PJM Merchant Transmission Request
Queue #U3-026
Collins 765kV
(492MW Firm)
System Impact Study Report

November 2012
DOCS#: 704214v6

Preface

The intent of this System Impact Study is to determine a plan, with cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

The PJM Reliability Planning Process utilizes PJM planning criteria, NERC Planning Standards, NERC Regional Council planning criteria, and the individual Transmission Owner FERC filed planning criteria. In all cases, PJM applies the most conservative of all applicable planning criteria when identifying reliability problems and determining the need for system upgrades on the PJM system. The application of the NERC Planning Standards is adapted to the specific needs of the PJM system.

In some instances an interconnection customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. All facilities required for interconnection of a generation interconnection project must be designed in compliance with the technical specifications (on PJM web site) for the appropriate Transmission Owner.

After the System Impact Study Agreement is executed and prior to execution of the Interconnection Service Agreement, an Interconnection Customer may modify its project to reduce the electrical output (MW) (in the case of a Generation Interconnection Request) of the proposed project by up to the larger of 20 percent of the capability considered in the System Impact Study or 50 MW.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Rock Island Clean Line LLC (Interconnection Customer) is proposing an uprate to the existing S57/S58 Merchant Transmission projects interconnected to the ComEd transmission system at the Station 23 Collins 765kV Substation. U3-026 will convert 492MW to Firm transmission rights from existing S57/S58 projects to give a total of 2308MW Non-firm (1192 MW Firm) behind the S57/S58 POIs. The proposed in-service date for this project is **December 31, 2014**.

The intent of the System Impact Study is to determine system reinforcements, associated costs and construction time estimates required to facilitate the addition of the new generating plant to the transmission system. The reinforcements include the direct connection of the generator to the system and any network upgrades necessary to maintain the reliability of the transmission system.

Facilities to Accommodate the Interconnection

Attachment Facilities

The Interconnection Customer proposes to construct a high-voltage transmission line to connect his generator output from Collector Substation to the Interconnection Substation. The line termination at the Interconnection Substation will serve as the Point of Interconnection between Interconnection Customer and ComEd.

For the U3-026 interconnection, the Interconnection Customer will utilize the existing S57 and S58 765kV AC transmission lines from the Collector Station (HVDC Converter) to Collins Station 23 (Interconnection Substation). If existing S57/S58 projects withdraw from the PJM queue, U3-026 will have to build the necessary upgrades to interconnect this project.

Please refer to **Figure 1** below for a single line diagram including the proposed project. This diagram is intended to be conceptual and the exact configuration and lines would need to be determined as part of an inter-regional study.

The Interconnection Customer is responsible for constructing all of the facilities on the Interconnection Customer side of the point of interconnection. It will be the Interconnection Customer's responsibility to obtain any required right-of-way between the Collector Substation and Interconnection Substation.

Revenue Metering and SCADA Requirements

For PJM: The Interconnection Customer will install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 24.1 to 24.2.

For ComEd: The Interconnection Customer will install equipment necessary to provide bi-directional Revenue Metering (KWH, KVARH) and real time data (KW, KVAR, circuit breaker status, and 765 kV voltage) for IC's generating Resource. See ComEd Applicable Standards available on the PJM website ("TO Standards") – "Exelon Energy Delivery Interconnection Guidelines (Generators Greater than 20 MW)".

