

Effective immediately, the following modifications were done to **BC Hydro “35 kV and Below Interconnection Requirements for Power Generators”, May 2010:**

- Section 11 was added
- Appendix A was supplemented with the definitions listed below
- Appendix B was supplemented with the standards listed below
- Appendix E was supplemented with the submission requirements, listed below, related to Shore Power terminals capable of closed transition transfer
- Appendix F was supplemented with a new Declaration of Compatibility

The amendment is meant to provide BC Hydro requirements related to new type of customers that have generators running in parallel with utility: Shore Power terminals that feed ships capable of closed transition transfer.

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## **11. REQUIREMENTS FOR TERMINALS SUPPLYING SHIPS CAPABLE OF RUNNING IN PARALLEL WITH BC HYDRO (CTT SHORE POWER)**

This Section supplements or amends previous, general, sections of BC Hydro document “35 kV and Below Interconnection Requirements for Power Generators”, latest revision.

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## 11.1 General Requirements

### 11.1.1 Applicability

This section applies to terminals that provide Shore Power (SP) for the ships that have generators capable of running in parallel with the utility.

The above ships are capable of running their generators, temporarily, in parallel with BC Hydro for the purposes of “bumpless” (make-before-break) transfer of the ship load, from the ship generation to Shore Power (i.e. BC Hydro) and vice versa. The make-before-break transfer is also known as closed transition transfer (CTT) as it will be described throughout this document.

This document does not apply to terminals that provide Shore Power to ships not capable of paralleling their generators with BC Hydro. They are considered ‘load only’ customers and need to comply with other BC Hydro standards and requirements.

Neither intentional (planned), nor unintentional islanding, of BC Hydro System from the SP terminal is acceptable.

In addition to this amendment and its originating document (“35 kV and Below Interconnection Requirements for Power Generators, May 2010”), the SP terminal shall, as applicable, comply with the latest edition of following documents (normative references):

- a. IEC/ISO/IEEE 80005-1: "Utility connections in port Part 1: High Voltage Shore Connection (HVSC) Systems - General requirements",
- b. IEC/IEEE DIS 80005-2: Utility connections in port -- Part 2: High and Low Voltage Shore Connection Systems - Data Communication for Monitoring and Control
- c. IEC/PAS 80005-3: Utility connections in port -- Part 3: Low Voltage Shore Connection (LVSC) Systems - General requirements
- d. CSA-C22.3 No. 9-08, “Interconnection of Distributed Resources and Electricity Supply Systems”
- e. [BC Hydro Power Quality Standards](#) (refer to Appendix B for complete list of these standards)
- f. [BC Hydro Revenue Metering Requirements](#).

### 11.1.2 Roles and Responsibilities

The terminals that provide SP for the ships are BC Hydro customers, as opposed to the ships that dock at the terminals. Even though the ships have generators that can run in parallel with BC Hydro, and therefore can back-feed into BC Hydro Distribution System, the terminals (i.e. port customers) shall be responsible for ensuring that these interconnection requirements are met by the terminal and by the ships docking there.

### 11.1.3 Assumptions

The requirements are based on the following assumptions:

- Synchronous generators are employed on the ships
- Synchronization schemes (sync check relays, CTT related switchings, ...) are located on the ships.

## 11.2 Terminal Requirements

### 11.2.1 Interconnection Line

CTT SP terminal shall have a disconnect device installed at the POI, on the terminal side of the POI. Refer to section 2 of “35 kV and Below Interconnection Requirements for Power Generators” for disconnect device requirements.

### 11.2.2 Interconnection Transformer

The CTT SP terminal interconnection (also known as main or entrance) transformer energization shall not cause unacceptable rapid voltage changes at POI. BC Hydro acceptable limits are listed in Table 1 (copied below) of BC Hydro Power Quality Standard, ES55 Q2-04, “Rapid Voltage Changes”.

| Number of Changes (n)                | Voltage Change $\Delta U/U$ (%) |
|--------------------------------------|---------------------------------|
| $n \leq 4$ per year <sup>(2)</sup>   | $8 < \Delta U \leq 10$          |
| $n \leq 8$ per year <sup>(1)</sup>   | $6 < \Delta U \leq 8$           |
| $n \leq 4$ per day                   | $4 < \Delta U \leq 6$           |
| $n \leq 2$ per hour                  | $3 < \Delta U \leq 4$           |
| $n \leq 6$ per hour                  | $2 < \Delta U \leq 3$           |
| Restricted by flicker limits (Q2-05) | $0 < \Delta U \leq 2$           |

**Table 1 – LV and MV Network Rapid Voltage Change Planning Limits**

**Notes:**

- 1) Refers to allowable planning level for RVCs caused by customer loads subject to local operating order restrictions.
- 2) Refers to allowable planning level for RVCs caused by customer transformer energization subject to local operating order restrictions.

