Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC2-140

DC Cook 765 kV Unit #2

December 2019

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

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. 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 System Impact Study is performed.

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.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

An Interconnection Customer entering the New Services Queue on or after October 1, 2018 (except those regulated by the United States Nuclear Regulatory Commission) shall provide primary frequency response in accordance with Section 4.7.2 of Appendix 2 to the Interconnection Service Agreement. See PJM Manual 14D Section 7.1.1 for more information.

General

Indiana Michigan Power Company proposes to increase generation at the existing DC Cook 765 kV Unit #2 Generation Plant connected to the DC Cook 765 kV Substation by 28.0 MW (38.0 MW Capacity) in Bridgman, MI (see Figure 1). The total output of Unit #2 will be 1220.0 MW (1186.0 Capacity). The increase in production capability is due to a turbine generator steam upgrade project.

The requested in service date for the generation increase is March 18, 2018.

Attachment Facilities

Point of Interconnection (DC Cook 765 kV Substation)

Not required for an existing facility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Interconnection Customer Requirements

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

Revenue Metering and SCADA Requirements

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.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements

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may be found within the “Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System” document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

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Network Impacts

The Queue Project AC2-140 was evaluated as a 38.0 MW (Capacity 38.0 MW) injection into the Cook 765 kV substation in the AEP area. Project AC2-140 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-140 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

None

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

Short Circuit

(Summary of impacted circuit breakers)

N/A

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Steady-State Voltage Requirements

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

See Attachment 2

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

See Attachment 2

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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.

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

Affected System Analysis & Mitigation

LGEE Impacts:

None

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

OVEC Impacts to be determined during later study phases (as applicable).

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Conclusion

Based upon the results of this System Impact Study, the injection of an additional 28.0 MW (38.0 MW Capacity) at DC Cook 765 kV Unit #2 generating facility will not require additional interconnection charges.

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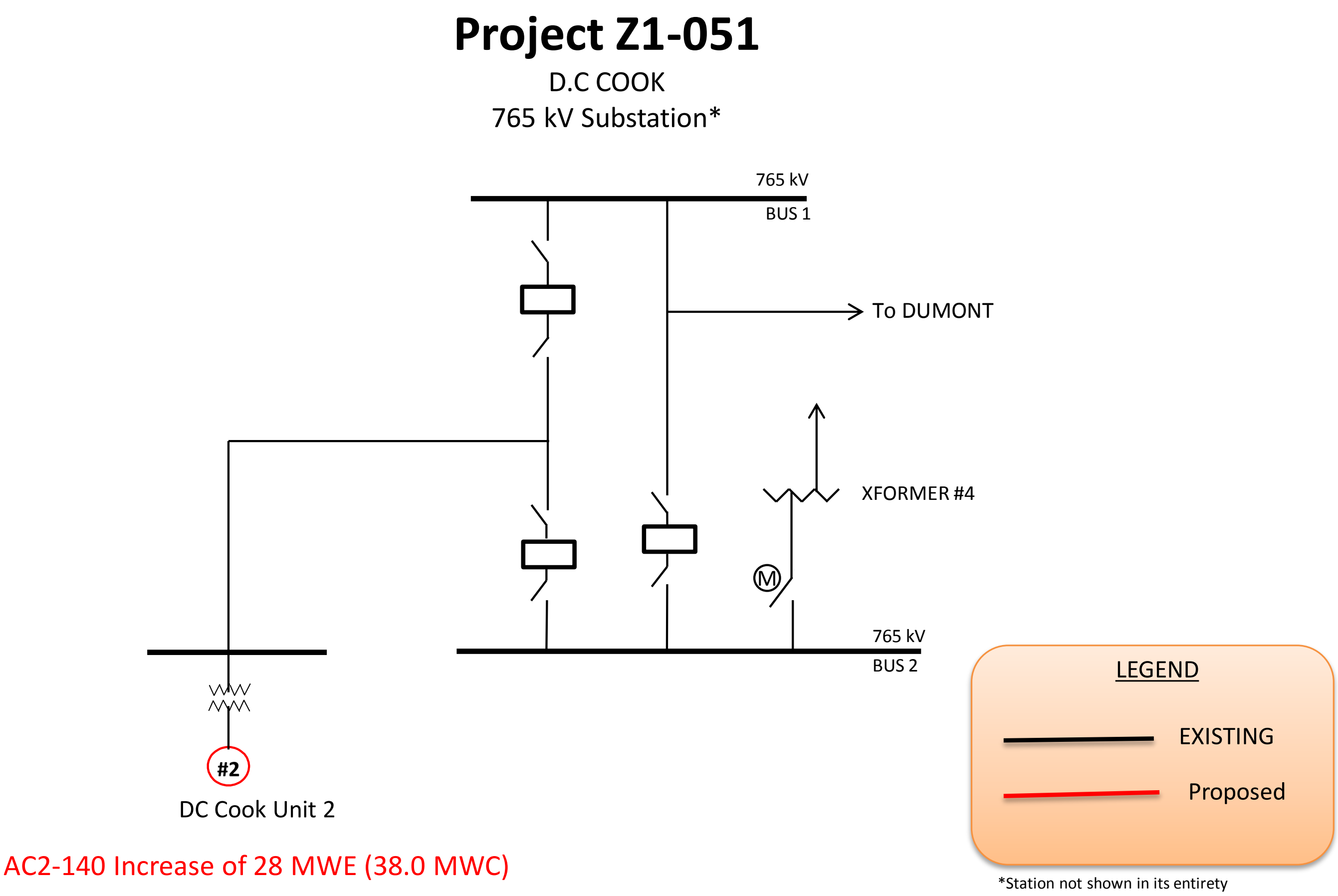
Attachment 1: Point of Interconnection (DC Cook 765 kV Substation)

