

**BC HYDRO**

**T&D SYSTEM OPERATIONS**

**SYSTEM OPERATING ORDER 7T-17**

**BC – ALBERTA INTERCONNECTION**

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Denotes Revision ||

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**1.0 GENERAL**

This System Operating Order (SOO) describes the operation of the BC-Alberta Interconnection, also defined as Path 1 in the WECC Path Rating Catalog. Documented in this order are the general operating requirements, responsibilities for entities associated with the Interconnection, voltage control and switching requirements, Synchronizing, and special operating configuration requirements. Also provided in this order are the BC Hydro System Operating Limits (SOL) and Remedial Action Scheme (RAS) arming requirements for the BC – Alberta Interconnection.

The SOL, Transfer Limits recommendations and RAS Arming requirements for the BC – Alberta Interconnection can be found in Sections 9 and 10, and supporting Attachments. These limits are in effect to cover the worst case operating conditions. Variations from these limits and arming conditions will be provided through additional Operating Plans, for specific operating conditions on a case basis. Operating Plans are engineered to support outages and short term operating requirements, superseding as necessary **any of the** requirements in this order.

**The BC-Alberta Interconnection (WECC Path) 1 is defined as:**

- One 500 kV circuit (designated 5L94 within BC Hydro and 1201L within Alberta operating entities) between BC Hydro’s Cranbrook Substation (CBK) and AltaLink’s Bennett 520s Substation (BNS). The path metering is at BNS.
- One 138 kV circuit (designated 1L274 within BC Hydro and 887L within Alberta operating entities) from BC Hydro’s Natal Substation (NTL) to AltaLink’s Pocaterra Substation. The path metering is at Pocaterra.
- One 138 kV circuit (designated 1L275 within BC Hydro and 786L within Alberta operating entities) from BC Hydro’s Natal Substation to AltaLink’s Coleman Substation. The path metering is at Natal.

The BC-Alberta Interconnection is monitored using the EMS OTC monitoring tool, to ensure that transfers do not exceed SOLs.

At present, the BC Hydro (BCH) and the Alberta Electric System Operator (AESO) jointly operate the above circuits (1201L/5L94, 1L274/887L and 1L275/786L).

The points of connection are at the BC – Alberta Border, and are described as follows:

Circuit	Distance from Station	Last BC Hydro Structure	Border Description
5L94 / 1201L	107.8 km from CBK	108-3 (AltaLink Str 510)	Approx. 130m east from structure
1L275 / 786L	18.4 km from NTL	8-7	Immediately east of structure
1L274 / 887L	103.4 km from NTL	64-8	Immediately north of structure

These interconnection circuits are equipped with undervoltage protection, overvoltage protection, direct transfer tripping and generator dropping Remedial Action Schemes (RAS). The purposes of these RASs are to maintain transient stability, to prevent thermal limit and voltage limit violations and to prevent uncontrolled tripping of transmission circuits for both single and double contingencies in the area.

The operating limits and RAS arming requirements in this System Operating Order have been programmed into the Energy Management System (EMS) at the BC Hydro Control Centre (BCHCC). This EMS monitors transfers on this path and associated circuits and provides alarms and recommendations when operating limits are exceeded.

The 140 kV circuit from AltaLink's Pocaterra Substation to AltaLink's Seebee Substation is designated 777L within Alberta operating entities, and is referred to elsewhere in this Order.

The 140 kV circuit from AltaLink's Coleman Substation to AltaLink's Russell Substation is designated 170L within the Alberta Operating entities, and is referred to elsewhere in this Order.

All references to time will be made on the basis of the 24-hour clock, Pacific Standard Time (PST) or Pacific Advanced Standard Time (PAST), as the case may be.

## **2.0 BCH ENTITIES ASSOCIATED WITH INTERTIE OPERATION**

**BC Hydro's Control Centre (BCHCC)** is the Balancing Authority Area and Transmission Operator (TOP) for the BC integrated electric system. In addition to all the Balancing Authority (BA) Area Operator responsibilities, BCHCC is responsible for secure operation of the BC Hydro bulk transmission system, coordination of interconnection operation with neighboring utilities, real time outage approval/rejection, determination of the real time interconnection Total Transfer Capability (TTC) and Available Transfer Capability (ATC), posting of real time TTC and ATC on the BCH Open Access Same time Information System (OASIS) node, and real-time transmission reservation and energy schedule implementation. BCHCC is also responsible for Outage Scheduling and Operational Planning for the day to day operation of the BC Hydro system as the TOP and BA for the BC Hydro Bulk Electric System.

BCHCC is also responsible for the operation of sub-transmission system and generating plants in the area and for all BCH related Power System Safety Protection (PSSP) issues associated with power system operations in the area, including the BC-Alberta interconnection.

**BCHCC** is responsible for coordinating scheduled outages on the BC - Alberta interconnection, establishing TTC for prescheduling and real-time, and for scheduling transmission and energy in real-time.

For the time period starting one day ahead, **BC Hydro Market Policy & Operations (BCH-MPO)** is responsible for selling transmission access to the BC-Alberta interconnection, posting TTC and ATC on the BCH OASIS node, and coordinating energy schedules for the control area. This group is also responsible for after-the-fact accounting and billing of transmission services.

### 3.0 **ALBERTA ENTITIES ASSOCIATED WITH INTERTIE OPERATION**

The AESO is the **Alberta Transmission Administrator**. AESO has signed an Interconnection Agreement with BCH to establish the terms and conditions for the operation of the BC - Alberta interconnection. They are responsible for:

- reviewing the operating and emergency transfer limits of the interconnection,
- posting on their website the ATC on an hourly real-time and hourly forecast basis (including the associated hourly loss factors and the corresponding tariff),
- providing the Import Load RAS (ILRAS) for the implementation, review and approval of planned interconnection outages,
- posting of such outages on their web site at least one month in advance of the actual outage, and;
- in coordination with BCH, establishing interconnection congestion management process such as schedule curtailment order.

**AESO** is the real-time control area operator of the Alberta Integrated Electric System (AIES). In addition to the control area operator responsibility, AESO is responsible for:

- scheduling energy transfer across the interconnection,
- revising ATC value in real-time on their website and coordinating with BCH for ATC posting on BC Hydro's OASIS node,
- pre-authorizing re-synchronizing to the BCH system, and
- coordinating with BCHCC regarding any schedule changes on the interconnection.

AESO, on managing import from BC, is responsible to dispatch the arming and disarming of ILRAS provided by the ILRAS Service Provider Operator. AESO is responsible for curtailing schedules with BCH due to withdrawal of service by the ILRAS Service Providers.

**AltaLink** is the transmission facility owner of the Alberta portion of the B.C. - Alberta interconnection. The AltaLink System Control Operator is responsible for the operation of the interconnection, including the safety protection issues associated with the Alberta portion of the interconnection.

#### 4.0 **OPERATING PROCEDURES BETWEEN BCH AND ALBERTA ENTITIES**

Both BCHCC and AESO must be notified of any plans or actions affecting the operation of the ties.

**Outage and Maintenance Scheduling** – Pre-scheduling of the interconnection outage will be coordinated amongst BCHCC, AESO and AltaLink. BCHCC and AESO will do real-time outage scheduling.

**BC Hydro TVC notifications** - Prior to implementing planned transmission system configuration changes for interconnection operations that may directly impact power quality to transmission voltage customers (FRO, GRH, EV1) on 1L274 interconnection line. These configurations include outages to 2L113 and 5L94 and when 1L274 is radially supplied. BC Hydro shall make these notifications (refer to OO's 3T-FRO-01, 3T-GRH-01, 3T-LCC-01 and 3T-EV1-01 for notification requirements).

**Pre-scheduled Transmission Access and Energy** will be coordinated between the BCH-MPO pre-scheduling group and the AESO pre-scheduling group.

**Coordination of Transfer Limits** - On a pre-schedule basis, the pre-schedule staff of BCH-MPO and AESO will coordinate their transfer limits for the next day, and agree on the Transmission Reliability Margin (TRM) to be applied, establishing a common hourly scheduling limit for the intertie for the next day. During the operation in real-time, these limits and margins will be adjusted as necessary and will be coordinated in a similar manner by BCHCC and AESO.

**Real-time transmission access scheduling** will be carried out by BCHCC. BCHCC is responsible for posting the appropriate ATC on the BCH OASIS node. BCHCC and AESO will coordinate real-time energy scheduling.

**Interconnection Switching Procedure** - BCHCC will coordinate any real-time removal of an interconnection element from service with the AltaLink System Control Operator once approval has been obtained from AESO.

**Interconnection Restoration Procedure** - AESO approval must be obtained prior to restoration efforts under circumstances when the synchronism has been lost between the two systems. When synchronism has NOT been lost, the transmission element can be restored through direct contact and coordination between BCHCC and AltaLink System Control Operator.

**Trouble Dispatch** - BCHCC and AltaLink-SCC will coordinate all trouble dispatch by mutual agreement depending on the circumstances. Each utility will apply its own patrol procedures and policies and will operate according to its own operating rules up to the point of interconnection.

##### **Safety Protection**

BCHCC Safety Protection will be issued on the line in the normal way, after a 'GUARANTEE OF ISOLATION' has been obtained from the AltaLink System Control Operator.

A Live-Line Permit will be issued on the line in the normal way, after a 'GUARANTEE OF NO RECLOSE' has been obtained from AltaLink System Control Operator.

Similarly, the AltaLink System Control Operator may ask BCHCC for a 'GUARANTEE OF ISOLATION' or a 'GUARANTEE OF NO RECLOSE' when safety protection is required on their section of the transmission line.

**Real-Time Outage Notification by BCHCC System Operator** - Just prior to taking the following elements out of service, the BCHCC System Operator will advise the AESO System Controller. Following emergency removals or tripouts, where the equipment stays out of service for some time, BCHCC must advise AESO System Controller.

Natal Sub - elements affecting 1L275  
1L274 (Natal - Pocaterra)  
2L113 (Cranbrook - Natal)  
2L293 (Selkirk - Nelway)  
2L294 (Cranbrook - Nelway)  
5L91 (Selkirk - Ashton Creek)  
5L92 (Selkirk - Cranbrook)  
5L94 (Cranbrook - Bennett)  
5L96 (Selkirk – Vaseux Lake)  
5L98 (Vaseux Lake – Nicola)

**Real-Time Outage Notification by AESO** - Just prior to taking the following element out of service, AESO System Controller will advise BCHCC. Following emergency removals or tripouts, where equipment stays out of service for some time, AESO System Controller must advise BCHCC.

887L (Natal - Pocaterra)  
777L (Pocaterra - Seebee)  
786L (Natal - Coleman)  
170L (Coleman – Russell)  
936L (East Calgary - Langdon)  
937L (East Calgary- Langdon)  
1064L (Janet - Langdon)  
1065L (Janet - Langdon)  
1201L (Cranbrook - Bennett)  
Langdon SVC



## 5.0 **VOLTAGE AND VAR CONTROL**

### **500 kV**

The CBK 500 kV bus voltage, nominal 525 kV, will range from 545 kV (light load/zero interchange) to 500 kV (heavy load/high interchange) assuming that the Langdon (LGN) Static Var Compensator (SVC) is in service and Selkirk (SEL) voltage can be maintained at 525 kV. Both CBK Auto-var RAS and CBK Overvoltage RAS should be left on all the time. The CBK Auto-var RAS is to operate for loss of 5L92 and 5L94. The CBK Overvoltage RAS is to operate for loss of 5L91 and 5L96, or loss of 5L91 and 5L98.

The CBK 500 kV line-end reactors on 5L92 (CBK 5RX4) and 5L94 (CBK 5RX5) will not be switched off for voltage control except during emergencies. This is because:

- Single-pole reclosing (SPR) on 5L92 will not succeed if CBK 5RX4 is out of service,
- Single-pole reclosing (SPR) on 5L94 may not succeed if CBK 5RX5 is out of service and
- Loss of generation in Alberta with high loads and high transfer from Alberta, with CBK at 500 kV, could cause the voltage to rise high enough to trip the circuit on overvoltage protection.

Under zero interchange conditions, there will generally be a MVAR flow to each system due to the charging effect of the lightly loaded 500 kV line. The MVAR flow should be equitably shared between the systems in proportion to the length of the line owned by each. Based on approximately +180 MVAR of net charging, the Alberta share is 120 MVAR and the BC share is 60 MVAR. The prime purpose will be to maintain adequate voltage levels at both terminals.

The LGN SVC has a normal range of +250 to -250 MVAR which can be covered in approximately 3 cycles. There is a ten-minute overload rating in the -250 to -430 MVAR range. After ten minutes in this overload range, the SVC will automatically go back to -250 MVAR.

In the AIES, the HVDC terminal station CROSS has an associated STATCOM ( $\pm 50$  MVAR) adjacent to LGN. The Shepard power plant near Calgary, with three thermal units ( $2 \times 275 + 318$ ) MW, contributes also to voltage regulation for path operation. Verified studies demonstrate the STATCOM with voltage regulating mode plus one Shepard unit provides an equivalent or better voltage performance than LGN SVC. Therefore, the BC-AB transfer limits historically associated with the status of LGN SVC are removed from Section 10.

