



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF1-275
COLE 345 KV
50 MW Capacity / 50 MW Energy**

January, 2020

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1 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. Cost allocation rules for network upgrades 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.

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

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.

2 General

The Interconnection Customer (IC), has proposed a Storage facility located in Franklin County, Ohio. The installed facilities will have a capability of 50 MW with 50 of new request MW of this output being recognized by PJM as capacity. Note that this project is an increase to the Interconnection Customer's AE2-214 project, which will share the same property and connection point.

The proposed in-service date for this project is 12/31/2022. This study does not imply a TO commitment to this in-service date.

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.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement.

Queue Number	AF1-275
Project Name	COLE 345 KV
State	Ohio
County	Franklin
Transmission Owner	AEP
MFO	250
MWE	50
MWC	50
Fuel	Storage
Basecase Study Year	2023

2.1 Point of Interconnection

AF1-275 will interconnect with the AEP transmission system at the Cole 345 kV station utilizing the same generation lead as queue position AE2-214 (Figure 2).

Note: It is assumed that the 345 kV revenue metering system, gen lead, and Protection & Control Equipment that will be installed for AE2-214 will be adequate for the additional facility connection requested in AF1-275. Depending on the timing of the completion of the AF1-275 interconnection construction relative to the AE2-214 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AF1-275.

2.2 Cost Summary

The AF1-275 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$0
Direct Connection Network Upgrade	\$0
Non Direct Connection Network Upgrades	\$0
Total Costs	\$0

In addition, the AF1-275 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	\$5,496,600

Cost allocations for these upgrades will be provided in the System Impact Study Report.

3 Transmission Owner Scope of Work

4 Attachment Facilities

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

Description	Total Cost
Total Attachment Facility Costs	\$0

5 Direct Connection Cost Estimate

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

Description	Total Cost
Total Direct Connection Facility Costs	\$0

6 Non-Direct Connection Cost Estimate

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

Description	Total Cost
Total Non-Direct Connection Facility Costs	\$0

7 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

8 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 generally be between 24 to 36 months after Agreement execution.

9 Interconnection Customer Requirements

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

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

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O.

10.2 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>

11 Network Impacts

The Queue Project AF1-275 was evaluated as a 50.1 MW (Capacity 50.0 MW) injection as an uprate to AE2-214 at the Cole 345kV substation in the AEP area. Project AF1-275 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-275 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

None

13 Multiple Facility Contingency

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
43592271	244022	05COL E	345.0	AEP	243457	05HAYDE N	345.0	AEP	1	AEP_P4_#3195_05BE ATTY 345_304E	breaker	1429.0	98.14	100.14	DC	28.57

14 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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
43592096	243453	05BEATY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P4_#10715_05C OLE 345_C	breaker	1203.0	133.6	135.73	DC	25.57
43592155	243453	05BEATY	345.0	AEP	244022	05COL E	345.0	AEP	1	AEP_P4_#3195_05BE ATTY 345_304E	breaker	1203.0	122.19	123.74	DC	18.67
43592156	243453	05BEATY	345.0	AEP	244022	05COL E	345.0	AEP	1	AEP_P4_#8094_05BIX BY 345_C	breaker	1203.0	120.23	121.86	DC	19.54
43592200	243454	05BIXBY	345.0	AEP	243459	05KIRK	345.0	AEP	1	AEP_P4_#10715_05C OLE 345_C	breaker	1409.0	113.97	115.02	DC	17.49

15 Potential Congestion due to Local Energy Deliverability

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

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC/D C	MW IMPACT
4359244 7	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	AEP_P1 - 2_#714	operation	1203. 0	124.76	126.68	DC	23.1
4359245 3	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	Base Case	operation	1096. 0	99.27	100.42	DC	12.56
4359257 2	24345 3	05BEATT Y	345. 0	AEP	24402 2	05COLE	345. 0	AEP	1	AEP_P1 - 2_#713	operation	1203. 0	113.6	115.22	DC	19.37

