GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

250 MW [redacted] PROJECT

(GI PROJECT #561)

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

in

JEROME COUNTY, IDAHO

for

[redacted]

Report v.1

December 29, 2020

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1.0 Introduction

[redacted] has contracted with Idaho Power Company ("Transmission Provider") to perform a Generator Interconnection System Impact Study for the integration of the proposed 250 MW [redacted] project (the Project). The Project location is in Idaho Power Company's (IPC's) Southern Region in Jerome County, Idaho. The Project latitude and longitude coordinates are approximately [redacted] [redacted]. The Project is Generator Interconnection (GI) queue number 561 (GI #561). The Project has chosen in the System Impact Study to be studied as both an Energy Resource (ER) Interconnection Service and a Network Resource (NR) Interconnection Service.

The Project has applied to connect to the Idaho Power's transmission system for an injection of 250 MW at a single Point of Interconnection (POI) at 230kV. The POI is IPC's [redacted] Station 230kV bus.

IPC projects queue GI #530, GI #551, GI #557, and GI #558 are senior queued projects in the affected area of IPC's transmission system and were modeled in this study. Other cases were developed without any senior queued projects to determine if there are any Contingent Facilities required for GI #561.

This report documents the basis for and the results of this System Impact Study for the GI #561 Generator Interconnection Customer. The report describes the proposed project, the determination of the project interconnection requirements, and estimated costs for integration of the project to the Transmission Provider transmission system. This report satisfies the system impact study requirements of the Idaho Power Tariff.

2.0 Summary

The system impact of interconnecting the GI #561 250 MW generation project to the Transmission Provider's transmission system was evaluated. GI #561 can be interconnected to the Idaho Power transmission system. The primary Point of Interconnection (POI) is located at Idaho Power's [redacted] station 230kV bus.

This System Impact Study has determined that additional network upgrades are not required to integrate this project into the IPCo transmission system and has evaluated full system impacts (thermal, voltage, transient stability, and reactive margin). No senior queued generation interconnections were identified as Contingent Facilities for the Project. Generator interconnection service (either as an Energy Resource or a Network Resource) does not in any way convey any right to deliver electricity to any specific customer or point of delivery.

The GI #561 project is a combined PV and BESS and it has been assumed that the BESS will be charged via the PV output. [redacted] will need to demonstrate the operating procedures and control measures which prevents the BESS from being charged via IPC's transmission system. However, if the intent is also to be able to charge the BESS via IPC's transmission system, [redacted] will need to make an IPC Large Load Service request.

GI #561 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. GI #561 will be required to manage the real power output of their generation project at the POI. Also, it may be beneficial for [redacted], for their own modeling compliance requirements, to install additional PMU devices at their facilities to monitor the generation source(s).

The total "Energy Resource Interconnection Service" generation interconnection preliminary cost estimate to interconnect the project to the primary study POI is as follows:

- Energy Resource Interconnection at proposed 230kV POI **- $1,193,153**

See Section 6.5 Energy Resource Cost Estimate for the required Energy Resource facilities and cost breakdowns.

The total "Network Resource Interconnection Service" generation interconnection preliminary cost estimate to interconnect the [redacted] project is as follows:

- Network Resource Interconnection Service **- $1,193,153**

See Section 7.3 Network Resource Cost Estimate for the required Network Resource facilities and cost breakdowns. The cost estimate includes a 20% contingency and 8.5% overhead. These are cost estimates only and final charges to the customer will be based on the actual construction costs incurred. It should be noted that the preliminary cost estimates do not include the cost of the customer's owned equipment.

The schedule for designing, procuring, and constructing facilities will be developed and optimized during the Facility Study should the generation interconnection customer choose to move to that study phase of the interconnection process.

