69 kV to 500 kV

INTERCONNECTION REQUIREMENTS

FOR

TRANSMISSION FACILITIES

Revision: 0.1

10 September 2013

Revision History

R 0	April 2008	Initial Release
R 0.1	September 2013	Changed branding to BC Hydro from BCTC

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1. COPYRIGHT AND REPRINT PROVISIONS

2. INTRODUCTION

In this document, the term “Transmission System” means the transmission system owned by BC Hydro and operated, managed and maintained by BC Hydro pursuant to the Transmission Corporation Act.

This document provides information on BC Hydro’s 69kV to 500 kV Interconnection Requirements for Transmission Facilities (TFs) by stating (a) the minimum technical requirements the Transmission Facilities connecting must meet, and (b) identifying expected system conditions the connected facilities could encounter while connected to the Transmission System.

Transmission Facility (TF) Definition:

> It is defined as a facility to transmit electricity between the Transmission System and an external system (within or outside BC) that is connected synchronously or asynchronously to the BCH system. The Transmission Facility may be used to serve Firm or Non-Firm (market) Point-to-Point transmission service (export/import). Transmission line(s) to connect Power Generators only are addressed by BC Hydro’s “69 kV to 500 kV Interconnection Requirements for Power Generators” report. Transmission Lines to connect Loads or End-user facilities only are addressed by BC Hydro’s “69 kV to 360 kV Technical Interconnection Requirements for Load Customers” report.
>
> The Transmission Facility could of the following type and construction:
>
> - AC transmission with one or more parallel circuits and station terminations,

which may include shunt and/or series reactive compensation, transformation, and phase shifting transformer/s. The circuits could consist of either or a combination of overhead lines, underground cables, and sub-marine cables.

- HVDC transmission system with conventional converter and inverter terminal station equipment and controls, and include lines and/or cables (U/G or submarine).
- HVDC transmission system with voltage source converter and inverter terminal station equipment and controls, and include under-ground cables and/or submarine cables.
- Back-to-Back DC connection

In general, the Transmission Facility Owner will be responsible for the design, [reference NERC] installation, operation, and maintenance of all necessary equipment, station and transmission line facilities that are required to connect its facilities to the Transmission System, unless otherwise agreed to in writing. The TF is responsible for obtaining all regulatory approvals, including environmental assessment approvals, if necessary, for the construction and operation of its facilities. The facilities shall be designed, constructed, operated and maintained in compliance with the applicable statutes, regulations, by-laws and codes.

The TF is also responsible for submitting all specifications of its facilities and detailed plans to BC Hydro for review prior to receiving permission to connect to the Transmission System.

3. FACILITY MODIFICATIONS

BC Hydro shall be notified during the design stage and prior to any alterations after full commercial operation of the TF facility has commenced. Changes that affect the TF's reliability, fault contribution, control, or protection schemes and/or settings require BC Hydro's confirmation.

4. DISCLAIMER

This document is not intended as a design specification or as an instruction manual for the TF and this document shall not be used by the TF for those purposes. Persons using information included in this guide do so at no risk to BC Hydro, and they rely solely upon themselves to ensure that their use of all or any part of this guide is appropriate in the particular circumstances.

The TF, its employees or agents must recognize that they are, at all times, solely responsible for the transmission project design, construction and operation. Neither BC

Hydro nor any of their employees or agents shall be nor become the agents of the TF in any manner howsoever arising.

BC Hydro has responsibility for the interconnection of facilities to the Transmission System including technical and operation criteria and processes. In certain cases (such as installation of revenue metering equipment), a review of plans and specifications by BC Hydro may also be required. BC Hydro review of the specifications and detailed plans shall not be construed as confirming or endorsing the design or as warranting the safety, durability or reliability of the TF's facilities. BC Hydro, by reason of such review or lack of review, shall be responsible for neither the strength, adequacy of design or capacity of equipment built pursuant to such specifications, nor shall BC Hydro, or any of their employees or agents, be responsible for any injury to the public or workers resulting from the failure of the TF facilities.

In general, the advice by BC Hydro, any of its employees or agents, that the TF's plant design or equipment meets certain limited requirements of BC Hydro does not mean, expressly or by implication, that all or any of the requirements of the law or other good engineering practices have been met by the TF in its plant, and such judgement shall not be construed by the TF or others as an endorsement of the design or as a warranty, by BC Hydro, or any of its employees.

The information contained in this document is subject to change and may be revised at any time. BC Hydro should be consulted in case of doubt on the current applicability of any item.

5. SCOPE

The document will generally apply to all transmission facilities interconnecting to the Transmission System. These requirements will ensure that the TF's equipment will:

- At all times be compatible with the safe operation of the Transmission System;
- Maintain a high standard of quality and reliability of electricity transmission;
- Meet BC Hydro's applicable operating, dispatching, metering and protection requirements;
- Be consistent with the required regulatory agencies and authorities such as the British Columbia Utilities Commission (BCUC).

6. CONTACT WITH BC HYDRO AND OTHER AUTHORITIES

BC Hydro's Market Operations: Interconnections Office will co-ordinate all consultation and communication that the TF has with various groups within BC Hydro on interconnection issues. The Interconnections Office is responsible to ensure that the appropriate groups within BC Hydro are informed as required about all aspects of the TF's project. The BC Hydro Interconnections Office can be reached via e-mail at Interconnections@bchydro.com or phone at 604-528-1720.

The TF will communicate directly with all regulatory and governmental authorities in order to ensure that the TF's facilities are designed, constructed, operated and maintained in compliance with the applicable statutes, regulations, by-laws and codes.

7. GENERAL REQUIREMENTS

7.1. Point of Interconnection Considerations

The TF Owner may apply to connect to the Transmission System at the nominal voltage levels above 69 kV (defined in Section 7.1.2). The physical Point of Interconnection (POI) is determined after agreement between BC Hydro and the TF Owner. The definition of this point will appear in the Interconnection Agreement (IA). The IA document will lay out these and other contractual details specific to the TF interconnection.

7.1.1. General Configurations and Constraints

Integration of transmission facility projects into the BC Hydro power systems is permitted only by a substation termination of a two terminal circuit. The use of a transmission line tap without circuit breakers or three terminal circuits, that can be considered for connecting Power Generators or End-Users, is not permitted for connecting TFs.

7.1.1.1 Substation Termination

A substation termination has the characteristics of connecting a TF to the Transmission System via a set of circuit breakers. Possible configurations are noted as follows:

- Interconnection into an existing Transmission System substation, with (depending on the bus configuration) the TF line or lines each terminated into the station with one or more additional breakers.

- Creation of a new station by looping an existing transmission line through the new station site.
- Interconnection into an existing or new station through a transformer or transformers, which is in turn terminated into one or more circuit breakers.