For interconnection transformers with delta connection on HV side, an additional, robust and very fast, protection from temporary overvoltages is required. The requirements are available in the “Protection Requirements” section of “35 kV and Below Interconnection Requirements for Power Generators”.

### 11.2.3 Utility Interconnection Protection

#### i. General

Utility interconnection protection shall, normally, be located on the terminal, at, or near, POI, and shall employ utility grade protection relay(s) and circuit breaker(s). Refer to Appendix A for definition of Utility Grade Relays.

There will be a relay protection scheme as well as circuit breaker protection scheme implemented for the utility interconnection protection. The relay self-diagnostic feature shall be implemented in the above scheme. The breakers’ trip coils shall be supplied from a dc battery, directly or via uninterruptible power supply.

#### ii. Protection Functions to be Active Just Before the CTT

Refer to clause 11.3.2 “Utility Interconnection Protection” (Ship Requirements)

iii. Protection Functions to be Active During CTT

The following protection functions are required to be active during CTT.

**Table 11.1: Protection Functions Required During CTT**

| Protection Function                                  | Maximum Acceptable Relay Settings<br>(Magnitude / Time Delay)           | Remark   |
|--|---|--|
| Undervoltage<br>(IEEE #27),<br>Note 1, 2             | $V < 50\%V_n / 0.16 \text{ s}$  | Anti-islanding protection (in case BC Hydro disconnecting means opens before terminal's device)<br>Relay sensing point: near POI         |
|  | $50\% < V < 90\% V_n / 2.0 \text{ s}$                                   |  |
| Overvoltage<br>(IEEE #59)                            | $106\% < V < 120\% V_n / 1.0 \text{ s}$                                 | Anti-islanding protection<br>Relay sensing point: near POI   |
|  | $V \geq 120\% V_n / 0.16 \text{ s}$                                     |  |
| Underfrequency<br>(IEEE #81U)                        | $59.4\text{-}57.0 \text{ Hz} / 2 \text{ s}$                             | Anti-islanding protection<br>Relay sensing point: near POI   |
|  | $< 57.0 \text{ Hz} / \text{Instantaneous}$                              |  |
| Overfrequency<br>(IEEE #81O)                         | $60.6\text{-}62.0 \text{ Hz} / 2 \text{ s}$                             | Anti-islanding protection<br>Relay sensing point: near POI   |
|  | $> 62.0 \text{ Hz} / \text{Instantaneous}$                              |  |
| Directional Power<br>(IEEE #32U)<br>towards BC Hydro | Project specific information<br>To be determined by CTT<br>SP applicant | Anti-islanding protection (steady-state)<br>Relay sensing point: near POI  |
| Breaker Failure<br>(BF)                              | Project specific information<br>To be determined by CTT<br>SP applicant | Breaker failure protection<br>If the breaker fails to trip, another device shall isolate the terminal with minimal delay                 |
| Relay Failure<br>(RF)                                | Instantaneous   | Relay failure protection<br>Upon detection of a relay failure (self-diagnostics), a breaker shall trip without delay                     |
| Directional<br>Overcurrent, phase<br>(IEEE #67)      | Project specific information  | Overcurrent protection for phase faults on BCH side of the POI<br>Relay sensing point: near POI  |
| Directional<br>Overcurrent, neutral<br>(IEEE #67N)   | Project specific information  | Overcurrent protection for ground faults on BC Hydro side of the POI<br>Relay sensing point: near POI                                    |
| Overvoltage<br>(IEEE #59N)<br>Note 7                 | $120\%V_n / 0 \text{ s}$<br>Note 3                                      | Temporary overvoltage protection for ground faults on BCH side of the POI<br>Relay sensing point: at POI, on HV side of main transformer |
| Maximum Allowed<br>CTT Time<br>(IEEE #62), Note 4    | 60 s  |  |

Notes:

1. CTT is to be abandoned on undervoltage condition on any of the three phases

2. For Vn values, refer to clause 2.2, “Operating Voltage, Rotation and Frequency” of “35 kV and Below Interconnection Requirements for Power Generators”
3. No intentional time delay shall be added. Total clearing time (relay reaction + breaker tripping time) shall be less than 0.167 s (10 cycles)
4. This is same as the “transfer time limit” described in clause 9.3 of the IEC/ISO/IEEE 80005 standard
5. Should any of the above conditions occur, or in case of failure of a piece of equipment, CTT shall be interrupted by tripping a circuit breaker
6. Coordination of overcurrent protection devices is to include a coordination time margin (a difference in tripping times of two protection devices for the same current). For coordination between CTT SP terminal and BC Hydro relays, the time margin is to be between 0.25 s and 0.4 s
7. An example: a zero sequence over-voltage relay can be connected to three VTs in grounded-wye/broken delta (HV/LV) configuration to trip an entrance circuit breaker in the event of ground fault on BC Hydro Distribution System. Refer to clause 3.5 “Generator Transformers”.

iv. Protection Functions to be Active During Load Only Operation

This is the case where no Generators are running in parallel with BC Hydro and the ship is supplied from Shore Power only.

**Table 11.2: Protection Functions Required During Load Only Operation**

|  |                              |   |
|--|------------------------------|---|
| Directional Power (IEEE #32R) towards terminal | Project specific information | Maximum terminal demand<br>Relay sensing point: near POI  |
| Overcurrent, phase (IEEE #50/51)†              | Project specific information | Overcurrent protection for phase faults on terminal side of the POI<br>Relay sensing point: at POI  |
| Overcurrent, neutral (IEEE #50/51G)†           | Project specific information | Overcurrent protection for ground faults on terminal side of the POI<br>Relay sensing point: at POI |

†For load only operating mode, the terminal is also to meet requirements from:

- “Requirements for Customer-owned Primary Services Supplied at 4 to 35 kV (Primary Guide)” or
- “Distribution Technical Standards and Guides” for services at secondary voltage.

#### 11.2.4 Power Quality

Operation of the CTT SP terminal (during or outside CTT) shall not degrade the quality of electricity in the BC Hydro Distribution System. Applicable BC Hydro Power Quality Standards are listed in the Appendix B.

A Power Parameter Information System (PPIS) is required for all CTT SP terminals that are expected to have CTT capable generators (as individual units) larger than, or equal to, 1 MVA. Sensing point of the PPIS will be located at the POI. Refer to clause 3.2.1 “Power Parameter Information System” for details.

BC Hydro might have additional requirements if the CTT SP terminal is unable to meet the Power Quality requirements.

### **11.2.5 BC Hydro Revenue Metering (RM)**

The port customer (i.e. CTT SP terminal) shall purchase electricity from BC Hydro at the Point of Delivery/Receipt (POD/R). The Customer shall not generate energy with the intention of selling it back to BC Hydro where allowed. The port customer will be metered in accordance with Shore Power Service Agreement, which states that BC Hydro determines the location of Point of Metering (POM), and as such port customer shall be responsible for all costs required for revenue metering and associated apparatus as determined and supplied by BC Hydro.

Type of metering solution ranging from smart to complex will be determined by BC Hydro in consideration of any or all of the following: POM location with respect to POD/R, loss compensation both in terms of line and transformer, deductive/totalizing, and any other requirements arising from time to time.

The port customer shall be responsible for all the metering related design, equipment and installation costs as outlined in BC Hydro Revenue Metering Requirements.

BC Hydro owns and is responsible for the maintenance of meter(s), metering transformers, and any other associated equipment on the port customer's premises for the purpose of billing.

BC Hydro Revenue Metering Department shall be contacted in advance to discuss in details metering requirements for any upcoming project.

### **11.2.6 Remote Control/Data Acquisition and Telecommunications**

SCADA is required for all CTT SP terminals that are expected to have CTT capable generators (as individual units) larger than, or equal to, 1 MVA. Sensing point of the SCADA will be located at, or near, the POI. Refer to clause 6 "Control and Telecommunications Requirements" for details.

## **11.3 Ship Requirements**

### **11.3.1 General**

The CTT SP terminal shall allow, to interconnect to BC Hydro, only the ships that have

- generating units smaller, or equal, to the maximum unit size allowed by BC Hydro
- CTT duration shorter, or equal, to the maximum CTT duration allowed by BC Hydro.

The ship (especially large ships such as cruise ships) may be required to reduce a load before transferring it to Shore Power. This may be needed where BC Hydro Distribution System have limited service capacity.

The number of ship generators running in parallel with BC Hydro at one time may also be limited. This is to limit short circuit contribution from the terminal to BC Hydro Distribution System.

As noted in clause 11.1.2, the CTT SP terminal (i.e. port customer) is responsible for ensuring that these interconnection requirements are met by the terminal and by the ships docking at the terminal.

### **11.3.2 Utility Interconnection Protection**

Utility interconnection protection is, normally, located on the terminal. However, since the CTT equipment is located on the ship, some protection is to be implemented on the ship, too. These protection functions (acting as permissives) are to be active just before the CTT happens.

| Protection Function       | Acceptable Relay Settings<br>(Magnitude / Time Delay)   | Remark   |
|---------------------------|---|--|
| Synch Check (IEEE #25)    | Refer to clause 2.8.3 “Synchronization – Synchronous Generators” of “35 kV and Below Interconnection Requirements for Power Generators” | Synchronization (i.e. CTT) permission<br>Relay sensing points: on the ship |
| Undervoltage (IEEE #27) † | $V < 88\%V_n$<br>/ 1 s  | Denying permission for CTT<br>Relay sensing point: on the ship             |

† - CTT shall be disallowed if there is undervoltage condition on any of the three phases

The ships are to meet the above synchronization and protection requirements where the relays are located onboard. The ships are recommended to have breaker and relay failure protection schemes implemented for the CTT schemes.

## 11.4 Operation Requirements

The CTT SP terminal shall have a written operating procedure to connect the ships. This procedure is to be submitted to BC Hydro with the interconnection application and again whenever material updates are made.

Only one ship docked at a terminal shall be in closed transition transfer at any time.

There could be a possibility of connecting a CTT SP terminal to a BC Hydro feeder that was already designated as standby feeder for another customer. In a case where the primary customer needs service from the standby feeder, the CTT SP terminal will be notified and disconnected.

In case of emergency, BC Hydro may, as determined by BC Hydro, locally (or remotely) disconnect and isolate the CTT SP terminal.

An Operating Order (OO) will be prepared by BCH Real-time Operations for the CTT SP terminal. The OO defines the switching authority boundary (between BC Hydro and the terminal), isolation responsibilities and procedures, and lists contact and operating personnel. The OO is signed by BC Hydro and by CTT SP terminal representatives.

For CTT capable Shore Power terminals, the following declarations are required:

- Declaration of Compatibility, Load, Generator’s Facilities
- Declaration of Compatibility, Generator (1st Synchronization), Generator’s Facilities



## Appendix A Definitions and Acronyms

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**Closed-Transition Transfer (CTT)** — Interconnection (running in parallel) of a Power Generator for a definitive period of time to the BC Hydro Distribution System with the purpose of uninterrupted (“bumpless”) transfer of load from the BC Hydro Distribution System to the Power Generator or from the Power Generator to the BC Hydro Distribution System.

**Shore Power (SP)** — This is utility provided electrical power for vessels (ships) while being docked at berth at a port or a terminal. The shore power is used for non-propulsion load in place of vessel’s own diesel generators. The scenario of receiving electrical power and other utilities from shore is also known as “cold ironing”.

**Utility Grade Relay** – Utility grade relays are designed to provide the highest degree of reliability, repeatability, longevity, security, and calibration accuracy. Such relays comply with the IEEE Standard C37.90, “Standard for Relays and Relay Systems Associated with Electrical Power Apparatus”.

## Appendix B: Codes and Standards

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1. ISO/IEC/IEEE 80005-1: "Utility connections in port Part 1: High Voltage Shore Connection (HVSC) Systems - General requirements"
2. IEC/IEEE DIS 80005-2: Utility connections in port -- Part 2: High and low voltage shore connection systems - Data communication for monitoring and control
3. IEC/PAS 80005-3: Utility connections in port -- Part 3: Low Voltage Shore Connection (LVSC) Systems - General requirements
4. IEEE Std 1547a-2014, “IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems - Amendment 1.”
5. [BC Hydro Power Quality Standards](#),
  - ES55 Q2-02, Voltage Frequency
  - ES55 Q2-03, Steady-State Voltage
  - ES55 Q2-04, Rapid Voltage Changes
  - ES55 Q2-05, Voltage Flicker
  - ES55 Q2-08, Voltage Sags and Swells, and
  - ES55 Q2-09, Voltage Harmonics.