3.0 Scope of Interconnection System Impact Study

The Interconnection System Impact Study was done and prepared in accordance with the Transmission Provider's Standard Generator Interconnection Procedures to provide an evaluation of the system impact of the interconnection of the proposed generating project to the Idaho Power system. As listed in the Interconnection System Impact Study agreement, the Interconnection System Impact Study report provides the following information:

- identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection;
- identification of any thermal overload or voltage limit violations resulting from the interconnection;
- identification of any instability or inadequately damped response to system disturbances resulting from the interconnection and
- description and non-binding, good faith estimated cost of facilities required to interconnect the Large Generating Facility to the Transmission System and to address the identified short circuit, instability, and power flow issues.

All other proposed Generation projects prior to this project in the Generator Interconnect queue were considered in this study**.** A current list of these projects can be found in the Generation Interconnection folder located on the Idaho Power web site at the link shown below:

http://www.oatioasis.com/ipco/index.html.

4.0 Contingent Facilities

GI #561 Energy Resource, ER, service at the [redacted] 230kV POI is not contingent upon upgrades associated with any senior queued project.

GI #561 Network Resource, NR, service at the [redacted] 230kV POI is not contingent upon upgrades associated with any senior queued project.

5.0 Description of Proposed Generating Project

Assumptions

The primary point of interconnection for GI #561 is the [redacted] Station 230kV bus. Assumed GI #561 Project's maximum generation is 250 MW from the combined Photovoltaic (PV) and Battery Energy Storage System (BESS). The Project's Commercial Operation Date (COD) is December 1, 2022.

GI #561:

- [redacted]-mile 230kV transmission line from [redacted] 230kV bus to project
- Two 230/34.5kV GSU transformers with a 100/130/169 MVA capacity each
- Each 230/34.5kV GSU transformer will have approximately 125 MW of PV and 75 MW of BESS connected.
- All generation in voltage regulation (Reactive capability used to regulate voltage – supply/absorb reactive)

6.0 Energy Resource (ER) Interconnection Service

Energy Resource (ER) Interconnection Service allows the Interconnection Customer to connect its Generating Facility to Transmission Provider's transmission system and to be eligible to deliver electric output using firm or non-firm transmission capacity on an as available basis.

The GI #561 project has applied to connect to the Idaho Power transmission system for an injection of 250 MW with a new 230kV interconnection at the [redacted] 230kV bus. All generation projects in the area ahead of this project in the IPC generation queue and their associated transmission system improvements were modeled in a power flow analysis to evaluate the system impact of interconnecting GI #561.

6.1 Description of Substation/Transmission Facilities

As an Energy Resource, a Transmission Service Request will be required to determine the specific Network Upgrades required to deliver the project output to a designated point of delivery. Listed below are the required transmission facilities to interconnect the Project based on the System Impact Study.

Substation/Transmission Interconnection Facilities:

The proposed interconnection will require a new line terminal interconnection at the [redacted] 230kV bus.

The actual station layout and detailed equipment requirements will be determined in the Facility Study should the interconnection customer choose to move to that study phase of the interconnection process.

6.2 Description of Distribution Facilities

No distribution facilities are directly impacted by this project.

6.3 Short Circuit Study Results

The short circuit/fault duty at approximate GI #561 POI 230kV bus location (with/without GI #561 modeled) is as follows:

Fault Study (w/o GI #561)			
Location	**SLG (A)**	**LTL (A)**	**3PH (A)**
[redacted] 230kV Bus	29477.5	24790.7	29178.8

Fault Study (w/ GI #561)			
Location	**SLG (A)**	**LTL (A)**	**3PH (A)**
[redacted] 230kV Bus	31366	25280	29330.4

Studies indicate that there is adequate load and short circuit interrupting capability on the Transmission Provider's existing 230kV breakers after this project is interconnected.

6.4 Electric System Protection Results and Grounding Requirements

For 230kV line protection, the Transmission Provider's System Protection Department utilizes permissive and line differential protection schemes integrated with our existing digital communication infrastructure. Digital communication infrastructure for the interconnection customer's 230kV line terminal will be the responsibility of said interconnection customer.

