

P47 - Mansfield-South Troy 115 kV Generation Interconnection

Network Impacts

The #P47 project was studied as an injection of 100 MW (20 MW of capacity) at two distinct points. Option 1 considers the injection into a tap of Mansfield to South Troy 115 kV circuit. Option 2 considers the injection into a tap of Grover to East Towanda 230 kV circuit. Project #P47 was evaluated for compliance with reliability criteria for summer peak conditions in 2010. Potential network impacts were as follows:

Generator Deliverability – at the 20 MW capacity value level

No problem identified (no facility overloads under system single contingency conditions).

Multiple Facility Contingency – Reliability Requirements at the 100 MW full output level

NOTE: For Feasibility Studies, only double circuit (tower) outages are evaluated – not line fault and stuck breaker.

For option 1:

1. The South Troy – P47_opt1 Tap 115 kV line is overloaded to approximately 157% of its emergency rating (119MVA) for the **tower outage** of the Lackawanna - Mountain 230kV line and the Lackawanna – Stanton 230kV line. The P47 project contributes approximately 72 MW to the contingency facility loading.
To increase the emergency rating to mitigate this overload would require replacement of a disconnect switch at South Troy (approximately \$80,000) and substation conductor at South Troy (approximately \$125,000).
2. The South Troy – East Towanda 115 kV line is overloaded to approximately 140% of its emergency rating (119MVA) for the **tower outage** of the Lackawanna - Mountain 230kV line and the Lackawanna – Stanton 230kV line. The P47 project contributes approximately 67 MW to the contingency facility loading.
To increase the emergency rating to mitigate this overload would require replacement of a disconnect switch at South Troy (approximately \$80,000) and reconductor 19.54 miles of 115 kV transmission line conductor between East Towanda and South Troy substations (approximately \$5,000,000).

For option 2:

No problem identified (no facility loading that exceeded the facility's emergency rating).

Contribution to Previously Identified Overloads

None.

New System Reinforcements – Single Contingency Reliability requirements

None.

Contribution to Previously Identified System Reinforcements

None.

Short Circuit

Under review by FirstEnergy. It will be completed in the Impact Study.

Potential Congestion Issues

PJM also studied the delivery of the energy portion of this interconnection request. The following analysis has been performed to inform the Interconnection Customer (Queue P47) of potential congestion issues (operational restrictions) that may occur and affect the P47 project's ability to operate at full output for certain system conditions.

Interpretation of the results is left to the Interconnection Customer. **The upgrades listed below are not required reliability upgrades for the Queue P47 interconnection.**

Please note that the number of facilities identified below as requiring upgrades is quite extensive – with a number of these facilities requiring reconductoring/rebuilding of transmission lines. Some of the reconductoring/rebuilding projects can be done in a “short” time frame while others are quite extensive and will require a “long” time to complete. In general, the time necessary to design and rebuild an extensive facility upgrade will take approximately 2-3 years to complete. If the P47 Interconnection Customer wants to pursue construction of any of these upgrades, a separate “Transmission Interconnection” request must be submitted and the upgrades must be performed as merchant transmission projects.

Category A – Transmission System Impacts (Facilities monitored and operated by PJM)

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding P47) at 100% energy output and Peak summer loading (80/20 load forecast).

P47 Operational considerations: The facilities below (potentially overloaded) are monitored and operated by PJM. PJM rules and methods for readjusting pre-contingency (N-1) dispatch will be followed if this system condition occurs. This may or may not cause curtailment of P47 generation to below its 100% energy output.

For option 1:

1. The P47 project contributes approximately 15 MW to the overloading of the Keystone 500/230kV transformer #4 (113% of its emergency rating of 465 MVA) for the outage of the Keystone 500/230kV transformer #3, which was originally identified as a potential congestion issue for the P22, P28 and P45A projects. The upgrade is a replacement of the existing 500-230 kV transformer rated at 436 MVA summer normal / 465 MVA summer emergency with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.
2. The P47 project contributes approximately 15 MW to the overloading of the Keystone 500/230kV transformer #3 (112% of its emergency rating of 471 MVA) for the outage of the Keystone 500/230kV transformer #4, which was originally identified as a potential congestion issue for the P22, P28 and P45A projects. The upgrade is a replacement of the existing 500-230 kV transformer rated at 440 MVA summer normal / 471 MVA summer emergency with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.