The BNS T1 500/246 kV transformer is rated at 1200 MVA (forced air/forced oil). The present off-load tap is set at 512/246 kV. This bank does not have an on-load tapchanger.

### **138 kV**

The NTL 138 kV bus voltage should be maintained between 138 - 144 kV. Nominal: 140 kV.

**6.0 5L94 ENERGIZING AND DE-ENERGIZING**

**6.1 5L94 Energizing**

The following table presents a guide for line energizing sequences for various operating cases. Line de-energizing should take place in the reverse order.

Condition	Lead End For Energizing	Maximum Voltage at Lead End Prior to Energizing the Line (Use Where Practical)
System Normal	CBK (Preferred)	530 kV
	BNS (2nd choice)	LGN at 252 kV with -250 MVAR room on SVC
LGN SVC OOS	CBK (Preferred)	530 kV
	BNS (2nd choice)	LGN at 248 kV
BNS RX OOS	BNS (Note 1)	LGN at 248 kV with -400 MVAR room on SVC
CBK 5RX4 OOS	CBK (Preferred)	530 kV
	BNS (2nd choice)	LGN at 248 kV with -250 MVAR room on SVC
CBK 5RX5 OOS	CBK (Note 1)	510 kV
	BNS (2nd choice) (Note 1)	LGN at 248 kV with -400 MVAR room on SVC
5L92 OOS	BNS	LGN at 252 kV with -250 MVAR room on SVC
CBK 5RX4 & 5RX5 OOS	BNS (Note 1, 2)	LGN at 248 kV with -400 MVAR room on SVC
LGN SVC & CBK 5RX4 OOS	CBK	530 kV
LGN SVC & CBK 5RX5 OOS	CBK (Note 1)	510 kV
LGN SVC & BNS RX OOS	DO NOT ATTEMPT TO ENERGIZE unless the voltage can be reduced to 236 kV at LGN prior to picking up the line (Note 1)	
BNS RX & CBK 5RX4 OOS	BNS (Note 1)	LGN at 248 kV with -400 MVAR room on SVC
BNS RX & CBK 5RX5 OOS	DO NOT ATTEMPT TO ENERGIZE	
BC System Normal Black out in Calgary including Langdon, LGN SVC OOS (CBK 5RX5 and BNS RX connected)	CBK	510 kV (See Note 3 for operating procedure)

Note 1: Single-Pole Reclosing (SPR) setting on 5L94 is 0.6 seconds (36 cycles), which may not succeed if one of its two line reactors (with its associated neutral reactor) is not in service. Blocking SPR on 5L94 is required when only one reactor is in service. Bypassing of only one neutral reactor at either end of the line is expected to result in an unsuccessful single pole reclose.

Note 2: Consider energizing for emergencies only. It will be difficult to keep CBK voltage below 550 kV after 5L94 is on load.

Note 3: The following operating procedure is for energizing 5L94 from CBK for black start of Calgary including Langdon:

- Adjust CBK 500 kV bus voltage to a minimum level, preferably less than 510 kV. This may require all ACK reactors, NIC reactors and CBK 12 kV reactors in service and the adjustment of REV, MCA, SEV and KCL generator terminal voltages.
- Retain the Single-Pole Trip and Reclose of 5L94 (1201L) at CBK and BNS.
- Energize 5L94 from CBK. 5L94 can be energized with either CBK 5CB21 or 5CB23, although the 5CB23 with Point-On-Wave control is preferred.
- After 5L94 is energized, AltaLink will pick up load in the Calgary area to help control the high voltages and to provide power to substations and generating plants.

## **6.2 5L94 De-energizing**

5L94 line de-energizing sequences for various operating cases should take place in the reverse order of the 5L94 energizing table in Section 6.1.

Prior to de-energizing 5L94 circuit, reduce the transfer on this circuit to as close to 0 MW as possible. This is to prevent power surge from depressing the 138 kV voltage at NTL sufficiently to trip the NTL ties on undervoltage protection operation (Section 12.0). As a precaution, block POC and NTL RAS 3 before switching 5L94.

After 5L94 is switched out, the transfer on NTL 138 kV ties can be increased to limits as in Sections 10.1 and 10.2.

## 7.0 AUTO-RECLOSING AND LOOP CLOSURE

### 7.1 500 kV Auto Reclosing

Single-pole auto-reclosing only will normally be used on 5L94 circuit (Position 4). Positions 2, 3 and 5 are not to be used.

Position for trip and reclose selector switch 79CS.

Position 1	off any fault	trip 3P & non-reclose
Position 2	slg fault	trip 3P & reclose
	multi phase	trip 3P & non-reclose
Position 3	any fault	trip 3P & reclose
Position 4	slg fault	trip 1P & reclose
	multi phase	trip 3P & non-reclose
Position 5	slg fault	trip 1P & reclose
	multi phase	trip 3P & reclose

The reclose selector switch should normally be in the same position at both terminals of the line.

### 7.2 Supervisory Reclose ON/OFF Schemes for 5L92 and 5L94

For the transfer limits in this Operating Order, there is no need to block single-pole reclosing on 5L92 or 5L94 circuit.

**5L92:** Blocking of 5L92 reclosing at CBK is accomplished by supervisory control at BCHCC (On / Off indication).

Single-pole reclosing on 5L92 shall be blocked during live line maintenance.

During 2L294 outage, three-pole reclosing does not need to be blocked because there is a synch-check verifier on the follow end.

**5L94:** BCH will rely on AltaLink's supervisory blocking of 5L94 reclose at BNS for blocking of BNS 5L94 reclosing.

Single-pole reclosing on 5L94:

- Shall be blocked during live line maintenance, and
- Should be blocked when the neutral reactor at either end of the line is bypassed.

### 7.3 500 kV Manual Reclosing

Generally one manual reclose attempt should be made from the appropriate end of the line before initiating any line patrols.

#### **7.4 138 kV Reclosing**

The Pocaterra-Seebee 138 kV circuit (777L) has no auto-reclosing at either terminal of the circuit. SEL relays at Seebee have the capability of using a recloser feature, but it is not used. AltaLink-SCC will normally contact BCHCC and attempt a manual reclose from Seebee 245S. If the manual reclose is successful, the circuit will be synchronized closed at Pocaterra.

The Natal-Pocaterra 138 kV circuit (1L274/887L) has auto-reclosing at the Natal end only. The circuit will be energized from Natal and synchronize closed at Pocaterra. As per SOO 1T-29A, one additional manual reclose may be attempted at Natal on 1L274/887L circuit prior to sectionalizing. BCHCC will coordinate the sectionalizing and contact AltaLink-SCC to energize from Pocaterra when required.

The Natal-Coleman 138 kV circuit (1L275/786L) has auto reclosing at the Coleman end only. AltaLink has supervisory control of Coleman. If the auto reclose is unsuccessful, then AltaLink SCC will normally call BCHCC before attempting a manual reclose. Only if requested by the AltaLink SCC will BCH attempt a manual energizing of 1L275/786L.

#### **7.5 Loop Closure 500 kV**

For manual closing of 5L94, with the 138 kV tie in service, the following synchro-check relay settings are provided:

CBK Sub + or - 15 degrees for 10 sec  
BNS Sub + or - 20 degrees for 5 sec

BCHCC has phase angle telemetry across CBK CBs.  
AltaLink-SCC has phase angle telemetry across BNS CBs.

**Note:** It is expected that a loop angle of less than 15 degrees can be obtained provided the power flow on the 138 kV tie does not exceed 20 MW.

#### **7.6 Loop Closure 138 kV**

For manual closing of the 138 kV tie or 2L113 at NTL, with 5L94 in service, the following synchro-check relay settings are provided:

NTL Sub: + or - 20 degrees for 2 seconds.

BCHCC has phase angle telemetry across NTL CBs.

### **8.0 SYNCHRONIZING**

CBK and Pocaterra have full supervisory automatic and local manual synchronizing facilities. LGN has full supervisory and local automatic synchronizing facilities (no synchroscope at substation). The full supervisory automatic and local manual synchronizing facilities at NTL are retained as a backup.

On complete loss of the BC/Alberta interconnection, synchronizing is carried out at:

First Choice BNS end of 5L94  
Second Choice CBK end of 5L94  
Third Choice Pocaterra (NTL as a backup)

## 9.0 **REMEDIAL ACTION SCHEMES (RAS)**

Attachment 9 summarizes all the Remedial Action Schemes (RAS) related to transfer tripping 5L94, 1L274 at Pocaterra, 1L275 at NTL, and load shedding at NTL. The AB TIE RAS is a general term used to encompass a number of related RAS further described in SOO 2T-34 and referenced in this Section.

In general, RAS trips of WECC Path 1 (the BC-Alberta Interconnection, consisting of 5L94, 1L274 and 1L275) are in response to numerous 500 kV contingencies in the South Interior Subsystem. The RAS actions are necessary to mitigate line overloads in the BC Hydro system and frequency excursions and transient stability issues in the Alberta system. These RAS schemes can also trigger in response to BPA/PACI or BPA/NW RAS operation in order to minimize SI voltage deviations and prevent uncoordinated 5L94 undervoltage tripping that would occur with heavy load shedding during heavy import conditions.

### 9.1 **5L94 RAS**

When armed, the operation of this RAS results in tripping of 5L94 circuit (and in turn, tripping 1L274 at Pocaterra if the Pocaterra RAS is armed and tripping 1L275 at NTL if the NTL RAS is armed).

Whenever BCH arms this RAS, AltaLink-SCC and AESO System Controller will receive a "B2S TIE TRIP SCHEME ON" alarm from CBK. BCHCC will advise AESO System Controller of the contingency for which the RAS has been armed.

The 5L94 RAS may be armed for the following contingencies:

- 5L51 and 5L52 – This RAS allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L51 AND 5L52 during high US to BC transfers. Refer to System Operating Order 7T-18 Sections 6.1 and 6.2 for the details of the RAS.
- 5L76 and 5L79 - This RAS allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L76 AND 5L79 if both Alberta to BC transfer and the required generation shedding are high. Refer to System Operating Order 7T-34, Attachment 1 for details of the RAS arming requirements.
- 5L81 and 5L82 - This RAS allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L81 AND 5L82 if both Alberta to BC transfer and the required generation shedding are high. Refer to System Operating Order 7T-34, Attachment 1 for details of the RAS arming requirements.
- 5L91 or 5L96 or 5L98 – This RAS allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L91 or 5L96 or 5L98, 5L91 and 5L96 – This RAS allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L91 and 5L96. This RAS is available but not used now as loss of 5L91 and 5L96 will transfer trip 2L112 and FortisBC's 48L and leave South Interior East island tied to Alberta.
- 5L96 and 5L98 - This RAS allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L96 and 5L98.
- 5L92 - This contingency allows direct transfer tripping of the BC-Alberta Interconnection for the loss of 5L92 with 2L294 in service.
  - The 5L92 contingency is field supervised by 2L294 status and will not key tripping of 5L94 RAS, 1L274 (Pocaterra RAS), and 1L275 (NTL RAS) if 2L294 is open. The purpose of the blocking is to maintain the supply to CBK/NTL area loads.
  - TSA-PM will also not allow arming of these RAS for this contingency in the EMS when 2L294 is OOS. The purpose of the arming prevention is to maintain the supply to CBK/NTL area loads.
  - The field supervision also covers for the simultaneous loss of 5L92 and 2L294, which

share part of a common right of way, preventing the loss of CBK/NTL area load. However, sequential loss of 5L92 followed by 2L294 will result in loss of CBK /NTL area loads.

- BPA Contingencies – BPA contingencies that initiate generation shedding via BPA/NW and BPA/PACI RAS can also initiate 5L94 RAS by DTT (Direct Transfer Tripping) action. This action is armed when Alberta is heavily exporting to BC, and a large amount of generation shedding is required for BPA contingencies. Refer to SOO 7T-18 Sections 6.3, 9.6 and 9.7 for the details of the two RAS arming requirements. The purpose of this DTT of 5L94 RAS is to purposely trip AB-BC tie to avoid the uncontrolled operation by 5L94 U/V protection. Under heavy import flow, Pocaterra RAS and NTL RAS will also be armed as noted in Section 9.3. The CBK OV RAS will may also be armed as noted in Section 9.5.
- The 5L94 RAS is referred to as RAS1 in some technical field documentation.

## **9.2 Keephills Generator Shedding**

Keephills Generator Shedding is presently unavailable as there is no contract between Altalink or AESO and Keephills. This RAS is referred to as RAS2 in some field technical documentation. This facility is no longer utilized in the operation of the interconnection tie.

## **9.3 Pocaterra RAS and NTL RAS**

The purpose of these RAS schemes is to trip the two NTL 138 kV ties with Alberta to avoid low voltage conditions at Natal and/or eliminate overloading on NTL T1 and T2 for the contingencies listed in Attachment 9. These two RAS are referred to together as RAS3 in some technical field documentation.

BCHCC System Operator will control the two supervisory points at NIC (location of the RAS controller). The BCHCC System Operator has the capability to manually block and “dispatcher set” the NTL RAS and Pocaterra RAS independently.

