BC HYDRO

T&D SYSTEM OPERATIONS

SYSTEM OPERATING ORDER 7T – 18

BC - US INTERCONNECTION

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1.0 DESCRIPTION

1.1 General

This System Operating Order (SOO) describes the operation of the BC-US Interconnection, also defined as Path 3 in the WECC Path Rating Catalog. This SOO documents operating requirements, responsibilities for entities associated with the Interconnection, voltage control and switching requirements, synchronizing requirements, and special operating configuration requirements.

This SOO also provides BC Hydro (BCH) System Operating Limits (SOL) information, recommended Total Transfer Capability (TTC), and Remedial Action Scheme (RAS) arming requirements for the BC–US Interconnection. The SOL, recommended TTC, and RAS Arming requirements for the BC–US Interconnection can be found in Sections 8 and 9, and supporting attachments. These limits 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** requirements in this order.

The BC-US Interconnection (WECC Path 3) is defined as:

- One 500 kV circuit (designated 5L51 within BC Hydro operating area and Custer-Ingledow 500 kV Line #1 within BPA operating area) between BC Hydro's Ingledow Substation (ING) and BPA's Custer Substation (CUS). The path metering is at Ingledow.
- One 500 kV circuit (designated 5L52 within BC Hydro operating area and Custer-Ingledow 500 kV Line #2 within BPA operating area) between BC Hydro's Ingledow Substation (ING) and BPA's Custer Substation (CUS). The path metering is at Ingledow.
- One 230 kV circuit (designated 2L112 within BC Hydro operating area and Boundary-Nelway 230 kV circuit within BPA's operating area) between BC Hydro's Nelway Substation (NLY) and Boundary Substation in the BPA operating area. The path metering is Boundary.
- One 230 kV circuit (designated 71L within FortisBC operating areas and designated Boundary-Waneta 230 kV Line within the BPA operating area) between Waneta Generating Station in the FortisBC operating area, and Boundary Generating station in the BPA operating area. The path metering is at Boundary. This circuit is Normally Open, and cannot be operated in parallel with other interconnection lines for the present implemented RAS schemes.

The circuits between Ingledow and the international border will be known within BCH as 5L51 and 5L52. However, when communicating with BPA these lines will be referred to as the "Custer - Ingledow 500 kV Line 1" and "Custer - Ingledow 500 kV Line 2" respectively. These circuits are also collectively referred to Path 3 "West Side".

The circuit between Nelway and the international border will be known within BCH as 2L112, however when communicating with BPA will be referred to as the "Boundary-Nelway 230 kV line". This circuit together with the Nelway 230 kV Phase Shifting Transformer (PST) may also be referred to as Path 3 "East Side".

BC Hydro Control Centre (BCHCC) and BPA's Dittmer Control Centre will coordinate all trouble dispatch by mutual agreement depending upon 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.

Both BPA and BCHCC Operators must be notified of any plans or actions affecting the operation of the interconnection.

References:
SOO 2T-34 “Remedial Action Schemes (RAS)”
SOO 7T-01 “Establishing and Monitoring SOL's and IROL's”
SOO 7T-17 “BC - Alberta Interconnection”
SOO 7T-33 “South Interior Subsystem”
SOO 7T-34 “South Interior Generation Shedding and Outage Requirements”

1.2 Circuit Boundaries

Circuits 5L51 and 5L52 and 2L112 connect the B.C. Hydro Integrated System to the American part of the Northwest Power Pool (NWPP).

Each 500 kV circuit runs 22 km from Ingledow Substation to the international border and extends 14 km to the BPA Custer station:

- 5L51 structure 13-4 is in B.C. Hydro’s Lower Mainland division.
- 5L52 structure 13-4 is in B.C. Hydro’s Lower Mainland division.

Circuit 2L112 (the Boundary to Nelway transmission line) is approximately 4.0 km long with the BPA Boundary Substation situated south of the Canada - U.S.A. international boundary, and Nelway Substation on the north. At the Nelway terminal, a phase shifting transformer (with a bypass) forms part of the 2L112 circuit.

1.3 Communication

BCHCC and BPA Dittmer CC: Dispatch Intercom and DATS phone.

1.4 Safety Protection

NWPP Terminology:
“Terminal Hold” may be used instead of “Guarantee of No Reclose”.
“Terminal Clearance” may be used instead of “Guarantee of Isolation”.

A Clearance on circuit 5L51, 5L52 or 2L112 will be issued by the Grid Desk Operator after a **Guarantee of Isolation** (Terminal Clearance) is obtained from the BPA Dispatcher via the Transmission Coordinator.

A Live Line Permit on circuit 5L51, 5L52 or 2L112 will be issued by the Grid Desk Operator after a **Guarantee of No Reclose (Terminal Hold)** is obtained from the BPA Dispatcher via the Transmission Coordinator.

Similarly, the BPA Dispatcher may ask BCH for a **Guarantee of Isolation (Terminal Clearance** or a **Guarantee of No Reclose (Terminal Hold)** on these circuits.

For a Guarantee of Isolation (Terminal Clearance), the Grid Desk Operator will issue a GOI to the BPA Dispatcher via the Transmission Coordinator. The Transmission Coordinator will log the GOI # and communicate the GOI (Terminal Clearance) information to the BPA Dispatcher.

For a Guarantee of No Reclose (Terminal Hold), the Grid Desk Operator will issue a GNR to the BPA Dispatcher via the Transmission Coordinator. The Transmission Coordinator will log the GNR and communicate the GNR (Terminal Hold) information to the BPA Dispatcher.

1.5 Equipment Rating

At Ingledow Substation (ING), the disconnects (5D23 or 5D25) for 5L51 and 5L52 circuits are rated at 3000 A continuously and for 30 minutes.

The continuous current rating of 5L51 is:

- 3584 A at 20 degree C ambient temperature,
- 3198 A at 30 degree C ambient temperature, and
- 2692 A at 40 degree C ambient temperature.

The continuous current rating of 5L52 is:

- 3355 A at 20 ºC ambient temperature,
- 2990 A at 30ºC ambient temperature, and
- 2538 A at 40 ºC ambient temperature.

Refer to System Operating Order 5T-10 for their detailed sources.

Attachment 1 have charts showing the continuous current and MW ratings and 30-minute current and MW ratings of 5L51 or 5L52 facilities based on the ratings of 5L51, 5L52 line and the ratings of ING DS (3000 A) at various ambient temperatures.

1.6 Operating Procedures to Support RC West

BC Hydro Operators may be called upon in real time to take actions to support the RC West Operating Procedure for the North West Washington (NW-WA) Area Net Load Limit IROL. Normally, the communications will be initiated through the British Columbia Reliability Coordinator (BCRC).

Under heavy loads and certain major 500 kV line outage conditions, the NW-WA Load Area may experience voltage instability under identified contingencies in the plan.

BPA and RC West monitor the loading and the voltage stability limit, and as margin between the load and limit decrease, the RC West procedure requires consultations and actions in a prescribed plan. BC Hydro may be called upon to take actions under the plan that includes:

- Removing RX and inserting shunt CX to reduce VAR flow into the BCH system, while maintaining BCH voltages within operating limits, and
- Moving S-N flow from the West Side of Path 3 to the East Side if beneficial to reduction in VAR depletion, and
- Considering a reduction in interruptible energy schedules flowing S-N on Path 3 “West Side” during an alert stage.
- Firm energy interruption if beneficial to reducing S-N flows on Path 3 “West Side”, when firm curtailments are implemented in the NW WA area.

1.7 Meridian (MDN) Transformers – Normal Operation

One of the three MDN transformers (T1, T2, or T3) must normally be offloaded. It is preferred that it be T2 on hot standby (unless otherwise specified in an operating plan) to prevent excessive injection into the Metro 230 kV network for any 500 kV circuit contingencies. The remaining two MDN transformers shall remain on load at all times, to prevent voltage collapse and cascading impacts on the loss of the remaining transformer. This operation procedure should be considered system normal operation. The following actions and exceptions should be considered:

- On the loss of one of the two in-service transformers the standby transformer should be returned to service.
- Prior to switching an in-service transformer out for maintenance, the third transformer should be returned to service.
- When an operating plan specifically identifies an exception (for example, to address abnormal configurations of the system that may include outages, RAS/generation shedding, or other topology/load/generation requirements), then the number or selection of on load transformers may differ from the standing recommendation.

2.0 AUTO RECLOSING

5L51 and 5L52 auto-reclosing lead end is Custer and follow end is Ingledow. It is supervised by return of voltage potential and parallel line current supervision at the ING slave end.

There is no auto-reclosing available on 2L112.

3.0 LOOP CLOSURE / SYNCHRONIZING

5L51 and 5L52 closing angle at ING is supervised by a synchro-verifier set at 30 degrees for 10 seconds. If synchronism is maintained through Boundary Substation (BDY), the ING closing angle should be reduced by reducing 2L112 MW transfer to zero by setting the Nelway phase shifter at tap 17. An angle greater than 30 degrees could occur due to power flow patterns in the BPA system. However, the ING closing angle can then be reduced to 30 degrees or less by adjusting the Nelway phase shifter.

The circuits 5L51 and 5L52 will normally be energized from Custer and synchronized at Ingledow.

The circuit 2L112 is normally energized from Boundary and synchronized closed at Nelway but this may be reversed as required. See System Operating Order 7T-33 for further details.

Local manual and supervisory automatic synchronizing is available at Nelway; only local manual synchronizing is available at Boundary.

All 230 kV circuit breakers at Nelway have synchronizing control. For the synchronizer to work, some slip (maximum 0.20 hertz) must exist across the circuit breaker. A synchro-check relay has also been provided to allow closing of the circuit breaker when no slip exists across it. If the bus on either side of the circuit breaker is de-energized then sync bypass must be used to close the circuit breaker via supervisory control.

Phase angle telemetering has been provided at Nelway. The reading from this device will only be accurate if both sides of the selected circuit breaker are energized. The synchro-check relay will allow the circuit breaker to close if the angle across the circuit breaker is 15 degrees or less.

4.0 VOLTAGE CONTROL SCHEMES

Voltage controls schemes are used to manage system voltages within normal operating limits pre and post contingency, to support interconnection transfers. These schemes are located at KLY, ING, NIC, MDN, ACK and SEL, and involve the Reactive Power Remedial Action Scheme (RX RAS), local Auto-VAR schemes and circuit Direct Transfer Tripping (DTT) for 5L83.

4.1 Reactive Power Remedial Action Scheme (RX RAS)

4.1.1 Purpose

The Reactive Power Remedial Action Scheme (RX RAS) was designed to reduce high voltages in the BC Hydro system for loss of 5L51 and 5L52 when the Ingledow to Custer (CUS) transfer exceeds 2000 MW. RX RAS has six components:

- RX RAS at KLY
- RX RAS at NIC
- RX RAS at ING
- RX RAS at MDN
- RX RAS at ACK
- RX RAS at SEL

4.1.2 Operation

Arm the RX RAS if the ING to CUS transfer > 2000 MW. The BCH EMS Transient Stability Analysis (TSA-PM) advanced application normally arms/disarms the RX RAS.

The BCH Transmission Coordinator is responsible to arm and disarm the RX RAS. When TSA-PM is unavailable, the operator can manually arm/disarm the RX RAS from the EMS Generation Shedding Display.

With the RX RAS armed and upon the loss of 5L51 and 5L52, the RX RAS will:

- Switch out in-service shunt capacitors at:
  - Ingledow 2CX11, 2CX2, 2CX31 and 2CX32
  - Meridian 2CX1, 2CX2, 2CX3 and 2CX4
  - Ashton Creek 5CX1 and 5CX2 (each of ACK 5CX1 and 5CX2 has individual arming/disarming facility)
- Switch in shunt reactors at:
  - Ingledow 12RX4 and 12RX5
  - Meridian 2RX2, 12RX31 and 12RX32
  - Kelly Lake 5RX1, 5RX3, 5RX5, 5RX6, 2RX2 and 12RX1
  - Nicola 5RX3, 5RX4 and 5RX11
  - Selkirk 5RX3

4.1.3 Coordination with Auto-VAR Schemes

The arming of the RX RAS at ING, MDN, ACK or SEL does not block the operation of the ING, MDN, ACK or SEL auto-VAR scheme respectively. When each of these RX RASs operates, the corresponding substation auto-VAR scheme is frozen for 10 seconds. After 10 seconds, the corresponding auto-VAR scheme is automatically re-enabled and the RX RAS at the corresponding substation is automatically disarmed. The RX RAS at KLY and at NIC remain armed unless they are disarmed manually.

4.2 Direct Transfer Tripping of 5L83 and 5L12

The DTT of 5L83 and 5L12 is designed to reduce high voltage for loss of both of 5L51 and 5L52 when the Ingledow to Custer (CUS) transfer exceeds certain amount under light load condition.

The arming conditions for DTT 5L83 are as follows:

- If ING to CUS transfer > 600 MW, AND,
- BCH Load < 6500 MW, AND,
- All the following 500 kV lines are in service.
  - 5L81,
  - 5L82,
  - 5L83,
  - 5L42, and
  - 5L41.

The arming conditions for DTT 5L12 are as follows:

- If ING to CUS transfer > 600 MW, AND,
- BCH Load < 6500 MW, AND,
- All the following 500 kV lines are in service.
  - 5L11,
  - 5L12, and
  - 5L13.

5.0 EASTERN CONTROLLED SEPARATION REMEDIAL ACTION SCHEME (ECS RAS)

5.1 ECS RAS Description

The Eastern Controlled Separation Remedial Action Scheme (ECS RAS) allows the controlled separation of the BC-US interconnection for loss of 5L51 and 5L52. Refer to Section 1.0 for the configuration of Path 3. The ECS RAS has two components:

- ECS RAS at NLY
- ECS RAS at WAN

The ECS RAS will be armed during moderate to heavy import and exports conditions. The operation of ECS RAS will prevent the cascading outage of transmission circuits in the Selkirk, Nelway and Cranbrook areas when loss of 5L51 and 5L52 will overload 2L112 or 71L:

- The arming of the ECS RAS at NLY will trip 2L112 for loss of 5L51 and 5L52.
- The arming of the ECS RAS at WAN will trip 71L for loss of 5L51 and 5L52. The ECS RAS at WAN shall not be armed as the circuit is presently connected to NLY as 2L277 (71L).

2L277 must be connected to NLY at present because there are no operating studies to support 71L connected to BDY. In this WHS-NLY configuration, the circuit is referred to as 2L277 (71L), acknowledging both the BC Hydro and FortisBC designations. While 71L can be manually switched so that it can be connect WHS–BDY (referred to only as 71L in that configuration), there are no supporting BCH RAS schemes for the operating configuration while looped ties exist to the BC Hydro system. Therefore, the circuit can not be operating in this WHS-BDY configuration.

The BCH EMS Transient Stability Analysis (TSA-PM) advanced application normally arms/disarms the ECS RAS.

The BCH Transmission Coordinator is responsible to arm and disarm the ECS RAS. When TSA-PM is unavailable, the Operator can manually arm/disarm the ECS RAS from the EMS Generation Shedding Display.

5.2 ECS RAS at NLY Requirement when 2L277 is connected to NLY

With 2L112 in service, arm ECS RAS at NLY:

- If Abs (5L51 ING + 5L52 ING + 2L112 NLY) > 400 MW

5.3 ECS RAS Operation Due to Loss of Custer-Monroe #1 and #2 500kV Circuits

BPA has installed the Northern Intertie Separation RAS (NIS RAS) at Custer Substation. The NIS RAS is armed by BPA when the Custer to Ingledow transfer is higher than 100 MW. This RAS will not be armed when the transfer is from Ingledow to Custer.

