Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-191

Melmore 138 kV

December 2018

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.

For Local and Network Upgrades which are required due to overloads associated with the System Impact Studies of an individual New Services Queue, and have a cost less than $5,000,000, the cost of the Local and Network Upgrades will be shared by all proposed projects which have been assigned a Queue Position in the New Services Queue in which the need for the Local and Network Upgrades was identified. The Load Flow Cost Allocation methods discussed in this manual, including cutoffs, still apply to the individual projects. •

For Local and Network Upgrades which are required due to the overloads associated with the System Impact Studies of an individual New Services Queue, and have a cost of $5,000,000 or greater, the cost of the Local and Network Upgrades will be allocated according to the order of the New Service Requests in the New Services Queue and the MW contribution of each individual Interconnection Request for those projects which cause or contribute to the need for the Local or Network Upgrades. The Load Flow Cost Allocation methods discussed in this manual, including cutoffs, still apply to the individual projects.

Cost allocation rules can be found in PJM Manual 14A, Attachment B. 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 Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment G-2 of Manual 14A. Manufacturer models may be updated from time to

time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 2.2.2. of Manual 14A for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment G-1 of Manual 14A) in order to document the request for the study.

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 install PJM Project #AD2-191, a 200.0 MW (26.0 MW Capacity) Wind generating facility in Seneca County, Ohio (see Figure 2). The primary point of interconnection is a direct connection to AEP's Melmore 138 kV substation utilizing the same gen lead of the previously proposed PJM Projects #U4-028 and #U4-029 (see Figure 1). The secondary point of interconnection is also a direct connection to AEP's Melmore 138kV substation but through a separate gen lead (see Figure 3).

The requested in service date is November 2, 2020.

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 for maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (Melmore 138 kV)

To be constructed by PJM Project #U4-028 and #U4-029.

Note: It is assumed that the 138 kV revenue metering and gen lead installed for the #U4-028 and U4-029 will be adequate for the additional generation since AD2-191 will be utilizing the same gen lead.

Interconnection Customer Requirements

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. 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 American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

Revenue Metering and SCADA Requirements

PJM Requirements

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

AEP Requirements

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

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

Network Impacts – Option 1

The Queue Project AD2-191 was evaluated as a 200.0 MW (Capacity 26.0 MW) injection at the Melmore 138kV substation in the AEP area. Project AD2-191 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-071 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2021 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
ATSI-P2-3-OEC-345-026	ATSI-P2-3-OEC-345-026 /* BEAVER 345KV BRK B-182 DISCONNECT BRANCH FROM BUS 238569 TO BUS 907060 CKT 1 /* 02BEAVER 345 X1-027A TAP 345 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239171 CKT 1 /* 02BEAVER 345 02WLORG-2 14 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239172 CKT 1 /* 02BEAVER 345 02WLORG-3 14 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239173 CKT 1 /* 02BEAVER 345 02WLORG-4 14 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239174 CKT 1 /* 02BEAVER 345 02WLORG-5 14 REMOVE LOAD AX FROM BUS 239171 /* 02WLORG-2 14 REMOVE LOAD AX FROM BUS 239172 /* 02WLORG-3 14 REMOVE LOAD AX FROM BUS 239173 /* 02WLORG-4 14 REMOVE LOAD AX FROM BUS 239174 /* 02WLORG-5 14 REMOVE MACHINE 2 FROM BUS 239171 /* 02WLORG-2 14 REMOVE MACHINE 3 FROM BUS 239172 /* 02WLORG-3 14 REMOVE MACHINE 4 FROM BUS 239173 /* 02WLORG-4 14 REMOVE MACHINE 5 FROM BUS 239174 /* 02WLORG-5 14 DISCONNECT BUS 239171 /* 02WLORG-2 14 DISCONNECT BUS 239172 /* 02WLORG-3 14 DISCONNECT BUS 239173 /* 02WLORG-4 14 DISCONNECT BUS 239174 /* 02WLORG-5 14 END
AEP_P7-1_#7114	AEP_P7-1_#7114 OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1 OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1 OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1 / 243110 05STIFFI 138 245630 05S TIFFIN 69.0 1 END
AEP_P7-1_#7731	AEP_P7-1_#7731 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1 END
AEP_P4_#7111_05MELMOR 138	AEP_P4_#7111_05MELMOR 138 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 END
AEP_P7-1_#7732	AEP_P7-1_#7732 OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1 OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1

Contingency Name	Description
	END
ATSI-P7-1-OEC-345-001	ATSI-P7-1-OEC-345-001 /* BEAVER-LAKAVE 345 CK 1 & 2 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239725 CKT 1 /* 02BEAVER 345 02LAKEAVE 345 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239725 CKT 2 /* 02BEAVER 345 02LAKEAVE 345 END
ATSI-P2-3-CEI-345-001	ATSI-P2-3-CEI-345-001 /* BREAKER FAILURE ON S145 BREAKER AT AVON 345KV DISCONNECT BRANCH FROM BUS 239725 TO BUS 238551 CKT 1 /* 02LAKEAVE 345 02AVON 345 DISCONNECT BRANCH FROM BUS 239725 TO BUS 238551 CKT 2 /* 02LAKEAVE 345 02AVON 345 END
ATSI-P7-1-CEI-345-001	ATSI-P7-1-CEI-345-001 /* AVON-BEAVER #1 AND #2 345KV LINE OUTAGES DISCONNECT BRANCH FROM BUS 238551 TO BUS 239725 CKT 1 /* 02AVON 345 02LAKEAVE 345 DISCONNECT BRANCH FROM BUS 238551 TO BUS 239725 CKT 2 /* 02AVON 345 02LAKEAVE 345 END
ATSI-P2-3-OEC-345-023	ATSI-P2-3-OEC-345-023 /* BEAVER 345KV BRK B-121 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239725 CKT 1 /* 02BEAVER 345 02LAKEAVE 345 DISCONNECT BRANCH FROM BUS 238569 TO BUS 238607 CKT 1 /* 02BEAVER 345 02CARLIL 345 END
ADD202	ADD202 DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAVIS BESSE 345 02HAYES 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAVIS BESSE 345 X1-027A TAP 345 END
ATSI-P2-3-TE-345-010T	ATSI-P2-3-TE-345-010T /* LEMOYNE BK-B1 345 DISCONNECT BRANCH FROM BUS 238889 TO BUS 242936 CKT 1 /* 02LEMOYN 345 05FOSTOR 345 REMOVE MACHINE 1 FROM BUS 238885 /* 02LEMOG1 18 DISCONNECT BUS 238885 /* 02LEMOG1 18 REMOVE MACHINE 2 FROM BUS 238886 /* 02LEMOG2 18 DISCONNECT BUS 238886 /* 02LEMOG2 18 REMOVE MACHINE 3 FROM BUS 238887 /* 02LEMOG3 18 DISCONNECT BUS 238887 /* 02LEMOG3 18 REMOVE MACHINE 4 FROM BUS 238888 /* 02LEMOG4 18 DISCONNECT BUS 238888 /* 02LEMOG4 18 END
AEP_P4_#517	AEP_P4_#517 OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLENDORF 345 242936 05FOSTOR 345 1 OPEN BRANCH FROM BUS 238889 TO BUS 242936 CKT 1 / 238889 02LEMOYN 345 242936 05FOSTOR 345 1 END
ATSI-P7-1-TE-345-024T	ATSI-P7-1-TE-345-024T /* Y1-069-FOSTORIA/LEMOYNE-FOSTORIA 345 DISCONNECT BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 /* 02_Y1-069 345 05FOSTOR 345 DISCONNECT BRANCH FROM BUS 238889 TO BUS 242936 CKT 1 /* 02LEMOYN 345 05FOSTOR 345 END
ATSI-P7-1-TE-138-026	ATSI-P7-1-TE-138-026 /* WEST FREMONT-OTTAWA & W.FREMONT-KH-OTTAWA DISCONNECT BRANCH FROM BUS 239030 TO BUS 239154 CKT 1 /* 02OTTAWA 138 02W.FREM 138 DISCONNECT BUS 238871 /* 02KY-HS 138 END
AEP_P7-1_#7734	AEP_P7-1_#7734 OPEN BRANCH FROM BUS 242984 TO BUS 243039 CKT 1 / 242984 05CHATFL 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 END
AEP_P2-2_#7730_05FREMCT 138	AEP_P2-2_#7730_05FREMCT 138 OPEN BRANCH FROM BUS 243008 TO BUS 243009 CKT 1 / 243008 05FREMCT 138 243009 05FRMNT 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1 / 243008 05FREMCT 138 243130 05TIFFIN 138 1

Contingency Name	Description
	OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 2 / 243008 05FREMCT 138 243130 05TIFFIN 138 2 OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 1 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 1 END
AEP_P4_#7730_05FREMCT 138	AEP_P4_#7730_05FREMCT 138 OPEN BRANCH FROM BUS 243008 TO BUS 243009 CKT 1 / 243008 05FREMCT 138 243009 05FRMNT 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1 / 243008 05FREMCT 138 243130 05TIFFIN 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 2 / 243008 05FREMCT 138 243130 05TIFFIN 138 2 OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 1 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 1 END
AEP_P4_#7727_05TIFFIN 138	AEP_P4_#7727_05TIFFIN 138 OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1 / 243008 05FREMCT 138 243130 05TIFFIN 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 2 / 243008 05FREMCT 138 243130 05TIFFIN 138 2 END
AEP_P1-3_#744	AEP_P1-3_#744 OPEN BRANCH FROM BUS 242936 TO BUS 243006 CKT 1 / 242936 05FOSTOR 345 243006 05FOSTOR 138 1 END
AEP_P1-2_#7104	AEP_P1-2_#7104 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1 END
AEP_P1-2_#7105	AEP_P1-2_#7105 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 END
AEP_P1-2_#5250	AEP_P1-2_#5250 OPEN BRANCH FROM BUS 243008 TO BUS 243009 CKT 1 / 243008 05FREMCT 138 243009 05FRMNT 138 1 END
712_B3_05TIFFIN 138-1_WOMOAB	712_B3_05TIFFIN 138-1_WOMOAB OPEN BRANCH FROM BUS 243008 TO BUS 243009 CKT 1 / 243008 05FREMCT 138 243009 05FRMNT 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1 / 243008 05FREMCT 138 243130 05TIFFIN 138 1 OPEN BRANCH FROM BUS 243015 TO BUS 243130 CKT 1 / 243015 05GREENL 138 243130 05TIFFIN 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 1 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 1 OPEN BRANCH FROM BUS 243130 TO BUS 245637 CKT 1 / 243130 05TIFFIN 138 245637 05TIFFIN C 69.0 1 OPEN BRANCH FROM BUS 247481 TO BUS 245637 CKT 1 / 247481 05HOLME STSS69.0 245637 05TIFFIN C 69.0 1 OPEN BRANCH FROM BUS 245648 TO BUS 245637 CKT 1 / 245648 05MAULE RD 69.0 245637 05TIFFIN C 69.0 1 END
1016_B3_05CHATFL 138-1_WOMOAB-A	1016_B3_05CHATFL 138-1_WOMOAB-A OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1 OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1 OPEN BRANCH FROM BUS 242984 TO BUS 932050 CKT 1 / 242984 05CHATFL 138 932050 AC2-015 TAP 138 1 OPEN BRANCH FROM BUS 242984 TO BUS 243039 CKT 1 / 932050 05CHATFL 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 242984 TO BUS 245656 CKT 1 / 242984 05CHATFL 138 245656 05CHATFIEL 69.0 1 OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1 / 243110 05STIFFI 138 245630 05S TIFFIN 69.0 1 OPEN BRANCH FROM BUS 247193 TO BUS 245655 CKT 1 / 247193 05BULLHDSS 69.0 245655 05CARROTHR 69.0 1 OPEN BRANCH FROM BUS 247193 TO BUS 245669 CKT 1 / 247193 05BULLHDSS 69.0 245669 05N WILLAR 69.0 1 OPEN BRANCH FROM BUS 245655 TO BUS 245656 CKT 1 / 245655 05CARROTHR 69.0 245656 05CHATFIEL 69.0 1 OPEN BRANCH FROM BUS 245655 TO BUS 245674 CKT 1 / 245655 05CARROTHR 69.0 245674 05ST.STEPHSS69.0 1 OPEN BRANCH FROM BUS 245656 TO BUS 247380 CKT 1 / 245656 05CHATFIEL 69.0 247380 05NEW WASHSS69.0 1 END
ATSI-P1-2-SYS-345-809	ATSI-P1-2-SYS-345-809 /* LINE 02HAYES TO 02BEAVER 345 CK 1 DISCONNECT BRANCH FROM BUS 239289 TO BUS 238569 CKT 1 /* 02HAYES 345 02BEAVER 345 END

Table 1

Generator Deliverability

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

None

Multiple Facility Contingency

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

AD2-191 Multiple Facility Contingency													
		Contingency	Affected	Facility	Bus			Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	ATSI-P2-3-OEC-345-026	FE - FE	02HAYES-02BEAVER 345 kV line	239289	238569	DC	99.88	100.39	ER	1844	24.82	1
2	DCTL	AEP_P7-1_#7114	AEP - FE	05FRMNT-02W.FREM 138 kV line	243009	239154	DC	89.06	114.28	ER	361	92	2
3	DCTL	AEP_P7-1_#7731	AEP - FE	05FRMNT-02W.FREM 138 kV line	243009	239154	DC	87.09	112.08	ER	361	90.21	
4	LFFB	AEP_P4_#7111_05MELMOR 138	AEP - AEP	05MELMOR-05CHATFL 138 kV line	243039	242984	DC	91.81	111.65	ER	245	48.62	3
5	DCTL	AEP_P7-1_#7732	AEP - AEP	05BERWICK-05SBERWICK 69 kV line	243162	243180	DC	78.56	104.92	ER	90	23.72	4
6	DCTL	AEP_P7-1_#7732	AEP - AEP	05BASCOM-05BASCOM8 69 kV line	245604	245605	DC	94.05	111.52	ER	31	12.02	5
7	DCTL	AEP_P7-1_#7732	AEP - AEP	05BASCOM8-05E END 69 kV line	245605	245610	DC	85.34	102.81	ER	31	12.02	6
8	DCTL	AEP_P7-1_#7732	AEP - AEP	05RIVERVIE-05BASCOM 69 kV line	245628	245604	DC	97.6	115.07	ER	31	12.02	7
9	DCTL	AEP_P7-1_#7732	AEP - AEP	05S TIFFIN-05SENECA SS 69 kV line	245630	245713	DC	90.01	116.36	ER	90	23.72	8
10	DCTL	AEP_P7-1_#7732	AEP - AEP	05SENECA SS-05BERWICK 69 kV line	245713	243162	DC	84.56	110.92	ER	90	23.72	9

Table 2

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)

AD2-191 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	DCTL	ATSI-P7-1-OEC-345-001	FE - FE	02BEAVER-02CARLIL 345 kV line	238569	238607	1	DC	124.86	125.71	ER	1243	23.13	10
2	LFFB	ATSI-P2-3-CEI-345-001	FE - FE	02BEAVER-02CARLIL 345 kV line	238569	238607	1	DC	105.84	106.67	ER	1243	22.66	
3	DCTL	ATSI-P7-1-CEI-345-001	FE - FE	02BEAVER-02CARLIL 345 kV line	238569	238607	1	DC	105.84	106.67	ER	1243	22.66	
4	LFFB	ATSI-P2-3-OEC-345-023	FE - FE	02BEAVER-02LAKEAVE 345 kV line	238569	239725	2	DC	128.43	129.24	ER	1646	29.09	11
5	DCTL	ADD202	FE - FE	02LAKVEW-02GRNFLD 138 kV line	238874	238768	1	DC	134.38	135.99	ER	316	11.19	12
6	DCTL	ADD202	FE - FE	02OTTAWA-02LAKVEW 138 kV line	239030	238874	1	DC	131.56	132.91	ER	375	11.19	13
7	LFFB	ATSI-P2-3-TE-345-010T	FE - FE	02WOOD+-02LEMOYN 138 kV line	239176	238890	1	DC	112.09	121.29	ER	223	20.51	14
8	LFFB	AEP_P4_#517	FE - FE	02WOOD+-02LEMOYN 138 kV line	239176	238890	1	DC	107.84	117.82	ER	223	22.26	
9	DCTL	ATSI-P7-1-TE-345-024T	FE - FE	02WOOD+-02LEMOYN 138 kV line	239176	238890	1	DC	107.84	117.82	ER	223	22.26	
10	DCTL	ATSI-P7-1-TE-138-026	FE - FE	02WOOD+-02LEMOYN 138 kV line	239176	238890	1	DC	103.89	114.51	ER	223	23.7	
11	LFFB	ATSI-P2-3-CEI-345-001	FE - FE	02BLKRVR-02USSTEEL 138 kV line	239728	239734	1	DC	110.79	111.81	ER	500	11.21	15
12	DCTL	ATSI-P7-1-CEI-345-001	FE - FE	02BLKRVR-02USSTEEL 138 kV line	239728	239734	1	DC	110.79	111.81	ER	500	11.21	
13	LFFB	ATSI-P2-3-CEI-345-001	FE - FE	02USSTEEL-02LRN Q2 138 kV line	239734	238915	1	DC	104.47	105.49	ER	500	11.21	16
14	DCTL	ATSI-P7-1-CEI-345-001	FE - FE	02USSTEEL-02LRN Q2 138 kV line	239734	238915	1	DC	104.47	105.49	ER	500	11.21	
15	LFFB	AEP_P4_#7111_05 MELMOR 138	AEP - AEP	05AIRCO8-05W.END 138 kV line	242953	243137	1	DC	107.61	135.12	ER	167	45.94	17
16	LFFB	AEP_P4_#7111_05 MELMOR 138	AEP - AEP	05CHATFL-AC2-015 TAP 138 kV line	242984	932050	1	DC	107.88	133.93	ER	167	43.49	18
17	DCTL	AEP_P7-1_#7114	AEP - AEP	05FREMCT-05FRMNT 138 kV line	243008	243009	1	DC	130.11	161.9	ER	251	79.81	19