7.1.2. Operating Voltage, Phase Rotation, and Frequency

The Transmission System operates at 60Hz with an A-B-C counterclockwise phase rotation. The standard operating voltages are as follows:

Table 1: System Voltages

Nominal Voltage (RMS, L-L)	Normal Maximum Voltages (RMS, L-L)
69	72
138	145
230	253
287	315
345	362
500	550

In some cases, lines insulated to higher than energized voltage may be used.

7.1.3. Special Configurations and Constraints

The constraints and considerations described below may substantially affect the costs of a particular integration plan, sometimes making an alternate Point of Interconnection more desirable.

7.1.4. Interconnection to Main Grid Transmission Lines

Main Grid transmission lines include all 500 kV, 360 kV, 287 kV and 230 kV lines, as defined by BC Hydro. These circuits form the backbone of the Transmission System and provide the primary means of serving large geographical areas. These transmission lines connect major generating plants to load centres and interties. Modification to the Main Grid system such as to accommodate TF interconnections can have considerable effect on system reliability and security. On the other hand,

interconnection of TFs at lower voltage, 138 kV and 60 kV, may not be feasible because of limited capacity of the 138 kV and 60 kV systems. For this reason, TF interconnections will need to be reviewed on a case-by-case basis to ensure that system integrity is not impacted.

7.1.5. Other Considerations

7.1.5.1. Equipment

Existing electrical equipment, such as transformers, power circuit breakers, disconnect switches, arresters, and line conductors were purchased based on the operating duties expected in response to system additions identified in long-range plans. However, with the interconnection of a new TF resource, some equipment may become under-rated and need to be replaced or upgraded.

7.1.5.2. System Stability and Reliability

The BCH system has been developed with careful consideration for system stability and reliability during disturbances. The size of the TF, breaker configurations, external system characteristics, and the ability to set protective relays will affect where and how the Point of Interconnection is made. The TF may also be required to participate in special protection schemes (SPS, or remedial action schemes, RAS) such as generator shedding, transfer tripping of circuits, and reactive compensation switching..

7.1.5.3. Control and Protection

The Transmission System includes protective relays and control schemes to provide for personnel safety, equipment protection, and to minimize disruption of services during disturbances. TF interconnection usually requires the addition or modification of protective relays and/or control schemes. New projects must be compatible with the existing protective relay schemes. Sometimes the addition of voltage transformers (VTs), current transformers (CTs), or transfer trip schemes also are necessary, based on the Point of Interconnection. Single-pole protective relaying is used on many 500-kV lines, and transfer tripping on all 500-kV and many 230-kV lines. Conventional zone protection is generally used at 138-kV and below (refer to section 9).

7.1.5.4. Dispatching and Maintenance

BC Hydro operates and maintains the system to provide reliable customer service while meeting the seasonal and daily peak loads even during equipment outages and disturbances. TF integration requires that the equipment at the Point of Interconnection not restrict timely outage coordination, automatic switching or equipment maintenance scheduling. Preserving reliable service to all customers is essential and may require additional switchgear, equipment redundancy, or bypass capabilities at the Point of Interconnection for acceptable operation of the system.

The TF will be designed with adequate reactive power compensation to provide adequate reactive power supply and absorption capability acceptable to BC Hydro (as outlined in Section 8.4.3).

7.1.5.5. Atmospheric and Seismic Conditions

The effects resulting from wind storms, floods, lightning, elevation, temperature extremes, and earthquakes must be considered in the design and operation of the TF. The TF is responsible for determining that the appropriate standards, codes, criteria, recommended practices, guides and prudent utility practices are met.

7.2. Safety

At the point of interconnection to the Transmission System, an isolating disconnect device must be present that meets the following requirements:

7.2.1. Disconnect Device Requirements

Physically and visibly isolates the Transmission System from the TF.

- Compliance with safety and operating procedures of Worker's Compensation Board (WCB) of British Columbia and the TF's safety guidelines in respect of the disconnect device. Terms and conditions covering the control and operation of the disconnect device are normally covered by the operating agreements between the TF and BC Hydro. These operating agreements are normally in the form of "Local Operating Orders" (LOOs).
- Rated for the voltage and current requirements of the particular development.
- Gang operated.

- Operable under all weather conditions in the area.
- Lockable in both the open and closed positions if manually operated.
- Interlocked with the TF's entrance breaker. (Disconnecting interlocks to comply with the latest Canadian Electrical Code requirements).

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

Surge arresters are recommended for the protection of station equipment, such as transformers. Surge arresters shall be located on the station side of the entrance protection CTs.

7.3. Substation Grounding

The equipment and station shall be grounded in accordance with the latest Canadian Electrical Code. It is recommended that the ground grid be designed based on the ultimate fault duty for the site. If not, the TF assumes the responsibility for upgrading when necessary to accommodate changes to the system. It is the TF's responsibility to contact BC Hydro periodically if they have designed the ground grid to less than the ultimate fault duty specified by BC Hydro.

The integration of 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. Studies by BC Hydro will determine if modifications are required and the estimated cost of such modifications.

7.4. Insulation Coordination

<u>Insulation Requirements:</u>

- Coordination of the TF station insulation with the incoming transmission line insulation is required. Care should be taken where the line is constructed for future requirements to a higher voltage than the initial operating voltage.
- Surge arresters rated for temporary ungrounded operation installed in all 69 kV and 138 kV systems locations that may become temporarily ungrounded during certain contingencies.
- Surge arresters rated for temporary ungrounded operation installed in all 230 kV and 287kV systems locations that may become temporarily ungrounded during

certain contingencies.

- The 500 kV system is always grounded and no surge arresters are required for 500 kV system locations.

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 high voltages, as well as all transformers and reactors, should 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 arresters on the incoming lines.

7.5. Station Service and Start-up Power

Power that is provided for local use at the POI substation to operate lighting, heat and auxiliary equipment, is the responsibility of the TF owner, or as agreed to by BC Hydro. The station service requirements of the TF, including voltage and reactive requirements, shall not impose operating restrictions on the Transmission System.

Appropriate providers of station service and alternate station service are determined during the project planning process.

7.6. Isolating and Synchronizing

7.6.1. Isolation Requirements:

Specific approval from BC Hydro is required prior to TF energizing a de-energized transmission line or cable circuit.

Switching device connecting the TF to the system to remain open and not reclose until approved by BC Hydro or as specified in the Local Operating Orders, if for any reason the Transmission System is disconnected from the TF (eg. fault conditions, line switching etc.).

7.6.2. Synchronization Requirements:

Synchronization of TF and external system to the Transmission System.

The automatic synchronizing relay shall have frequency, voltage, slip and phase angle matching, and compensate for circuit breaker closing times.

Supervision of all automatic synchronization by a synchronizing check relay, IEEE

device 25. This assures the unit is not connected to the energized power system out of synchronization.

7.7. Certification of the Transmission Facility

A Professional Engineer, licensed in the Province of British Columbia, must declare that the TF's facility has been designed, constructed and tested in accordance with the requirements stated in this document, project specific requirements as stated by BC Hydro, and prudent utility practice.

