



# **Generation Interconnection**

## **Feasibility Study Report**

**for**

**Queue Project AF1-230**

**CHATFIELD 138 KV**

**29.4 MW Capacity / 49 MW Energy**

January, 2020

# Table of Contents

- 1 Preface..... 4
- 2 General..... 5
  - 2.1 Point of Interconnection ..... 6
  - 2.2 Cost Summary..... 6
- 3 Transmission Owner Scope of Work..... 7
- 4 Attachment Facilities ..... 7
- 5 Direct Connection Cost Estimate..... 7
- 6 Non-Direct Connection Cost Estimate..... 7
- 7 Schedule..... 8
- 8 Interconnection Customer Requirements..... 8
- 9 Revenue Metering and SCADA Requirements ..... 8
  - 9.1 PJM Requirements ..... 8
  - 9.2 AEP Requirements..... 8
- 10 Network Impacts..... 9
- 11 Generation Deliverability ..... 11
- 12 Multiple Facility Contingency ..... 11
- 13 Contribution to Previously Identified Overloads ..... 11
- 14 Potential Congestion due to Local Energy Deliverability..... 12
- 15 System Reinforcements..... 14
- 16 Flow Gate Details ..... 18
  - 16.1 Index 1 ..... 19
    - 1.1 Index 2 ..... 20
    - 1.2 Index 3 ..... 21
    - 1.3 Index 4 ..... 22
    - 1.4 Index 5 ..... 23
    - 1.5 Index 6 ..... 24
    - 1.6 Index 7 ..... 25
    - 1.7 Index 8 ..... 26
- 17 Affected Systems ..... 28
  - 17.1 LG&E..... 28
  - 17.2 MISO ..... 28

17.3 TVA.....28  
17.4 Duke Energy Progress.....28  
17.5 NYISO .....28  
18 Short Circuit.....34

## 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.

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

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 Solar generating facility located in Crawford County, Ohio. The installed facilities will have a total capability of 49 MW with 29.4 MW of this output being recognized by PJM as Capacity. The point of interconnection for the solar facility will be a direct connection to AEP's Chatfield 138 kV substation.

The proposed in-service date for this project is 10/31/2022. This study does not imply a TO commitment to this in-service date.

<b>Queue Number</b>	<b>AF1-230</b>
<b>Project Name</b>	CHATFIELD 138 KV
<b>State</b>	Ohio
<b>County</b>	Crawford
<b>Transmission Owner</b>	AEP
<b>MFO</b>	49
<b>MWE</b>	49
<b>MWC</b>	29.4
<b>Fuel</b>	Solar
<b>Basecase Study Year</b>	2023

## 2.1 Point of Interconnection

AF1-230 will interconnect with the AEP transmission system via a direct connection to Chatfield 138 kV station (see Figure 1).

To accommodate the interconnection at the Chatfield 138 kV substation, the station will require the installation of one (1) 138 kV circuit breaker (see Figure 2). Installation of associated protection and control equipment, 138 kV line risers, SCADA and 138 kV revenue metering will also be required.

## 2.2 Cost Summary

The AF1-230 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$250,000
Direct Connection Network Upgrade	\$1,250,000
Non Direct Connection Network Upgrades	\$0
<b>Total Costs</b>	<b>\$1,500,000</b>

In addition, the AF1-230 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	\$90,220,000

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
138 kV Revenue Metering	\$250,000
<b>Total Attachment Facility Costs</b>	<b>\$250,000</b>

#### 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
Expand the Chatfield 138 kV substation: Install one (1) additional 138 kV circuit breaker. Installation of associated protection and control equipment, 138 kV line risers and SCADA will also be required.	\$1,250,000
<b>Total Direct Connection Facility Costs</b>	<b>\$1,250,000</b>

#### 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
<b>Total Non-Direct Connection Facility Costs</b>	<b>\$0</b>

## 7 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.

## 8 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 Chatfield 138 kV station 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.

In addition, if the Interconnection Customer considers use of the Option to Build, they should consult the guidance AEP has posted at:

<https://www.aep.com/assets/docs/requiredpostings/TransmissionStudies/docs/2019/MerchantGenerationGuidelinesPJMoptiontoBuild.pdf>

## 9 Revenue Metering and SCADA Requirements

### 9.1 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.

### 9.2 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>

## 10 Network Impacts

The Queue Project AF1-230 was evaluated as a 49.0 MW (Capacity 29.4 MW) injection at Chatfield 138 kV substation in the AEP area. Project AF1-230 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-230 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

