GRANT PUD
INTERCONNECTION
TECHNICAL REQUIREMENTS

March 15, 2022
Rev. 07

Public Utility District No. 2 of Grant County, Washington
P.O. Box 878, Ephrata, WA 98823
(509) 754-0500

Preface

This document has been prepared as accurately as possible to aid interconnection Requesters to understand and correctly comply with requirements to interconnect to the Grant PUD Electric System. Requirements specified in this document are subject to change from time to time and without prior notice.

Guidelines in this document shall comply with applicable Washington State requirements (WAC or RCW) and NERC/WECC reliability Standards and guidelines. If a conflict arises over interpretation of any statement in this document, the applicable official authority having jurisdiction shall take precedence. Additionally, if a guideline specified in this document is in conflict with an officially executed Interconnection Agreement or other contract between the Requester and Grant PUD, the Interconnection Agreement or other contract shall take precedence.

1. General Requirements

1-A. Safety and Isolating Devices

For an interconnection to Grant PUD's Electric System, an isolating device, typically a disconnect switch with a visible air gap for clearance tagging, shall be provided to physically and visibly isolate Grant PUD's Electric system from the connected facilities. The isolation device may be placed in a location other than the Point of Interconnection (POI), by agreement of Grant PUD and affected parties.

Safety and operating procedures for the isolating device shall comply with Grant PUD's Switching and Clearance Procedures and the Requester's or interconnecting utility's operating safety manuals. The following requirements apply for all devices separating Grant PUD's Electric System from the connected facilities:

- Must simultaneously open all three phases (gang operated) to the connected facilities.
- Must be accessible by Grant PUD personnel.
- Must be lockable in the open position by Grant PUD personnel.
- Will not be operated without advance notice to affected parties, unless an emergency condition requires that the device be opened to isolate the connected facilities.
- Must be suitable for safe operation under all foreseeable operating conditions.
- All switchgear that could energize equipment shall be visibly identified, so that all maintenance crews can be made aware of potential hazards.

All work practices involving Grant PUD owned, maintained, and/or operated equipment, must be done in accordance with the principles contained in Grant PUD's Switching and Clearance Procedures and performed at the direction of Grant PUD's system operations personnel. Grant PUD personnel may lock the isolating device in the open position and install safety grounds:

- For the protection of maintenance personnel when working on de-energized circuits.
- If the connected facilities or equipment presents a hazardous condition.
- If the connected facilities interfere or jeopardize the operation of Grant PUD's System.
- If Grant PUD's system interferes or jeopardizes the operation of the connected facilities.

Since the device is primarily provided for safety and cannot normally interrupt load current, consideration shall be given as to the capacity, procedures to open, and the location of the device.

1-B. Considerations at Point of Interconnection

1-B.1 General Constraints

Connected facilities shall not restrict Grant PUD's ability to schedule and perform maintenance on the interconnection line and all its components.

1-B.2 General Configurations

Connection of new facilities into the transmission system shall conform to Grant PUD's Transmission Planning Guidelines and usually falls into one of two categories:

a. Connection into an existing 115 kV or 230 kV bulk power substation, with (depending on the bus configuration) the existing transmission and new connecting lines each terminated into bays containing one or more breakers.

b. Connection by looping an existing 115 kV or 230kV transmission line into a new customer or Grant PUD owned substation.

Grant PUD must maintain full operational control of the looped transmission path. This may include, but not be limited to, SCADA control and monitoring of circuit breakers, disconnects and other equipment in the new substation. Additionally, Grant PUD will retain contractual path rights and any new equipment shall not degrade the operational capability of the line.

A multi-terminal line is created when the new connection, such as (b) above, becomes an additional source of real power and fault current beyond the existing sources at the line terminals. A line with three terminals affects Grant PUD's ability to protect, operate, dispatch and maintain the transmission line. Grant PUD determines the feasibility of multi-terminal line connections on a case-by-case basis. Examples of a possible configuration based on magnitude of customer owned generation and necessary system protection is outlined in Section 3-D, Generator Configuration and Protection.

1-B.3 Special Configurations

Grant PUD's Bulk Electric System transmission lines include all 230 kV and 115 kV lines that are loop connected at transmission circuit breakers at all terminals. These circuits form the backbone of Grant PUD's transmission system and provide the primary means of serving large geographical areas. In general, Grant PUD requires a substation with additional breakers at the POI to maintain reliability and security of the main grid system. Depending on generator (or load) size, contractual arrangements and the Interconnection System Impact Study results, multiple connection points including additional transmission lines and breakers may also be required.

Small generators less than 10 MVA may be connected directly to Grant PUD's Distribution System at distribution level voltages.

1-B.4 Mechanical (or Electrical) Interlocking System

To ensure safety of working personnel, Grant PUD may require a mechanical (or electrical) interlocking system between the utility tie breakers and the visible disconnect switch at the POI.

1-C. Transformer Considerations

Transformers connecting to the transmission system where a source of real power flows through the transformer to Grant PUD's high voltage transmission system shall provide a ground source of current on the high voltage side. Grant PUD requires a **wye-grounded configuration on the high side and delta on the low side**. This type of connection will allow Grant PUD to continue using the conventional high voltage line protective devices and surge arresters without any major modifications to protective schemes and to minimize hazardous ferroresonance/neutral-shift conditions. A wye grounded-delta-wye grounded (YG-Δ-YG) transformer with the Y ground connection on the high voltage side can also accomplish this. New delta-wye grounded (Δ –YG) transformers with the delta connection on the high side are not allowed.

1-D. Other Interconnection Considerations

1-D.1 Existing Equipment

The proposed new connection may cause existing equipment such as transformers, power circuit breakers, disconnect switches, arresters, and transmission lines to exceed their ratings. New connections may require equipment replacement or an alternate plan of service.

1-D.2 System Stability and Reliability

Grant PUD's Electric system has been developed with careful consideration for system stability and reliability during disturbances. The type of connection, size of the source or load, breaker configurations, source or load characteristics, and the ability to set protective relays will affect where and how the connection is made.
To mitigate any stability or reliability issues, generators and/or end-user facilities may be required to participate in special protection or remedial action schemes (RAS) including automatic tripping or damping of generation or load. Section 3 provides additional information and requirements for RAS schemes.

1-D.3 Control and Protection

Grant PUD coordinates its protective relays and control schemes to provide for personnel safety, equipment protection and to minimize system instability and disruption of services during disturbances. New connections usually require the addition or modification of protective relays and/or control schemes, including replacement or modification of equipment at the remote terminal(s). The new protection must be compatible with existing protective relay schemes and present standards. The addition of voltage transformers, current transformers, or pilot scheme (transfer trip) may also be necessary. Grant PUD will supply the Requester with recommended protective relay systems. Should the Requester

select a relay system different from standard Grant PUD applications, Grant PUD reserves the right to perform a full set of acceptance tests prior to granting permission to use the selected protection scheme. Requester selected equipment must have interfaces compatible with Grant PUD equipment.

1-D.4 Dispatching for System Operations and Maintenance

Grant PUD operates and maintains its system to provide reliable customer service while meeting the seasonal and daily peak loads even during equipment outages and disturbances. New line and load connections must not restrict timely outage coordination, automatic switching or equipment maintenance scheduling. Preserving reliable service to all Grant PUD customers is essential and may require additional switchgear, equipment redundancy, or bypass capabilities at the POI for acceptable operation of the system.

1-D.5 Atmospheric and Seismic

The effects of fires, windstorms, floods, lightning, elevation, temperature extremes, icing, contamination and earthquakes must be considered in the design and operation of the connected facilities. The Requester is responsible for determining that the appropriate standards, codes, criteria, recommended practices, guides and prudent utility practices are met for equipment that they are installing.

1-D.6 Physical Security

The potential vulnerability of the facility to sabotage or terrorist threat should be factored into the design and operating procedures. The Requester is responsible for determining that the appropriate standards, codes, criteria, recommended practices, guides and prudent utility practices are met for equipment that they are installing.

1-D.7 Ownership

Grant PUD shall own any and all improvements or equipment attached to Grant PUD's distribution or transmission system on Grant PUD's side of the Change of Ownership point. All required equipment shall meet Grant PUD's equipment specifications. Grant PUD shall be deemed the owner of such equipment and/or improvements upon completion of construction.

1-E. Transmission and Substation Facilities

Some new connections to Grant PUD's Electric system may require that one or more Grant PUD lines (a transmission path) be looped through the Requester's facilities or sectionalized with the addition of switches. The design and ratings of these facilities shall not restrict the capability of the line(s) and Grant PUD's contractual transmission path rights.

1-E.1 Transmission Line Designs

Grant PUD's owned or maintained transmission lines shall be designed such that the requirements of Grant PUD's design criteria are met. Among these requirements are the following:

a. The requirements of the NESC C2, WISHA and OSHA shall be met.

b. The minimum approach distances shall be designed in accordance with chapter 296-45 WAC of the Washington State safety standard for electrical workers.

c. All new transmission lines connecting to a Grant PUD substation shall have one or more overhead ground wires (OHGW) to provide substation shielding. For transmission lines 115 kV, the OHGW shall extend ½ mile in length from the substation. For transmission lines 230 kV, the OHGW shall extend 1 mile in length from the substation. The OHGW design and connection points shall be approved by Grant PUD.

d. All lines connecting to a Grant PUD substation shall include surge arresters for substation entrance protection. Grant PUD staff will recommend the appropriate level of entrance protection.

e. Access to all Grant PUD structures on customer property shall be provided.

f. Underbuilds to existing Grant PUD transmission line facilities will generally not be allowed. If an underbuild is requested and approved, a special 'pole contract agreement' will have to be negotiated.

1-E.2 Customer Built Substations and Facilities

Customer built substations that interrupt an existing Grant PUD transmission path and customer-built facilities in a Grant PUD substation must meet, at a minimum, the following requirements:

a. The facility must be designed to applicable requirements of the NESC, NEC, ANSI and IEEE Standards.

b. The site selection must consider environmental aspects, oil containment, and fire suppression, as applicable.

c. Grounding must be in accordance with IEEE Standard 80.

d. Where Grant PUD transmission may be affected by an outage of the customer-built substation, two sources of station service are required. Exceptions will be considered on a case-by-case basis.

e. Electrical equipment in the substation must be sized to carry the full current rating of the interrupted transmission path. This includes circuit breakers; disconnect switches, current transformers and all the ancillary equipment that will serve as the continuation of the path during any switching configuration.

f. The acceptable bus configurations of any new switching stations shall conform to the allowable configurations specified in Grant PUD's Transmission Planning Guidelines. In most cases, Grant PUD may not allow three-terminal line configurations due to complexity of 3-terminal line protection and switching operation and also due to undesirable impact to system stability.

1-F. Insulation Coordination

Power system equipment is designed to withstand voltage stresses associated with expected operation. Adding or connecting new facilities can change equipment duty, and may require that equipment be replaced or switchgear, telecommunications, shielding, grounding and/or surge protection be added to control voltage stress to acceptable levels. Interconnection System Impact Studies may include the evaluation of the impact on equipment insulation coordination. Grant PUD may identify additional requirements to maintain an acceptable level of Grant PUD's Electric system availability, reliability, equipment insulation margins and safety. The customer shall be fully responsible for the protection of his/her facility from transient surges initiated by lightning, switching, or other system disturbances.

Voltage stresses, such as lightning or switching surges, and temporary overvoltage may affect equipment duty. Remedies depend on the equipment capability and the type and magnitude of the stress. In general, stations with equipment operated at 15 kV and above, as well as all transformers and reactors, shall be protected against lightning and switching surges. Typically this includes station shielding against direct lightning strokes, surge arresters on all transformers, and surge protection with arresters (and/or rod gaps) on the incoming lines. The following requirements may be necessary to satisfy these objectives:

1-F.1 Lightning Surges

If the Requester proposes to connect to a shielded transmission line, the interconnection line to the substation must also be shielded. For an unshielded transmission line, the interconnection line does not typically require shielding beyond that needed for substation entrance. However, special circumstances such as the length of the interconnection line may affect shielding requirements.

Lines at voltages of 115 kV and higher that terminate at Grant PUD substations must meet additional shielding and/or surge protection requirements identified in Section 1-E. For certain customer service substations at 115 kV and below, Grant PUD may require only an arrester at the station entrance in lieu of line shielding, or a reduced shielded zone adjacent to the station. These variations depend on the interconnection line length, the presence of a power circuit breaker on the transmission side of the transformer, and the size of the transformer.

1-F.2 Temporary Overvoltages

Temporary overvoltages can last from seconds to minutes and are not characterized as surges. These overvoltages are present during islanding, faults,

loss of load, or long-line situations. All new and existing equipment must be capable of withstanding a minimum of 10% overvoltage.

1-F.3 Local Islanding

When the connection involves connecting to a transmission line, a local island may be created when the breakers at the ends of the transmission line open. This can leave generating resources and any other end-user facilities that also are connected off this line isolated from the power system. Delayed fault clearing, overvoltages, ferroresonance, extended undervoltages and degraded service to other Grant PUD customers can result from this local island condition. Therefore local islands involving Grant PUD transmission facilities are not allowed to persist, except for a temporary, area-wide grid separation under control of Grant PUD's System Operator. Special relays to detect this condition and isolate the local generation from Grant PUD facilities are described in Section 3-B2.

1-G. Substation Grounding

Each substation must have a ground grid that is solidly connected to all metallic structures and other non-energized metallic equipment. This grid shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment which are in, or immediately adjacent to, the station under normal and fault conditions. The ground grid size and type are in part based on local soil conditions and available electrical fault current magnitudes. In areas where ground grid voltage rises beyond acceptable and safe limits (for example due to high soil resistivity or limited substation space), grounding rods and grounding wells might be used to reduce the ground grid resistance to acceptable levels.

If a new ground grid is close to another substation, the two ground grids may be isolated or connected. If the ground grids are to be isolated, there must be no metallic ground connections between the two substation ground grids. Cable shields, cable sheaths, station service ground sheaths and overhead transmission shield wires can all inadvertently connect ground grids. Fiber-optic cables are required for providing telecommunications and control between two substations while maintaining isolated ground grids. If the ground grids are to be interconnected, the interconnecting cables must have sufficient capacity to handle fault currents and control ground grid voltage rises. Grant PUD must approve any connection to a Grant PUD substation ground grid.

New interconnections of Projects may substantially increase fault current levels at nearby substations. Modifications to the ground grids of existing substations may be necessary to keep grid voltage rises within safe levels. The System Impact Study will determine if modifications are required and the estimated cost. The ground grid should be designed to all applicable NESC, ANSI, IEEE and WISHA Standards relating to safety in substation grounding.

1-H. Inspection, Test, Calibration and Maintenance

Transmission elements (e.g. lines, line rights of way, transformers, circuit breakers, control and protection equipment, metering, and telecommunications) that are part of the proposed

connection and could affect the reliability of Grant PUD's Electric system need to be inspected and maintained in conformance with NERC reliability standards. The Requester has full responsibility for the inspection, testing, calibration, and maintenance of their equipment, up to the location of Point of Change of Ownership or POI.

1-H.1 Pre-energization Inspection and Testing

The Requester is responsible for the pre-energization and testing of their equipment. Section 3-F describes specific installation testing requirements for protections systems.

For equipment that can impact Grant PUD's Electric system, the Requester shall develop an Inspection and Test Plan for pre-energization and energization testing. Grant PUD may request to review the test plan prior to the test(s). Grant PUD may require additional tests. The Requester shall make available to Grant PUD, upon request, all drawings, specifications, and test records of the POI equipment. Also, upon request Grant PUD will make available to the Requester similar documents describing Grant PUD's POI equipment.

1-H.3 Calibration and Maintenance of Revenue and Interchange Metering

Unless specified otherwise in interconnection agreement documents executed by Grant PUD and the Requester, Revenue and interchange metering will be calibrated at least every two years. All interested parties or their representatives may witness the calibration test. Calibration records shall be made available to all interested parties.