## Appendix E: Submission Requirements

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The following documentation is required for Shore Power Terminals serving CTT capable ships:

- a. Application for Interconnection, Power Generator(s) in Closed Transition Transfer Mode
- b. SP Terminal, 1-Line Diagram, Overall Power Distribution, Issue to BC Hydro (to show all major equipment, BC Hydro Revenue Metering complete with all key interlocks, location of POI, etc.)
- c. SP Terminal, 1-Line Diagram, Protection, Control, and Data Communication, Issue to BC Hydro (to show interconnection protection functions, relays, associated CTs, VTs, PPIS, SCADA, etc.)
- d. SP Terminal, Site Plan, Issue to BC Hydro (to show main pieces of equipment, location of POI, property fence, main gate(s), location of BC Hydro revenue metering, a piece of access road and BC Hydro feeder (for reference only))

- e. A narrative description of CTT SP Terminal having, at least,
- brief operating procedure of docking/undocking of the ships
  - detailed description of a ship CTT to/from BC Hydro procedures (devices involved, reduction of load (if any), protection and control settings, type of CTT, etc.)
  - maximum expected (present and future) frequency and duration of CTT
  - maximum expected generation (MVA, MW) being in CTT mode at time
  - maximum fault contribution, at POI, from the CTT SP terminal (i.e. the ship) to BC Hydro
  - maximum expected demand of the terminal
  - description of utility interconnection protection (participating relays, breakers tripped, associated protection transformers) complete with their purpose, functions, and settings (magnitudes and timings)
  - open transition transfer (break-before-make) capabilities
  - brief information of, if any, on the terminal, CTT capable automatic transfer switches. If there are such switches, an additional procedure (standby CTT capable generators) will be applicable
- f. Brief technical description (length, size, type, impedance, over/below ground) of
- terminal interconnection lines, from POI to ship-to-shore cables
  - ship-to-shore cables
- g. Technical specifications (data sheets) of
- entrance transformer (make, model, ratings, connections, impedance, grounding)
  - loadbreak switch/breaker located at POI (make, model, ratings, tripping time)
  - Interconnection protection relay (make, model, approvals, description of self-diagnostic function)

Note: additional documents might be required such as 3-line diagrams, schematics, substation manufacturer drawings if necessary.

## Appendix F: Declaration of Compatibility

CTT SP terminal shall comply with two levels of Declarations of Compatibility:

- “Declaration of Compatibility – Load”, reference Appendix F in “35 kV and Below Interconnection Requirements for Power Generators”, and
- “Declaration of Compatibility – Generator (Shore Power, CTT Capable)”, shown below.

**Requirements for “Declaration of Compatibility – Shore Power, CTT Capable”**

| <b>Declaration of Compatibility, Generator (Shore Power, CTT Capable), IC’s Facilities</b>   |                          |                                     |             |
|--|--------------------------|-------------------------------------|-------------|
| <b>Generator:</b> <i>3-ph, approx. nn MVA (total maximum allowed), nn kV, diesel, synchronous generator.</i>   |                          |                                     |             |
| <i>Note: the generator is located on a xyz type of ship, one ship in parallel with BC Hydro at time</i>  |                          |                                     |             |
| <b>Project:</b> <i>ABC Port Authority, XYZ Terminal, Shore Power (BCH Facility Code)</i>   |                          |                                     |             |
| The IC shall design, construct, own, and maintain the Customer’s Facilities.   |                          |                                     |             |
|  | <b>Yes</b>               | <b>No</b>                           |             |
| 1. BCH has reviewed the proposed facilities to confirm compliance with BC Hydro’s technical requirements for Shore Power Facilities capable of closed transition transfer.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 2. Accepted by BCH Real Time Operations for energization for generator operation.  | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 3. Protective relay settings field verified.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 4. Revenue Metering Installation completed and checked. Attach BCH Metering Checklist.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 5. Completed the Power Parameter Information System (PPIS) requirements.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 6. Operating Order (OO) approved by BCH and the Generator. Generator and Control Centre have copies.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 7. Electrical Inspection Approval attached.  | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 8. Professional Engineer’s declaration(s) that the Generator’s Facilities have been designed, constructed, and tested to a state suitable for operation as generator in accordance with applicable standards and prudent electrical utility practices. | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 12. BC Hydro facilities ready.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 13. Telemetry requirements complete.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| 14. BC Hydro Operations approval to energize for generator commissioning received.   | <input type="checkbox"/> | <input type="checkbox"/>            |             |
| Provide explanation if “No” has been checked for any item above.   |                          |                                     |             |
| The undersigned do hereby declare that the IC’s Facility is compatible for interconnection with the BC Hydro system for the purpose of generator operation.  |                          |                                     |             |
| _____  | _____                    | _____                               | _____       |
| <i>(Generator or Delegate)</i>   | <i>Date</i>              | <i>(BC Hydro Field Coordinator)</i> | <i>Date</i> |