Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AB1-087

Sullivan 345 kV

June 2016

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. 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.

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, 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 impact study is performed.

The Feasibility 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

The Interconnection Customer (IC) proposes to interconnect a 575 MW (550 MW Capacity) natural gas fired Electric Power Plant to the American Electric Power (AEP) Transmission System at two (2) alternative points. The proposed PJM Project #AB1-087 is located in Sullivan County, Indiana.

The requested in-service date is 06/01/2019.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP Transmission System. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required to maintain the reliability of the AEP Transmission System. Stability analysis is not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (Sullivan Station 345 kV Yard)

To accommodate the interconnection at the Sullivan substation 345 kV yard an additional 345 kV circuit breaker and associated protection and control equipment will be installed. Installation of associated 345 kV line risers, SCADA, and metering equipment will be also required.

The following work is required to connect Project AB1-087 to the Proposed Primary Point of Interconnection (Sullivan Station 345 kV Yard)**:**

Station Cost:

- Install a new 345 kV circuit breaker and associated bus work including SCADA and 345 kV revenue metering.
- **Estimated Station Cost: $2,500,000**

Protection and Relaying Cost:

- Line protection and controls at the Sullivan 345 kV substation will need to be upgraded.
- **Estimated Protection and Relaying Cost: $600,000**

Note: The Interconnection Customer's generation facilities were not included in the cost estimate. These are assumed to be Interconnection Customer's 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 utility to determine if a local service agreement is required.

Secondary Point of Interconnection (Sullivan Station 765 kV Yard)

To accommodate the interconnection at the Sullivan substation 765 kV yard an additional 765 kV circuit breaker and associated protection and control equipment will be installed. Installation of associated 765 kV line risers, SCADA, and metering equipment will be also required.

The following work is required to connect Project AB1-087 to the Proposed Secondary Point of Interconnection (Sullivan Station 765 kV Yard)**:**

Station Connection:

- Install a new 765 kV circuit breaker and associated bus work including SCADA and 765 kV revenue metering.
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Protection and Relaying:

- Line protection and controls at the Sullivan 765 kV substation will need to be upgraded.

Local and Network Impacts

The impact of the proposed natural gas fired generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet performance parameters prescribed in the AEP FERC Form 715[1] and Connection Requirements for AEP Transmission System[2]. Therefore, these criteria were used to assess the impact of the proposed facility on the AEP System. PJM project AB1-087 was studied as a 575 MW (550 MW capacity) injection to AEP system consistent with the interconnection application. The proposed Project AB1-087 was evaluated for compliance with reliability criteria for summer peak conditions in 2019.

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https://www.aep.com/about/codeofconduct/oasis/transmissionstudies/GuideLines/2015%20AEP%20PJM%20FERC%20715_Final_Part%204.pdf

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https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/Requirements/AEP_Interconnection_Requirements_rev1.pdf

Network Impacts

The Queue Project AB1-087 was evaluated as a 575.0 MW (Capacity 550.0 MW) injection at the Sullivan 345 kV substation in the COMED area. Project AB1-087 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-087 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2019

System Reinforcement responsible by Transmission Owner

1. Existing Baseline project

(This project contributes to the following contingency overloads, and there are existing PJM baseline projects to fix the following overloads. If a customer desires to expedite the required date for the existing PJM baseline projects, the customer will be financially responsible)

1. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 122.46% to 128.83% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 89.7 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

2. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 102.36% to 107.3% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '8808_B2'. This project contributes approximately 69.59 MW to the thermal violation.

CONTINGENCY '8808_B2'
OPEN BRANCH FROM BUS 243229 TO BUS 243878 CKT 1 / 243229 05OLIVE 345 243878 05MEADOW 345 1
END

PJM baseline project (b2449 Rebuild 7-,mile Meadow Lake-Reynolds 345kV line) will eliminate the identified overloads; incremental costs are listed in the Reinforcements Section. The scheduled in service date b2449 is 06/01/2017.

Primary Point of Interconnection (Sullivan Station 345 kV Yard) Potential network impacts were as follows:

Generator Deliverability

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

Table 1 - Primary Point of Interconnection

AB1-087 Generator Deliverability

#	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	DC	82.43	92.12	NR	971	94.07	
2	N-1	672_B2_TOR1713	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	89.05	95.13	NR	971	59.11	
3	N-1	363_B2_TOR1682	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	80.19	94.74	NR	1332	193.79	
4	N-1	667_B2_TOR1697	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	82.43	92.12	NR	971	94.07	
5	N-1	363_B2_TOR1682	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	DC	98.08	100.32	ER	1241	27.76	

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

Table 2 - Primary Point of Interconnection

AB1-087 Multiple Facility Contingency

#	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	LFFB	6189_C2_05HANGR 765-D1	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	90.95	95.73	ER	2354	97.72	
2	DCTL	430	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	DC	98.13	103.49	ER	4253	227.82	1
3	DCTL	431	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	DC	98.13	103.49	ER	4253	227.82	

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.)

Table 3 - Primary Point of Interconnection

AB1-087 Contribution to Previously Identified Overloads

#	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	LFFB	1760_C2_05JEFRSO 765-A	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	114.65	120.48	ER	2354	137.21	2
2	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	129.29	141.59	NR	971	119.4	3
3	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	119.65	128.46	ER	1419	125	
4	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	117.48	125.81	NR	971	80.91	4
5	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	112.03	118.56	ER	1304	85.14	
6	LFFB	8648_C2_05JEFRSO 765-B1	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	124.88	138.72	ER	1466	202.88	5
7	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	129.29	141.59	NR	971	119.4	6
8	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	119.65	128.46	ER	1419	125	
9	LFFB	6485_C2_05DEQUIN 345-C1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	141.66	147.02	ER	1304	69.94	7
10	N-1	6490_B2_TOR16000	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	128.74	135.55	NR	971	66.17	
11	N-1	363_B2_TOR1682	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	100.6	106.34	NR	971	55.79	
12	LFFB	4704_C2_05DEQUIN 345-B1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	141.66	147.02	ER	1304	69.94	8
13	N-1	6472_B2_TOR15258	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	128.74	135.55	NR	971	66.17	
14	N-1	363_B2_TOR1682	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	100.6	106.34	NR	971	55.79	
15	N-1	667_B2_TOR1697	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	112.59	116.81	NR	971	41.01	9
16	N-1	363_B2_TOR1682	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	112.25	116	NR	971	36.45	
17	LFFB	8648_C2_05JEFRSO 765-B1	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	144.59	149.57	ER	1918	95.48	10
18	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	122.46	128.83	NR	1409	89.7	
19	N-1	8808_B2	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	102.36	107.3	NR	1409	69.59	
20	N-1	345-L8014_T_-S	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	DC	123.71	126.07	ER	1241	29.27	11

Short Circuit

(Summary of impacted circuit breakers)

None

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection request.

Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

Table 4 - Primary Point of Interconnection

AB1-087 Delivery of Energy Portion of Interconnection Request

#	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	8695_B2	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	DC	95.65	100.24	NR	4055	186.15	
2	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	174.01	186.86	NR	971	124.83	
3	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	147.78	156.49	NR	971	84.59	
4	N-1	363_B2_TOR1682	AEP - MISO IPL	05BREED-16WHEAT 345 kV line	243213	254539	1	DC	123.49	134.67	NR	1386	154.95	
5	N-1	363_B2_TOR1682	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	136.1	151.31	NR	1332	202.6	
6	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	174.01	186.86	NR	971	124.83	
7	N-1	6490_B2_TOR16000	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	184.47	191.6	NR	971	69.17	
8	N-1	6472_B2_TOR15258	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	184.47	191.6	NR	971	69.17	
9	N-1	667_B2_TOR1697	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	128.4	130.38	NR	971	42.88	
10	N-1	363_B2_TOR1682	AEP - MISO DEM	05EUGENE-08CAYSUB 345 kV line	243221	249504	1	DC	94.43	100.83	NR	1374	88	
11	N-1	8695_B2	AEP - AEP	05MEADOW-05OLIVE 345 kV line	243878	243229	1	DC	125.49	127.26	NR	971	38.05	
12	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	190.27	196.93	NR	1409	93.78	
13	N-1	363_B2_TOR1682	AEP - AEP	05SULVN3-05BREED 345 kV line	247158	243213	Z3	DC	74	106.35	NR	1754	567.43	

New System Reinforcements

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

Generator Deliverability (Table 1)

1. (AEP - AEP) The 05BREED-05DARWIN 345 kV line (from bus 243213 to bus 243216 ckt 1) loads from 82.43% to 92.12% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '667_B2_TOR1697'. This project contributes approximately 94.07 MW to the thermal violation.

Reinforcement: (1) Reconductor/Rebuild the entire 12.65 mile section of line. Estimated cost: (2) Replace Darwin Wavetrap. Estimated Cost: $400,000
Cost: $25,360,000. Line rebuild; $400,000 wave trap
Time: 24-36 months

2. (AEP - AEP) The 05BREED-05DEQUIN 345 kV line (from bus 243213 to bus 243217 ckt 1) loads from 89.05% to 95.13% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '672_B2_TOR1713'. This project contributes approximately 59.11 MW to the thermal violation.

Reinforcement: (1) Reconductor/Rebuild the entire 97.19 mile ACSR/PE ~ 1414 ~ 62/19 ~ Conductor Section 1. (2) Replace the Dequine Riser. Estimated Cost: $100,000; (3) Rebuild the entire 0.09 mile ACAR ~ 2303.5 ~ 54/37 ~ Conductor Section 2. Estimated Cost: $180,000.
Cost: $194, 380,000, line rebuild conductor section 1; $100,000, replace Dequine Riser; $180,000, Conductor section 2
Time: 24-36 months

3. (AEP - MISO AMIL) The 05BREED-7CASEY 345 kV line (from bus 243213 to bus 346809 ckt 1) loads from 80.19% to 94.74% (**DC power flow**) of its normal rating (1332 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 193.79 MW to the thermal violation.

Reinforcement: To mitigate this overload the following actions will be required: 1) Reconductor/Rebuild 1.0 miles of conductor section. This is an AEP-AMIL tie line therefore, PJM is going to have to coordinate this upgrade with NIPSCO as well to make sure that their equipment will not set a limit lower than what is specified here. AMIL's portion of the conductor needs to be reconductored/rebuilt as well as to mitigate this overload.
Cost: $2M
Time: 24-36 months

4. (AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 82.43% to 92.12% (**DC power flow**) of its normal rating (971 MVA) for the single line

contingency outage of '667_B2_TOR1697'. This project contributes approximately 94.07 MW to the thermal violation.

Reinforcement: (1) Reconductor/Rebuild the entire the entire 39.32 mile section of line.; (2) Reconductor/Rebuild the entire t he entire 0.09 mile section of line.
Cost: $ 78,640,000, reconductor 1; $180,000, reconductor 2
Time: 24-36 months

5. (CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 98.08% to 100.32% (**DC power flow**) of its emergency rating (1241 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 27.76 MW to the thermal violation.
END

Reinforcement: The limiting element is 345kV L8012. The SLTE rating of 1241 MVA is limited by the sag of the line. Sag mitigation of the line is required. Upon full mitigation of sag limit, the SLTE rating for L8012 will be 1656 MVA.
Cost: $14.5M
Time: 18-24 months

Multiple Facility Contingency (Table 2)

1. (AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 90.95% to 95.73% (**DC power flow**) of its emergency rating (2354 MVA) for the line fault with failed breaker contingency outage of '6189_C2_05HANG R 765-D1'. This project contributes approximately 97.72 MW to the thermal violation.

Reinforcement: A Sag Study will be required on the 0.75 mile section of line to mitigate the overload on the Jefferson - Clifty Creek 345 kV line. Depending on the sag study results, cost for this upgrade is expected to be between $4,000 (no remediation required just sag study) and $2.0 million (complete line rebuild required).

This is an AEP-OVEC tie line therefore; PJM is going to have to coordinate this upgrade with OVEC as well to make sure that their equipment will not set a limit lower than what is specified here.
Cost: $4000, sag study; $2M for the line rebuild
Time: 6-12 months for the sag study; 24-36 months for line rebuild

2. (AEP - AEP) The 05ROCKPT-05JEFRSO 765 kV line (from bus 243209 to bus 243208 ckt 1) loads from 98.13% to 103.49% (**DC power flow**) of its emergency rating (4253 MVA) for the tower line contingency outage of '430'. This project contributes approximately 227.82 MW to the thermal violation.

Reinforcement: Replace Rockport Wavetrap. Estimated Cost: $500,000.

Replace Jefferson Wavetrap. Estimated Cost: $500,000.
Cost: $1,000,000
Time: 12 months

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

3. (AEP - AEP) The 05ROCKPT-05JEFRSO 765 kV line (from bus 243209 to bus 243208 ckt 1) loads from 98.13% to 103.49% (**DC power flow**) of its emergency rating (4253 MVA) for the tower line contingency outage of '431'. This project contributes approximately 227.82 MW to the thermal violation.

Same as Multiple Facility #2

Contribution to Previously Identified Overloads (Table 3)

1. (AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 114.65% to 120.48% (**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 137.21 MW to the thermal violation.

Reinforcement: A Sag Study will be required on the 0.75 mile section of line to mitigate the overload on the Jefferson - Clifty Creek 345 kV line. Depending on the sag study results, cost for this upgrade is expected to be between $4,000 (no remediation required just sag study) and $2.0 million (complete line rebuild required).

This is an AEP-OVEC tie line therefore, PJM is going to have to coordinate this upgrade with OVEC as well to make sure that their equipment will not set a limit lower than what is specified here.
Cost: $4000, sag study; $2M for the line rebuild
Time: 6-12 months for the sag study; 24-36 months for line rebuild

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

2. (AEP - AEP) The 05BREED-05DARWIN 345 kV line (from bus 243213 to bus 243216 ckt 1) loads from 129.29% to 141.59% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.4 MW to the thermal violation.

Reinforcement: (1) Reconductor/Rebuild the entire 12.65 mile section of line. Estimated cost: $25,360,000. (2) Replace Darwin Wavetrap. Estimated Cost: $400,000
Cost: $25,360,000,reconductor/rebuild; $400,000, replace Darwin wavetrap
Time: 24-36 months

Please refer to Appendix 4 for a table containing the generators having contribution to this flowgate.

3. (AEP - AEP) The 05BREED-05DARWIN 345 kV line (from bus 243213 to bus 243216 ckt 1) loads from 119.65% to 128.46% (**DC power flow**) of its emergency rating (1419 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 125.0 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #2

4. (AEP - AEP) The 05BREED-05DEQUIN 345 kV line (from bus 243213 to bus 243217 ckt 1) loads from 117.48% to 125.81% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 80.91 MW to the thermal violation.