When the NIS RAS is armed, the loss of both Custer-Monroe #1 and #2 500 kV circuits will open both ends of 5L51 and 5L52 circuits at Custer. The open-breaker keying at Custer will then send transfer trip signals to Ingledow to trip the Ingledow ends of 5L51 and 5L52.

If the ECS RAS is armed, the loss of 5L51 and 5L52 will initiate a controlled separation of the BCH system from BPA.

6.0 ALBERTA - TIE TRIPPING SCHEMES

6.1 Description

The AB TIE RAS is a general term that encompasses a number of related RAS further described in SOO 7T-17 and SOO 2T-34 and Attachments and referenced in this section. These RAS may be armed for a number of conditions related to Path 3 operations as described below.

5L94 RAS allows the tripping of the BC-Alberta Interconnection during high US to BC transfers for:

- the loss of **5L51 AND 5L52**, or
- loss of 5L51 with 5L52 out of service.
- loss of 5L52 with 5L51 out of service.
- BPA system contingencies that trigger the BPA NW RAS or BPA PACI RAS.

For all system conditions with the exception of 5L94 out of service, the 5L94 RAS will be armed based on the system conditions specified in Section 6.2. When armed, the RAS will trip 5L94 if the frequency at CBK is below 59.95 Hz for more than 3 cycles after loss of 5L51 AND 5L52 or loss of 5L51 (or 5L52) with 5L52 (or 5L51) out of service.

Tripping of the 5L94 tie will in turn trip 1L274 tie at Pocaterra (by the Pocaterra RAS) and 1L275 tie at NTL (by the NTL RAS) to separate BC from Alberta (refer to SOO 7T-17 for more details). The separation is to prevent the Alberta system frequency from dropping below 59 Hz, or to prevent the transient voltage dip violation at 500 kV buses at CBK and at AltaLink's Bennett 520s Substation.

Further, the CBK Overvoltage RAS may be armed to prevent overvoltage on the SEV 230 kV bus when significant generation shedding occurs in response to the BPA NW/PACI RAS operations or the loss of the BC-US intertie.

For 5L94 out of service, refer to Section 9.3 for the arming requirements for 1L274 by the Pocaterra RAS and for 1L275 by the Natal RAS.

The BCH EMS Transient Stability Analysis (TSA-PM) advanced application normally arms/disarms these RAS.

6.2 AB Tie Separation - Arming for imports from RTA and US

Arm the 5L94 RAS at CBK if:

- BCH load < 5260 MW
  AND
  ING - Custer transfer plus
  NLY - Boundary transfer plus
  MIN to Kitimat transfer is less than 0.17 * (3800 - BCH Load) - 1100 MW
- BCH load >= 5260 MW
  AND
  ING - Custer transfer plus
  NLY - Boundary transfer plus
  MIN to Kitimat transfer is less than 0.38 * (5260 - BCH Load) - 1350 MW

OR

- 5L61 RAS is armed:
  AND
  ING - Custer transfer plus
  NLY - Boundary transfer plus
  WSN to GLN transfer is less than -1.31 * Z – 2000 MW

- 5L61 RAS is not armed:
  AND
  ING - Custer transfer plus
  NLY - Boundary transfer plus
  MIN to Kitimat transfer is less than -1.31 * Z – 2000 MW

  Where
  Z = BC - AB Transfer MW (West to East is: +)

Disarm the 5L94 RAS if the arming condition specified above is not met.

Example:

System condition:

- BCH load: 5000 MW
- ING - Custer transfer : -1200 MW (BCH is importing 1200 MW on 5L51 and 5L52)
- NLY - Boundary transfer: -300 MW (BCH is importing 300 MW on 2L112)
- MIN to Kitimat transfer: -280 MW (BCH is importing 280 MW on 2L103)
- BC to AB transfer: - 600 MW
- 5L61 RAS is not armed

Arming condition calculation:

- ING - Custer transfer plus NLY - Boundary transfer plus MIN to Kitimat transfer
  = -1200 – 300 – 280 = -1780
- 0.17 * (3800 – BCH Load) – 1100 MW = 0.17*(3800 – 5000) –1100 = -1304
- -1.31* (-600) – 2000 MW = -1214
- Because (-1780) is less than (-1304), or (-1780) is less than (-1214), arm 5L94 RAS

6.3 AB Tie Separation – For BPA Contingencies

5L94 RAS arming (for contingencies triggering BPA/NW and BPA/PACI RAS) is supervised by the phase angle from Grand Coulee 500 kV bus to Malin 500 kV bus in the BPA system (Grand Coulee 500 kV – Malin 500 kV).

If the phase angle is greater than 40 degrees, the 5L94 RAS will NOT be armed for the BPA contingencies. Instead, Alberta to BC transfer is restricted to prevent Alberta-BC tie from being tripped by 5L94 undervoltage protection at CBK and BNS. The reason for this is that larger phase angles (>40º) indicate the WECC system is highly stressed in N-S transfer. In this situation, the separation of Alberta system could result in poor oscillation damping in the greater WECC Interconnection.

Detailed 5L94 RAS arming requirements for BPA contingencies:

(1) If Phase Angle[1] > 40º, the 5L94 RAS shall NOT be armed. AB to BC transfer shall be limited based on system configurations given below.

System Configuration	AB to BC Limit
System Normal Configuration 1[2]	If armed gen-shed amount (GS1[3] or GS2[4]) > 1600 MW, then limit AB to BC transfer ≤ 850 MW
2L112, or 2L293 OOS	If armed gen-shed amount (GS1 or GS2) > 1500 MW, then limit AB to BC transfer ≤ 800 MW
2L294, or MATL OOS[5]	If armed gen-shed amount (GS1 or GS2) > 1300 MW, then limit AB to BC transfer ≤ 750 MW

(2) If Phase Angle <= 40º, then

a. The 5L94 RAS and the CBK Overvoltage RAS shall be armed for BPA/NW RAS if the conditions are met under system configurations given below.

System Configuration	Arming Condition
System Normal Configuration 1	If armed gen-shed amount GS1 > 1600 MW, and AB to BC transfer ≥ 850 MW
2L112, or 2L293 OOS	If armed gen-shed amount GS1 > 1500 MW, and AB to BC transfer ≥ 800 MW
2L294, or MATL OOS	If armed gen-shed amount GS1 > 1300 MW, and AB to BC transfer ≥ 750 MW

b. The 5L94 RAS and the CBK Overvoltage RAS shall be armed for BPA/PACI RAS if the conditions are met under system configurations given below.

System Configuration	Arming Condition
System Normal Configuration 1	If armed gen-shed amount GS2 > 1600 MW, and AB to BC transfer ≥ 850 MW
2L112, or 2L293 OOS	If armed gen-shed amount GS2 > 1500 MW, and AB to BC transfer ≥ 800 MW
2L294, or MATL OOS	If armed gen-shed amount GS2 > 1300 MW, and AB to BC transfer ≥ 750 MW

Notes:

[1]. "Phase Angle" is defined as the phase angle between Grand Coulee 500 kV bus and Malin 500 kV bus in BPA.

[2]. "System Normal Configuration 1" means all the following equipment must be in service, including: 5L91, 5L92, 5L96, 5L98, 2L112, 2L293, 2L294, and MATL.

[3]. GS1 is BCH armed gen-shedding amount for BPA/NW RAS assuming 5L94 RAS is not armed. Depending on DTT 5L94 armed or not, see Section 9.6 for the details on the final BCH gen-shedding requirements
GS2 is BCH armed gen-shedding amount for BPA/PACI RAS assuming 5L94 RAS is not armed. See Section 9.7 for the details on the final BCH gen-shedding requirements irrespective of whether 5L94 RAS is armed or not,

[4]. "MATL OOS" means Montana-Alberta Tie Line open, i.e., any component of "Picture Butte 240 kV bus – Hay Lake 230 kV bus path" from Alberta to Montana is OOS. This is also WECC Path 83.

[5]. If the Phase Angle signal measurement fails, the limitations same as Phase Angle > 40º shall apply.

[6]. For AB-BC limits in other system configurations, refer to Section 10.1 in SOO 7T-17.

7.0 5L61 TRIPPING REMEDIAL ACTION SCHEME (5L61 RAS)

7.1 Description

5L61 Tripping Remedial Action Scheme (5L61 RAS) allows the controlled separation of North Coast area including Rio-Tinto Alcan (RTA) system from BCH system for loss of 5L51 and 5L52 during BCH import period. This RAS allows the tripping of 5L61 for the simultaneous loss of 5L51 and 5L52, OR for loss of 5L51 (or 5L52) with 5L52 (or 5L51) out of service during high US to BC and high Alcan to BCH transfers.

When armed during BCH moderate to heavy import conditions from US and high import from Alcan, the 5L61 RAS will trip open 5L61 after loss of (5L51 and 5L52) OR loss of 5L51 (or 5L52) with 5L52 (or 5L51) out of service.

The Energy Management System (EMS) Transient Stability Analysis (TSA-PM) advanced application arms/disarms the 5L61 RAS.

The BCHCC Transmission Coordinator is responsible for the arming and disarming of the 5L61 RAS at WSN. When TSA is unavailable, the BCHCC Transmission Coordinator can manually arm/disarm the 5L61 RAS from the BCHCC EMS Generation Shedding Display.

7.2 5L61 RAS Arming for Imports from US and Alcan

Arm the 5L61 RAS at WSN if:

- 5L61 WSN <= 75 MW **AND**
- (ING - Custer transfer) + (NLY - Boundary transfer) is less than:
  0.125 × (3900 - BCH Load) – 600 MW

Disarm the 5L61 RAS if the arming conditions specified above are not met.

8.0 SYSTEM OPERATING LIMITS AND TRANSFER LIMITS

8.1 General

In the following tables:

"BC to US"	=	net of the power flowing from BC to US, on ING-CUS 500 kV and NLY-BDY 230 kV ties
"US to BC"	=	net of the power flowing from US to BC, on CUS-ING 500 kV and BDY-NLY 230 kV ties
"Eastern tie"	=	NLY-BDY 230 kV tie

For import/export restrictions due to equipment outages in the BPA/PSE (Puget Sound Energy) system, refer to BPA Standing Order #320 that is updated by BPA. BPA may use limits other than those stated in BPA Standing Order #320 as a result of special operating studies. The BPA Dispatcher will advise the BCHCC Operator on special limits being used.

The BPA and the BCHCC Operator must agree on the transfer limits between BC and US that will be used and posted on OASIS.

The BCH recommended TTC's for paths in this Order have been developed in accordance with the BCRC's SOO 8T-30 "BCRC System Operating Limit Methodology for the Operations Horizon". Recommended TTC's for BC Hydro's operation of Path 3 are found in Sections 8.4 and 8.6.

8.2 Corrective Measure when Transfer Limits Are Exceeded

When the BC-US transfer limit or BC-Alberta transfer limit is exceeded, adjust the BC-Alberta transfer and/or BC-US transfer to stay within the limits after confirming that next contingency impacts can be managed within facility SOLs or path SOL (should an SOL be determined, refer to Section 8.4 and 8.6).

8.3 System Requirements for BC Exporting to US

8.3.1 5L51 or 5L52 Thermal Limit vs Ambient Temperature at ING

The Amp rating of 5L51 or 5L52, in Attachment 1, is based on clearance requirements within BCH Engineering Standard 41K and the enforcement of right-of-way usage by BCH, and the rating of ING DS (3000 A). For details of the MW rating refer to Attachment 2.

Attachment 2 shows the ING-CUS transfer limits for all system conditions. These ING-CUS transfer limits are to prevent the pre-outage and post-outage loading on 5L51 or 5L52 from exceeding its thermal limit upon any Peace, LM, or SI contingencies.

Attachments 1 and 2 are implemented in TSA-PM.

If the ING to CUS transfer limit has been exceeded, the BCHCC Operator must reduce the transfer below the limit by:

- Adjusting NLY PST, or
- Curtailing BC to US export schedule.

8.3.2 On-line Burrard (BSY) Synchronous Condensers (SC) (Attachment 3)

Attachment 3 shows the ING to CUS transfer limits as a function of BCH load and the number of on-line BSY SC. Operating above the transfer limits will cause high voltages that can damage underground cables in the Lower Mainland upon the loss of 5L51 and 5L52 during light load condition. The BCHCC Operator must reduce the ING to CUS transfer to be within the transfer limit.

TSA-PM will provide an alarm if the conditions in Attachment 3 are violated.

8.3.3 Increasing the ING to CUS transfer above 2000 MW

5L51 and 5L52 double contingency is not an Always Credible Multiple Contingency. When both 5L51 and 5L52 are in service, the recommendations in the subsections of 8.3.3 can relaxed, providing real time tools show no voltage issues post contingency (as verified with RTCA) for credible single contingencies. If conditions arise that demonstrate a higher likelihood of a double contingency (conditionally credible), then the loss of 5L51/5L52 should be treated as a credible multiple contingency and the subsection requirements should be adhered to (similar to 8.3.3 single contingency). These criterion for assessing conditionally credible contingencies can include: storms approaching the Lower Mainland, or BPA circuits out of service that can initiate intertie separation on their next contingency, for examples. Refer to SOO 7T-01 Section 4.1 for Conditionally Credible Multiple Contingencies.

The following conditions must be met before increasing the ING to CUS transfer above 2000 MW. TSA-PM will automatically check these conditions and provide an alarm if any of the conditions is not met.

***Table**: Group Definitions for circuits and combinational elements:*

Group:	Circuit Group Elements:
ILM_500	5L40, 5L41, 5L42, 5L45, 5L82,5L83, 5L87
LM_VI_500	5L29, 5L30, 5L31, 5L32, (5L29 & 5L30), (5L29 & 5L32), (5L30 & 5L31), (5L31 & 5L32)
NORTH_COAST_500	5L61, 5L62, 5L63
NORTH_OF_KLY_500	5L1, 5L2, 5L3, 5L4, 5L7, 5L11, 5L12, 5L13
SI_5L7x	5L71, 5L72, 5L75, 5L76, 5L77, 5L79, (5L72 & SYA 5CX1), (5L71 & SYA 5CX2), (5L71 & 5L75), (5L71 & 5L77), (5L72 & 5L75), (5L72 & 5L77)
SI_5L9x	5L91, 5L92, 5L94, 5L96, 5L98, (5L96 & 5L98), (5L94 & 5L96)

Note: *5L44 and 5L81 are not included in any group because their associated ING-CUS restriction is less than 2000 MW regardless of 5L83 in or out status.*

Note: *A group element is defined an individual circuit or specified combination of circuits. For example, under the LM_VI_500 Group, 5L29 is an element, and (5L29 & 5L30) is also an element, etc.*

Note: *The shunt reactor statuses are described as available or unavailable if they are part of an autovar and/or RX RAS scheme. They are described as energized or de-energized if they are not part of an autovar and/or RX RAS scheme.*

8.3.3.1 BC-Alberta transfer must be within the normal transfer limits specified in Sections 10.1 and 10.2, SOO 7T-17.

8.3.3.2 The RX RAS must be fully available and armed as per Section 4.1.2. All auto-var schemes at ING, MDN, ACK and WSN must be in service. The auto-var scheme at SEL must be in service if SEL 5RX3 is available.

8.3.3.3 The following circuit(s) is/are allowed to be out of service:

A. one of NORTH_OF_KLY_500 group elements, **OR**
B. any combination of NORTH_COAST_500 group elements

AND/OR,

One of the following elements or group elements is allowed to be out of service (OOS):

C. (5L51, or 5L52, or ILM_500, or SI_5L7x, or SI_5L9x)
(see Table A1 in this section for applicable transfer limits)

D. (5L51, or 5L52, or SI_5L7x, or SI_5L9x) **AND** 5L83 OOS
(see Table A2 in this section for applicable transfer limits)

AND/OR,

E. One of LM_VI_500 group elements.

All limits in the tables are applicable under these conditions.

