



## **APPENDIX “B-2”**

# **TECHNICAL CONNECTION REQUIREMENTS**

**for**

# **LOAD DELIVERY FACILITIES**

**and**

# **SMALL GENERATION FACILITIES**

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This shall cover Project Sponsor generator(s) more than 5 MW or 50% of light load, whichever is the lesser value, connected to Okanogan PUD's 115 kV system. Appendix C-1 shall cover the protection requirements and shall provide guidelines accommodating the generating facilities to be connected to the Okanogan PUD System. This document covers the protective relay scheme modifications at Okanogan PUD System as well as the recommendations for the relay scheme to be installed at the Project Sponsor's generating facility.

Appendix C-2: Protection Requirements and Guidelines - Interconnection:

This document shall cover the protection requirements for bulk power interconnection between Okanogan PUD and other control area utilities (Examples: BPA, PSE). Currently, Appendix C-2 consists of Bonneville's "Technical Requirements for the Interconnection of Facilities to the BPA Transmission Grid"

Appendix C-3: Protection Requirements and Guidelines – Small Generator Connection:

This document shall cover the protection requirements for (a) 115 kV load, (b) 13.2 kV load and (c) generation of 5 MW or 50% of light load, whichever is the lesser value, connected to Okanogan PUD's system. It includes protection requirements for Load Delivery for small public power companies. (Examples: Co-ops, Mutual(s), and municipal utilities).

## DEFINITIONS

For industry standard definitions of electric industry terminology, please refer to: The New IEEE Standard Dictionary of Electrical and Electronic Terms, ANSI / IEEE Std 100-1992 or the latest version.

For the purposes of this document the following definitions apply:

**Bonneville:** The Bonneville Power Administration, a federal power marketing agency responsible for, among other things, operating High Voltage transmission facilities and a Balancing Authority area in the Pacific Northwest.

**Bonneville System:** The integrated electrical transmission, control area, and generation facilities operated by Bonneville.

**Chemical Contamination:** Any level of chemical contamination that exceeds the latest Washington State Model Toxics Control Act (WAC 173-340) method A residential limits.

**Connection and Operating Agreement:** The document signed between Okanogan PUD and the Project Sponsor and/or Interconnecting Utility for the electrical connection between both parties.

**Connection Point:** The physical location on the power system of the change of ownership between Okanogan PUD and the Project Sponsor and/or Interconnecting Utility.

**Douglas PUD:** Public Utility District No. 1 of Douglas County, a Washington State Public Utility District responsible for the planning and operation of certain High Voltage & distribution facilities located in and around Douglas County, Washington. Douglas PUD acts as Okanogan PUD's Balancing Authority.

**Douglas PUD System:** The integrated electrical transmission, control area, and generation facilities operated by Douglas PUD.

**Okanogan PUD:** Public Utility District No. 1 of Okanogan County, a Washington State Public Utility District responsible for the planning and operation of certain High Voltage & distribution facilities located in and around Okanogan County, Washington.

**Okanogan PUD System:** The integrated electrical High Voltage and distribution facilities owned by Okanogan PUD, including primarily 115 & 13.2 kV lines and stations.

**Effectively Grounded:** A system that provides an  $X_0 / X_1 < 3$ , and,  $R_0 / X_1 < 1$  where  $X_0$  and  $R_0$  are zero sequence reactance and resistance, and  $X_1$  is positive sequence reactance.

**Generation – Distribution Connection:** Technical Connection Requirements for Load Delivery Facilities and Small Generation Facilities apply to generation Projects connected to the low-voltage side of a new or existing customer service transformer that was originally designed to serve retail load, and having generating capability of greater than 100 kW, but less than i) 5 MW; and ii) 50% of the customer service transformer light load.

**Generation – Transmission Connection:** Technical Connection Requirements for Generation & Interconnection Facilities apply to generation Projects having generating capability in excess of 100 kW and that do not otherwise meet the criteria for "Generation – Distribution Connection".

**High Voltage:** Nominal facility operating voltages above 34.5 kV (e.g. 115 kV).

**Interconnection:** High Voltage or distribution system tie point between two Balancing Authority areas.

**Interconnecting Utility:** The utility that owns the High Voltage or distribution system that connects the Project to Okanogan PUD's System at the Connection Point.

**Load Delivery Project:** Technical Connection Requirements for Load Delivery Facilities and Small Generation Facilities apply to end-use loads with a Maximum Demand in excess of 1 MW that are connected to the Okanogan PUD System at a voltage of 115 kV, and any Interconnecting Utility load that is connected to the Okanogan PUD System regardless of voltage.

**NERC:** The North American Electric Reliability Corporation and its successors.

**NERC Reliability Standards:** Standards and criteria for the reliable operation of the North American electric power system that have been adopted by the NERC Board of Trustees and are applicable to Okanogan PUD, Douglas PUD, Bonneville, and the Project.

**Project:** The Load Delivery, Interconnection, or generation facility and all equipment associated with integration of the Project up to the Connection Point with the Okanogan PUD System. None of the facilities that make up the Project are owned by Okanogan PUD.

**Project Operator:** The entity that operates a Load Delivery, Interconnection, or generation Project.

**Project Sponsor:** The entity that owns and/or develops a new Load Delivery, Interconnection or generation Project.

**Prudent Electric Utility Practices or Prudent Utility Practice or Prudent Engineering Practices:** The generally accepted design, practices, methods, and operation of a power system, to achieve safety, dependability, efficiency, and economy, and to meet utility and industry codes, standards, and regulations.

**RTU (Remote Terminal Unit):** An electronic device that monitors substation or field equipment for status, analog, accumulator values. The RTU is scanned by the master station periodically for new values or for integrity checks, or, it reports to the master station "by exception". It responds to commands from the master station and provides remote contact closure(s) as necessary when dispatchers remotely control equipment and devices in the field.

**SCADA (Supervisory Control and Data Acquisition):** A system of remote control and data acquisition used to monitor and control the High Voltage and distribution system.

**Station Service:** The electric supply for the ancillary equipment used to operate a generating station or substation.

**Engineering Department:** Okanogan PUD's Engineering Department located at 1331 Second Ave. North, Okanogan, WA responsible for High Voltage and distribution dispatch and monitoring for the Okanogan PUD System.

**System Impact Study:** A study of the electrical effects of a proposed Generation – Distribution Connection and/or Load Delivery Project connected to the Okanogan PUD System, along with the determination of facility additions and associated costs necessary to maintain the reliability of the Okanogan PUD System and surrounding electric systems, as well as verification that all technical requirements in the document are properly addressed.

**Temporary Overvoltage:** A Temporary Overvoltage is defined as an oscillatory line-to-ground or line-to-line overvoltage lasting greater than 20 milliseconds, which is undamped or only weakly damped.

**Temporary Undervoltage:** A Temporary Undervoltage is defined as an oscillatory phase-to-ground or phase-to-phase voltage of 85% or less of nominal voltage lasting greater than 20 milliseconds, occurring during fault conditions.

**Transient Overvoltage:** A Transient Overvoltage is defined as the peak line-to-line or line-to-ground voltage during the transient conditions resulting from operation of a switching device.

**Unplanned Outage:** An Unplanned Outage is defined as the electrical isolation of equipment from the electrical system, without scheduling and notification of Okanogan PUD, such that the equipment is unable to perform its intended function for the duration of the isolation.

**Voltage Regulation:** The difference between expected maximum and minimum voltages at any particular delivery point. The Voltage Regulation limits are expressed as a percent of the nominal voltage and are defined for both normal and contingency conditions. Voltage Regulation for delivery point voltages shall not exceed the guidelines.

**Voltage Unbalance:** The percent deviation of one phase rms (root mean square) voltage value from the average of all three phases' rms voltage values.

**WECC:** The Western Electricity Coordinating Council or its successor, which is responsible for overseeing the reliability of the Western Interconnection.

**Western Interconnection:** The interconnected electric systems of the western portions of the United States, Canada, and Mexico, and which operate synchronously with each other.

## A. Scope

The technical requirements contained herein apply to all permanent or temporary (1) Load Delivery Projects and (2) Generation – Distribution Connection Projects. It also applies to existing Load Delivery and Generation – Distribution Connection Projects that are connected to the Okanogan PUD System through interim agreements.

The Okanogan PUD System interconnects with the Bonneville System and Douglas PUD System at various locations. Douglas PUD also serves as the Balancing Authority for the Okanogan PUD System. Larger Projects connecting to the Okanogan PUD System could have an effect on the Bonneville System and/or Douglas PUD System, as well as Douglas PUD's Balancing Authority area. As a result, a Project may also be subject to all or portions of Douglas PUD's "Facility Connection Standards", Bonneville's "Line and Load Interconnection Procedures", "Generator Interconnection – Large" (Business Practice), and "Technical Requirements for Interconnection with the BPA Transmission Grid". The Project location, interconnection voltage, transmission access requirements, and capacity will dictate the extent to which the Bonneville and Douglas PUD procedures and technical requirements apply to a given Project. Okanogan PUD will work with the Project Sponsor, Douglas PUD and/or Bonneville to resolve any discrepancies arising from the use of multiple procedures and technical requirements applicable to a given Project.

The location of the Connection Point and the impacts on the Okanogan PUD System, or another utility's system, determine the specific technical requirements applicable to a given Project. The Project shall not degrade the safe operation, integrity, or reliability of the Okanogan PUD System or the Western Interconnection.

### 1. Ownership

The Project Sponsor or Project Operator is responsible for the planning, design, construction, reliability, protection, safe operation, and all attendant costs or expenses for non-Okanogan PUD-owned facilities.

In cases of Projects with a peak load of 1 MW or greater that require the construction of a new substation, the Project Sponsor will have an option to own or not own the substation. The Project Sponsor who chooses to own a substation will incur all costs associated with and will be responsible for design, construction, operation, maintenance, and ownership of the substation facilities as outlined in the adjacent appendices. If the Project Sponsor chooses to not own the substation, the Project Sponsor will still incur all costs associated with the Project (including maintenance costs), but Okanogan PUD will be responsible for the design and construction and will operate, maintain, and own the substation facilities as outlined in the adjacent appendices. Again, regardless of whether the sponsor or Okanogan PUD ultimately owns and operates the facilities, the Project Sponsor will be responsible for all costs of the connection facilities and for providing a site for the substation.