AD2-191 Contribution to Previously Identified Overloads														
		Contingency	Affected	Facility	Bus		Cir.	PF	Loading		Rating		MW	FG
18	DCTL	AEP_P7-1_#7731	AEP - AEP	05FREMCT-05FRMNT 138 kV line	243008	243009	1	DC	128.35	159.63	ER	251	78.52	
19	LFFB	AEP_P4_#7111_05 MELMOR 138	AEP - AEP	05STIFFI-05AIRCO8 138 kV line	243110	242953	1	DC	113.6	141.11	ER	167	45.94	20
20	DCTL	AEP_P7-1_#7732	AEP - AEP	05STIFFI 138/69 kV transformer	243110	245630	1	DC	116.85	146.36	ER	72	21.24	21
21	DCTL	AEP_P7-1_#7734	AEP - AEP	05GREENLAW-05E.TIFF2 69 kV line	245621	245646	1	DC	161.32	173.39	ER	39	10.45	22
22	DCTL	AEP_P7-1_#7731	AEP - AEP	05TIFFIN C-05MAULE RD 69 kV line	245637	245648	1	DC	174.43	207.9	ER	73	24.43	23
23	DCTL	AEP_P7-1_#7114	AEP - AEP	05TIFFIN C-05MAULE RD 69 kV line	245637	245648	1	DC	163.98	195.14	ER	73	22.74	
24	BUS	AEP_P2-2_#7730_05FREMCT 138	AEP - AEP	05TIFFIN C-05MAULE RD 69 kV line	245637	245648	1	DC	121.32	133.42	ER	73	19.6	
25	LFFB	AEP_P4_#7730_05FREMCT 138	AEP - AEP	05TIFFIN C-05MAULE RD 69 kV line	245637	245648	1	DC	121.32	133.42	ER	73	19.6	
26	LFFB	AEP_P4_#7727_05TIFFIN 138	AEP - AEP	05TIFFIN C-05MAULE RD 69 kV line	245637	245648	1	DC	118.68	130.94	ER	73	19.87	
27	DCTL	AEP_P7-1_#7731	AEP - AEP	05TIFFIN T-05RIVERVIE 69 kV line	245638	245628	1	DC	156.49	189.95	ER	73	24.43	24
28	DCTL	AEP_P7-1_#7114	AEP - AEP	05TIFFIN T-05RIVERVIE 69 kV line	245638	245628	1	DC	146.18	177.33	ER	73	22.74	
29	BUS	AEP_P2-2_#7730_05FREMCT 138	AEP - AEP	05TIFFIN T-05RIVERVIE 69 kV line	245638	245628	1	DC	103.52	115.61	ER	73	19.6	
30	LFFB	AEP_P4_#7730_05FREMCT 138	AEP - AEP	05TIFFIN T-05RIVERVIE 69 kV line	245638	245628	1	DC	103.52	115.61	ER	73	19.6	
31	LFFB	AEP_P4_#7727_05TIFFIN 138	AEP - AEP	05TIFFIN T-05RIVERVIE 69 kV line	245638	245628	1	DC	100.87	113.14	ER	73	19.87	
32	DCTL	AEP_P7-1_#7731	AEP - AEP	05MAULE RD-05DAVIS STSS 69 kV line	245648	247480	1	DC	165.67	199.13	ER	73	24.43	25
33	DCTL	AEP_P7-1_#7114	AEP - AEP	05MAULE RD-05DAVIS STSS 69 kV line	245648	247480	1	DC	155.35	186.51	ER	73	22.74	
34	BUS	AEP_P2-2_#7730_05FREMCT 138	AEP - AEP	05MAULE RD-05DAVIS STSS 69 kV line	245648	247480	1	DC	112.69	124.79	ER	73	19.6	
35	LFFB	AEP_P4_#7730_05FREMCT 138	AEP - AEP	05MAULE RD-05DAVIS STSS 69 kV line	245648	247480	1	DC	112.69	124.79	ER	73	19.6	

AD2-191 Contribution to Previously Identified Overloads														
		Contingency	Affected	Facility	Bus		Cir.	PF	Loading		Rating		MW	FG
36	LFFB	AEP_P4_#7727_05TIFFIN 138	AEP - AEP	05MAULE RD-05DAVIS STSS 69 kV line	245648	247480	1	DC	110.05	122.31	ER	73	19.87	
37	DCTL	AEP_P7-1_#7734	AEP - AEP	05ST.STEPHSS-05CARROTHR 69 kV line	245674	245655	1	DC	153.92	169.11	ER	31	10.45	26
38	DCTL	AEP_P7-1_#7731	AEP - AEP	05DAVIS STSS-05TIFFIN T 69 kV line	247480	245638	1	DC	165.67	199.13	ER	73	24.43	27
39	DCTL	AEP_P7-1_#7114	AEP - AEP	05DAVIS STSS-05TIFFIN T 69 kV line	247480	245638	1	DC	155.35	186.51	ER	73	22.74	
40	BUS	AEP_P2-2_#7730_05FREMCT 138	AEP - AEP	05DAVIS STSS-05TIFFIN T 69 kV line	247480	245638	1	DC	112.69	124.79	ER	73	19.6	
41	LFFB	AEP_P4_#7730_05FREMCT 138	AEP - AEP	05DAVIS STSS-05TIFFIN T 69 kV line	247480	245638	1	DC	112.69	124.79	ER	73	19.6	
42	LFFB	AEP_P4_#7727_05TIFFIN 138	AEP - AEP	05DAVIS STSS-05TIFFIN T 69 kV line	247480	245638	1	DC	110.05	122.31	ER	73	19.87	
43	LFFB	AEP_P4_#7111_05MELMOR 138	AEP - AEP	AC2-015 TAP-05HOWARD 138 kV line	932050	243024	1	DC	143.92	169.96	ER	167	43.49	28

Table 3

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

LGEE Impacts to be determined during later study phases (as applicable).

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

OVEC Impacts to be determined during later study phases (as applicable).

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

AD2-191 Delivery of Energy Portion of Interconnection Request												
		Contingency	Affected	Facility	Bus			Loading		Rating		MW
#	Type	Name	Area	Description	From	To	PF	Initial	Final	Type	MVA	Con.
1	N-1	AEP_P1-3_#744	FE - FE	02WOOD+-02LEMOYN 138 kV line	239176	238890	DC	91.63	106.15	ER	223	32.38
2	N-1	AEP_P1-2_#7104	AEP - AEP	05AIRCO8-05W.END 138 kV line	242953	243137	DC	103.1	127.92	ER	167	41.45
3	N-1	AEP_P1-2_#7105	AEP - AEP	05CHATFL-AC2-015 TAP 138 kV line	242984	932050	DC	97.93	118.26	ER	167	33.95
4	N-1	AEP_P1-2_#7104	AEP - AEP	05FREMCT-05FRMNT 138 kV line	243008	243009	DC	100.9	125.54	ER	251	61.86
5	Non	Non	AEP - AEP	05FREMCT-05FRMNT 138 kV line	243008	243009	DC	84.39	103.64	NR	251	48.32
6	N-1	AEP_P1-2_#5250	AEP - AEP	05FREMCT 138/69 kV transformer	243008	245614	DC	100.9	117.69	ER	151	25.35
7	Non	Non	AEP - FE	05HOWARD-02BRKSID 138 kV line	243024	238586	DC	135.92	150.26	NR	167	23.93
8	N-1	712_B3_05TIFFIN 138-1_WOMOAB	AEP - FE	05HOWARD-02BRKSID 138 kV line	243024	238586	DC	119.58	133.72	ER	245	34.65
9	Non	Non	AEP - AEP	05MELMOR-05CHATFL 138 kV line	243039	242984	DC	84.72	100.78	NR	167	26.82
10	N-1	712_B3_05TIFFIN 138-1_WOMOAB	AEP - AEP	05MELMOR-05FOSTOR 138 kV line	243039	243006	DC	139.74	170.24	ER	245	74.71
11	Non	Non	AEP - AEP	05MELMOR-05FOSTOR 138 kV line	243039	243006	DC	130.55	160.37	NR	167	49.8
12	N-1	1016_B3_05CHATFL 138-1_WOMOAB-A	AEP - AEP	05MELMOR-05HOWARD 138 kV line	243039	243024	DC	122.88	147.53	ER	173	42.66
13	Non	Non	AEP - AEP	05MELMOR-05HOWARD 138 kV line	243039	243024	DC	83.8	101.8	NR	138	24.85

AD2-191 Delivery of Energy Portion of Interconnection Request													
		Contingency	Affected	Facility	Bus			Loading		Rating		MW
#	Type	Name	Area	Description	From	To	PF	Initial	Final	Type	MVA	Con.
14	N-1	712_B3_05TIFFIN 138-1_WOMOAB	AEP - AEP	05MELMOR-05STIFFI 138 kV line	243039	243110	DC	97.03	117.36	ER	245	49.81
15	Non	Non	AEP - AEP	05MELMOR-05STIFFI 138 kV line	243039	243110	DC	83.78	102.6	NR	167	31.44
16	N-1	AEP_P1-2_#7104	AEP - AEP	05STIFFI-05AIRCO8 138 kV line	243110	242953	DC	109.09	133.91	ER	167	41.45
17	N-1	ATSI-P1-2-SYS-345-809	FE - FE	X1-027A TAP-02BEAVER 345 kV line	907060	238569	DC	113.01	113.56	ER	1742	20.73
18	N-1	AEP_P1-2_#7105	AEP - AEP	AC2-015 TAP-05HOWARD 138 kV line	932050	243024	DC	132.01	152.34	ER	167	33.95
19	Non	Non	AEP - AEP	AC2-015 TAP-05HOWARD 138 kV line	932050	243024	DC	115.85	132.94	NR	138	23.59

Table 4

New System Reinforcements

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

Multiple Facility Contingency

1. (FE - FE) The 02HAYES-02BEAVER 345 kV line (from bus 239289 to bus 238569 ckt 1) loads from 99.88% to 100.39% (**DC power flow**) of its emergency rating (1844 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-OEC-345-026'. This project contributes approximately 24.82 MW to the thermal violation.

ATSI:
FE will propose to upgrade the Beaver substation line drop 3000 SAC, the line limiting element. The estimated cost is $196,000 without tax. An approximate construction time would be 10 months after execution of CSA, assuming no scheduling outage, ROW, or permitting delays.

2. (AEP - FE) The 05FRMNT-02W.FREM 138 kV line (from bus 243009 to bus 239154 ckt 1) loads from 89.06% to 114.28% (**DC power flow**) of its emergency rating (361 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 92.0 MW to the thermal violation.

ATSI:
FE proposes to reconductor approximately 0.9 miles of the West Fremont-Fremont 138kV line 954Kcmil ACSR conductor and the 1033.5 ACSR 45/7 with 954 45/7 ACSS conductor and the 1272 AAC 61 substation conductor at West Fremont

138kV substation with 954 45/7 ACSS conductor. The estimated cost is $2,239,000 without tax. An approximate construction time would be 12 months after execution of CSA, assuming no scheduling outage, ROW, or permitting delays.

AEP:

1. **Reconductor / rebuild 0.13 miles of conductor. (Limiting Element: ACSR ~ 1033.5 ~ 45/7 ~ ORTOLAN - Conductor Section 1); Estimated Cost: $195,000.**
2. **Replace Fremont Switch (Limiting Element: Switch (1200A)); Estimated Cost: $500,000.**
3. **Replace Fremont Riser (Limiting Element: Sub cond 1590 AAC 61 Str. - Fremont Riser); Estimated Cost: $100.000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

3. (AEP - FE) The 05FRMNT-02W.FREM 138 kV line (from bus 243009 to bus 239154 ckt 1) loads from 87.09% to 112.08% (**DC power flow**) of its emergency rating (361 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 90.21 MW to the thermal violation.

Same as Multiple Facility Contingency #2

4. (AEP - AEP) The 05MELMOR-05CHATFL 138 kV line (from bus 243039 to bus 242984 ckt 1) loads from 91.81% to 111.65% (**DC power flow**) of its emergency rating (245 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 48.62 MW to the thermal violation.

AEP:

1. **A Sag Study will be required on the 11 miles of conductor to mitigate the overload. (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor Section 1) Depending on the sag study results. The cost for this upgrade is expected to be between $44,000 (no remediations required, just sag study) and $16.5 million (complete line reconductor/rebuild).**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

5. (AEP - AEP) The 05BERWICK-05SBERWICK 69 kV line (from bus 243162 to bus 243180 ckt 1) loads from 78.56% to 104.92% (**DC power flow**) of its emergency rating (90 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 23.72 MW to the thermal violation.

AEP:

1. **Replace Berwich switch (Limiting Element: Switch (600A)); Estimated cost: $250,000**

2. **Replace Berwick risers (Limiting Element: Sub cond 477 AAC 19 Str. - Berwick Risers); Estimated cost: $100,000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

6. (AEP - AEP) The 05BASCOM-05BASCOM8 69 kV line (from bus 245604 to bus 245605 ckt 1) loads from 94.05% to 111.52% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 12.02 MW to the thermal violation.

AEP:

1. **Rebuild 11.3 miles of line between East End Fostoria – Riverview 69kV with 795 ACSR (129 MVA rating) and steel poles (PJM Upgrade Id: s1486.1).**
2. **Install new Bascom 69 kV 1200 amp line switches (PJM Upgrade Id: s1486.2).**

The scheduled in-service date is 8/3/2018.

7. (AEP - AEP) The 05BASCOM8-05E END 69 kV line (from bus 245605 to bus 245610 ckt 1) loads from 85.34% to 102.81% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 12.02 MW to the thermal violation.

Same as Multiple Facility Contingency #6

8. (AEP - AEP) The 05RIVERVIE-05BASCOM 69 kV line (from bus 245628 to bus 245604 ckt 1) loads from 97.6% to 115.07% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 12.02 MW to the thermal violation.

Same as Multiple Facility Contingency #6

9. (AEP - AEP) The 05S TIFFIN-05SENECA SS 69 kV line (from bus 245630 to bus 245713 ckt 1) loads from 90.01% to 116.36% (**DC power flow**) of its emergency rating (90 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 23.72 MW to the thermal violation.

AEP:

1. **Replace S Tiffin risers (Limiting Element: Sub cond 300 MCM CU 37 Str - S Tiffin Risers); Estimated cost: $100,000**
2. **Replace S Tiffin CB F (Limiting Element: Switch (600A) - S Tiffin Sw. CB F (2)); Estimated cost : $500,000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

10. (AEP - AEP) The 05SENECA SS-05BERWICK 69 kV line (from bus 245713 to bus 243162 ckt 1) loads from 84.56% to 110.92% (**DC power flow**) of its emergency rating (90 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 23.72 MW to the thermal violation.

AEP:

1. **Replace Berwick Switch (Limiting Element: Switch (600A)); Estimated cost: $250,000.**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

The System Reinforcements listed below are not part of the Bulk Electric System (BES), but was identified by AEP and will be required for the interconnection of AD2-191.

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
1	05BERWICK-05SBERWICK 69 kV line	Replace Berwick switch. Replace Berwick risers.	An approximate construction time would be 12 to 24 months after signing an interconnection agreement.	$350,000
2	05RIVERVIE-05BASCOM 69 kV line	COPPER ~ # 1 ~ 3 ~ - Conductor Section 1 will need to be rebuilt/ reconductored. **Note:** PJM project S1486 will mitigate the constraint identified above.	The projected in service date for PJM project S1486 is 08/03/2018.	N/A
3	05S TIFFIN-05SENECA SS 69 kV line	Replace S Tiffin risers. Replace S Tiffin Switch.	An approximate construction time would be 12 to 24 months after signing an interconnection agreement	$600,000
4	05SENECA SS-05BERWICK 69 kV line	Replace Berwick Switch.	See item #1 above	See item #1 above
			Total Network Upgrades	**$950,000**

Table 5

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Contribution to Previously Identified System Reinforcements

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

1. (FE - FE) The 02BEAVER-02CARLIL 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 124.86% to 125.71% (**DC power flow**) of its emergency rating (1243 MVA) for the tower line contingency outage of 'ATSI-P7-1-OEC-345-001'. This project contributes approximately 23.13 MW to the thermal violation.

ATSI:

1. **Upgrade the Beaver-Carlisle 345kV line relay, the line limiting element. The relay upgrade project will increase the Beaver-Carlisle 345kV circuit thermal rating from 1243MVA/SE to 1424MVA/SE**
2. **Upgrade the Carlisle 345kV 2000A wavetrap on Beaver-Carlisle 345kV line to 3000A.**

The estimated cost to upgrade the Beaver-Carlisle 345kv line relay and wavetrap is $470,000 (without tax). The project requires 10 months to complete after the execution of CSA, assuming no ROW or permitting delays.

2. (FE - FE) The 02BEAVER-02CARLIL 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 105.84% to 106.67% (**DC power flow**) of its emergency rating (1243 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-001'. This project contributes approximately 22.66 MW to the thermal violation.

Same as Contribution to Previously Identified #1

3. (FE - FE) The 02BEAVER-02CARLIL 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 105.84% to 106.67% (**DC power flow**) of its emergency rating (1243 MVA) for the tower line contingency outage of 'ATSI-P7-1-CEI-345-001'. This project contributes approximately 22.66 MW to the thermal violation.

Same as Contribution to Previously Identified #1

4. (FE - FE) The 02BEAVER-02LAKEAVE 345 kV line (from bus 238569 to bus 239725 ckt 2) loads from 128.43% to 129.24% (**DC power flow**) of its emergency rating (1646 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-OEC-345-023'. This project contributes approximately 29.09 MW to the thermal violation.

ATSI:

1. **The proposed upgrade is 3500 SAC line drops at Beaver substation. The estimated cost to upgrade the substation conductor at Beaver is $45,000(without tax).**
2. **The proposed upgrade is to reconductor the Beaver to Lake Ave #2 345kV transmission line with (2) 954 kcmil ACSS conductors. The estimated cost to reconductor the Beaver-Lake Ave #2 345kV line $5,396,900(without tax).**

The project requires 18 months to complete after the execution of CSA; assuming no ROW or permitting delays.

5. (FE - FE) The 02LAKVEW-02GRNFLD 138 kV line (from bus 238874 to bus 238768 ckt 1) loads from 134.38% to 135.99% (**DC power flow**) of its emergency rating (316 MVA) for the tower line contingency outage of 'ADD202'. This project contributes approximately 11.19 MW to the thermal violation.

ATSI:

1. **Reconductor the substation conductor SCCIR 1000 Cu (at Greenfield), 795 26/7 ACSR (at Greenfield), 795 26/7 ACSR (at Lakeview) with 795 ACSS (or equivalent ampere rating).**
2. **Reconductor transmission (line drop) 795 26/7 ACSR conductor at (Greenfield) and the Lakeview-Greenfield 138kV line section conductor 795Kcmil 26/7 ACSR with 795kCmil ACSS.**

The estimated cost estimate to upgrade the limiting substation and line conductor is approximately $2,650,000 (without tax), he project requires 12 months to complete after the execution of CSA; assuming no ROW or permitting delays. Also, it is assumed that the relay upgrade work will be completed within the same time frame of the substation and line upgrade work.

6. (FE - FE) The 02OTTAWA-02LAKVEW 138 kV line (from bus 239030 to bus 238874 ckt 1) loads from 131.56% to 132.91% (**DC power flow**) of its emergency rating (375 MVA) for the tower line contingency outage of 'ADD202'. This project contributes approximately 11.19 MW to the thermal violation.

ATSI:

1. **FE proposed to reconductor existing 7.6 miles of 336.4 ACSR six wired circuit with 336.4 ACSS six wired circuit (maintaining the six wired configuration).**
2. **Replace substation line drops and single spans outside Lakeview and Ottawa with 795 ACSS conductors.**
3. **Replace substation conductors at Lakeview and Ottawa with 1590 ACSS conductors.**

4. **Additionally, replace existing 1600A wave trap at Lakeview with a 2000A wave trap.**

The estimated cost estimate for the project is $15,720,000 (without tax). The project requires 18 months to complete after the execution of CSA; assuming no ROW or permitting delays.

7. (FE - FE) The 02WOOD+-02LEMOYN 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 112.09% to 121.29% (**DC power flow**) of its emergency rating (223 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-TE-345-010T'. This project contributes approximately 20.51 MW to the thermal violation.

ATSI:
FE has proposed to reconductor approximately 0.4 miles of the Lemoyne-Woodville tap 138kV line 954Kcmil ACSR 45/7 with 954Kcmil ACSS conductor and the existing Lemoyne 138kV substation conductor 954Kcmil ACSR 54/7 with 954Kcmil ACSS conductor and relay thermal at Lemoyne. The estimated cost of the upgrade is $610,710 (without tax). Estimated schedule: 6 months.

8. (FE - FE) The 02WOOD+-02LEMOYN 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 107.84% to 117.82% (**DC power flow**) of its emergency rating (223 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#517'. This project contributes approximately 22.26 MW to the thermal violation.

Same as Contribution to Previously Identified #7

9. (FE - FE) The 02WOOD+-02LEMOYN 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 107.84% to 117.82% (**DC power flow**) of its emergency rating (223 MVA) for the tower line contingency outage of 'ATSI-P7-1-TE-345-024T'. This project contributes approximately 22.26 MW to the thermal violation.

Same as Contribution to Previously Identified #7

10. (FE - FE) The 02WOOD+-02LEMOYN 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 103.89% to 114.51% (**DC power flow**) of its emergency rating (223 MVA) for the tower line contingency outage of 'ATSI-P7-1-TE-138-026'. This project contributes approximately 23.7 MW to the thermal violation.

Same as Contribution to Previously Identified #7

11. (FE - FE) The 02BLKRVR-02USSTEEL 138 kV line (from bus 239728 to bus 239734 ckt 1) loads from 110.79% to 111.81% (**DC power flow**) of its emergency rating (500 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-001'. This project contributes approximately 11.21 MW to the thermal violation.

ATSI:

1. **Build a new 138kV four circuit breaker ring bus switching substation adjacent to the exiting Astor substation.**
2. **Expand the Charleston 138kV substation into five (6) circuit breaker ring bus.**
3. **Disconnect the Black River-Republic Vine 138kV line from Republic Vine substation at Republic Vine and reroute the line to extend to the new AstorQ11 138kV substation by building a new ~7.1 miles 138kV line with 795Kcmil ACSS conductor with fiber optics and rebuild the cut opened section of the Black River-Republic Vine 138kV line (~0.8 miles) with 795Kcmil ACSS conductor with fiber optics as part of the new Black River-Aster Q11 138kV line.**
4. **Loop/Terminate the existing Avon - Fox Q11 138kv line into the new AstorQ11 ring bus, switching substation.**
5. **Build a new ~1.9 miles 138kV line to connect the Republic Vine sub to Charleston substation with 795Kcmil ACSR (require negotiation with Republic steel/US Steel to obtain ROW)**
6. **Protection Per FE Standard.**

7. Adjust relay at terminal as required.

The estimated cost is $20,153,000 without tax. An approximate construction time would be 30 months after execution of CSA, assuming no scheduling outage, ROW, or permitting delays

Note: The Black River-Astor 138kV Line mitigation project is a future (to be proposed to PJM) supplemental project that will address overloads in the AD1 Generation Queue. The AD2-191 project has some cost responsibility at this Feasibility phase, but the AD2-191 project's cost responsibility will be re-evaluated in the Impact Study phase. If the supplemental project is approved, then this would factor into the AD2-191 project's cost responsibility at that time.

12. (FE - FE) The 02BLKRVR-02USSTEEL 138 kV line (from bus 239728 to bus 239734 ckt 1) loads from 110.79% to 111.81% (**DC power flow**) of its emergency rating (500 MVA) for the tower line contingency outage of 'ATSI-P7-1-CEI-345-001'. This project contributes approximately 11.21 MW to the thermal violation.

Same as Contribution to Previously Identified #11

13. (FE - FE) The 02USSTEEL-02LRN Q2 138 kV line (from bus 239734 to bus 238915 ckt 1) loads from 104.47% to 105.49% (**DC power flow**) of its emergency rating (500 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-001'. This project contributes approximately 11.21 MW to the thermal violation.

Same as Contribution to Previously Identified #11

14. (FE - FE) The 02USSTEEL-02LRN Q2 138 kV line (from bus 239734 to bus 238915 ckt 1) loads from 104.47% to 105.49% (**DC power flow**) of its emergency rating (500 MVA) for the tower line contingency outage of 'ATSI-P7-1-CEI-345-001'. This project contributes approximately 11.21 MW to the thermal violation.

Same as Contribution to Previously Identified #11

15. (AEP - AEP) The 05AIRCO8-05W.END 138 kV line (from bus 242953 to bus 243137 ckt 1) loads from 107.61% to 135.12% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 45.94 MW to the thermal violation.

AEP:

1. **A Sag Study will be required on the 11.6 mile section of line to mitigate the overload. Depending on the sag study results, cost for this upgrade is expected to be between $46,400 (no remediations required just sag study) and $17.4 million (complete line reconductor /rebuild required)**
2. **An engineering study will need to be conducted to determine if the relay thermal limits settings can be adjusted to mitigate the overload. Estimated Cost: $25,000. New relay package will be required if the settings cannot be adjusted. Estimated Cost: $600,000.**
3. **An engineering study will need to be conducted to determine if the compliance thermal limits settings can be adjusted to mitigate the overload. Estimated Cost: $25,000. New relay packages will be require if settings cannot be adjusted. Estimated Cost: $600,000.**

(A) Sag Study: 6 to 12 months.

(B) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

16. (AEP - AEP) The 05CHATFL-AC2-015 TAP 138 kV line (from bus 242984 to bus 932050 ckt 1) loads from 107.88% to 133.93% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 43.49 MW to the thermal violation.

AEP:

1. **Reconductor / Rebuild 4.5 miles of conductor (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor Section1); Estimated cost: $ 6.75 million.**
2. **Replace Howard line risers (Limiting Element: Sub cond 300 MCM CU 37 Str - Howard Line Risers); Estimated cost: $100,000.**
3. **Replace Chatfield Sw. MOAB "Y" (Limiting Element: Switch (600A)); Estimated cost: $800,000.**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

17. (AEP - AEP) The 05FREMCT-05FRMNT 138 kV line (from bus 243008 to bus 243009 ckt 1) loads from 130.11% to 161.9% (**DC power flow**) of its emergency rating (251 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 79.81 MW to the thermal violation.

AEP:

1. **A Sag Study will be required on the 6.97 miles of conductor to mitigate the overload. (Limiting Element: ACSR ~ 795 ~ 45/7 ~ TERN - Conductor Section 1) Depending on the sag study results. The cost for this upgrade is expected to be between $27,880 (no remediations required, just sag study) and $10.455 million (complete line reconductor/rebuild).**
2. **Replace Fremont Relaying CT (Limiting Element: CT (2.0 Rating) 600 A - Fremont CT Relaying CT); Estimated Cost: $250,000**
3. **Replace Fremont Switch (Limiting Element: Switch (1200A)); Estimated cost: $500,000**
4. **Replace Fremont Riser (Limiting Element: Sub cond 1590 AAC 61 Str.); Estimated Cost: $100.000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

18. (AEP - AEP) The 05FREMCT-05FRMNT 138 kV line (from bus 243008 to bus 243009 ckt 1) loads from 128.35% to 159.63% (**DC power flow**) of its emergency rating (251 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 78.52 MW to the thermal violation.

Same as Contribution to Previously Identified #17

19. (AEP - AEP) The 05STIFFI-05AIRCO8 138 kV line (from bus 243110 to bus 242953 ckt 1) loads from 113.6% to 141.11% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 45.94 MW to the thermal violation.

Same as Contribution to Previously Identified #15

20. (AEP - AEP) The 05STIFFI 138/69 kV transformer (from bus 243110 to bus 245630 ckt 1) loads from 116.85% to 146.36% (**DC power flow**) of its emergency rating (72 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 21.24 MW to the thermal violation.

AEP:

1. **Replace Transformer (Limiting Element: Transformer Rating); Estimated cost: $1.5 million**
2. **Replace Switch (Limiting Element: Switch (600A)); Estimated cost: $500,000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

21. (AEP - AEP) The 05GREENLAW-05E.TIFF2 69 kV line (from bus 245621 to bus 245646 ckt 1) loads from 161.32% to 173.39% (**DC power flow**) of its emergency rating (39 MVA) for the tower line contingency outage of 'AEP_P7-1_#7734'. This project contributes approximately 10.45 MW to the thermal violation.

AEP:

1. **Reconductor / Rebuild 1.74 mile of conductor (Limiting Element: ACSR ~ 133.1 ~ 6/1 ~ QUAIL (2/0) - Conductor Section 2); Estimated cost: $2.088 million.**
2. **An engineering study will need to be conducted to determine if the Relay Trip limit settings can be adjusted to mitigate the overload (Limiting Element: Relay Trip Limit 351 Amps - Greenlawn RTL); Estimated cost: $25,000. New relay package will be required if the settings cannot be adjusted. Estimated cost: $600,000.**
3. **An Engineering study will need to be conducted to determine if the CT Thermal Limit settings can be adjusted to mitigate the overload (Limiting Element: CT Thermal Limit 443 Amps - Greenlawn CTHL); Estimated Cost: $25,000. New relay package will be required if the settings cannot be adjusted, Estimated Cost: $600,000.**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

22. (AEP - AEP) The 05TIFFIN C-05MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 174.43% to 207.9% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

AEP:

1. **Replace Tifffin Center risers (Limiting Element: Sub cond 300 MCM CU 37 Str - Tiffin Center Risers); Estimated cost: $100,000**
2. **Reconductor / rebuild 3.28 miles of conductor (Limiting Element: ACSR ~ 556.5 ~ 18/1 ~ OSPREY- Conductor Section 2); Estimated cost: $3.936 million.**
3. **Replace Tiffin Center CB A (Limiting Element: Breaker (1200A) Oil - Tiffin Ct CB A); Estimated cost: $500,000.**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

23. (AEP - AEP) The 05TIFFIN C-05MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 163.98% to 195.14% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 22.74 MW to the thermal violation.

Same as Contribution to Previously Identified #22

24. (AEP - AEP) The 05TIFFIN C-05MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 121.32% to 133.42% (**DC power flow**) of its emergency rating (73 MVA) for the bus fault outage of 'AEP_P2-2_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #22

25. (AEP - AEP) The 05TIFFIN C-05MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 121.32% to 133.42% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #22

26. (AEP - AEP) The 05TIFFIN C-05MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 118.68% to 130.94% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7727_05TIFFIN 138'. This project contributes approximately 19.87 MW to the thermal violation.

Same as Contribution to Previously Identified #22

27. (AEP - AEP) The 05TIFFIN T-05RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 156.49% to 189.95% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

AEP:

1. **Reconductor / rebuild 1.03 miles of conductor (Limiting Element: ACSR ~ 336.4 ~ 18/1 ~ MERLIN - Conductor Section 1); Estimated cost: $1.236 million**
2. **Replace Riverview risers (Limiting Element: Sub cond 300 MCM CU 37 Str - Riverview Risers); Estimated cost: $100,000**
3. **Replace Tiffin Tapoff MOAB Switch W. (Limiting Element: Sub cond 300 MCM CU 37 Str - Tiffin Tapoff MOAB Switch W); Estimated cost: $250,000**
4. **Replace Riverview Switch (Limiting Element: Switch (600A)); Estimated cost: $250,000**
5. **Replace Riverview Switch (Limiting Element: Switch (600 A)); Estimated cost: $250,000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

28. (AEP - AEP) The 05TIFFIN T-05RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 146.18% to 177.33% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 22.74 MW to the thermal violation.

Same as Contribution to Previously Identified #27

29. (AEP - AEP) The 05TIFFIN T-05RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 103.52% to 115.61% (**DC power flow**) of its emergency rating (73 MVA) for the bus fault outage of 'AEP_P2-2_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #27

30. (AEP - AEP) The 05TIFFIN T-05RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 103.52% to 115.61% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #27

31. (AEP - AEP) The 05TIFFIN T-05RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 100.87% to 113.14% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7727_05TIFFIN 138'. This project contributes approximately 19.87 MW to the thermal violation.

Same as Contribution to Previously Identified #27

32. (AEP - AEP) The 05MAULE RD-05DAVIS STSS 69 kV line (from bus 245648 to bus 247480 ckt 1) loads from 165.67% to 199.13% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

AEP:

1. **Reconductor / rebuild 1.75 miles of conductor (Limiting Element: ACSR ~ 336.4 ~ 18/1 ~ MERLIN - Conductor Section 1); Estimated cost: $2.1 million.**
2. **Replace Davis St Switch (Limiting Element: Switch (600A)); Estimated cost: $250,000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

33. (AEP - AEP) The 05MAULE RD-05DAVIS STSS 69 kV line (from bus 245648 to bus 247480 ckt 1) loads from 155.35% to 186.51% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 22.74 MW to the thermal violation.