16 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43592271	1	05COLE 345.0 kV - 05HAYDEN 345.0 kV Ckt 1	AEPO0041a : A Sag Study will be required on the 7.7 miles of bundled ACSR ~ 954 ~ 45/7 ~ RAIL- Conductor section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between \$40,000 (no remediations required, just sag study) and \$11.55 million (complete line reconductor/rebuild). New rating after sag study: S/N: 1409 S/E: 1887. Time Estimate: a) Sag Study: 6-12 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. Project Type : FAC Cost : \$40,000 Time Estimate : 6-12 Months	\$40,000
43592155,43592156	3	05BEATTY 345.0 kV - 05COLE 345.0 kV Ckt 1	AEPO0001a : Upgrade/Replace 3-345kV 1600A switches at Beatty station Project Type : FAC Cost : \$1,500,000 Time Estimate : 12-18 Months AEPO0001b : 1) A sag study will be required on the 9.7 miles of ACSR ~ 954 ~ 45/7 ~ Bundled - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between \$42,000 (no remediation required, just sag study) and \$40 million (complete line reconductor/rebuild). New rating after sag study: S/N:1409 S/E: 1887 . Time Estimate: a) Sag Study: 6-12 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. Project Type : FAC Cost : \$42,000 Time Estimate : 6-12 Months	\$1,542,000

ID	Index	Facility	Upgrade Description	Cost
43592200	4	05BIXBY 345.0 kV - 05KIRK 345.0 kV Ckt 1	AEPO0038a : Replace Kirk Riser, Sub Cond 954 ACSR 45/7. Project Type : FAC Cost : \$100,000 Time Estimate : 12-18 Months AEPO0038b : An engineering study will need to be conducted to determine if the Kirk Relay Thermal limits 1386 Amps settings can be adjusted to mitigate the overload, Estimated Cost \$25,000. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: \$600,000.. Project Type : FAC Cost : \$25,000 Time Estimate : 12-18 Months AEPO0038c : Replace two Kirk risers, Sub cond 1700 kcm AAC 61 Str.. Project Type : FAC Cost : \$200,000 Time Estimate : 12-18 Months AEPO0038d : Sag Study will be required on 37.9 miles of line between Bixby and Kirk .The cost is expected to be 151,600.New Ratings after sag study : S/N: 1409MVA S/E: 1888MVA.Rebuild/Reconductor, cost : \$ 75.8 million. Project Type : FAC Cost : \$151,600 Time Estimate : 6-12 Months AEPO0038e : An engineering study will need to be conducted to determine if the Kirk Compliance Thermal limits 2396 Amps settings can be adjusted to mitigate the overload, Estimated Cost \$25,000. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: \$600,000. Project Type : FAC Cost : \$25,000 Time Estimate : 12-18 Months AEPO0038f : Replace Bixby switch (2000A) Project Type : FAC Cost : \$100,000 Time Estimate : 12-18 Months AEPO0038g : Replace Bixby Riser, Sub Cond 954 ACSR 45/7 Project Type : FAC Cost : \$100,000 Time Estimate : 12-18 Months	\$701,600

ID	Index	Facility	Upgrade Description	Cost
43592096	2	05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1	AEPO0003a : Upgrade/Replace Three 345kV 1600A switches and 2-954 ACSR risers at Beatty station. Project Type : FAC Cost : \$1,500,000 Time Estimate : 12-18 Months AEPO0003b : 1) A sag study will be required on the 9.5 miles of ACSR ~ 954 ~ 45/7 ~ Bundled - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between \$38,000 (no remediation required, just sag study) and \$19 million (complete line reconductor/rebuild). New rating after sag study: S/N:1409 S/E: 1887 . Time Estimate: a) Sag Study: 6-12 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. Project Type : FAC Cost : \$38,000 Time Estimate : 12-18 Months AEPO0003c : Upgrade/Replace four 345kV 2000A Bixby switches Project Type : FAC Cost : \$1,500,000 Time Estimate : 12-18 Months AEPO0003d : Replace 2-954 ACSR risers at Bixby station Project Type : FAC Cost : \$175,000 Time Estimate : 12-18 Months	\$3,213,000
			TOTAL COST	\$5,496,600

17 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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 gauge 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.

