BC HYDRO

OPERATIONS SUPPORT

OPERATING ORDER 7T – 18

CUSTER-INGLEDOW 500 KV INTERCONNECTION

(Supersedes 7T-18 issued 15 November 2010)

Effective Date: 18 April 2011

Expiry Date: 17 April 2015

APPROVED BY: *Original signed by:*

Douglas Cave
Manager
Operations Support

Denotes Revision ‖

CONTENTS

1.0 DESCRIPTION 4
1.1 General 4
1.2 Circuit Boundaries 4
1.3 Communication 4
1.4 Safety Protection 4
1.5 Equipment Rating 5

2.0 AUTO RECLOSING 5

3.0 LOOP CLOSURE / SYNCHRONIZING 5

4.0 REACTIVE POWER REMEDIAL ACTION SCHEME (RX RAS) 6
4.1 Purpose 6
4.2 Operation 6
4.3 Ingledow, Meridian, Ashton Creek, and Selkirk Auto-VAR Schemes 6

5.0 EASTERN CONTROLLED SEPARATION REMEDIAL ACTION SCHEME (ECS RAS) 7
5.1 ECS RAS Description 7
5.2 ECS RAS at NLY Requirement when 2L277 is connected to NLY 7
5.3 ECS RAS Operation Due to Loss of Custer-Monroe #1 and #2 500kV Circuits 7

6.0 ALBERTA TIE TRIPPING REMEDIAL ACTION SCHEME (AB TIE RAS) 8
6.1 Description 8
6.2 AB TIE RAS Arming for imports from Alcan and US 9

7.0 5L61 TRIPPING REMEDIAL ACTION SCHEME (5L61 RAS) 9

8.0 TRANSFER LIMITS 10
8.1 General 10
8.2 Corrective Measure when Transfer Limits Are Exceeded 10
8.3 System Requirements for BC Exporting to US 11
8.3.1 5L51 or 5L52 Thermal Limit vs. Ambient Temperature at ING 11
8.3.2 On-line Equivalent Burrard Synchronous Condensers (Attachment 3) 11
8.3.3 Increasing the ING to CUS transfer above 2000 MW 12
8.3.4 Operating Guidelines and Restrictions 15
8.3.5 (5L87 AND 5L71 OOS) or (5L87 and 5L72 OOS) 15
8.3.6 NTL Tie O.O.S. 16
8.3.7 5L44 Contingency 16
8.3.8 5L71 or 5L72 O.O.S with One MCA Unit On-Line 16
8.4 Ingledow to Custer Transfer Limits - (Export from BCH System) 16
8.5 System Requirements for BC Importing from US 18
8.5.1 5L51 or 5L52 Thermal Limit versus Ambient Temperature at Ingledow 18
8.5.2 (5L87 AND 5L71 OOS) or (5L87 AND 5L72 OOS) 18
8.5.3 NTL Tie O.O.S. 18
8.5.4 Operating Guidelines and Restrictions 18
8.5.5 5L71 or 5L72 O.O.S with One MCA Unit On-Line 18
8.6 Custer to Ingledow Transfer Limits - (Import into BCH System) 19

9.0 GENERATOR SHEDDING 20
9.1 Initiation 20
9.2 Allocation 21
9.3 Shedding for: Loss of “5L51 AND 5L52”, or Loss of 5L51 (or 5L52) with 5L52 (or 5L51) O.O.S. 22
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.: 22
9.3.2 2L112 O.O.S.: 22
9.3.3 5L92 O.O.S. 22
9.3.4 5L94 O.O.S. or 5L94 AND 5L96 O.O.S.: 22
9.4 Shedding For Loss of 5L51 With Both 5L51 AND 5L52 In Service 22
9.5 Shedding For Loss of 5L52 With Both 5L51 AND 5L52 In Service 23
9.6 Shedding for Loss of Pacific Northwest Circuits (BPA/NW RAS) 24
9.7 Shedding for Loss of an Element(s) of the U.S. 500 kV Pacific AC Intertie (BPA/PACI RAS) 25