Reinforcement: (1) Reconductor/Rebuild the entire 97.19 mile ACSR/PE ~ 1414 ~ 62/19 ~ Conductor Section 1. Estimated Cost: $194, 380,000; (2) Replace the Dequine Riser. Estimated Cost: $100,000; (3) Rebuild the entire 0.09 mile ACAR ~ 2303.5 ~ 54/37 ~ Conductor Section 2. Estimated Cost: $180,000. (4) An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: $600,000
Cost: $195,260,000
Time: 24-36 months

Please refer to Appendix 5 for a table containing the generators having contribution to this flowgate.

5. (AEP - AEP) The 05BREED-05DEQUIN 345 kV line (from bus 243213 to bus 243217 ckt 1) loads from 112.03% to 118.56% (**DC power flow**) of its emergency rating (1304 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 85.14 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #4

6. (AEP - MISO AMIL) The 05BREED-7CASEY 345 kV line (from bus 243213 to bus 346809 ckt 1) loads from 124.88% to 138.72% (**DC power flow**) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 202.88 MW to the thermal violation.

Reinforcement: Under the Breed station rebuild project Breed station was replaced by the new Sullivan 345kV station: the ACSR 2156 84/19 Bluebird conductor line section was eliminated, the Breed Wavetrap (2500A) was replaced by Sullivan Wavetrap(3000A) , Breed RCTL (3322) was replaced by Sullivan RCTL (4523), and Breed Line Risers were replaced by Sullivan Line Risers. In order to mitigate the identified overloads the following actions will be required: (1) Reconductor/Rebuild 0.61miles of conductor section. Estimated cost is $2,000,000. (2) Upgrade Sullivan Wavetrap. Estimated cost is $400,000, (3) Upgrade Sub Cond 2-2000 AAC 91 Str. Sullivan Line Risers $250,000, and (4) Reconductor/Rebuild 0.82miles of conductor section 3. Estimated

Cost is: $2,000,000. This is an AEP-AMIL tie line therefore; PJM is going to have to coordinate this upgrade with AMIL as well to make sure that their equipment will not set a limit lower than what is specified here. AMIL's portion of the conductor needs to be reconductored/rebuilt as well as the West Casey Wavetrap (3000A) to mitigate this overload.
Cost: $4,650,000
Time: 24-36 months

Please refer to Appendix 6 for a table containing the generators having contribution to this flowgate.

7. (AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 129.29% to 141.59% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.4 MW to the thermal violation.

Same as Generator Deliverability #4

Please refer to Appendix 7 for a table containing the generators having contribution to this flowgate.

8. (AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 119.65% to 128.46% (**DC power flow**) of its emergency rating (1419 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 125.0 MW to the thermal violation.

Reinforcement: (1) Reconductor/Rebuild the entire 39.32 mile ACSR/PE ~ 1414 ~ 62/19 ~ Conductor Section 1, Estimated Cost: $ 78,640,000 (2) Rebuild the entire 0.09 mile ACAR ~ 2303.5 ~ 54/37 ~ Conductor Section 2, Estimated Cost: $ 180,000 (3) Replace Eugene Wavetrap. Estimated Cost: $400,000, (4) Replace Darwin Wavetrap. Estimated Cost: $400,000, and (5) An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: $600,000 (6) Upgrade Eugene Risers Estimated Cost is $100,000
Cost: $79,780,000
Time: 24-36 months

9. (AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 141.66% to 147.02% (**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 69.94 MW to the thermal violation.

Reinforcement: (1) Replace the Dequine line riser, Estimated cost: $ 100,000, (2) Rebuild the entire 22.17 mile of ACAR ~ 2303.5 ~ 54/37 ~ Conductor Section 1, Estimate cost: $44,340,000, (3) An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: $600,000, (4) Replace Dequine Wavetrap (2500A), $400,000.
Cost:$45,440,000
Time: 24-36 months

Please refer to Appendix 8 for a table containing the generators having contribution to this flowgate.

10. (AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 128.74% to 135.55% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '6490_B2_TOR16000'. This project contributes approximately 66.17 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #9

11. (AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 100.6% to 106.34% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 55.79 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #9

12. (AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 141.66% to 147.02% (**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 69.94 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #9

Please refer to Appendix 9 for a table containing the generators having contribution to this flowgate.

13. (AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 128.74% to 135.55% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '6472_B2_TOR15258'. This project contributes approximately 66.17 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #9

14. (AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 100.6% to 106.34% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 55.79 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #9

15. (AEP - AEP) The 05EUGENE-05DEQUIN 345 kV line (from bus 243221 to bus 243217 ckt 1) loads from 112.59% to 116.81% (**DC power flow**) of its normal rating (971 MVA) for the single

line contingency outage of '667_B2_TOR1697'. This project contributes approximately 41.01 MW to the thermal violation.

Reinforcement:
(1) Rebuild the entire 22.17 mile of ACSR/PE ~ 1414 ~ 62/19 ~ Conductor Section 1. Estimated cost: $44,340,000
(2) Replace the Dequine riser. Estimated cost: $100,000.

Cost: $44,440,000
Time: 24-36 months

Please refer to Appendix 10 for a table containing the generators having contribution to this flowgate.

16. (AEP - AEP) The 05EUGENE-05DEQUIN 345 kV line (from bus 243221 to bus 243217 ckt 1) loads from 112.25% to 116.0% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 36.45 MW to the thermal violation.

Same as Contribution to Previously Identified Overload #15

17. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 144.59% to 149.57% (**DC power flow**) of its emergency rating (1918 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 95.48 MW to the thermal violation.

Reinforcement: [B2449-Rebuild 7 miles of Meadow Lake-Reynolds 345kV line. ISD 6/1/17]
AEP is in the process of rebuilding this line and we cannot use a larger conductor to mitigate this overload for various constraints. Therefore, building a third line between Meadow Lake and Reynolds is proposed as an alternate mitigation which will also involve work at Meadow Lake and Reynolds Stations.

Cost: $32,000,000.
Time: 24-36 months

Please refer to Appendix 11 for a table containing the generators having contribution to this flowgate.

18. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 122.46% to 128.83% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 89.7 MW to the thermal violation.

B2449-Rebuild 7 miles of Meadow Lake-Reynolds 345kV line. ISD 6/1/17

19. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 102.36% to 107.3% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '8808_B2'. This project contributes approximately 69.59 MW to the thermal violation.

B2449-Rebuild 7 miles of Meadow Lake-Reynolds 345kV line. ISD 6/1/17

20. (CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 123.71% to 126.07% (**DC power flow**) of its emergency rating (1241 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 29.27 MW to the thermal violation.

Reinforcement: The limiting element is 345kV L8012. The SLTE rating of 1241 MVA is limited by the sag of the line. Sag mitigation of the line is required. Upon full mitigation of sag limit, the SLTE rating for L8012 will be 1656 MVA.

Cost: $14.5M
Time: 18-24 months

Please refer to Appendix 12 for a table containing the generators having contribution to this flowgate.

Local/Network Upgrades

Mitigation plan for the Rockport – Jefferson 765 kV Line:

- Replace the Rockport Wavetrap (3000A). Estimated Cost: $500,000.
- Replace the Jefferson Wavetrap (3000A). Estimated Cost: $500,000.