8.3.3.4 If all of the following circuits are in service: 5L40, 5L41, 5L42, 5L81, 5L82, and 5L83, then at least three of the CHP, CRK, RYC, AMC 5CX1 and AMC 5CX2 series capacitors (all segments) must be in service.

If one of the following circuits is OOS: 5L40, 5L41, 5L42, 5L82, or 5L83, then at least four of the CHP, CRK, RYC, AMC 5CX1 and AMC 5CX2 series capacitors must be in service.

8.3.3.5 Two of ING 2CX11, 2CX2, 2CX31 and 2CX32 must be available.

8.3.3.6 The following equipment must be available, in service or energized:

A. ING 12RX4, 12RX5, 2RX1, 2RX2
B. KI2 One of (12RX1, 12RX2, 12RX3)
C. KLY One of (On-line KLY SC2 with AVR, 12RX1, 2RX2)
D. MDN 12RX31, 12RX32, 2RX1, 2RX2
E. MSA 12RX1, 12RX2
F. TBY 2RX1

With the following exceptions:

G. If 2L129 ARN > 500 MW,
then one of (TBY 2RX1, ING 12RX4, 12RX5, 2RX1, 2RX2) AND one of (MDN 12RX31, 12RX32, (12RX31 AND 12RX32), 2RX1, 2RX2) may be unavailable or de-energized, OR

If 300 MW < 2L129 ARN <= 500 MW,
then one of (TBY 2RX1, ING 12RX4, 12RX5, 2RX1, 2RX2, MDN 12RX31, 12RX32, (12RX31 AND 12RX32), 2RX1, 2RX2) may be unavailable or de-energized, OR

If 2L129 ARN <= 300 MW,
then one of (TBY 2RX1, MDN 12RX31, 12RX32, (12RX31 AND 12RX32), 2RX1, 2RX2) may be unavailable or de-energized, OR

If 2L129 (including all sections from ARN 230 to VIT 2PST1) is OOS,
then one of (MDN 12RX31, 12RX32, (12RX31 AND 12RX32), 2RX1, 2RX2) may be unavailable.

AND

H. If 5L30 or 5L32 is O.O.S.
then one of MSA 12RX1 and 12RX2 may be de-energized, OR

I. If 5L30 and 5L32 are in service **AND**
If ING 12RX4, 12RX5, 2RX1, 2RX2 are available
then one of the MSA 12RX1 and 12RX2 reactors may be or de-energized.

8.3.3.7 At least 4 of (PIK 2RX2, SAT 2RX1, VIT SC2, VIT SC3, VIT SC4) must be energized or in service (breaker closed). The AVR of VIT SCs must be on.

8.3.3.8 BSY SC unit(s) per Attachment 3 must be in service, and BSY 230 kV bus voltage must be less than 243 kV. If post-contingency voltage at ING 230 kV bus or MDN 230 kV bus exceeds 243 kV upon loss of 5L51 and 5L52, the BCHCC Operator should increase Mvar absorption from BSY to reduce the ING 230 kV and MDN 230 kV voltages below 243 kV within 15 minutes.

8.3.3.9 DMR SVC in automatic control mode with automatic control of DMR 500 kV reactor switching enabled must be in service.

8.3.3.10 500 kV Reactor Exceptions

All 500 kV shunt reactors (VAS 5RX1 excluded) must be available or energized with the following exceptions:

Note: *The exceptions in this section are valid regardless of 5L83 in or out of service status unless specifically stated or results in line combinations that causes an ING-CUS restriction lower than 2000 MW as per rules in Section 8.3.3.3.*

Note: *Under circuit group element combinations that allow for ING-CUS transfers greater than 2000 MW as per rules in Section 8.3.3.3.*

- The line reactor (or reactors) associated with the OOS line (or lines) may be unavailable or de-energized, or
- If a line reactor at one end of the OOS line is available or energized, one of the 500kV reactors at the same substation may be unavailable or de-energized, or
- If both line reactors at both ends of the OOS line are available or energized, two of the reactors (one at each line end substation) may be unavailable or de-energized.
- Additional exceptions may apply for certain circuits as described in the following exemption rules:

Note: *If 5L83 in service **AND** 5L83 DTT is armed according to conditions described in Section 4.2, **then***

- NIC 5RX8 may be de-energized

8.3.3.10.1 System Normal (All 500 kV circuits are in service) or 5L4 or 5L30 or 5L32 or 5L45 or 5L75 or 5L77 or 5L76 or 5L79 OOS Reactor Exceptions

If ING 12RX4, 12RX5, 2RX1, 2RX2 are available, **then**
One of the following A-M conditions are permitted:

A. CKY 5RX1 may be de-energized, **OR**
B. One of (MSA 5RX1 or 5RX2) may be de-energized if 5L30 and 5L32 and MSA 12RX1 and 12RX2 are in service or energized, **OR**
C. One of (MSA 5RX1 or 5RX2) may be de-energized if 5L30 or 5L32 is O.O.S., **OR**
D. One of (TIR 5RX1/2/3 or 5RX11/12/13 or 5RX21/22/23 or 5RX4/5/6 or 5RX14/15/16 or 5RX24/25/26) may be de-energized, **OR**

E. One of (DMR 5RX1 or 5RX2 or 5RX3 or 5RX4 or 5RX5 or 5RX6 or 5RX7 or 5RX8) may be unavailable, **OR**

F. If all of (KLY SC2 with AVR, KLY 12RX1, KLY 2RX2) are available, **then** two or less of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) may be unavailable or de-energized, **OR**
If two of (KLY SC2 with AVR, KLY 12RX1, KLY 2RX2) are available, then one of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) may be unavailable or de-energized, **OR**

G. Two or less of (NIC 5RX3 or 5RX4 or 5RX8 or 5RX9 or 5RX10 or 5RX11) may be unavailable or de-energized, **OR**

H. One of (GMS 5RX1, GMS 5RX2, PCN 5RX1) may be de-energized if the generator terminal voltage of each of GMS and PCN units is maintained under 14.1 kV, **OR**

I. One of WSN (5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6, 5RX7) may be unavailable or de-energized if all of WSN (12RX1, 12RX2, 2RX10) are available or energized and the generator terminal voltage of each of GMS and PCN units is maintained under 14.0 kV, **OR**

J. One of WSN (5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6, 5RX7) may be unavailable or de-energized if two of WSN (12RX1, 12RX2, 2RX10) are available or energized and the generator terminal voltage of each of GMS and PCN units is maintained under 13.9 kV, **OR**

K. One of ACK (5RX4, 5RX7, 5RX8) may be unavailable if the generator terminal voltage of each of REV units is maintained under 16.0 kV, **OR**

L. One of (SEL 5RX2 or 5RX3) may be unavailable or de-energized, **OR**

M. One of (MCA 5RX3 or 5RX4) may be de-energized if the generator terminal voltage of each of MCA units is maintained under 16.5 kV.

8.3.3.10.2 Reactor Exceptions for Other Lower Mainland and VI Conditions

A. If 5L29 is OOS, **then**

- One of Item F, H, I, J, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in Peace and SI areas, and KLY Substation).

B. If 5L31 is OOS, **then**

- One of Item F, H, I, J, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in Peace and SI areas, and KLY Substation).

8.3.3.10.3 Reactor Exceptions for Other Conditions in North Coast and Peace Areas

A. If 5L61 OOS, **then**

- One of WSN (5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6, 5RX7) and/or GLN 5RX5 and/or TKW 5RX1 may be unavailable or de-energized,

OR

- One of Item A, B, D, E, F, G, H, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, and SI areas, and KLY, NIC, GMS, PCN Substations) and/or GLN 5RX5 and/or TKW 5RX1 may be de-energized.

B. If 5L62 OOS, **then**
- GLN 5RX5 and/or TKW 5RX1 may be de-energized, **AND/OR**
- One of Item A, B, D, E, F, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, SI areas, and KLY Substation)

C. If 5L63 OOS, **then**
- TKW 5RX1 may be de-energized, **AND/OR**
- One of Item A, B, D, E, F, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, and SI areas, and KLY Substation)

D. If one of 5L1 or 5L2 is OOS, **then**
- One of (GMS 5RX1, GMS 5RX2, PCN 5RX1) may be de-energized, **AND/OR**
- One of Item A, B, D, E, F, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, SI areas, and KLY Substation)

E. If 5L3 is OOS, **then**
- One of (GMS 5RX1, GMS 5RX2, PCN 5RX1) may be de-energized, **AND/OR**
  One of Item A, B, D, E, F, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, SI areas, and KLY Substation)

F. If 5L7 is OOS, **then**
- One of Item A, B, D, E, F, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, SI areas, and KLY Substation)

G. If one of 5L11 or 5L12 or 5L13 is OOS, **then**
- One of Item A, B, D, E, F, K, L or M in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, SI areas, and KLY Substation)

8.3.3.10.4 Reactor Exceptions for Other Conditions in South Interior

A. If 5L91 is OOS, **then**
- One of (SEL 5RX3, ACK (5RX4, 5RX7, 5RX8)) may be unavailable, **AND/OR**
- One of Item A, B, D, E, F, H, I, or J in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, Peace areas and KLY Substation).

B. If 5L92 or 5L94 OOS, **then**
- One of (SEL 5RX2 or 5RX3) may be unavailable or de-energized.

AND/OR

- One of Item A, B, D, E, F, H, I, or J in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, Peace areas and KLY Substation)

C. If 5L96 is OOS, **then**
- SEL 5RX2 and SEL 5RX3 may be unavailable or de-energized**, AND/OR**
- One of Item A, B, D, E, F, H, I, or J in Section 8.3.3.10.1 (for the reactor exceptions in LM, VI, Peace areas and KLY Substation).

D. If 5L98 is OOS, **AND**
If ING 12RX4, 12RX5, 2RX1, 2RX2 are available, **then**
- Two or less of (NIC (5RX3, 5RX4, 5RX8, 5RX9, 5RX10, 5RX11) and ACK (5RX4, 5RX7, 5RX8)) may be unavailable or de-energized, **OR**
- One of Item F, H, I or J in Section 8.3.3.10.1 (for the reactor exceptions in KLY Substation and Peace area).

E. If (5L96&5L98) OOS, **then**
- SEL 5RX2 and SEL 5RX3 may be unavailable or de-energized, **AND**
- If ING 12RX4, 12RX5, 2RX1, 2RX2 are available, **then**
  - Two or less of the NIC (5RX3 or 5RX4 or 5RX8 or 5RX9 or 5RX10 or 5RX11) may be unavailable or de-energized, **OR**
  - One Item F, H, I or J in Section 8.3.3.10.1 (for the reactor exceptions in KLY Substation and Peace area).

F. If (5L94&5L96) OOS, **then**
- SEL 5RX2 and SEL 5RX3 may be unavailable or de-energized, **AND**
- One of ACK (5RX4, 5RX7, 5RX8) may be unavailable

AND/OR

- One of Item F, H, I or J in Section 8.3.3.10.1 (for the reactor exceptions in KLY Substation and Peace area).

G. If 5L71 OOS **AND** any SYA 5CX2 status, or (5L71&5L75) OOS, or (5L71&5L77) OOS, **then**
- One of (SEL 5RX2 or 5RX3) may be unavailable or de-energized, **AND**
- One of ACK (5RX4, 5RX7, 5RX8) may be unavailable.

AND/OR

- One of Item F, H, I or J in Section 8.3.3.10.1 (for the reactor exceptions in KLY Substation and Peace area).

H. If 5L72 OOS **AND** any SYA 5CX1 status, or (5L72&5L75) OOS, or (5L72&5L77) OOS, **then**

- One of (SEL 5RX2 or 5RX3) may be unavailable de-energized, **AND**
- One of ACK (5RX4, 5RX7, 5RX8) may be unavailable.

AND/OR

- One of Item F, H, I or J in Section 8.3.3.10.1 (for the reactor exceptions in KLY Substation and Peace area).

8.3.4 General Operating Guidelines and Restrictions

Refer to the corresponding tables of Attachment 1 in SOO 7T-34 for the operating guidelines and restrictions.

System operating considerations affecting and affected by 2L112 operation are covered in System Operating Orders 7T-17, 7T-33 and 7T-34.

8.3.5 (5L83 AND 5L87 AND 5L71 OOS) or (5L83 AND 5L87 and 5L72 OOS)

Refer to Section 7.0 of SOO 7T-34 and Table 2.18 in Attachment 1 of SOO 7T-34 for operating guidelines and restrictions.

8.3.6 NTL Tie O.O.S.

This topology has no impact on transfer capability on the BC-US Interconnection.

8.3.7 5L44 Contingency

Refer to each table of Attachment 1 in SOO 7T-34 for pre-outage restrictions in the Lower Mainland. These restrictions are required under certain ING to CUS or CUS to ING transfer levels to prevent overloading 60L15 upon loss of 5L44 and the subsequent tripping of 2L22 by its overload protection.

8.3.8 5L71 and 5L72 O.O.S. (Any Status of FBC's VAS-WTS and VAS-VNT Loops)

Pre-Outage Restrictions:
At least 5 of NIC (5RX3, 5RX4, 5RX8, 5RX9, 5RX10, 5RX11) are energized.

8.3.9 5L83 AND 5L71 and 5L72 O.O.S. (Any Status of FBC's VAS-WTS and VAS-VNT Loops)

Pre-Outage Restrictions:
At least 4 of NIC (5RX3, 5RX4, 5RX8, 5RX9, 5RX10, 5RX11) are energized.

8.3.10 MCA restrictions

The generator terminal voltage of each of MCA units shall be maintained under 16.6 kV if gen-shedding is armed at MCA for loss of "5L51 AND 5L52", or loss of 5L51 (or 5L52) with 5L52 (or 5L51) O.O.S. This requirement is applicable to all system configurations with all of 5L40, 5L41, 5L42, 5L44, 5L71, 5L72, 5L76, 5L79, 5L81, 5L82, 5L87 and 5L98 in service and BCH load is less than 7000 MW.

8.4 BC to US Transfer Limits (Export from BCH System)

This section provides Path 3 North-South transfer limits for different system topologies. The path capability is a function of West side transfer (Ingledow to Custer) and East side transfer (Nelway to Boundary) where the Total Transfer Capability cannot exceed 3150 MW (Path Rating) or System Operating Limits noted in this section.

- For both BC Hydro and BPA, the System Operating limit (SOL) is normally greater than 3150 MW, unless otherwise noted in this section. BPA may also advise of a SOL lower than 3150 MW in real time to address stability limitations in their system.

- The recommend TTC's in Table A1 and A2 are intended to address worst case operating conditions and to aid in managing other internal (non-path) operating constraints (thermal, voltage or stability), and are not SOLs for the path itself.

- These recommended TTC can be superseded by recommendations in Operating Plans (see Section 1). Operating Plan recommendations for TTC must also respect SOLs.

- The recommended TTC's can be raised or lowered by Operators when Real Time Assessments confirm additional transfer capabilities exist, while respecting SOL 's pre and post contingency.

- Operators will determine SOLs in real time, confirming with BPA for their SOL (if any), and TTC will be set in real time to respect the SOLs.

- Operators will convey changes for the BC Hydro SOL to the Reliability Coordinator (RC).