Each meter shall be calibrated against a standard or reference instrument or meter that has been calibrated and certified during the preceding twelve months. Calibration of standard meters and instruments must meet accuracy requirements of ANSI C12.1 or its successor industry standard.

1-H.4 Grant PUD Inspection and Customer Maintenance Records

The Requestor shall maintain their facilities in good working order. All customer owned facilities may be subject to Grant PUD inspection upon reasonable notice by Grant PUD. The customer shall assume full responsibility for the routine maintenance of the facility equipment and associated protective devices and the keeping of records for such maintenance. These records shall be available to Grant PUD for inspection at all times.

1-I. Station Service

Power that is provided for local use at an interconnection substation to operate lighting, heat and auxiliary equipment is termed station service. Alternate station service is a backup source of power, used only in emergency situations or during maintenance when primary station service is not available. Two sources of AC station service, primary and alternate,

shall be provided for stations with generation interconnection. At least one of the station service sources shall be supplied by the utility's Distribution System.

For Requester owned facilities, station service power is the responsibility of the Requester. The station service requirements of the new facilities, including voltage and reactive requirements, shall not impose operating restrictions on Grant PUD's Electric system beyond those specified in applicable NERC, WECC and/or NWPP Reliability Criteria. Generally, Grant PUD will be the sole provider of utility-sourced station service.

The Requester must provide metering for station service and alternate station service, as specified by the metering section of this document or negotiate other acceptable arrangements.

g1-J. Ancillary Services

All generators, end-user facilities and transmission facilities must be part of a Balancing Authority area. The Balancing Authority Area provides critical ancillary services, including load regulation, frequency response, operating reserves, voltage control from generating resources, scheduling, system controls and dispatching service, as defined by FERC, NERC or their successors. All new connections to Grant PUD's Electric system also require a transmission contract. The Requester must choose the Balancing Authority Area in which the new facilities will be located and the source and/or provider of ancillary services per applicable Grant PUD business practices for transmission service. This election and associated data requirements should be identified in the ancillary service exhibit of the transmission contract.

Of particular importance is the Requester's selection of the source for regulating and contingency reserves, if needed. Grant PUD will then determine the telemetering, controls, and metering that will be required to integrate the load or facility into the chosen Balancing Authority Area and to provide the necessary ancillary services. If self-provision is an available option per current Grant PUD business practices and the Requester chooses self-provision or to utilize a third-party for provision of reserves, then special certification and deployment procedures may be required into Grant PUD's automatic generation control, (AGC) system. The provision of the required ancillary services must meet all relevant NERC, WECC and NWPP reliability standards and criteria.

Normally, the generator will operate in voltage control mode, regulating the voltage to a Grant PUD provided schedule. Typically, the generator should supply reactive power for its station service loads and reactive power losses up to the POI. Generator projects may be requested to supply reactive power as an ancillary service.

Normally, the generator will operate its governor to respond independently for frequency deviations. If the governor is controlled through the plant central controller, the governor shall be in 'droop control' mode. Droop setting and performance shall comply with applicable NERC and WECC reliability standards.

2. Performance Requirements

2-A. System Operation and Power Quality

2-A.1 Isolating

The Requester shall not energize any de-energized Grant PUD equipment unless Grant PUD's System Operator specifically approves the energization. Where the connection is to a radial load the circuit may be interrupted and reclosed by Grant PUD. In cases where the interconnection breaks an existing Grant PUD line, an automatic isolation scheme may be required to maintain continuity to Grant PUD's line. If the interconnected facilities are networked or looped back to Grant PUD's Electric system or where generation resources are present, a switching device must open to eliminate fault contributions or neutral shifts. Once open, the device must not reclose until approved by Grant PUD's System Operator or as specified in the interconnection agreement.

2-A.2 Synchronizing

The Requester's system or portion of system with energized generators must synchronize its equipment to Grant PUD's Electric system. The exception to this is under large-scale islanding conditions, where Grant PUD's Electric system will re-synchronize to neighboring systems over major interties. Automatic or manual synchronization shall be supervised by a synchronizing check relay, IEEE Device 25. Please refer to Section 3-D.2, for specific requirements regarding synchronizing and reclosing.

2-A.3 Voltage Schedules

Voltage schedules are necessary to maintain optimal voltage profiles across the transmission system. Optimal profiles minimize transmission of reactive power and preserve flexibility in use of reactive-power control facilities. To this end, a voltage schedule will be developed by Grant PUD in coordination with regional voltage requirements. On its transmission system, Grant PUD maintains voltages according to requirements specified by its Reliability Coordinator. This typically allows for variances of ±5% from nominal for all transmission voltage levels on Grant PUD's system with all facilities in service (pre-contingency) and ±10% post-contingency. Limitations of equipment connected to Grant PUD's Electric system must not restrict this range of operation. In rare occasions, deviations from the voltage schedule may be ordered by Grant PUD's System Operator to meet unexpected emergent or emergency system conditions.

The project voltage controller must be coordinated with existing generation plants or VAR devices at or near the POI, and it must be optimized to support the POI voltage schedule as prescribed by Grant PUD's Operations, including during times of contingencies on the main grid. The Project is required to install additional shunt VAR devices if the inverter is not capable of preventing overvoltage conditions or controlling POI voltage schedule during low MW output conditions.

All generation projects shall meet NERC and WECC requirements for Low Voltage Ride Through (LVRT). The generation shall be capable of staying online for nearby faults, except for faults on the line or bus the generation is connected to. This requirement applies to all forms of generation. 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 consistent with NERC reliability guidelines specific to inverter-based generation.

2-A.4 Reactive Power

Each entity shall provide for its own reactive power requirements, at both leading and lagging power factors unless otherwise specified by Grant PUD. Grant PUD generally requires customers to minimize exchange of reactive power with Grant PUD's system, especially under peak load conditions. This can be accomplished by installing equipment to allow matching of internal supply and demand of reactive power.

In general, customer owned generating facilities shall not take reactive power from Grant PUD's system. Generator operating limits shall be reviewed and approved by Grant PUD prior to start up. For reliability reasons or to mitigate emergency system conditions, Grant PUD's system operator may request customer owned generation to supply maximum available reactive capability and/or to adjust generation levels all the way to zero if necessary.

2-A.5 Power Quality

Power quality is the responsibility of both the facility connected to a utility system and the utility(s) providing distribution and transmission. Since this document focuses on the interconnection of generation, transmission and end-user facilities to Grant PUD's Electric system, this section will deal primarily with power quality problems typically introduced by the Requester as termed in this document. The Requester is expected to address, in the design of their facilities, potential sources and mitigation of power quality degradation prior to interconnection. Design considerations should include applicable standards including, but not limited to IEEE Standards 142, 519, 1100 1159, 1547, ANSI C84.1 and Grant PUD's Customer Service Policies.

In general, the Requester has the responsibility not to degrade the quality and reliability of service provided to Grant PUD's facilities or customers. The Requester also has certain responsibilities to account for transmission system events like switching transients and fault induced voltage sags. Standards exist for manufacturers and system designers to consider short duration system events in order to design equipment or systems with sensitivities capable of riding through events that are within utility system operating standards. If it is determined that the new connection facility is causing a power quality problem, then the Requester will be held responsible for installation of the necessary equipment or operational

measures to mitigate the problem. Typical forms of power quality degradation include, but are not limited to voltage regulation/unbalance, harmonic distortion, flicker, voltage sags/interruptions, and transients. Some of the more common forms of degradation are discussed below.

Voltage Fluctuations and Flicker - Voltage fluctuations may be noticeable as visual lighting variations (flicker) and can damage or disrupt the operation of electronic equipment. IEEE Standard 519, 241 and 141 provide definitions and limits on acceptable levels of voltage fluctuation. End-user facilities or system connections to Grant PUD's Electric system shall comply with the applicable limits set by these standards.

Harmonic Distortion - Nonlinear devices such as adjustable or variable speed drives (ASD/VSD), power converters, arc furnaces, and saturated transformers can generate harmonic voltages and currents on the transmission system. These harmonics can cause telecommunication interference, increase thermal heating in transformers and reactors, disable or cause mis-operations of solid-state equipment and create resonant overvoltages. In order to protect power system equipment from damage or mis-operations, harmonics must be managed and mitigated. The new connection shall not introduce harmonics into Grant PUD's Electric system in excess of the applicable limits specified in IEEE Standard 519.

In addition to end-user facilities with nonlinear devices, new generation resources or distributed resources should be evaluated not only for possible injected harmonics, but also for potential resonant conditions. For example, some generation resources, whether due to power factor correction capacitors or cable capacitances, may be capacitive during certain operating configurations. These types of configurations may result in resonant conditions within the project or in combination with the utility system. The short circuit ratio (SCR) tests as listed in IEEE 1547 and IEEE 519 can be good indicators of this potential problem. If the evaluation of the new connection indicates potential harmonic resonance the Requester may be required to filter, detune, or mitigate in some way the potential resonant conditions associated with connection of the new resource.

For individual end users, the IEEE 519 Standard limits the level of harmonic currents injected at the POI (listed in IEEE as the PCC) between the end user and the utility. Recommended limits are provided for individual harmonic components and for the total demand distortion. These limits are expressed as a percentage of the customer's demand current level, rather than as a percentage of the fundamental, in order to provide a basis for evaluation over time. There are also limits for voltage distortion for both individual frequency and total harmonic distortion.

Phase Unbalance - Unbalanced phase voltages and currents can affect coordination of protective relaying, induce higher flows of current on neutral connections, and cause thermal overloading of transformers. A phase unbalance is

measured as a percent deviation of one phase from the average of all three phases. To protect equipment owned by Grant PUD and by the Requester, the contribution from the new facilities at the POI shall not be allowed to cause a voltage unbalance greater than 1% or a current unbalance greater than 5%.

System problems such as a blown transformer fuse or open conductor on a transmission system can result in extended periods of phase unbalance. It is the Requester's responsibility to protect all of its connected equipment from damage that could result from such an unbalanced condition.

2-B. Reliability and Availability

2-B.1 Maintaining Service

All users, operators and owners of the Bulk Electric System share in the responsibility for maintaining system reliability. An adequate level of reliability occurs when the system is planned, constructed, and operated such that:

- The System remains within acceptable limits.
- The System performs acceptably after credible contingencies.
- The System design prevents instability and cascading outages.
- The System's facilities are protected from severe damage; and
- The System's integrity can be restored if it is lost.

2-B.2 Transmission Lines

The Requestor's facilities may be part of or connected to key transmission lines that must be kept in service as much as possible. They may be removed from service only after power flow studies indicate that system reliability will not be degraded below acceptable levels, in accordance with NERC and WECC requirements. The entity responsible for operating such transmission line(s) shall promptly notify other affected control areas, when removing such facilities from and returning them back to service.

2-B.3 Switchable Devices

Devices frequently switched to regulate transmission voltage and reactive power shall be switchable without de-energizing other facilities. Switches designed for sectionalizing, loop switching, or line dropping shall be capable of performing their duty under heavy load and maximum operating voltage conditions.

2-B.4 Frequency and Duration of Outages

Planned outages of significant system equipment shall be coordinated with all affected parties to minimize their impact on the remaining system. The operator of the Requester's facilities should respond promptly to automatic and forced outages in order to mitigate any impacts on the remaining system, and in a manner that treats all interruptions with the same priority.

2-B.5 Key Reliability and Availability Considerations

a. Connectional new or modified interconnected facilities shall meet all NWPP, NERC, WECC, and Grant PUD planning standards as well as respective NERC/WECC Operating Policies, Reliability Standards, and any other WECC guides or policies that apply.

b. Tools and spare equipment must be readily available to accomplish necessary operations and maintenance tasks.

c. Any bypass equipment must be fully rated to allow continued operation without creating a bottleneck. Alternate feeds, when provided, shall have sufficient rating to not restrict operation of Grant PUD's Electric system.

d. Shielding and electromagnetic interference (EMI) protection shall be provided to ensure personnel safety and proper equipment functioning during disturbances such as faults and transients.

e. Standardized design, planning, operating practices and procedures should be used so the new connection may be readily incorporated into the existing transmission network.

f. For reliable operation, the telecommunications, control and protection equipment must be redundant to the extent described in Sections 3 and 5.

g. The equipment for the new connection shall have sufficient capabilities for both the initial operation and for long-range plans.

h. Operations and maintenance personnel must be properly trained for both normal and emergency conditions.

2-C. Power System Disturbances and Emergency Conditions

2-C.1 Minimizing Disturbances

The new facilities shall be designed, constructed, operated, and maintained in conformance with this document, applicable laws and regulations, and standards to minimize the impact of the following:

- Electric disturbances that produce abnormal power flows
- Power system faults or equipment failures
- Overvoltages during ground faults
- Audible noise, radio, television, and telephone interference
- Power system harmonics
- Other disturbances that might degrade the reliability of the interconnected Electric system

2-C.2 System Frequency During Disturbances

Power system disturbances initiated by system events such as faults and forced equipment outages, expose the system to oscillations in voltage and frequency. It

is important that lines remain in service for dynamic oscillations that are stable and damped.

Large-scale blackouts can result from the excessive loss of generation, outage of a major transmission facility, or rejection of load during a disturbance. In order to prevent such events, under frequency load shedding (UFLS) has been implemented throughout the western interconnection. When system frequency declines, discrete blocks of load are automatically interrupted by frequency relays, with most of the interruptions initiated between 59.3 Hz and 58.6 Hz. Load shedding attempts to stabilize the system by balancing the generation and load. It is important that lines and generators remain connected to the system during frequency excursions, both to limit the amount of load shedding required and to help the system avoid a complete collapse. The limited ability of some generators to withstand off-nominal frequency operation has been taken into account in the development of frequency relay setting delays provided in Section 3-D.3.

2-C.3 Voltages During Disturbances

In order to prevent voltage collapse in certain areas of the Pacific Northwest, undervoltage load shedding (UVLS) may also been implemented. Most of the load interruptions will occur automatically near 0.9 per unit voltage after delays ranging from 3.5 to 8.0 seconds. Depending on the type and location of any new load, the Requester may be required to participate in this scheme. The undervoltage relay settings in Section 3-D.3 shall coordinate with the undervoltage load shedding program.

2-C.4 Responsibilities During Emergency Conditions

Balancing Authorities are ultimately responsible for maintaining system frequency within their prescribed boundaries. All emergency operations involving Grant PUD's Balancing Authority Area and transmission system must be coordinated with Grant PUD's system operations. Each party, as appropriate, must participate in any pre-defined local or regional remedial action schemes. All end-user facilities or generators tripped by underfrequency or undervoltage action must **not** be restored without Grant PUD's system operator's permission. Schedule cuts also need to be promptly coordinated according to NERC/WECC reliability standards. All parties have the responsibility for clear communications and to report promptly any suspected problems affecting others.

2-D. Switchgear

2-D.1 General Requirements

Circuit breakers, disconnect switches, and all other current-carrying equipment connected to Grant PUD's transmission system shall be capable of carrying normal and emergency load currents up to their respective rating (if non-BES) or System Operating Limit (if BES), and must also withstand available fault currents without damage. This equipment shall not become a limiting factor, or bottleneck, in the ability to transfer power on Grant PUD's Electric system. During prolonged

steady-state operation, all such equipment shall be capable of carrying the maximum continuous current that the interconnected facility is rated to deliver.

All circuit breakers and other fault-interrupting devices shall be capable of safely interrupting fault currents for any fault that they may be required to interrupt. Application shall be in accordance with ANSI/IEEE C37 Standards. These requirements apply to the equipment at the POI as well as other locations on Grant PUD's Electric system. Grant PUD shall supply the available fault current level information upon request.