Mitigation plan for the Jefferson – Clifty Creek (OVEC) 345 kV Line:

- A sag study analysis has been completed and determined that grading is needed for Span 1-2. Estimated Cost: $243,000
- This is an AEP-OVEC tie line therefore; PJM is going to have to coordinate this upgrade with OVEC as well to make sure that their equipment will not set a limit lower than what is specified here.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 575 MW (550 MW Capacity) natural gas generating facility of 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 IC's natural gas generating facility.

A summary table of the cost estimates below is for the Primary Point of Interconnection (Sullivan Station 345 kV Yard) only:

Upgrade	Cost
Direct Connection Cost	$3,100,000
Sullivan – Reynolds 345 kV Line Reconductoring	$104,040,000
Sullivan – Reynolds 345 kV Line Rebuild	$404,360,000
Rockport 765 kV Wavetrap (3000A)	$500,000
Jefferson 765 kV Wavetrap (3000A)	$500,000
Jefferson – Clifty Creek 345 kV Line Grading (Span 1-2)	$243,000
Eugene Wavetrap (2500A)	$400,000
Darwin Wavetrap (2500A)	$400,000
Dequine Wavetrap (2500A)	$400,000
Sullivan Wavetrap (2500A)	$400,000
Sullivan Line Risers	$250,000
Dequine line riser	$100,000
Eugene Risers	$100,000
Dequine riser	$100,000
An engineering study will need to be conducted to determine if the Darwin – Eugene Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted.	$600,000
An engineering study will need to be conducted to determine if the Dequine Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted.	$600,000
An engineering study will need to be conducted to determine if the Darwin Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted.	$600,000
An engineering study will need to be conducted to determine if the Meadow Lake Relay Compliance Trip limits settings can be adjusted to mitigate the overload. New relay packages will be required if the settings cannot be adjusted.	$600,000
Total Cost for Project AB1-087	**$112,933,000**
	This cost estimate assumes reconductoring will mitigate the line sections that are identified as constraints for this project using existing tower structures.
Total Cost for Project AB1-087	**$413,253,000**
	This cost estimate assumes a complete rebuild will be required to mitigate the line sections that are identified as constraints for this project.

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. The cost estimates for the secondary point of interconnection are not included in this estimate. Final estimates will require an on-site review and coordination to determine final construction requirements.

Generator Deliverability

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

Secondary Point of Interconnection AB1-087 Generator Deliverability														
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	363_B2_TOR1682	AEP - MISO IPL	05BREED-16WHEAT 345 kV line	243213	254539	1	DC	79.2	89.89	NR	1386	148.2	1
2	N-1	363_B2_TOR1682	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	80.14	94.68	NR	1332	193.79	
3	N-1	363_B2_TOR1682	AEP - AEP	05SULVN1-05BREED 345 kV line	247065	243213	Z1	DC	74	89.46	NR	1754	271.15	2
4	N-1	363_B2_TOR1682	AEP - AEP	05SULVN3-05BREED 345 kV line	247158	243213	Z3	DC	74	89.46	NR	1754	271.15	3
5	N-1	363_B2_TOR1682	CE - CE	LORETTO ; B-WILTON ; B 345 kV line	270704	270926	1	DC	99.4	101.56	ER	1280	27.58	4
6	N-1	363_B2_TOR1682	CE - CE	PONTIAC ; B-LORETTO ; B 345 kV line	270852	270704	1	DC	98.15	100.38	ER	1241	27.75	5

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

Secondary Point of Interconnection AB1-087 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	LFFB	6189_C2_05HANGR 765-D1	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	90.84	96.77	ER	2354	124.17	
2	DCTL	431	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	DC	98.13	104.64	ER	4253	276.52	6
3	DCTL	430	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	DC	98.13	104.64	ER	4253	276.52	

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.)

Secondary Point of Interconnection AB1-087 Contribution to Previously Identified Overloads															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	1760_C2_05JEFRSO 765-A	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	113.68	121.37	ER	2354	181.14	7
2	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	129.34	141.63	NR	971	119.4	8
3	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	119.68	128.49	ER	1419	125	
4	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	117.53	125.86	NR	971	80.91	9
5	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	112.07	118.6	ER	1304	85.14	
6	LFFB	8648_C2_05JEFRSO 765-B1	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	124.83	138.67	ER	1466	202.88	10
7	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	129.34	141.63	NR	971	119.4	11
8	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	119.68	128.49	ER	1419	125	
9	LFFB	6485_C2_05DEQUIN 345-C1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	141.76	146.28	ER	1304	58.97	12
10	N-1	6490_B2_TOR16000	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	128.87	134.62	NR	971	55.79	
11	N-1	363_B2_TOR1682	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	100.67	106.42	NR	971	55.79	
12	LFFB	4704_C2_05DEQUIN 345-B1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	141.76	146.28	ER	1304	58.97	13
13	N-1	6472_B2_TOR15258	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	128.87	134.62	NR	971	55.79	
14	N-1	363_B2_TOR1682	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	100.67	106.42	NR	971	55.79	
15	N-1	363_B2_TOR1682	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	112.33	116.09	NR	971	36.45	14
16	N-1	667_B2_TOR1697	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	112.69	116.24	NR	971	34.44	
17	LFFB	8648_C2_05JEFRSO 765-B1	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	144.63	149.61	ER	1918	95.49	15
18	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	122.51	128.88	NR	1409	89.7	
19	N-1	8808_B2	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	102.45	106.58	NR	1409	58.3	

Short Circuit

(Summary of impacted circuit breakers)

Bus Number	Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AB1-087_op2_aep_v1	Duty Percent Without AB1-087_op2_aep_v1	Duty Percent Difference	Duty Amps With AB1-087_op2_aep_v1	Duty Amps Without AB1-087_op2_aep_v1
0	05TWIN B 345.kV	J1	T	48000	100.07%	99.99%	0.08%	48032.5	47996.1
0	05TWIN B 345.kV	JM	T	48000	100.07%	99.99%	0.08%	48032.5	47996.1

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection request.

Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

Secondary Point of Interconnection

AB1-087 Delivery of Energy Portion of Interconnection Request

#	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	709_B2_TOR546	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	89.56	95.48	NR	2354	124.28	
2	N-1	8695_B2	AEP - AEP	05ROCKPT-05JEFRSO 765 kV line	243209	243208	1	DC	95.64	101.58	NR	4055	240.88	
3	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DARWIN 345 kV line	243213	243216	1	DC	174.05	186.91	NR	971	124.83	
4	N-1	363_B2_TOR1682	AEP - AEP	05BREED-05DEQUIN 345 kV line	243213	243217	1	DC	147.83	156.54	NR	971	84.59	
5	N-1	363_B2_TOR1682	AEP - MISO IPL	05BREED-16WHEAT 345 kV line	243213	254539	1	DC	123.49	134.66	NR	1386	154.93	
6	N-1	363_B2_TOR1682	AEP - MISO AMIL	05BREED-7CASEY 345 kV line	243213	346809	1	DC	136.04	151.25	NR	1332	202.6	
7	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	174.05	186.91	NR	971	124.83	
8	N-1	6490_B2_TOR16000	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	184.61	190.62	NR	971	58.33	
9	N-1	6472_B2_TOR15258	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	184.61	190.62	NR	971	58.33	
10	N-1	667_B2_TOR1697	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	128.5	130.17	NR	971	36	

Secondary Point of Interconnection AB1-087 Delivery of Energy Portion of Interconnection Request															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
11	N-1	363_B2_TOR1682	AEP - MISO DEM	05EUGENE-08CAYSUB 345 kV line	243221	249504	1	DC	94.45	100.85	NR	1374	87.98	
12	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	190.32	196.98	NR	1409	93.78	
13	N-1	363_B2_TOR1682	AEP - AEP	05SULVN1-05BREED 345 kV line	247065	243213	Z1	DC	74	90.16	NR	1754	283.48	
14	N-1	363_B2_TOR1682	AEP - AEP	05SULVN3-05BREED 345 kV line	247158	243213	Z3	DC	74	90.16	NR	1754	283.48	

Appendices for Primary Point of Interconnection(345 kV)

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

(AEP - AEP) The 05ROCKPT-05JEFRSO 765 kV line (from bus 243209 to bus 243208 ckt 1) loads from 98.13% to 103.49% (**DC power flow**) of its emergency rating (4253 MVA) for the tower line contingency outage of '430'. This project contributes approximately 227.82 MW to the thermal violation.