17.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPACT
4359227 1	24402 2	05COL E	AEP	24345 7	05HAYDE N	AEP	1	AEP_P4_#3195_05BEATT Y 345_304E	breaker	1429. 0	98.14	100.14	DC	28.57

Bus #	Bus	MW Impact
251827	WILLYESP	0.3510
251828	CLNTESP1	0.3672
251829	CLNTESP2	0.2448
253077	09STUART (Deactivation : 09/30/17)	155.2792
253110	09ADKINS	23.0328
253261	09MON D	0.1867
902531	W2-040 C	0.6631
902532	W2-040 E	1.0818
904722	V4-073 E	0.1466
913222	Y1-054 E	1.1502
918802	AA1-099 E	0.2448
923522	AB1-169 C OP	99.8580
925921	AC1-068 C	9.5424
925922	AC1-068 E	4.4625
925931	AC1-069 C	9.5424
925932	AC1-069 E	4.4625
926011	AC1-078 C O1	4.1940
926012	AC1-078 E O1	6.9901
926061	AC1-085 C	18.2005
926062	AC1-085 E	29.6955
926101	AC1-089 C O1	3.3251
926102	AC1-089 E O1	5.4252
926791	AC1-165 C	9.4302
926792	AC1-165 E	4.5748
926801	AC1-166 C	9.4302
926802	AC1-166 E	4.5748
926951	AC1-182	1.3631
930062	AB1-014 E	6.1455
932381	AC2-055 C	1.5746
932382	AC2-055 E	2.5691
932421	AC2-060 C	5.5831
932422	AC2-060 E	3.1405
932431	AC2-061 C	3.3809
932432	AC2-061 E	3.4274
932461	AC2-066 C	2.2600
932462	AC2-066 E	3.6873
932481	AC2-068 C	2.2334
932482	AC2-068 E	3.6576
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	4.1350
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	3.2801
932661	AC2-088 C O1	3.1077
932662	AC2-088 E O1	2.5573

Bus #	Bus	MW Impact
934491	AD1-073 C	1.1515
934492	AD1-073 E	0.5932
934561	AD1-081 C	0.8388
934562	AD1-081 E	0.4321
935031	AD1-136 C	0.4370
935032	AD1-136 E	0.3723
935041	AD1-140 C O1	7.6951
935042	AD1-140 E O1	6.3617
936251	AD2-031 C O1	2.1707
936252	AD2-031 E O1	3.5417
938051	AE1-007 C	0.6405
938052	AE1-007 E	1.0450
938271	AE1-040 C O1	3.9105
938272	AE1-040 E O1	1.9676
938921	AE1-120	3.4890
939141	AE1-144 C O1	5.3411
939142	AE1-144 E O1	2.6506
940531	AE2-038 C O1	3.5630
940532	AE2-038 E O1	1.7648
941411	AE2-138 C	10.8656
941412	AE2-138 E	4.0188
941511	AE2-148 C	140.5608
941512	AE2-148 E	63.5761
941981	AE2-210 C O1	3.7440
941982	AE2-210 E O1	1.4083
942021	AE2-214 C	68.5728
942022	AE2-214 E	45.7152
942061	AE2-218 C	7.2404
942062	AE2-218 E	4.9180
942091	AE2-221 C	22.6782
942092	AE2-221 E	15.1188
942521	AE2-267 C O1	1.0735
942522	AE2-267 E O1	0.6636
942951	AE2-315	2.2226
942981	AE2-320 C O1	18.7762
942982	AE2-320 E O1	9.2898
943191	AE2-319 C O1	18.7762
943192	AE2-319 E O1	9.2898
943201	AE2-318 C	5.0283
943202	AE2-318 E	2.4543
943771	AF1-045	2.0701
944521	AF1-117 C	40.0109
944522	AF1-117 E	12.3251
944941	AF1-159	1.2567
945631	AF1-228 C	34.7894
945632	AF1-228 E	23.1930
945681	AF1-233 C O1	5.3367
945682	AF1-233 E O1	2.6365
945821	AF1-247 C	1.0735
945822	AF1-247 E	0.6636
945841	AF1-249 C	0.4657
945842	AF1-249 E	0.2192