2-D.2 Circuit Breaker Operating Times

Table 2-1 specifies the interrupting times typically required of circuit breakers on Grant PUD's Electric system. These times will generally apply to equipment at or near the POI. System stability considerations may require faster opening times than those listed. Modern breaker opening times are typically four to eight cycles. Circuit breaker interrupting time may vary from those in Table 2-1 but must coordinate with other circuit breakers and protective devices.

Table 2-1 Typical Circuit Breaker Interrupting Times

Voltage Class (kV L-L rms)	Rated Interrupting Time (Cycles)
Below 100 kV	$\leq$ 5
115 kV	$\leq$ 3
230 kV	$\leq$ 2

2-D.3 Other Fault-Interrupting Devices

Depending on the application, the use of other fault-interrupting, non-circuit breaker, devices may be allowed provided that these devices be tested for the duty in which they are to be applied and coordinate with other protective device operating times. Examples of these types of devices include S&C Circuit Switchers and Line-Rupters, line fuses, etc. Additionally, fault-interrupting devices shall not cause 'single phasing' transmission lines or transformers under normal operation.

2-D.4 Automatic Isolation and Synchronization

Depending on the application, Grant PUD may require automatic isolation and lockout when Grant PUD's high voltage system service is interrupted for any reason. In these cases, the isolation shall be done prior to Grant PUD's switching station breaker reclosing and typically less than two seconds in the absence of direct transfer trip relaying.

2-E. Transformers, Shunt Reactance and Phase Shifters

Transformer tap settings (including those available for load and no load tap changers), reactive control set points of shunt reactive equipment, and phase shift angles for phase shifters must be coordinated with Grant PUD to optimize both reactive flows and voltage profiles. Automatic controls may be necessary to maintain these profiles on the

interconnected system. Any automatic control change may be required to be coordinated with established regional requirements established by NERC, WECC, the RC, and/or the NWPP.

Transformer reactance and tap settings for generator transformers should also be coordinated with Grant PUD to optimize the reactive power capability (lagging and leading) that can be provided to the network. Refer to IEEE Standard, C57.116, Guide for Transformers Directly Connected to Generators. The continuous reactive-power capability of the generator shall not be restricted by main or auxiliary equipment, control and protection, or operating procedures.

2-F. Generators (General Requirements)

The latest applicable NERC/WECC Reliability Standards must be followed for all generator interconnections.

2-F.1 Generator Operation During Emergency System Conditions

The generator, when requested by Grant PUD's System Operator during emergency conditions, will be expected to supply reactive power up to its maximum available capability, even if reductions in real power output is necessary to make this happen. Dispatch for non-synchronous sources will be examined on a case-by-case basis, depending upon the performance characteristics of the source and its location within Grant PUD's Electric System.

2-F.2 Generator Performance During System Disturbances (Swings)

Response to frequency and voltage variances during a system disturbance are defined in Section 3-D.3. Unless otherwise allowed, the generators are to stay connected and operational during such disturbances, up to the limits provided in Section 3-D.3. Deviation from these requirements will be reviewed on a case-by-case basis and may result in additional reserve requirements or other system compensation.

2-F.3 Generator Ride-Through Capability

Depending on generator size and other system factors, the generator(s) may be required to stay on-line for nearby faults, not including the line connected to or the adjacent buses, for faults cleared assuming the relay and breaker clearing times given in Table 3-1. Deviation from these requirements will be reviewed on a case-by-case basis and may result in additional reserve requirements or other system compensation.

2-F.4 Reactive Power Requirements

Generators shall be designed to maintain a composite power delivery at continuous rated power output at the POI at a power factor between 0.95 to 1.00 unless specified differently in the Interconnection Agreement. The design shall consider the effects of step-up transformer reactance and voltage taps/turns ratios, and bus-fed auxiliary load.

2-F.5 Placement of Customer-owned Generating Facility

Customer owned generating facilities shall not be allowed within 150 feet (horizontal distance) from any existing overhead electrical distribution (less than 13.2kV) facilities and 250 feet (horizontal distance) from any high voltage (115kV and higher) electrical facilities. Exhaust fumes shall not be directed toward any existing overhead electrical facilities. Grant PUD also does not allow more than one customer owned generating facility per Grant PUD owned distribution substation.

2-F.6 Starting as Induction Motor (if applicable)

In general, induction generators start as motors and synchronous generators may be designed to start as motors. The customer-owned generator(s) starting as a motor(s) shall meet the motor starting requirements in Grant PUD Customer Service Policies.

Grant PUD may require the customer to provide, at his/her expense, special or additional starting equipment.

2-G. Asynchronous Generators

2-G.1 Asynchronous Generators With Solid-State Inverters or Double-fed Wound Rotor Induction Generators

These machines shall be operated to provide reactive power similar to that of synchronous generators within the capabilities of the machines. This may include operation on voltage schedules provided by Grant PUD's System Operators.

2-G.2 Voltage Control

Voltages at the POI shall not vary more than 0.5% per capacitor switching operation; and shall not deviate more than 3% due to changes in generation output caused by rapid fluctuations in the prime mover speed. The automatic voltage control system shall be fast enough to react to the maximum change in generation anticipated without invoking the operation of system voltage control devices such as shunt capacitors and tap changers. Further, the control system shall be coordinated to minimize operation of customer load regulation equipment including voltage regulators and tap changers. This may typically require the control system to adjust reactive compensation in less than 30 seconds. The alternative may be to require controllable compensation such as static var compensators (SVC).

2-H. Synchronous Generators

2-H.1 Excitation Equipment

Synchronous generator excitation equipment shall follow industry Good Utility Practices and the latest applicable industry standards. Excitation equipment includes the exciter, automatic voltage regulator, power system stabilizer and over-excitation limiter. Supplementary controls may also be required to meet Grant PUD transmission voltage schedules.

The NERC 'VAR' Standards and associated WECC regional criteria requirements for excitation equipment shall be met. In general, the following requirements must be followed:

- All synchronous generators connected to the interconnected transmission systems shall be operated with their excitation system in the automatic voltage control mode unless approved otherwise by the transmission system operator.
- Generators shall maintain a network voltage or reactive power output as required by the transmission system operator within the reactive capability of the units. Generator step-up and auxiliary transformers shall have their tap settings coordinated with the electric system voltage requirements.
- Generators shall maintain a network voltage or reactive power output as required by the transmission system operator within the reactive capability of the units. Generator step-up and auxiliary transformers shall have their tap settings coordinated with the electric system voltage requirements.
- Voltage regulator controls and limit functions (such as over and under excitation and volts/hertz limiters) shall coordinate with the generator's short duration capabilities and protective relays.
- Generator voltage regulators to extent practical should be tuned for fast response to step changes in terminal voltage or voltage reference. It is preferable to run the step change in voltage tests with the generator not connected to the system so as to eliminate the system effects on the generator voltage. Terminal voltage overshoot should generally not exceed 10% for an open circuit step change in voltage test

The exciter is normally of the brushless rotating type or the static thyristor type. The excitation system nominal response shall be 2.0 or higher (for definitions see IEEE Standard 421.2). The excitation system nominal response defines combined response time and ceiling voltage. In some cases, the high initial response static type may be required to economically improve power system dynamic performance and transfer capability.

Automatic voltage regulators (AVRs) should be of continuously acting solid state analog or digital design. Tuning results should be included in commissioning test reports provided to Grant PUD.

WECC requires that voltage regulators of generating units whose rated output exceeds a certain threshold, individually or in aggregate, be equipped with a power system stabilizer (PSS). The PSS should be tuned in accordance with WECC guidelines and other industry practices. The 'integral of accelerating power' type of PSS is preferred. Its input can be a speed-related signal derived from terminal voltage and current measurements used in the basic AVR. The PSS can be implemented as a software module within the AVR.

The voltage regulator shall include an over-excitation limiter. The over-excitation limiter shall be of the 'inverse-time' type, adjusted to coordinate with the generator field circuit time-overcurrent capability. Automatic voltage regulation shall be restored automatically when system conditions allow field current below the continuous rating. Grant PUD may request connection of the voltage regulator line drop compensation circuit to regulate a virtual location 50–80% through the step-up transformer reactance.

The supplementary automatic control is required to adjust the AVR set point to meet Grant PUD's network side voltage schedule. This supplementary control should operate in a 10–30 second time frame, and may also balance reactive power output of the power plant generators.

2-H.2 Governors

NERC/WECC requirements specify that prime mover control (governors) shall operate with appropriate speed/load characteristics to regulate frequency.

Additionally, prime mover control (governors) should operate freely to regulate frequency. In the absence of regional requirements for the speed/load control characteristics, governor droop should generally be set at 5% and total governor dead band (intentional plus unintentional) should generally not exceed ±0.06%. These characteristics should in most cases ensure a coordinated and balanced response to electric system frequency disturbances. Prime movers operated with valves or gates wide open should control for overspeed/overfrequency."

Grant PUD realizes that some generating facilities will operate at maximum turbine output unless providing frequency control and spinning reserve ancillary services. Grant PUD interprets NERC/WECC requirements to set governor controls for 'droop control mode'.

2-I. Generator Performance Testing, Monitoring and Validation

A generator owner is responsible for providing power flow and dynamic models in PowerWorld format of its generating plant to Grant PUD. The plant model will comply with the appropriate NERC and WECC generation modeling guideline, and dynamic models must be taken from the current Approved WECC Model List. The plant model must characterize plant responses to system disturbances (voltage and frequency deviations at point of interconnection, oscillations) and control signals (power and voltage schedule). The dynamic model will be a part of the power system model used in system studies to determine operating transfer limits and network reinforcements. An incorrect model may result in incorrect transfer limits, which can either put the system at risk of failure or unnecessarily restrict transmission use. Additional models may be required depending on the type of generation to be interconnected.

2-I.1 Parametric Testing

Parametric testing is a detailed test performed on a generator to determine parameters of a synchronous machine and its controls, as defined in the

WECC test guidelines. Parametric testing shall be done for the following equipment:

- Synchronous machines
- Exciter and voltage regulators
- Turbine – governor
- Power System Stabilizer (PSS)
- Over-Excitation Limiter (OEL)

Typical data can not be substituted for actual parametric test data which is required for every generator greater than 10 MW:

- On a new generator during commissioning.
- When the generator or turbine is retrofitted.
- When the generator controls are replaced or retuned.
- When a severe discrepancy is observed in performance validation.

2-I.2 Performance Validation

Performance validation of the generator model is done using measurements recorded during actual disturbances and tests. Recorded generator voltage and frequency are input into the model to verify that simulated real and reactive power responses are in good agreement with the recorded responses. Owners of generation facilities shall provide an Evidence of Performance Validation every five years in accordance with NERC/WECC reliability requirements. Performance validation shall include:

- Responses to at least three frequency excursions greater than 0.1 Hz (alternatively 1% speed or 20% power reference steps);
- Responses to at least three voltage changes greater than 2% (alternatively 2% voltage reference steps).

2-I.3 Performance Monitoring

The transmission operator at the POI will monitor performance of the generating plant by taking measurements of bus voltage and frequency, generator current and power, and, if applicable, control signals sent to the generating plant.

Performance monitoring is recommended for use with performance validation. The transmission operator will collect disturbance data and will perform performance validation. If a severe discrepancy is observed, the owner of the generation facility shall be required to perform parametric testing of the generation equipment in question. See section 3-G for additional requirements for performance and disturbance monitoring.

2-J. Generator Black-start Capability

Black-start is the term describing the startup of a generating plant under local power, isolated from the power system. Black-start capability is needed in some rare

circumstances, depending on the size and location of the generation facility. It is generally not needed for small generators or for projects that are near other major generation. When black-start capability is requested by Grant PUD, this capability will be addressed in the planning and review process. The requests will then be indicated on the Interconnection Agreement. Loads which are scheduled and available for black-starts are selected to avoid the trip-out of generation units by exceeding frequency and voltage set points. During the restoration, the tapped connection must be able to be opened to avoid interference with Grant PUD restoration procedures on Grant PUD's transmission path.

Considerations related to black-start capability include the following:

1. Proximity to other major generation facilities (i.e. Can startup power be provided more efficiently from an existing plant?)
2. Location on the transmission system (i.e. Is the generation facility near major load centers and far from generation?)
3. Cost of on-site start-up
4. Periodic testing to ensure personnel training and capability.

2-K. Small Scale Generator Facility Planning Requirements

Small customer-owned generation facilities (0–10 MVA) can usually be connected to Grant PUD substations via a power circuit breaker and a radial line or may be able to be connected to Grant PUD's existing Distribution System. Additionally, all interconnection configurations, including station bus arrangements, shall conform to Grant PUD's Transmission Planning Guidelines and Distribution Planning Guidelines. All cases need to be modeled and evaluated separately due to the technical nature of each generation application.

Customer-owned generating facilities that qualify for Net Metering (100 kW or less and energy sources such as hydroelectric power, fuel cell, photovoltaic generation, and wind energy conversion system), should refer to Grant PUD's net metering requirements as specified in its Customer Service Policies Manual.

Generation, not qualifying for net metering, up to 10 MVA will typically require a dedicated feeder from a three-phase distribution substation while generation smaller than 3.5 MVA may be able to be connected on an existing feeder along with other customers. **In all cases Grant PUD shall allow only one customer-owned generating facility per distribution substation with circuit breakers typically required at both the substation and generator locations.**

Generation greater than 10 MVA will typically require a 115 kV or 230 kV, three phase connection. The generator(s) shall be connected to a 115 kV or 230 kV high voltage line and may also require additional breakers and/or transmission line connections depending on contractual requirements and Interconnection System Impact Study results. Typical configurations are described in Grant PUD's Transmission Planning Guidelines and protection schemes are shown in section 3-D, Generator Configuration and Protection.

3. Protection Requirements

3-A. Introduction

The protection requirements identified in this document address the following objectives:

- Minimize risk to the general public, Grant PUD and other utility personnel.
- Minimize property damage to the general public, Grant PUD, and its customers.
- Minimize adverse operating conditions affecting Grant PUD and its customers.
- Comply with all current NERC, WECC, RC and NWPP protection criteria in existence.

In order to achieve these objectives, certain protective equipment (relays, circuit breakers, etc.) must be installed. These devices ensure that faults or other abnormal conditions the appropriate equipment is promptly disconnected from Grant PUD's Electric system. Protective equipment requirements depend on the plan of service. Significant issues that could affect these requirements include:

- The location and configuration of the proposed connection.
- The level of existing service and protection to adjacent facilities (including those of other Grant PUD customers and potentially those of other utilities).
- The connection of a line or load that coincidentally connects a generation resource, which was not previously connected to Grant PUD's Electric system. In this case, the Requester will also have to follow the additional requirements for interconnection of generation resources.

Grant PUD will work with the Requester to achieve an installation that meets the Requester's and Grant PUD's requirements.

Grant PUD will not assume any responsibility for protection of Requester's equipment. Requester is solely responsible for protecting their equipment in such a manner that faults, imbalances, or other disturbances do not cause damage to their facilities or result in problems with other customers.

3-B. Protection Criteria

The protection system must be designed to reliably detect faults or abnormal system conditions and provide an appropriate means and location to isolate the equipment or system automatically. The protection system must be able to detect power system faults within the protection zone. The protection system should also detect abnormal operating conditions such as equipment failures or open phase conditions. Special relaying practices may be required for system disturbances, such as undervoltage or underfrequency detection for load shedding or reactive device switching. For some generation and end-user facilities, the Requester may be required to participate in special protection schemes or RAS including automatic tripping or damping.