CONTINGENCY '430'
OPEN BRANCH FROM BUS 243213 TO BUS 243216 CKT 1 / 243213 05BREED 345 243216 05DARWIN 345 1
OPEN BRANCH FROM BUS 243213 TO BUS 243217 CKT 1 / 243213 05BREED 345 243217 05DEQUIN 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*74.9*
243443	*05RKG2*	*73.76*
274650	*KINCAID ;1U*	*5.5*
274651	*KINCAID ;2U*	*5.5*
900404	*X3-028 C*	*592.71*
900405	*X3-028 E*	*790.28*
915151	*Y3-038*	*24.05*
LTF	*Z1-070*	*105.01*
LTF	*AA1-001*	*8.92*
930461	*AB1-087 C OP*	*217.91*
930462	*AB1-087 E OP*	*9.91*
930471	*AB1-088 C OP*	*217.91*
930472	*AB1-088 E OP*	*9.91*

Appendix 2

(AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 114.65% to 120.48% (**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 137.21 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*	*6.1*
247901	*05FR-12G E*	*6.*
247902	*05FR-21G E*	*6.41*
247903	*05FR-22G E*	*6.14*
247904	*05FR-3G E*	*12.43*
247905	*05FR-4G E*	*9.35*
247906	*05MDL-1G E*	*10.38*
247907	*05MDL-2G E*	*5.15*
247912	*05MDL-3G E*	*5.38*
247913	*05MDL-4G E*	*5.13*
243442	*05RKG1*	*54.24*
243443	*05RKG2*	*53.42*
251940	*08BKJGT1*	*-3.25*
251941	*08BKJGT2*	*-3.25*
251942	*08BKJGT3*	*-3.25*
251943	*08BKJGT4*	*-3.25*
251949	*08M.FRT6*	*-10.21*
294401	*BSHIL;1U E*	*4.83*
294410	*BSHIL;2U E*	*4.83*
274890	*CAYUG;1U E*	*7.61*
274891	*CAYUG;2U E*	*7.61*
274849	*CRESCENT ;1U*	*3.27*
927331	*J196 C*	*0.63*
927332	*J196 E*	*2.5*
990901	*L-005 E*	*7.46*
293771	*O-035 E*	*3.55*
296309	*R-030 E1*	*8.98*
296272	*R-030 E2*	*8.98*
296128	*R-030 E3*	*9.09*
274853	*TWINGROVE;U1*	*11.82*
274854	*TWINGROVE;U2*	*11.82*
276150	*W2-048 E*	*5.21*

905081	*W4-005 C*	*3.64*
905082	*W4-005 E*	*24.38*
909052	*X2-022 E*	*15.77*
900404	*X3-028 C*	*356.52*
900405	*X3-028 E*	*475.36*
913222	*Y1-054 E*	*-1.29*
915151	*Y3-038*	*17.42*
915662	*Y3-099 E*	*0.14*
915672	*Y3-100 E*	*0.14*
LTF	*Z1-043*	*15.53*
916182	*Z1-065 E*	*0.37*
LTF	*Z1-070*	*90.81*
916211	*Z1-072*	*0.6*
LTF	*Z1-112*	*5.89*
917501	*Z2-087 C*	*1.76*
917502	*Z2-087 E*	*11.78*
LTF	*AA1-001*	*5.83*
LTF	*AA1-071*	*3.93*
918711	*AA1-086 C*	*2.08*
918712	*AA1-086 E*	*13.89*
LTF	*AA2-038*	*16.52*
919621	*AA2-039 C*	*1.18*
919622	*AA2-039 E*	*7.87*
930041	*AB1-006 C*	*1.69*
930042	*AB1-006 E*	*11.31*
930451	*AB1-086 C*	*37.2*
930452	*AB1-086 E*	*1.69*
930461	*AB1-087 C OP*	*131.25*
930462	*AB1-087 E OP*	*5.97*
930471	*AB1-088 C OP*	*131.25*
930472	*AB1-088 E OP*	*5.97*

Appendix 3

(AEP - AEP) The 05BREED-05DARWIN 345 kV line (from bus 243213 to bus 243216 ckt 1) loads from 129.29% to 141.59% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.4 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*	*24.33*
243443	*05RKG2*	*23.97*
900404	*X3-028 C*	*325.64*
915151	*Y3-038*	*7.81*
930461	*AB1-087 C OP*	*119.4*
930471	*AB1-088 C OP*	*119.4*

Appendix 4

(AEP - AEP) The 05BREED-05DEQUIN 345 kV line (from bus 243213 to bus 243217 ckt 1) loads from 117.48% to 125.81% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 80.91 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*	*16.49*
243443	*05RKG2*	*16.24*
900404	*X3-028 C*	*220.67*
915151	*Y3-038*	*5.3*
930461	*AB1-087 C OP*	*80.91*
930471	*AB1-088 C OP*	*80.91*

Appendix 5

(AEP - MISO AMIL) The 05BREED-7CASEY 345 kV line (from bus 243213 to bus 346809 ckt 1) loads from 124.88% to 138.72% (**DC power flow**) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 202.88 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B1'
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*	*4.67*
247901	*05FR-12G E*	*4.59*
247902	*05FR-21G E*	*4.9*
247903	*05FR-22G E*	*4.69*
247904	*05FR-3G E*	*9.51*
247905	*05FR-4G E*	*7.15*
243442	*05RKG1*	*39.57*
243443	*05RKG2*	*38.97*
927421	*J201 C*	*0.24*
927422	*J201 E*	*0.95*
927501	*J246 C*	*0.08*
927502	*J246 E*	*0.33*
927581	*J325 C*	*0.05*
927582	*J325 E*	*0.14*
927591	*J327 C*	*1.78*
927592	*J327 E*	*5.34*
927611	*J332*	*8.93*
927621	*J333*	*19.55*
927631	*J334*	*20.98*
927651	*J340 C*	*1.19*
927652	*J340 E*	*3.56*
927691	*J354 C*	*0.62*
927692	*J354 E*	*1.85*
900404	*X3-028 C*	*529.25*
900405	*X3-028 E*	*705.66*
915151	*Y3-038*	*12.71*
LTF	*AA1-051*	*5.01*
LTF	*AA1-053*	*55.76*
LTF	*AA1-055*	*182.56*
930461	*AB1-087 C OP*	*194.06*

