X3-023 S. Greenwich-Willard (Greenwich) 69kV

Generation Interconnection

Local Network Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet single contingency performance criteria in accordance with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of the proposed facility on the AEP System. The Interconnection Customer project was studied as a 60 MW (7.8 MW capacity) generating facility consistent with the interconnection application. Project #X3-023 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential network impacts were as follows:

Primary Interconnection – Greenwich-S. Greenwich 69kV

Normal System (2015 Summer Conditions Capacity Level)

- None

Single Contingency (2015 Summer Conditions Capacity Level)

- None

Multiple Contingency (2015 Summer Conditions Capacity Level)

- None

Contribution to Previously Identified Overloads (2015 Summer Conditions Capacity Level)

- None

Normal System (2015 Summer Conditions Full Output)

- Boughtonville (Firelands CO-OP) – Greenwich 69 kV line loads from 22.5% to 109.3% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded.

AEP suggests adding SCADA the Greenwich 69 kV Station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- Boughtonville (Firelands CO-OP) – Willard 69 kV line loads from 18.5% to 106.4% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to the Boughtonville 69 kV Station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- Greenwich – X3-023 69 kV line loads from 12.1% to 114.5% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Brookside - Howard 138 kV FE-AEP tie line loads from 324.4% to 338.1% for the base case
    - AEP and First Energy are working together to come up with a solution to mitigate this overload.

- Bridgeville - Chandlersville 138 kV line loads from 116.5% to 119.9% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Bethel Church – West Dover 138 kV line loads from 106.2% to 109.6% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Chandlersville – Philo 138 kV line loads from 114% to 117.2% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Hillview – Newcomerstown 138 kV line loads from 131.3% to 134.3% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Newcomerstown – South Coshocton 138 kV line loads from 111.6% to 115.3% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Broken Sword – Nevada (North Central CO-OP) 69 kV line loads from 135.3% to 145.4% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to both the Broken Sword 69 kV Station and the Nevada (North Central CO-OP). Estimated Cost (2012 Dollars) for the SCADA: $500,000.

- Nevada (North Central CO-OP) – Upper Sandusky 69 kV line loads from 130.2% to 140.3% for the base case
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

Single Contingency (2015 Summer Conditions Full Output)

- Sycamore Tap – East Tiffin 69 kV line loads from 79.9% to 113% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA to both the Sycamore Tap 69 kV and the East Tiffin 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $500,000.

- Boughtonville (Firelands CO-OP) – Greenwich 69 kV line loads from 18.7% to 110% for contingency 7161_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Boughtonville (Firelands CO-OP) – Willard 69 kV line loads from 22.7% to 107% for contingency 7161_B2

- Carrothers – St. Stephen (North Central CO-OP) 69 kV line loads from 72% to 103.3% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA to the St. Stephen 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- Crestline – Howard 69 kV line loads from 99.3% to 105.3% for contingency 7159_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA to the Crestline 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- Crestline – North Robinson 69 kV line loads from 99.2% to 105.2% for contingency 7159_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- North Robinson – West Galion Tap 69 kV line loads from 99.1% to 105.1% for contingency 7159_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA to the North Robinson 69 kV station and the West Galion Tap 69 kV. Estimated Cost (2012 Dollars) for the SCADA: $500,000.

Multiple Contingency (2015 Summer Conditions Full Output)

- None

Contribution to Previously Identified Overloads (2015 Summer Conditions Full Output)

- Academia – Apple Valley 138 kV line loads from 100.8% to 107.6% of its emergency rating of 251 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The 795 ACSR conductor (section 1) is the limiting element for the Academia – Apple Valley 138 kV line.

- Apple Valley – North Lexington 138 kV line loads from 125.7% to 134.1% of its emergency rating of 205 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The 556.5 ACSR conductor (section 1), North Lexington Risers, and North Lexington Bus are the limiting elements for the Apple Valley – North Lexington 138 kV line.

- Fostoria Central – Melmore 138 kV line loads from 122.6% to 127% of its emergency rating of 167 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The 397.5 ACSR conductor section 2 is the limiting element for the Fostoria Central – Melmore 138 kV line.

- Greenlawn – Tiffin138 kV line loads from 103.6% to 107.6% of its emergency rating of 143 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Tiffin138 kV line.

- Howard – North Lexington138 kV line loads from 148.2% to 157.9% of its emergency rating of 179 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The Howard Bus, Howard Risers, Howard Switch, 556.5 ACSR conductor (section 1), Howard Wavetrap, North Lexington Risers, and North Lexington Bus are the limiting elements for the Howard – North Lexington138 kV line.

- Brookside - Howard 138 kV line loads from 285.7% to 296.7% for contingency 7111_C2
    - AEP and First Energy are working together to come up with a solution to mitigate this overload.

- Millwood – North Bellville 138 kV line loads from 104.7% to 111.6% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Chatfield – South Tiffin 138 kV line loads from 101% to 109.4% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Howard – North Bellville138 kV line loads from 116% to 123% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- General Electric Tiffin – Tiffin Tap 69kV line loads from 160.9% to 165.2% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA at the General Electric Tiffin 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- General Electric Tiffin – Maule Road 69kV line loads from 161.8% to 166.1% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Greely – Tiffin Center 69kV line loads from 106.7% to 117.8% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA to the Greely and Tiffin Center 69 kV stations. Estimated Cost (2012 Dollars) for the SCADA: $500,000.

- Riverview – Tiffin Tap 69kV line loads from 143% to 147.4% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Tiffin Center – Maule Road 69kV line loads from 175.5% to 179.8% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Bucyrus Center – Broken Sword 69kV line loads from 148.2% to 156.5% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Broken Sword – Nevada (North Central CO-OP) 69 kV line loads from 237.2% to 251.6% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in

question would be overloaded. We suggest adding SCADA. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- Nevada (North Central CO-OP) – Upper Sandusky 69 kV line loads from 231.9% to 246.3% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

Short Circuit Analysis

- No problems identified.