# Summer Peak Load Flow

## 11 Generation Deliverability

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

None

## 12 Multiple Facility Contingency

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

None

## 13 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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJE CT LOADI NG %	POST PROJE CT LOADI NG %	AC  DC	MW IMPA CT
43924087	242953	05AIRCO8	138.0	AEP	243137	05W.ENDED	138.0	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	142.87	147.66	DC	8.0
43924062	242984	05CHATFL	138.0	AEP	932050	AC2-015TAP	138.0	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	154.53	165.91	DC	19.0
43924063	242984	05CHATFL	138.0	AEP	932050	AC2-015TAP	138.0	AEP	1	AEP_SUBT_P4_#1208_05HOWARD69.0_U	breaker	167.0	146.31	156.84	DC	17.57
43923816	243008	05FREMCT	138.0	AEP	243009	05FRMNT	138.0	AEP	1	AEP_P2-2_#7118_05HOWARD138_1-B	bus	251.0	138.31	144.2	DC	14.78
43923817	243008	05FREMCT	138.0	AEP	243009	05FRMNT	138.0	AEP	1	AEP_SUBT_P2-2_#1175_05FREMNTC69.0_1	bus	251.0	127.26	131.53	DC	10.72
43924103	243008	05FREMCT	138.0	AEP	243009	05FRMNT	138.0	AEP	1	AEP_P4_#10134_05HOWARD138_B	breaker	251.0	138.31	144.2	DC	14.78
43924104	243008	05FREMCT	138.0	AEP	243009	05FRMNT	138.0	AEP	1	AEP_P4_#10133_05HOWARD138_H	breaker	251.0	138.35	144.24	DC	14.78
43924923	243008	05FREMCT	138.0	AEP	243009	05FRMNT	138.0	AEP	1	AEP_P7-1_#10929	tower	251.0	120.07	125.07	DC	12.57
41641083	243009	05FRMNT	138.0	AEP	239154	02W.FRETM	138.0	ATS	1	AEP_P4_#10133_05HOWARD138_H	breaker	361.0	102.74	107.64	DC	17.67
41641084	243009	05FRMNT	138.0	AEP	239154	02W.FRETM	138.0	ATS	1	AEP_P4_#10134_05HOWARD138_B	breaker	361.0	102.71	107.61	DC	17.67
41861546	243009	05FRMNT	138.0	AEP	239154	02W.FRETM	138.0	ATS	1	AEP_P2-2_#7118_05HOWARD138_1-B	bus	361.0	102.71	107.61	DC	17.67
43923778	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P2-2_#7118_05HOWARD138_1-B	bus	167.0	216.26	225.11	DC	14.78
43923779	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P2-2_#7725_05FREMCT138_1	bus	167.0	218.29	226.05	DC	12.95
43924037	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P4_#10134_05HOWARD138_B	breaker	167.0	216.26	225.11	DC	14.78
43924038	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P4_#10133_05HOWARD138_H	breaker	167.0	216.2	225.05	DC	14.78
43924039	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P4_#7725_05FREMCT138_M	breaker	167.0	218.29	226.05	DC	12.95
43924040	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P4_#7112_05MELMOR138_C	breaker	167.0	215.24	219.16	DC	6.55

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 PROJE CT LOADI NG %	POST PROJE CT LOADI NG %	AC  DC	MW IMPAC T
43924041	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P4_#10118_05W.END138_AA	breaker	167.0	198.44	205.47	DC	11.73
43924052	243039	05MELMOR	138.0	AEP	243110	05STIFFI	138.0	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	168.54	173.84	DC	8.85
43924092	243110	05STIFFI	138.0	AEP	242953	05AIRCO8	138.0	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	142.93	147.72	DC	8.0
43924042	932050	AC2-015TAP	138.0	AEP	243024	05HOWARD	138.0	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	189.67	201.05	DC	19.0
43924043	932050	AC2-015TAP	138.0	AEP	243024	05HOWARD	138.0	AEP	1	AEP_SUBT_P4_#1208_05HOWARD69.0_U	breaker	167.0	177.71	188.23	DC	17.57

## 14 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 PROJE CT LOADI NG %	POST PROJE CT LOADI NG %	AC  DC	MW IMPAC T
43924568	242953	05AIRCO8	138.0	AEP	243137	05W.END	138.0	AEP	1	AEP_P1-2_#7104	operation	167.0	128.15	132.88	DC	7.9
43924492	242984	05CHATFL	138.0	AEP	932050	AC2-015TAP	138.0	AEP	1	AEP_P1-2_#7105	operation	167.0	137.1	147.54	DC	17.44
43924497	242984	05CHATFL	138.0	AEP	932050	AC2-015TAP	138.0	AEP	1	Base Case	operation	136.0	98.99	111.94	DC	17.61
43924745	243006	05FOSTOR	138.0	AEP	247172	05EBERSO	138.0	AEP	1	AEP_P1-2_#7761-A	operation	245.0	107.26	107.93	DC	3.7
43924649	243008	05FREMCT	138.0	AEP	243009	05FRMNT	138.0	AEP	1	AEP_P1-2_#7104	operation	251.0	113.77	118.49	DC	11.85
41323721	243024	05HOWARD	138.0	AEP	241111	02ASHLAN D	138.0	ATSI	1	Base Case	operation	167.0	108.02	113.31	DC	8.83
41323722	243024	05HOWARD	138.0	AEP	241111	02ASHLAN D	138.0	ATSI	1	AEP_P1-2_#5249	operation	245.0	96.58	100.84	DC	10.45
43924433	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	AEP_P1-2_#7708	operation	167.0	197.51	204.55	DC	11.75
43924438	243039	05MELMOR	138.0	AEP	243006	05FOSTOR	138.0	AEP	1	Base Case	operation	167.0	156.9	162.51	DC	9.37
43924484	243039	05MELMOR	138.0	AEP	243110	05STIFFI	138.0	AEP	1	AEP_P1-2_#7104	operation	167.0	150.66	155.89	DC	8.73
43924489	243039	05MELMOR	138.0	AEP	243110	05STIFFI	138.0	AEP	1	Base Case	operation	167.0	100.7	104.16	DC	5.77