930462	*AB1-087 E OP*	*8.82*
930471	*AB1-088 C OP*	*194.06*
930472	*AB1-088 E OP*	*8.82*
930972	*AB1-146 E*	*0.1*

Appendix 6

(AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 129.29% to 141.59% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.4 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*	*24.33*
243443	*05RKG2*	*23.97*
900404	*X3-028 C*	*325.64*
915151	*Y3-038*	*7.81*
930461	*AB1-087 C OP*	*119.4*
930471	*AB1-088 C OP*	*119.4*

Appendix 7

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 141.66% to 147.02% (**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 69.94 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*	*0.89*
247900	*05FR-11G E*	*42.01*
243862	*05FR-12G C*	*0.88*
247901	*05FR-12G E*	*41.31*
243864	*05FR-21G C*	*0.94*
247902	*05FR-21G E*	*44.16*
243866	*05FR-22G C*	*0.9*
247903	*05FR-22G E*	*42.28*
243870	*05FR-3G C*	*1.82*
247904	*05FR-3G E*	*85.63*
243873	*05FR-4G C*	*1.41*
247905	*05FR-4G E*	*64.39*
927331	*J196 C*	*1.16*
927332	*J196 E*	*4.64*
927621	*J333*	*19.77*
927631	*J334*	*22.34*
900404	*X3-028 C*	*182.81*
900405	*X3-028 E*	*243.74*
LTF	*Z1-070*	*53.7*
930461	*AB1-087 C OP*	*66.9*
930462	*AB1-087 E OP*	*3.04*
930471	*AB1-088 C OP*	*66.9*
930472	*AB1-088 E OP*	*3.04*

Appendix 8

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 141.66% to 147.02% (**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 69.94 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*	*0.89*
247900	*05FR-11G E*	*42.01*
243862	*05FR-12G C*	*0.88*
247901	*05FR-12G E*	*41.31*
243864	*05FR-21G C*	*0.94*
247902	*05FR-21G E*	*44.16*
243866	*05FR-22G C*	*0.9*
247903	*05FR-22G E*	*42.28*
243870	*05FR-3G C*	*1.82*
247904	*05FR-3G E*	*85.63*
243873	*05FR-4G C*	*1.41*
247905	*05FR-4G E*	*64.39*
927331	*J196 C*	*1.16*
927332	*J196 E*	*4.64*
927621	*J333*	*19.77*
927631	*J334*	*22.34*
900404	*X3-028 C*	*182.81*
900405	*X3-028 E*	*243.74*
LTF	*Z1-070*	*53.7*
930461	*AB1-087 C OP*	*66.9*
930462	*AB1-087 E OP*	*3.04*
930471	*AB1-088 C OP*	*66.9*
930472	*AB1-088 E OP*	*3.04*

Appendix 9

(AEP - AEP) The 05EUGENE-05DEQUIN 345 kV line (from bus 243221 to bus 243217 ckt 1) loads from 112.59% to 116.81% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '667_B2_TOR1697'. This project contributes approximately 41.01 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*	*1.19*
927621	*J333*	*14.96*
927631	*J334*	*15.69*
900404	*X3-028 C*	*112.08*
LTF	*Z1-070*	*52.78*
930461	*AB1-087 C OP*	*41.01*
930471	*AB1-088 C OP*	*41.01*

Appendix 10

(AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 144.59% to 149.57% (**DC power flow**) of its emergency rating (1918 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 95.48 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B1'
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*	*0.82*
247900	*05FR-11G E*	*38.44*
243862	*05FR-12G C*	*0.8*
247901	*05FR-12G E*	*37.8*
243864	*05FR-21G C*	*0.86*
247902	*05FR-21G E*	*40.4*
243866	*05FR-22G C*	*0.82*
247903	*05FR-22G E*	*38.69*
243870	*05FR-3G C*	*1.66*
247904	*05FR-3G E*	*78.35*
243873	*05FR-4G C*	*1.29*
247905	*05FR-4G E*	*58.91*
246909	*05MDL-1G C*	*2.01*
247906	*05MDL-1G E*	*94.3*
246910	*05MDL-2G C*	*1.*
247907	*05MDL-2G E*	*46.77*
246976	*05MDL-3G C*	*1.*
247912	*05MDL-3G E*	*48.89*
246979	*05MDL-4G C*	*2.01*
247913	*05MDL-4G E*	*46.65*
243442	*05RKG1*	*18.61*
243443	*05RKG2*	*18.33*
927331	*J196 C*	*1.1*
927332	*J196 E*	*4.41*
927621	*J333*	*17.94*
927631	*J334*	*20.74*
900404	*X3-028 C*	*249.09*
900405	*X3-028 E*	*332.12*
915151	*Y3-038*	*5.98*
LTF	*Z1-007*	*5.09*

LTF	*Z1-029*	*3.12*
LTF	*Z1-070*	*71.53*
LTF	*AA1-001*	*5.14*
930041	*AB1-006 C*	*15.35*
930042	*AB1-006 E*	*102.75*
LTF	*AB1-023*	*6.18*
930461	*AB1-087 C OP*	*91.33*
930462	*AB1-087 E OP*	*4.15*
930471	*AB1-088 C OP*	*91.33*
930472	*AB1-088 E OP*	*4.15*

Appendix 11

(CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 123.71% to 126.07% (**DC power flow**) of its emergency rating (1241 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 29.27 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*	*1.26*
927641	*J339*	*13.94*
274650	*KINCAID ;1U*	*9.25*
274651	*KINCAID ;2U*	*9.25*
296308	*R-030 C1*	*1.27*
296271	*R-030 C2*	*1.27*
296125	*R-030 C3*	*1.28*
290261	*S-027 C*	*1.24*
290265	*S-028 C*	*1.24*
905081	*W4-005 C*	*14.1*
900404	*X3-028 C*	*79.95*
LTF	*Z1-070*	*259.11*
917501	*Z2-087 C*	*11.65*
LTF	*AA1-001*	*5.83*
918711	*AA1-086 C*	*8.04*
930451	*AB1-086 C*	*247.12*
930461	*AB1-087 C OP*	*29.27*
930471	*AB1-088 C OP*	*29.27*

Appendices for Secondary Point of Interconnection(765 kV)

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

(AEP - MISO IPL) The 05BREED-16WHEAT 345 kV line (from bus 243213 to bus 254539 ckt 1) loads from 79.2% to 89.89% (**DC power flow**) of its normal rating (1386 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 148.2 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*
243859	*05FR-11G C*	*0.09*
243862	*05FR-12G C*	*0.09*
243864	*05FR-21G C*	*0.09*
243866	*05FR-22G C*	*0.09*
243870	*05FR-3G C*	*0.18*
243873	*05FR-4G C*	*0.14*
243442	*05RKG1*	*30.2*
243443	*05RKG2*	*29.74*
927331	*J196 C*	*0.7*
927641	*J339*	*4.28*
274650	*KINCAID ;1U*	*3.55*
274651	*KINCAID ;2U*	*3.55*
290261	*S-027 C*	*0.19*
290265	*S-028 C*	*0.19*
905081	*W4-005 C*	*2.82*
900404	*X3-028 C*	*404.22*
915151	*Y3-038*	*9.7*
LTF	*Z1-070*	*71.4*
LTF	*AA1-001*	*4.44*

LTF	*AA1-052*	*65.54*
LTF	*AA1-054*	*45.44*
918711	*AA1-086 C*	*1.61*
930461	*AB1-087 C OP*	*148.2*
930471	*AB1-088 C OP*	*148.2*

