Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-137

Dequine 345 kV

May 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. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

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

General

The Interconnection Customer (IC) proposes to install PJM Project #AD1-137, a 500.0 MW (65.0 MW Capacity) wind generating facility in Benton, IN (see Figure 2). The point of interconnection will be a direct connection to AEP's Dequine 345 kV substation (see Figure 1).

The requested in service date is December 18, 2020.

Attachment Facilities

Point of Interconnection (Dequine 345 kV Substation)

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

Dequine Station Work:

- Install one (1) new 345 kV circuit breaker and associated bus work. Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.
    - **Estimated Station Cost: $2,500,000**

Non-Direct Connection Cost Estimate

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

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
345 kV Revenue Metering	**$350,000**
Upgrade line protection and controls at the expanded Dequine 345 kV substation.	**$600,000**
Total	**$950,000**

Table 1

Interconnection Customer Requirements

It is understood that The 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 Dequine 345 kV substation are not included in this report; these are assumed to be 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.

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 the IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

AEP Requirements

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

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

Network Impacts

The Queue Project AD1-137 was evaluated as a 500.0 MW (Capacity 65.0 MW) injection at Dequine 345 kV substation in the AEP area. Project AD1-137 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-137 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:

Contingencies		
Contingency Name	**Description**	
'AEP_P4_#1760_05JEFRSO 765'	OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 765 1 OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 1 END	/ 243207 05GRNTWN 765 243208 05JEFRSO / 242924 05HANG R 765 243208 05JEFRSO 765
'AEP_P4_#6189_05HANG R 765'	OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 1 OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 1 END	/ 242921 05CORNU 765 242924 05HANG R 765 / 242924 05HANG R 765 243208 05JEFRSO 765
'AEP_P4_#6485_05DEQUIN 345'	OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 345 2 OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 345 1 END	/ 243217 05DEQUIN 345 243878 05MEADOW / 243217 05DEQUIN 345 249525 08WESTWD
'AEP_P1-2_#6490'	OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 345 2 END	/ 243217 05DEQUIN 345 243878 05MEADOW
'AEP_P4_#4704_05DEQUIN 345'	OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 345 1 OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 345 1 END	/ 243217 05DEQUIN 345 243878 05MEADOW / 243217 05DEQUIN 345 249525 08WESTWD
'AEP_P4_#2978_05DUMONT 765'	OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 765 1 END	/ 243206 05DUMONT 765 X1-020 / 243206 05DUMONT 765 270644 WILTON ;
'AEP_P1-2_#709'	OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 1 END	/ 242924 05HANG R 765 243208 05JEFRSO 765
'AEP_P1-2_#8695'	OPEN BRANCH FROM BUS 243878 TO BUS 255205 CKT 1 17REYNOLDS 345 1 END	/ 243878 05MEADOW 345 255205
'AEP_P1-2_#6472'	OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 345 1 END	/ 243217 05DEQUIN 345 243878 05MEADOW

Table 2

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)

None

Contribution to Previously Identified Overloads

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	LFFB	AEP_P4_#1760_05 JEFRSO 765	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	135.85	136.63	ER	2045	32.84	1
2	LFFB	AEP_P4_#6189_05 HANG R 765	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	101.28	102.18	ER	2045	59.56	
3	LFFB	AEP_P4_#6485_05 DEQUIN 345	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	123.95	137.97	ER	1959	274.61	2
4	N-1	AEP_P1-2_#6490	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	120.41	122.89	NR	1409	34.91	
5	LFFB	AEP_P4_#4704_05 DEQUIN 345	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	123.07	136.99	ER	1959	272.67	3
6	N-1	AEP_P1-2_#6472	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	119.54	121.99	NR	1409	34.66	
7	LFFB	AEP_P4_#2978_05 DUMONT 765	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	2	DC	119.21	120.81	ER	1409	43.74	4

Table 3

Steady-State Voltage Requirements

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

None

Short Circuit

(Summary of impacted circuit breakers)

None

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.

