Generation Interconnection
REVISED System Impact Study Report

For

PJM Generation Interconnection
Request Queue Position AB1-087

Sullivan 345 kV

February 2022

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner. In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Invenergy Thermal Development (Invenergy) proposes to interconnect a 575.0 MW (550.0 MW Capacity) natural gas fired Electric Power Plant to the American Electric Power (AEP) Transmission System. The point of interconnection is a direct connection to AEP's Sullivan 345 kV substation as shown in Figures 1 and 2. The proposed PJM Project #AB1-087 is located in Sullivan County, Indiana.

Generating Facility Capability	Summer	Winter
Total net capacity output (CIR)	550 MW	
Total net energy output (energy resource)	550 MW	575 MW

Table 1

The requested in service date is June 1, 2019.

Attachment Facilities

Point of Interconnection (Sullivan 345 kV)

To accommodate the interconnection at the Sullivan 345 kV substation, the Sullivan substation will have to be expanded requiring one (1) additional 345 kV circuit breaker (see Figure 1). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.

Station Work and Cost:

- Install one (1) new 345 kV circuit breaker and associated bus work. Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.
    - **Estimated Station Cost: $1,700,000**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following tables below:

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
345 kV Revenue Metering	$350,000
Total	**$350,000**

Table 2

Interconnection Customer Requirements

It is understood that Invenergy is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Invenergy generating plant and the costs for the line connecting the generating plant to Invenergy switching station are not included in this report; these are assumed to be Invenergy responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.
2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Network Impacts

The Queue Project AB1-087 was evaluated as a 550.0 MW (Capacity 550.0 MW) injection into the Breed/Sullivan 345 kV substation in the AEP area. Project AB1-087 was evaluated for

compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Organizations, and Transmission Owners). Project AB1-087 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

Contingencies

Contingency Name	Description
BF_ALDE_2-8_LT	CONTINGENCY 'BF_ALDE_2-8_LT' DISCONNECT BUS 218307 /* ALDENE BUS SECTION 2 DISCONNECT BUS 218430 /* STANELTY TERRACE BUS SECTION 1 DISCONNECT BUS 219038 /* ALDENE BUS SECTION 8 DISCONNECT BUS 219053 /* WESTFIELD SECTION 2 CLOSE LINE FROM BUS 218415 TO BUS 218416 CKT 1 /* WESTFIELD END
BF_MET2_7-8_LT	CONTINGENCY 'BF_MET2_7-8_LT' DISCONNECT BRANCH FROM BUS 218394 TO BUS 218469 CKT 1 /* AB 132-1 26KV TX DISCONNECT BUS 218355 /* NEW DOVER REMOVE H DISCONNECT BUS 218357 /* REMOVE PIERSON H DISCONNECT BUS 218320 /* REMOVE FANWOOD SECTION 1 DISCONNECT BUS 218367/* WOOD BRIDGE REMOVE V DISCONNECT BUS 218335 /* LAFAYETTE V CLOSE LINE FROM BUS 218401 TO BUS 218402 CKT 1 /* PIERSON AVE CLOSE LINE FROM BUS 218428 TO BUS 218429 CKT 1 /* PIERSON AVE MOVE 8 MW LOAD FROM BUS 218401 TO BUS 218384 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO KILMER T2 MOVE 8 MW LOAD FROM BUS 218401 TO BUS 218399 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO NEWDOVR T2 MOVE 8 MW LOAD FROM BUS 218402 TO BUS 218399 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO NEWDOVR T2 MOVE 8 MW LOAD FROM BUS 218402 TO BUS 218390 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO LAFAYET T2 CLOSE LINE FROM BUS 218398 TO BUS 218399 CKT 1 /* NEW DOVER MOVE 8 MW LOAD FROM BUS 218398 TO BUS 218412 /*

Contingency Name	Description
	INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO WDBRDG T2 MOVE 8 MW LOAD FROM BUS 218398 TO BUS 218391 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO LAFAYET T1 MOVE 8 MW LOAD FROM BUS 218399 TO BUS 218401 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO PRSNAVS T1 MOVE 8 MW LOAD FROM BUS 218399 TO BUS 218402 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO PRSNAVS T2 CLOSE LINE FROM BUS 218380 TO BUS 218381 CKT 1 /* FANWOOD MOVE 8 MW LOAD FROM BUS 218381 TO BUS 218415 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO WESTFIELD T1 MOVE 8 MW LOAD FROM BUS 218380 TO BUS 218374 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO ALDENE T10 MOVE 8 MW LOAD FROM BUS 218381 TO BUS 216926 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO SPRINGRD T1 MOVE 8 MW LOAD FROM BUS 218380 TO BUS 216927 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO SPRINGRD T2 END
G2207+H2286_LT	CONTINGENCY 'G2207+H2286_LT' /*FANWOOD-METUCHEN & LINDEN-DEANS DISCONNECT BUS 218354 /* MINUE STREET G DISCONNECT BUS 218355 /* NEW DOVER REMOVE H DISCONNECT BUS 218357 /* REMOVE PIERSON H DISCONNECT BUS 218320 /* REMOVE FANWOOD SECTION 1 CLOSE LINE FROM BUS 218401 TO BUS 218402 CKT 1 /* PIERSON AVE CLOSE LINE FROM BUS 218428 TO BUS 218429 CKT 1 /* PIERSON AVE MOVE 8 MW LOAD FROM BUS 218401 TO BUS 218384 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO KILMER T2 MOVE 8 MW LOAD FROM BUS 218401 TO BUS 218399 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO NEWDOVR T2 MOVE 8 MW LOAD FROM BUS 218402 TO BUS 218399 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO NEWDOVR T2 MOVE 8 MW LOAD FROM BUS 218402 TO BUS 218390 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO LAFAYET T2 CLOSE LINE FROM BUS 218398 TO BUS 218399 CKT 1 /* NEW DOVER MOVE 8 MW LOAD FROM BUS 218398 TO BUS 218412 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO WDBRDG T2

Contingency Name	Description
	MOVE 8 MW LOAD FROM BUS 218398 TO BUS 218391 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO LAFAYET T1 MOVE 8 MW LOAD FROM BUS 218399 TO BUS 218401 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO PRSNAVS T1 MOVE 8 MW LOAD FROM BUS 218399 TO BUS 218402 /* INTERSTATION TIE TRANSFER LOAD FROM NEWDOVR TO PRSNAVS T2 CLOSE LINE FROM BUS 218380 TO BUS 218381 CKT 1 /* FANWOOD MOVE 8 MW LOAD FROM BUS 218381 TO BUS 218415 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO WESTFIELD T1 MOVE 8 MW LOAD FROM BUS 218380 TO BUS 218374 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO ALDENE T10 MOVE 8 MW LOAD FROM BUS 218381 TO BUS 216926 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO SPRINGRD T1 MOVE 8 MW LOAD FROM BUS 218380 TO BUS 216927 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO SPRINGRD T2 CLOSE LINE FROM BUS 218396 TO BUS 218397 CKT 1 /* MINUE STREET MOVE 8 MW LOAD FROM BUS 218397 TO BUS 218413 /* INTERSTATION TIE TRANSFER LOAD FROM MINUEST TO WDBRDG T3 MOVE 8 MW LOAD FROM BUS 218396 TO BUS 218414 /* INTERSTATION TIE TRANSFER LOAD FROM MINUEST TO WDBRDG T1 MOVE 8 MW LOAD FROM BUS 218397 TO BUS 218410 /* INTERSTATION TIE TRANSFER LOAD FROM MINUEST TO WARINICO T1 MOVE 8 MW LOAD FROM BUS 218396 TO BUS 218414 /* INTERSTATION TIE TRANSFER LOAD FROM MINUEST TO WDBRDG T1 END