There are two separate latch points at NIC to arm / disarm independently the transfer trip of 1L274/887L at Pocaterra and the transfer trip of 1L275/786L at NTL (1CB2):

- The first point is called “Pocaterra RAS”.
- The second point is called “NTL RAS”.
- The two points can be controllable locally or from BCHCC.

These RAS are normally armed.

For loss of 5L94, the two RAS arming conditions use a cut plane calculation. cutAB is defined as:

$$\text{cutAB} = 5L94 \text{ CBK} + \text{MT\_AB} + (1L274 + 1L275) \text{ NTL}$$

Where,

- 5L94 CBK: 5L94 MW flow from CBK to BNS
- MT\_AB: MATL MW flow from Montana to Alberta at the Alberta terminal and (MATL is the circuit connecting Picture Butte 240 kV bus – Hay Lake 230 kV bus (and is also WECC Path 83)
- (1L274 + 1L275) NTL: MW flow from NTL to both 1L274 and 1L275

The arming conditions of these two RAS are:

- With both NTL T1 and T2 in service,  
If  $\text{cutAB} < -88 \text{ MW}$ , or  $\text{cutAB} > 96 \text{ MW}$ , Pocaterra RAS and NTL RAS shall be armed;
- With one of NTL T1 or T2 OOS,  
If  $\text{cutAB} < -44 \text{ MW}$ , or  $\text{cutAB} > 48 \text{ MW}$ , Pocaterra RAS and NTL RAS shall be armed.

Both Pocaterra RAS and NTL RAS must be **disarmed** for corresponding contingencies listed in Attachment 9 when:

- 2L113 is out of service, or
- NTL T3 AND T4 are out of service, or
- NTL T1 AND T2 are out of service, or
- NTL 1VR1 is out of service and bypass open,

to avoid loss of the NTL Substation or 1L274 customer load or low voltage conditions at NTL upon a trip of 5L94 circuit. TSA will disarm the two RAS for corresponding contingencies listed in Attachment 9 when any of the above conditions are met.

NTL RAS must be **disarmed** for corresponding contingencies listed in Attachment 9 when 1L275 is radially fed from NTL. This is primarily the case when feeding radial load a Coleman Substation (AESO operating area) when AltaLink's 170L transmission line is out of service.

Pocaterra RAS must be **disarmed** for corresponding contingencies listed in Attachment 9 when either 1L274/887L customers are radially fed from Pocaterra or Pocaterra Substation is fed radially from BC Hydro. This is to prevent the loss of customer load on the loss of 5L94/1201L initiating a Pocaterra RAS operation.

For maintenance outages on Pocaterra 48S887X CB the Pocaterra RAS shall be **disarmed** for corresponding contingencies listed in Attachment 9. For maintenance outages on NTL 1CB2 the NTL RAS shall be disarmed for corresponding contingencies listed in Attachment 9.



#### **9.4 2L294 RAS**

The purpose of this RAS is to trip 5L94, 1L274 at Pocaterra and 1L275 at NTL for a controlled separation of the Alberta system from BC on detection of a non-recoverable power swing on 2L294 during a 5L92 circuit outage.

This RAS makes use of the out-of-step detection function of the SEL321 relays at CBK and NLY substations. These relays will determine if the power swing on 2L294 is non-recoverable and initiate tripping of the 5L94 circuit, the 1L274 circuit at Pocaterra and the 1L275 circuit at NTL and blocking the tripping of the 2L294 circuit. With 5L92 circuit out of service, a power swing on 2L294 is generally due to a disturbance in Alberta.

Refer to Section 9.3 for the conditions that transfer tripping of 1L274 at Pocaterra and transfer tripping of 1L275 at NTL for the 2L294 <PS> contingency must be disarmed.

This RAS can be armed manually at BCHCC and should only be armed when 5L92 is out of service.

TSA will monitor 5L92 status and arm/disarm this RAS.

This RAS is referred to as RAS4 in some technical field documentation.

#### **9.5 Cranbrook Auto-Var RAS and Overvoltage RAS**

- The CBK Auto-Var control scheme controls the CBK 230 kV voltage after both 5L92 and 5L94 circuits are out of service, by switching in or out the 12 kV reactors and shunt capacitors at CBK.
- The CBK Overvoltage RAS scheme prevents an overvoltage situation on the SEV 230 kV voltage after loss of 5L91 and 5L96, or 5L91 and 5L98, or upon the tripping of 5L94 by BPA NW/PACI RAS. This is accomplished by switching out the 12kV shunt capacitors and switching in the 12 kV shunt reactors. This scheme should always be in service and has indication and control at BCHCC.

For details about the operations of either of these separate schemes, refer to BCH SOO 7T-22 "System Voltage Control".

#### **9.6 Natal Load Shedding RAS (NTL LS RAS)**

This RAS is to avoid voltage collapse in the CBK-NTL-INV area, which could happen due to loss of both 5L92, 5L94 and the opening of 138 kV ties to Alberta under heavy area load conditions. This RAS is to trip the load on 1L274 and 60L288 at Natal. The RAS functionalities are included in Attachment 9 and described as follows,

- (1) If AAL/CBK/NTL area load is higher than a certain value, the RAS will be armed by TSAPM at BCHCC. The RAS arming matrix is located at Nicola.

$$\begin{aligned} \text{AAL/CBK/NTL area load} &= 2L294 \text{ NLY} + (\text{CBK } 500 \text{ kV to } 230 \text{ kV MW}) \\ &+ 1L274 \text{ POC} - 1L275 \text{ NTL} \end{aligned}$$

- (2) If loss of 5L92, 5L94 and the opening of 138 kV ties to Alberta with the RAS armed, then the RAS will send a trip signal to NTL;

- (3) At Natal, the trip signal will be combined with a local under voltage detection using “AND” function. Only when both conditions are met, then a load shedding action will be initiated at Natal to trip open 1L274 (NTL 1CB1) and 60L288 (NTL 60CB15) at Natal. The new under voltage relay will have pick-up voltage setting of 0.98 pu with timer delay setting of 70 ms and reset voltage setting of 1.0 pu.

The detailed RAS arming requirements are specified in Attachment 10. When the LS RAS is unavailable and the AAL/CBK/NTL load is higher than the level specified in Attachment 10, then the AB/BC transfer must be limited to the level that the load shedding is not required.

## 10.0 EXPORT/IMPORT LIMITS AND RAS ARMING REQUIREMENTS

The BC Hydro System Operating Limits (SOL) and recommended transfer limits in this order have been developed in accordance with the British Columbia Reliability Coordinator (BCRC) System Operating Limit Methodology for the Operations Horizon.

The WECC Transfer Limit Ratings for Path 1 are:

- 1000 MW from Alberta to BC and
- 1200 MW from BC to Alberta.

These WECC Transfer Limit Ratings are the normal Path 1 SOLs, as these limits are stability limits for AESO.

The BC Hydro SOL's for the path exceed the WECC Path rating and are static for BC Hydro, unless values are otherwise identified through voltage stability assessment. Currently, there are no forecasted operating points that are stability limiting for BC Hydro. BC Hydro will observe and respect changes to the SOL as identified by AESO, for changing conditions on the AIES.

For 5L94 OOS, the transfer limit is a thermal limit for the remaining 138 kV ties between BC and Alberta. In this operating condition, the NTL transformer facility ratings that are facility SOL are used as a path limit for simplicity, and the limit is 100 MW. In accordance with BCRC SOL methodology this is not a path SOL, but the facility SOL must be respected at all times in the operation of the path.

On a contingency or during switching, operators must restore to the pre-disturbance or pre-switching capabilities within 30 minutes. The operating point must be brought within the new Path SOL within the applicable time frame if the predisturbance topology cannot be restored.

The Recommended Transfer Limits in section 10.1 and 10.2 tables are used to simplify management of other constraints and operating limitations within the BC Hydro system. **The Recommended Transfer Limits shall be used to set a maximum ATC for energy scheduling purposes.** A  $TRM_U$  should be established as a buffer up between the ATC up to the level of the Path SOL. The maximum TTC plus  $TRM_U$  will not exceed the Path 1 SOL. See Section 15.3 for details of the TRM determination.

Exceeding the Recommended Transfer Limits is not itself a SOL exceedance, unless it exceeds the agreed path SOL. However, all facilities must remain within their operating limits, when a path TTC exceedance occurs. Operators must use TSA-PM and perform a contingency analysis to confirm no other assets will exceed their limits for energy transfers on the path.

There are system limitations preventing the simultaneous maximum utilization of Path 1 and Path 3 Import/Export limits. The interaction between these two paths is shown in SOO 7T-18 Attachment 4. The relationship is used to set transfer limits to manage constraints and operating limitations inside the BC Hydro system.

**10.1 Alberta to BC - Recommended Transfer Limits and RAS Arming Requirements**

**NOTE: Under all operating scenarios the transfer limit used must be set to less than the either Path SOL or WECC Path rating (whichever is the more restrictive).**

System Condition	Flow Level (MW)	Contingency (Note 27)	ARM 5L94 RAS, Pocaterra RAS and NTL RAS (Note 5, 24)	Alberta-BC (Path 1) Recommended Transfer Limit (MW)	Limitation Type/Description	Monitored Element	Contributing Contingencies (Note 27)
System Normal, or 5L76 OOS, or 5L79 OOS, or 5L75 OOS, or 5L77 OOS, or NTL Tie OOS, or one of NORTH_KLY_500, or NORTH_COAST_500 Note (1,2,3,4,5,15,23)	0 - 100	5L92	NO	The least of: <ul style="list-style-type: none"> <li>• 1000</li> <li>• Attachment 4 of SOO 7T-18</li> <li>• Attachment 5</li> <li>• Note 19</li> </ul>			
	101 - 800	5L92	YES (Note 5)				
	801 - 1000	5L91	NO				
		5L92	YES				
		5L96	NO				
		5L98	NO				
	5L96 & 5L98	NO					
2L113 OOS, or/and NTL T3 & T4 OOS Note 14	0 – 100	5L92	NO	The least of: <ul style="list-style-type: none"> <li>• 700 + 1L274 POC – 1L275 NTL</li> <li>• Attachment 4 of SOO 7T-18</li> <li>• Note 19</li> </ul>			
	101 – (700 + 1L274 POC – 1L275 NTL)	5L92	YES				
2L112 OOS Note (1, 23)	0 – 100	5L92	NO	The lesser of: <ul style="list-style-type: none"> <li>• 600</li> <li>• Attachment 5 of SOO 7T-18</li> <li>• Note 19</li> </ul>	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 – 600	5L92	YES				
2L293 OOS Note (1, 23)	0 – AAL/CBK/NTL load	5L92	NO	The least of: <ul style="list-style-type: none"> <li>• 600</li> <li>• Attachment 6 of SOO 7T-18</li> <li>• Note 19</li> </ul>	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	AAL/CBK/NTL load + 1 to 600	5L92	YES				
2L294 OOS Note (1, 9, 12, 23)	0 – 500	5L92	NO	The lesser of: <ul style="list-style-type: none"> <li>• 500</li> <li>• Note 19</li> </ul>	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
2L112 AND 2L294 OOS Note (9, 12, 23)	0 - 500	5L92	NO	The lesser of: <ul style="list-style-type: none"> <li>• 500</li> <li>• Note 19</li> </ul>			
5L91 OOS Note (1, 23)	0 – 100	5L92	NO	The least of: <ul style="list-style-type: none"> <li>• 500</li> <li>• Attachment 7 of SOO 7T-18</li> <li>• Note 19</li> </ul>	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 500	5L92	YES				
5L92 OOS Note (1, 7)	0 - 300	2L294<PS>	YES	300	Power Swing	2L294	Any disturbance can cause AB/BC swing on 2L294

System Condition	Flow Level (MW)	Contingency (Note 27)	ARM 5L94 RAS, Pocaterra RAS and NTL RAS (Note 5, 24)	Alberta-BC (Path 1) Recommended Transfer Limit (MW)	Limitation Type/Description	Monitored Element	Contributing Contingencies (Note 27)
5L94 OOS, or 5L94 AND 5L96 OOS Note (1, 10, 11)	0 - 100	5L92	NO	100	Thermal	NTL T1 NTL T2	System Normal or Any
5L96 OOS, or 5L96 & 5L98 OOS Note (1, 23)	0 - 100	5L92	NO	The lesser of: • 450 • Note 25	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 450	5L92	YES				
5L98 OOS Note (1, 23)	0 - 100	5L92	NO	The lesser of: • 450 • Note 20	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 450	5L92	YES				
5L71 OOS, or 5L72 OOS Note (1, 23, 26)	0 - 100	5L92	NO	If MCA on-line units > 1, the limit is the lesser of: • 1000 • Note 19 If MCA on-line unit =1, the limit is the lesser of: • 400 • Note 19 • Note 26	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 700	5L92	YES				
SEL T1&T2&T3&T4 I/S AND (SEL 5CB1 OOS AND/OR SEL 5CB2 OOS) Note (1, 23)	0 - 100	5L92	NO	The least of: • 700 • Note 21 • Attachment 4 of SOO 7T-18	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 700	5L92	YES				
SEL T1&T2&T3&T4 I/S AND SEL 5CB4 OOS, Note (1, 23)	0 - 100	5L92	NO	The least of: • 700 • Note 21 • Attachment 4 of SOO 7T-18	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 700	5L92	YES				
SEL (T2 or T3 OOS) AND (SEL 5CB1 OOS AND/OR SEL 5CB2 OOS) Note (1, 23)	0 - 100	5L92	NO	The least of: • 700 • Note 21 • Attachment 4 of SOO 7T-18	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 700	5L92	YES				
SEL (T2 or T3 OOS) AND SEL 5CB4 OOS Note (1, 23)	0 - 100	5L92	NO	The least of: • 700 • Note 21 • Attachment 4 of SOO 7T-18	Voltage - Risk of transient UV PN tripping of 5L94	5L94 CBK 500 kV Bus	
	101 - 700	5L92	YES				

See Section 10.3 for the supporting notes.