6.5 Energy Resource Cost Estimate

In Table 1 below, a summary is provided of the generation interconnection facilities and conceptual costs required to interconnect the GI #561 project to the Transmission Provider's transmission system as an Energy Resource.

GI #561 [redacted] Solar Project Energy Resource Generation Interconnection Facilities	
	Cost
[redacted] 230kV Line Terminal	$916,400
Subtotal	**$916,400**
Contingencies (~20.0%) (1)	$183,280
Subtotal	**$1,099,680**
Overheads (~8.5%) (2)	$93,473
Energy Resource – Total Estimated Cost (3)	**$1,193,153**

Table 1. Estimated GI #561 Project's Energy Resource Generation Interconnection Costs

(1) Contingency is added to cover the unforeseen costs in the estimate. These costs can include unidentified design components, material cost increases, labor estimate shortfalls, etc.
(2) Overhead costs cover the indirect costs associated with the Project.
(3) This cost estimate includes direct equipment, material, labor, and overheads as shown.

- Note that these estimates do not include the cost of the customer's equipment/facilities or required communication circuits for SCADA, PMU, and metering.
- Note that the overhead rates are subject to change during the year.
- These are estimated costs only and final charges to the customer will be based on the actual construction costs incurred.
- These are non-binding conceptual level cost estimates that will be further refined upon the request and completion of the Facility Study.

The schedule for designing, procuring, and constructing facilities will be developed and optimized during the Facility Study should the generation interconnection customer choose to move to that study phase of the interconnection process.

7.0 Network Resource (NR) Interconnection Service

Network Resource Interconnection Service allows the Interconnection Customer to integrate its Generating Facility with the Transmission Provider's Transmission System in a manner comparable to that in which the Transmission Provider integrated its generating facilities to serve native load customers. The transmission system is studied under a variety of conditions to determine the transmission improvements/upgrades which are necessary. Network

Resource Interconnection Service in and of itself does not convey Transmission Service.

7.1 Description of Power Flow Cases

For the Network Resource Interconnection Service study, three power flow cases were used to study the Transmission Provider's transmission system with westbound and eastbound transmission flows to determine the required Network Transmission Upgrades.

The WECC 2019 Heavy Summer case was chosen as a power flow base case for the study. The case was modified to represent a summer month with high west to east (eastbound) transfers across Midpoint West.

For the second case, a WECC 2019 Light Winter operating case, was modified to represent a shoulder month condition with high east to west (westbound) transfers across Midpoint West.

For the third case, a WECC 2019 Light Summer case was modified to represent a shoulder month with high west to east transfers (eastbound) transfers across Borah West.

7.2 Network Resource Transmission Upgrades

From the power flow/contingency analysis, no additional Network Transmission upgrades were identified for the integration of GI #561 in addition to the Energy Resource generation interconnection facilities.

GI #561 Network Resource service at the [redacted] 230kV POI is not contingent upon upgrades associated with any senior queued project.

7.3 Network Resource Cost Estimate

Table 2 below is a summary of the Network Transmission generation interconnection facilities and conceptual costs required to interconnect the GI #561 project to the Transmission Provider's transmission system as a Network Resource.

GI #561 [redacted] Solar 250 MW Project Network Upgrades Network Resource Generation Interconnection Facilities	
Network Resource Transmission Upgrades:	**Cost**
Network Transmission – Total Estimated Cost	**$0**
Energy Resource – Total Estimated Cost	$1,193,153

Network Resource – Total Estimated Cost (3)	$1,193,153

Table 2. Estimated GI #561 Network Resource Generation Interconnection Costs

(1) Contingency is added to cover the unforeseen costs in the estimate. These costs can include unidentified design components, material cost increases, labor estimate shortfalls, etc.
(2) Overhead costs cover the indirect costs associated with the Project.
(3) This cost estimate includes direct equipment, material, labor, and overheads as shown.

