4.6.2 Planning Standards

Planning Standards are not objectives in themselves but are used by planners in the development of projects to meet the above objectives.

BCTC is a member of the Western Electricity Coordinating Council ("WECC"), which is a regional member of the North American Electric Reliability Council ("NERC"). BCTC plans and operates the transmission system in accordance with NERC planning and operating standards, augmented by WECC. The NERC/WECC Planning Standards establish the criteria within which members plan and operate their systems. Regional differences (economics, geography, weather, etc.) often dictate that more detail is required in each utility's planning and operating criteria, which direct their individual planning while still conforming to NERC/WECC Planning Standards.

In the aftermath of the August 2003 blackout in the northeast, NERC has undertaken to update and augment its Planning Standards and Operating Policies into new NERC Reliability Standards. These new standards which will become mandatory as of June 2007, address functional responsibilities of the various entities responsible for the reliability of the electric system and add to the documentation requirements. However, the underlying fundamental performance requirements are not changing. This work is ongoing and BCTC is monitoring the NERC activities and assessing the potential future impact on the planning and operation of the transmission system.

BCTC applies NERC/WECC Planning Standards to ensure reliability in the planning of the transmission system. NERC defines reliability as comprising both adequacy and security. Adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of their customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements. Security is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements.

NERC/WECC Planning Standards detail the system performance criteria used to address these two objectives. These criteria are based on many years of experience by utilities across North America as to the general level of reliability expected by customers, relative to the cost of achieving this reliability. These criteria also take into consideration that operators will require time to adjust their systems to a secure operating condition following a system event. Protection systems and Remedial Action Schemes are often required to meet these criteria.

The transmission system is interconnected with three other systems: the Alberta Electric System Operator (“AESO”) to the east, Bonneville Power Authority (“BPA”) to the south, and FortisBC internally. WECC members have mutually agreed to apply performance standards with respect to the impacts that each system can have on its neighbours. Specifically, the WECC Planning Standards state:

> WECC Member Systems shall comply with the WECC Disturbance-Performance Table of Allowable Effects on Other Systems… To the extent permitted by NERC Planning Standards, individual systems or a group of systems may apply standards that differ from the WECC specific standards … for internal impacts. If the individual standards are less stringent, other systems are permitted to have the same impact on that part of the individual system for the same category of disturbance. If these standards are more stringent, these standards may not be imposed on other systems. This does not relieve the system or group of systems from WECC standards for impacts on other systems.

The system performance requirements of the NERC/WECC Planning Standards are summarized in Table 4-1. These standards, and BCTC’s own standards, which together represent the performance requirements for the transmission system, are described in more detail below.

Table 4-1. Summary of NERC and WECC Planning Standards

Event Category	Contingency Description	Mean Time Between Failure (Actual Category Performance)	Loss of Load or Curtailed Firm Transfers	Thermal Limits	Voltage Stability	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard
A	All facilities in service		All loads served.	All facilities within applicable ratings				
B	Includes most single contingencies (n-1)	0 to 3 years	No loss of firm loads except on radial systems and local networks served by the affected facility. System adjustments and curtailment of firm transfers permitted to prepare for the next contingency.	All facilities within applicable ratings	Voltage stable at 105% of path rating	Not to exceed 25% at load buses or 30% at non-load buses.Not to exceed 20% for more than 20 cycles at load busses.	Not below 59.6 Hz for 6 cycles or more at a load bus.	Not to exceed 5% at any bus.
C	Some single contingencies. Most double contingencies (n-2)	3 to 30 years	Planned/controlled interruption of loads, generators, and firm transfers permitted.	All facilities within applicable ratings	Voltage stable at 102.5% of path rating	Not to exceed 30% at any bus. Not to exceed 20% for more than 40 cycles at load buses.	Not below 59.0 Hz for 6 cycles or more at a load bus.	Not to exceed 10% at any bus.
D	Some double contingencies initiated by very low probability events. Some multiple contingencies (>n-2). Multiple contingencies	30 to 300 years Greater than 300 years	No cascading loss of loads. Evaluate for risks and consequences Evaluate for risks and consequences	Evaluate for risks and consequences				

4.6.2.1 Thermal Limits

Excessive current flowing through a transmission line will heat the conductor and associated hardware to a temperature which can damage the conductor or cause it to sag too close to the ground, causing a public safety issue. Similarly, overloading of substation transformers, circuit breakers, and other equipment can damage this equipment, resulting in long outage times until this equipment can be repaired. To ensure that these conditions do not occur, the line current must be planned and operated to stay within the rated capacity.

The thermal ratings used for planning and operating purposes are specific to individual equipment characteristics, asset condition, and ambient conditions. Individual circuit and equipment ratings are used in all planning studies. In some cases, short-term overload ratings are established. These allow the operator to maintain schedules for a reasonable length of time after an outage to implement remedial action measures or to re-dispatch generation and avoid having to immediately limit the transfer because of thermal restrictions.

4.6.2.2 Voltage Limits and Voltage Stability

The transmission system must be able to maintain acceptable voltages after the failure of one or more elements. Immediately following a system disturbance, voltages will swing as the system readjusts to a new stable operating point. Once the system has stabilized, operating voltages will normally be different than prior to the disturbance. Excessive voltage deviations may cause voltage sensitive power system and other customer equipment to disconnect from the system, or in some cases, damage to equipment.

Voltage stability is the ability of the transmission system to settle at a stable voltage after the failure of system element(s). An unstable system would demonstrate voltage collapse at the receiving end of the system (load end), which would lead to local load loss and could lead to widespread blackouts. Very low voltages can damage equipment, such as motors, due to overheating caused by the resulting high current flow.

To achieve voltage stability, sufficient reactive power sources need to be available to serve the pre-disturbance reactive load plus the extra reactive power required following the loss of the transmission element(s) in a system disturbance. Voltage levels are managed with equipment such as capacitors, reactors, static VAr compensators ("SVC"), and other types of reactive equipment. Generators also provide reactive power that is used to control voltages on the system.

4.6.2.3 Underfrequency Limits (Minimum Transient Frequency Standard)

Frequency deviations occur following system disturbances. The WECC system is operated at a frequency of 60 Hz. Immediately following a disturbance, frequencies will vary until the system adjusts to a new stable operating point. As the total connected generator output changes in response to the disturbance, the system frequency will gradually return to 60 Hz.

One of the WECC standards establishes a limit on the dip in frequency for various contingencies. BCTC has adopted, for internal impacts only, a less stringent standard than the WECC standard. This exception is solely for the loss of the BC to US interties when importing from the US. This decision was made because adoption of the WECC standard (for internal purposes) would result in a significant reduction to the historical import limit of 2000 MW from the US The risk of this event actually occurring is very low and the consequence of this greater frequency dip is acceptable. The trigger event for this underfrequency risk is a double circuit outage on the short interconnections between Vancouver and Blaine, Washington. Furthermore, BCTC can selectively reduce the import limit during higher-risk conditions (e.g., lightning activity in a geographic area that could lead to this contingency) to mitigate the risk of the underfrequency dip. Based on discussions with its Alberta and BC stakeholders, BCTC chose the minimum allowable frequency dip to be 58 Hz within the BC system. This is one Hz lower than the WECC standard of 59 Hz. WECC recommends that it is prudent to prevent dips from falling below 58 Hz. BCTC continues to meet the WECC standard of 59 Hz in terms of impacts on its neighbours.

4.6.2.4 Transient and Dynamic Stability

Transient stability is the condition in which, following a system disturbance, a generator or group of generators will return to pre-disturbance rotational speed and will not lose synchronism with the integrated system. Transient stability depends upon the physical characteristics of the generators themselves, the controls and excitation systems on these generators, their connections to the system, and the whole power system.

After a disturbance, the generators' output in one area will oscillate against the generators' output in other parts of the large area interconnected system. The interconnected system must have sufficient damping so that power oscillations dissipate quickly. WECC requires installation and use of power system stabilizers on individual generating units to provide this damping.

4.6.2.5 Safety Nets

The power system, with many interconnected facilities in different geographic areas, is occasionally challenged by unexpected combinations of operating conditions and multiple disturbances. To mitigate the potential impact of these types of disturbances, BCTC has put in place various "safety nets". Some of these safety nets are WECC requirements, while others have been put in place at BCTC's initiative. Examples of such safety nets are as follows:

4.6.2.5.1 Underfrequency Load Shedding

WECC has identified the amount of load and the underfrequency trip levels which should be incorporated in an underfrequency load-shedding program. The purpose of this "safety net" is to deliberately trip loads during a severe underfrequency situation, the outcome of which is that the frequency in that area should increase towards the required 60 Hz.

4.6.2.5.2 No Generation Shedding for Single Contingency Events

BCTC's policy is to avoid the use of generation shedding for first contingency events, when all facilities are in-service. This is based on a number of factors including:

(a) Impact on generation equipment – Excessive generation shedding can lead to advanced ageing of the generator units.

(b) Generation shedding for single contingencies on the transmission system compromises system reliability and could impact capacity reserve requirements.

(c) Generation shedding reduces the flexibility for generation dispatch.

(d) A deferral of system reinforcements by using generation shedding forgoes the benefits that can occur from reinforcements in one part of the system providing secondary benefits in another part of the system.

Some exceptions to this general policy are made if the amount of shedding is less than the largest unit on the transmission system, and the required investment to avoid the shedding cannot be justified.

BCTC will accept generation shedding for a double contingency and for a single contingency if one element is already out of service. BCTC has adopted this policy so that the transmission system is more robust and is able to depend on generation shedding for less common and more severe events.

4.6.2.5.3 Over Voltage Line Tripping

The transmission system has many expensive pieces of equipment that can be damaged by excessive voltages. For example, underground cables in Metro Vancouver and the submarine cables to Vancouver Island can be severely damaged if exposed to excessively high voltages. Because of this, a staged protection scheme has been implemented which trips 500 kV lines at specific increasing levels of over voltage. This system is intended to backup other specific measures that are taken to control voltages to acceptable levels for well-defined contingencies that may occur on the system.

Tripping a single line reduces system voltages due to two phenomena. Firstly, because 500 kV lines have some capacitance which tends to support system voltages, the removal of a line will reduce a source of capacitive reactive power and the voltage will fall somewhat. Secondly, tripping one line also increases the reactive power demand by putting more current onto the remaining lines. The demand for reactive power is proportional to the square of the current on the remaining lines and this is a non-linear effect. Consequently, the reactive power required to maintain a given level of voltage is higher after a line trips than it was before and the sources of reactive power are lower. The net result of these two phenomena is that the voltage stabilizes at a lower value than it had before the line tripping occurred. One alternative to the reliance on line tripping is to install additional reactors on the system.

BCTC's planning policy is that the line over voltage protection scheme shall not be triggered when the system responds to a single (N-1) or double (N-2) contingency. To effect this standard, BCTC requires that sufficient voltage control equipment be installed so that the 500 kV lines do not trip on over voltage protection for N, N-1, or N-2 contingencies.

4.6.3 Key Drivers

Growth projects are predominantly customer and volume driven. BCTC determines investments to meet growth in peak demand, OATT requests, and generation identified and forecast by BCTC's customers. Projects range from minor facility enhancements to major transmission line projects and can be needed at three different levels:

(a) Bulk transmission system facilities used to transfer bulk amounts of capacity and energy between large generating stations and the major load centres. These include the 500 kV system, parts of the 230 kV system, interconnections to other utilities, and the circuits to Vancouver Island;

(b) Regional transmission system facilities within specific geographic areas, which are closer to the loads and are generally 230 kV and below; and

(c) Substations or points of connection for loads or generators.

Consideration of bulk system reinforcements to comply with NERC/WECC Planning Standards is triggered by growth in the coincident BC Hydro service area system peak demand load forecast. This includes the BC Hydro domestic peak load plus firm exports to FortisBC, New Westminster, Alberta, and the US. The system-wide peak is known as the coincident system peak demand.

Investigation of regional, or area, system transmission requirements is determined using the coincident regional peak demand forecast; while investigation of local area or substation reinforcement requirements is determined using non-coincident station peak demand forecasts.