**10.2 B.C. to Alberta - Recommended Transfer Limits and RAS Arming Requirements**

**NOTE: Under all operating scenarios the transfer limit used must be set less than the lessor of Path SOL or WECC Path rating.**

The NTL LS RAS arming requirements are included in a separate table of Attachment 10.

System Condition	Flow Level (MW)	Contingency (Note 5)	Arm 5L94RAS Pocaterra RAS NTL RAS (Note 5, 24)	BC-Alberta (Path 1) – Recommended Transfer Limit (MW)	Limitation Type	Monitored Elements	Contributing Contingencies (Note 26)
System Normal, or 5L76 OOS, or 5L79 OOS, or NTL Tie OOS Note (1,2,3,4,5,15)	0 - 100	5L92	NO	The lesser of: • 850 (Note 6) • Attachment 4 of SOO 7T-18			
	101 – 850	5L92	YES (Note 5)				
	851 - 1160	5L92	YES				
2L113 OOS, or/and NTL T3 & T4 OOS Note 14	0 - 100	5L92	NO	The lesser of: • 850 (Notes 9,6) Attachment 4 of SOO 7T-18			
	101 – 850	5L92	YES				
2L112 OOS Note 1	0 - 100	5L92	NO	560			
	101 - 560	5L92	YES				
2L293 OOS Note 1	0 - 100	5L92	NO	The lesser of: • 560 • Attachment 6 of SOO 7T-18			
	101 - 560	5L92	YES				
2L294 OOS Note (1,12)	>= 0	5L92	NO	850 (Note 8,6)			
2L112 AND 2L294 OOS Note (12)	>= 0	5L92	NO	850 (Note 8,6)			
5L91 OOS Note 1	0 – 100	5L92	NO	560			
	101 – 560	5L92	YES				
5L96 OOS, or 5L98OOS, or 5L96 & 5L98 OOS Note 1	0 - 100	5L92	NO	560			
	101 - 560	5L92	YES				
5L92 OOS Note (1, 7)	0 – 110	2L294<PS>	YES	110			
5L94 OOS, or 5L94 AND 5L96 OOS Notes (1, 10)	0 - 50	5L92	NO	50			
SEL T1&T2&T3&T4 I/S AND (SEL 5CB1 or/and SEL 5CB2 OOS, or SEL 5CB4 OOS) Note 1	0 - 100	5L92	NO	The lesser of: • 850 • Attachment 4 of SOO 7T-18			
	101 - 850	5L92	YES				

SEL (T2 or T3) AND (SEL 5CB1 or/and SEL 5CB2 or SEL 5CB4) OOS Note 1	0 - 100	5L92	NO	The lesser of: <ul style="list-style-type: none"> <li>• 700</li> <li>• Attachment 4 of SOO 7T-18</li> </ul>			
	101 - 700	5L92	YES				
5L71 OOS, or 5L72 OOS Note (1, 26)	0 - 100	5L92	NO	850			
	101 – 850	5L92	YES				
5L75 OOS, or 5L77 OOS Notes (1, 5)	0 - 100	5L92	NO	850			
	101 – 850	5L92	YES (Note 5)				

See Section 10.3 for the supporting notes.

**10.3 Notes for Both Import and Export Limit Tables**

- Note 1 Refer to S.O.O. 7T-34 for South Interior generation shedding requirements.
- Note 2 "NORTH\_OF\_KLY\_500" circuits are defined as: 5L1, 5L2, 5L3, 5L4, 5L7, 5L11, 5L12, and 5L13 (See 7T-18 Section 8.3.3)
- Note 3 "NORTH\_COAST\_500" circuits and combinational elements consist of 5L61, 5L62, 5L63 and combinations of these circuits.
- Note 4 For the case of heavy transfer from AB to BC (up to 1000 MW), with one of NORTH\_OF\_KLY\_500 circuits OOS, a double contingency on adjacent parallel lines causes separation of the Peace region forming an island North of KLY, and could result in 5L94 being tripped by its under-voltage protection at CBK (due to the transient voltage dip when Peace area generation output is high). As this is an extreme event (N-1-2) and the probability is very low, it is acceptable for 5L94 to be tripped by the protection. This protection tripping is also acceptable for the combination of one of NORTH\_OF\_KLY\_500 circuits OOS and one of NORTH\_COAST\_500 circuits OOS.
- Note 5 The following arming condition of DTT AB Tie for loss of 5L92 when 2L294 is in service is determined by the post-contingency voltage deviation at AAL 230 kV bus.
- For system normal, one of NORTH\_OF\_KLY\_500 line OOS, 5L76 OOS, 5L79 OOS, 5L75 OOS, 5L77 OOS, or NTL Tie OOS condition
- If  $(5L92 + 2L294) \text{ CBK} > 370 \text{ MW}$  (westbound flow exceed 370 MW)
- or,  $(5L92 + 2L294) \text{ CBK} < -315 \text{ MW}$  (eastbound flow exceed 315 MW)
- Note 6 Operating above this range is to provide assistance to the Alberta system during an urgent or emergency condition in Alberta. However, It can be used for any non-emergency condition authorized by AESO System Controller to operate with a transfer limit above the recommended 850 MW limit. This limit is set by AESO, is voluntary, and can be adjusted at the consent or request of AESO, providing that a Path SOL is not exceeded, and internal/facility SOLs are respected.
- Note 7 TSA will arm 2L294 RAS when the condition specified in Section 9.4 is met.



Note 8 During outages of 2L294, including 2L294 open ended at CBK or 2L294 open-ended at NLY, the BCH System Operator (Transmission Coordinator) will inform the AESO System Controller that:

- The BC-AB recommended limit is 850 MW, and
- Greater transfer is permitted with concurrence of the AESO System Controller (see Note 6), and
- There will be a separation of the BC Hydro and Alberta systems on a 5L92 contingency, with islanding of the Cranbrook & Natal area load with Alberta.

The AESO System Controller has visibility of the Cranbrook & Natal area will use this information to determine the Alberta operating requirements and will inform the BCH Transmission Coordinator for the next hour of the BC to Alberta Total Transfer Capability (TTC) Limit and Transmission Reliability Margin (TRM).

This TTC set by AESO is to prevent the Alberta and East Kootenay frequency from dropping below 59.5 Hz on loss of 5L92, and separation from the WECC with the subsequent MATL (Path 83) trip.

Note 9 During outages of 2L113, the BCH System Operator (Transmission Coordinator) will inform the AESO System Controller that:

- The BC-AB limit is 850 MW, and
- Greater transfer is permitted with concurrence of the AESO System Controller (see Note 6), and
- There will be a separation of the BC Hydro and Alberta systems on a 5L94 contingency, with islanding of the Natal area load with Alberta.

The AESO System Controller has visibility of the Natal area will use this information to determine the Alberta operating requirements and will inform the BCH Transmission Coordinator for the next hour of the BC to Alberta Total Transfer Capability (TTC) Limit and Transmission Reliability Margin (TRM).

This TTC set by AESO is to prevent the Alberta and East Kootenay frequency from dropping below 59.5 Hz on loss of 5L94, and separation from the WECC with the subsequent MATL (Path 83) trip.

Note 10 When 5L94 is out of service, any planned maintenance outage on either one of the two 138 kV ties should be avoided. If one of the two 138 kV ties has to be taken out when 5L94 is already out of service, open one end on the remaining tie (at Pocaterra for NTL-Pocaterra tie, or at NTL for NTL-Coleman tie) to separate BC from Alberta until either 5L94 or both 138 kV ties can be back in service.

Note 11 Removed.

Note 12 2L294 OOS includes 2L294 open-ended at CBK and 2L294 open-ended at NLY.

Note 13 Refer to Section 7.0 and Table 1.9 of Attachment 1 in SOO 7T-34 for operating guidelines and restrictions.

Note 14 When 2L113 OOS or/and NTL T3 & T4 is OOS, 60L281 must be open end at NTL. Do not open 60L285 at NTL, as SPD load is radially supplied by 60L285 (60D21 on 60L281 at SPD is normally open).

- Note 15 The system condition of “NTL Tie OOS” includes any of the following:
- 1L274/887L OOS, or
  - 1L274/887L radial, or
  - 1L275/786L OOS, or
  - 1L275/786L radial, or
  - AltaLink’s 777L OOS (Seebee 245S77 CB open), or
  - NTL T1 AND NTL T2 OOS, or
  - NTL 1VR1 OOS.
- Note 16 Removed.
- Note 17 Removed.
- Note 18 Removed.
- Note 19 Refer to pre-contingency operating restriction for 5L91 AND 5L96 contingency with all system conditions except for 5L91 or 5L96 or 5L98 or 5L92 or 5L94 or 5L94 AND 5L96 OOS, or for 5L96 or 5L98 or 5L96 & 5L98 contingency with 5L91 OOS in Attachment 1 of SOO 7T-34.  
If SEL 5RX3 is available, then limit:  
 $(AB \text{ to } BC) + (\text{FBC injection into SEL area}) < (\text{WAN shedable generation amount} + 1000 - 1 \text{ SEV @ MIN.MW} - Z + \text{ALH MW} + \text{BRX MW} + \text{WAX MW},$   
Otherwise, limit:  
 $(AB \text{ to } BC) + (\text{FBC injection into SEL area}) < (\text{WAN shedable generation amount} + 1000 - 1 \text{ SEV @ MIN.MW} - 1 \text{ KCL @ MIN.MW}) - Z + \text{ALH MW} + \text{BRX MW} + \text{WAX MW}$   
Where:  
 $(\text{FBC injection into SEL area}) = (2L288 \text{ BTS} + 2L289 \text{ BTS} + \text{FBC AAL Tie MW} + 2L277 \text{ WAN} - 60L225 \text{ KCL} - 60L227 \text{ KCL} - 2L286 \text{ SEL}) \text{ MW}$   
 $\text{FBC AAL Tie MW} = (2L294 \text{ AAL-NLY}) \text{ AAL} + (2L294 \text{ AAL-CBK}) \text{ AAL MW}$   
 $Z = 48L \text{ KET}$  if VAS-WTS loop is closed, or  
 $Z = 0$  if VAS-WTS loop is open.

- Note 20 Refer to pre-contingency operating restriction for 5L91 or 5L91 & 5L96 contingency with 5L98 OOS in Attachment 1 of SOO 7T-34.  
If SEL 5RX3 is available, then limit:  
 $(AB \text{ to } BC) + (FBC \text{ injection into SEL area}) < (WAN \text{ shedable generation amount} + 1000 - 1 \text{ SEV @ MIN.MW} - Z + ALH \text{ MW} + BRX \text{ MW} + WAX \text{ MW},$   
Otherwise, limit:  
 $(AB \text{ to } BC) + (FBC \text{ injection into SEL area}) < (WAN \text{ shedable generation amount} + 1000 - 1 \text{ SEV @ MIN.MW} - 1 \text{ KCL @ MIN.MW}) - Z + ALH \text{ MW} + BRX \text{ MW} + WAX \text{ MW}$   
Where: The definition of (FBC injection into SEL area) is the same as in Note 19.  
  
