Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-181

Richland 138kV

June 2018

Preface

The intent of the feasibility study is to determine a plan, with ballpark 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.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility 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

Richland-Stryker Generation LLC, the Interconnection Customer (IC), has proposed an uprate to an existing Natural Gas generating facility located in Defiance, Ohio. This projects requests an increase to the install capability of 5 MW with 5 MW of this output being recognized by PJM as capacity for generation units 4, 5, & 6. The installed facilities will have a total capability of 428 MW with 392 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2019. **This study does not imply a ATSI commitment to this in-service date.**

AC1-181 Unit #	Current MWE	Current MWC	Proposed MWE	Proposed MWC
1	11	11	11	11
2	11	11	11	11
3	11	11	11	11
4	130	118	131.66	119.66
5	130	118	131.67	119.67
6	130	118	131.67	119.67
Total	423	387	428	392

Point of Interconnection

AC1-181 is interconnected with the ATSI Transmission system at the Richland 138kV Substation.

Cost Summary

The AC1-181 project will be responsible for the following costs:

Description	Total Cost
Transmission Owner facilities	$ 0
Transmission Upgrades	$ 0
Total Costs	**$ 0**

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

No Direct Connection Facilities are required to support this interconnection request.

Non-Direct Connection Cost Estimate

No Non-Direct Connection Facilities are required to support this interconnection request.

Power Factor Requirements

The AC1-181 generation facility must maintain a 1.00 (Unity) to 0.90 lagging power factor at the Point of Interconnection.

FE Facility Upgrades and Costs

There are no direct connection requirements for this interconnection since it only deals with a capacity increase with no modification of the transmission connection. No network reinforcement requirements were identified since the Power Flow Analysis did not identify any valid system violations.

Richland-Stryker Generation, LLC is responsible to provide metering, disconnect switches and high-side breakers for each unit, as required, since Richland-Stryker Generation, LLC will own this equipment. FE herein reserves the right to return to any issues in this document and upon appropriate justification, request additional monies to complete any reinforcements to the transmission or sub-transmission systems.

PJM Requirements

The Interconnection Customer will be required to 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 Sections 24.1 and 24.2.

FE Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts

The Queue Project AC1-181 was evaluated as a 5 MW (Capacity 5 MW) injection at the Richland 138kV substation in the ATSI area. Project AC1-181 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-181 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Generator Deliverability

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

None.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None.

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)

None.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None. See Attachment 3

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic

Short Circuit

(Summary of impacted circuit breakers)

None. See Attachment 3

Potential Congestion due to Local Energy Deliverability

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.

None.

New System Reinforcements

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

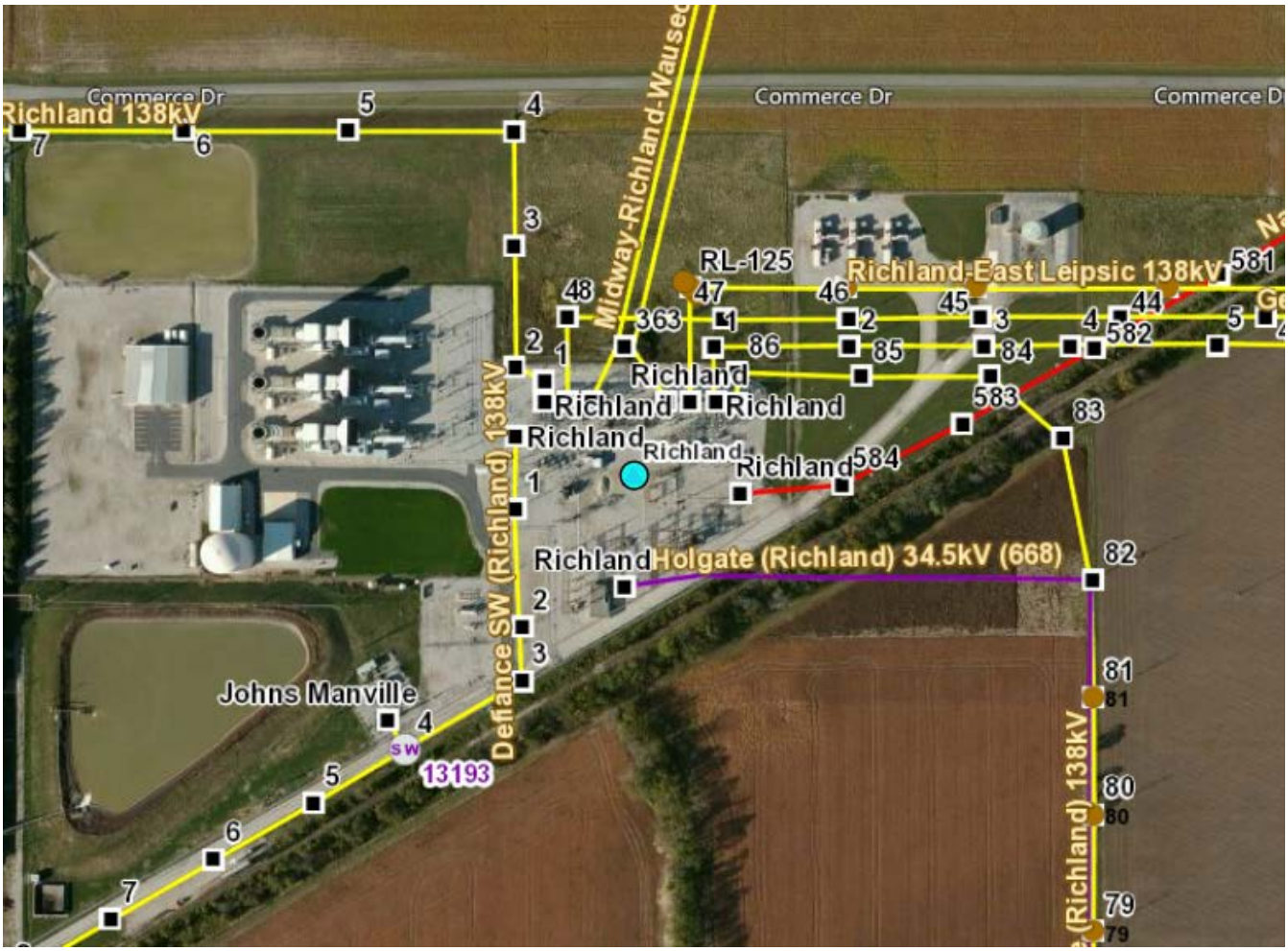
None.