3-B.1 General Protection Practices

The following summarizes the general protection practices as required by NERC and WECC, as well as specific practices and applications as applied to Grant PUD's transmission lines and interconnections. The protection schemes and equipment necessary to integrate the new connection must be consistent with these practices. Table 3-1 specifies maximum allowable operating times for protection systems and breakers by voltage category.

a. Protection Requirements for All Voltages

1. Relays and circuit breakers, etc. are required at the POI, or a connecting substation to isolate Grant PUD equipment from the Requester's system during faults.
2. At the POI, the Requester is not allowed to energize a de-energized line connected to Grant PUD's Electric system without approval of Grant PUD's System Operator.
3. Breaker reclose supervision (automatic and manual including SCADA) may be required at the connecting substation and/or electrically 'adjacent' stations; e.g., hot bus and dead line check, synchronization check, etc.
4. Dual batteries are not required, but each set of relays must have its own separately protected DC source.
5. Relay settings shall not infringe upon Grant PUD's ability to operate at maximum transfer levels.
6. Protection schemes shall be designed with sufficient test switches and isolating devices to provide ease of testing and maintenance without the necessity for lifting wires. Isolating switches shall be alarmed or operating and maintenance tagging procedures developed and followed to assure switches are not inadvertently left in an open position.
7. The POI protection system security and dependability and their relative effects on the power system must be carefully weighed when selecting the protection system.
8. Grant PUD reserves the right to review and recommend changes to the protection system and settings for POI protection equipment.
9. If required, automatic underfrequency load tripping total trip time, including relay operating time and breaker operating time, shall not exceed 14 cycles. Any underfrequency load tripping must comply with the NERC, WECC, RC and NWPP requirements.
10. Use of capacitive voltage transformers (CVTs) and magnetically-coupled voltage transformers (MVTs) are generally acceptable for protection purposes.
11. Use of bushing potential devices for protective relaying, or to respond to overvoltages and frequency deviations, may not be appropriate.
12. Current transformers used for protective relaying should generally have a C800 accuracy class rating.
13. Total fault-clearing times, with or without a pilot scheme, must be provided for Grant PUD review and concurrence. Breaker operating times, relay makes, types and models, and relay settings must be identified specifically.

14. Generator protection shall meet WECC under/overvoltage and under/over frequency requirements as specified in Section 3-D3.

b. Additional Protection Requirements for Voltages Below 115 kV

1. Redundant or overlapping relay systems are required such that no single protection system component failure would disable the entire relay system and result in the failure to trip for a fault condition.
2. Multi-shot automatic reclosing is allowed for single and multi-phase faults. The total number of automatic recloses should not exceed three.

c. Additional Protection Requirements for Voltages 115 kV and Above

1. Breaker failure relays (BFR) are required. Total time for BFR scheme fault clearing must not exceed eight cycles for three cycle breakers. Clearing time may be longer for slower breakers. System requirements may dictate faster BFR operating times. Breaker failure relays need not be redundant.
2. Dual circuit breaker trip coils are required.
3. Redundant relay systems are required if a single point of failure could disable the entire relay system. Both relay systems shall contain an instantaneous trip element with the ability to output a trip in 1.5 cycles or less, for faults within 80% of the line. If ground distance elements are used, the relay must include ground overcurrent elements to provide tripping for high-resistance ground faults.
4. A pilot telecommunication scheme must be installed for either of the following conditions: 1) high-speed clearing is necessary for any fault location for stability purposes or 2) remote tripping for equipment protection. If a pilot telecommunications scheme is required for stability purposes, it must be redundant or designed to allow high speed tripping by the protective relays upon failure of the pilot scheme.
5. The relay systems shall provide backup protection for loss of the telecommunication channel(s).
6. The selected pilot schemes and telecommunication system must be compatible with existing Grant PUD protection and telecommunications equipment.
7. The telecommunications and pilot scheme channels required for protection systems should be continuously monitored via SCADA.
8. Redundant relays shall not be connected to a common current transformer secondary winding.
9. Directional relay systems are required on all non-radial connections.
10. Automatic reclosing for single line-to-ground faults shall be no faster than 35 cycles.
11. Automatic reclosing is allowed for multiphase faults.
12. Multi-shot automatic reclosing may be required for automatic line sectionalizing schemes. The total number of automatic recloses should not exceed three.

e. Additional Protection Requirements for Voltages at 230 kV

1. For most lines, total fault clearing time with a pilot scheme must not be more than four cycles, including relay and breaker operating times. Slower times may be acceptable for some lines. Refer to Table 3.1.
2. Automatic reclosing for single line-to-ground faults shall be no faster than 20 cycles and usually no slower than 60 cycles.
3. Automatic reclosing is not allowed for three phase faults. It is acceptable to block reclosing for time-delayed trips or loss of all pilot channels on the protected line.

3-B.2 Protection Measures

Protection systems must be capable of performing their intended function during fault conditions. The magnitude of the fault depends on the fault type, system configuration, and fault location. It may be necessary to perform extensive model line tests of the protective relay system to verify that the selected relay works properly for various system configurations. Power system swings, major system disturbances and islanding may require the application of special protective devices or schemes. The following discussion identifies the conditions under which relay schemes must operate.

a. Phase Fault Detection

The relay system must be able to detect multi-phase faults and trip at high speed for high fault currents. Non-directional overcurrent, directional overcurrent, distance, and line differential relays may be applicable depending on system requirements. In-feed detection to faults within the power system usually requires directional current-sensing relays to remove the contribution to the fault from the POI. The distance relay (21) is a good choice for this application since it is generally immune to changes in the source impedance.

b. Ground Fault Detection

Ground fault detection has varying requirements. The availability of sufficient zero-sequence current sources and the ground fault resistance both significantly affect the relay's ability to properly detect ground faults. The same types of relays used for phase fault detection are suitable for ground fault detection. If ground fault distance relays are used, backup ground time-overcurrent relays should also be applied to provide protection for the inevitable high-resistance ground fault.

c. Islanding

Islanding describes a condition where the power system splits into isolated load and generation groups, usually when breakers operate for fault clearing or system stability remedial action. Grant PUD does not allow islanding conditions to exist that include its facilities, except for a controlled, temporary, area-wide grid separation. Where generation is connected, implications of islanding must be addressed to minimize adverse impacts on connected end-user facilities.

During an islanded condition or system disturbance, power swings may result which can affect the operation of protective relays, especially distance relays. Out-

of-step blocking is commonly available for distance relays to prevent them from operating during a power swing. However, the application of such schemes must be coordinated with Grant PUD to assure that the blocking of the distance elements will not result in inappropriate or undesirable formation of islands.

d. Relay Performance and Transfer Trip Requirements

Relay systems are designed to isolate the transmission line and/or other facilities from Grant PUD's Electric system. However, the performance (clearing time speed) of these local relay systems and the associated isolating devices (circuit breakers, circuit switchers, etc.) will vary. The protection equipment of the new connection must, at least maintain the performance level of the existing protection equipment at that location. This may require transfer trip (pilot telecommunications) to insure high-speed and secure fault clearing. Other types of pilot tripping such as current differential may also be acceptable if the scheme chosen can achieve the total clearing times required. Transfer trip is required when any of the following conditions apply to the new connections:

1. Transient or steady-state studies identify conditions where maintaining system stability requires immediate high-speed separation of the POI facility from the power system.
2. Special operational control considerations require immediate separation of the POI from Grant PUD's Electric system.
3. Extended fault duration represents an additional safety hazard to personnel and can cause significant damage to power system equipment.
4. Slow clearing or other undesirable conditions such as extended overvoltages or ferroresonance which, cannot be resolved by local conventional protection measures, will require the addition of pilot tripping using remote relay detection at other substation sites. This scenario is a distinct possibility should a Grant PUD circuit that connects other customer loads become part of a 'local island' that includes a generator.
5. When remote circuit breaker tripping is required, in order to clear faults in a transformer not terminated by a high side breaker, high-speed transfer tripping will be required. The transfer trip may also be required to block automatic reclosing. Other unique configurations may impose the same requirement.
6. Relay operate times are adjusted to coordinate for faults on the local configuration such as a three terminal lines, fault currents available, etc. Total clearing times must be less than those listed in Table 3-1. Refer to Section 5-D for telecommunication issues as they pertain to control and protection requirements.

Table 3-1 Relay and Breaker Operating Times by System Voltage

Connection Voltage (Line-Line rms)	Total Clearing Time (Cycles)	Maximum Relay Operate Time (Cycles)	PCB Trip Time (Cycles)	Time Delayed Tripping Acceptable?
< 115 kV	≤ 9-11*	≤ 4-6*	≤ 5	Yes

115 kV	≤ 5-7*	≤ 2-4*	≤ 3	Yes
230 kV	≤ 4-6*	≤ 2-4*	≤ 2	Yes/No**

* Relay operating and total clearing times are for instantaneous element trips at the terminal closest to the fault. Inverse time and time delayed elements are considerably longer. Sequential instantaneous or time delay tripping may occur at the remote terminal.

** Transfer trip or other communications aided-tripping may be required.

e. Synchronizing and Reclosing

If the connection is made to an existing line, automatic reclosing schemes at the remote line breakers may need to be modified. On transmission lines below 230 kV, automatic-sectionalizing schemes may be installed to isolate a portion of the system that has a permanent fault. This includes multi-shot automatic reclosing at remote terminals. A new interconnection should be compatible with such existing schemes. Section 3-D identifies protection requirements specifically related to generator additions.

3-C. Protection System Selection and Coordination

3-C.1 Protection Requirements for the Interconnecting System

If the Requester is responsible for furnishing and installing the protective relay systems on their side of the POI, Grant PUD will supply the Requester with a list of protective relay systems considered to be suitable for use. Should the Requester select a relay system not on the Grant PUD approved list, Grant PUD reserves the right to perform a full set of acceptance tests prior to granting permission to use the selected protection scheme. Alternatively, the Requester, its relay vendor, or other designee, may perform, with Grant PUD witnessing, thorough model line tests of the proposed relay system. If there are special performance requirements for the protective relays at the POI, Grant PUD will notify the Requester.

3-C.2 Protection System Coordination and Programming

The following are basic considerations that must be used in determining the settings of the protection systems. Depending upon the complexity and criticality of the system at the POI, complete model line testing of the protection system, including the settings and programming, may have to be performed prior to installation to verify the protection system performance.

a. Fault study models used for determining protection settings should take zero-sequence impedances into account. Up-to-date fault study system models shall be used.
b. Protection system applications and settings should not normally limit transmission use. NERC/WECC relay loadability criteria shall be followed.
c. Application of zone three relays or other relays with settings overly sensitive to overload or depressed voltage conditions should be avoided.
d. Protection systems should prevent tripping for stable swings on the interconnected transmission system.

e. Protection system applications and settings should be reviewed whenever significant changes in generating sources, transmission facilities, or operating conditions are anticipated.
f. All protection system trip mis-operations shall be analyzed for cause, reported, and corrective action taken in accordance with NERC Reliability Standards.

3-C.3 Relays for the Point of Interconnection

The following list of relays has been developed in recognition of varied interconnection requirements. Relay performance under certain fault scenarios is also a consideration in the selection of these relays. The specific relays used must be functionally consistent with and complementary to Grant PUD's general protection practices identified in Section 3-B1.

The relay functions generally necessary to serve this purpose as used by Grant PUD may include:

a. Phase overcurrent (non-directional) (50/51)
b. Neutral overcurrent (non-directional) (50/51-N)
c. Zone distance (phase or phase and ground distance) (21/21-N)
d. Directional ground overcurrent (67-N)
e. Ground overcurrent (51-G) or ground fault detection scheme (59-Z)
f. Over/under voltage (59/27)
g. Over/under frequency (81)
h. Instantaneous overvoltage (ungrounded high side) (59)
i. Remote automatic breaker reclose supervision (79-X) (HB/DL, HB/HL with synchronism check)
j. Current differential (87)

Except as otherwise agreed by Grant PUD, Grant PUD will furnish, install, operate and maintain all relaying at the POI for the purposes of protecting Grant PUD's Electric system. Other relaying for protection of the Requester's equipment will be the responsibility of the Requester. All relays, which can adversely affect Grant PUD's Electric system, shall be of 'utility grade' quality, subject to review by Grant PUD.

Refer to Section 5-D for telecommunication issues as they pertain to control and protection requirements.

3-D. Generator Configuration and Protection

Integration of new generation has special requirements in addition to the previously described protection requirements. This section primarily deals with the protection requirements for the integration of synchronous and induction rotating machines. The actual protection requirements and choice of relay type will vary depending upon several factors:

- MVA capacity of the generation

- Type of generation: synchronous or non-synchronous
- Location of the generation interconnection on the transmission grid
- Voltage level of the generation interconnection
- Transformer winding configuration for the generator step-up transformer and/or interconnecting transformer
- Change in the fault current capacity as a result of the added generation
- Availability of telecommunications facilities

3-D.1 Fault Protection

Protective relays will be required to detect phase and ground faults on the generator interconnection. The relay systems shown in Figure 3-1 are designed to isolate the generator from Grant PUD's Electric system at or near the POI. However, the performance (clearing time speed) of these local relay systems and the associated isolating devices (circuit breakers, circuit switches etc.) will vary. In most cases, protective devices described in Section 3-B will also be appropriate for this interconnection.

Ground fault detection has varying requirements. The most significant consideration in the ability to detect ground faults on Grant PUD's Electric system is the winding configuration of the transformer connecting the generator to the Electric System. The scenarios below assume that the generator is connected to the low-voltage side of this transformer.

Transformer Grounded Wye (YG) Connection on Grant PUD's Electric System Side

This is Grant PUD's required transformer connection when adding a new generation resource to the transmission grid. The transformers will either be YG-Δ or YG-Δ-YG. Either of these connections provides a solid ground source for the transmission grid. Other transformer configurations are disallowed.

For a transformer connected with a grounded-wye on the primary (high voltage) side, a ground overcurrent relay (50/51-G) connected in the neutral of the wye winding provides transmission fault detection. This relay also protects the transformer.

A directional ground overcurrent relay (67-N) is generally provided for detection of ground faults in the transmission system when transformer connections are of the types identified above. Since this relay function complements zone-distance protection used for phase fault detections, it is included in many presently manufactured relays. See Figure 3-1 for a typical example of this configuration.

Generation Integration Configuration diagrams

The following Figure 3-1 shows recommended protection schemes on a typical configuration.