Stability Analysis

- Not required

Additional Limitations of Concern

- None

.

Local/Network Upgrades

- The 795 ACSR conductor section 1 is the limiting element for the Academia – Apple Valley 138 kV line. A sag check will be required for the 795 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 251 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 0.2 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$800**.

- The 556.5 ACSR conductor section 1, North Lexington Risers, and North Lexington Bus are the limiting elements for the Apple Valley – North Lexington 138 kV line. A sag check will be required for the 556.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 205 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 13.8 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$55,200**. The risers at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$100,000**. The 138 kV bus at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$300,000**.

- The 397.5 ACSR conductor section 2 is the limiting element for the Fostoria Central – Melmore 138 kV line. A sag check will be required for the 397.5 ACSR conductor section 2 to determine if the line section can be operated above its emergency rating of 167 MVA. The results of the sag study could prove that no additional upgrades are

necessary, that some upgrades on the circuit are necessary, or that the entire 18.0 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$72,000**.

- The Howard Bus, Howard Risers, Howard Switch, 556.5 ACSR conductor section 1, Howard Wavetrap, North Lexington Risers, and North Lexington Bus are the limiting elements for the Howard – North Lexington138 kV line. A sag check will be required for the 556.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 200 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 12.5 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$50,000**. The risers at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$100,000**. The 138 kV bus at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$300,000**. The risers at Howard Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: $100,000. The 138 kV bus at Howard Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$300,000**.

- The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Tiffin 138 kV line. An engineering study will need to be conducted to determine if the relay thermal limit settings can be adjusted to mitigate the overload. A new relay package will be required if the relay thermal settings cannot be adjusted. Estimated Cost (2012 Dollars) for the relay package: **$300,000**.

Contribution to Previously Identified System Reinforcements

None

Secondary Interconnection – Howard 138kV

Normal System (2015 Summer Conditions Capacity Output)

- No problems identified

Normal System (2015 Summer Conditions Full Output)

- Brookside - Howard 138 kV FE-AEP tie line loads from 324.4% to 336.7% for the base case
    - AEP and First Energy are working together to come up with a solution to mitigate this overload.

- Broken Sword – Nevada (North Central CO-OP) 69 kV line loads from 135.3% to 145.8% for the base case

- The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. We suggest adding SCADA to both the Broken Sword 69 kV Station and the Nevada (North Central CO-OP). Estimated Cost (2012 Dollars) for the SCADA: $500,000.

- Nevada (North Central CO-OP) – Upper Sandusky 69 kV line loads from 130.2% to 140.6% for the base case
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

Single Contingency (2015 Summer Conditions Capacity Output)

- No problems identified

Single Contingency (2015 Summer Conditions Full Output)

- Crestline – Howard 69 kV line loads from 99.3% to 102.4% for contingency 7159_B2
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to the Crestline 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- North Robinson – West Galion Tap 69 kV line loads from 99.1% to 102.3% for contingency 7159_B2
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to the North Robinson 69 kV station and the West Galion Tap 69 kV. Estimated Cost (2012 Dollars) for the SCADA: $500,000.

Multiple Contingency (2015 Summer Conditions Capacity Output)

- No problems identified.

Multiple Contingency (2015 Summer Conditions Full Output)

- No problems identified.

Contribution to Previously Identified Overloads (2015 Summer Conditions Capacity Output)

- No problems identified.

Contribution to Previously Identified Overloads (2015 Summer Conditions Full Output)

- Academia – Apple Valley 138 kV line loads from 100.8% to 108.7% of its emergency rating of 251 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The 795 ACSR conductor (section 1) is the limiting element for the Academia – Apple Valley 138 kV line.

- Apple Valley – North Lexington 138 kV line loads from 125.7% to 135.4% of its emergency rating of 205 MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The 556.5 ACSR conductor (section 1), North Lexington Risers, and North Lexington Bus are the limiting elements for the Apple Valley – North Lexington 138 kV line.

- Bucyrus Center 138 kV – Bucyrus Center 69kV transformer loads from 107.9% to 112.8% of its emergency rating of 113MVA for contingency 7118_C1
    - Contingency '7118' Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
    - The Bucyrus Center #1 138/69/13 transformer is the limiting element for the Bucyrus Center 138 kV – Bucyrus Center 69kV transformer.

- Fostoria Central – Melmore 138 kV line loads from 122.6% to 129.7% of its emergency rating of 167 MVA for contingency 7118_C1

- Contingency ‘7118’ Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
- The 397.5 ACSR conductor (section 2) is the limiting element for the Fostoria Central – Melmore 138 kV line.

- Greenlawn – Melmore 138 kV line loads from 135.4% to 142.8% of its emergency rating of 143 MVA for contingency 7118_C1
  - Contingency ‘7118’ Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
  - The Greenlawn relay thermal limit and Greenlawn circuit breaker R are the limiting elements for the Greenlawn – Melmore 138 kV line.

- Greenlawn – Tiffin138 kV line loads from 103.6% to 110.6% of its emergency rating of 143 MVA for contingency 7118_C1
  - Contingency ‘7118’ Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
  - The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Tiffin138 kV line.

- Howard – North Lexington138 kV line loads from 148.2% to 159.4% of its emergency rating of 179 MVA for contingency 7118_C1
  - Contingency ‘7118’ Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
  - The Howard Bus, Howard Risers, Howard Switch, 556.5 ACSR conductor (section 1), Howard Wavetrap, North Lexington Risers, and North Lexington Bus are the limiting elements for the Howard – North Lexington138 kV line.