The topologies defined in Tables A1 and A2 are for export cases, and are distinguished by system normal and elements out of service (Table A1), or 5L83 OOS with other elements also out of service (Table A2). The limits described in these tables are conditional to the "System Requirements for BC Exporting to US" in Section 8.3. The following notes are to be used where referenced in Table A1 and A2:

Note 1: Arm ECS RAS per Section 5.2.

Note 2: Internal path Voltage Stability constraints for ILM are only accurate if the actual ILM flows approach the VSAT predicted limit for ILM. VSAT ILM limits should only supersede other recommended limitations as actual export flow approaches the limit, Operators need to validate that the limit is accurate, for example, when exporting on BC-US and either ILM Flow > 6000 MW (on EMS System Overview), or BC Hydro customer current day load forecast > 8000 MW (see SOO 6T-34).

If the actual transfer exceeds VSAT Limit for ILM for the ILM internal path example, the BCHCC Operator should adjust the generation and/or schedule to reduce the transfer to within the limit in 30 minutes. Among the remedial actions Operators can undertake are:

- Increase generation shedding for the limiting contingency.
- Redispatch Generation.
- Adjust ARN-VIT flow on VIT PST1.
- Increase NLY PST1 flow to BDY, to offload Path 3 west side.
- Switch in any remaining VAR support (including S/C on line in boost).
- Cut Path 3 TTC, and curtail Path 3 schedule export flows.
- See SOO 7T-01 Section 7.3 for general guidance and recommendations.

Note 3: Limiting factor is to avoid the total armed gen-shedding exceeding 2500 MW for loss of 5L81. This limit can be raised with removal of AMC 5CX1 (bypassing the bank), which decreases flow on 5L81, reducing the generation shedding requirement. Operators can revise the transfer limit using real time studies provided the 2500 MW shedding limit is respected.

Note 4: Limiting factor is overload of 5L44. Transfer from VIT to ARN reduces the overload, and will increase the transfer limit above 1950 MW.

Note 5: Limiting factor is overload of 2L51. If higher ING-CUS transfer is required, 5L83 can be switched off and the ING-CUS transfer can be increased to a maximum of 1700 MW. If Real Time Contingency Analysis (RTCA) does not indicate a thermal limit violation for next contingency, the transfer limit can be increased above 800 MW using real time study results.

Note 6: Limiting factors are overloads on 2L90 or 5L41.

Note 7: Removed.

Table A1 - ING to CUS Transfer Limits for System Normal, N-1 or N-2 system status

Note: The TTC should be set to the lesser of Table A1 or BPA's recommended TTC.

No.	System Status	Recommended ING to CUS TTC (MW) (Note 2)	Recommended BC to US TTC (MW)	Remarks
1	System Normal, or 5L45 O.O.S., or 5L76 O.O.S., or 5L79 O.O.S., or 5L82 O.O.S., or 5L83 O.O.S., or	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1, Section 8.3.2, Section 8.3.3, Section 8.3.4
2.	5L91 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 7, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
3.	5L92 O.O.S., or 5L94 O.O.S., or 5L96 O.O.S., or 5L98 O.O.S., or 5L96 & 5L98 O.O.S., or 5L94 AND 5L96 O.O.S.	The least of: 1) 2850*, or 2) Attachment 2, or 3) Attachment 3, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
4.	5L51 O.O.S., or 5L52 O.O.S.	The least of: 1) Attachment 2, or 2) Attachment 3, or 3) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3
5.	5L40 O.O.S., or 5L41 O.O.S.	The least of: 1) 2400*, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Note 3, Section 8.3.1 Section 8.3.2 Section 8.3.4
6.	5L81 O.O.S.	The least of: 1) 1950 – 0.28 × 2L129ARN, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Note 4, Section 8.3.1 Section 8.3.2 Section 8.3.4
7.	5L44 O.O.S.	The least of: 1) 800, or 3) Attachment 2, or 4) Attachment 3, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Note 5, Section 8.3.1 Section 8.3.2 Section 8.3.4
8.	5L42 O.O.S.	The least of: 1) 2300*, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Note 6, Section 8.3.1 Section 8.3.2
9.	5L87 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2
10.	2L112 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 5, or	The lesser of: 1) ING to CUS limit	Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
11.	2L293 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 6, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
12.	5L71 O.O.S., or 5L72 O.O.S., or 5L71 AND SYA 5CX2 O.O.S., or 5L72 AND SYA 5CX1 O.O.S. 5L75 O.O.S., or 5L77 O.O.S., or 5L71 AND 5L75 O.O.S., or 5L71 AND 5L77 O.O.S., or 5L72 AND 5L75 O.O.S., or 5L72 AND 5L77 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
13.	5L71 AND 5L72 O.O.S.	The least of: 1) 2000, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.4 Section 8.3.8

Table A2 - ING to CUS Transfer Limits for 5L83 AND Other Line/Equipment O.O.S

Note: The TTC should be set to the lesser of Table A2 or BPA's recommended TTC.

No.	System Status	Recommended ING to CUS TTC (MW) (Note2)	Recommended BC to US TTC(MW)	Remarks
1	5L83 AND 5L76 O.O.S., or 5L83 AND 5L79 O.O.S., or	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
2	5L83 AND 5L91 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 7, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
3	5L83 AND 5L92 O.O.S., or 5L83 AND 5L94 O.O.S., or 5L83 AND 5L96 O.O.S., or 5L83 AND 5L98 O.O.S., or 5L83 AND 5L96 & 5L98 O.O.S., or 5L83 AND 5L94 AND 5L96 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
4	5L83 AND 5L51 O.O.S., or 5L83 AND 5L52 O.O.S.	The least of: 1) Attachment 2, or 2) Attachment 3, or 3) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3
5	5L83 AND 5L40 O.O.S., or 5L83 AND 5L41 O.O.S., or 5L83 AND 5L44 O.O.S., or 5L83 AND 5L81 O.O.S., or 5L83 AND 5L82 O.O.S.	The least of: 1) 1700, or 2) Attachment 2, or 3) Attachment 3, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.4
6	5L83 AND 5L42 O.O.S.	The least of: 1) 1300, or 2) Attachment 2, or 3) Attachment 3, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2
7	5L83 AND 5L87 AND (5L71 or 5L72) O.O.S.	The least of: 1) 2000, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.5
8	5L83 AND 2L112 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 5, or	The lesser of: 1) ING to CUS limit	Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
9	5L83 AND 2L293 O.O.S.	The least of: 1) 2850, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 6, or	The least of: 1) 3150, or 2) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
10	5L83 AND 5L71 O.O.S., or 5L83 AND 5L72 O.O.S., or 5L83 AND 5L71 AND SYA 5CX2 O.O.S., or 5L83 AND 5L72 AND SYA 5CX1 O.O.S., or 5L83 AND 5L75 O.O.S., or 5L83 AND 5L77 O.O.S., or 5L83 AND 5L71 AND 5L75 O.O.S., or 5L83 AND 5L71 AND 5L77 O.O.S., or 5L83 AND 5L72 AND 5L75 O.O.S., or 5L83 AND 5L72 AND 5L77 O.O.S.	The least of: 1) 2400, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
13	5L83 AND 5L71 AND 5L72 O.O.S.	The least of: 1) 2000, or 2) Attachment 2, or 3) Attachment 3, or 4) Attachment 4, or	The lesser of: 1) ING to CUS limit + 400	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.4 Section 8.3.9

8.5 System Requirements for BC Importing from US

8.5.1 5L51 or 5L52 Thermal Limit versus Ambient Temperature at Ingledow

The Amp rating of 5L51 or 5L52, in Attachment 1, is based on clearance requirements within BCH Engineering Standard 41K, the enforcement of right-of-way usage by BCH, and the rating of ING DS (3000 A). For details of the MW rating refer to Attachment 2.

Attachment 2 shows the CUS to ING transfer limits for all system conditions. The transfer limit is to prevent the post-outage loading on 5L51 or 5L52 from exceeding its thermal limit for any Peace, LM, or SI contingencies.

Attachments 1 and 2 are implemented in TSA-PM.

If the CUS to ING transfer limit has been exceeded, TSA-PM will give an alarm to indicate the dominant factor which causes the violation. The BCHCC Operator should reduce the transfer below the limit.

8.5.2 (5L83 AND 5L87 AND 5L71 OOS) or (5L83 AND 5L87 AND 5L72 OOS)

Refer to Section 7.0 of SOO 7T-34 and Table 2.18 in Attachment 1 of SOO 7T-34 for the operating guidelines and restrictions.

8.5.3 Removed.

8.5.4 Operating Guidelines and Restrictions

Refer to the corresponding tables of Attachment 1 in SOO 7T-34 for the operating guidelines and restrictions.

System operating considerations affecting and affected by 2L112 operation are covered in SOO's 7T-17, 7T-33 and 7T-34.

DO NOT schedule 5L51 or 5L52 maintenance outage during high imports from US.

- Without 5L51 or 5L52 in service, after generation shedding due to the worst Peace, LM or SI contingency, about 70% to 90% of the shed generation would flow on the ING-CUS circuit. The CUS-ING transfer limit takes into consideration that this additional MW flow will not overload the single ING-CUS circuit for the worst contingency (see 5.8.1)
- Without 5L51 or 5L52 in service, when conditions arise that put the remaining in service circuit at risk, the post contingency load shedding may be avoided by adding further rotation energy on-line (exceeding requirements in SOO 7T-64). If an outage must be scheduled, consider conditions and identify recall plans to avoid or reduce system and generation impacts.

8.5.5 5L71 or 5L72 O.O.S with One MCA Unit On-Line

Operations with one of 5L71 or 5L72 OOS and only one MCA generating unit are no longer supported, as studies with the Seymour Arm Capacitor station (SYA) in service has not been undertaken. There are no plans to operate with one line–one unit configuration for future.

In the event of a forced outage leading to a one line one unit condition, a second unit must be resynchronized immediately. If it is not possible to operate with 2 units in service, the plant/unit must be islanded (by opening the remaining 500 kV line). This requirement prevents self-excitation risks to the one unit that remains on line.

8.6 US-BC Transfer Limits (Import into BCH System)

This section provides Path 3 South-North recommended TTC for BC Hydro system topologies. The path capability is a function of West side transfer (Custer to Ingledow) and East side transfer (Boundary to Nelway) where the Total Transfer Capability cannot exceed 3000 MW (Path Rating) or topology driven System Operating Limits when noted in this section.

- For BC Hydro, the SOL normally exceeds the path rating of 3000 MW for South-North transfers.
  .
- For BPA, South-North transfer is normally limited by transient stability in the BPA system that is a function of the path transfers. BPA will establish the SOL in real time operation and convey this to the BC Hydro Operator. Operators can expect the SOL to be 2500 MW or lower as determined by BPA.

- The recommend TTC's in Table A1 and A2 are intended to address worst case operating conditions and to aid in managing other internal (non-path) operating constraints (thermal, voltage or stability, and is not a SOL for the path itself).

- These recommended TTC can be superseded by recommendations in Operating Plans (see Section 1). Operating Plan recommendations for TTC must also respect SOLs.

- The recommended TTC's can be raised or lowered by Operators when Real Time Assessments confirm additional transfer capabilities exist, while respecting SOL's pre and post contingency.

- Operators will determine SOLs in real time, confirming with BPA for their SOL, and TTC will be set in real time to respect the SOLs.

- Operators will convey changes for the BC Hydro SOL to the Reliability Coordinator (RC).

As a result of the agreement with BPA, BC Hydro's TSA-PM, operating tools and procedures will observe a recommended TTC not to exceed 2500 MW (South to North). This operating practice of capping the transfer capability simplifies planning and prescheduling for the path.

The topologies defined in Tables B1 and B2 are for import cases, and are distinguished by system normal and elements out of service (Table B1), or 5L83 OOS with other elements also out of service (Table B2). The following notes are to be used where referenced in Table B1 and B2:

Note 1: Arm ECS RAS per Section 5.2.

Note 2: Arm AB TIE RAS per Section 6.2.

Note 3: Pre-Outage Restrictions for 5L51 or 5L52 contingency:
Alarm
if ING 5MB1 is energized and its voltage < 531 kV, or
if ING 5MB2 is energized and its voltage < 531 kV
AND
CUS to ING transfer > 2600 MW

If the alarm comes, the BC Hydro Control Centre staff must put more Var resources on-line at ING and/or MDN to support voltage to prevent overload of 5L51 or 5L52 for system contingencies, such as switching off shunt reactors and switching in shunt capacitors at ING and MDN, and/or putting more BSY SC units online.

Table B1 – CUS to ING Transfer Limits for System Normal, N-1 or N-2 system status

Note: The TTC should be set to the lesser of Table B1 or BPA's recommended TTC.

No.	System Status	Recommended CUS to ING TTC (MW)	Recommended US to BC TTC (MW)	Remarks
1.	System Normal, or 5L75 O.O.S., or 5L76 O.O.S, or 5L77 O.O.S., or 5L79 O.O.S., or 5L91 O.O.S., or 5L92 O.O.S., or 5L94 O.O.S., or 5L96 O.O.S., or 5L98 O.O.S., or 5L71 AND 5L72 O.O.S., or 5L96 AND 5L98 O.O.S., or 5L94 AND 5L96 O.O.S., or 2L293 O.O.S	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1
2.	5L51 O.O.S., or 5L52 O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1
3.	5L40 O.O.S., or 5L41 O.O.S., or 5L42 O.O.S., or 5L45 O.O.S., or 5L81 O.O.S., or 5L82 O.O.S., or 5L83 O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1 Section 8.5.4
4.	5L44 O.O.S.	The least of: 1) 2750, or 2) 2050 + 2.0 × 2L129 ARN (May 1-Oct. 31), or 3) 2650 + 2.0 × 2L129 ARN (Nov. 1–Apr. 30), or 4) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1 Section 8.5.4
5.	5L87 O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1
6.	2L112 O.O.S.	The least of: 1) 2650, or 2) Attachment 2	The least of: 1) 2650, or 2) CUS to ING limit	Note 2 Note 3 Section 8.5.1
7.	5L71 O.O.S., or 5L72 O.O.S., or 5L71 AND SYA 5CX2 O.O.S., or 5L72 AND SYA 5CX1 O.O.S., or 5L71 AND 5L75 O.O.S., or 5L71 AND 5L77 O.O.S., or 5L72 AND 5L75 O.O.S., or 5L72 AND 5L77 O.O.S.	The least of: 1) 2750, or 2) Attachment 2*	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1 Section 8.5.5

Table B2 – CUS to ING Transfer Limits for 5L83 AND Other Line/Equipment O.O.S

Note: The TTC should be set to the lesser of Table B2 or BPA's recommended TTC.