- Note that these estimates do not include the cost of the customer's equipment/facilities or required communication circuits for SCADA, PMU, and metering.
- Note that the overhead rates are subject to change during the year.
- These are estimated costs only and final charges to the customer will be based on the actual construction costs incurred.
- These are non-binding conceptual level cost estimates that will be further refined upon the request and completion of the Facility Study.

The schedule for designing, procuring, and constructing facilities will be developed and optimized during the Facility Study should the generation interconnection customer choose to move to that study phase of the interconnection process.

8.0 Voltage Stability Analysis

A Voltage Stability study was performed using the WECC 2019 Light Winter case with Midpoint West East-to-West flows stressed up to 2940 MW (105% of the Path Rating). All contingencies solved successfully so there were no Voltage Stability issues found for the Project.

9.0 Transient Stability Analysis

The WECC 2019 Heavy Summer case modified to represent a summer month with high west to east (eastbound) transfers across Midpoint West was used along with PowerWorld's Transient Stability Analysis tool to perform the transient stability analysis for the Project.

Five transient stability runs were performed with the Project on the system to validate model and system performance:

1. 9.0 Cycle [redacted] – [redacted] 500kV Line 3-phase fault, loss of [redacted] – [redacted] 500kV Line (to test the voltage/frequency ride-through capability of the Project)
2. 4.0 Cycle [redacted] – [redacted] 500kV Line 3-phase fault, loss of [redacted] – [redacted] 500kV Line

3. 5.0 Cycle [redacted] 230kV Breaker 206A 3-phase fault, loss of [redacted] – [redacted] 230kV Line, [redacted] 345kV/230kV Transformer T342, [redacted] 345kV Shunt Capacitor C347, and [redacted] 345kV Shunt Reactor L344
4. 5.0 Cycle [redacted] 345kV Breaker 305A 3-phase fault, loss of [redacted] – [redacted] 345kV Line, [redacted] 500kV/345kV Transformer T501, and [redacted] – [redacted] 500kV Line
5. 5.0 Cycle [redacted] – [redacted] 230kV Line 3-phase fault, loss of [redacted] – [redacted] 230kV Line

The results showed no transient stability violations. Appendix B contains the transient stability plots for the 4.0 Cycle [redacted] – [redacted] 500kV Line 3-phase fault.

10.0 Description of Operating Requirements

It is the generation project's responsibility to provide reactive power capability of the project to have a power factor operating range of at least 0.95 leading to at least 0.95 lagging at the POI over the range of real power output (up to maximum output of 250 MW).

At full output of 250 MW, the Project would need to provide approximately +/- 82.17 MVAr reactive support at the POI. Based on the information provided, the Project's own facilities will require approximately 56 MVAr of reactive support for 0.95 leading and 40 MVAr of reactive support for 0.95 lagging. If the installed inverters cannot supply the sum of these needs (+138.17/-42.17 MVAr), the Project will be required to install additional shunt reactive support.

Based on the P-Q Capability curve provided for the inverter model, it appears the specified inverters satisfy the reactive requirements for the Project.

GI #561 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations, and GI#561 will be required to manage the real power output of their stated generation at the project's POI.

The project(s) is required to comply with the applicable Voltage and Current Distortion Limits found in IEEE Standard 519-1992 *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

Installation of phasor measurement unit devices at the POI and maintenance costs associated with communication circuits needed to stream PMU data will also be required to be provided to interconnect GI #561. The specific costs associated with the IPC requirements for interconnection customers with aggregate facilities larger than 20 MW to provide PMU data to IPC will be identified in the Facility Study should the generation interconnection customer choose to proceed to that phase of the interconnection process. Also, it may be beneficial for [redacted], for their own modeling compliance requirements, to install additional PMU devices at their facilities to monitor the generations sources separately.

11.0 Conclusion

GI #561 can be interconnected to the Idaho Power transmission system.