Bus #	Bus	MW Impact
945911	AF1-256 C	1.7195
945912	AF1-256 E	1.1464
946101	AF1-275	28.5720
946171	AF1-282 C	7.1844
946172	AF1-282 E	4.7896
946181	AF1-283 C	9.3397
946182	AF1-283 E	6.2265
946511	AF1-315 C O1	1.4387
946512	AF1-315 E O1	0.9591
LGEE	LGEE	2.3744
CPL	CPL	0.2315
WEC	WEC	0.3745
CBM-W2	CBM-W2	16.1916
NY	NY	0.6564
CBM-W1	CBM-W1	10.1456
TVA	TVA	2.5368
O-066	O-066	7.8154
CBM-S2	CBM-S2	3.7917
CBM-S1	CBM-S1	19.1615
G-007	G-007	1.2043
MEC	MEC	2.3533

17.2 Index 2

ID	FROM BUS#	FROM BUS	FRO M BUS AREA	TO BUS#	TO BUS	TO BUS ARE A	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPAC T
43592096	243453	05BEATT Y	AEP	243454	05BIXB Y	AEP	1	AEP_P4_#10715_05COL E 345_C	break er	1203.0	133.6	135.73	DC	25.57

Bus #	Bus	MW Impact
250164	08BKJDB1	0.1414
250165	08BKJDB2	0.1414
251827	WILLYESP	0.4536
251828	CLNTESP1	0.4602
251829	CLNTESP2	0.3068
253077	09STUART (Deactivation : 09/30/17)	192.5288
253110	09ADKINS	28.8099
253261	09MON D	0.2517
902531	W2-040 C	0.8837
902532	W2-040 E	1.4419
904722	V4-073 E	0.1941
913222	Y1-054 E	1.4787
918802	AA1-099 E	0.3068
923522	AB1-169 C OP	123.8127
925242	AB2-178 E (Withdrawn : 12/10/2019)	1.3999
925921	AC1-068 C	11.9258
925922	AC1-068 E	5.5771
925931	AC1-069 C	11.9258
925932	AC1-069 E	5.5771
926011	AC1-078 C O1	11.5229
926012	AC1-078 E O1	19.2049
926061	AC1-085 C	23.0675
926062	AC1-085 E	37.6365
926101	AC1-089 C O1	4.0839
926102	AC1-089 E O1	6.6631
926791	AC1-165 C	11.7855
926792	AC1-165 E	5.7174
926801	AC1-166 C	11.7855
926802	AC1-166 E	5.7174
926951	AC1-182	1.7315
930062	AB1-014 E	7.7607
932381	AC2-055 C	1.8038
932382	AC2-055 E	2.9431
932421	AC2-060 C	6.3958
932422	AC2-060 E	3.5976
932431	AC2-061 C	4.1543
932432	AC2-061 E	4.2115
932461	AC2-066 C	2.8539
932462	AC2-066 E	4.6564
932481	AC2-068 C	3.0051
932482	AC2-068 E	4.9215
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	4.7369

Bus #	Bus	MW Impact
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	3.7575
932661	AC2-088 C O1	3.8959
932662	AC2-088 E O1	3.2060
934491	AD1-073 C	1.3191
934492	AD1-073 E	0.6796
934561	AD1-081 C	2.3046
934562	AD1-081 E	1.1872
935031	AD1-136 C	0.5479
935032	AD1-136 E	0.4667
935041	AD1-140 C O1	11.5655
935042	AD1-140 E O1	9.5615
936251	AD2-031 C O1	2.3235
936252	AD2-031 E O1	3.7910
938051	AE1-007 C	0.8618
938052	AE1-007 E	1.4061
938271	AE1-040 C O1	3.9353
938272	AE1-040 E O1	1.9801
938921	AE1-120	4.4061
939141	AE1-144 C O1	6.6650
939142	AE1-144 E O1	3.3076
940531	AE2-038 C O1	4.4461
940532	AE2-038 E O1	2.2023
941411	AE2-138 C	13.6759
941412	AE2-138 E	5.0582
941511	AE2-148 C	176.4926
941512	AE2-148 E	79.8281
941981	AE2-210 C O1	4.7124
941982	AE2-210 E O1	1.7725
942021	AE2-214 C	61.3740
942022	AE2-214 E	40.9160
942051	AE2-217 C	11.5099
942052	AE2-217 E	7.6733
942061	AE2-218 C	10.3155
942062	AE2-218 E	7.0068
942091	AE2-221 C	28.9998
942092	AE2-221 E	19.3332
942521	AE2-267 C O1	1.3877
942522	AE2-267 E O1	0.8578
942621	AE2-278 C	7.2522
942622	AE2-278 E	4.8374
942951	AE2-315	2.9429
942981	AE2-320 C O1	23.4658
942982	AE2-320 E O1	11.6102
943191	AE2-319 C O1	23.4658
943192	AE2-319 E O1	11.6102
943201	AE2-318 C	6.3757
943202	AE2-318 E	3.1120
943771	AF1-045	2.6249
943943	AF1-062 BAT	20.0860
944521	AF1-117 C	49.9861
944522	AF1-117 E	15.3979
944621	AF1-127 C O1	2.0165

