BONNEVILLE
POWER ADMINISTRATION

TECHNICAL REQUIREMENTS FOR THE CONNECTION OF TRANSMISSION LINES AND LOADS

PREPARED BY THE INTERCONNECTION DEVELOPMENT TEAM

U.S. DEPARTMENT OF ENERGY
BONNEVILLE POWER ADMINISTRATION
TRANSMISSION BUSINESS LINE
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CONTENTS

1. Introduction

The Bonneville Power Administration Transmission Business Line (BPA TBL) has prepared this document to identify technical requirements for connecting transmission lines and loads into the BPA transmission system (BPA System). A similar document that discusses the interconnection of generating resources is also available from BPA TBL by requesting DOE/BP-3162 [Ref. 1.5] from BPA's Document Request Line. The aim of these requirements is to assure the safe operation, integrity and reliability of the BPA System. Contractual matters, such as costs, ownership, scheduling, and billing are not the focus of this document.

In this document the terms BPA, BPA System, BPA TBL, BPA Load Control Area, etc. all refer only to the BPA Transmission Business Line (BPA TBL) and/or its transmission system, not to the BPA Power Business Line (BPA PBL). Connection proposals from the BPA PBL are handled in the same manner as those from any other Requester. The term Requester describes the utility or other entity that requests a new or modified line or load connection.

All requests for transmission service must be made pursuant to the terms of BPA TBL's prevailing transmission tariffs. BPA TBL evaluates connection requests on a case-by-case basis. Specific connection requirements are then provided back to the Requester.

Physical laws that govern the behavior of electric systems do not recognize boundaries of electric facility ownership. Therefore the electric power systems must be studied, without regard to ownership, to develop a properly designed connection. Before approving these studies (See Section 3), BPA TBL reviews them with the affected parties, considering issues such as short-circuit duties, transient voltages, reactive power requirements, stability requirements, harmonics, safety, operations, maintenance and Prudent Electric Utility Practices. BPA TBL calculates transfer capability in accordance with the Tariff.

There is another form of interconnection that may not result in a direct connection to the BPA System but, through telemetering, can incorporate loads, generators or transmission lines into the BPA Load Control Area. This type of interconnection uses dynamic signals, consisting of the techniques of dynamic scheduling and pseudo-ties, to transfer ancillary service responsibilities from one party to another.

This document is not intended as a design specification or an instruction manual and the information presented is subject to change. Technical requirements stated herein are consistent with BPA **TBL**'s current internal practices for system additions and modifications. These requirements are also generally consistent with the North American Electric Reliability Council (NERC), Western Systems Coordinating Council (WSCC) and Northwest Power Pool (NWPP) principles and practices. This document is also intended to be consistent with the Federal Energy Regulatory Commission (FERC) regulations governing separation of transmission and generation functions. This document is based upon the standards in place at the time the document was written or revised. At the time of the request for a connection, the standards in place at that time will govern. Important terms used in this document may be capitalized and are defined in Section 9 - *Definitions*.

Copies of this document are available by calling:
BPA's Document Request Line at (800) 622-4520 and
Requesting DOE/BP - 3183
If you have questions or need additional information, please call:
BPA's Public Information Center at (503) 230-3478 or (800) 622-4519

2. Scope

The technical requirements contained herein generally apply to all new or modified line or load connections regardless of type or size. The location of the facility, type of connection, and impacts on the BPA System or another utility's system determine the specific requirements. The connection must not degrade the safe operation, integrity and reliability of the BPA System. The requirements in this document are intended to protect BPA TBL facilities, but cannot be relied upon to protect the Requester's facilities. Although a physical connection may not exist, this document also addresses technical requirements for dynamic signals.

2-A Applicable Codes, Standards, Criteria and Regulations

To the extent that the codes, standards, criteria and regulations are applicable, the facilities shall be in compliance with those listed in Section 10 of this document.

2-B Environmental Considerations of the National Environmental Policy Act

Federal Law requires that BPA TBL comply with the National Environmental Policy Act (NEPA) [Ref. 1.6]. Compliance includes a written assessment of the environmental impacts of a Federal action. Depending on the complexity of the proposed facilities, NEPA requirements may include an Environmental Impact Statement, Environmental Assessment, or Categorical Exclusion. TBL can make the final connections when those requirements are satisfied.

2-C Safety, Protection, and Reliability

BPA TBL, in cooperation with affected parties, makes the final determination as to whether the BPA System is properly protected before an interconnection is closed. The Requester is responsible for correcting such problems before facilities are energized or interconnected operation begins. However, BPA TBL may determine equivalent measures to maintain the safe operation and reliability of the BPA System. In situations where there is direct connection with another utility's system, the requirements of that utility also apply.

2-D Responsibilities

BPA TBL and the Requester are each responsible for the planning, design, construction, reliability, protection, and safe operation and maintenance of their own facilities unless otherwise identified in the construction, operation and/or maintenance agreements.

2-E Special Disturbance Studies

BPA TBL uses series and shunt capacitors, high-speed reclosing, single-pole switching and high-speed reactive switching at various locations. These devices and operating modes, as well as other disturbances and imbalances, may cause stress on connected facilities. The Requester is responsible for any studies necessary to evaluate possible stresses on the proposed facilities and for all corrective actions.

2-F Steps for Connecting Facilities

A flow chart (Figure 3-1) describes the steps for connecting transmission lines and loads.

2-G Study Estimates

BPA TBL develops cost estimates on a case-by-case basis when asked to perform interconnection studies. BPA TBL may provide estimates for the required interconnection facilities that are identified by the interconnection studies and shown on the approved Project Requirements Diagram.

3. Connection Studies and Requester-Supplied Information

All requests for transmission service must be made pursuant to the terms of BPA TBL's prevailing transmission tariffs. If a connection is requested without an accompanying transmission service request, the connection and its operation will comply with regional practices, which may change with time. BPA TBL should be contacted as early in the planning process as possible for any proposed transmission line or load connections to the BPA System and/or changes to the BPA's Load Control Area. Changes within certain areas of BPA System may be costly due to extensive reinforcements. That is, BPA TBL may have to add or modify its transmission system substantially before allowing a new transmission line or load to begin connected operation. A study must be made to determine the required facilities and modifications to accommodate the new connection. This study may also address the transmission system capability, impact on other interconnections, transient stability, voltage stability, losses, voltage regulation, harmonics, voltage flicker, electromagnetic transients, machine dynamics, ferroresonance, metering requirements, protective relaying, substation grounding, and fault duties.

3-A. Initial Request to BPA TBL for Connection

The Requester should provide BPA TBL with sufficient information to determine if a detailed System Impact and Facility Requirement Study is required by submitting BPA Form No. F6420.25, *Transmission Line and Loads Connection Information*, and completing Sections 1 and 2. (A copy of this form is at the end of this document).

3-B. System Impact and Facility Requirement Study (Detailed Connection Study)

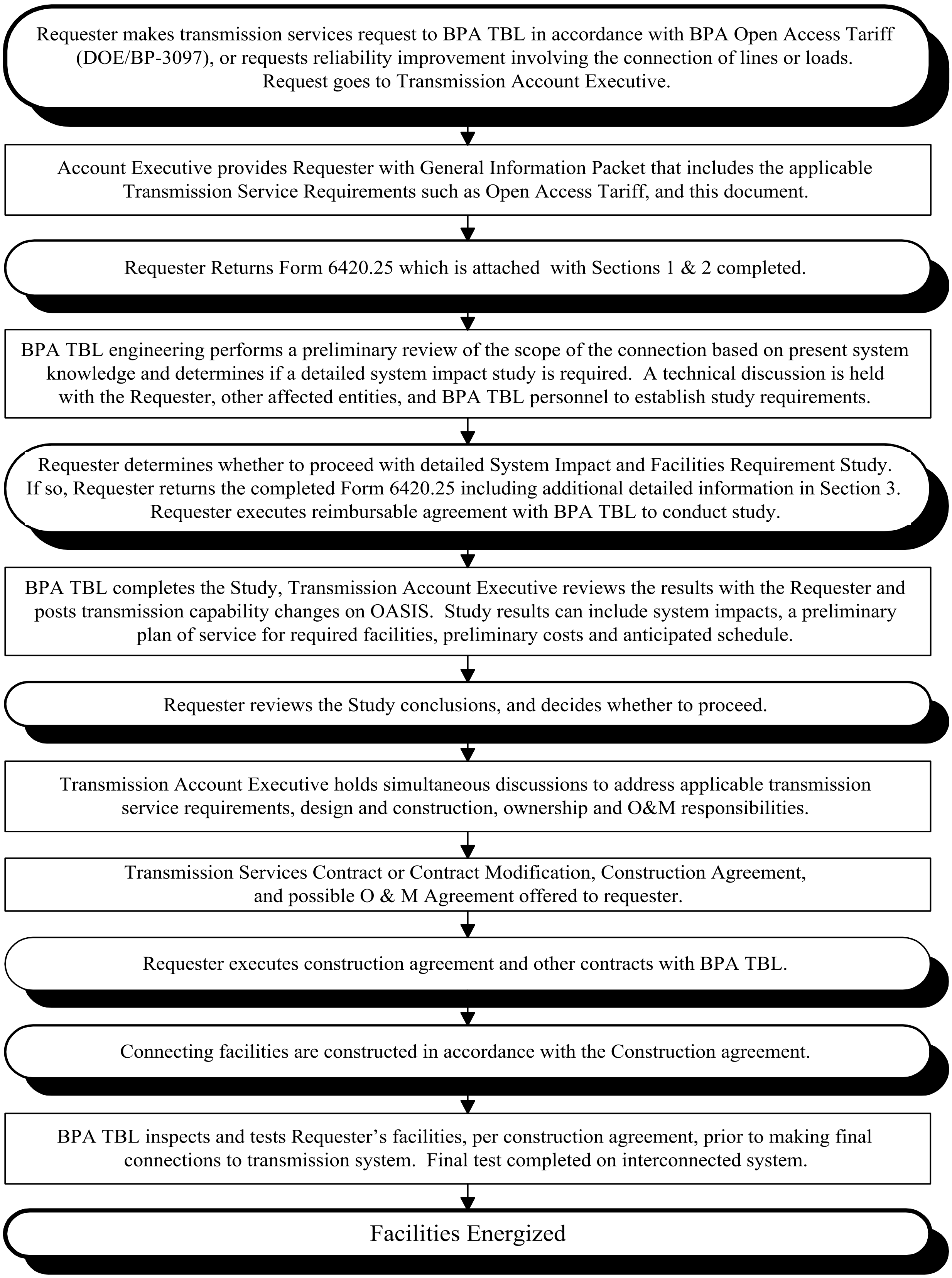
If a System Impact and Facility Requirements Study is required, BPA TBL will notify the Requester and forward a study agreement to cover the cost of the study. The Requester will then be asked to complete Section 3 of the above form. This section provides BPA TBL with specific information required to perform the study. Upon request BPA TBL will also provide system-modeling data for the requester to study their side of the connection.

The System Impact and Facility Requirement Study can require considerable time and effort, depending on the type of connection and its potential system impacts. Because of this, BPA TBL and the Requester must enter into an agreement prior to performing the study.