Interconnection requirements detailed in Section 6.5 totaling **$1,193,153** are required to interconnect the Project as an Energy Resource at the proposed [redacted] 230kV POI. No additional upgrades were identified for the integration of the Project as a Network Resource. No senior queued generation interconnections were identified as Contingent Facilities for the Project.

Generator interconnection service (either as an Energy Resource or a Network Resource) does not in any way convey any right to deliver electricity to any specific customer or point of delivery. A Transmission Service Request will be required to study the Transmission System Impacts.

APPENDIX A

A-1.0 Method of Study

The System Impact Study plan inserts the Project up to the maximum requested injection into the selected Western Electricity Coordinating Council (WECC) power flow case and then, using Power World Simulator or GE's Positive Sequence Load Flow (PSLF) analysis tool, examines the impacts of the new resource on Idaho Power's transmission system (lines, transformers, etc.) within the study area under various operating and outage scenarios. The WECC and Idaho Power reliability criteria and Idaho Power operating procedures were used to determine the acceptability of the configurations considered. The WECC case is a recent case modified to simulate stressed but reasonable pre-contingency energy transfers utilizing the IPC system. For distribution feeder analysis, Idaho Power utilizes DNV·GL's Synergi Electric software and EPRI's OpenDSS software.

A-2.0 Acceptability Criteria

The following acceptability criteria were used in the power flow analysis to determine under which system configuration modifications may be required:

> The continuous rating of equipment is assumed to be the normal thermal rating of the equipment. This rating will be as determined by the manufacturer of the equipment or as determined by Idaho Power. Less than or equal to 100% of continuous rating is acceptable.
>
> Idaho Power's Voltage Operating Guidelines were used to determine voltage requirements on the system. These states, in part, that distribution voltages, under normal operating conditions, are to be maintained within plus or minus 5% (0.05 per unit) of nominal everywhere on the feeder. Therefore, voltages greater than or equal to 0.95 pu voltage and less than or equal to 1.05 pu voltage are acceptable.
>
> Voltage flicker during starting or stopping the generator is limited to 5% as measured at the point of interconnection, per Idaho Power's T&D Advisory Information Manual.
>
> Idaho Power's Reliability Criteria for System Planning was used to determine proper transmission system operation.
>
> All customer generation must meet IEEE 519 and ANSI C84.1 Standards.
>
> All other applicable national and Idaho Power standards and prudent utility practices were used to determine the acceptability of the configurations considered.
>
> The stable operation of the system requires an adequate supply of volt-amperes reactive (VAr or VArs) to maintain a stable voltage profile under both steady-state and dynamic system conditions. An inadequate supply of VArs will result in voltage decay or even collapse under the worst conditions.

Equipment/line/path ratings used will be those that are in use at the time of the study or that are represented by IPC upgrade projects that are either currently under construction or whose budgets have been approved for construction in the near future. All other potential future ratings are outside the scope of this study. Future transmission changes may, however, affect current facility ratings used in the study.

A-3.0 Grounding Guidance

IPC requires interconnected transformers on the distribution system to limit their ground fault current to 20 amps at the Point of Interconnection.

A-4.0 Electrical System Protection Guidance

IPC requires electrical system protection per Facility Connection Requirements found on the Idaho Power Web site,