- Howard 138 kV – Howard1EQ 999 kV (Howard #1 138/69/12 kV transformer) transformer loads from 115.4% to 122.8% of its emergency rating of 120 MVA for contingency 7118_C1
  - Contingency ‘7118’ Brookside – Howard 138 kV line, Chatfield – Howard 138 kV line, Howard – North Bellville 138 kV line, Howard – City of Shelby 138 kV line, Howard – U4-001 138 kV line, and U4-001 generator.
  - The Howard #1 138/69/12 kV transformer is the limiting element for the Howard 138 kV – Howard1EQ 999 kV transformer.

- Brookside - Howard 138 kV line loads from 285.7% to 297.2% for contingency 7111_C2
    - AEP and First Energy are working together to come up with a solution to mitigate this overload.

- Howard – North Bellville138 kV line loads from 116% to 122% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection customer can choose to upgrade the equipment to mitigate this overload.

- Chatfield – Howard 138 kV line loads from 113.6% to 122% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Chatfield – South Tiffin 138 kV line loads from 101% to 109.3% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Millwood – North Bellville 138 kV line loads from 104.7% to 110.6% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Fremont – Stroks Brewery 69 kV line loads from 109.1% to 112.7% for contingency 5250_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to the Stroks Brewery 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- General Electric Tiffin – Tiffin Tap 69kV line loads from 160.9% to 164.8% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to

upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Custoer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA at the General Electric Tiffin 69 kV station. Estimated Cost (2012 Dollars) for the SCADA: $250,000.

- General Electric Tiffin – Maule Road 69kV line loads from 161.8% to 165.6% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Greely – Tiffin Center 69kV line loads from 106.7% to 111.6% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to the Greely and Tiffin Center 69 kV stations. Estimated Cost (2012 Dollars) for the SCADA: $500,000.

- Holran – Maple Grove 69kV line loads from 151% to 155% for contingency 5121_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload. Rather than requiring the Interconnection Customer to fix this overload, they could curtail. However, the 69 kV facilities do not currently have SCADA to provide monitoring capability. There is no way to know in real time if the lines in question would be overloaded. AEP suggests adding SCADA to the Holran and Maple Grove 69 kV stations. Estimated Cost (2012 Dollars) for the SCADA: $500,000.

- Maple Grove – Riverview 69kV line loads from 171.6% to 175.7% for contingency 5150_B2
    - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Riverview – Tiffin Tap 69kV line loads from 143% to 146.9% for contingency 5150_B2

- The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Tiffin Center – Maule Road 69kV line loads from 175.5% to 179.4% for contingency 5150_B2
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Bucyrus Center – Broken Sword 69kV line loads from 148.2% to 156.3% for contingency 5121_B2
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Broken Sword – Nevada (North Central CO-OP) 69 kV line loads from 237.2% to 251.3% for contingency 5121_B2
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

- Nevada (North Central CO-OP) – Upper Sandusky 69 kV line loads from 231.9% to 246% for contingency 5121_B2
  - The overload on this line will expose project X3-023 to curtailment for summer peak conditions. The Interconnection Customer can choose to upgrade the equipment to mitigate this overload.

Short Circuit Analysis

- No problems identified.

Local/Network Upgrades

- The 795 ACSR conductor section 1 is the limiting element for the Academia – Apple Valley 138 kV line. A sag check will be required for the 795 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 251 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 0.2 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$800**.

- The 556.5 ACSR conductor section 1, North Lexington Risers, and North Lexington Bus are the limiting elements for the Apple Valley – North Lexington 138 kV line. A sag check will be required for the 556.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 205 MVA. The results of the sag

study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 13.8 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$55,200**. The risers at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$100,000**. The 138 kV bus at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$300,000**.

- The 397.5 ACSR conductor section 2 is the limiting element for the Fostoria Central – Melmore 138 kV line. A sag check will be required for the 397.5 ACSR conductor section 2 to determine if the line section can be operated above its emergency rating of 167 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 18.0 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$72,000**.

- The Howard Bus, Howard Risers, Howard Switch, 556.5 ACSR conductor section 1, Howard Wavetrap, North Lexington Risers, and North Lexington Bus are the limiting elements for the Howard – North Lexington138 kV line. A sag check will be required for the 556.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 200 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 12.5 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$50,000**. The risers at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$100,000**. The 138 kV bus at North Lexington Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$300,000**. The risers at Howard Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: $100,000. The 138 kV bus at Howard Station will be replaced. Estimated Cost (2012 Dollars) for the line risers: **$300,000**.

- The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Tiffin 138 kV line. An engineering study will need to be conducted to determine if the relay thermal limit settings can be adjusted to mitigate the overload. A new relay package will be required if the relay thermal settings cannot be adjusted. Estimated Cost (2012 Dollars) for the relay package: **$300,000**.

- The Greenlawn relay thermal limit and Greenlawn circuit breaker R are the limiting elements for the Greenlawn – Melmore 138 kV line. An engineering study will need to be conducted to determine if the relay thermal limit settings can be adjusted to mitigate the overload. A new relay package will be required if the relay thermal settings cannot be adjusted. Estimated Cost (2012 Dollars) for the relay package: **$300,000**. Breaker R at the Greenlwan 138 kV Station will be replaced. Estimated Cost (2012 Dollars) for breaker R: **$550,000**.

- The Bucyrus Center #1 138/69/13 transformer is the limiting element for the Bucyrus Center 138 kV – Bucyrus Center 69kV transformer. Bucyrus Center #1 138/69/13 kV

transformer will be replaced. Estimated Cost (2012 Dollars) for the transformer: **$2,500,000**.