Figure 3-1 Typical Integration of Generation into a Transmission Level Substation

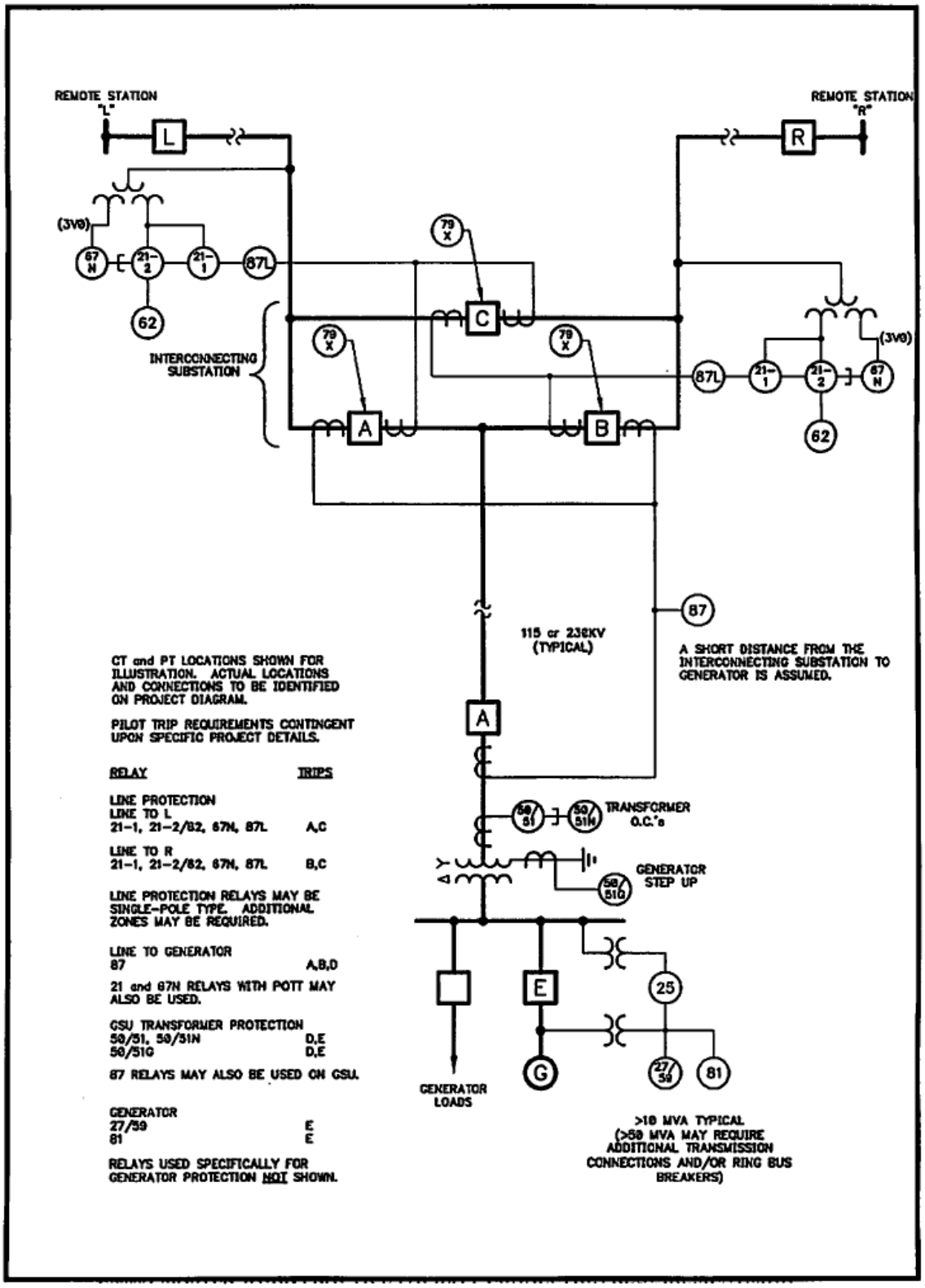

Table 3.2 identifies only the protection equipment, which may affect the operation of Grant PUD's Electric system. The type of resource proposed, and location of the POI will determine any special protection requirements for other types of resources, such as photovoltaic, wind, etc.

Table 3-2 Relay Functions

Interconnecting Substation, High Voltage Transmission Line Protection	
The following relays are intended for the interconnecting substation to detect faults on Grant PUD's Electric system and isolate the interconnecting substation from Grant PUD's Electric system.	
Relay	**Intent**
21-1, 21-2/62	Distance relays trip line breakers for multi-phase faults on the transmission lines to the Interconnecting Substation. Ground distance relays may be used for ground faults. These relays may have single pole switching capability. They also may be connected to a transfer trip or other pilot channel. More than two zones may be required.
67 N	Directional ground overcurrent relay trips line breakers for ground faults on the transmission lines to the Interconnecting Substation. These relays may have single pole switching capability. They may also be connected to a transfer trip or other pilot channel. Potential polarization: shown in the figures. Current polarizing or negative sequence polarizing may also be used.
87 L	Line differential relays are often necessary to avoid coordination problems with other relays to limit nuisance trips of the generator. Distance relays (21), directional overcurrent ground relays (67N) and a permissive overreach transfer trip may also be used.
79 X	Automatic reclose supervision is necessary at the interconnecting substation and/or the remote high voltage substations when a generator is added. This includes a hot bus/deadline (HB/DL) check and a synchronism check. The automatic reclose supervision will prevent the transmission line from reclosing if the generator remains in service and is not in synchronism with Grant PUD's Electric system.

59 Z	A ground fault detection scheme is used to detect ground faults on the tapped transmission line. (Normally the open delta 3VO scheme with inverse time characteristic). Trips of this relay may need to be time coordinated with other relays so that faults beyond the tapped transmission line do not cause unnecessary trips of the generator feeder. This scheme is most often required when the interconnecting substation includes a Δ-YG transformer.
Interconnecting Substation, Transformer Protection	
The following devices are typically used at the interconnecting substation to provide protection of the power transformer that interfaces between the generator and Grant PUD's Electric system	
Relay	**Intent**
50/51, 50/51N	These relays protect transformers from overcurrent conditions caused by low side faults, extreme overloads or unbalances. Phase overcurrent relays are usually set to pickup at approximately twice the transformer thermal rating. These relays are time-coordinated with low side feeder relaying. Voltage restrained time overcurrent relays may be used instead of the standard 50 element. 50/51 relays may also provide backup for transformer 87 relays.
50/51G	This relay protects transformers from overcurrent conditions caused by low side ground faults or extreme unbalances. These relays are time-coordinated with low side feeder relaying.
63	Sudden pressure relays may also be provided for the transformer.
87 T	Transformer differentials relays may be used for transformer protections
Generator Interconnection	
The following relays are required at or near the generation. These relays do not provide fault protection for the generator itself, which is the responsibility of the generator owner.	
Relay	**Intent**
25	This relay provides synchronism check supervising function for all closes of generator breakers.

27/59	These relays detect abnormal voltage conditions often caused by islanded operation scenarios. The undervoltage relay can serve as a means of fault detection for instances of weak fault current in-feed from generator to faults on the feeder or interconnected system. It protects generator against extended operation at abnormal voltages. Undervoltage relay settings are coordinated with Pacific Northwest undervoltage load shedding plan (Section3.-D.3)
81	This relay detects abnormal frequency conditions, often caused by islanded operation scenarios. It protects generator against extended operation at abnormal frequencies. Underfrequency relay settings are coordinated with the WECC and NWPP underfrequency load-shedding plan (Section 3.-D.3)

3-D.2. Synchronizing and Reclosing

The generator(s) shall be synchronized to Grant PUD's Electric system. Circuit breakers under the control of Grant PUD, required to maintain system integrity, shall not be used for synchronization. All circuit breaker closing operations must automatically synchronize the generator to the transmission system. Grant PUD's system operations must give the operator of the customer-owned generation permission before a generator is synchronized to Grant PUD's Electric system.

If a synchronizing check relay is used to supervise synchronization, then its output contacts shall be rated to interrupt the circuit breaker closing circuit current and the interrupting device shall be capable of trip-free operation.

If the generator connects to an existing line, automatic reclosing schemes at the remote terminals will need to be modified to accommodate the generator. A hot bus/dead line check is usually needed at one terminal before attempting an automatic reclose. Hot bus/hot line with synchronism check supervision is necessary for automatic reclosing at the other terminal. For an induction unit(s), automatic reclosing of the breakers at the terminal(s) of the integrating line may be performed without supervision, but will usually be time delayed to assure isolation of the generator(s).

3-D.3. Required Generator Relay Settings

Voltage and frequency relays used for protecting a generator and preventing a 'local island' condition from persisting must meet the requirements listed below to allow proper coordination with the power system. These relays are usually installed at the generation site or at the interconnecting substation. Grant PUD will evaluate proposed voltage/frequency ranges, settings, and delays based upon the impact on system performance and reliability. The settings must comply with existing WECC and NWPP requirements.

a. Voltage Relays (27, 59)

Generators shall not disconnect for dynamic (transient) oscillations on the power system that are stable and damped. The oscillatory frequency of the system during a disturbance may range between 0.25 and 1.5 Hz. Also, each occurrence of over/undervoltage on the system lasts for a short time period (less than one second) and is nearly damped within 20 seconds following the disturbance. During severe system voltage disturbances it is critical that generators do not trip prior to the completion of any automatic undervoltage load shedding.

b. Frequency Relays (81)

If a generator facility includes a frequency relay (81) for under and/or overfrequency protection, the frequency settings and time delays must coordinate with the underfrequency load shedding plan established by the NERC and WECC requirements and the NWPP Enhanced Underfrequency Load Shedding Program. The objective of underfrequency load sheeting plan is to use the machine capability to support the power system and prevent unnecessary loss of system load during disturbances, and ultimately, to help prevent system collapse. Generating resources must not trip off before load is shed by underfrequency relays. Frequency relays shall be solid state or microprocessor technology; electro-mechanical relays used for this function are unacceptable.

3-D.4 Generator Relays

Except as specifically identified in these technical requirements, Grant PUD does not have requirements for the type of protection used for a generator. Generator protection is the responsibility of the Requester. However, the protection shall meet the general requirements of the NERC/WECC Reliability Standards. The level of redundancy and overlap of protection schemes are determined by the Requester. Grant PUD's primary concern with generator protection is that the protection is available to isolate a generator fault from Grant PUD's Electric system. Types of protection used to isolate a generator from Grant PUD's Electric system may include:

a. Percentage differential (87)
b. Phase balance current (46)
c. Phase sequence voltage (47)
d. Reverse power (32)
e. Thermal (49)
f. Loss of field (40)
g. Over-speed device (12)
h. Transformer sudden pressure (63)
i. Voltage controlled/restrained o.c. (51-V)
j. Volts per Hertz (overexcitation) (24)
k. Neutral overvoltage (59-N)
l. Under-, overvoltage relays (27, 59)*
m. Under-, overfrequency relays (81)*

* The settings of 27, 59 and 81 relays must be reviewed and approved by Grant PUD.

3-E. Special Protection or Remedial Action Schemes

Connections to Grant PUD's Electric system may require special protection or remedial action schemes, (RAS). The need for RAS, if any, will be determined during the System Impact Studies and specified in the Interconnection Agreement. The type of RAS depends upon several factors such as type of connection, location of connection, etc. Some RAS must be fully compliant with WECC requirements. WECC RAS criteria specifies no single point of failure which, in most cases, includes geographically diverse communication paths. WECC compliant RAS schemes must also be tested annually in accordance with WECC reliability standards. The annual test includes an operational or functional test of the scheme. The most common special protection schemes include load shedding, line loss detection, and generator tripping.

Grant PUD staff will design most RAS schemes, but if any part of the scheme is designed by the Requester or their designate, that design must be reviewed and approved by Grant PUD. Grant PUD will ensure the design meets Grant PUD and WECC requirements. If the Requester designs a portion of the scheme, they must be prepared to present the design to the WECC Remedial Action Scheme Subcommittee, or its successor, for acceptance. If the WECC Remedial Action Scheme Subcommittee determines changes must be made, the changes will be the responsibility of the Requester.

If a RAS is necessary, the Requester is expected to provide sufficient rack space and DC power in their facilities to accommodate additional equipment for relaying, telecommunications, special protection or RAS Schemes needed to facilitate the interconnection.

3-E.1 Load Shedding

The proposed connection may require special load shedding schemes based upon Grant PUD's Balancing Authority Area requirements. These may include underfrequency load shedding, undervoltage load shedding, or direct load tripping. The intent of load shedding is to balance the load to the available generation resources, reduce the possibility of voltage collapse, and to minimize the impact of a system disturbance. Underfrequency load shedding generally includes a coordinated restoration plan, which is intended to minimize frequency overshoot following a load shedding condition. Tripping levels, restoration, and other details of load shedding schemes will be determined by Grant PUD, following NERC, WECC and NWPP criteria. Section 3-D3 includes specific requirements for generation tripping by voltage and frequency relays.

a. Direct Load Tripping

Direct load tripping may be required for certain large loads. Communications channels may be either digital or analog. Communication channels should be alternately routed when possible. Grant PUD's System Operators will enable or disable direct load tripping schemes depending upon system conditions.

b. Underfrequency Load Tripping

Underfrequency load tripping may be required to balance generation resources and loads. Underfrequency load shedding must meet the following requirements:

1. Electromechanical frequency relays (81) are not allowed.
2. Frequency relays should be of the definite time variety.
3. Total operate time for underfrequency load tripping, including circuit breaker tripping, shall not exceed 14 cycles.
4. The frequency relay should be voltage supervised to prevent operation when the bus voltage drops below 0.7 pu voltage.
5. The frequency element (81) may be included as a part of a multifunction protective relay.
6. Frequency setting levels will be supplied by Grant PUD and shall be in conformance with regional underfrequency load shedding requirements as specified by NERC,WECC and/or the NWPP.
7. Load restoration settings will be supplied by Grant PUD and shall be in conformance with regional underfrequency load restoration requirements as specified by NERC, WECC and/or the NWPP.

c. Undervoltage Load Tripping

Undervoltage load tripping may be required to prevent possible voltage collapse or loss of major transmission paths or generation resources. Undervoltage load shedding must meet the following requirements:

1. Electromechanical voltage relays (27) are not allowed.
2. Voltage relays should be of the definite time variety.
3. The voltage transformer source for the voltage relay (27) must be on the source side of any automatic load tap changers or voltage regulators.
4. A three-phase voltage element must be used to detect the undervoltage condition. Averaging of the three phase voltages is not acceptable.
5. The undervoltage element (27) may be included as a part of a multifunction protective relay.
6. The undervoltage relay should not operate for a single-phase low voltage nor for a three phase low voltage below 0.5 pu.
7. Total operate time for undervoltage load tripping shall be greater than expected fault clearing times, typically 30 cycles or 0.5 seconds.
8. Voltage setting levels and operate time delays will be supplied by Grant PUD.
9. Restoration settings will be determined and supplied by Grant PUD.

3-E.2. Transmission Line Loss

New transmission lines may require line loss detection logic). Line loss is typically sensed by the position of the circuit breaker (52/b) auxiliary switch, isolating disconnect switch status, and also from the circuit breaker trip bus. Substation bus configuration and the type of protective line relaying will determine the exact requirements for implementing line loss detection logic.

3-E.3. Generation Reduction

Generation resources may be subject to generator dropping, curtailment, and/or run back schemes as part of mitigation actions during emergency conditions. These

actions or schemes are intended to maintain the balance between system loads and available generation during and following a system disturbance. They may also be used to prevent transmission system overloads during abnormal operating conditions. Grant PUD's System Operators will arm or disarm any generator tripping and run back schemes depending upon system conditions. When implemented as part of a RAS, these schemes must be fully redundant. In those instances, the Grant PUD control system will send generator reduction signals to the generators via redundant communication channels. If the new connection includes generation not previously part of Grant PUD's Balancing Authority Area, the generation may also require additional special trip schemes and RAS arming procedures. These schemes will typically require a sequential events recorder as described in Section 3-G.

When a RAS is deemed necessary, it is the plant operator's responsibility to develop and maintain procedures for the arming of the generator units for the RAS and also procedures for plant restoration following a RAS action.

a. Generator Dropping

Generator dropping or tripping is the most common mitigation action. Generator dropping is achieved with the use of redundant communication channels from the Grant PUD control system to the power plant unit breaker trip circuits.

b. Generator Run Back or Ramp Down

Generator run back may be used in addition to generator tripping. Runback will allow the generation output levels to be decreased to a pre-agreed upon level within a pre-agreed upon time. A stand-alone run back or ramp down scheme is rarely allowed. If the runback scheme must be WECC compliant, it will be backed up by a WECC compliant generation dropping scheme.

3-E.4 Other Special Protection and Control Schemes

The location of the POI, amount of load or generation expected and various other system conditions may require special protection schemes. The need for and type of schemes required will be determined as part of the system studies done following the request for a new connection. For example, RAS may be required for stability purposes or out-of-step tripping may be needed for controlled system grid separations. Generator or load tripping may be required to prevent line or equipment overloading. Special breaker tripping or closing schemes such as staggered closing or point-on-wave closing may be necessary to reduce switching transients. These special protection and control schemes may require stand-alone relay systems or additional capabilities of substation equipment. When required, those protection and control schemes will be identified during the Interconnection System Impact Study phase, unless the generation parameters or basic assumptions change from the initial study phase. Any special protection and/or control schemes will be listed in the Interconnection Agreement.