Contribution to Previously Identified System Reinforcements

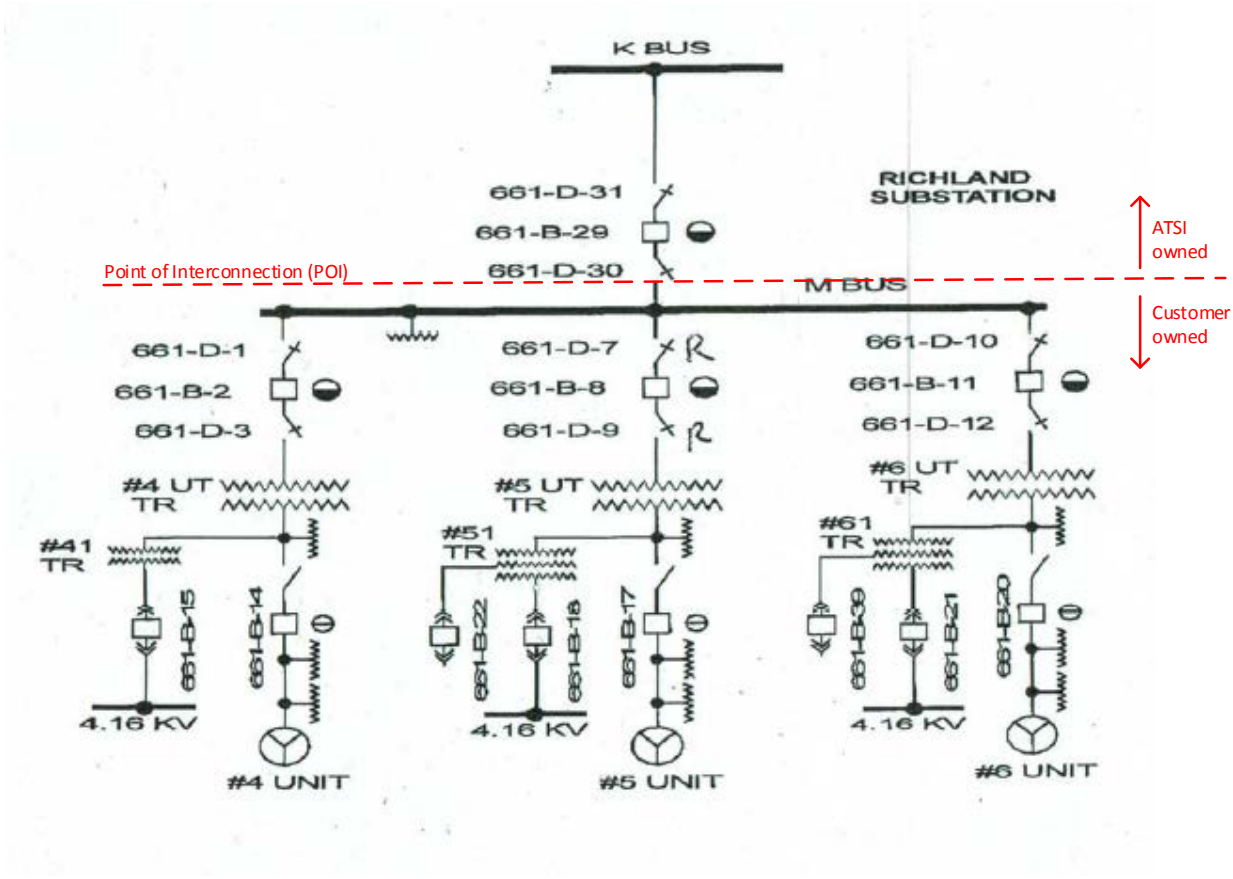
(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None.