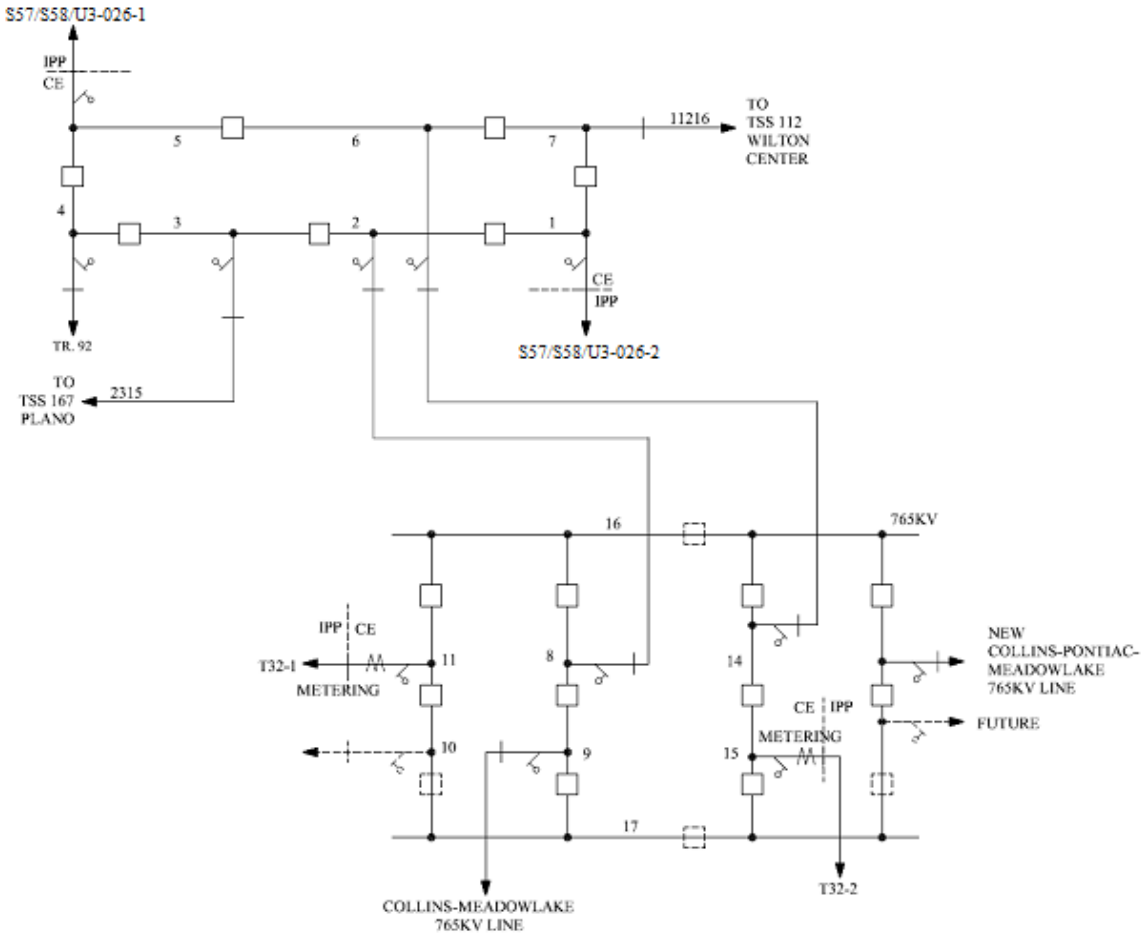

Figure 1. Interconnection Single Line Diagram

Network Impacts

The U3-026 project was studied as a 492MW (492MW Capacity) injection into ComEd's system at the Collins 765kV substation. Project U3-026 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

Generator Deliverability

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

No problems were identified.

Generator Deliverability Impacts Caused By MISO Generator Interconnection Projects

(*Single or N-1 contingencies for the Capacity portion of the interconnection. Overloads initially caused by projects in the MISO Queue with additional contribution to the overload by this project.)*

No problems were identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study)

Table 1. Multiple Facility Contingency

Item	Contribution MVA	Overloaded Element	Overload %		Rating		Contingency Element
			From	To	Type	MVA	
1a	59.73	WILTO; B-B ISL;BT 345 kV line	98.17%	100.92%	ER	1944.7	tower outage of '023-65-BT3-4__'

Item 1a. The WILTO; B-B ISL;BT 345 kV line (from bus 36414 to bus 36270 ckt 1) loads from 98.17% to 100.92% (DC power flow) of its emergency rating (1944.65002441406 MVA) for the line fault with failed breaker contingency outage ('023-65-BT3-4__'). This project contributes approximately 59.73 MW to the thermal violation.

Multiple Facility Contingency Impacts Caused By MISO Generator Interconnection Projects

(*Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output. Overloads initially caused by projects in the MISO Queue with additional contribution to the overload by this project.)*

No problems were 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)

Table 2. Contribution to Previously Identified Overloads							
Item	Contribution MVA	Overloaded Element	Overload %		Rating		Contingency Element
			From	To	Type	MVA	
2a	25.9	PLANO; R-ELECT;4R 345 kV line	102.48%	104.43%	ER	1341	single outage of '345-L1223T_R-S'
2b	33.36	PLANO; B-ELECT; B 345 kV line	103.55%	106.08%	ER	1341	single outage of '345L-16703_R-S'
2c	81.16	WILTO; 765/345 kV transformer	100.28%	106.16%	ER	1380	line outage of '023-65-BT3-4__'
2d	81.21	WILTO; 765/345 kV transformer	100.45%	106.33%	ER	1380	line outage of '023-65-BT3-4__'
2e	65	WILTO; R-B ISL;RT 345 kV line	105.09%	108.44%	ER	1944.7	line outage of '023-65-BT3-4__'
2f	148.55	WILTO;4M-WILTO; B 345 kV line	102.59%	113.36%	ER	1380	line outage of '112-65-BT2-3__'
2g	148.58	WILTO;3M-WILTO; R 345 kV line	102.66%	113.42%	ER	1380	line outage of '112-65-BT4-5__'
2h	145.54	PLANO;3M-PLANO; 3B 345kV line	122.29%	132.84%	ER	1380	line outage of '112-65-BT2-3__'
2i	149.91	PLANO;4M-PLANO; R 345kV	126.37%	137.23%	ER	1380	line outage of '112-65-BT2-3__'
2j	145.54	PLANO; 765/345 kV transformer	122.30%	132.85%	ALDR	1380	line outage of '112-65-BT5-6__'
2k	149.91	PLANO; 765/345 kV transformer	126.38%	137.25%	ALDR	1380	line outage of '112-65-BT2-3__'