3-E.5 Telecommunications Requirements for Special Protection or Remedial Action Schemes

Many of the special protection schemes described in this section will require telecommunications channels for transfer trip between the RAS controllers and the remote device. If the RAS is part of a scheme that must comply with WECC criteria, it will require redundant transfer trips, redundant channels, and in most cases geographically diverse communication paths. Specific details for telecommunications channels are in Section 5, Telecommunications Requirements.

3-E.6 RAS Design and Operational Requirements

When a RAS is required, the minimum requirements the RAS scheme include the following:

- The RAS should be independent of all other control actions.
- The RAS will have a common architecture as much as possible with existing schemes.
- The RAS will utilize standard alarms to identify operation actions and trouble.
- The RAS scheme must be designed with the ability to safely test the scheme.
- The RAS will be provided with the ability to arm/disarm via SCADA.

3-E.7 Future Modifications or Revisions to Special Protection or Remedial Action Schemes

Any modification, change, or revision of an installed RAS scheme at a requestor's site must be reviewed by Grant PUD before it is implemented. Proposed changes may also have to be reviewed by the WECC Remedial Action Scheme Reliability Subcommittee.

3-F. Installation and Commissioning Test Requirements for Protection Systems

Thorough commissioning or installation testing of the protection system(s) is an important step for the installation of a new terminal or when changes to the protection system are made. The protection system includes the protective relays, the circuit breakers, instrument transformer inputs, and all other inputs and outputs associated with the protection scheme. The actual protection equipment used will determine the type and extent of commissioning tests required. Following are the minimum tests that must be performed on protection schemes at the POI that could affect Grant PUD's Electric system.

3-F.1 Verify All Protective System Inputs

a. Check for proper ratio, polarity, connections, accuracy, and appropriate grounding on current and voltage transformer circuits.
b. Verify that shorting of unused current transformer windings is proper and that windings used for protection systems are not shorted.

c. Verify that all other inputs to the protection system including battery supplies, circuit breaker auxiliary switches, pilot channel inputs, etc. are correct.

3-F.2 Verify Protection System Settings

a. Check protection system settings and programming.
b. Perform acceptance or calibration tests of the protection system.
c. Verify that any changes in relay settings required for relay acceptance testing are restored to the desired operational settings.

3-F.3 Protection System Drawings and Wiring

a. Verify control panel wiring is intact and matches drawings.
b. Verify interconnections between protection system and other devices are intact and match drawings.
c. Verify that the drawings are correct.
d. Coordinate any design changes with the project engineer and annotate (“redline") changes on the drawings.

3-F.4 Verify All Protective System Outputs

a. Verify that all trip outputs will trip intended trip coil(s).
b. Verify that all close outputs will properly close the breaker(s).
c. Verify proper relays key the appropriate pilot channel.
d. Verify other outputs such as breaker failure initiate, special protection scheme signals, reclose initiate and reclose block, relay alarms, event recorder points, and any other relay outputs to other equipment.

3-F.5 Perform Trip or Other Operational Tests

a. Assure correct operation of the overall protection systems.
b. Test automatic reclosing.

3-F.6 Pilot Schemes

a. Measure channel delays.
b. Check for noise immunity.
c. Check for proper settings, programming, etc.
d. Check transmit and receive levels.
e. If automatic channel switching or routing is utilized, check for proper relay operation for alternate routing.

3-F.7 In Service, Load and Directional Tests

a. Measure AC current and/or voltage magnitudes applied to the relay system.
b. Measure AC current and/or voltage phase angles applied to the relay system.
c. Test the relay system for proper directional operation when applicable.

3-F.8 Special Protection Scheme/Remedial Action Scheme Testing (where applicable)

a. The RAS must be thoroughly tested prior to energization. This includes an end-to-end test, functional test, or operational tests.

b. If the RAS is a part of a WECC compliant RAS, an annual functional or operational test is required.

Many utilities now use coordinated end-to-end tests to verify the overall operation of the protection system and the pilot channel as part of their commissioning tests. This method is acceptable to Grant PUD.

Modifications to a protection system or RAS scheme also requires testing similar to that listed above. The extent of testing and types of tests required depend upon the changes made. Modifications include changes or additions to protection circuits, changes or upgrades of protective relay firmware, and changes in protective relay logic and/or programming. Many utilities also consider it good practice to perform various levels of tests and calibrations following changes in protective relay settings. When making protection system modifications, attention must be paid to any circuits that may be inadvertently affected (e.g.) an auxiliary relay having multiple circuits tied to its outputs.

3-G. Disturbance Monitoring

Depending upon the type of connection, location, and operating voltage, disturbance monitoring equipment may be required. The monitoring equipment is intended to record system disturbances, identify possible protection scheme problems, and to provide power quality measurements. Sequential event recorders, digital fault recorders (DFR), and dynamic disturbance recorders may be required. Grant PUD may require remote access to these recorders and relay systems at the POI.

3-G.1. Sequential Event Recorders (SER)

These devices time tag digital events occurring in a substation. They must have a one millisecond time resolution when recording events. The SER uses a synchronized clock receiver for a timing reference. The SER should have sufficient channels to monitor relay and RAS performance, circuit breaker positions, generator status, and other events within the interconnecting substation or generator plant. SERs are required in all 115 kV and above substations. Generators that are part of a WECC compliant RAS must also have SERs.

3-G.2 Digital Fault Recorders (DFR)

The DFR must have sufficient analog channels to monitor critical currents and voltages. The DFR may also include digital channels to monitor selected equipment status in the substation. The DFR must be time synchronized via a clock. For 115 kV and higher substations, a stand-alone DFR is required. Such a relay must be synchronized to a clock receiver. Both the DFR and digital relays that provide protection for Grant PUD's Electric system must have remote communications capability such that Grant PUD personnel can retrieve information.

3-G.3 Dynamic Disturbance Recorders

A dynamic disturbance recorder may be required at key 230 kV and higher voltage substations, major load centers, and generating stations with a combined 1500 MW

or greater output at the same POI. The disturbance recorder should record bus voltage and frequency, line currents, MW and Mvar. Measurement of additional status and control information may be required. The recorder must be able to either record data locally with a ten-day minimum continuous archive or be connected to the master station at Grant PUD's control center for real-time data transmission and recording. Phasor measurements are preferred, but other measurement types may be acceptable. Data must be time stamped to at least one millisecond accuracy, though Phasor measurements should be at a five-microsecond accuracy in accordance with the IEEE standard (PC37.118). Additional status and control system measurements may be required for WECC compliance.

4. Data Requirements for System Operation and Scheduling

4-A. Introduction

All transmission arrangements for power schedules within, across, into or out of Grant PUD's Balancing Authority Area require metering and telemetering. Some generation or end-user facilities physically located in another Balancing Authority, referred to as the 'host' Balancing Authority, may also require metering and telemetering to Grant PUD's Balancing Authority Area. Transmission arrangements with end-user facilities, generation facilities, or transmission facilities may include voltage control, and automatic generation control (AGC). The Reliability Coordinator for the region also needs data to ensure the reliable operation of the entire grid. The technical plan of service for interconnecting a load, generator, or new transmission shall include the metering and telemetering equipment consistent with the interconnection agreement and the transmission services agreement. Such metering and telemetering equipment may be owned, operated, and maintained by Grant PUD or by other parties approved by Grant PUD. Telecommunications requirements for data collection are included in Section 5.

Revenue billing, system dispatching, operation, control, transmission scheduling and power scheduling each have slightly different needs and requirements concerning metering, telemetering, data acquisition, and control. Specific requirements also vary depending upon whether the new connection is physically connected to Grant PUD's Electric system or electronically connected via telemetering placing the Project within Grant PUD's Balancing Authority Area. In all cases, the requester will be required to follow the latest approved NERC Cyber Security (CIP) Standards which can be found on the NERC website.

4-B. Telemetering Control Center Requirements

Grant PUD requires telemetering data for the integration of new interconnections at adjacent Balancing Authority boundaries, as well as new generation within Grant PUD's Balancing Authority. This typically consists of the continuous telemetering of active power quantities (in kW) and hourly transmission of the previous hour's energy (in kWh) from the POI to Grant PUD's operations control center. Table 4-1 summarizes the general metering and telemetering requirements and Table 4-2 identifies requirements based on connection location. The following are general requirements for telemetering:

4-B.1 Facilities Tied to Grant PUD's Balancing Authority Area Boundary

Telemetering is required for all interconnections at a Grant PUD Balancing Authority boundary. For this case, telemetering of active power and energy (kW, kWh) is required. There may also be a need for reactive power (kvar, kvarh) information for purposes of billing based on power factor. High capacity interconnections may require redundant metering and telemetering. For connections that are to be normally open, or closed only for emergencies, Grant PUD determines telemetering needs on a case-by-case basis.

Table 4-1 General Metering and Telemetering Data Requirements

District Data Requirements[1]			
System or Quantity	**System Operations Center**	**High Voltage Scheduling**	**Revenue Billing**
KW	Yes	No	No[2]
KWh	Yes	Yes	Yes
KVAr	Yes	No	No
KVArh	Yes	No	Yes
KV	Yes	No	No
Number of Units	Number on Line Number Available	Number on Line Number Available	No
Resource Size	≥ 3.5 MVA[1]	≥ 1 MVA	≥ 1 kW
AGC	≥ 50 MVA[3]	No	No
Data Sample Rate	1 Second or other approved rate compatible with NERC Policy	Last Hour kWh sent each hour	Hourly kWh Data Retrieved daily
Generation Reserves	Contingency non-spinning MW Contingency Spinning MW Regulating MW	Contingency non-spinning MW Contingency Spinning MW Regulating MW	No

Notes:

1. Requirements for customer-owned generating facilities below 3.5 MVA are determined on an individual basis.
2. A kW reading for revenue billing may be required where special transmission arrangements are necessary.
3. The actual AGC requirements shall be determined on an individual basis.

Table 4-2 Metering, Telemetering and SCADA Data Requirements vs. Connection

Connection to Grant PUD's Electric System	Connection Located Inside Grant PUD's Balancing Authority Area	Connection Located Outside Grant PUD's Balancing Authority Area
Direct Electrical Connection[1]	**kW, kWh, RMS[2], kva, kvarh, kV circuit breaker status & control**	**kW, kWh, RMS[2], kva, kvarh, kV circuit breaker status & control**
No Direct Electrical Connection	**kW, KWh, RMS[3]**	**kW[3]**

Notes:

1. Dedicated circuit is required for kW, kWh, kvar, kvarh, and kV.
2. Dial-up phone line required for RMS.
3. kW is required if capacity of WECC path Grant PUD manages is impacted.

Table 4-3 Metering, Telemetering and SCADA Data Requirements for Loads, (L),

Quantity	L < 3.5 MVA	3.5 ≤ L < 25 MVA	L ≥25 MVA
Billing Information [RMS[3]]; Hourly kWh & kvarh[2]	Yes If L ≥1 kW	Yes	Yes
Hourly Estimate of Load (by web, FAX, or phone)	No	Yes[4]	Yes[4]
Continuous Data	No	Yes	Yes
Loss of Meter Potential Alarm	No	Yes	Yes
Telemetering Equipment Failure Alarm	No	Yes	Yes
Uni-Directional kW & Bi-Directional kvar Meter	Yes	No	No
kV	No	Yes If L ≥10 MVA	Yes
Kvar	No	Yes If L ≥10 MVA	Yes
Redundant Meters	No	No	Yes

Notes:

1. Hourly estimate of load must equal the sum of transmission schedules for delivered power.
2. Hourly integration of kvar may be used for reactive billing if kvarh not available from meters.
3. RMS requires dial-up phone line.
4. Required from the scheduling agent to Grant PUD.

Table 4-4 Metering, Telemetering and SCADA Data Requirements for Generation

System or Quantity	G < 3.5 MVA	3.5 ≤ G < 50 MVA Local[2] Load Only	3.5 ≤ G < 50 MVA Exporting Output	G ≥50 MVA
Billing information (RMS)	Yes, if X≥1 kW No, if X<1 kW	Yes	Yes	Yes
Hourly Estimate of Generation[1] (by web, FAX, or phone)	Conditional2	Yes	Yes	Yes
Hourly kWh (telemetered)	No	Yes	Yes	Yes
kW Continuous Data	Yes If G ≥1 MVA	Yes	Yes	Yes
Loss Of Meter Potential	No	Yes	Yes	Yes
MW & Mvar on Each Unit[3]	No	No	No	Yes If integrated at 230 kV or above
Uni-directional kW & Bidirectional kvar meter	Yes	Yes	No	No
Bi-directional kW & kvar Meter	No	No	Yes	Yes
Redundant Meters	No	Yes If G ≥25 MVA	Yes If G ≥25 MVA	Yes
Gen-ICCP (Redundant Links)	No	No	No	Yes[4]

Notes:

1. Hourly estimate of generation must equal the sum of transmission schedules for marketed power. It is required from the scheduling agent to Grant PUD.
2. Hourly estimate is not required if generation is serving local load only. It is required if generation is being used as a marketing resource. Local load is defined as load that is on the generator side of the meter.
3. Separate meters for each unit are required when generators per line are not identical.
4. Possible exception for intermittent projects such as wind generators.
5. Required if Grant PUD is the designated scheduling agent.

4-B.2 Loads Within Grant PUD's Balancing Authority Area

For end-user facilities with direct electrical connections to Grant PUD's Balancing Authority Area, AGC telemetering is not normally required. For interruptible loads, Grant PUD determines telemetering needs on a case-by-case basis. Connecting eccentric (non-conforming) end-user facilities may require an interface to Grant PUD's AGC system. Existing practices throughout North America usually require a warning signal of pre-loading in order to assure that adequate generation reserves are spinning before any sudden load change occurs. Table 4-3 summarizes metering, telemetering, and SCADA requirements for end-user facilities based upon size.

4-B.3 Generation Within Grant PUD's Balancing Authority Area

For generation connected internally to Grant PUD's Balancing Authority Area, telemetering is required for generation facilities of aggregate output equaling or exceeding 3.5 MVA. For this case, telemetering of real power and energy (kW,

kWh), and reactive power (kvar, kvarh) is normally required. Grant PUD will determine telemetering needs on a case-by-case basis for generation sites that remain below 3.5 MVA. Station service load may require separate telemetering if it comes from a different Balancing Authority. Station service taken directly from the generator POI may require separate metering and separate current transformers to accurately measure the station service load. Table 4-4 summarizes metering, telemetering and SCADA requirements for generation within Grant PUD's Balancing Authority Area. Additional requirements, listed in NERC standard IRO-010 or its successor standard, will apply if the generation is within Grant PUD's Balancing Authority.

Metering and telemetering for temporary generation installations (planned for less than one year of service) will be determined on a case-by-case basis. Generation sites with an aggregate output equaling or exceeding 50 MVA may require a direct link with Grant PUD via a generation ICCP communication server in order to send and receive data directly from Grant PUD's AGC System. ICCP is the Inter-Control Center Communications Protocol, defined by IEC 870-6 TASE.2 standard. See Section 4-C.2 for additional details on the ICCP requirements. Wind projects and other intermittent generation may be exempted from these criteria, subject to a case-by-case review.

4-B.4 Jointly-owned Load or Generation

Telemetering for interconnection of shared or jointly owned end-user facilities or generation commonly use dynamic signals. These signals are usually a calculated portion of an actual metered value. The calculation may include adjustments for losses, changing ratios of customer obligations or shares, or thresholds and limits. Two-way dynamic signals are used when a customer request for MW change that can only be met by an actual change in generation. In this case, a return signal is the official response to the request and its integrated value is designated the official meter reading. Previous integration intervals were typically one hour. Some types of dynamic signals may require shorter integration intervals. The integration interval is determined by the type of service provided consistent with Grant PUD's tariffs to properly account for transmission usage. Grant PUD uses the NERC recommended 'accumulator method' for accounting, not the 'rounding method' for integrated values.