Single-Line Diagram



Attachment 2: Dynamic Simulation Analysis

Executive Summary

Generator Interconnection Request AC2-140 is for an increase of 28 MW to the existing Cook Unit #2 Nuclear Facility (Z1-051). The details of the uprate are given in Table 1.

Table 1: Uprate change in MW

Queue Project	Gross Output (MW)	MFO (MW)	Reason for uprating
D.C. Cook unit 2	N/A	1090	Original request
Z1-051	1225[1]	1192	N/A
AC2-140	1255	1220	Increase in capacity due to turbine generator steam upgrade project.

Cook Unit #2 consists of a 1333 MVA steam turbine generator and the uprate increases the Maximum Facility Output (MFO) of the plant from 1192 MW to 1220 MW. AC2-140 has a Point of Interconnection (POI) at the Cook 765 kV substation, in the America Electric Power (AEP) transmission system, Berrien County, Michigan.

This report describes a dynamic simulation analysis of AC2-140 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2020 light load case, modified to include applicable queue projects. AC2-140 has been dispatched online at maximum power output, with 0.95 p.u. voltage at the generator bus.

AC2-140 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. 49 contingencies were studied, each with a 30 second simulation time period. Studied faults included:

a) Steady state operation (20 second);
b) Three phase faults with normal clearing time and high-speed reclosing (HSR);
c) Single phase bus faults with normal clearing time;
d) Single phase faults with stuck breaker;
e) Three phase faults with normal clearing time – prior outage;

[1] Based on Pmax of pre-uprate model in the case.

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f) Single-phase fault with loss of multiple-circuit tower line.

No relevant delayed (Zone 2) clearing contingencies were identified for this study.

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 all of the fault contingencies tested on the 2020 light load case:

a) AC2-140 was able to ride through the faults (except for faults where protective action trips a generator(s)),
b) Post-contingency oscillations were positively damped with a damping margin of at least 3%.
c) Following fault clearing, all bus voltages recovered to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).
d) No transmission element tripped, other than those either directly connected or designed to trip as a consequence of that fault.

It was found that:

- Insufficient damping was observed at AC2-140 for P1.02, P1.04, P4.14, P4.15, P4.18 and P4.24 due to Ludington MISO hydro units operating in pumping mode. The AC2-140 uprate is not the cause of the damping issue as this damping is present at lower Cook U2 power levels.
- The damping issue was resolved by turning off the Ludington MISO units operating in pumping mode. Another potential option to resolve the damping issue is to add a Power System Stabilizer (PSS) which was recommended during the Z1-051 project.
- High frequency oscillation was observed at University Park North units. The dynamic model of the units was updated in accordance with the AC2-117 dynamic model and the issue was resolved.

No mitigations were found to be required.

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