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC DC	MW IMPACT
43924490	243039	05MELMOR	138.0	AEP	243024	05HOWARD	138.0	AEP	1	AEP_P1-2_#9519-B	operation	167.0	145.17	148.73	DC	5.95
43924563	243110	05STIFFI	138.0	AEP	242953	05AIRCO8	138.0	AEP	1	AEP_P1-2_#7104	operation	167.0	128.21	132.94	DC	7.9
43924459	932050	AC2-015 TAP	138.0	AEP	243024	05HOWARD	138.0	AEP	1	AEP_P1-2_#7105	operation	167.0	170.33	180.77	DC	17.44
43924461	932050	AC2-015 TAP	138.0	AEP	243024	05HOWARD	138.0	AEP	1	Base Case	operation	136.0	141.89	154.84	DC	17.61
43924693	939160	AE1-146 TAP	138.0	AEP	247172	05EBERSO	138.0	AEP	2	AEP_P1-2_#7757	operation	245.0	115.08	115.73	DC	3.55

## 15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43924040,43924041, 43924037,43924039, 43924038,43923779, 43923778	5	05MELMOR 138.0 kV - 05FOSTOR 138.0 kV Ckt 1	<p><u>AEP</u> AEPO0019a (938) : Reconfigure Fremont 138kV station into 5 breaker ring .This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including :</p> <p>1) Rebuild 18 mile double circuit line between Melmore and Fostoria Central with 1590 ACSR (Replacing current 397.5 ACSR conductor) [\$54,000,000]</p> <p>2) Upgrade Relay Compliance Trip Limit 1540 Amps at Fostoria central [\$25,000]</p> <p>Project Type : CON Cost : \$10,000,000 Time Estimate : 24-36 months Months</p>	\$10,000,000
41641084,41861546, 41641083	4	05FRMNT 138.0 kV - 02W.FREM 138.0 kV Ckt 1	<p><u>AEP</u> AEPO0026a (966) : Relocate Fostoria Central- Melmore or the Howard- Melmore #1 line into a new breaker string at Melmore. This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including :</p> <p>Project Type : CON Cost : \$4,000,000 Time Estimate : 24-36 months Months</p> <p><u>ATSI</u> TE-002B (2273) : Reconductor the 0.8 miles of transmission line between West Fremont-Fremont 138 kV line. Existing transmission line conductor size 954 ACSR should be replaced with 954 ACSS AEP would need to replace their section of limiting conductor and provide estimates for their replacement.</p> <p>Project Type : FAC Cost : \$1,950,000 Time Estimate : 18.0 Months</p>	\$5,950,000

ID	Index	Facility	Upgrade Description	Cost
43924092	7	05STIFFI 138.0 kV - 05AIRCO8 138.0 kV Ckt 1	<p><u>AEP</u>            AEPO0024a (956) : Relocate Fostoria Central - Melmore or the Howard- Melmore #1 line into a new breaker string at Melmore. This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including :</p> <p>1) Sag Study - A Sag Study will be required on the 10 miles of Conductor Section 1, ACSR ~ 397.5 ~ 30/7 ~ LARK. Depending on the sag study results, cost for this upgrade is expected to be between \$50,000 (no remediations required just sag study, new ratings : S/N: 167 S/E: 245 and \$30 million (complete line rebuild). Time Estimate: a) Sag Study: 18-24 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. [\$]</p> <p>2) Upgrade CT Thermal Limit 749 Amps at West End Fostoria [\$]</p> <p>3) Upgrade Relay Thermal Limit 749 Amps at West End Fostoria [\$]</p> <p>4) Upgrade Relay Compliance Trip Limit 975 Amps at West End Fostoria [\$]</p> <p>Project Type : CON            Cost : \$4,000,000            Time Estimate : 24-36 months Months</p>	\$4,000,000
43924087	1	05AIRCO8 138.0 kV - 05W.END 138.0 kV Ckt 1	<p><u>AEP</u>            AEPO0025a (961) : Relocate Fostoria Central- Melmore or the Howard- Melmore #1 line into a new breaker string at Melmore. This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including :</p> <p>1) Sag Study - A Sag Study will be required on the 2 miles of Conductor Section 1, ACSR ~ 397.5 ~ 30/7 ~ LARK. Depending on the sag study results, cost for this upgrade is expected to be between \$20,000 (no remediations required just sag study, new ratings : S/N: 167 S/E: 245 and \$6 million (complete line rebuild). Time Estimate: a) Sag Study: 18-24 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. [\$]</p> <p>2) Upgrade CT Thermal Limit 749 Amps at West End Fostoria [\$]</p> <p>3) Upgrade Relay Thermal Limit 749 Amps at West End Fostoria [\$]</p> <p>4) Upgrade Relay Compliance Trip Limit 975 Amps at West End Fostoria [\$]</p> <p>Project Type : CON            Cost : \$4,000,000            Time Estimate : 24-36 months Months</p>	\$4,000,000

