GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

2.333 MW [redacted] PROJECT

IPC PROJECT QUEUE #559

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

for

[redacted]

REPORT v.0

September, 2019

Revision History

Date	Revision	Initials	Summary of Changes
9/06/2019	0	PMA	SISR GI #559 – Original issue.

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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 2.333 MW [redacted] Project (the Project). The Project is in IPC's Capital Region near the corner of [redacted] in Ada County, Idaho The POI is located at [redacted]. (See Figure 1: Location of [redacted] – GI #559 in Appendix B). The Project is Generation Interconnect queue number 559 (GI #559).

The Project has applied to connect to the IPC distribution system for an injection of 2.333 MW at a single Point of Interconnection (POI) at a 12.47 kV distribution voltage level. The POI is located approximately [redacted] from [redacted] substation.

This report documents the basis for and the results of this System Impact Study for the GI #559 Generation Interconnection Customer. The report describes the proposed Project, the determination of Project interconnection 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 2.333 MW Project to IPC's [redacted] substation was evaluated.

The preliminary power flow analysis indicated that interconnecting the [redacted] Project to [redacted] will not adversely impact the IPC system with the upgrades detailed in this report. Additionally, Operating Requirements will require the generator to provide leading and lagging reactive power as detailed in section 12.0 of this report

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations.

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] substation is $683,497 and includes the following:

- Install a four-pole 12.47 kV generation interconnection package at the POI
    - This includes a SEL-421 protective relay, which requires 3-phase PTs, 3-phase CTs, and remote connectivity
    - Additionally, a single-phase PT shall be installed on the interconnect customer side of the IPC recloser

- Install dead-line check at the [redacted] substation for [redacted]
- Rebuild and reconductor approximately [redacted] of existing feeder with 3-phase, larger 336 AAC conductor.
- Relocate or replace [redacted] and [redacted] fuses.
- Vested interest charge for previously customer funded line upgrades

The cost estimate includes direct equipment and installation labor costs, indirect labor costs and general overheads, and a 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 $683,497 does not include the cost of the customer's owned equipment to construct the 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.
- 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

[redacted], GI #559, consists of a single POI with a single 2.1 MW rated synchronous generator with a 10% service factor and has requested to connect to Idaho Power's 12.47 kV distribution system. The Project will use a single [redacted] The Project has applied for 2.333 MW injection.

The Project's Projected in-service date is May 2020.

5.0 Description of Transmission Facilities

The [redacted] substation is fed from the [redacted] 138 kV transmission line and is located within the treasure valley load center.

6.0 Description of Power Flow Case

The Project was studied using DNV-GL Synergi load flow analysis software to analyze the impact to the [redacted] distribution feeder. The Project was studied at peak load and minimum load conditions with all generators on the feeder generating at 100% output. The model included approximately [redacted] of upgraded 3-phase 336 AAC conductor on the [redacted] feeder to the Project POI. The Project was also reviewed for potential impacts on the IPC transmission system.

7.0 Power Flow Analysis Study Results

The modeling studies showed that using 336 AAC conductor will ensure that voltage requirements should be met at the POI, even during periods of light load and peak Project output. Modeling showed that smaller conductor will not satisfy the voltage requirements at the POI. The model included the Project's proposed 1/0 conductor connecting the Project to the POI. While the voltage at the POI remains acceptable during times of peak Project output during light load conditions, modeling indicates the Project may experience high voltage. If 4/0 conductor were used to connect the Project to the POI, modeling indicates that this would mitigate high voltage at the Project. It is recommended that the Project consider using larger conductor between the Project and the POI. While modeling shows 4/0 will mitigate high voltage at the Project, 336 AAC is still necessary to mitigate high voltage on the [redacted] feeder circuit.

The impact of the proposed Project on the IPC transmission system was analyzed. Due to the size and location of this Project, the review determined that there would not be an adverse impact on the IPC transmission system. The generation at this location does not cross any IPC transmission paths nor will it impact operation of any IPC transmission paths.

8.0 Description of Substation Facilities

Idaho Power's [redacted] substation is in Ada County, Idaho. [redacted] substation is fed by a 138-kV transmission line. The existing substation transformer, [redacted], is a three-phase 138-13.09

kV delta wye-grounded transformer rated for 44.8 MVA. [redacted] currently serves four 12.47 kV distribution feeders: [redacted].