If both VAS-WTS and VAS-VNT loops are closed, then  $Z = 48L \text{ KET}$ , otherwise,  
 $Z = 0$
- Note 21 Refer to pre-contingency operating restriction for SEL T4 contingency with (SEL T1&T2&T3&T4 I/S AND (SEL 5CB1 or/and SEL 5CB2 OOS)) or (SEL T2 OOS AND SEL (5CB1 or/and 5CB2) OOS) or (SEL T3 OOS AND SEL (5CB1 or/and 5CB2) OOS) in Tables 2.2, 2.25 and 2.35 of Attachment 2 of SOO 7T-34:  
Limit:  
 $(AB \text{ to } BC) + (FBC \text{ injection into SEL area}) < (WAN \text{ shedable generation amount} + ALH \text{ MW} + BRX \text{ MW} + WAX \text{ MW} + 0.98 * SELT1MVA\_0.5hr\_Rating + AAL/CBK/NTL \text{ load} - 660) \text{ MW}$   
  
OR  
Refer to pre-contingency operating restriction for SEL T1 contingency with (SEL T1&T2&T3&T4 I/S AND SEL 5CB4 OOS) or (SEL T2 AND SEL 5CB4 OOS) or (SEL T3 AND SEL 5CB4 OOS) in Tables 2.2, 2.25 and 2.35 of Attachment 2 of SOO 7T-34:  
Limit:  
 $(AB \text{ to } BC) + (FBC \text{ injection into SEL area}) < (WAN \text{ shedable generation amount} + ALH \text{ MW} + BRX \text{ MW} + WAX \text{ MW} + 0.98 * SELT4MVA\_0.5hr\_Rating + AAL/CBK/NTL \text{ load} - 660) \text{ MW}$   
  
Where:  
  - The definition of (FBC injection into SEL area) is the same as in Note 19.
  - The definition of AAL/CBK/NTL load is the same as in Section 9.6.
  - $SELT1MVA\_0.5hr\_Rating = 1764 \text{ MVA}$  (at 30°C DAAT)
  - $SELT4MVA\_0.5hr\_Rating = 1800 \text{ MVA}$  (at 30°C DAAT)
- Note 22 Removed
- Note 23 If real-time Alberta to BC transfer exceeds the limit in Note 19, 20, or 25, TSA will alarm "7T-34: REDUCE FBC-BC AND AB-BC 7T-34 ATT1(7T17)" from SOO 7T-34 group. If real-time Alberta to BC transfer exceeds the limit in Note 21, TSA will alarm "7T-34: REDUCE FBC-BC AND AB-BC 7T34ATT2 2.2 or 2.25 or 2.35 (7T-17)" from SOO 7T-34 group. In both situations, the System Operator should take actions to adjust  $(AB \text{ to } BC) + (FBC \text{ injection into SEL area})$  transfer.
- Note 24 Refer to Section 9.3 for the conditions that transfer tripping of 1L274 at Pocaterra and transfer tripping of 1L275 at NTL for corresponding contingencies listed in Attachment 9 must be disarmed.

- Note 25 Refer to pre-contingency operating restriction for 5L91 contingency with 5L96 OOS or 5L96 AND 5L98 OOS in Attachment 1 of SOO 7T-34.  
If SEL 5RX3 is available, then limit:  
 $(AB \text{ to } BC) + (\text{FBC injection into SEL area}) < (\text{WAN shedable generation amount} + \text{ALH MW} + \text{BRX MW} + \text{WAX MW} + 1000 - 1 \text{ SEV @ MIN.MW}),$   
Otherwise, limit  
 $(AB \text{ to } BC) + (\text{FBC injection into SEL area}) < (\text{WAN shedable generation amount} + \text{ALH MW} + \text{BRX MW} + \text{WAX MW} + 1000 - 1 \text{ SEV @ MIN.MW} - 1 \text{ KCL @ MIN.MW})$   
Where: The definition of (FBC injection into SEL area) is the same as in Note 19.
- Note 26 If 5L71 or 5L72 OOS with one MCA unit on-line, please refer to Section 7.3 of SOO 7T-33 for pre-outage restrictions. These restrictions are not implemented in TSA. It is permissible to shed down to 1 unit on line post contingency; however, to limit self-excitation risk, a second unit must be brought on line within 10 minutes; otherwise the remaining line must be removed from service.
- Note 27 Refer to Section 9.1 for other contingencies than 5L92 to transfer trip 5L94, and refer to Section 9.3 for 5L94 contingency to transfer trip 1L274 at Pocaterra and 1L275 at NTL.

## 11.0 **500 kV PROTECTION**

The protection on 5L94 is a directional permissive scheme, with phase identification to facilitate single pole trip and reclose (relay scheme same as 5L92).

**Open Breaker Transfer Tripping** - Three pole opening of either 500 kV terminal by causes other than line protection results in a three pole direct transfer trip to the remote end.

**Overvoltage Protection** - Overvoltage protection will trip both ends of 5L94. Settings are:

CBK	Stage 1	575 kV for at least 5 sec.
	Stage 2	625 kV for at least 250 msec.
BNS:	Alarm:	575 kV for 0.4 sec. at T102S
	Stage 1 Trip:	575 kV for a further 5.0 minutes.
	Stage 2 Trip:	625 kV for 200 msec.

### **Undervoltage / Power Protection**

At CBK: If CBK voltage drops below 421 kV for at least 500 msec. It will trip 5L94. There is no power supervision of the U/V relay at this terminal.

At BNS: If BNS voltage drops below 425 kV for 290 msec. and 5L94 transfer from Alberta to BC exceeds 234 MW then 5L94 will be tripped.

### **Underfrequency/Power Protection**

At CBK: BC Hydro does not have underfrequency tripping of 5L94 at this terminal.

At BNS: If the frequency is less than 59.0 Hz and the 5L94 power flow from Alberta to BC exceeds 940 MW, then 5L94 will be tripped.

**12RX32 Special Reactor Protection** - For CBK 12RX32 zone faults note that if fault current exceeds 20 kA, tripping of the neutral 12CB32 is blocked and a lockout trip of T2 via T2 PY and SY Protection will be initiated. If fault current is below 20 kA then a lockout trip of 12CB32 will be initiated which does not necessarily remove the fault. A callout should then be initiated.

**Channel Independent Backup Protection** - For a catastrophic microwave failure or for a planned major microwave outage, all permissive and direct tripping from line, overvoltage, undervoltage, breaker failure or reactor protection and from open-end keying will be lost. Even though the line would still be protected by slower channel independent back-up protection, remote clearing for a reactor fault would be unavailable. Therefore, it has been agreed between BCH and AESO to remove the circuit as soon as this can practically be done.

**NOTE:** In the event the circuit cannot be removed quickly, auto-reclosing should be blocked.

## 12.0 **138 kV PROTECTION**

### 12.1 **Ratings**

The nominal rating of each NTL T1 and T2 138/66 kV transformers is 50 MVA at 30 degrees C ambient and 55 degrees C temperature rise.

NTL T1 and T2 banks may be operated at the following overload limit while the hot spot temperature in the transformer would not exceed 105 degrees C at rated ambient:

56 MVA at 30 degrees C ambient.  
61 MVA at 20 degrees C ambient.  
69 MVA at 0 degrees C ambient.

1L274 is rated at:

Summer (30°C)	274 Amps	65 MVA@138 kV
Winter (10°C)	439 Amps	105 MVA@138 kV
Winter (0°C)	489 Amps	117 MVA@138 kV

1L275 (BC portion) is rated at:

Summer (30°C)	435 Amps	104 MVA@138 kV
Winter (10°C)	594 Amps	142 MVA@138 kV
Winter (0°C)	600 Amps	143 MVA@138 kV

1L275 (Alberta portion) is rated at:

Summer (30°C)	414 Amps	99 MVA@138 kV
Winter (0°C)	552 Amps	132 MVA@138 kV

### 12.2 **Undervoltage Protection**

1L274/887L tie is transfer tripped at Pocaterra and 1L275/786L tie tripped at NTL 1CB2 when Natal 138 kV voltage drops below 117.3 kV for longer than 0.5 seconds. This is a back up to the 138 kV tie tripping (NTL and Pocaterra RAS Schemes). This protection only operates in the condition of 2L113 in service.

### 12.3 **Out-of-Step Protection**

A true out-of-step protection element in 2L113 PN was enabled to replace the old reverse impedance protection. When the out-of-step protection detects the swing between AB and BC, in which the swing centre is expected within NTL Substation, it will trip 1L274 at POC and 1L275 at NTL. The element can be enabled/disabled locally or from the EMS. A 43-2L113 OOS enable (ON) disable (OFF) point is available on the station SCADA display. The element should be disabled when 2L113 is out of service for maintenance.

### 12.4 **NTL T1 and T2 Thermal Overload Protection**

NTL T1 and T2 each have a type BL-1 relay with an inverse time characteristic which provides an initial overload alarming signal and eventual tripping signal. The overload alarm is transmitted to BCHCC. The relay monitors the current on the 66 kV side of the associated transformer. The relay operation is independent of the ambient temperature.

With the Relay Pointer Setting of 400 Amps, relay operation for each bank is as follow:

Loading	Time to alarm	Time to Trip
400 Amps 45 MVA at 66 kV	Relay not operate	Relay not operate
472 Amps 54 MVA at 66kV	more than 15 minutes	Indefinite
500 Amps 57 MVA at 66kV	15 minutes	60 minutes

Note: An individual transformer loading of 54 MVA will eventually initiate a tripping signal. The tripping signal initiated by the relay will transfer trip 1L274 at Pocaterra and 1L275 at Natal. If the overload still exists 5 minutes after the tripping signal sent out, the transformer will be tripped.

If NTL T1/T2 overload alarm occurs during high AB to BC transfers, the System Operator should request AESO to adjust the Russell Substation (632S) PST taps to alleviate overloading on NTL T1/T2 first. If not successful, request AESO to consider reducing their generation in SW AB area. If AESO finds it is not possible to reduce the overload, then advise AESO and open-end 1L275 at NTL. Opening 1L275 may cause transmission lines in Alberta to overload due to the wind generation in southern Alberta. This overload may cause a RAS operation and shed some of the wind generation units.

Based on the above line ratings, transformer ratings and relay characteristics, the normal operating procedure for NTL T1 and T2 is:

NTL T1 / T2 Status	1L274/887L plus 777L, and 1L275/786L Status	Operating Restriction
Both in-service	Both circuits in-service	Monitor that combined T1 / T2 loading is less than 105 MVA. If combined loading exceeds 105 MVA limit then advise AESO and open-end 1L275/786L at NTL.
Both in-service	One circuit out-of-service	Summer: If 1L275 is open, monitor that combined T1 / T2 loading is less than 63 MVA to avoid overloading on 1L274. If 1L274 is open, monitor that combined T1 / T2 loading is less than 105 MVA. Winter: Monitor that combined T1 / T2 loading is less than 105 MVA If combined loading exceeds limit, then: for both 1L274/887L and 777L in-service have AESO open-end the 1L274/887L circuit at Pocaterra. For 1L275/786L in-service then advise AESO and open-end the circuit at NTL.
One transformer out-of-service	Both circuits in-service	Monitor that transformer loading is less than 52 MVA. If loading exceeds limit then advise AESO and open-end 1L275/786L at NTL. If loading still exceeds limit then have AESO open-end 1L274/887L circuit at Pocaterra. If loading still exceeds limit then advise the customer to reduce loading.

NTL T1 / T2 Status	1L274/887L plus 777L, and 1L275/786L Status	Operating Restriction
One transformer out-of-service	One circuit out-of-service	Monitor that transformer loading is less than 52 MVA. If loading exceeds limit then: For both 1L274/887L and 777L in-service have AESO open-end the 1L274/887L circuit at Pocaterra. If loading still exceeds limit then advise the customer to reduce loading. For 1L275/786L in-service, advise AESO and open-end the circuit at NTL.

**12.5 1L274 Overload Protection**

When a 1L274 overload alarm occurs, the operating preference is to take actions to keep the line in service as much as possible. The priority for actions is:

- if power flow is from Coleman to NTL on 1L275, the BCHCC Operator should request AESO to adjust Russell Substation (632S) PST to alleviate overloading on 1L274 and/or NTL T1/T2 immediately. If the action is not successful, request AESO to consider reducing their generation in SW AB area. If it is not possible to run back Alberta generation to relieve the overload, the Operator should open 1L275 at NTL and notify AESO prior to switching. Opening 1L275 may cause transmission lines in Alberta overload under heavy wind generation, which may further cause RAS or protection operation including shedding some of the AB wind generation units. Alternatively the BCHCC Operator should request AESO open 1L274 at POC. The BCHCC should notify 1L274 customers of the topology change as early as possible. This topology can result in greater variability in the voltage performance.
- if power flow is from NTL to Coleman on 1L275, the BCHCC Operator should request AESO to adjust Russell Substation (632S) PST to alleviate overloading on 1L274 and/or NTL T1/T2 immediately. If not successful, the BCHCC Operator should request AESO open 1L274 at POC. The BCHCC should notify 1L274 customers of the topology change as early as possible. This topology can result in greater variability in the voltage performance.



### **13.0 1L274/887L OPERATION**

There are five substations / taps between NTL and Seebee on 1L274 / 887L and 777L:

- Line Creek Tap
- Elkford Tap (EFT)
- Greenhills Tap
- Britt Creek Substation (BCK) and
- Pocaterra Substation that is on the Alberta side of the circuit.

Attachments 6, 7 and 8 include a simplified drawing of Natal-Pocaterra-Seebee circuit, circuit distance for each segment and information on switching equipment. BCHCC has supervisory control of EFT 1D21 and 1D22, BCK 1D21 and 1D22 to aid in restoration.

#### **13.1 Loads Supplied by 1L274/887L**

1L274 / 887L supplies four BCH loads: Line Creek Resources coal mine to town of Elkford, Greenhills Operations and Fording River Operations. In addition, AltaLink's Pocaterra and Interlakes hydro plants, which include some distribution load, are connected to this line.

#### **13.2 1L274/887L Planned Outages**

When undertaking planned outages, BC Hydro's three transmission voltage customers supplied off 1L274/887L should be provided with at least 24 hours advance notice, if possible, and advised of any load supply restrictions.

Depending on the section to be removed from service, reviews by both AltaLink and BCH may be required to identify supply constraints. In these instances, the utility initiating the outage will request the other utility to undertake a review as required.

BCH will have sole responsibility for advising the customers of any supply constraints during outages.

Outages on sections of 1L274/887L can have a significant impact on supply to these customers. For example, voltages along the circuit can drop significantly during outages and some customers may change transformer taps to compensate for low voltages if sufficient advance notice is provided.

#### **13.3 1L274/887L Switching Procedures**

Subject to conditions and procedures as described above, system sectionalizing for outage purposes can be implemented by opening the disconnects at the appropriate tap locations as required. For information on disconnect switch capabilities refer to SOO 5T-04.

For planned outages, immediately prior to removing 1L274/887L from service, or facilities at Natal that affects 1L274/887L, BCH System Operator will advise the AESO System Controller. Similarly, the AESO System Controller will advise the BCHCC immediately prior to removing facilities that affect 887L and 777L.

#### **13.4 1L274/887L Fault Locating**

The preferred fault locator information is from NTL since the data is more accurate. BCHCC can access this fault location information. This information can also be accessed from Pocaterra as an alternative.

**13.5 1L274/887L Radial Connection**

When either 1L274/887L customers are radially fed from Pocaterra or Pocaterra Substation is fed radially from BC Hydro, the transfer tripping of 1L274 at Pocaterra for corresponding contingencies listed in Attachment 9 must be disabled. This is to prevent the loss of customer load for these contingencies. See Section 15.1 for TRM consideration for this configuration.

**13.6 AltaLink References**

AltaLink Operating Procedure B-1.6 - Operating Procedure for 887L (Kanelk Line)  
AltaLink Operating Procedure B-1.3 - BCH/AltaLink Outage Notifications

## 14.0 **SPECIAL SYSTEM CONFIGURATIONS**

Note: "Loss of 5L91 and 5L96 and/or 5L98" in this Section means:

- "loss of 5L91 AND 5L96", or
- "loss of 5L91 AND 5L98", or
- "loss of 5L91 AND 5L96 AND 5L98".

Where:

Loss of 5L91 AND 5L96 may be caused by:

- double contingency of 5L91 AND 5L96, or
- 5L91 single contingency with 5L96 OOS pre-contingency, or
- 5L96 single contingency with 5L91 OOS pre-contingency

Loss of 5L91 AND 5L98 may be caused by:

- 5L91 single contingency with 5L98 OOS pre-contingency, or
- 5L98 single contingency with 5L91 OOS pre-contingency

Loss of 5L91 AND 5L96 AND 5L98 may be caused by:

- 5L96 AND 5L98 double contingency with 5L91 OOS pre-contingency, or
- 5L91 AND 5L96 double contingency with 5L98 OOS pre-contingency

### 14.1 **Operating Procedure for Loss of 5L91 AND 5L96 AND/OR 5L98**

The operating procedures in Sections 14.1.1, 14.1.2 and 14.1.3 apply to all system conditions except for the conditions including 5L94 O.O.S.

#### Conditions including 5L94 O.O.S.:

For loss of 5L91 and 5L96 and/or 5L98, South Interior East AND FBC system will be tied to US at Boundary and to Alberta if the BC-Alberta 138 kV tie is in service. The BC-Alberta 138 kV ties may be tripped by NTL undervoltage protection, or NTL T1/T2 may be tripped by their overload protection.

#### Conditions with 5L94 in-service:

A double contingency loss of 5L91 and 5L96 and/or 5L98 will result in a RAS operation to trip 2L112 (NLY-BDY) when Waneta is connected directly to Nelway **OR** combined trip of 2L112 and 2L277 (WAN – BDY) when Waneta is connected directly to Boundary. This contingency results in an island formed with part of the BC system and the Alberta system (including 80–200 MW of South Interior East load for BCH, 160–450 MW of FBC load, and about 2000 MW of generation).

- A 5L91 and 5L96 trip will include a 48L (OLI-KET) DTT if the VAS-WTS loop is closed.
- A 5L91 and 5L98 trip will include a 73L (LEE-RGA) DTT.
- A 5L91 and 5L96 and 5L98 trip will include a 76L (VAS-RGA) DTT.

#### 14.1.1 **Post-Contingency Issues**

- Upon a 5L91 and 5L96 and/or 5L98 trip and subsequent 2L112 RAS operation the islanded system will experience generation shedding potentially at SEV, KCL, ALH, and WAN.
- Generation shedding is designed such that the maximum dynamic frequency of the islanded system will not exceed 61.0 Hz per WECC criteria and will settle below 60.5 Hz in less than 3 minutes. AESO has identified further operating requirements including reducing the over frequency to 60.3 Hz in 5 minutes, preventing overfrequency tripping for sensitive thermal generation units and lengthy un-availability for these resources.
- When transfer to AB increases as a result of the contingency, the source is most likely from the BC Hydro & FortisBC generation in the island that was formed. There is limited regulating margin in the AESO system (only a small amount of generation on AGC) to be able to reduce the over frequency. Further a loss of generation in AESO system may increase transfers into Alberta.
- A loss of 5L91 and 5L96 and/or 5L98 will suspend AGC.

##### Immediate concerns and solutions:

##### **Generation Coordinator Desk:**

- Ensure all voltage levels are within acceptable range in particular the SEV SF6 bus. This may require additional SEV S/C units.
- Take CBK / NTL / POC off tie-line control.
- Ensure SEV and KCL are not in a regulation mode (SREG / BREG) and place in JOG.
- Ensure TSA recognizes the situation and solves correctly including no selection of SEV or KCL units for shedding outside of island.
- Ensure the status of CBK auto-var control is on.
- Actively monitor the frequency in the islanded system, and be prepared to ramp generation down to reduce excessive transfer into the AESO system.
- After generation shedding, the frequency of the islanded system must be reduced to below 60.5 Hz in less than 3 minutes, and 60.3 Hz in less than 5 minutes. Reducing frequency down to 60.0 Hz may require a further ramp down on any available unit left in the island, starting at SEV and KCL. The AESO system controller will coordinate with BCHCC to lower the islanded system frequency. The final transfer between the BCH island and AESO will be governed by the above procedures to maintain an acceptable frequency and is at the discretion of the AESO controller.

##### **Transmission Coordinator Desk:**

If 5L91 and (5L96 or 5L98) are unavailable to be returned to service immediately –

- Ensure integrity of remaining transmission system.
- Contact AESO to verify system configuration.
- In consultation with AESO, identify the sources of excessive transfer to AESO, and actions needed to limit further impact to their system.
- Contact FBC to verify system configuration and ensure they are aware any potential load switching may be synchronizing two large systems together unless they use a “break before make” procedure.
- Contact BPA to verify system configuration.
- Open line disconnects and close ring breakers making shunt reactors available for service.

**Interchange Scheduling Desk:**

- ALL current hour wheel-through schedules to / from Alberta curtailed to 0.
- ALL current hour schedules from Alberta to be curtailed in MODS application. Upon request by the AESO, BCH sourced schedules may continue for the duration of the current scheduling hour if sufficient generation is available in the island.
- No future hour schedules to / from Alberta will be accepted until approval is received from the AESO controller.

**System Control Manager:**

- Contact BCRC to explain situation.
- Contact PSEO to explain situation.
- Attempt fault location (FLAR, Schweitzer, Indiji).
- Ensure bulletin placed on OASIS that Real-time scheduling on the AB path is suspended until further notice.

**14.1.2 Long Term Operation**

If 5L91 and (5L96 or 5L98) are to remain out of service for an extended period it is expected that 2L112 (and 2L277 - depending on configuration) will also remain out of service. In this islanded configuration, a modified energy market between Alberta and BC may be opened if both BCH and the AESO agree. It is expected that the BC portion of the system would have the capacity to deliver energy. However, with the large surplus of generation and minimum unit requirements, it is not expected to be able receive energy.

This modified market can be enabled by:

- Modifying the existing bulletin to state US to AB wheel through schedules are not available. However, generation sourced in the islanded area of BC can be exported to AB.
- TTC will be agreed upon in real time by both the AESO and BCH.
- Valid E-tag will still be required. Manual intervention may be required to cancel invalid wheel through E-tags. OASIS requests must have the correct Source bus in the islanded area.
- Manual Generation ramp will be required by BCH and FBC for delivery of energy schedules. This will be accomplished by manually pulsing the applicable generating units.
- Spinning and contingency reserve schedules can resume from BC to AB.

The flow on 5L94 will be approximate the desired transfer after the scheduled ramp and periodic manual adjustments will be made by pulsing a SEV or KCL unit to remain at that level. BCHCC will contact AESO for any reasons that the scheduled MW flow on 5L94 is not achievable.

It is important that BCHCC is made aware of the impact of any large scale generation or load changes have on the islanded system.

### 14.1.3 Restoration

Restoration of the first 500 kV circuit will require the Transmission Coordinator at BCHCC to conference with the AESO, and BCHCC Generation and Transmission.

If 5L96/5L98 is to be used as the first line(s) – Recommended to energize from NIC to VAS and synchronize at SEL. If attempted to energize from SEL to VAS and then synchronize at NIC, ensure enough units and reactive equipment on-line to absorb VARS, 5L92 and 5L94 in service.

5L91 as first line – Can be energized from either ACK or SEL. If attempted to energize from ACK ensure bus voltage is depressed enough to limit open end voltage at SEL. If attempted from SEL ensure enough units and reactive equipment on-line to absorb VARS, 5L92 and 5L94 in service.

### 14.2 Operating Procedure for a 5L76 AND 5L79 Contingency (With 5L96 OOS or 5L98 OOS or 5L96 and 5L98 OOS)

A double contingency loss of 5L76 and 5L79 will result in a RAS operation to trip 1L209 (SAM-VVW), 1L214 (VNT-VVW), and 2L112 (NLY - BDY) when Waneta is connected directly to Nelway **OR** combined trip of 2L112 and 2L277 (WAN - BDY) when Waneta is connected directly to Boundary. This contingency results in an island formed with part of the BC system and the Alberta system (including 180–480 MW of South Interior load for BCH, 400–800 MW of FBC load, and about 4000 MW of generation).

#### 14.2.1 Post-Contingency Issues

- Upon a 5L76 and 5L79 trip and subsequent 1L209, 1L214, and 2L112 RAS operation the islanded system will experience generation shedding potentially at REV, SEV, KCL, ALH and WAN. Generation shedding is designed such that the maximum dynamic frequency of the islanded system will not exceed 61.0 Hz per WECC criteria and will settle below 60.5 Hz in less than 3 minutes. A loss of 5L76 and 5L79 will suspend AGC. AESO has identified further operating requirements including reducing the over frequency to 60.3 Hz in 5 minutes, preventing overfrequency tripping for sensitive thermal generation units and lengthy un-availability for these resources.
- When transfer to AB increases as a result of the contingency, the source is most likely from the BC Hydro & FortisBC generation in the island that was formed. There is limited regulating margin in the AESO system (only a small amount of generation on AGC) to be able to reduce the over frequency. Further a loss of generation in AESO system may increase transfers into Alberta.

#### Immediate concerns and solutions:

##### **Generation Coordinator Desk:**

- Ensure all voltage levels are within acceptable range in particular the SEV SF6 bus. This may require additional REV and SEV S/C units.
- Take CBK / NTL / POC off tie-line control.
- Ensure REV, SEV and KCL are not in a regulation mode (SREG / BREG) and place in JOG.
- Ensure TSA recognizes the situation and solves correctly including no selection of REV, SEV or KCL units for shedding outside of island.
- Ensure the status of CBK and ACK auto-var control is on.
- Actively monitor the frequency in the islanded system, and be prepared to ramp generation down to reduce excessive transfer into the AESO system.

- After generation shedding, the frequency of the islanded system must be reduced to 60.5 Hz in less than 3 minutes, and 60.3 Hz in less than 5 minutes.
- Further reducing frequency down to 60.0 Hz may require a further ramp down on any available unit left in the island, starting at REV then SEV and KCL. The AESO system controller will coordinate with BCHCC to lower the islanded system frequency. The final transfer between the BCH island and AESO will be governed by the above procedures to maintain an acceptable frequency and is at the discretion of the AESO controller.

**Transmission Coordinator Desk:**

If 5L76 and 5L79 and 5L96/5L98 are unavailable to be returned to service immediately:

- Ensure integrity of remaining transmission system.
- Contact AESO to verify system configuration.
- In consultation with AESO, identify the sources of excessive transfer to AESO, and actions needed to limit further impact to their system.
- Contact FBC to verify system configuration.
- Contact BPA to verify system configuration.
- Open line disconnects and close ring breakers making shunt reactors available for service.

**Interchange Scheduling Desk:**

- All current hour wheelthrough schedules to / from Alberta curtailed to 0.
- All current hour schedules from Alberta to be curtailed in the MODS application. Upon request by the AESO, BCH sourced schedules may continue for the duration of the current scheduling hour if sufficient generation is available in the island.
- No future hour schedules to / from Alberta will be accepted until approval is received from the AESO controller.

**System Control Manager:**

- Contact BCRC to explain situation.
- Contact PSOSE to explain situation.
- Attempt fault location (FLAR, Schweitzer, Indiji).
- Ensure bulletin placed on OASIS that Real-time scheduling on the AB path is suspended until further notice.