Attachment 1. Project Location



Attachment 2. Single Line diagram



Attachment 3. Dynamic Simulation Analysis

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Executive Summary

Generator Interconnection Requests AC1-181 is for a 5MW uprate to the existing Richland 138kV natural gas unit 4, 5, and 6. The total Maximum Facility Output (MFO) after uprate would become 428 MW and the 5MW uprate would be distributed equally to the units 4, 5, and 6. AC1-181 connects to the ATSI transmission system, Defiance County, Ohio.

This report describes a dynamic simulation analysis of AC1-181 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2020 Summer Peak case, modified to include applicable queue projects. AC1-181 has been dispatched online at maximum power output, with POI voltage of (1.011 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 138 kV system.

The AC1-181 queue project was tested for compliance with NERC, PJM and other applicable criteria. The range of contingencies evaluated was limited to that necessary to assess compliance and each was limited to a 20-second simulation time period.

Simulated NERC Standard TPL-001 faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are covered by P1 and P4 contingencies.

The system was tested for a system intact condition and the fault types listed above. Specific fault descriptions and breaker clearing times used for this study are provided in the result table.

No relevant High Speed Reclosing (HSR) contingencies were identified.

For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.

For the remaining fault contingencies tested on the 2020 Summer Peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AC1-181 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

No mitigations were found to be required.

1. Introduction

Generator Interconnection Requests AC1-181 is for a 5MW uprate to the existing Richland 138kV natural gas unit 4, 5, and 6. The total Maximum Facility Output (MFO) after uprate would become 428 MW and the 5MW uprate would be distributed equally to the units 4, 5, and 6. AC1-181 connects to the ATSI transmission system, Defiance County, Ohio.

This analysis is effectively a screening study to determine whether the addition of AC1-181 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

In this report the AC1-181 project and how it is proposed to be connected to the grid are first described, followed by a description of how the project is modeled in this study. The fault cases are then described and analyzed, and lastly a discussion of the results is provided.

2. Description of Project

Generator Interconnection Requests AC1-181 is for a 5MW uprate to the existing Richland 138kV natural gas unit 4, 5, and 6. The total Maximum Facility Output (MFO) after uprate would become 428 MW and the 5MW uprate would be distributed equally to the units 4, 5, and 6. AC1-181 connects to the ATSI transmission system, Defiance County, Ohio.

Figure 1 shows the simplified one-line diagram of the AC1-181 load flow models. Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AC1-181 load flow models.

The dynamic models for the AC1-181 plant are based on the data supplied by the Developer in the attachments to the System Impact Study (SIS) Data Submittal.

