SPP DISIS-2021-001 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-2021 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 #	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2021-001	OGE	100	100	Battery Storage	138kV Brown Substation
GEN-2021-004[1]	OGE	250	250	Solar	Poolville 138kV Bus
GEN-2021-005	WERE	350	350	Battery Storage	Summit 345 kV substation in Saline County, KS
GEN-2021-006	WERE	300	300	Battery Storage	Neosho 345kV substation in Labette County, KS
GEN-2021-007	NPPD	600	600	Wind	345kV bus of Turtle Creek Substation
GEN-2021-008	BEPC	200	200	Solar	345kV Bus at BEPC Patent Gate Substation, McKenzie County, ND
GEN-2021-010	OGE	233.98	233.98	Solar	Border 345 kV interconnection substation
GEN-2021-012	OGE	227	227	Battery Storage	Border 345 kV interconnection substation
GEN-2021-014	OGE	233.98	233.98	Solar	Border 345 kV interconnection substation
GEN-2021-016[2]	AEP	255	255	Wind	Sunnyside-Johnston 345 kV
GEN-2021-018	OGE	235.35	235.35	Solar	Sooner 345 kV
GEN-2021-019	OGE	75.89	75.89	Battery Storage	Sooner 345 kV
GEN-2021-023	WERE	306.18	306.18	Solar	Wild Plains 345kV Substation
GEN-2021-024	WAPA	203.04	203.04	Wind	WAPA 230kV Jamestown Substation
GEN-2021-025	WFEC	203.04	203.04	Wind	Western Farmers 138kV Mooreland Substation
GEN-2021-027	NPPD	102.06	102.06	Solar	Olive Creek 115 kV Substation
GEN-2021-028	WFEC	204.12	204.12	Solar	Western Farmers 138kV Mooreland Substation
GEN-2021-029	KCPL	253.8	253.8	Battery Storage	Evergy Tap the La Cygne to Stillwell 345 kV Line
GEN-2021-030	KCPL	510.3	510.3	Solar	Evergy Tap the La Cygne to Stillwell 345 kV Line
GEN-2021-033	OGE	204.12	204.12	Solar	Grand Prairie 161kV Substation
GEN-2021-034	LES	113	113	Solar	Rokeby 115 kV Substation
GEN-2021-036	AEP	204.12	204.12	Solar	Craig to Patterson 138 kV Transmission Line
GEN-2021-037	NPPD	244.22	244.22	Wind	NPPD Sidney to Keystone 345 kV Line
GEN-2021-038	AEP	200	200	Battery Storage	Welsh 345kV Substation

[1] GIR withdrew mid-study, removal will be captured in a future restudy.
[2] GIR decreased in MW capacity mid-study, this change will be captured in a future restudy.

Project #	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2021-039	OPPD	100	100	Battery Storage	New 161kV substation looping in OPPD 161kV lines S1211 to S1220 and S1211 to S1299
GEN-2021-040	OPPD	200	200	Battery Storage	OPPD District, Cass County Power Plant Substation, 345kV Bus
GEN-2021-041	OGE	100.657	100.657	Battery Storage	Mustang 138kV Substation
GEN-2021-042	INDN	100	100	Battery Storage	Independence Power & Light, Blue Valley Substation, 161kV Bus
GEN-2021-043	LES	250	250	Battery Storage	8000 SW 12th (Rokeby) Station, 115kV Bus
GEN-2021-047	GRDA	250	250	Solar	Tulsa (Bus #509852) - Igloo (Bus #513596) 345kV line
GEN-2021-048	LES	75	75	Battery Storage	Wagener 115kV Substation
GEN-2021-049	LES	250	250	Solar	Wagener 115kV Substation
GEN-2021-050	KCPL	200	200	Solar	161kV Stilwell-Clinton Line
GEN-2021-051	KCPL	75	75	Battery Storage	161kV Stilwell-Clinton Line
GEN-2021-053	OGE	300	300	Solar	Pecan Creek 345 kV Substation
GEN-2021-056	WERE	300	300	Wind	Viola 345kV Substation
GEN-2021-057	NPPD	300	300	Wind	Antelope 345kV substation
GEN-2021-063	AEP	155	155	Solar	Craig JCT 138kV
GEN-2021-064	AEP	100	100	Solar	Carnegie South 138kV
GEN-2021-068	SUNC	249.6	249.6	Wind	SUNC Spearville - Holcomb 345kV
GEN-2021-069	SUNC	249.6	249.6	Wind	SUNC Spearville - Holcomb 345kV
GEN-2021-070	SUNC	504	504	Wind	SUNC Spearville - Holcomb 345kV
GEN-2021-072	BEPC	600	600	Solar	345kV Transmission Line from Antelope Valley to Leland Olds Substation
GEN-2021-073	NPPD	240	240	Solar	Tap on the Sweetwater to Gerald Gentleman 345 kV Line
GEN-2021-075	AEP	300	300	Solar	CAMPCOR4 138kV Substation
GEN-2021-077	GMO	95	95	Solar	Windsor to AEC Sedalia 161 kV
GEN-2021-086	AEP	165	165	Solar	Okay - Turk 138kV
GEN-2021-088	OGE	100	100	Battery Storage	Cedar Lane - Canadian 138 kV Transmission Line
GEN-2021-090	SPS	400	400	Solar	Yoakum 345kV Substation
GEN-2021-096	WERE	500	500	Solar	Wolf Creek - Benton 345 kV
GEN-2021-098	OGE	160	160	Wind	Dewey District 138 kV Substation
GEN-2021-101	WERE	159	159	Solar	Evergy's Midland Substation 115kV bus
GEN-2021-103	WERE	150	150	Battery Storage	Evergy's Atlantic Substation115kV bus
GEN-2021-106	NPPD	102.06	102.06	Solar	Hebron North 115Kv substation
GEN-2021-107	WERE	201.6	201.6	Solar	Evergy 345kV Jeffrey Energy Center
GEN-2021-108	OPPD	182.25	182.25	Solar	OPPD 345KV Cass County Substation

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. Modeling parameters from the SPP DISIS 2021-001 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-001-5 Planning Standard Table 1 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 requests, 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 requests to have a negative impact (i.e. criteria violation) on the system, the Study Cycle must cause a three percent (3%) or greater increase in flow on an overloaded 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 requests under P0, P1, P2.1, P2.2 (EHV only), and P2.3 (EHV only) system conditions. For the purpose of this study, P2.1

events are included as part of the P1 contingency file. As such, these events will be denoted as a P1 event in the results. All improvements were developed and studied in coordination with AECI.

AECI will perform an annual limited operations study which will indicate seasonal operating limits for SPP/MISO/AECI generation interconnection requests that will reach commercial operation in the 12 month horizon but whose AECI network upgrades have not yet been energized.

STEADY STATE ANALYSIS RESULTS

Steady state analysis results showed ten (10) constraints reported on the AECI transmission system, as shown in Table 2, which are attributed to the Study Cycle requests. Transmission upgrades were evaluated to mitigate the impacts reported from the analysis as a result of the Study Cycle requests. Simulations were performed on each of the scenarios with the identified network upgrade and contingent network upgrades included.

The upgrades shown in Table 7 were evaluated in order to mitigate the reported steady state constraints for the Study Cycle requests; results from the simulations found that the network upgrades were able to mitigate the reported overload conditions as shown in Table 2.