Bus #	Bus	MW Impact
944622	AF1-127 E O1	0.9932
944941	AF1-159	0.7129
945631	AF1-228 C	43.6282
945632	AF1-228 E	29.0854
945681	AF1-233 C O1	6.6577
945682	AF1-233 E O1	3.2890
945821	AF1-247 C	1.3877
945822	AF1-247 E	0.8578
945841	AF1-249 C	0.5989
945842	AF1-249 E	0.2819
945861	AF1-251 C	5.0053
945862	AF1-251 E	3.3368
945911	AF1-256 C	2.1455
945912	AF1-256 E	1.4304
946101	AF1-275	25.5725
946171	AF1-282 C	9.1056
946172	AF1-282 E	6.0704
946181	AF1-283 C	11.8373
946182	AF1-283 E	7.8915
946511	AF1-315 C O1	1.8226
946512	AF1-315 E O1	1.2151
LGEE	LGEE	3.1144
CPL	CPL	0.2097
WEC	WEC	0.7217
CBM-W2	CBM-W2	23.3743
NY	NY	0.9445
CBM-W1	CBM-W1	22.3304
TVA	TVA	3.4062
O-066	O-066	11.2896
CBM-S2	CBM-S2	4.2599
CBM-S1	CBM-S1	25.5174
G-007	G-007	1.7410
MEC	MEC	3.9566

17.3 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
43592155	243453	05BEATTY	AEP	244022	05COL E	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	122.19	123.74	DC	18.67

Bus #	Bus	MW Impact
247964	Y1-063 BAT	0.3062
250164	08BKJDB1	0.1221
250165	08BKJDB2	0.1221
251827	WILLYESP	0.3864
251828	CLNTESP1	0.4043
251829	CLNTESP2	0.2696
253077	09STUART (Deactivation : 09/30/17)	170.8071
253110	09ADKINS	25.3067
253261	09MON D	0.2050
902531	W2-040 C	0.7288
902532	W2-040 E	1.1891
904722	V4-073 E	0.1611
913222	Y1-054 E	1.2662
918802	AA1-099 E	0.2696
923522	AB1-169 C OP	109.8438
925242	AB2-178 E (Withdrawn : 12/10/2019)	1.2092
925921	AC1-068 C	10.4859
925922	AC1-068 E	4.9037
925931	AC1-069 C	10.4859
925932	AC1-069 E	4.9037
925981	AC1-074 C O1	3.4396
925982	AC1-074 E O1	1.4741
926011	AC1-078 C O1	4.7584
926012	AC1-078 E O1	7.9307
926061	AC1-085 C	20.0108
926062	AC1-085 E	32.6492
926101	AC1-089 C O1	3.6623
926102	AC1-089 E O1	5.9754
926791	AC1-165 C	10.3626
926792	AC1-165 E	5.0271
926801	AC1-166 C	10.3626
926802	AC1-166 E	5.0271
926951	AC1-182	1.4999
930062	AB1-014 E	6.7608
932381	AC2-055 C	1.7366
932382	AC2-055 E	2.8334
932421	AC2-060 C	6.1575
932422	AC2-060 E	3.4636
932431	AC2-061 C	3.7241
932432	AC2-061 E	3.7754
932461	AC2-066 C	2.4862
932462	AC2-066 E	4.0565