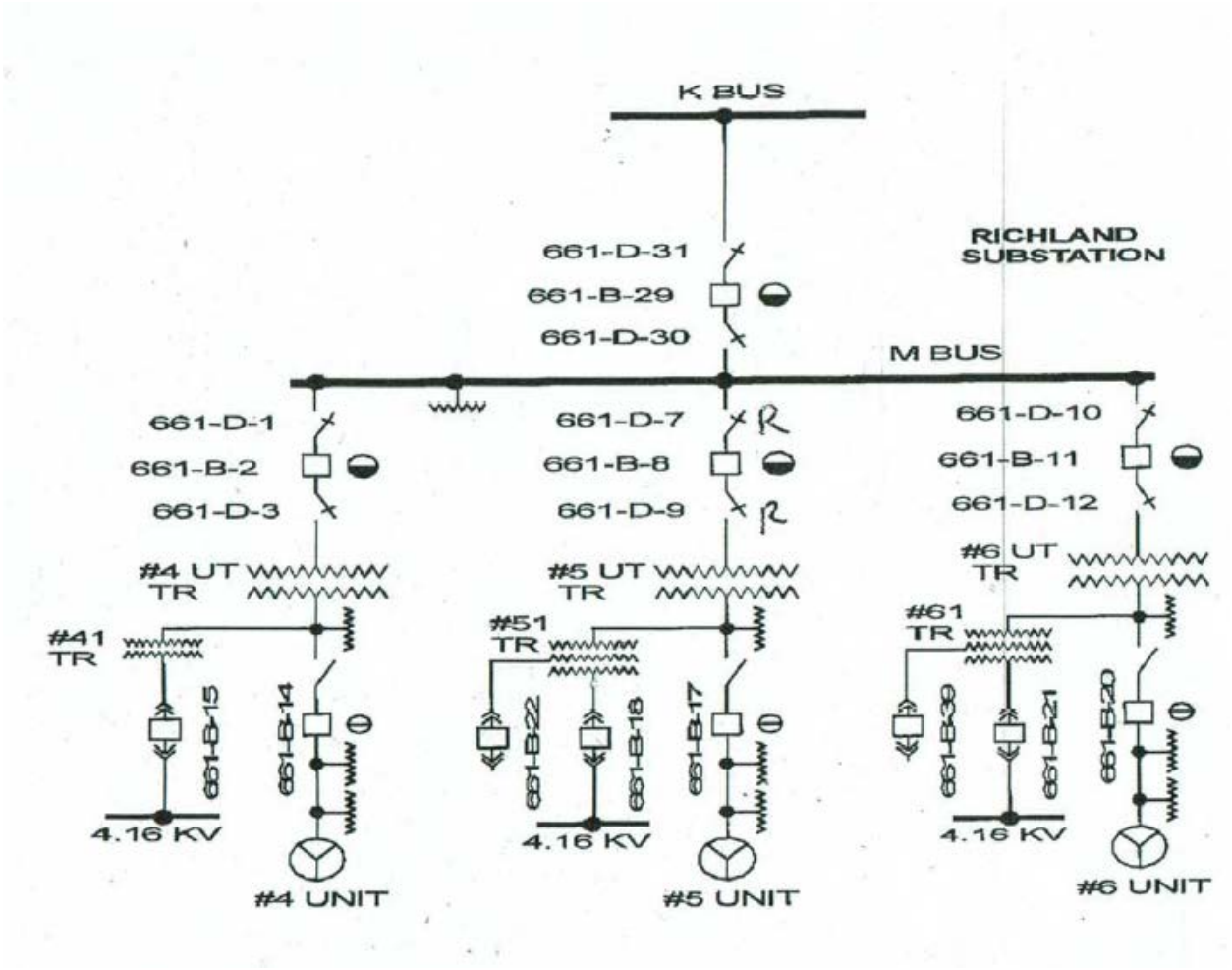

Figure 1: AC1-181 Plant Model

Table 1: AC1-181 Plant Model

	Impact Study Data	Model
Generators	3 × 132 MW ABB Combustine Turbine MVA base = 145 MVA Vt = 13.8 kV	3 × 132 MW ABB Combustine Turbine MVA base = 145 MVA Vt = 13.8 kV Pgen 132 MW Pmax 132 MW Pmin 0 MW Qmax 76 MVAr Qmin -60 MVAr Mbase 145 MVA Zsorce 0.0 + j0.15 pu @Mbase
GSU transformer	3 x 138/13.8 kV two winding transformers Transformer base = 90 MVA Rating = 90/120/150 MVA Impedance = 0.00866+j0.09 pu @ MVA base Number of taps = 5 Tap step size = 0.025	3 x 138/13.8 kV two winding transformers (As built in the case) Transformer base = 100 MVA Rating = 150 MVA Impedance = 0.018+j0.096 pu @ MVA base Number of taps = 5 Tap step size = 0.025
Auxiliary Load	0.1 MW + 1.0 MVAr on LV side of GSU	0.1 MW + 1.0 MVAr
Transmission Line	N/A	N/A

3. Loadflow and Dynamics Case Setup

The dynamics simulation analysis was carried out using PSS/E Version 33.7.

The load flow scenario and fault cases for this study are based on PJM's Regional Transmission Planning Process[1].

The selected load flow scenario is the RTEP 2020 Summer Peak case with the following modifications:

a) Addition of all applicable queue projects prior to AC1-181.

b) Addition of AC1-181 queue project.

c) Removal of withdrawn and subsequent queue projects in the vicinity of AC1-181.

d) Dispatch of units in the PJM system to maintain slack generators within limits.

The AC1-181 initial conditions are listed in Table 2, indicating maximum power output, with AC1-181 regulating POI voltage of (1.011 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 138 kV system.

Table 2: AC1-181 machine initial conditions

Bus	Name	Unit	PGEN (MW)	QGEN (MVAR)	ETERM (p.u.)	POI Voltage (p.u.)
239064	02RICHG1 13.200	1	11	2.5	1.01	1.01
239065	02RICHG2&3 13.200	2	11	-3.8	0.94	1.01
239065	02RICHG2&3 13.200	3	11	-3.8	0.94	1.01
239067	02RICHG4 13.800	4	132	2.5	0.98	1.01
239068	02RICHG5 13.800	5	132	2.5	0.98	1.01
239069	02RICHG6 13.800	6	132	2.5	0.98	1.01

Generation within the vicinity of AC1-181 has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AC1-181 is given in Attachment 3.