- The Howard #1 138/69/12 kV transformer is the limiting element for the Howard 138 kV – Howard1EQ 999 kV transformer. Howard #1 138/69/12 kV transformer will be replaced. Estimated Cost (2012 Dollars) for the transformer: **$2,500,000**.

Contribution to Previously Identified System Reinforcements

None

Network Impacts

Queue project X3-023 was studied as a(n) 60.0 MW (7.8 MW of which was Capacity) injection into AEP's system. Project X3-023 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential transmission network impacts are as follows:

Primary Interconnection – Greenwich-S. Greenwich 69kV

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

- No problems identified.

Multiple Facility Contingency
(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

- No problems identified.

Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

- No problems identified
-

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.)

1. (AEP) The Greenlawn-Tiffin 138 kV line (from bus 243015 to bus 243130 ckt 1) loads from 121.73% to 127.45% (DC power flow) of its emergency rating (143 MVA) for the tower contingency 'C5-TWL-SR062', outage of the Brookside-Howard, Brookside-

Leaside 138kV tower line. This project contributes approximately 8.18 MW to the thermal violation.

2. (FE) The Woodville Tap-Lemoyne 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 103.30% to 105.21% (DC power flow) of its emergency rating (343 MVA) for the tower contingency 'C5-TWL-WR022', outage of the WEST Fremont-Ottawa & W.Fremont-KH-Ottawa 138kV tower line. This project contributes approximately 6.54 MW to the thermal violation.

3. (AEP) The Tiffin-Fremont Center 138 kV line (from bus 243130 to bus 243008 ckt 1) loads from 112.79% to 117.64% (DC power flow) of its emergency rating (205 MVA) for the tower contingency 'C5-TWL-SR062', Brookside-Howard, Brookside-Leaside 138kV tower line. This project contributes approximately 9.95 MW to the thermal violation.

4. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 240.62% to 248.22% (DC power flow) of its emergency rating (173 MVA) for the tower contingency 'C5-TWL-CR040', outage of the Davis Besse-Beaver and Davis Besse-Hayes 345KV tower line. This project contributes approximately 13.15 MW to the thermal violation.

System Reinforcements

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.)

1. The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Tiffin 138 kV line. An engineering study will need to be conducted to determine if the relay thermal limit settings can be adjusted to mitigate the overload. A new relay package will be required if the relay thermal settings cannot be adjusted. Estimated Cost (2011 Dollars) for the relay package: **$300,000**.

2. The overload on the Woodville Tap-Lemoyne 138 kV circuit can be alleviated by installing a new 138kV line between the proposed Hayes substation to West Fremont substation. Install a new 138kV loop from future Hayes-WestFremont 138kV line to the proposed Bellevue area substation. Install a new 69kV loop from existing Bellevue-Greenfiled 69kV line to proposed Bellevue area substation. Estimated cost: **$48,158,300**.

3. The 556 ACSR (section 1) of the conductor is the limiting elements for the Fremont Center – Tiffin 138 kV line. A sag check will be required to determine if the line section

can be operated above the emergency rating of 205 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 12.7 mile section of line would need to be rebuilt. Estimated Cost (2011 Dollars) for the sag study: **$50,800**

4. FirstEnergy and AEP are working together to come up with an upgrade for the Howard-Brookside 138kV tie line.

   One possible solution is listed below:

   - Replace Howard switch:
     Estimated Cost (2009 Dollars): **$100,000**

   - Reconductor and rebuild the Howard – Brookside 138 kV circuit (8 miles):
     Estimated Cost (2009 Dollars): **$ 12,000,000**
     - This estimate only includes the reconductoring and rebuild of the AEP 8 mile section of the circuit, it does not include First Energy's 13.74 miles.

   - Replace Howard line riser:
     Estimated Cost (2009 Dollars): **$50,000**

   - Replace Howard wavetrap:
     Estimated Cost (2009 Dollars): **$50,000**

   - Replace Howard metering CT:
     Estimated Cost (2009 Dollars): **$100,000**

   - Reconductor and rebuild the FirstEnergy portion of the Howard-Brookside 138kV circuit (approximately 13.75 miles).
     Estimated cost by PJM: **$15,000,000**

Energy Portion of Interconnection Request

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

Note: *Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified*.

5. (AEP) The CARROTHR-ST STPH8 69 kV line (from bus 245655 to bus 245674 ckt 1) loads from 111.33% to 147.32% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 11.15 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

6. (AEP) The TIFFIN T-RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 99.32% to 100.62% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 5.89 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

7. (AEP) The ST STPH8-BLOOMVL 69 kV line (from bus 245674 to bus 245650 ckt 1) loads from 104.11% to 140.09% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 11.15 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

8. (AEP) The NEVADA8-U SANDSK 69 kV line (from bus 245709 to bus 245715 ckt 1) loads from 145.51% to 148.41% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 5.55 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

9. (AEP) The South Tiffin-Airco (North Central Co-Op) 138 kV line (from bus 243110 to bus 242953 ckt 1) loads from 158.84% to 166.37% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 12.59 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
```

```
 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

10. (AEP) The BROK SWR-NEVADA8 69 kV line (from bus 245687 to bus 245709 ckt 1) loads from 151.97% to 154.86% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 5.55 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
 OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

11. (AEP) The BLOOMVL-SYCAMORZ 69 kV line (from bus 245650 to bus 245635 ckt 1) loads from 83.62% to 119.61% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 11.15 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

12. (AEP) The E.TIFF2-GREENLAW 69 kV line (from bus 245646 to bus 245621 ckt 1) loads from 78.90% to 107.5% (DC power flow) of its emergency rating (39 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 11.15 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

13. (AEP) The Greenlawn-Tiffin 138 kV line (from bus 243015 to bus 243130 ckt 1) loads from 121.27% to 126.99% (DC power flow) of its emergency rating (143 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 8.18 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

14. (AEP) The SYCAMORZ-E.TIFF2 69 kV line (from bus 245635 to bus 245646 ckt 1) loads from 99.26% to 135.24% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 11.15 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

15. (AEP) The Chatfield-South Tiffin 138 kV line (from bus 242984 to bus 243110 ckt 1) loads from 202.99% to 211.69% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 14.54 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

16. (AEP) The Chatfield-South Tiffin 138 kV line (from bus 242984 to bus 243110 ckt 1) loads from 122.29% to 129.11% (DC power flow) of its normal rating (148 MVA) for non contingency condition. This project contributes approximately 10.10 MW to the thermal violation.

