GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

5 MW [redacted] PROJECT

IPC PROJECT QUEUE #566

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

for

[redacted]

REPORT v.0

June, 2020

Revision History

Date	Revision	Initials	Summary of Changes
6/10/2020	0	KLH	SISR GI #566 – Original issue.

Table of Contents

1.0 Introduction

[redacted] has contracted with Idaho Power Company (IPC) to perform a Generator Interconnection System Impact Study for the integration of the proposed 5 MW [redacted]Project (the Project). The Project is proposed to be in IPC's Western Region near [redacted]in Malheur County, Oregon (See Figure 2: Location of [redacted]Project – GI # 566 in Appendix B). The project latitude and longitude are approximately [redacted]N, [redacted] W with a proposed Point of Interconnection (POI) of approximately [redacted] N, [redacted] W. The Project is Generation Interconnect queue number 566 (GI #566).

The Project has applied to connect to the Idaho Power distribution system for an injection of 5 MW at a single POI at 12.47 kilovolts (kV). The POI evaluated is in the [redacted] distribution circuit boundary.

This report documents the basis for, and the results of this system impact study for, the GI #566 Generation Interconnection Customer. The report describes the proposed project, the determination of project interconnection system impact and estimated costs for integration of the Project to the Idaho Power System. This report satisfies the system impact study requirements of the Idaho Power Tariff.

2.0 Summary

The system impact of interconnecting the 5 MW [redacted]Project to IPC's 12.47 kV [redacted] distribution circuit was evaluated. The POI evaluated is approximately located at [redacted] N, [redacted] W.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #566 will be required to install a plant controller for managing the real and reactive power output of the 5 MW inverter array at the project POI. The project will need to meet the reactive power requirements for the interconnection. The step-up transformers will need to be grounded-wye - grounded-wye or grounded-wye - wye with the grounded-wye connection on the utility side.

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 total preliminary cost estimate to interconnect the [redacted]Project to the [redacted] distribution circuit is [redacted] and includes the following tasks:

- Install a four-pole 12.47 kV generation interconnection package at the POI. This includes an SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs), SCADA and remote connectivity.
- Install a single-phase PT and wiring for dead-line check on [redacted]R70.
- Change Protection Settings on [redacted]R70.
- Upgrade line switches [redacted]X8 and [redacted]X83 from 300 amp to 600 amp.
- Rebuild approximately 1950'of single phase #4 ACSR distribution circuit to three phase 336 AAC.
- Rebuild approximately 5430' of three phase 2/0 ACSR distribution circuit to three phase 336 AAC.
- Relocate [redacted]RG60.

The cost estimate includes direct equipment and installation labor costs, indirect labor costs and general overheads. The estimate includes estimated overheads and a 20% contingency allowance. 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 estimate of $[redacted] does not include the cost of the customer's owned equipment to construct the solar generation site or required communication circuits.

3.0 Scope of Interconnection Transmission System Impact Study

The Interconnection Transmission System Impact Study was completed, in accordance with Idaho Power Company Standard Generator Interconnection Procedures, to provide an evaluation of the system impacts of the interconnection of the proposed generating project to the Idaho Power system. As listed in the Interconnection Transmission System Impact Study agreement, the Interconnection Transmission System Impact Study report provides the following information:

- identification of additional transformer load tap changer operations, voltage fluctuations (flicker) and additional feeder losses.
- identification of required reactive power support.
- identification of islanding conditions.
- 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 angular instability.
- description and non-binding estimated cost of facilities required to interconnect the Small Generating Facility to the IPC System and to address the identified short circuit 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 Description of Proposed Generating Project

The proposed [redacted]Project, GI #566, consists of a 5 MW photovoltaic solar plant which requested to be connected to Idaho Power's 12.47 kV [redacted] distribution circuit. The project will need to install a plant controller for managing the real and reactive power output. The supplied single line drawing shows the project using 46 Sungrow SG125-HV inverters. There are two inverter stations. Each station is connected via a 2800 kVA grounded-wye grounded-wye transformer. Each inverter station consists of 23 inverters totaling 2875 kVA.