Contingency Name	Description
H2286+W2249_LT	CONTINGENCY 'H2286+W2249_LT' /* DEANS - WESTFIELD & METUCHEN - FANWOOD DISCONNECT BUS 218355 /* NEW DOVER REMOVE H DISCONNECT BUS 218357 /* REMOVE PIERSON H DISCONNECT BUS 218320 /* REMOVE FANWOOD SECTION 1 DISCONNECT BUS 218305 /* REMOVE WESTFIELD BUS 1 DISCONNECT BUS 218356 /* RMEOVE NEW DOVER BUS W SIDE DISCONNECT BUS 218398 /* NEW DOVER LOAD LOSS DISCONNECT BUS 218399 /* NEW DOVER LOAD LOSS CLOSE LINE FROM BUS 218415 TO BUS 218416 CKT 1 /* WESTFIELD CLOSE LINE FROM BUS 218401 TO BUS 218402 CKT 1 /* PIERSON AVE CLOSE LINE FROM BUS 218428 TO BUS 218429 CKT 1 /* PIERSON AVE MOVE 8 MW LOAD FROM BUS 218401 TO BUS 218384 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO KILMER T2 MOVE 8 MW LOAD FROM BUS 218401 TO BUS 218399 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO NEWDOVR T2 MOVE 8 MW LOAD FROM BUS 218402 TO BUS 218399 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO NEWDOVR T2 MOVE 8 MW LOAD FROM BUS 218402 TO BUS 218390 /* INTERSTATION TIE TRANSFER LOAD FROM PRSNAVS TO LAFAYET T2 CLOSE LINE FROM BUS 218380 TO BUS 218381 CKT 1 /* FANWOOD MOVE 8 MW LOAD FROM BUS 218381 TO BUS 218415 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO WESTFIELD T1 MOVE 8 MW LOAD FROM BUS 218380 TO BUS 218374 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO ALDENE T10 MOVE 8 MW LOAD FROM BUS 218381 TO BUS 216926 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO SPRINGRD T1 MOVE 8 MW LOAD FROM BUS 218380 TO BUS 216927 /* INTERSTATION TIE TRANSFER LOAD FROM FANWOOD TO SPRINGRD T2 END
L_G-2285/* ALDENE TO SPRINGFIELD ROAD	CONTINGENCY 'L_G-2285/* ALDENE TO SPRINGFIELD ROAD' DISCONNECT BUS 218345 /* ALDENE BUS SECTION 6 DISCONNECT BUS 216911 /* SPRINGFIELD RD BUS SECTION2

Contingency Name	Description
	END
L_G-2285_LT/* ALDENE TO SPRINGFIELD ROAD	CONTINGENCY 'L_G-2285_LT/* ALDENE TO SPRINGFIELD ROAD' DISCONNECT BUS 218345 /* ALDENE BUS SECTION 6 DISCONNECT BUS 216911 /* SPRINGFIELD RD BUS SECTION2 CLOSE LINE FROM BUS 218374 TO BUS 218375 CKT 1 /* ALDENE 10 MOVE 8 MW LOAD FROM BUS 218375 TO BUS 218416 /* INTERSTATION TIE TRANSFER LOAD FROM ALDENE TO WESTFIELD T2 MOVE 8 MW LOAD FROM BUS 218374 TO BUS 218380 /* INTERSTATION TIE TRANSFER LOAD FROM ALDENE TO FANWOOD T2 MOVE 8 MW LOAD FROM BUS 218375 TO BUS 216932 /* INTERSTATION TIE TRANSFER LOAD FROM ALDENE TO DORMPL T2 MOVE 8 MW LOAD FROM BUS 218374 TO BUS 218410 /* INTERSTATION TIE TRANSFER LOAD FROM ALDENE TO WARINICO T1 CLOSE LINE FROM BUS 216926 TO BUS 216927 CKT 1 /* SPRING LOAD MOVE 8 MW LOAD FROM BUS 216927 TO BUS 218380 /* INTERSTATION TIE TRANSFER LOAD FROM SPRINGRD TO FANWOOD T2 MOVE 8 MW LOAD FROM BUS 216926 TO BUS 218320 /* INTERSTATION TIE TRANSFER LOAD FROM SPRINGRD TO FANWOOD T1 MOVE 8 MW LOAD FROM BUS 216926 TO BUS 216930 /* INTERSTATION TIE TRANSFER LOAD FROM SPRINGRD TO DORMPL T1 MOVE 8 MW LOAD FROM BUS 216926 TO BUS 216931 /* INTERSTATION TIE TRANSFER LOAD FROM SPRINGRD TO DORMPL T3 MOVE 8 MW LOAD FROM BUS 216927 TO BUS 216931 /* INTERSTATION TIE TRANSFER LOAD FROM SPRINGRD TO DORMPL END
L_H-2286	CONTINGENCY 'L_H-2286' /* FANWOOD TO METUCHEN DISCONNECT BUS 218355 /* NEW DOVER REMOVE H DISCONNECT BUS 218357 /* REMOVE PIERSON H DISCONNECT BUS 218320 /* REMOVE FANWOOD SECTION 1 END
L_J-2315	CONTINGENCY 'L_J-2315' /* MCCARTER TO STANLEY TERRACE DISCONNECT BUS 217101 /* STAN TERRANCE SECTION 2 REMOVE

Contingency Name	Description
	END
L_N-2240	CONTINGENCY 'L_N-2240' /* WARRINCO TO ALDENE DISCONNECT BUS 218316 /* WARRINCO SECTION 2 DISCONNECT BUS 217122 /* ALDENE SECTION 5 END
L_U-2273	CONTINGENCY 'L_U-2273' /* VFT TO WARRNICO DISCONNECT BUS 219050 /* VFT SECTION 1 DISCONNECT BUS 219049 /* WARRINACO 1 END
T_LIND3_2301	CONTINGENCY 'T_LIND3_2301' /* LINDEN 345 TO LINDEN 230 KV AUTO TRANSFORMER DISCONNECT BRANCH FROM BUS 217958 TO BUS 218300 CKT 1 /* 230-345KV AUTO TX LINDEN345-LINDE230 END

Table 3

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	N-1	667_B2_TOR1697	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	AC	80.29	90.29	NR	971	94.25	
2	N-1	672_B2_TOR1713	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	AC	89.08	95.42	NR	971	59.25	
3	N-1	363_B2_TOR1682	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	78.99	93.53	NR	1332	193.7	
4	N-1	667_B2_TOR1697	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	AC	80.29	90.29	NR	971	94.25	
5	N-1	363_B2_TOR1682	CE - CE	LORETTO ; B-WILTON ; B 345 kV line	270704	270926	1	DC	98.98	101.14	ER	1280	27.7	
6	N-1	363_B2_TOR1682	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	DC	97.82	100.07	ER	1241	27.87	
7	N-1	345-L8002___-S	MISO AMIL - CE	7BROKAW-Z2-087 TAP 345 kV line	348847	917500	1	AC	96.8	98.94	ER	1528	33.17	1
8	N-1	345-L8002___-S	CE - CE	Z2-087 TAP-PONTIAC ; R 345 kV line	917500	270853	1	AC	97.87	100.02	ER	1528	33.17	2