Item 2a. The PLANO; R-ELECT;4R 345 kV line (from bus 36373 to bus 36311 ckt 1) loads from 102.48% to 104.43% (AC power flow) of its emergency rating (1341 MVA) for the single line contingency outage ('345-L1223T_R-S'). This project contributes approximately 25.9 MW to the thermal violation.

Item 2b. The PLANO; B-ELECT; B 345 kV line (from bus 36372 to bus 36310 ckt 1) loads from 103.55% to 106.08% (AC power flow) of its emergency rating (1341 MVA) for the single line contingency outage ('345L-16703_R-S'). This project contributes approximately 33.36 MW to the thermal violation.

Item 2c. The WILTO; 765/345 kV transformer (from bus 36260 to bus 36086 ckt 1) loads from 100.28% to 106.16% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('023-65-BT3-4__'). This project contributes approximately 81.16 MW to the thermal violation.

Item 2d. The WILTO; 765/345 kV transformer (from bus 36260 to bus 36085 ckt 1) loads from 100.45% to 106.33% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('023-65-BT3-4__'). This project contributes approximately 81.21 MW to the thermal violation.

Item 2e. The WILTO; R-B ISL;RT 345 kV line (from bus 36415 to bus 36271 ckt 1) loads from 105.09% to 108.44% (DC power flow) of its emergency rating (1944.65002441406 MVA) for the line fault with failed breaker contingency outage ('023-65-BT3-4__'). This project contributes approximately 65 MW to the thermal violation.

Item 2f. The WILTO;4M-WILTO; B 345 kV line (from bus 36086 to bus 36414 ckt 1) loads from 102.59% to 113.36% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('112-65-BT3-4__'). This project contributes approximately 148.55 MW to the thermal violation.

Item 2g. The WILTO;3M-WILTO; R 345 kV line (from bus 36085 to bus 36415 ckt 1) loads from 102.66% to 113.42% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('112-65-BT4-5__'). This project contributes approximately 148.58 MW to the thermal violation.

Item 2h. The PLANO;3M-PLANO; B 345 kV line (from bus 36060 to bus 36372 ckt 1) loads from 122.29% to 132.84% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('112-65-BT2-3__'). This project contributes approximately 145.54 MW to the thermal violation.

Item 2i. The PLANO;4M-PLANO; R 345 kV line (from bus 36061 to bus 36373 ckt 1) loads from 126.37% to 137.23% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('112-65-BT2-3__'). This project contributes approximately 149.91 MW to the thermal violation.

Item 2j. The PLANO; 765/345 kV transformer (from bus 36258 to bus 36060 ckt 1) loads from 122.3% to 132.85% (DC power flow) of its emergency rating (1380

MVA) for the line fault with failed breaker contingency outage ('112-65-BT2-3__'). This project contributes approximately 145.54 MW to the thermal violation.

Item 2k. The PLANO; 765/345 kV transformer (from bus 36258 to bus 36061 ckt 1) loads from 126.38% to 137.25% (DC power flow) of its emergency rating (1380 MVA) for the line fault with failed breaker contingency outage ('112-65-BT2-3__'). This project contributes approximately 149.91 MW to the thermal violation.

Short Circuit
(Summary of impacted circuit breakers)

Not required.

Steady-State Voltage Requirements
(Summary of VAR requirements based upon the results of the steady-state voltage studies.)

None.

Stability and Reactive Power Requirement
(Summary of VAR requirements based upon the results of the dynamic studies.)

This report evaluates the system dynamics related to the proposed PJM queue position U3-026. Project U3-026 is a merchant transmission request to convert 492 MW of the non-firm transmission injection rights of S57 to firm transmission injection rights.

The study was performed assuming S57/S58 and the other HVDC connected to Collins 765 kV were injecting at the full, firm plus non-firm, power output levels (3500 MW for S57/S58, 2500 MW for T32.)

