X2-058 Buckley Road (Colt Station Wind) 138kV

Generation Interconnection

AEP 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. Reserve Energy project X2-058 was studied as a 149.5 MW (19.5 MW capacity) wind generating facility consistent with the interconnection application. Project #X2-058 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

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)

- None

Single Contingency (2015 Summer Conditions Full Output)

- Fremont Center – West Fremont 69 kV line loads from 96.7% to 101.5% of its emergency rating (96 MVA) for contingency 5250_B2.

Multiple Contingency (2015 Summer Conditions Full Output)

- Woodville Tap – Lemoyne 138 kV line (FE) loads from 99.19% to 105.56% of its emergency rating (343) for contingency C5_TWL_WR022.

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

- Brookside (FE) - Howard 138 kV line loads from 308.6% to 313.5% of its normal rating (133 MVA) for the base case. U4-028 overloads the Howard (AEP) – Brookside (FE) 138 kV to 115% (158.9 MVA) of the summer normal rating of 138 MVA.

- Fremont Center - Tiffin 138 kV line loads from 106.7% to 110.5% of its normal rating (205 MVA) for the base case.

- Brookside (FE) - Howard 138 kV line loads from 280.4% to 283.7% of its emergency rating (173 MVA) for contingency 1996_C3. U4-028 overloads the Howard (AEP) – Brookside (FE) 138 kV to 120% (200.4 MVA) of the summer emergency rating of 167 MVA for a single contingency outage of the First Energy Beaver – Davis Betsy 345 kV line.

- Apple Valley – North Lexington 138 kV line loads from 116.5% to 119.8% of its emergency rating (205) for contingency 7118_C1. Project W3-085 loads this line from 82.1% to 107.5% with an impact of 25.37% for contingency category C1 '7118_C1_05HO'

- Fremont Center - Tiffin 138 kV line loads from 137.6% to 142.7% of its normal rating (205 MVA) for contingency 517_C2. Project W4-021A loads this line from 96.9% to 106.3% of its emergency rating (205 MVA) with an impact of 9.34% for contingency 513 (Category C5).

- Greenlawn - Melmore 138 kV line loads from 121.7% to 125.9% of its emergency rating (143 MVA) for contingency 7162_B1. Project W3-012 loads this line from 92.8% to 105.8% with an impact of 12.95% for contingency category C2 '517_C2'

- Greenlawn - Tiffin 138 kV line loads from 105.9% to 110.4% of its emergency rating (143 MVA) for contingency 7162_B1. Project W3-085 loads this line from from 90.1% to 104.9% with an impact of 14.81% for contingency category C2 '517_C2'

- Howard – North Bellville 138 kV line (CKT. 1) loads from 107.2% to 110.3% of its emergency rating (133 MVA) for contingency 7162_B1. Project W4-021A loads this line from 90.3% to 110.6% of its emergency rating (133 MVA) with an impact of 20.29% for contingency 5121_B2_TOR6.

- Howard – North Lexington 138 kV line loads from 137.7% to 141.5% of its emergency rating (179 MVA) for contingency 7118_C1. Project W4-021A loads this line from 86.3% to 111% of its emergency rating (179 MVA) with an impact of 24.65% for contingency 5121_B2_TOR6.

- Fremont Center – Holran 69 kV line loads from 117.2% to 126.8% of its emergency rating (31 MVA) for contingency 5150_B2.

- Holran – Maple Grove 69 kV line loads from 126.1% to 136% of its emergency rating (31 MVA) for contingency 5150_B2. Project W2-011 loads this line from 99.2% to 102.6% with an impact of 3.4% for contingency 5150_B2_TOR7

- Maple Grove – Riverview 69 kV line loads from 146.4% to 156.5% of its emergency rating (31 MVA) for contingency 5150_B2. Project W3-011 loads this line from 99.5 % to 110.4% with an impact of 10.88% for contingency 517

- Broken Sword – Nevada (North Central CO-OP) 69 kV line loads from 230% to 232.9% of its emergency rating (31 MVA) for contingency 5121_B2.

Short Circuit Analysis

- None

Stability Analysis

- Not required in Feasibility Study. Will be done in the Impact Study.

Additional Limitations of Concern

- None

Local/Network Upgrades

- The East Fremont MOAB Switch "W" and Fremont Center Switch "J" are the limiting elements for the Fremont Center – West Fremont 69 kV line. SCADA system will be used to determine if the above items need to be curtailed.

- A team of AEP and First Energy planners are working on resolving the issues that cause the overload of the Brookside (FE) – Howard (AEP) 138 kV line. The solution could be to build a new line parallel to the existing line.