ID	Index	Facility	Upgrade Description	Cost
43924052	6	05MELMOR 138.0 kV - 05STIFFI 138.0 kV Ckt 1	<p><u>AEP</u>            AEPO0022a (949) : Relocate Fostoria Central- Melmore or the Howard- Melmore #1 line into a new breaker string at Melmore. This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including:</p> <p>1) Rebuild 6 mile double circuit line between Melmore and South Tiffin with 1590 ACSR (Replacing current 397.5 ACSR conductor) [\$18,000,000]            2) Replace four sub Cond 500 MCM CU 37 Str at South Tiffin [\$400,000]</p> <p>Project Type : CON            Cost : \$4,000,000            Time Estimate : 24-36 months Months</p>	\$4,000,000
43924103,43924923, 43924104,43923816, 43923817	3	05FREMCT 138.0 kV - 05FRMNT 138.0 kV Ckt 1	<p><u>AEP</u>            AEPO0020a (941) : Reconfigure Fremont Center 69kV yard into 8 breaker ring for \$12,000,000. This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including :</p> <p>1) Rebuild 7 miles of single circuit line ( ACSR ~ 795 ~ 45/7 ~ TERN conductor ) between Fremont and Fremont Center with 1590 ACSR. [\$10,500,000]            2) Replace 1200A switch at Fremont [\$200,000]            3) Replace two Sub Cond 1590 AAC 61 Str at Fremont [\$200,000]</p> <p>Project Type : con            Cost : \$12,000,000            Time Estimate : 24-36 months Months</p> <p>AEPO0020b (942) : Rebuild 7 miles of single circuit line ( ACSR ~ 795 ~ 45/7 ~ TERN conductor ) between Fremont and Fremont Center with 1590 ACSR.            Project Type : fac            Cost : \$10,500,000            Time Estimate : 24-36 months Months</p>	\$22,500,000
43924062,43924063	2	05CHATFL 138.0 kV - AC2- 015 TAP 138.0 kV Ckt 1	<p><u>AEP</u>            AEP_AE1_REF_r0025 (877) : 1) A sag study will be required on the 4.5 miles of ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between \$20,000 (no remediation required, just sag study) and \$6.75 million (complete line reconductor/rebuild). New rating after sag study: S/N:167 S/E: 245. 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.            2) Replace 600A Switch at Chatfield. Estimated cost: \$500,000.</p> <p>Project Type : FAC            Cost : \$520,000            Time Estimate : 12-18 Months</p>	\$520,000

ID	Index	Facility	Upgrade Description	Cost
43924042,43924043	8	AC2-015 TAP 138.0 kV - 05HOWARD 138.0 kV Ckt 1	<p><b>AEP</b>  <b>AEPO0027a (972) : Relocate Fostoria Central- Melmore or the Howard- Melmore #1 line into a new breaker string at Melmore. This upgrade will be tested during the System Impact studies. If not adequate, additional mitigation may be required including:</b>  <b>Project Type : CON</b>  <b>Cost : \$4,000,000</b>  <b>Time Estimate : 24-36 months Months</b></p> <p><b>AEPO0027b (973) : Rebuild 11.5 mile double circuit line between AC2-015 TAP and Howard with 1590 ACSR (replacing ACSR ~ 397.5 ~ 30/7 ~ LARK conductor)</b>  <b>Project Type : FAC</b>  <b>Cost : \$34,500,000</b>  <b>Time Estimate : 24-36 months Months</b></p> <p><b>AEPO0027c (974) : Replace sub Cond 300 MCM CU 37 Str at Howard</b>  <b>Project Type : FAC</b>  <b>Cost : \$100,000</b>  <b>Time Estimate : 12-18 months Months</b></p> <p><b>AEPO0027d (975) : Upgrade CT Thermal Limit 749 Amps &amp; Relay Thermal Limit 749 Amps at Howard</b>  <b>Project Type : FAC</b>  <b>Cost : \$25,000</b>  <b>Time Estimate : 12-18 months Months</b></p> <p><b>AEPO0027e (976) : Replace Sub cond 397.5 ACSR 26/7 at Howard</b>  <b>Project Type :</b>  <b>Cost : \$100,000</b>  <b>Time Estimate : 12-18 months Months</b></p> <p><b>AEPO0027f (977) : Upgrade Relay Compliance Trip Limit 975 Amps at Howard</b>  <b>Project Type : FAC</b>  <b>Cost : \$25,000</b>  <b>Time Estimate : 12-18 months Months</b></p> <p><b>AEPO0027g (978) : Replace five Sub cond 795 AAC 37 Str at Howard</b>  <b>Project Type : FAC</b>  <b>Cost : \$500,000</b>  <b>Time Estimate : 12-18 months Months</b></p>	\$39,250,000
			<b>TOTAL COST</b>	<b>\$90,220,000</b>

## 16 Flow Gate Details

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.

## 16.1 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
43924087	242953	05AIRCO8	AEP	243137	05W.END	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	142.87	147.66	DC	8.0

Bus #	Bus	MW Impact
244357	05GRANGER EL	-0.2194
247548	V4-010 C	4.7502
247551	U4-028 C	2.9424
247552	U4-029 C	2.9424
247940	U4-028 E	19.6916
247941	U4-029 E	19.6916
247947	V4-010 E	31.7898
925751	AC1-051 C	0.9858
925752	AC1-051 E	6.5976
932051	AC2-015 C	7.5147
932052	AC2-015 E	8.9039
937021	AD2-136 C O1	10.5927
937022	AD2-136 E O1	70.8897
937381	AD2-191 C	5.0021
937382	AD2-191 E	33.4757
941741	AE2-174 C	6.3671
941742	AE2-174 E	29.8075
945651	AF1-230 C	4.8016
945652	AF1-230 E	3.2011
DUCKCREEK	DUCKCREEK	0.3719
NEWTON	NEWTON	0.3062
FARMERCITY	FARMERCITY	0.0160
G-007A	G-007A	0.3021
VFT	VFT	0.8127
PRAIRIE	PRAIRIE	0.6922
COFFEEN	COFFEEN	0.1549
EDWARDS	EDWARDS	0.1155
CHEOAH	CHEOAH	0.0706
TILTON	TILTON	0.1972
GIBSON	GIBSON	0.1540
CALDERWOOD	CALDERWOOD	0.0711
BLUEG	BLUEG	0.4340
TRIMBLE	TRIMBLE	0.1391
CATAWBA	CATAWBA	0.0287