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
9	N-1	SPS-2102&2106_A	CE - CE	Z2-087 TAP-PONTIAC ; R 345 kV line	917500	270853	1	AC	95.58	97.84	ER	1528	33.54	

Table 4

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
10	DCTL	6094	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	AC	93.03	98.61	ER	4571	193.24	3
11	LFFB	3130_C2_05EUGENE 345-B2	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	AC	89.7	95.52	ER	4571	195.08	
12	LFFB	3107_C2_05BREED 345-C	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	AC	98.57	101.39	ER	1304	43.28	
13	LFFB	8648_C2_05JEFRSO 765-B	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	AC	99.07	101.51	ER	1304	37.44	

Table 5

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
14	LFFB	1760_C2_05JEFRSO 765-A	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	112.39	117.95	ER	2354	130.99	4
15	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	128.57	140.87	NR	971	119.47	5
16	LFFB	8648_C2_05JEFRSO 765-B	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	119.19	127.62	ER	1419	119.63	
17	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	118.74	127.08	NR	971	80.97	6
18	LFFB	8648_C2_05JEFRSO 765-B	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	113.07	119.32	ER	1304	81.5	
19	LFFB	8648_C2_05JEFRSO 765-B	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	128.34	141.57	ER	1466	193.98	7
20	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	128.57	140.87	NR	971	119.47	8
21	LFFB	8648_C2_05JEFRSO 765-B	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	119.19	127.62	ER	1419	119.63	
22	LFFB	6485_C2_05DEQUIN 345-C1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	142.9	148.04	ER	1304	67.08	9
23	N-1	6490_B2_TOR16000	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	AC	125.5	132.74	NR	971	66.35	

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
24	N-1	363_B2_TOR1682	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	101.71	107.46	NR	971	55.85	
25	LFFB	4704_C2_05DEQUIN 345-B1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	142.9	148.04	ER	1304	67.08	10
26	N-1	6472_B2_TOR15258	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	AC	125.5	132.74	NR	971	66.35	
27	N-1	363_B2_TOR1682	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	101.71	107.46	NR	971	55.85	
28	N-1	667_B2_TOR1697	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	AC	108.9	113.49	NR	971	41.13	11
29	N-1	363_B2_TOR1682	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	108.57	112.33	NR	971	36.51	
30	LFFB	8648_C2_05JEFRSO 765-B	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	145.17	149.93	ER	1918	91.4	12
31	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	119.56	125.93	NR	1409	89.77	
32	N-1	362_B2_TOR1680	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	AC	101.48	105.88	NR	1409	60.54	
33	N-1	345-L8014_T_-S	CE - CE	LORETTO ; B-WILTON ; B 345 kV line	270704	270926	1	AC	127.09	129.42	ER	1280	29.23	13
34	N-1	345-L8014_T_-S	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	AC	126.5	128.91	ER	1241	29.4	14
35	N-1	345-L11212_B-S	CE - CE	PONTIAC ; R-DRESDEN ; R 345 kV line	270853	270717	1	AC	107.73	109.77	ER	1481	30.22	15
36	N-1	345-L8012__B-S	CE - CE	PONTIAC ; R-DRESDEN ; R 345 kV line	270853	270717	1	AC	105.7	107.74	ER	1481	30.31	
37	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	134.38	137.36	ER	1370	40.78	16

Table 6

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

- The output of AB1-087 contributes to the steady-state voltage constraints (voltage collapse) identified in the X3-028 MTX Study. The constraints are caused by the single contingency loss of the Jefferson – Rockport 765 kV line, as well as various stuck breaker contingencies at Jefferson and Rockport involving the Jefferson – Rockport 765 kV line.
  The solution for these voltage constraints is to build a new 765 kV line from Sullivan to Reynolds. AB1-087 will have some cost responsibility for the new 765 kV line from Sullivan to Reynolds. Reference the **Contribution to Previously Identified System Reinforcements** section below for more details.

Short Circuit

(Summary of impacted circuit breakers)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

No mitigations were found to be required. See Attachment 1.

Affected System Analysis & Mitigation

LGEE Impacts:

AB1-087 contributes to the Trimble - Clifty 345 kV line capacity import limit (CIL) constraint. The LG&E proposed upgrade is to reconductor the line with a high temperature conductor and upgrade necessary terminal equipment to achieve ratings of 2610/2610 MVA SN/SE. Cost estimate is $17.4M with a time estimate of 18 months. PJM Network Upgrade N5469. AB1-087 will have some responsibility for this cost. Reference the **Contribution to Previously Identified System Reinforcements** section below for more details.

MISO Impacts:

None

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

Note: This OVEC constraint and upgrade is provided as information only. OVEC is currently not part of PJM, but is planning to integrate into PJM. The customer may have cost responsibility for this upgrade if and when OVEC integrates into PJM as planned.

OVEC Impacts have been identified on the Clifty – Dearborn 345 kV line. AB1-087 contributes loading onto the Clifty – Dearborn 345 kV line (956 MVA emergency rating) for the stuck breaker contingency loss of the Jefferson – Greentown 765 kV line and loss of the Jefferson – Hanging Rock 765 kV line.

There is a planned 2018 baseline upgrade, B2943, to perform a LIDAR study on the line. OVEC does not yet know the new expected SE rating.

If the LIDAR study shows that OVEC can go to the full 311 degree conductor rating, OVEC could obtain a SE rating of 1384 MVA.
However, after reviewing the plan profiles, OVEC is not certain the LIDAR will support this 1384 MVA SE rating.
OVEC believes there will be sufficient clearance to support an increase in the conservative rating, but not the full 311 degree conductor rating.

Options may be to construct intermediate supporting structures to increase clearance distances, or reconductoring.
Cost estimates are:
Towers: xx Poles at $350,000 each. The number is unknown at this time, pending results of LIDAR.
Reconductor: 42 miles of line, estimated at $1,500,000 to $3,000,000 per mile per line,

depending on the type of conductor used and the modifications to the suspension systems required.

The LIDAR study and results of the LIDAR study will need to be determined during the Facilities Study phase of AB1-087.

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request. Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

Not Applicable

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

1. To relieve the Borkaw – Z2-087 Tap – Pontiac 345 kV line overloads: The ComEd SSTE rating is 1793 MVA and is sufficient. No upgrades required.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1. To relieve all AEP (and AEP tie line) constraints identified:
    a. The planned upgrade is to build a new Sullivan – Reynolds 765 kV line (N5034). The need is driven by the X3-028 MTX project.

    Sullivan – Reynolds 765 kV line: $442 million
    Work at Sullivan Station: $6 million
    Work at Reynolds Station: $16 million
    Total Cost: $464 million
    (3) three to (4) four years to build once ICSA is signed.

    AB1-087 will receive cost allocation as follows:

Queue	MW contribution	Percentage of Cost	$ Cost ($464 M)
X3-028	1230.5	0.863	400.499
AB1-087	195.1	0.137	63.501

Table 7

    b. PJM Baseline Upgrade B2449 – Rebuild the 7-mile 345 kV line between Meadowlake and Reynolds 345 kV stations. This upgrade is presently in-service. AB1-087 will have no cost responsibility for this upgrade.
    c. PJM Supplemental Project S1141 – Loop in the Meadowlake – Olive 345 kV circuit into Reynolds. This upgrade is presently in-service. AB1-087 will have no cost responsibility for this upgrade.

