

#T94 Cook-Palisades (Covert) 345kV
Generation Interconnection

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

Network Impacts

AEP Local and Network Impacts

The impact on the AEP System of the proposed connection of the Covert generating facility was assessed for adherence to applicable reliability criteria. EHV transmission system performance must meet single and double contingency operational planning criteria in accordance with the AEP FERC Form 715. The proposed project was studied as a 1,200 MW net capacity consistent with the interconnection application.

The impact analysis was conducted using a study base case that models 2010 summer conditions. It includes a detailed model of the AEP transmission and subtransmission systems with load scaled to the most recent forecast for 2010 summer. The non-AEP transmission system was obtained from the 2007 Series MMWG base case for 2009 summer, since this was the closest date available from the 2007 Series (the most recent series). The resulting case represented summer peak load conditions.

Historical data indicates that loading on the Cook - Palisades 345 kV DCT is heaviest during shoulder peak load conditions when the Ludington pumped storage facility near Ludington, Michigan is operating in pumping mode. Facility loading data for the past year indicates flows are in the Cook to Palisades direction (south to north) approximately 95 percent of the time. When flows are in the Cook to Palisades direction, they exceed 750 MW out of Cook on the Cook - Benton Harbor - Palisades 345 kV #1 circuit 25 percent of the time and on the Cook - Palisades 345 kV #2 circuit 20 percent of the time. In the 2009 summer MMWG base case, flows on these two circuits are less than 100 MVA. This is because in this peak load model, the Ludington pumped storage facility is in generating rather than pumping mode. Also, in general, this case does not include the effects of non-firm transactions. In order to develop a reasonable study case for use in impact analysis, it was necessary to modify the base case so that increased flows were modeled.

Prior to modeling additional transfers into Michigan, load on the AEP, METC, and ITC systems was reduced to 80 percent of peak to represent shoulder peak conditions. Ludington generation was turned off, and AEP, METC, and ITC generation was adjusted to match the reduced load (Covert generation remained at full output). In this step, existing area interchange was maintained. Following load adjustment, all six Ludington pumps were turned on, Zeeland generation (in west-central Michigan) was turned off, and pumping/replacement power was obtained from Illinois (from the Commonwealth Edison and Ameren Illinois systems). These changes resulted in flows at Cook of 745 MVA on the Cook - Benton Harbor - Palisades 345 kV #1 circuit and 707 MVA on the Cook - Palisades 345 kV #2 circuit.

As a final base case creation step, the 1,200 MW output from Covert generation was dispatched into the PJM market. Generation in the mid-Atlantic region of PJM was reduced by 1,200 MW, generation in METC was increased by 1,200 MW, and PJM and METC area interchanges were adjusted accordingly. This resulted in reduced flows at Cook of 560 MVA on the Cook - Benton Harbor - Palisades 345 kV #1 circuit and 510 MVA on the Cook - Palisades 345 kV #2 circuit.

In order to analyze the three options described above in “Attachment Facilities,” the base case was modified to represent the proposed interconnection configurations. The results of the analysis for the three options are summarized below. All thermal analysis was conducted using linear techniques.

Thermal Analysis, Option #1

Normal System (2010 Summer Conditions)

- No problems identified.

Single Contingency (2010 Summer Conditions)

- Outage of the Covert - Palisades 345 kV #1 circuit (the existing circuit) overloads the Covert - Palisades 345 kV #2 circuit (one of the new circuits) to 120 percent of its normal rating (1,409 MVA). AEP transmission planning criteria for the EHV system requires that loading not exceed normal rating for single contingency conditions.

Double Contingency (2010 Summer Conditions)

- Several double contingencies involving the Covert - Palisades 345 kV #1 circuit and elements of the Cook - Benton Harbor - Palisades 345 kV #1 circuit result in exceeding the emergency rating (1,887 MVA) of the Covert - Palisades 345 kV #2 circuit. The worst of these overloads is 106 percent for outage of the Covert - Palisades 345 kV #1 circuit and the Cook - Benton Harbor segment of the Cook - Benton Harbor - Palisades 345 kV #1 circuit.

Thermal Analysis, Option #2

Normal System (2010 Summer Conditions)

- The new Covert Tap - Palisades 345 kV circuit is loaded to 120 percent of its normal rating (1,409 MVA) under base case conditions.

Single Contingency (2010 Summer Conditions)

- Outage of the Covert Tap - Palisades 345 kV circuit overloads the Cook - Benton Harbor - Palisades 345 kV #1 circuit to 109 percent of its normal rating (1,409 MVA) on the Cook - Benton Harbor segment and 107 percent of its normal rating (1,409 MVA) on the Benton Harbor - Palisades segment.