No.	System Status	Recommended CUS to ING TTC (MW)	Recommended US to BC TTC (MW)	Remarks
1.	5L83 AND 5L75 O.O.S., or 5L83 AND 5L77 O.O.S, or 5L83 AND 5L76 O.O.S., or 5L83 AND 5L79 O.O.S., or 5L83 AND 5L91 O.O.S., or 5L83 AND 5L92 O.O.S., or 5L83 AND 5L94 O.O.S., or 5L83 AND 5L96 O.O.S., or 5L83 AND 5L98 O.O.S., or 5L83 AND 5L71 AND 5L72 O.O.S., or 5L83 AND 5L96 AND 5L98 O.O.S., or 5L83 AND 5L94 AND 5L96 O.O.S., or 5L83 AND 2L293 O.O.S	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1
2.	5L83 AND 5L51 O.O.S., or 5L83 AND 5L52 O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1
3.	5L83 AND 5L40 O.O.S., or 5L83 AND 5L41 O.O.S., or 5L83 AND 5L42 O.O.S., or 5L83 AND 5L81 O.O.S., or 5L83 AND 5L82 O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1 Section 8.5.4
4.	5L83 AND 5L44 O.O.S.	The least of: 1) 1500, or 2) Attachment 2	The least of: 1) 1900, or 2) CUS to ING limit + 400	Note 1 Note 2 Section 8.5.1 Section 8.5.4
5.	5L83 AND 5L87 AND (5L71 or 5L72) O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1 Section 8.5.2
6.	5L83 AND 2L112 O.O.S.	The least of: 1) 2650, or 2) Attachment 2	The least of: 1) 2650, or 2) CUS to ING limit + 400	Note 2 Note 3 Section 8.5.1
7.	5L83 AND 5L71 O.O.S., or 5L83 AND 5L72 O.O.S., or 5L83 AND 5L71 AND SYA 5CX2 O.O.S., or 5L83 AND 5L72 AND SYA 5CX1 O.O.S., or 5L83 AND 5L71 AND 5L75 O.O.S., or 5L83 AND 5L71 AND 5L77 O.O.S., or 5L83 AND 5L72 AND 5L75 O.O.S., or 5L83 AND 5L72 AND 5L77 O.O.S.	The least of: 1) 2750, or 2) Attachment 2	The least of: 1) 3000, or 2) CUS to ING limit + 400	Note 1 Note 2 Note 3 Section 8.5.1 Section 8.5.5

9.0 GENERATOR SHEDDING

9.1 Initiation

When power flow is North to South on Path 3, any one of the following contingencies can initiate generator shedding and AGC suspension in the BCH system:

(a) Loss of both 5L51 AND 5L52.
(b) Loss of 5L51 OR 5L52.
(c) Loss of any Pacific Northwest circuits (BPA/NW RAS initiation) as follows:
- Both Custer - Monroe #1 and #2 500 kV circuits
- Monroe - Echo Lake 500 kV circuit
- Raver - Echo Lake and Echo Lake-Maple Valley 500 kV circuits due to breaker failure at Echo Lake
- Raver - Paul 500 kV circuit
- Paul - Allston #1 and #2 500 kV circuits
- Allston - Keeler 500 kV circuit
- Sedro - Horse Ranch - Bothell 230 kV circuit

(d) Loss of an element(s) of Path 66 - 500 kV Pacific AC Intertie (BPA/PACI RAS initiation).

TSA-PM automatically calculates and recommends generator-shedding requirement in the BCH Balancing Authority (BA) area, for contingencies in (a), (b) and (c),

The BPA dispatcher will call to advise generator-shedding requirement for contingencies in (d).

Note: Generator shedding facilities for the contingencies in (c) and (d) are labeled differently in BPA and at BCH, as follows:

Contingency	BPA Label	BCH EMS Label	BCH Generating Stations and ING Substation Label
(c)	Gen drop to BCH ckt 2	BPA/NW (cct #2)	BPA WS RAS Level 2
(d)	Gen drop to BCH ckt 1	BPA/PACI (cct #1)	BPA AC RAS Level 1

The routing of the generation shedding signals is as follows:

Contingency	Generator Shedding Signal
(a),(b)	Two independent redundant signals (one primary and one standby)
(c)	Two independent redundant signals from BPA. One signal from Dittmer (WS-A RAS controller) via ING. Another signal from Monroe (WS-B RAS controller) via KCL.
(d)	Two independent redundant signals from BPA. One signal from Dittmer (AC-A RAS controller). Another signal from Monroe (AC-B RAS controller). Both signals go directly to GMS, MCA and REV.

9.2 Allocation

The generation plants available for shedding for each of the contingencies listed in Section 9.1 are specified in Sections 9.3 to 9.7 respectively. Allocation of generator shedding between the available generation plants is left to the BCH Transmission Coordinator's discretion.

Some considerations regarding generator shedding are:

- Shedding base loaded units rather than AGC controlled units will require fewer changes to shedding.
- At high export levels, splitting shedding between the available generation plants should reduce voltage problems and improve restoration time.
- If manual generation shedding is required at MCA, select the MCA unit(s) above 435 MW for shedding first.
- If generation shedding is armed at PCN for any contingencies in SOO 7T-18, the general requirements in Section 5.5.2 in SOO 7T-13 shall be followed.
- WAN G4 shall not participate in any generation shedding requirement.

After generation shedding for the loss of 5L51 and 5L52 or the BPA outages, a minimum of the following generator units should remain on-line to control post-disturbance voltages:

- 2 MCA units if MCA gen-shedding is armed, AND
- 2 REV units if REV gen-shedding is armed, AND
- At SEV/KCL/ALH/BRX/WAN if gen-shedding is armed at SEV and/or ALH and/or BRX and/or WAN:
  - If SEL 5RX3 is available:
    - If KCL is not shut down: 1 KCL unit and 2 equivalent SEV units AND 1 WAN unit; OR
    - If KCL is shut down: 2 and 2/3 equivalent SEV units and 1 WAN unit.

  OR
  - If SEL 5RX3 is unavailable
    - If KCL is not shut down: 1 KCL unit, 3 equivalent SEV units, and 1 WAN unit; OR
    - If KCL is shut down: 3 and 2/3 equivalent SEV units and 1 WAN unit

AND

- At GMS and PCN if GMS and/or PCN gen-shedding are armed:
  - 4 GMS and 3 PCN units, OR
  - 5 GMS and 2 PCN units, OR
  - 6 GMS and 1 PCN units only if 5L4 is in service, OR
  - 7 GMS and 0 PCN units.

(Note: 1 KCL unit = 2/3 equivalent SEV unit
1 ALH unit = 1/3 equivalent SEV unit
1 WAX unit = 1 equivalent SEV unit
1 WAN unit = 1/3 equivalent SEV unit
1 BRX unit = 1/3 equivalent SEV unit)

Breaker failure protections on Waneta G1, G2, G3 and G4 have been commissioned and put into service (refer to Section 4.3 of SOO 7T-34 for details). There is no requirement to shed one extra WAN unit, to cover historical WAN circuit breaker failure risks.

9.3 Shedding for: Loss of "5L51 AND 5L52", or Loss of 5L51 (or 5L52) with 5L52 (or 5L51) O.O.S.

- Shedding generation at MCA, REV, KCL, SEV, ALH, BRX, WAN and WAX first, then at GMS and PCN.
- Maximum generation shedding must not exceed 3450 MW.

9.3.1 All system conditions except 2L112 O.O.S., or 5L92 O.O.S., or 5L94 O.O.S., or (5L94 AND 5L96) O.O.S.:

If BC to US transfer > 400 MW, then
Gen shed = 1.1 * (5L51 ING + 5L52 ING + 2L112 NLY) + *Y* - 1000
Y = 0 if AB to BC >= 0 MW, or
Y = (BC to AB transfer) if BC to AB > 0 MW.

9.3.2 2L112 O.O.S.:

Gen shed = 1.1 * (5L51 ING + 5L52 ING) + *Y* - 1000
Y = 0 if AB to BC >= 0 MW, or
Y = (BC to AB transfer) if BC to AB > 0 MW.

9.3.3 5L92 O.O.S.:

IF BC to US transfer > 400 MW **AND** AB to BC >= 0 MW **THEN**

Gen shed = 1.1 * (5L51 ING + 5L52 ING + 2L112 NLY) – (AB to BC transfer) - 200

IF BC to US transfer > 400 MW, **AND** BC to AB >= 0 MW **THEN**

Gen shed = 1.1 * (5L51 ING + 5L52 ING + 2L112 NLY)

9.3.4 5L94 O.O.S. or 5L94 AND 5L96 O.O.S.:

IF Abs (5L51 ING + 5L52 ING + 2L112 NLY) > 400 MW, THEN
- Arm DTT 1L274 and DTT 1L275 except for the RAS blocking conditions specified in Section 9.3 of SOO 7T-17
- Gen shed = 1.1 * (5L51 ING + 5L52 ING + 2L112 NLY) + (BC_AB) – 400 MW

9.4 Shedding For Loss of 5L51 With Both 5L51 AND 5L52 In Service

(Shedding available at GMS, PCN, MCA and REV)

Generation shedding for loss of 5L51 = 1.34 x (ING to CUS transfer – *B1*)
Where, *B1* = 5L51or5L52_30Minute_MW_Rating_EX (see Attachment 1 for the 30-minute MW rating).

The generation shedding is to prevent the flow on the remaining parallel circuit (5L52) from exceeding its ambient temperature-dependent MW rating. If the 5L51 circuit cannot be returned to service immediately, reduce the Ingledow to Custer transfer as in Section 8.4.

9.5 Shedding For Loss of 5L52 With Both 5L51 AND 5L52 In Service

(Shedding available at GMS, PCN, MCA and REV)

Generation shedding for loss of 5L52 = 1.27 x (ING to CUS transfer – *B1*)
Where, *B1* = 5L51or5L52_30Minute_MW_Rating_EX (see Attachment 1 for the 30-minute MW rating).

The generation shedding is to prevent the flow on the remaining parallel circuit (5L51) from

exceeding its ambient temperature-dependent MW rating. If the 5L52 circuit cannot be returned to service immediately, reduce the Ingledow to Custer transfer as in Section 8.4.

9.6 Shedding for Loss of Pacific Northwest Circuits (BPA/NW RAS)

BCH calls this RAS the "BPA/NW RAS". BPA calls this the "Gen Drop to BCH Circuit 2" RAS, and is labeled as BPA Westside RAS in SOO 2T-34 Appendix 2.
Shedding for this RAS is available at GMS, PCN, MCA, REV, KCL and SEV**.**

Normally, when the ING to CUS transfer is higher than 800 MW, BC Hydro will shed generation and suspend AGC for the following contingencies in the Northwest:

- Loss of Custer - Monroe #1 and #2 500 kV circuits
- Loss of Monroe - Echo Lake 500 kV circuit
- Loss of Raver - Echo Lake 500 kV and Echo Lake-Maple Valley 500 kV circuits
- Loss of Raver - Paul 500 kV circuit
- Loss of Paul - Allston #1 and #2 500 kV circuits
- Loss of Allston - Keeler 500 kV circuit
- Loss of Sedro - Horse Ranch - Bothell 230 kV circuit

The arming level for transfer greater than 800 MW is called the "BPA Normal" or "800 MW" Arming Level in BPA's terminology. The TSA-PM determines the amount of BC Hydro shedding using the following formula:

Ingledow to Custer Actual Transfer (MW)	Shedding Requirement at "800 MW Arming Level" of BPA/NW RAS for Northwest Contingencies in Section 9.6
-2750 to +800	None
+801 to +2850	GS0 = 1.5 x (ING to CUS transfer – 800). Maximum of 1850 MW shed If 5L94 RAS is armed, then • The gen-shed shall be: GS = GS0 - (AB - BC) Transfer Otherwise, • The gen-shed is: GS = GS0

At times, BPA will require BC Hydro generation shedding and AGC suspension when the ING to CUS transfer exceeds only 100 MW for the same contingencies. This is called the "BPA Outage" or "100 MW" Arming Level. The TSA-PM determines the amount of BC Hydro generation using the following formula:

Ingledow to Custer Actual Transfer (MW)	Shedding Requirement at "100 MW Arming Level" of BPA/NW RAS for Northwest Contingencies in Section 9.6
-2750 to +100	None
+101 to +2850	GS0 = 0.95 x (ING to CUS transfer – 100). Maximum of 1850 MW shed If 5L94 RAS is armed, then • The gen-shed shall be: GS = GS0 - (AB - BC) Transfer Otherwise, • The gen-shed is: GS = GS0

Notes

1. Do not undershed.
2. The requirement is to shed up to 1850 MW per the formula. The actual amount of generation armed for shedding, whether determined by TSA-PM or manually, may be slightly higher than the requirement depending on the loading of generators available for shedding.
3. For the arming conditions for 5L94 RAS, refer to Section 6.3.

The BCH Transmission Coordinator can select the "800 MW" Arming Level or "100 MW" Arming Level by toggling a switch on the EMS Generation Shedding Overview display. The BPA RAS Dispatcher will call the BCH Transmission Coordinator when the arming level is changed and the time of the change, as follows:

1) BPA will say "Circuit #2 Gen Drop Arming Level at 100 MW, effective at ….." when the formula 0.95 x (Ingledow>Custer – 100) is used.
2) BPA will say "Circuit #2 Gen Drop Arming Level at 800 MW, effective at ….." when the formula 1.5 x (Ingledow>Custer – 800) is used.

The BPA RAS Dispatcher will call the BCH Transmission Coordinator when the status of the "Circuit #2 Gen Drop RAS" is changed, i.e. from armed to disarmed, or from disarmed to armed.

When Generation Shedding has to be armed manually:

- If AB is exporting more than 700 MW, the preferred gen-shedding sequence is: GMS/PCN, MCA, REV and the last at SEV and KCL.

9.7 Shedding for Loss of an Element(s) of the U.S. 500 kV Pacific AC Intertie (BPA/PACI RAS)

BCH calls this RAS the "PACI RAS". BPA calls this the "Gen Drop to BCH Circuit 1" RAS and is labelled as BPA Pacific AC RAS in 2T-34 Appendix 2.

Shedding for this RAS is available at GMS, PCN, MCA and REV**.**

Provided that BCH is exporting to the U.S. Southwest using the PACI and/or the Pacific DC Intertie (PDCI), the BPA Dittmer Dispatcher can request the BCHCC Operator to participate in generator shedding for PACI contingencies. The Dittmer Dispatcher will specify a MW figure for generation to be put on shed and the BCHCC Operator selects the appropriate plant and generators. The total amount of shedding requested cannot exceed the total of BCH/FortisBC schedules to the U.S. Southwest on the PACI and/or the PDCI.

Assuming the specified MW figure provided is GS0,
If 5L94 RAS is armed, then

- The gen-shed shall be:
  GS = GS0 - (AB - BC) Transfer

Otherwise,

- The gen-shed is:
  GS = GS0

For the arming conditions for 5L94 RAS, refer to Section 6.3.

When Generation Shedding has to be armed manually:

- If AB is exporting more than 700 MW, the preferred gen-shedding sequence is: GMS/PCN, MCA, and the last at REV.

10.0 AUTOMATIC GENERATION CONTROL (AGC) SUSPENSION

See SOO 2T-43 for details of AGC suspension.

11.0 TSA-PM IMPLEMENTATION

With respect to SOO 7T-18, the EMS Transient Stability Analysis – Pattern Matching (TSA-PM) advanced application arms/disarms generators to be shed for:

- Loss of 5L51 AND 5L52
- Loss of 5L51
- Loss of 5L52

- BPA / NW RAS operation
- PACI RAS operation

TSA-PM normally arms/disarms the ECS RAS, the RX RAS, 5L61 RAS, and 5L94 RAS during high transfer on BC-US intertie and/or high transfer on BC-RTA path, for contingencies and outages that result in BC-US intertie separation.

TSA-PM arms DTT of 5L83 for 5L51 AND 5L52 double contingency for system conditions identified in Section 4.2.

All recommended transfer limits in SOO 7T-18 have been implemented in TSA-PM and will alarm in AOR GS if the limits are exceeded.