2. To relieve the Trimble – Clifty 345 kV line constraint identified: The LG&E proposed upgrade is to reconductor the line with a high temperature conductor and upgrade necessary terminal equipment to achieve ratings of 2610/2610 MVA SN/SE. Cost estimate is $17.4M with a time estimate of 18 months. PJM Network Upgrade N5469. AB1-087 will have some responsibility for this cost.
   AB1-087 will receive cost allocation as follows:

Queue	MW contribution	Percentage of Cost	$ cost ($17.4 M)
X3-028 MTX	131.3	76.29%	13.275
AB1-087	40.8	23.71%	4.125

Table 8

3. To relieve the Loretto – Wilton 345 kV line overloads: there is a planned 2019 baseline upgrade B2728 to mitigate sag limitations and replace station conductor at Wilton Center. The new ratings to be 1364/1528/1846/2221 SN/SLTE/SSTE/SLD and are sufficient. AB1-087 has no cost responsibility for this upgrade.

4. To relieve the Pontiac - Loretto 345 kV line overloads: baseline upgrade B2732.2 to raise towers to remove the sag limitations is in-service. The new ratings are 1364/1528/1846/1912/2199 and are sufficient. AB1-087 has no cost responsibility for this upgrade.

5. To relieve the Pontiac – Dresden 'R' 345 kV line overloads: The ComEd SSTE rating is 1797 MVA and is sufficient. No upgrades required.

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.
Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this System Impact Study, the construction of the 575.0 MW (550.0 MW Capacity) natural gas generating facility of Invenergy (PJM Project #AB1-087) will require the following additional interconnection charges. This plan of service will interconnect the proposed natural gas generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Invenergy natural gas generating facility.

Cost Breakdown for Point of Interconnection (Sullivan 345 kV)			
Type of Network Upgrade	**Network Upgrade #**	**Description**	**Estimated Cost**
Attachment Cost	**n6037**	Expand the Sullivan 345 kV Substation	$1,700,000
Non-Direct Connection Cost Estimate	**n6038**	345 kV Revenue Metering	$350,000
Non-Direct Connection Cost Estimate	**n5469**	Reconductor Trimble - Clifty 345 kV line	$17,400,000
Non-Direct Connection Cost Estimate	**n5034**	Build a new Sullivan-Reynolds 765 kV Line	$464,000,000
		Total Estimated Cost for Project AB1-087	**$483,450,000**

Table 9

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements.

Figure 1: Point of Interconnection (Sullivan 345 kV)
Single-Line Diagram

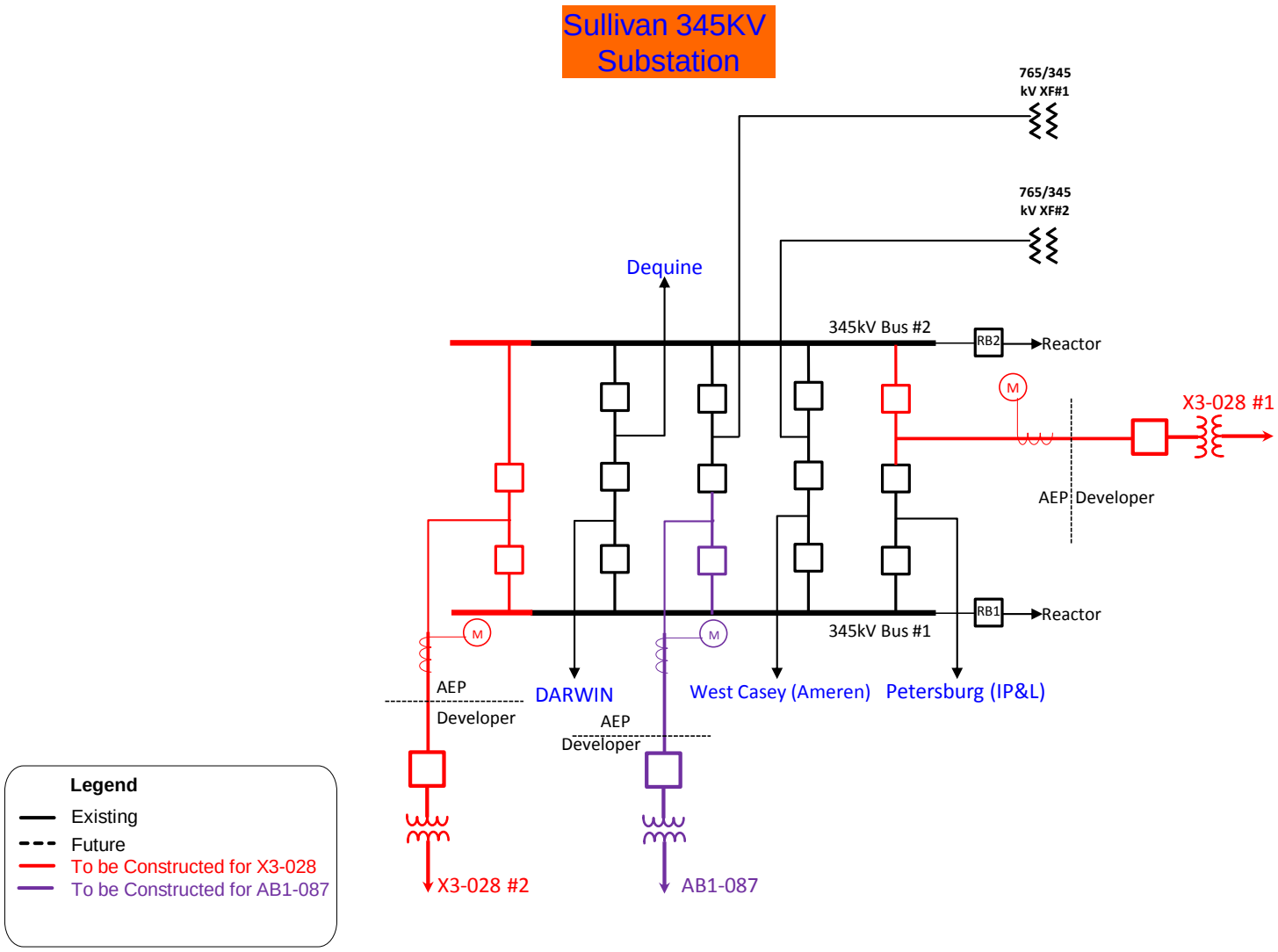
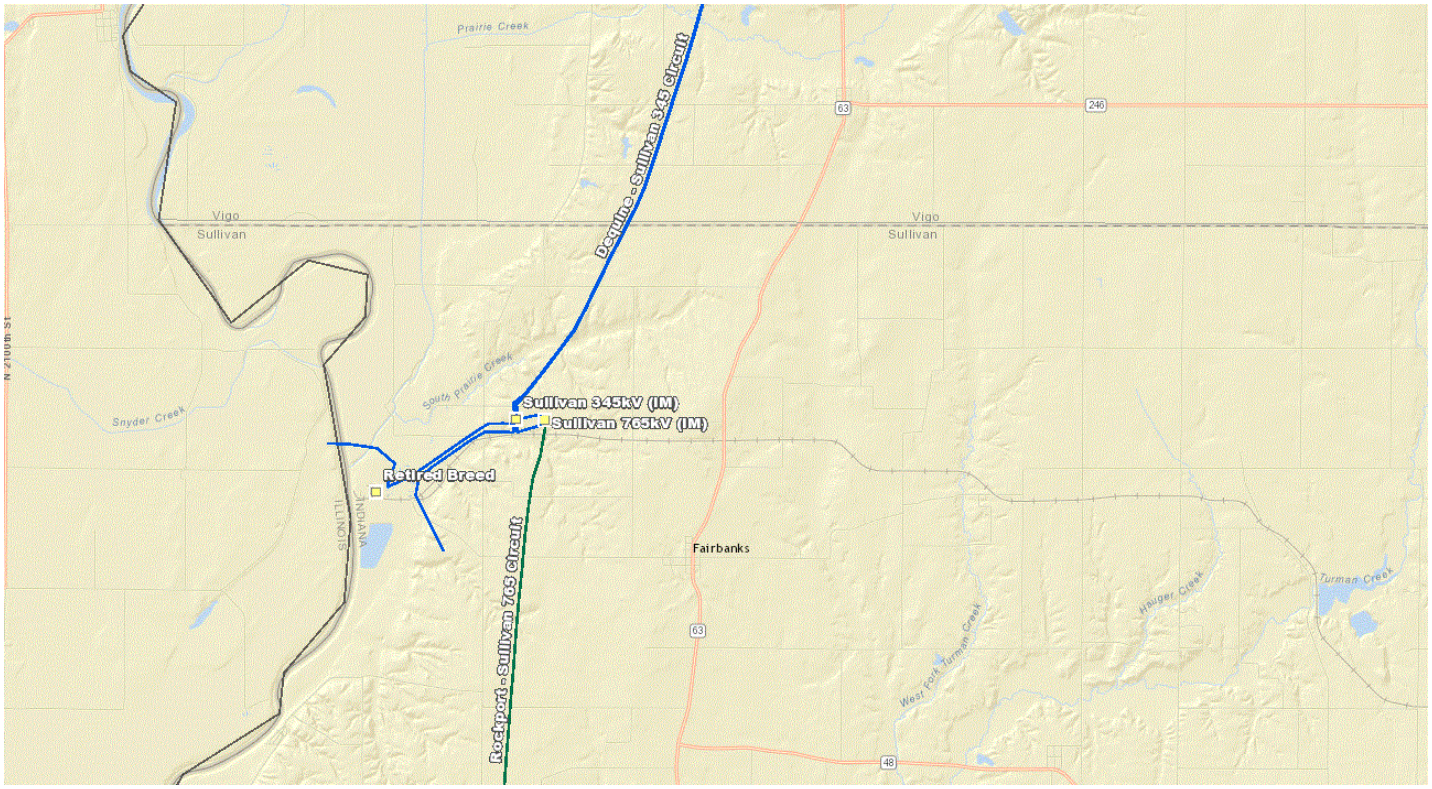