[1] Manual 14B: PJM Region Transmission Planning Process, Rev 33, May 5 2016, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

4. Fault Cases

Tables 3 listed the contingencies and results that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 20 second simulation time interval.

Simulated NERC Standard TPL-001 faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are covered by P1 and P4 contingencies.

The system was tested for a system intact condition and the fault types listed above. No relevant High Speed Reclosing (HSR) contingencies were studied.

5. Evaluation Criteria

This study is focused on AC1-181, along with the rest of the PJM system, maintaining synchronism and having all states return to an acceptable new condition following the disturbance. The recovery criteria applicable to this study are as per PJM's Regional Transmission Planning Process and Transmission Owner criteria:

a) The system with AC1-181 included is transiently stable and post-contingency oscillations should be positively damped with a damping margin of at least 3%.

b) The AC1-181 is able to ride through faults (except for faults where protective action trips AC1-181).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

6. Summary of Results

Plots from the dynamic simulations are provided in Attachment 4, with results summarized in Table 3.

The frequency protection was disabled due to the PSSE deficiency in calculating frequencies for 3ph fault at POIs.

For the fault contingencies tested in this study:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AC1-181 generator was able to withstand all contingencies.

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

7. Mitigations

No Mitigations were found to be required.

Table 3: Fault list

P0: Steady State

Fault ID	Duration
P0.00	Steady State 20 sec run

P1: Three Phase Faults with normal clearing

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.00	Fault at Saxony 138 kV (V2-006 POI) on V2-006 circuit (Trips V2-006).	6	Stable
P1.01	Fault at Saxony 138 kV (V2-006 POI) on North Leipsic – Yellow Creek circuit.	6	Stable
P1.02	Fault at Saxony 138 kV (V2-006 POI) on East Ottawa circuit.	6	Stable
P1.03	Fault at Saxony 138 kV (V2-006 POI) on Richland (FE) circuit.	6	Stable
P1.04	Fault at Yellow Creek 138 kV on North Leipsic – Saxony (V2-006 POI) circuit.	6	Stable
P1.05	Fault at Yellow Creek 138 kV on East Leipsic circuit.	6	Stable
P1.06	Fault at East Ottawa 138 kV on Saxony (V2-006 POI) circuit.	6	Stable
P1.07	Fault at East Ottawa 138 kV on East Lima circuit.	6	Stable
P1.08	Fault at East Ottawa 138 kV on East Leipsic circuit.	6	Stable
P1.09	Fault at Richland (FE) 138 kV on Saxony (V2-006 POI) circuit.	6	Stable
P1.10	Fault at Richland 138 kV on Richland 138 kV / 13.8 kV Transformer 5 (Trips Richland generating units PK1).	6	Stable
P1.11	Fault at Richland 138 kV on Richland 138 Kv / 13.2 kV Transformer 6 (Trips Richland generating units PK2 and PK3).	6	Stable
P1.12	Fault at Richland 138 kV on Richland generating units PK4, PK5 and PK6 (Trips Richland generating units PK4, PK5 and PK6).	6	Stable
P1.13	Fault at Richland 138 kV on 33.6 MVAr capacitor connected to breaker 13230.	6	Stable
P1.14	Fault at Richland 138 kV on 33.6 MVAr capacitor connected to breaker 13234.	6	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.15	Fault at Richland 138 kV on Lockwood Road circuit.	6	Stable
P1.16	Fault at Richland 138 kV on Johns Manville 2 – Johns Manville – Southwest Defiance circuit (normally open to Ayersville – Richland).	6	Stable
P1.17	Fault at Richland 138 kV on GM Defiance circuit 1.	6	Stable
P1.18	Fault at Richland 138 kV on GM Defiance circuit 2.	6	Stable
P1.19	Fault at Richland 138 kV on Wauseon – Midway circuit.	6	Stable
P1.20	Fault at Richland 138 kV on Ridgeville – Stryker – Northside Napoleon Muni circuit.	6	Stable
P1.21	Fault at Richland 138 kV on Ayersville circuit (normally open to Southwest Defiance – Johns Manville – Johns Manville 2 – Richland).	6	Stable
P1.22	3ph @ Stryker – East Fayette 138kV line, normal clear	6	Stable
P1.23	3ph @ Stryker 138/69kV TF, normal clear loss of Stryker unit	6	Stable
P1.24	3ph @ Stryker 138kV capacitor, normal clear	6	Stable
P1.25	3ph @ Stryker – Ridgeville – Northside Napoleon Muni 138kV line, normal clear	6	Stable
P1.26	3ph @ Northside Napoleon Muni – Midway 138kV line, normal clear	6	Stable