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

AD1-137 Delivery of Energy Portion of Interconnection Request													
	Contingency		Affected		Bus				Loading		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.
1	N-1	'AEP_P1-2_#709'	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	115.98	117.04	NR	1756	59.68
2	N-1	'AEP_P1-2_#6490'	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	168.3	187.36	NR	1409	268.55
3	N-1	'AEP_P1-2_#6472'	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	167.07	185.99	NR	1409	266.58
4	N-1	'AEP_P1-2_#8695'	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	2	DC	143.52	156.91	NR	2114	283.08

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)

None

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)

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

1. PJM Network Upgrade Project #N5034 will relieve the Dequine – Meadow Lake 345 kV constraint identified in this report. The constraint is driven by the X3-028 MTX project. The X3-028 upgrade is to build a new Sullivan – Reynolds 765 kV line. Cost is $464 Million. AD1-137 could receive cost allocation.
2. PJM Network Upgrade Project #N4512 will relieve the X2-052 Tap – Dumont 345 kV constraint identified in this report. Cost is: $1,382,077. AD1-137 could receive cost allocation.
3. PJM Baseline Project #B2878 will increase the SE rating for Jefferson – Clifty Creek 345 kV line to 2354 MVA. Network upgrade Project #N4106 will relieve the constraint identified for this line and increase the SE rating to 3113 MVA. Cost is: $243,875. AD1-137 could receive cost allocation.
4. AD1-137 will need the upgrades listed above in-service in order to be fully deliverable to the PJM system.

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 or associated network upgrades caused by the X3-028 project are required. If line work is required, construction time would be between 24 to 36 months after signing an Interconnection Construction Service Agreement (ICSA).

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed In-Service Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this Feasibility Study, the construction of the IC's 500.0 MW (65.0 MW Capacity) wind generating facility (PJM Project #AD1-137) will require the following additional interconnection charges. This plan of service will interconnect the proposed wind generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the IC's generating facility.

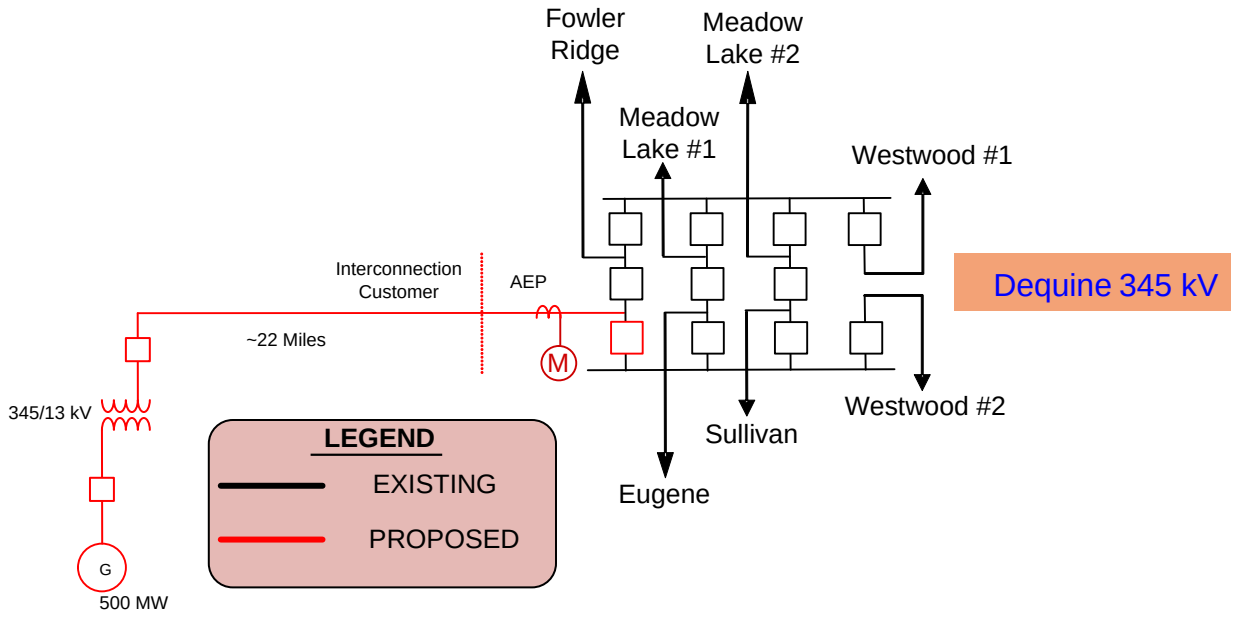
Cost Breakdown for Point of Interconnection (Dequine 345 kV Substation)		
Attachment Cost	Expand Dequine 345 kV Substation	**$2,500,000**
Non-Direct Connection Cost Estimate	345 kV Revenue Metering	**$350,000**
	Upgrade line protection and controls at the expanded Dequine 345 kV substation.	**$600,000**
	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)*	**$465,625,952**
	Total Estimated Cost for Project AD1-137	**$469,075,952**