4-B.5 Generation in Grant PUD's Balancing Authority Area Not Controlled by Grant PUD

Telemetering is required for generation located internal to Grant PUD's Balancing Authority to account for the scheduling that is required to deliver that energy to the appropriate host Balancing Authority. The requirements are similar to interchange telemetering requirements. In this case, Gen ICCP is typically not required by Grant PUD.

4-C. Data Requirements for Balancing Authority Services

This section contains the data requirements for Balancing Authority services if the Requestor wishes to locate a generation or end-user facility in Grant PUD's Balancing Authority Area. **Provision for all ancillary services are normally specified in the contract. The technical information below is included for general conceptual purposes only.** Technical discussions between the Requestor and Grant PUD are necessary before specific implementation requirements can be determined.

4-C.1 Requirements for Interconnected End-user facilities

Non-traditional sources are sometimes used for supplying ancillary services. If a load provides regulating or contingency reserve services, data requirements for deployment of the reserves will be similar to those applied to generating resources. To the extent that a third party may externally supply regulating or contingency reserve services at Grant PUD's Balancing Authority Area interconnecting boundary, data requirements for their deployment may be similar to those applied to generating resources.

Technical discussions are necessary before the specific data requirements can be determined. The following provides a brief overview of these requirements:

a. Supplemental AGC Services

If Grant PUD is purchasing supplemental AGC services, AGC interface is required on a long-term basis. Prior to Grant PUD purchasing supplemental services, an investigation into the capabilities, cost, and benefits of AGC control is required to determine the specific AGC requirements. Most supplemental services are scheduled and delivered using real-time dynamic signals, thus requiring telemetering.

b. Ancillary Services

Ancillary Services requirements are also driven by how the interconnected customer chooses to meet these obligations. Either the Requester or the entity making the transmission arrangements is responsible for meeting obligations for necessary ancillary services associated with the interconnection. Most self-provided ancillary services are scheduled and delivered using real-time dynamic signals, which require telemetering. The responsible party may fulfill these obligations in the following ways according to the limitations and requirements in any applicable Grant PUD business practices, which are subject to change:

- Directly provide ancillary services by making resources available to the Grant PUD to deploy
- Contract with a third party to make resources available to Grant PUD to deploy
- Contract with Grant PUD to cover this ancillary services obligation

The Requester must demonstrate that the selected options are technically sound and are in compliance with all relevant reliability standards and criteria of NERC,

WECC and NWPP or their successors as well as Grant PUD's approved business practices.

Where a third party is providing ancillary services, the following data is required with a sampling rate established in Grant PUD's business practices – typically four seconds between samples for regulation and ten seconds for operating reserves:

- Net instantaneous active power transferred (in MW)
- Instantaneous reactive power (in Mvar) and total reactive power (Mvarh) transferred
- Operating reserve capability during the upcoming ten minutes
- kWh for most-recent hour
- Area Control Error (Station Control Error for Generating unit)
- Actual Scheduled Interchange

c. Supervisory Control and Data Acquisition System (SCADA)

Additional data may be required from end-user facilities, in order to make generation control performance more predictable. Such additional data may include, but not be limited to, precursor signals of expected load changes. SCADA control may also be required. Specific requirements and needs are determined for each load. This may require a separate SCADA remote terminal unit or it may require data be added into an existing SCADA as determined by Grant PUD.

4-C.2 Requirements for Interconnected Generation

Data requirements for Balancing Authority services, such as regulation or operating reserves, apply only to generation resources inside Grant PUD's Balancing Authority Area. For resources that are not part of Grant PUD's Balancing Authority, the operator of the host Balancing Authority determines the data requirements.

Inter-Control Center Communication Protocol (ICCP) is a standard communications protocol for data exchange used by Grant PUD and many other entities. ICCP is an international standard for communications of real time data. The IEC 870-6 TASE.2

For generation resources inside Grant PUD's Balancing Authority Area, ancillary services, (e.g. reserves) must be acquired. Provision for all ancillary services are specified in the transmission provider or Balancing Authority services contracts and agreements. Grant PUD must specifically approve all arrangements for generators intending to provide Ancillary Services to Grant PUD. If the generator is capable of providing Ancillary Services in excess of its obligation, then Grant PUD may choose to contract with the generator operator to provide additional Ancillary Services. Technical discussions between Grant PUD and generator developers are necessary before the specific implementation requirements can be determined. For generation facilities with a total capacity of 50 MVA or above, telemetry will generally be required to bring in unit information as well as MW, Mvar and kV

from the project. The AGC data to be passed over the data link may include some or all of the data quantities listed in Table 4-5. For each project a detailed data requirements list with definitions will be provided during the design phase of the interconnection of the project. Actual generator specific data requirements are developed after an Interconnection Agreement or Balancing Authority Services Agreement is signed.

Wind projects may be exempt from the ICCP requirement, but will be required to provide kW, kvar, kV and interconnection circuit breakers(s) status, at a minimum. All wind projects with external capacitor compensation will be required to have automatic control on a voltage schedule provided by Grant PUD's System Operators. Status and availability of each external capacitor may also be required. Projects with internal automatic var compensation (i.e. double fed wound rotor) may be required to receive a voltage set point signal. This will be determined on a case-by case basis.

a. Automatic Generator Control Services

If Grant PUD is purchasing ancillary services from the generation facility, AGC control of the generator capability is required on a long-term basis. Prior to purchasing AGC services, a capabilities, cost, and benefit investigation as to the AGC control capabilities of the generation facility is required to determine the specific AGC requirements.

b. Ancillary Services

Requirements for Ancillary Services are also driven by how the generator operator or the purchaser chooses to meet the reserve obligations of the generation facility, as described below. Either the generation operator or the entity making the transmission arrangements is liable for the reserve obligations associated with the operation of the generation facility. Generation marketed as interruptible power is treated separately under special provisions and guidelines by the WECC and Grant PUD. The responsible party may fulfill these obligations in the following ways according to the limitations and requirements in any applicable Grant PUD business practices, which are subject to change:

- Make these reserves available to Grant PUD from the generating facility
- Make these reserves available to Grant PUD from another one of their generation resources
- Contract with another generator operator to make these reserves available to Grant PUD on their behalf
- Contract with Grant PUD to cover this reserve obligation

c. Supervisory Control and Data Acquisition (SCADA) Requirements

New substations will require Grant PUD's SCADA control and status indication of the power circuit breakers and associated isolating switches used to connect with Grant PUD. SCADA indication of real and reactive power flows and voltage levels are also required. If the connection is made directly to another utility's

transmission system, SCADA control and status indication requirements shall be jointly determined with the Requester, and Grant PUD. SCADA control of breakers and isolating switches that are located at other than the generating facility are not normally required, although status and indication may be necessary for system security purposes. Section 5-D discusses telecommunications requirements for SCADA systems.

d. GEN ICCP Installation

A GEN ICCP installation may be required for generation facilities greater than 50 MVA and is required for generation facilities over 200 MVA. If Grant PUD is not providing any ancillary services, a GEN ICCP configuration with single server and single router are acceptable. If Grant PUD is providing ancillary services, a primary server and back-up server must be installed. If Grant PUD is performing automatic generation control, redundant servers and redundant routers are required. The GEN ICCP installation at the generating facility provides capability to bring additional data from the generator(s) to Grant PUD's control centers. Table 4-5 shows the typical GEN ICCP data required.

Table 4-5a Automatic Generation Control (AGC) Quantities

	Generation Plant to District's Control Center(s):
1.	Plant in District AGC mode / local mode[1]
2.	Net instantaneous power output (MW), unit MW output for plants >200 MW
3.	Plant output attributed to natural governor response (MW)
4.	Plant ramp rate capability – maximum raise and lower
5.	Plant jerk rate capability (rate of change of ramp rate) – maximum raise and lower
6.	Regulating reserve capability - during next 10-minutes
7.	Spinning reserve capability - during next 10-minutes
8.	Operating reserve capability - during next 10-minutes
9.	Maximum capability - normal conditions
10.	Maximum capability - power system emergency conditions
11.	Minimum generation capability
12.	Unit power system stabilizer and automatic voltage regulation status
13.	Unit status - defined below for each generator unit in numerical order.
	- Out of Service - unit not available for use on 10 minutes notice.
	- Standby Mode - unit available for use on 10 minutes notice.
	- Standby Mode - unit available for use within 60 minutes
	- On-line / Not on AGC
	- On-line / On AGC
	- On-line / Condensing
14.	Total Mvar output, unit Mvar output for plants >200 MW
15.	Total instantaneous maximum Mvar capacity boost or each POI voltage level
16.	Total maximum Mvar capacity boost or each POI voltage level
17.	Total instantaneous maximum Mvar capacity buck or each POI voltage level
18.	Total maximum Mvar capacity buck
19.	Plant in District kV mode / local kV mode[2]

Notes:

1. When plant is in Grant PUD AGC mode, Grant PUD's AGC system is enabled at the plant. The plant is controlling power output to meet the generation request and generation rate of response (MW/minute) originating from Grant PUD. When the plant is in local mode Grant PUD's AGC system is disabled. The plant is not controlling its power output to meet generation request and generation rate of response originating from Grant PUD.
2. When plant is in Grant PUD kV mode, the coordinated var control system is enabled at the plant. The plant is controlling reactive power output to meet the voltage schedule originating from Grant PUD. When the plant is in local kV mode, Grant PUD coordinated var control system is disabled at the plant but automatic voltage regulators are still in service. The plant is controlling its reactive power output to meet the nominal voltage schedule originating from Grant PUD.

Table 4-5b Automatic Generation Control (AGC) Quantities

District Control Center(s) to Generation Plant:	
1.	Generation request at rated frequency set point - AGC-requested power output level in MW for the following look-ahead time horizons: 0, 5, 10, 15, 20, and 30 minutes.
2.	Generation requested rate of response.
3.	Amount of regulating reserve to carry.
4.	Generation base point - The generation level in MW at which the District expects to be operating the plant at the end of the ramp.
5.	Plant MW control mode - regulating, base load, standby, or off control
6.	District operating mode indication to the plant – normal, assist, emergency
7.	Bus voltage schedule(s) in kV and actual measurement(s)
8.	District AGC control center identifier – Primary or Backup Control Center
9.	District Mvar Control Mode – coordinated voltage schedule, nominal voltage schedule

4-D. Generation and Transmission Interchange Scheduling Requirements

Any new transmission, end-user or generation facility being integrated into Grant PUD's Electric system must adhere to the scheduling requirements of the prevailing tariff and business practices under which it is taking transmission service or Balancing Authority area service from Grant PUD. Customers may be required to provide Grant PUD's scheduling department with a forecast estimate of their hourly load, hourly generation schedules, and/or net hourly interchange transactions. These estimates will be used for both pre-scheduling and planning purposes. Grant PUD will require customers to provide these estimates as necessary in order for Grant PUD to manage the load or resource balance within Grant PUD's Balancing Authority Area and to determine usage of Grant PUD's Electric system.

In the case of new transmission facilities, scheduling and accounting procedures are needed if the facility is part of an interface between Grant PUD's Balancing Authority Area and another Balancing Authority. This scheduling and accounting of interchange between two Balancing Authority areas normally requires telemetered data from the POI to the control

centers of the Balancing Authority operators. This data is termed interchange metering and telemetering by Grant PUD and includes kW and kWh quantities. Grant PUD requires that all Balancing Authority Area transactions be prescheduled for each hour using the normal scheduling procedures. The end-of-hour actual interchange must be conveyed each hour to Grant PUD's system control center. This can be accomplished through the use of telemetering or data link.

When the new interconnection represents a shared or jointly owned interface to Grant PUD, or a split resource between Grant PUD's Balancing Authority and any other, then a calculated allocation is usually required to divide up the total metered interchange. This non-physical interface is accomplished by dynamic signal. A two way dynamic signal is required when a combined request and response interface is used. An example is supplemental AGC services. A one-way dynamic signal is required when a response (or following) interface is used. Moving a Balancing Authority Area boundary is an example of this requirement.

4-D.1 Generation Metering Requirements

Generation metering usually consists of bi-directional meters and related communications systems providing active power (in kW) and energy (in kWh) from the POI. Active power is telemetered on a continuous basis for AGC and hourly energy is sent each hour to the Interchange accounting for Grant PUD. All generation projects of aggregate size equaling or exceeding one MVA require hourly pre-scheduling. Grant PUD may also require indication of available spinning reserve and controlled reserves, both in MW. (See section 4- F for more on reserves

a. Interchange Metering Requirements

Interchange telemetering generally consists of bi-directional meters and related telecommunications systems providing kW and kWh at or near the POI. The kW measurement is telemetered on a continuous basis for AGC and hourly kWh is sent each hour to the control center. (Tables 4-1, 2 and 4 summarize the requirements). Interchange telemetering accuracy and calibration requirements are identical with those stated in Sections 4-F and 1-H.

Effective telemetering requires real-time knowledge of the quality of measurement. Associated with the telemetering signal are various indications of this quality. Analog telemetering is commonly accompanied with squelch and telemetering carrier fail alarms. A loss of meter potential or meter potential phase unbalance should trigger a telemetering carrier failure alarm. Digital telemetering has equivalent signal failure alarms. The metering equipment must also be monitored and alarmed in the telemetering signal. Typical alarms include but are not limited to:

- Loss of meter potential
- Loss of telemetering signal
- Loss of meter potential signal

b. Generation Station Service and Start-Up Metering

If Grant PUD supplies a generation site station service, then that station service must be properly and accurately metered. This may require separate dedicated meters for station service. It is preferred to meter generation by locating metering accuracy current transformers such that accurate station service can also be metered. Then net generation, start-up and station service can be accomplished from one-meter location. However, if this is not possible, then metering with demand interval data recording (MV90™ compatible) and communications would be required at the station service transformer(s). Meter data is recorded when Grant PUD is supplying either transmission, energy or both.

4-E. Revenue and Interchange Metering System

All interconnections of facilities capable of exchanging at least 1 kW of active power require Grant PUD qualified metering for revenue or interchange. Energy data recording is required for Grant PUD's billing and scheduling functions. Revenue metering includes energy (kWh) and reactive power (kvarh) produced by revenue meters and recorded on a demand interval basis. Interchange metering includes bi-directional energy and reactive data as well as special telemetering requirements for scheduling purposes. The metering shall be located to measure the net power at the POI to or from Grant PUD's Electric system.

The revenue metering system (RMS) includes a remote metering system to record the hourly kWh data. The hourly kWh data is downloaded from the metering recorder on a daily basis over voice-grade telephone lines. All recorders must be fully compatible with the MV-90™ protocol. Demand data will be available to the customer or their agent.

Grant PUD typically owns and maintains the revenue metering at load-metering sites. Grant PUD will supply the Requester with a list of pre-qualified metering systems should the Requester desire to furnish, own or maintain the metering system. If the selected system is not on Grant PUD's pre-qualified list, Grant PUD reserves the right to perform a full set of acceptance tests, possibly at the Requester's expense, prior to granting permission to use the selected system

4-E.1 Requirements for Revenue and Interchange Metering

Three-element, three-phase, four-wire meters shall be used on grounded power systems. Two-element, three-phase, three-wire meters can be used on balanced, ungrounded power systems. Both revenue metering and interchange metering shall be bi-directional to record both active and reactive power flows to or from the POI. Metering packages include a kWh recording device compatible with Grant PUD's RMS or scheduling system, as applicable.

Should the new POI result in the addition of generation to Grant PUD's Electric system not previously accounted for, there will be additional metering requirements. Tables 4-1 through 4-4 identify revenue metering requirements. Section 5 discusses telecommunications requirements for the RMS system.