P4: SLG Stuck Breaker (SB) Faults at Backup Clearing

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.01	Fault at Saxony 138 kV (V2-006 POI) on V2-006 circuit. Breaker A stuck. Fault cleared with loss of North Leipsic – Yellow Creek circuit. Trips V2-006.	6 / 20	Stable
P4.02	Fault at Saxony 138 kV on V2-006 circuit. Breaker C stuck. Fault cleared with loss of Richland circuit. Trips V2-006.	6 / 20	Stable
P4.03	Fault at Saxony 138 kV on North Leipsic – Yellow Creek circuit. Breaker A stuck. Fault cleared with loss of V2-006 circuit (Trips V2-006).	6 / 20	Stable
P4.04	Fault at Saxony 138 kV on North Leipsic – Yellow Creek circuit. Breaker B stuck. Fault cleared with loss of East Ottawa circuit.	6 / 20	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.05	Fault at Saxony 138 kV on East Ottawa circuit. Breaker B stuck. Fault cleared with loss of North Leipsic – Yellow Creek circuit.	6 / 20	Stable
P4.06	Fault at Saxony 138 kV on East Ottawa circuit. Breaker D stuck. Fault cleared with loss of Richland circuit.	6 / 20	Stable
P4.07	Fault at Saxony 138 kV on Richland (FE) circuit. Breaker C stuck. Fault cleared with loss of V2-006 circuit (Trips V2-006).	6 / 20	Stable
P4.08	Fault at Saxony 138 kV on Richland circuit. Breaker D stuck. Fault cleared with loss of East Ottawa circuit.	6 / 20	Stable
P4.09	Fault at Yellow Creek 138 kV on North Leipsic – Saxony circuit. Breaker B stuck. Fault cleared with loss of 138/13.8 kV transformer 3.	5.5 / 16	Stable
P4.10	Fault at Yellow Creek 138 kV on East Leipsic circuit. Breaker A stuck. Fault cleared with loss of 138/13.8 kV transformer 4.	5.5 / 16	Stable
P4.11	Fault at East Ottawa 138 kV on Saxony circuit. Breaker A stuck. Fault cleared with loss of East Leipsic circuit.	5.5 / 16	Stable
P4.12	Fault at East Ottawa 138 kV on Saxony circuit. Breaker C stuck. Fault cleared with loss of East Lima circuit.	5.5 / 16	Stable
P4.13	Fault at East Ottawa 138 kV on East Lima circuit. Breaker C stuck. Fault cleared with loss of Saxony circuit.	5.5 / 16	Stable
P4.14	Fault at East Ottawa 138 kV on East Lima circuit. Breaker B stuck. Fault cleared with loss of East Leipsic circuit.	5.5 / 16	Stable
P4.15	Fault at East Ottawa 138 kV on East Leipsic circuit. Breaker A stuck. Fault cleared with loss of Saxony circuit.	5.5 / 16	Stable
P4.16	Fault at East Ottawa 138 kV on East Leipsic circuit. Breaker B stuck. Fault cleared with loss of East Lima circuit.	5.5 / 16	Stable
P4.17	Fault at Richland (FE) 138 kV on Saxony circuit. Breaker 13250 stuck. Fault cleared with loss of Richland 138 kV bus J (Trips Richland generating units PK2 and PK3).	6 / 20	Stable
P4.18	Fault at Richland 138 kV on Richland generating units PK4, PK5 and PK6. Breaker 29 stuck. Fault cleared with loss of Richland 138 kV bus K (Trips Richland generating units PK1, PK4, PK5 and PK6).	6 / 20	Stable
P4.19	Fault at Richland 138 kV on 33.6 MVAr capacitor connected to breaker 13230. Breaker 13230 stuck. Fault cleared with loss of Richland 138 kV bus K (Trips Richland generating units PK1, PK4, PK5 and PK6).	6 / 20	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.20	Fault at Richland 138 kV on 33.6 MVAr capacitor connected to breaker 13234. Breaker 13234 stuck. Fault cleared with loss of Richland 138 kV bus J (Trips Richland generating units PK2 and PK3).	6 / 20	Stable
P4.21	Fault at Richland 138 kV on Lockwood Road circuit. Breaker 13291 stuck. Fault cleared with loss of Richland 138 kV bus K (Trips Richland generating units PK1, PK4, PK5 and PK6).	6 / 20	Stable
P4.22	Fault at Richland 138 kV on Johns Manville 2 Johns Manville – Southwest Defiance circuit (normally open to Ayersville – Richland). Breaker 13236 stuck. Fault cleared with loss of Richland 138 kV bus K (Trips Richland generating units PK1, PK4, PK5 and PK6).	6 / 20	Stable
P4.23	Fault at Richland 138 kV on GM Defiance circuit 1. Breaker 13242 stuck. Fault cleared with loss of Richland 138 kV bus K (Trips Richland generating units PK1, PK4, PK5 and PK6).	6 / 20	Stable
P4.24	Fault at Richland 138 kV on GM Defiance circuit 2. Breaker 13243 stuck. Fault cleared with loss of Richland 138 kV bus J (Trips Richland generating units PK2 and PK3).	6 / 20	Stable
P4.25	Fault at Richland 138 kV on Wauseon – Midway circuit. Breaker 13245 stuck. Fault cleared with loss of Richland 138 kV bus K (Trips Richland generating units PK1, PK4, PK5 and PK6).	6 / 20	Stable
P4.26	Fault at Richland 138 kV on Ridgeville – Stryker – Northside Napoleon Muni circuit. Breaker 13246 stuck. Fault cleared with loss of Richland 138 kV bus J (Trips Richland generating units PK2 and PK3).	6 / 20	Stable
P4.27	Fault at Richland 138 kV on Ayersville circuit (normally open to Southwest Defiance – Johns Manville – Johns Manville 2 – Richland). Breaker 13235 stuck. Fault cleared with loss of Richland 138 kV bus J (Trips Richland generating units PK2 and PK3).	6 / 20	Stable
P4.28	Fault at Richland 138kV bus section between K and J, normal clear split bus K and J, SB 13247 @ Richland 138kV, delayed clear loss of Richland 138kV bus J, loss of unit 2, 3	6 / 20	Stable
P4.29	Fault at Richland 138kV bus section between K and J, normal clear split bus K and J, SB 13249 @ Richland 138kV, delayed clear loss of Richland 138kV bus K, loss of unit 1, 4, 5, 6	6 / 20	Stable

