X3-031 Southwest Lima-West Moulton (Apollo I) 138kV

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. X3-031 was studied as a 150 MW (19.5 MW capacity) generating facility consistent with the interconnection application. Project #X3-031 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential network impacts were as follows for the primary point of interconnection:

Primary Interconnection Option - Southwest Lima – West Moulton 138 kV line

Normal System (2015 Summer Conditions Full/Capacity Output)

- No problems identified

Single Contingency (2015 Summer Conditions Full/Capacity Output)

- No problems identified

Multiple Contingency (2015 Summer Conditions Full/Capacity Output)

- No problems identified

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

- None

Normal System (2015 Summer Conditions Full Output)

- Lincoln – T-131 138 kV line loads from 138.8% to 143.5% for the base case
    - The overload on this line will expose project X3-031 to curtailment for summer peak conditions. The IC can choose to upgrade the equipment to mitigate this overload.

Single Contingency (2015 Summer Conditions Full Output)

- None

Multiple Contingency (2015 Summer Conditions Full Output)

- Fostoria Central – West End 138 kV line loads from 98.4% to 100.5% of its emergency rating of 296 MVA for contingency 517_C2/C5
    - Contingency '517' Breaker Failure and Double Circuit Tower Outage of Fostoria Central – Bayshore 345 kV line, Fostoria Central – Lemoyne-Teco 345 kV line.
    - The 1033.5 ACSR conductor section 1 is the limiting element for the Fostoria Central – West End 138 kV line.

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

- Tillman – Timber Switch 138 kV line loads from 124.2% to 128.4% of its emergency rating of 167 for contingency 6631_B2
    - The overload on this line will expose project X3-031 to curtailment for summer peak conditions. The IC can choose to upgrade the equipment to mitigate this overload.

- Timber Switch – S-073 138 kV line loads from 107.7% to 111.9% of its emergency rating of 167 for contingency 6669_C5
    - Contingency '6669' Double Circuit Tower Outage of Lincoln – Robinson Park 138 kV line, and Lincoln – T-131 138 kV line.
    - The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – S-073 138 kV line.

Short Circuit Analysis

- No problems identified.

Additional Limitations of Concern

- None

Local Network Upgrades

- The 1033.5 ACSR conductor section 1 is the limiting element for the Fostoria Central – West End 138 kV line. A sag check will be required for the 1033.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 296 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 1.6 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$6,400.**

- The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – S-073 138 kV line. A sag check will be required for the 397.5 ACSR conductor section 1 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 7.5 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$30,000**.

Secondary Interconnection Option - Southwest Lima 138 kV Station

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)

- Lincoln – T-131 138 kV line loads from 138.8% to 143.4% for the base case
    - The overload on this line will expose project X3-031 to curtailment for summer peak conditions. The IC can choose to upgrade the equipment to mitigate this overload.

Single Contingency (2015 Summer Conditions Full Output)

- None

Multiple Contingency (2015 Summer Conditions Full Output)

- Fostoria Central – West End 138 kV line loads from 98.4% to 100.5% of its emergency rating of 296 MVA for contingency 517_C2/C5
    - Contingency '517' Breaker Failure and Double Circuit Tower Outage of Fostoria Central – Bayshore 345 kV line, Fostoria Central – Lemoyne-Teco 345 kV line.
    - The 1033.5 ACSR conductor section 1 is the limiting element for the Fostoria Central – West End 138 kV line.

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

- Tillman – Timber Switch 138 kV line loads from 124.2% to 128.4% of its emergency rating of 167 for contingency 6669_C5
    - Contingency '6669' Double Circuit Tower Outage of Lincoln – Robinson Park 138 kV line, and Lincoln – T-131 138 kV line.
    - The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – Tillman 138 kV line.

- Timber Switch – S-073 138 kV line loads from 107.7% to 111.8% of its emergency rating of 167 for contingency 6669_C5
    - Contingency '6669' Double Circuit Tower Outage of Lincoln – Robinson Park 138 kV line, and Lincoln – T-131 138 kV line.
    - The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – S-073 138 kV line.

- Moulton – Wapakoneta 69 kV line loads from 104.2% to 109.5% of its emergency rating of 35 MVA for contingency 7330_B2
    - This line will be rebuilt using 336.4 ACSR conductor. The In-Service date is 06/01.2012. The new summer emergency rating will be 73 MVA.

Short Circuit Analysis

- No problems identified.