The following alarms have been implemented in TSA-PM:

ALARM DESCRIPTION	REMARKS
C5L51_52 - DTT 5L83 RAS	Section 4.2
C5L51_52 - DTT 5L12 RAS	Section 4.2
ING_CUS 2850 - REQD 500KV CCTS NOT I/S	Section 8.3.3 Conditions required for increasing the ING to CUS transfer above 2000 MW
5L44 MUST BE IN SERVICE	
5L81 MUST BE IN SERVICE	
RX RAS MUST BE FULLY AVAILABLE AND ARMED	
ING_CUS 2850 - REQUIRED SERIES CAPS NOT I/S	
ING_CUS 2850: REQD ING CAPS NOT AVAIL	
ING_CUS 2850: REQD KI2 12RX NOT ENERGIZED	
ING_CUS 2850: MSA 12RX REQD NOT ENERGIZED	
ING_CUS 2850: REQD VIT SCS/SAT PIK RXS NOT ENERGIZED	
ING_CUS 2850: KLY_SC2/12RX/2RX REQD NOT AVAL	
ING_CUS 2850: ING 12RX/2RX REQD NOT AVAIL	
ING_CUS 2850: MDN 12RX/2RX REQD NOT AVAIL	
ING_CUS 2850: TBY 2RX1 REQD NOT ENERGIZED	
ING_CUS 2850: DMR SVC REQRMNTS NOT MET	
ING_CUS 2850: REQD ACK 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD CBK 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD MCA 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD NIC 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD SEL 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD KLY 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD CKY 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD DMR 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD MSA 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD WSN 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD GMS 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD PCN 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD GLN 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD TKW 500 KV RXS NOT ENERGIZED	
ING_CUS 2850: REQD TIR 500 KV RXS NOT ENERGIZED	
ING AUTO-VAR MUST BE IN SERVICE	
MDN AUTO-VAR MUST BE IN SERVICE	
ACK AUTO-VAR MUST BE IN SERVICE	
WSN AUTO-VAR MUST BE IN SERVICE	
SEL AUTO-VAR MUST BE IN SERVICE	
BSY 230KV BUS VOLTAGE REQRMNT NOT MET	
MCA UNITS MUST BE MAINTAINED UNDER 16.6 KV	Section 8.3.10
AT LEAST 5 NIC 5RX MUST BE ENERGIZED	Section 8.3.8
AT LEAST 4 NIC 5RX MUST BE ENERGIZED	Section 8.3.9

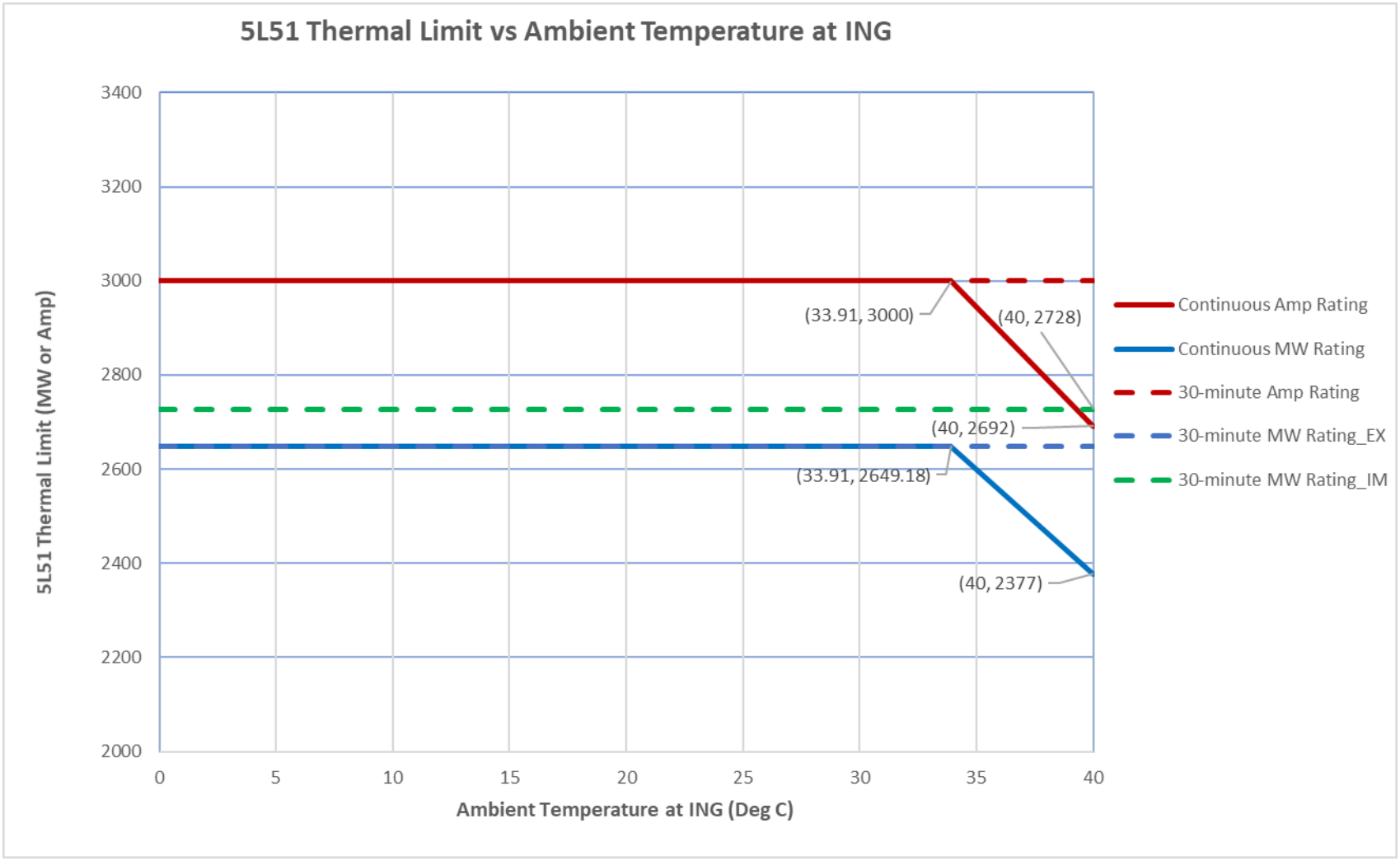
ALARM DESCRIPTION	REMARKS
ING_EXP_CUS PRE_OUTAGE LIMIT VIOLATED	Section 8.4 ING to CUS Transfer Limits
BCH_EXP_BPA PRE_OUTAGE LIMIT VIOLATED	
LOAD > 7000! CHECK VSA FOR ING_EXP_CUS	Attachment 3 Note 1
EACH BSY UNIT MVAR MUST BE WITHIN [-40, -60]	Attachment 3 Note 2
BR1/BR2 UNITS MUST BE MAINTAINED UNDER 1.03 PU	
CONSULT OPS PLANNING FOR ING TO CUS LIMIT	Attachment 3 Note 6
ING_IMP_CUS PRE_OUTAGE LIMIT VIOLATED	Section 8.6 CUS to ING Transfer Limits
BCH_IMP_BPA PRE_OUTAGE LIMIT VIOLATED	
VIOLATION OF PRE-OUTAGE RESTRICTION FOR C5L51 OR 52	Section 8.6: Pre-outage restriction in Note 3.
<CTG NAME> - MIN UNITS ONLINE VIOLATION	Section 9.2 Post-Shedding requirement for loss of 5L51 and/or 5L52, or the BPA outages General requirement for loss of 5L51 or 5L52 or 5L51 and 5L52.
<CTG NAME> - INSUFFICIENT GEN SHEDING	
<CTG NAME> - GMS/PCN SHEDDING RATIO INCORRECT	
C5L51_52 GEN SHED > 3450MW	
C5L51_52 - DTT 1L274 RAS	Section 9.3.4
C5L51_52 - DTT 1L275 RAS	Section 9.3.4

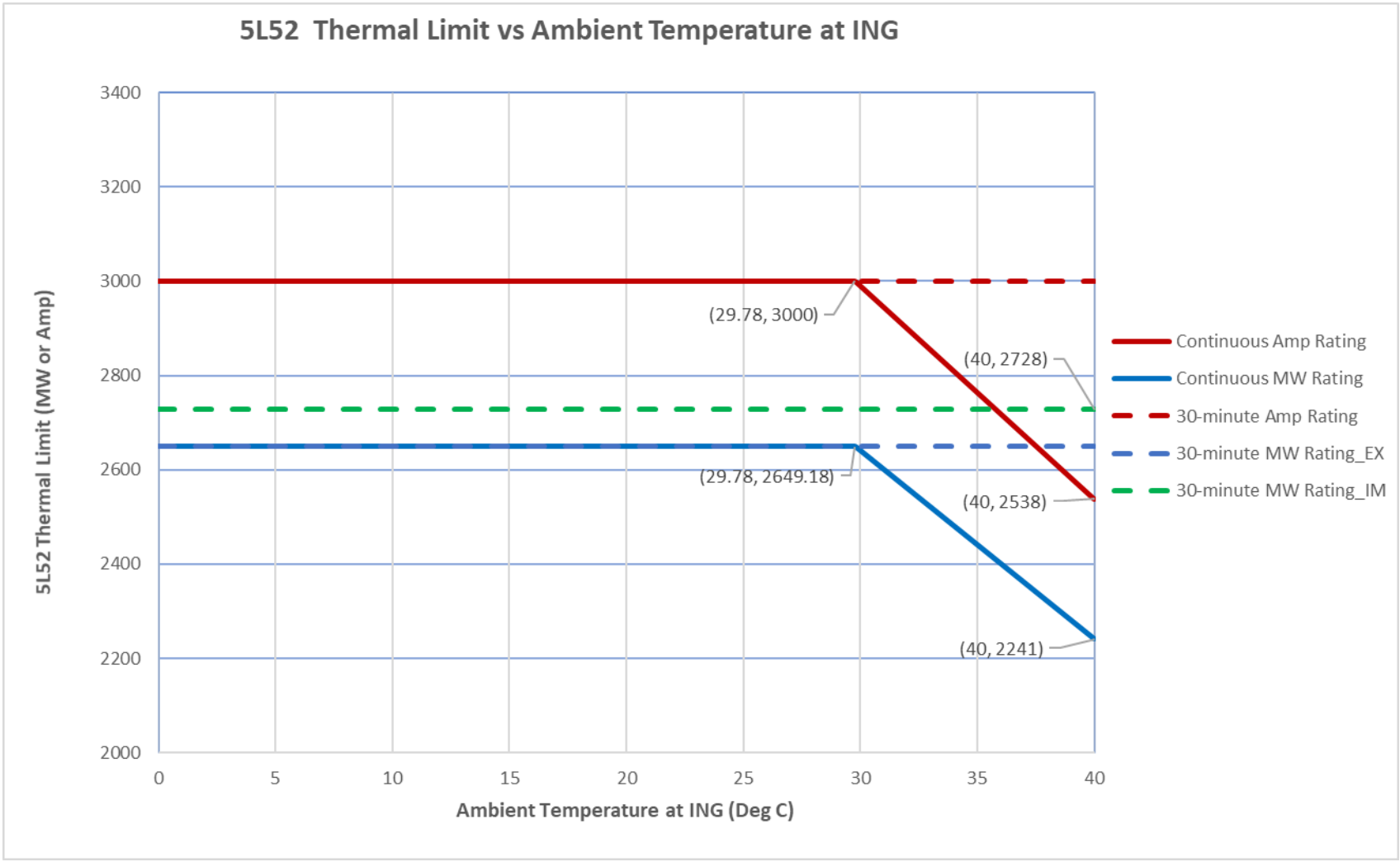
12.0 REVISION HISTORY

Revised By	Revision Date	Summary of Revision
RAC	27 July 2018	• Revised 8.3.3.6 to remove HVDC from equations, as it has been removed from the one-line. • Revised 8.3.3.10.1 to add PCN 5RX1 for the case of BCH load > 6000MW to increase TTC above 2000MW on ING to CUS path.
RAC/LBao/ CZ	23 July 2019	• Section 1.0 revised to clarify that the 71L circuit is in the FortisBC operating area with respect to Path 3. • Section 5.0 revised to eliminate the legacy label L71. • Section 5.0 clarify the use of circuit label 2L277(71L) for the operation of the circuit as WHS-NLY, and 71L for the circuit operation as WHS-Boundary (BPA). • Section 6.1 is revised to describe the AB tie separation responses are response to Path 3 Operations, • Section 6.2 section title is revised. • Section 6.3 adds the arming requirements for AB separation for BPA contingencies. • Section 8.3.8 referring to MCA single unit operation is removed. • Section 8.5.4: REV restrictions are added with one of ACK (5RX4, 5RX7, 5RX8) OOS. • Section 9.6: shedding requirements are updated to reflect the RAS function addition of tripping the AB-BC ties for BPA contingencies using 5L94 RAS. • Section 9.7: shedding requirements are updated to reflect the RAS function addition of tripping the AB-BC ties for BPA contingencies using 5L94 RAS. • Attachment 4: updated to reflect the RAS function addition of tripping AB-BC ties for BPA contingencies using 5L94 RAS.
LBao/RAC	16 April 2020	• Section 9.1: revised for path and flow direction • Section 8.3.3, 8.3.4, 3.3.8, 3.3.9, and 3.3.10.: revised to accommodate the outage of one of the 500 kV reactors at GMS/PCN/WSN/ACK/MCA in order to increase BC to US transfer limit • Section 11: updated alarm list • minor clarifications in Section 9.6 and 9.7 for the RAS labels and the manual generation shedding recommendation.
RAC/BJH/ LBu/SJC/ LBao/ GWang	15 June 2021	• Section 1 – added references to SOO's noted in this System Operating Order. • Sections 1.5, 8.3.1, 8.5.1, 8.6, Attachment 1, and Attachment 2 - revised due to 5L51 and 5L52 line/ING disconnect rating changes. • Section 8.3.3 – added note on applicability to Double Contingencies (Intertie Separation). These rules are relaxed when Both 5L51 and 5L52 are in service, provided RTCA shows no post contingency voltage issues. • Sections 8.3.3.10.1 -8.3.3.10.4 – added "One of" to the criterion. • Section 8.4 Corrections for recommended TTC (that are not Stability limitations) were made in Tables A1 & A2. • Sections 8.4 & 8.6 - Clarified purposes for recommended TTC in paragraphs preceding Tables A1, A2, B1, B2.