NOTE: If the substation is not located on the Project Sponsor's property, requiring feeder(s) to be built on the Public right-of-way, Okanogan PUD will own the feeder(s) as well as the substation at the expense of the Project Sponsor. The Project Sponsor will not have a discounted rate if Okanogan PUD operates and maintains these feeders.

Regarding existing Project Sponsors that own a substation, Okanogan PUD is not obligated, but may consider owning, operating, and maintaining that substation if it is designed to Okanogan PUD's standards, if it is an economical addition to the Okanogan



PUD System, and if it does not adversely affect existing Okanogan PUD customer rates and/or service.

## 2. Connection and Operating Agreement

Okanogan PUD and the Project Sponsor or Project Operator will execute a Connection and Operating Agreement before Okanogan PUD will authorize the Project Sponsor or Project Operator to commence commercial operation of the Project.

The signing of the Connection and Operating Agreement establishes the Project Sponsor or Project Operator's right to connection/interconnect to the Okanogan PUD System at the Connection Point, but the Connection and Operating Agreement in no way provides or guarantees transmission service. Okanogan PUD will provide transmission service across the Okanogan PUD System under the terms and conditions of a transmission agreement between Okanogan PUD and the Project Sponsor, Interconnecting Utility, or other entity that wishes to move power between the boundaries of the Okanogan PUD System and the Connection Point.

## 3. Load Following, Regulation, and Reserves

Because Okanogan PUD is embedded in the Douglas PUD Balancing Authority area, the Project Sponsor or the Project Operator may negotiate an agreement for provision by/to Douglas PUD of load following, load regulation, and/or reserve products. Okanogan PUD reserves the right to participate in such negotiations to ensure that Project operation has no adverse effect on the cost to Okanogan PUD of Douglas PUD load following, load regulation, reserve, or any other power sale products that Okanogan PUD requires for service to its other customers.

## 4. Applicable Codes, Standards, Criteria and Regulations

The Project, to the extent applicable, shall comply with those codes, standards, criteria and regulations listed in the "REFERENCES" section of this document, as well as any other codes, standards, criteria and regulations that may apply to the Project.

## 5. Safety, Protection, and Reliability

The Project Sponsor is required to submit design and preliminary relay settings for the protection of the Project's equipment. The submittal shall be at least 2 months before the Project Sponsor anticipates initial operation of the Project. Okanogan PUD, after consultation with the Project Sponsor and other relevant parties, particularly Bonneville and/or Douglas PUD, shall make the sole and final determination as to whether the Okanogan PUD System is properly protected from any problems that the Project might cause. The Project Sponsor is responsible for correcting such problems before initial operation begins. The Project Sponsor is responsible for safety, protection, and reliability on the Project side of the Connection Point. See the appropriate Appendix on Protection.

## 6. Non-Okanogan PUD Responsibilities

Project Sponsors and Project Operators shall comply with NERC & WECC Reliability Standards, the Douglas PUD "Facility Connection Standards", the Bonneville "Line and Load Interconnection Procedures", and "Technical Requirements for Interconnection with the BPA Transmission Grid". At the Project's expense, the Project Sponsor is responsible for the planning, design, construction, reliability, protection and safe operation of non-Okanogan PUD-owned facilities. The design and operation of the Project is subject to applicable local, state and federal statutes and regulations.

## 7. Cost of Analysis and System Impact Studies

The Project Sponsor shall reimburse Okanogan PUD, or its designated consultant(s), for the actual costs to perform any work and/or analysis associated with the Project, including the cost of the System Impact Study and a Facility Study, if required.

## 8. Approval and Acceptance

The terms “approve”, “approved” and “approval” used in this document means acceptance. Approval by Okanogan PUD does not mean that Okanogan PUD endorses or is to be responsible for the safety or reliability or damage-free operation of Project’s design, facility, construction or equipment.

## B. Request for System Impact Studies

The Project Sponsor shall supply information on the location, proposed voltage, and other pertinent connection requirements for a Project, without coming to any conclusions on the final location or voltage or connection configuration. A System Impact Study of the region shall be performed either by Okanogan PUD or by a consulting company approved by Okanogan PUD to determine the required connection facilities and modifications to accommodate the Project. This study also addresses the High Voltage and distribution system capability, transient stability, voltage stability, losses, Voltage Regulation, harmonics, voltage flicker, electromagnetic transients, ferroresonance, metering requirements, protective relaying, substation grounding, and fault duties. The data that the Project Sponsor is required to provide to perform these studies are listed in the “Required Project Sponsor-Supplied Information” section.

Proposals for Project Interconnection with other Balancing Authority areas shall require coordination of studies, including a Connection Study, among the Project Sponsor, Okanogan PUD, Balancing Authority (if different from the Project Sponsor), and Douglas PUD.

### 1. Connection Configuration

Okanogan PUD shall evaluate on a case-by-case basis whether a Project shall be connected to the Okanogan PUD System by tapping an existing High Voltage or distribution line or by connecting directly into an existing transmission or distribution station.

A new transmission switching station may be built in the middle of an existing transmission line. Okanogan PUD’s 115 kV transmission facilities are typically reserved for the bulk transport of large amounts of electricity.

Connection options are dependent upon many factors, including location of the desired Connection Point relative to existing Okanogan PUD transmission facilities, the size of the Project’s electric demand profile, present line loading, and other requirements of the Project. The most feasible option(s) shall be considered in the System Impact Study, with the most economic option meeting all requirements being selected.

### 2. Power Flow, Short Circuit and Stability Analysis

The Project is “modeled” by Okanogan PUD or its consultant using the data provided by the Project Sponsor. System simulations are performed to determine the impact of the Project on the transmission and/or distribution system. The primary intent is to determine

if the Project causes any violations of Okanogan PUD's Douglas PUD's and/or Bonneville's planning & reliability criteria. A summary of these study modules is shown below:

a. System Rating and Voltage Screening – power flow analysis

The purpose of this study is to ensure that the connection of the Project does not create any system loading or voltage levels outside of the limits in this document or in Okanogan PUD's planning & reliability criteria. Project information obtained from the Project Sponsor is used to model the Project. System simulation tools are used to model a wide range of transmission and distribution system operating conditions to determine the system loading and voltage level changes created by the Project on the Okanogan PUD System.

b. Transfer Capability – power flow analysis

The purpose of this study is to ensure that the connection of the Project does not reduce the ability of the transmission system to transport power over long distances between and among control areas. Joint studies with other utilities, particularly Bonneville and Douglas PUD, may be necessary. Power transfers are simulated across the Okanogan PUD System and Bonneville System in various directions to determine how the Project affects Okanogan PUD's ability to transfer power across its system.

c. Fault Duty – short circuit analysis

The purpose of this study is to determine the changes in available fault duty caused by the Project. Transformer, line and generator impedances, and the circuit configuration are needed to create the model for the study. The data is inserted into the current Okanogan PUD, Douglas PUD, and Bonneville models. The new generation buses and/or Load Delivery buses, and those local to it are faulted to allow comparison with fault conditions prior to the addition of the Project. The study results are reviewed to ensure that no equipment ratings shall be exceeded and are utilized for determining the size of grounds used for personnel protection for conducting de-energized line and station work.

d. Stability – stability analysis

The Project Sponsor may be requested to perform stability studies on a Generation – Distribution Connection Project using dynamics software to evaluate the impact of the new system configuration and additional generating capacity on system stability. In addition to the normal steady state model data, generator impedances and time constants, turbine governor data, and voltage regulator data are needed to create a model for the study. Study results are evaluated to ensure system stability shall be maintained and that any necessary changes to relaying or controls are identified.

### 3. Protection

After studying the possible ways to connect the Project to the Okanogan PUD System, the protection requirements shall be determined. This shall include an impedance model at the Connection Point (short-circuit data), protective changes to the transmission and/or distribution system, protective requirements for a Load Delivery Project and any special protective needs for the Project. See the "General Requirements" and "Protection Requirements & Guidelines" sections for more details on these requirements. Okanogan PUD may need to coordinate protection requirements with Douglas PUD and/or Bonneville.

#### 4. Power Quality and Reliability

There is a very diverse set of users connected to the Okanogan PUD System with different system requirements. In the past, most customers were only concerned with extended interruptions. However, the increased use of highly sensitive power electronic devices within all customer sectors has changed the definition of reliability. Due to the sensitivity of many industrial and commercial loads, such as adjustable speed drives (ASDs) and computer controlled processes, reliability is no longer only defined by the frequency and duration of sustained interruptions. There are many power quality variations other than sustained interruptions that may result in inadequate service for the proper operation of customer equipment. Variations such as Voltage Unbalance, voltage flicker, harmonic distortion, Transient Overvoltages, Temporary Overvoltages and steady-state Voltage Regulation can adversely affect customer processes.

The challenge for Okanogan PUD is to design and operate the Okanogan PUD System such that it meets the requirements of this diverse set of users. To meet this challenge, Okanogan PUD or its consultant(s) performs studies to determine the power quality and reliability impacts of any new Project on the Okanogan PUD System at the Connection Point. The intent of these studies is to ensure that the connection of the Project does not compromise the reliability and integrity of the Okanogan PUD System.

The studies performed for each new Project may include:

##### a. Voltage Unbalance

The purpose of this study is to ensure that the operation of any new Project does not create a Voltage Unbalance condition in excess of the limits provided in the "Performance Requirements" section. Project information obtained from the Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission and distribution system operating conditions to determine the range of Voltage Unbalance created by the Project at the Connection Point.

##### b. Voltage Fluctuations or Flicker

The purpose of this study is to ensure that the operation of any new Project does not create voltage fluctuations in excess of the limits provided in the "Performance Requirements" section. Project information obtained from the Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission and distribution system operating conditions to determine the range of voltage fluctuations created by the Project at the Connection Point.

##### c. Harmonic Distortion

The purpose of this study is to ensure that the operation of any new Project does not create harmonic current injections in excess of the limits provided in the "Performance Requirements" section. Project information obtained from the Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission and distribution system operating conditions to determine the range of harmonic distortion created by the Project at the Connection Point.

#### d. Transient Overvoltage

The purpose of this study is to ensure that the operation of any new Project does not create a Transient Overvoltage condition in excess of the limits provided in the “Performance Requirements” section. Project information obtained from the Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission and distribution system operating conditions to determine the range of Transient Overvoltages created by the Project at the Connection Point.

#### e. Temporary Overvoltage

The purpose of this study is to ensure that the operation of any new Project does not create a Temporary Overvoltage condition in excess of the limits provided in the “Performance Requirements” section. Project information obtained from the Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission and distribution system operating conditions to determine the range of Temporary Overvoltages created by the Project at the Connection Point.

#### f. Temporary Undervoltage

The purpose of this study is to ensure that the operation of any new Project does not create a Temporary Undervoltage condition in excess of the limits provided in the “Performance Requirements” section. Project information obtained from the Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission and distribution system operating conditions to determine the range of Temporary Undervoltages created by the Project at the Connection Point.

#### g. Insulation Coordination

The purpose of this study is to ensure that the operation of any new Project does not create a situation that exposes Okanogan PUD-owned transmission and distribution equipment to a condition in excess of the limits provided in the “Performance Requirements” section. Project information obtained from the Project Sponsor regarding insulation coordination studies is reviewed and shall be approved by Okanogan PUD prior to connection. Okanogan PUD may perform independent studies verifying that the models and assumptions used by the Project Sponsor are appropriate for their application.

### 5. Changes to Project Sponsor-Supplied Information

If the Project Sponsor or Project Operator requires any change in data, design drawings, as-built drawings, settings, construction details, schedules, CT/PT ratios or other information previously supplied pursuant to these connection requirements, the Project Sponsor or Project Operator shall notify Okanogan PUD in writing within 30 days. The Project Sponsor must follow up by supplying Okanogan PUD all details and documentation of the changes. This notification shall include:

- The time and date at which the change became, or is expected to become effective
- If the change is only temporary, an estimate of the time and date at which the data shall revert to the previously supplied form.

A request for a change in Connection Point, crucial system data, increase in load levels, or expected supply may be considered as a new request and may trigger a new System Impact Study. A new completion date shall be negotiated with the Project Sponsor or Project Operator when Project data is changed during the System Impact Study process.

Okanogan PUD may request load growth projections after the initial connection is made. This will require an annual submittal by the Project detailing the load projections for each of the next 5 to 10 years.

## 6. Required Project Sponsor-Supplied Information

Any Project Sponsor desiring a new connection or modification of an existing connection shall provide the following applicable information:

- a. Project name, company name and contact name
- b. Address
- c. Phone number, fax number, e-mail address of contact name
- d. Effective date of new connection or modification
- e. Proposed geographic location & plot plan providing Project orientation on the site
- f. Electrical connection point
- g. Voltage level of proposed connection
- h. One-line diagram of Project
- i. Proposed start-up date
- j. Load demand under normal and emergency conditions
- k. Power factors under various load conditions
- l. Expansion plans (type and size of potential loads)
- m. Line voltage, conductor rating, impedance, length, insulation, grounding etc.
- n. Transformer ratings, connections, voltage taps, impedances and grounding
- o. Lightning protection designs for High Voltage/distribution lines & stations
- p. Special requirements (e.g. sensitive equipment, dual feeds, etc.)
- q. Preferred method of connection (series, automatic flop-over to alternate feeds, etc.)
- r. Relay schemes, relay settings, protection equipment
- s. Maintenance schedules & procedures
- t. If applicable, generator data (for each generator)
  1. Manufacturer
  2. Base MVA
  3. Maximum MVA
  4. Rated MW (Summer & Winter)
  5. Rated kV
  6. Rated power factor
  7. Reactance- synchronous, sub-transient & transient
  8. Capability curve data
  9. Auxiliary load data
  10. \*Dynamic modeling data - H, Ra, Xd, Xq, X'd, X'q, X''d, X''q, XI, T'do, T'qo, T''do, T''qo, S(1.0), S(1.2)
  11. \*Governor & excitation system models - PTI format (P/SSE Version 25.4)

Note: "\*\*": This data shall be verified and supplied to Okanogan PUD at the time of the commissioning. If the data is different from original data, Okanogan PUD has the right to request additional stability studies.

- u. Generator step-up transformer data
  1. Manufacturer
  2. Connection (delta-wye)
  3. KVA ratings of all windings
  4. H winding kV

5. X winding kV
6. Y winding kV
7. Transformer neutral load (if wye connected on the high side) in ohms
8. Impedance (%Z) and load losses (W) @kVA for all tap combinations of H-X, H-Y, & X-Y
9. No load losses and magnetizing current
- v. Other transformer ratings, connections, voltage taps, impedances, and grounding

For industrial loads connected to the Okanogan PUD System the following data is needed:

- w. One-line diagram of plant distribution system & loads
- x. Power factor correction capacitor size, connection and control scheme
- y. In-plant switchgear and protective device
- z. Motor loads, rated horsepower, voltage and type (synchronous or induction) starting frequency, efficiency, starting time (starting current versus time curves), etc.
- aa. Method of motor starting
- bb. Size, location & characteristics (a) single phase (b) large fluctuating loads (arc furnaces, welders, etc.) (c) harmonic producing loads (variable speed drives, induction furnaces, etc.)
- cc. On-site generation data as noted above
- dd. Size, location & characteristics of power conditioning equipment.
- ee. If applicable, interconnection schemes and equipment (e.g., ring bus, breaker and a half, etc.)

## C. General Requirements

### 1. Safety

All safety and operating procedures for joint use equipment shall be in compliance with the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.269, the National Electrical Code (NEC), the National Electric Safety Code (NESC), Washington State Administrative code (WAC rules), the Washington Industrial Safety and Health Administration (WISHA) standard, and the Project Sponsor's safety manuals.

#### a. Isolation Requirements

The Project Operator shall not energize any Okanogan PUD System line or equipment unless the Okanogan PUD Engineering Department [**or Douglas PUD System Operations Office**] specifically approves energization. If, for any reason, a protective device operation separates the Project from the Okanogan PUD System, the Project Operator shall contact the Okanogan PUD Engineering Department before attempting to restore the connection to the Okanogan PUD System.

At its expense, the Project Sponsor shall install a disconnect switch of Okanogan PUD's choice. The purpose of the switch is to physically and visibly isolate the Project from the Okanogan PUD System. Okanogan PUD may agree to site the disconnect switch at another location other than the Connection Point provided that the purpose described herein is satisfied. The device:

1. Shall be accessible by, and under, Okanogan PUD's Engineering Department jurisdiction.
2. Shall be gang-operated, shall be lockable in the open position by Okanogan PUD.
3. Shall be suitable for safe operation under the conditions of use.

4. Shall not be operated without advance notice to either party, unless an emergency condition requires that the device be opened to isolate the Project.

At its discretion, Okanogan PUD personnel may open the switch:

1. If it is necessary for the protection of Okanogan PUD maintenance crews when working on de-energized circuits.
2. If Project equipment or Okanogan PUD System equipment presents a hazardous condition.

Consideration shall be given as to the design and capacity of the switch on a case-by-case basis. The switch is required for safety and it shall not interrupt excessive load or charging current. However, a suitable switch for the safety requirements herein described may also be used to provide for other operational purposes.

b. Load and Generation Connected to the Project

The Project Sponsor shall maintain a record of all load and generation customers served by the Project. Such record shall be made available to Okanogan PUD annually or upon request. For the requirements of energized line maintenance or line construction on the Okanogan PUD System, the Project Sponsor shall ensure that all generation customers served by the Project shall disconnect their generation upon request by Okanogan PUD.

c. Chemical Hazards

The Project Sponsor shall supply a list to Okanogan PUD identifying all hazardous chemicals used in equipment installed by the Project Sponsor in Okanogan PUD facilities or rights-of-way. The list shall include hazardous chemicals in use in Project Sponsor facilities that will be accessed by Okanogan PUD employees during the course of this agreement and used by the Project Sponsor to maintain its equipment. A current Material Safety Data Sheet (MSDS) shall be supplied by the Project Sponsor to Okanogan PUD for each chemical on the list. The list shall include the name and volume of the chemical and shall include, but not be limited to, mineral oil, sulfur hexafluoride, Trichloroethane, etc. All Project facilities and equipment shall be Polychlorinated Biphenyl (PCB) free, or other hazardous chemicals as prohibited by State or Federal regulations.

2. Connection Point Considerations

a. General Configurations and Constraints

Integration of Projects, either Load Delivery or Generation – Distribution Connection Projects, into power systems usually falls into one of the following three categories:

1. Connection into an existing transmission substation (for example: Okanogan or Brewster substations).
2. Connection to a transmission line by tapping the line, looping the line(s) or by building a new switching station as long as the connection shall not adversely impact reliability, operation, control, protection or safety of the Okanogan PUD System.



3. Connection of a Generation – Distribution Project to the low-voltage side, or to an existing feeder, of a distribution substation that was originally designed to serve load.

b. Other Considerations

Below are some of the other factors Okanogan PUD will consider when evaluating Project proposals:

1. Equipment

Existing electrical equipment, such as transformers, power circuit breakers, disconnect switches, and line conductors were purchased based on the duties and capacity limits expected in response to system additions identified in any plans. However, the connection of a new Generation – Distribution Connection or Load Delivery Project could overload specific equipment, thereby requiring equipment replacement prior to Project operation.

2. Phase Orientation

The Project Sponsor or Project Operator is required to coordinate with Okanogan PUD on the phase rotation and phase sequence of the High Voltage and the distribution system before proper construction starts and before connection is achieved. Okanogan PUD is not obligated to “roll phases” at the Connection Point, to accommodate the needs of the Project.

3. Outage Coordination & Maintenance

Okanogan PUD operates and maintains its system to provide reliable and safe customer service at all times. Project integration requires that the equipment at the Connection Point not restrict timely outage coordination, automatic switching, or equipment maintenance scheduling. Preserving reliable service to all Okanogan PUD customers is essential. When the condition is violated, the Project shall provide additional switchgear, equipment redundancy, or bypass capabilities at the Connection Point for acceptable operation of the system.

4. Atmospheric & Seismic

The effects resulting from wind storms, floods, lightning, altitude, temperature extremes, and earthquakes shall be considered in the design and operation of the Project. The Project Sponsor is responsible for determining that the appropriate standards are met, including, but not limited to, the Uniform Building Code (UBC) and the National Electrical Code (NEC). Depending on Project location, size, type, and importance, Okanogan PUD may request that additional capabilities be designed into the Project.

3. Substation Grounding

Each Load Delivery site and/or Interconnection substation shall have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid shall limit the ground potential gradients to such voltage and current levels that shall not endanger the safety of people (step and touch potential) or damage equipment which are in, or immediately adjacent to, the station under normal and fault conditions.

If the Project is physically close to another substation, the two ground grids should be connected unless noted otherwise below. The interconnecting cables shall have sufficient capacity to handle fault currents and control ground grid voltage rises. Okanogan PUD shall approve any connection to a Okanogan PUD substation ground grid. From time to time, Okanogan PUD may test the ground connection between Okanogan PUD and the Project. If it is found that the ground connection is inadequate due to corrosion, both parties shall be equally responsible in reinforcing the ground connection so as to meet the intent of this requirement.

If the ground grids are isolated for operational reasons, there shall be no metallic ground connections between the two substation ground grids. Cable shields, cable sheaths, Station Service ground sheaths, and overhead High Voltage shield wires can all inadvertently connect ground grids. Fiber-optic cables are required for telecommunications and control between two substations to maintain isolated ground grids. In the case where the Project is physically close to another substation but the ground grids are isolated, the Project Sponsor shall demonstrate that the ground grids are properly isolated in compliance with all applicable codes and standards. Okanogan PUD prefers to connect static wires on incoming transmission lines to the station ground grid. If the Project Sponsor prefers not to connect static wires on incoming transmission lines to the station ground grid, the Project Sponsor shall notify Okanogan PUD in writing and demonstrate that relay performance, lightning protection, and personnel safety are not compromised by isolating the static wires from the station ground grid.

The Project ground grid shall be designed to ANSI/IEEE Std. 80-1986, IEEE Guide for Safety in AC Substation Grounding, and shall be measured in accordance with IEEE -81 Part 1: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Potentials and Part 2: Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems. Project grounding requirements shall also comply with the National Electrical Safety Code, ANSI/IEEE -665 Guide for Generating Station Grounding, IEEE-837 Standard for Qualifying Permanent Connections Used in Substation Grounding, IEEE-487 Protection of Wire-Line Communication Serving Electric Power Stations, ANSI/IEEE 367-1987 IEEE Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault, and any applicable state and local codes.

#### 4. Insulation Coordination

Power system equipment is designed to withstand voltage stresses associated with expected operation. System Impact Studies include the evaluation of the impact of the Project on equipment insulation coordination. Okanogan PUD identifies additions required to maintain an acceptable level of Okanogan PUD System availability, reliability, equipment insulation margins, and safety.

Voltage stresses such as lightning surges, switching surges, Temporary Overvoltages, and normal 60Hz voltages affect equipment duty. Remedies depend on the equipment capability and the type and magnitude of the stress. Below are the requirements that shall be met to connect to the Okanogan PUD System. In general, stations shall be protected against lightning and switching surges. Typically this includes station shielding against direct lightning strokes, surge arresters on all wound devices, and shielding on the incoming lines.

##### a. Lightning Surges

Lightning related causes are not exempt from the "Performance Requirements" section. Although it is not always cost effective to design and build a power system to withstand every possible lightning strike, it has been demonstrated that with proper design and in-

stallation procedures, the effects of lightning can be mitigated to achieve a reliability level equal to or exceeding the requirements of the "Project Performance Criteria" section. Techniques used to help control lightning related events on transmission lines include proper use of shield wires, insulation levels, low resistance grounding, and surge arresters. Techniques used to help control lightning related outages in substations include substation shielding, proper arrester applications, and shielding of incoming transmission lines.

If the Project proposes to tap an Okanogan PUD transmission line that is shielded, the new tap line shall also be properly shielded for at least 0.5 mile for 115 kV from the Okanogan PUD station. If any stations are within 1.0 to 0.5 mile of the Okanogan PUD System, these also shall be properly shielded from direct lightning strikes. The Project Sponsor shall be able to demonstrate that the proposed designs for any transmission lines and substations shall perform within the limits for service interruptions as stated in the "Performance Requirements" section.

For transmission line design, an industry recognized lightning performance estimating algorithm shall be used to demonstrate acceptable performance of the design. The Project Sponsor shall make reasonable assumptions based on the area that the transmission line shall be installed including ground flash density and grounding conditions. The Project Sponsor shall be able to provide an alternative plan if the ground conditions required for acceptable performance are not achieved during construction of the transmission line.

For substation design, the Project Sponsor shall be able to demonstrate their proposed designs shall operate within the performance requirements. The shielding designs and arrester applications shall adhere to applicable IEEE standards. In addition, any normally open points that are subject to voltage "doubling" of incoming lightning surges shall be considered and protected accordingly so the Performance Requirements are not violated.

#### b. Temporary Overvoltages

Temporary overvoltages can last from seconds to minutes, and are not characterized as surges. These overvoltages are usually present during faults and other abnormal system conditions. The Okanogan PUD System is considered Effectively Grounded at all voltages. A system that loses proper grounding may be impedance grounded and can have line to ground voltages approaching 1.73 times normal line to ground voltage during fault conditions on unfaulted phases. Therefore, Okanogan PUD requires that the Project Sponsor periodically evaluate and maintain Project grounding conditions in order to ensure system integrity and performance.

When generation is connected to the low-voltage side of a delta-wye grounded (D-YG) transformer, remote end breaker operations initiated by the detection of faults on the High Voltage side can cause overvoltages that can affect personnel safety and damage equipment. In these instances, Okanogan PUD shall require the Project to rapidly separate the generator from the GSU by tripping a breaker using either transfer trip or local relay detection of overvoltage condition. See the appropriate Appendix on Protection.

A system study may be performed for each Project based on the point on the Okanogan PUD System that is being connected. The Project Sponsor shall be supplied the system characteristics needed to calculate the Temporary Overvoltages that need to be considered. Gapless metal-oxide surge arresters are especially sensitive

to system Temporary Overvoltages and Okanogan PUD shall review and approve the specification of arresters used to ensure proper application.

c. Normal Operating Voltages

The Okanogan PUD System voltages are normally operated within the limits specified in the "Performance Requirements" section of this document. Insulation coordination usually does not need to consider this operating range once lightning and switching surge requirements are met; however, in highly contaminated areas, special consideration and additional insulation requirements are required for proper insulation coordination. The Project Sponsor is responsible for determining whether special insulation requirements are needed for its system.

5. Inspection, Verification, Testing, Calibration and Maintenance

At the Connection Point, the inspection, verification, testing, calibration and maintenance responsibilities by the two entities are shown in the diagram Figure 1.

The Project Sponsor has full responsibility for the verification, testing, calibration, and maintenance of its equipment up to the Connection Point, consistent with the Connection and Operating Agreement.

a. Project Sponsor - Pre-energization Inspection, Verification and Testing

The Washington State Department of Labor and Industries (L&I) requires permitting and inspection of electrical wiring for compliance with the latest version of the National Electrical Code (NEC). Okanogan PUD (or its independent contractor) shall inspect Project Sponsor's facility when it is connected to Okanogan PUD's meter(s). The Project shall be energized only after successful completion of the inspection.

Before initial Project energization, the Project Sponsor or Project Operator shall develop a verification and test plan for pre-energization and energization testing. This plan shall include provisions for testing protective equipment that comply with the NERC Reliability Standards (PRC-004-1 and PRC-005-1). Okanogan PUD (or its independent contractor) shall review and approve the test plan prior to the test. Okanogan PUD may require additional tests. The Project Sponsor shall make available to Okanogan PUD all drawings, specifications, and test records of the Project equipment pertinent to interconnected operation.

b. Project Sponsor - Equipment Maintenance

The Project Sponsor or Project Operator shall implement a maintenance program for the Project equipment. The program shall be designed and executed in a manner to ensure the proper operation of the Project equipment. There shall be no damage to Okanogan PUD's equipment or other customer's equipment. The program shall be based on time or on other factors, including performance levels or reliability. Appropriate equipment performance data shall be collected and maintained by the Project Sponsor or Project Operator. Upon request, Okanogan PUD reserves the right to review and approve the Project's maintenance program, records and/or operational logs pertinent to the interconnection.

6. Station Service

See "Connection Agreement for Generation and Interconnection Facilities" or "Connection Agreement for Load Delivery" on Station Service.

## 7. Fault Interruption, Synchronization and Blackstarts

### a. Fault Interruption

The Project Sponsor shall ensure that proper current-interrupting, isolating equipment is acquired and installed at the Connection Point for the purposes of protecting the Project from faults or other undesirable conditions on the transmission system, and to protect the transmission system from faults internal to the Project.

During emergency conditions, the Project Operator's first duty is to ensure safety guidelines are achieved and to protect station equipment. The Project Operator shall have a Okanogan PUD approved set of procedures on file at the Engineering Department and at the Project that are to be followed when separating from, and reconnecting to, the transmission or distribution system. These procedures, jointly developed by the Project Operator and Okanogan PUD typically include:

1. A frequency limit duration table
2. A circuit breaker operation procedure
3. A generator loading/circuit protection procedure
4. A set of unit operating conditions that shall be maintained to prevent damage to the unit(s) and/or the transmission or distribution system.

Unless authorized by the Engineering Department, the Project Operator shall NOT

- Energize any equipment
- Connect to any energized equipment
- Parallel any generation to the system

If, for any reason, Okanogan PUD is disconnected from the Project (through a fault condition, line switching, etc.), the Project breaker(s) shall be tripped and not reclose until approved by the Engineering Department.

### b. Synchronization

The Project Operator shall be responsible for synchronizing its equipment to the Okanogan PUD System. During all other conditions, the generator shall have Okanogan PUD approved procedures in place when connecting to the system. For automatic or manual synchronization, a sync-check relay shall be installed to assure that the unit is not connected to the energized power system out of synchronization.

### c. Blackstart

Not applicable for Generation – Distribution Connection Projects.

## 8. Environmental Considerations

a. Property Contamination

The Project Sponsor shall be responsible for identifying all chemical contamination on its properties that may be accessed by Okanogan PUD personnel for the duration of this agreement.

b. Polychlorinated Biphenyls (PCBs)

The Project Sponsor shall not use electrical equipment that contains PCBs in or on Okanogan PUD facilities.

c. Contamination Remediation

The Project Sponsor or the Project Operator shall notify Okanogan PUD immediately of any releases of hazardous chemicals to Okanogan PUD property or facilities by Project Sponsor equipment or activities. Okanogan PUD shall notify the Project Sponsor or the Project Operator if Okanogan PUD personnel are the first to notice the release. The Project Sponsor shall respond immediately to mitigate and remediate the release in accordance with all federal, state, and local requirements and especially with WAC 173-340. The Project Sponsor shall restore all remediated areas to their former status.

## D. Performance Requirements

All Projects shall be properly designed, constructed, operated and maintained to avoid degrading the reliability of the Okanogan PUD System and the Western Interconnection. A Project shall comply with the Project Performance Criteria, listed below, and shall be able to operate satisfactorily within the limits defined in the “Okanogan PUD System Characteristics” section below, in order to be considered properly connected. The Project Sponsor or Project Operator is expected to demonstrate, through monitoring, that the Project meets the performance criteria. The Project outages and undervoltages noted below shall be continuously monitored. The remaining criteria shall be met and considered in the design and operation of the Project although these do not necessarily have to be continuously monitored. If problems are suspected at any time, Okanogan PUD may require the Project Sponsor and/or Project Operator to demonstrate through monitoring the performance of the Project at the Connection Point meets these requirements.

If the requirements are not met, the Project Sponsor or Project Operator shall demonstrate to Okanogan PUD a plan to improve and meet the performance criteria. Additional relay and control requirements may be developed and enforced by Okanogan PUD after connection is made if these performance criteria are violated.

### 1. Project Performance Criteria

To ensure the reliability and integrity of the Okanogan PUD System, all Projects shall meet the Project performance criteria at the Connection Point. The Project shall not operate its equipment or system to harm the Okanogan PUD System or to its customers. The following section details the “Project Performance Criteria”:

#### a. Power Factor

At the metering point, the Project shall operate with a power factor 95% lagging (or better) during system peak. The Project Sponsor shall install power factor corrective equipment to reduce any detriment to other Okanogan PUD customers. Failure to do so may result in disconnecting or refusal to serve the Project Sponsor.

#### b. Transmission and Distribution System Outages

The Project shall not operate its equipment or system in such a manner as to cause the Unplanned Outage of any Okanogan PUD System components more than 1 time in any 12 month period, more than 3 times in any 5 year period, or more than 5 times in any 10 year period.

#### c. Temporary Undervoltages

The Project shall not operate its equipment or system in such a manner as to cause Temporary Undervoltages at the Connection Point more than 2 times in any 12 month period, more than 5 times in any 5 year period, or more than 8 times in any 10 year period. Undervoltages due to non-fault events are covered in the Voltage Fluctuations and Flicker requirements. Multiple Temporary Undervoltage conditions occurring within 1 minute shall be considered the same event

## d. Transient Overvoltages

The Project shall not operate its equipment or system in such a manner as to cause a peak transient voltage at the Connection Point greater than or equal to 140% of the nominal peak voltage.

## e. Temporary Overvoltages

The Project shall not operate its equipment or system in such a manner as to cause a Temporary Overvoltage at the Connection Point greater than or equal to 120% of the nominal system voltage.

## f. Voltage Fluctuations and Flicker

The allowable voltage fluctuation limits as a function of the frequency of occurrence at the Connection Point are provided in Okanogan PUD "Voltage Flicker" standards.

## g. Harmonic Content/Harmonic Distortion

The maximum allowable harmonic current injections (percentage harmonic distortion at each frequency as a function of load current) at the Connection Point for Projects connected at 115 kV and 13.2 kV are defined in Table 1 and Table 2, respectively. Operation of the Project in such a manner as to create a condition where the harmonic current injection at the Connection Point exceeds the limits provided for in Tables 1 and 2 for a duration greater than or equal to 1 hour on any single day or exceeds 150% of the limits provided for the given connection voltage for a duration greater than 5 minutes on any 2 days during a 6 month period is not allowed.

Table 1. Current Injection Harmonic Distortion Limits  
Connection Point Voltage 63,508 V to 132,790 V

Individual Harmonic Order (Odd Harmonics)						
$I_{sc} / I_{load}$	$h < 11$	$11\Omega h < 17$	$17\Omega h < 23$	$23\Omega h < 35$	$h > 35$	TDD
<20	2.0%	1.0%	0.75%	0.3%	0.15%	2.5%
20<50	3.5%	1.75%	1.25%	0.5%	0.25%	4.0%
50<100	5.0%	2.25%	2.0%	0.75%	0.35%	6.0%
100<1000	6.0%	2.75%	2.5%	1.0%	0.5%	7.5%
>1000	7.5%	3.5%	3.0%	1.25%	0.7%	10.0%

**Notes:** Even harmonics are limited to 25% of the odd harmonic limits above

Current distortions that result in DC offset are not allowed

$I_{load}$  is the maximum load current (fundamental frequency component) at the Connection Point

$I_{sc}$  is the maximum short-circuit current at the Connection Point

TDD (Total Demand Distortion) is the total harmonic current distortion expressed in % of maximum demand load current



Table 2. Current Injection Harmonic Distortion Limits  
Connection Point Voltage 120 V to 63,508 V

Individual Harmonic Order (Odd Harmonics)						
$I_{sc} / I_{load}$	$h < 11$	$11\Omega h < 17$	$17\Omega h < 23$	$23\Omega h < 35$	$h > 35$	TDD
<20	4.0%	2.0%	1.5%	0.6%	0.3%	5.0%
20<50	7.0%	3.5%	2.5%	1.0%	0.5%	8.0%
50<100	10.0%	4.5%	4.0%	1.5%	0.7%	12.0%
100<1000	12.0%	5.5%	5.0%	2.0%	1.0%	15.0%
>1000	15.0%	7.0%	6.0%	2.5%	1.4%	20.0%

#### h. Voltage Unbalance and Voltage Excursions

At the Connection Point, the Project shall not introduce more than 1% of Voltage Unbalance for more than 30 seconds without violating this performance criteria.

The Project shall operate its system without creating voltage excursions at the Connection Point. The voltage excursions may cause malfunction or dropout of motor contactors, electromechanical relays, high-intensity discharge lamps, adjustable speed motor drives, programmable logic controllers and computers. The Project may be responsible for correcting high or low voltage excursions and/or replacing damaged equipment if the excursions lie beyond the industry accepted CBEMA operating voltage envelope (ANSI/IEEE Std 446).

## 2. Okanogan PUD System Characteristics

All Project equipment connected to the Okanogan PUD System shall be designed to operate within the system conditions defined in this section. These characteristics are typical to the Okanogan PUD System during normal and contingency conditions, but may be exceeded for very short times.

#### a. Frequency

The frequency of the Okanogan PUD System shall be nominally 60 Hz. Douglas PUD has installed underfrequency relays to trip under various conditions, as outlined in the appropriate Appendix on Protection.

#### b. Steady-State Voltage Variations

The transmission and distribution system planning guidelines for Steady State Voltage Variations and Voltage Regulation at the Connection Point are listed in Table 3.

Table 3. System Voltage Variations at the Connection Point

Nominal Voltage (kV)	Absolute Voltage		Voltage Regulation	
	Minimum	Maximum	Normal	Contingency
13.2	95%	105%	5%	7%
115	95%*	103%	5%	5%

\* On unregulated 13.2 kV, maximum allowable contingency drop is based on Bonneville operating and planning criteria.

#### c. Harmonic Voltage Distortion

The maximum harmonic voltage distortion at the Connection Point for each transmission and distribution voltage level is defined in Table 4.

Table 4. System Harmonic Voltage Distortion Limits

Nominal Voltage (kV)	Maximum Individual Harmonic Voltage Distortion (%)	Maximum Total Voltage Distortion (%)
13.2	3.0	5.0
115	1.5	2.5

The limits in Table 4 represent the maximum harmonic voltage distortion at a given connection voltage for a duration less than or equal to 1 hour on any single day. The maximum harmonic voltage distortion shall not exceed 150% of the limits for a given connection voltage for a duration greater than 5 minute on any 2 days during a 6 month period.

#### d. Transient Overvoltages

The maximum peak Transient Overvoltage at the Connection Point should be less than or equal to 200% of the nominal system peak voltage.

#### e. Temporary Overvoltages

For the Okanogan PUD System, the maximum Temporary Overvoltages at any Connection Point should be significantly less than 180% of nominal system voltage.

### 3. Switchgear

#### a. All Voltage Levels

Circuit breakers, disconnect switches, and all other current carrying equipment connected to Okanogan PUD's transmission and distribution facilities shall be capable of carrying normal and emergency load currents without damage. For Interconnections, the equipment shall not become a limiting factor (bottleneck) in the ability to transfer power on the Okanogan PUD System.

All circuit breakers and other fault-interrupting devices shall be capable of safely interrupting fault currents for any fault that they are specified to interrupt. Application shall be in accordance with ANSI/IEEE C37 Standards. These requirements apply to the generation site, the interconnecting substation, the Connection Point as well as other locations on the Okanogan PUD System. Minimum fault-interrupting requirements are supplied by Okanogan PUD as part of the System Impact Study, and are based on the greater of the fault duties at the time of the connection request or those projected in long-range plans

#### b. Circuit Breaker Operating Times

Table 5 specifies the operating times typically required of circuit breakers on the Okanogan PUD System. These times also apply to equipment at the generation site and the Connection Point. System stability considerations may require very fast opening and reclosing times. The total automatic recloser time is the summation of the breaker interrupt and close time plus intentionally added delay to allow for de-ionization and subsequent extinction of the fault arc (referred to as the dead timer delay), and the protective relay requirements. The following table shows Okanogan PUD's required interrupting time of the breaker and the dead "timer" delay at system voltages.

Table 5 Circuit Breaker Operating Times

Voltage Class	Rate Interrupting Time (Cycles)
115 kV	5
Below 109 kV	8

c. Other Fault-interrupting Device Operating Times

Depending on the application, Okanogan PUD may allow the use of other fault-interrupting devices such as circuit switchers. Trip times of these devices are generally slower, and current interrupting capabilities are often lower than those of circuit breakers. Often circuit switchers are utilized to isolate generator step-up transformers from the transmission breakers. The dead "timer" delay on circuit switchers is typically 15 seconds and consequently, these devices usually are not reclosed.

4. Excitation System and Power System Stabilizers

The excitation system and power system stabilizers shall comply with WECC and NERC Reliability Standards for operation, maintenance, testing and reporting. Bus voltage control shall be operated in the automatic-terminal-Voltage Regulation mode.

For small generators (less than 20 MVA/unit or 75 MVA total facility capacity), Okanogan PUD shall evaluate the need for a power system stabilizer on a case-by-case basis.

5. Governor Speed and Frequency Control

For small generators, Okanogan PUD shall evaluate the need, on a case-by-case basis, for Project governor speed and frequency control systems. If it is, then the standards used shall conform to "Connection Requirements – Technical, Generation & Interconnection Facilities."

6. Voltage Regulation and Reactive Power Requirements

a. Okanogan PUD transmission & Distribution System Voltages

Okanogan PUD operates its transmission and distribution system within the voltage guidelines defined in Table 6 below. Projects shall operate within the full voltage range at the Connection Point without restricting the operational range of the Okanogan PUD System.

Table 6 - System Voltage Guidelines

Nominal Voltage (kV)	Absolute Voltage		Voltage Regulation	
	Minimum	Maximum	Normal	Contingency
13.2	95%	105%	5%	7%
115	95%*	103%	5%	5%

\* On unregulated 13.2 kV, maximum allowable contingency drop is based on Bonneville operating and planning criteria.

## b. Voltage Schedules and Operation of the Project

Major generators (10 MVA or greater) are provided voltage schedules by the Engineering Department. Voltage schedules are necessary for efficient and reliable electric power operations for adequate service to loads.

For small generators, Okanogan PUD shall evaluate the need to define the voltage schedules and operations of the Project on a case-by-case basis. If it is, then the standards used shall conform to "Connection Requirements – Technical, Generation & Interconnection Facilities."

### 1. Synchronous Generators and Projects with Solid State Inverters

Synchronous generators and Projects with solid-state inverters are required to produce or absorb reactive power up to the temporary thermal capability of the generator during disturbances.

For small generators, Okanogan PUD shall evaluate whether it is necessary to define need for voltage schedules for synchronous generators and Projects with solid state inverters. If it is, then the standards used shall conform to "Connection Requirements – Technical, Generation & Interconnection Facilities."

### 2. Induction Generators

Projects using induction generators (without solid-state inverters) are usually not required to participate in Voltage Regulation, however they shall not adversely affect voltage schedules. The System Impact Study determines the reactive power capability necessary to insure that these voltage schedules are maintained.

## c. Reactive Power and Voltage Regulator Requirements

### 1. Synchronous Generators And Projects With Solid State Inverters

For Generation – Distribution Connection Projects, Okanogan PUD shall evaluate the need for Voltage Regulation capability on a case-by-case basis for synchronous generators and Projects with solid state inverters. If it is required, then the standards used shall conform to "Connection Requirements – Technical, Generation & Interconnection Facilities."

For Generation – Distribution Connection Projects, Okanogan PUD shall evaluate the need for power factor compensation on a case-by-case basis. If it is required, then the standards used shall conform to "Connection Requirements – Technical, Generation & Interconnection Facilities."

## 7. Voltage and Frequency Operation during Disturbances

Power system disturbances initiated by faults, forced equipment outages, etc., expose connected generators to oscillations in voltage and frequency.

For Generation – Distribution Connection Projects, Okanogan PUD shall evaluate the need to define voltage and frequency operation during disturbances on a case-by-case basis. If it is required, then the standards used shall conform to "Connection Requirements – Technical, Generation & Interconnection Facilities."

## **E. Protection Requirements & Guidelines**

Refer to appropriate Appendices for different connections to the Okanogan PUD System.

### Appendix C-1: Protection Requirements and Guidelines - Non-Utility Generator Connection to Okanogan PUD:

This shall cover Project Sponsor generator(s) more than 5 MW or 50% of light load, whichever is the lesser value, connected to Okanogan PUD's 115 kV facilities. Appendix C-1 shall cover the protection requirements and shall provide guidelines accommodating the generating facilities to be connected to the Okanogan PUD System. This document identifies protective relay scheme modifications on the Okanogan PUD System as well as recommendations for the relay scheme to be installed at the Project Sponsor's generating facility.

### Appendix C-2: Protection Requirements and Guidelines - Interconnection:

This document shall cover the protection requirements for bulk power Interconnection between Okanogan, Bonneville, Douglas PUD, and Balancing Authority areas other than Bonneville or Douglas PUD.

### Appendix C-3: Protection Requirements and Guidelines – Small Generator Connection

This document shall cover the protection requirements for Generation – Distribution Connection Projects.

## F. SCADA, Metering and Telecommunication Requirements

This section states the minimum requirements for SCADA, metering and telecommunication associated with Projects connected to the Okanogan PUD System. All Projects that are connected to the Okanogan PUD System shall require metering equipment with revenue-metering-accuracy (i.e. metering enclosure with meter, associated equipment, instrument transformers, and certain interface enclosures with associated isolation devices) and the equipment shall belong to Okanogan PUD. Most SCADA analog values may not require revenue-metering accuracy, however hourly accumulator values used for energy accounting shall be revenue-metering accuracy.

At Project's expense, all of the following equipment for SCADA, metering, and telecommunications shall be owned, operated and maintained by Okanogan PUD.

Adequate space in an environmentally suitable and secure room with A/C & D/C supply, lights and cable trays shall be made available for sensitive equipment. Battery power back-up sufficient for 8-hour continuous operation of all devices is required. The following 19"-rack spaces (60" height) are required. For working clearance, approximately 3.5-foot clearance for front, and for back, of the 19" racks is required.

- 0.5 rack space for protection relays for each line/feeder bay & breaker
- 2 rack space for all SCADA – RTU and telecommunications equipment
- 2 vacant rack spaces for future growth (located at each end)

Where applicable, the Project Sponsor shall provide full access to the equipment by Okanogan PUD operating staff to maintain or to calibrate equipment owned by Okanogan PUD. If Project Sponsor installs locks, Okanogan PUD personnel shall be able to use existing Okanogan PUD keys issued to them to gain access.

### 1. Supervisory Control and Data Acquisition (SCADA)

The SCADA - RTU shall be installed at the Project facility for remote energy management of Project's devices by Okanogan PUD's Engineering Department. It shall be for the control, indication, monitoring, archiving and energy accounting of all breakers and devices at the Connection Point necessary to operate the Okanogan PUD System in a manner consistent with Prudent Electric Utility Practices.

The RTU compatible with Okanogan PUD's SCADA master shall be procured, installed, tested and maintained by Okanogan PUD at Project's expense. RTU size and point count to include alarms, analogs, accumulators, control-and-indication points, and any additional peripheral equipment shall be determined on a case-by-case basis.

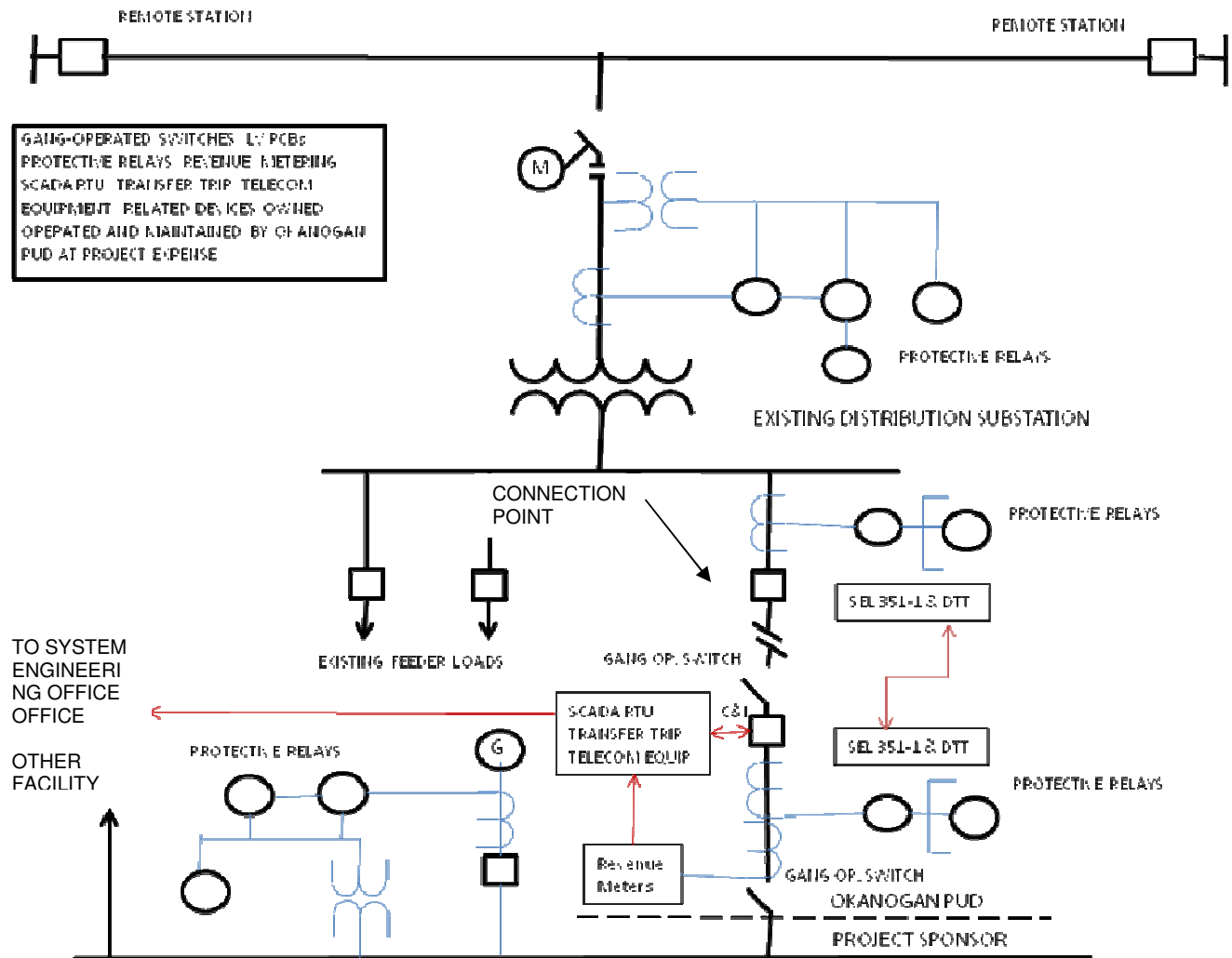
### 2. Metering

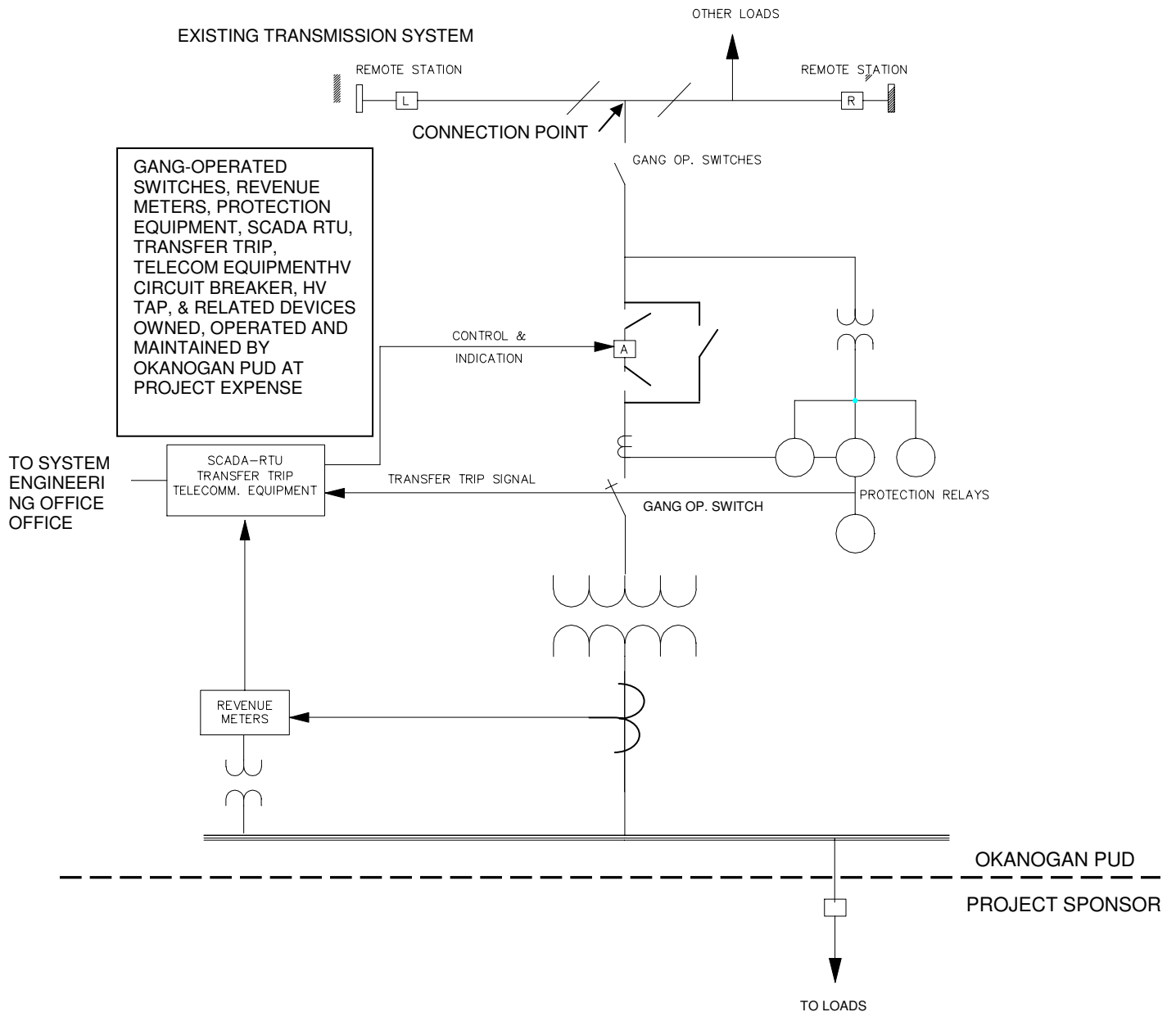
At Project's expense, all metering designs and construction drawings must be stamped by a Washington State licensed electrical engineer prior to submittal to Okanogan PUD for approval. The metering package shall be designed to conform to Okanogan PUD metering standards.

At Project's expense, Okanogan PUD's metering equipment shall be installed and maintained on the low voltage side (13.2 kV side) of Connection Point. If installed at the low voltage side of the Connection Point then power transformer and/or line losses shall need to be considered. Okanogan PUD prefers not to install metering at the 115 kV lev-

el due to cost prohibitive expenses and adverse maintenance issues. Okanogan PUD shall determine when separate metering is necessary.

**Figure 1. Okanogan PUD - Equipment Calibration & Maintenance at Connection Point (see accompanying Appendix E on Ownership)**

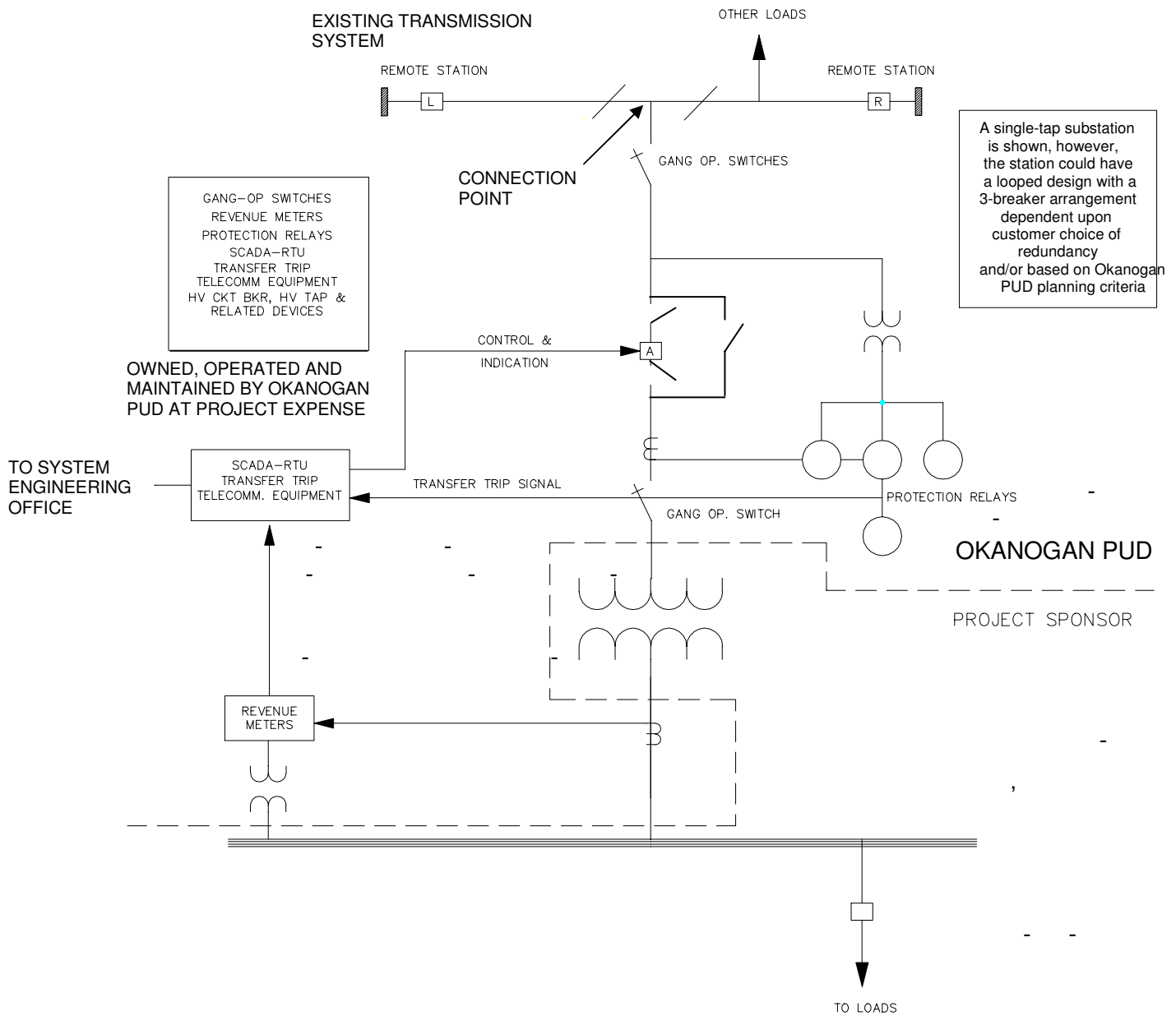




**Figure 2 - Equipment Ownership & Maintenance at Connection Point**

Note: Low Voltage Load Delivery Facility  
For 5 MW or Greater with No Substation Ownership by Project Sponsor





**Figure 3 - Equipment Ownership & Maintenance at Connection Point**

Note: Transmission Load Delivery Facility  
For 5 MW or Greater WITH Substation Ownership by Project Sponsor

a. Metering Equipment Requirements

A solid state meter shall be used to measure the real and reactive power interchange between the Okanogan PUD System and the Project. Three-element, three-phase, four-wire meters shall be utilized on wye connected power systems. Okanogan PUD will consider other metering configurations on a case-by-case basis.