4-E.2 Required Accuracy of Meters

Watt-hour meters shall be calibrated to ±0.1% accuracy at unity power factor for both full load and light load. Watt-hour meters shall also be calibrated to ±0.3% accuracy for 0.5 power factor at full load. Var-hour meters shall have ±0.2% accuracy at unity power factor and ±0.6% accuracy at 0.5 power factor. Full load is defined as 100% meter current rating at nominal voltage. Light load is defined as 10% meter current rating at nominal voltage.

4-E.3 Instrument Transformers

Voltage and current instrument transformers shall be 0.3% accuracy class for both magnitude and phase angle over the burden range of the installed metering circuit. The instrument transformers shall be of a shielded design in order to prevent unintentional energization of the transformer secondary during a transformer failure. Instrument transformers for metering must be located such that the input to the metering and telemetering is not interrupted during possible switching configurations at the POI.

4-E.4 Loss Compensation

Transmission system losses, such as those in transformers, often must be accounted for in the revenue metering process. Grant PUD prefers that this accounting be done as a calculated part of Grant PUD's billing and settlement process.

4-E.5 Station Service Power

Depending upon its electrical source and electrical location, the station service power for the connecting substation facilities may also require revenue metering. It may not be necessary to meter station service var hours although most modern electronic meters include this feature as part of the meter.

4-F. Calibration of Metering, Telemetering, and Data Facilities

4-F.1 Revenue and Interchange Metering

The meter owner is responsible to calibrate and document revenue and interchange metering at least every two years. More frequent calibration intervals may be negotiated. All parties to the transmission interconnection agreement may witness the calibration. Calibration information will be maintained for 7 years and will be made available to Grant PUD upon request.

4-F.2 SCADA and ICCP Data

SCADA and ICCP data shall be calibrated every two years as a minimum or more often if significant errors occur affecting the state estimator results. All parties to the transmission interconnection agreement may witness the calibration.

5. Telecommunication Requirements

5-A. Introduction

Telecommunications facilities shall be installed to fulfill the control, protection, operation, dispatching, scheduling, and revenue metering requirements. They may be owned by Grant PUD, another utility or a third party. At a minimum, telecommunications facilities must be compatible with, and have similar reliability and performance characteristics to, that currently used for operation of the power system to which the new facility will be connected. Telecommunications facilities will be identified by Grant PUD. Telecommunication infrastructure at customer-owned facilities is the responsibility of the customer. Depending on the performance and reliability requirements of the control and metering systems to be supported, the facilities may consist of any or all of the following:

5-A.1 Radio Systems

A radio system requires transmitters, receivers, telecommunication fault alarm equipment, antennas, batteries, chargers, and multiplex equipment. It may also include buildings, towers, emergency power systems, mountaintop repeater stations and their associated land access rights, as needed to provide an unobstructed and reliable telecommunications path. In order to meet power system reliability requirements, radio path diversity, equipment redundancy or route redundancy may be required. These measures protect against telecommunications outages caused by equipment failure or atmospheric conditions.

5-A.2 Fiber Optic Systems (Grant PUD's preferred option wherever feasible)

A fiber optic system requires light wave transmitters, receivers, telecommunication fault alarm equipment, multiplex equipment, batteries, chargers, emergency power systems, fiber optic cable (underground or overhead) and rights-of-way. Cable route redundancy may be required in order to prevent telecommunications outages caused by cable breaks.

5-A.3 Wireline Facilities

A wireline facility (e.g., leased line) requires telecommunications cable (underground or overhead), high-voltage isolation equipment, and rights-of way. It may also include multiplex equipment, emergency power systems, and batteries, depending on the wireline technology employed. Cable route redundancy may be required in order to prevent telecommunications outage.

5-A.4 Power Line Carrier (Grant PUD's least preferred option)

A power line carrier current system uses the actual power line conductor(s) as the transmission media. Coupling capacitors, line tuning units and wave traps are used to connect the carrier transmitter and receiver to the power line. Power line carrier availability and performance is greatly affected by line outages.

5-B. Voice Communications

5-B.1 Basic Requirements

If the generation or load facility is within Grant PUD's Balancing Authority Area and any type of telemetering is required, then voice communications to the operator are also required. If the facility is not staffed with operators, alternative arrangements may be made subject to Grant PUD's approval.

5-B.2 Automatic Ringdown Trunks

Dedicated, direct automatic ringdown trunk (or equivalent) voice circuits between each appropriate Grant PUD control center and the operator of the generation or end-user facilities may be required for:

- Generation or end-user facilities of 50 MW or greater,
- Eccentric (non-conforming) generators or end-user facilities
- Connected networks that include automatic generation dropping for Grant PUD Transmission system remedial action.
- A non-radial interconnection to another electric utility with a transfer capability in either direction of 50 MW or greater.

5-B.3 Independent Communications

Independent voice communications for coordination of system protection, control and telecommunication maintenance activities between Grant PUD and the generation facility or POI should also be provided.

5-C. Data Communications

General telemetering of power and energy data (in kW, kvar, kWh) and data acquisition systems typically require one or more dedicated communication circuits. These circuits link the new facility to the master computer receiving the data Telecommunications for SCADA, RMS and telemetering must function at the full performance level before and after any power system fault condition. Repair personnel must restore service continuity immediately after the fault without the need for intervention. The following requirements for telemetering of data are specified:

5-C.1 SCADA

For communication of SCADA information, one or more dedicated circuits are typically required between a new facility and the appropriate Grant PUD control center(s).

To ensure safety of working personnel and prompt response to system abnormalities, Grant PUD shall be allowed to know the status of certain breakers (e.g., utility tie breaker, interconnection breaker, and generator breaker(s)) and the real & reactive power flow at the generator breakers and at Grant PUD primary meter. A dedicated communications link for SCADA shall be required. In general, a Grant PUD-owned local Remote Terminal Unit (RTU) shall be installed to perform certain control and monitoring functions as specified elsewhere in this document.

5-C.2 Automatic Generator Control (AGC) Interchange and Control Telemetering

One or more dedicated circuits are typically required between the new generation facility and the appropriate Grant PUD control center(s) for telemetering of AGC Interchange and control information for operations and scheduling applications. If AGC services are required, data will be sent to and from the appropriate Grant PUD control center(s) using the ICCP over private control synchronous communication channels operating at a minimum rate of 9600 baud.

5-C.3 Revenue Metering System (RMS)

Commercial dial-up telephone exchange line facilities are required for support of the MV-90™ compatible remote RMS equipment. The exchange line facilities communicate with the MV-90™ compatible master computer at Grant PUD's designated location. The circuit used for this purpose may also be shared with voice communications and other dial-up data communications.

5-D. Telecommunications for Control and Protection

Telecommunications for control and protection must function at the full performance level before, during and after any power system fault condition. The delivery of a false trip or control signal, or the failure to deliver a valid trip signal is unacceptable. Active telecommunication circuits for control and protection must not be tested, switched, shorted, grounded or changed in any manner by any worker, unless prior arrangements have been made through Grant PUD's system operations control center.

5-D.1 Application on Bulk Electric System Transmission

The highest telecommunications performance level as specified by the WECC is 99.95% availability. This level of performance is required on all protection circuits for lines connected to Grant PUD's Bulk Electric System. This performance level is also required for RAS circuits that must meet WECC compliance criteria. These circuits require totally redundant schemes.

Availability is determined for the total path of the protective relaying circuit, from one end of the transmission line to the other. Options for achieving these availability requirements by utilizing two or more separate telecommunication methods, routes or systems may be considered. When alternately routed telecommunications for protective relaying schemes are required, a combination of two of these telecommunications methods may be used to meet availability requirements.

5-D.2 Non-Bulk Electric System Transmission Applications

A telecommunications performance level of 99.5% is required for less critical protection circuits. This level of performance is also required for RAS circuits not required to meet the WECC criteria. Redundant telecommunications systems are only required in certain circumstances to ensure the reliability and speed of the transmission of signals for protection and RAS.

5-D.3 Speed of Operation

Throughput operating times of the telecommunications system must not add unnecessary delay to the clearing or operating times protection or RAS. System studies and WECC trip time requirements determine maximum permissible throughput operating times of control schemes.

5-D.4 Equipment Compatibility

Protection systems and supporting telecommunications equipment installed at the interconnecting facility must be functionally compatible or identical to the corresponding equipment employed at Grant PUD's facility. This functionality need not extend to peripherals, such as signal counters and test switches that might be present on Grant PUD's equipment. Teleprotection equipment employed by the Requester must be approved by Grant PUD prior to installation. At the time of the request for interconnection Grant PUD will supply the Requester with a list of acceptable, pre-qualified equipment. Should the Requester choose to employ equipment not on this list, Grant PUD reserves the right to test the equipment for acceptable performance in the required control application. Equipment that passes this testing can be approved by Grant PUD for subsequent installations.

Tele-protection systems, including transfer trip, must be properly designed and tested to demonstrate that they perform their intended functions. When applying digital telecommunications systems to protection schemes, care must be taken ensure equipment compatibility

5-E. Telecommunications During Emergency Conditions

5-E.1 Emergency Conditions

Emergency telecommunications conditions may develop that affect telecommunications equipment with or without directly affecting power transmission system facilities.

Emergency Conditions as specified in Grant PUD's Control Center Manual. Examples of telecommunications emergencies include the following:

- Interruption of power to telecommunications repeater and relay stations
- Telecommunications equipment failure, whether minor or catastrophic
- Interruption or failure of commercial, public switched telephone network facilities or services
- Damage to telecommunications facilities resulting from accident, acts of vandalism, or natural causes

Equipment redundancy and telecommunications route redundancy can protect against certain kinds of failure and telecommunications path interruption. A repair team dedicated to the telecommunications of the interconnecting facility should be retained along with an adequate supply of spare components.

5-E.2 Backup Equipment

Where commercial, public telephone network facilities or services support important power system telecommunications, a backup strategy should always be developed by the Requester to protect against interruption of such services. Backup methods could include redundant services, self-healing services, multiple independent routes, carriers and combinations of independent facilities such as wire line and cellular, fiber and radio, etc. Backup telecommunications system equipment such as emergency standby power generators with ample onsite fuel storage and reserve storage battery capacity must be incorporated in critical telecommunications facilities. Backup equipment should also be considered for certain non-critical telecommunications to provide continued operation of telecommunications during interruption of transmission services.

5-E.3 Disaster Recovery

The Requester shall have a disaster recovery plan in place for telecommunications restoration that shall also be exercised periodically in accordance with NERC/WECC reliability requirements. The disaster recovery plan shall include the ability to provide equipment capable of bypassing or replacing entire telecommunication stations or major apparatus until permanent repairs can be made.

5-E.4 Telecommunications Security

The operation of power system telecommunications facilities should be continuously monitored at a central alarm point so that problems can be immediately reported, diagnosed and repaired. Telecommunication sites and facilities should be secured against unauthorized access.

6. References

6-A. Grant PUD Standards and Requirements

a. Control Center Manual
b. Customer Service Policies Manual
c. Distribution Planning Guideline
d. Switching and Clearance Procedure
e. Transmission Planning Guideline

6-B. ANSI – IEEE - NFPA

a. IEEE Std 80 -Guide for Safety in AC Substation Grounding
b. ANSI/IEEE Std 81 Part 1 -Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System & Part 2: Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
c. IEEE 100 – The Authoritative Dictionary of IEEE Standards Terms
d. IEEE Std 367 -Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault
e. ANSI/IEEE Std 421.1 – IEEE Standard Definitions for Excitation Systems for Synchronous Machines
f. IEEE Std 421.2 – IEEE Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems
g. IEEE Std 487 -Recommended Practice for the Protection of Wire-Line Communication Facilities Serving Electric Power Stations
h. IEEE Std 519 -IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
i. IEEE Std - 837 -Standard for Qualifying Permanent Connections Used in Substation Grounding
j. IEEE Std – 1159 – Recommended Practice for Monitoring Electric Power Quality
k. IEEE Std – 1547 – Interconnecting Distributed Resources with Electric Power Systems
l. IEEE Std – C37.118 – Enclosed Field Discharge Circuit Breakers for Rotating Electric Machinery
m. IEEE Std, C57.116, Guide for Transformers Directly Connected to Generators
n. NESC C2 -National Electrical Safety Code
o. ANSI C84.1 – Electric Power System and Equipment – Voltage Ratings (60 Hz)
p. NFPA 70 -National Electrical Code
q. IEC 870-6 TASE.2 -Inter-Control Center Communication Protocol (ICCP) Standard.
r. IEEE Std. 141 Recommended Practice for Electric Power Distribution for Industrial Plants.
s. IEEE Std. 241 Recommended Practice for Electrical Systems in Commercial Buildings.

6-C. NERC-NWPP -WECC

a. NERC Glossary of Terms
b. NERC Operating Standards
c. NERC Reliability Standards
d. NERC/WECC Planning Standards
e. NWPP Operating Manual
f. RC West Procedures

6-D. Other Applicable References

a. National Environmental Policy Act - 42 U.S.C. & 4321 et seq.
b. Uniform Building Code
c. Occupational Safety and Health Administration
d. Open Access Transmission Tariff
e. Washington Industrial Safety and Health Act (WISHA)

7. Definitions

Balancing Authority - The responsible entity that integrates resource plans ahead of time, maintains Demand and resource balance within a Balancing Authority Area, and supports interconnection frequency in real time.

Balancing Authority Area - The collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority. The Balancing Authority maintains load-resource balance within this area.

Distribution System - Grant PUD's facilities and equipment used to transmit electricity to ultimate usage points such as homes and industries directly from nearby generators or from interchanges with higher voltage transmission networks which transport bulk power over longer distances. The voltage levels at which Distribution Systems operate differ among areas.

Electric System – the system and all components necessary to transport and deliver electric energy. The system includes transmission and Distribution System facilities.

Emergency Condition - a condition or situation: (1) that in the judgment of the Party making the claim is imminently likely to endanger life or property; or (2) that, in the case of Grant PUD, is imminently likely (as determined in a non-discriminatory manner)to cause a material adverse effect on the security of, or damage to Grant PUD's transmission system, Grant PUD's Interconnection Facilities or the Electric Systems of others to which Grant PUD's transmission system is directly connected; or (3) that, in the case of Customer, is imminently likely (as determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to, the Generating Facility, Customer's Interconnection Facilities, or Grant PUD Facilities. System restoration and black start shall be considered Emergency Conditions; provided, that Customer is not obligated by this Agreement to possess black start capability.

Generating Facility - Customer's device for the production and/or storage for later injection of electricity identified in the interconnection request, but shall not include customer's Interconnection Facilities.

Interconnection Agreement – Agreement between Grant PUD and third party specifying the terms and conditions for interconnecting to Grant PUD’s Electric System.

Interconnection Facilities - Grant PUD's Interconnection Facilities and Customer's Interconnection Facilities. Collectively, Interconnection Facilities include all facilities and equipment between the Generating Facility and the Point of Interconnection, including any modification, Material Modifications, additions or upgrades that are necessary to physically and electrically interconnect the Generating Facility to Grant PUD's transmission system. Interconnection Facilities are sole use facilities and shall not include Distribution Upgrades or Network Upgrades.

Interconnection System Impact Study – A study that addresses the capability of a transmission system to support a requested interconnection and may include the development of mitigation plans to support the requested interconnection.

NERC - the North American Electric Reliability Council or its successor organization.

NWPP – the Northwest Power Pool or its successor organization.

Point of Change of Ownership - the point where Customer's Interconnection Facilities connect to Grant PUD's Interconnection Facilities.

Point of Interconnection (POI) - the point where the Interconnection Facilities connect to Grant PUD's transmission system.

Reliability Coordinator (RC) – the western interconnection entity responsible for secure and reliable operations.

System Operator - An individual at a Control Center of a Balancing Authority, Transmission Operator, or Reliability Coordinator, who operates or directs the operation of the Bulk Electric System (BES) in Real-time.

WECC – Western Energy Coordinating Council

Other capitalize terms as defined in the NERC Glossary of Terms