Appendix 2

(AEP - AEP) The 05SULVN1-05BREED 345 kV line (from bus 247065 to bus 243213 ckt Z1) loads from 74.0% to 89.46% (**DC power flow**) of its normal rating (1754 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 271.15 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*	*55.27*
243443	*05RKG2*	*54.43*
915151	*Y3-038*	*17.75*
930461	*AB1-087 C OP*	*271.15*
930471	*AB1-088 C OP*	*271.15*

Appendix 3

(AEP - AEP) The 05SULVN3-05BREED 345 kV line (from bus 247158 to bus 243213 ckt Z3) loads from 74.0% to 89.46% (**DC power flow**) of its normal rating (1754 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 271.15 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*	*55.27*
243443	*05RKG2*	*54.43*
915151	*Y3-038*	*17.75*
930461	*AB1-087 C OP*	*271.15*
930471	*AB1-088 C OP*	*271.15*

Appendix 4

(CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 99.4% to 101.56% (**DC power flow**) of its emergency rating (1280 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 27.58 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*	*5.62*
243443	*05RKG2*	*5.53*
274863	*CAYUGA RI;1U*	*1.09*
274864	*CAYUGA RI;2U*	*1.09*
274659	*DRESDEN ;3U*	*4.88*
927331	*J196 C*	*0.82*
927641	*J339*	*9.15*
274650	*KINCAID ;1U*	*6.58*
274651	*KINCAID ;2U*	*6.58*
296308	*R-030 C1*	*0.85*
296271	*R-030 C2*	*0.85*
296125	*R-030 C3*	*0.86*
290261	*S-027 C*	*0.85*
290265	*S-028 C*	*0.85*
905081	*W4-005 C*	*9.69*
900404	*X3-028 C*	*75.24*
915151	*Y3-038*	*1.8*
LTF	*Z1-070*	*179.79*
917501	*Z2-087 C*	*7.85*

LTF	*AA1-001*	*4.5*
918711	*AA1-086 C*	*5.52*
930451	*AB1-086 C*	*166.46*
930461	*AB1-087 C OP*	*27.58*
930471	*AB1-088 C OP*	*27.58*
930762	*AB1-122 2*	*22.56*

Appendix 5

(CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 98.15% to 100.38% (**DC power flow**) of its emergency rating (1241 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 27.75 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*	*5.65*
243443	*05RKG2*	*5.57*
274659	*DRESDEN ;3U*	*4.9*
927331	*J196 C*	*0.82*
927641	*J339*	*9.15*
274650	*KINCAID ;1U*	*6.6*
274651	*KINCAID ;2U*	*6.6*
296308	*R-030 C1*	*0.85*
296271	*R-030 C2*	*0.85*
296125	*R-030 C3*	*0.86*
290261	*S-027 C*	*0.85*
290265	*S-028 C*	*0.85*
905081	*W4-005 C*	*9.7*
900404	*X3-028 C*	*75.72*
915151	*Y3-038*	*1.82*
LTF	*Z1-070*	*180.13*
917501	*Z2-087 C*	*7.86*
LTF	*AA1-001*	*4.53*
918711	*AA1-086 C*	*5.53*

930451	*AB1-086 C*	*166.64*
930461	*AB1-087 C OP*	*27.75*
930471	*AB1-088 C OP*	*27.75*
930762	*AB1-122 2*	*22.67*

Appendix 6

(AEP - AEP) The 05ROCKPT-05JEFRSO 765 kV line (from bus 243209 to bus 243208 ckt 1) loads from 98.13% to 104.64% (**DC power flow**) of its emergency rating (4253 MVA) for the tower line contingency outage of '431'. This project contributes approximately 276.52 MW to the thermal violation.

CONTINGENCY '431'
OPEN BRANCH FROM BUS 243213 TO BUS 243217 CKT 1 / 243213 05BREED 345 243217 05DEQUIN 345 1
OPEN BRANCH FROM BUS 243216 TO BUS 243221 CKT 1 / 243216 05DARWIN 345 243221 05EUGENE 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*74.9*
243443	*05RKG2*	*73.76*
274650	*KINCAID ;1U*	*5.51*
274651	*KINCAID ;2U*	*5.5*
900404	*X3-028 C*	*592.74*
900405	*X3-028 E*	*790.32*
915151	*Y3-038*	*24.05*
LTF	*Z1-070*	*105.04*
LTF	*AA1-001*	*8.93*
930461	*AB1-087 C OP*	*264.5*
930462	*AB1-087 E OP*	*12.02*
930471	*AB1-088 C OP*	*264.5*
930472	*AB1-088 E OP*	*12.02*

Appendix 7

(AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 113.68% to 121.37% (**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 181.14 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*	*6.1*
247901	*05FR-12G E*	*6.*
247902	*05FR-21G E*	*6.41*
247903	*05FR-22G E*	*6.14*
247904	*05FR-3G E*	*12.43*
247905	*05FR-4G E*	*9.35*
247906	*05MDL-1G E*	*10.38*
247907	*05MDL-2G E*	*5.15*
247912	*05MDL-3G E*	*5.38*
247913	*05MDL-4G E*	*5.13*
243442	*05RKG1*	*54.24*
243443	*05RKG2*	*53.42*
251940	*08BKJGT1*	*-3.25*
251941	*08BKJGT2*	*-3.25*
251942	*08BKJGT3*	*-3.25*
251943	*08BKJGT4*	*-3.25*
251949	*08M.FRT6*	*-10.21*
274890	*CAYUG;1U E*	*7.61*

274891	*CAYUG;2U E*	*7.61*
927331	*J196 C*	*0.63*
927332	*J196 E*	*2.5*
990901	*L-005 E*	*7.47*
296309	*R-030 E1*	*8.98*
296272	*R-030 E2*	*8.98*
296128	*R-030 E3*	*9.09*
274853	*TWINGROVE;U1*	*11.82*
274854	*TWINGROVE;U2*	*11.82*
276150	*W2-048 E*	*5.21*
905081	*W4-005 C*	*3.64*
905082	*W4-005 E*	*24.39*
909052	*X2-022 E*	*15.77*
900404	*X3-028 C*	*356.52*
900405	*X3-028 E*	*475.36*
913222	*Y1-054 E*	*-1.29*
915151	*Y3-038*	*17.42*
915662	*Y3-099 E*	*0.14*
915672	*Y3-100 E*	*0.14*
LTF	*Z1-043*	*15.54*
LTF	*Z1-070*	*90.82*
LTF	*Z1-112*	*5.89*
917501	*Z2-087 C*	*1.76*
917502	*Z2-087 E*	*11.78*
LTF	*AA1-001*	*5.83*
LTF	*AA1-071*	*3.93*
918711	*AA1-086 C*	*2.08*
918712	*AA1-086 E*	*13.89*

LTF	*AA2-038*	*16.52*
930041	*AB1-006 C*	*1.69*
930042	*AB1-006 E*	*11.31*
930451	*AB1-086 C*	*37.2*
930452	*AB1-086 E*	*1.69*
930461	*AB1-087 C OP*	*173.26*
930462	*AB1-087 E OP*	*7.88*
930471	*AB1-088 C OP*	*173.26*
930472	*AB1-088 E OP*	*7.88*

Appendix 8

(AEP - AEP) The 05BREED-05DARWIN 345 kV line (from bus 243213 to bus 243216 ckt 1) loads from 129.34% to 141.63% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.4 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*	*24.34*
243443	*05RKG2*	*23.97*
900404	*X3-028 C*	*325.64*
915151	*Y3-038*	*7.81*
930461	*AB1-087 C OP*	*119.4*
930471	*AB1-088 C OP*	*119.4*