3. The P47 project contributes approximately 18 MW to the overloading of the Homer City -Shelocta 230 kV circuit (110% of its emergency rating of 854 MVA) for the outage of the Handsome Lake to Wayne 345 kV circuit, which was originally identified as a potential congestion issue for the O56, O72, P22, P28 and P45A projects. The Homer City-Shelocta 230 kV line is rated at 694 MVA summer normal / 854 MVA summer emergency. The loading on this 230 kV line during the contingency condition reaches 939 MVA (or 110% of its 854 MVA rating). To mitigate this overload would require replacement/upgrade of a disconnect switch at Shelocta (estimated to cost approximately \$85,000), 10.73 miles of transmission line (estimated to cost approximately \$4,800,000), a line/wave trap at Homer City (estimated to cost approximately \$125,000), and a CT circuit at Homer City (estimated to be approximately \$100,000).
4. The P47 project contributes 11 MW to the overloading of the Lewistown - Juniata 230 kV line (108% of its emergency rating of 617 MVA) for the outage of Juniata to Keystone 500 kV line, which was originally identified as a potential congestion issue for the O38, O72, and P45A projects. The Lewistown-Juniata 230 kV line is rated at 499 MVA summer normal / 617 MVA summer emergency. The loading on this 230 kV line during the contingency condition reaches 654 MVA (or 106% of its rating). To mitigate this overload would require replacement/upgrade of 24.69 miles of 230 kV transmission line (estimated to cost approximately \$11,750,000) and the upgrade/replacement of a disconnect switch at Juniata (estimated to cost approximately \$100,000).
5. The P47 project contributes 15 MW to the overloading (102% of its emergency rating of 854 MVA) of the Shelocta – Keystone 230 kV line for the outage of the Homer City to Watercure Road 345 kV line, which was originally identified as a potential congestion issue for the P28 and P45A projects. The Shelocta-Keystone 230 kV line is rated at 694 MVA summer normal / 854 MVA summer emergency. The loading on this 230 kV line during the contingency condition reaches 871 MVA (or 102% of its rating). To mitigate this overload would require replacement/upgrade of the disconnect switches at Shelocta and Keystone substations and is estimated to cost approximately \$150,000.

For option 2:

1. The P47 project contributes approximately 15 MW to the overloading of the Keystone 500/230kV transformer #4 (113% of its emergency rating of 465 MVA) for the outage of the Keystone 500/230kV transformer #3, which was originally identified as a potential congestion issue for the P22, P28 and P45A projects. The upgrade is a replacement of the existing 500-230 kV transformer rated at 436 MVA summer normal / 465 MVA summer emergency with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.
2. The P47 project contributes approximately 15 MW to the overloading of the Keystone 500/230kV transformer #3 (113% of its emergency rating of 471 MVA) for the outage of the Keystone 500/230kV transformer #4, which was originally identified as a potential congestion issue for the P22, P28 and P45A projects. The upgrade is a replacement of the existing 500-230 kV transformer rated at 440 MVA summer normal / 471 MVA summer emergency with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.