Stability Analysis

- Not required

Additional Limitations of Concern

- None

Local/Network Upgrades

- The 1033.5 ACSR conductor section 1 is the limiting element for the Fostoria Central – West End 138 kV line. A sag check will be required for the 1033.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 296 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 1.6 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$6,400**.

- The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – S-073 138 kV line and the Tillman – Timber Switch 138 kV line. A sag check will be

required for the 397.5 ACSR conductor section 1 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 9.0 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$52,000**.

Network Impacts

Queue project X3-031 was studied as a(n) 150.0 MW (19.5 MW of which was Capacity) injection into AEP's system. Project X3-031 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential transmission network impacts are as follows:

Primary Interconnection Option - Southwest Lima – West Moulton 138 kV line

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 Southwest Lima-West Lima 138 kV line (from bus 243122 to bus 243136 ckt 1) loads from 104.96% to 112.98% (DC power flow) of its emergency rating (388 MVA) for the tower contingency '6533', loss of East Lima-Southwest Lima and East Lima-U2-041 345kV circuits. This project contributes approximately 31.13 MW to the thermal violation.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

1. The 1590 ACSR conductor section 1 and the West Lima Bus 1 are the limiting elements for the Southwest Lima - West Lima 138 kV line.

   A sag check will be required for the 1590 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 388 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 3.8 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$15,200**

   The 138 kV Bus 1 at West Lima 138 kV Station will be replaced. Estimated Cost (2012 Dollars) for the 138 kV Bus: **$300,000**

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*.

2. (AEP) The Convoy-Robison Park 345 kV line (from bus 242933 to bus 243231 ckt 1) loads from 120.33% to 120.59% (DC power flow) of its emergency rating (897 MVA) for the operational contingency '724_B2_TOR581_WOMOP'. This project contributes approximately 14.68 MW to the thermal violation.

Secondary Interconnection Option - Southwest Lima 138 kV Station

Potential transmission network impacts are as follows:

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 Southwest Lima-West Lima 138 kV line (from bus 243122 to bus 243136 ckt 1) loads from 104.96% to 113.68% (DC power flow) of its emergency rating (388 MVA) for the tower contingency '6533', loss of East Lima-Southwest Lima and East Lima-U2-041 345kV circuits. This project contributes approximately 31.13 MW to the thermal violation.

2. (FE) The Beaver-Carlisle 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 117.64% to 117.8% (DC power flow) of its emergency rating (1030 MVA) for the tower contingency '513', loss of the tower line between Avon and Beaver 345kV stations. This project contributes approximately 10.41 MW to the thermal violation.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

1. The 1590 ACSR conductor section 1 and the West Lima Bus 1 are the limiting elements for the Southwest Lima - West Lima 138 kV line.

A sag check will be required for the 1590 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 388 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 3.8 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$15,200**

The 138 kV Bus 1 at West Lima 138 kV Station will be replaced. Estimated Cost (2012 Dollars) for the 138 kV Bus: **$300,000**

2. The overload on the Beaver-Carlisle 345kV circuit can be alleviated by the replacement of a wave trap at Beaver substation. The total cost for this work is **$91,000**.

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*.

3. (AEP) The Convoy-Robison Park 345 kV line (from bus 242933 to bus 243231 ckt 1) loads from 120.33% to 122.04% (DC power flow) of its emergency rating (897 MVA) for the operational contingency '724_B2_TOR581_WOMOP'. This project contributes approximately 15.39 MW to the thermal violation.

X3-031 Southwest Lima-West Moulton (Apollo I) 138kV

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 X3-031 was studied as a 150 MW (19.5 MW capacity) generating facility consistent with the interconnection application. Project #X3-031 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential network impacts were as follows for the primary point of interconnection:

Primary Interconnection Option - Southwest Lima – West Moulton 138 kV line

Normal System (2015 Summer Conditions Full/Capacity Output)

- No problems identified

Single Contingency (2015 Summer Conditions Full/Capacity Output)

- No problems identified

Multiple Contingency (2015 Summer Conditions Full/Capacity Output)

- No problems identified

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

- None

Normal System (2015 Summer Conditions Full Output)

- Lincoln – T-131 138 kV line loads from 138.8% to 143.5% for the base case
    - The overload on this line will expose project X3-031 to curtailment for summer peak conditions. The IC can choose to upgrade the equipment to mitigate this overload.