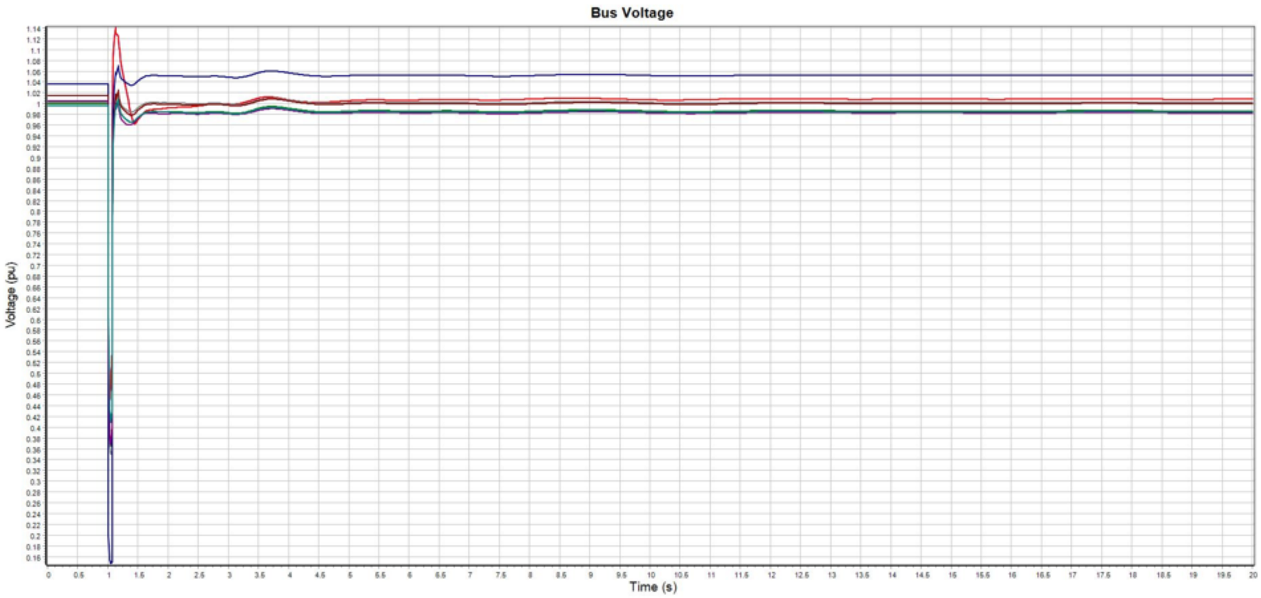
https://docs.idahopower.com/pdfs/BusinessToBusiness/FacConnReq.pdf

A-5.0 WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Requirements

IPC requires frequency operational limits to adhere to WECC Under-frequency and Over-frequency Limits per the WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Requirements available upon request.