8. PERFORMANCE REQUIREMENTS

The following performance requirements can be satisfied by various methods. It is the responsibility of the TF to provide the appropriate documentation and/or test reports to demonstrate concurrence.

8.1. Electrical Disturbances Requirement:

- The TF's equipment shall be designed, constructed, operated and maintained in conformance with this document, applicable laws/regulations, and standards to minimize the impact of the following:

Electric disturbances that produce abnormal power flows;

Overvoltages during ground faults;

Audible noise, radio, television and telephone interference; and

Other disturbances that might degrade the reliability of the interconnected electrical system.

8.2. Power Quality

The operation of the TF's transmission line(s) shall not degrade the quality of electricity in the interconnected electrical system.

8.2.1. Power Parameter Information System

BC Hydro requires a Power Parameter Information System (PPIS) to ensure proper power quality is maintained for on-line, off-line, steady and dynamic states. The PPIS is capable of high-speed sampling to capture information such as harmonics, and voltage and current levels. The information captured will allow BC Hydro and TF

staff to assess the condition of electricity transmitted from the TF's facility.

BC Hydro will provide the system's requirements, including approved measurement devices (i.e. PML 7700) to the TF. The TF will supply, install and commission the PPIS at the TF's expense. If requested, BC Hydro will perform or arrange for these services at the TF's cost.

8.2.2. Voltage Fluctuations and Flicker

Voltage flicker is an increase or decrease in voltage over a short period of time, normally associated with fluctuating load. The characteristics of a particular flicker problem depend on the characteristics of the load change.

The voltage flicker problem may arise during the start-up of an induction generator, motor, energization of a transformer or other equipment as the large starting current may cause the voltage to drop considerably. The TF shall take steps to minimize flicker problems from the external system being imposed on the Transmission System..

In order to prevent voltage fluctuations from causing serious disturbances to equipment of BC Hydro or third-parties connected nearby on the grid, voltage fluctuation on a phase-to-phase and phase-to-ground basis shall not exceed +5% and -6% on a 60 Hz rms basis compared to the average in the immediately preceding one second period. The value, which is compared to the preceding one-second average, is the root mean squared (rms) value calculated over any ½ 60 Hz cycle.

The standards for voltage fluctuations at the point of connection of the TF's facility with the Transmission System are as follows:

Table 2: Voltage Fluctuations

Voltage Change	Maximum Rate of Occurrence
+/-3% of normal level	once per hour
+5/-6% of normal level	once per 8-hour work shift
Exceeding +5/-6%	pre-scheduled by BC Hydro

Voltage dips more frequent than once per hour must be limited to the “Border Line of Visibility Curve” contained in Appendix H, Permissible Voltage Dips – Border Line of Visibility Curve.

8.2.3. Voltage and Current Harmonics

Harmonics can cause telecommunication interference and thermal heating in transformers; they can disable solid state equipment and create resonant overvoltages. In order to protect equipment from damage, harmonics must be managed and mitigated. The TF's equipment shall not cause voltage and current harmonics on the Transmission 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 Point of Interconnection, Generation Site, or other locations on the Transmission System to determine whether the TF's equipment is the source of excessive harmonics.

8.2.4. Phase Unbalance

Unbalanced phase voltages and currents can affect protective relay coordination and cause high neutral currents and thermal overloading of transformers. In general, to protect equipment of BC Hydro and third-parties, the TF's contribution at the Point of Interconnection 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. However, if the existing unbalance at the Point of Connection is shown to be already quite high, the TF's contribution may cause the unbalance to exceed the specified amount. This will be considered on a case by case basis.

8.2.5 Reliability Standards

The TF will be connected to the BC Hydro system as an element of this system as well as possibly another system in the interconnection. To ensure system reliability, the TF must meet all NERC and WECC Reliability Standards. In addition, BC Hydro System Operating Limits Methodology will be applied to determine BC Hydro's permitted operating limits on the TF.

8.3. Switchgear

8.3.1. General

Circuit breakers, disconnect switches, and all other current carrying equipment connected to the Transmission System shall be capable of carrying normal and emergency load currents without damage. Only circuit breakers (CB) will be acceptable as an interrupting device, for protection initiated tripping, at TF

installations.

8.3.1.1. Circuit Breaker Requirements:

- An interrupting rating equal to or higher than the fault duty at the specific location as determined by BC Hydro.
- Interrupting capability without the use of intentional time delay in clearing, fault reduction schemes, etc.
- Compliance with ANSI/IEEE C37 Standards in respect of all Circuit Breakers. These requirements apply to the TF, the Interconnected external system, the Point of Interconnection as well as other locations on the Transmission System. BC Hydro will also determine an 'ultimate' fault duty for the location. If the CB supplied has a lower interrupting rating, the TF assumes the responsibility for upgrading when necessary to accommodate changes to the system and the TF is responsible for contacting BC Hydro to ensure their equipment is suitably rated.
- Ability to perform all other required switching duties such as but not limited to: capacitive current switching, load current switching, and out-of-step switching.
- Ability to perform all required duties without creating transient overvoltages that could damage equipment of BC Hydro or third parties.

8.3.2. Circuit Breaker Operating Times

Table 3 specifies the operating times typically required of circuit breakers on the Transmission System. These times apply to equipment at the TF Site and the Point of Interconnection and exclude fault detection and communications times. System stability considerations may require faster opening times than those listed. Breaker close times are typically four to eight cycles.

Table 3: Circuit Breaker Operating Times

Nominal Voltage Class	**Rated Interrupting Time (Cycles)**
500 kV	2
287 kV – 345 kV	2

230 kV	3
115 kV – 161 kV	3
69 kV and below	5

8.4. Transmission Rating and Modeling

The TF shall be designed in accordance with applicable standards and as specified below.

8.4.1. Rating

The TF owner shall provide a documentation of how the voltage (kV) and thermal MVA ratings are determined for the components of the TF project. Rating methods shall follow industry practice including NERC Standard FAC-008 requirements.

8.4.2. Transmission Modelling

The TF shall provide complete models for each component of the TF.

8.4.3. Transmission Reactive Power Compensation Requirements:

The TF shall include adequate reactive power compensation facilities to control reactive power flows into or out of the Transmission System over the TF under a range of operating conditions, including ability to switch portions of the reactive power supply/absorption devices or provide infinite control if necessary

The TF shall be planned to meet NERC TPL standards applicable for the western interconnection and address reactive power compensation requirements as follows:

Reactive compensation should be adequate to compensate for reactive power losses on the TF at high power transfers, and to compensate for excess reactive power generated by the TF line or cable charging at low power transfers.

Meet WECC voltage stability reactive margin requirements.

Not (unduly) rely on reactive support from the BC Hydro system under stressed conditions on the TF or on the BC Hydro system.