Table 2: Steady State Constraints for the Study Cycle Requests with Upgrades

Constraint ID	Event	Monitored Facility	Contingency	Season	Base Loading	Project Loading	Upgrade Loading
NU01	P2EHV	300101 5MORGAN 161.00 547478 DAD368 5 161.00 1	OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1 OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 549984 [BROOKLINE 7345.00] CKT 1	28W	89.2	108.0	85.3
				33W	87.7	107.4	85.1
NU02	P1	300101 5MORGAN 161.00 549969 BROOKLINE 5161.00 1	OPEN LINE FROM BUS 300045 [7MORGAN 345.00] TO BUS 549984 [BROOKLINE 7345.00] CKT 1	33S	75.0	100.4	69.4
	P2EHV		OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1 OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 549984 [BROOKLINE 7345.00] CKT 1	28S	82.6	106.1	74.5
				28W	84.1	106.3	91.8
				33S	83.6	106.8	75.0
				33W	82.7	105.2	90.8
NU03	P2EHV	300648 2LAMRRLS 69.000 300655 2LAMRCTN 69.000 1	OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1 OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1	33S	51.5	100.3	53.2
NU04	P2EHV	300651 2LAMR 69.000 300656 2JACK ST 69.000 1	OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1 OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1	28W	72.3	102.1	60.6
				33W	70.5	100.9	60.0
NU05	P1	300655 2LAMRCTN 69.000 300656 2JACK ST 69.000 1	OPEN LINE FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1	28S	54.6	101.2	53.7
				33S	55.7	102.3	54.2

Constraint ID	Event	Monitored Facility	Contingency	Season	Base Loading	Project Loading	Upgrade Loading
	P2EHV		OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1 OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1	28S	57.3	105.9	56.2
				33S	58.5	107.1	56.8
NU06	P2EHV	300712 2RICHLND 69.000 547548 BOS249 2 69.000 1	OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1 OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1	33S	51.1	100.0	75.8
NU07	P1	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 4	OPEN LINE FROM BUS 300048 [7STFRAN 345.00] TO BUS 300054 [7GOBKNOB 345.00] CKT 1	28W	149.7	152.7	98.9[3]
NU08	P2EHV	300381 5BEVIER 161.00 300387 2BEVIER 69.000 1	OPEN BRANCH FROM BUS 344000 [7ZACHARY 345.00] TO BUS 345438 [7FABIUS 345.00] CKT 1 OPEN BRANCH FROM BUS 345438 [7FABIUS 345.00] TO BUS 345435 [7MAYWOOD 345.00] CKT 1 OPEN BRANCH FROM BUS 345992 [7SPENCER 345.00] TO BUS 345435 [7MAYWOOD 345.00] CKT 1	28S	NB[4]	100.0[5]	90.9[3]
NU09	P1	300123 5WPLAINW 161.00 301123 2WSTPL3 69.000 1	OPEN LINE FROM BUS 301123 [2WSTPL3 69.000] TO BUS 301549 [5WPLAINE 161.00] CKT 2	28S	122.2	126.3	87.1[3]
NU10	P1	301123 2WSTPL3 69.000 301549 5WPLAINE 161.00 2	OPEN LINE FROM BUS 300123 [5WPLAINW 161.00] TO BUS 301123 [2WSTPL3 69.000] CKT 1	28S	120.4	126.7	87.3[3]
				33W	101.6	106.1	76.1[3]

Table 2 shows stressed modeling conditions in which the Base Loading represents models built with higher queue generation requests in service, but without network upgrades tagged to those higher queue requests. Multiple iterations of solutions, which can include applicable higher queued network upgrades, were tested to alleviate both the Base Loading and the additional loading contributed by the Study Cycle (Project Loading). Table 2 lists facilities in which Project Loading cannot be mitigated by higher queue upgrades and in which a negative impact due to the Study Cycle was still present.

[3] 'Upgrades Loading' reflects loading on Monitored Facility with tap adjustments.
[4] Monitored Facility created as part of the Network Upgrades, no Base loading available. NB = no branch.
[5] 'Project Loading' reflects the loading with the Network Upgrades included, prior to mitigation.

CONTINGENT FACILITY RESULTS

Sixty-six (66) facilities were reported as Contingent Facilities with the addition of the Study Cycle requests, as shown in Table 3. 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 may otherwise be the responsibility of the Study Cycle requests as necessary to interconnect to the transmission system.

The transmission upgrades for the Contingent Facilities were evaluated in order to confirm that the planned system adjustments were sufficient to mitigate the overload seen for the addition of the Study Cycle requests. Simulations were performed on each of the scenarios with the identified network upgrade and contingent network upgrades included. The upgrades shown in Table 5 were evaluated in order to mitigate the reported constraints as listed in Table 3 below.

Table 3: Steady State Contingent Constraints for the Study Cycle Requests with Upgrades

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
CF01	P1	300073 5GENTRY 161.00 300076 5FAIRPTB2 161.00 1	28S	94.1	101.2	96.9	SPP DISIS-2017-002 SPP NU
CF02	P1	300323 2CENTRV 69.000 300336 2HOLDEN 69.000 1	28S	90.8	100.5	95.0	SPP DISIS-2017-002 SPP NU
			33S	90.2	100.0	95.1	
CF03	P1	300688 2AUSTIN 69.000 300696 2CREIGH 69.000 1	28S	83.1	104.9	82.6	SPP DISIS-2017-002 SPP NU
			33S	79.7	101.7	80.9	
CF04	P1	300651 2LAMR 69.000 300794 5LAMAR 161.00 1	28H	89.4	110.5	73.8	SPP DISIS-2017-002
			28S	84.8	101.9	64.9	
			28W	118.6	139.4	91.0	
			33S	87.5	104.2	65.3	
			33W	115.5	137.9	90.3	
	P2EHV		28H	91.2	113.9	75.5	
			28S	116.1	140.2	88.7	
			28W	119.7	142.0	92.4	
			33S	118.9	142.6	89.2	
			33W	116.7	140.4	91.4	
CF05	P1	300772 2COFMAN 69.000 300780 2KNOBBY 69.000 1	28S	75.1	106.7	49.3	SPP DISIS-2017-002
			28W	98.0	120.0	77.5	
			33S	79.3	100.8	57.7	
			33W	96.8	119.3	76.9	

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
CF06	P1	300780 2KNOBBY 69.000 301401 2TURKEYCRK 69.000 1	28S	80.6	110.5	29.7	SPP DISIS-2017-002
			28W	86.2	109.3	36.2	
			33S	90.2	111.6	35.0	
			33W	86.5	109.1	36.2	
CF07	P1	300173 2GOBKNOB 69.000 301230 2FAIRDLG 69.000 1	28S	102.8	111.9	61.6	GI-099/100/SPP DISIS-2018-001
			33S	103.3	112.0	61.6	
CF08	P1	301201 2DONIPH 69.000 301227 2RIPLEY 69.000 1	28S	86.9	103.1	52.9	GI-099/100/SPP DISIS-2018-001
			33S	88.2	103.2	52.9	
CF09	P1	301217 2OXLEY 69.000 301227 2RIPLEY 69.000 1	28S	87.0	103.2	53.0	GI-099/100/SPP DISIS-2018-001
			33S	88.4	103.3	53.0	
CF10	P1	301217 2OXLEY 69.000 301230 2FAIRDLG 69.000 1	28S	95.4	104.9	33.1	GI-099/100/SPP DISIS-2018-001
			33S	96.4	105.0	33.1	
CF11	P1	300293 2CAMRNJ 69.000 300312 2TURNEY 69.000 1	28H	150.7	160.5	45.2	AECI
			28L	142.9	148.7	38.3	
			28S	185.3	191.4	57.0	
			33S	183.7	189.3	56.4	
CF12	P1	301201 2DONIPH 69.000 505440 DONIPHN5 161.00 1	28S	109.8	113.6	78.6	SPP DISIS-2018-001
			28W	109.6	116.1	76.1	
CF13	P1	300541 2SEDALI 69.000 300545 2SYLVAN 69.000 1	28W	100.5	110.6	60.6	GI-091
			33W	88.6	101.4	55.1	
CF14	P1	300772 2COFMAN 69.000 300779 2J&7 69.000 1	28S	65.6	100.5	25.4	SPP DISIS-2020
			28W	90.2	120.5	41.3	
			33S	70.7	100.6	30.4	
			33W	88.5	119.1	40.7	
CF15	P0	300115 5STFRANB2 161.00 338202 5JIM HILL% 161.00 1	28H	122.0	126.7	57.4	MISO DPP-2019
			28S	129.9	132.9	60.2	
			28W	116.1	119.4	65.4	
			33S	128.8	131.8	59.8	
			33W	116.5	119.8	65.6	
	P1		28H	126.9	131.5	59.6	
			28L	162.3	165.5	75.0	
			28S	138.1	141.1	64.0	
			28W	120.5	123.8	67.7	
			33S	133.9	136.9	62.1	
			33W	120.9	124.2	68.0	
	P2EHV		28H	124.2	128.7	58.3	
			28L	181.1	208.5	93.7	
			28S	137.8	140.9	63.8	

