#U1-024 Dequine-Eugene 345kV

Generation Interconnection

This analysis was completed to assess the reliability impact for the new generation interconnecting to the PJM system as a capacity resource.

Local & Network AEP 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 Horizon project was studied as a 500 MW net energy injection (65 MW capacity) consistent with the interconnection application. This project was studied with PJM projects #Q01, Q03, S06, T126, T127, T183, and T184 already in service in the vicinity of U1-024.The results are summarized below.

Normal System (2011 Summer Conditions)

- AEP Olive – S06[1] 345 kV line is overloaded to 111% (936 MVA) of its normal rating under system normal conditiions. Without the addition of U1-024 Project, the same facilities are loaded to 101% (854 MVA) of normal rating.

*** It was observed that under certain contingencies NIPSCO owned Reynolds transformer, Ameren owned Casey West – Breed line, and Duke owned Westwood transformer were overloaded. These overloads will be addressed with NIPSCO, Duke, Ameren, or MISO in the Impact Study.

Single Contingency (2011 Summer Conditions)

- AEP Dequine – Reynolds[3] 345 kV line[2] gets overloaded to 131% (1221 MVA) of its normal rating for an outage of the AEP Olive – S06 345 kV line. Without the addition of U1-024 Project, the same facilities are loaded to 124% (1124 MVA) of normal rating under the same contingency.

- AEP Dequine – S06[3] 345 kV line gets overloaded to 131% (1221 MVA) of its normal rating for an outage of the AEP Olive – S06 345 kV line. Without the addition of U1-024 Project, the same facilities are loaded to 122% (1000 MVA) of normal rating under the same contingency.

- AEP Olive – Reynolds 345 kV line[2] gets overloaded to 103% (994 MVA) of its normal rating for an outage of the AEP Olive – S06 345 kV line. Without the addition of U1-024

[1] Please note that because these lines are overloaded under normal conditions, the same overload issues may appear for several contingencies in the following sections but may not be discussed hereafter.
[2] A section of AEP Dequine – Olive 345 kV line.

Project, the same facilities are loaded to 93% (891 MVA) of normal rating under the same contingency.

Multiple Contingency (2011 Summer Conditions)

- AEP Dequine – Reynolds[3] 345 kV line[2] gets overloaded to 132% (1272 MVA) of its emergency rating for an outage of AEP Jefferson - Greentown 765 kV line and AEP Olive – S06 345 kV line. Without the addition of U1-024 Project, the same facilities are loaded to 118% (1130 MVA) of emergency rating under the same contingency.

- AEP Olive – Reynolds[3] 345 kV line[2] gets overloaded to 129% (1239 MVA) of its emergency rating for an outage of AEP Jefferson – Rockport 765 kV line and AEP Olive – S06 345 kV line. Without the addition of U1-024 Project, the same facilities are loaded to 115% (1102 MVA) of emergency rating under the same contingency.

- AEP Olive – S06 345 kV line gets overloaded to 164% (1392 MVA) of its emergency rating for an outage of AEP Jefferson – Rockport 765 kV line and AEP Olive – Reynolds345 kV line. Without the addition of U1-024 Project, the same facilities are loaded to 149% (1259 MVA) of emergency rating under the same contingency.

- AEP Olive 345/138 kV Transformer #2 gets overloaded to 102% (842 MVA) of its emergency rating for an outage of AEP Cook – Olive 345 kV line and AEP Dumont – Olive 345 kV line. Without the addition of U1-024 Project, the same facilities are loaded to 97% (792 MVA) of emergency rating under the same contingency.

- Assuming that the generators at bus U1-024 are operating at unity power factor, a voltage collapse could occur at AEP Dequine 345 kV bus for an outage of AEP Olive – S06 345 kV line and AEP Jefferson – Greentown 765 kV line. The voltage violation and upgrades required to address these violations will be discussed in the stability analysis which is part of the impact study.

*** Please note that other voltage issues and collapses were observed within the Dequine area when certain contingencies were taken. These issues were not addressed in the above sections and will be studied in detail as part of the stability analysis.

Short Circuit Analysis

- No problems identified

Stability Analysis

- Stability studies were not performed as part of this Feasibility Study and are not normally performed as part of a Facility Study effort. The stability assessments are part of the System Impact Study. Based upon the results of this future System Impact Study, the

[3] The affected line may appear in multiple contingencies that are not mentioned.

extent of system upgrades could change and the associated costs could be significantly different.