Bus #	Bus	MW Impact
932481	AC2-068 C	2.4559
932482	AC2-068 E	4.0221
932551	AC2-075 C	0.8169
932552	AC2-075 E	0.4115
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	4.5604
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	3.6176
932661	AC2-088 C O1	3.4190
932662	AC2-088 E O1	2.8136
934491	AD1-073 C	1.2700
934492	AD1-073 E	0.6542
934561	AD1-081 C	0.9517
934562	AD1-081 E	0.4903
935031	AD1-136 C	0.4808
935032	AD1-136 E	0.4096
935041	AD1-140 C O1	8.3962
935042	AD1-140 E O1	6.9414
936251	AD2-031 C O1	2.3877
936252	AD2-031 E O1	3.8958
936381	AD2-048 C	2.8334
936382	AD2-048 E	1.4137
938051	AE1-007 C	0.7043
938052	AE1-007 E	1.1492
938271	AE1-040 C O1	4.3077
938272	AE1-040 E O1	2.1675
938921	AE1-120	3.8384
939141	AE1-144 C O1	5.8769
939142	AE1-144 E O1	2.9165
940531	AE2-038 C O1	3.9204
940532	AE2-038 E O1	1.9419
941411	AE2-138 C	11.9578
941412	AE2-138 E	4.4227
941511	AE2-148 C	154.4305
941512	AE2-148 E	69.8494
941981	AE2-210 C O1	4.1203
941982	AE2-210 E O1	1.5498
942061	AE2-218 C	7.9874
942062	AE2-218 E	5.4254
942091	AE2-221 C	24.9318
942092	AE2-221 E	16.6212
942521	AE2-267 C O1	1.1814
942522	AE2-267 E O1	0.7303
942951	AE2-315	2.4419
942981	AE2-320 C O1	20.6326
942982	AE2-320 E O1	10.2084
943191	AE2-319 C O1	20.6326
943192	AE2-319 E O1	10.2084
943201	AE2-318 C	5.5321
943202	AE2-318 E	2.7002
943771	AF1-045	2.2775
944521	AF1-117 C	43.9679
944522	AF1-117 E	13.5441
944621	AF1-127 C O1	1.7620

Bus #	Bus	MW Impact
944622	AF1-127 E O1	0.8678
944941	AF1-159	1.3824
945631	AF1-228 C	38.2221
945632	AF1-228 E	25.4814
945681	AF1-233 C O1	5.8720
945682	AF1-233 E O1	2.9009
945821	AF1-247 C	1.1814
945822	AF1-247 E	0.7303
945841	AF1-249 C	0.5126
945842	AF1-249 E	0.2412
945861	AF1-251 C	4.3749
945862	AF1-251 E	2.9166
945911	AF1-256 C	1.8921
945912	AF1-256 E	1.2614
946102	AF1-275 BAT	18.6700
946171	AF1-282 C	7.8990
946172	AF1-282 E	5.2660
946181	AF1-283 C	10.2687
946182	AF1-283 E	6.8458
946511	AF1-315 C O1	1.5829
946512	AF1-315 E O1	1.0553
LGEE	LGEE	2.6157
CPL	CPL	0.2514
WEC	WEC	0.4158
CBM-W2	CBM-W2	17.8624
NY	NY	0.7250
CBM-W1	CBM-W1	11.5217
TVA	TVA	2.7944
O-066	O-066	8.6486
CBM-S2	CBM-S2	4.1443
CBM-S1	CBM-S1	21.1040
G-007	G-007	1.3322
MEC	MEC	2.6028

17.4 Index 4

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
43592200	243454	05BIXBY	AEP	243459	05KIRK	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1409.0	113.97	115.02	DC	17.49