Same as Contribution to Previously Identified #32

34. (AEP - AEP) The 05MAULE RD-05DAVIS STSS 69 kV line (from bus 245648 to bus 247480 ckt 1) loads from 112.69% to 124.79% (**DC power flow**) of its emergency rating (73 MVA) for the bus fault outage of 'AEP_P2-2_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #32

35. (AEP - AEP) The 05MAULE RD-05DAVIS STSS 69 kV line (from bus 245648 to bus 247480 ckt 1) loads from 112.69% to 124.79% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #32

36. (AEP - AEP) The 05MAULE RD-05DAVIS STSS 69 kV line (from bus 245648 to bus 247480 ckt 1) loads from 110.05% to 122.31% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7727_05TIFFIN 138'. This project contributes approximately 19.87 MW to the thermal violation.

Same as Contribution to Previously Identified #32

37. (AEP - AEP) The 05ST.STEPHSS-05CARROTHR 69 kV line (from bus 245674 to bus 245655 ckt 1) loads from 153.92% to 169.11% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7734'. This project contributes approximately 10.45 MW to the thermal violation.

AEP:

1. **Rebuild West Rockaway Switch-St. Stephen's Switch, Tiffin-Howard 69kV line. New protection at South Tifflin. Replace CBs at Chatfield (PJM Upgrade Id: s1298).**

The scheduled in-service date is 6/1/2021.

38. (AEP - AEP) The 05DAVIS STSS-05TIFFIN T 69 kV line (from bus 247480 to bus 245638 ckt 1) loads from 165.67% to 199.13% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

AEP:

1. **Reconductor / rebuild 0.26 mile of conductor (Limiting Element: ACSR ~ 336.4 ~ 18/1 ~ MERLIN - Conductor Section 1); Estimated cost: $ 312,000**
2. **Replace Davis St Switch(Limiting Element: Switch (600A) -Davis St Sw.); Estimated cost: $250,000**
3. **Replace Tiffin Tapoff MOAB "Y" (Limiting Element: Switch (600A) - Tiffin Tapoff MOAB "Y"); Estimated cost: $600,000**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

39. (AEP - AEP) The 05DAVIS STSS-05TIFFIN T 69 kV line (from bus 247480 to bus 245638 ckt 1) loads from 155.35% to 186.51% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 22.74 MW to the thermal violation.

Same as Contribution to Previously Identified #38

40. (AEP - AEP) The 05DAVIS STSS-05TIFFIN T 69 kV line (from bus 247480 to bus 245638 ckt 1) loads from 112.69% to 124.79% (**DC power flow**) of its emergency rating (73 MVA) for the bus fault outage of 'AEP_P2-2_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #38

41. (AEP - AEP) The 05DAVIS STSS-05TIFFIN T 69 kV line (from bus 247480 to bus 245638 ckt 1) loads from 112.69% to 124.79% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7730_05FREMCT 138'. This project contributes approximately 19.6 MW to the thermal violation.

Same as Contribution to Previously Identified #38

42. (AEP - AEP) The 05DAVIS STSS-05TIFFIN T 69 kV line (from bus 247480 to bus 245638 ckt 1) loads from 110.05% to 122.31% (**DC power flow**) of its emergency rating (73 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7727_05TIFFIN 138'. This project contributes approximately 19.87 MW to the thermal violation.

Same as Contribution to Previously Identified #38

43. (AEP - AEP) The AC2-015 TAP-05HOWARD 138 kV line (from bus 932050 to bus 243024 ckt 1) loads from 143.92% to 169.96% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 43.49 MW to the thermal violation.

AEP:

1. **Reconductor / rebuild 11.5 miles of conductor (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor Section 1); Estimated cost: $17.25 million**
2. **Replace Howard line risers (Limiting Element: Sub cond 300 MCM CU 37 Str - Howard Line Risers); Estimated cost: $100,000**
3. **Replace Chatfield Sw. MOAB "Y" (Limiting Element: Switch (600A) - Chatfield Sw. MOAB "Y"); Estimated cost: $100,000**
4. **Replace Howard Relaying CT (Limiting Element: CT (2.0 Rating) 500 A - Howard CTs (2000A capable)); Estimated Cost: $250,000**
5. **Replace Howard bus & risers (Limiting Element: Sub cond 795 AAC 37 Str. - Howard Bus & Risers) Estimated cost: $400,000.**
6. **Replace Chatfield bus & risers (Limiting Element: Sub cond 795 AAC 37 Str. - Chatfield Bus & Risers) Estimated cost: $400,000.**

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

The System Reinforcements listed below are not part of the Bulk Electric System (BES), but was identified by AEP and will be required for the interconnection of AD2-191.

Violation #	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
1	05STIFFI 138/69 kV transformer	Replace Transformer. Replace Switch.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$2,000,000
2	05TIFFIN C-05MAULE RD 69 kV line	Replace Tifffin Center risers. 3.28 miles of ACSR ~ 556.5 ~ 18/1 ~ OSPRE conductor will need to be rebuilt/reconductored. Replace Tiffin Center CB A.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$4,536,000
3	05TIFFIN T-05RIVERVIE 69 kV line	1.03 miles of ACSR ~ 336.4 ~ 18/1 ~ MERLIN conductor need to be rebuilt/ reconductored. Replace Reverview risers. Replace Tiffin Tapoff MOAB Switch W. Replace Riverview Switch. Replace Riverview Switch.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$2,086,000
4	05MAULE RD-05DAVIS STSS 69 kV line	1.75 miles of ACSR ~ 336.4 ~ 18/1 ~ MERLIN conductor need to be rebuilt/reconductored. Estimated cost. Replace Davis St Switch. Estimated cost.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$2,350,000
5	05ST.STEPHSS-05CARROTHR 69 kV line	2.6 miles of COPPER ~ # 1 ~ 3 ~ - Conductor Section 1 need to be rebuilt/reconductored. Estimated cost: $3.12 million. **Note:** The upgrade costs are presently the responsibilities of the Transmission Owner under PJM project B2791 which is scheduled to be put in service by 06/01/2021. Any cost to advance the in service date would be determined in the facility study.	The projected in service date for project B2791 is 06/01/2021.	N/A
6	05DAVIS STSS-05TIFFIN T 69 kV line	0.26 mile of conductor needs to be rebuilt/ reconductored. Replace Davis St Switch. Estimated cost. Replace Tiffin Tapoff MOAB "Y".	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$1,162,000
			Total New Network Upgrades	**$12,134,000**

Table 6

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Conclusion

Based upon the results of this System Impact Study, the construction of the Interconnection Customer's 200.0 MW (26.0 MW Capacity) Wind generating facility (PJM Project #AD2-191) will require the following additional interconnection charges. This plan of service will interconnect the proposed generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the IC's generating facility.

Cost Breakdown for Point of Interconnection (Melmore 138 kV)		
Attachment Cost	PJM Project U4-028 and U4-029 will pay for the necessary direct connection work required. Project U4-028, U4-029 and AD2-191 will share the same Generator lead to the Melmore 138kV station.	PJM Project #U4-028 and U4-029 to pay for Attachment Facilities
Non-Direct Connection Cost Estimate	New System Reinforcements *Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)*	$20,930,000
	New System Reinforcements-Not part of the BES	$950,000
	Contribution to Previously Identified System Reinforcements *(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, identified for earlier generation or transmission interconnection projects in the PJM Queue)*	$116,522,610
	Contribution to Previously Identified System Reinforcements-Not part of the BES	$12,134,000
	Total Estimated Cost for Project AD2-191	**$151,536,610**

Table 7

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. Please note that the costs include estimated costs for line reconductoring/rebuild rather than the estimated cost for a sag study where applicable.

Network Impacts – Option 2

The study results are the same for the primary and secondary point of interconnections requested as reflected in the appendices to this report.

Figure 1: Primary Point of Interconnection (Melmore 138 kV)

One-Line Diagram

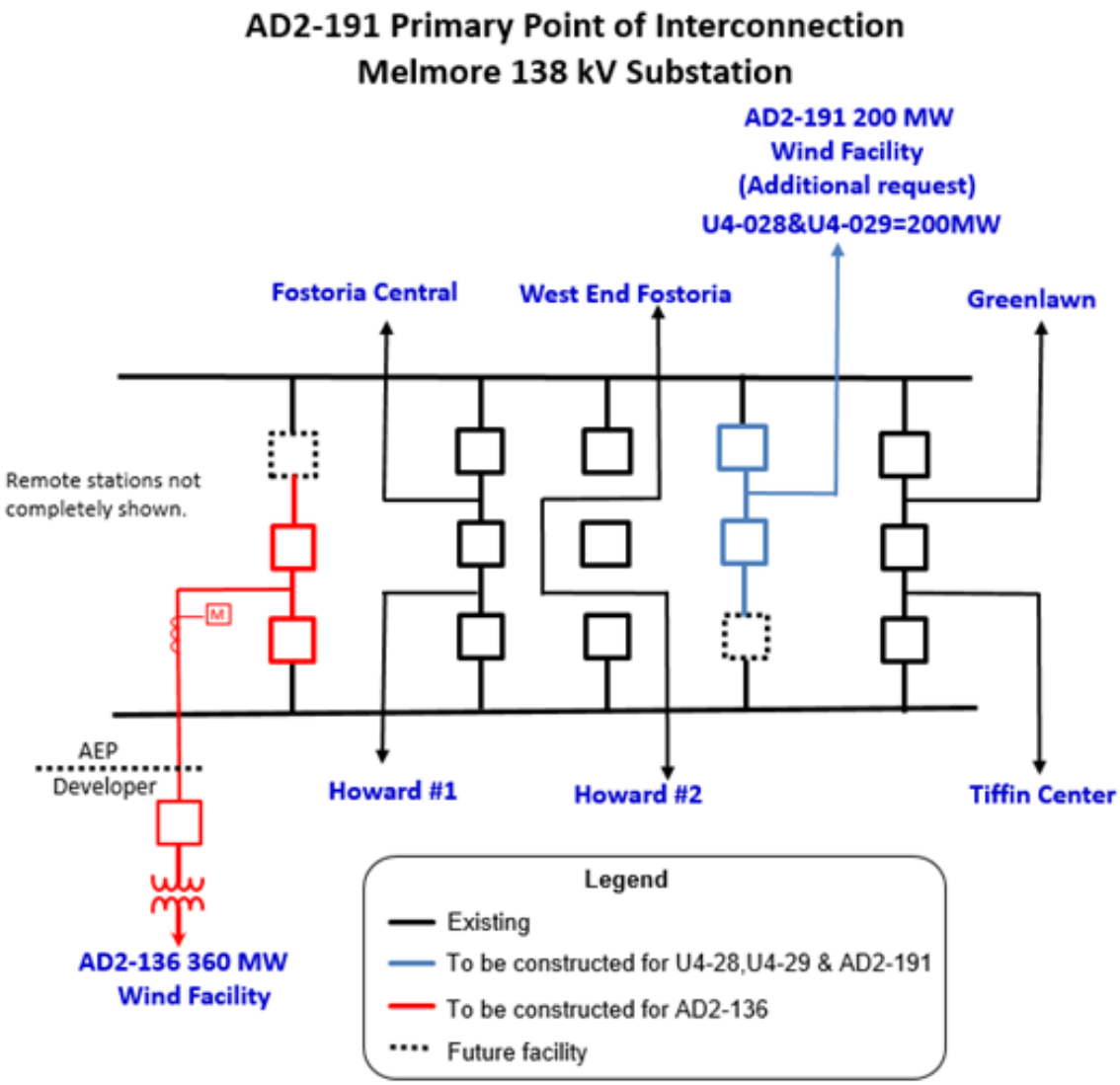
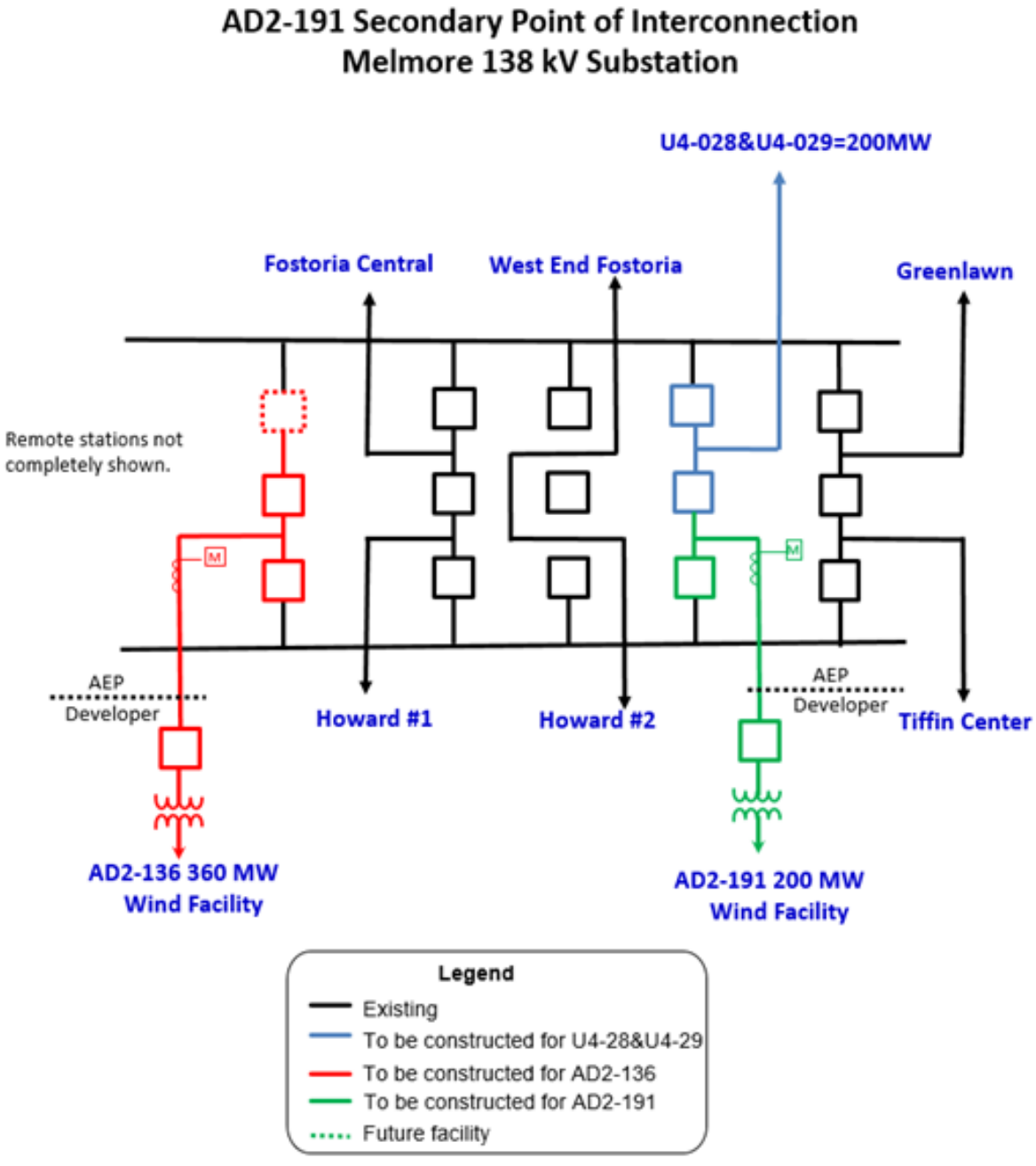


Figure 3: Secondary Point of Interconnection (Melmore 138 kV)

One-Line Diagram



Appendices – Primary POI and Alternate POI

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

(FE - FE) The 02HAYES-02BEAVER 345 kV line (from bus 239289 to bus 238569 ckt 1) loads from 99.88% to 100.39% (**DC power flow**) of its emergency rating (1844 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-OEC-345-026'. This project contributes approximately 24.82 MW to the thermal violation.