3. The P47 project contributes around 18 MW to the overloading of the Homer City - Shelocta 230 kV circuit (110% of its emergency rating of 854 MVA) for the outage of the Handsome Lake to Wayne 345 kV circuit, which was originally identified as a potential congestion issue for the O56, O72, P22, P28 and P45A projects. The Homer City-Shelocta 230 kV line is rated at 694 MVA summer normal / 854 MVA summer emergency. The loading on this 230 kV line during the contingency condition reaches 939 MVA (or 110% of its rating). To mitigate this overload would require replacement/upgrade of a disconnect switch at Shelocta (estimated to cost approximately \$85,000), 10.73 miles of transmission line (estimated to cost approximately \$4,800,000), a line/wave trap at Homer City (estimated to cost approximately \$125,000), and a CT circuit at Homer City (estimated to cost approximately \$100,000).
4. The P47 project contributes 11 MW to the overloading of the Lewistown - Juniata 230 kV line for the outage of Juniata to Keystone 500 kV line, which was originally identified as a potential congestion issue for the O38, O72 and P45A projects. The Lewistown-Juniata 230 kV line is rated at 499 MVA summer normal / 617 MVA summer emergency. The loading on this 230 kV line during the contingency condition reaches 654 MVA (or 108% of its emergency rating of 617 MVA). To mitigate this overload would require replacement/upgrade of 24.69 miles of 230 kV transmission line (estimated to cost approximately \$11,750,000) and the upgrade/replacement of a disconnect switch at Juniata (estimated to cost approximately \$100,000).
5. The P47 project contributes 12 MW to the overloading of the Shelocta – Keystone 230 kV line (102% of its emergency rating of 854 MVA) for the outage of Homer City to Watercure Road 345 kV line, which was originally identified as a potential congestion issue for the P28 project and P45A projects. The Shelocta-Keystone 230 kV line is rated at 694 MVA summer normal / 854 MVA summer emergency. The loading on this 230 kV line during the contingency condition reaches 871 MVA (or 102% of its rating). To mitigate this overload would require replacement/upgrade of the disconnect switches at Shelocta and Keystone substations and is estimated to cost approximately \$150,000.

Category B – Underlying Transmission System Impacts (Facilities monitored and operated by Penelec)

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding P47) at 100% energy output and Peak summer loading (80/20 load forecast).

P47 Operational considerations: The facilities below (potentially overloaded) are not monitored and operated by PJM. Penelec monitors these facilities in real time and will readjust the system according to Penelec's rules and methods if this system condition occurs. This may or may not cause curtailment of P47 generation to below its 100% energy output.

For option 1: None.

For option 2: None.

Category C – Underlying Transmission System Impacts (Facilities monitored and operated by Penelec). These contingency overloads were not possible prior to the Queue P47 project. The identified contingency overloads are caused directly by P47 and are likely to cause P47 curtailment to less than 100% energy output during summer and possibly winter operation.

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding P28) at 100% energy output and Peak summer loading (80/20 load forecast).

P47 Operational considerations: The facilities below (potentially overloaded) are not monitored and operated by PJM. Penelec monitors these facilities in real time and will readjust the system according to Penelec's rules and methods if this system condition occurs. This may or may not cause curtailment of P47 generation to below its 100% energy output.

For option 1:

6. P47-South Troy 115 kV line (part of the Mansfield-South Troy 115 kV line) overloads to 144.6% with the addition of the energy portion of P47 under normal conditions. P47 energy contributes 76 MW to this overload condition. The P47-South Troy 115 kV line is rated at 119 MVA summer normal / 119 MVA summer emergency. The loading on this 115 kV line during the normal condition reaches 172 MVA (or 144.6% of its rating). To mitigate this overload would require replacement/upgrade of a disconnect switch at South Troy (estimated to cost approximately \$80,000) and some substation conductor at South Troy (estimated to cost approximately \$125,000).
7. South Troy- East Towanda 115 kV overloads to 161.9% with the addition of the energy portion of P47 under normal conditions. P47 energy contributes 55 MW to this overload condition. The South Troy-East Towanda 115 kV line is rated at 94 MVA summer normal / 119 MVA summer emergency. The loading on this 115 kV line during the normal condition reaches 192 MVA (or 161.9% of its rating). To mitigate this overload would require replacement/upgrade of:

At East Towanda:

- Replace line/wave trap – (estimated to cost approximately \$115,000).
- Upgrade substation conductor – (estimated to cost approximately \$125,000).
- Replace/upgrade 2 CT circuits - (estimated to cost approximately \$150,000).
- Upgrade 19.54 miles of transmission line conductor from South Troy-Towanda (estimated to be approximately \$5,000,000).

At South Troy

- Replace/upgrade substation conductor (estimated to cost approximately \$125,000).
- Upgrade/replace disconnect switch at South Troy (estimated to cost approximately \$80,000).