This study includes several system upgrades in the ComEd and western AEP transmission system, namely:

- Collins-Meadow Lake 765 kV line (No Meadow Lake-Sullivan 765 kV line)
- Meadow Lake-Greentown 765 kV line
- Meadow Lake 765/345 kV transformer
- Collins-Pontiac Midpoint-Meadow Lake 765 kV line
- 2-765/345 kV transformers at Pontiac Midpoint 765 kV
- Byron-Charter Grove-Wayne Blue 345 kV line 0629
- Wayne 345 kV Blue-Red bus tie closed

Summary

Based on the simulations of the power system conducted for this study, the system dynamic performance met applicable NERC and PJM/ComEd standards with the operation of the U3-026 project.

The assumptions and criteria utilized for the study are presented in this section of the report. Section 3 of this report details the results of the stability analysis. Section 4 provides the dynamic simulation results. Section 5 presents the report conclusions. Further details concerning the study are presented in the Appendices.

Throughout this report the study cases are referred to:

- Base Case – network and dispatch including all U-queue Southeast projects (including the U3-026 non-firm to firm conversion) and transmission upgrades as in Section 1, Light Load Southeast case.

Base Case Dynamic Simulation Results

System Intact Conditions

For a network condition that considers all elements in service, no new fault contingencies that result in problematic conditions following the U3-026 conversion of 492 MW from from NF/TIR to F/TIR were found. Prior to the addition of project U3-026, several contingencies cause instability in the study area. These contingencies are documented in Appendix E. The U3-026 project is not responsible for mitigation of contingencies found to be unstable in prior studies.

Prior Outage System Conditions

For network conditions that consider prior outages no new fault contingencies that result in problematic conditions following the addition of project U3-026 were found.

Special Protection Systems

The Powerton and Kincaid Stations incorporate numerous Special Protection Systems (SPS) (See SPOG 1-3-A and SPOG 1-3-B). SPS are typically used to enhance stability and, in this case, involve tripping of equipment beyond that normally required to be tripped to clear a fault. Contingency scenarios that include SPS are evaluated to determine if the new interconnection or proposed transmission mitigation obviates the need for the SPS. No Powerton contingency scenarios that incorporate SPS are unstable for the Base Case for system intact conditions. No Kincaid contingency scenarios that incorporate SPS are unstable for the Base Case system intact or prior outage conditions.

In addition, the Wilton Center-Dumont 765 kV SPS scenarios were tested and all were found to be stable.

Dynamics Results at U3-026 POI

Following is the POI voltage for worst-case transmission faults at the U3-026 POI (Collins 765 kV). No new instabilities were caused by addition of the U-queue projects and associated transmission upgrades. Based on visual inspection of the output traces, the worst-case NERC Category B fault is Col05 (Collins-Wilton Center 765 kV L11216), and the worst-case NERC Category C fault is Col150 (Collins-Meadow Lake 765 kV proposed line, Failure of 10-11 breaker and loss of Collins T32 HVDC Pole 1, Failover to DC Pole 2.)

Based on the simulations of the power system conducted for this study, the system dynamic performance met applicable NERC and PJM/ComEd standards with the operation of the U3-026 project.

Light Load Reliability Analysis

*(Summary of any reinforcements required to mitigate system reliability issues during light load periods. This light load study was evaluated for compliance with reliability criteria for **Light Load conditions** in 2014.)*

None.

New System Reinforcements

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

All of the upgrades that mitigate the S57/S58 Light Load overloads mitigate these overloads. At this time, no cost allocation is required for U3-026. If either S57 or S58 withdraw from the PJM queue, upgrades will be assessed to U3-026. Please see below:

- Build new Sorenson – East Lima 345kV line. The total cost to build this reinforcement is **$115,000,000** (PJM Network Upgrade Number #n**3460**).

- Voltage/Thermal upgrades #1. The total cost to build these reinforcements is **$352,000,000**. (See cost breakdown table below by project. All of the following upgrades are required for this project.)

PJM Network Upgrade #:	Description	Cost $M	TO
n3436	Collins - Meadow Lake 765kV line	330	CE
n3437	Meadow Lake Station work for Collins-Meadow Lake line	10	AEP
n3448	250 MVAR Cap at Dumont 765kV sub	12	AEP
	Total:	**352**	

The following MISO MVP projects are also required for this project, but at this time no cost allocation is given to projects S57/S58:

- Meadow Lake – Green Town 765kV line
- Meadow Lake 765/345kV transformer (1)
- Reynolds – Hiple 345kV line

MISO has approved a 765kV line from Reynolds – Green Town, therefore, the final path of the Meadow Lake Green Town 765kV line MISO MVP project will be reviewed during the Facilities Study. Should the MISO MVP projects be withdrawn from MISO's baseline, these projects would still have to be built by S57/S58.

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)

Please refer to New System Reinforcements section for reinforcements and cost details.

Potential Issues

None.

Potential Congestion Issues

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.

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 will study all overload conditions associated with the overloaded element(s) identified.

As a result of the aggregate energy resources in the area, no violations were identified.