CONTINGENCY 'ATSI-P2-3-OEC-345-026' /* BEAVER 345KV BRK B-182
DISCONNECT BRANCH FROM BUS 238569 TO BUS 907060 CKT 1 /* 02BEAVER 345 X1-027A TAP 345
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239171 CKT 1 /* 02BEAVER 345 02WLORG-2 14
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239172 CKT 1 /* 02BEAVER 345 02WLORG-3 14
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239173 CKT 1 /* 02BEAVER 345 02WLORG-4 14
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239174 CKT 1 /* 02BEAVER 345 02WLORG-5 14
REMOVE LOAD AX FROM BUS 239171 /* 02WLORG-2 14
REMOVE LOAD AX FROM BUS 239172 /* 02WLORG-3 14
REMOVE LOAD AX FROM BUS 239173 /* 02WLORG-4 14
REMOVE LOAD AX FROM BUS 239174 /* 02WLORG-5 14
REMOVE MACHINE 2 FROM BUS 239171 /* 02WLORG-2 14
REMOVE MACHINE 3 FROM BUS 239172 /* 02WLORG-3 14
REMOVE MACHINE 4 FROM BUS 239173 /* 02WLORG-4 14
REMOVE MACHINE 5 FROM BUS 239174 /* 02WLORG-5 14
DISCONNECT BUS 239171 /* 02WLORG-2 14
DISCONNECT BUS 239172 /* 02WLORG-3 14
DISCONNECT BUS 239173 /* 02WLORG-4 14
DISCONNECT BUS 239174 /* 02WLORG-5 14
END

Bus Number	*Bus Name*	*Full Contribution*
241902	*02_Y1-069 GE*	*28.73*
238564	*02BAYSG1*	*26.7*
240968	*02BG2 GEN*	*1.33*
240969	*02BG4 G1*	*0.33*
240970	*02BG4 G2&3*	*0.67*
240971	*02BG4 G4&5*	*0.67*
240950	*02BG5*	*4.08*

240973	*02BG6 AMPO*	*5.94*
239276	*02COLLW 11*	*-3.29*
239297	*02CPPW41*	*-4.02*
238670	*02DVBSG1*	*244.25*
238885	*02LEMOG1*	*5.49*
238886	*02LEMOG2*	*5.49*
238887	*02LEMOG3*	*5.49*
238888	*02LEMOG4*	*5.49*
238979	*02NAPMUN*	*6.43*
240975	*02PGE GEN*	*9.21*
932051	*AC2-015 C*	*4.97*
932052	*AC2-015 E*	*5.8*
932791	*AC2-103 C*	*10.4*
932792	*AC2-103 E*	*69.61*
934251	*AD1-052 C1*	*0.9*
934261	*AD1-052 C2*	*0.9*
934461	*AD1-070 C O1*	*5.03*
934462	*AD1-070 E O1*	*23.63*
LTF	*AD1-092*	*5.87*
LTF	*AD1-093*	*10.09*
LTF	*AD1-094*	*1.92*
934741	*AD1-101 C O1*	*1.68*
934742	*AD1-101 E O1*	*2.74*
934761	*AD1-103 C O1*	*17.49*
934762	*AD1-103 E O1*	*117.02*
934891	*AD1-118*	*13.97*
937021	*AD2-136 C O1*	*5.81*
937022	*AD2-136 E O1*	*38.87*
937081	*AD2-143 C O1*	*3.3*
937082	*AD2-143 E O1*	*15.46*
937381	*AD2-191 C*	*3.23*
937382	*AD2-191 E*	*21.6*
LTF	*CARR*	*1.84*
LTF	*CBM-S1*	*9.86*
LTF	*CBM-S2*	*3.62*
LTF	*CBM-W1*	*91.46*
LTF	*CBM-W2*	*71.52*
LTF	*CIN*	*11.59*
LTF	*CPLE*	*0.59*
LTF	*G-007*	*2.92*
LTF	*IPL*	*7.46*
940241	*J419*	*9.99*
981121	*J444*	*23.62*
938021	*J793*	*116.31*

938351	*J799*	*18.88*
938881	*J833*	*9.99*
LTF	*LGEE*	*2.05*
LTF	*MEC*	*23.4*
LTF	*MECS*	*50.55*
LTF	*O-066*	*18.88*
LTF	*RENSSELAER*	*1.44*
LTF	*ROSETON*	*10.41*
247926	*U1-059 E*	*3.95*
247551	*U4-028 C*	*1.61*
247940	*U4-028 E*	*10.8*
247552	*U4-029 C*	*1.61*
247941	*U4-029 E*	*10.8*
247567	*V2-006 C*	*2.14*
247961	*V2-006 E*	*14.31*
247548	*V4-010 C*	*3.49*
247947	*V4-010 E*	*23.33*
247942	*W1-056 E*	*1.45*
LTF	*WEC*	*3.82*
907061	*X1-027A C1*	*0.75*
907064	*X1-027A C2*	*0.75*
907066	*X1-027A C3*	*0.75*
907068	*X1-027A C4*	*0.75*
907062	*X1-027A E1*	*29.25*
907065	*X1-027A E2*	*29.25*
907067	*X1-027A E3*	*29.25*
907069	*X1-027A E4*	*29.25*
LTF	*Y3-032*	*42.68*
LTF	*Z1-043*	*14.69*
918401	*AA1-056*	*1.65*
931951	*AB1-107 1*	*52.34*
931961	*AB1-107 2*	*123.93*
LTF	*AB2-013*	*8.4*
925751	*AC1-051 C*	*0.7*
925752	*AC1-051 E*	*4.71*
926941	*AC1-181*	*0.7*

Appendix 2

(AEP - FE) The 05FRMNT-02W.FREM 138 kV line (from bus 243009 to bus 239154 ckt 1) loads from 89.06% to 114.28% (**DC power flow**) of its emergency rating (361 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 92.0 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7114'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1 / 243110 05STIFFI 138 245630 05S TIFFIN 69.0 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*17.7*
932052	*AC2-015 E*	*20.65*
937021	*AD2-136 C O1*	*21.53*
937022	*AD2-136 E O1*	*144.07*
937381	*AD2-191 C*	*11.96*
937382	*AD2-191 E*	*80.04*
LTF	*CARR*	*0.05*
LTF	*CBM-S1*	*0.49*
LTF	*CBM-S2*	*0.56*
LTF	*CBM-W2*	*1.52*
LTF	*CIN*	*0.19*
LTF	*CPLE*	*0.14*
LTF	*DEARBORN*	*1.94*
LTF	*EDWARDS*	*0.05*
LTF	*FARMERCITY*	*< 0.01*
LTF	*G-007A*	*0.15*
LTF	*IPL*	*0.13*
LTF	*LGEE*	*0.1*
LTF	*RENSSELAER*	*0.04*
LTF	*ROSETON*	*0.29*
LTF	*TATANKA*	*0.03*
LTF	*TILTON*	*< 0.01*

247542	*U4-001 C*	*6.27*
247934	*U4-001 E*	*41.94*
247551	*U4-028 C*	*5.98*
247940	*U4-028 E*	*40.02*
247552	*U4-029 C*	*5.98*
247941	*U4-029 E*	*40.02*
247548	*V4-010 C*	*13.7*
247947	*V4-010 E*	*91.65*
LTF	*VFT*	*0.41*
925751	*AC1-051 C*	*2.36*
925752	*AC1-051 E*	*15.81*

Appendix 3

(AEP - AEP) The 05MELMOR-05CHATFL 138 kV line (from bus 243039 to bus 242984 ckt 1) loads from 91.81% to 111.65% (**DC power flow**) of its emergency rating (245 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 48.62 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7111_05MELMOR 138'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
934251	*AD1-052 C1*	*0.34*
934261	*AD1-052 C2*	*0.34*
937021	*AD2-136 C O1*	*11.38*
937022	*AD2-136 E O1*	*76.14*
937381	*AD2-191 C*	*6.32*
937382	*AD2-191 E*	*42.3*
LTF	*CALDERWOOD*	*< 0.01*
LTF	*CARR*	*0.02*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-S1*	*0.15*
LTF	*CBM-W1*	*7.16*
LTF	*CBM-W2*	*2.34*
LTF	*CELEVELAND*	*0.06*
LTF	*CHEOAH*	*< 0.01*
LTF	*CHILHOWEE*	*< 0.01*
LTF	*CIN*	*0.43*
LTF	*CLIFTY*	*0.37*
LTF	*G-007*	*0.13*
LTF	*HAMLET*	*0.09*
LTF	*IPL*	*0.28*
938021	*J793*	*15.02*
LTF	*LGEE*	*0.04*
LTF	*MEC*	*1.15*
LTF	*MECS*	*5.08*
LTF	*O-066*	*0.84*
LTF	*RENSSELAER*	*0.02*
LTF	*ROSETON*	*0.11*
LTF	*ROWAN*	*0.05*

LTF	*SANTEETLA*	*< 0.01*
247551	*U4-028 C*	*3.16*
247940	*U4-028 E*	*21.15*
247552	*U4-029 C*	*3.16*
247941	*U4-029 E*	*21.15*
LTF	*UNIONPOWER*	*< 0.01*
247548	*V4-010 C*	*4.85*
247947	*V4-010 E*	*32.48*
LTF	*WEC*	*0.22*

Appendix 4

(AEP - AEP) The 05BERWICK-05SBERWICK 69 kV line (from bus 243162 to bus 243180 ckt 1) loads from 78.56% to 104.92% (**DC power flow**) of its emergency rating (90 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 23.72 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*4.32*
932052	*AC2-015 E*	*5.05*
937021	*AD2-136 C O1*	*5.55*
937022	*AD2-136 E O1*	*37.15*
937381	*AD2-191 C*	*3.08*
937382	*AD2-191 E*	*20.64*
LTF	*AMIL*	*0.04*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.18*
LTF	*BIG_CAJUN2*	*0.35*
LTF	*BLUEG*	*0.25*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.04*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.07*
LTF	*CHEOAH*	*0.05*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.89*
LTF	*COTTONWOOD*	*0.47*
LTF	*DEARBORN*	*0.06*
LTF	*EDWARDS*	*0.08*
LTF	*ELMERSMITH*	*0.12*
LTF	*FARMERCITY*	*0.05*
LTF	*G-007A*	*0.12*

LTF	*GIBSON*	*0.09*
LTF	*HAMLET*	*0.07*
LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.19*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.34*
LTF	*ROWAN*	*0.04*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.09*
LTF	*TILTON*	*0.09*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.08*
247542	*U4-001 C*	*1.39*
247934	*U4-001 E*	*9.31*
247551	*U4-028 C*	*1.54*
247940	*U4-028 E*	*10.32*
247552	*U4-029 C*	*1.54*
247941	*U4-029 E*	*10.32*
LTF	*UNIONPOWER*	*0.07*
247548	*V4-010 C*	*2.9*
247947	*V4-010 E*	*19.42*
LTF	*VFT*	*0.33*
925751	*AC1-051 C*	*0.56*
925752	*AC1-051 E*	*3.77*

Appendix 5

(AEP - AEP) The 05BASCOM-05BASCOM8 69 kV line (from bus 245604 to bus 245605 ckt 1) loads from 94.05% to 111.52% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 12.02 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
937021	*AD2-136 C O1*	*2.81*
937022	*AD2-136 E O1*	*18.83*
937381	*AD2-191 C*	*1.56*
937382	*AD2-191 E*	*10.46*
LTF	*AMIL*	*0.04*
LTF	*BAYOU*	*0.09*
LTF	*BIG_CAJUN1*	*0.13*
LTF	*BIG_CAJUN2*	*0.27*
LTF	*BLUEG*	*0.19*
LTF	*CALDERWOOD*	*0.03*
LTF	*CANNELTON*	*0.03*
LTF	*CATAWBA*	*0.01*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.04*
LTF	*CHEOAH*	*0.03*
LTF	*CHILHOWEE*	*0.01*
LTF	*CHOCTAW*	*0.09*
LTF	*CLIFTY*	*0.52*
LTF	*COTTONWOOD*	*0.36*
LTF	*DEARBORN*	*0.2*
LTF	*EDWARDS*	*0.07*
LTF	*ELMERSMITH*	*0.09*
LTF	*FARMERCITY*	*0.04*
LTF	*G-007A*	*0.12*
LTF	*GIBSON*	*0.07*
LTF	*HAMLET*	*0.03*

LTF	*MORGAN*	*0.13*
LTF	*NEWTON*	*0.16*
LTF	*NYISO*	*0.25*
LTF	*PRAIRIE*	*0.3*
LTF	*ROWAN*	*0.02*
LTF	*SANTEETLA*	*< 0.01*
LTF	*SMITHLAND*	*0.02*
LTF	*TATANKA*	*0.08*
LTF	*TILTON*	*0.08*
LTF	*TRIMBLE*	*0.04*
LTF	*TVA*	*0.06*
247551	*U4-028 C*	*0.78*
247940	*U4-028 E*	*5.23*
247552	*U4-029 C*	*0.78*
247941	*U4-029 E*	*5.23*
LTF	*UNIONPOWER*	*0.04*
247548	*V4-010 C*	*1.56*
247947	*V4-010 E*	*10.43*
LTF	*VFT*	*0.31*

Appendix 6

(AEP - AEP) The 05BASCOM8-05E END 69 kV line (from bus 245605 to bus 245610 ckt 1) loads from 85.34% to 102.81% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 12.02 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
937021	*AD2-136 C O1*	*2.81*
937022	*AD2-136 E O1*	*18.83*
937381	*AD2-191 C*	*1.56*
937382	*AD2-191 E*	*10.46*
LTF	*AMIL*	*0.04*
LTF	*BAYOU*	*0.09*
LTF	*BIG_CAJUN1*	*0.13*
LTF	*BIG_CAJUN2*	*0.27*
LTF	*BLUEG*	*0.19*
LTF	*CALDERWOOD*	*0.03*
LTF	*CANNELTON*	*0.03*
LTF	*CATAWBA*	*0.01*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.04*
LTF	*CHEOAH*	*0.03*
LTF	*CHILHOWEE*	*0.01*
LTF	*CHOCTAW*	*0.09*
LTF	*CLIFTY*	*0.52*
LTF	*COTTONWOOD*	*0.36*
LTF	*DEARBORN*	*0.2*
LTF	*EDWARDS*	*0.07*
LTF	*ELMERSMITH*	*0.09*
LTF	*FARMERCITY*	*0.04*
LTF	*G-007A*	*0.12*
LTF	*GIBSON*	*0.07*
LTF	*HAMLET*	*0.03*

LTF	*MORGAN*	*0.13*
LTF	*NEWTON*	*0.16*
LTF	*NYISO*	*0.25*
LTF	*PRAIRIE*	*0.3*
LTF	*ROWAN*	*0.02*
LTF	*SANTEETLA*	*< 0.01*
LTF	*SMITHLAND*	*0.02*
LTF	*TATANKA*	*0.08*
LTF	*TILTON*	*0.08*
LTF	*TRIMBLE*	*0.04*
LTF	*TVA*	*0.06*
247551	*U4-028 C*	*0.78*
247940	*U4-028 E*	*5.23*
247552	*U4-029 C*	*0.78*
247941	*U4-029 E*	*5.23*
LTF	*UNIONPOWER*	*0.04*
247548	*V4-010 C*	*1.56*
247947	*V4-010 E*	*10.43*
LTF	*VFT*	*0.31*

Appendix 7

(AEP - AEP) The 05RIVERVIE-05BASCOM 69 kV line (from bus 245628 to bus 245604 ckt 1) loads from 97.6% to 115.07% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 12.02 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
937021	*AD2-136 C O1*	*2.81*
937022	*AD2-136 E O1*	*18.83*
937381	*AD2-191 C*	*1.56*
937382	*AD2-191 E*	*10.46*
LTF	*AMIL*	*0.04*
LTF	*BAYOU*	*0.09*
LTF	*BIG_CAJUN1*	*0.13*
LTF	*BIG_CAJUN2*	*0.27*
LTF	*BLUEG*	*0.19*
LTF	*CALDERWOOD*	*0.03*
LTF	*CANNELTON*	*0.03*
LTF	*CATAWBA*	*0.01*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.04*
LTF	*CHEOAH*	*0.03*
LTF	*CHILHOWEE*	*0.01*
LTF	*CHOCTAW*	*0.09*
LTF	*CLIFTY*	*0.52*
LTF	*COTTONWOOD*	*0.36*
LTF	*DEARBORN*	*0.2*
LTF	*EDWARDS*	*0.07*
LTF	*ELMERSMITH*	*0.09*
LTF	*FARMERCITY*	*0.04*
LTF	*G-007A*	*0.12*
LTF	*GIBSON*	*0.07*
LTF	*HAMLET*	*0.03*

LTF	*MORGAN*	*0.13*
LTF	*NEWTON*	*0.16*
LTF	*NYISO*	*0.25*
LTF	*PRAIRIE*	*0.3*
LTF	*ROWAN*	*0.02*
LTF	*SANTEETLA*	*< 0.01*
LTF	*SMITHLAND*	*0.02*
LTF	*TATANKA*	*0.08*
LTF	*TILTON*	*0.08*
LTF	*TRIMBLE*	*0.04*
LTF	*TVA*	*0.06*
247551	*U4-028 C*	*0.78*
247940	*U4-028 E*	*5.23*
247552	*U4-029 C*	*0.78*
247941	*U4-029 E*	*5.23*
LTF	*UNIONPOWER*	*0.04*
247548	*V4-010 C*	*1.56*
247947	*V4-010 E*	*10.43*
LTF	*VFT*	*0.31*

Appendix 8

(AEP - AEP) The 05S TIFFIN-05SENECA SS 69 kV line (from bus 245630 to bus 245713 ckt 1) loads from 90.01% to 116.36% (**DC power flow**) of its emergency rating (90 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 23.72 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*4.32*
932052	*AC2-015 E*	*5.05*
937021	*AD2-136 C O1*	*5.55*
937022	*AD2-136 E O1*	*37.15*
937381	*AD2-191 C*	*3.08*
937382	*AD2-191 E*	*20.64*
LTF	*AMIL*	*0.04*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.18*
LTF	*BIG_CAJUN2*	*0.35*
LTF	*BLUEG*	*0.25*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.04*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.07*
LTF	*CHEOAH*	*0.05*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.89*
LTF	*COTTONWOOD*	*0.47*
LTF	*DEARBORN*	*0.06*
LTF	*EDWARDS*	*0.08*
LTF	*ELMERSMITH*	*0.12*
LTF	*FARMERCITY*	*0.05*
LTF	*G-007A*	*0.12*