5.0 Description of Transmission Facilities

The Project's impact on the Idaho-Northwest transmission path (WECC Path #14) and Brownlee East transmission path (WECC Path #55) were evaluated in this Generation System Impact Study. The Idaho-Northwest transmission path was studied at both its West-to-East [redacted]and East-to-West rated transfer capabilities. The Brownlee East transmission path was studied at its [redacted]rated West-to-East transfer capability.

The Idaho-Northwest transmission path (WECC Path #14) is defined as the sum of the flows on the following five lines:

- Oxbow-Lolo 230kV
- Hells Canyon-Hurricane 230kV
- North Powder-La Grande 230kV
- Hines-Harney 115kV
- Hemingway-Summer Lake 500kV

The Brownlee East transmission path (WECC Path #55) is defined as the sum of the flows on the following seven lines:

- Brownlee-Boise Bench #1 230kV
- Brownlee-Boise Bench #2 230kV
- Brownlee-Boise Bench #3 230kV
- Brownlee-Horse Flat #4 230kV
- Brownlee-Ontario 230kV
- Oxbow-Starkey 138kV
- Quartz-Ontario 138kV

For this generation interconnection System Impact Study, the flow on the Path 14 Idaho-Northwest transmission path was modeled at [redacted]West-to-East and the Brownlee East transmission path

was modeled at [redacted] West-to-East. The paths were stressed to these specific levels to determine if the addition of the Project's 5 MW degraded the existing Brownlee East path's transfer capability.

And, a Path 14 Idaho-Northwest study was performed to determine the Project's 5 MW potential impact on Path 14 Idaho-Northwest West-to-East rating of 1200 MW.

6.0 Description of Power Flow Case

For this Generation Interconnection System Impact Study, three power flow were used to evaluate the potential impacts due to the 5 MW [redacted] Project, GI #566.

For the Path 14 Idaho-Northwest West-to-East [redacted] transfer path rating impact study due to the addition of the Project, the WECC 2019 Heavy Summer case was chosen as the power flow base case. These cases were modified to stress the Idaho-Northwest transmission path West-to-East flows to [redacted] simultaneous with the Brownlee East transmission path modeled at [redacted] to determine the potential impact due to the addition of the 5 MW Project.

7.0 Power Flow Analysis Study Results

Results from the Path 14 Idaho-Northwest West-to-East [redacted] transfer path rating impact study case indicate the addition of the GI #566 project will not result in violations. These results are contingent on a senior queue project performing the assigned upgrades during the system impact study.

In case the senior queue project was to be dropped out of the queue, the addition of [redacted] would result in violations to the system that need to be mitigated.

1. The N-1 loss of Ontario – Langley 230kV line
    a. This contingency results in a post-transient overload violating the emergency rating of the Nyssa – Apple Valley Junction 69kV line, which requires network upgrades.
2. The N-2 loss of Boise Bench – Brownlee #1&#2 230kV lines
    a. This contingency results in a post-transient overload violating the emergency rating of the Nyssa – Apple Valley Junction 69kV line, which requires network upgrades.
    b. This contingency results in a post-transient overload violating the emergency rating of the Langley – Caldwell 230 kV line, which requires network upgrades.
3. The N-2 loss of Boise Bench – Brownlee #3 and Boise Bench – Horse Flat 230kV lines
    a. This contingency results in a post-transient overload violating the emergency rating of the Nyssa – Apple Valley Junction 69kV line, which requires network upgrades.

8.0 Description of Substation Facilities

Idaho Power's [redacted] substation is in [redacted] [redacted] The existing substation transformer feeding [redacted] [redacted] T134, is a three phase 138-13.09/7.56 kV transformer rated for 30 MVA.