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
			28W	117.5	120.6	66.0	
			33S	136.6	139.8	63.3	
			33W	117.9	121.0	66.2	
CF16	P1	300124 5HOLDENB2 161.00 300336 2HOLDEN 69.000 1	28S	114.6	127.4	64.1	MISO DPP-2019
			33S	115.2	128.2	64.9	
CF17	P1	300327 2ELM 69.000 300336 2HOLDEN 69.000 1	28S	108.7	122.6	89.0	MISO DPP-2019
			33S	110.3	124.5	90.9	
CF18	P1	300061 5BOONE 161.00 300519 5MLRSBGB1 161.00 1	33S	96.1	100.5	85.8	MISO DPP-2019
CF19	P0	300387 2BEVIER 69.000 301623 2BEVIERTP 69.000 1	28S	108.8	129.3	80.1	MISO DPP-2019
			33S	108.7	129.8	80.4	
	P1		28H	86.1	101.3	62.8	
			28L	89.2	101.9	62.2	
			28S	107.3	127.5	78.9	
			28W	85.5	105.8	79.5	
			33S	107.3	128.0	79.3	
			33W	83.4	103.1	77.4	
	P2EHV		28H	84.8	100.0	62.0	
			28S	109.6	130.5	80.8	
			28W	81.8	102.2	77.1	
			33S	109.6	131.0	81.1	
CF20	P1	300398 2LOVELK 69.000 300401 2MACNTP 69.000 1	28S	80.9	102.5	71.6	MISO DPP-2019
			33S	80.3	102.1	71.4	
CF21	P0	300400 2MACNLK 69.000 301623 2BEVIERTP 69.000 1	28H	103.1	122.2	51.0	MISO DPP-2019
			28S	135.7	162.6	67.9	
			28W	87.3	106.8	44.9	
			33S	135.7	163.2	68.1	
			33W	85.0	104.1	43.7	
	P1		28H	101.4	120.0	50.1	
			28L	93.2	108.1	45.5	
			28S	133.8	160.2	66.9	
			28W	85.9	105.1	44.1	
			33S	133.8	160.9	67.1	
			33W	83.5	102.3	42.9	
	P2EHV		28H	103.8	123.0	51.3	
			28L	87.1	101.0	42.7	
			28S	136.5	163.6	68.3	
			28W	88.0	107.6	45.2	
			33S	136.5	164.2	68.5	

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
			33W	85.7	104.9	44.0	
CF22	P0	300388 2AXTELL 69.000 300401 2MACNTP 69.000 1	28H	87.9	106.4	44.7	MISO DPP-2019
			28S	117.4	143.8	60.4	
			33S	116.5	143.5	60.3	
	P1		28H	86.2	104.2	43.8	
			28L	88.6	103.3	43.6	
			28S	115.5	141.5	59.4	
			28W	88.6	114.4	48.7	
			33S	114.7	141.3	59.4	
			33W	85.3	110.2	47.0	
	P2EHV		28H	88.6	107.2	45.1	
			28L	88.7	100.5	42.2	
			28S	118.3	144.8	60.8	
			28W	83.8	109.8	47.0	
			33S	117.5	144.6	60.8	
			33W	80.0	104.8	44.9	
CF23	P0	300388 2AXTELL 69.000 300400 2MACNLK 69.000 1	28H	92.9	111.6	46.8	MISO DPP-2019
			28S	123.9	150.4	63.0	
			33S	123.2	150.4	63.0	
	P1		28H	91.2	109.4	45.8	
			28L	90.2	105.0	44.2	
			28S	122.0	148.1	62.0	
			28W	82.0	102.3	43.1	
			33S	121.4	148.1	62.0	
			33W	81.4	101.5	42.8	
	P2EHV		28H	93.6	112.4	47.1	
			28L	90.2	102.2	42.8	
			28S	124.7	151.5	63.4	
			28W	80.4	100.2	42.3	
			33S	124.2	151.4	63.4	
			33W	87.5	112.4	47.9	
CF24	P1	300571 2MEXICO 69.000 300580 2SLTRVR 69.000 1	28S	59.4	102.1	74.6	GI-083
			33S	59.4	103.6	75.7	
CF25	P1	300090 5KINGDMB1 161.00 300523 5WLMSBG 161.00 1	28W	95.5	101.3	83.3	GI-083
CF26	P1	300099 5MONTCT 161.00 300523 5WLMSBG 161.00 1	28W	98.4	104.4	85.5	GI-083
			33W	94.9	100.4	82.4	

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
CF27	P1	300517 2KINGDM 69.000 301497 5KINGDMB2 161.00 2	28H	99.2	102.2	NB[6]	GI-083
			28S	145.4	149.5	NB[6]	
			28W	129.9	133.1	NB[6]	
			33S	147.2	151.0	NB[6]	
			33W	133.1	136.1	NB[6]	
	P2EHV		28H	99.1	102.5	NB[6]	
			28W	116.8	120.1	NB[6]	
			33W	120.2	123.6	NB[6]	
CF28	P1	300517 2KINGDM 69.000 301497 5KINGDMB2 161.00 3	28H	109.6	113.1	66.7	GI-083
			28S	145.2	149.4	88.1	
			28W	129.8	132.9	80.8	
			33S	147.0	150.8	88.5	
			33W	133.0	136.0	82.8	
	P2EHV		28H	99.0	102.4	65.7	
			28W	116.7	120.0	79.4	
			33W	120.1	123.5	82.1	
CF29	P1	300530 2GEOGT2 69.000 300541 2SEDALI 69.000 1	28S	94.7	137.2	81.1	GI-091
			33S	93.7	135.8	81.0	
CF30	P2EHV	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 3	28W	135.2	138.5	93.5	GI-099/100
CF31	P2EHV	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 4	28W	144.2	147.6	99.7	GI-099/100
CF32	P1	300254 2GOWER 69.000 300268 2STEWRV 69.000 1	28S	97.7	102.6	85.2	GI-101/102
			33S	96.7	101.1	83.7	
CF33	P1	300259 2MAYSVL 69.000 300268 2STEWRV 69.000 1	28S	104.2	109.1	91.7	GI-101/102
			33S	103.2	107.7	90.3	
CF34	P0	500 SHOALCR 161.00 300036 5ELATHRP 161.00 1	28H	134.8	140.6	39.5	GI-101/102
			28L	136.6	140.1	38.4	
			28S	151.8	155.7	43.8	
			33S	150.4	153.8	43.3	
	P1		28H	135.4	141.2	39.6	
			28L	137.1	140.7	38.6	
			28S	153.4	157.3	44.1	
			28W	NC[7]	143.6	42.2	
			33S	152.0	155.4	43.7	
			33W	NC[7]	143.5	42.2	

[6] With the inclusion of Network Upgrades and Contingent Facilities, monitored facility no longer exists. NB = no branch.
[7] Contingency that causes reported overload created as part of the Project or Network Upgrades; no Base loading available. NC = no contingency.