3-C. Study Results

The System Impact and Facility Requirement Study results may include the following:

1. A preliminary Project Requirements Diagram;
2. Any modifications and/or additions needed to the BPA Transmission System to accommodate the connection;
3. The major connection equipment that the Requester would provide;
4. The requirements for voltage regulation, harmonics, and power factor control;
5. Revenue metering and interchange telemetering requirements;
6. Protective relaying, grounding, remedial action and control requirements;
7. Telecommunication requirements;
8. Operational control of facilities and maintenance requirements;
9. Approximate schedule and lead times for BPA TBL to perform its design, material procurement, construction and energization;
10. An estimate of costs for additions and modifications to be performed by BPA TBL; and
11. The alternate locations where the new facility(s) may be connected to the BPA System.



Items which are shadowed identify actions by the Requester.

Figure 3-1 Steps for Connecting Transmission Lines and Loads

4. General Requirements

4-A. Safety and Isolating Devices

At the Connection Point to the BPA System, an isolating device, which is typically a disconnect switch, shall be provided that physically and visibly isolates the BPA System from the connected facilities. Safety and operating procedures for the isolating device shall be in compliance with the BPA Accident Prevention Manual and the Requester's and interconnecting utility's safety manuals. All switchgear that could energize equipment shall be visibly identified, so that all maintenance crews can be made aware of the potential hazards. The isolating device may be placed in a location other than the Connection Point, by agreement of BPA TBL and affected parties. In any case the device:

- Must simultaneously open all phases (gang operated) to the connected facilities;
- Must be accessible by BPA TBL and may be under ultimate BPA TBL Dispatcher jurisdiction;
- Must be lockable in the open position by BPA TBL;
- Would not be operated without advance notice to affected parties, unless an emergency condition requires that the device be opened to isolate the connected facilities; and
- Must be suitable for safe operation under all foreseeable operating conditions.

All work practices, involving BPA owned, maintained, and/or operated equipment, must be done in accordance with the principles contained in the BPA Accident Prevention Manual, and done at the direction of BPA Dispatchers. BPA TBL personnel may lock the device in the open position and install safety grounds:

- If it is necessary for the protection of maintenance personnel when working on deenergized circuits;
- If the connected facilities or BPA TBL equipment presents a hazardous condition;
- If the connected facilities jeopardize the operation of the BPA System.

4-B. Point of Connection Considerations

1. General Constraints

Connected facilities shall not restrain BPA TBL from taking a transmission line or line section or other equipment out of service for operation and maintenance purposes. The line and all components must be designed and installed to be maintainable within BPA TBL’s right to maintain.

2. General Configurations

Connection of new facilities into the transmission system usually falls into one of four categories:

a. Connection into an existing 69 to 500 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 on the low-voltage side (typically 12 to 69 kV) of a new or existing power transformer in a BPA TBL owned substation. This connection, which is discussed below, may create a multi-terminal line if the load side of the transformer includes a generation source or is non-radial on the low voltage side;

c. Connection at 69 to 500 kV by directly tapping an existing transmission line; or

d. Connection at 69 to 500 kV by looping an existing transmission line into a new customer or BPA TBL owned substation. This connection may result in a new, non-BPA TBL owned substation within an existing transmission path.

BPA TBL must maintain full operational control of the 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, BPA TBL will retain contractual path rights. 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 or c 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 BPA TBL's ability to protect, operate, dispatch, and maintain the transmission line. The increased complexity of the control and protection schemes affects system stability and reliability. The additional terminal may also decrease the overall performance and availability of the existing line. BPA TBL determines the feasibility of multi-terminal line connections on a case-by-case basis.

These four categories can include the situation where another utility owns the transmission line or equipment that directly connects to the BPA System.

3. Special Configurations

The following configurations may substantially affect the costs of a particular connection plan, sometimes making an alternate Connection Point more desirable.

a. Connection to Main Grid Transmission Lines and Substations

Main Grid transmission lines include all 500 kV, 345 kV, and some lower voltage lines, as defined by BPA's Reliability Criteria. These circuits form the backbone of the Pacific NW transmission system and provide the primary means of serving large geographical areas. The use of three-terminal lines on the Main Grid often adversely affects system stability and reliability, as well as critical operation and maintenance of these lines. Therefore BPA TBL discourages proposals to create three-terminal lines on the Main Grid. Typically a substation, with additional breakers at the Connection Point, will have to be developed. The cost of this step may make connection to non-Main Grid lines more appropriate for most lines and loads.

b. Connection to 287 and 345 kV Lines

BPA TBL can operate its 287 and 345 kV transmission lines at either the normal voltage or at 230 kV. Each of these lines is currently terminated in transformers that can be bypassed for 230 kV operation. BPA TBL reserves the right to operate these lines at 230 kV. If a transformer fails at an end terminal, extended 230 kV operation may be required. For continued operation the connected facilities must be capable of operating at these voltages.

4. Other Considerations

a. Existing Equipment

Existing electrical equipment, such as transformers, power circuit breakers, disconnect switches, arresters, and line conductors were purchased based on the duties expected in response to system additions identified in long-range plans. System modifications such as, the connection of a new line, equipment or load may cause existing equipment to be underrated, requiring replacement.

b. System Stability and Reliability

The BPA System has been developed with careful consideration for system stability and reliability during disturbances. The type of connection, size of the load, breaker configurations, load characteristics, and the ability to set protective relays will affect where and how the Connection Point is made. The Requester may also be required to participate in special protection schemes, called remedial action schemes (RAS) such as generator dropping, load shedding, or load tripping. The portion of the transmission path capacity that the Requester uses determines the pro rata share of RAS. If RAS participation is required, the Requester and BPA TBL will jointly plan and coordinated the RAS implementation.

c. Control and Protection

BPA TBL coordinates its protective relays and control schemes to provide for personnel safety and equipment protection and to minimize disruption of services during disturbances. New Connection Points usually require the addition or modification of protective relays and/or control schemes. The new protection must be compatible with existing protective relay schemes. Sometimes the addition of voltage transformers, current transformers, or pilot scheme (transfer trip) also is necessary. BPA TBL uses single-pole protective relaying on most 500 kV lines and pilot tripping on all 500, 345, 287 and most 230 kV lines. Conventional directional zone protection is usually used on 69 to 345 kV lines. Distribution type protection is generally used for circuits below 69 kV. At the time of the connection request, BPA TBL will supply the Requester with an approved list of protective relay systems suitable for the interconnection. Should the Requester select a relay system not on our approved list, BPA TBL reserves the right to perform a full set of acceptance tests prior to granting permission to use the selected protection scheme.

d. Dispatching and Maintenance

BPA TBL 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 BPA TBL customers is essential and may require additional switchgear, equipment redundancy, or bypass capabilities at the Connection Point for acceptable operation of the system.

e. Atmospheric and Seismic

The effects of wind storms, 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.

4-C. Transmission and Substation Facilities

Some new connections to the BPA System require that one or more BPA TBL 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 and/or switches shall not restrict the capability of the line(s) and BPA TBL's contractual transmission path rights.

1. **Transmission line designs** shall meet the requirements of BPA Reliability Criteria and Accident Prevention Manual which, among other things, indicates that**:**

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

   b. The minimum approach distances shall be designed in accordance with BPA's Accident Prevention Manual.

   c. The line shall be designed and sagged to meet or exceed the NESC C2 clearance to ground while operating at 100°C mean operating temperature.

   d. All new transmission lines connecting to a BPA TBL substation shall have one or more overhead ground wires (OHGW) to provide substation shielding. For transmission lines from 115 to 161 kV, the OHGW shall be 1/2 mile in length. For transmission lines 230 kV and above, the OHGW shall be 1 mile in length. The OHGW shall be insulated from the substation and grounded at the remote point.

- **e.** All 500 kV double-circuit transmission lines shall have one or more OHGW for the entire length of the line. All 500 kV transmission lines east of the Cascade Mountains shall have OHGW. These OHGW are not continuous but are approximately 15 mile segments with a ground connection in the center.
- **f.** All lines connecting to a BPA TBL substation shall include either rod gaps or surge arresters for substation entrance protection. BPA TBL staff will recommend the appropriate level of entrance protection.
- **g.** Access to all structures shall be provided.
- **h.** Underbuilds to existing BPA TBL transmission line facilities will generally not be allowed. If an underbuild is requested, a special 'pole contract agreement' will have to be negotiated.

2. **Customer-built substations** that interrupt an existing BPA TBL transmission path or customer-built facilities in a BPA TBL substation must meet the requirements of the BPA Reliability Criteria and Accident Prevention Manual. A summary of these requirements follows:
   - **a.** The facility must be designed to applicable requirements of the NESC C2, NEC, ANSI and IEEE Standards.
   - **b.** The site selection must consider environmental aspects, oil containment, and fire suppression.
   - **c.** Grounding must be in accordance with IEEE Guide 80.
   - **d.** Two sources of station service may be required.
   - **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 other ancillary equipment which will serve as the continuation of the path during any switching configuration.

4-D. 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 added to control voltage stress to acceptable levels. Connection studies include the evaluation of the impact on equipment insulation coordination. BPA TBL may identify additional requirements to maintain an acceptable level of BPA System availability, reliability, equipment insulation margins, and safety.

Voltage stresses, such as lightning or switching surges, and temporary overvoltages 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 wound devices, and shielding with rod gaps (or arresters) on the incoming lines. The following requirements may be necessary to meet the intent of BPA's Reliability Criteria.

1. Lightning Surges

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

Lines at voltages of 69 kV and higher that terminate at BPA substations must meet additional shielding and/or surge protection requirements identified in Section 4-C. For certain customer service substations at 230 kV and below, BPA TBL 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 tap line length, the presence of a power circuit breaker on the transmission side of the transformer, and the size of the transformer.

2. Switching Surges

At voltages below 500 kV, modifications to protect BPA System equipment from switching surges are not anticipated. However, the results of the System Impact and Facility Requirements Study identify the actual needs. At 500 kV, BPA TBL requires that arresters be added to new line terminations at BPA substations.

3. 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 these duties.

a. Local Islanding

When the connection involves tapping 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 loads that also are tapped off this line isolated from the power system. Delayed fault clearing, overvoltages, ferroresonance, extended undervoltages, and degraded service to other BPA TBL customers can result from this 'local island' condition. Therefore local islands involving BPA transmission facilities are not allowed to persist. Special relays to detect this condition and isolate the local generation from BPA TBL facilities are described in Section 6-B.2.

b. Neutral Shifts

When generation or a source of 'back-feed' is connected to the low-voltage side of a delta-grounded wye customer service 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. This type of overvoltage is commonly described as a neutral shift and can increase the voltage on the unfaulted phases to as high as 1.73 per unit. At this voltage, the equipment insulation withstand-duration can be very short. Several alternative remedies are possible:

- Provide an effectively grounded system on the high-voltage side of the transformer that is independent of other transmission system connections.
- Size the high-voltage-side equipment to withstand the amplitude and duration of the neutral shift.
- Rapidly separate the back-feed source from the step-up transformer by tripping a breaker, using either remote relay detection with pilot scheme (transfer trip) or local relay detection of overvoltage condition (see Section 6-B.2).