9.0 Description of Distribution Facilities

The Project was studied with a 12.47 kV connection to [redacted]. This is a grounded-wye feeder operating at 12.47 kV. The Project must have a grounded-wye transformer connection on the IPC side of the transformer.

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

The existing single-phase and three-phase portions of the IPC circuit feeding the Project will need to be rebuilt to 3-phase 336 AAC conductor. Modeling studies show that using 336 AAC conductor will ensure that voltage requirements should be met at the POI, even during periods of light load and peak Project output. Modeling showed that smaller conductor will not satisfy the voltage requirements at the POI. The model included the Project's proposed 1/0 conductor connecting the Project to the POI. While the voltage at the POI remains acceptable during times of peak Project output during light load conditions, modeling indicates the Project may experience high voltage. If 4/0 conductor were used to connect the Project to the POI, modeling indicates that this would mitigate high voltage at the Project. It is recommended that the Project consider using larger conductor between the Project and the POI. While modeling shows 4/0 will mitigate high voltage at the Project, 336 AAC is still necessary to mitigate high voltage on the [redacted] feeder circuit.

10.0 Short Circuit Study Results

The Project single line shows a wye-grounded to delta transformer. This connection type is not allowed. The maximum ground fault current from the Project into the IPC system is 20 amps. The delta connection causes the ground fault current to be well above this level. The transformer must be wye-grounded OR wye-ungrounded to wye-grounded, where the IPC side must be wye-grounded.

The [redacted] metal clad breakers are rated at 20kA interrupting capability. The maximum fault duty is 12482.6A with the Project connected to [redacted]. This is up from 12298.1A (the Project adding an additional 184.5 amps of fault duty). There are no concerns about the breaker ratings with the addition of the Project. The table shows the fault duties with and without the Project.

Table 1 - GI #559 Short Circuit Currents

	Close-in 3PH fault	Close-in SLG fault
Without the Project	12298.1 A	11529.9 A

With the Project	12482.6 A	11711.5 A

The protection package would be a standard SEL-421 interconnection relay, setup with a standard 4-pole installation. The 4-pole setup includes a 3-phase PT on the IPC side of the recloser and a single-phase PT on the customer side of the recloser for dead-checking prior to recloser closing. Since the interconnection is less than 3MW, the protection package will not require a remote access communication connection.

Additionally, dead-line check will need to be installed at the [redacted] substation for [redacted].

11.0 Description of Required Facility Upgrades

The following upgrades will be required to IPC-owned facilities to facilitate the interconnection of GI #559:

- Install a four-pole 12.47 kV generation interconnection package at the POI
    - This includes an SEL-421 protective relay, which requires 3-phase PTs, 3-phase CTs, and remote connectivity
    - Additionally, a single-phase PT shall be installed on the interconnect customer side of the IPC recloser
- Install dead-line check at the [redacted] substation for [redacted]
- Rebuild and reconductor approximately [redacted] of existing feeder with 3-phase, larger 336 AAC conductor.
- Relocate or replace [redacted] fuses.

See the conceptual-level cost estimate in Table 2.

Table 2 - Conceptual Level Cost Estimate

Item of Work	Estimate
Generation interconnection and protection package	$ 168,200
Substation upgrades	$ 11,600
Distribution upgrades	$ 319,000
Transmission upgrades	$ 0
Unloaded costs	$ 498,800
Contingency (1)	$ 99,760
Total unloaded costs	$ 598,560
Overheads (2)	$ 47,885
Total loaded costs	$ 646,445
Vested interest charge (3)	$ 37,052
Total Conceptual-level Cost Estimate in 2019 dollars (4)	**$ 683,497**

(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) Vested interest charge for previously customer funded line upgrades

(4) This cost estimate includes direct equipment, material, labor, overheads, and contingency as shown.

- Note that these estimates do not include the cost of the customer's equipment/facilities or required communication circuits for 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

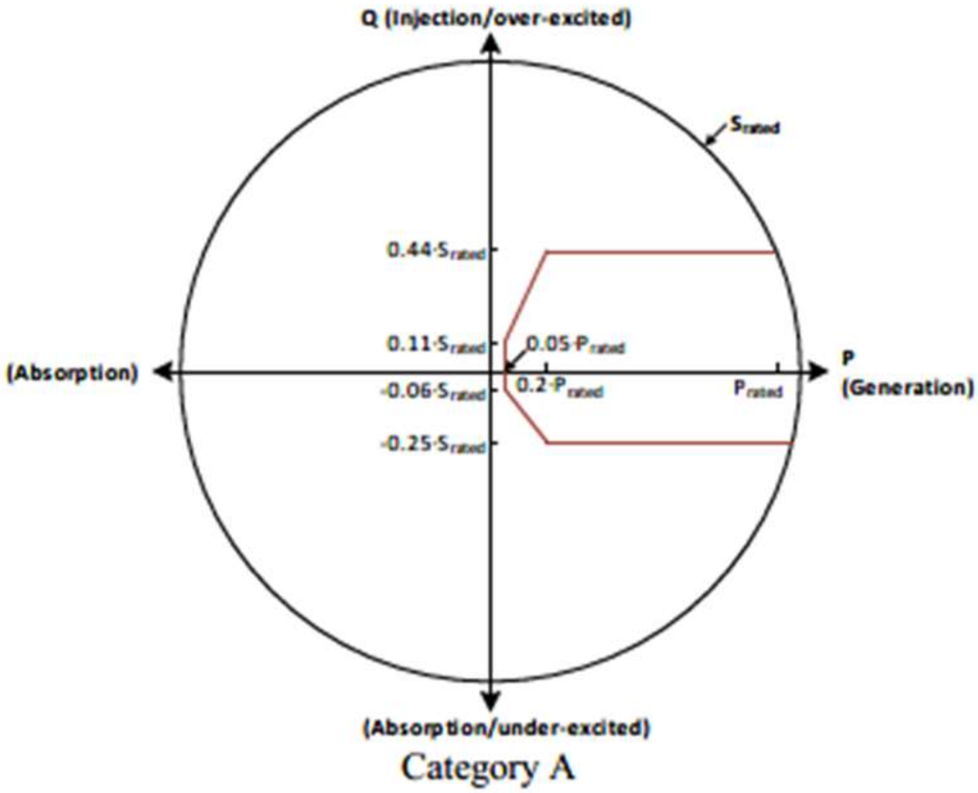

Figure 1 - Operating Requirements (IEEE 1547-2018)

The Project shall be capable of injecting reactive power (over-excited) equal to 1.026 MVAr and absorbing reactive power (under-excited) equal to 0.583 MVAR at all active power output between 20% and 100% of nameplate active power rating as defined in IEEE 1547-2018 Category A reactive power capability and shown in Figure 1.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations.

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*.

Additional operating requirements for the Project may be identified in the System Impact Study when it is performed.

13.0 Conclusion

The requested interconnection of the [redacted] Project, GI #559, to Idaho Power's system was studied. The Project will interconnect to [redacted] feeder at the 12.47 kV distribution voltage level.

The results of this study confirm that GI #559, [redacted] will not adversely impact the IPC system with the upgrades detailed in this report. A four-pole generation interconnect package at the POI, rebuilding of approximately [redacted] of distribution line to 3-phase 336 AAC conductor, and the addition of deadline check at the [redacted] substation for [redacted] are required to integrate the 2.333 MW Project. Operating Requirements will require the generator to provide leading and lagging reactive power as detailed in section 12.0 of this report.

All generation Projects in the area ahead of the Project in the IPC generation interconnection queue and their associated transmission system improvements were included in this study.

The estimated cost to interconnect GI #559 to the IPC system at the [redacted] feeder at the 12.47 kV point of interconnection considered in this study is approximately $683,497.

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. Transmission requirements to integrate the Project will be determined during the System Impact Study phase of the generator interconnection process.

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. This states that, in part, 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 found on the Idaho Power Web site,

http://www.idahopower.com/pdfs/BusinessToBusiness/facilityRequirements.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

[redacted]

Figure 2 - [redacted] GI #559 Site Location

APPENDIX C

[redacted]

Figure 3 - [redacted] GI #559 Line Rebuild

[redacted]

Figure 4 - [redacted] GI #559 Line Rebuild Zoomed In View