Appendix 9

(AEP - AEP) The 05BREED-05DEQUIN 345 kV line (from bus 243213 to bus 243217 ckt 1) loads from 117.53% to 125.86% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 80.91 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*	*16.49*
243443	*05RKG2*	*16.24*
900404	*X3-028 C*	*220.68*
915151	*Y3-038*	*5.3*
930461	*AB1-087 C OP*	*80.91*
930471	*AB1-088 C OP*	*80.91*

Appendix 10

(AEP - MISO AMIL) The 05BREED-7CASEY 345 kV line (from bus 243213 to bus 346809 ckt 1) loads from 124.83% to 138.67% (**DC power flow**) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 202.88 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B1'
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*	*4.67*
247901	*05FR-12G E*	*4.59*
247902	*05FR-21G E*	*4.9*
247903	*05FR-22G E*	*4.69*
247904	*05FR-3G E*	*9.51*
247905	*05FR-4G E*	*7.15*
243442	*05RKG1*	*39.56*
243443	*05RKG2*	*38.96*
927421	*J201 C*	*0.24*
927422	*J201 E*	*0.95*
927501	*J246 C*	*0.08*
927502	*J246 E*	*0.33*
927581	*J325 C*	*0.05*
927582	*J325 E*	*0.14*
927591	*J327 C*	*1.78*
927592	*J327 E*	*5.35*
927611	*J332*	*8.94*

927621	*J333*	*19.55*
927631	*J334*	*20.98*
927651	*J340 C*	*1.19*
927652	*J340 E*	*3.57*
927691	*J354 C*	*0.62*
927692	*J354 E*	*1.85*
900404	*X3-028 C*	*529.2*
900405	*X3-028 E*	*705.6*
915151	*Y3-038*	*12.7*
LTF	*AA1-051*	*5.01*
LTF	*AA1-053*	*55.82*
LTF	*AA1-055*	*182.68*
930461	*AB1-087 C OP*	*194.06*
930462	*AB1-087 E OP*	*8.82*
930471	*AB1-088 C OP*	*194.06*
930472	*AB1-088 E OP*	*8.82*
930972	*AB1-146 E*	*0.1*

Appendix 11

(AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 129.34% to 141.63% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 119.4 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*	*24.34*
243443	*05RKG2*	*23.97*
900404	*X3-028 C*	*325.64*
915151	*Y3-038*	*7.81*
930461	*AB1-087 C OP*	*119.4*
930471	*AB1-088 C OP*	*119.4*

Appendix 12

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 141.76% to 146.28% (**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 58.97 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*	*0.89*
247900	*05FR-11G E*	*42.01*
243862	*05FR-12G C*	*0.88*
247901	*05FR-12G E*	*41.31*
243864	*05FR-21G C*	*0.94*
247902	*05FR-21G E*	*44.16*
243866	*05FR-22G C*	*0.9*
247903	*05FR-22G E*	*42.28*
243870	*05FR-3G C*	*1.82*
247904	*05FR-3G E*	*85.63*
243873	*05FR-4G C*	*1.41*
247905	*05FR-4G E*	*64.38*
927331	*J196 C*	*1.16*
927332	*J196 E*	*4.64*
927621	*J333*	*19.76*
927631	*J334*	*22.33*
900404	*X3-028 C*	*182.82*

900405	*X3-028 E*	*243.76*
LTF	*Z1-070*	*53.72*
930461	*AB1-087 C OP*	*56.4*
930462	*AB1-087 E OP*	*2.56*
930471	*AB1-088 C OP*	*56.4*
930472	*AB1-088 E OP*	*2.56*

Appendix 13

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 141.76% to 146.28% (**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 58.97 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*	*0.89*
247900	*05FR-11G E*	*42.01*
243862	*05FR-12G C*	*0.88*
247901	*05FR-12G E*	*41.31*
243864	*05FR-21G C*	*0.94*
247902	*05FR-21G E*	*44.16*
243866	*05FR-22G C*	*0.9*
247903	*05FR-22G E*	*42.28*
243870	*05FR-3G C*	*1.82*
247904	*05FR-3G E*	*85.63*
243873	*05FR-4G C*	*1.41*
247905	*05FR-4G E*	*64.38*
927331	*J196 C*	*1.16*
927332	*J196 E*	*4.64*
927621	*J333*	*19.76*
927631	*J334*	*22.33*
900404	*X3-028 C*	*182.82*

900405	*X3-028 E*	*243.76*
LTF	*Z1-070*	*53.72*
930461	*AB1-087 C OP*	*56.4*
930462	*AB1-087 E OP*	*2.56*
930471	*AB1-088 C OP*	*56.4*
930472	*AB1-088 E OP*	*2.56*

Appendix 14

(AEP - AEP) The 05EUGENE-05DEQUIN 345 kV line (from bus 243221 to bus 243217 ckt 1) loads from 112.33% to 116.09% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 36.45 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*	*7.43*
243443	*05RKG2*	*7.32*
927331	*J196 C*	*1.23*
927621	*J333*	*15.66*
927631	*J334*	*16.5*
900404	*X3-028 C*	*99.42*
915151	*Y3-038*	*2.39*
LTF	*Z1-070*	*57.1*
930461	*AB1-087 C OP*	*36.45*
930471	*AB1-088 C OP*	*36.45*

Appendix 15

(AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 144.63% to 149.61% (**DC power flow**) of its emergency rating (1918 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 95.49 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B1'
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*	*0.82*
247900	*05FR-11G E*	*38.44*
243862	*05FR-12G C*	*0.8*
247901	*05FR-12G E*	*37.8*
243864	*05FR-21G C*	*0.86*
247902	*05FR-21G E*	*40.4*
243866	*05FR-22G C*	*0.82*
247903	*05FR-22G E*	*38.69*
243870	*05FR-3G C*	*1.66*
247904	*05FR-3G E*	*78.35*
243873	*05FR-4G C*	*1.29*
247905	*05FR-4G E*	*58.91*
246909	*05MDL-1G C*	*2.01*
247906	*05MDL-1G E*	*94.3*
246910	*05MDL-2G C*	*1.*
247907	*05MDL-2G E*	*46.77*
246976	*05MDL-3G C*	*1.*

247912	*05MDL-3G E*	*48.89*
246979	*05MDL-4G C*	*2.01*
247913	*05MDL-4G E*	*46.65*
243442	*05RKG1*	*18.61*
243443	*05RKG2*	*18.33*
927331	*J196 C*	*1.1*
927332	*J196 E*	*4.41*
927621	*J333*	*17.94*
927631	*J334*	*20.73*
900404	*X3-028 C*	*249.12*
900405	*X3-028 E*	*332.16*
915151	*Y3-038*	*5.98*
LTF	*Z1-007*	*5.09*
LTF	*Z1-029*	*3.12*
LTF	*Z1-070*	*71.55*
LTF	*AA1-001*	*5.14*
930041	*AB1-006 C*	*15.35*
930042	*AB1-006 E*	*102.75*
LTF	*AB1-023*	*6.18*
930461	*AB1-087 C OP*	*91.34*
930462	*AB1-087 E OP*	*4.15*
930471	*AB1-088 C OP*	*91.34*
930472	*AB1-088 E OP*	*4.15*