A bi-directional WATT/VAR-hour meter shall be utilized to measure the power flow in and out of the Okanogan PUD System.

For metering equipment located in the Project substation, the installation of metering test switches is required. The metering devices shall be consistent with (approved meter type and communication media) Okanogan PUD's remote metering and data acquisition system.

b. Meter Accuracy

Meters shall be calibrated in accordance to Okanogan PUD standards.

c. Instrument Transformers

Voltage and current transformers shall be 0.3% metering accuracy class for both magnitude and phase angle over the burden range of the installed metering circuit. Instrument transformer correction factors may be applied to the meter to adjust the meter for inaccuracies associated with the secondary burdens in the current transformer and potential transformer circuits. In bi-directional situations where there are significant differences in the magnitude of capacity delivered to the Okanogan PUD System compared to the load supplied by it, prudent engineering practices shall be in place to accurately meter power flow in both directions. All instrument transformers shall comply with ANSI / IEEE Standard C57.13.

d. Loss Compensation

If the metering is not located at the Connection Point, then Okanogan PUD approved power transformer and/or line loss compensation values shall be applied to the meter to properly compensate for the losses in the power transformer and/or line.

The Project Sponsor is required to calculate the loss compensation and clearly document the values. The calculations are subject to Okanogan PUD's review and approval before a permanent connection of the Project is permitted.

e. Access to Metering Data

Okanogan PUD requires access to the Project meters. The Project Operator shall implement proper security to ensure that the integrity of the meter is not compromised. If data pulses are required from the revenue meter, then a pulse meter with "k-y-z" output will be installed. If additional information or reports are requested by the Project Sponsor, they shall be coordinated with Okanogan PUD.

The Project Sponsor is required to maintain metering information consisting of meter-relay one-line diagrams, scale factors, CT & PT ratios, transformer test data, meter calibration and any meter test reports in a 3-ring binder at the site. All information in the binder shall be accessible and the contents are subject to Okanogan PUD's review and approval.

f. Station Service Power

Metering requirements for the Station Service Power, if any, shall be determined on a case-by-case basis.

g. Calibration of Metering Facilities

Metering facilities shall be tested and calibrated by Okanogan PUD every five years. The Project Operator may request more frequent test intervals; however, the District shall perform such additional calibration testing at Project Operator expense, unless the tests demonstrate that metered amounts are outside of an acceptable range of accuracy. Under such circumstances, Okanogan PUD shall bear the cost of the calibration testing and the Project Operator and the District shall negotiate a mutually agreeable settlement to resolve the discrepancy. All interested parties or their representatives may witness the calibration tests. Calibration records shall be made available to all interested parties. The accuracy of the standard utilized for calibration purposes shall be traceable to the National Institute of Standards and Technology (NIST).

h. Totalized Metering & Special Meters

When totalized metering is requested, it may be installed at Project's expense. It shall be Okanogan PUD's option to provide totalized meter data either by hard-wired method or by summing various meters through use of a PC and billing software. Special metering to meet the Project Sponsor's need may be installed if primary metering accuracy is not compromised nor instrument transformer burdens exceeded.

3. Voice Communications – Phone Line and/or Radio Coverage

Voice communication is required between Okanogan PUD's Engineering Department and the Project Operator and/or Okanogan PUD's operating crews.

A typical phone line at the Project is sufficient to supply this communication path. In the event that the Project is supplying additional services (AGC, load following, reserves, system restoration, etc.) or if the Project is in excess of a specified generation capacity, back up communication with the Project is necessary. Independent voice communications for coordination of system protection, control, and communications maintenance activities between Okanogan PUD and the Project is required in addition to the communications stated above.

If Okanogan PUD crews are required to maintain lines or station equipment at or near the Project, two-way radio coverage is needed. At Project expense, Okanogan PUD may apply for modification of FCC licenses, relocate existing radio transmitters, install radio towers, communication buildings, microwave transmitters and/or acquire additional radio transmitters (and channel banks) to provide 95% probability of radio coverage:

- along the route to the site, and
- at the Project itself.

The radio channels and the functional capabilities of the radio transmitter(s) shall be compatible with Okanogan PUD's:

- radios now installed in operating crew vehicles
- transmitter(s) central controller
- Engineering Department consoles/console interface, and
- radio test equipment, fixtures, cables assemblies, software, and "flash memory" programs

#### 4. Data Communications

All generating and transmission /distribution facilities shall have in place, a means of transmitting monitoring, accounting, and control data where appropriate to the Okanogan PUD Engineering Department or designated communications "hub". In general, communications system availability for data on Okanogan PUD's main communication paths achieves a system availability of 99.995% or better. At Project expense, additions and maintenance to Okanogan PUD's communications shall be comparable to the aforementioned system availability figures.

If repeated outages occur, the Project Operator may be required to log the outages electronically and submit them to Okanogan PUD for evaluation. If the communication system fails to meet availability of 99.995% or better, the Project Operator is required to add backup communication equipment and communication paths at its expense.

##### a. SCADA

SCADA requirements consist of microwave channels, or fiber-optics from the site to the Engineering Department or to an alternate site designated by Okanogan PUD's Communications group. These are dedicated channels. Factors involved in selecting a type of circuitry are availability, proximity to the site, and cost. Fiber is preferred. Okanogan PUD shall determine whether alternative communication channels may be implemented on a case-by-case basis.

##### b. AGC

Data for AGC calculations and control is transferred to the above center at the Engineering Department and/or to another designated communication "hub" if required.

##### c. Energy Accounting

Energy accounting data may be transmitted from the site to Engineering Department by an RTU and/or telemetering, and/or dial-up phone lines through any one of the above mentioned data communication media.

## 5. Separate Telecommunications for Revenue-accuracy Metering

At Project's expense, a compatible and reliable communication channel may be required for remote interrogation of the meter, collect, merge, and store metering data with Okanogan PUD's remote metering and data acquisition system.

## 6. Telecommunications for Protection & Transfer Trip

Telecommunication channels shall be used for transfer trip if performance of the channel and the equipment meets the "Protection Requirements & Guidelines" of the connection.

Communications for protection shall function at the full performance level before, during, and after any power system fault condition (Service Performance Objective Class A per IEEE Standard 487).

### a. Speed of Operation

Throughput operating times of the telecommunications system shall not add unnecessary delay to the clearing or operating times of protection or remedial action schemes. Maximum permissible clearing times for faults are specified in "Protection Requirements & Guidelines" section. The throughput operating times of the telecommunications system is only a portion of that total clearing time.

### b. Equipment Compatibility

In order to provide maintainability and operability between the Project and the Okanogan PUD System, transfer trip units shall be acquired, installed, tested, owned, operated and maintained by Okanogan PUD at the expense of the Project. "Tone" equipment shall be of the same manufacturer and type. The need or implementation of peripheral capabilities such as signal counters, test switches, etc., are not required to be identical to those used at Okanogan PUD facilities but they shall be supplied by the Project Sponsor. Okanogan PUD shall consider the use of alternative equipment and/or technologies as proposed by the Project Sponsor as long as the equipment is suitable for the purposes of the application required.

**REFERENCES**

- ANSI / IEEE:** ANSI / IEEE Std C37 IEEE Standards for Circuit Breakers, Switchgears, Substations, and Fuses Standards Collection  
 ANSI / IEEE Std 80-1986 or latest version, IEEE Guide for Safety in AC Substation Grounding  
 ANSI / IEEE Std 100-1992 or latest version, The New IEEE Standard Dictionary of Electrical and Electronic Terms  
 ANSI / IEEE C 57.13 IEEE Standards on Instrument Transformers  
 ANSI / IEEE 367 IEEE Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault  
 ANSI / IEEE Std 446 Emergency & Standby Power for Industrial & Commercial Applications  
 ANSI / IEEE 665 Guide for Generating Station Grounding

**Institute of Electrical & Electronics Engineers, Inc.**

- (IEEE): IEEE C37.95 Guide for Utility-Consumer Interconnections  
 IEEE C37.102 Guide for AC Generator Protection  
 IEEE Std C57.116 IEEE Guide for Transformers Directly Connected to Generators  
 IEEE 81 Part 1 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Potentials  
 IEEE 81 Part 2 Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems.  
 IEEE Std 421.4 Guide for Preparation of Excitation System Specifications  
 IEEE 487 Protection of Wire-Line Communication Serving Electric Power Stations  
 IEEE 837 Standard for Qualifying Permanent Connections Used in Substation Grounding

**National Electrical Safety Code (NESC):****National Electrical Code**

- (NEC): Article 705, 1999 or latest version

**National Institute of Standards and Technology (NIST):****North American Electric Reliability Council**

- (NERC): Planning Standards & Operating Policies  
 Operating Policy 1 - Generation Control and Performance

**Occupational Safety and Health Administration**

- (OSHA): Standard 29 CFR 1910.269 or later

**Okanogan PUD:****Uniform Building Code (UBC):****Washington State Administrative Code**

- (WAC): WAC Rules

**Washington Industrial Safety and Health Administration**

- (WISHA): WISHA Standards

**Western Electricity Coordinating Council**

- (System Dispatch Office):  
 Progress Report  
 Policies and Procedures  
 Reliability Criteria for Transmission System Planning  
 Policy Statement on Power System Stabilizers  
 New Generation Connection Policy  
 Coordinated Off-Nominal Frequency Load Shedding and Restoration Program  
 Voltage Stability Criteria  
 Procedures for Regional Planning Project Review & Rating Transmission Facilities  
 Testing Guidelines for Synchronous Unit Dynamic Testing & Model Validation

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1.0	2/25/2008	Created	
2.0	10/11/2011	Updated	DD/RG/DM/TD
4.0	12/30/2011	Made wording more consistent.	TD