- Numerous single contingencies result in exceeding the normal rating (1,409 MVA) of the Covert Tap - Palisades 345 kV circuit. The worst of these overloads is 142 percent for outage of the Cook - Benton Harbor segment of the Cook - Benton Harbor - Palisades 345 kV #1 circuit. This loading is 106 percent of the emergency rating (1,887 MVA).

Double Contingency (2010 Summer Conditions)

- Outage of the Covert Tap - Palisades 345 kV and Twin Branch - Argenta 345 kV circuits overloads the Benton Harbor - Palisades segment of the Cook - Benton Harbor - Palisades 345 kV #1 circuit to 103 percent of its emergency rating (1,887 MVA).
- Numerous double contingencies result in exceeding the emergency rating (1,887 MVA) of the Covert Tap - Palisades 345 kV circuit. The worst of these overloads is 121 percent for outage of the Cook - Benton Harbor - Palisades 345 kV #1 and Twin Branch - Argenta 345 kV circuits.

Thermal Analysis, Option #3

Normal System (2010 Summer Conditions)

- No problems identified.

Single Contingency (2010 Summer Conditions)

- Outage of either of the two new Covert Tap - Palisades 345 kV circuits overloads the remaining Covert Tap - Palisades 345 kV circuit to 149 percent of its normal rating (1,409 MVA).

Double Contingency (2010 Summer Conditions)

Outage of either of the two new Covert Tap - Palisades 345 kV circuits along with the Twin Branch - Argenta 345 kV circuit overloads the remaining Covert Tap - Palisades 345 kV circuit to 130 percent of its emergency rating (1,887 MVA).

Short Circuit Analysis, All Three Options

- No problems identified.

Stability Analysis, All Three Options

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

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

Local/Network Upgrades

In addition to construction of Attachment Facilities, the Option #1 and Option #3 interconnection configurations would require reconductoring of one or both 345 kV circuits between the proposed tap point in the Cook - Palisades 345 kV DCT and Palisades Station. Reconductoring of the AEP owned portion of these circuits would be accomplished as part of the Attachment Facilities. Most of the line segments requiring reconductoring are owned by METC. Option #2 would require rebuilding/reconductoring the Cook - Benton Harbor - Palisades 345 kV #1 circuit.

The AEP construction scope for system upgrades, Option #1 and #3:

- No additional system upgrades required.

The AEP construction scope for system upgrades, Option #2:

- Rebuild/reconductor the AEP owned portion of the Cook - Benton Harbor - Palisades 345 kV #1 circuit (will require rebuild of entire Cook - Palisades 345 kV DCT).

Estimated Cost (2007 Dollars)*: **\$63,000,000**

*The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. It will take approximately one year after obtaining the authorization to construct the facilities as outlined above.

Network Impacts

The Queue T94 Project was studied as a 1200 MW injection on the Cook – Palisades 345kV transmission line. The generators are physically interconnected at the Covert 345kV switchyard (Option #1); however, for analytical purposes an equivalent bus was created to model the connection point. Project T94 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows for both interconnection Option #1 and #3:

Generator Deliverability

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

No Problems were 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 Kemptown – North-Northwest 500kV line is overloaded from 218% to 222% of its emergency rating (2901 MVA) for the tower outage of the Granite – High Ridge ckt 2312 and 2332-A. This project contributes approximately 112 MW to cause the thermal violation.
2. Contribution of 102 MW further overloads to the Kemptown – N NWest 500kV line from 200% to 205% of its normal rating (2078 MVA).
3. Contribution of 6.6 MW further overloads to the Greene – Roxbury 138 kV line from 110% to 114% of its emergency rating (142 MVA) for the outage of Kemptown – North Northwest 500 kV ckt.

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 & 2. The overload on the Kemptown-North Northwest circuit can be alleviated by constructing a second Kemptown to North Northwest 500kV circuit. The estimated cost of \$ 279 million and estimated time of 10 yrs. Including adding a 3- breaker bay at Kemptown and North Northwest substations at \$7.7 million apiece, the total cost for the upgrade is **\$294.4 million**.

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 Greene-Roxbury 138kV circuit can be alleviated by replacing the Roxbury 138/115 kV transformer and associated terminal equipment (circuit breaker, substation conductor, CT circuits), which is estimated to cost approximately **\$2,250,000** and require a lead time of at least 2 years.