Effectively grounded is defined as an $X_0/X_1 \leq 3$ and $R_0/X_1 \leq 1$. Methods available to obtain an effective ground on the high-voltage side of the transformer include the following:

- A transformer with the transmission voltage (BPA TBL's) side connected in a grounded-wye configuration and low voltage (Connection Point) side in closed delta.
- A three-winding transformer with a closed-delta tertiary winding. Both the transmission and distribution side windings are connected in grounded wye.
- Installation of a grounding transformer on the transmission voltage (BPA TBL) side.

Any of these result in an effectively grounded system with little risk of damage to surge arresters and other connected equipment.

4-E. 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 would not be within acceptable and safe limits (due for example to high soil resistivity or limited substation space), grounding rods and grounding wells can 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. A fiber optic cable is an excellent choice for telecommunications and control between two substations to maintain 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. BPA TBL must approve any connection to a BPA substation ground grid.

New interconnections of transmission lines and/or generation 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 connection study will determine if modifications are required and the estimated cost.

The ground grid should be designed to applicable ANSI and IEEE Standards relating to safety in substation grounding [Ref. 2.1, 2.2, 2.4, 2.5, 2.6, 2.7].

4-F. Inspection, Test, Calibration and Maintenance

Transmission elements (e.g. lines, line rights of way, circuit breakers, control and protection equipment, metering, and telecommunications) that are a part of the proposed connection and could affect the reliability of the BPA System need to be inspected and maintained in conformance with regional standards. The Requester has full responsibility for the inspection, testing, calibration, and maintenance of its equipment, up to the location of change of ownership or Connection Point. Transmission Maintenance and Inspection Plan (TMIP) requirements are a portion of the WSCC Reliability Management System for transmission. The Requester or utility may be required by WSCC to annually certify that it has developed, documented, and implemented an adequate TMIP.

1. Pre-energization Inspection and Testing

Before initial energization, the Requester shall develop an Inspection and Test Plan for pre-energization and energization testing. Section 6-D describes specific installation testing requirements for protection systems. BPA TBL may request to review the test plan prior to the test(s). BPA TBL may require additional tests. Cost sharing for these tests is subject to negotiation. The Requester shall make available to BPA TBL, upon request, all drawings, specifications, and test records of the Connection Point equipment. Also upon request BPA TBL will make available to the Requester similar documents describing the BPA TBL Connection Point equipment.

2. Summary of the WSCC Transmission Maintenance and Inspection Plan (TMIP)

WSCC requires that member utilities prepare a written description of, and update as necessary, its annual TMIP. The TMIP shall provide descriptions of the various maintenance activities, schedules and condition triggers for performing the maintenance, and samples of any checklists, forms, or reports used for maintenance activities.

The TMIP may be performance-based, time-based, or both, as may be appropriate. The TMIP shall:

- Include the schedule interval (i.e., every two years) for any time-based maintenance activities and a description of conditions that will initiate any performance-based activities;
- Describe the maintenance and inspection methods for each activity or component listed in Sections 4-F.2.a and b below.;
- Provide any checklists, forms, or reports used for maintenance activities;
- Where appropriate, provide criteria to be used to assess the condition of a transmission facility or component;
- Where appropriate, specify condition assessment criteria and the requisite response to each condition as may be appropriate for each specific type of component or feature of the transmission facilities;
- Include specific details regarding transmission line and station maintenance practices as per Section 4-F.2.a and b below.

a. Transmission Line Maintenance

The TMIP shall, at a minimum, describe the maintenance practices for all applicable transmission line activities including

- Patrols and inspections, routine, detailed and emergency.
- Vegetation management and right-of-way maintenance.
- Contamination control (insulator washing)

b. Station Maintenance

The TMIP shall describe the maintenance practices for all applicable station facilities:

- Circuit breakers
- Power transformers
- Reactive devices (including, but not limited to, shunt capacitors, series capacitors, synchronous condensers, shunt reactors, and tertiary reactors.)
- Regulators
- Protective relays

c. Maintenance Record Keeping and Reporting

Maintenance records of all maintenance and inspection activities for at least five years shall be maintained. The records of maintenance and inspection activities shall be made available to the WSCC or other regulatory body, as requested, to demonstrate compliance with the TMIP. The maintenance and inspection records shall, at a minimum:

- Identify the person(s) responsible for performing the work or inspection;
- Indicate the date(s) the work or inspection was performed;
- Identify the transmission facility; and
- Describe the inspection or maintenance that was performed.

The transmission owner shall maintain and make available on request, records for substantial maintenance or inspection of the items listed in **a.** and **b.** above.

3. Calibration and Maintenance of Revenue and Interchange Metering

Revenue and Interchange Metering will be calibrated every two years. Other calibration intervals may be negotiated. All interested parties or their representatives may witness the calibration tests. Calibration records shall be made available to all interested parties.

The calibration standards used for calibration shall have their accuracy traceable to the National Institute of Standards and Technology. The calibration standard shall have been calibrated and certified within twelve months prior to the actual meter calibration.

4-G. Station Service

Power that is provided for local use at a 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.

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 the BPA transmission system beyond those specified in applicable NERC, WSCC, and NWPP reliability criteria.

Appropriate providers of station service and alternate station service are determined during the connection planning process, including Project Requirements Diagram development and review. Generally, the local utility will be the preference provider of primary station service unless it is unable to serve the load, or costs to connect to the local utility are prohibitive.

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

4-H. Ancillary Services

All loads and transmission facilities must be part of a control area. The control area provides critical ancillary services, including load regulation, and frequency response, operating reserves, voltage control from generating resources, scheduling, system controls and dispatching service, as defined by FERC, or their successors. All new connections to the BPA System also require a transmission contract. The Requester must choose the control area in which the new facilities will be located and the source or provider of ancillary services. This election 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. BPA TBL will then determine the telemetering, controls, and metering that will be required to integrate the load or facility into the chosen control area and to provide the necessary ancillary services. If the Requester chooses a self-provision or a third party provision of reserves, then special certification and deployment procedures must be incorporated into the BPA TBL AGC system. Detailed requirements are available in the document, “Criteria for Self Provision of Operating Reserves and Load Regulation and Frequency Response”. The provision of the required ancillary services must meet all relevant NERC, WSCC, and NWPP reliability policies and criteria, or their successors.

5. Performance Requirements

The following performance requirements can be satisfied by various methods. It is the responsibility of the Requester to propose a preferred method for BPA TBL concurrence.

5-A. Electrical 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, and
- Other disturbances that might degrade the reliability of the interconnected BPA System.

5-B. Switchgear

1. All Voltage Levels

Circuit breakers, disconnect switches, and all other current-carrying equipment connected to BPA's transmission facilities shall be capable of carrying normal and emergency load currents without damage. This equipment shall not become a limiting factor, or bottleneck, in the ability to transfer power on the BPA System.

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. The circuit breaker shall have this capability without the use of intentional time delay in clearing, fault reduction schemes, etc. Application shall be in accordance with ANSI/IEEE C37 Standards. These requirements apply to the equipment at the connection point as well as other locations on the BPA System. Minimum fault-interrupting requirements are supplied by BPA TBL, and are based on the greater of the fault duties at the time of the interconnection request or those projected in long-range plans.

The circuit breaker shall be capable of performing other duties as required for the specific application. These duties may include: capacitive current switching, load current switching, and out-of-step switching. The circuit breaker shall perform all required duties without creating transient overvoltages that could damage BPA TBL equipment. Switchgear on the high side of a delta-grounded wye transformer that can interrupt faults or load must be capable of the increased recovery voltage duty involving interruptions while ungrounded. The connection of a transmission line or load can coincidentally include other generating resources. When this system configuration is connected to the low-voltage side of a delta-grounded wye transformer, the high-voltage side may become ungrounded when remote end breakers open, resulting in high phase-to-ground voltages. This phenomena is described in Section 4-D.3.b under 'neutral shifts.'

2. Circuit Breaker Operating Times

Table 5-1 specifies the operating times typically required of circuit breakers on the BPA System. These times will generally apply to equipment at or near the Connection Point. System stability considerations may require faster opening times than those listed. Breaker close times are typically four to eight cycles. The automatic recloser times in Table 5-1 are the summation of the breaker close time plus intentionally added delay to allow for extinction of the fault arc (de-ionization), and the protective relay requirements. Circuit breaker interrupting time may vary from those in Table 5-1 but must coordinate with other circuit breakers and protective devices.

Table 5-1 Typical Circuit Breaker Operating Times

Voltage Class (kV L-L rms)	Rated Interrupting Time (Cycles)	Automatic Reclose Time (Cycles)
Below 100 kV	≤ 8	*
100 to 138 kV	≤ 5	35 to 120
161 to 230 kV	≤ 3	35 to 120
287 to 345 kV	2	35 to 60
500 kV	2	20 to 90

* - Varies significantly by line.

3. Other Fault-Interrupting Device Operating Times

Depending on the application, the use of other fault-interrupting devices such as circuit switchers may be allowed. Fuses may be adequate for protecting the high voltage side of a high voltage delta - low voltage grounded wye transformer. Trip times of these devices are generally slower, and current-interrupting capabilities are often lower, than those of circuit breakers. These devices must have been tested for the duty in which they are to be applied and they must coordinate with other protective devices operating times. Use of transformer fuses may result in ‘single phasing’ of low side connected loads.

5-C. Transformers, Shunt Reactive and Phase Shifters

Transformer tap settings (including those available for under load and no load tap changers), reactive control setpoints, and phase shift angles must be coordinated with the BPA TBL to optimize both reactive flows and voltage profiles. Automatic controls may be necessary to maintain these profiles on the interconnected system. Timed changes should be coordinated with time schedules established by the NWPP.

5-D. Power Quality Requirements

1. 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 [Ref. 2.5] provides definitions and limits on acceptable levels of voltage fluctuation. Loads or system connections to the BPA System shall comply with the limits set by IEEE 519. If it is determined that the new connection is the source of the fluctuations, the necessary equipment to control the fluctuations to the limits identified in IEEE 519 is the responsibility of the Requester.

2. Harmonics

Harmonics can cause telecommunication interference, increase thermal heating in transformers, disable solid state equipment and create resonant overvoltages. In order to protect equipment from damage, harmonics must be managed and mitigated. The new connection shall not cause voltage and current harmonics on the BPA System that exceed the limits specified in IEEE Standard 519. Harmonic distortion is defined as the ratio of the root mean square (rms) value of the harmonic to the rms value of the fundamental voltage or current. Single frequency and total harmonic distortion measurements may be conducted at the Connection Point, or other locations on the BPA System to determine whether the new connection is the source of excessive harmonics. If it is determined that the new connection is the source of the harmonic voltage and currents the necessary equipment to control the harmonic voltage and currents to the limits identified in IEEE 519 is the responsibility of the Requester.