- The 556 ACSR (section 1) of the conductor is the limiting elements for the Apple Valley (Licking CO-OP) – North Lexington 138 kV line. A sag check will be required to determine if the line section can be operated above their 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 19.3 mile section of line would need to be rebuilt. Estimated Cost (2011 Dollars) for the sag study: **$77,200**

- 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 their 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**

- The Greenlawn relay thermal limit is the limiting element for the Greenlawn – Melmore 138 kV line. The cost to perform an engineering study to determine if the thermal limits can be adjusted is **$10,000** (2011 dollars).

- The relay thermal limit is the limiting element for the overload on the Greenlawn – Tiffin 138 kV line. The cost to perform an engineering study to determine if the thermal limits can be adjusted is **$10,000** (2011 dollars)*.

- The 556 ACSR (section 1) of the conductor is the limiting elements for the Howard – North Bellville 138 kV line. A sag check will be required to determine if the line section can be operated above their emergency rating of 133 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 mile section of line would need to be rebuilt. Estimated Cost (2011 Dollars) for the sag study: **$72,000**

- The Howard Bus, Howard Risers, Howard Switch, Howard Wavertrap, and the 556 ACSR (section 1) of the conductor are the limiting elements for the Howard – North Lexington 138 kV line. A sag check will be required to determine if the line section can be operated above their 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 12.6 mile section of line would need to be rebuilt. Estimated Cost (2011 Dollars) for the sag study: **$50,400**. Estimated Cost (2011 Dollars) for the bus, riser, switch, and wavetrap replacement: **$500,000.**

- The Copper (section 1) conductor is the limiting element for the Fremont Center – Holran 69 kV line. SCADA system will be used to determine if the line needs to be curtailed.

- The Copper (section 2) conductor is the limiting element for the Holran – Maple Grove 69 kV line. If SCADA exists at the station it will be used to determine if the line needs to be curtailed. If no SCADA exists, it will cost approximately **$250,000** to install a new SCADA system.

- The Copper (section 1) conductor is the limiting element for the Maple Grove – Riverview 69 kV line. SCADA system will be used to determine if the line needs to be curtailed.

- The Copper (section 1) conductor is the limiting element for the Broken Sword – Nevada (North Central CO-OP) 69 kV line. If SCADA exists at the station it will be used to determine if the line needs to be curtailed. If no SCADA exists, it will cost approximately **$250,000** to install a new SCADA system.

Network Impacts

Queue project X2-058 was studied as a(n) 149.5 MW (19.4 MW of which was Capacity) injection into AEP's system at the 05BUCKLR 138.0 kV substation. Project X2-058 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

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 Hayes 345/138 kV transformer (from bus 239289 to bus 239290 ckt 1) loads from 99.91% to 100.12% (DC power flow) of its emergency rating (573 MVA) for the tower contingency 'C5-TWL-CR041'. This project contributes approximately 7.51 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.)

2. (FE) The Lakeview-Greenfield 138 kV line (from bus 238874 to bus 238768 ckt 1) loads from 276.70% to 277.57% (DC power flow) of its emergency rating (243 MVA) for the tower contingency 'C5-TWL-CR040'. This project contributes approximately 13.17 MW to the thermal violation.

3. (AEP) The Greenlawn-Tiffin 138 kV line (from bus 243015 to bus 243130 ckt 1) loads from 118.53% to 119.37% (DC power flow) of its emergency rating (143 MVA) for the tower contingency 'C5-TWL-SR062'. This project contributes approximately 7.39 MW to the thermal violation.

4. (FE) The Woodville Tap-Lemoyne 138 kV line (from bus 239176 to bus 238890 ckt 1) loads from 100.05% to 106.5% (DC power flow) of its emergency rating (343 MVA) for the tower

contingency 'C5-TWL-WR022'. This project contributes approximately 22.11 MW to the thermal violation.

5. (FE) The Ottawa-Lakeview 138 kV line (from bus 239030 to bus 238874 ckt 1) loads from 202.07% to 202.69% (DC power flow) of its emergency rating (339 MVA) for the tower contingency 'C5-TWL-CR040'. This project contributes approximately 13.17 MW to the thermal violation.

6. (AEP) The Tiffin-Fremont Center 138 kV line (from bus 243130 to bus 243008 ckt 1) loads from 110.13% to 110.85% (DC power flow) of its emergency rating (205 MVA) for the tower contingency 'C5-TWL-SR062'. This project contributes approximately 9.07 MW to the thermal violation.

7. (FE) The Beaver-Carlisle 345 kV line (from bus 238569 to bus 238607 ckt 1) loads from 103.70% to 104.0% (DC power flow) of its emergency rating (1030 MVA) for the tower contingency '513'. This project contributes approximately 19.46 MW to the thermal violation.

New 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.)