Not unduly rely on reactive absorption from the BC Hydro system under light load conditions on the TF or on the BC Hydro system.

The adequacy of the reactive power compensation shall be demonstrated by the Interconnection Studies.

8.4.3. Voltage and Frequency at Point(s) of Interconnection

The TF when interconnected to the Transmission System shall be capable of operating continuously within the minimum and maximum voltage limits as defined by BC Hydro. The TF shall also be capable of withstanding the voltage and frequency swings that may occur at the POI due to power system disturbances initiated by system events such as faults and forced equipment outages. To ensure that the TF is not tripped prematurely, the required time delays for setting these relays are presented in the 'Protection Requirements' Section 9.

8.4.3.1. Frequency

Each TF must be capable of continuous operation at 59.5 to 60.5 Hz and limited time operation for larger deviations from normal frequency. Also, when system frequency declines, loads are automatically interrupted in discrete steps, with most of the interruptions between 59.5 and 57.5 Hz. Load shedding within the BC Hydro interconnected system attempts to stabilize the system by balancing the generation and load.

Over/under frequency relays are normally installed to protect the generators from extended off-nominal operation. It is imperative that generators remain connected to the system during frequency excursions, both to limit the amount of load shedding required and to help the system avoid a complete collapse. To ensure that the TF is not tripped prematurely, BC Hydro will specify the minimum required time delays for setting the TF over/under frequency protection relays.

8.4.3.2. Voltage

Each TF must be capable of continuous operation at 0.90 to 1.10pu. To avoid voltage collapse in certain areas of the BC Hydro interconnected system, under-voltage load shedding has also been implemented. The TF under-voltage relay settings must coordinate with the under-voltage load shedding program.

The nominal voltage levels available for connecting to Transmission System will depend on the location of the TF facility. Normal operating voltages on Transmission System can vary by up to +/-10% of nominal voltage levels. The normal voltage level may vary over a wider range at certain locations, and larger variations will occur during abnormal or emergency conditions.

Over-voltage protective relaying coordination is necessary with BC Hydro system over-voltage line tripping scheme.

8.4.4. Resonance and Self-Excitation

The TF shall be designed to avoid introducing detrimental resonances into the BC Hydro Transmission System.

The TF Owner shall assess the risk of self-excitation of any internal generators or motor load and implement appropriate design measures to protect the TF as required.

The TF shall be responsible for determining and adequately designing and protecting its facilities against the impacts caused by switching operations and contingencies in the BC Hydro interconnected system. Some examples are as follows:

1. Resonance situations may occur where an islanded transmission system is left connected to the TF. This will cause unacceptably high transient over-voltages unless corrective measures are provided.
2. BC Hydro will provide the TF Owner with harmonic impedance characteristics at the POI on request. The TF Owner shall ensure that any issues related to resonance and self-excitation is addressed in the TF design.

8.5. Transformer Requirements:

- For installations that connect to a substation, wye-connected HV windings are recommended together with appropriate ground fault protection for the connecting transmission line.

8.6. Transmission Line Design Requirements:

- Accordance with sound engineering practices to ensure satisfactory operation and to avoid adverse impacts on the safety and security of the Transmission System.
- Compliance with the latest version of Canadian Standards Association standard for Overhead System CAN/CSA C22.3 No. 1, which forms part of the Canadian Electrical Code Part III.
- Consideration of television interference, audible noise, radio noise, electromagnetic and electrostatic induction effects and electric field effects.
- Preparation of design studies to determine the actual climatic loadings at high elevations (rime icing), long water crossings (high wind exposure) and coastal areas (possible heavy glaze icing).

8.6.1. Line Insulation

Table 4 provides the typical values used in the BC Hydro Transmission System. The values may need to be increased depending on altitudes, degree of pollution, and where special icing problems exist.

Table 4: Line Insulators and Clearances

Nominal Voltage (rms, L-L)(1)	Number of insulator elements(2) in a string	Conductor to Tower Clearance
69 kV	4	0.46 m
138 kV	7	0.84 m
230 kV	12	1.38 m
287 kV	15	1.78 m

Note 1: Requirements for 360 kV and 500 kV will be supplied on a case by case basis.
Note 2: Insulator elements are utility standard porcelain or glass insulators with a height of 5 ¾" and a diameter of 10".

8.6.2. Shield Wire

Interconnections at operating voltages of 230 kV or greater must provide overhead shielding on transmission structures up to a distance of 500 m out from each terminating station. The objective of the shielding is to limit the rate-of-rise of the surges entering the substation. Longer shield wires may be required in some circumstances.

The overhead shield wires should be capable of carrying the present and future fault currents. BC Hydro will provide the existing and expected future fault currents for various types of faults at the point of interconnection when the output, equipment characteristics and location of the TF's development has been submitted.

9. PROTECTION REQUIREMENTS

Protection systems on the Transmission System are to be implemented so as to ensure fast, reliable clearing of system faults.

The TF Owner is responsible for the following:

- Ensuring that the TF is protected for all operating conditions and for all faults on the Transmission System.

- Installing protective relaying equipment and systems that will sense and properly react to failure of equipment and to faults on the TF. Main and backupprotective relaying systems are required on TF. The protection shall fully protect the safety of the public and of BC Hydro/BCH personnel interfacing with the TF.

- Determining the settings for relays that protect the TF. The protection and associated protection settings for installed equipment shall be coordinated by the TF with settings of the Transmission System protection schemes in the area. BC Hydro will provide details of the BC Hydro system protection to the TF to facilitate this coordination.

- Providing BC Hydro with information as to the type of protection used and the settings for these protections. BC Hydro in consultation with the TF Owner will develop control and protection settings to minimize impact of the TF on the operation of the Transmission System.

Fault interrupting devices shall have adequate fault interrupting and momentary withstand ratings to satisfy the short circuit level requirements and shall meet maximum clearing times established by the Interconnection Studies.

Reclosing of transmission lines by BC Hydro could connect an islanded TF generating system to the Transmission System when the two systems are out of synchronism. To prevent the TF generating plant from being damaged by such reclosing operations, the plant may need to be disconnected from the Transmission System prior to the reclose or BC Hydro may provide a means of preventing reclosing.

Interconnection Studies conducted by BC Hydro may require that the TF installs additional protection for the TF so as not to jeopardize the reliability of the Transmission system.

These protections can include but are not limited to the following:

- Fully redundant protection systems, including associated communication facilities, such that no single protection system component failure will prevent required operation,

- Overvoltage protections,

- System stability protections such as out-of-step or underfrequency.

Data on the protection and control systems including settings shall be provided to BC Hydro.