17. (AEP) The X3-023 TAP-GREENWIC 69 kV line (from bus 910670 to bus 245662 ckt 1) loads from 11.80% to 108.2% (DC power flow) of its normal rating (50 MVA) for non contingency condition. This project contributes approximately 60.00 MW to the thermal violation.

18. (AEP) The GE TIFFI-TIFFIN T 69 kV line (from bus 245619 to bus 245638 ckt 1) loads from 120.77% to 122.08% (DC power flow) of its emergency rating (73 MVA) for the

operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 5.89 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

19. (AEP) The MAULE RD-GE TIFFI 69 kV line (from bus 245648 to bus 245619 ckt 1) loads from 121.69% to 122.99% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 5.89 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

20. (AEP) The TIFFIN C-MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 137.18% to 138.49% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 5.89 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

21. (AEP) The BUCYRS C-BROK SWR 69 kV line (from bus 245653 to bus 245687 ckt 1) loads from 101.11% to 102.77% (DC power flow) of its emergency rating (54 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 5.55 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

22. (AEP) The V1-010 TAP-Melmore 138 kV line (from bus 892000 to bus 243039 ckt 1) loads from 194.36% to 198.06% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5240_B2_TOR4783_WOMOAB_V1-010B'. This project contributes approximately 6.18 MW to the thermal violation.

```
CONTINGENCY '5240_B2_TOR4783_WOMOAB_V1-010B'
  OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1          / 242953 05AIRCO8 138 243110 05STIFFI
138 1
  OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1          / 242953 05AIRCO8 138 243137 05W.END
138 1
```

OPEN BRANCH FROM BUS 892010 TO BUS 243024 CKT 1 / 242984 05CHATFL 138 243024 05HOWARD 138 1
OPEN BRANCH FROM BUS 242984 TO BUS 243110 CKT 1 / 242984 05CHATFL 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242984 TO BUS 245656 CKT 1 / 242984 05CHATFL 138 245656 CHATFIEL 69.0 1
OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1 / 243110 05STIFFI 138 245630 S TIFFIN 69.0 1
OPEN BRANCH FROM BUS 242953 TO BUS 245602 CKT 1 / 242953 05AIRCO8 138 245602 AIRCO L8 12.0 1
OPEN BRANCH FROM BUS 245655 TO BUS 245656 CKT 1 / 245655 CARROTHR 69.0 245656 CHATFIEL 69.0 1
OPEN BRANCH FROM BUS 245656 TO BUS 245670 CKT 1 / 245656 CHATFIEL 69.0 245670 NEWWASH8 69.0 1
END

23. (AEP) The Tiffin-Fremont Center 138 kV line (from bus 243130 to bus 243008 ckt 1) loads from 112.36% to 117.21% (DC power flow) of its emergency rating (205 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 9.95 MW to the thermal violation.

CONTINGENCY '5121_B2_TOR608'
OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1 / 238586 02BRKSID 138 243024 05HOWARD 138 1
END

24. (AEP) The South Tiffin-S TIFFIN 138/69 kV transformer (from bus 243110 to bus 245630 ckt 1) loads from 103.58% to 104.61% (DC power flow) of its emergency rating (72 MVA) for the operational contingency '5243_B2_TOR4783C_MOAB'. This project contributes approximately 4.61 MW to the thermal violation.

CONTINGENCY '5243_B2_TOR4783C_MOAB'
OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1 / 242953 05AIRCO8 138 243110 05STIFFI 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1 / 242953 05AIRCO8 138 243137 05W.END 138 1
OPEN BRANCH FROM BUS 242953 TO BUS 245602 CKT 1 / 242953 05AIRCO8 138 245602 AIRCO L8 12.0 1
END

25. (AEP) The Melmore-Fostoria Central 138 kV line (from bus 243039 to bus 243006 ckt 1) loads from 211.43% to 219.59% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5149_B2_TOR709_WOMOAB'. This project contributes approximately 13.63 MW to the thermal violation.

CONTINGENCY '5149_B2_TOR709_WOMOAB'
OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1 / 243008 05FREMCT 138 243130 05TIFFIN 138 1
OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 1 / 243008 05FREMCT 138 245614 FREMNT C 69.0 1

```
 OPEN BRANCH FROM BUS 243130 TO BUS 245637 CKT 1          / 243130 05TIFFIN 138 245637 TIFFIN C
69.0 1
 OPEN BRANCH FROM BUS 245620 TO BUS 245637 CKT 1          / 245620 GREELY 69.0 245637 TIFFIN C
69.0 1
 OPEN BRANCH FROM BUS 245648 TO BUS 245637 CKT 1          / 245648 MAULE RD 69.0 245637 TIFFIN
C 69.0 1
END
```

26. (AEP) The GREENWIC-BOUGHTN8 69 kV line (from bus 245662 to bus 245651 ckt 1) loads from 18.12% to 101.88% (DC power flow) of its normal rating (50 MVA) for non contingency condition. This project contributes approximately 60.00 MW to the thermal violation.