**14.2.2 Long Term Operation**

If 5L76 and 5L79 and (5L96 or 5L98) are to remain out of service for an extended period it is expected that 2L112 (and 2L277 – depending on configuration) will also remain out of service. In this island configuration, a modified energy market between Alberta and BC may be opened if both BCH and the AESO agree. It is expected that the BC portion of the system would have the capacity to deliver energy. However, with the large surplus of generation and minimum unit requirements, it is not expected to be able receive energy.

This modified market can be enabled by:

- Modifying the existing bulletin to state US to BC wheel through schedules not available. However, generation sourced in the island area of BC can be exported to AB.
- TTC will be agreed upon in real time by both the AESO and BCH.
- Valid E-tags will still be required. Manual intervention may be required to cancel

invalid wheel through E-tags. OASIS requests must have the correct Source bus in the island area.

- Manual Generation ramp will be required by BCH and FBC for delivery of energy schedules. This will be accomplished by manually pulsing the applicable generation units.
- Spinning and contingency reserve schedules can resume from BC to AB.

The flow on 5L94 will be approximate the desired transfer after the scheduled ramp and periodic manual adjustments will be made by pulsing a REV, SEV, or KCL unit to remain at that level. BCHCC will contact AESO for any reasons that the scheduled MW flow on 5L94 is not achievable.

It is important that BCHCC is made aware of the impact of any large scale generation or load changes have on the islanded system.

### **14.2.3 Restoration**

Restoration of the first 500 kV circuit will require the BCH Transmission Coordinator to conference with the AESO and BCHCC Generation and Transmission as the two systems will be synchronized at that time.

Any of the 5L76, 5L79, or 5L96/5L98 line can be used as the first line to be energized. However, any “test” energizing should be made from NIC when possible.

If 5L96/5L98 is to be used as the first line(s) – Recommended to energize from NIC to VAS and synchronize at SEL. If attempted to energize from SEL to VAS and then synchronize at NIC, ensure enough units and reactive equipment on-line to absorb VARS, 5L92 and 5L94 in service.



## 15.0 **TRM IMPLEMENTATION**

### 15.1 **TRM Values for 1L274 / 887L Radial Configuration**

When 1L274 / 887L is opened ended and some of the BC load is fed radially from the Alberta system an increase in TRM must account for this increased (unscheduled) flow BC-AB on the remaining ties. TRM must be increased above the normal 65 MW by the additional MW load fed from Alberta. This increase will depend on the system configuration.

FRO load = 25 MW maximum

GRH load = 18 MW maximum

EFD load = 15 MW maximum

LCC Load = 15 MW maximum

Actual load and TRM increase to be provided on scheduled outage request.

### 15.2 **TRM Values for AESO Increased MSSC**

The AESO may increase the value of TRM BC-AB to cover the increased Most Severe Single Contingency in the AIES. The possible configuration of the Genesee plant being fed by a single 240 kV line will necessitate this increase. This TRM value will be provided by the AESO (depending on plant loading) and will be implemented by BCHCC.

The Transmission Coordinator should confirm with the AESO operator the current MSSC, the AESO CRO, and any constraints on Path 3 that could impact reserve deliveries from NWPP Reserve Sharing Group to the Alberta border.

### 15.3 **Normal TRM<sub>u</sub> Value Determination**

The Transmission Coordinator should confirm with the AESO operator the current Path SOL for Path 1. Based on the suggest transfer limits in Sections 10, A TRM<sub>u</sub> should be established to prevent commercial energy scheduling above the recommended transfer limits, but can be used for emergency use (such as operating reserve delivery). The TRM<sub>u</sub> shall normally be a minimum of 65 MW. For clarity,

$$\text{TRM}_u = \text{TTC-ATC} \geq 65$$

Where:

- TTC will normally be the lesser of the (Path SOL, WECC Path Rating), and
- SOL determined by AESO, or BC Hydro (using real time tools if applicable), and
- ATC will be the recommended Transfer Limit from Section 10, or lower to ensure a minimum TRM<sub>u</sub> of 65.

## 16.0 **TSA IMPLEMENTATION**

With respect to SOO 7T-17, the Transient Stability Analysis (TSA) application in the BC Hydro EMS performs the following functions:

- Monitors and initiates alarms if the actual BC-Alberta transfer violates the limits specified in all transfer limit tables and nomograms.
- 5L94 RAS (RAS1): Arms / disarms the 5L94 Tripping RAS, including the requirement of blocking the arming if 2L294 is out of service.
- NTL RAS & Pocaterra RAS (RAS3): Arms / disarms the Pocaterra RAS and the NTL RAS.
- 2L294 RAS (RAS4): Arms / disarms the 2L294 RAS.

The following alarms have been implemented in TSA:

ALARM MESSAGE	REFERENCES
	Section 10.1 – Alberta to BC Transfer Limits and RAS Arming Requirements
VIOLATING IMP FROM ALTALINK OPER LIMIT	
VIOLATING EXP TO ALTALINK OPER LIMIT	Section 10.2 – BC to Alberta Transfer Limits and RAS Arming Requirements
VIOLATING EXP TO ALTALINK EMERG LIMIT	
NTL 13CX1 MUST BE IN-SERVICE	Section 10.3 – Notes 11,18
CBK 12RX32 MUST BE OUT OF SERVICE	
60L281 MUST BE OPEN END AT NTL	Section 10.3 – Notes 15
REDUCE SUM OF FBC-SEL AREA & AB-BC (7T17/7T34-ATT1)	Section 10.3 – Notes 19, 21, 22
REDUCE AB-BC < 700 OR REDUCE GENSHED-BPA/NW RAS < 1650	Attachment 5
NTL LOAD SHED RAS MUST BE AVAILABLE	
STATUS D OPERATION MUST BE AVOIDED	Attachment 10
STATUS E OPERATION MUST BE AVOIDED	

**17.0 (intentionally blank)**

**18.0 FORT NELSON AREA TRANSMISSION OPERATIONS**

**18.1 7L81 RAS (AESO RAS 162) Enabling/Disabling**

Under emergency conditions in the Fort Nelson area, the BCH System Operator may request that AESO's RAS 162 be disabled by the AESO System Operator, due to increase load in the area Reference: AESO 5-TXMN-01 SCP

AESO will request the reason for disabling the RAS; this may be due to the loss of local generation.

**18.2 7L81 Return to Service**

Whenever there is a trip of 7L81 and the Fort Nelson area needs to be resynchronized to Alberta, AESO, ATCO, and BC Hydro will co-ordinate the return to service of 7L81:

- To prevent unsynchronized closure there is no auto-reclosing on Breaker 702 at 791s Rainbow Lake.
- 7L81 can only be energized from 791s Rainbow Lake (ATCO) on a dead bus close.
- The BC Hydro restored load must remain below the 7L81 RAS Trip settings.

Note: The Fort Nelson / Wescup load has the same priority as DTS load in Alberta.

- If Fort Nelson Gas generation is online; it must be islanded.
- After energizing the transmission line, the BCH System Operator synchronizes FNG to 7L81.

**19.0 REVISION HISTORY**

Revised by	Revision Date	Summary of Revision
Charlie Zuo, Jun Sun, Yan Ling Cong, Bob Cielen, Eric Desjardins, Charlie Zuo, Guihua Wang	15 December 2015	Section 10.2 SOL updated for LGN SVC out of service.  Attachment 1 and Attachment 5, as well as wording in Section 10.0 to accommodate AB to BC 1000 MW transfer.  Keephills GS RAS has been removed from all operating requirements, tables, and notes. Section 9.2 has been retained to identify this permanent change.

Revised by	Revision Date	Summary of Revision
YLC,RAC LBU, CZ, GW, SJC	23 November 2017	<ul style="list-style-type: none"> <li>• Section 1 – minor change to add transfer limits recommendation to purpose.</li> <li>• Section 3.0 – clarified sentence on AESO responsibilities</li> <li>• Section 5.0 – Identified additional base resources in AESO footprint that support voltage control for Path 1 operation.</li> <li>• Section 9.1 - Clarification: 5L92 contingency with 2L294 out of service will NOT key tripping 5L94, 1L274 and 1L275</li> <li>• Updated section 10.1 and 10.2, under system normal condition, one of north KLY 500 kV line OOS, 5L76 OOS, 5L79 OOS, NTL Tie OOS, 5L75 OOS, 5L77 OOS.</li> <li>• Added limitation type, monitored elements and contributing contingency columns to Section 10.1 and 10.2 tables</li> <li>• Section 10.3 - added Notes 2,-4 to define North of KLY 500 kV lines, North coast lines, and identify impact of concurrent outage topologies. Added note 5 redefine the criteria for DTT AB tie for 5L92 contingency. Revised Note 6 to identify that the recommended TTC of 850 MW is to accommodate AESO, and can be raised with AESO's consent or request. Note 8 and 9 revised for consistency with Note 6. Revised Notes 19, 20, 21, and 25 for alarm references</li> <li>• Section 10.1 and Section 10.2 - Removed LGN SVC OS condition based on AESO system reinforcements (Section 5.0).</li> <li>• Section 10.1 and Section 10.2 - Removed 5L87 OOS AND (5L71 or 5L72) OOS condition</li> <li>• Section 15.3 added to define the normal TRMu.</li> <li>• Section 17.0 re-labelled from TSA Back-up (which was decommissioned in 2010) to "intentionally blank" for future use</li> <li>• Remove nomogram in Attachment 1, 2, 3 and 4; changed references to Notes 28, 29, 30, and 31, which reference nomograms in Attachment 4,5,6 and 7 in SOO 7T-18</li> </ul>
Charlie Zuo, Guihua Wang	27 May 2019	<ul style="list-style-type: none"> <li>• Add the BPA/NW and BPA/PACI RAS DTT 5L94 function in section 9.1, 9.5, 9.7 and Attachment 9</li> <li>• Remove the gen-shed amount requirement in Attachment 5</li> </ul>

Revised by	Revision Date	Summary of Revision
Charlie Zuo, Guihua Wang, Kelvin Foo, Don McNamara	21 October 2019	<p>Section 1 – updating border description of BC-AB tie lines</p> <ul style="list-style-type: none"> <li>• Section 2 – clarification that BCHCC includes operations planning and outage scheduling in addition to real time TOP and BA responsibilities. Revise BCH-MO to BCH MPO.</li> <li>• Section 4.0 – added reference to customer notifications for transmission outages that may affect power quality.</li> <li>• Section 9.3, updated the arming rule for RAS3 with MATL line flow included.</li> <li>• Section 12.2 – clarification on the protection operations requirement.</li> <li>• Section 12.3 Revised for out of step protection blocking from SCADA display.</li> <li>• Section 10.1 – revising 5L71 or 72 OOS AB-BC TTC to max of 1000. Revising 2L112 OOS to max of 600.</li> <li>• Section 18 revised for Fort Nelson Area transmission constraints and procedures.</li> <li>• Revisions to Attachment 9 and Attachment 10.</li> </ul> <p>References to Peak RC changed to BCRC where appropriate.</p>
Charlie Zuo, Guihua Wang	20 November 2020	<ul style="list-style-type: none"> <li>• Section 10 – revised references from Attachment 1-4 to the corresponding SOO 7T-18 Attachments</li> <li>• Section 12.0 - 1L275 (BC portion) rating change, as per new FAC-008 Normal rating</li> <li>• Attachment 1-4 headings revised to “Removed”</li> </ul>