Single Contingency (2015 Summer Conditions Full Output)

- None

Multiple Contingency (2015 Summer Conditions Full Output)

- Fostoria Central – West End 138 kV line loads from 98.4% to 100.5% of its emergency rating of 296 MVA for contingency 517_C2/C5
    - Contingency '517' Breaker Failure and Double Circuit Tower Outage of Fostoria Central – Bayshore 345 kV line, Fostoria Central – Lemoyne-Teco 345 kV line.
    - The 1033.5 ACSR conductor section 1 is the limiting element for the Fostoria Central – West End 138 kV line.

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

- Tillman – Timber Switch 138 kV line loads from 124.2% to 128.4% of its emergency rating of 167 for contingency 6631_B2
    - The overload on this line will expose project X3-031 to curtailment for summer peak conditions. The IC can choose to upgrade the equipment to mitigate this overload.

- Timber Switch – S-073 138 kV line loads from 107.7% to 111.9% of its emergency rating of 167 for contingency 6669_C5
    - Contingency '6669' Double Circuit Tower Outage of Lincoln – Robinson Park 138 kV line, and Lincoln – T-131 138 kV line.
    - The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – S-073 138 kV line.

Short Circuit Analysis

- No problems identified.

Additional Limitations of Concern

- None

Local Network Upgrades

- The 1033.5 ACSR conductor section 1 is the limiting element for the Fostoria Central – West End 138 kV line. A sag check will be required for the 1033.5 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 296 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 1.6 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$6,400.**

- The 397.5 ACSR conductor section 1 is the limiting element for the Timber Switch – S-073 138 kV line. A sag check will be required for the 397.5 ACSR conductor section 1 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 7.5 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$30,000**.

Network Impacts

Queue project X3-031 was studied as a(n) 150.0 MW (19.5 MW of which was Capacity) injection into AEP's system. Project X3-031 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential transmission network impacts are as follows:

Primary Interconnection Option - Southwest Lima – West Moulton 138 kV line

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 Southwest Lima-West Lima 138 kV line (from bus 243122 to bus 243136 ckt 1) loads from 104.96% to 112.98% (DC power flow) of its emergency rating (388 MVA) for the tower contingency '6533', loss of East Lima-Southwest Lima and East Lima-U2-041 345kV circuits. This project contributes approximately 31.13 MW to the thermal violation.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

1. The 1590 ACSR conductor section 1 and the West Lima Bus 1 are the limiting elements for the Southwest Lima - West Lima 138 kV line.

   A sag check will be required for the 1590 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 388 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 3.8 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$15,200**

   The 138 kV Bus 1 at West Lima 138 kV Station will be replaced. Estimated Cost (2012 Dollars) for the 138 kV Bus: **$300,000**

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*.

2. (AEP) The Convoy-Robison Park 345 kV line (from bus 242933 to bus 243231 ckt 1) loads from 120.33% to 120.59% (DC power flow) of its emergency rating (897 MVA) for the operational contingency '724_B2_TOR581_WOMOP'. This project contributes approximately 14.68 MW to the thermal violation.

Secondary Interconnection Option - Southwest Lima 138 kV Station

Potential transmission network impacts are as follows:

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 Southwest Lima-West Lima 138 kV line (from bus 243122 to bus 243136 ckt 1) loads from 104.96% to 113.68% (DC power flow) of its emergency rating (388 MVA) for the tower contingency '6533', loss of East Lima-Southwest Lima and East Lima-U2-041 345kV circuits. This project contributes approximately 31.13 MW to the thermal violation.

2. (FE) The Beaver-Carlisle 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 117.64% to 117.8% (DC power flow) of its emergency rating (1030 MVA) for the tower contingency '513', loss of the tower line between Avon and Beaver 345kV stations. This project contributes approximately 10.41 MW to the thermal violation.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

1. The 1590 ACSR conductor section 1 and the West Lima Bus 1 are the limiting elements for the Southwest Lima - West Lima 138 kV line.

A sag check will be required for the 1590 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 388 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 3.8 mile section of line would need to be rebuilt. Estimated Cost (2012 Dollars) for the sag study: **$15,200**

The 138 kV Bus 1 at West Lima 138 kV Station will be replaced. Estimated Cost (2012 Dollars) for the 138 kV Bus: **$300,000**

2. The overload on the Beaver-Carlisle 345kV circuit can be alleviated by the replacement of a wave trap at Beaver substation. The total cost for this work is **$91,000**.

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*.

3. (AEP) The Convoy-Robison Park 345 kV line (from bus 242933 to bus 243231 ckt 1) loads from 120.33% to 122.04% (DC power flow) of its emergency rating (897 MVA) for the operational contingency '724_B2_TOR581_WOMOP'. This project contributes approximately 15.39 MW to the thermal violation.