10.0 AUTOMATIC GENERATION CONTROL (AGC) SUSPENSION 25

11.0 TSA-PM IMPLEMENTATION 26

12.0 TSA BACKUP IMPLEMENTATION 29

13.0 REVISION HISTORY 29

ATTACHMENT 1: 5L51 OR 5L52 THERMAL LIMIT VERSUS AMBIENT TEMPERATURE AT ING 30

ATTACHMENT 2: ING-CUS TRANSFER LIMITS FOR ALL SYSTEM CONDITIONS 31

1. ING to CUS transfer Limit 31
   All system conditions except 5L51 or 5L52 O.O.S.: 31
   5L51 or 5L52 O.O.S.: 31
2. CUS to ING transfer limit 32
   All system conditions except for 5L51 or 5L52 O.O.S.: 32
   5L51 or 5L52 O.O.S: 32

ATTACHMENT 3: ING TO CUS TRANSFER LIMIT VERSUS BCH LOAD AND NUMBER OF ON-LINE EQUIVALENT BURRARD SYNCHRONOUS CONDENSERS (ALL SYSTEM CONDITIONS) 33

ATTACHMENT 4: ING TO CUS TRANSFER VERSUS BC-ALBERTA TRANSFER (SYSTEM NORMAL OR 5L4 OR 5L76 OR 5L79 OR NTL TIE OOS) 34

ATTACHMENT 5: ING TO CUS TRANSFER VERSUS BC-ALBERTA TRANSFER (2L112 OOS) 35

ATTACHMENT 6: ING TO CUS TRANSFER VERSUS BC-ALBERTA TRANSFER (2L293 OOS) 36

ATTACHMENT 7: ING TO CUS TRANSFER VERSUS BC-ALBERTA TRANSFER (5L91 OOS) 37

1.0 DESCRIPTION

1.1 General

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.

The circuits between Ingledow and the international border will be known within BCH as 5L51 and 5L52. However, when dealing with BPA these lines will be referred to as the "Ingledow-Custer No. 1 500 kV" and "Ingledow-Custer No. 2 500 kV" lines respectively.

1.2 Circuit Boundaries

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

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 or 5L52 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 or 5L52 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 current transformers for 5L51 and 5L52 circuits are rated at 3000 A continuously and 3300 A for 30 minutes.

The continuous current rating of 5L51 is:

- 3334 A at 20 degree C ambient temperature,
- 2992 A at 30 degree C ambient temperature, and
- 2483 A at 40 degree C ambient temperature.

The continuous current rating of 5L52 is:

- 3328 A at 20 ºC ambient temperature,
- 2992 A at 30ºC ambient temperature, and
- 2521 A at 40 ºC ambient temperature.

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

Attachment 1 has chart showing the continuous current and MW ratings of 5L51 or 5L52 based on the round off ratings of 5L51 and the 30-minute rating of ING CT (3300 A) at various ambient temperatures.

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.

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 will normally be energized from Custer and synchronized at Ingledow.

4.0 REACTIVE POWER REMEDIAL ACTION SCHEME (RX RAS)

4.1 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

4.2 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:
- 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

4.3 Ingledow, Meridian, Ashton Creek, and Selkirk 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.

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. 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 2L277 (L71).

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 2L277 (L71, WAN-NLY) for loss of 5L51 and 5L52. The ECS RAS at WAN shall not be armed as 2L277 is presently connected to NLY.

The FortisBC system permits 2L277 to be manually switched so that it can be connect to NLY or BDY. However, 2L277 must be connected to NLY at present because the studies have not been completed for 2L277 to be connected to BDY.

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 500 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 REMEDIAL ACTION SCHEME (AB TIE RAS)

6.1 Description

The AB TIE RAS allows the tripping of the BC-Alberta Interconnection for the loss of 5L51 AND 5L52, or loss of 5L51 (or 5L52) with 5L52 (or 5L51) out of service during high US to BC transfers.

For all system conditions with the exception of 5L94 out of service, when armed during BCH moderate to heavy import conditions from US and Alcan, the AB TIE RAS will trip 5L94 tie 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. The separation is to prevent the Alberta system frequency from dropping below 59 Hz, as required by the WECC. Refer to OO 7T-17 for more details.

For 5L94 out of service, refer to Section 9.3 for the arming requirement of DTT 1L274 and DTT 1L275.