9.1. General Requirements

The TF protection must satisfy the following fundamental requirements:

9.1.1. Sensitivity and Coordination

The TF shall provide protection with adequate sensitivity to detect and clear all electrical faults on the TF, and coordinate with other BC Hydro protection systems, considering present to ultimate fault levels. In terms of this document coordination is defined as either:

a) Fully selective clearing - the TF's protection shall clear all faults in the TF's installation before other relaying within Transmission System initiates tripping for such faults;

b) Simultaneous clearing - the TF's protection shall clear all faults in the TF's installation simultaneously with the clearing of such faults by Transmission System protection.

Alternative a) will apply for TF installations, unless protection requirements on the Transmission System dictate that alternative b) must be used.

9.1.2. External Fault Detection

Additional protection shall be provided to detect transmission faults on the Transmission System. This protection is generally referred to as 'Transmission Line Protection.' Required fault clearing times will be specified by BC Hydro.

9.1.3. Equipment Rating

The TF's equipment shall be rated to carry and interrupt the fault levels that are or will be available at the TF's location - this includes the ultimate fault currents specified by BC Hydro. The TF's equipment includes all its station and transmission facilities, including but not limited to all protection equipment forming the entrance and transmission line protection: current transformers, potential transformers, secondary cabling, dc system/battery charger, switchboard wiring and protective relays. If the equipment supplied is not designed for the ultimate fault duty, the TF assumes the responsibility for upgrading when necessary to accommodate changes to the system and the TF is responsible for contacting BC Hydro to ensure their equipment is suitably rated. BC Hydro assumes no responsibility should fault currents exceed or be expected to exceed those originally specified.

9.1.4. Unbalance and Undervoltage

The TF's equipment may be subjected to negative sequence current due to unbalance on the Transmission System. These unbalances will be of particular concern where rotating three-phase synchronous machines are present. The TF is

therefore encouraged to consider the provision of negative sequence (unbalance) protection (46) to protect the equipment on the TF's internal system.

If under-frequency tripping of generator units is applied, a solid state or microprocessor-based relay should be used. The setting must co-ordinate with BC Hydro requirements.

During emergencies or abnormal operating situations on the Transmission System, the TF may experience under-voltage conditions. The TF is encouraged to consider the provision of timed under-voltage-tripping (27) to protect his equipment.

9.2. Transmission Line Protection Requirements:

- Provision of redundant equipment to clear all phase and ground faults on the Transmission System by the TF, in the event of faults on the Transmission System caused in part by the TF.
- Physical separation of protection where redundant or equal grade protection is provided.
- Provision of breaker failure protection for the entrance circuit breaker, in addition to providing protection to detect transmission line faults and prevent ungrounded energization.
- Provision of a method to prevent energization of the ungrounded transmission line to the TF, as could happen if the TF's transformer has a delta connected HV winding and the line is open at the transmission line terminal(s). Depending on the specific circumstances, redundant equipment may be required.
- Depending on the location and method of connecting to the Transmission System, communications assisted line protection may be required to provide acceptable fault clearing times.
- Provision of power quality protection (i.e. undervoltage, overvoltage, underfrequency and overfrequency protection) which complies with BC Hydro (WECC) requirements.

9.2.1. Detection of Ground Faults

The method used to detect ground faults depends on the winding configuration of the TF's transformer. Possible methods include zero sequence voltage detection (using a voltage relay, 59N, connected to the broken delta secondary connection of primary voltage instrument transformers) or zero sequence current detection (using a current relay, 51N, to measure zero sequence current flow from the TF to the Transmission

System).

9.2.2. Detection of Phase Faults Requirements:

Provision of dedicated phase fault protection by the TF to clear isolated multi-phase faults on the Transmission System, and consist of: under-voltage relaying (27); directional inverse time over-current relaying (67); impedance relaying (21); or inverse time over-current relaying (51), appropriate to the installation.

9.2.3. Breaker Failure Protection of TF HV Circuit Breaker

Breaker failure protection shall take one of the following forms:

CB auxiliary switch scheme;

Current-based scheme; or

Remote back-up coverage via other relaying within the TF's plant.

9.2.4. Prevention of Energization of Ungrounded Transmission Line

An acceptable method to prevent energization of a line that is open at its terminal(s) on the Transmission System side is to send a transfer trip signal from the open terminal(s) to the TF.

10. CONTROL AND TELECOMMUNICATIONS REQUIREMENTS

10.1. General

As a result of the connection of a TF to the Transmission System, control and telecommunications facilities, including those related to protective relaying, may be required at the TF premises and within the Transmission System for safe and efficient operation of the power system and for the safety of personnel. This may include the upgrade of transmission or other interconnected facilities.

All facilities and equipment defined in the following sub-sections must meet BC Hydro approval to ensure that applicable standards and other considerations, such as functionality, proven reliability, and the availability of maintenance spares, are met. In some cases specific equipment may be defined in order to ensure compatibility with existing equipment such as Supervisory Control and Data Acquisition (SCADA) and other data monitoring master systems located at control centres and at monitoring location.

BC Hydro reserves the right to modify its control and telecommunications requirements

when detailed information becomes available or due to changes in previously submitted information.

All costs associated with the installation, maintenance and continued support for communications access are the responsibility of the TF.

10.2. Telecommunications Assisted Protection Facilities

Telecommunications assisted protection facilities may be required for power system protection functions at the TF's premises and between locations affected by the TF connection. Facilities may include:

- Specialized high-speed tele-protection signals for transmission line protection and to maintain power system stability;
- Specialized high speed transfer-trip tele-protection signals for functions such as transformer protection, reactor protection, over-voltage protection, circuit overload protection, breaker failure protection and the initiation of generator shedding;
- Telecommunications media for the protection facilities, and for remote access to electronic relays, event recorders and fault recorders (used for the analysis of power system disturbances); and
- Suitable battery and charger systems for the above.

10.3. Operations Control and Telecommunications Facilities

Facilities reporting to BC Hydro's System Control Centre (SCC) and/or regional Area Control Centres (ACC), and its backup control centre, may be required at the TF's premises for the real-time operation of the power system within acceptable parameter limits. Facilities may include:

- Digital and/or analog telemetering equipment.
- Remote control and status/alarm reporting equipment, which may be used for the dispatching of power and satisfying WECC contractual obligations, as well as for Automatic Generation Control (AGC) and generation shedding set-up for very large plants.
- Voice telecommunications for operating. *
- Data telecommunications for access to remote control and telemetry equipment.
- Telecommunications media for the above.

- Suitable battery/charger systems for the above.

Note: The first two items above are often combined in one or more SCADA Remote Terminal Units (RTUs).

* - In some cases, a single analog business telephone dial-up line may be used to interrogate the Main Revenue Meter, Backup Revenue Meter, PPIS equipment, RTU(s) and provide telephone service. This is achieved by sharing a central line using a balanced telephone line-sharing device.

10.4. Telecommunications Media

Telecommunications media alternatives with the TF may include dedicated or leased metallic wire line circuits, powerline carrier, microwave radio, fibre optics, UHF/VHF radio and satellite. When two-way telecommunications media is required, full duplex (4 wire or equivalent) circuits will generally be used (except for standard voice telephone circuits on wire line, where 2 wire circuits are used).