LTF	*GIBSON*	*0.09*
LTF	*HAMLET*	*0.07*
LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.19*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.34*
LTF	*ROWAN*	*0.04*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.09*
LTF	*TILTON*	*0.09*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.08*
247542	*U4-001 C*	*1.39*
247934	*U4-001 E*	*9.31*
247551	*U4-028 C*	*1.54*
247940	*U4-028 E*	*10.32*
247552	*U4-029 C*	*1.54*
247941	*U4-029 E*	*10.32*
LTF	*UNIONPOWER*	*0.07*
247548	*V4-010 C*	*2.9*
247947	*V4-010 E*	*19.42*
LTF	*VFT*	*0.33*
925751	*AC1-051 C*	*0.56*
925752	*AC1-051 E*	*3.77*

Appendix 9

(AEP - AEP) The 05SENECA SS-05BERWICK 69 kV line (from bus 245713 to bus 243162 ckt 1) loads from 84.56% to 110.92% (**DC power flow**) of its emergency rating (90 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 23.72 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*4.32*
932052	*AC2-015 E*	*5.05*
937021	*AD2-136 C O1*	*5.55*
937022	*AD2-136 E O1*	*37.15*
937381	*AD2-191 C*	*3.08*
937382	*AD2-191 E*	*20.64*
LTF	*AMIL*	*0.04*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.18*
LTF	*BIG_CAJUN2*	*0.35*
LTF	*BLUEG*	*0.25*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.04*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.07*
LTF	*CHEOAH*	*0.05*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.89*
LTF	*COTTONWOOD*	*0.47*
LTF	*DEARBORN*	*0.06*
LTF	*EDWARDS*	*0.08*
LTF	*ELMERSMITH*	*0.12*
LTF	*FARMERCITY*	*0.05*
LTF	*G-007A*	*0.12*

LTF	*GIBSON*	*0.09*
LTF	*HAMLET*	*0.07*
LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.19*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.34*
LTF	*ROWAN*	*0.04*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.09*
LTF	*TILTON*	*0.09*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.08*
247542	*U4-001 C*	*1.39*
247934	*U4-001 E*	*9.31*
247551	*U4-028 C*	*1.54*
247940	*U4-028 E*	*10.32*
247552	*U4-029 C*	*1.54*
247941	*U4-029 E*	*10.32*
LTF	*UNIONPOWER*	*0.07*
247548	*V4-010 C*	*2.9*
247947	*V4-010 E*	*19.42*
LTF	*VFT*	*0.33*
925751	*AC1-051 C*	*0.56*
925752	*AC1-051 E*	*3.77*

Appendix 10

(FE - FE) The 02BEAVER-02CARLIL 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 124.86% to 125.71% (**DC power flow**) of its emergency rating (1243 MVA) for the tower line contingency outage of 'ATSI-P7-1-OEC-345-001'. This project contributes approximately 23.13 MW to the thermal violation.

CONTINGENCY 'ATSI-P7-1-OEC-345-001' /* BEAVER-LAKAVE 345 CK 1 & 2
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239725 CKT 1 /* 02BEAVER 345 02LAKEAVE 345
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239725 CKT 2 /* 02BEAVER 345 02LAKEAVE 345
END

Bus Number	*Bus Name*	*Full Contribution*
238564	*02BAYSG1*	*22.57*
240968	*02BG2 GEN*	*1.13*
240969	*02BG4 G1*	*0.28*
240970	*02BG4 G2&3*	*0.57*
240971	*02BG4 G4&5*	*0.57*
240950	*02BG5*	*3.45*
240973	*02BG6 AMPO*	*5.02*
238670	*02DVBSG1*	*196.73*
238979	*02NAPMUN*	*5.37*
240975	*02PGE GEN*	*7.78*
239171	*02WLORG-2*	*5.38*
239172	*02WLORG-3*	*5.53*
239173	*02WLORG-4*	*5.51*
239174	*02WLORG-5*	*5.53*
932051	*AC2-015 C*	*5.01*
932052	*AC2-015 E*	*5.85*
932791	*AC2-103 C*	*11.45*
932792	*AC2-103 E*	*76.64*
934251	*AD1-052 C1*	*0.84*
934261	*AD1-052 C2*	*0.84*
934461	*AD1-070 C O1*	*4.34*
934462	*AD1-070 E O1*	*20.39*
LTF	*AD1-092*	*4.74*
LTF	*AD1-093*	*8.13*
LTF	*AD1-094*	*1.55*
934761	*AD1-103 C O1*	*19.25*
934762	*AD1-103 E O1*	*128.85*

934891	*AD1-118*	*11.54*
937021	*AD2-136 C O1*	*5.41*
937022	*AD2-136 E O1*	*36.22*
937081	*AD2-143 C O1*	*2.76*
937082	*AD2-143 E O1*	*12.91*
937381	*AD2-191 C*	*3.01*
937382	*AD2-191 E*	*20.12*
LTF	*CARR*	*1.38*
LTF	*CBM-S1*	*7.69*
LTF	*CBM-S2*	*2.48*
LTF	*CBM-W1*	*74.54*
LTF	*CBM-W2*	*56.61*
LTF	*CIN*	*9.29*
LTF	*CPLE*	*0.35*
LTF	*G-007*	*2.56*
LTF	*IPL*	*5.98*
940241	*J419*	*8.35*
981121	*J444*	*19.71*
938021	*J793*	*97.09*
938351	*J799*	*15.79*
938881	*J833*	*8.35*
LTF	*LGEE*	*1.63*
LTF	*MEC*	*18.78*
LTF	*MECS*	*41.64*
LTF	*O-066*	*16.5*
LTF	*RENSSELAER*	*1.08*
LTF	*ROSETON*	*7.83*
247551	*U4-028 C*	*1.5*
247940	*U4-028 E*	*10.06*
247552	*U4-029 C*	*1.5*
247941	*U4-029 E*	*10.06*
247567	*V2-006 C*	*1.79*
247961	*V2-006 E*	*11.98*
247548	*V4-010 C*	*3.25*
247947	*V4-010 E*	*21.72*
LTF	*WEC*	*3.08*
907061	*X1-027A C1*	*0.83*
907064	*X1-027A C2*	*0.83*
907066	*X1-027A C3*	*0.83*
907068	*X1-027A C4*	*0.83*
907062	*X1-027A E1*	*32.2*
907065	*X1-027A E2*	*32.2*
907067	*X1-027A E3*	*32.2*
907069	*X1-027A E4*	*32.2*

LTF	*Y3-032*	*35.21*
LTF	*Z1-043*	*11.85*
931951	*AB1-107 1*	*44.21*
931961	*AB1-107 2*	*102.03*
LTF	*AB2-013*	*6.78*
925751	*AC1-051 C*	*0.71*
925752	*AC1-051 E*	*4.76*
926941	*AC1-181*	*0.58*

Appendix 11

(FE - FE) The 02BEAVER-02LAKEAVE 345 kV line (from bus 238569 to bus 239725 ckt 2) loads from 128.43% to 129.24% (**DC power flow**) of its emergency rating (1646 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-OEC-345-023'. This project contributes approximately 29.09 MW to the thermal violation.

CONTINGENCY 'ATSI-P2-3-OEC-345-023' /* BEAVER 345KV BRK B-121
DISCONNECT BRANCH FROM BUS 238569 TO BUS 239725 CKT 1 /* 02BEAVER 345 02LAKEAVE 345
DISCONNECT BRANCH FROM BUS 238569 TO BUS 238607 CKT 1 /* 02BEAVER 345 02CARLIL 345
END

Bus Number	*Bus Name*	*Full Contribution*
241902	*02_Y1-069 GE*	*29.95*
238564	*02BAYSG1*	*28.45*
240968	*02BG2 GEN*	*1.42*
240969	*02BG4 G1*	*0.36*
240970	*02BG4 G2&3*	*0.71*
240971	*02BG4 G4&5*	*0.71*
240950	*02BG5*	*4.35*
240973	*02BG6 AMPO*	*6.34*
239276	*02COLLW 11*	*-4.25*
239297	*02CPPW41*	*-5.22*
238670	*02DVBSG1*	*248.95*
238979	*02NAPMUN*	*6.81*
240975	*02PGE GEN*	*9.82*
239171	*02WLORG-2*	*6.82*
239172	*02WLORG-3*	*7.01*
239173	*02WLORG-4*	*7.*
239174	*02WLORG-5*	*7.02*
932051	*AC2-015 C*	*6.33*
932052	*AC2-015 E*	*7.38*
932791	*AC2-103 C*	*14.51*
932792	*AC2-103 E*	*97.15*
934251	*AD1-052 C1*	*1.04*
934261	*AD1-052 C2*	*1.04*
934461	*AD1-070 C O1*	*5.51*
934462	*AD1-070 E O1*	*25.89*
LTF	*AD1-092*	*6.36*
LTF	*AD1-093*	*10.91*

LTF	*AD1-094*	*2.08*
934761	*AD1-103 C O1*	*24.4*
934762	*AD1-103 E O1*	*163.32*
934891	*AD1-118*	*14.61*
937021	*AD2-136 C O1*	*6.81*
937022	*AD2-136 E O1*	*45.56*
937081	*AD2-143 C O1*	*3.53*
937082	*AD2-143 E O1*	*16.54*
937381	*AD2-191 C*	*3.78*
937382	*AD2-191 E*	*25.31*
LTF	*CARR*	*2.23*
LTF	*CBM-S1*	*10.82*
LTF	*CBM-S2*	*4.*
LTF	*CBM-W1*	*97.53*
LTF	*CBM-W2*	*77.98*
LTF	*CIN*	*12.65*
LTF	*CPLE*	*0.65*
LTF	*G-007*	*3.37*
LTF	*IPL*	*8.14*
938021	*J793*	*120.29*
LTF	*LGEE*	*2.25*
LTF	*MEC*	*25.37*
LTF	*MECS*	*53.2*
LTF	*O-066*	*21.78*
LTF	*RENSSELAER*	*1.75*
LTF	*ROSETON*	*12.63*
247551	*U4-028 C*	*1.89*
247940	*U4-028 E*	*12.66*
247552	*U4-029 C*	*1.89*
247941	*U4-029 E*	*12.66*
247567	*V2-006 C*	*2.3*
247961	*V2-006 E*	*15.42*
247548	*V4-010 C*	*4.06*
247947	*V4-010 E*	*27.2*
LTF	*WEC*	*4.13*
907061	*X1-027A C1*	*1.05*
907064	*X1-027A C2*	*1.05*
907066	*X1-027A C3*	*1.05*
907068	*X1-027A C4*	*1.05*
907062	*X1-027A E1*	*40.82*
907065	*X1-027A E2*	*40.82*
907067	*X1-027A E3*	*40.82*
907069	*X1-027A E4*	*40.82*
LTF	*Y3-032*	*44.77*

LTF	*Z1-043*	*15.89*
918401	*AA1-056*	*1.72*
931951	*AB1-107 1*	*55.74*
931961	*AB1-107 2*	*129.19*
LTF	*AB2-013*	*9.09*
925751	*AC1-051 C*	*0.9*
925752	*AC1-051 E*	*6.02*
926941	*AC1-181*	*0.75*

Appendix 12

(FE - FE) The 02LAKVEW-02GRNFLD 138 kV line (from bus 238874 to bus 238768 ckt 1) loads from 134.38% to 135.99% (**DC power flow**) of its emergency rating (316 MVA) for the tower line contingency outage of 'ADD202'. This project contributes approximately 11.19 MW to the thermal violation.

CONTINGENCY 'ADD202'
DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAVIS BESSE 345 02HAYES 345
DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAVIS BESSE 345 X1-027A TAP 345
END

Bus Number	*Bus Name*	*Full Contribution*
238564	*02BAYSG1*	*12.52*
240968	*02BG2 GEN*	*0.53*
240969	*02BG4 G1*	*0.14*
240970	*02BG4 G2&3*	*0.27*
240971	*02BG4 G4&5*	*0.27*
240950	*02BG5*	*1.63*
240973	*02BG6 AMPO*	*2.39*
238670	*02DVBSG1*	*57.59*
238601	*02FRMENG 1*	*3.15*
238602	*02FRMENG 2*	*3.15*
238603	*02FRMENG 3*	*5.69*
238979	*02NAPMUN*	*2.36*
240975	*02PGE GEN*	*3.69*
934251	*AD1-052 C1*	*0.54*
934261	*AD1-052 C2*	*0.54*
934461	*AD1-070 C O1*	*1.86*
934462	*AD1-070 E O1*	*8.73*
934891	*AD1-118*	*4.36*
937021	*AD2-136 C O1*	*2.62*
937022	*AD2-136 E O1*	*17.53*
937381	*AD2-191 C*	*1.46*
937382	*AD2-191 E*	*9.74*
LTF	*CARR*	*0.61*
LTF	*CBM-S1*	*3.29*
LTF	*CBM-S2*	*1.22*
LTF	*CBM-W1*	*30.38*
LTF	*CBM-W2*	*23.89*
LTF	*CIN*	*3.87*

LTF	*CPLE*	*0.2*
LTF	*G-007*	*0.96*
LTF	*IPL*	*2.49*
938021	*J793*	*38.13*
LTF	*LGEE*	*0.68*
LTF	*MEC*	*7.82*
LTF	*MECS*	*16.71*
LTF	*O-066*	*6.23*
LTF	*RENSSELAER*	*0.48*
LTF	*ROSETON*	*3.43*
247551	*U4-028 C*	*0.73*
247940	*U4-028 E*	*4.87*
247552	*U4-029 C*	*0.73*
247941	*U4-029 E*	*4.87*
247548	*V4-010 C*	*1.7*
247947	*V4-010 E*	*11.36*
LTF	*WEC*	*1.27*
LTF	*Y3-032*	*14.08*
931951	*AB1-107 1*	*24.26*
931961	*AB1-107 2*	*39.8*
926941	*AC1-181*	*0.25*

Appendix 13

(FE - FE) The 02OTTAWA-02LAKVEW 138 kV line (from bus 239030 to bus 238874 ckt 1) loads from 131.56% to 132.91% (**DC power flow**) of its emergency rating (375 MVA) for the tower line contingency outage of 'ADD202'. This project contributes approximately 11.19 MW to the thermal violation.

CONTINGENCY 'ADD202'
DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAVIS BESSE 345 02HAYES 345
DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAVIS BESSE 345 X1-027A TAP 345
END

Bus Number	*Bus Name*	*Full Contribution*
238564	*02BAYSG1*	*12.52*
240968	*02BG2 GEN*	*0.53*
240969	*02BG4 G1*	*0.14*
240970	*02BG4 G2&3*	*0.27*
240971	*02BG4 G4&5*	*0.27*
240950	*02BG5*	*1.63*
240973	*02BG6 AMPO*	*2.39*
238670	*02DVBSG1*	*57.59*
238601	*02FRMENG 1*	*3.15*
238602	*02FRMENG 2*	*3.15*
238603	*02FRMENG 3*	*5.69*
238979	*02NAPMUN*	*2.36*
240975	*02PGE GEN*	*3.69*
934251	*AD1-052 C1*	*0.54*
934261	*AD1-052 C2*	*0.54*
934461	*AD1-070 C O1*	*1.86*
934462	*AD1-070 E O1*	*8.73*
934891	*AD1-118*	*4.36*
937021	*AD2-136 C O1*	*2.62*
937022	*AD2-136 E O1*	*17.53*
937381	*AD2-191 C*	*1.46*
937382	*AD2-191 E*	*9.74*
LTF	*CARR*	*0.61*
LTF	*CBM-S1*	*3.29*
LTF	*CBM-S2*	*1.22*
LTF	*CBM-W1*	*30.38*
LTF	*CBM-W2*	*23.89*
LTF	*CIN*	*3.87*

LTF	*CPLE*	*0.2*
LTF	*G-007*	*0.96*
LTF	*IPL*	*2.49*
938021	*J793*	*38.13*
LTF	*LGEE*	*0.68*
LTF	*MEC*	*7.82*
LTF	*MECS*	*16.71*
LTF	*O-066*	*6.23*
LTF	*RENSSELAER*	*0.48*
LTF	*ROSETON*	*3.43*
247551	*U4-028 C*	*0.73*
247940	*U4-028 E*	*4.87*
247552	*U4-029 C*	*0.73*
247941	*U4-029 E*	*4.87*
247548	*V4-010 C*	*1.7*
247947	*V4-010 E*	*11.36*
LTF	*WEC*	*1.27*
LTF	*Y3-032*	*14.08*
931951	*AB1-107 1*	*24.26*
931961	*AB1-107 2*	*39.8*
926941	*AC1-181*	*0.25*

Appendix 14

(FE - FE) The 02WOOD+-02LEMOYN 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 112.09% to 121.29% (**DC power flow**) of its emergency rating (223 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-TE-345-010T'. This project contributes approximately 20.51 MW to the thermal violation.