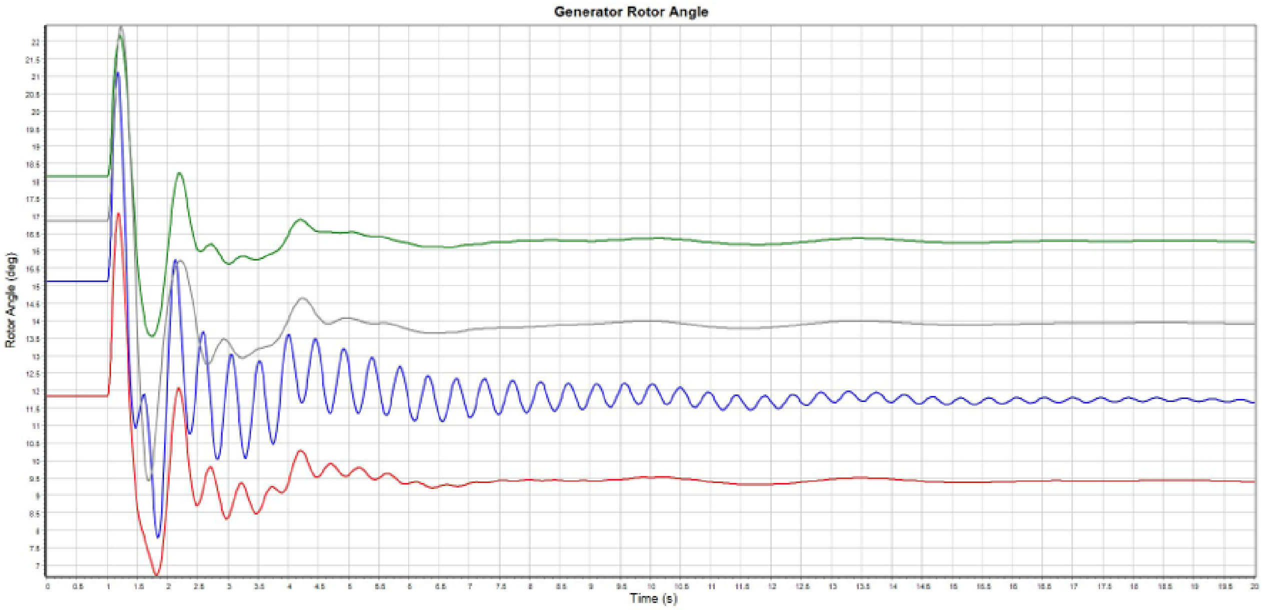
APPENDIX B – Transient Stability Plots

B-1.0 4.0 Cycle [redacted] – [redacted] 500kV Line 3-Phase Fault Bus Voltage



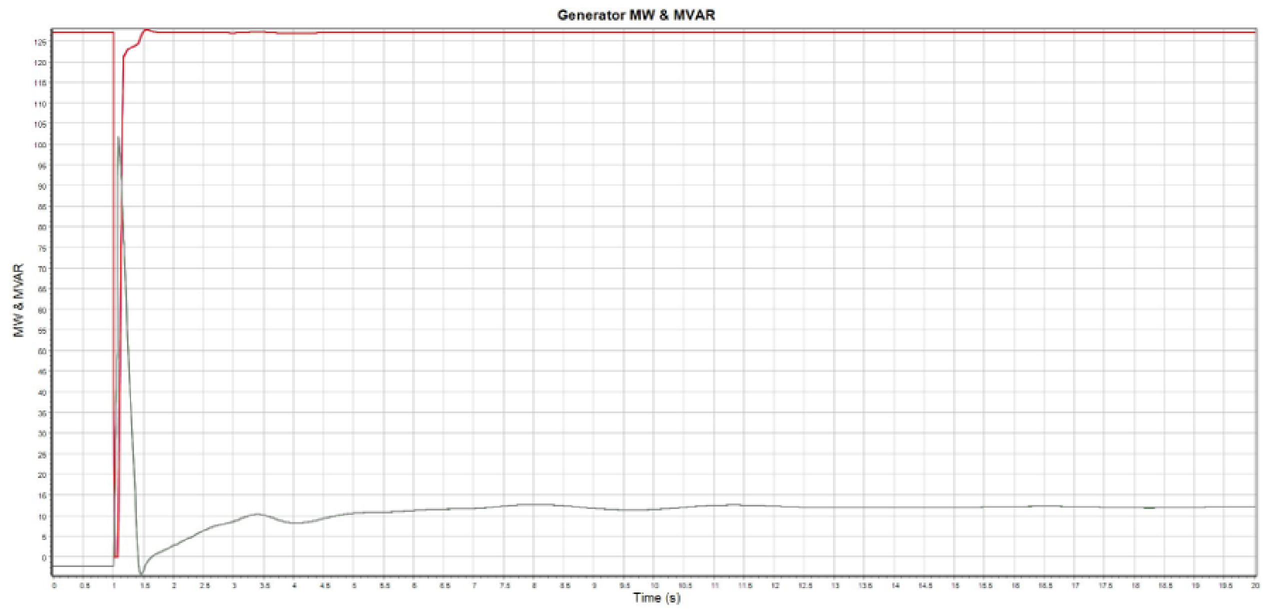
[redacted]

B-2.0 4.0 Cycle [redacted] – [redacted] 500kV Line 3-Phase Fault Generator Rotor Angle



[redacted]

B-3.0 4.0 Cycle [redacted] – [redacted] 500kV Line 3-Phase Fault Generator MW & MVAR



[redacted]

Revision History

Date	Revision	Initials	Summary of Changes
12/29/2020	1	SWL	Initial Report