Whenever metallic pairs are used, appropriate telecommunications entrance protection must be provided since the station ground potential can rise to hazardous levels above remote ground potential during a power system fault. Telecommunications entrance protection provides safety to personnel, prevents damage to equipment, and allows continuous use of the telecommunications media and the attached equipment during and after power system faults. This equipment must be designed to meet public carrier and BC Hydro safety and protective requirements.

Whenever powerline carrier facilities are used, appropriate carrier accessories are required. These include wavetraps, line matching units and carrier coupling devices (often CVTs with carrier accessories) both at the TF's premises and at the BC Hydro station having the other carrier terminal. In cases where a TF taps into a circuit which has power line carrier operating on it, a wavetrap will be required at the tap point on phase/s which the carrier signal may be attenuated. In some cases specialized carrier bypass facilities may be required.

11. SYSTEM OPERATING REQUIREMENTS

11.1. Generating Reserves

BC Hydro is required to carry its own generation reserves according to requirements specified in the WECC Minimum Operating Reliability Criteria. These include regulating reserves, contingency spinning reserves and contingency non-spinning reserves. Reserves are the obligation of the TF Operator or the purchasing agent (with respect to

the generation output may assume the obligation.) Reserves may be provided by the TF, some other generator via contract, or by purchasing the reserves from a separate entity.

11.2. Generation Dispatching

BC Hydro's Area Control Centres (ACCs) will be the main contact for all entities with generation connected to the Transmission System. Installations with large generating capacities may involve BC Hydro's System Control Centre (SCC). For non-integrated areas, contacts will be as designated by BC Hydro.

Generating schedules shall be provided to or by BC Hydro depending on the TFs contract with the purchasing agent. The detail of the schedule shall be agreed upon with BC Hydro's ACC or SCC. BC Hydro dispatchers may request real time changes as necessary to maintain system security. The TF will have final responsibility for the plant.

If the TF's generation is dispatched by BC Hydro the TF must either provide full supervisory control facilities for each generator from a BC Hydro control centre, or provide 24 hour telephone access to a continuously manned TF control centre via a dedicated telephone line. Within an agreed time, the manned TF control centre (or remote control) must be able to:

- Start-up, synchronize and fully load the TF's available generators,
- Change the output of any of the TF's on-line generators and
- Change the mode of operation of any of the TF's generators (i.e., from synchronous condenser mode to generation mode).

11.3. Remote Synchronization

The ability to remotely synchronize the TF's generator to the Transmission System may be required in the case where the TF's generators are operated remotely by BC Hydro's control centre. Synchronization will normally be accomplished using the generator unit breakers.

11.4. Generation Shedding

Each generator or group of generators greater than or equal to 10 MW is required to provide generation shedding equivalent to the amount of Wholesale Transmission Service (WTS) requested. For generators or group of generators greater than or equal to 100 MW, a Remedial Action Scheme for shedding of the generation equivalent to the

amount of WTS is required. For generators or a group of generators less than 100 MW, the equivalent Generation Shedding may be provided by some other generator via contract, or by purchasing the reserves from a separate entity, as long as the total amount of Generation Shedding is greater than or equal to the sum of both parties' transmission service.

11.5. Generation 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.

BC Hydro does not generally allow islanding conditions to exist except for a controlled (temporary, area-wide) grid separation.

Relaying that responds to frequency and voltage fluctuation will trip the generator for the large voltage and frequency deviations that would tend to occur during an island condition.

In the case where a TF remains connected because of a balanced load situation, the generation in the affected in the local island must be disconnected prior to synchronizing to the main Transmission System.

11.6. Ancillary Services

Beyond the basic production and delivery of electrical energy, successful operation of generators, loads, and the transmission system may involve ancillary services. Some of these services include scheduling, control and dispatch, reactive support from generators, load regulation, and operating reserves. Ancillary services are provided by contractual agreement with BC Hydro.

For large generating sources a high level of dispatchability may be mandatory to provide BC Hydro with the ancillary services needed to support the provision of Wholesale Transmission Services (WTS). In certain cases, smaller generating plants may be required to be dispatchable due to local considerations.

If the TF has agreed to, or is required to, provide ancillary services, the requirements for providing full remote or 24 hour manned generation control must be met as described above. The TF's generators will need to be connected to BC Hydro's automatic generation control (AGC) system to permit the plant output to be automatically controlled

based on system frequency, time error, load, intertie flows, etc.

11.7. Normal and Emergency Operations

The generator owner shall provide a 24 hour contact for normal and emergency operations. Communications between the generator and BC Hydro will be specified in a joint operating order.

11.8. Other Requirements

Other requirements such as reserve obligations, coordination during restoration, synchronizing requirements and other technical issues will be determined in negotiations or consultations between the TF and BC Hydro as required.

12. OPERATING DATA REQUIREMENTS

12.1. Telemetering

BC Hydro may require telemetering equipment for readings such as MW, Mvar, MWh, and Volts. Some or all of this data may need to be supplied continuously or via historical dial-up to BC Hydro's ACC or SCC. The specific requirements depend on the size of the plant, location strength of system at the Point of Interconnection, other generation in the area, etc. Telemetry information guidelines are as follows:

Data: MW, Mvar, MWh, kV, and line status

Description:

- Real-time report by exception using an IED with DNP 3.0 protocol
- Dedicated (always on) communication, i.e., Telus lease, PLC, fibre optic, microwave, etc.

Notes:

a) IEDs (Intelligent Electronic Devices) may be an RTU (Remote Terminal Unit), digital meter or digital relay.

b) The IED must be capable of providing all required data to BC Hydro's System Control Centre (SCC) and/or Area Control Centre (ACC) at a one second polling frequency.

12.2. Revenue Metering

BC Hydro may require the installation of revenue metering equipment. Details on these

requirements can be found on the BC Hydro website at: http://www.bchydro.com/ext/metering.

13. COMMISSIONING REQUIREMENTS

13.1. General

The TF has full responsibility for the inspection, testing, and calibration of its equipment, up to the Point of Interconnection, consistent with the Interconnection Agreement.

13.1.1. General Commissioning Requirements:

Performance of all commissioning by competent personnel.

Compliance with the various levels of Declarations of Compatibility defined in Appendix D prior to loading, synchronizing and operating. These declarations refer to key aspects where BC Hydro must be confident of the correct operation, setting, calibration and/or installation of equipment. This may include, but is not limited to, protective relaying, telecommunications, revenue metering, and shall confirm the compatibility of the TF's equipment and controls with BC Hydro's systems where applicable.

Testing to confirm the safe, reliable and effective operation of all equipment in the TF's facility under normal and abnormal conditions.