3. Phase Unbalance

Unbalanced phase voltages and currents can affect protective relay coordination and cause high neutral currents and thermal overloading of transformers. To protect BPA TBL and customer equipment, the contribution from the new facilities at the Connection Point shall not cause a voltage unbalance greater than 1% or a current unbalance greater than 5%. Phase unbalance is the percent deviation of one phase from the average of all three phases.

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 any of their connected equipment from damage that could result from such an unbalanced condition.

4. Voltage Schedules

Voltage schedules are necessary to maintain voltage profiles across the transmission system to insure that reactive flows are kept low and that optimum use of reactive control facilities can be maintained. To this end a voltage schedule will be mutually developed between BPA TBL and the Requester, when appropriate, which will be coordinated via time changes developed by the NWPP for such coordination purposes. BPA TBL maintains voltages according to the ANSI Standard C84.1. This allows for variances of ±5% off nominal for all voltage levels except for the 500 kV system that normally operates between 500 and 550 kV.

5. 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 (transient) oscillations that are stable and damped.

To avoid large-scale blackouts that can result from the excessive generation loss, major transmission loss, or load loss during a disturbance, underfrequency load shedding has been implemented in the Pacific Northwest. When system frequency declines, loads are automatically interrupted in discrete steps, with most of the interruptions between 59.3 and 58.6 Hz. Load shedding attempts to stabilize the system by balancing the generation and load. It is important that lines remain connected to the system during frequency declines, both to limit the amount of load shedding required and to help the system avoid a complete collapse.

6. Voltages During Disturbances

To avoid voltage collapse in certain areas of the Pacific Northwest, undervoltage load shedding has 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.

5-E. Reliability and Availability

1. Maintaining service.

To minimize risk of overloads, instability, or voltage collapse, reliable operation of the interconnected power system requires the following: reactive sources, control of real and reactive generation, adequate real and reactive reserves, and maintenance of transmission system voltages.

2. Transmission lines.

Key transmission lines and other facilities should be kept in service as much as possible. They may be removed from service for voltage control only after powerflow studies, in accordance with WSCC requirements, indicate that system reliability will not be degraded below acceptable levels. The entity responsible for operating such transmission line(s) shall promptly notify other affected load control areas, per the WSCC *Procedure for Coordination of Scheduled Outages and Notification of Forced Outages,* or other applicable outages, when removing such facilities from and returning them back to service.

3. Switchable devices.

Devices frequently switched to regulate transmission voltage and reactive flow 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.

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. Automatic and forced outages should be responded to promptly, mitigating any impacts on the remaining system, and in a manner that treats all customer interruptions with the same priority.

5. Key Reliability and Availability Considerations

- **a.** The new connection shall meet the NWPP and WSCC Minimum Reliability Standards for Planning and Operation.
- **b.** Tools and spare equipment must be readily available to accomplish operations and maintenance tasks.
- **c.** Bypass equipment must be fully rated to allow continued operation and not create a bottleneck. Alternate feeds, when provided, shall have sufficient rating to not restrict operation of the BPA System.
- **d.** Shielding and EMI protection shall be provided to insure personnel safety and proper equipment functioning during disturbances such as faults and transients.
- **e.** Standardized design, planning and 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 6 and 8.
- **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.

5-F. Power Factor Requirements

Each system is supposed to provide for their own reactive power requirements, both leading and lagging. (Section 5-F). Reactive power control including reserves is required to maintain adequate voltage levels to prevent voltage instabilities and insure transient stability.

BPA TBL encourages customers to maintain their own power factor without relying on the transmission system, especially under peak load conditions. Controlling reactive flow can enhance the transfer capability of the affected line and may also reduce system losses. Reactive flows at Interchange points between Control Areas are expected to be kept at a minimum as per the WSCC, *Minimum Operating Reliability Criteria*.

5-G. Isolating, Synchronizing and Blackstarts

1. Isolation

At the Connection Point, the Requester shall not energize a de-energized BPA line unless the BPA TBL Dispatcher specifically approves the energization. Where the connection is to a radial load the circuit may be interrupted and reclosed by BPA TBL. In cases where the connection breaks an existing path, an autoisolation scheme may be required to sectionalize the connection to BPA System. If the connected facilities are networked or looped back to the BPA 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 the BPA TBL dispatcher or as specified in the connection agreement.

2. **Synchronization**

The Requester's system or portion of system with energized generators must synchronize its equipment to the BPA System. The exception to this is under large-scale islanding conditions, where the BPA System will re-synchronize to neighboring systems over major interties. Automatic synchronization shall be supervised by a synchronizing check relay, IEEE device 25.

3. **Blackstarts**

Loads that are scheduled and available for blackstarts are selected to avoid the trip-out of generation units by exceeding frequency and voltage setpoints. This is accomplished by selecting voltage variable loads, avoiding motor start-up loads and imposing block size limits (50 MW). During blackstart restoration, the tapped connection must be able to be opened to avoid interference with BPA TBL restoration procedures on the BPA transmission path.

5-H. Responsibilities During Emergency Conditions

Each Load Control Area operator has the ultimate responsibility to maintain the frequency within its control area boundaries. All emergency operation involving the BPA transmission system must be coordinated with the BPA Dispatcher either at the Munro Control Center in Spokane, or at the Dittmer Control Center in Vancouver, Washington. Each party, as appropriate, must participate in any local or regional remedial action schemes. All loads tripped by underfrequency or undervoltage action must not be restored without the Load Control Area operator's permission. All schedule cuts need to be coordinated with the appropriate Load Control Area operator, and need to be made promptly. All parties have the responsibility for clear communications and to report promptly any suspected problems affecting others.

6. Protection Requirements

6-A. Introduction

The protection requirements identified in this document are intended to achieve the following objectives:

- Insure safety of the general public, BPA TBL and other utility personnel.
- Minimize property damage to the general public, BPA TBL, and BPA TBL's customers.
- Minimize adverse operating conditions affecting BPA TBL's System and customers.
- Permit the Requester to operate their system in a safe and efficient manner with minimum impact to the BPA TBL System and BPA TBL's customers.
- Comply with NERC, WSCC and NWPP protection criteria in existence at the time of the connection request.

To achieve these objectives, certain protective equipment (relays, circuit breakers, etc.) must be installed. These devices ensure that faults or other abnormalities initiate prompt and appropriate disconnection from the BPA 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 BPA TBL customers and potentially those of other utilities).
- The coincidental connection of a new generation resource which was not previously connected to the BPA System. In this case, the Requester will also have to follow the requirements for interconnection of generation resources [Ref. 1.5].

BPA TBL makes the final determination as to the devices used for protecting the BPA System and identifies modifications and/or additions to the BPA System that are required by the connection. BPA TBL works with the Requester to achieve an installation that meets the Requester's and BPA TBL's requirements.

BPA TBL cannot assume any responsibility for protection of the Requester's system. Requesters are solely responsible for protecting their system and equipment in such a manner that faults, imbalances, or other disturbances on the BPA System do not cause damage to their facilities or result in problems with their customers.

6-B. Protection Criteria

The protection system must be designed to reliably detect faults or various 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 also be required for system disturbances, such as undervoltage or underfrequency detection for load shedding.

1. General Protection Practices

The following summarizes the general protection practices as required by NERC and the WSCC and specific practices and applications as applied to BPA System transmission lines and interconnections. The protection schemes necessary to integrate the new connection must be consistent with these practices and the equipment used to implement them. Table 6-1 gives relay and breaker operating time versus voltage levels.

a. All Voltages

1. Relays, breakers, etc. are required at the Connection Point or a connecting substation to isolate BPA TBL equipment from the Requester's system during faults.
2. At the Connection Point, the Requester is not allowed to energize a de-energized line in the BPA System without approval of the BPA Dispatcher.
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 BPA TBL ability to operate at maximum transfer levels, even with system voltages as low as 0.8 per unit.
6. Redundant relays shall not be connected to a common current transformer secondary winding.
7. Redundant relay systems, which are physically and electrically separated, are required such that no single protection system component failure or other event or condition would disable the entire relay system.
8. Protection schemes shall be designed with sufficient number of 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.
9. Directional relay systems are required on all non-radial connections.
10. BPA TBL reserves the right to review and recommend changes to the protection system and settings for equipment at the Connection Point.

11. The protection system security and dependability and their relative effects on the power system must be carefully weighed when selecting the protection system.
12. If required, automatic underfrequency load tripping total trip time, including relay operate time and breaker operate time shall not exceed 14 cycles.

b. Voltages Below 100 kV

1. Redundant or overlapping relays 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. Total fault-clearing times, with or without a pilot scheme, must be provided for BPA TBL review and concurrence. Breaker operating times, relay makes, types and models, and relay settings must be identified specifically.
3. Multi-shot automatic reclosing is allowed. The total number of automatic reclosures should not exceed three.

c. Voltages Above 100 kV

1. Breaker failure relays (BFR) are required. Total time for BFR scheme fault clearing must not exceed 14 cycles. System requirements may dictate faster BFR operating times. Breaker failure relays do not have to be redundant.
2. Dual circuit breaker trip coils are required.
3. Redundant directional relay systems are required if a single point of failure could disable the entire relay system. Both relay systems shall contain an instantaneous tripping element capable of outputting 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. Redundant telecommunications schemes may be required if time-delayed fault clearing can result in stability, cascading or voltage problems. In some cases, an acceptable alternative to redundant transfer trip schemes may include the use of a directional comparison-blocking 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 BPA TBL protection and telecommunications equipment.
7. The telecommunications and pilot scheme(s) channels required for protection systems should be either continuously monitored, or automatically or manually tested.

d. Additional Requirements for Voltages Between 100 and 138 kV

1. A pilot telecommunication scheme may be required if high-speed clearing is required for any fault location for stability purposes or if remote tripping for equipment protection is required. 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.
2. Total fault-clearing times, with or without a pilot scheme, must be provided for BPA TBL review and concurrence. Breaker operating times, relay makes, types and models, and relay settings must be identified specifically.
3. Automatic reclosing for single line-to-ground faults shall be no faster than 35 cycles.
4. Automatic reclosing is allowed for multiphase faults.

5. Multi-shot automatic reclosing may be required for automatic line sectionalizing schemes. The total number of automatic reclosures should not exceed three.

e. Additional Requirements for Voltages Between 161 and 345 kV

1. A pilot telecommunication scheme is necessary if high-speed clearing is required for any fault location for stability purposes or if remote tripping for equipment protection is required. 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.
2. Total fault clearing time with a pilot scheme must not be more than four cycles, including relay and breaker operating time, when connected to a Main Grid line. Slower times may be acceptable for some lines. Refer to Table 6.1.
3. Automatic reclosing for single line-to-ground faults shall be no faster than 35 cycles and no slower than 60 cycles.
4. Automatic reclosing is not allowed for multiphase faults. It is also acceptable to block reclosing for time-delayed trips as well.

f. Additional Requirements for 500 kV

1. Two independent sets of directional line protection with separate pilot telecommunication for each relay set shall be installed at each line terminal to trip the line terminal breakers.
2. Total fault clearing time with a pilot scheme must not be more than four cycles, including relay and breaker time.
3. Line protection may be required to be compatible with existing or future series compensation.
4. Protection must be able to interface with BPA's single-pole protection schemes.
5. Automatic reclosing shall be no faster than 35 cycles and usually no slower than 60 cycles for standard three-pole or single-pole switching, and no slower than 100 cycles for 'hybrid' type single-pole switching.
6. Automatic reclosing is not allowed for multiphase faults.

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 provide assurance the selected relay system is capable of detecting faults 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

Phase overcurrent (type 50/51) and neutral overcurrent (type 50/51-N) relays are provided to detect abnormally high currents. These non-directional relays are used to detect faults on the distribution class lines or serve as supervisory fault detectors for transmission relays. They may also serve to backup other protective relays. Line differential relays may be a necessary consideration for some connections when coordination with other relays is not possible.

Infeed detection to faults within the power system usually requires directional current-sensing relays to remove the contribution to the fault from the Connection Point. Zone-distance relays (type 21) usually serve this need. The distance relay 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. Generally, the 'islanded groups' do not have a stable load to generation resource balance. However, it is possible that, under unique situations, generator controls can establish a new equilibrium in an islanded group.

Some utilities isolate their distribution system and use local generation to feed loads during power system outages. BPA TBL does not allow islanding conditions to exist that include its facilities, except for a controlled (temporary, area-wide) grid separation. When BPA TBL customer loads are being served over another utility's transmission and distribution system or where generation is also interconnected, implications of islanding must be addressed to minimize adverse impacts on these loads.

While operating in an islanded condition or during a 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 BPA TBL to assure that the blocking of the distance elements will not result in inappropriate or undesirable formation of islands.

d. Load Shedding

The proposed connection may require special load-shedding schemes based upon BPA Load Control 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, 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 BPA TBL, following NERC, WSCC and NWPP criteria. Reference 1.5 includes specific requirements for generation tripping by voltage and frequency relays.

e. Generator Dropping

The proposed connection may also require additional logic to supply signals to existing special protection schemes including, but not limited to, line-loss detection and generator dropping. These schemes are also designed to maintain the balance between system loads and available generation during and following a system disturbance. If the new connection includes generation not previously part of the BPA Load Control Area, the generation may also require additional special trip schemes.

f. Other Special Protection and Control Schemes

The location of the Connection Point, amount of load transfer expected and various other system conditions may require other 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. Special breaker tripping or closing schemes (e.g. staggered closing, 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 particular substation equipment (e.g. independent-pole operation of circuit breakers). Overvoltage tripping may also be required to protect equipment following a system disturbance that may result in lightly loaded transmission lines.

g. Relay Performance and Transfer Trip Requirements

Relay systems are designed to isolate the transmission line and/or load facilities from the BPA System. However, the performance (clearing time speed) of these local relay systems and the associated isolating devices (breakers, 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. Transfer trip is required when any of the following conditions apply to the new connection. Other types of pilot tripping such as directional comparison, phase comparison or current differential may also be acceptable if the scheme chosen can achieve the total clearing times required.

1. Transient or steady-state studies identify conditions where maintaining system stability requires immediate isolation of the Connection Point facilities from the power system.

2. Special operational control considerations require immediate isolation of the Connection Point.

3. Extended fault duration represents an additional safety hazard to personnel and can cause significant damage to power system equipment (e.g. lines, transformers).

4. Slow clearing or other undesirable operations (e.g., extended overvoltages, ferroresonance, etc.), 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 BPA TBL circuit that connects other customer loads become part of a 'local island' that includes a generator.

5. When remote-breaker tripping is required to clear faults in a transformer not terminated by a high-side breaker, high-speed transfer tripping will be necessary. 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 based on the local configuration (e.g. three terminal lines), fault currents available, etc. Total clearing times must be less than those listed in Table 6-1. Otherwise, immediate isolation of the Connection Point is required. Refer to Section 8-E for telecommunication issues as they pertain to control and protection requirements.

Table 6-1 – Relay and Breaker Operating Times by System Voltage

Connection Voltage (kV L-L rms)	Total Clearing Time (Cycles)	Maximum Relay Operate Time (Cycles)	PCB Trip Time (Cycles)	Time Delayed Tripping Acceptable?
≤ 100	68	≤ 60	≤ 8	Yes
100 to 138	47	≤ 42	≤ 5	Yes
161 to 230	28	≤ 25	3	Yes
230 Main Grid to 500	4	1	2	No*
500	4	1	2	No*

* - Transfer trip not an optional consideration

h. 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 138 kV, automatic-sectionalizing schemes may be installed to isolate a portion of the system that has a permanent fault. This may include multi-shot automatic reclosing at remote terminals. A new Connection Point should be compatible with such existing schemes. If the new connection results in the possibility of connecting a generation source to the BPA System, special considerations may be required.

i. Protection System Performance Monitoring

Depending upon the type and location of the connection, monitoring equipment may be required. The monitoring equipment is intended to identify possible protection scheme problems and to provide power quality measurements. The monitoring equipment may provide information similar to that of an oscillograph or fault recorder. The availability of current and voltage measurements determines the number of channels for the device. Sequential event recorders and/or annunciators may also be required to record and time-tag operations of protection equipment. In some cases, it may be acceptable to utilize the recording and monitoring capabilities of a protective relay system to provide for system monitoring and event recording.

These recorders are connected to a GPS satellite receiver or other time source with equivalent accuracy. Remote access to monitoring equipment may be accomplished by using the Revenue Metering System (RMS) telecommunication equipment. BPA TBL will supply a list of quantities to be monitored and the appropriate terminology when connections are made at a BPA-owned substation. If monitoring or relay performance indicates inadequate protection of the BPA System, the owner of the connected facilities will be notified of additional protection requirements or changes.

BPA TBL may request limited remote telecommunications access to relay systems at the Connection Point to query their operational history and fault data. Upon request, and if available, BPA TBL will reciprocate by supplying the Requester with limited access to the appropriate BPA relays.

6-C. Protection System Selection and Coordination

1. Relays to be Installed for the Connection

At the time of the connection request, BPA TBL will supply the Requester with an approved list of protective relay systems considered to be suitable for use at the Connection Point. The performance of protective relays applied at the connection that can directly affect the performance of the BPA System should follow the recommendations from the supplied list. Should the Requester select a relay system not on our approved list, BPA TBL reserves the right to perform a full set of acceptance tests prior to granting permission to use the selected protection scheme. Alternatively, the relay vendor or a third party may be asked to perform thorough model line tests of the proposed relay system.

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 Connection Point, 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.

- Fault study models used for determining protection settings should take into account significant mutual and zero sequence impedances. Up-to-date fault study system models shall be used.
- Protection system applications and settings should not normally limit transmission use.
- Application of zone 3 relays with settings overly sensitive to overload or depressed voltage conditions should be avoided where possible.
- Protection systems should avoid tripping for stable swings on the interconnected transmission systems.
- Protection system applications and settings should be reviewed whenever significant changes in generating sources, transmission facilities, or operating conditions are anticipated.
- All protection system trip misoperations shall be analyzed for cause and corrective action taken.

6-D. 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 also will determine the type and extent of commissioning tests required. The following tests are the minimum tests that must be performed. They need to be performed on all protection schemes at the Connection Point that could affect the performance of the BPA transmission system.

1. Verifying all protective system inputs.

- Current and voltage transformers: check the ratio, polarity, accuracy class, and single-point grounding.
- Verify all other inputs to the protection system including battery supplies, circuit breaker auxiliary switches, pilot channel inputs, etc.

2. Verify protection system settings.

- Check protection system settings and programming.
- Perform acceptance testing of protection system if not done previously.
- Perform calibration tests of the protection system using actual settings.

3. **Protection system drawings and wiring**
   - Verify switchboard panel and equipment wiring is intact and matches drawings.
   - Verify drawings are correct.
4. **Verify proper relay system operation and directionality.**
5. **Verify all protective system outputs.**
   - Trip outputs: trip intended trip coil(s) and open breaker
   - Close outputs: energize close coils and close the breaker(s)
   - Assure relay outputs to pilot channel are functional.
   - Assure all other outputs such as breaker failure initiate, special protection scheme signals, alarms, event recorder points, etc. are functional.
6. **Perform trip or other operational tests.**
   - Assure correct operation of the overall protection systems.
   - Test automatic reclosing.
7. **Pilot schemes.**
   - Measure channel delays.
   - Check for noise immunity.
   - Check for proper settings, programming, etc.
   - Check transmit and receive levels.
   - If automatic channel switching or routing is utilized, check for proper relay operation for alternate routing.

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 is an acceptable method of operational testing. Modifications to a protection system also require similar testing to ensure correct system operation. The extent of testing and types of tests required depend upon the modifications made.

7. System Operation and Scheduling Data Requirements

7-A. Introduction

All transmission arrangements for power schedules within, across, into or out of the BPA Load Control Area require metering and telemetering. Transmission arrangements with loads or new transmission facilities may include wheeling, voltage control, and Automatic Generation Control (AGC). The technical plan of service for interconnecting a load or new transmission facility, as shown on the Project Requirements Diagram, will include the metering and telemetering equipment consistent with the transmission contract provisions. Such metering and telemetering equipment may be owned, operated, and maintained by BPA TBL or by other parties approved by BPA TBL.

Revenue metering, 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 directly connected to the BPA System or electronically connected via telemetering that places the connection within or outside the BPA Load Control Area.

7-B. System Operation Requirements

1. Telemetering Requirements

BPA System Dispatching requires telemetering data for the integration of new interconnections at adjacent Load Control Area boundaries. This typically consists of the continuous telemetering of kW quantities and hourly transmission of the previous hour's kWh from the Connection Point to the appropriate BPA transmission dispatching and control center.

Section 8-D discusses telecommunications requirements for telemetering and AGC. Table 7-1 summarizes telemetering requirements and Table 7-2 identifies requirements based on connection location. The following includes generic requirements based on connection size:

a. Telemetering is required for all normally closed interconnections at a BPA Load Control Area boundary. For this case, telemetering of real power and energy (kW, kWh) is required. There may be a need for reactive power (kvar, kvarh) information for power factor billing purposes also. High capacity interconnections may require redundant metering and telemetering.

b. For normally open or emergency tie connections, BPA TBL determines telemetering needs on a case-by-case basis. Note that FERC requires telemetering for these connections.

c. For loads connected internally to the BPA Load Control Area, AGC telemetering is not normally required. For interruptible loads, BPA TBL determines telemetering needs on a case-by-case basis. Connecting eccentric (non-conforming) loads may require an interface to the BPA 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.

d. Telemetering for interconnection of shared or jointly-owned loads 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 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 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 BPA TBL tariffs to properly account for transmission usage.

2. Data Requirements for Load Control Area Services

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 the BPA Load Control 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. If BPA TBL is purchasing supplemental AGC services, AGC interface is required on a long-term basis. Prior to 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 dynamic signals.

b. 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 liable for the ancillary services obligations associated with the connection. Most self-provided ancillary services are scheduled and delivered using dynamic signals. The responsible party may fulfill these obligations in any of the following ways:

- Self-provide ancillary services by making resources available to BPA TBL to deploy.
- Contract with a third party to make resources available to BPA TBL to deploy.
- Contract with BPA TBL to cover this ancillary services obligation.

c. Where a third party is providing ancillary services the following data is required with a sampling rate of once per second or other rate established by NERC:

- Net instantaneous power transferred (MW)
- Instantaneous and total Mvar transferred
- Operating reserve capability during the next ten minutes
- kWh for last hour

The Requester must demonstrate that the selected options are technically sound and meet all relevant reliability policies and criteria of NERC, WSCC and NWPP or their successors.

3. Supervisory Control and Data Acquisition (SCADA) Requirements

Interconnection may require BPA SCADA control and status indication of the power circuit breakers and associated isolating switches used to connect with BPA TBL. 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 BPA TBL. SCADA control of breakers and isolating switches that are located at other than the Connection Point is not normally required, although status indication may be necessary. Section 8-D discusses telecommunications requirements for SCADA systems.

7-C. Interchange Scheduling Requirements

A new load being integrated into the BPA System must adhere to the scheduling requirements of the prevailing tariff under which it is taking transmission service from BPA TBL. Customers may be required to provide BPA TBL Transmission Scheduling with an estimate of the their hourly load, hourly generation schedules, and/or net hourly interchange transactions. These estimates will be used for both prescheduling and planning purposes. BPA TBL will require customers to provide these estimates as necessary in order for BPA TBL to manage the load/resource balance within the BPA Load Control Area and to determine usage of the BPA System.

In the case of new transmission facilities, scheduling and accounting procedures are needed if the facility is part of an interface between the BPA Load Control Area and another load control area. This scheduling and accounting of interchange between two load control areas normally requires telemetered data from the Connection Point to the control centers of the load control area operators. This data is termed interchange metering and telemetering by BPA TBL and includes kW and kWh quantities. BPA TBL requires that all Load Control Area transactions be prescheduled for each hour using the normal scheduling procedures. The end-of-hour actual interchange must be conveyed each hour to the BPA TBL Hourly Accounting Desk (Numbers) in System Operations. This can be accomplished through the use of telemetering or data link.

When the interconnection represents a shared or jointly owned interface to BPA TBL, 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 control area boundary is an example of this requirement.

1. Interchange Telemetering Requirements

Interchange telemetering generally consists of bi-directional meters and related telecommunications systems providing kW and kWh at or near the Connection Point. The kW measurement is telemetered on a continuous basis for AGC and hourly kWh is sent each hour to the Numbers accounting function. Table 7-1 summarizes telemetering requirements and Table 7-2 identifies different scenarios that require telemetering. Interchange telemetering accuracy and calibration requirements are identical with those stated in Sections 7-D and 4-F.

Telemetering requires continuous knowledge of the quality of the meter reading. 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
- Meter potential phase unbalance

2. Data Acquisition System

Loads such as steel rolling mills, wind tunnels, etc. require additional data to make generation control performance more predictable. Such additional data may include, but not be limited to, precursor signals of expected load changes, etc. SCADA control may also be required. Specific requirements and needs are determined for each load. Section 8-D discusses telecommunications requirements for telemetering and data acquisition.

7-D. Revenue and Interchange Metering System

All connections one kW or greater require TBL-qualified revenue or interchange metering and data recording for the TBL billing and/or scheduling processes. Revenue metering includes energy data (kWh) and reactive data (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 Connection Point to or from the BPA System.

The Revenue Metering System 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 BPA TBL Billing Data Acquisition System. The system currently being used is the MV-90™. Demand data will be available to the customer or their agent. The hourly data will appear on the BPA TBL ‘Billing Information System’ web site, typically by 0800 hours the following day.

BPA TBL typically owns and maintains the revenue metering at load-metering sites. BPA TBL will supply the Requester with a list of prequalified metering systems should the Requester desire to furnish, own and/or maintain the metering system. If the selected system is not on the BPA prequalified list, BPA TBL 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. Other meters will be considered, subject to BPA TBL approval, where a BPA TBL authorized party performs the metering and telemetering functions.

1. Revenue and Interchange Metering Requirements

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. Revenue metering shall be bi-directional to record real and reactive flow to or from the Connection Point. The revenue-metering package includes a kWh recording device compatible with the BPA TBL Revenue Metering System (RMS). Interchange metering shall be bi-directional in order to record both real and reactive flow at the Connection Point. The interchange-metering package includes a kWh recording device compatible with the BPA TBL scheduling system.

Should the new Connection Point result in the addition of generation to the BPA System not previously accounted for, there will be additional metering requirements. [Ref. 1.5]

Section 8-D discusses telecommunications requirements for the RMS system. Table 7-1 summarizes Revenue Metering requirements and Table 7-2 identifies requirements based on resource location.

2. Meter Accuracy

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 nominal voltage, 100% meter current rating. Light load is nominal voltage, 10% meter current rating.

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. This is a safety requirement to prevent unintentional energization of the transformer secondary during a transformer failure. Instrument transformers for metering need to be located such that the input to the metering and telemetering is not interrupted during possible switching configurations at the Connection Point.

4. Loss Compensation

Transmission system losses, such as those in transformer, often must be accounted for in the revenue metering process. BPA TBL prefers that this accounting be done as a calculated part of the TBL billing and settlement process. If the Requester strongly desires that the loss compensation be performed in the meter rather than calculated, BPA TBL will consider modifying the revenue metering to accommodate the request. However, compensation in JEM-1™ meters used for Interchange Metering will not be performed. Compensation in the JEM-1™ affects only the pulse integrator circuits (kWh), which disturbs the relationship between the direct analog outputs (kW) and the integrated pulse outputs (kWh).

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. The other requirements of this section do apply to station service metering.

Table 7-1 General Metering and Telemetering Data Requirements

System or Quantity	System Dispatching and Operations	Transmission Scheduling	Revenue Billing
kW	Yes	No	No[1]
kWh	Yes	Yes	Yes
kvar	Maybe	No	No
kvarh	Maybe	No	Yes
kV	Yes	No	No
Load Size	≥ 1 MVA	≥ 1 MVA	≥ 1 kW
Data Sample Rate	kW: 1 second or other approved rate compatible with NERC Policy	Last Hour kWh sent each hour	Hourly kWh Data Retrieved daily (RMS type system)[2]
Tie Capacity	all normally closed ties	all normally closed ties	all ties
AGC	all Load Control Area boundaries & customer connections providing ancillary services	No	No

Notes
1. A kW reading for revenue billing may be required where special transmission arrangements are necessary.
2. Dial-up phone line required for the RMS.

Table 7-2 Metering, Telemetering and SCADA Data Requirements vs. Connection Location

	Connection Located INSIDE BPA Load Control Area	Connection Located OUTSIDE BPA Load Control Area
Direct Electrical Connection to BPA TBL System	kW, kWh, RMS, kvar, kvarh, kV breaker status & control	kW, kWh, RMS, kvar, kvarh, kV breaker status & control
NO Direct Electrical Connection to BPA TBL System	kW, kWh, RMS	None

Note - Dedicated circuit is required for kW, kWh, kvar, kvarh, and kV

8. Telecommunication Requirements

8-A. Introduction

Telecommunications facilities shall be tailored to fulfill the control, protection, operation, dispatching, scheduling, and revenue metering requirements. 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 at the Connection Point. Telecommunications facilities will be identified on the Project Requirements Diagram. 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:

1. Microwave Systems

A microwave system requires transmitters, receivers, telecommunication fault alarm equipment, antennas, batteries, 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. Microwave path diversity, equipment redundancy, and/or route redundancy may be required to meet power system reliability requirements by protecting against telecommunications outage caused by equipment failure or atmospheric conditions.

2. Fiber Optic Systems

A fiber optic system requires light wave transmitters, receivers, telecommunication fault alarm equipment, multiplex equipment, batteries, emergency power systems, fiber optic cable (underground or overhead) and rights-of-way. Cable route redundancy may be required to protect against cable breaks and resulting telecommunications outage.

3. Wireline Facilities

A wireline facility 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 to protect against cable breaks and resulting telecommunications outage.

4. Power Line Carrier Current Systems

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 connected to the circuit to connect the carrier transmitter and receiver to the power line. Power line carrier availability and performance is greatly affected by line outages. For this reason its use for control, data, and voice communications is limited. In some instances it can be used with line protective devices.

8-B. Telecommunications Availability

1. Common Carrier

Dedicated telecommunication facilities are required for the operation of Main Grid power system control and protection functions. Common carrier telecommunications are not considered acceptable for supporting Main Grid control and protection functions. However, for secondary transmission systems, other than Main Grid, common carrier telecommunications alternatives may be considered, subject to reliability and availability requirements and capabilities.

2. Main Grid

Telecommunications systems serving Main Grid transmission systems shall be fully redundant with a service availability time equal to or exceeding the power system availability goal. The design availability for telecommunications systems serving Main Grid transmission shall be at least 99.986%. This is based on total outage time of 24 hours in 20 years due to path or components. The design availability for telecommunications systems serving secondary transmission shall be at least 99.88%. This is based on total outage time of 10-1/2 hours per year due to path or components.

3. Alternate Routing

If alternately routed telecommunications are required for Main Grid protective relaying schemes, the overall availability of the alternately-routed telecommunications shall be at least 99.9998%. 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 are acceptable and 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.

8-C. Voice Communications

If the Connection Point is within the BPA Load Control Area:

1. **Voice Communications** to the Connection Point operator are required whenever any type of telemetering is required.
2. **A Dedicated, Direct, Automatic Ringdown Trunk** (or equivalent) voice circuit between the appropriate BPA TBL dispatchers and the Connection Point operator or dispatcher may be required for:
   - Loads of 50 MW or greater,
   - Eccentric (non-conforming) Loads
   - Connected networks that include automatic generation dropping for BPA Transmission system remedial action.
   - A non-radial interconnection to another electric utility with a transfer capability in either direction of 50 MW or greater.
3. **Independent Voice Communications** for coordination of system protection, control, and telecommunication maintenance activities between BPA TBL and the Connection Point should be provided, in addition to the voice telecommunications specified.

8-D. Data Communications

Telecommunications for SCADA, RMS and Telemetering must function at the full performance level before and after any power system fault condition. Service continuity must be restored immediately after the fault without requiring any repair personnel activity.

1. **SCADA Requirements** typically include one or more dedicated circuits between the new Connection Point and the appropriate BPA transmission dispatching center(s).
2. **AGC Interchange and Control Telemetering** for operations and scheduling applications typically require one or more dedicated circuits between the new Connection Point and the appropriate BPA transmission dispatching center(s). Digital telecommunications capabilities from 1200 to 2400 baud rate are required. In rare circumstances, the Inter-Control Center Communications Protocol Network could be used for AGC purposes upon the agreement of both parties. This would be for very small and/or radial interchanges and generation quantities. These situations may require a NERC waiver. (For these rare circumstances, refresh times as slow as one minute may be acceptable.)
3. **General Telemetering** for kWh and data acquisition systems typically require one or more dedicated circuits between the new Connection Point and the appropriate kWh or data acquisition system master computer.

4. **Revenue Metering System** (MV-90™) remote equipment require commercial 'dial-up' telephone exchange line facilities to communicate with the MV-90™ master computer at the Dittmer Control Center. The circuit used for this purpose may also be shared with voice communications and other dial-up data communications.

8-E. 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/or protection must not be tested, switched, shorted, grounded or changed in any manner by any worker, unless prior arrangements have been made through the BPA Outage Dispatcher.

1. Main Grid Transmission

New connections to the BPA Main Grid, and connections which require remedial actions on the BPA System, shall have redundant (i.e. hot-standby or frequency-diversity) telecommunications systems. Alternately routed telecommunication circuits shall be used where feasible.

2. Secondary Transmission.

New connections to the BPA secondary grid transmission generally do not require redundant telecommunications systems. However, under some circumstances, redundant telecommunications are required to satisfy stability criteria.

3. Speed of Operation

Throughput operating times of the telecommunications system must not add unnecessary delay to the clearing or operating times of protection or remedial action schemes. Maximum permissible throughput operating times of control schemes are determined by system studies.

4. Equipment Compatibility

In order to provide maintainability and operability between the new connection and the BPA System, the protection systems and their supporting telecommunications system equipment (teleprotection) do not have to be identical but must be functionally compatible. The need or implementation of peripheral capabilities such as signal counters, test switches, etc. are not required to be identical to those used at BPA TBL facilities. At the time of the new connection request, BPA TBL will supply the Requester with a list of acceptable, prequalified equipment. Should the Requester choose to use something other than what has been prequalified by BPA, BPA TBL reserves the right to test and approve the equipment prior to installation.

BPA TBL will acknowledge the use of alternative equipment and/or technologies as proposed by the Requester as long as the equipment is suitable for the purposes of the control application required. The teleprotection systems, including transfer trip, must be engineered and tested to demonstrate that they perform their intended functions. When applying sophisticated digital telecommunications systems to certain protection schemes, care must be taken to avoid combining approaches with inherent technical conflicts or incompatible methodologies.

8-F. Telecommunications during Emergency Conditions

1. Emergency Conditions

The previous requirements address the availability and redundancy for telecommunications systems and equipment to assure reliable operation of the BPA System under normal telecommunications conditions. Normal conditions for telecommunications include both normal and emergency conditions for the transmission system. However, emergency conditions may develop that affect power system telecommunications with or without directly affecting power transmission system facilities.

Examples of telecommunications emergencies include the following:

- Interruption of power service to telecommunications repeater and relay stations
- Telecommunications equipment failure, whether minor or catastrophic
- Interruption or failure of commercial, public 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 dedicated repair team should be maintained along with an adequate supply of spare components.

2. Backup Equipment

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

3. Disaster Recovery

A disaster recovery plan should be in place for telecommunications restoration, and should be exercised periodically. The disaster recovery plan should include the ability to deploy transportable restoration equipment capable of temporarily bypassing or replacing entire telecommunication stations or major apparatus until permanent repairs can be made.

4. Telecommunications Security

The operation of power system telecommunications facilities should be continuously monitored at a central alarm point so that trouble can be immediately reported, diagnosed, repaired and service restored. Power system telecommunication sites and facilities should be secured against unauthorized access by means of locked gates, security fences, warning signs, security doors, and entry alarms.

9. Definitions

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

For Bonneville Power definitions of electric utility terminology, please refer to:
BPA Definitions, December 1993, available through BPA's Document Request Line by calling (800) 622-4520.

For the purposes of this document the following definitions apply:

ACE – Area Control Error is the instantaneous difference between net actual and scheduled interchange, taking into account the effects of frequency bias including a correction for meter error.

Active Power - The component of total volt-amperes in an electric circuit where the voltage and current are in phase. It is also called real power and is measured in watts (W), kW or MW. This is the electrical power associated with useful energy, including mechanical work and heat. Active power used or transmitted over time is measured in kilowatt-hours (kWh) or MWh.

Ancillary Services - The term used by FERC to describe the special services that must be exchanged among generation resources, load customers and transmission providers to operate the system in a reliable fashion and allow separation of generation, transmission and distribution functions. These include: 1) scheduling, system control and dispatch, 2) reactive supply and voltage control from generators, 3) regulation and frequency response, 4) energy imbalance, 5) spinning reserves, and 6) supplemental reserves. Most of these services are included in a similar set by NERC and termed Interconnected Operations Services, which also include load following and black start capability.

WSCC Definition: *Interconnected Operations Services identified by the U.S. Federal Energy Regulatory Commission (Order No. 888 issued April 24, 1996) as necessary to effect a transfer of electricity between purchasing and selling entities and which a transmission provider must include in an open access transmission tariff.*

Automatic Generation Control (AGC) System - A system that measures instantaneous loads at interchange points (boundaries with adjacent Load Control Area) and adjusts generation to follow load. It consists of continuous, real time load signals (kW), telemetered to AGC computers at a transmission control center. At BPA TBL this would require connection to the microwave system.

NERC Definition: *Equipment which automatically adjusts a Load Control Area's generation from a central location to maintain its interchange schedule plus frequency bias.*

Baud Rate – A unit of signaling speed equal to the number of discrete conditions or signal events per second, or the reciprocal of the time of the shortest signal element in a character.

Bi-directional Metering - Measures kWh and kvarh flowing in both directions ('in' and 'out' kWh and leading and lagging reactive).

Bonneville Power Administration Transmission System (BPA System) - The transmission facilities owned or controlled by BPA's Transmission Business Line (BPA TBL).

Blackstart Capability - The ability of a generating plant to start its unit(s) with no external source of electric power. (WSCC)

Bottleneck – A location in the transmission system where line or equipment ratings limit transfer capabilities. These situations may require special operating practices to avoid overloads under certain system conditions.

Connection Point - The location on the BPA System where a new connection is established to serve a load or connect a line to another electrical system.

Demand - The rate at which energy is being used by a customer. (NERC)

Directional Relay - A relay that responds to the relative phase position of a current with respect to another current or voltage reference.

Distribution – The lower voltage lines and equipment directly serving electrical consumers. This is generally a radial circuit, operating at voltages at or below 69 kV. The term 'distribution' may also be used to refer to equipment operating at or below 69 kV.

Disturbance - An unplanned event that produces an abnormal system condition. (WSCC)

Dynamic Schedule - A telemetered reading or value which is updated in real time and which is used as schedule in the automatic generation control and area control error equation (AGC/ACE) and the integrated value of which is treated as a schedule for interchange accounting purposes. Commonly used for 'scheduling' jointly owned generation to or from another control area.

Dynamic Scheduling Service - Provides the metering, telemetering, computer software, hardware, telecommunications, engineering, and administration required to electronically move a transmission customer's generation or demand out of the Control Area to which it is physically connected and into a different Control Area.

Dynamic Signal - A telemetered reading or value that is updated in real time, and which is used either as a tie line flow or as a schedule in the AGC/ACE equation (depending on the particular circumstances). Common applications of dynamic signals include 'scheduling' jointly owned generation to or from another control area and to move control area boundaries. Another application provides for an entity to request (schedule) a change in power flow. The resulting response is telemetered to the entity signifying the actual movement of a resource. This form of dynamic signal is applied to supplemental control area services. The integrated value of this signal is used for interchange accounting purposes, as appropriate.

Eccentric (Non-Conforming) Loads - Any cyclic load with the ability to change periodically by more than 50MW at a rate of greater than 50MW per minute, regardless of the duration of this change.

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

Fault - A short circuit on an electrical transmission or distribution system between phases or between phases(s) and ground, characterized by high currents and low voltages.

Feeder - A radial electrical circuit, generally operating at or below 69 kV serving one or more customers.

FERC - Federal Energy Regulatory Commission

Ferroresonance - A phenomenon usually characterized by overvoltages and very irregular voltage and current wave shapes and associated with the excitation of one or more saturable inductors through capacitance in series with the inductor (IEEE). A condition of sustained waveform distortion and overvoltages created when a relatively weak source of voltage energizes the combination of capacitance and saturable transformers. A sufficient amount of damping, or resistance, in the circuit usually controls or eliminates the phenomenon.

Hybrid Switching - A variation of single-pole switching that is used on long lines to extinguish the secondary arc of single line-to-ground faults. The faulted phase is detected and opened first via single-pole relaying. After approximately fifty cycles the two unfaulted phases are opened to extinguish the secondary arc. Three-phase automatic reclosing follows.

IEEE - Institute of Electrical and Electronic Engineers.

Interchange Metering - Metering at interchange points between two controlling utilities. Consists of AGC (continuous kW) telemetering and hourly kWh (on-the-hour hourly load kWh). These quantities must go to both controlling utilities so they can manage their respective Load Control Areas.

Interchange Point - Locations where power flows from one Load Control Area to another (i.e. connection between two controlling utilities).

Island - A portion of the interconnected WSCC system that has become isolated due to the tripping of transmission system elements. 'Local' Island - A portion of the transmission system, often a single line, that is isolated from the main system and energized by a local generator.

kWh System (Kilowatt Hour System) - Provides interchange point hourly data **each hour** (as compared to RMS system that reports hourly load data each day). Requires connection into BPA TBL microwave system. Old system provides bi-directional kWh; new system (presently being installed to replace old one) will also provide bi-directional reactive. kWh data is used to verify hourly schedules.

Load Control Area - 1. The electrical (not necessarily geographical) area within which a controlling utility has the responsibility to adjust its generation to match internal load and power flow across interchange boundaries to other Load Control Areas. 2. A resource or portion of a resource that is scheduled by a specific utility. If the utility schedules the resource, the resource becomes part of its Load Control Area. Physical location of the Connection Point does not determine its Load Control Area.

> ***WSCC Definition****: A system which regulates its generation in order to maintain its interchange schedule with other Load Control Areas and contributes its frequency bias obligation to the interconnection.*

Main Grid - As presently defined by the BPA Reliability Criteria and Standards, BPA's Main Grid transmission facilities include all 500 kV lines, 345 kV lines, and those lower voltage lines that perform the main grid function. Those portions of substations, including transformers, supporting the main grid, are also included.

MV-90™ - The Multi-Vendor Translation System interprets a variety of metering communication protocols used for data collection and analysis. Data is retrieved over dial-up (voice grade) telephone lines by the MV90™ master located at Dittmer Control Center. Master automatically polls the remotes daily. Master can also be forced to poll a remote at any time through dial-in terminal ports available on the master. In addition to polling raw impulses from the recorders, MV-90™ can perform data validation, editing, reporting and historical database functions.

NERC - North American Electric Reliability Council is a not-for-profit company formed by the electric utility industry in 1968 to promote the reliability of the electricity supply in North America. NERC consists of nine Regional Reliability Councils, one of which is the Western Systems Coordinating Council.

Non-spinning Reserve - That portion of the operating reserve capable of being connected to the bus and loaded within ten minutes. Also included is any load which is designated for use as reserve and can be reduced by dispatcher action within ten minutes. (WSCC)

NWPP - Northwest Power Pool

OASIS – Open Access Same-Time Information System is an electronic posting system for transmission access data that allows all Transmission Customers to view the data simultaneously.