Table 5

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

Figure 1: Point of Interconnection (Dequine 345 kV Substation)

Single-Line Diagram



Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

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

Appendix 1

(AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 135.85% to 136.63% (**DC power flow**) of its emergency rating (2045 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#1760_05JEFRSO 765'. This project contributes approximately 32.84 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#1760_05JEFRSO 765'
OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1
OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANGR 765 243208 05JEFRSO 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*5.14*
247901	*05FR-12G E*	*5.06*
247902	*05FR-21G E*	*5.41*
247903	*05FR-22G E*	*5.18*
247904	*05FR-3G E*	*10.48*
247905	*05FR-4G E*	*7.88*
247906	*05MDL-1G E*	*9.05*
247907	*05MDL-2G E*	*4.49*
247912	*05MDL-3G E*	*4.69*
247913	*05MDL-4G E*	*4.48*
243442	*05RKG1*	*83.74*
243443	*05RKG2*	*82.47*
933391	*AC2-152 C*	*0.22*
933392	*AC2-152 E*	*0.35*
933441	*AC2-157 C*	*13.32*
933442	*AC2-157 E*	*21.73*
934051	*AD1-031 C O1*	*1.44*

934052	*AD1-031 E O1*	*2.34*
934421	*AD1-066*	*0.53*
LTF	*AD1-092*	*5.73*
LTF	*AD1-093*	*9.73*
LTF	*AD1-094*	*1.81*
935001	*AD1-133 C O1*	*9.32*
935002	*AD1-133 E O1*	*6.21*
935271	*AD1-137 C*	*4.27*
935272	*AD1-137 E*	*28.57*
935141	*AD1-148*	*3.42*
274832	*ANNAWAN ; 1U*	*5.37*
LTF	*BLUEG*	*16.89*
294401	*BSHIL;1U E*	*4.32*
294410	*BSHIL;2U E*	*4.32*
LTF	*CARR*	*0.43*
274890	*CAYUG;1U E*	*6.4*
274891	*CAYUG;2U E*	*6.4*
LTF	*CBM-S1*	*4.12*
LTF	*CBM-S2*	*0.71*
LTF	*CBM-W1*	*37.92*
LTF	*CBM-W2*	*103.09*
LTF	*CIN*	*16.67*
LTF	*CLIFTY*	*86.79*
274849	*CRESCENT ;1U*	*2.93*
LTF	*G-007*	*1.22*
LTF	*IPL*	*10.96*

983071	*J332*	*5.17*
981181	*J708*	*22.11*
981521	*J759*	*5.6*
981531	*J762*	*12.42*
981571	*J783*	*5.55*
990901	*L-005 E*	*6.61*
LTF	*MEC*	*25.49*
LTF	*MECS*	*4.15*
293516	*O-009 E1*	*4.21*
293517	*O-009 E2*	*2.14*
293518	*O-009 E3*	*2.35*
293715	*O-029 E*	*4.5*
293716	*O-029 E*	*2.47*
293717	*O-029 E*	*2.27*
293771	*O-035 E*	*3.19*
LTF	*O-066*	*4.1*
296308	*R-030 C1*	*1.89*
296271	*R-030 C2*	*1.89*
296125	*R-030 C3*	*1.91*
296309	*R-030 E1*	*7.57*
296272	*R-030 E2*	*7.57*
296128	*R-030 E3*	*7.66*
LTF	*RENSSELAER*	*0.34*
LTF	*ROSETON*	*2.47*
247943	*T-127 E*	*4.59*
LTF	*TRIMBLE*	*3.9*

274853	*TWINGROVE;U1*	*9.91*
274854	*TWINGROVE;U2*	*9.91*
276150	*W2-048 E*	*0.94*
903433	*W3-046*	*10.63*
905082	*W4-005 E*	*20.4*
LTF	*WEC*	*3.16*
909052	*X2-022 E*	*13.1*
900404	*X3-028 C*	*262.86*
900405	*X3-028 E*	*350.48*
913222	*Y1-054 E*	*-1.34*
915662	*Y3-099 E*	*0.14*
915672	*Y3-100 E*	*0.14*
LTF	*Z1-043*	*13.83*
916182	*Z1-065 E*	*0.37*
916272	*Z1-080 E*	*0.3*
917501	*Z2-087 C*	*1.48*
917502	*Z2-087 E*	*9.93*
918802	*AA1-099 E*	*0.2*
919221	*AA1-146*	*7.89*
919581	*AA2-030*	*7.89*
919621	*AA2-039 C*	*1.05*
919622	*AA2-039 E*	*7.05*
930041	*AB1-006 C*	*1.47*
930042	*AB1-006 E*	*9.86*
930461	*AB1-087*	*96.38*
930471	*AB1-088*	*96.38*

LTF	*AB2-013*	*8.11*
924041	*AB2-047 C O1*	*1.87*
924042	*AB2-047 E O1*	*12.53*
924261	*AB2-070 C O1*	*1.79*
924262	*AB2-070 E O1*	*11.99*
925161	*AB2-173*	*1.41*
925242	*AB2-178 E*	*1.43*
925581	*AC1-033 C*	*0.71*
925582	*AC1-033 E*	*4.73*
927331	*AC1-040 C*	*15.01*
927332	*AC1-040 E*	*24.48*
925771	*AC1-053 C*	*1.8*
925772	*AC1-053 E*	*12.05*
926821	*AC1-168 C*	*0.54*
926822	*AC1-168 E*	*3.61*
926841	*AC1-171 C*	*0.61*
926842	*AC1-171 E*	*4.09*
927201	*AC1-214 C*	*1.02*
927202	*AC1-214 E*	*2.72*

Appendix 2

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 123.95% to 137.97% (**DC power flow**) of its emergency rating (1959 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#6485_05DEQUIN 345'. This project contributes approximately 274.61 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#6485_05DEQUIN 345'
OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 / 243217 05DEQUIN 345 243878 05MEADOW 345 2
OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*2.11*
247900	*05FR-11G E*	*43.*
243862	*05FR-12G C*	*2.08*
247901	*05FR-12G E*	*42.29*
243864	*05FR-21G C*	*2.22*
247902	*05FR-21G E*	*45.2*
243866	*05FR-22G C*	*2.12*
247903	*05FR-22G E*	*43.28*
243870	*05FR-3G C*	*4.3*
247904	*05FR-3G E*	*87.66*
243873	*05FR-4G C*	*3.33*
247905	*05FR-4G E*	*65.91*
933441	*AC2-157 C*	*10.2*
933442	*AC2-157 E*	*16.64*
935271	*AD1-137 C*	*35.7*
935272	*AD1-137 E*	*238.91*
LTF	*CARR*	*0.05*

LTF	*CBM-S1*	*9.98*
LTF	*CBM-S2*	*4.08*
LTF	*CBM-W2*	*91.82*
LTF	*CIN*	*23.66*
LTF	*CPLE*	*0.83*
LTF	*DEARBORN*	*2.45*
LTF	*G-007A*	*0.2*
LTF	*IPL*	*12.7*
960026	*J196 E*	*4.59*
983081	*J333*	*17.41*
983091	*J334*	*19.52*
940541	*J468 C*	*4.28*
940542	*J468 E*	*17.13*
940552	*J515 E*	*66.58*
981511	*J754 C*	*8.21*
981512	*J754 E*	*32.83*
LTF	*LGEE*	*1.68*
LTF	*MEC*	*8.45*
LTF	*O-066A*	*0.09*
LTF	*RENSSELAER*	*0.04*
LTF	*ROSETON*	*0.26*
LTF	*VFT*	*0.54*
LTF	*X1-078*	*0.16*
900404	*X3-028 C*	*201.3*
900405	*X3-028 E*	*268.4*
930461	*AB1-087*	*73.81*

930471	*AB1-088*	*73.81*

Appendix 3

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 123.07% to 136.99% (**DC power flow**) of its emergency rating (1959 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#4704_05DEQUIN 345'. This project contributes approximately 272.67 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#4704_05DEQUIN 345'
OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 / 243217 05DEQUIN 345 243878 05MEADOW 345 1
OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*2.1*
247900	*05FR-11G E*	*42.7*
243862	*05FR-12G C*	*2.07*
247901	*05FR-12G E*	*41.99*
243864	*05FR-21G C*	*2.21*
247902	*05FR-21G E*	*44.88*
243866	*05FR-22G C*	*2.11*
247903	*05FR-22G E*	*42.97*
243870	*05FR-3G C*	*4.27*
247904	*05FR-3G E*	*87.04*
243873	*05FR-4G C*	*3.31*
247905	*05FR-4G E*	*65.44*
933441	*AC2-157 C*	*10.13*
933442	*AC2-157 E*	*16.52*
935271	*AD1-137 C*	*35.45*
935272	*AD1-137 E*	*237.22*
LTF	*CARR*	*0.05*

LTF	*CBM-S1*	*9.91*
LTF	*CBM-S2*	*4.06*
LTF	*CBM-W2*	*91.17*
LTF	*CIN*	*23.49*
LTF	*CPLE*	*0.82*
LTF	*DEARBORN*	*2.44*
LTF	*G-007A*	*0.2*
LTF	*IPL*	*12.61*
960026	*J196 E*	*4.56*
983081	*J333*	*17.29*
983091	*J334*	*19.39*
940541	*J468 C*	*4.25*
940542	*J468 E*	*17.01*
940552	*J515 E*	*66.11*
981511	*J754 C*	*8.15*
981512	*J754 E*	*32.6*
LTF	*LGEE*	*1.67*
LTF	*MEC*	*8.39*
LTF	*O-066A*	*0.09*
LTF	*RENSSELAER*	*0.04*
LTF	*ROSETON*	*0.26*
LTF	*VFT*	*0.54*
LTF	*X1-078*	*0.16*
900404	*X3-028 C*	*199.88*
900405	*X3-028 E*	*266.5*
930461	*AB1-087*	*73.29*

930471	*AB1-088*	*73.29*

Appendix 4

(AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 247610 to bus 243219 ckt 2) loads from 119.21% to 120.81% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 43.74 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#2978_05DUMONT 765'
OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1 / 243206 05DUMONT 765 X1-020
OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*6.85*
247901	*05FR-12G E*	*6.74*
247902	*05FR-21G E*	*7.2*
247903	*05FR-22G E*	*6.89*
247904	*05FR-3G E*	*13.96*
247905	*05FR-4G E*	*10.5*
247906	*05MDL-1G E*	*15.64*
247907	*05MDL-2G E*	*7.76*
247912	*05MDL-3G E*	*8.11*
247913	*05MDL-4G E*	*7.74*
932011	*AC2-007 C*	*0.5*
932012	*AC2-007 E*	*0.92*
932601	*AC2-080 C*	*3.73*
932602	*AC2-080 E*	*24.95*
932881	*AC2-115 1*	*1.41*
932891	*AC2-115 2*	*1.41*
932921	*AC2-116*	*0.49*

932931	*AC2-117*	*5.2*
933341	*AC2-147 C*	*0.52*
933342	*AC2-147 E*	*0.85*
933351	*AC2-148 C*	*0.52*
933352	*AC2-148 E*	*0.85*
933361	*AC2-149 C*	*0.55*
933362	*AC2-149 E*	*0.89*
933371	*AC2-150 C*	*0.52*
933372	*AC2-150 E*	*0.85*
933381	*AC2-151 C*	*0.57*
933382	*AC2-151 E*	*0.93*
933391	*AC2-152 C*	*0.25*
933392	*AC2-152 E*	*0.41*
933401	*AC2-153 C*	*0.27*
933402	*AC2-153 E*	*0.45*
933411	*AC2-154 C*	*1.41*
933412	*AC2-154 E*	*2.3*
933431	*AC2-156 C*	*0.56*
933432	*AC2-156 E*	*0.91*
933511	*AC2-166 C*	*1.37*
933512	*AC2-166 E*	*1.51*
933911	*AD1-013 C O1*	*1.09*
933912	*AD1-013 E O1*	*1.74*
933931	*AD1-016 C*	*0.55*
933932	*AD1-016 E*	*0.89*
934001	*AD1-024 C*	*1.41*

934002	*AD1-024 E*	*2.31*
934051	*AD1-031 C O1*	*1.77*
934052	*AD1-031 E O1*	*2.89*
934101	*AD1-039 1*	*4.55*
934111	*AD1-039 2*	*4.65*
934401	*AD1-064 C O1*	*1.9*
934402	*AD1-064 E O1*	*8.89*
934421	*AD1-066*	*0.67*
934431	*AD1-067 C*	*0.08*
934432	*AD1-067 E*	*0.33*
LTF	*AD1-092*	*7.*
LTF	*AD1-093*	*12.05*
LTF	*AD1-094*	*2.32*
934651	*AD1-096 C*	*0.53*
934652	*AD1-096 E*	*0.87*
934701	*AD1-098 C O1*	*4.07*
934702	*AD1-098 E O1*	*2.97*
934721	*AD1-100 C*	*12.9*
934722	*AD1-100 E*	*60.4*
934871	*AD1-116 C*	*0.57*
934872	*AD1-116 E*	*0.94*
934881	*AD1-117 C*	*3.22*
934882	*AD1-117 E*	*2.15*
934941	*AD1-126 C*	*3.44*
934942	*AD1-126 E*	*2.29*
934971	*AD1-129 C*	*0.53*

934972	*AD1-129 E*	*0.36*
935001	*AD1-133 C O1*	*12.64*
935002	*AD1-133 E O1*	*8.43*
935271	*AD1-137 C*	*5.69*
935272	*AD1-137 E*	*38.05*
274832	*ANNAWAN ; 1U*	*6.74*
LTF	*CARR*	*0.62*
LTF	*CATAWBA*	*0.03*
274890	*CAYUG;1U E*	*8.26*
274891	*CAYUG;2U E*	*8.26*
LTF	*CBM-S1*	*4.53*
LTF	*CBM-W1*	*39.47*
LTF	*CBM-W2*	*52.32*
LTF	*CELEVELAND*	*0.06*
LTF	*CIN*	*6.65*
274849	*CRESCENT ;1U*	*3.66*
LTF	*DEARBORN*	*1.72*
274859	*EASYR;U1 E*	*6.6*
274860	*EASYR;U2 E*	*6.6*
LTF	*G-007*	*1.62*
290051	*GSG-6; E*	*6.19*
LTF	*HAMLET*	*0.29*
LTF	*IPL*	*3.39*
275149	*KEMPTON ;1E*	*10.39*
290108	*LEEDK;1U E*	*14.28*
LTF	*LGEE*	*0.57*

LTF	*MEC*	*25.48*
274850	*MENDOTA H;RU*	*3.56*
293061	*N-015 E*	*9.02*
293516	*O-009 E1*	*5.55*
293517	*O-009 E2*	*2.82*
293518	*O-009 E3*	*3.1*
293715	*O-029 E*	*5.93*
293716	*O-029 E*	*3.25*
293717	*O-029 E*	*2.99*
293771	*O-035 E*	*3.98*
LTF	*O-066*	*5.45*
293644	*O22 E1*	*5.94*
293645	*O22 E2*	*11.53*
290021	*O50 E*	*11.5*
294392	*P-010 E*	*11.46*
294763	*P-046 E*	*5.59*
274888	*PILOT HIL;1E*	*10.39*
274830	*PWR VTREC;1U*	*3.6*
274831	*PWR VTREC;2U*	*3.6*
LTF	*RENSSELAER*	*0.49*
LTF	*ROSETON*	*3.54*
LTF	*ROWAN*	*0.16*
274722	*S-055 E*	*6.57*
295111	*SUBLETTE E*	*1.61*
247943	*T-127 E*	*7.94*
299993	*U3-031C*	*2.9*