Assignment of a BC Hydro Field Coordinator to the installation in order to assure compatibility. BC Hydro personnel may:

- Witness any part of the commissioning test
- Request additional testing
- Conduct their own testing

Correction of any deficiencies identified during commissioning prior to the interconnection is approved for operation.

Submission of a copy of the commissioning reports signed and sealed by the Engineer of Record for the testing upon the request of BC Hydro.

13.2. TF Commissioning Requirements

Testing and inspection to confirm the safe, reliable and effective operation of the TF under normal and abnormal conditions.

13.3. Protection Equipment

Commissioning of protection equipment shall include but not be limited to:

- Ratio, phase and polarity testing of current transformers and potential transformers.
- Calibration checks of each protective relay by injecting the appropriate AC quantities.
- Functional testing of the protective relays to circuit breakers and telecommunications equipment. Testing shall include minimum operating point verification for relays.
- Load tests of protective relays immediately after initial energization.

The settings applied to selected relays will be as determined or reviewed by BC Hydro.

13.4. Telecommunications Equipment

Functional end-to-end testing of telemetry, protection, alarms, voice, etc equipment is required.

13.5. Operating, Measurement and Control Systems Commissioning Requirements:

- Testing to prove synchronization, governor, excitation, voltage regulator, power system stablizer systems among other control schemes.
- Testing of the ratio, phase and polarity of non-protection instrument transformers.
- Testing of the revenue metering in accordance with Measurement Canada requirements and BC Hydro standards.
- BC Hydro may request to witness the commissioning of the Power Parameter Information System (PPIS). Commissioning involves download and testing of the device configuration, check of instrument transform connections, UPS function test, and confirmation of dial-up connection and download of data.

13.6. Apparatus Commissioning Requirements:

Commissioning of station apparatus equipment shall be performed in accordance with the Canadian Electrical Association's "Commissioning Guide for Electric Apparatus" or equivalent. Commissioning shall include but not be limited to:

- Power factor test of high voltage equipment at 10 kV to ensure insulation adequacy.
- Timing and resistance test of main and/or circuit breaker(s).
- Integrity checks of auxiliary switches.
- Continuity checks on control, power and protection cabling to equipment.

14. MAINTENANCE REQUIREMENTS

14.1. General

The TF has full responsibility for the maintenance of its equipment, up to the Point of Interconnection, consistent with the Interconnection Agreement.

14.1.1. General Maintenance Requirements:

Performance of maintenance by competent personnel only.

Maintenance of equipment used to control, generate, protect, and transmit electricity to the Transmission System such that the reliability of the Transmission System is not adversely affected. BC Hydro reserves the right to inspect and test the equipment given reasonable notice.

Performance of necessary maintenance by TF within a reasonable period as requested by BC Hydro.

14.2. Scheduled Outages Requirements:

- Coordination with BC Hydro’s Area or System Control Centres for planned outages for maintenance on TF equipment.
- Planned outages should not impair the safe and reliable operation of the Transmission System where at all possible.

14.3. Preventive Maintenance Requirements:

- Provision of a plan by TF to BC Hydro outlining a preventive maintenance program for the TF's electrical equipment.
- Maintenance to be based on time or on other factors, including performance levels or reliability, following the manufacturers' recommendations and/or accepted electric utility preventive maintenance practices.

14.4. Protection and Telecommunications Equipment

Periodic maintenance of protection equipment shall include but not be limited to calibration testing of all protective relays and function testing to circuit breakers and telecommunications equipment at intervals of not more than 2 years.

Telecommunications equipment shall be tested every 2 years.

Facilities to provide isolation from current transformers, potential transformers and trip buses and to allow AC injection tests should be provided.

15. REGULATORY AND RELIABILITY REQUIREMENTS:

- Compliance with all existing and future regulatory and reliability requirements imposed by various authorities, such as the British Columbia Utilities Commission (BCUC), and the Western Electricity Coordinating Council (WECC), by all entities connected to the Transmission System
- The authorities having jurisdiction over facilities connected to the Transmission System may change from time to time and the regulatory and reliability requirements may change from time to time. It is the responsibility of each TF to ensure it complies with current regulatory and reliability requirements. Any cost associated to comply with these authorities is the responsibility of the TF.

15.1. WECC Reliability Requirements:

- Adherence to the Western Electricity Coordinating Council (WECC) standards, policies, and procedures. WECC provides reliability guidelines to ensure the safe and reliable operation of the western interconnected system, by all TFs connected to the Transmission System.
- Compliance with applicable NERC Reliability Standards as ordered by the British Columbia Utilities Commission.

- For as long as it remains in force for British Columbia, participation in the WECC's Reliability Management System (RMS), by all TFs connected to the Transmission System.

A DEFINITIONS

Area Control Centre (ACC) – Each ACC is responsible for the control and operation of an exclusive area of responsibility. BC Hydro has four ACCs controlling four sections of the Transmission System.

British Columbia Utilities Commission (BCUC) – The BCUC is an independent provincial agency set up to regulate energy utilities in the province, which distribute and sell electricity and gas.

Interconnection Agreement (IA) – A legal document stating the contractual obligations between the TF and BC Hydro. The document covers, but is not limited to, issues relating to facility ownership, operation, dispute mechanisms, and technical requirements. The Interconnection Requirements are incorporated in the IA.

Island – A portion of the Transmission System which has become isolated due to the tripping of transmission system elements, often a single line, that is isolated from the main system and energized by a local generator.

Main Grid – The Transmission System facilities operated at 500, 360, 287 and 230 kV.

Point of Interconnection (POI) – The point where the TF's system connects to the BC Hydro Transmission System. This may be at a different location than the Generation Site and is specified in the Interconnection Agreement.

Rated TF Capacity – The MVA or MW power transfer rating of the transmission facility.

System Control Centre (SCC) – SCC dispatches generation and performs major system operating functions.

Transmission Facility (TF) – A facility to transmit electricity that is connected and synchronized to the Transmission System.

Transmission Facility Site – The geographical location of the Transmission Facility Owner's equipment. This may extend from the Point of Interconnection on the BC Hydro Transmission System to that on an external transmission system.

Western Electricity Coordinating Council (WECC) – Provides regional electric service reliability through: development of planning and operating reliability criteria and policies; the monitoring of compliance with these criteria and policies; the facilitation of a regional transmission planning process; and, the coordination of system operation through security centers. The territory of operation includes the western part of the continental United

States, Canada, and Mexico.

B REFERENCES

ANSI C84.1 – Voltage Ratings for Electric Power Systems and Equipment (60 Hz)

CSA C22.1, C22.2 and C22.3 – Canadian Electric Code Parts I, II & III.

IEEE Standards (www.ieee.org)

IEEE Std. C37.1 – Standard Definition, Specification and Analysis of Systems Used for Supervisory Control, Data Acquisition and Automatic Control.

IEEE Std. C37.2 – Standard Electrical Power System Device Function Numbers

IEEE Std. C37.122 –Standard Gas Insulated Substations.

