7.68-mile-long Cameron-Turney 69 kV line to 336 ACSR at 100C	\$3,564,000	2025
Total Cost:		\$36,995,000	

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

COST ALLOCATION

Network upgrade costs are allocated to each of the Study Cycle projects based on the worst MW impact¹ each project had on the constraint and 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:

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

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

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

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

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

¹ All negative impacts > 0 MW.

The associated cost allocation of the network upgrades to each of the Study Cycle projects is provided in Table 8².

² Associated is exploring business practice updates to include a process to remove certain “de minimis” contributions from cost allocation. A future update of this study may remove cost allocation from some projects.

Table 8: Network Upgrade Cost Allocation

Project	NU01	NU02	NU03	NU04	NU05	NU06	NU07	NU08	NU09	NU10	Total Cost
G16-037	\$0	\$0	\$0	\$0	\$68,800	\$68,800	\$0	\$0	\$0	\$0	\$137,600
G16-103	\$186,343	\$214,267	\$457,768	\$276,172	\$0	\$0	\$95,302	\$465,474	\$319,050	\$318,109	\$2,332,484
G16-159	\$380,001	\$436,945	\$930,068	\$467,663	\$0	\$0	\$161,702	\$945,726	\$648,229	\$661,533	\$4,631,867
G16-172	\$0	\$0	\$0	\$0	\$29,544	\$29,544	\$0	\$0	\$0	\$0	\$59,089
G17-004	\$0	\$0	\$0	\$58,914	\$0	\$0	\$22,654	\$0	\$0	\$0	\$81,568
G17-005	\$0	\$0	\$0	\$0	\$98,040	\$98,040	\$0	\$0	\$0	\$0	\$196,081
G17-007	\$0	\$0	\$0	\$0	\$39,362	\$39,362	\$0	\$0	\$0	\$0	\$78,723
G17-008	\$232,218	\$267,017	\$367,289	\$256,253	\$0	\$0	\$89,967	\$373,472	\$255,989	\$417,934	\$2,260,139
G17-009	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
G17-010	\$151,059	\$173,696	\$381,664	\$244,911	\$0	\$0	\$83,944	\$388,089	\$266,008	\$254,973	\$1,944,344
G17-014	\$225,185	\$258,930	\$545,539	\$332,662	\$0	\$0	\$114,397	\$554,723	\$380,224	\$386,110	\$2,797,770
G17-018	\$0	\$0	\$0	\$4,905	\$0	\$0	\$2,669	\$0	\$0	\$0	\$7,574
G17-022	\$0	\$0	\$0	\$0	\$20,640	\$20,640	\$0	\$0	\$0	\$0	\$41,280
G17-026	\$0	\$0	\$0	\$0	\$31,611	\$31,611	\$0	\$0	\$0	\$0	\$63,221
G17-027	\$0	\$0	\$0	\$0	\$67,918	\$67,918	\$0	\$0	\$0	\$0	\$135,836
G17-030	\$97,645	\$112,277	\$0	\$137,767	\$0	\$0	\$50,968	\$0	\$0	\$197,857	\$596,515
G17-033	\$0	\$0	\$0	\$0	\$51,159	\$51,159	\$0	\$0	\$0	\$0	\$102,318
G17-039	\$0	\$0	\$0	\$0	\$26,916	\$26,916	\$0	\$0	\$0	\$0	\$53,832
G17-040	\$0	\$0	\$0	\$0	\$157,888	\$157,888	\$0	\$0	\$0	\$0	\$315,775
G17-048	\$228,412	\$262,640	\$586,757	\$379,736	\$0	\$0	\$129,696	\$596,635	\$408,952	\$383,229	\$2,976,056
G17-055	\$212,612	\$244,472	\$383,788	\$221,602	\$0	\$0	\$77,573	\$390,249	\$267,488	\$381,540	\$2,179,323
G17-060	\$0	\$0	\$0	\$0	\$40,193	\$40,193	\$0	\$0	\$0	\$0	\$80,385
G17-061	\$0	\$0	\$0	\$0	\$2,006,300	\$2,006,300	\$0	\$0	\$0	\$0	\$4,012,600
G17-064	\$78,073	\$89,772	\$177,805	\$111,884	\$0	\$0	\$38,749	\$180,799	\$123,925	\$134,882	\$935,889
G17-065	\$0	\$0	\$0	\$0	\$51,236	\$51,236	\$0	\$0	\$0	\$0	\$102,472
G17-071	\$0	\$0	\$0	\$0	\$78,919	\$78,919	\$0	\$0	\$0	\$0	\$157,839
G17-072	\$0	\$0	\$0	\$0	\$33,036	\$33,036	\$0	\$0	\$0	\$0	\$66,072
G17-073	\$0	\$0	\$0	\$0	\$1,458,704	\$1,458,704	\$0	\$0	\$0	\$0	\$2,917,409



Project	NU01	NU02	NU03	NU04	NU05	NU06	NU07	NU08	NU09	NU10	Total Cost
G17-074	\$0	\$0	\$0	\$0	\$659,159	\$659,159	\$0	\$0	\$0	\$0	\$1,318,317
G17-075	\$0	\$0	\$0	\$0	\$101,877	\$101,877	\$0	\$0	\$0	\$0	\$203,754
G17-076	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
G17-077	\$0	\$0	\$0	\$0	\$1,036,524	\$1,036,524	\$0	\$0	\$0	\$0	\$2,073,048
G17-078	\$0	\$0	\$0	\$0	\$29,593	\$29,593	\$0	\$0	\$0	\$0	\$59,186
G17-080	\$0	\$0	\$0	\$0	\$70,619	\$70,619	\$0	\$0	\$0	\$0	\$141,239
G17-082	\$0	\$0	\$0	\$0	\$150,887	\$150,887	\$0	\$0	\$0	\$0	\$301,774
G17-086	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
G17-090	\$0	\$0	\$0	\$58,859	\$0	\$0	\$24,428	\$0	\$0	\$0	\$83,287
G17-092	\$0	\$0	\$0	\$0	\$157,888	\$157,888	\$0	\$0	\$0	\$0	\$315,775
G17-094	\$156,576	\$180,039	\$400,870	\$239,567	\$0	\$0	\$82,621	\$407,619	\$279,394	\$266,371	\$2,013,057
G17-097	\$93,877	\$107,944	\$223,453	\$138,588	\$0	\$0	\$47,549	\$227,214	\$155,740	\$161,462	\$1,155,827
G17-104	\$0	\$0	\$0	\$0	\$33,342	\$33,342	\$0	\$0	\$0	\$0	\$66,683
Total Cost	\$2,042,000	\$2,348,000	\$4,455,000	\$2,929,000	\$6,500,000	\$6,500,000	\$1,022,000	\$4,530,000	\$3,105,000	\$3,564,000	\$36,995,000

VERSION HISTORY

Version Number and Date	Author	Change Description
V0 – 04/16/2021	AECI	Initial release