Bus #	Bus	MW Impact
250164	08BKJDB1	0.1374
250165	08BKJDB2	0.1374
251827	WILLYESP	0.4183
251828	CLNTESP1	0.4809
251829	CLNTESP2	0.3206
253077	09STUART (Deactivation : 09/30/17)	179.8069
253110	09ADKINS	20.2467
902531	W2-040 C	0.7025
902532	W2-040 E	1.1461
904722	V4-073 E	0.1532
913222	Y1-054 E	1.3887
918802	AA1-099 E	0.3206
923522	AB1-169 C OP	115.6314
924351	AB2-083 C O1	4.1984
924352	AB2-083 E O1	1.9757
924371	AB2-085 C O1	5.1285
924372	AB2-085 E O1	2.4134
925242	AB2-178 E (Withdrawn : 12/10/2019)	1.3600
925341	AC1-001 C O1	8.3967
925342	AC1-001 E O1	3.9514
925921	AC1-068 C	8.7451
925922	AC1-068 E	4.0896
925931	AC1-069 C	8.7451
925932	AC1-069 E	4.0896
925981	AC1-074 C O1	3.8380
925982	AC1-074 E O1	1.6449
926011	AC1-078 C O1	7.5645
926012	AC1-078 E O1	12.6075
926061	AC1-085 C	16.7753
926062	AC1-085 E	27.3703
926101	AC1-089 C O1	4.6425
926102	AC1-089 E O1	7.5746
926791	AC1-165 C	8.6423
926792	AC1-165 E	4.1925
926801	AC1-166 C	8.6423
926802	AC1-166 E	4.1925
926951	AC1-182	1.6056
930062	AB1-014 E	7.0947
932201	AC2-029 C	4.4503
932202	AC2-029 E	7.2611
932381	AC2-055 C	2.6832
932382	AC2-055 E	4.3779

Bus #	Bus	MW Impact
932411	AC2-059 C	13.4238
932412	AC2-059 E	13.8533
932421	AC2-060 C	9.5140
932422	AC2-060 E	5.3516
932431	AC2-061 C	4.7760
932432	AC2-061 E	4.8418
932451	AC2-064 C (Withdrawn : 12/09/2019)	5.0838
932452	AC2-064 E (Withdrawn : 12/09/2019)	3.3892
932461	AC2-066 C	2.6090
932462	AC2-066 E	4.2568
932481	AC2-068 C	2.3611
932482	AC2-068 E	3.8668
932551	AC2-075 C	0.9115
932552	AC2-075 E	0.4592
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	7.0463
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	5.5895
932661	AC2-088 C O1	3.6364
932662	AC2-088 E O1	2.9925
934481	AD1-072 C	2.9489
934482	AD1-072 E	1.3467
934491	AD1-073 C	1.9623
934492	AD1-073 E	1.0109
934561	AD1-081 C	1.5129
934562	AD1-081 E	0.7794
935031	AD1-136 C	0.5114
935032	AD1-136 E	0.4356
935041	AD1-140 C O1	8.4394
935042	AD1-140 E O1	6.9770
935051	AD1-141 C O1	2.2065
935052	AD1-141 E O1	1.4710
936111	AD2-016 C	13.4238
936112	AD2-016 E	13.8533
936251	AD2-031 C O1	2.1531
936252	AD2-031 E O1	3.5130
936381	AD2-048 C	3.1847
936382	AD2-048 E	1.5890
937231	AD2-162 C	15.4455
937232	AD2-162 E	7.5731
938051	AE1-007 C	0.6771
938052	AE1-007 E	1.1048
938271	AE1-040 C O1	4.8442
938272	AE1-040 E O1	2.4374
938921	AE1-120	4.0280
939141	AE1-144 C O1	6.4557
939142	AE1-144 E O1	3.2037
940531	AE2-038 C O1	4.3065
940532	AE2-038 E O1	2.1331
941411	AE2-138 C	13.2355
941412	AE2-138 E	4.8953
941511	AE2-148 C	121.9115
941512	AE2-148 E	55.1409
941521	AE2-149 C	100.7020