## 1.1 Index 2

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
43924062	242984	05CHATFL	AEP	932050	AC2-015 TAP	AEP	1	AEP_P4_#7110_05MELMOR 138_B	breaker	167.0	154.53	165.91	DC	19.0

Bus #	Bus	MW Impact
247548	V4-010 C	4.4694
247551	U4-028 C	2.7264
247552	U4-029 C	2.7264
247940	U4-028 E	18.2456
247941	U4-029 E	18.2456
247947	V4-010 E	29.9106
925751	AC1-051 C	0.4174
925752	AC1-051 E	2.7935
934252	AD1-052 E1	0.2997
934262	AD1-052 E2	0.2997
937021	AD2-136 C O1	9.8149
937022	AD2-136 E O1	65.6843
937381	AD2-191 C	4.6348
937382	AD2-191 E	31.0176
941741	AE2-174 C	5.9907
941742	AE2-174 E	28.0455
945651	AF1-230 C	11.4019
945652	AF1-230 E	7.6013
LGEE	LGEE	0.0285
WEC	WEC	0.0891
CBM-W2	CBM-W2	0.8845
NY	NY	0.0702
CBM-W1	CBM-W1	7.5560
TVA	TVA	0.0336
O-066	O-066	0.9542
CHEOAH	CHEOAH	0.0150
CBM-S1	CBM-S1	0.2471
G-007	G-007	0.1487
MADISON	MADISON	0.4274
MEC	MEC	0.3416
CALDERWOOD	CALDERWOOD	0.0139
CATAWBA	CATAWBA	0.0280

## 1.2 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
43924104	243008	05FREMC T	AEP	243009	05FRMNT	AEP	1	AEP_P4_#10133_05HOWARD 138_H	breaker	251.0	138.35	144.24	DC	14.78

Bus #	Bus	MW Impact
244357	05GRANGER EL	0.1988
247548	V4-010 C	10.1306
247551	U4-028 C	4.0365
247552	U4-029 C	4.0365
247926	U1-059 E	1.8769
247940	U4-028 E	27.0135
247941	U4-029 E	27.0135
247942	W1-056 E	0.6903
247947	V4-010 E	67.7974
925751	AC1-051 C	2.0246
925752	AC1-051 E	13.5496
932051	AC2-015 C	16.1582
932052	AC2-015 E	19.1454
934252	AD1-052 E1	-0.6529
934262	AD1-052 E2	-0.6529
934461	AD1-070 C O1	2.8801
934462	AD1-070 E O1	13.5203
937021	AD2-136 C O1	14.5314
937022	AD2-136 E O1	97.2486
937381	AD2-191 C	6.8621
937382	AD2-191 E	45.9229
939161	AE1-146 C O1	5.6076
939162	AE1-146 E O1	2.6187
941741	AE2-174 C	13.5790
941742	AE2-174 E	63.5698
945651	AF1-230 C	8.8709
945652	AF1-230 E	5.9139
LGEE	LGEE	0.2362
CPL	CPL	0.1250
WEC	WEC	0.1143
CBM-W2	CBM-W2	2.8747
NY	NY	0.0863
CBM-W1	CBM-W1	1.6638
TVA	TVA	0.4480
O-066	O-066	0.7594
CBM-S2	CBM-S2	1.2947
CBM-S1	CBM-S1	2.8712
G-007	G-007	0.1144
MEC	MEC	0.5689

### 1.3 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
41861546	243009	05FRMNT	AEP	239154	02W.FREM	ATSI	1	AEP_P2-2_#7118_05HOWARD 138_1-B	bus	361.0	102.71	107.61	DC	17.67

Bus #	Bus	MW Impact
244357	05GRANGER EL	0.2417
247548	V4-010 C	12.0281
247551	U4-028 C	4.8140
247552	U4-029 C	4.8140
247926	U1-059 E	2.3132
247940	U4-028 E	32.2170
247941	U4-029 E	32.2170
247942	W1-056 E	0.8508
247947	V4-010 E	80.4959
925751	AC1-051 C	2.4348
925752	AC1-051 E	16.2942
932051	AC2-015 C	19.3144
932052	AC2-015 E	22.8851
934252	AD1-052 E1	-0.8022
934262	AD1-052 E2	-0.8022
934461	AD1-070 C O1	4.1170
934462	AD1-070 E O1	19.3268
937021	AD2-136 C O1	17.3305
937022	AD2-136 E O1	115.9811
937381	AD2-191 C	8.1839
937382	AD2-191 E	54.7688
939161	AE1-146 C O1	6.8153
939162	AE1-146 E O1	3.1827
941741	AE2-174 C	16.1223
941742	AE2-174 E	75.4764
945651	AF1-230 C	10.6037
945652	AF1-230 E	7.0691
LGEE	LGEE	0.2898
CPLE	CPLE	0.1541
WEC	WEC	0.1402
CBM-W2	CBM-W2	3.5299
NY	NY	0.1062
CBM-W1	CBM-W1	2.0266
TVA	TVA	0.5502
O-066	O-066	0.9206
CBM-S2	CBM-S2	1.5895
CBM-S1	CBM-S1	3.5273
G-007	G-007	0.1394
MEC	MEC	0.6976