Local/Network Upgrades

The 932 MVA SN/SE rating for the Dequine – Reynolds 345 kV circuit is not correct. It is based on a relay limitation that has been eliminated. The present rating should be based on the conductor rating. However, the conductor for this circuit was installed following extensive ice storm damage and is not the original conductor. The original conductor was 1414 MCM ACSR (paper expanded), and this is what the transmission towers were designed for. However, the replacement conductor was 2303 MCM ACAR. Although similar in size, this conductor has different sag characteristics than the original conductor. Therefore, a sag study is required for the Dequine – Reynolds 345 kV circuit to determine the maximum conductor operating temperature(s), and the associated rating(s).

To address the Olive – S06 345 kV circuit overload and Dequine – S06 345 kV circuit overload, structure & sag analyses will be required to determine if the circuit can be reconductored with a higher capacity conductor. If these analyses eliminate this alternative, then Olive – S06 345 kV and Dequine – S06 345 kV circuits will need to be rebuilt. The cost of rebuilding this double circuit line will be approximately **$1,700,000 per mile**. The cost of reconductoring will be less than rebuilding. However, the cost for reconductoring cannot be provided before the structure and sag studies are completed (some structures may still need to be replaced).

The structure & sag studies required for the Olive – S06 345 kV, Dequine – S06 345 kV and Dequine – Reynolds 345 kV overloads can be performed in the Facility Study and is estimated to cost approximately **$350,000**. It will require approximately 20 weeks from initiation. Most of the conductor lengths for the two circuits involved are located on the same towers. Therefore, a single study should be required to address both overload issues.

AEP Olive 345/138 kV transformer gets overloaded under a double contingency involving AEP Cook – Olive 345 kV line and AEP Dumont – Olive 345 kV line. The overload condition does not exist in the absence of U1-024 Project. The plans for improvement to relieve the overload condition for this facility as well as the cost estimate can be provided as part of the System Impact Study.

AEP Transmission Planning seeks direction from PJM concerning cost allocation protocols. The best plan to relieve the overload conditions may require system reconfiguration, which, in turn, may create bottlenecks. From a cost perspective, even though such plans have long-term benefits, these improvements tend to be very expensive. The least expensive plan, on the other hand, may be merely a bandage. Since such an upgrade may require cost allocation, AEP hereby seeks direction from PJM in evaluating improvement plans.

Reactive Requirements

PJM requires a power factor correction to 95% lead/lag at the point of interconnection for wind generating facilities. It is expected that Horizon will adhere to this standard.

Network Impacts

The queue project U1-024 was studied as a 500MW (100MW capacity) injection into the AEP system. The project is modeled as a tap of the Dequine - Eugene 345kV substation. U1-024 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were 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 contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

No problems identified.

Short Circuit

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. The Dequine-Westwood (PSI) 345kV line loads from 102.18% to 109.36% (DC power flow) of its emergency rating (809MVA) for the tower line outage (AEP_TOWER33_WITH_S06B_S31A). This project contributes approximately 58.1MW to the thermal violation.

2. The Kempton-N. Northwest 500kV line loads from 195.34% to 197.12% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (19). This project contributes approximately 51.4MW to the thermal violation.

3. The Conastone-Peach Bottom 500kV line loads from 155.00% to 156.77% (DC power flow) of its emergency rating (2598MVA) for the tower line outage (CONAS_PB). This project contributes approximately 45.8MW to the thermal violation.

Delivery of Energy Portion of Interconnection Request

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

As a result of the aggregate energy resources in the area, the following violations were identified:

1. The S06C-Olive 345kV line loads from 127.5% to 138.2% (DC power flow) of its emergency rating (848MVA) for the single line contingency outage (AEP70). This project contributes approximately 91.1MW to the thermal congestion.

2. The Breed-W. Casey (CIPS) 345kV line loads from 99.5% to 101.6% (DC power flow) of its emergency rating (1466MVA) for the single line contingency outage (AEP24). This project contributes approximately 30.5MW to the thermal congestion.

3. The Dequine-Reynolds 345kV line loads from 111.7% to 120.4% (DC power flow) of its emergency rating (932MVA) for the single line contingency outage (AEP24). This project contributes approximately 81.3MW to the thermal congestion.

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 overload on the Dequine-Westwood 345kV circuit can be alleviated by reconductoring the circuit. Actual cost will be detailed in the Impact Study report after collabaration with MISO.