27. (AEP) The Airco (North Central Co-Op)-West End 138 kV line (from bus 242953 to bus 243137 ckt 1) loads from 150.63% to 158.16% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 12.59 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
 OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
 OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

28. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 206.43% to 213.63% (DC power flow) of its emergency rating (173 MVA) for the operational contingency 'B_LINE1_SR_022'. This project contributes approximately 12.47 MW to the thermal violation.

```
CONTINGENCY 'B_LINE1_SR_022'     /* GALION-GM MANSFIELD 138KV LINE OUTAGE
 DISCONNECT BRANCH FROM BUS 238746 TO BUS 238758 CKT 1     /* 02GALION 138.00 02GM MAN
138.00
END
```

29. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 249.96% to 259.66% (DC power flow) of its normal rating (133 MVA) for non contingency condition. This project contributes approximately 12.90 MW to the thermal violation.

Secondary Interconnection – Howard 138kV

Generator Deliverability

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

- No problems identified.

Multiple Facility Contingency
(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

1. (FE) The Brookside-Troy 138 kV line (from bus 238586 to bus 239216 ckt 1) loads from 95.71% to 96.31% (DC power flow) of its emergency rating (135 MVA) for the tower contingency 'C5-TWL-CR040', outage of the Davis Besse-Beaver & Davis Besse-Hayes 345KV circuits. This project contributes approximately 5.03 MW to the thermal violation.

2. (FE) The Troy-Brighton 138 kV line (from bus 239216 to bus 239215 ckt 1) loads from 94.05% to 94.65% (DC power flow) of its emergency rating (135 MVA) for the tower contingency 'C5-TWL-CR040', outage of the Davis Besse-Beaver & Davis Besse-Hayes 345KV circuits. This project contributes approximately 5.03 MW to the thermal violation.

3. (FE) The 02CAMDEN-Firelands 138 138 kV line (from bus 239319 to bus 239318 ckt 1) loads from 91.07% to 91.67% (DC power flow) of its emergency rating (135 MVA) for the tower contingency 'C5-TWL-CR040', outage of the Davis Besse-Beaver & Davis Besse-Hayes 345kV circuits. This project contributes approximately 5.03 MW to the thermal violation.

Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

- No problems identified

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.)

4. (AEP) The Greenlawn-Tiffin 138 kV line (from bus 243015 to bus 243130 ckt 1) loads from 121.73% to 127.4% (DC power flow) of its emergency rating (143 MVA) for the tower contingency 'C5-TWL-SR062', outage of the Brookside-Howard, Brookside-Leaside 138kV tower line. This project contributes approximately 8.10 MW to the thermal violation.

5. (FE) The Woodville Tap-Lemoyne 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 103.30% to 103.55% (DC power flow) of its emergency rating (343 MVA)

for the tower contingency 'C5-TWL-WR022', outage of the West Fremont-Ottawa & W.Fremont-KH-Ottawa 138kV tower line. This project contributes approximately 5.14 MW to the thermal violation.

6. (AEP) The Tiffin-Fremont Center 138 kV line (from bus 243130 to bus 243008 ckt 1) loads from 112.79% to 116.83% (DC power flow) of its emergency rating (205 MVA) for the tower contingency 'C5-TWL-SR062', Brookside-Howard, Brookside-Leaside 138kV tower line. This project contributes approximately 8.29 MW to the thermal violation.

7. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 240.62% to 250.42% (DC power flow) of its emergency rating (173 MVA) for the tower contingency 'C5-TWL-CR040', outage of the Davis Besse-Beaver and Davis Besse-Hayes 345KV tower line. This project contributes approximately 16.96 MW to the thermal violation.

System Reinforcements

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.)

5. The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Tiffin 138 kV line. An engineering study will need to be conducted to determine if the relay thermal limit settings can be adjusted to mitigate the overload. A new relay package will be required if the relay thermal settings cannot be adjusted. Estimated Cost (2011 Dollars) for the relay package: **$300,000**.

6. The overload on the Woodville Tap-Lemoyne 138 kV circuit can be alleviated by installing a new 138kV line between the proposed Hayes substation to West Fremont substation. Install a new 138kV loop from future Hayes-WestFremont 138kV line to the proposed Bellevue area substation. Install a new 69kV loop from existing Bellevue-Greenfiled 69kV line to proposed Bellevue area substation. Estimated cost: **$48,158,300**.

7. The 556 ACSR (section 1) of the conductor is the limiting elements for the Fremont Center – Tiffin 138 kV line. A sag check will be required to determine if the line section can be operated above the emergency rating of 205 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 12.7 mile section of line would need to be rebuilt. Estimated Cost (2011 Dollars) for the sag study: **$50,800**

8. FirstEnergy and AEP are working together to come up with an upgrade for the Howard-Brookside 138kV tie line.

   One possible solution is listed below:

   - Replace Howard switch:
     Estimated Cost (2009 Dollars): **$100,000**

   - Reconductor and rebuild the Howard – Brookside 138 kV circuit (8 miles):
     Estimated Cost (2009 Dollars): **$ 12,000,000**
     - This estimate only includes the reconductoring and rebuild of the AEP 8 mile section of the circuit, it does not include First Energy's 13.74 miles.

   - Replace Howard line riser:
     Estimated Cost (2009 Dollars): **$50,000**

   - Replace Howard wavetrap:
     Estimated Cost (2009 Dollars): **$50,000**

   - Replace Howard metering CT:
     Estimated Cost (2009 Dollars): **$100,000**

   - Reconductor and rebuild the FirstEnergy portion of the Howard-Brookside 138kV circuit (approximately 13.75 miles).
     Estimated cost by PJM: **$15,000,000**

Energy Portion of Interconnection Request

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

Note: *Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified*.