## 1.4 Index 5

ID	FROM BUS#	FROM BUS	FRO M BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CK T ID	CONT NAME	Type	Ratin g MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
43924039	243039	05MELMOR	AEP	243006	05FOSTOR	AEP	1	AEP_P4_#7725_05FREM CT 138_M	breake r	167.0	218.29	226.05	DC	12.95

Bus #	Bus	MW Impact
244357	05GRANGER EL	-0.1827
247548	V4-010 C	8.3582
247551	U4-028 C	4.4144
247552	U4-029 C	4.4144
247940	U4-028 E	29.5426
247941	U4-029 E	29.5426
247947	V4-010 E	55.9358
925751	AC1-051 C	1.6768
925752	AC1-051 E	11.2220
932051	AC2-015 C	12.7417
932052	AC2-015 E	15.0973
937021	AD2-136 C O1	15.8919
937022	AD2-136 E O1	106.3533
937381	AD2-191 C	7.5045
937382	AD2-191 E	50.2224
941741	AE2-174 C	11.2032
941742	AE2-174 E	52.4478
945651	AF1-230 C	7.7681
945652	AF1-230 E	5.1787
DUCKCREEK	DUCKCREEK	0.3731
NEWTON	NEWTON	0.2740
CPLE	CPLE	0.0139
FARMERCITY	FARMERCITY	0.0150
G-007A	G-007A	0.3596
VFT	VFT	0.9675
PRAIRIE	PRAIRIE	0.6096
COFFEEN	COFFEEN	0.1432
EDWARDS	EDWARDS	0.1169
CHEOAH	CHEOAH	0.0330
TILTON	TILTON	0.1859
GIBSON	GIBSON	0.1278
CALDERWOOD	CALDERWOOD	0.0338
BLUEG	BLUEG	0.3090
TRIMBLE	TRIMBLE	0.0985
CATAWBA	CATAWBA	0.0017

## 1.5 Index 6

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 DC	MW IMPACT
43924052	243039	05MELMOR	AEP	243110	05STIFFI	AEP	1	AEP_P4_#7110_05MELMOR_138_B	breaker	167.0	168.54	173.84	DC	8.85

Bus #	Bus	MW Impact
244357	05GRANGER EL	-0.1587
247548	V4-010 C	5.1087
247551	U4-028 C	3.3862
247552	U4-029 C	3.3862
247940	U4-028 E	22.6618
247941	U4-029 E	22.6618
247947	V4-010 E	34.1893
925751	AC1-051 C	1.0018
925752	AC1-051 E	6.7046
932051	AC2-015 C	8.2285
932052	AC2-015 E	9.7497
937021	AD2-136 C O1	12.1905
937022	AD2-136 E O1	81.5823
937381	AD2-191 C	5.7566
937382	AD2-191 E	38.5250
941741	AE2-174 C	6.8477
941742	AE2-174 E	32.0573
945651	AF1-230 C	5.3126
945652	AF1-230 E	3.5417
DUCKCREEK	DUCKCREEK	0.3489
NEWTON	NEWTON	0.2912
FARMERCITY	FARMERCITY	0.0151
G-007A	G-007A	0.2805
VFT	VFT	0.7611
PRAIRIE	PRAIRIE	0.6587
COFFEEN	COFFEEN	0.1464
EDWARDS	EDWARDS	0.1078
CHEOAH	CHEOAH	0.0711
TILTON	TILTON	0.1859
GIBSON	GIBSON	0.1469
CALDERWOOD	CALDERWOOD	0.0716
BLUEG	BLUEG	0.4236
TRIMBLE	TRIMBLE	0.1352
CATAWBA	CATAWBA	0.0304

## 1.6 Index 7

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 DC	MW IMPACT
43924092	243110	05STIFFI	AEP	242953	05AIRCO8	AEP	1	AEP_P4_#7110_05MELMOR138_B	breaker	167.0	142.93	147.72	DC	8.0

Bus #	Bus	MW Impact
244357	05GRANGER EL	-0.2194
247548	V4-010 C	4.7502
247551	U4-028 C	2.9424
247552	U4-029 C	2.9424
247940	U4-028 E	19.6916
247941	U4-029 E	19.6916
247947	V4-010 E	31.7898
925751	AC1-051 C	0.9858
925752	AC1-051 E	6.5976
932051	AC2-015 C	7.5147
932052	AC2-015 E	8.9039
937021	AD2-136 C O1	10.5927
937022	AD2-136 E O1	70.8897
937381	AD2-191 C	5.0021
937382	AD2-191 E	33.4757
941741	AE2-174 C	6.3671
941742	AE2-174 E	29.8075
945651	AF1-230 C	4.8016
945652	AF1-230 E	3.2011
DUCKCREEK	DUCKCREEK	0.3719
NEWTON	NEWTON	0.3062
FARMERCITY	FARMERCITY	0.0160
G-007A	G-007A	0.3021
VFT	VFT	0.8127
PRAIRIE	PRAIRIE	0.6922
COFFEEN	COFFEEN	0.1549
EDWARDS	EDWARDS	0.1155
CHEOAH	CHEOAH	0.0706
TILTON	TILTON	0.1972
GIBSON	GIBSON	0.1540
CALDERWOOD	CALDERWOOD	0.0711
BLUEG	BLUEG	0.4340
TRIMBLE	TRIMBLE	0.1391
CATAWBA	CATAWBA	0.0287