Bus #	Bus	MW Impact
941522	AE2-149 E	37.5300
941981	AE2-210 C O1	4.5606
941982	AE2-210 E O1	1.7155
942021	AE2-214 C	41.9868
942022	AE2-214 E	27.9912
942051	AE2-217 C	7.9416
942052	AE2-217 E	5.2944
942061	AE2-218 C	7.6783
942062	AE2-218 E	5.2155
942091	AE2-221 C	20.3230
942092	AE2-221 E	13.5487
942521	AE2-267 C O1	1.2430
942522	AE2-267 E O1	0.7683
942831	AE2-302 C O1	1.4527
942832	AE2-302 E O1	0.9685
942951	AE2-315	2.3225
942981	AE2-320 C O1	17.2073
942982	AE2-320 E O1	8.5137
943041	AE2-327 C	6.5603
943042	AE2-327 E	1.9656
943111	AE2-339 C	1.7347
943112	AE2-339 E	0.8544
943191	AE2-319 C O1	17.2073
943192	AE2-319 E O1	8.5137
943201	AE2-318 C	5.8491
943202	AE2-318 E	2.8549
943771	AF1-045	2.4080
943943	AF1-062 BAT	43.0180
944521	AF1-117 C	36.7205
944522	AF1-117 E	11.3115
944621	AF1-127 C O1	1.9547
944622	AF1-127 E O1	0.9628
944941	AF1-159	0.6607
945631	AF1-228 C	30.0195
945632	AF1-228 E	20.0130
945681	AF1-233 C O1	6.4453
945682	AF1-233 E O1	3.1841
945821	AF1-247 C	1.2430
945822	AF1-247 E	0.7683
945841	AF1-249 C	0.5492
945842	AF1-249 E	0.2584
945861	AF1-251 C	4.8477
945862	AF1-251 E	3.2318
945911	AF1-256 C	2.0727
945912	AF1-256 E	1.3818
946101	AF1-275	17.4945
946171	AF1-282 C	3.5096
946172	AF1-282 E	2.3397
946181	AF1-283 C	4.5624
946182	AF1-283 E	3.0416
946441	AF1-308 C O1	1.8806
946442	AF1-308 E O1	1.2538

Bus #	Bus	MW Impact
946511	AF1-315 C O1	1.6730
946512	AF1-315 E O1	1.1154
LGEE	LGEE	3.1218
CPL	CPL	0.6185
WEC	WEC	0.5840
CBM-W2	CBM-W2	23.8575
NY	NY	0.9395
CBM-W1	CBM-W1	19.3154
TVA	TVA	3.9200
O-066	O-066	11.2493
CBM-S2	CBM-S2	8.0284
CBM-S1	CBM-S1	28.0904
G-007	G-007	1.7316
MEC	MEC	3.5832

Affected Systems

18 Affected Systems

18.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

18.2 MISO

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

18.3 TVA

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

18.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

18.5 NYISO

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

Contingency Name	Contingency Definition
Base Case	
AEP_P4_#8094_05BIXBY 345_C	CONTINGENCY 'AEP_P4_#8094_05BIXBY 345_C' OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1 OPEN BRANCH FROM BUS 941520 TO BUS 243454 CKT 1 / 941520 AE2-149 TAP 345 243454 05BIXBY 345 1 END
AEP_P1-2_#714	CONTINGENCY 'AEP_P1-2_#714' OPEN BRANCH FROM BUS 244022 TO BUS 243457 CKT 1 / 244022 05COLE 345 243457 05HAYDEN 345 1 END
AEP_P4_#10715_05COLE 345_C	CONTINGENCY 'AEP_P4_#10715_05COLE 345_C' OPEN BRANCH FROM BUS 244022 TO BUS 243457 CKT 1 / 244022 05COLE 345 243457 05HAYDEN 345 1 OPEN BRANCH FROM BUS 244022 TO BUS 244023 CKT 1 / 244022 05COLE 345 244023 05COLE 138 1 END
AEP_P4_#3195_05BEATTY 345_304E	CONTINGENCY 'AEP_P4_#3195_05BEATTY 345_304E' OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1 OPEN BRANCH FROM BUS 243453 TO BUS 243468 CKT 4 / 243453 05BEATTY 345 243468 05BEATTX 138 4 END
AEP_P1-2_#713	CONTINGENCY 'AEP_P1-2_#713' OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1 END

Short Circuit

19 Short Circuit

The following Breakers are overduty

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue