

TRANSMISSION PLANNING

GENERATION INTERCONNECTION REPORT

INTERCONNECTION SYSTEM IMPACT STUDY (ISIS)

G0605

May 31, 2019

PREPARED BY:
Mickie Cassady – TPPC
Dason Elwess – TPMC
Cherilyn Randall – TPCV

Table of Contents

1 Introduction 1
2 Conclusions 1
3 Impacted Parties 2
4 Facilities 2
4.1 High Voltage Plan of Service 2
4.2 Contingent Facilities 3
4.3 Communications Plan of Service 3
4.3.1 Interconnection Station 3
4.3.2 Collector Station 3
4.3.3 Control Centers 4
4.3.4 Network Communications Expansion 4
4.4 Remedial Action Schemes 4
4.5 Plant Reactive Requirements 4
4.6 Generator Low Voltage Ride through Capability 4
4.7 Protection, Control, and Monitoring Requirements 5
4.7.1 Relaying, Transfer Trip, and Auto-reclosing 5
4.7.2 Limit Generation to Schedule 5
4.7.3 Revenue or Interchange Metering and SCADA 5
4.7.4 Phasor Measurement Unit 5
5 Project Requirements Diagram 6
6 Estimates 7
6.1 Estimated Cost 7
6.2 Estimated Schedule 7
7 Technical Analysis 8
7.1 Methodology and Assumptions 8
7.2 Queue Priority 8
7.3 Powerflow Results 8
7.4 Voltage Stability Results 8
7.5 Short Circuit analysis 8
7.6 NRIS Analysis 9
7.7 ERIS 10
8 Communications Detailed Requirements 10
8.1.1 Typical Collector Station Requirements 10
9 Project Team 12

1 Introduction

This ISIS examines the System Impacts of interconnecting the proposed generation project to the Bonneville Power Administration Transmission Service's (BPA-TS) transmission system. The Developer has requested interconnection into Morrow Flat Substation. This request was entered into the BPA-TS Interconnection queue as Request G0605. The project is a 50 MW solar generation project plus a 30 MW x 4H battery project proposed for Morrow County, Oregon. The requested interconnection limit is 0 MW, as this project is proposed to be added to the G0365 (300 MW wind project) and total output controlled to 300 MW. The requested commercial operation date is 12/31/2020. This project has requested to be in Portland General Electric's (PGE) Balancing Authority Area.

The ISIS consists of voltage stability and short circuit analysis and provides a list of facilities and non-binding good faith estimates of cost and a non-binding good faith estimated time to construct. The purpose is to identify any potential adverse system impacts resulting from the requested interconnection.

Interconnection of this project is contingent upon the completion of the following projects:

- Morrow Flat – Blueridge 230 kV line (Umatilla Electric Cooperative [UEC] is building the line; BPA-TS is building the line terminal at Morrow Flat Substation)
    - $4.3 Million
    - June 2020

In accordance with the BPA Open Access Transmission Tariff, requests impacting the affected system were studied in queue order. Generation Interconnection requests modeled ahead of this request include:

- G0365 – 300 MW Wind project at Morrow Flat Substation

Because this project is not requesting an interconnection limit above that of G0365, no subsequent queue requests were modeled.

The Developer requested this project be considered for Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). The ERIS and NRIS impacts were evaluated in this study.

2 Conclusions

The ISIS evaluated an interconnection at Morrow Flat Substation through UEC's Morrow Flat – Blueridge 230 kV line. The ISIS concluded that the requested 80 MW could be interconnected at Morrow Flat Substation provided the reactive compensation and voltage control requirements are met and the total output of this Request and G0365 is kept to 300 MW. This interconnection is subject to the following requirements: (1) Main Grid Remedial Action Scheme (RAS), (2) 0.95 pu lead/lag dynamic voltage control plus compensation for losses and charging on the collector system, (3) total project output combine with G0365 cannot exceed 300 MW at the Point of Interconnection.

With the upgrades listed above, the full 80 MW of generation type generation can be interconnected.

This project will be required to have the necessary communications and controls equipment installed in order to be available for generator tripping in order to maintain flexibility and effectiveness of BPA-TS Main Grid RAS.

The NRIS analysis concluded that the largest impact on a network flow gate was West of McNary but does not require additional reinforcments. Transmission expansion could be required based on requests in the transmission queue at the time that transmission service is requested for this Project.

A non-binding good faith estimated cost to build the facilities associated with interconnection of G0605 is $876,711. These costs are associated with necessary upgrades detailed in section 3. Facilities and include 40% contingency and applicable overhead costs.

BPA-TS typically integrates the construction of interconnection projects into its 3-year work plan. Depending on when the final environmental approvals are completed, construction of the interconnection can be expected to be completed 12-18 months after the environmental approvals. This schedule can be further refined as the studies proceed and the higher-queued project firms up their interconnection plans.

The technical study results included in this document are for generator interconnection only. Technical studies for transmission service for delivery of output beyond the point of interconnection are not included. Any transmission service for delivery beyond the point of interconnection must be requested and arranged for separately. In addition, the technical studies included in this document only address generator interconnection capacity and do not address generator balancing services.

These studies were conducted using the best available information at the time of the study. Findings and recommendations are based on assumptions, which could change. BPA-TS reserves the right to add, delete, or modify any content in this report.

3 Impacted Parties

Umatilla Electric Cooperative is an affected system and results of this study will be shared with them.

4 Facilities

4.1 High Voltage Plan of Service

1. Main Grid RAS – BPA-TS will need RAS trip point at Blueridge Substation. The RAS trip points are on the 34.5 kV feeder breakers and the new feeder breaker(s) for this project will need to be wired into the RAS relay in the control house.

2. Voltage Control – the solar and battery project are required to compensate for the reactive charging and losses they add to the system. In addition, they must have dynamic 0.95 pu lead/lag reactive power for voltage control.
3. The total output of G0365 and G0605 cannot exceed 300 MW at the Point of Interconnection. The primary control mechanism will be the onsite plant controller owned by the developer. BPA-TS also requires a high side breaker to manually trip in case of emergency. The 230 kV breaker at Blueridge should already be wired into BPA-TS's control centers when G0365 goes online, so this requirement should be met without further equipment additions.

4.2 Contingent Facilities

The following were assumed for this study and are contingency facilities for this interconnection:

- Morrow Flat – Blueridge 230 kV line
  - $4.3 Million
  - June 2020

There is a proposed transmission line Project with a energization date of June 2020. Completion of this project is a requirement of interconnection for G0605, therefore it is assumed in service for these studies. The cost of this project is not included in the cost of interconnection.

4.3 Communications Plan of Service

The G0605 plan of service assumes the communications required for the G0365 project are installed. The class of service for G0605 is WECC Level I, BPA Class "B".

4.3.1 Interconnection Station

For G0605, the communications installed by the G0365 project will be used. The following C&C equipment will be added or expanded as required:

- BPA will provide incremental additions on its existing communications system to provide the required connectivity for the added circuits for the projects.

4.3.2 Collector Station

The plan of service for G0605 at the Developer's substation will require WECC-compliant, fully-redundant communications to each collector substation where the Main Grid RAS and Local RAS Generation Dropping (GD) will occur. This will be installed by G0365 project. Incremental equipment for additional circuits may be needed.

BPA-TS will install, own and operate the metering and RAS equipment at the Developer's Blueridge Substation. The new collector strings associated with G0605 will need to be wired to the existing Local and Main Grid RAS Gen Drop panels that were installed by the G0365 project.

4.3.3 Control Centers

- BPA-TS will update the existing SCADA, KWH, SEMM and RAS masters at Dittmer and Munro Control Centers.

4.3.4 Network Communications Expansion

- BPA will add extra points to the existing Field Information Network (FIN) and Network Management System (NMS) systems.
- BPA will add extra points to the Sequential Events Recorder (SER) and Substation Information Server (SIS) for one millisecond time-tagging of events.

4.4 Remedial Action Schemes

Remedial Action Schemes (RAS) take quick, automatic action to protect the reliability of the transmission system and prevent cascading outages or other adverse impacts related to system events. Actions include, but are not limited to, generator tripping, switching of shunt reactive compensation devices, and/or system configuration changes.

For Remedial Action Scheme requirements, see the System Impact Study Report for G0365.

4.5 Plant Reactive Requirements

Reactive support is required at the Developer site as outlined in Section 6 of BPA's Technical Requirements for Interconnection to the BPA Transmission Grid.

To maintain voltage stability and existing transfer capabilities across the main grid transmission system BPA-TS will require a dynamic compensation level of 0.95 lead / lag power factor at the POI. The dynamic reactive power capability can be provided by inverters capable of voltage control through internal reactive power capability. The reactive compensation will be on voltage control using line drop compensation (LDC) with BPA-TS providing voltage schedules.

These reactive power support requirements are dictated by voltage stability issues caused by contingencies across the main grid system outside the local area. The voltage stability problem is caused by high real power flows across the system causing an exponential increase in transmission line reactive power losses. When transmission line reactive power losses increase due to a transmission contingency, the voltage collapses very quickly requiring dynamic reactive power sources to respond in a similar time frame.

4.6 Generator Low Voltage Ride through Capability

All generator installations shall meet NERC and WECC requirements for low voltage ride through (LVRT). The generator(s) shall be capable of staying on-line for nearby faults, except for faults on the line or bus the generator is connected to. This includes traditional thermal, hydro, wind, solar PV, and solar thermal resources. Inverter-based resources will not be allowed to use momentary cessation as a form of LVRT for voltages outside the continuous operating

range. Inverter-based LVRT solutions shall include some form of current injection, which accounts for Active Power (current-based frequency controls) and Reactive power (current-based voltage controls).

In addition to the NERC and WECC LVRT requirements, all generators must meet the BPA under/over voltage and under/over frequency requirements for operation in the BPA system listed in the Technical Requirements for Interconnection, unless this report determines otherwise.

4.7 Protection, Control, and Monitoring Requirements

4.7.1 Relaying, Transfer Trip, and Auto-reclosing

The developer is responsible for control and relaying for the line and terminal at the G0605 project site.

Auto-reclosing will be allowed at the Blueridge Substation line terminal, provided the generation has been tripped prior to reclosing the line side PCB. For the case where a temporary fault reclosed successfully and the generation has shut down, auto-restoration will be permitted. All other outages will require permission from BPA-TS Dispatch to resume generation operation.

4.7.2 Limit Generation to Schedule

G0605 will be in PGE's balancing authority and therefore will not be subject to Operational Controls for Balancing Reserves (OCBR).

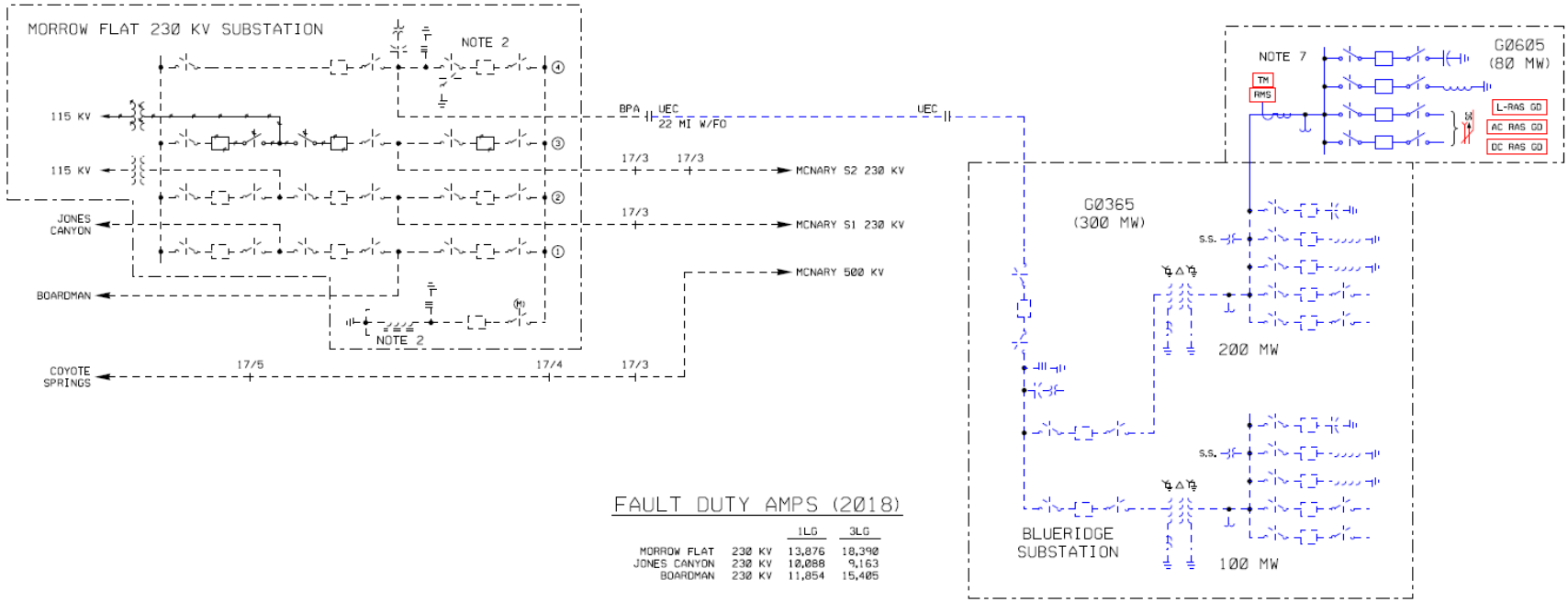
4.7.3 Revenue or Interchange Metering and SCADA

The interchange metering will connect to metering accuracy (0.15% accuracy class) Current Transformer's and Potential Transformer's on either the high or low side connection to the collector station. KWH telemetry will be required on a separate circuit. Analog kV, kW, LOMP, and KVar will be included on the SCADA system provided by BPA-TS for control and monitoring purposes. A dial-up or IP RMS link will be required for meter data.

4.7.4 Phasor Measurement Unit

For Performance Monitoring, Phasor Measurement Units are required for more accurate data measurement for validation of simulation models and post disturbance evaluation. BPA-TS will install Phasor Measurement Units (PMU) at Blueridge Substation and the Morrow Flat Substation during the construction of G0365 and the data transmitted to the Dittmer and Munro Control Centers. The PMUs will connect to existing Phasor Data Collectors (PDC) installed at each control center. These PMUs will need additional points from G0605.

5 Project Requirements Diagram



FAULT DUTY AMPS (2018)

		1LG	3LG
MORROW FLAT	230 KV	13,876	18,390
JONES CANYON	230 KV	10,088	9,163
BOARDMAN	230 KV	11,854	15,405

6 Estimates

6.1 Estimated Cost

The following are non-binding good faith estimates of cost based on previous estimates for similar projects. They represent only scopes of work that will be performed by BPA. This estimate table assumes that new RAS tripping points are required on the 34.5 kV feeder. Costs for any work being performed by the Developer are not included. These costs include overhead rates of 57% for BPA Labor and 26% for contracts and materials. The costs also include a 40% contingency to try to allocate for scope creep. Not included in these estimates are costs for land acquisition, permitting and environmental mitigations. More accurate estimates based on in-depth scoping for the project will be available at the Facilities Study Phase.

Estimate Summary with Overheads

		BPA Labor OH	57%
		Contract Design OH	57%
		Material/Contract OH	26%

		CONTRACT			BPA			
Estimate	Facility	Design	Other Labor	Material	Labor	Material	Misc	Total
C3-2201-3-0	Dittmer Control Center	0	11,241	13,120	21,104	0	0	45,465
C3-2201-4-0	Munro Control Center	0	11,241	13,120	21,104	0	0	45,465
CT-030-22-4	Typical Ras, Sensing Equi	25,690	30,743	17,850	30,125	0	0	104,408
CT-030-45-3	Typical Channel Bank Pac	8,339	33,293	28,913	19,182	0	0	89,727
CT-030-94-2	TYPICAL Interchange Me	47,500	45,608	17,904	41,328	0	5,500	157,840
Subtotal:		81,529	132,127	90,907	132,843	0	5,500	442,906
Contingency:	40%	32,612	52,851	36,363	53,137	0	2,200	177,163
Subtotal w/ Contingency:		114,141	184,978	127,270	185,980	0	7,700	620,069
Overheads:		65,060	48,094	33,090	106,009	0	4,389	256,642
Grand Total:		179,201	233,073	160,360	291,989	0	12,089	876,711

6.2 Estimated Schedule

The schedule is dependent on,

1) The acquisition of long lead time equipment,
2) BPA-TS' ability to fit the Project into its 3-year construction work plan, and
3) The Developer's completing the necessary permitting for the Project and any associated permits.

A non-binding good faith estimated time to construct the interconnection facilities is 12-18 months after a signed agreement to proceed. Subsequent to the Large Generation Interconnection Process, BPA-TS will make the decision to proceed with this interconnection based on an environmental evaluation as required by the National Environmental Policy Act. A Large Generation Interconnection Agreement (LGIA) cannot be tendered and construction cannot proceed until after NEPA clearance (completion of environmental review). The BPA-TS NEPA process is contingent upon the Developer having obtained all state or county

environmental approvals for the transmission line required to interconnect with BPA-TS as well as the permitting or certification of the project itself.

7 Technical Analysis

7.1 Methodology and Assumptions

G0605 was assumed to add no incremental flow above what was studied for G0365 and results for G0365 are still sufficient. Refer to the G0362/G0363/G0365 System Impact Study and Facilities Study reports for detailed results.

7.2 Queue Priority

The following higher priority generation interconnection requests were considered in this study .

BPA-TS reserves the right to add, delete, or modify any content in this report should the queue in the area change.

- G0365 – Morrow Flat Substation through the Morrow Flat – Blueridge 230 kV transmission line

7.3 Powerflow Results

This project was assumed to add no incremental flow above what was studied for G0365. For powerflow results, see the Interconnection System Impact Study report for G0365.

7.4 Voltage Stability Results

To maintain voltage stability during main grid, COI, and local outages, the proposed project will be required to have the capability of +/- 0.95 power factor dynamic reactive support at the POI in order to maintain system voltage performance. The dynamic reactive power capability can be provided by traditional thermal units, external dynamic reactive devices (i.e. SVC or DVAR), or by inverters capable of voltage control through internal reactive power capability, provided the inverters are available to provide the reactive compensation needed at all times, regardless of the projects generation output. A combination of external devices and plant capability can also be used. The reactive compensation will be on voltage control using line drop compensation (LDC) with BPA-TS providing voltage schedules.

It was concluded that no additional voltage stability results for G0365 were still sufficient and no additional stability studies were required for G0605.

7.5 Short Circuit analysis

In general, short circuit studies are calculated for single-phase and three phase bus fault currents.

To determine the circuit breaker interrupting requirements, the maximum short-circuit current duty must be determined. The maximum short-circuit current is higher than the symmetrical short-circuit current calculated by sequence networks (i.e., Aspen program) due to the AC and DC component offsets which are defined by the inductance of the network at the node of interest. BPA-TS determines the maximum values by applying ANSI/IEEE Standard C37.010, section 5.3. Based on a symmetrical short-circuit study the Standard specifies that when the short-circuit current reaches 80% of a breaker short-circuit rating (70% within two transformations of a generator), a more exact method such as the E/X Method with Adjustment for AC and DC Decrements should be used. BPA-TS applies this method based on X/R ratio and adjusts the short-circuit current accordingly.

The ISIS concluded that the proposed interconnection of the Project would not cause any circuit breaker short circuit capability limits to be exceeded above any that were identified for G0365. The results are summarized in the attached Project Requirements Diagram. These fault study results are symmetrical (not corrected for X/R ratio), but still are not expected to exceed any short circuit capability limits.

7.6 NRIS Analysis

The LGIP defines Network Resource Interconnection Service as Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the transmission Provider's transmission system in a manner comparable to that in which the Transmission provider would integrate new generating facilities to serve native load customers. FERC has stated that the Interconnection Customer may designate their Large Generating Facility as a Network Resource any time before the commercial operation date (COD). Further, the LGIP states that Network Resource Interconnection Service does not convey in and of itself transmission service. A new or existing Network Customer of the Transmission Provider must file a Transmission Service Request to designate the Large Generating facility as a Network Resource. Once the Interconnection Customer has obtained Network Interconnection Service, requests for Network Integration Transmission Service from the Generating Facility to points inside the Transmission Provider's transmission system will not require additional Interconnection studies or additional upgrades. However, requests for delivery service inside the Transmission Provider's transmission system may require additional studies and upgrades if they are necessary to reduce congestion to acceptable levels.

A preliminary evaluation of NRIS was done for BPA's main grid flowgates. It was assumed that to serve network load in BPA's system the Project would displace federal NT resources. Since specific NT service is not known at this time (network load being served, NT resource being displaced), the worst case was assumed. Power Transfer Distribution Factors were calculated from the project area to each federal NT resource. If the impact is positive, that indicates an increase in flow across the flowgate which is beyond the existing Network Transmission obligation. The largest impacts of this resource are across the following flowgates: West of Cascades McNary. For NRIS results and summary of Power Transfer Distribution Factors, see the NRIS table in the G0365 System Impact Study.

Presently, there are more generation interconnection requests in the interconnection queue that have requested NRIS than the aggregate network load obligations for the Federal Columbia River Power System (FCRPS), which is presently being served by existing generation. Therefore, NRIS may not be available since at full output the aggregate of generation in the local area cannot reliably be delivered to the aggregate of network load on the transmission provider's system.

7.7 ERIS

In general, main grid flowgates are congested across the BPA transmissions system. Until such a time as long-term firm transmission service is acquired, it is recommended this generation project interconnecting to the BPA-TS transmission system participate in any Curtailment Calculator(s) or any other tools that may be implemented now or in the future to provide congestion relief across appropriate main grid flowgates.

If congestion occurs or is anticipated to occur and the preceding tools are not available or sufficient congestion relief cannot be achieved by using them, then access to the various forms of Hourly Transmission Products by the generation project can expect to be denied. Historical path flows are available electronically at http://transmission.bpa.gov/Business/Operations/Paths/default.aspx. Historical data is not a good indication of future performance. Also, times of maximum path stress do not always coincide with times of maximum path flow.

The ISIS results in this report include ERIS.

8 Communications Detailed Requirements

8.1.1 Typical Collector Station Requirements

- Communications Media
  - Developer shall be responsible for installing, maintaining, and operating redundant, geographically diverse, minimum 10 foot aerial spacing, single mode fiber optic cables from the POI substation to the Collector substation. The fiber cables will comply with WECC requirements for Class I communications and BPA-TS Class B Compliance. BPA-TS will require a minimum of 24 strands from each cable for its use. BPA-TS will install, own and operate the redundant SONET 155.52 MBPS Optical Carrier system installed on the Developer's fiber cables.
- Voice
  - DATS (Dial Automatic Telephone System) installed by BPA-TS will be provided for maintenance purposes.
  - Service Channel installed by BPA-TS will be provided for maintenance purposes.
  - PSTN (Public Switch Telephone Network) will be provided by Developer for BPA-TS metering purposes.
- Data including metering installed by BPA-TS:
  - Dual metering for the wind generation will be at the low side of the 34.5/230kV step-up transformer at the Collector substation. It could be located on the high voltage

side as well. Bi-directional metering is required and accuracy requirements for metering must be met.
    - GPS receiver for accurate time tagging.
    - Watt/VAR transducers are required to monitor the quantities of each line position to the POI Substation and the Developer's Collector substations.
    - BPA-TS will collect PCB and relay status and alarm information from meters, transducers, relays, and other power system equipment
    - A SER (Sequence of Events Recorder) will monitor, record and time-tag to one millisecond accuracy
    - A FIN (Field Information Network) server is included for remote access for O&M purposes
    - A NMS (Network Management System) RTU to monitor/alarm events on the communications media equipment
    - A PMU (Phasor Measurement Unit) at the Collector substation to monitor generator performance through digital high-speed time-synchronized voltage and current phasors and frequency measurements
- Control installed by BPA-TS:
    - A SCADA RTU will monitor and alarm equipment.
    - A limit wind generation will be implemented for each collector PCB at the Collector Substations using a fiber SCADA DNP 3.0 interface to Wind Operator.
- Protection:
    - BPA-TS will provide redundant transfer trip equipment at the Developer's Collector substation which matches the equipment installed at BPA's POI substation. To meet WECC requirements, the Developer will provide redundant relays.
- RAS (Remedial Action Scheme):
    - Redundant WECC compliant RAS Generation Dropping (GD) is required for this project. BPA-TS will provide redundant main grid RAS generation tripping at each of the collector sites for application to each 34.5 kV Collector line..
    - Redundant DC RAS for PDCI (Pacific Direct Current Intertie) Generation Dropping is included at the Collector Substation.
- General
    - Some of the BPA-TSC&C equipment will operate from the Collector substation station battery (125-129VDC). The communication equipment will operate from a BPA-TS supplied and installed 48VDC battery and redundant charger system. Load to be defined later.
    - The BPA-TS C&C equipment needs to be indoors (away from dirt/moisture) in a climate controlled facility between 60 and 80 degrees F.
    - For Cyber Security reasons in non-BPA-TS owned stations, BPA-TS Communications equipment, including but not limited to SONET, Channel Banks, Ethernet devices, FIN, and NMS will be housed in the control house in an alarmed, locked area.

9 Project Team

The project team for this request is as follows:

Role	Person
Account Executive	Kim Gilliland
Account Specialist	Nicole Adams
GI Administrator	Anna Cosola
Customer Service Engineer	Cherilyn Randall
Transmission Infrastructure Development Planning Manager	Ricky Bustamante
Transmission Planning Engineer	Mickie Cassady
Communications Planning Engineer	Dason Elwess
Environmental Specialist	Douglas Cockran