		• Removed conflicting messages about SOLs for path that are actually internal constraints • Removed references to VSAT in Tables A1, A2, B1, B2, replacing with VSAT for ILM. • revised for Operators use of RT Assessments for decisions to raise or lower recommended TTCs for interconnection path operations.
LBao/ GWang/ RAC	10 August 2021	The following sections are revised with the addition of DTT 5L12 RAS function for loss of 5L51&5L52 double contingency: • Section 4.2 - revised the arming conditions of DTT 5L83 and 5L12. • Section 9.3 - added gen-shedding sequence requirements for loss of "5L51 AND 5L52", or loss of 5L51 (or 5L52) with 5L52 (or 5L51) O.O.S. • Attachment 3 - updated ING-CUS transfer limit for different operating configurations and conditions. • Removed notes in Section 9.3.2, 9.3.3, and 9.3.4 for the scenarios that are not covered. • Added Item C in Section 8.3.3.10.3 for 5L63 OOS • Added Item F for KLY reactor exceptions in Section 8.3.3.10.2 - 8.3.3.10.4 • Updated alarm list in Section 11 Other updates include: • Section 8.5.1 - Moved note on 5L51/or 5L52 outage scheduling to Section 8.5.4 • Section 8.5.4 – added note on rotational energy mitigations and recall planning

Attachment 1: **5L51 or 5L52 Thermal Limit versus Ambient Temperature at ING**




5L52 Thermal Limit vs Ambient Temperature at ING
5L52 Thermal Limit (MW or Amp)
3400
3200
3000
2800
2600
2400
2200
2000
0
5
10
15
20
25
30
35
40
Ambient Temperature at ING (Deg C)
(29.78, 3000)
(40, 2728)
(29.78, 2649.18)
(40, 2538)
(40, 2241)
Continuous Amp Rating
Continuous MW Rating
30-minute Amp Rating
30-minute MW Rating_EX
30-minute MW Rating_IM

Attachment 2: ING-CUS Transfer Limits for All System Conditions

Assuming:
B1 = 5L51or5L52_30Minute_MW_Rating_EX = 1.732 * 0.99 * 515kV * 5L51or5L52_30Minute_Amp_Rating/1000 (see Attachment 1)
B2 = 5L51or5L52_30Minute_MW_Rating_IM= 1.732 * 525kV * 5L51or5L52_30Minute_Amp_Rating/1000 (see Attachment 1)
A1 = 5L51_Continous_MW_Rating = 1.732 * 0.99 * 515kV * 5L51_Continuous_Amp_Rating/1000 (see Attachment 1)
A2 = 5L52_Continous_MW_Rating = 1.732 * 0.99 * 515kV * 5L52_Continuous_Amp_Rating/1000 (see Attachment 1)

1. ING to CUS Transfer Limit

All system conditions except 5L51 or 5L52 O.O.S.:

ING to CUS transfer limit = 2 * *A2*

5L51 or 5L52 O.O.S.:

ING to CUS transfer limit is the lesser of:

- **IF** 5L51 is OOS **THEN** *A2*, or
- **IF** 5L52 is OOS **THEN** *A1*, or
- *B1* – 2L112 NLY

2. CUS to ING Transfer Limit

All system conditions except for 5L51 or 5L52 O.O.S.:

CUS to ING transfer limit is the least of:

- *B2*
- **IF** 2L112 NLY >= -250 MW **THEN** 2 * *B2* - 0.73 * (Max. armed GMS shed for any contingencies except for 5L51 or/and 5L52 contingency), or
- **IF** 2L112 NLY < - 250 MW **THEN** 2 * *B2* - 0.86 * (Max. armed GMS shed for any contingencies except for 5L51 or/and 5L52 contingency) + 2L112 NLY + 200, or
- **IF** DTT 5L94 is not armed **THEN** 2 * *B2* - 0.90 * (Armed generation shedding for loss of 5L81 & 5L82) + 2L112 NLY or
- **IF** DTT 5L94 is armed **THEN** 2 * *B2* - 0.95 * (Armed generation shedding for loss of 5L81 & 5L82 + AB to BC) + 2L112 NLY, or
- **IF** 5L98 or (5L98 and 5L96) OOS **THEN** 2 * *B2* + 2L112 NLY - 0.95 * [(5L76 + 5L79) ACK + 1L209 SAM + 1L214 VNT], or
- **IF** 5L96 is OOS **THEN** 2 * *B2* + 2L112 NLY - 0.95 * [(5L76 + 5L79) ACK + 1L209 SAM + 1L214 VNT + 73L LEE], or
- **IF** 5L91 is OOS **THEN** 3700 - 5L96 SEL, or
- **IF** 5L96 is OOS **THEN** 3700 - 5L91 SEL, or
- **IF** DTT 5L94 is not armed **THEN** 2 * *B2* - 0.87 * (Armed generation shedding for loss of 5L76 & 5L79) – 100, or
- **IF** DTT 5L94 is armed **THEN** 2 * *B2* - 0.95 * (Armed generation shedding for loss of 5L76 & 5L79 + AB to BC) – 100, or
- **IF** DTT 2L112 RAS for 5L92 or 5L94 contingency is armed **THEN** 2 * *B2* - (AB to BC transfer) + 2L112 NLY.

The limits are to prevent the post-outage loading on 5L51 or 5L52 circuit from exceeding its thermal limit upon loss of 5L52 or 5L51, or any Peace, or LM, or SI contingencies.

5L51 or 5L52 O.O.S:

CUS to ING transfer limit is the least of:

- **IF** 5L51 is OOS **THEN** A2, or
- **IF** 5L52 is OOS **THEN** A1, or
- B2 + 2L112 NLY, or
- **IF** 2L112 NLY >= -250 MW **THEN** B2 - 0.72 * (Max. armed GMS shed for any contingencies except for 5L52 contingency), or
- **IF** 2L112 NLY < - 250 MW **THEN** B2 - 0.85 * (Max. armed GMS shed for any contingencies except for 5L52 contingency) + 2L112 NLY + 200, or
- **IF** DTT 5L94 is not armed **THEN** B2 - 0.88 * (Armed generation shedding for loss of 5L81 & 5L82) + 2L112 NLY, or
- **IF** DTT 5L94 is armed **THEN** B2 - 0.95 * (Armed generation shedding for loss of 5L81 & 5L82 + AB to BC) + 2L112 NLY, or
- **IF** 5L91 is OOS **THEN** B2 - 5L96 SEL, or
- **IF** 5L96 is OOS **THEN** B2 - 5L91 SEL, or
- **IF** DTT 5L94 is not armed **THEN** B2 - 0.86 * (Armed generation shedding for loss of 5L76 & 5L79) – 100, or
- **IF** DTT 5L94 is armed **THEN** B2 - 0.95 * (Armed generation shedding for loss of 5L76 & 5L79 + AB to BC) – 100, or
- **IF** DTT 2L112 RAS for 5L92 or 5L94 contingency is armed **THEN** B2 - (AB to BC transfer) + 2L112 NLY.

Attachment 3: **ING to CUS Transfer Limit versus BCH Load and Number of BSY Synchronous Condensers, BR1 and BR2 units (All System Conditions)**

ING to CUS Transfer Limits are calculated by the equations below for different operating configurations.

A. KLY SC2 in service and all KLY 12RX1, KLY 2RX2, KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, and 5RX6 available or energized regardless of 2L90 in or out status

ING – CUS transfer limit (y) (MW)	BCH load (x) (MW)
y=600	x < a1 - N_BSY *140
y=k * (x + 140 * N_BSY) - b	a1 - N_BSY *140 <= x = < a2 - N_BSY *140
y=2850	x > a2 - N_BSY * 140

Note: refer to the Nomogram in Figure 3-1 for Operating Configuration A.

B. One of No. B.1 - B.5 operating configurations in Table 3-1

ING – CUS transfer limit (y) (MW)	BCH load (x) (MW)
y=600	x < a1 - N_BSY *50 - ((N_BR1) - 3) * 60 – ((N_BR2) - 3) * 120
y=k * (x + 50 * N_BSY + 60 * ((N_BR1) - 3) + 120 * ((N_BR2) - 3)) - b	a1 - N_BSY *50 - ((N_BR1) - 3) * 60 - ((N_BR2) - 3) * 120 <= x = < a2 - N_BSY * 50 - ((N_BR1) - 3) * 60 - ((N_BR2) - 3) * 120
y=2850	x > a2 - N_BSY * 50 - ((N_BR1) - 3) * 60 - ((N_BR2) - 3) * 120

Note: refer to the Nomogram in Figure 3-2 for a graphical example of Operating Configuration B.1 with 3 BR1 and 3 BR2 units online.

C. One of No. C.1 – C.2 operating configurations in Table 3-1

ING – CUS transfer limit (y) (MW)	BCH load (x) (MW)
y=600	x < a1 - N_BSY *50
y=k * (x + 50 * N_BSY) - b	a1 - N_BSY *50 <= x = < a2 - N_BSY * 50
y=2850	x > a2 - N_BSY * 50

Where:
k: slope
N_BSY: number of online BSY units
N_BR1: number of online BR1 units
N_BR2: number of online BR2 units

a1: BCH load when ING-CUS transfer limit is 600 MW, if BSY = 0, BR1 = 3, BR2 = 3 for one of No. B.1 – B.5 system configurations in Table 3-1, or if BSY = 0 for one of No. A, C.1, C.2 system configurations in Table 3-1
a2: BCH load when ING-CUS transfer limit is 2850 MW, if BSY = 0, BR1 = 3, BR2 = 3 for one of No. B.1 – B.5 system configurations in Table 3-1, or if BSY = 0 for one of No. A, C.1, C.2 system configurations in Table 3-1
b: constant

Table 3-1 Parameters for different operating configurations and conditions

No.	Operating Configuration and Condition	k	b	a1	a2
A	KLY SC2 in service and all KLY 12RX1, KLY 2RX2, KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, and 5RX6 available or energized regardless of 2L90 in or out status	3.1	11100	3774	4500
B.1	KLY SC2 OOS, or KLY 12RX1 unavailable ,or one of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized	1.6316	5308	3621	5000
B.2	Any two of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized	1.1923	3588	3513	5400
B.3	KLY SC2 OOS & One of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized, or 12RX1 & One of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized	1.2917	4254	3758	5500
B.4	KLY SC2 OOS & 12RX1 unavailable, or KLY 2RX2 unavailable	1.9375	8388	4639	5800
B.5	KLY SC2 OOS & 2RX2 unavailable, or 12RX1 & 2RX2 unavailable, or 2RX2 & One of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized	1.7222	7828	4894	6200
C.1	2L90 & KLY SC2 OOS, or 2L90 OOS &12RX1 unavailable, or 2L90 OOS & one of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized	1.6316	5471	3721	5100
C.2	2L90 & KLY SC2 OOS & 12RX1 unavailable, or 2L90 OOS & KLY 2RX2 unavailable	1.9375	8388	4639	5800

Notes:

1. For BC Hydro loads greater than 7000 MW use the limits for 7000 MW. At loads in excess of 7000 MW VSA limits may be more restrictive.

2. BSY SC/BR1/BR2 must have AVR in automatic mode.
   If LDC is available, put LDC in service.
   If the BC Hydro load is less than 6000 MW and the ING to CUS transfer is larger than 2000 MW, then:
   Each on-line BSY SC unit shall be operated under-excited with output within (-40 to -60 MVARs).
   If the BC Hydro load is less than 6500 MW and the ING to CUS transfer is larger than 600 MW, then:
   The terminal voltage of each on-line BR1 and BR2 unit must be less than 1.03 pu.

3. Operating above these transfer limits will result in high voltages that can damage underground cables in the Lower Mainland for the loss of 5L51 AND 5L52 during light load condition. Reduce ING-CUS transfer to be within the transfer limit.

4. For the ING to CUS transfer to exceed 2000 MW, the BSY 230 kV voltage must be less than 243 kV.

5. The requirements in Section 8.3.3 for increasing the ING to CUS transfer above 2000 MW are applicable to each system configuration and condition in Table 3-1.

6. For the conditions that are not covered by Table 3-1, for example, three of (KLY 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) unavailable or de-energized, or all KLY SC2 OOS & 12RX1 & 2RX2 unavailable, TSAPM shall give “alarm signal” for operator(s) to call OP study engineers to get real capabilities while a temporary limit of 600 MW can be applied.

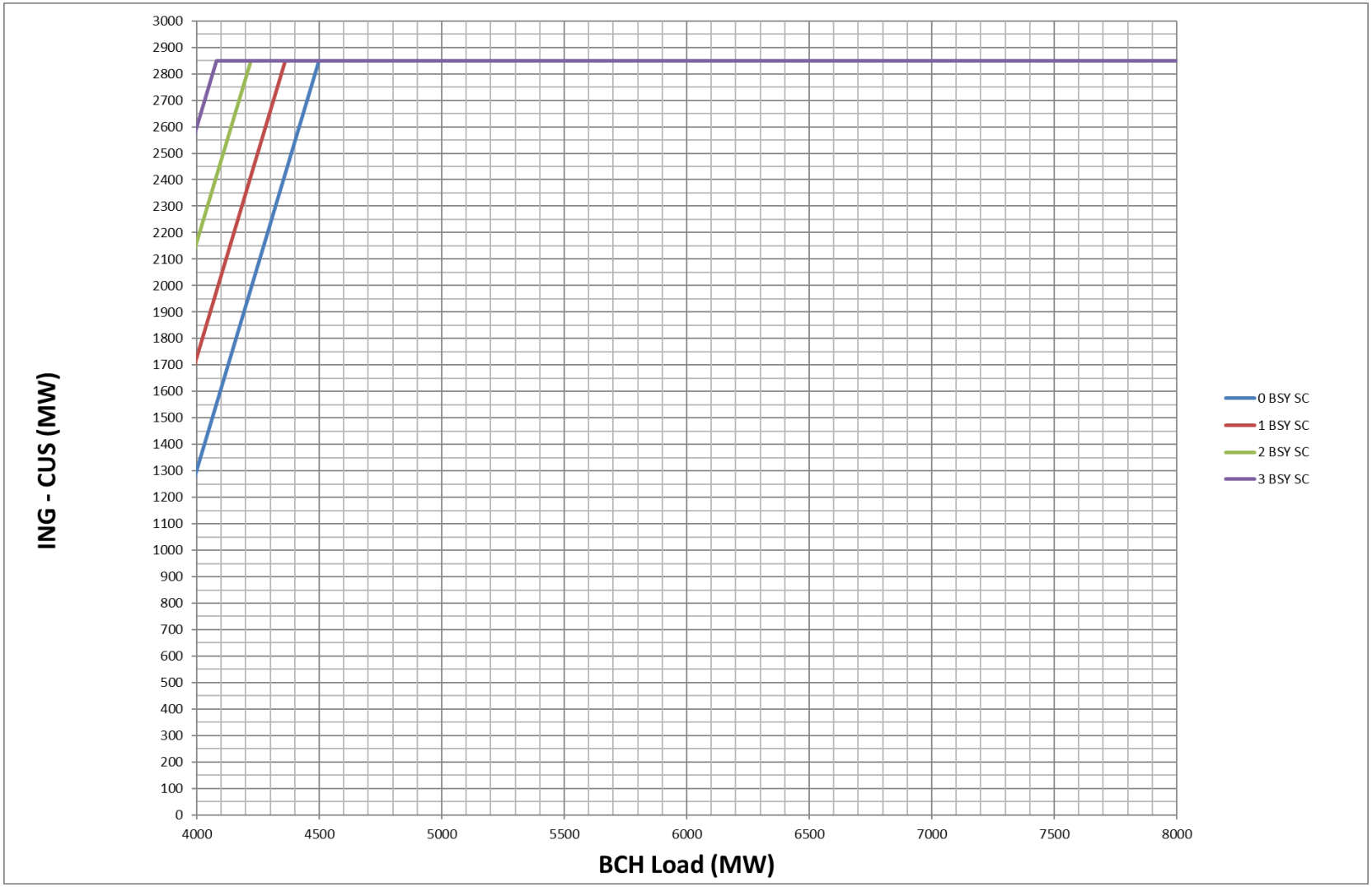


Figure 3-1 ING to CUS Transfer Limit versus BCH Load and Number of BSY Synchronous Condensers for Operating Configuration A