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
	P2EHV		28H	134.8	140.6	39.5	
			28L	136.7	140.2	38.5	
			28S	151.9	155.8	43.8	
			33S	150.5	153.8	43.3	
CF35	P1	300091 5LATHRP 161.00 300302 2LATHRP 69.000 1	28H	227.3	234.3	82.8	GI-101/102
			28L	221.2	224.3	82.5	
			28S	252.1	256.6	86.5	
			33S	251.4	255.6	88.0	
CF36	P1	300192 2RCKWOLT 69.000 300292 2CAMERN 69.000 1	28H	109.2	115.9	68.0	GI-101/102
			28L	100.0	104.0	54.6	
			28S	134.8	139.1	86.3	
			33S	133.9	137.8	85.6	
CF37	P1	300192 2RCKWOLT 69.000 300293 2CAMRNJ 69.000 1	28H	103.5	110.2	62.1	GI-101/102
			28L	98.2	102.1	52.7	
			28S	127.3	131.4	78.3	
			33S	126.1	129.9	77.4	
CF38	P0	300297 2HOLT 69.000 300302 2LATHRP 69.000 1	28H	106.3	111.9	53.4	GI-101/102
			28S	130.7	134.3	65.1	
			33S	131.1	134.4	65.3	
	P1		28H	107.3	113.0	53.8	
			28L	111.1	114.1	45.8	
			28S	132.2	135.3	65.7	
			28W	NC[7]	108.7	59.0	
			33S	131.7	134.9	65.5	
			33W	NC[7]	109.3	59.5	
	P2EHV		28H	106.5	112.1	53.4	
			28L	98.5	103.1	43.7	
			28S	131.0	134.5	65.1	
			33S	131.3	134.5	65.3	
CF39	P0	300297 2HOLT 69.000 300311 2SMRSET 69.000 1	28H	93.9	100.0	47.1	GI-101/102
			28S	114.7	118.3	56.7	
			33S	114.8	118.2	56.9	
	P1		28H	95.1	101.1	47.5	
			28L	107.4	110.4	43.8	
			28S	116.4	119.4	57.4	
			33S	115.3	118.8	57.1	
	P2EHV		28H	97.4	103.4	48.3	
			28S	115.0	118.5	56.8	
			33S	117.0	120.1	57.2	

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
CF40	P1	300301 2KEARNY 69.000 300311 2SMRSET 69.000 1	28H	97.7	102.3	31.5	GI-101/102
			28L	103.2	106.3	31.4	
			28S	109.5	112.7	36.0	
CF41	P1	300302 2LATHRP 69.000 300313 2WESTBR 69.000 1	28H	142.2	147.7	84.4	GI-101/102
			28S	157.2	160.6	91.7	
			33S	156.1	159.9	91.4	
CF42	P1	300302 2LATHRP 69.000 301627 2LATHRPLD 69.000 1	28H	137.3	147.1	75.5	GI-101/102
			28L	138.4	144.3	71.9	
			28S	168.3	174.2	95.1	
			33S	166.2	171.7	93.2	
CF43	P1	300312 2TURNEY 69.000 300316 2LATHRPEMG 69.000 1	28H	146.0	155.8	42.7	GI-101/102
			28L	141.2	147.1	37.5	
			28S	179.3	185.4	53.8	
			33S	177.6	183.2	53.1	
CF44	P1	300316 2LATHRPEMG 69.000 301627 2LATHRPLD 69.000 1	28H	145.9	155.7	42.6	GI-101/102
			28L	141.1	146.9	37.4	
			28S	179.2	185.2	53.7	
			33S	177.5	183.1	53.0	
CF45	P1	300249 2FAIRPT 69.000 300259 2MAYSVL 69.000 1	28S	95.7	101.4	72.7	GI-101/102
			33S	106.0	110.5	93.1	
CF46	P1	300306 2PARADS 69.000 300310 2SMITHV 69.000 1	28S	103.9	107.8	59.7	GI-101/102
			33S	102.7	106.3	58.5	
CF47	P1	300306 2PARADS 69.000 300313 2WESTBR 69.000 1	28S	104.2	108.0	60.0	GI-101/102
			33S	102.9	106.6	58.8	
CF48	P0	300036 5ELATHRP 161.00 300091 5LATHRP 161.00 1	28H	123.1	128.9	34.7	GI-101/102
			28L	125.0	128.5	33.7	
			28S	140.1	144.0	39.1	
			33S	138.7	142.1	38.6	
	P1		28H	123.7	129.5	34.9	
			28L	125.5	129.0	33.8	
			28S	141.7	145.6	39.4	
			28W	NC[7]	134.2	42.4	
			33S	140.3	143.7	39.0	
			33W	NC[7]	134.0	42.4	
	P2EHV		28H	123.0	128.9	34.7	
			28L	125.1	128.6	33.7	
			28S	140.2	144.1	39.1	
			33S	138.7	142.1	38.6	
CF49	P0		28H	99.2	104.7	29.6	GI-101/102

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
		300091 5LATHRP 161.00 301563 5MOCITYB1 161.00 1	28L	105.3	108.9	31.2	
			28S	113.0	116.7	33.2	
			33S	111.4	114.6	32.5	
	P1		28H	99.7	105.3	29.8	
			28L	105.9	109.4	31.4	
			28S	114.7	118.3	33.7	
			28W	NC[7]	111.8	31.3	
			33S	113.1	116.3	33.0	
			33W	NC[7]	111.5	31.2	
	P2EHV		28H	99.1	104.7	29.6	
			28L	105.4	108.9	31.2	
			28S	113.0	116.7	33.2	
			33S	111.5	114.7	32.5	
CF50	P1	300107 5OSBORN 161.00 300290 2OSBORN 69.000 1	28H	145.8	150.7	80.5	GI-101/102
			28L	127.4	130.5	55.9	
			28S	166.2	169.9	93.8	
			33S	178.4	181.9	93.1	
CF51	P1	300290 2OSBORN 69.000 301629 2OSBORNTPS 69.000 1	28H	95.7	101.7	55.7	GI-101/102
			28S	108.1	111.2	73.1	
			33S	117.9	121.4	70.2	
CF52	P1	300292 2CAMERN 69.000 301629 2OSBORNTPS 69.000 1	28H	95.7	101.7	55.7	GI-101/102
			28S	108.1	111.2	73.1	
			33S	117.9	121.4	70.2	
CF53	P1	300137 4BRISTOW 138.00 300140 4SILVCTY 138.00 1	28L	94.9	100.3	51.5	GI-103
CF54	P1	300137 4BRISTOW 138.00 300686 4WOODY 138.00 1	28H	NC[7]	127.2	66.4	GI-103
			28L	140.3	145.9	78.3	
			28S	NC[7]	133.3	69.5	
			28W	NC[7]	109.0	59.6	
			33S	NC[7]	133.6	69.6	
			33W	NC[7]	111.2	60.9	
CF55	P1	300137 4BRISTOW 138.00 300889 2BRIISTOW 69.000 2	28H	NC[7]	147.0	50.1	GI-103
			28L	78.4	104.8	36.0	
			28S	NC[7]	158.9	53.4	
			28W	NC[7]	136.0	46.1	
			33S	NC[7]	160.4	53.9	
			33W	NC[7]	137.5	46.6	
CF56	P1	300686 4WOODY 138.00 521026 PHAROAH4 138.00 1	28H	NC[7]	120.0	71.7	GI-103
			28L	141.4	146.1	89.1	

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
			28S	NC[7]	123.6	73.8	
			33S	NC[7]	123.5	73.7	
CF57	P1	300889 2BRIISTOW 69.000 513092 BEGGS 2 69.000 1	28W	97.1	100.1	67.2	GI-103
			33S	97.0	101.2	74.7	
			33W	97.4	101.0	67.8	
CF58	P1	300196 2WOODY 69.000 300906 2NUYAKA 69.000 1	28L	102.8	117.1	63.5	AECI/GI-105
CF59	P1	300906 2NUYAKA 69.000 513092 BEGGS 2 69.000 1	28L	104.2	118.5	64.2	AECI/GI-105
CF60	P1	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	28S	90.7	112.2	78.7	DISIS-2018-001
			28W	85.8	100.9	71.6	
			33S	92.3	113.1	79.6	
			33W	86.3	102.5	72.5	
	P2EHV		28H	88.6	104.4	74.1	
			28S	104.4	122.6	87.5	
			28W	113.6	126.7	91.4	
			33S	105.6	123.1	88.0	
			33W	113.2	127.3	91.6	
CF61	P1	300043 7KINGDM 345.00 300090 5KINGDMB1 161.00 1	28H	91.1	102.7	58.4	GI-113[8]
			28L	96.0	106.0	60.3	
			28S	91.4	102.4	58.2	
			28W	101.8	116.4	66.1	
			33S	90.7	101.3	57.6	
			33W	100.6	114.6	65.1	
CF62	P1	300520 2REFORM 69.000 300626 2CHAMOI 69.000 1	28W	61.0	102.5	62.5	GI-113[8]
			33W	59.0	102.2	62.4	
CF63	P1	300889 2BRIISTOW 69.000 300898 2GYPSY 69.000 1	28H	97.5	101.7	NB[6]	AECI
CF64	P1	300773 2ELKTON 69.000 300817 2OSCEOLA 69.000 1	28S	66.7	105.8	83.8	AECI
			28W	85.7	102.1	85.8	
			33S	67.2	106.3	84.6	
			33W	86.8	103.2	90.7	
CF65	P1	301050 2CONWY 69.000 301071 2PBURG 69.000 1	28S	76.8	101.3	81.8	AECI
			33S	78.0	102.1	82.5	
CF66	P1	300069 5CHOTEAU1 161.00 512648 MAID 5 161.00 1	28H	114.5	129.9	129.8	Prior Queue Studies[9]
			28L	126.9	131.0	130.9	
			28S	119.7	133.5	133.4	
			28W	110.4	123.8	123.6	

[8] GI-113 withdrew mid-study, the impact of its withdrawal will be evaluated in a future restudy.
[9] Ongoing studies show this element will be the responsibility of a higher queue SPP cluster. Current mitigations for these clusters are still being determined. Withdrawals from those clusters may result in a restudy of DISIS-2021.

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
			33S	119.8	133.5	133.3	
			33W	109.9	123.4	123.2	

NEIGHBORING SYSTEM RESULTS

The Study has identified impacts from the Study Cycle requests on the AECI ties with neighboring systems. The most limiting component of the AECI owned portion of the facility was evaluated and if found inadequate, a network upgrade for the AECI equipment was determined. Network upgrades for transmission facilities limited by non-AECI equipment are not captured and may need to be coordinated with the appropriate transmission owner.

Three (3) facilities were reported on the AECI ties with the addition of the Study Cycle requests. The most severe constraints are shown in Table 4.

Table 4: Steady State Neighboring System Constraints for the Study Cycle Requests

Constraint ID	Event	Monitored Facility	Area	Season	Base Loading	Project Loading
AFS01	P1	300071 5CLINTN 161.00 761278 G17-108-TAP 161.00 1	AECI/KCPL	28S	34.2	106.3
				33S	34.4	106.6
AFS02	P0	300098 5MOCITYB2 161.00 541248 LBRTYST5 161.00 1	AECI/KCPL	28S	81.2	101.4
				33S	82.4	101.7
	P1			28H	87.1	115.5
				28L	95.2	119.6
				28S	87.1	107.1
				28W	89.9	114.3
				33S	88.3	107.5
				33W	90.3	115.8
	P2EHV			28S	85.4	104.2
				33S	86.5	104.5
AFS03	P1	300740 7SPORTSMAN 345.00 512650 GRDA1 7 345.00 1	AECI/GRDA	28H	96.4	110.5
				28L	107.1	111.1
				28S	101.7	113.9
				28W	106.9	120.2
				33S	101.6	113.8
				33W	106.5	119.8

NETWORK UPGRADES

The upgrades shown in Table 5 were evaluated in order to mitigate the reported steady state contingent constraints for the Study Cycle requests as listed in Table 3.

Table 5: Network Upgrades for the Study Cycle Contingent Constraints

Constraint ID	Monitored Facility	Network Upgrade
CF01	300073 5GENTRY 161.00 300076 5FAIRPTB2 161.00 1	**Contingent on SPP DISIS-2017-002 SPP NU:** Build a new 161 kV line from Archie to G17-108-TAP and place into service.
CF02	300323 2CENTRV 69.000 300336 2HOLDEN 69.000 1	
CF03	300688 2AUSTIN 69.000 300696 2CREIGH 69.000 1	
CF04	300651 2LAMR 69.000 300794 5LAMAR 161.00 1	**Contingent on SPP DISIS-2017-002:** Install a second Lamar 161/69 kV transformer rated at 84 MVA Summer, 95 MVA Winter unit**.**
CF05	300772 2COFMAN 69.000 300780 2KNOBBY 69.000 1	**Contingent on SPP DISIS-2017-002:** Rebuild 4.70 mile long line from Coffman Bend-Knobby 69 kV to 795 ACSR rated at 100C.
CF06	300780 2KNOBBY 69.000 301401 2TURKEYCRK 69.000 1	**Contingent on SPP DISIS-2017-002:** Rebuild 12.1 mile long line from Knobby to Turkey Creek 69 kV to 795 ACR rated at 100C.
CF07	300173 2GOBKNOB 69.000 301230 2FAIRDLG 69.000 1	**Contingent on GI-099/100:** See upgrade for CF30 below. **Contingent on SPP DISIS-2018-001:** Rebuild 2.5 mile long 4/0 section of Gobbler Knob-Fairdealing 69 kV line to 795 ACSR at 100C.
CF08	301201 2DONIPH 69.000 301227 2RIPLEY 69.000 1	**Contingent on GI-099/100:** See upgrade for CF30 below. **Contingent on SPP DISIS-2018-001:** Rebuild 1.3 mile long line from Doniphan-Ripley 69 kV to 336 ACSR, rated at 100C.
CF09	301217 2OXLEY 69.000 301227 2RIPLEY 69.000 1	**Contingent on GI-099/100:** See upgrade for CF30 below. **Contingent on SPP DISIS-2018-001:** Rebuild 3.8 mile long line from Ripley-Oxly 69 kV to 336 ACSR, rated at 100C.
CF10	301217 2OXLEY 69.000 301230 2FAIRDLG 69.000 1	**Contingent on GI-099/100:** See upgrade for CF30 below. **Contingent on SPP DISIS-2018-001:** Rebuild 5.9 mile long 4/0 section of Oxly-Fairdealing 69 kV line to 795 ACSR at 100C.
CF11	300293 2CAMRNJ 69.000 300312 2TURNEY 69.000 1	**Contingent on AECI:** Rebuild 7.7-mile-long Cameron Junction-Turney 69 kV line to 336 ACSR at 100C.
CF12	301201 2DONIPH 69.000 505440 DONIPHN5 161.00 1	**Contingent on SPP DISIS-2018-001:** See upgrade for CF07. See upgrade for CF10.
CF13	300541 2SEDALI 69.000 300545 2SYLVAN 69.000 1	**Contingent on GI-091:** Upgrade bushing CTs (via breaker upgrade), breaker switchers on Sylvan-Sedalia 69 kV line (at Sedalia) to 1200 amp rating.

Constraint ID	Monitored Facility	Network Upgrade
CF14	300772 2COFMAN 69.000 300779 2J&7 69.000 1	**Contingent on SPP DISIS-2020:** Rebuild 69 kV 6.31 mile long line from Coffman Bend- J-7 to 795 ACSR rated at 100C.
CF15	300115 5STFRANB2 161.00 338202 5JIM HILL% 161.00 1	**Contingent on MISO DPP-2019:** Rebuild 9.9 mile-long St. Francis to Jim Hill 161 kV line to 1192 ACSS at 250C. Replace jumpers at St. Francis with 1192 ACSS at 250C. Replace disconnect switches at St. Francis 161 kV bus on Jim Hill line with 3000A switches.
CF16	300124 5HOLDENB2 161.00 300336 2HOLDEN 69.000 1	**Contingent on MISO DPP-2019:** Add a second 161/69 kV transformer at Holden with rating of 84 MVA Summer, 95 MVA Winter.
CF17	300327 2ELM 69.000 300336 2HOLDEN 69.000 1	**Contingent on MISO DPP-2019:** Rebuild 3.1 mile 336 ACSR segment of Elm-Holden (existing double circuit). Utilize 556 ACSR at 100C for 69 kV circuit.
CF18	300061 5BOONE 161.00 300519 5MLRSBGB1 161.00 1	**Contingent on MISO DPP-2019:** Reconductor 9.4 mile long Boone-Millersburg 161 kV line with 795 ACSS at 250C. Replace jumpers on both side of line with 795 ACSS High Temp.
CF19	300387 2BEVIER 69.000 301623 2BEVIERTP 69.000 1	**Contingent on MISO DPP-2019:** Rebuild 0.1 mile-long Bevier-Bevier Tap 69 line to 795 ACSR at 100C.
CF20	300398 2LOVELK 69.000 300401 2MACNTP 69.000 1	**Contingent on MISO DPP-2019:** Rebuild 12.2 mile-long Love Lake-Macon Tap line to 336 ACSR at 100C.
CF21	300400 2MACNLK 69.000 301623 2BEVIERTP 69.000 1	**Contingent on MISO DPP-2019:** Rebuild the 4.136-mile-long Bevier-Macon Lake 69 kV line to 795 ACSR.
CF22	300388 2AXTELL 69.000 300401 2MACNTP 69.000 1	**Contingent on MISO DPP-2019:** Rebuild 1.05 mile-long Axtell-Macon Tap 69 kV line to 795 ACSR.
CF23	300388 2AXTELL 69.000 300400 2MACNLK 69.000 1	**Contingent on MISO DPP-2019:** Rebuild 1.15 mile-long Axtell-Macon Lake 69 line to 795 ACSR.
CF24	300571 2MEXICO 69.000 300580 2SLTRVR 69.000 1	**Contingent on GI-083:** Kingdom City/Auxvasse/Salt River Upgrades: Rebuild 8 mile-long Kingdom City-Auxvasse 69 kV line to 161 kV. - Utilize 795 ACSR at 100C. - Re-terminate the line on the 161 kV Bus #1 at Kingdom City. Rebuild 9 mile Auxvasse-Salt River Tap 69 kV line to 161 kV. - Utilize 795 ACSR at 100C. - Re-terminate the line on the 161 kV bus at Salt River. Rebuild 1 mile-long Salt River Tap-Salt River line to 161/69 kV D.C. - 161 kV will be 795 ACSR at 100C. - 69 kV will be 336 ACSR at 100C. Modify the Salt River 69 kV station to include a 161/69 kV 84 MVA Summer/96 MVA Winter transformer and 2 161 kV terminal positions. Construct new 69 kV section between Salt River and Vandiver. Convert Auxvasse 69 kV station to 161 kV.
CF25	300090 5KINGDMB1 161.00 300523 5WLMSBG 161.00 1	
CF26	300099 5MONTCT 161.00 300523 5WLMSBG 161.00 1	
CF27	300517 2KINGDM 69.000 301497 5KINGDMB2 161.00 2	
CF28	300517 2KINGDM 69.000 301497 5KINGDMB2 161.00 3	
CF29	300530 2GEOGT2 69.000 300541 2SEDALI 69.000 1	**Contingent on GI-091:** Upgrade bushing CTs (via breaker upgrade), breaker switchers on Georgetown-Sedalia 69 kV line (at Sedalia) to 1200 amp rating.
CF30	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 3	**Contingent on GI-099/100:** Rebuild existing 69 kV line from Gobbler - PB South - Harviell - Poplar Bluff - Township - Green Forest to double circuit 161 and 69 kV. The 69 kV circuit will be constructed to 795 ACSR and terminate at stations as it currently does. The 161 kV circuit will be constructed to 795 ACSS High Temp at 200C and terminate only at Gobbler Knob and Green Forest. Add terminals and associated equipment as needed at Gobbler and Green Forest stations.

Constraint ID	Monitored Facility	Network Upgrade
CF31	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 4	The individual line segments are: - Rebuild 4.4-mile-long Gobbler Knob-Poplar Bluff South 69 kV line with 795 ACSR at 100C. - Rebuild 2.5-mile-long Green Forest-Township 69kV line with 795 ACSR at 100C. - Rebuild 4.5-mile-long Harviell-Poplar Bluff South 69 kV line with 795 ACSR at 100C. - Rebuild 6.3-mile-long Harviell-Poplar Bluff 69 kV line with 795 ACSR at 100C. - Rebuild 2.7-mile-long Poplar Bluff-Township 69 kV line with 795 ACSR at 100C. - Construct a new 161 kV circuit from Gobbler Knob-Green Forest along the existing 69 kV path between these stations. Use 795 ACSS High Temp at 200C.
CF32	300254 2GOWER 69.000 300268 2STEWRV 69.000 1	**Contingent on GI-101/102:** Build a new 27.8 mile long 161 kV circuit between Shoal Creek and Missouri City utilizing 1192 ACSS at 200C. Line will be overbuilt on the 69 kV line from Turney-Lathrop Load-Lathrop-Holt-Summerset-Kearney-Missouri City. The 69 kV lines will be replaced with 336 ACSR at 100C. Add a new 161 kV terminal and reconfigure Missouri City 161 kV bus to accommodate the new 161 kV line between Missouri City and Shoal Creek. Add a new 161 kV terminal and reconfigure MO City 161 kV bus as needed to accommodate the new 161 kV line between MO City and Shoal Creek.
CF33	300259 2MAYSVL 69.000 300268 2STEWRV 69.000 1	
CF34	500 SHOALCR 161.00 300036 5ELATHRP 161.00 1	
CF35	300091 5LATHRP 161.00 300302 2LATHRP 69.000 1	
CF36	300192 2RCKWOLT 69.000 300292 2CAMERN 69.000 1	
CF37	300192 2RCKWOLT 69.000 300293 2CAMRNJ 69.000 1	
CF38	300297 2HOLT 69.000 300302 2LATHRP 69.000 1	
CF39	300297 2HOLT 69.000 300311 2SMRSET 69.000 1	
CF40	300301 2KEARNY 69.000 300311 2SMRSET 69.000 1	
CF41	300302 2LATHRP 69.000 300313 2WESTBR 69.000 1	
CF42	300302 2LATHRP 69.000 301627 2LATHRPLD 69.000 1	
CF43	300312 2TURNEY 69.000 300316 2LATHRPEMG 69.000 1	
CF44	300316 2LATHRPEMG 69.000 301627 2LATHRPLD 69.000 1	
CF45	300249 2FAIRPT 69.000 300259 2MAYSVL 69.000 1	
CF46	300306 2PARADS 69.000 300310 2SMITHV 69.000 1	
CF47	300306 2PARADS 69.000 300313 2WESTBR 69.000 1	
CF48	300036 5ELATHRP 161.00 300091 5LATHRP 161.00 1	**Contingent on GI-101/102:** Rebuild 2.2 mile long Lathrop-Lathrop East 161 kV line to 1192 ACSS at 200C. Upgrade jumpers at Lathrop East and Lathrop on line to 1192 ACSS at 200C.
CF49	300091 5LATHRP 161.00 301563 5MOCITYB1 161.00 1	**Contingent on GI-101/102:** Rebuild 23.2 mile long Missouri City-Lathrop 161 kV line to 1192 ACSS at 200C. Upgrade jumpers at Lathrop and Missouri City on line to 1192 ACSS at 200C. Upgrade relay limits at Missouri City to 477 MVA Summer, 595 MVA Winter minimum.
CF50	300107 5OSBORN 161.00 300290 2OSBORN 69.000 1	**Contingent on GI-101/102:** Osborn Upgrades: -Construct a new 161 kV switchyard called Shoal Creek ~0.5 miles east of Rockies Express. - Cut existing REX-Osborn 161 kV line in/out of new switchyard. - Rebuild 12.2 mile long Osborn-Shoal Creek 161 kV line to 1192 ACSR at 100C. - Upgrade jumpers at Osborn on line to 1192 ACSR. - Upgrade disconnect switches at Osborn on line to 2,000 amp switches. - Upgrade bushing CTs at Osborn on line to 2,000 base amps.

Constraint ID	Monitored Facility	Network Upgrade
CF51	300290 2OSBORN 69.000 301629 2OSBORNTPS 69.000 1	**Contingent on GI-101/102:** See upgrades on CF50
CF52	300292 2CAMERN 69.000 301629 2OSBORNTPS 69.000 1	
CF53	300137 4BRISTOW 138.00 300140 4SILVCTY 138.00 1	**Contingent on GI-103:** Rebuild 21.6 mile Bristow-Silver City 138 kV line to 1192 ACSR at 100C. At Bristow 138 kV substation: - Upgrade wave trap to 2000 A. - Upgrade jumpers to 1192 ACSR. - Upgrade disconnect switches to 2000 A. - Upgrade breaker switchers to 2000 A. At Silver City 138 KV substation: - Upgrade jumpers to 1192 ACSR.
CF54	300137 4BRISTOW 138.00 300686 4WOODY 138.00 1	**Contingent on GI-103:** Rebuild 21.7 mile Bristow-Woody 138 kV line to 1192 ACSR at 100C. At Bristow 138 kV substation: - Upgrade wave trap to 2000 A. - Upgrade jumpers to 1192 ACSR. - Upgrade disconnect switches to 2000 A. - Upgrade breaker switchers to 2000 A. - Upgrade bushing CTs to 2000 A. At Woody 138 KV substation: - Upgrade jumpers to 1192 ACSR.
CF55	300137 4BRISTOW 138.00 300889 2BRIISTOW 69.000 2	**Contingent on GI-103:** Upgrade existing Bristow 138/69 kV transformer to a 112 MVA Summer/127 MVA Winter rated unit. Add a second 138/69 kV transformer at Bristow with rating of 112 MVA Summer/127 MVA Winter.
CF56	300686 4WOODY 138.00 521026 PHAROAH4 138.00 1	**Contingent on GI-103:** Rebuild 13.40 mile Woody-Pharoah 138 kV line to 1192 ACSR at 100C. At Woody 138 kV substation: - Upgrade jumpers to 1192 ACSR. At Pharoah 138 kV substation: - Upgrade jumpers to 1192 ACSR.
CF57	300889 2BRIISTOW 69.000 513092 BEGGS 2 69.000 1	**Contingent on GI-103:** Rebuild 0.90 mile KAMO owned line section of Bristow-Beggs 69 kV line to 336 ACSR at 100C.
CF58	300196 2WOODY 69.000 300906 2NUYAKA 69.000 1	**Contingent on AECI:** See upgrade for CF63 below. **Contingent on GI-105:** Rebuild 9.4 mile Woody-Nuyaka 69 kV line to 336 ACSR at 100C.
CF59	300906 2NUYAKA 69.000 513092 BEGGS 2 69.000 1	**Contingent on AECI:** See upgrade for CF63 below. **Contingent on GI-105:** Rebuild 9.20 mile Beggs-Nuyaka 69 kV line to 336 ACSR at 100C
CF60	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	**Contingent on DISIS-2018-001:** Replace the Morgan 345/161 kV transformer with a unit rated 560 MVA Summer and 638 MVA Winter. Upgrade 161 kV breaker switchers and relay limits as needed to accommodate larger transformer rating.
CF61	300043 7KINGDM 345.00 300090 5KINGDMB1 161.00 1	**Contingent on GI-113[8]:** Install a second 345/161 kV transformer rated for 560 MVA Summer, 638 MVA Winter at Kingdom City.
CF62	300520 2REFORM 69.000 300626 2CHAMOI 69.000 1	**Contingent on GI-113[8]**: Upgrade Bushing CT's to 600A rating at the Chamois bus on Chamois-Reform 69 kV line.

Constraint ID	Monitored Facility	Network Upgrade
CF63	300889 2BRIISTOW 69.000 300898 2GYPSY 69.000 1	**Contingent on AECI:** Rebuild and convert 9.5-mile-long section of Bristow-Gypsy 69 kV line to 138 kV 1192.5 ACSR at 100C -Convert Gypsy substation to 138kV. -Install a GOAB near Gypsy station to create a 3 terminal 138 kV line between Stroud, Gypsy, and Bristow. -Build additional 138kV bay at Bristow. -Re-terminate line at Bristow sub to land on 138kV bay. Rebuild and convert 0.09-mile-long section of Gypsy-Stroud 69 kV line to 138 kV 1192.5 ACSR at 100C. -Build additional 138kV bay at Stroud. -Re-terminate line at Stroud sub to land on 138 kV bay.
CF64	300773 2ELKTON 69.000 300817 2OSCEOLA 69.000 1	**Contingent on AECI:** Rebuild and convert Buffalo Area to 161 kV. -Add 84 MVA 161/69 kV transformer at Buffalo. -Rebuild March-Buffalo-Long Lane 69 kV lines to 161 kV at 795 ACSR at 100C. -Convert Long Lane and March load substations to 161 kV. -Convert Long Lane-Phillipsburg and Cross Way-March to 161 kV operation. They are currently designed for 161 kV but operated at 69 kV.
CF65	301050 2CONWY 69.000 301071 2PBURG 69.000 1	
CF66	300069 5CHOTEAU1 161.00 512648 MAID 5 161.00 1	**Contingent on Prior Queued Studies:** Overload will be mitigated by upgrades tagged to higher queue request. Final scope of the upgrades tagged to higher queue request are still being developed.

No upgrades were evaluated for the neighboring system constraints listed in Table 4. The upgrades for these impacts may need to be resolved through coordination with the transmission owner as listed in Table 6 below.

Table 6: Neighboring System Constraints

Constraint ID	Monitored Facility	Network Upgrade
AFS01	300071 5CLINTN 161.00 761278 G17-108-TAP 161.00 1	MLE owned by KCPL; no upgrade evaluated.
AFS02	300098 5MOCITYB2 161.00 541248 LBRTYST5 161.00 1	MLE owned by KCPL; no upgrade evaluated.
AFS03	300740 7SPORTSMAN 345.00 512650 GRDA1 7 345.00 1	MLE owned by GRDA; no upgrade evaluated.

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 requests as shown in Table 7.

Table 7: Network Upgrade Costs

ID	Option/Description	Estimated Cost	Estimated Lead Time[10]
NU01	Upgrade separately mounted bushing CTs on Morgan-Dadeville 161 kV line (at Morgan) to 2,000 amp rating.	$500,000	36 months
NU02	Rebuild 26.5 mile long line from Morgan-Brookline 161 kV to 1192 ACSR, rated at 100C.	$20,352,000	48 months
NU03	Rebuild 1.2 mile long line from Lamar City North-Lamar Rural South 69 kV to 336 ACSR, rated at 100C.	$1,000,000	36 months
NU04	Rebuild 4.5 mile long line from Lamar-Jackson Street 69 kV to 795 ACSR, rated at 100C.	$3,456,000	36 months
NU05	Rebuild 0.3 mile long line from Lamar City North-Jackson Street 69 kV to 336 ACSR, rated at 100C.	$500,000	36 months
NU06	Rebuild 2.4 mile long line from Richland-Boston 69 kV (AECI owned portion) to 336 ACSR, rated at 100C.	$1,740,000	36 months
NU07/08/09/10	Adjustment of transformer taps required to mitigate overload.	$0	-

[10] Estimated Lead Time is the estimated time to place a network upgrade in service once AECI has received Provision of Security equal to the total Estimated Cost of the Network Upgrade.

ID	Option/Description	Estimated Cost	Estimated Lead Time[10]
N11	Rebuild 2.6 mile 161 kV line from Truman to Lost Valley to 1192 ACSR at 100C[11]	See footnote	See footnote
	Total:	$27,548,000	

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

[11] SPP identified Facility as overloaded in their study of DISIS-2021. AECI owns limiting equipment on this facility and has provided SPP an estimated cost to perform work shown. Reference SPP report for cost information on this facility.

COST ALLOCATION

Network upgrade costs are allocated to each of the Study Cycle projects based on the worst MW impact[12] 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 in the season it was reported:

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

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

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

2. Determine the maximum MW% impact each generator has as a percentage of the total Study Cycle impact on a given constraint.

$$X2\ =\ Project\ X\ MW\ impact\ \%\ = \frac{X1}{Total\ MW\ Impact\ of\ Study\ Cycle\ on\ Constraint}$$

$$Y2\ =\ Project\ Y\ MW\ impact\ \%\ = \frac{Y1}{Total\ MW\ Impact\ of\ Study\ Cycle\ on\ Constraint}$$

$$Z2\ =\ Project\ Z\ MW\ impact\ \%\ = \frac{Z1}{Total\ MW\ Impact\ of\ Study\ Cycle\ on\ Constraint}$$

3. Apply three percent (3%) MW impact De Minimis Threshold: If a Study Cycle project MW% impact is less than 3% for a particular constraint then the project MW% impact is adjusted to 0 for that constraint and the Study Cycle project will not be allocated cost for that particular constraint.

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

$$Project\ X\ Upgrade\ 1\ Cost\ Allocation\ (\$) = \frac{Network\ Upgrade\ 1\ Cost\ (\$) * X2}{X2 + Y2 + Z2}$$

The associated cost allocation of the network upgrades to each of the Study Cycle projects is shown below in Table 8. Further breakdown of costs is provided in Appendix B.

[12] All negative MW impacts (helpers) were set to 0 MW impact.

Table 8: Network Upgrade Cost Allocation

Project	Cluster Group	POI	MW	Total Cost
GEN-2021-001	04 SOUTHEAST	138kV Brown Substation	100	**$0**
GEN-2021-004[1]	04 SOUTHEAST	Poolville 138kV Bus	250	**$0**
GEN-2021-005	03 CENTRAL	Summit 345 kV substation in Saline County, KS	350	**$1,567,534**
GEN-2021-006	03 CENTRAL	Neosho 345kV substation in Labette County, KS	300	**$3,225,881**
GEN-2021-007	02 NEBRASKA	345kV bus of Turtle Creek Substation	600	**$1,636,782**
GEN-2021-008	01 NORTH	345kV Bus at BEPC Patent Gate Substation, McKenzie County, ND	200	**$0**
GEN-2021-010	04 SOUTHEAST	Border 345 kV interconnection substation	233.98	**$0**
GEN-2021-012	04 SOUTHEAST	Border 345 kV interconnection substation	227	**$0**
GEN-2021-014	04 SOUTHEAST	Border 345 kV interconnection substation	233.98	**$0**
GEN-2021-016[13]	04 SOUTHEAST	Sunnyside-Johnston 345 kV	250	**$0**
GEN-2021-018	04 SOUTHEAST	Sooner 345 kV	235.35	**$0**
GEN-2021-019	04 SOUTHEAST	Sooner 345 kV	75.89	**$0**
GEN-2021-023	03 CENTRAL	Wild Plains 345kV Substation	306.18	**$1,223,681**
GEN-2021-024	01 NORTH	WAPA 230kV Jamestown Substation	203.04	**$0**
GEN-2021-025	04 SOUTHEAST	Western Farmers 138kV Mooreland Substation	203.04	**$0**
GEN-2021-027	02 NEBRASKA	Olive Creek 115 kV Substation	102.06	**$0**
GEN-2021-028	04 SOUTHEAST	Western Farmers 138kV Mooreland Substation	204.12	**$0**
GEN-2021-029	03 CENTRAL	Evergy Tap the La Cygne to Stillwell 345 kV Line	253.8	**$2,025,870**
GEN-2021-030	03 CENTRAL	Evergy Tap the La Cygne to Stillwell 345 kV Line	510.3	**$4,073,291**
GEN-2021-033	04 SOUTHEAST	Grand Prairie 161kV Substation	204.12	**$0**
GEN-2021-034	02 NEBRASKA	Rokeby 115 kV Substation	113	**$0**
GEN-2021-036	04 SOUTHEAST	Craig to Patterson 138 kV Transmission Line	204.12	**$0**
GEN-2021-037	02 NEBRASKA	NPPD Sidney to Keystone 345 kV Line	244.22	**$0**
GEN-2021-038[13]	04 SOUTHEAST	Welsh 345kV Substation	201.32	**$0**
GEN-2021-039	02 NEBRASKA	New 161kV substation looping in OPPD 161kV lines S1211 to S1220 and S1211 to S1299	100	**$0**
GEN-2021-040	02 NEBRASKA	OPPD District, Cass County Power Plant Substation, 345kV Bus	200	**$0**
GEN-2021-041	04 SOUTHEAST	Mustang 138kV Substation	100.657	**$0**
GEN-2021-042	03 CENTRAL	Independence Power & Light, Blue Valley Substation, 161kV Bus	100	**$0**
GEN-2021-043	02 NEBRASKA	8000 SW 12th (Rokeby) Station, 115kV Bus	250	**$0**
GEN-2021-047	04 SOUTHEAST	Tulsa (Bus #509852) - Igloo (Bus #513596) 345kV line	250	**$0**
GEN-2021-048	02 NEBRASKA	Wagener 115kV Substation	75	**$0**
GEN-2021-049	02 NEBRASKA	Wagener 115kV Substation	250	**$0**
GEN-2021-050	03 CENTRAL	161kV Stilwell-Clinton Line	200	**$2,402,822**
GEN-2021-051	03 CENTRAL	161kV Stilwell-Clinton Line	75	**$676,826**
GEN-2021-053	04 SOUTHEAST	Pecan Creek 345 kV Substation	300	**$0**
GEN-2021-056	03 CENTRAL	Viola 345kV Substation	300	**$885,234**
GEN-2021-057	02 NEBRASKA	Antelope 345kV substation	300	**$666,156**

[13] MW used in Cost Allocations reflects the latest information available in SPP's queue.

Project	Cluster Group	POI	MW	Total Cost
GEN-2021-063	04 SOUTHEAST	Craig JCT 138kV	155	**$0**
GEN-2021-064	04 SOUTHEAST	Carnegie South 138kV	100	**$0**
GEN-2021-068	03 CENTRAL	SUNC Spearville - Holcomb 345kV	249.6	**$0**
GEN-2021-069	03 CENTRAL	SUNC Spearville - Holcomb 345kV	249.6	**$0**
GEN-2021-070	03 CENTRAL	SUNC Spearville - Holcomb 345kV	504	**$1,266,366**
GEN-2021-072	01 NORTH	345kV Transmission Line from Antelope Valley to Leland Olds Substation	600	**$1,385,901**
GEN-2021-073	02 NEBRASKA	Tap on the Sweetwater to Gerald Gentleman 345 kV Line	240	**$0**
GEN-2021-075	04 SOUTHEAST	CAMPCOR4 138kV Substation	300	**$0**
GEN-2021-077	03 CENTRAL	Windsor to AEC Sedalia 161 kV	95	**$747,513**
GEN-2021-086	04 SOUTHEAST	Okay - Turk 138kV	165	**$0**
GEN-2021-088	04 SOUTHEAST	Cedar Lane - Canadian 138 kV Transmission Line	100	**$0**
GEN-2021-090	05 SOUTHWEST	Yoakum 345kV Substation	400	**$0**
GEN-2021-096	03 CENTRAL	Wolf Creek - Benton 345 kV	500	**$4,966,537**
GEN-2021-098	04 SOUTHEAST	Dewey District 138 kV Substation	160	**$0**
GEN-2021-101	03 CENTRAL	Evergy's Midland Substation 115kV bus	159	**$0**
GEN-2021-103	03 CENTRAL	Evergy's Atlantic Substation115kV bus	150	**$0**
GEN-2021-106	02 NEBRASKA	Hebron North 115Kv substation	102.06	**$0**
GEN-2021-107	03 CENTRAL	Evergy 345kV Jeffrey Energy Center	201.6	**$797,607**
GEN-2021-108	02 NEBRASKA	OPPD 345KV Cass County Substation	182.25	**$0**
			Total Cost	**$27,548,000**

VERSION HISTORY

Version Number and Date	Author	Change Description
V0 – 06/20/2024	AECI	Initial release