9.0 Description of Distribution Facilities

The requested POI for the Project is on the [redacted] distribution circuit. This is a grounded-wye circuit operating at 12.47 kV at the POI. The Project must have a grounded-wye transformer connection on the IPC side, as well as a wye or grounded wye connection on the Project side of the transformer. Modifications to the distribution facilities will be required to integrate the project output of 5 MW. Under daytime light load conditions with both [redacted] and [redacted] Solar operating, facility capacity ratings will be exceeded. These include the 2/0 ACSR conductor along [redacted] and two switches. In addition, a voltage regulator will require relocating to compensate for high voltages. The conductor along [redacted] will need to be upgraded to 336 AAC conductor, the two switches upgraded to 600 amp and the voltage regulator relocated. Additionally, the line from the POI to the [redacted] Solar POI will need to be upgraded from a single phase #4 ACSR conductor to three phase 336 AAC conductor. The locations of the conductor upgrades can be seen in Figure 3: Location of [redacted] Project Conductor Upgrades– GI # 566 in Appendix B.

Refer to Appendix A, Section 3, for additional grounding requirements.

10.0 Short Circuit Study Results

The fault current contribution from the PV generators does not exceed any circuit breaker rating.

However, under light loading conditions the currents being supplied by the PV generators will exceed the protection level pickup setting of [redacted] R70. This will require the settings to be change and a re-coordination of the protection scheme from the [redacted] circuit breaker along the circuit path to the PV site.

11.0 Description of Required Facility Upgrades

The Project will be required to provide a plant controller that will operate the inverter system in Volt/VAr control mode. This is to regulate voltage according to a voltage schedule that will be provided by Idaho Power.

The following upgrades will be required to IPC-owned facilities to facilitate the interconnection of GI #566:

- Install a four-pole 12.47 kV generation interconnection package at the POI. This includes an SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs), SCADA and remote connectivity.
- Install a single-phase PT and wiring for dead-line check on [redacted] R70.

- Change Protection Settings on [redacted]R70 and re-coordinate upstream and downstream system fault protection devices.
- Upgrade line switches [redacted]X8 and [redacted]X83 from 300 amp to 600 amp.
- Rebuild approximately 1950'of single phase #4 ACSR distribution circuit to three phase 336 AAC.
- Rebuild approximately 5430' of three phase 2/0 ACSR distribution circuit to three phase 336 AAC.
- Relocate [redacted]RG60.

See the conceptual-level cost estimate in Table 1.

Table 1 Conceptual-level Cost Estimate for GI #546

Item of Work	Estimate
Generation interconnection and protection package	[redacted]
Substation upgrades	[redacted]
Distribution upgrades	[redacted]
Transmission upgrades	[redacted]
Unloaded costs	[redacted]
Contingency 20% (1)	[redacted]
Total unloaded costs	[redacted]
Overheads (2)	[redacted]
Total loaded costs	[redacted]
Total Conceptual-level Cost Estimate in 2020 dollars (3)	

(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, 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 Transmission and Distribution Facility Studies.

12.0 Description of Operating Requirements

The Project shall be capable of injecting reactive power (over-excited) and absorbing reactive power (under-excited) equal to 2.2 MVAR at all active power output between 20% and 100% of nameplate active power rating as stated by IEEE 1547-2018.

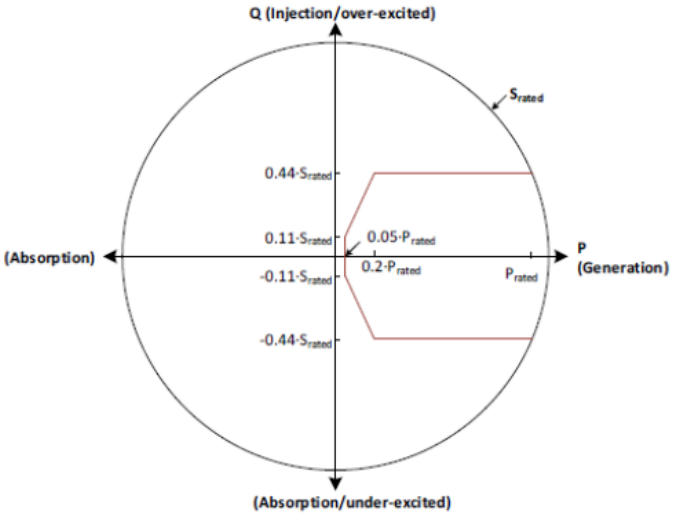

Figure 1 Operating requirements (IEEE 1547-2018)

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #566 will be required to install a plant controller for managing the real and reactive power output of the 5 MW inverter array at the project POI. The latest dynamic files for the inverter shall be submitted to Idaho Power one month prior to commissioning.