P5: SLG Fault with Delayed (Zone 2) Clearing

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P5.01	Fault at 80% of 138 kV line from Saxony 138 kV to North Leipsic – Yellow Creek circuit. Delayed clearing at Saxony.	5.5 / 60	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P5.02	Fault at 80% of 138 kV line from Saxony 138 kV to East Ottawa circuit. Delayed clearing at Saxony.	5.5 / 60	Stable
P5.03	Fault at 80% of 138 kV line from Saxony 138 kV to Richland circuit. Delayed clearing at Saxony.	5.5 / 60	Stable
P5.04	Fault at 80% of 138 kV line from Yellow Creek 138 kV to East Leipsic circuit. Delayed clearing at Yellow Creek.	5.5 / 60	Stable
P5.05	Fault at 80% of 138 kV line from East Ottawa 138 kV to East Lima circuit. Delayed clearing at East Ottawa.	5.5 / 60	Stable
P5.06	Fault at 80% of 138 kV line from East Ottawa 138 kV to East Leipsic circuit. Delayed clearing at East Ottawa.	5.5 / 60	Stable
P5.07	Fault at 80% of 138 kV line from Richland 138 kV to Lockwood Road circuit. Delayed clearing at Richland.	6 / 65	Stable
P5.08	Fault at 80% of 138 kV line from Richland 138 kV to Wauseon – Midway circuit. Delayed clearing at Richland.	6 / 65	Stable
P5.09	Fault at 80% of 138 kV line from Richland 138 kV to Ridgeville – Stryker – Northside Napoleon Muni circuit. Delayed clearing at Richland.	6 / 65	Stable

P7: 3ph Fault with Common Structure Failure

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P7.01	Fault at Richland 138 kV on Wauseon – Midway circuit resulting in tower failure. Fault cleared with loss of Ridgeville – Stryker – Northside Napoleon Muni circuit. CONTINGENCY 'C5-TWL-WR013' /* RICHL-RIDGV JCT NO.1 & NO.2 138	6	Stable
P7.02	Fault at Saxony 138 kV on East Ottawa circuit resulting in tower failure. Fault cleared with loss of Saxony – Richlands circuit.	6	Stable
P7.03	Fault at Saxony 138 kV on East Ottawa circuit resulting in tower failure. Fault cleared with loss of East Ottawa – East Leipsic circuit.	6	Stable