1,2,4,5. Install a new 138kV line between 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. See fix under AEP Local Network Upgrades

6. See fix under AEP Local Network Upgrades

7. The overload on the Beaver-Carlisle 345kV circuit can be alleviated by replacing the 1600A wave trap at Beaver substation with a wave trap rated at 3000A or better. PJM estimates the cost to be **$250,000**.

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.)

9. (AEP) The Findlay-New Liberty 138 kV line (from bus 243005 to bus 243057 ckt 1) loads from 102.77% to 113.93% (DC power flow) of its emergency rating (150 MVA) for the operational contingency '5145_B2_TOR706_WOMOAB'. This project contributes approximately 16.73 MW to the thermal violation.

10. (FE) The Lakeview-Greenfield 138 kV line (from bus 238874 to bus 238768 ckt 1) loads from 147.78% to 148.38% (DC power flow) of its emergency rating (243 MVA) for the operational contingency 'B_LINE_SY_21B'. This project contributes approximately 9.12 MW to the thermal violation.

11. (AEP) The Northeast Findlay Tap-North Findlay 138 kV line (from bus 243054 to bus 243059 ckt 1) loads from 111.59% to 122.86% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5248_B2_TOR8651_W3-012A'. This project contributes approximately 18.82 MW to the thermal violation.

12. (AEP) The Greenlawn-Tiffin 138 kV line (from bus 243015 to bus 243130 ckt 1) loads from 118.16% to 118.99% (DC power flow) of its emergency rating (143 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 7.38 MW to the thermal violation.

13. (AEP) The Melmore-V1-010 TAP 138 kV line (from bus 243039 to bus 892000 ckt 1) loads from 134.39% to 135.23% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5149_B2_TOR709_WOMOAB'. This project contributes approximately 8.71 MW to the thermal violation.

14. (AEP) The Fostoria Central-Northeast Findlay Tap 138 kV line (from bus 243006 to bus 243054 ckt 1) loads from 127.69% to 139.46% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5248_B2_TOR8651_W3-012A'. This project contributes approximately 19.66 MW to the thermal violation.

15. (AEP) The V1-010 TAP-Howard 138 kV line (from bus 892000 to bus 243024 ckt 1) loads from 222.80% to 223.7% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5240_B2_TOR4783_WOMOAB_V1-010B'. This project contributes approximately 9.36 MW to the thermal violation.

16. (AEP) The V1-010 TAP-Howard 138 kV line (from bus 892000 to bus 243024 ckt 1) loads from 127.30% to 128.15% (DC power flow) of its normal rating (138 MVA) for non

contingency condition. This project contributes approximately 7.20 MW to the thermal violation.

17. (AEP) The V1-010 TAP-Howard 138 kV line (from bus 892010 to bus 243024 ckt 1) loads from 214.98% to 215.91% (DC power flow) of its emergency rating (167 MVA) for the operational contingency '5147_B2_TOR707_V1-010A'. This project contributes approximately 9.62 MW to the thermal violation.

18. (AEP) The V1-010 TAP-Howard 138 kV line (from bus 892010 to bus 243024 ckt 1) loads from 120.63% to 121.49% (DC power flow) of its normal rating (138 MVA) for non contingency condition. This project contributes approximately 7.33 MW to the thermal violation.

19. (FE) The Ottawa-Lakeview 138 kV line (from bus 239030 to bus 238874 ckt 1) loads from 129.69% to 130.12% (DC power flow) of its emergency rating (339 MVA) for the operational contingency 'B_LINE_SY_21B'. This project contributes approximately 9.12 MW to the thermal violation.

20. (AEP) The W3-012 TAP-Findlay 138 kV line (from bus 903280 to bus 243005 ckt 1) loads from 103.86% to 112.35% (DC power flow) of its emergency rating (219 MVA) for the operational contingency '5145_B2_TOR706_WOMOAB'. This project contributes approximately 18.60 MW to the thermal violation.

21. (AEP) The W3-012 TAP-Findlay 138 kV line (from bus 903280 to bus 243005 ckt 1) loads from 110.74% to 112.27% (DC power flow) of its normal rating (150 MVA) for non contingency condition. This project contributes approximately 14.21 MW to the thermal violation.

22. (AEP) The Tiffin-Fremont Center 138 kV line (from bus 243130 to bus 243008 ckt 1) loads from 109.79% to 110.51% (DC power flow) of its emergency rating (205 MVA) for the operational contingency '5121_B2_TOR608'. This project contributes approximately 9.06 MW to the thermal violation.

23. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 215.29% to 216.02% (DC power flow) of its emergency rating (173 MVA) for the operational contingency 'B_LINE1_SR_022'. This project contributes approximately 7.84 MW to the thermal violation.

24. (AEP/FE) The Howard-Brookside 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 270.15% to 271.1% (DC power flow) of its normal rating (133 MVA) for non contingency condition. This project contributes approximately 7.81 MW to the thermal violation.