Generation Interconnection

REVISED System Impact Study Report

for

Queue Project AF1-088

Sullivan 345 kV

1000 MW Capacity / 1000 MW Energy

February 2022

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is AEP.

2 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: 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 an Interconnection Customer 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 possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

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.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer 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.

3 General

The Interconnection Customer (IC), has proposed a HVDC tie located in Sullivan County, Indiana. The installed facilities will have a total capability of 1000 MW with 1000 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is December 31, 2025. This study does not imply a TO commitment to this in-service date.

Queue Number	AF1-088
Project Name	Sullivan 345 KV
State	Indiana
County	Sullivan
Transmission Owner	AEP
MFO	1000
MWE	1000
MWC	1000
Fuel	HDVC
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AF1-088 will interconnect with the AEP transmission system via a direct connection to the Sullivan 345 kV substation.

To accommodate the interconnection to the Sullivan 345 kV substation, one (1) new 345 kV circuit breaker will be installed (Attachment 1). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

Installation of the generator lead first span exiting the POI station, including the first structure outside the AEP fence, will also be included in AEP's scope. In the case where the generator lead is a single span, the structure in the customer station will be the customer's responsibility.

5 Cost Summary

The AF1-088 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$3,517,000
Allocation towards System Network Upgrade Costs*	$196,512,000
Total Costs	**$200,029,000**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

The estimates provided in this report 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. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 2016-36, 2016-25 I.R.B. (6/20/2016). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not

closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

The total physical interconnection costs is given in the table below:

6.1 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
345 kV Revenue Metering	$431,000
Generator lead first span exiting the POI station, including the first structure outside the fence	$651,000
Total Attachment Facility Costs	**$1,082,000**

6.2 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
One (1) new 345 kV circuit breaker will be installed (Attachment 1). Installation of associated protection and control equipment, 345 kV line risers, and SCADA will also be required.	$2,390,000
Total Direct Connection Facility Costs	**$2,390,000**

6.3 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Review line protection and control settings at the Sullivan 345 kV substation	$45,000
Total Non-Direct Connection Facility Costs	**$45,000**

7 Interconnection Customer Requirements

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Transmission Owner 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.

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.

8 Revenue Metering and SCADA Requirements

8.1 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 Section 8 of Attachment O.

8.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

8.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

9 Summer Peak Analysis

The Queue Project AF1-088 was evaluated as a 525kV HVDC tie at Sullivan substation in the AEP area. The installed facilities will have a capability of 1000MW- with 1000MW of this output being recognized by PJM as of Firm Transmission Withdrawal Rights (TWR), and 1000MW being recognized as of non-firm TWR. The installed facilities will also have a capability of 1000MW Firm Transmission Injection Rights (TIR), and 1000MW being recognized as of non-firm TIRs. Project AF1-088 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-088 was studied with a commercial probability of 100%. Potential network impacts were as follows:

9.1 Generation Deliverability

AD2-071 Multiple Facility Contingency														
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	Non	Non	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	AC	91.64	101.17	NR	3452	305.43	
2	Non	Non	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	AC	91.64	101.17	NR	3452	305.43	
3	N-1	AEP_P1-2_#363	AEP - MISO AMIL	05SULLIVAN-J1180 TAP 345 kV line	247712	956820	1	DC	95.66	120.6	NR	1466	365.67	
4		AEP_P1-2_#363	AEP - MISO AMIL	05SULLIVAN-J1180 TAP 345 kV line	247712	956820	1	DC	95.72	120.6	NR	1466	365.67	
5		AEP_P1-2_#363	(AEP - MISO AMIL	05SULLIVAN-J1180 TAP 345 kV line	247712	956820	1	DC	95.72	120.6	NR	1466	365.67	

AD2-071 Multiple Facility 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.
6		AEP_P1-2_#363	(AEP - MISO AMIL	05SULLIVAN-J1180 TAP 345 kV line	247712	956820	1	DC	95.72	120.6	NR	1466	365.67	
7	Non	Non	MISO AMIL - AEP	J1180 TAP-05SULLIVAN 345 kV line	956820	247712	1	AC	94.67	113.38	NR	1334	256.77	
8	Non	Non	MISO AMIL - AEP	J1180 TAP-05SULLIVAN 345 kV line	956820	247712	1	AC	94.67	113.38	NR	1334	256.77	

9.2 Multiple Facility Contingency

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

AD2-071 Multiple Facility 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	LFFB	AEP_P4_#6189_05HANG R 765_D1	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	AC	99.45	102.27	ER	2354	170.76	
10	LFFB	AEP_P4_#1760_05JEFRSO 765_A	AEP - AEP	05JEFRSO 765/345 kV transformer	243208	242865	2	AC	92.38	100.83	ER	3039	234.58	2
11	LFFB	AEP_P4_#8648_05JEFRSO 765_B	AEP - AEP	05SULLIVAN-05DEQUIN 345 kV line	247712	243217	1	DC	90.32	101.46	ER	1318	146.82	3

AD2-071 Multiple Facility 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.
12	LFFB	AEP_P4_#8648_05JEFRSO 765_B	AEP - MISO IPL	05SULLIVAN-16PETE 345 kV line	247712	254529	1	DC	83.27	101.53	ER	1409	255.73	4

9.3 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)

AD2-071 Multiple Facility 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.
13	LFFB	AEP_P4_#1760_05JEFRSO 765_A	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	AC	117.34	128.06	ER	2354	234.58	5
14	DCTL	AEP_P7-1_#11042	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	AC	104.92	114.62	ER	3970	332.53	6
15	DCTL	AEP_P7-1_#11014	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	AC	100.22	109.95	ER	3970	348.56	
16	LFFB	AEP_P4_#8648_05JEFRSO 765_B	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	116.9	135.72	ER	1160	218.22	7
17	N-1	AEP_P1-2_#363	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	107.99	126.78	NR	1160	217.91	

AD2-071 Multiple Facility Contingency															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
18	N-1	AEP_P1-2_#363	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	107.99	126.78	NR	1160	217.91	
19	LFFB	AEP_P4_#8648_05JEFRSO 765_B	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	116.9	135.72	ER	1160	218.22	8
20	N-1	AEP_P1-2_#363	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	107.99	126.78	NR	1160	217.91	
21	N-1	AEP_P1-2_#363	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	107.99	126.78	NR	1160	217.91	
22	LFFB	AEP_P4_#8648_05JEFRSO 765_B	AEP - MISO AMIL	05SULLIVAN-J1180 TAP 345 kV line	247712	956820	1	DC	114.41	139.31	ER	1466	365.83	9
23	LFFB	AEP_P4_#1760_05JEFRSO 765_A	OVEC - OVEC	06CLIFTY-06DEARB1 345 kV line	248000	248001	1	AC	104.65	110.62	ER	1023	61.04	10
24	LFFB	AEP_P4_#1760_05JEFRSO 765_A	(OVEC - OVEC	06CLIFTY-06DEARB1 345 kV line	248000	248001	1	AC	104.65	110.62	ER	1023	61.04	10
25	N-1	COMED_P1-2_345-L8014___-S-B	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	AC	119.11	123.29	ER	1528	58.1	11

AD2-071 Multiple Facility Contingency															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
26	N-1	COMED_P1-2_345-L8014___-S-B	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	AC	119.11	123.29	ER	1528	58.1	
27	N-1	AEP_P1-2_#363	LGEE - OVEC	7TRIMBL REAC-06CLIFTY 345 kV line	324010	248000	1	DC	117.09	121.49	ER	1451	63.83	12
28	N-1	AEP_P1-2_#10136	LGEE - OVEC	7TRIMBL REAC-06CLIFTY 345 kV line	324010	248000	1	AC	112.25	117.28	ER	1451	64.25	
29	N-1	COMED_P1-2_345-L8001___-S	CE - CE	CHESTNUT ;-BLUEMOUND; B 345 kV line	270912	270668	1	AC	114.53	118.66	ER	1334	50	13
30	N-1	COMED_P1-2_345-L8001___-S	CE - CE	CHESTNUT ;-BLUEMOUND; B 345 kV line	270912	270668	1	AC	114.53	118.66	ER	1334	50	
31	N-1	COMED_P1-2_345-L11212_B-S-B	CE - CE	AD1-133 TAP-DRESDEN ; R 345 kV line	935000	270717	1	AC	116.65	120.5	ER	1528	53.47	14
32	N-1	COMED_P1-2_345-L11212_B-S-B	CE - CE	AD1-133 TAP-DRESDEN ; R 345 kV line	935000	270717	1	AC	116.65	120.5	ER	1528	53.47	16
33	N-1	COMED_P1-2_345-L11212_B-S-B	(CE - CE	AD1-133 TAP-	935000	270717	1	AC	116.65	120.5	ER	1528	53.47	16

AD2-071 Multiple Facility 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.
				DRESDEN ; R 345 kV line										
34	N-1	COMED_P1-2_345-L11212_B-S-B	(CE - CE	AD1-133 TAP-DRESDEN ; R 345 kV line	935000	270717	1	AC	116.65	120.5	ER	1528	53.47	16
35	LFFB	AEP_P4_#3128_05EUGENE 345_A2	MISO AMIL - AEP	J1180 TAP-05SULLIVAN 345 kV line	956820	247712	1	AC	131.14	148.33	ER	1466	280.08	16
36	N-1	AEP_P1-2_#286	MISO AMIL - AEP	J1180 TAP-05SULLIVAN 345 kV line	956820	247712	1	AC	103.41	120.72	NR	1466	260.98	
37	N-1	AEP_P1-2_#286	MISO AMIL - AEP	J1180 TAP-05SULLIVAN 345 kV line	956820	247712	1	AC	103.41	120.72	NR	1466	260.98	

9.4 Steady-State Voltage Requirements

To be determined.