IEEE Std. C57.116 – Guide for Transformers Directly Connected to Generators

IEEE Std 80 – Guide for Safety in AC Substation Grounding

IEEE Std 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

IEEE Std 100 – The New IEEE Standard Dictionary of Electrical and Electronics Terms (ANSI).

IEED Std. 122 –Recommended Practice for Functional and Performance Characteristics of Control Systems for Steam Turbine-Generator Units.

IEEE Std. 125 – Recommended Practice for Preparation of Equipment Specifications for Speed Governing of Hydraulic Turbines Intended to Drive Electric Generators

IEEE Std 421-1 – IIEE Standard Definitions for Excitation Systems for Synchronous Machines

IEEE Std 421-2 – Guide for the Identification, Testing and Evaluation of the Dynamic Performance of Excitation Control Systems

IEEE Std. 421-4 – Guide for the Preparation of Excitation System Specifications

IEEE Std 519 – IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

IEEE Std 525 – IEEE Guide for the Design and Installation of Cable Systems in Substations.

IEEE Std 605 – Guide for Design of Substation Rigid-Bus Structures

IEEE Std 979 – IEEE Guide for Substation Fire Protection.

IEEE Std 1109 – Guide for the Interconnection of User-Owned Substations of Electric Utilities

IEEE Std 1127 – Guide for the Design, Construction and Operation of Safe and Reliable Substations for Environmental Acceptance.

WECC Guidelines (WECC website)

WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Plan

WECC Undervoltage Load Shedding Guidelines

WECC Generator Test Guide

WECC RMS Agreement to be entered into between the WECC and non-FERC-jurisdictional Transmission Operators within the WECC – Canadian Version

WECC Reliability Criteria

C DATA REQUIREMENTS

The following outlines data that will be required at various stages of planning, design, commissioning and in-service of the TF's commercial project. This data is required by BC Hydro to ensure suitable steps are taken to interconnect the TF to the Transmission System.

C.1 Submission Requirements

Wherever possible, all documents shall be provided in both paper and electronic form.

The preferred format for reports and other documents is Word for Microsoft Office97 and for data, drawing indexes and the like is Excel for Microsoft Office97.

The preferred formats for drawings are (in order of preference): (i) Auto-CADD *.DXF format, (ii) Intergraph MicroStation *.DGN format, or (iii) Portable Document Format (PDF).

Unless legibility will be a problem, all drawings must be submitted on either, 'A'-size (8.5" x 11"; 21.6cm x 27.9cm), or 'B'-size, sheets (11" x 17"; 27.9 cm x 43.2 cm).

C.2 General Submissions

- Six (6) copies of the previously submitted Application for Preliminary Study form.
- Six (6) copies of completed Transmission Entrance Equipment Statement sealed by a Professional Engineer.

C.3 Transmission Facility Technical Data

Transmission Facility technical data requirements are listed in the table below.

Transmission Facility Technical Data Requirements

Overhead Transmission Line or Underground Cable	Nominal Voltage (kV)	
	Length (km)	
	Route Map (including transposition locations)	
	Plan and profile drawings	
	Electrical single line diagram showing transmission line and any other associated devices required for switching, reactive compensation, protection and control and communication and the interface to the other system, generator, or end-user facility	
	Nominal power transfer rating (MW, MVA)	
	Emergency power transfer rating (MW, MVA)	
	Conductor type and size	
	Overhead ground wire type and size	
	Configuration of conductors and overhead ground wires on tower (include diagram showing phase spacing and clearances to ground)	
	Positive Sequence R_1, X_1 and B_1 (ohms/km)	
	Zero sequence R_0 and X_0 (ohms/km)	
	Description of protections provided	
	Description of communication systems	
Reactive Compensation device (if applicable)	Connection Location	
	Type, make, model	
	Configuration	
	Rated Voltage (kV)	
	Size (MVAr)	
	Switching device: type, make, model, interrupting capability, continuous current rating, tripping and closing times and any switching restrictions	
	Criteria for automatic switching	
	Description of protections provided	
Intermediate or terminal substation (if applicable)	Electrical single line diagram	
	Circuit Breakers: type, make, model, interrupting capability, continuous current rating, tripping and closing times	
	Description of protections	

Transmission Facility Technical Data Requirements (cont'd)

Transformer (if applicable)	Type, make, model	
	MVA rating—Normal	
	MVA rating—Emergency	
	Voltage rating of each winding	
	Connection configuration of each winding	
	Saturation Characteristics	
	Tap-changer nominal tap, tap step size and tap range	
	Positive sequence impedance on own base (p.u.) at nominal tap for each winding	
	Zero sequence impedance on own base (p.u.) at nominal tap for each winding	
Circuit Breakers	Type, make, model, interrupting capability, continuous current rating, tripping and closing times	
Surge arresters	Type, make, model and rating	
Protection & Control	Description of protection and control provided including block diagrams and schematic diagrams	
	List of protection and control settings	
Supervisory Control	Description of interface provided for remote control and monitoring	
Metering	Description of facilities for metering	
Communication System	Description of communication systems provided	

C.4 Transmission Facility Outage Data

The TF Owner is expected to provide its expected forced and planned (maintenance) transmission circuit outage performance, and the actual recorded data annually to BC Hydro.

D DECLARATION OF COMPATIBLITY

The TF shall comply with the various levels of Declarations of Compatibility as listed below. These declarations refer to key aspects where BC Hydro must be confident of the correct operation, setting, calibration and/or installation of equipment.

D.1 Requirements for “Declaration of Compatibility”:

The compatibility of load describes conditions that must be satisfied before the TF’s facility can be connected to receive electricity from the Transmission System and usually occurs during construction.

Declaration of Compatibility

Transmission Facility

Project:

The TF Owner shall design, construct, own, and maintain the TF Facility.

	Yes	No
Interconnection		
1. Executed Interconnection Agreement	☐	☐
2. BCTC has reviewed the TF's proposed facilities to confirm compliance with BCTC technical requirements for operation as a load.	☐	☐
Field Verification		
1. Protective Relay Coordination confirmed.	☐	☐
2. Revenue Metering Installation completed and checked, if required	☐	☐
3. Operating Order approved by BCTC and the TF. and Control Centre have copies.	☐	☐
4. Electrical Inspection Approval attached.	☐	☐
5. Professional Engineer's declaration(s) that the TF Facility have been designed, constructed, and tested to a state suitable for operation as a load in accordance with prudent electrical utility practice.	☐	☐
6. BCTC facilities ready.	☐	☐

Provide explanation if "No" has been checked for any item above.

The undersigned do hereby declare that the Generator's Facilities are compatible for interconnection with the Transmission System for the purposes of operating as a load.

_____	_____	_____	_____
(TF Owner or Delegate)	*Date*	*BCTC Field Coordinator*	*Date*