8. (AEP) The V1-010 TAP-Chatfield 138 kV line (from bus 892010 to bus 242984 ckt 1) loads from 269.78% to 277.86% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 13.50 MW to the thermal violation.

CONTINGENCY '5147_B2_TOR707_V1-010A'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1 / 243015 05GREENL 138 243039 05MELMOR 138 1

OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

9. (AEP) The V1-010 TAP-Chatfield 138 kV line (from bus 892010 to bus 242984 ckt 1) loads from 170.26% to 177.23% (DC power flow) of its normal rating (138 MVA) for non contingency condition. This project contributes approximately 9.62 MW to the thermal violation.

10. (AEP) The CARROTHR-ST STPH8 69 kV line (from bus 245655 to bus 245674 ckt 1) loads from 111.33% to 113.18% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 3.55 MW to the thermal violation.

CONTINGENCY '5147_B2_TOR707_V1-010A'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1 / 243015 05GREENL 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

11. (AEP) The TIFFIN T-RIVERVIE 69 kV line (from bus 245638 to bus 245628 ckt 1) loads from 99.32% to 100.0% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 3.06 MW to the thermal violation.

CONTINGENCY '5150_B2_TOR709A_MOAB'
OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1 / 243008 05FREMCT 138 243130 05TIFFIN 138 1
END

12. (AEP) The ST STPH8-BLOOMVL 69 kV line (from bus 245674 to bus 245650 ckt 1) loads from 104.11% to 105.96% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 3.55 MW to the thermal violation.

CONTINGENCY '5147_B2_TOR707_V1-010A'
OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1 / 243006 05FOSTOR 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1 / 243015 05GREENL 138 243039 05MELMOR 138 1
OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1 / 243024 05HOWARD 138 243039 05MELMOR 138 1
END

13. (AEP) The Melmore-Greenlawn 138 kV line (from bus 243039 to bus 243015 ckt 1) loads from 113.97% to 117.11% (DC power flow) of its emergency rating (201 MVA) for the operational contingency '5240_B2_TOR4783_WOMOAB_V1-010B'. This project contributes approximately 6.32 MW to the thermal violation.

```
CONTINGENCY '5240_B2_TOR4783_WOMOAB_V1-010B'
  OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1          / 242953 05AIRCO8 138 243110 05STIFFI
138 1
  OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1          / 242953 05AIRCO8 138 243137 05W.END
138 1
  OPEN BRANCH FROM BUS 892010 TO BUS 243024 CKT 1          / 242984 05CHATFL 138 243024
05HOWARD 138 1
  OPEN BRANCH FROM BUS 242984 TO BUS 243110 CKT 1          / 242984 05CHATFL 138 243110 05STIFFI
138 1
  OPEN BRANCH FROM BUS 242984 TO BUS 245656 CKT 1          / 242984 05CHATFL 138 245656
CHATFIEL 69.0 1
  OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1          / 243110 05STIFFI 138 245630 S TIFFIN
69.0 1
  OPEN BRANCH FROM BUS 242953 TO BUS 245602 CKT 1          / 242953 05AIRCO8 138 245602 AIRCO
L8 12.0 1
  OPEN BRANCH FROM BUS 245655 TO BUS 245656 CKT 1          / 245655 CARROTHR 69.0 245656
CHATFIEL 69.0 1
  OPEN BRANCH FROM BUS 245656 TO BUS 245670 CKT 1          / 245656 CHATFIEL 69.0 245670
NEWWASH8 69.0 1
END
```

14. (AEP) The NEVADA8-U SANDSK 69 kV line (from bus 245709 to bus 245715 ckt 1) loads from 145.51% to 147.94% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 4.66 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

15. (AEP) The South Tiffin-Airco (North Central Co-Op) 138 kV line (from bus 243110 to bus 242953 ckt 1) loads from 158.84% to 165.13% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 10.51 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

16. (AEP) The BROK SWR-NEVADA8 69 kV line (from bus 245687 to bus 245709 ckt 1) loads from 151.97% to 154.4% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 4.66 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

17. (AEP) The Greenlawn-Tiffin 138 kV line (from bus 243015 to bus 243130 ckt 1) loads from 121.27% to 126.93% (DC power flow) of its emergency rating (143 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 8.10 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

18. (AEP) The Chatfield-South Tiffin 138 kV line (from bus 242984 to bus 243110 ckt 1) loads from 202.99% to 210.74% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 12.94 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

19. (AEP) The Chatfield-South Tiffin 138 kV line (from bus 242984 to bus 243110 ckt 1) loads from 122.29% to 128.79% (DC power flow) of its normal rating (148 MVA) for non contingency condition. This project contributes approximately 9.63 MW to the thermal violation.

20. (AEP) The GE TIFFI-TIFFIN T 69 kV line (from bus 245619 to bus 245638 ckt 1) loads from 120.77% to 121.45% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 3.06 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

21. (AEP) The MAULE RD-GE TIFFI 69 kV line (from bus 245648 to bus 245619 ckt 1) loads from 121.71% to 122.38% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 3.06 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

22. (AEP) The SYCAMORZ-E.TIFF2 69 kV line (from bus 245635 to bus 245646 ckt 1) loads from 99.26% to 101.11% (DC power flow) of its emergency rating (31 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 3.55 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

23. (AEP) The TIFFIN C-MAULE RD 69 kV line (from bus 245637 to bus 245648 ckt 1) loads from 137.18% to 137.86% (DC power flow) of its emergency rating (73 MVA) for the operational contingency '5150_B2_TOR709A_MOAB'. This project contributes approximately 3.06 MW to the thermal violation.

```
CONTINGENCY '5150_B2_TOR709A_MOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
END
```