Attachment 1. PSS/E Model One Line Diagram

Attachment 2. PSS/E Dynamic Model

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/*********************************/
/*AC1-181 data update
/*********************************/
 239067 'GENROU' 4     8.3900      0.19000E-01  0.81000      0.29000E-01
        1.4100       0.0000       1.9900       1.8500      0.20000
       0.33000      0.15000      0.13000      0.70000E-01  0.26000    /
 239067 'ESST1A' 4          1           1      0.20000E-01  0.92000E-01
       -0.80000E-01   2.4900       24.900      0.40000      0.91000E-01
        500.00      0.85000E-02   4.5900      -4.1200       4.5900
       -4.1200      0.50000E-01   0.0000       1.0000       15.000
        5.1600    /
 239067 'GGOV1' 4           1         0
        0.40000E-01    1.0000       0.50000E-01  -0.50000E-01    10.000
         2.0000        0.0000        1.0000        1.0000       0.10000
        0.50000        1.5000       0.15000       0.50000        0.0000
         0.0000        3.0000        5.0000        5.0000        1.0200
         0.0000        99.000       -99.000        0.0000        99.000
         10.000        1.0000        131.00        0.0000        1.0000
         1.0000        99.000       -99.000    /
 239068 'GENROU' 5     8.3900      0.19000E-01  0.81000      0.29000E-01
        1.4100       0.0000       1.9900       1.8500      0.20000
       0.33000      0.15000      0.13000      0.70000E-01  0.26000    /
 239068 'ESST1A' 5          1           1      0.20000E-01  0.92000E-01
       -0.80000E-01   2.4900       24.900      0.40000      0.91000E-01
        500.00      0.85000E-02   4.5900      -4.1200       4.5900
       -4.1200      0.50000E-01   0.0000       1.0000       15.000
        5.1600    /
 239068 'GGOV1' 5           1         0
        0.40000E-01    1.0000       0.50000E-01  -0.50000E-01    10.000
         2.0000        0.0000        1.0000        1.0000       0.10000
        0.50000        1.5000       0.15000       0.50000        0.0000
         0.0000        3.0000        5.0000        5.0000        1.0200
         0.0000        99.000       -99.000        0.0000        99.000
         10.000        1.0000        131.00        0.0000        1.0000
         1.0000        99.000       -99.000    /
 239069 'GENROU' 6     8.3900      0.19000E-01  0.81000      0.29000E-01
        1.4100       0.0000       1.9900       1.8500      0.20000
       0.33000      0.15000      0.13000      0.70000E-01  0.26000    /
 239069 'ESST1A' 6          1           1      0.20000E-01  0.92000E-01
       -0.80000E-01   2.4900       24.900      0.40000      0.91000E-01
        500.00      0.85000E-02   4.5900      -4.1200       4.5900
       -4.1200      0.50000E-01   0.0000       1.0000       15.000
        5.1600    /
 239069 'GGOV1' 6           1         0
```

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0.40000E-01    1.0000       0.50000E-01  -0.50000E-01    10.000
 2.0000        0.0000       1.0000       1.0000       0.10000
0.50000        1.5000       0.15000      0.50000        0.0000
 0.0000        3.0000       5.0000       5.0000       1.0200
 0.0000        99.000      -99.000       0.0000       99.000
 10.000        1.0000       131.00       0.0000       1.0000
 1.0000        99.000      -99.000    /
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Attachment 3. PSS/E Case Dispatch

Bus Number	Bus Name	Id	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)
238601	02FRMENG 1 18.000	1	1	184.7	184.7	0	-29.6	121.7	-88.7
238602	02FRMENG 2 18.000	2	1	184.7	184.7	0	-29.6	121.7	-88.7
238603	02FRMENG 3 23.000	3	1	344	344	0	-29.6	233.3	-173
238670	02DVBSG1 25.000	1	1	960	960	0	52.6	478.8	52.6
238885	02LEMOG1 18.000	1	1	160	160	90	-45	100	-45
238886	02LEMOG2 18.000	2	1	160	160	90	-45	100	-45
238887	02LEMOG3 18.000	3	1	160	160	90	-45	100	-45
238888	02LEMOG4 18.000	4	1	160	160	90	-45	100	-45
238979	02NAPMUN 138.00	1	1	25	25	24	-10	14	-10
238979	02NAPMUN 138.00	2	1	12	12	10	-6	5	-6
239064	02RICHG1 13.200	1	1	11	11	0	-5	11	-5
239065	02RICHG2&3 13.200	2	1	11	11	5	-3.8	9.8	-3.8
239065	02RICHG2&3 13.200	3	1	11	11	5	-3.8	9.8	-3.8
239067	02RICHG4 13.800	4	1	132	132	40	-6.55	76	-60
239068	02RICHG5 13.800	5	1	132	132	40	-6.55	76	-60
239069	02RICHG6 13.800	6	1	132	132	40	-6.55	76	-60
239202	02STRYCT 13.200	1	1	14.3	14.3	0	-5	10.4	-5
240950	02BG5 69.000	1	1	11	11	0	3.307	20	0
240950	02BG5 69.000	2	1	11	11	0	3.307	12.7	0
297015	V2-006 WTG 0.6900	1	1	150	150	11.48	16.19	49.3	-49.3
926813	AC1-167 GEN 0.3570	1	1	49.98	49.98	0	-5.3	16.4	-16.4