## 1.7 Index 8

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
4392404 2	93205 0	AC2-015 TAP	AEP	24302 4	05HOWAR D	AEP	1	AEP_P4_#7110_05MELMOR 138_B	breaker	167.0	189.67	201.05	DC	19.0

Bus #	Bus	MW Impact
247548	V4-010 C	4.4694
247551	U4-028 C	2.7264
247552	U4-029 C	2.7264
247940	U4-028 E	18.2456
247941	U4-029 E	18.2456
247947	V4-010 E	29.9106
925751	AC1-051 C	0.4174
925752	AC1-051 E	2.7935
932051	AC2-015 C	26.8591
932052	AC2-015 E	31.8246
934252	AD1-052 E1	0.2997
934262	AD1-052 E2	0.2997
937021	AD2-136 C O1	9.8149
937022	AD2-136 E O1	65.6843
937381	AD2-191 C	4.6348
937382	AD2-191 E	31.0176
941741	AE2-174 C	5.9907
941742	AE2-174 E	28.0455
945651	AF1-230 C	11.4019
945652	AF1-230 E	7.6013
LGEE	LGEE	0.0285
WEC	WEC	0.0891
CBM-W2	CBM-W2	0.8845
NY	NY	0.0702
CBM-W1	CBM-W1	7.5560
TVA	TVA	0.0336
O-066	O-066	0.9542
CHEOAH	CHEOAH	0.0150
CBM-S1	CBM-S1	0.2471
G-007	G-007	0.1487
MADISON	MADISON	0.4274
MEC	MEC	0.3416
CALDERWOOD	CALDERWOOD	0.0139
CATAWBA	CATAWBA	0.0280

# Affected Systems

## **17 Affected Systems**

### **17.1 LG&E**

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

### **17.2 MISO**

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

### **17.3 TVA**

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

### **17.4 Duke Energy Progress**

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

### **17.5 NYISO**

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

Contingency Name	Contingency Definition
<b>AEP_P4_#10134_05HOWARD 138_B</b>	CONTINGENCY 'AEP_P4_#10134_05HOWARD 138_B' OPEN BRANCH FROM BUS 241111 TO BUS 243024 CKT 1 / 241111 02ASHLAND 138 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 932050 TO BUS 243024 CKT 1 / 932050 AC2-015 TAP 138 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243050 CKT 1 / 243024 05HOWARD 138 243050 05NBELVL 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243100 CKT 1 / 243024 05HOWARD 138 243100 05SHELGH 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243061 CKT 1 / 243024 05HOWARD 138 243061 05NLEXTN 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243101 CKT 1 / 243024 05HOWARD 138 243101 05SHELNS 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243117 CKT 1 / 243024 05HOWARD 138 243117 05SULFRS 138 REMOVE SWSHUNT FROM BUS 243024 / 243024 05HOWARD 138 END
<b>AEP_P4_#7112_05MELMOR 138_C</b>	CONTINGENCY 'AEP_P4_#7112_05MELMOR 138_C' 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
<b>AEP_P7-1_#10929</b>	CONTINGENCY 'AEP_P7-1_#10929' OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243006 TO BUS 243137 CKT 1 / 243006 05FOSTOR 138 243137 05W.END
<b>AEP_P4_#7110_05MELMOR 138_B</b>	CONTINGENCY 'AEP_P4_#7110_05MELMOR 138_B' 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
<b>AEP_P1-2_#7757</b>	CONTINGENCY 'AEP_P1-2_#7757' OPEN BRANCH FROM BUS 247172 TO BUS 243006 CKT 1 / 247172 05EBERSO 138 243006 05FOSTOR 138 1 END

Contingency Name	Contingency Definition
<b>AEP_P2-2_#7118_05HOWARD 138_1-B</b>	CONTINGENCY 'AEP_P2-2_#7118_05HOWARD 138_1-B' OPEN BRANCH FROM BUS 241111 TO BUS 243024 CKT 1 / 241111 02ASHLAND 138 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 932050 TO BUS 243024 CKT 1 / 932050 AC2-015 TAP 138 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243050 CKT 1 / 243024 05HOWARD 138 243050 05NBELVL 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243100 CKT 1 / 243024 05HOWARD 138 243100 05SHELGH 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243061 CKT 1 / 243024 05HOWARD 138 243061 05NLEXTN 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243101 CKT 1 / 243024 05HOWARD 138 243101 05SHELNS 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243117 CKT 1 / 243024 05HOWARD 138 243117 05SULFRS 138 1 REMOVE SWSHUNT FROM BUS 243024 / 243024 05HOWARD 138 END
<b>AEP_P1-2_#7104</b>	CONTINGENCY 'AEP_P1-2_#7104' OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1 END
<b>AEP_P4_#10118_05W.END 138_AA</b>	CONTINGENCY 'AEP_P4_#10118_05W.END 138_AA' OPEN BRANCH FROM BUS 239177 TO BUS 243137 CKT 1 / 239177 02WOODVI 138 243137 05W.END
<b>AEP_SUBT_P4_#1208_05HOWARD 69.0_U</b>	CONTINGENCY 'AEP_SUBT_P4_#1208_05HOWARD 69.0_U' OPEN BRANCH FROM BUS 245666 TO BUS 243024 CKT 1 / 245666 05HOWARD1EQ 999 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 245666 TO BUS 245663 CKT 1 / 245666 05HOWARD1EQ 999 245663 05HOWARD 69.0 1 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243061 CKT 1 / 243024 05HOWARD 138 243061 05NLEXTN 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243101 CKT 1 / 243024 05HOWARD 138 243101 05SHELNS 138 1 OPEN BRANCH FROM BUS 245659 TO BUS 245663 CKT 1 / 245659 05E BUCYRU 69.0 245663 05HOWARD 69.0 1 OPEN BRANCH FROM BUS 245663 TO BUS 245678 CKT 1 / 245663 05HOWARD 69.0 245678 05NGALIOSS 69.0 1 OPEN BRANCH FROM BUS 245663 TO BUS 245679 CKT 1 / 245663 05HOWARD 69.0 245679 05WILLARD 69.0 1 OPEN BRANCH FROM BUS 245663 TO BUS 245657 CKT 1 / 245663 05HOWARD 69.0 245657 05WSHELBY 69.0 1 REMOVE SWSHUNT FROM BUS 245663 / 245663 05HOWARD 69.0 END
<b>AEP_P1-2_#7105</b>	CONTINGENCY 'AEP_P1-2_#7105' OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 END