CONTINGENCY 'ATSI-P2-3-TE-345-010T' /* LEMOYNE BK-B1 345
DISCONNECT BRANCH FROM BUS 238889 TO BUS 242936 CKT 1 /* 02LEMOYN 345 05FOSTOR 345
REMOVE MACHINE 1 FROM BUS 238885 /* 02LEMOG1 18
DISCONNECT BUS 238885 /* 02LEMOG1 18
REMOVE MACHINE 2 FROM BUS 238886 /* 02LEMOG2 18
DISCONNECT BUS 238886 /* 02LEMOG2 18
REMOVE MACHINE 3 FROM BUS 238887 /* 02LEMOG3 18
DISCONNECT BUS 238887 /* 02LEMOG3 18
REMOVE MACHINE 4 FROM BUS 238888 /* 02LEMOG4 18
DISCONNECT BUS 238888 /* 02LEMOG4 18
END

Bus Number	*Bus Name*	*Full Contribution*
240968	*02BG2 GEN*	*-0.72*
240969	*02BG4 G1*	*-0.17*
240970	*02BG4 G2&3*	*-0.34*
240971	*02BG4 G4&5*	*-0.34*
240973	*02BG6 AMPO*	*-3.13*
238601	*02FRMENG 1*	*3.24*
238602	*02FRMENG 2*	*3.24*
238603	*02FRMENG 3*	*5.85*
932051	*AC2-015 C*	*4.1*
932052	*AC2-015 E*	*4.78*
934251	*AD1-052 C1*	*0.55*
934261	*AD1-052 C2*	*0.55*
934461	*AD1-070 C O1*	*4.79*
934462	*AD1-070 E O1*	*22.49*
937021	*AD2-136 C O1*	*4.8*
937022	*AD2-136 E O1*	*32.12*
937381	*AD2-191 C*	*2.67*
937382	*AD2-191 E*	*17.84*
LTF	*AMIL*	*0.09*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.16*
LTF	*BIG_CAJUN2*	*0.32*

LTF	*BLUEG*	*0.02*
LTF	*CANNELTON*	*0.03*
LTF	*CARR*	*< 0.01*
LTF	*CBM-S2*	*0.19*
LTF	*CHOCTAW*	*0.08*
LTF	*COTTONWOOD*	*0.49*
LTF	*CPLE*	*0.06*
LTF	*DEARBORN*	*4.*
LTF	*EDWARDS*	*0.25*
LTF	*ELMERSMITH*	*0.09*
LTF	*FARMERCITY*	*0.12*
LTF	*G-007A*	*0.18*
LTF	*GIBSON*	*0.1*
LTF	*LGEE*	*< 0.01*
LTF	*MORGAN*	*0.1*
LTF	*NEWTON*	*0.35*
LTF	*PRAIRIE*	*0.65*
LTF	*RENSSELAER*	*< 0.01*
LTF	*ROSETON*	*0.04*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.25*
LTF	*TILTON*	*0.21*
LTF	*TRIMBLE*	*< 0.01*
LTF	*TVA*	*0.04*
247542	*U4-001 C*	*1.51*
247934	*U4-001 E*	*10.13*
247551	*U4-028 C*	*1.33*
247940	*U4-028 E*	*8.92*
247552	*U4-029 C*	*1.33*
247941	*U4-029 E*	*8.92*
LTF	*UNIONPOWER*	*< 0.01*
247548	*V4-010 C*	*2.66*
247947	*V4-010 E*	*17.82*
900041	*V4-011*	*0.06*
LTF	*VFT*	*0.46*
925751	*AC1-051 C*	*0.56*
925752	*AC1-051 E*	*3.75*

Appendix 15

(FE - FE) The 02BLKRVR-02USSTEEL 138 kV line (from bus 239728 to bus 239734 ckt 1) loads from 110.79% to 111.81% (**DC power flow**) of its emergency rating (500 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-001'. This project contributes approximately 11.21 MW to the thermal violation.

CONTINGENCY 'ATSI-P2-3-CEI-345-001' /* BREAKER FAILURE ON S145 BREAKER AT AVON 345KV
DISCONNECT BRANCH FROM BUS 239725 TO BUS 238551 CKT 1 /* 02LAKEAVE 345 02AVON 345
DISCONNECT BRANCH FROM BUS 239725 TO BUS 238551 CKT 2 /* 02LAKEAVE 345 02AVON 345
END

Bus Number	*Bus Name*	*Full Contribution*
238564	*02BAYSG1*	*9.28*
238572	*02BEAVGB*	*1.44*
240968	*02BG2 GEN*	*0.46*
240969	*02BG4 G1*	*0.12*
240970	*02BG4 G2&3*	*0.23*
240971	*02BG4 G4&5*	*0.23*
240950	*02BG5*	*1.42*
240973	*02BG6 AMPO*	*2.08*
239276	*02COLLW 11*	*-2.18*
239297	*02CPPW41*	*-2.75*
238670	*02DVBSG1*	*72.38*
238979	*02NAPMUN*	*2.19*
240975	*02PGE GEN*	*3.21*
239175	*02WLORG-6*	*2.28*
932791	*AC2-103 C*	*3.87*
932792	*AC2-103 E*	*25.88*
934251	*AD1-052 C1*	*0.41*
934261	*AD1-052 C2*	*0.41*
934461	*AD1-070 C O1*	*1.89*
934462	*AD1-070 E O1*	*8.87*
934761	*AD1-103 C O1*	*6.5*
934762	*AD1-103 E O1*	*43.5*
934891	*AD1-118*	*4.55*
937021	*AD2-136 C O1*	*2.62*
937022	*AD2-136 E O1*	*17.55*
937381	*AD2-191 C*	*1.46*
937382	*AD2-191 E*	*9.75*

LTF	*CARR*	*0.93*
LTF	*CBM-S1*	*3.89*
LTF	*CBM-S2*	*1.57*
LTF	*CBM-W1*	*32.06*
LTF	*CBM-W2*	*27.43*
LTF	*CIN*	*4.42*
LTF	*CPLE*	*0.27*
LTF	*G-007*	*1.21*
LTF	*IPL*	*2.84*
938021	*J793*	*36.09*
LTF	*LGEE*	*0.8*
LTF	*MEC*	*8.73*
LTF	*MECS*	*16.84*
LTF	*O-066*	*7.81*
LTF	*RENSSELAER*	*0.73*
LTF	*ROSETON*	*5.27*
247551	*U4-028 C*	*0.73*
247940	*U4-028 E*	*4.88*
247552	*U4-029 C*	*0.73*
247941	*U4-029 E*	*4.88*
247548	*V4-010 C*	*1.58*
247947	*V4-010 E*	*10.54*
LTF	*WEC*	*1.41*
907062	*X1-027A E1*	*10.87*
907065	*X1-027A E2*	*10.87*
907067	*X1-027A E3*	*10.87*
907069	*X1-027A E4*	*10.87*
LTF	*Y3-032*	*14.04*
931951	*AB1-107 1*	*18.15*
931961	*AB1-107 2*	*39.82*

Appendix 16

(FE - FE) The 02USSTEEL-02LRN Q2 138 kV line (from bus 239734 to bus 238915 ckt 1) loads from 104.47% to 105.49% (**DC power flow**) of its emergency rating (500 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-001'. This project contributes approximately 11.21 MW to the thermal violation.

CONTINGENCY 'ATSI-P2-3-CEI-345-001' /* BREAKER FAILURE ON S145 BREAKER AT AVON 345KV
DISCONNECT BRANCH FROM BUS 239725 TO BUS 238551 CKT 1 /* 02LAKEAVE 345 02AVON 345
DISCONNECT BRANCH FROM BUS 239725 TO BUS 238551 CKT 2 /* 02LAKEAVE 345 02AVON 345
END

Bus Number	*Bus Name*	*Full Contribution*
238564	*02BAYSG1*	*9.28*
238572	*02BEAVGB*	*1.44*
240968	*02BG2 GEN*	*0.46*
240969	*02BG4 G1*	*0.12*
240970	*02BG4 G2&3*	*0.23*
240971	*02BG4 G4&5*	*0.23*
240950	*02BG5*	*1.42*
240973	*02BG6 AMPO*	*2.08*
239276	*02COLLW 11*	*-2.18*
239297	*02CPPW41*	*-2.75*
238670	*02DVBSG1*	*72.38*
238979	*02NAPMUN*	*2.19*
240975	*02PGE GEN*	*3.21*
239175	*02WLORG-6*	*2.28*
932791	*AC2-103 C*	*3.87*
932792	*AC2-103 E*	*25.88*
934251	*AD1-052 C1*	*0.41*
934261	*AD1-052 C2*	*0.41*
934461	*AD1-070 C O1*	*1.89*
934462	*AD1-070 E O1*	*8.87*
934761	*AD1-103 C O1*	*6.5*
934762	*AD1-103 E O1*	*43.5*
934891	*AD1-118*	*4.55*
937021	*AD2-136 C O1*	*2.62*
937022	*AD2-136 E O1*	*17.55*
937381	*AD2-191 C*	*1.46*
937382	*AD2-191 E*	*9.75*

LTF	*CARR*	*0.93*
LTF	*CBM-S1*	*3.89*
LTF	*CBM-S2*	*1.57*
LTF	*CBM-W1*	*32.06*
LTF	*CBM-W2*	*27.43*
LTF	*CIN*	*4.42*
LTF	*CPLE*	*0.27*
LTF	*G-007*	*1.21*
LTF	*IPL*	*2.84*
938021	*J793*	*36.09*
LTF	*LGEE*	*0.8*
LTF	*MEC*	*8.73*
LTF	*MECS*	*16.84*
LTF	*O-066*	*7.81*
LTF	*RENSSELAER*	*0.73*
LTF	*ROSETON*	*5.27*
247551	*U4-028 C*	*0.73*
247940	*U4-028 E*	*4.88*
247552	*U4-029 C*	*0.73*
247941	*U4-029 E*	*4.88*
247548	*V4-010 C*	*1.58*
247947	*V4-010 E*	*10.54*
LTF	*WEC*	*1.41*
907062	*X1-027A E1*	*10.87*
907065	*X1-027A E2*	*10.87*
907067	*X1-027A E3*	*10.87*
907069	*X1-027A E4*	*10.87*
LTF	*Y3-032*	*14.04*
931951	*AB1-107 1*	*18.15*
931961	*AB1-107 2*	*39.82*

Appendix 17

(AEP - AEP) The 05AIRCO8-05W.END 138 kV line (from bus 242953 to bus 243137 ckt 1) loads from 107.61% to 135.12% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 45.94 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7111_05MELMOR 138'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*7.67*
932052	*AC2-015 E*	*8.95*
937021	*AD2-136 C O1*	*10.75*
937022	*AD2-136 E O1*	*71.94*
937381	*AD2-191 C*	*5.97*
937382	*AD2-191 E*	*39.96*
LTF	*AMIL*	*0.09*
LTF	*BAYOU*	*0.22*
LTF	*BIG_CAJUN1*	*0.33*
LTF	*BIG_CAJUN2*	*0.67*
LTF	*BLUEG*	*0.46*
LTF	*CALDERWOOD*	*0.08*
LTF	*CANNELTON*	*0.08*
LTF	*CATAWBA*	*0.03*
LTF	*CBM-N*	*0.04*
LTF	*CELEVELAND*	*0.09*
LTF	*CHEOAH*	*0.08*
LTF	*CHILHOWEE*	*0.03*
LTF	*CHOCTAW*	*0.21*
LTF	*CLIFTY*	*1.3*
LTF	*COTTONWOOD*	*0.9*
LTF	*DEARBORN*	*0.49*
LTF	*EDWARDS*	*0.18*
LTF	*ELMERSMITH*	*0.23*
LTF	*FARMERCITY*	*0.11*
LTF	*G-007A*	*0.28*
LTF	*GIBSON*	*0.18*
LTF	*HAMLET*	*0.08*

LTF	*MORGAN*	*0.33*
LTF	*NEWTON*	*0.4*
LTF	*NYISO*	*0.62*
LTF	*PRAIRIE*	*0.73*
LTF	*ROWAN*	*0.06*
LTF	*SANTEETLA*	*0.02*
LTF	*SMITHLAND*	*0.05*
LTF	*TATANKA*	*0.2*
LTF	*TILTON*	*0.21*
LTF	*TRIMBLE*	*0.09*
LTF	*TVA*	*0.15*
247542	*U4-001 C*	*2.23*
247934	*U4-001 E*	*14.95*
247551	*U4-028 C*	*2.99*
247940	*U4-028 E*	*19.98*
247552	*U4-029 C*	*2.99*
247941	*U4-029 E*	*19.98*
LTF	*UNIONPOWER*	*0.11*
247548	*V4-010 C*	*4.85*
247947	*V4-010 E*	*32.46*
LTF	*VFT*	*0.75*
925751	*AC1-051 C*	*0.97*
925752	*AC1-051 E*	*6.5*

Appendix 18

(AEP - AEP) The 05CHATFL-AC2-015 TAP 138 kV line (from bus 242984 to bus 932050 ckt 1) loads from 107.88% to 133.93% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 43.49 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7111_05MELMOR 138'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
934251	*AD1-052 C1*	*0.33*
934261	*AD1-052 C2*	*0.33*
937021	*AD2-136 C O1*	*10.18*
937022	*AD2-136 E O1*	*68.11*
937381	*AD2-191 C*	*5.65*
937382	*AD2-191 E*	*37.84*
LTF	*CALDERWOOD*	*< 0.01*
LTF	*CARR*	*0.02*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-S1*	*0.17*
LTF	*CBM-W1*	*7.07*
LTF	*CBM-W2*	*2.39*
LTF	*CELEVELAND*	*0.06*
LTF	*CHEOAH*	*< 0.01*
LTF	*CHILHOWEE*	*< 0.01*
LTF	*CIN*	*0.44*
LTF	*CLIFTY*	*0.32*
LTF	*G-007*	*0.13*
LTF	*HAMLET*	*0.08*
LTF	*IPL*	*0.28*
938021	*J793*	*14.63*
LTF	*LGEE*	*0.04*
LTF	*MEC*	*1.16*
LTF	*MECS*	*4.97*
LTF	*O-066*	*0.84*
LTF	*RENSSELAER*	*0.02*
LTF	*ROSETON*	*0.12*
LTF	*ROWAN*	*0.05*

LTF	*SANTEETLA*	*< 0.01*
247551	*U4-028 C*	*2.83*
247940	*U4-028 E*	*18.92*
247552	*U4-029 C*	*2.83*
247941	*U4-029 E*	*18.92*
247548	*V4-010 C*	*4.62*
247947	*V4-010 E*	*30.89*
LTF	*WEC*	*0.22*

Appendix 19

(AEP - AEP) The 05FREMCT-05FRMNT 138 kV line (from bus 243008 to bus 243009 ckt 1) loads from 130.11% to 161.9% (**DC power flow**) of its emergency rating (251 MVA) for the tower line contingency outage of 'AEP_P7-1_#7114'. This project contributes approximately 79.81 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7114'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1 / 243110 05STIFFI 138 245630 05S TIFFIN 69.0 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*15.3*
932052	*AC2-015 E*	*17.85*
937021	*AD2-136 C O1*	*18.67*
937022	*AD2-136 E O1*	*124.98*
937381	*AD2-191 C*	*10.37*
937382	*AD2-191 E*	*69.43*
LTF	*AMIL*	*< 0.01*
LTF	*CARR*	*0.04*
LTF	*CBM-S1*	*0.37*
LTF	*CBM-S2*	*0.45*
LTF	*CBM-W2*	*0.98*
LTF	*CIN*	*0.12*
LTF	*CPLE*	*0.11*
LTF	*DEARBORN*	*1.65*
LTF	*EDWARDS*	*0.05*
LTF	*FARMERCITY*	*0.01*
LTF	*G-007A*	*0.14*
LTF	*IPL*	*0.08*
LTF	*LGEE*	*0.07*
LTF	*RENSSELAER*	*0.03*
LTF	*ROSETON*	*0.22*
LTF	*TATANKA*	*0.04*

LTF	*TILTON*	*0.02*
247542	*U4-001 C*	*5.41*
247934	*U4-001 E*	*36.21*
247551	*U4-028 C*	*5.19*
247940	*U4-028 E*	*34.72*
247552	*U4-029 C*	*5.19*
247941	*U4-029 E*	*34.72*
247548	*V4-010 C*	*11.91*
247947	*V4-010 E*	*79.68*
LTF	*VFT*	*0.38*
925751	*AC1-051 C*	*2.03*
925752	*AC1-051 E*	*13.56*

Appendix 20

(AEP - AEP) The 05STIFFI-05AIRCO8 138 kV line (from bus 243110 to bus 242953 ckt 1) loads from 113.6% to 141.11% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 45.94 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7111_05MELMOR 138'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*7.67*
932052	*AC2-015 E*	*8.95*
937021	*AD2-136 C O1*	*10.75*
937022	*AD2-136 E O1*	*71.94*
937381	*AD2-191 C*	*5.97*
937382	*AD2-191 E*	*39.96*
LTF	*AMIL*	*0.09*
LTF	*BAYOU*	*0.22*
LTF	*BIG_CAJUN1*	*0.33*
LTF	*BIG_CAJUN2*	*0.67*
LTF	*BLUEG*	*0.46*
LTF	*CALDERWOOD*	*0.08*
LTF	*CANNELTON*	*0.08*
LTF	*CATAWBA*	*0.03*
LTF	*CBM-N*	*0.04*
LTF	*CELEVELAND*	*0.09*
LTF	*CHEOAH*	*0.08*
LTF	*CHILHOWEE*	*0.03*
LTF	*CHOCTAW*	*0.21*
LTF	*CLIFTY*	*1.3*
LTF	*COTTONWOOD*	*0.9*
LTF	*DEARBORN*	*0.49*
LTF	*EDWARDS*	*0.18*
LTF	*ELMERSMITH*	*0.23*
LTF	*FARMERCITY*	*0.11*
LTF	*G-007A*	*0.28*
LTF	*GIBSON*	*0.18*
LTF	*HAMLET*	*0.08*