Attachment 1 - Removed

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Attachment 2 - Removed

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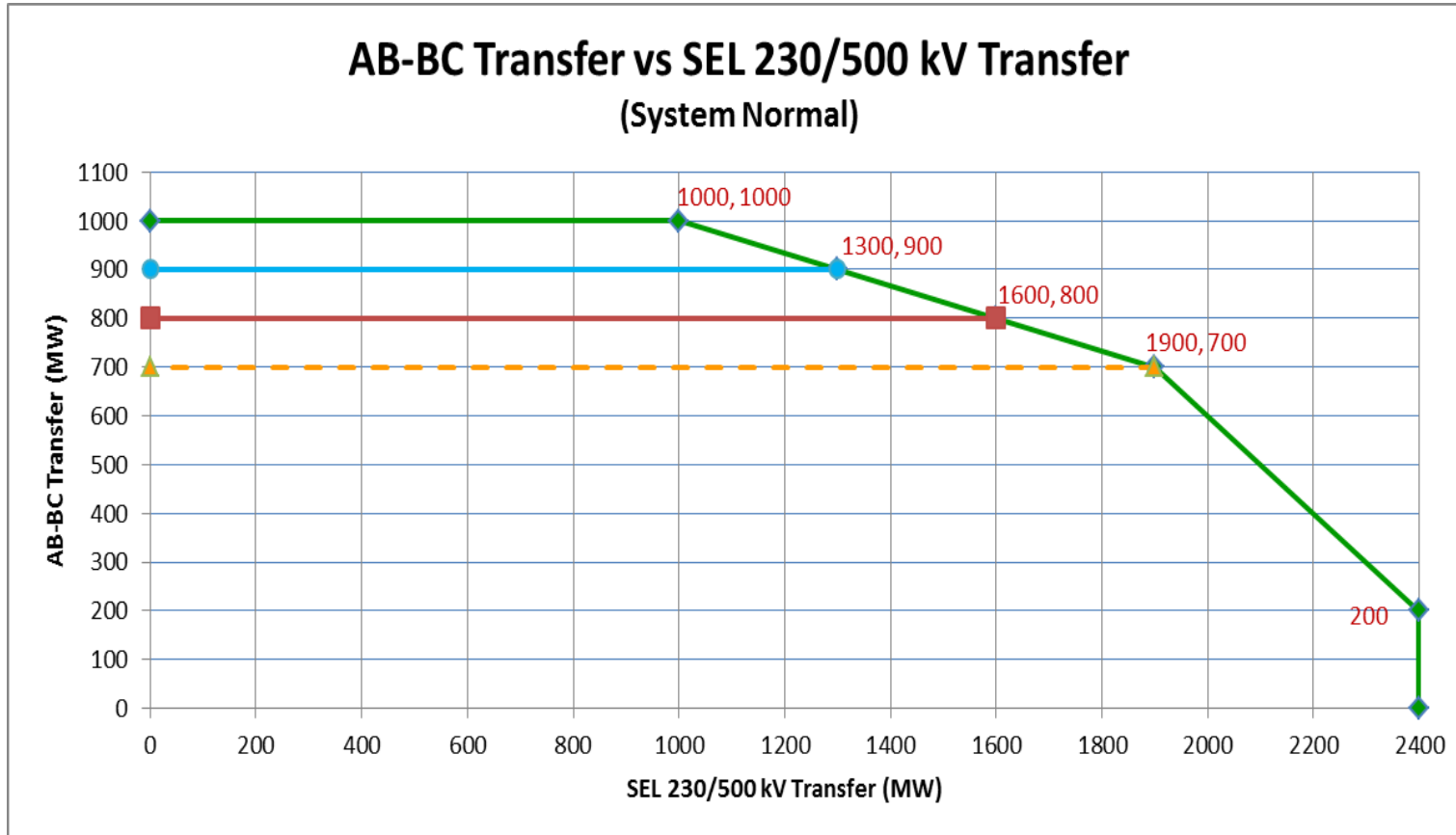
Attachment 3 - Removed

||

Attachment 4 - Removed

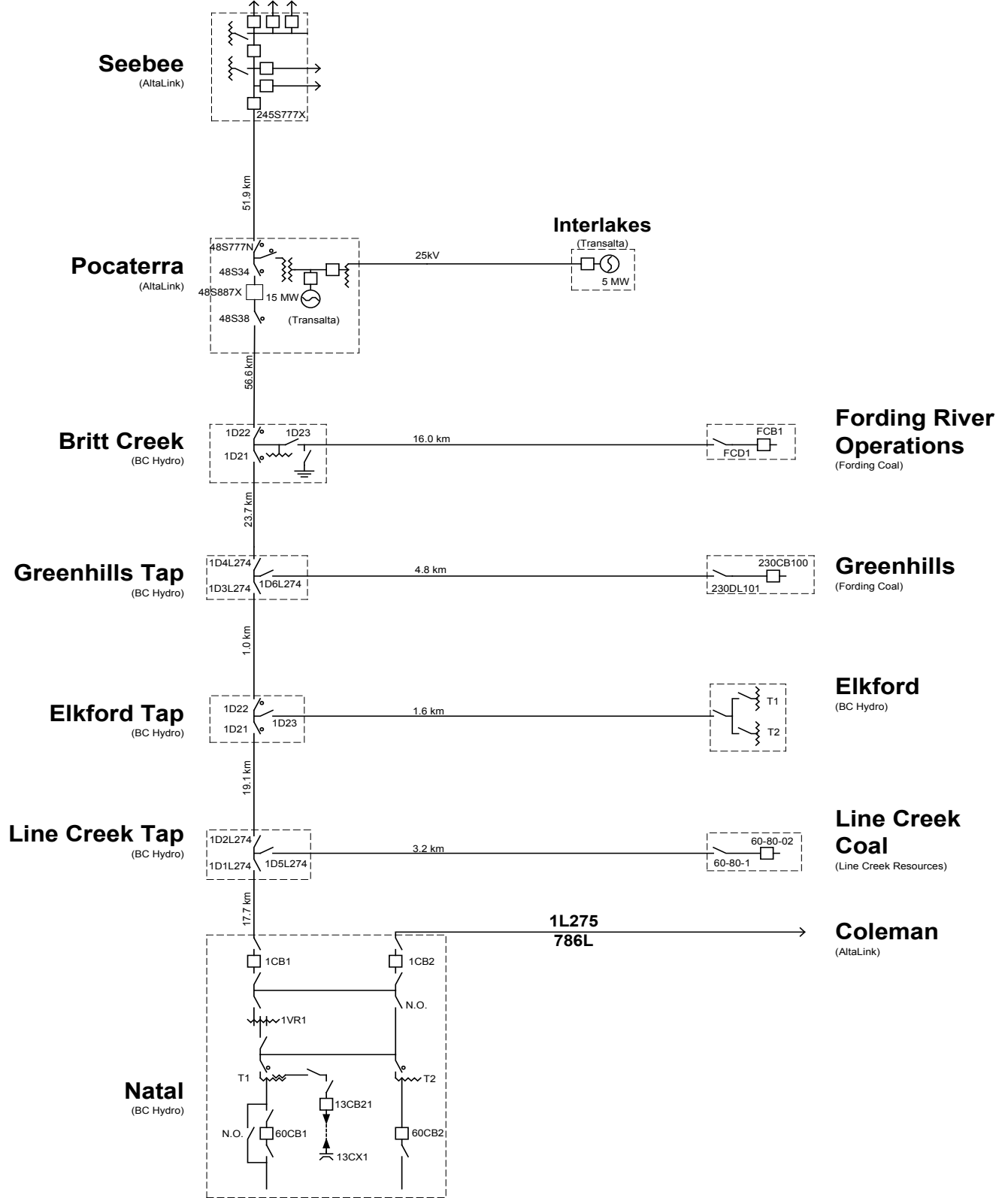
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Attachment 5 - Alberta to BC Transfer versus SEL 230/500 kV Transfer for: System Normal





**Attachment 6 - Simplified Natal-Pocaterra-Seebee Circuit Diagram - Do not use for switching.**



**Attachment 7 - 1L274/887L and AltaLink's 777L Circuit Distance & Travel Time**

Circuit Distance for 1L274/887L and AltaLink's 777L Segments

<b>Station</b>	<b>Distance from Natal (Km)</b>	<b>Distance from Seebee (Km)</b>
AltaLink 245S Seebee	170.0	0
AltaLink 48S Pocaterra	118.1	51.9
BCH 978S Britt Creek Tap	61.5	108.5
BCH Greenhills Tap	37.8	132.2
BCH Elkford	36.8	133.2
BCH Line Creek Tap	17.7	152.3
BCH Natal	0	170.1

Travel Time for 1L274/887L and AltaLink's 777L Segments

<b>Line Segments</b>	<b>Line Length (Km)</b>	<b>Estimated Travel Time (Hours)</b>
Seebee – Pocaterra	51.9	1
Pocaterra – Britt Creek	56.6	N/A
Britt Creek – Greenhills	23.7	1
Greenhills – Elkford	1.0	0.1
Elkford - Line Creek	19.1	0.4
Line Creek - Natal	17.7	0.4
Crowsnest - Line Creek	56 by road	1.25
Crowsnest - Britt Creek	96 by road	2
Calgary - Britt Creek		5
Sparwood - Line Creek	18 by road	0.4
Fernie - Line Creek	54 by road	0.7

**Attachment 8 - 1L274/887L and AltaLink's 777L Switching Devices**

Station/Tap	Switching Device	Supervisory Control	Operating Responsibility
Seebee	245S777X	AltaLink SCC	AltaLink SCC
Pocaterra	48S777N	AltaLink SCC	AltaLink SCC
	48S887X	AltaLink SCC	AltaLink SCC
	48S34	AltaLink SCC	AltaLink SCC
	48S38	AltaLink SCC	AltaLink SCC
Britt Creek	1D22	BCHCC (via cell modem)	BCHCC
	1D21	BCHCC (via cell modem)	BCHCC
	1D23	N/A	BCHCC
Greenhills Tap	1D3L274	N/A	BCHCC
	1D4L274	N/A	BCHCC
	1D6L274	N/A	BCHCC
Elkford Tap	1D22	BCHCC (via dial-up modem)	BCHCC
	1D21	BCHCC (via dial-up modem)	BCHCC
	1D23	N/A	BCHCC
Line Creek Tap	1D1L274	N/A	BCHCC
	1D2L274	N/A	BCHCC
	1D5L274	N/A	BCHCC
Natal	1CB1	BCHCC	BCHCC

**Attachment 9 - Remedial Action Schemes (RAS)**

No.	Contingency	Direct Transfer Tripping				NTL LS RAS (DTT 1L274 NTL and DTT 60L288 NTL)	CBK Overvoltage RAS
		5L94 CBK	1L274 POC (Note 1)	1L275 NTL (Note 1)	5L94 <UF>		
1	5L91	A	A	A			
2	5L92 <2L294 I/S>	A	A	A		A	
3	5L94		A	A		A	
4	5L96	A	A	A			
5	5L98	A	A	A			
6	5L96 & 5L98	A	A	A			
7	5L51 & 5L52		A	A	A		
8	5L76 & 5L79	A	A	A			
9	5L81 & 5L82	A	A	A			
10	5L81 & 5L83	A	A	A			
11	5L82 & 5L83	A	A	A			
12	5L91 & 5L96	A	A	A			A
13	5L91 & 5L98						A
14	2L294 <PS>	A	A	A		A	
15	BPA Circuits	A	A	A			A

**Definitions:**

“A” : Available for arming

“5L92 <2L294 I/S>” : Loss of 5L92 with 2L294 in-service.

“5L94 <UF>” : Transfer tripping 5L94 supervised by frequency at CBK < 59.95 Hz for more than 3 cycles.

“2L294 <PS>” : Non-recoverable power swing on 2L294 during a 5L92 circuit outage.

“BPA Circuits”: a List of BPA circuits that initiate DTTs are listed in SOO 7T-18 Section 9.1 (c) and (d).

**Note 1:** See Note 24 in Section 10.3 for the conditions that the RAS must be disarmed.

**Attachment 10 - NTL LS RAS Arming Requirements**

Note: When the LS RAS is unavailable and the ALL/CBK/NTL load level is higher than the level specified in this table, then the AB/BC transfer must be limited to the level that the load shedding is not required.

Definitions:

1. AAL/CBK/NTL area load = 2L294 NLY + (CBK 500 kV to 230 kV MW) + 1L274 POC – 1L275 NTL
2. Status of NTL 12 CX3 and CBK (12CX2, 12CX3) in the following table:  
 Status A: NTL 12CX3 in service AND both CBK (12CX2, 12CX3) available  
 Status B: One of NTL 12CX3 OOS OR CBK 12CX2 or CBK 12CX3 unavailable  
 Status C: NTL 12CX3 OOS AND one of CBK (12CX2, 12CX3) unavailable  
 Status D: NTL 12CX3 OOS AND both CBK (12CX2, 12CX3) unavailable  
 Status E: NTL 12CX3 in service AND both CBK (12CX2, 12CX3) unavailable

Status D & E are not studied conditions. Status D & E operation must be avoided. In the event of forced outages leading to operation in Status D or E, TSAPM will send an alarm and arm at all times that Load Level exceeds 250 MW, and Transfer Level criterion are met (see table below). Please consult Operational Planning to determine whether the NTL LS RAS arming requirement can be relaxed.

System Condition	Contingency	NTL LS RAS Arming Requirement is the “AND” logic of the following three conditions		
		BC/AB Transfer Level (MW)	Status of NTL 12CX3 and CBK (12CX2, 12CX3)	AAL/CBK/NTL Load Level (MW)
All system conditions listed in Sections 10.1 and 10.2, except for (2L113 or/and NTL T3&T4 OOS) or 2L293 or 2L294 or 5L92 or (2L112 & 2L294) OOS	5L92 <2L294 I/S>	<ul style="list-style-type: none"> <li>• AB to BC &gt; 100 MW, or BC to AB &gt; 100 MW</li> </ul>	Status A	> 290 MW
			Status B	> 280 MW
			Status C	> 270 MW
2L293 OOS	5L92 <2L294 I/S>	AB to BC > AAL/CBK/NTL load, or BC to AB > 100 MW	Status A	> 290 MW
			Status B	> 280 MW
			Status C	> 270 MW

System Condition	Contingency	NTL LS RAS Arming Requirement is the “AND” logic of the following three conditions		
		BC/AB Transfer Level (MW)	Status of NTL 12CX3 and CBK (12CX2, 12CX3)	AAL/CBK/NTL Load Level (MW)
5L92 OOS	5L94	See Section 9.3	Status A	> 290 MW
			Status B	> 280 MW
			Status C	> 270 MW
5L92 OOS	2L294 <PS>	Not applicable	Status A	> 290 MW
			Status B	> 280 MW
			Status C	> 270 MW