Figure 2: Point of Interconnection (Sullivan 345 kV)



Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(MISO AMIL - CE) The 7BROKAW-Z2-087 TAP 345 kV line (from bus 348847 to bus 917500 ckt 1) loads from 96.8% to 98.94% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8002___-S'. This project contributes approximately 33.17 MW to the thermal violation.

CONTINGENCY '345-L8002___-S'
TRIP BRANCH FROM BUS 270852 TO BUS 270668 CKT 1 / PONTI; B 345 BLUEM; B 345
END

Bus Number	*Bus Name*	*Full Contribution*
274848	*CAMPGROVE;RU*	*0.18*
927331	*J196 C*	*1.22*
997761	*J291*	*4.05*
927641	*J339*	*14.7*
998111	*J468*	*22.57*
274650	*KINCAID ;1U*	*13.03*
274651	*KINCAID ;2U*	*13.01*
290261	*S-027 C*	*1.03*
290265	*S-028 C*	*1.03*
905081	*W4-005 C*	*10.33*
900404	*X3-028 C*	*90.47*
LTF	*Z1-029*	*3.09*
LTF	*AA1-001*	*6.13*
LTF	*AA1-051*	*5.23*
930461	*AB1-087 C OP*	*33.17*
930471	*AB1-088 C OP*	*33.17*

Appendix 2

(CE - CE) The Z2-087 TAP-PONTIAC ; R 345 kV line (from bus 917500 to bus 270853 ckt 1) loads from 97.87% to 100.02% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8002___-S'. This project contributes approximately 33.17 MW to the thermal violation.

CONTINGENCY '345-L8002___-S'
TRIP BRANCH FROM BUS 270852 TO BUS 270668 CKT 1 / PONTI; B 345 BLUEM; B 345
END

Bus Number	*Bus Name*	*Full Contribution*
274848	*CAMPGROVE;RU*	*0.18*
927331	*J196 C*	*1.22*
997761	*J291*	*4.05*
927641	*J339*	*14.7*
998111	*J468*	*22.57*
274650	*KINCAID ;1U*	*13.03*
274651	*KINCAID ;2U*	*13.01*
290261	*S-027 C*	*1.03*
290265	*S-028 C*	*1.03*
905081	*W4-005 C*	*10.33*
900404	*X3-028 C*	*90.47*
LTF	*Z1-029*	*3.09*
917501	*Z2-087 C*	*17.16*
LTF	*AA1-001*	*6.13*
LTF	*AA1-051*	*5.23*
930461	*AB1-087 C OP*	*33.17*
930471	*AB1-088 C OP*	*33.17*

Appendix 3

(AEP - AEP) The 05ROCKPT-05JEFRSO 765 kV line (from bus 243209 to bus 243208 ckt 1) loads from 93.03% to 98.61% (AC power flow) of its emergency rating (4571 MVA) for the tower line contingency outage of '6094'. This project contributes approximately 193.24 MW to the thermal violation.

CONTINGENCY '6094'
OPEN BRANCH FROM BUS 243213 TO BUS 243217 CKT 1 / 243213 05BREED 345 243217 05DEQUIN 345 1
OPEN BRANCH FROM BUS 243217 TO BUS 243221 CKT 1 / 243217 05DEQUIN 345 243221 05EUGENE 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*97.66*
243443	*05RKG2*	*96.18*
998111	*J468*	*23.81*
274650	*KINCAID ;1U*	*7.9*
274651	*KINCAID ;2U*	*7.9*
276150	*W2-048 E*	*6.73*
905081	*W4-005 C*	*4.56*
905082	*W4-005 E*	*30.57*
909052	*X2-022 E*	*20.36*
900404	*X3-028 C*	*527.03*
900405	*X3-028 E*	*702.7*
915151	*Y3-038*	*23.22*
LTF	*AA1-001*	*8.95*
930461	*AB1-087 C OP*	*193.24*
930471	*AB1-088 C OP*	*193.24*

Appendix 4

(AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 112.39% to 117.95% (**DC power flow**) of its emergency rating (2354 MVA) for the line fault with failed breaker contingency outage of '1760_C2_05JEFRSO 765-A'. This project contributes approximately 130.99 MW to the thermal violation.