Operating Reserve - That reserve above firm system load capable of providing for regulation within the hour to cover load variations and power supply reductions. It consists of spinning reserve and non-spinning reserve. (WSCC)

NERC Definition: *Provides additional capacity from electricity generators that are on line, loaded to less than their maximum output, and available to serve customer demand immediately should a contingency occur.*

Phase Unbalance - The percent deviation of voltage or current in one phase as compared to the average of all three phases.

Pilot Protection - A form of line protection that uses a communication channel as a means to compare electrical conditions at the terminals of a line. (IEEE) The communication channel may be power line carrier, microwave or other radio, fiber optics, leased telephone line or a dedicated hardwire circuit.

Power Factor - The ratio of real power in watts to the product of volts times amperes in an alternating current circuit. The power factor is unity when the voltage and current are in phase. A ‘lagging’ power factor is associated with a partially or wholly inductive load that ‘absorbs’ positive reactive power. A ‘lagging’ power factor is also associated with a generator that ‘delivers’ positive reactive power. A ‘leading’ power factor is associated with a capacitive load that ‘delivers’ or a generator that ‘absorbs’ positive reactive power. See reactive power.

Power System - The integrated electrical generation and transmission facilities owned or controlled by one electric utility organization. (WSCC)

Project Requirements Diagram (PRD) - A BPA TBL simplified drawing showing the electrical requirements for the connection of a transmission line or load to the BPA System.

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

Pseudo-Tie - A telemetered reading or value that is updated in real time and used as a tie line flow in the AGC/ACE equation but for which no physical tie or energy metering actually exists. It usually represents a portion of an actual metered flow. The integrated value is used as a metered megawatthour (MWh) value for interchange accounting purposes. A pseudo-tie is one form of dynamic signal.

Radial Line - A transmission line that is connected to the transmission network only at one end. More typically, a distribution line where only one end connects back to the network and loads are served at the other end and along the line.

Reactive Power - The component of total volt-amperes in an alternating current circuit where the voltage and current are out of phase by ninety electrical degrees. It is measured in units of volt-amperes reactive (var), kvar or Mvar. It represents the power involved in the alternating exchange of stored energy in inductive and capacitive electromagnetic fields. Although this type of power supplies no useful energy, it is an inherent requirement for all alternating current power systems. By convention, positive reactive power is 'absorbed' by an inductance and 'generated' by a capacitance. Reactive power transferred over time is measured in var-hours (varh). See power factor.

Real Power - The component of total volt-amperes in an electric circuit where the voltage and current are in phase. It is also called active power and is measured in watts (W), kW or MW. This is the electrical power associated with useful energy, including mechanical work and heat. Real power used or transmitted over time is measured in kilowatt-hours (kWh) or MWh.

Real Time - Data reported as it happens, with reporting (update) intervals no longer than a few seconds. Applies to AGC type data, but not to kWh or RMS data, which are accumulated and reported only when queried by a master station.

Remedial Action - Special pre-planned corrective measures which are initiated following a disturbance to provide for acceptable system performance. (WSCC)

Remedial Action Scheme (RAS) - A protection system that automatically initiates one or more control actions following electrical disturbances. Also called 'Special Protection System.' (WSCC) Typical examples are generating dropping, load tripping, shunt capacitor switching and shunt reactor switching.

Requester - An electrical utility or other customer or their representative that is requesting a new connection to the BPA Transmission System.

Revenue Metering - General term for metering which is calibrated to ANSI Standards for Billing Accuracy.

Revenue Metering System (RMS) - Provides hourly data daily (as compared to kWh system that reports hourly load each hour). A meter and recording device is installed at points where billing quality data is required. The device meters kW and kvar (bi-directional for Points of Interconnection) and records kWh and kvarh data on a hourly basis. Data is retrieved over dial-up (voice grade) telephone lines by the MV-90™ system located at Dittmer Control Center. The MV-90™ system automatically polls the device every morning beginning at 0001 am. The MV-90™ system can also be forced to poll a remote at any time through dial-in-terminal ports available to BPA TBL personnel.

SAIDI - System automatic interruption duration index is **a** measure of electric utility performance using the length of automatic interruptions as the measure.

SAIFI - System automatic interruption frequency index is a measure of electric utility performance using the number of automatic interruptions as the measure.

Single Pole Switching (SPS) - The practice of tripping and reclosing one pole (phase) of a three pole circuit breaker without changing the state of the remaining poles. Tripping is initiated by single-pole relays that respond selectively to the faulted phase. Notes: 1) Circuit breakers used for single pole switching must inherently be capable of independent pole opening. 2) In most single pole switching schemes it is the practice to trip all poles for any fault involving more than one phase. (IEEE)

Spinning Reserve - That portion of the operating reserve which is synchronized to the system, responds automatically to fluctuations in system frequency, and is capable of assuming load up to the cited spinning reserve magnitude within ten minutes. (WSCC)

Station Service - The electric supply for the ancillary equipment used to operate a generating station or substation. (NERC)

Supervisory Control and Data Acquisition (SCADA) A system of remote control and telemetering used to monitor and control the transmission system. (NERC)

Tap Line – A line that connects to an existing transmission or distribution line without breakers at the tap point, resulting in an additional terminal on the existing line.

TCSC – Thyristor Controlled Series Capacitor

Telemetering - Continuous, real time data reporting, as for AGC and Generation kW (but not for kWh or RMS Systems, which are not continuously reported).

NERC Definition: *The process by which measurable electrical quantities from substations and generating stations are instantaneously transmitted using telecommunication techniques.*

Three-Pole Switching - A relay system and corresponding switchgear that trips or opens all three poles (phases) regardless of fault type.

Wheeling - Transmitting power from one point to another within a Load Control Area or between Load Control Areas.

WSCC - Western Systems Coordinating Council

10. References

1. Bonneville Power Administration - United States and Other Codes
   - 1.1 *Definitions*, December 1993 - DOE/BP 2279
   - 1.2 *Accident Prevention Manual* (APM) - DOE/BPA I-9911
   - 1.3 *Reliability Criteria and Standards -* DOE/BP I-9113
   - 1.4 *AGC Requirements Document*
   - 1.5 *Technical Requirements for the Interconnection of Generation Resources* - DOE/BP 3162
   - 1.6 *National Environmental Policy Act* - 42 U.S.C. & 4321 et seq.
   - 1.7 *Uniform Building Code*
   - 1.8 *Occupational Safety and Health Administration*

2. ANSI – IEEE - NFPA
   - 2.1 ANSI/IEEE Std 80 - *Guide for Safety in AC Substation Grounding*
   - 2.2 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.*
   - 2.3 IEEE Std 100 - *IEEE Standard Dictionary of Electrical and Electronic Terms*,.
   - 2.4 IEEE Std 367 - *Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault*
   - 2.5 IEEE Std 519 - *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*
   - 2.6 IEEE - 487 - *Recommend Practice for the Protection of Wire-Line Communication Facilities Serving Electric Power Stations*
   - 2.7 IEEE - 837 - *Standard for Qualifying Permanent Connections Used in Substation Grounding*
   - 2.8 NESC C2 - *National Electrical Safety Code*
   - 2.9 ANSI C84.1 – *Electric Power System and Equipment – Voltage Ratings (60Hz)*
   - 2.10 NFPA 70 - *National Electrical Code*

3. NERC – NWPP - WSCC
   - 3.1 NERC *Operating Standards*
   - 3.2 NERC *Planning Standards*
   - 3.3 NWPP *Operating Manual*
   - 3.4 WSCC Reliability Criteria including:
     - 3.4.1 *Reliability Criteria for System Design*
     - 3.4.2 *Power Supply Design Criteria*
     - 3.4.3 *Minimum Operating Reliability Criteria*.
     - 3.4.4 *Reliability Management System*

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BPA F6420.25

U.S. DEPARTMENT OF ENERGY
BONNEVILLE POWER ADMINISTRATION
TRANSMISSION BUSINESS LINE

Electronic Form

TRANSMISSION LINES AND LOADS CONNECTION INFORMATION

WHO SHOULD FILE THIS FORM:
Any customer expressing an interest in connecting transmission lines or loads to BPA TBL's Transmission System.

INFORMATION:
This application will be used by the BPA TBL to determine if a System Impact and Facility Requirement Study is required. This study is used to determine the location (Connection Point), equipment requirements (Requester & BPA TBL), system modifications, etc. to connect transmission lines and/or loads. Sections 1 and 2 should be completed as soon as possible and returned to the BPA TBL Account Executive. Section 3 must be completed if it is determined that a System Impact and Facility Requirement Study is required. Following completion of the study the Requester will receive a preliminary estimate for the utility interface requirements that may be used in calculating the overall connection requirements.

SECTION 1

REQUESTER INFORMATION

Company

Mailing Address

City	County	State	9 Digit Zip Code
Phone Number	Contact		

CONNECTION DESIGN ENGINEER *(As applicable)*

Company

Mailing Address

City	County	State	9 Digit Zip Code
Phone Number	Contact		

ELECTRICAL CONTRACTOR *(As applicable)*

Company

Mailing Address

City	County	State	9 Digit Zip Code
Phone Number	Contact		

BPA F6420.25
(Page 2)

SECTION 2

Preliminary Review Information

Type of connection

☐Radial Load ☐ Network Connection with Other Sources Present

Comments:

Connection Point

Identify the BPA TBL Line or Substation

Type of Load

Identify the characteristics which best describe the type of load to be served.

More specific information may be required for loads such as those associated with arc furnaces, large motor, **etc.**

Load Data (at the time of energization and every year for 10 years)

Projected Peak Load

Summer Peak Load

Winter Peak Load

Anticipated Power Factor

Quality of Service (Special Requirements such as power quality, frequency and duration of outages, etc.)

Future Plans (Where known)

Modification or changes affecting the connection or connected equipment

SECTION 3

Study Data Requirements

One Line Diagram

Attach Diagram

Network Power Flow Model (as required)

Enclose a model using approved WSCC format

Line Data

Positive and zero sequence: resistance (ohms/mile), reactance (ohms/mile) and susceptance (mhos/mile)

Conductor Rating (amperes @ °C temperature rise) and Conductor Type

Line Length (miles)

System Data (only applicable where generation resources are present or if the connection includes another network source.)

Provide a system equivalent (R1,X1,R0,X0 in per unit on a 100 MVA base) at the proposed Connection Point looking into the connecting system. This values should be determined such that the system model *does not* include the physical connection to the BPA System. Assuming there are no other connections to the BPA System at any other point, these quantities are available by computing a single line-to-ground 'bus fault' at the proposed Connection Point.

Generation (if applicable)

Must follow the process as described in the BPA document – 3162, *Interconnection of Generation Resource*s

Future Plans

Modification or changes affecting the connection or connected equipment

Reactive Equipment

Location, size, and rated voltage

More specific information is required for reactive with dynamic capability (SVC, TCSC, Sync Condensers, etc.)

To be filled out by the BPA Transmission Account Executive:

Transmission Account Executive	Region
Internal Routing	Phone Number

Copy of Interconnection Study Request and Attachments to:

Network Planning - TOP
Customer Service Planning and Engineering - TOC