8. The P47 project contributes 95 MW to loading the Potter-O52 115 kV line to 102.3% of its summer emergency rating for the outage of the P47-South Troy 115 kV line.
The Potter-O52 115 kV line is rated at 178 MVA summer normal / 226 MVA summer emergency. The loading on this 115 kV line during the contingency condition reaches 231 MVA (or 102.3% of its rating). To mitigate this overload would require replacement/upgrade of the 12 miles of transmission line and is estimated to cost approximately \$3,000,000.
9. The P47 project contributes 35 MW to loading the Mansfield 115-34.5 kV transformer #1 to 210% of its summer emergency rating for the outage of the P47-South Troy 115 kV line.
The Mansfield 115-34.5 kV transformer is rated at 22.9 MVA summer normal / 25.1 MVA summer emergency. The loading on this 115-34.5 kV transformer during the contingency condition reaches 52.7 MVA (or 210% of its rating). To mitigate this overload would require replacement/upgrade of the transformer, its circuit breaker and associated substation conductor and is estimated to cost approximately \$1,500,000.
10. The P47 project contributes 76 MW to the overloading of the South Troy-P47 115 kV line (part of the Mansfield-South Troy 115 kV line) for the outage of the Potter-O52 115 kV line.
The South Troy-P47 115 kV line is rated at 119 MVA summer normal / 119 MVA summer emergency. The loading on this 115 kV line during the contingency condition reaches 240 MVA (or 202% of its rating). To mitigate this overload would require replacement/upgrade of a disconnect switch at South Troy (estimated to be approximately \$80,000), some substation conductor at South Troy (estimated to cost approximately \$125,000) and the replacement/reconductor of the 8 miles of transmission line conductor from South Troy to P47 (estimated to cost approximately \$2,000,000).
11. The P47 project contributes 10 MW to loading the South Troy 115-34.5 kV transformer #1 to 152% of its summer emergency rating for the outage of the East Towanda-South Troy 115 kV line.
The South Troy 115-34.5 kV transformer #1 is rated at 19.6 MVA summer normal / 21 MVA summer emergency. The loading on this 115-34.5 kV transformer during the contingency condition reaches 32 MVA (or 152% of its rating). To mitigate this overload would require replacement/upgrade of the transformer, its circuit breaker and associated substation conductor and is estimated to cost approximately \$1,500,000.
12. The P47 project contributes 10 MW to loading the South Troy 115-34.5 kV transformer #2 to 162% of its summer emergency rating for the outage of the East Towanda-South Troy 115 kV line.
The South Troy 115-34.5 kV transformer #2 is rated at 19.6 MVA summer normal / 21 MVA summer emergency. The loading on this 115-34.5 kV transformer during the contingency condition reaches 34 MVA (or 162% of its rating). To mitigate this overload would require replacement/upgrade of the transformer, its circuit breaker and maybe some substation conductor and is estimated to cost approximately \$1,500,000.

13. The P47 project contributes 76 MW to loading the South Troy–East Towanda 115 kV line to 175% of its summer emergency rating for the outage of the Farmers Valley-Two Mile Run 115 kV line. The South Troy-East Towanda 115 kV line is rated at 94 MVA summer normal / 119 MVA summer emergency. The loading on this 115 kV line during the contingency condition reaches 208 MVA (or 175% of its rating). To mitigate this overload would require replacement/upgrade of:

East Towanda:

- Replacement/upgrade of a line trap/wave trap – (estimated to be approximately \$115,000).
- Replacement/upgrade of a substation conductor – (estimated to be approximately \$125,000).
- Replacement/upgrade of a CT Circuit - (estimated to be approximately \$75,000).
- Upgrade/Replacement of 19.54 miles of transmission line from South Troy-East Towanda (estimated to be approximately \$5,000,000).

South Troy:

- Replacement/upgrade of a substation conductor – (estimated to be approximately \$125,000).
- Replacement/upgrade of a disconnect switch – (estimated to be approximately \$80,000).

For option 2:

6. The P47 project contributes 7.4 MW to loading the Laurel Lake-Goudey 115 kV line to 100.3% of its summer emergency rating for the outage of the East Towanda-Hillside 230 kV and East Sayre-East Towanda 115 kV line. The Laurel Lake-Goudey 115 kV line is rated at 108 MVA summer normal / 129 MVA summer emergency. The loading on this 115 kV line during the contingency condition reaches 129.4 MVA (or 100.3% of its rating). To mitigate this overload would require replacement/upgrade of the some of substation conductor at Goudey substation and is estimated to be approximately \$125,000.