Voltage flicker at startup and during operation will be limited to less than 5% as measured at the POI. The allowable voltage flicker limit is further reduced during operation due to multiple voltage fluctuations per hour or minute, per Idaho Power's T&D Advisory Information Manual.

The Project is required to comply with the applicable voltage fluctuation limits found in IEEE Standard 1453-2004 *IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems.*

The project is required to comply with the applicable Voltage and Current Distortion Limits found in IEEE Standard 519-2014 *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

12.0 Conclusion

The requested interconnection of the [redacted] project, GI #566, to Idaho Power's system was studied for impact to the IPC electrical transmission and distribution system.

The results of this study list the modifications required to interconnect the [redacted] project, GI #566, to the existing Idaho Power system.

All generation projects in the area ahead of the Project in the IPC generation interconnection queue and their associated transmission system improvements were modeled in a preliminary power flow analysis to evaluate the system impact of interconnecting GI #566. The results and conclusions of this System Impact Study are based on the realization of these projects in the unique queue/project order.

The estimated cost to interconnect GI #566 to the IPC system at the [redacted] 12.47 kV point of interconnection considered in this study is approximately $[redacted].

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.

APPENDIX A

A-1.0 Method of Study

The Transmission 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. It 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 at each meter or POI 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 the starting or stopping of the generator will be limited to less than 5% as measured at the POI. Allowable voltage flicker limit is further reduced during operation due to multiple voltage fluctuations per hour or minute, 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, IEEE1453, IEEE1547, 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 (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 Requirements for Generation Interconnections currently 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

B-1.0 [redacted] GI Project #566 Site Location

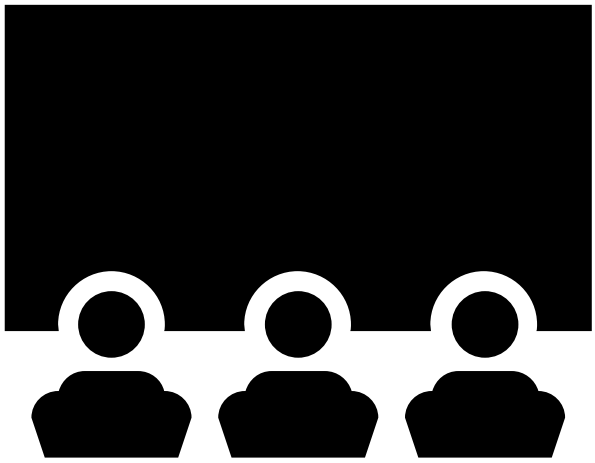

Figure 2 Location of [redacted] GI #566

B-2.0 [redacted] Project GI #566 Reconductor Locations

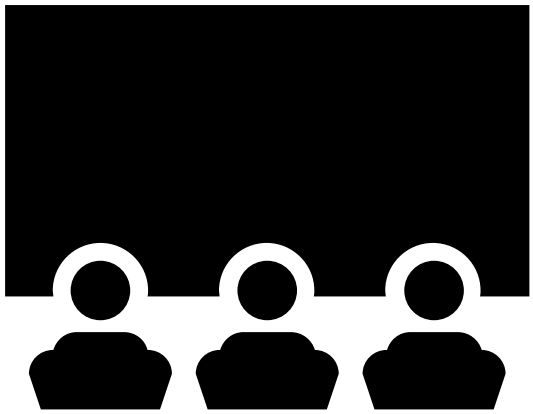

Figure 3 Location of [redacted] Project Conductor Upgrades - GI #566