CONTINGENCY '1760_C2_05JEFRSO 765-A'
OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1
OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*6.14*
247901	*05FR-12G E*	*6.04*
247902	*05FR-21G E*	*6.45*
247903	*05FR-22G E*	*6.18*
247904	*05FR-3G E*	*12.51*
247905	*05FR-4G E*	*9.41*
247906	*05MDL-1G E*	*10.46*
247907	*05MDL-2G E*	*5.19*
247912	*05MDL-3G E*	*5.42*
247913	*05MDL-4G E*	*5.17*
243442	*05RKG1*	*73.32*
243443	*05RKG2*	*72.21*
294401	*BSHIL;1U E*	*4.87*
294410	*BSHIL;2U E*	*4.87*
274890	*CAYUG;1U E*	*7.67*
274891	*CAYUG;2U E*	*7.67*
274849	*CRESCENT ;1U*	*3.31*
927331	*J196 C*	*0.59*
927332	*J196 E*	*2.34*
998111	*J468*	*15.79*
990901	*L-005 E*	*7.53*
293771	*O-035 E*	*3.6*
296308	*R-030 C1*	*2.26*
296271	*R-030 C2*	*2.26*
296125	*R-030 C3*	*2.29*
296309	*R-030 E1*	*9.05*
296272	*R-030 E2*	*9.05*
296128	*R-030 E3*	*9.16*
274853	*TWINGROVE;U1*	*11.89*
274854	*TWINGROVE;U2*	*11.89*
276150	*W2-048 E*	*5.25*
905081	*W4-005 C*	*3.66*
905082	*W4-005 E*	*24.54*

909052	*X2-022 E*	*15.86*
900404	*X3-028 C*	*357.26*
900405	*X3-028 E*	*476.34*
913222	*Y1-054 E*	*-1.28*
915151	*Y3-038*	*17.44*
915662	*Y3-099 E*	*0.14*
915672	*Y3-100 E*	*0.14*
LTF	*Z1-043*	*15.62*
916211	*Z1-072*	*0.61*
LTF	*Z1-112*	*5.95*
917501	*Z2-087 C*	*1.77*
917502	*Z2-087 E*	*11.87*
LTF	*AA1-001*	*5.87*
LTF	*AA1-071*	*3.96*
919621	*AA2-039 C*	*1.19*
919622	*AA2-039 E*	*7.95*
930041	*AB1-006 C*	*1.7*
930042	*AB1-006 E*	*11.39*
930451	*AB1-086 C*	*37.47*
930461	*AB1-087 C OP*	*130.99*
930471	*AB1-088 C OP*	*130.99*

Appendix 5

(AEP - AEP) The 05BREED-05DARWIN 345 kV line (from bus 243213 to bus 243216 ckt 1) loads from 128.57% to 140.87% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.47 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*32.88*
243443	*05RKG2*	*32.38*
900404	*X3-028 C*	*325.82*
915151	*Y3-038*	*7.82*
930461	*AB1-087 C OP*	*119.47*
930471	*AB1-088 C OP*	*119.47*

Appendix 6

(AEP - AEP) The 05BREED-05DEQUIN 345 kV line (from bus 243213 to bus 243217 ckt 1) loads from 118.74% to 127.08% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 80.97 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*22.29*
243443	*05RKG2*	*21.95*
900404	*X3-028 C*	*220.83*
915151	*Y3-038*	*5.3*
930461	*AB1-087 C OP*	*80.97*
930471	*AB1-088 C OP*	*80.97*

Appendix 7

(AEP - MISO AMIL) The 05BREED-7CASEY 345 kV line (from bus 243213 to bus 346809 ckt 1) loads from 128.34% to 141.57% (**DC power flow**) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B'. This project contributes approximately 193.98 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 1 / 243208 05JEFRSO 765 242865 05JEFRSO 345 1
OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*4.66*
247901	*05FR-12G E*	*4.58*
247902	*05FR-21G E*	*4.89*
247903	*05FR-22G E*	*4.69*
247904	*05FR-3G E*	*9.49*
247905	*05FR-4G E*	*7.14*
243442	*05RKG1*	*53.41*
243443	*05RKG2*	*52.6*
997781	*G934 C*	*8.09*
927421	*J201 C*	*0.22*
927422	*J201 E*	*0.87*
927501	*J246 C*	*0.08*
927502	*J246 E*	*0.3*
997791	*J264 C*	*6.5*
997511	*J301*	*5.51*
997521	*J308*	*16.43*
997541	*J321*	*8.26*
927581	*J325 C*	*0.04*
927582	*J325 E*	*0.13*
927591	*J327 C*	*1.64*
927592	*J327 E*	*4.91*
927651	*J340 C*	*1.09*
927652	*J340 E*	*3.27*
927691	*J354 C*	*0.57*
927692	*J354 E*	*1.7*
997602	*J392*	*23.43*
997641	*J401*	*2.15*
997721	*J419 C*	*5.5*
997731	*J422*	*1.64*
998000	*J431*	*6.11*
997801	*J440*	*4.4*

997772	*J453 E*	*1.42*
997821	*J466*	*1.64*
997831	*J469*	*0.1*
998120	*J515*	*41.85*
900404	*X3-028 C*	*529.04*
900405	*X3-028 E*	*705.38*
915151	*Y3-038*	*12.7*
LTF	*AA1-051*	*5.02*
LTF	*AA1-053*	*55.91*
LTF	*AA1-055*	*176.47*
930461	*AB1-087 C OP*	*193.98*
930471	*AB1-088 C OP*	*193.98*
930972	*AB1-146 E*	*0.1*

Appendix 8

(AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 128.57% to 140.87% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.47 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*32.88*
243443	*05RKG2*	*32.38*
900404	*X3-028 C*	*325.82*
915151	*Y3-038*	*7.82*
930461	*AB1-087 C OP*	*119.47*
930471	*AB1-088 C OP*	*119.47*

Appendix 9

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 142.9% to 148.04% (**DC power flow**) of its emergency rating (1304 MVA) for the line fault with failed breaker contingency outage of '6485_C2_05DEQUIN 345-C1'. This project contributes approximately 67.08 MW to the thermal violation.

CONTINGENCY '6485_C2_05DEQUIN 345-C1'
OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 / 243217 05DEQUIN 345 243878 05MEADOW 345 2
OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1
OPEN BRANCH FROM BUS 249525 TO BUS 249874 CKT 1 / 249525 08WESTWD 345 249874 08WESTWD 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.21*
247900	*05FR-11G E*	*42.02*
243862	*05FR-12G C*	*1.19*
247901	*05FR-12G E*	*41.32*
243864	*05FR-21G C*	*1.27*
247902	*05FR-21G E*	*44.17*
243866	*05FR-22G C*	*1.21*
247903	*05FR-22G E*	*42.29*
243870	*05FR-3G C*	*2.46*
247904	*05FR-3G E*	*85.65*
243873	*05FR-4G C*	*1.9*
247905	*05FR-4G E*	*64.4*
927331	*J196 C*	*0.95*
927332	*J196 E*	*3.79*
997772	*J453 E*	*1.01*
998111	*J468*	*16.84*
998120	*J515*	*58.51*
900404	*X3-028 C*	*182.96*
900405	*X3-028 E*	*243.94*
930461	*AB1-087 C OP*	*67.08*
930471	*AB1-088 C OP*	*67.08*

Appendix 10

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 142.9% to 148.04% (**DC power flow**) of its emergency rating (1304 MVA) for the line fault with failed breaker contingency outage of '4704_C2_05DEQUIN 345-B1'. This project contributes approximately 67.08 MW to the thermal violation.