291984	*U4-033*	*0.8*
274814	*UNIV PK N;0U*	*0.65*
274808	*UNIV PK N;4U*	*0.65*
274809	*UNIV PK N;5U*	*0.65*
274810	*UNIV PK N;6U*	*0.65*
274811	*UNIV PK N;7U*	*0.65*
274812	*UNIV PK N;8U*	*0.65*
274813	*UNIV PK N;9U*	*0.65*
274815	*UNIV PK N;XU*	*0.65*
274816	*UNIV PK N;YU*	*0.65*
903433	*W3-046*	*14.48*
274874	*WALNR;2U*	*1.44*
294502	*WALNR;2U E*	*5.74*
LTF	*WEC*	*4.72*
295109	*WESTBROOK E*	*3.31*
274687	*WILL CNTY;4U*	*38.09*
247611	*X2-052*	*73.95*
910542	*X3-005 E*	*0.37*
914641	*Y2-103*	*26.29*
915011	*Y3-013 1*	*2.19*
915021	*Y3-013 2*	*2.19*
915031	*Y3-013 3*	*2.19*
LTF	*Z1-043*	*17.72*
916502	*Z1-106 E1*	*0.73*
916504	*Z1-106 E2*	*0.73*
916512	*Z1-107 E*	*1.52*

916522	*Z1-108 E*	*1.45*
916651	*Z1-127 1*	*0.96*
916652	*Z1-127 2*	*0.57*
917711	*Z2-114 C*	*0.08*
917712	*Z2-114 E*	*0.39*
918051	*AA1-018 C*	*1.47*
918052	*AA1-018 E*	*9.85*
918972	*AA1-116 E*	*1.48*
918982	*AA1-117 E*	*1.48*
919221	*AA1-146*	*10.63*
919581	*AA2-030*	*10.63*
919591	*AA2-035*	*75.55*
920112	*AA2-107 E*	*1.44*
920272	*AA2-123 E*	*1.44*
930041	*AB1-006 C*	*2.55*
930042	*AB1-006 E*	*17.04*
930391	*AB1-080*	*4.38*
930481	*AB1-089*	*38.91*
930491	*AB1-090*	*38.91*
930501	*AB1-091*	*40.61*
930761	*AB1-122 1*	*41.9*
930771	*AB1-122 2*	*42.8*
931221	*AB1-172*	*0.47*
LTF	*AB2-013*	*10.05*
924471	*AB2-096*	*24.97*
925161	*AB2-173*	*1.9*

925301	*AB2-191 C*	*0.75*
925302	*AB2-191 E*	*0.66*
925581	*AC1-033 C*	*0.87*
925582	*AC1-033 E*	*5.85*
926311	*AC1-109 1*	*1.11*
926321	*AC1-109 2*	*1.11*
926331	*AC1-110 1*	*1.1*
926341	*AC1-110 2*	*1.1*
926351	*AC1-111 1*	*0.44*
926361	*AC1-111 2*	*0.44*
926371	*AC1-111 3*	*0.44*
926381	*AC1-111 4*	*0.44*
926391	*AC1-111 5*	*0.44*
926401	*AC1-111 6*	*0.44*
927511	*AC1-113 1*	*0.71*
927522	*AC1-113 2*	*0.71*
926431	*AC1-114*	*1.41*
927451	*AC1-142A 1*	*2.43*
927461	*AC1-142A 2*	*2.43*
926701	*AC1-153 C1*	*45.54*
926711	*AC1-153 C2*	*46.52*
926702	*AC1-153 E1*	*1.82*
926712	*AC1-153 E2*	*1.86*
926821	*AC1-168 C*	*0.71*
926822	*AC1-168 E*	*4.77*
927531	*AC1-185 1*	*0.41*

927541	*AC1-185 2*	*0.41*
927551	*AC1-185 3*	*0.41*
927561	*AC1-185 4*	*0.41*
927571	*AC1-185 5*	*0.41*
927581	*AC1-185 6*	*0.41*
927591	*AC1-185 7*	*0.41*
927601	*AC1-185 8*	*0.41*
927091	*AC1-204 1*	*42.04*
927101	*AC1-204 2*	*42.04*
927201	*AC1-214 C*	*1.28*
927202	*AC1-214 E*	*3.39*