Contingency Name	Contingency Definition
<b>AEP_SUBT_P2-2_#1175_05FREMNT C 69.0_1</b>	CONTINGENCY 'AEP_SUBT_P2-2_#1175_05FREMNT C 69.0_1' OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 1 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 1 OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 3 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 3 OPEN BRANCH FROM BUS 245645 TO BUS 245614 CKT 1 / 245645 05CLYDE 69.0 245614 05FREMNT C 69.0 1 OPEN BRANCH FROM BUS 245611 TO BUS 245614 CKT 2 / 245611 05E FREMON 69.0 245614 05FREMNT C 69.0 2 OPEN BRANCH FROM BUS 245614 TO BUS 245623 CKT 1 / 245614 05FREMNT C 69.0 245623 05HOLRAN 69.0 1 END
<b>AEP_P4_#10133_05HOWARD 138_H</b>	CONTINGENCY 'AEP_P4_#10133_05HOWARD 138_H' OPEN BRANCH FROM BUS 241111 TO BUS 243024 CKT 1 / 241111 02ASHLAND 138 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 932050 TO BUS 243024 CKT 1 / 932050 AC2-015 TAP 138 243024 05HOWARD 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243050 CKT 1 / 243024 05HOWARD 138 243050 05NBELVL 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243039 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243061 CKT 1 / 243024 05HOWARD 138 243061 05NLEXTN 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243101 CKT 1 / 243024 05HOWARD 138 243101 05SHELNS 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243117 CKT 1 / 243024 05HOWARD 138 243117 05SULFRS 138 1 OPEN BRANCH FROM BUS 243024 TO BUS 243100 CKT 1 / 243024 05HOWARD 138 243100 05SHELGH 138 1 OPEN BRANCH FROM BUS 243050 TO BUS 245567 CKT 1 / 243050 05NBELVL 138 245567 05NBELLVIL 69.0 1 REMOVE SWSHUNT FROM BUS 243024 / 243024 05HOWARD 138 END
<b>AEP_P4_#7725_05FREMCT 138_M</b>	CONTINGENCY 'AEP_P4_#7725_05FREMCT 138_M' 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 OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 3 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 3 REMOVE SWSHUNT FROM BUS 243008 / 243008 05FREMCT 138 END

Contingency Name	Contingency Definition
<b>AEP_P2-2_#7725_05FREMCT 138_1</b>	CONTINGENCY 'AEP_P2-2_#7725_05FREMCT 138_1' 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 OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 3 / 243008 05FREMCT 138 245614 05FREMNT C 69.0 3 REMOVE SWSHUNT FROM BUS 243008 / 243008 05FREMCT 138 END
<b>Base Case</b>	
<b>AEP_P1-2_#7708</b>	CONTINGENCY 'AEP_P1-2_#7708' 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
<b>AEP_P1-2_#7761-A</b>	CONTINGENCY 'AEP_P1-2_#7761-A' OPEN BRANCH FROM BUS 247172 TO BUS 939160 CKT 2 / 247172 05EBERSO 138 939160 AE1- 146 TAP 138 2 END
<b>AEP_P1-2_#9519-B</b>	CONTINGENCY 'AEP_P1-2_#9519-B' OPEN BRANCH FROM BUS 932050 TO BUS 243024 CKT 1 / 932050 AC2-015 TAP 138 243024 05HOWARD 138 1 END
<b>AEP_P1-2_#5249</b>	CONTINGENCY 'AEP_P1-2_#5249' OPEN BRANCH FROM BUS 245616 TO BUS 243009 CKT 1 / 245616 05FREMNT EQ 999 243009 05FRMNT 138 1 OPEN BRANCH FROM BUS 245616 TO BUS 245617 CKT 1 / 245616 05FREMNT EQ 999 245617 05FREMONT 69.0 1 OPEN BRANCH FROM BUS 245616 TO BUS 245618 CKT 1 / 245616 05FREMNT EQ 999 245618 05FREMONT- 12.0 1 OPEN BRANCH FROM BUS 239154 TO BUS 243009 CKT 1 / 239154 02W.FREM 138 243009 05FRMNT 138 1 OPEN BRANCH FROM BUS 243008 TO BUS 243009 CKT 1 / 243008 05FREMCT 138 243009 05FRMNT 138 1 END

# Short Circuit

## 18 Short Circuit

The following Breakers are overduty

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