9.5 Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

Not Applicable.

9.6 System Reinforcements

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

9.6.1 New System Reinforcements

1. To alleviate the Jefferson 765-345kV transformer overload:
   Replace Jefferson 765/345 kV transformer, new SN/SE 3113/3113MVA. $6M. 12-18 months. N7964

Queue	MW contribution	Percentage of Cost	$ cost ($6 M)
AF1-088	255.73	100.00	$6.00

   Note: It should be re-confirmed during the Facilities Study whether reconfiguring the Jefferson 765 kV station to eliminate the stuck breaker contingency is a more economical upgrade.

2. To alleviate the Sullivan - Dequine 345kV line overload:
   Add a 765 kV breaker 'B2' at Jefferson 765 kV to eliminate stuck breaker contingency. $4M. N6628.

Queue	MW contribution	Percentage of Cost	$ cost ($4 M)
AF1-088	146.82	100.00	$4.00

3. To alleviate the Sullivan - Petersburg 345kV line overload:
   A sag study will be required on the ~0.5 miles section of 954 2x Rail Conductor section 2 to mitigate the overload. New Ratings after the sag study S/N: 1410 MVA S/E: 1888 MVA. Depending on the sag study results, cost for this upgrade is expected to be between $25,000 (no remediation required just sag study) and $0.75 million (complete line reconductor/rebuild required). PJM Network Upgrade N6781.

Queue	MW contribution	Percentage of Cost	$ cost ($25,000)
AF1-088	255.7	100.000	$25,000

MISO end:
The IP&L end SE rating is 1506 MVA and is sufficient. No IP&L upgrade required.

4. To alleviate the Rockport - Jefferson 765 kV line overload:
   1). Rockport & Jefferson Relay Thermal Limits - An engineering study will need to be conducted to determine if the Relay Thermal limits settings (2996 A/3970 MVA) can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted. Estimated Cost for study: $50,000 ($25,000 each). Estimated Cost for new relay packages: $1.2 M ($600,000 each). New SE rating 3975 MVA. PJM Network Upgrade N6497.1
   2). Replace 6 Rockport 3000A CTs. $4.8 M. New SE rating 4142 MVA. PJM Network Upgrade N6497.2
   3). Replace 2 Rockport 3000A non-oil Breakers at Rockport. $6 M. New SE rating 4571 MVA. PJM Network Upgrade N6497.3

   Since the cost of the upgrades 1) and 2) are less than $5M, based on PJM cost allocation criteria, AF1-088 currently does not receive cost allocation towards this upgrade. As changes to the PJM queue process occur (such as prior queued projects withdrawing from the queue, reducing in size, etc.) AF1-088 could receive cost allocation. Although Queue Project AF1-088 may not presently have cost responsibility for this upgrade, Queue Project AF1-088 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF1-088 comes into service prior to completion of the upgrade, Queue Project AF1-088 will need an interim study.

   Cost allocation for 3)

Queue	MW contribution	Percentage of Cost	$ cost ($6 M)
AF1-088	332.4	1.000	6.000

5. To alleviate the Sullivan-J1180 TAP 345kV line and J1180 TAP-Sullivan 345kV line overloads:
   - MISO Recommended Upgrade: Upgrade is to build a second parallel Breed – Casey 345 kV line. $60-74M (AMIL owns approximately 97% of the line, estimate for entire line of about 28 miles). Time estimate is 5 years for obtaining permits and line construction, per MISO.

- AEP end cost estimate for about 0.9 miles of the line and adding two breakers to accommodate the new line is $4M. PJM Network Upgrade N7204.
- Total Cost: $78 million. During the Facilities Study Phase, MISO & PJM (AEP) will break down this cost for each ISO. The AF1-088 Interconnection customer will be responsible for posting security with PJM for the AEP portion for the upgrade only.

Queue	MW Contribution	Percentage of cost	Cost ($78 M)
AF1-088	256.85	100.00%	$78.000

9.6.2 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)

1. To alleviate the Jefferson - Clifty 345 kV line overload:
   1). Replace 2 Clifty breakers and evaluate Clifty CT thermal limit of 3595 A. $2.4 M. 12-18 months. New SE rating expected to be 2255 MVA. N4106.2
   2). Replace 4 Clifty switches. $2M. 12-18 months. New SE rating expected to be 2354 MVA. N4106.1
   3). A sag check will be required for the ACSR ~ 2156 ~ 84/19 ~ BLUEBIRD Conductor Section 1 to determine if the line section can be operated above its emergency rating. Past/preliminary sag study results (from Z1-070 Facilities Study): Jefferson – Clifty Creek 345 kV line work will include one location of grading to remediate clearance location of concern in span 1 to 2. Cost is $244 K. 6-12 months. New SE rating on line expected to be 2826 MVA. N4106.3
   4). rebuild the 0.75 mile ACSR ~ 2156 ~ 84/19 ~ BLUEBIRD @ 284 F - Conductor section 1. $1.96M. New conductor SE rating to be 3212 MVA SE. New SE rating on line expected to be 2826 MVA. N4106.4
   5). Replace Clifty Bus 5"0 AL Tubular Sch 40. $100 K. 12-18 months. New SE rating to be 3113 MVA. N4106.5

   Since the cost of the upgrades 1), 2), 3), and 4) are less than $5M, based on PJM cost allocation criteria, AF1-088 currently does not receive cost allocation towards this upgrade. As changes to the PJM queue process occur (such as prior queued projects withdrawing from the queue, reducing in size, etc.) AF1-088 could receive cost allocation. Although Queue Project AF1-088 may not presently have cost responsibility for this upgrade, Queue Project AF1-088 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF1-088 comes into service prior to completion of the upgrade, Queue Project AF1-088 will need an interim study.

   Cost allocation for 5)

Queue	MW contribution	Percentage of Cost	$ cost ($0.1 M)
AF1-088	234.58	100.000	0.100

2. To alleviate the Sullivan-Darwin-Eugene 345kV line overload:

1). Rebuild 3.83 miles of 2303.5 ACAR , conductor section 1, new ratings 1166/1419 MVA SN/SE. 24-36 months. $7.66M. N7980.1.
2). Rebuild 47.02 miles of 1414 ACSR/PE, conductor section 2, new ratings 1759/1759 MVA SN/SE. 24-36 months. $94M. N7980.2.

Cost allocation for 1)

Queue	MW contribution	Percentage of Cost	$ cost ($7.66 M)
AE2-130	104.51	0.324	2.483
AF1-088	217.9	0.676	5.177

Cost allocation for 2)

Queue	MW contribution	Percentage of Cost	$ cost ($94 M)
AF1-088	217.9	1.000	94.000

3. To alleviate the Pontiac - Loretto 345 kV line overload:
   Replace the Pontiac 345 kV breaker BT 4-5. Cost Estimate is $4M. Time estimate is 24 months. New SSTE rating will be 1909 MVA. ALDR remains at 2199 MVA. PJM Network Upgrade N6260.1.

   Since the cost of the upgrades are less than $5M, based on PJM cost allocation criteria, AF1-088 currently does not receive cost allocation towards this upgrade. As changes to the PJM queue process occur (such as prior queued projects withdrawing from the queue, reducing in size, etc.) AF1-088 could receive cost allocation. Although Queue Project AF1-088 may not presently have cost responsibility for this upgrade, Queue Project AF1-088 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF1-088 comes into service prior to completion of the upgrade, Queue Project AF1-088 will need an interim study.

4. To alleviate the AD1-133 TAP - Dresden 345 kV line overload:
   Perform sag mitigation on the 345kV line, upgrade station conductor at a line terminal, upgrade 2 breakers, 2 disconnect switches, and CTs. A preliminary estimate for this work is $20.5 M with an estimated construction timeline of 30 months. Upon completion of the upgrade the will be a minimum of 1679/2058/2107/2280 MVA (SN/SLTE/SSTE/SLD). PJM Network Upgrade N6261.

Queue	MW contribution	Percentage of Cost	$ cost ($20.5 M)
J955	162.70	47.64%	$9.766
AE2-173	23.36	6.84%	$1.402
AE2-223	69.79	20.44%	$4.189
AE2-261	32.2	9.43%	$1.933
AF1-088	53.47	15.66%	$3.210

5. To alleviate the Clifty - Dearborn 345 kV line overload:

   Replace one 1600 A Wavetrap at Clifty Creek, $200k, 12-18 months. The new SE rating is 1281 MVA SE. PJM Network Upgrade N7979.

   Since the cost of the upgrades are less than $5M, based on PJM cost allocation criteria, AF1-088 currently does not receive cost allocation towards this upgrade. As changes to the PJM queue process occur (such as prior queued projects withdrawing from the queue, reducing in size, etc.) AF1-088 could receive cost allocation. Although Queue Project AF1-088 may not presently have cost responsibility for this upgrade, Queue Project AF1-088 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF1-088 comes into service prior to completion of the upgrade, Queue Project AF1-088 will need an interim study.

6. To alleviate the Trimble - Clifty 345 kV line overload:

   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.

   No OVEC upgrades required. LG&E will determine if there are any LG&E system impacts, including on Trimble- Clifty line. Final LG&E Impacts and necessary LG&E system upgrade(s) will be determined once the LG&E affected system study is completed by LG&E.

7. To alleviate the Chestnut - Bluemound 345 kV line overload:
   SSTE is 1863MVA. No overload

9.7 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#10136	"CONTINGENCY 'AEP_P1-2_#10136' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 OPEN BRANCH FROM BUS 243209 TO BUS 243443 CKT 2 / 243209 05ROCKPT 765 243443 05RKG2 26.0 2 REMOVE UNIT 2H FROM BUS 243443 / 243443 05RKG2 26.0 REMOVE UNIT 2L FROM BUS 243443 / 243443 05RKG2 26.0 END"
AEP_P1-2_#286	"CONTINGENCY 'AEP_P1-2_#286' OPEN BRANCH FROM BUS 243221 TO BUS 348885 CKT 1 / 243221 05EUGENE 345 348885 7BUNSONVILLE 345 1 END"
AEP_P1-2_#363	"CONTINGENCY 'AEP_P1-2_#363' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END"
AEP_P4_#1760_05JEFRSO 765_A	"CONTINGENCY 'AEP_P4_#1760_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"
AEP_P4_#3128_05EUGENE 345_A2	"CONTINGENCY 'AEP_P4_#3128_05EUGENE 345_A2' OPEN BRANCH FROM BUS 243221 TO BUS 249504 CKT 1 / 243221 05EUGENE 345 249504 08CAYSUB 345 1 OPEN BRANCH FROM BUS 243221 TO BUS 348885 CKT 1 / 243221 05EUGENE 345 348885 7BUNSONVILLE 345 1 END"
AEP_P4_#6189_05HANG R 765_D1	"CONTINGENCY 'AEP_P4_#6189_05HANG R 765_D1' OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORNU 765 242924 05HANG R 765 1 OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1 OPEN BRANCH FROM BUS 242921 TO BUS 242934 CKT 1 / 242921 05CORNU 765 242934 05CORNU 345 1 REMOVE UNIT 1A FROM BUS 247245 / 247245 05HRKG1A 18.0 REMOVE UNIT 1B FROM BUS 247246 / 247246 05HRKG1B 18.0 REMOVE UNIT 1S FROM BUS 247247 / 247247 05HRKG1S 18.0 REMOVE UNIT 2A FROM BUS 247248 / 247248 05HRKG2A 18.0 REMOVE UNIT 2B FROM BUS 247249 / 247249 05HRKG2B 18.0 REMOVE UNIT 2S FROM BUS 247250 / 247250 05HRKG2S 18.0 END"
AEP_P4_#8648_05JEFRSO 765_B	"CONTINGENCY 'AEP_P4_#8648_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 2 / 243208 05JEFRSO 765 242865 05JEFRSO 345 2 OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1 END"
AEP_P7-1_#11014	"CONTINGENCY 'AEP_P7-1_#11014' OPEN BRANCH FROM BUS 243217 TO BUS 243221 CKT 1 / 243217 05DEQUIN 345 243221 05EUGENE 345 1 OPEN BRANCH FROM BUS 243217 TO BUS 247712 CKT 1 / 243217 05DEQUIN 345 247712 05SULLIVAN 345 1 END"

Contingency Name	Contingency Definition
AEP_P7-1_#11042	"CONTINGENCY 'AEP_P7-1_#11042' OPEN BRANCH FROM BUS 243878 TO BUS 255205 CKT 1 / 243878 05MEADOW 345 255205 17REYNOLDS 345 1 OPEN BRANCH FROM BUS 243878 TO BUS 255205 CKT 2 / 243878 05MEADOW 345 255205 17REYNOLDS 345 2 END"
COMED_P1-2_345-L11212_B-S-B	"CONTINGENCY 'COMED_P1-2_345-L11212_B-S-B' TRIP BRANCH FROM BUS 934720 TO BUS 939400 CKT 1 / AD1-100 TAP 345 AE1-172 TAP 345 END"
COMED_P1-2_345-L8001___-S	"CONTINGENCY 'COMED_P1-2_345-L8001___-S' TRIP BRANCH FROM BUS 270853 TO BUS 917500 CKT 1 / PONTI; R 345 Z2-087 TAP 345 END"
COMED_P1-2_345-L8014___-S-B	"CONTINGENCY 'COMED_P1-2_345-L8014___-S-B' TRIP BRANCH FROM BUS 935000 TO BUS 270717 CKT 1 / AD1-133 TAP 345 DRESDEN ; R 345 END"

10 Light Load Analysis

The Queue Project AF1-088 was evaluated as a 525kV HVDC tie at Sullivan substation in the AEP area. The installed facilities will have a capability of 1000MW- with 1000MW of this output being recognized by PJM as of Firm Transmission Withdrawal Rights (TWR), and 1000MW being recognized as of non-firm TWR. The installed facilities will also have a capability of 1000MW Firm Transmission Injection Rights (TIR), and 1000MW being recognized as of non-firm TIRs. Project AF1-088 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-088 was studied with a commercial probability of 100%. Potential network impacts were as follows:

10.1 Generation Deliverability

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

1. (AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 98.41% to 104.32% (**DC power flow**) of its normal rating (2354 MVA) for the single line contingency outage of 'AEP_P1-2_#709'. This project contributes approximately 131.26 MW to the thermal violation.

CONTINGENCY 'AEP_P1-2_#709'
OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1
END

Please refer to Appendix 17 for a table containing the generators having contribution to this flowgate.

10.2 Multiple Facility Contingency

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

None

10.3 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)

None

10.4 Steady-State Voltage Requirements

To be determined

10.5 Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

Not Applicable

10.6 System Reinforcements

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

10.6.1 New System Reinforcements

See Summer Peak Reinforcements.

10.6.2 Contribution to Previously Identified System Reinforcements

None.

11 Short Circuit Analysis

The following Breakers are overdutied:

None

12 Stability and Reactive Power

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined in the Facilities Study Phase.

13 N-1-1 Analysis:

To be determined during the Facilities Study.

14 Load Deliverability Analysis:

To be determined during the Facilities Study.

15 Affected Systems

15.1 MISO

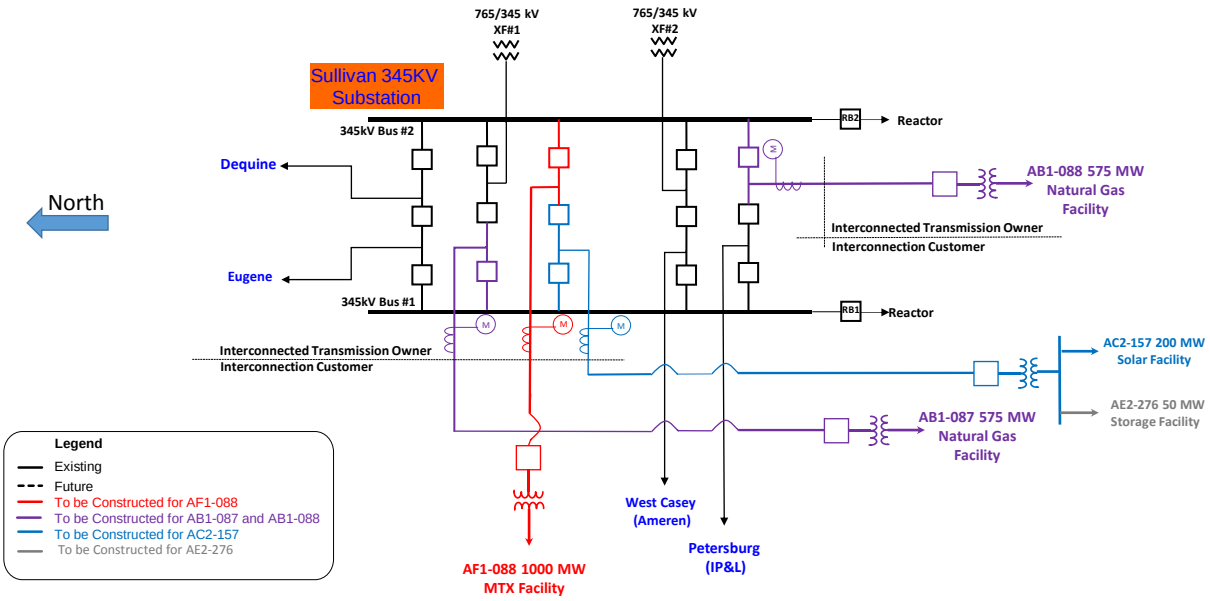
Preliminary MISO impacts have been identified. Please refer to the MISO Affected System report for details. Final MISO impacts to be determined by MISO during the Facilities Study phase.

15.2 LG&E

To be determined during the Facilities Study. An LG&E Affected System Study may be required.

16 Attachment 1: One Line Diagram and Site Location

AF1-088
Point of Interconnection
Sullivan 345kV Station




Neely Creek
Vigo
Sullivan
Breed - Dequine East 345
Sullivan Station
AF1-088 MTX Lead
INDIANA
ILLINOIS
Fairbanks
Rockport - Sullivan 765 kV AEP - IMP

17 Attachment 2: 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. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

None.

Appendix 2

(AEP - AEP) The 05JEFRSO 765/345 kV transformer (from bus 243208 to bus 242865 ckt 2) loads from 92.38% to 100.83% (AC power flow) of its emergency rating (3039 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#1760_05JEFRSO 765_A'. This project contributes approximately 234.58 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
247900	05FR-11G E	6.17
247901	05FR-12G E	6.07
247902	05FR-21G E	6.49
247903	05FR-22G E	6.21
247904	05FR-3G E	12.58
247905	05FR-4G E	9.86
247906	05MDL-1G E	10.78
247907	05MDL-2G E	5.4
247912	05MDL-3G E	5.4
247913	05MDL-4G E	5.4
243442	05RKG1	115.57
243443	05RKG2	113.82
933441	AC2-157 C	17.83
933442	AC2-157 E	29.09
935141	AD1-148	3.82
936771	AD2-100 C	10.62
936772	AD2-100 E	7.08
936971	AD2-131 C	0.7
936972	AD2-131 E	3.51
937211	AD2-159 C	2.54
937212	AD2-159 E	11.91
939741	AE1-205 C O1	5.41
939742	AE1-205 E O1	7.47
941341	AE2-130 C	229.41
941342	AE2-130 E	152.94
941571	AE2-154 C	2.19
941572	AE2-154 E	14.69
941731	AE2-173 O1	3.22
942111	AE2-223 C	1.26
942112	AE2-223 E	8.4
942481	AE2-261 C	14.87
942482	AE2-261 E	9.91
942601	AE2-276	11.73
944201	AF1-088 FTIR	234.58
944221	AF1-090 C O1	3.11
944222	AF1-090 E O1	14.56

Bus Number	Bus Name	Full Contribution
946581	AF1-322 C	5.67
946582	AF1-322 E	7.83
LTF	BLUEG	14.83
LTF	CALDERWOOD	0.08
LTF	CATAWBA	0.25
274890	CAYUG;1U E	7.21
274891	CAYUG;2U E	7.21
LTF	CBM-W1	46.41
LTF	CBM-W2	34.95
LTF	CHEOAH	0.09
LTF	G-007	1.51
954681	J949 C	11.05
LTF	LGE-GI-0012019	10.49
LTF	MADISON	23.22
LTF	MEC	8.74
LTF	NY	0.86
LTF	O-066	9.73
290261	S-027 E	11.36
290265	S-028 E	11.36
247943	T-127 E	5.4
LTF	TRIMBLE	5.31
LTF	TVA	1.86
276153	W2-048 E	4.87
274882	W4-005 E	20.51
LTF	WEC	1.63
909052	X2-022 E	14.64
913222	Y1-054 E	-1.29
250163	Y3-099 BAT	0.14
250167	Y3-100 BAT	0.14
251823	Z1-065 BAT	0.36
917502	Z2-087 E	11.2
930042	AB1-006 E	11.75
930461	AB1-087	129.02
930471	AB1-088	129.02
924041	AB2-047 C O1	2.09
924042	AB2-047 E O1	14

945391	AF1-204 C O1	6.45
945392	AF1-204 E O1	19.35
945421	AF1-207 C	2.12
945422	AF1-207 E	9.11
945871	AF1-252 O1	5.51
945881	AF1-253 O1	3.82

924261	AB2-070 C O1	2
924262	AB2-070 E O1	13.38
925771	AC1-053 C	2.01
925772	AC1-053 E	13.43
926841	AC1-171 C O1	0.64
926842	AC1-171 E O1	4.3

Appendix 3

(AEP - AEP) The 05SULLIVAN-05DEQUIN 345 kV line (from bus 247712 to bus 243217 ckt 1) loads from 90.32% to 101.46% (**DC power flow**) of its emergency rating (1318 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8648_05JEFRSO 765_B'. This project contributes approximately 146.82 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
243442	05RKG1	35.5
243443	05RKG2	34.96
933441	AC2-157 C	11.16
933442	AC2-157 E	18.21
941341	AE2-130 C	70.47
941342	AE2-130 E	46.98
942601	AE2-276	7.34
944201	AF1-088 FTIR	146.82
LTF	CBM-S1	14.55
LTF	CBM-S2	3.29
LTF	CBM-W2	20.2

Bus Number	Bus Name	Full Contribution
LTF	CPLE	0.26
LTF	G-007	0.21
LTF	LGEE	0.97
LTF	MADISON	1.7
LTF	MEC	1.98
LTF	NY	0.12
LTF	O-066	1.34
LTF	TVA	2.39
930461	AB1-087	80.75
930471	AB1-088	80.75

Appendix 4

(AEP - MISO IPL) The 05SULLIVAN-16PETE 345 kV line (from bus 247712 to bus 254529 ckt 1) loads from 83.27% to 101.53% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8648_05JEFRSO 765_B'. This project contributes approximately 255.73 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
247900	05FR-11G E	4.2
247901	05FR-12G E	4.13
247902	05FR-21G E	4.42
247903	05FR-22G E	4.23

Bus Number	Bus Name	Full Contribution
LTF	CALDERWOOD	0.46
LTF	CATAWBA	0.28
LTF	CBM-W1	25.12
LTF	CHEOAH	0.46

247904	05FR-3G E	8.56
247905	05FR-4G E	6.71
243442	05RKG1	61.82
243443	05RKG2	60.89
933441	AC2-157 C	19.44
933442	AC2-157 E	31.71
935141	AD1-148	2.49
936771	AD2-100 C	7.2
936772	AD2-100 E	4.8
936971	AD2-131 C	0.47
936972	AD2-131 E	2.38
937211	AD2-159 C	1.65
937212	AD2-159 E	7.74
941341	AE2-130 C	122.72
941342	AE2-130 E	81.81
942481	AE2-261 C	10.01
942482	AE2-261 E	6.68
942601	AE2-276	12.79
944201	AF1-088 FTIR	255.73
944221	AF1-090 C O1	2.15
944222	AF1-090 E O1	10.07
945391	AF1-204 C O1	4.02
945392	AF1-204 E O1	12.05
945871	AF1-252 O1	3.81
945881	AF1-253 O1	2.64
LTF	BLUEG	9.32

LTF	G-007	0.85
LTF	GIBSON	6.45
956451	J1139	8.48
954761	J468 C	1.93
954762	J468 E	10.94
953401	J811	6.47
953651	J815	12.76
953881	J848 C	2.05
953882	J848 E	11.1
954411	J912	5.5
954681	J949 C	11.77
955131	J991	13.63
LTF	LGE-GI-0012019	5.71
LTF	MADISON	12.56
LTF	MEC	4.85
LTF	NY	0.47
LTF	O-066	5.48
LTF	TRIMBLE	2.89
276153	W2-048 E	3.18
274882	W4-005 E	13.34
LTF	WEC	0.9
909052	X2-022 E	9.56
930461	AB1-087	140.65
930471	AB1-088	140.65
925771	AC1-053 C	1.3
925772	AC1-053 E	8.73

Appendix 5

(AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 117.34% to 128.06% (AC power flow) of its emergency rating (2354 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#1760_05JEFRSO 765_A'. This project contributes approximately 234.58 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
247900	05FR-11G E	6.17
247901	05FR-12G E	6.07
247902	05FR-21G E	6.49
247903	05FR-22G E	6.21
247904	05FR-3G E	12.58
247905	05FR-4G E	9.86
247906	05MDL-1G E	10.78
247907	05MDL-2G E	5.4

Bus Number	Bus Name	Full Contribution
946581	AF1-322 C	5.67
946582	AF1-322 E	7.83
LTF	BLUEG	14.83
LTF	CALDERWOOD	0.08
LTF	CATAWBA	0.25
274890	CAYUG;1U E	7.21
274891	CAYUG;2U E	7.21
LTF	CBM-W1	46.41

247912	05MDL-3G E	5.4
247913	05MDL-4G E	5.4
243442	05RKG1	115.57
243443	05RKG2	113.82
933441	AC2-157 C	17.83
933442	AC2-157 E	29.09
935141	AD1-148	3.82
936771	AD2-100 C	10.62
936772	AD2-100 E	7.08
936971	AD2-131 C	0.7
936972	AD2-131 E	3.51
937211	AD2-159 C	2.54
937212	AD2-159 E	11.91
939741	AE1-205 C O1	5.41
939742	AE1-205 E O1	7.47
941341	AE2-130 C	229.41
941342	AE2-130 E	152.94
941571	AE2-154 C	2.19
941572	AE2-154 E	14.69
941731	AE2-173 O1	3.22
942111	AE2-223 C	1.26
942112	AE2-223 E	8.4
942481	AE2-261 C	14.87
942482	AE2-261 E	9.91
942601	AE2-276	11.73
944201	AF1-088 FTIR	234.58
944221	AF1-090 C O1	3.11
944222	AF1-090 E O1	14.56
945391	AF1-204 C O1	6.45
945392	AF1-204 E O1	19.35
945421	AF1-207 C	2.12
945422	AF1-207 E	9.11
945871	AF1-252 O1	5.51
945881	AF1-253 O1	3.82

LTF	CBM-W2	34.95
LTF	CHEOAH	0.09
LTF	G-007	1.51
954681	J949 C	11.05
LTF	LGE-GI-0012019	10.49
LTF	MADISON	23.22
LTF	MEC	8.74
LTF	NY	0.86
LTF	O-066	9.73
290261	S-027 E	11.36
290265	S-028 E	11.36
247943	T-127 E	5.4
LTF	TRIMBLE	5.31
LTF	TVA	1.86
276153	W2-048 E	4.87
274882	W4-005 E	20.51
LTF	WEC	1.63
909052	X2-022 E	14.64
913222	Y1-054 E	-1.29
250163	Y3-099 BAT	0.14
250167	Y3-100 BAT	0.14
251823	Z1-065 BAT	0.36
917502	Z2-087 E	11.2
930042	AB1-006 E	11.75
930461	AB1-087	129.02
930471	AB1-088	129.02
924041	AB2-047 C O1	2.09
924042	AB2-047 E O1	14
924261	AB2-070 C O1	2
924262	AB2-070 E O1	13.38
925771	AC1-053 C	2.01
925772	AC1-053 E	13.43
926841	AC1-171 C O1	0.64
926842	AC1-171 E O1	4.3

Appendix 6

(AEP - AEP) The 05ROCKPT-05JEFRSO 765 kV line (from bus 243209 to bus 243208 ckt 1) loads from 104.92% to 114.62% (AC power flow) of its emergency rating (3970 MVA) for the tower line contingency outage of 'AEP_P7-1_#11042'. This project contributes approximately 332.53 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
243859	05FR-11G C	0.65
247900	05FR-11G E	14.27

Bus Number	Bus Name	Full Contribution
942601	AE2-276	16.63
944201	AF1-088 FTIR	332.53

243862	05FR-12G C	0.64
247901	05FR-12G E	14.03
243864	05FR-21G C	0.69
247902	05FR-21G E	15
243866	05FR-22G C	0.66
247903	05FR-22G E	14.36
243870	05FR-3G C	1.33
247904	05FR-3G E	29.09
243873	05FR-4G C	1.03
247905	05FR-4G E	22.78
246909	05MDL-1G C	1.34
247906	05MDL-1G E	29.1
246910	05MDL-2G C	0.66
247907	05MDL-2G E	14.58
246976	05MDL-3G C	0.67
247912	05MDL-3G E	14.58
246979	05MDL-4G C	0.66
247913	05MDL-4G E	14.58
243442	05RKG1	153.23
243443	05RKG2	150.91
933441	AC2-157 C	25.27
933442	AC2-157 E	41.23
936771	AD2-100 C	14.24
936772	AD2-100 E	9.49
936971	AD2-131 C	0.94
936972	AD2-131 E	4.71
941341	AE2-130 C	304.15
941342	AE2-130 E	202.77
941571	AE2-154 C	5.92
941572	AE2-154 E	39.64
942481	AE2-261 C	19.78
942482	AE2-261 E	13.18
944221	AF1-090 C O1	4.27
944222	AF1-090 E O1	19.97
945391	AF1-204 C O1	10.62
945392	AF1-204 E O1	31.87
945871	AF1-252 O1	7.56
945881	AF1-253 O1	5.24
946581	AF1-322 C	15.31
946582	AF1-322 E	21.14
LTF	BLUEG	0.34
LTF	CATAWBA	0.04
LTF	CBM-S1	26.89
LTF	CBM-W1	42.63
LTF	CBM-W2	61.24
LTF	G-007	1.91
954761	J468 C	3.09
954762	J468 E	17.51
954681	J949 C	18.64
274650	KINCAID ;1U	11.12
LTF	LGEE	0.27
LTF	MADISON	16.91
LTF	MEC	10.34
LTF	NY	1.05
LTF	O-066	12.36
247556	T-127 C	0.67
247943	T-127 E	14.58
LTF	TRIMBLE	0.47
LTF	TVA	5.27
LTF	WEC	1.4
930041	AB1-006 C	0.87
930042	AB1-006 E	31.71
930461	AB1-087	182.89
930471	AB1-088	182.89

Appendix 7

(AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 116.9% to 135.72% (**DC power flow**) of its emergency rating (1160 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8648_05JEFRSO 765_B'. This project contributes approximately 218.22 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
243442	05RKG1	52.77
243443	05RKG2	51.97
933441	AC2-157 C	16.58
LTF	EDWARDS	0.05
LTF	G-007	0.27
955131	J991	10.51

933442	AC2-157 E	27.06
941341	AE2-130 C	104.74
941342	AE2-130 E	69.83
942601	AE2-276	10.91
944201	AF1-088 FTIR	218.22
LTF	CBM-S1	9.32
LTF	CBM-S2	1.76
LTF	CBM-W2	10.67
LTF	CPLE	0.11

LTF	LGEE	0.4
LTF	MADISON	1.76
LTF	MEC	1.1
LTF	NY	0.15
LTF	O-066	1.77
LTF	TILTON	4.77
LTF	TVA	1.65
930461	AB1-087	120.02
930471	AB1-088	120.02

Appendix 8

(AEP - AEP) The 05SULLIVAN-05DARWIN 345 kV line (from bus 247712 to bus 243216 ckt 1) loads from 116.9% to 135.72% (**DC power flow**) of its emergency rating (1160 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8648_05JEFRSO 765_B'. This project contributes approximately 218.22 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
243442	05RKG1	52.77
243443	05RKG2	51.97
933441	AC2-157 C	16.58
933442	AC2-157 E	27.06
941341	AE2-130 C	104.74
941342	AE2-130 E	69.83
942601	AE2-276	10.91
944201	AF1-088 FTIR	218.22
LTF	CBM-S1	9.32
LTF	CBM-S2	1.76
LTF	CBM-W2	10.67
LTF	CPLE	0.11

Bus Number	Bus Name	Full Contribution
LTF	EDWARDS	0.05
LTF	G-007	0.27
955131	J991	10.51
LTF	LGEE	0.4
LTF	MADISON	1.76
LTF	MEC	1.1
LTF	NY	0.15
LTF	O-066	1.77
LTF	TILTON	4.77
LTF	TVA	1.65
930461	AB1-087	120.02
930471	AB1-088	120.02

Appendix 9

(AEP - MISO AMIL) The 05SULLIVAN-J1180 TAP 345 kV line (from bus 247712 to bus 956820 ckt 1) loads from 114.41% to 139.31% (**DC power flow**) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8648_05JEFRSO 765_B'. This project contributes approximately 365.83 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
247900	05FR-11G E	4.01

Bus Number	Bus Name	Full Contribution
951731	J446 C	1.8

247901	05FR-12G E	3.94
247902	05FR-21G E	4.21
247903	05FR-22G E	4.03
247904	05FR-3G E	8.17
247905	05FR-4G E	6.4
243442	05RKG1	88.48
243443	05RKG2	87.14
933441	AC2-157 C	27.8
933442	AC2-157 E	45.36
936973	AD2-131 BAT	5.5
941341	AE2-130 C	175.64
941342	AE2-130 E	117.09
941732	AE2-173 BAT	2.73
942601	AE2-276	18.29
944201	AF1-088 FTIR	365.83
945872	AF1-252 BAT	7.69
945882	AF1-253 BAT	5.33
LTF	CALDERWOOD	1.09
LTF	CATAWBA	0.49
LTF	CHEOAH	1.09
LTF	COFFEEN	3.1
LTF	EDWARDS	1.88
LTF	FARMERCITY	0.38
LTF	G-007	0.07
955451	J1027	13.03
955461	J1028	12.34
955791	J1063	17.61
955821	J1067	13.92
955841	J1069 C	2.16
955842	J1069 E	11.67
955891	J1074	14.88
956561	J1152	14.47
956911	J1189	0.3
951732	J446 E	9.76
951811	J513 C	0.96
951812	J513 E	5.19
954772	J515 E	27.02
952811	J759	4.43
952821	J762	10.02
952861	J783 C	4.21
952862	J783 E	0.18
953351	J805	14.31
953161	J837 C	2.16
953162	J837 E	11.68
953171	J838 C	1.08
953172	J838 E	5.84
953931	J856	5.46
954351	J903	6.84
954421	J913 C	11.07
954941	J968 C	2.16
954942	J968 E	11.67
955141	J992	10.09
955151	J993	14.28
LTF	LGEE	0.75
LTF	LGE-TSR-0092018	< 0.01
LTF	NEWTON	26.37
LTF	NY	0.01
LTF	O-066	0.42
LTF	PRAIRIE	31.25
LTF	TILTON	1.46
276153	W2-048 E	-5.21
909052	X2-022 E	-15.68
930461	AB1-087	201.21
930471	AB1-088	201.21
924041	AB2-047 C O1	-1.77
LTF	AC1-056	11.94

Appendix 10

(OVEC - OVEC) The 06CLIFTY-06DEARB1 345 kV line (from bus 248000 to bus 248001 ckt 1) loads from 104.65% to 110.62% (AC power flow) of its emergency rating (1023 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#1760_05JEFRSO 765_A'. This project contributes approximately 61.04 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
933441	AC2-157 C	4.64
LTF	G-007	0.24

933442	AC2-157 E	7.57
941341	AE2-130 C	56.48
941342	AE2-130 E	37.65
942601	AE2-276	3.05
944201	AF1-088 FTIR	61.04
LTF	CBM-S1	28.24
LTF	CBM-S2	4.87
LTF	CBM-W1	13.42
LTF	CBM-W2	19.57
LTF	CPLE	0.39

LTF	LGEE	4.67
LTF	MADISON	14.12
LTF	MEC	2.74
LTF	NY	0.08
LTF	O-066	1.59
LTF	TVA	3.09
LTF	WEC	0.34
930461	AB1-087	33.57
930471	AB1-088	33.57

Appendix 11

(CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 119.11% to 123.29% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of 'COMED_P1-2_345-L8014___-S-B'. This project contributes approximately 58.1 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
933441	AC2-157 C	4.42
935001	AD1-133 C O1	87.98
935141	AD1-148	13.33
936771	AD2-100 C	24.65
936971	AD2-131 C	1.62
937211	AD2-159 C	9.97
939741	AE1-205 C O1	40.95
941731	AE2-173 O1	24.37
942111	AE2-223 C	9.51
942481	AE2-261 C	36.28
942601	AE2-276	2.91
944201	AF1-088 FTIR	58.1
944221	AF1-090 C O1	6.21
945391	AF1-204 C O1	4.39
945871	AF1-252 O1	11
945881	AF1-253 O1	7.62
LTF	CBM-S1	31.13
LTF	CBM-S2	12.48
LTF	CBM-W2	47.42
LTF	CPLE	1.24
LTF	G-007A	2.09
274880	GENERATOR;	2.22
955401	J1022 C	4.68
955711	J1055 C	2.19
956151	J1102	11.47
956281	J1115 C	7.75

Bus Number	Bus Name	Full Contribution
952271	J644	13.72
954721	J750 C	3.7
952651	J756 C	4.56
952871	J757 C	5.86
953401	J811	10.77
953651	J815	37.71
953741	J826 C	3.12
953851	J845 C	3.03
953881	J848 C	5.78
954411	J912	14.25
954681	J949 C	15.28
954821	J955	179.44
274650	KINCAID ;1U	20.85
274651	KINCAID ;2U	20.84
LTF	LGEE	1.54
LTF	MADISON	2.52
LTF	MEC	3.46
LTF	TVA	5.42
274853	TWINGROVE;U1	2.76
274854	TWINGROVE;U2	2.76
LTF	VFT	5.62
917501	Z2-087 C	2.32
930461	AB1-087	31.96
930471	AB1-088	31.96
924041	AB2-047 C O1	15.84
924261	AB2-070 C O1	7.5

956451	J1139	17.69
954761	J468 C	3.03
952251	J641	13.66

925771	AC1-053 C	7.37
926841	AC1-171 C O1	0.62

Appendix 12

(LGEE - OVEC) The 7TRIMBL REAC-06CLIFTY 345 kV line (from bus 324010 to bus 248000 ckt 1) loads from 117.09% to 121.49% (**DC power flow**) of its emergency rating (1451 MVA) for the single line contingency outage of 'AEP_P1-2_#363'. This project contributes approximately 63.83 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
243442	05RKG1	15.33
243443	05RKG2	15.1
342900	1COOPER1 G	2.56
342903	1COOPER2 G	4.96
342918	1JKCT 1G	2
342921	1JKCT 2G	1.41
342924	1JKCT 3G	2
342927	1JKCT 4G	1.33
342930	1JKCT 5G	1.32
342933	1JKCT 6G	1.33
342936	1JKCT 7G	1.33
342939	1JKCT 9G	1.36
342942	1JKCT 10G	1.36
342945	1LAUREL 1G	1.44
932551	AC2-075 C	0.95
933441	AC2-157 C	4.85
936381	AD2-048 C	3.43
936571	AD2-072 C O1	10.12
939131	AE1-143 C	9.58
940041	AE1-246 C O1	11.96
940831	AE2-071 C	3.03
941341	AE2-130 C	30.61
941411	AE2-138 C	15.15
941981	AE2-210 C O1	5.22
942411	AE2-254 C O1	4.03
942591	AE2-275 C O1	6.82
942601	AE2-276	3.19
942891	AE2-308 C O1	11.51
943111	AE2-339 C	2.56
943701	AF1-038 C	4.66

Bus Number	Bus Name	Full Contribution
943821	AF1-050 C	5.41
944151	AF1-083 C O1	4.98
944201	AF1-088 FTIR	63.83
944511	AF1-116 C	10.74
944621	AF1-127 C O1	4.44
945381	AF1-203 C	1.73
945861	AF1-251 C	10.72
LTF	CBM-S1	97.43
LTF	CBM-S2	14.8
LTF	CBM-W1	20.44
LTF	CBM-W2	56.25
LTF	CPLE	1.2
955451	J1027	13.72
955461	J1028	15.21
955891	J1074	22.99
956911	J1189	0.45
952811	J759	9.7
952821	J762	29.93
952861	J783 C	9.3
953611	J800	14.01
953931	J856	9.41
LTF	LGEE	18.14
LTF	MADISON	12.34
LTF	MEC	6.1
LTF	NY	0.27
LTF	TVA	9.52
LTF	WEC	0.67
930461	AB1-087	35.11
930471	AB1-088	35.11
925981	AC1-074 C O1	3.99

Appendix 13

(CE - CE) The CHESTNUT ;-BLUEMOUND; B 345 kV line (from bus 270912 to bus 270668 ckt 1) loads from 114.53% to 118.66% (AC power flow) of its emergency rating (1334 MVA) for the single line contingency outage of 'COMED_P1-2_345-L8001___-S'. This project contributes approximately 50.0 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
932931	AC2-117	-3.15
933441	AC2-157 C	3.8
935141	AD1-148	9.07
936771	AD2-100 C	22.5
936971	AD2-131 C	1.48
937211	AD2-159 C	11.59
939741	AE1-205 C O1	15.41
941731	AE2-173 O1	9.17
942111	AE2-223 C	3.58
942481	AE2-261 C	33.19
942601	AE2-276	2.5
944201	AF1-088 FTIR	50
944221	AF1-090 C O1	5.62
945391	AF1-204 C O1	3.65
945871	AF1-252 O1	9.97
945881	AF1-253 O1	6.9
LTF	CBM-S1	27.2
LTF	CBM-S2	11.17
LTF	CBM-W2	40.27
LTF	CPLE	1.12
LTF	G-007A	2.04
274880	GENERATOR;	2.57
955401	J1022 C	3.14
955711	J1055 C	1.82
956151	J1102	10.97
956281	J1115 C	7.71
956451	J1139	14.36
954761	J468 C	2.57

Bus Number	Bus Name	Full Contribution
952251	J641	12.27
952271	J644	12.51
954721	J750 C	3.32
952651	J756 C	4.3
952871	J757 C	5.37
953401	J811	9.85
953641	J813	17.16
953651	J815	34.76
953741	J826 C	2.09
953851	J845 C	2.05
953881	J848 C	5.33
953951	J859	10.5
954411	J912	13.11
954681	J949 C	13.35
954821	J955	166.98
274650	KINCAID ;1U	19.08
274651	KINCAID ;2U	19.11
LTF	LGEE	1.36
LTF	MADISON	1.1
LTF	MEC	2.36
LTF	TVA	4.73
LTF	VFT	5.48
917501	Z2-087 C	0.87
930461	AB1-087	27.5
930471	AB1-088	27.5
924041	AB2-047 C O1	5.96
924261	AB2-070 C O1	4.8
925771	AC1-053 C	4.8

Appendix 14

(CE - CE) The AD1-133 TAP-DRESDEN ; R 345 kV line (from bus 935000 to bus 270717 ckt 1) loads from 116.65% to 120.5% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of 'COMED_P1-2_345-L11212_B-S-B'. This project contributes approximately 53.47 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
933441	AC2-157 C	4.06
935001	AD1-133 C O1	118.75
935141	AD1-148	12.07
936771	AD2-100 C	22.02
936971	AD2-131 C	1.45
937211	AD2-159 C	9.05
939401	AE1-172 C O1	20.13
939741	AE1-205 C O1	37.72
940101	AE1-252 C O1	40.45
941731	AE2-173 O1	22.45
942111	AE2-223 C	8.76
942481	AE2-261 C	32.42
942601	AE2-276	2.67
944201	AF1-088 FTIR	53.47
944221	AF1-090 C O1	5.54
945391	AF1-204 C O1	4.06
945871	AF1-252 O1	9.82
945881	AF1-253 O1	6.8
274863	CAYUGA RI;1U	2.47
274864	CAYUGA RI;2U	2.47
LTF	CBM-S1	27.51
LTF	CBM-S2	11.57
LTF	CBM-W2	40.79
LTF	CPLE	1.17
LTF	G-007A	2.3
274880	GENERATOR;	2.01
955401	J1022 C	4.39
956151	J1102	10.36

Bus Number	Bus Name	Full Contribution
956281	J1115 C	7.22
956451	J1139	17.02
954761	J468 C	2.94
952271	J644	12.32
954721	J750 C	3.37
952651	J756 C	4.07
952871	J757 C	5.25
953401	J811	10.18
953651	J815	35
953741	J826 C	2.93
953851	J845 C	2.87
953881	J848 C	5.39
954411	J912	13.3
954821	J955	165.64
274650	KINCAID ;1U	18.63
274651	KINCAID ;2U	18.62
LTF	LGEE	1.46
LTF	MEC	1.12
LTF	TVA	4.73
274853	TWINGROVE;U1	2.52
274854	TWINGROVE;U2	2.52
LTF	VFT	6.18
917501	Z2-087 C	2.14
930461	AB1-087	29.41
930471	AB1-088	29.41
924041	AB2-047 C O1	14.59
924261	AB2-070 C O1	6.81
925771	AC1-053 C	6.68

Appendix 15

None.

Appendix 16

(MISO AMIL - AEP) The J1180 TAP-05SULLIVAN 345 kV line (from bus 956820 to bus 247712 ckt 1) loads from 131.14% to 148.33% (AC power flow) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#3128_05EUGENE 345_A2'. This project contributes approximately 280.08 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
932881	AC2-115 1	1.31
932891	AC2-115 2	1.31
932921	AC2-116	0.46
933911	AD1-013 C	0.98
933912	AD1-013 E	1.57
933931	AD1-016 C	0.47
933932	AD1-016 E	0.76
934051	AD1-031 C O1	2.32
934052	AD1-031 E O1	3.79
934101	AD1-039 1	3.49
934431	AD1-067 C	0.07
934432	AD1-067 E	0.3
934701	AD1-098 C O1	3.75
934702	AD1-098 E O1	2.74
934871	AD1-116 C	0.47
934872	AD1-116 E	0.77
934971	AD1-129 C	0.48
934972	AD1-129 E	0.32
935001	AD1-133 C O1	14.43
935002	AD1-133 E O1	9.62
935141	AD1-148	7.42
936291	AD2-038 C O1	1.85
936292	AD2-038 E O1	8.67
936511	AD2-066 C O1	4.79
936512	AD2-066 E O1	3.19
936771	AD2-100 C	22.48
936772	AD2-100 E	14.99
936791	AD2-102 C	8
936792	AD2-102 E	5.33
936971	AD2-131 C	1.48
936972	AD2-131 E	7.44
937001	AD2-134 C	1.4
937002	AD2-134 E	5.58
937211	AD2-159 C	4.89
937212	AD2-159 E	22.89
937311	AD2-172 C	1.43
937312	AD2-172 E	1.97
937531	AD2-214 C	3.25
937532	AD2-214 E	2.17
938851	AE1-113 C	4.53
938852	AE1-113 E	16.05
938861	AE1-114 C O1	2.39
938862	AE1-114 E O1	8.14
939051	AE1-134 1	0.91
939061	AE1-134 2	0.91

Bus Number	Bus Name	Full Contribution
946661	AF1-330 C	1.01
946662	AF1-330 E	0.22
946671	AF1-331	1.27
LTF	BLUEG	2.69
294401	BSHIL;1U E	6.98
294410	BSHIL;2U E	6.98
274890	CAYUG;1U E	10.37
274891	CAYUG;2U E	10.37
LTF	CBM-S1	37.05
LTF	CBM-S2	8.69
LTF	CBM-W1	63.46
LTF	CBM-W2	70.63
LTF	CPLE	0.6
274859	EASYR;U1 E	6.86
274860	EASYR;U2 E	6.86
LTF	G-007	0.76
274880	GENERATOR;	1.09
290051	GSG-6; E	5.64
956451	J1139	21.99
954761	J468 C	5.21
954762	J468 E	29.53
953401	J811	17.75
953641	J813	39.53
953651	J815	11.38
953881	J848 C	5.15
953882	J848 E	27.86
954411	J912	14.04
954681	J949 C	32.79
955131	J991	40.72
274650	KINCAID ;1U	17.45
274651	KINCAID ;2U	17.44
990901	L-005 E	10.82
290108	LEEDK;1U E	12.46
LTF	MADISON	25.01
LTF	MEC	15.78
LTF	NY	0.44
293516	O-009 E1	6.38
293517	O-009 E2	3.24
293518	O-009 E3	3.57
293715	O-029 E	6.82
293716	O-029 E	3.74
293717	O-029 E	3.44
293771	O-035 E	5.13
LTF	O-066	4.95
293644	O22 E1	4.99

939321	AE1-163 C O1	3.44
939322	AE1-163 E O1	21.11
939401	AE1-172 C O1	3.49
939402	AE1-172 E O1	16.36
939741	AE1-205 C O1	8.56
939742	AE1-205 E O1	11.82
940101	AE1-252 C O1	7.01
940102	AE1-252 E O1	4.67
940501	AE2-035 C	1.43
940502	AE2-035 E	1.97
941131	AE2-107 C	3.36
941132	AE2-107 E	2.24
941343	AE2-130 BAT	31.79
941731	AE2-173 O1	5.1
942111	AE2-223 C	1.99
942112	AE2-223 E	13.3
942421	AE2-255 C O1	1.71
942422	AE2-255 E O1	5.14
942481	AE2-261 C	31.08
942482	AE2-261 E	20.72
942602	AE2-276 BAT	14
942651	AE2-281 C O1	0.49
942652	AE2-281 E O1	3.02
942991	AE2-321 C	4.15
942992	AE2-321 E	2.04
943411	AF1-012 C	7.55
943412	AF1-012 E	5.03
943801	AF1-048 C	1.94
943802	AF1-048 E	1.29
943921	AF1-060	0.7
944202	AF1-088 FTWR	280.08
944221	AF1-090 C O1	6.81
944222	AF1-090 E O1	31.9
945871	AF1-252 O1	12.08
945881	AF1-253 O1	8.36
946151	AF1-280 C O1	9.92
946152	AF1-280 E O1	4.56
946161	AF1-281 C	0.22
946162	AF1-281 E	1.23
946321	AF1-296 C O1	3.08
946322	AF1-296 E O1	14.42
946501	AF1-314 C	2.54
946502	AF1-314 E	11.88
946541	AF1-318 C O1	4.54
946542	AF1-318 E O1	21.26

293645	O22 E2	9.69
290021	O50 E	10.97
294763	P-046 E	5.44
290261	S-027 E	20.38
290265	S-028 E	20.38
295111	SUBLETTE E	1.47
LTF	TRIMBLE	1
LTF	TVA	7.81
274853	TWINGROVE;U1	0.93
274854	TWINGROVE;U2	0.93
274830	U3-021 1	3.18
274831	U3-021 2	3.18
276153	W2-048 E	9.46
274882	W4-005 E	39.44
LTF	WEC	2.02
295109	WESTBROOK E	3.02
909052	X2-022 E	28.46
916211	Z1-072 E	3.88
916221	Z1-073 E	2.91
917501	Z2-087 C	0.49
917502	Z2-087 E	17.73
918052	AA1-018 E OP	8.06
919581	AA2-030	11.73
920272	AA2-123 E	1.23
930481	AB1-089	35.72
930741	AB1-122 1O1	35.62
924041	AB2-047 C O1	3.31
924042	AB2-047 E O1	22.16
924261	AB2-070 C O1	3.82
924262	AB2-070 E O1	25.59
924471	AB2-096	22.1
925302	AB2-191 E	0.75
925581	AC1-033 C	1.14
925582	AC1-033 E	7.65
925771	AC1-053 C	3.86
925772	AC1-053 E	25.83
927511	AC1-113 1	0.66
927521	AC1-113 2	0.66
926431	AC1-114	1.31
926821	AC1-168 C O1	0.83
926822	AC1-168 E O1	5.55
926841	AC1-171 C O1	1.04
926842	AC1-171 E O1	6.95
927201	AC1-214 C O1	1.65
927202	AC1-214 E O1	5.24

Appendix 17

(AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 98.41% to 104.32% (**DC power flow**) of its normal rating (2354 MVA) for the single line contingency outage of 'AEP_P1-2_#709'. This project contributes approximately 131.26 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
243859	05FR-11G C	1
243862	05FR-12G C	0.99
247901	05FR-12G E	3.93
243864	05FR-21G C	1.05
247902	05FR-21G E	4.2
243866	05FR-22G C	1.01
243870	05FR-3G C	2.04
247904	05FR-3G E	8.15
243873	05FR-4G C	1.58
247905	05FR-4G E	6.38
246909	05MDL-1G C	2.1
247906	05MDL-1G E	8.38
246910	05MDL-2G C	1.04
247907	05MDL-2G E	4.2
246976	05MDL-3G C	1.06
247912	05MDL-3G E	4.2
246979	05MDL-4G C	1.03
247913	05MDL-4G E	4.2
933281	AC2-140 C	3.89
933282	AC2-140 E	0.2
934431	AD1-067 C	0.08
934432	AD1-067 E	0.33
934721	AD1-100 C	11.46
934722	AD1-100 E	53.5
935141	AD1-148	3.55
936291	AD2-038 C O1	1.94
936292	AD2-038 E O1	9.07
936371	AD2-047 C O1	2.6
936372	AD2-047 E O1	12.68
936971	AD2-131 C	0.73
936972	AD2-131 E	3.67
937001	AD2-134 C	1.57
937002	AD2-134 E	6.27
937211	AD2-159 C	2.4
937212	AD2-159 E	11.24
938851	AE1-113 C	4.86
938852	AE1-113 E	17.22
938861	AE1-114 C O1	2.41

Bus Number	Bus Name	Full Contribution
945683	AF1-233 BAT	3.51
945871	AF1-252 O1	5.47
945881	AF1-253 O1	3.78
946161	AF1-281 C	0.26
946162	AF1-281 E	1.49
946321	AF1-296 C O1	2.51
946322	AF1-296 E O1	11.77
946501	AF1-314 C	2.66
946502	AF1-314 E	12.44
946541	AF1-318 C O1	3.81
946542	AF1-318 E O1	17.82
274857	BIG SKY ;U1	0.84
274858	BIG SKY ;U2	0.84
274877	BISHOP HL;1U	0.71
274878	BISHOP HL;2U	0.71
294401	BSHIL;1U E	2.82
294410	BSHIL;2U E	2.82
274848	CAMPGROVE;RU	1.06
274890	CAYUG;1U E	4.51
274891	CAYUG;2U E	4.51
274863	CAYUGA RI;1U	1.13
274864	CAYUGA RI;2U	1.13
274849	CRESCENT ;1U	0.35
274859	EASYR;U1 E	3.37
274860	EASYR;U2 E	3.37
274856	ECOGROVE ;U1	0.71
274871	GR RIDGE ;2U	1.44
274847	GR RIDGE ;BU	1.13
274855	GSG-6 ;RU	0.79
290051	GSG-6; E	3.17
275149	KELLYCK ;1E	5.33
274888	KELLYCK ;1U	1.33
990901	L-005 E	4.24
274872	LEE DEKAL;1U	1.75
290108	LEEDK;1U E	7.28
LTF	LGE-0012019	8.08
274850	MENDOTA H;RU	0.19
274879	MINONK ;1U	1.47

938862	AE1-114 E O1	8.21
939321	AE1-163 C O1	3.6
939322	AE1-163 E O1	22.09
939401	AE1-172 C O1	3.39
939402	AE1-172 E O1	15.9
939631	AE1-193 C	5.02
939632	AE1-193 E	33.61
939641	AE1-194 C	5.02
939642	AE1-194 E	33.61
939651	AE1-195 C	5.02
939652	AE1-195 E	33.61
939681	AE1-198 C	< 0.01
939682	AE1-198 E	8.59
940101	AE1-252 C O1	< 0.01
940102	AE1-252 E O1	14.18
940752	AE2-062 E	0.09
941341	AE2-130 C	< 0.01
941342	AE2-130 E	61.75
941561	AE2-153 C O1	2.69
941562	AE2-153 E O1	12.59
941571	AE2-154 C	3.42
941572	AE2-154 E	22.86
941731	AE2-173 O1	4.66
942111	AE2-223 C	1.46
942112	AE2-223 E	9.74
942421	AE2-255 C O1	1.84
942422	AE2-255 E O1	5.52
942601	AE2-276	8.2
942651	AE2-281 C O1	0.51
942652	AE2-281 E O1	3.16
942893	AE2-308 BAT	4.74
943021	AE2-325 C	2.75
943022	AE2-325 E	1.83
943772	AF1-045 BAT	5.35
943781	AF1-046 C	2.33
943782	AF1-046 E	1.55
943801	AF1-048 C	2.85
943802	AF1-048 E	1.9
943921	AF1-060	0.92
944201	AF1-088 FTIR	131.26
944221	AF1-090 C O1	2.47
944222	AF1-090 E O1	11.55
944241	AF1-092 C O1	< 0.01
944242	AF1-092 E O1	8.54
944931	AF1-158 C O1	< 0.01
944932	AF1-158 E O1	14.27
944961	AF1-161 C	2.2

293061	N-015 E	4.53
293513	O-009 C1	0.72
293514	O-009 C2	0.36
293515	O-009 C3	0.4
293516	O-009 E1	2.87
293517	O-009 E2	1.46
293518	O-009 E3	1.6
276156	O-029 C	0.39
276157	O-029 C	0.42
276158	O-029 C	0.77
293715	O-029 E	3.07
293716	O-029 E	1.68
293717	O-029 E	1.54
293771	O-035 E	2.11
293644	O22 E1	3.03
293645	O22 E2	5.89
290021	O50 E	5.88
294392	P-010 E	5.75
294763	P-046 E	2.84
274881	PILOT HIL;1E	5.33
274887	PILOT HIL;1U	1.33
274851	PROVIDENC;RU	0.53
290261	S-027 E	5.81
290265	S-028 E	5.81
295110	SUBLETTE C	0.11
247556	T-127 C	1.05
247943	T-127 E	4.2
274861	TOP CROP ;1U	0.76
274862	TOP CROP ;2U	1.47
274853	TWINGROVE;U1	1.45
274854	TWINGROVE;U2	1.45
274882	W4-005 E	8.24
295108	WESTBROOK C	0.26
917501	Z2-087 C	0.97
917502	Z2-087 E	6.48
918051	AA1-018 C OP	0.72
930041	AB1-006 C	1.36
930042	AB1-006 E	9.13
924041	AB2-047 C O1	2.43
924042	AB2-047 E O1	16.23
924261	AB2-070 C O1	1.9
924262	AB2-070 E O1	12.68
925301	AB2-191	0.3
925581	AC1-033 C	0.93
925582	AC1-033 E	6.21
925771	AC1-053 C	1.89
925772	AC1-053 E	12.66

944962	AF1-161 E	2.2
945111	AF1-176 C O1	4.2
945112	AF1-176 E O1	6.29
945351	AF1-200 FTIR	155.1
945391	AF1-204 C O1	5.03
945392	AF1-204 E O1	15.1
945421	AF1-207 C	3.61
945422	AF1-207 E	15.5

926821	AC1-168 C O1	0.74
926822	AC1-168 E O1	4.96
926841	AC1-171 C O1	0.73
926842	AC1-171 E O1	4.89
927201	AC1-214 C O1	1.35
927202	AC1-214 E O1	4.31