LTF	*MORGAN*	*0.33*
LTF	*NEWTON*	*0.4*
LTF	*NYISO*	*0.62*
LTF	*PRAIRIE*	*0.73*
LTF	*ROWAN*	*0.06*
LTF	*SANTEETLA*	*0.02*
LTF	*SMITHLAND*	*0.05*
LTF	*TATANKA*	*0.2*
LTF	*TILTON*	*0.21*
LTF	*TRIMBLE*	*0.09*
LTF	*TVA*	*0.15*
247542	*U4-001 C*	*2.23*
247934	*U4-001 E*	*14.95*
247551	*U4-028 C*	*2.99*
247940	*U4-028 E*	*19.98*
247552	*U4-029 C*	*2.99*
247941	*U4-029 E*	*19.98*
LTF	*UNIONPOWER*	*0.11*
247548	*V4-010 C*	*4.85*
247947	*V4-010 E*	*32.46*
LTF	*VFT*	*0.75*
925751	*AC1-051 C*	*0.97*
925752	*AC1-051 E*	*6.5*

Appendix 21

(AEP - AEP) The 05STIFFI 138/69 kV transformer (from bus 243110 to bus 245630 ckt 1) loads from 116.85% to 146.36% (**DC power flow**) of its emergency rating (72 MVA) for the tower line contingency outage of 'AEP_P7-1_#7732'. This project contributes approximately 21.24 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7732'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*3.73*
932052	*AC2-015 E*	*4.36*
937021	*AD2-136 C O1*	*4.97*
937022	*AD2-136 E O1*	*33.27*
937381	*AD2-191 C*	*2.76*
937382	*AD2-191 E*	*18.48*
LTF	*AMIL*	*0.03*
LTF	*BAYOU*	*0.08*
LTF	*BIG_CAJUN1*	*0.12*
LTF	*BIG_CAJUN2*	*0.23*
LTF	*BLUEG*	*0.16*
LTF	*CALDERWOOD*	*0.03*
LTF	*CANNELTON*	*0.03*
LTF	*CATAWBA*	*0.01*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.03*
LTF	*CHEOAH*	*0.03*
LTF	*CHILHOWEE*	*< 0.01*
LTF	*CHOCTAW*	*0.07*
LTF	*CLIFTY*	*0.47*
LTF	*COTTONWOOD*	*0.31*
LTF	*DEARBORN*	*0.19*
LTF	*EDWARDS*	*0.06*
LTF	*ELMERSMITH*	*0.08*
LTF	*FARMERCITY*	*0.04*
LTF	*G-007A*	*0.1*

LTF	*GIBSON*	*0.06*
LTF	*HAMLET*	*0.03*
LTF	*MORGAN*	*0.12*
LTF	*NEWTON*	*0.14*
LTF	*NYISO*	*0.23*
LTF	*PRAIRIE*	*0.25*
LTF	*ROWAN*	*0.02*
LTF	*SANTEETLA*	*< 0.01*
LTF	*SMITHLAND*	*0.02*
LTF	*TATANKA*	*0.07*
LTF	*TILTON*	*0.07*
LTF	*TRIMBLE*	*0.03*
LTF	*TVA*	*0.05*
247551	*U4-028 C*	*1.38*
247940	*U4-028 E*	*9.24*
247552	*U4-029 C*	*1.38*
247941	*U4-029 E*	*9.24*
LTF	*UNIONPOWER*	*0.04*
247548	*V4-010 C*	*1.88*
247947	*V4-010 E*	*12.59*
LTF	*VFT*	*0.28*
925751	*AC1-051 C*	*0.39*
925752	*AC1-051 E*	*2.62*

Appendix 22

(AEP - AEP) The 05GREENLAW-05E.TIFF2 69 kV line (from bus 245621 to bus 245646 ckt 1) loads from 161.32% to 173.39% (**DC power flow**) of its emergency rating (39 MVA) for the tower line contingency outage of 'AEP_P7-1_#7734'. This project contributes approximately 10.45 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7734'
OPEN BRANCH FROM BUS 242984 TO BUS 243039 CKT 1 / 242984 05CHATFL 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
937021	*AD2-136 C O1*	*2.44*
937022	*AD2-136 E O1*	*16.36*
937381	*AD2-191 C*	*1.36*
937382	*AD2-191 E*	*9.09*
LTF	*CARR*	*0.01*
LTF	*CATAWBA*	*< 0.01*
LTF	*CBM-S1*	*0.1*
LTF	*CBM-W1*	*2.97*
LTF	*CBM-W2*	*1.16*
LTF	*CELEVELAND*	*0.02*
LTF	*CIN*	*0.21*
LTF	*CLIFTY*	*0.06*
LTF	*G-007*	*0.06*
LTF	*HAMLET*	*0.03*
LTF	*IPL*	*0.13*
938021	*J793*	*5.84*
938441	*J841*	*2.41*
LTF	*LGEE*	*0.02*
LTF	*MEC*	*0.52*
LTF	*MECS*	*2.04*
LTF	*O-066*	*0.36*
LTF	*RENSSELAER*	*< 0.01*
LTF	*ROSETON*	*0.07*
LTF	*ROWAN*	*0.02*
247551	*U4-028 C*	*0.68*
247940	*U4-028 E*	*4.54*
247552	*U4-029 C*	*0.68*
247941	*U4-029 E*	*4.54*

247548	*V4-010 C*	*1.49*
247947	*V4-010 E*	*9.98*
LTF	*WEC*	*0.1*
LTF	*Y3-032*	*1.78*

Appendix 23

(AEP - AEP) The 05TIFFIN C-05MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 174.43% to 207.9% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7731'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*5.01*
932052	*AC2-015 E*	*5.85*
937021	*AD2-136 C O1*	*5.72*
937022	*AD2-136 E O1*	*38.26*
937381	*AD2-191 C*	*3.18*
937382	*AD2-191 E*	*21.25*
LTF	*AMIL*	*0.05*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.19*
LTF	*BIG_CAJUN2*	*0.38*
LTF	*BLUEG*	*0.26*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.05*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.05*
LTF	*CHEOAH*	*0.04*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.76*
LTF	*COTTONWOOD*	*0.5*
LTF	*DEARBORN*	*0.29*
LTF	*EDWARDS*	*0.1*
LTF	*ELMERSMITH*	*0.13*
LTF	*FARMERCITY*	*0.06*
LTF	*G-007A*	*0.16*
LTF	*GIBSON*	*0.1*
LTF	*HAMLET*	*0.05*

LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.22*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.41*
LTF	*ROWAN*	*0.03*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.11*
LTF	*TILTON*	*0.12*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.09*
247542	*U4-001 C*	*1.72*
247934	*U4-001 E*	*11.51*
247551	*U4-028 C*	*1.59*
247940	*U4-028 E*	*10.63*
247552	*U4-029 C*	*1.59*
247941	*U4-029 E*	*10.63*
LTF	*UNIONPOWER*	*0.06*
247548	*V4-010 C*	*3.36*
247947	*V4-010 E*	*22.52*
LTF	*VFT*	*0.44*
925751	*AC1-051 C*	*0.83*
925752	*AC1-051 E*	*5.52*

Appendix 24

(AEP - AEP) The 05TIFFIN T-05RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 156.49% to 189.95% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7731'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*5.01*
932052	*AC2-015 E*	*5.85*
937021	*AD2-136 C O1*	*5.72*
937022	*AD2-136 E O1*	*38.26*
937381	*AD2-191 C*	*3.18*
937382	*AD2-191 E*	*21.25*
LTF	*AMIL*	*0.05*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.19*
LTF	*BIG_CAJUN2*	*0.38*
LTF	*BLUEG*	*0.26*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.05*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.05*
LTF	*CHEOAH*	*0.04*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.76*
LTF	*COTTONWOOD*	*0.5*
LTF	*DEARBORN*	*0.29*
LTF	*EDWARDS*	*0.1*
LTF	*ELMERSMITH*	*0.13*
LTF	*FARMERCITY*	*0.06*
LTF	*G-007A*	*0.16*
LTF	*GIBSON*	*0.1*
LTF	*HAMLET*	*0.05*

LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.22*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.41*
LTF	*ROWAN*	*0.03*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.11*
LTF	*TILTON*	*0.12*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.09*
247542	*U4-001 C*	*1.72*
247934	*U4-001 E*	*11.51*
247551	*U4-028 C*	*1.59*
247940	*U4-028 E*	*10.63*
247552	*U4-029 C*	*1.59*
247941	*U4-029 E*	*10.63*
LTF	*UNIONPOWER*	*0.06*
247548	*V4-010 C*	*3.36*
247947	*V4-010 E*	*22.52*
LTF	*VFT*	*0.44*
925751	*AC1-051 C*	*0.83*
925752	*AC1-051 E*	*5.52*

Appendix 25

(AEP - AEP) The 05MAULE RD-05DAVIS STSS 69 kV line (from bus 245648 to bus 247480 ckt 1) loads from 165.67% to 199.13% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7731'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*5.01*
932052	*AC2-015 E*	*5.85*
937021	*AD2-136 C O1*	*5.72*
937022	*AD2-136 E O1*	*38.26*
937381	*AD2-191 C*	*3.18*
937382	*AD2-191 E*	*21.25*
LTF	*AMIL*	*0.05*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.19*
LTF	*BIG_CAJUN2*	*0.38*
LTF	*BLUEG*	*0.26*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.05*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.05*
LTF	*CHEOAH*	*0.04*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.76*
LTF	*COTTONWOOD*	*0.5*
LTF	*DEARBORN*	*0.29*
LTF	*EDWARDS*	*0.1*
LTF	*ELMERSMITH*	*0.13*
LTF	*FARMERCITY*	*0.06*
LTF	*G-007A*	*0.16*
LTF	*GIBSON*	*0.1*
LTF	*HAMLET*	*0.05*

LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.22*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.41*
LTF	*ROWAN*	*0.03*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.11*
LTF	*TILTON*	*0.12*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.09*
247542	*U4-001 C*	*1.72*
247934	*U4-001 E*	*11.51*
247551	*U4-028 C*	*1.59*
247940	*U4-028 E*	*10.63*
247552	*U4-029 C*	*1.59*
247941	*U4-029 E*	*10.63*
LTF	*UNIONPOWER*	*0.06*
247548	*V4-010 C*	*3.36*
247947	*V4-010 E*	*22.52*
LTF	*VFT*	*0.44*
925751	*AC1-051 C*	*0.83*
925752	*AC1-051 E*	*5.52*

Appendix 26

(AEP - AEP) The 05ST.STEPHSS-05CARROTHR 69 kV line (from bus 245674 to bus 245655 ckt 1) loads from 153.92% to 169.11% (**DC power flow**) of its emergency rating (31 MVA) for the tower line contingency outage of 'AEP_P7-1_#7734'. This project contributes approximately 10.45 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7734'
OPEN BRANCH FROM BUS 242984 TO BUS 243039 CKT 1 / 242984 05CHATFL 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
937021	*AD2-136 C O1*	*2.44*
937022	*AD2-136 E O1*	*16.36*
937381	*AD2-191 C*	*1.36*
937382	*AD2-191 E*	*9.09*
LTF	*CARR*	*0.01*
LTF	*CATAWBA*	*< 0.01*
LTF	*CBM-S1*	*0.1*
LTF	*CBM-W1*	*2.97*
LTF	*CBM-W2*	*1.16*
LTF	*CELEVELAND*	*0.02*
LTF	*CIN*	*0.21*
LTF	*CLIFTY*	*0.06*
LTF	*G-007*	*0.06*
LTF	*HAMLET*	*0.03*
LTF	*IPL*	*0.13*
938021	*J793*	*5.84*
938441	*J841*	*2.41*
LTF	*LGEE*	*0.02*
LTF	*MEC*	*0.52*
LTF	*MECS*	*2.04*
LTF	*O-066*	*0.36*
LTF	*RENSSELAER*	*< 0.01*
LTF	*ROSETON*	*0.07*
LTF	*ROWAN*	*0.02*
247551	*U4-028 C*	*0.68*
247940	*U4-028 E*	*4.54*
247552	*U4-029 C*	*0.68*
247941	*U4-029 E*	*4.54*

247548	*V4-010 C*	*1.49*
247947	*V4-010 E*	*9.98*
LTF	*WEC*	*0.1*
LTF	*Y3-032*	*1.78*

Appendix 27

(AEP - AEP) The 05DAVIS STSS-05TIFFIN T 69 kV line (from bus 247480 to bus 245638 ckt 1) loads from 165.67% to 199.13% (**DC power flow**) of its emergency rating (73 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731'. This project contributes approximately 24.43 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7731'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*5.01*
932052	*AC2-015 E*	*5.85*
937021	*AD2-136 C O1*	*5.72*
937022	*AD2-136 E O1*	*38.26*
937381	*AD2-191 C*	*3.18*
937382	*AD2-191 E*	*21.25*
LTF	*AMIL*	*0.05*
LTF	*BAYOU*	*0.12*
LTF	*BIG_CAJUN1*	*0.19*
LTF	*BIG_CAJUN2*	*0.38*
LTF	*BLUEG*	*0.26*
LTF	*CALDERWOOD*	*0.05*
LTF	*CANNELTON*	*0.05*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.05*
LTF	*CHEOAH*	*0.04*
LTF	*CHILHOWEE*	*0.02*
LTF	*CHOCTAW*	*0.12*
LTF	*CLIFTY*	*0.76*
LTF	*COTTONWOOD*	*0.5*
LTF	*DEARBORN*	*0.29*
LTF	*EDWARDS*	*0.1*
LTF	*ELMERSMITH*	*0.13*
LTF	*FARMERCITY*	*0.06*
LTF	*G-007A*	*0.16*
LTF	*GIBSON*	*0.1*
LTF	*HAMLET*	*0.05*

LTF	*MORGAN*	*0.19*
LTF	*NEWTON*	*0.22*
LTF	*NYISO*	*0.36*
LTF	*PRAIRIE*	*0.41*
LTF	*ROWAN*	*0.03*
LTF	*SANTEETLA*	*0.01*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.11*
LTF	*TILTON*	*0.12*
LTF	*TRIMBLE*	*0.05*
LTF	*TVA*	*0.09*
247542	*U4-001 C*	*1.72*
247934	*U4-001 E*	*11.51*
247551	*U4-028 C*	*1.59*
247940	*U4-028 E*	*10.63*
247552	*U4-029 C*	*1.59*
247941	*U4-029 E*	*10.63*
LTF	*UNIONPOWER*	*0.06*
247548	*V4-010 C*	*3.36*
247947	*V4-010 E*	*22.52*
LTF	*VFT*	*0.44*
925751	*AC1-051 C*	*0.83*
925752	*AC1-051 E*	*5.52*

Appendix 28

(AEP - AEP) The AC2-015 TAP-05HOWARD 138 kV line (from bus 932050 to bus 243024 ckt 1) loads from 143.92% to 169.96% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7111_05MELMOR 138'. This project contributes approximately 43.49 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7111_05MELMOR 138'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*27.82*
932052	*AC2-015 E*	*32.46*
934251	*AD1-052 C1*	*0.33*
934261	*AD1-052 C2*	*0.33*
937021	*AD2-136 C O1*	*10.18*
937022	*AD2-136 E O1*	*68.11*
937381	*AD2-191 C*	*5.65*
937382	*AD2-191 E*	*37.84*
LTF	*CALDERWOOD*	*< 0.01*
LTF	*CARR*	*0.02*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-S1*	*0.17*
LTF	*CBM-W1*	*7.07*
LTF	*CBM-W2*	*2.39*
LTF	*CELEVELAND*	*0.06*
LTF	*CHEOAH*	*< 0.01*
LTF	*CHILHOWEE*	*< 0.01*
LTF	*CIN*	*0.44*
LTF	*CLIFTY*	*0.32*
LTF	*G-007*	*0.13*
LTF	*HAMLET*	*0.08*
LTF	*IPL*	*0.28*
938021	*J793*	*14.63*
LTF	*LGEE*	*0.04*
LTF	*MEC*	*1.16*
LTF	*MECS*	*4.97*
LTF	*O-066*	*0.84*
LTF	*RENSSELAER*	*0.02*

LTF	*ROSETON*	*0.12*
LTF	*ROWAN*	*0.05*
LTF	*SANTEETLA*	*< 0.01*
247551	*U4-028 C*	*2.83*
247940	*U4-028 E*	*18.92*
247552	*U4-029 C*	*2.83*
247941	*U4-029 E*	*18.92*
247548	*V4-010 C*	*4.62*
247947	*V4-010 E*	*30.89*
LTF	*WEC*	*0.22*