2. The overload on the Kemptown-N. Northwest 500kV circuit can be alleviated by installing the following.

Kemptown to North Northwest 500 kV line – Install 2 single circuit 500kV lines at an estimated cost of **$ 279 million** and estimated time of 10 yrs.

Assumptions:
New 350 ft. wide R/W parallels existing Northwest to Mt Airy Tap R/W
Total R/W length = 28.3 miles

3 - bundle 1,590 kcm conductor
Kemptown located 1/4 mile west of Mt Airy Tap
North Northwest located 4 miles north of Northwest

Substation Terminations (all in 2012 dollars):
NNW - Install a 3 breaker bay **$7.7M**
Kemptown - Install a 3 breaker bay **$7.7M**

3. The overload on the Conastone-Beach Pottom 500kV circuit can be alleviated by installing the following.

The Peach Bottom – Conastone 500kV overload can be alleviated by a large upgrade which was originally proposed in the R queue, but has since grown and expanded:

BG&E portion of the Conastone – Peach Bottom line:
Conastone Substation - **3 - 4 years** to complete – total estimate for this work is $**39M**
• Rebuild 3 existing bays to 4000A (also add breaker in one of the existing bays)
• Build new 4000A bay and install 3 breakers
• Relocate Hunterstown 500kV line
• Replace 4 inch bus with 5 inch

Transmission Line Component - **7 years** to build after notice to proceed - total estimate for this work is **$320.2M**
• 2 - Double Circuit 500 kV OH lines from Conastone - Graceton - MD line
• 2 - UG 230 kV circuits from Conastone - Graceton *
• 3 - UG 230 kV circuits from Graceton - MD line
• 1 - UG 115 kV circuit from Graceton - Five Forks
• Acquire additional 50 ft. wide R/W Graceton - MD line
• Remove existing OH lines/structures

* assumes RTEP project b0497 Install a second Conastone - Graceton 230 kV circuit

PECO portion of the Conastone – Peach Bottom line:
Assumes 500 kV lines with ratings equal to the rating of the 4 inch diameter aluminum bus work at Peach Bottom, i.e. 3366 MVA normal and 4183 MVA emergency are able to be built.

• Relocate Peach Bottom to Graceton 220-08 line to underground to facilitate construction of additional 500kV lines in the Conastone to Peach Bottom right of way. The estimated cost to perform this work is **$29.6M**

• The underground line will require parallel pipe type cables to achieve a rating of 800MVA. The estimated cost to perform this work is **$61M** and **36 months** to complete.

Note: the 220-08 line is an offsite source for the Peach Bottom Atomic Power Station and its integrity must be maintained.

• Remove existing 220-08 line towers to clear the north side of the right of way for 500kV construction. The estimated cost to perform this work is **$1.5M** and **6 months** to complete.

• Construct new double circuit 500kV line on the north side of the 300 foot wide Peach Bottom to Maryland state line right of way. The estimated cost to perform this work is **$17M** and **30 months** to complete after the removal of the existing 230 kV tower line.

• Remove existing 5012 line towers to clear the south side of the right of way for new higher capacity 500kV lines. The estimated cost to perform this work is **$1.5M** and **6 months** to complete.

• Construct second new double circuit 500kV line on the south side of the Peach Bottom to Maryland state line right of way. The estimated cost to perform this work is **$17M** and **30 months** to complete after the removal of the existing 500 kV tower line.

• Upgrade 5012 line substation equipment to achieve the new higher rating. The estimated cost to perform this work is **$3M** and **18 months** to complete.

• Expand the 500kV substations (North and South) at Peach Bottom to accommodate three additional 500kV lines. The estimated cost to perform this work is **$18M** ($6M per new line) and **30 months** to complete.

• Build a third new (fourth overall) 500kV overhead line for an estimated cost of $15.0M. The Peach Bottom 500kV substation also needs to be expanded for an estimated cost of $10M. The total estimated cost of this portion of the upgrade is **$25.0M** and the time estimate to build the upgrade is **8 years**.

Note: The substation work may have to be coordinated with refueling outages at the Peach Bottom Atomic Power Station and that the overall project may overstress several 500 kV circuit breakers.

These estimates do not include the cost for the new right-of-way required to build the new lines. It should be noted that this right-of-way could be very difficult or even impossible to acquire. If the proper right-of-way is not available this project would be essentially infeasible based on the current system model.

MISO Impacts

Any impacts on the MISO transmission system will be identified in the Impact Study.