24. (AEP) The BUCYRS C-BROK SWR 69 kV line (from bus 245653 to bus 245687 ckt 1) loads from 101.11% to 102.5% (DC power flow) of its emergency rating (54 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 4.66 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
  OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

25. (AEP) The V1-010 TAP-Melmore 138 kV line (from bus 892000 to bus 243039 ckt 1) loads from 194.36% to 203.32% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5240_B2_TOR4783_WOMOAB_V1-010B'. This project contributes approximately 14.96 MW to the thermal violation.

```
CONTINGENCY '5240_B2_TOR4783_WOMOAB_V1-010B'
 OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1          / 242953 05AIRCO8 138 243110 05STIFFI
138 1
 OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1          / 242953 05AIRCO8 138 243137 05W.END
138 1
 OPEN BRANCH FROM BUS 892010 TO BUS 243024 CKT 1          / 242984 05CHATFL 138 243024
05HOWARD 138 1
 OPEN BRANCH FROM BUS 242984 TO BUS 243110 CKT 1          / 242984 05CHATFL 138 243110 05STIFFI
138 1
 OPEN BRANCH FROM BUS 242984 TO BUS 245656 CKT 1          / 242984 05CHATFL 138 245656
CHATFIEL 69.0 1
 OPEN BRANCH FROM BUS 243110 TO BUS 245630 CKT 1          / 243110 05STIFFI 138 245630 S TIFFIN
69.0 1
 OPEN BRANCH FROM BUS 242953 TO BUS 245602 CKT 1          / 242953 05AIRCO8 138 245602 AIRCO
L8 12.0 1
 OPEN BRANCH FROM BUS 245655 TO BUS 245656 CKT 1          / 245655 CARROTHR 69.0 245656
CHATFIEL 69.0 1
 OPEN BRANCH FROM BUS 245656 TO BUS 245670 CKT 1          / 245656 CHATFIEL 69.0 245670
NEWWASH8 69.0 1
END
```

26. (AEP) The Tiffin-Fremont Center 138 kV line (from bus 243130 to bus 243008 ckt 1) loads from 112.36% to 116.4% (DC power flow) of its emergency rating (205 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 8.29 MW to the thermal violation.

```
CONTINGENCY '5121_B2_TOR608'
 OPEN BRANCH FROM BUS 238586 TO BUS 243024 CKT 1          / 238586 02BRKSID 138 243024
05HOWARD 138 1
END
```

27. (AEP) The South Tiffin-S TIFFIN 138/69 kV transformer (from bus 243110 to bus 245630 ckt 1) loads from 103.58% to 104.64% (DC power flow) of its emergency rating (72 MVA) for the operational contingency '5243_B2_TOR4783C_MOAB'. This project contributes approximately 4.73 MW to the thermal violation.

```
CONTINGENCY '5243_B2_TOR4783C_MOAB'
 OPEN BRANCH FROM BUS 242953 TO BUS 243110 CKT 1          / 242953 05AIRCO8 138 243110 05STIFFI
138 1
 OPEN BRANCH FROM BUS 242953 TO BUS 243137 CKT 1          / 242953 05AIRCO8 138 243137 05W.END
138 1
 OPEN BRANCH FROM BUS 242953 TO BUS 245602 CKT 1          / 242953 05AIRCO8 138 245602 AIRCO
L8 12.0 1
END
```

28. (AEP) The Melmore-Fostoria Central 138 kV line (from bus 243039 to bus 243006 ckt 1) loads from 211.43% to 217.63% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5149_B2_TOR709_WOMOAB'. This project contributes approximately 10.35 MW to the thermal violation.

```
CONTINGENCY '5149_B2_TOR709_WOMOAB'
  OPEN BRANCH FROM BUS 243008 TO BUS 243130 CKT 1          / 243008 05FREMCT 138 243130
05TIFFIN 138 1
  OPEN BRANCH FROM BUS 243008 TO BUS 245614 CKT 1          / 243008 05FREMCT 138 245614
FREMNT C 69.0 1
  OPEN BRANCH FROM BUS 243130 TO BUS 245637 CKT 1          / 243130 05TIFFIN 138 245637 TIFFIN C
69.0 1
  OPEN BRANCH FROM BUS 245620 TO BUS 245637 CKT 1          / 245620 GREELY 69.0 245637 TIFFIN C
69.0 1
  OPEN BRANCH FROM BUS 245648 TO BUS 245637 CKT 1          / 245648 MAULE RD 69.0 245637 TIFFIN
C 69.0 1
END
```

29. (AEP) The Airco (North Central Co-Op)-West End 138 kV line (from bus 242953 to bus 243137 ckt 1) loads from 150.63% to 156.92% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 10.51 MW to the thermal violation.

```
CONTINGENCY '5147_B2_TOR707_V1-010A'
  OPEN BRANCH FROM BUS 243006 TO BUS 243039 CKT 1          / 243006 05FOSTOR 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243015 TO BUS 243039 CKT 1          / 243015 05GREENL 138 243039
05MELMOR 138 1
  OPEN BRANCH FROM BUS 243024 TO BUS 892000 CKT 1          / 243024 05HOWARD 138 243039
05MELMOR 138 1
END
```

30. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 206.43% to 215.78% (DC power flow) of its emergency rating (173 MVA) for the operational contingency 'B_LINE1_SR_022'. This project contributes approximately 16.19 MW to the thermal violation.

```
CONTINGENCY 'B_LINE1_SR_022'     /* GALION-GM MANSFIELD 138KV LINE OUTAGE
  DISCONNECT BRANCH FROM BUS 238746 TO BUS 238758 CKT 1     /* 02GALION 138.00 02GM MAN
138.00
END
```

31. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 249.96% to 262.57% (DC power flow) of its normal rating (133 MVA) for non contingency condition. This project contributes approximately 16.78 MW to the thermal violation.