CONTINGENCY '4704_C2_05DEQUIN 345-B1'
OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 / 243217 05DEQUIN 345 243878 05MEADOW 345 1
OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1
OPEN BRANCH FROM BUS 249525 TO BUS 249874 CKT 1 / 249525 08WESTWD 345 249874 08WESTWD 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.21*
247900	*05FR-11G E*	*42.02*
243862	*05FR-12G C*	*1.19*
247901	*05FR-12G E*	*41.32*
243864	*05FR-21G C*	*1.27*
247902	*05FR-21G E*	*44.17*
243866	*05FR-22G C*	*1.21*
247903	*05FR-22G E*	*42.29*
243870	*05FR-3G C*	*2.46*
247904	*05FR-3G E*	*85.65*
243873	*05FR-4G C*	*1.9*
247905	*05FR-4G E*	*64.4*
927331	*J196 C*	*0.95*
927332	*J196 E*	*3.79*
997772	*J453 E*	*1.01*
998111	*J468*	*16.84*
998120	*J515*	*58.51*
900404	*X3-028 C*	*182.96*
900405	*X3-028 E*	*243.94*
930461	*AB1-087 C OP*	*67.08*
930471	*AB1-088 C OP*	*67.08*

Appendix 11

(AEP - AEP) The 05EUGENE-05DEQUIN 345 kV line (from bus 243221 to bus 243217 ckt 1) loads from 108.9% to 113.49% (AC power flow) of its normal rating (971 MVA) for the single line contingency outage of '667_B2_TOR1697'. This project contributes approximately 41.13 MW to the thermal violation.

CONTINGENCY '667_B2_TOR1697'
OPEN BRANCH FROM BUS 243213 TO BUS 243217 CKT 1 / 243213 05BREED 345 243217 05DEQUIN 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
927331	*J196 C*	*0.99*
998111	*J468*	*15.77*
900404	*X3-028 C*	*112.19*
930461	*AB1-087 C OP*	*41.13*
930471	*AB1-088 C OP*	*41.13*

Appendix 12

(AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 145.17% to 149.93% (**DC power flow**) of its emergency rating (1918 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B'. This project contributes approximately 91.4 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 1 / 243208 05JEFRSO 765 242865 05JEFRSO 345 1
OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.1*
247900	*05FR-11G E*	*38.45*
243862	*05FR-12G C*	*1.09*
247901	*05FR-12G E*	*37.81*
243864	*05FR-21G C*	*1.16*
247902	*05FR-21G E*	*40.41*
243866	*05FR-22G C*	*1.11*
247903	*05FR-22G E*	*38.69*
243870	*05FR-3G C*	*2.25*
247904	*05FR-3G E*	*78.37*
243873	*05FR-4G C*	*1.74*
247905	*05FR-4G E*	*58.92*
246909	*05MDL-1G C*	*2.71*
247906	*05MDL-1G E*	*94.32*
246910	*05MDL-2G C*	*1.35*
247907	*05MDL-2G E*	*46.77*
246976	*05MDL-3G C*	*1.35*
247912	*05MDL-3G E*	*48.9*
246979	*05MDL-4G C*	*2.71*
247913	*05MDL-4G E*	*46.66*
243442	*05RKG1*	*25.15*
243443	*05RKG2*	*24.77*
927331	*J196 C*	*0.92*
927332	*J196 E*	*3.68*
997772	*J453 E*	*1.01*
998111	*J468*	*18.07*
998120	*J515*	*55.49*
900404	*X3-028 C*	*249.27*
900405	*X3-028 E*	*332.36*
915151	*Y3-038*	*5.98*
LTF	*Z1-007*	*5.09*

LTF	*Z1-029*	*3.13*
LTF	*AA1-001*	*5.15*
930041	*AB1-006 C*	*15.36*
930042	*AB1-006 E*	*102.76*
930461	*AB1-087 C OP*	*91.4*
930471	*AB1-088 C OP*	*91.4*

Appendix 13

(CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 127.09% to 129.42% (AC power flow) of its emergency rating (1280 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 29.23 MW to the thermal violation.

CONTINGENCY '345-L8014_T_-S'
TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1 / PONTIAC ; R 345 DRESDEN ; R 345
TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1 / PONTIAC ;2M 138 PONTIAC ; R 345
TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1 / PONTIAC ;2M 138 PONTIAC ; R 138
TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1 / PONTIAC ;2M 138 PONTIAC ;2C 34.5
CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1 / PONTIAC ; B 138 PONTIAC ; R 138
END

Bus Number	*Bus Name*	*Full Contribution*
274863	*CAYUGA RI;1U*	*1.86*
274864	*CAYUGA RI;2U*	*1.86*
927331	*J196 C*	*1.*
997761	*J291*	*3.88*
927641	*J339*	*11.35*
998111	*J468*	*19.35*
274650	*KINCAID ;1U*	*12.5*
274651	*KINCAID ;2U*	*12.49*
296308	*R-030 C1*	*14.91*
296271	*R-030 C2*	*14.91*
296125	*R-030 C3*	*15.09*
290261	*S-027 C*	*1.68*
290265	*S-028 C*	*1.68*
905081	*W4-005 C*	*14.1*
900404	*X3-028 C*	*79.73*
917501	*Z2-087 C*	*11.65*
LTF	*AA1-001*	*5.82*
930451	*AB1-086 C*	*247.06*
930461	*AB1-087 C OP*	*29.23*
930471	*AB1-088 C OP*	*29.23*

Appendix 14

(CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 126.5% to 128.91% (AC power flow) of its emergency rating (1241 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 29.4 MW to the thermal violation.

CONTINGENCY '345-L8014_T_-S'
TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1 / PONTIAC ; R 345 DRESDEN ; R 345
TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1 / PONTIAC ;2M 138 PONTIAC ; R 345
TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1 / PONTIAC ;2M 138 PONTIAC ; R 138
TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1 / PONTIAC ;2M 138 PONTIAC ;2C 34.5
CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1 / PONTIAC ; B 138 PONTIAC ; R 138
END

Bus Number	*Bus Name*	*Full Contribution*
927331	*J196 C*	*1.*
997761	*J291*	*3.88*
927641	*J339*	*11.35*
998111	*J468*	*19.35*
274650	*KINCAID ;1U*	*12.52*
274651	*KINCAID ;2U*	*12.51*
296308	*R-030 C1*	*14.92*
296271	*R-030 C2*	*14.92*
296125	*R-030 C3*	*15.1*
290261	*S-027 C*	*1.68*
290265	*S-028 C*	*1.68*
905081	*W4-005 C*	*14.11*
900404	*X3-028 C*	*80.19*
917501	*Z2-087 C*	*11.66*
LTF	*AA1-001*	*5.85*
930451	*AB1-086 C*	*247.24*
930461	*AB1-087 C OP*	*29.4*
930471	*AB1-088 C OP*	*29.4*

Appendix 15

(CE - CE) The PONTIAC ; R-DRESDEN ; R 345 kV line (from bus 270853 to bus 270717 ckt 1) loads from 107.73% to 109.77% (AC power flow) of its emergency rating (1481 MVA) for the single line contingency outage of '345-L11212_B-S'. This project contributes approximately 30.22 MW to the thermal violation.

CONTINGENCY '345-L11212_B-S'
  TRIP BRANCH FROM BUS 270926 TO BUS 270704 CKT 1 / WILTO; B 345 LORET; B 345
  END

Bus Number	*Bus Name*	*Full Contribution*
274863	*CAYUGA RI;1U*	*1.55*
274864	*CAYUGA RI;2U*	*1.55*
927331	*J196 C*	*1.06*
997761	*J291*	*3.78*
927641	*J339*	*11.72*
998111	*J468*	*20.56*
274650	*KINCAID ;1U*	*12.24*
274651	*KINCAID ;2U*	*12.23*
296308	*R-030 C1*	*14.97*
296271	*R-030 C2*	*14.97*
296125	*R-030 C3*	*15.15*
290261	*S-027 C*	*1.67*
290265	*S-028 C*	*1.67*
905081	*W4-005 C*	*14.02*
900404	*X3-028 C*	*82.43*
917501	*Z2-087 C*	*11.7*
LTF	*AA1-001*	*5.51*
LTF	*AA1-051*	*6.02*
930451	*AB1-086 C*	*248.03*
930461	*AB1-087 C OP*	*30.22*
930471	*AB1-088 C OP*	*30.22*

Appendix 16

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 134.38% to 137.36% (**DC power flow**) of its emergency rating (1370 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 40.78 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243243	*05ANDCT*	*0.98*
243442	*05RKG1*	*11.22*
243443	*05RKG2*	*11.05*
342900	*1COOPER1 G*	*1.95*
342903	*1COOPER2 G*	*3.78*
342910	*1DALE 3G*	*9.69*
342911	*1DALE 4G*	*9.4*
342918	*1JKCT 1G*	*1.55*
342921	*1JKCT 2G*	*1.55*
342924	*1JKCT 3G*	*1.55*
342927	*1JKCT 4G*	*1.03*
342930	*1JKCT 5G*	*1.03*
342933	*1JKCT 6G*	*1.03*
342936	*1JKCT 7G*	*1.03*
342939	*1JKCT 9G*	*1.05*
342942	*1JKCT 10G*	*1.05*
342945	*1LAUREL 1G*	*1.1*
900404	*X3-028 C*	*111.23*
LTF	*X4-041*	*9.86*
LTF	*Y1-004*	*53.57*
LTF	*Y2-006*	*16.34*
LTF	*Y2-030*	*87.56*
LTF	*Y2-031*	*87.56*
LTF	*Y2-032*	*87.56*
LTF	*Y2-034*	*18.63*
915151	*Y3-038*	*2.67*
LTF	*Y3-069*	*16.16*
LTF	*Y3-072*	*16.16*
LTF	*Z1-007*	*19.67*
LTF	*Z1-025*	*14.57*
LTF	*Z1-027*	*8.6*
LTF	*Z1-029*	*6.04*
LTF	*Z1-046*	*19.09*
LTF	*Z1-071*	*8.55*
LTF	*AA1-001*	*5.45*

LTF	*AA1-004*	*15.51*
930461	*AB1-087 C OP*	*40.78*
930471	*AB1-088 C OP*	*40.78*

Attachment 1

Dynamic Simulation Analysis

Executive Summary

Combined Generator Interconnection Request for AB1-087 and AB1-088 is for a 1150 MW Maximum Facility Output (MFO) 2 x 2 combined cycle natural gas facility. AB1-087 and AB1-088 each consists of 1 x 341 MW CT and 1x 243.6 MW ST with a Point of Interconnection (POI) at the Sullivan 345 kV Substation in the American Electric Power (AEP) Transmission System, Sullivan County, Indiana.

This report describes a dynamic simulation analysis of AB1-087 and AB1-088 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2021 Light Load case, modified to include applicable queue projects. AB1-087 and AB1-088 were dispatched at maximum power output, leading power factor and 0.95 pu voltage at the generator terminals.

AB1-087 and AB1-088 were tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. 50 contingencies were studied, each with a 20 second simulation time period. Studied faults included:

a) Steady-state operation,

b) Three-phase faults with normal clearing time on the intact network,

c) Three-phase faults with High Speed Reclosing (HSR),

d) Three-phase faults during planned outage of a transmission or generation element,

e) Single-phase faults with phase delayed clearing due to a stuck breaker,

f) Three-phase faults with loss of multiple-circuit tower line.

The three-phase fault contingencies with normal clearing time and HSR were performed under network intact conditions and a subset were performed with prior outage of:

- Sullivan – Rockport 765 kV circuit
- Sullivan – Petersburg 765 kV circuit
- Sullivan – West Casey 345 kV circuit
- Sullivan – Darwin 345 kV circuit
- Rockport – Jefferson 765 kV circuit

AB1-087 and AB1-088 queue projects were re-studied using 2021 Light Load case with the following system adjustments:

- X3-028, X1-020 and S57/S58 are not dispatched,
- Sullivan – Reynolds 765 kV circuit upgrade is not included,
- Rockport – Coleman – Duff 345 kV circuit upgrade is not included.

For all simulations, the queue projects under study, along with the rest of the PJM system, were required to ride through the fault, with all states returning to an acceptable new condition following the disturbance.

The results indicate that for fault contingencies tested on the 2021 Light Load case:

a) AB1-087 and AB1-088 were able to ride through all contingencies when the fast valving SPS at Rockport units was enabled except for contingency P6.ME.02 in which AB1-087 unit CT1 and AB1-088 units CT1 and ST1 were tripped due to angle deviation.

b) Post-contingency oscillations were positively damped with a damping margin of at least 3% for local and inter-area modes.

c) Following fault clearing, all bus voltages recovered to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No other transmission element tripped, except for those either directly connected or designed to trip as a consequence of that fault.

Contingencies P1.09, P4.17, and P6.ME.01 – P6.ME.04 (prior outage of Rockport – Jefferson 765 kV circuit) which showed tripping issue for AB1-087 and AB1-088 units and Rockport G1 and G2 units were tested after activation of fast-valving special protection scheme (SPS) at Rockport units. The fast-valving SPS resolved the tripping issue of AB1-087 and AB1-088 units and Rockport G1 and G2 units in the contingencies P1.09, P4.17, P6.ME.03 and P6.ME.04. In the contingency P6.ME.01, the fast-valving scheme resolved the tripping issue of AB1-087 and AB1-088 units while the Rockport units still showed tripping issue. However, in the contingency P6.ME.02, the fast-valving SPS just resolved the tripping issue of AB1-087 ST1 unit while AB1-087 CT1 unit and AB1-088 CT1 and ST1 units and Rockport units were still tripped due to angle deviation. For these contingencies, a user defined model has been used for the Rockport units in order to enable the testing of the fast-valving SPS.

Post-contingency oscillations of AB1-087, AB1-088 and Rockport units outputs were checked to be positively damped with a damping margin of at least 3% in contingency P6.ME.03. Simulating the contingency for 30 seconds also showed the oscillations will be damped.

The contingencies P6.ME.01 – P6.ME.02 (prior outage of Rockport – Jefferson 765 kV circuit) were tested on the pre-project case and the tripping issue of Rockport units G1 and G2 still existed with the active fast-valving SPS. Therefore, the tripping issue of Rockport units G1 and G2 in these contingencies is a pre-existing issue and it is not attributable to addition of AB1-087 and AB1-088 units. Furthermore, the prior outage cases have been tested for informational purposes and no mitigation is required.

The AB1-087 and AB1-088 combustion and steam turbine generators meet the 0.9 lagging PF and the 0.95 leading PF reactive power requirement as a single power plant in winter and summer.

No mitigations were required.