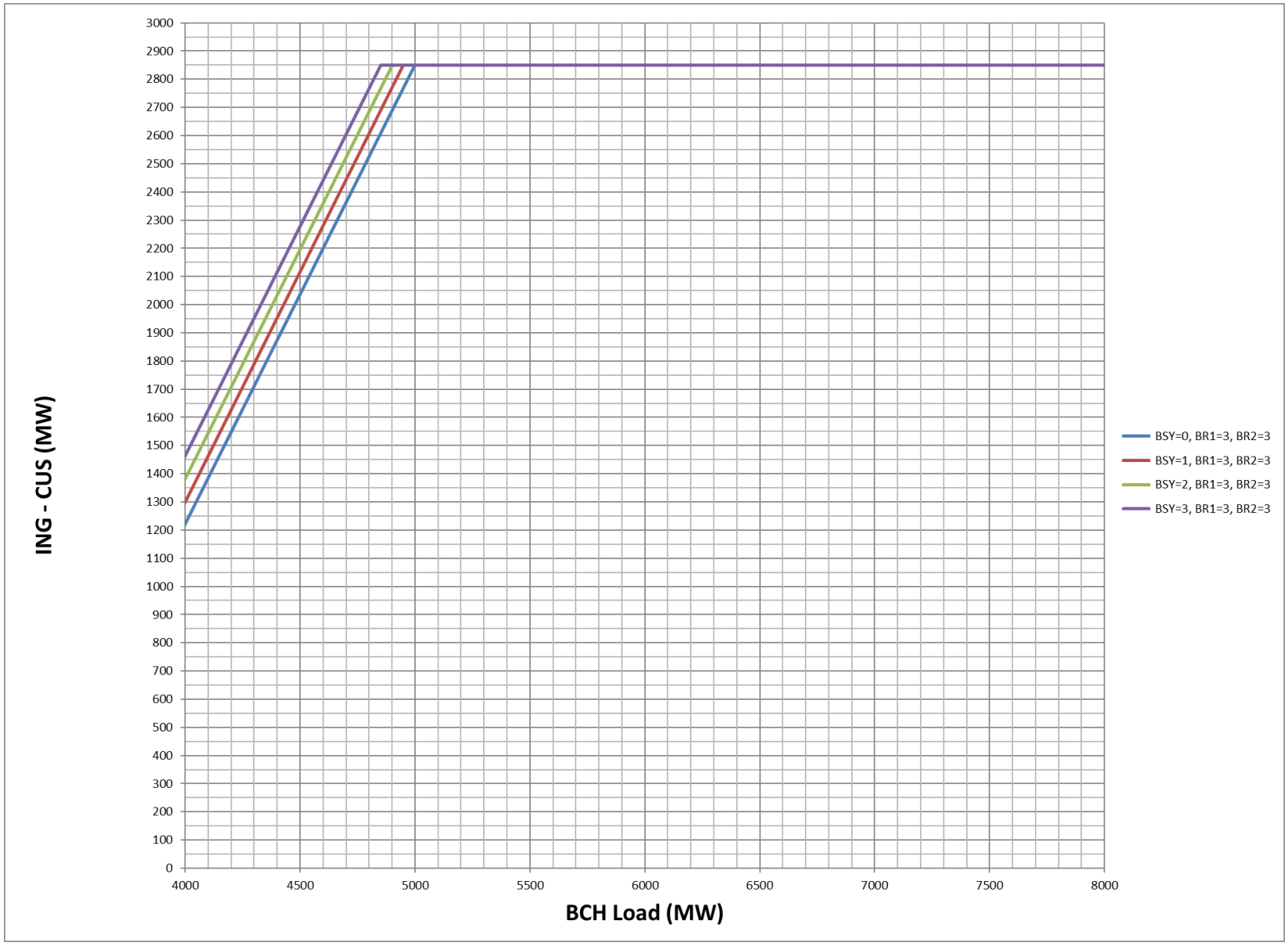
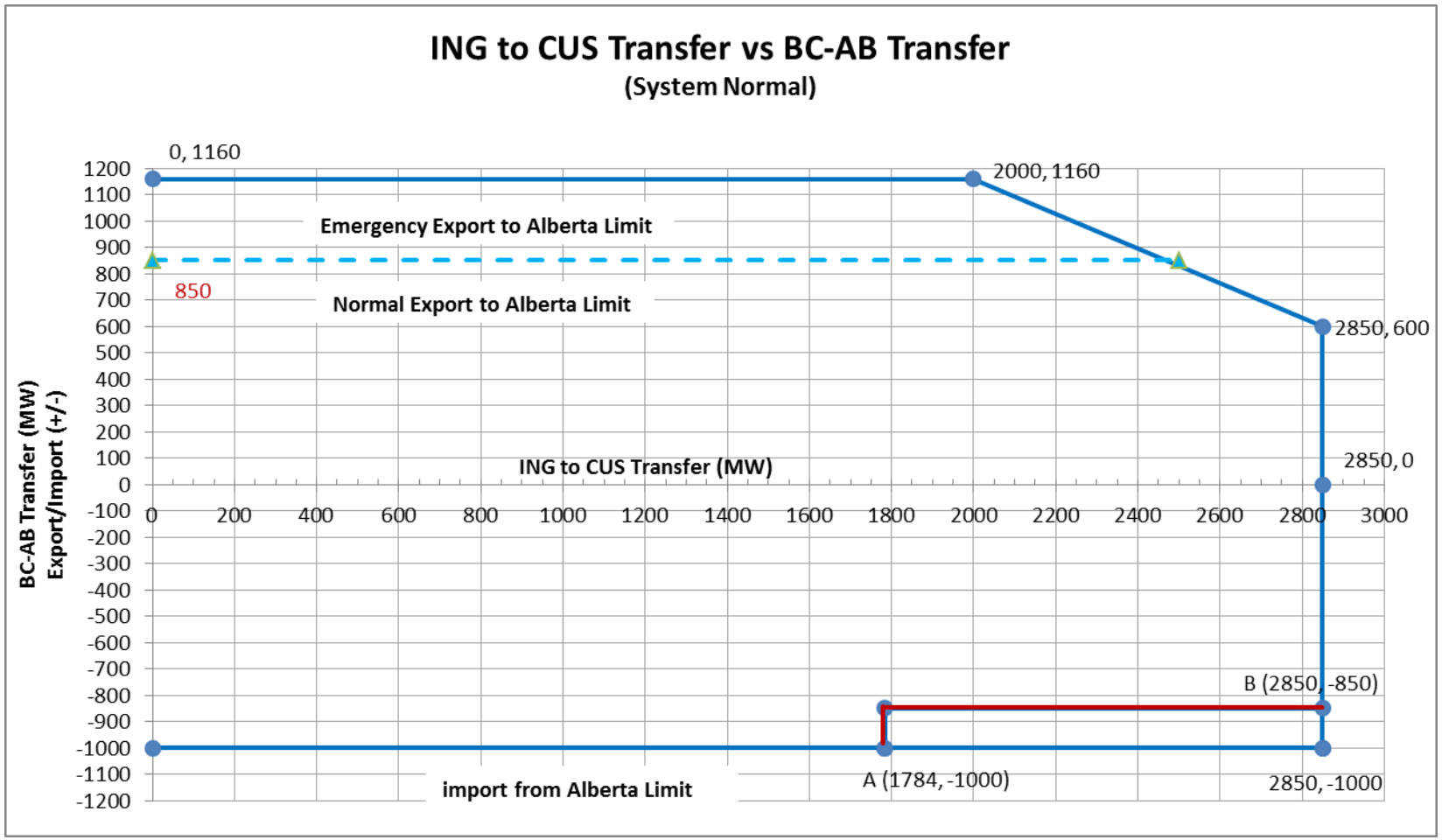


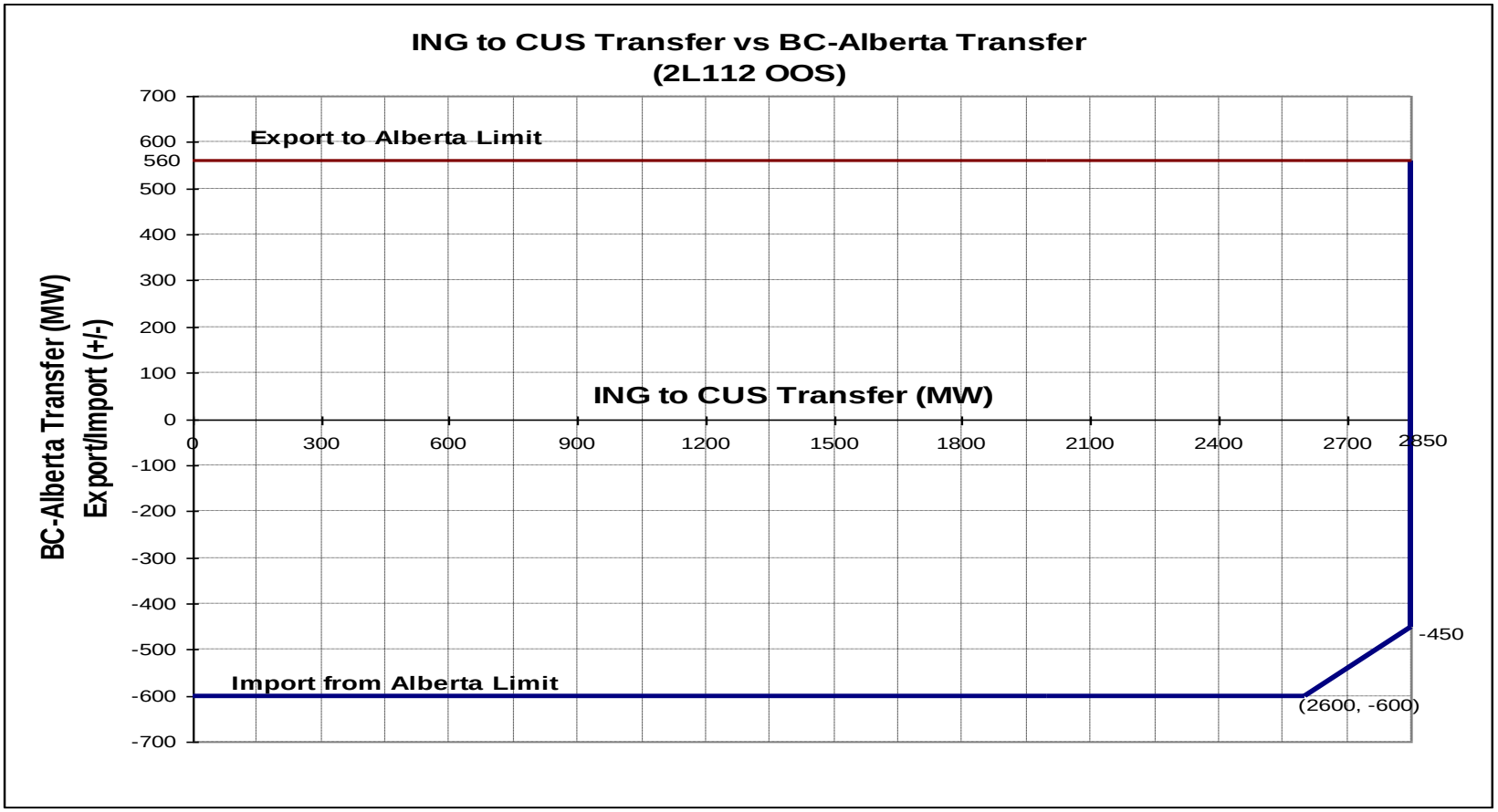
Figure 3-2 ING to CUS Transfer Limit versus BCH Load and Number of BSY Synchronous Condensers for Operating Configuration B.1 with 3 BR1 and BR2 units online

Attachment 4: ING to CUS Transfer versus BC-Alberta Transfer (System Normal)

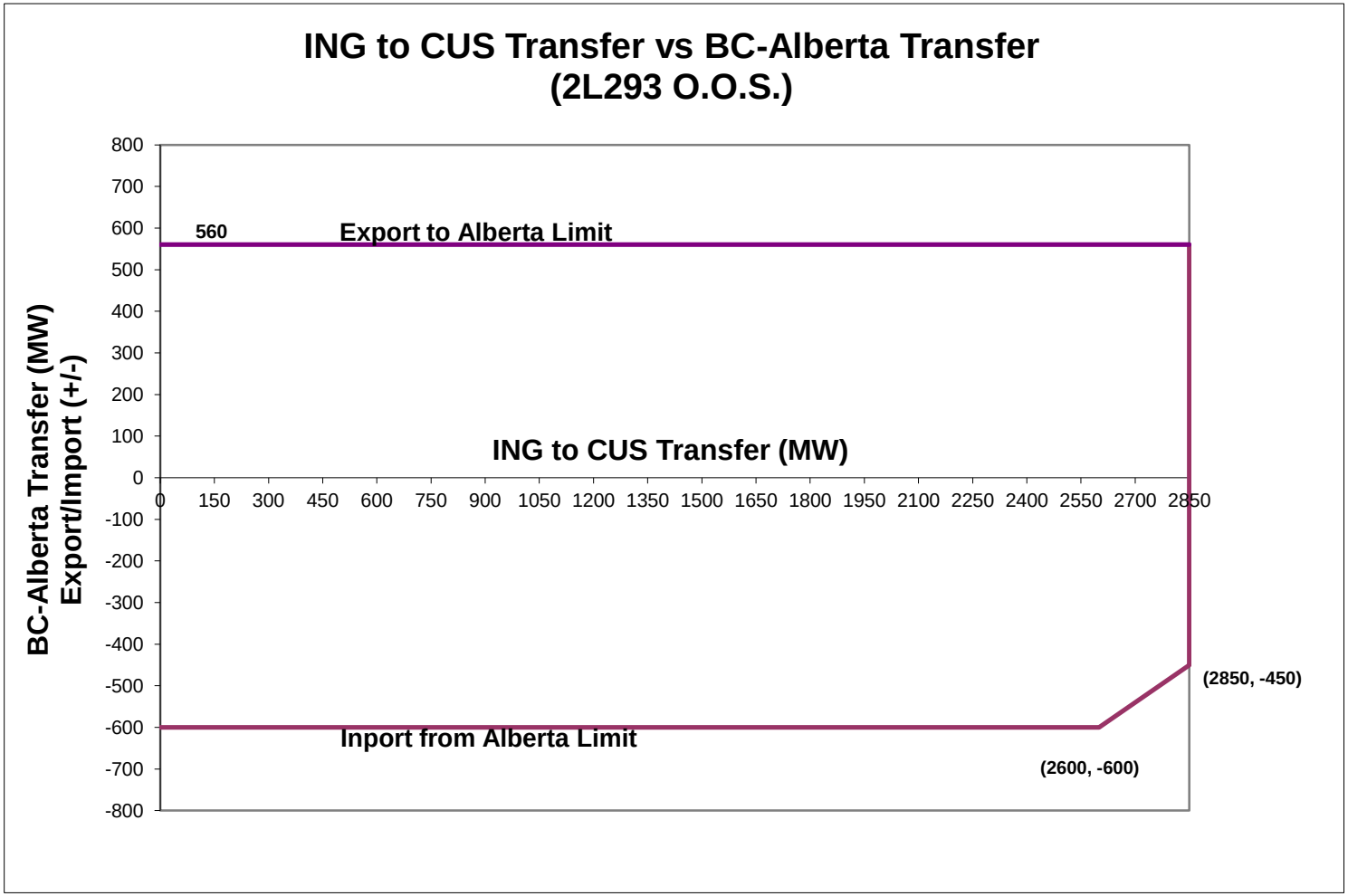


Notes:
1: This nomogram is also applicable to other system statuses in Table A1 in Section 8.4, including system statuses No 1, 4, 5, 6, 8, 9, 12, 13 and these system statuses in No 1, 4, 7, 10, 11 in Table A2.
2. For the monograms between Point A to Point B, if "Phase Angle" > 40, the red line shall be applied, otherwise, the dark blue line shall be applied, where "Phase Angle" is defined as the phase angle between Grand Coulee 500 and Malin 500 in BPA. For details, refer to Section 6.3.

Attachment 5: **ING to CUS Transfer versus BC-Alberta Transfer (2L112 OOS or 5L83 AND 2L112 OOS)**



Attachment 6: **ING to CUS Transfer versus BC-Alberta Transfer (2L293 OOS or 5L83 AND 2L293 OOS)**



Attachment 7: **ING to CUS Transfer versus BC-Alberta Transfer (5L91 OOS or 5L83 AND 5L91 OOS)**