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

The BCH Transmission Coordinator is responsible for the arming and disarming of the AB TIE RAS at CBK. When TSA-PM is unavailable, the Operator can manually arm/disarm the AB TIE RAS from the EMS Generation Shedding Display.

6.2 AB TIE RAS Arming for imports from Alcan and US

Arm the AB TIE 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

Disarm the AB TIE 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 5L51)
- 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)

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
- Because (-1780) is less than (-1304), arm AB TIE RAS

7.0 5L61 TRIPPING Remedial Action Scheme (5L61 RAS)

To optimize the North Coast system performance, 5L61 will be tripped for the simultaneous loss of 5L51 and 5L52, OR loss of 5L51 (or 5L52) with 5L52 (or 5L51) out of service when BCH is importing more than a certain amount of MW from US and the MW transfer on 5L61 from WSN is less than 75 MW. See Section 3 of S.O.O 7T – 64 for the detailed information.

8.0 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 in TSS and posted on OASIS.

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 recommended by TSA-PM and VSA

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 30-minute rating of ING CT (3300 A). The MW rating is equal to "1.732 x 0.99 x 515 kV x Amp rating /1000".

Attachment 2 shows the ING-CUS transfer limits for all system conditions. These ING-CUS transfer limits are to prevent the 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 Equivalent Burrard Synchronous Condensers (Attachment 3)

Attachment 3 shows the ING to CUS transfer limits as a function of BCH load and the number of on-line equivalent Burrard synchronous condensers. 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

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.

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

8.3.3.2 The RX RAS must be armed per Section 4.2.
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 All 500 kV circuits must be in service except the following circumstances:

- 5L4 or 5L51, or 5L52, or 5L71, or 5L72, or 5L75, or 5L77, or 5L76, or 5L79, or 5L91, or 5L92, or 5L94, or 5L96, or 5L98, or 5L96 AND 5L98, or 5L94 AND 5L96 O.O.S (see table in this section for applicable transfer limits).

- All combinations of the following conditions
  - One of (5L29 and 5L31) OOS
  - One of (5L30 and 5L32) OOS
  - 5L61 OOS

  All limits in the table are applicable under these conditions.

8.3.3.4 CHP, CRK, AMC 5CX1 and AMC 5CX2 series capacitors (all segments) 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 reactors must be available:

- ING 12RX4, 12RX5, 2RX1, 2RX2
- KI2 One of (12RX1, 12RX3)
- KLY 12RX1, 2RX2
- MDN 12RX31, 12RX32, 2RX1, 2RX2
- MSA 12RX1, 12RX2
- TBY 2RX1 must be in service if 2L129 is energized.

With the following exceptions:

- If (2L129 + HVDC) 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

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

  If (2L129 + HVDC) ARN <= 300 MW, then one of (TBY 2RX1, MDN 12RX31, 12RX32, (12RX31 AND 12RX32), 2RX1, 2RX2) may be unavailable.
- KLY 12RX1 may be unavailable if KLY S/C2 with AVR is in service
- If 5L30 or 5L32 is O.O.S. then one of MSA 12RX1 and 12RX2 may be unavailable.
- 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 unavailable.
- Refer to Section 8.3.3.11.3 and Section 8.3.3.11.12, KLY 2RX2 may be unavailable.

8.3.3.7 At least 4 of (PIK 2RX2, SAT 2RX1, VIT S/C3, VIT S/C4, VIT (S/C1 + S/C2)) must be in service. The AVR of VIT S/C must be on.

8.3.3.8 KLY S/C2 can be out of service if KLY 12RX1 is available

8.3.3.9 Burrard S/C unit(s) or equivalent Burrard S/C unit(s) per Attachment 3 must be in service, and BGS 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 SCC SPD should increase Mvar absorption from BGS to reduce the ING230 and MDN230 voltages below 243 kV within 15 minutes.

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

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

8.3.3.11.1 If 5L29 is O.O.S. **OR**
if 5L29 **AND** one of 5L30 and 5L32 are O.O.S
then all of the following 500 kV reactors may be unavailable:
- MSA 5RX1, and
- TIR 5RX1/2/3, 5RX11/12/13 and 5RX21/22/23, and
- DMR 5RX1, 5RX2, 5RX3 and 5RX4

8.3.3.11.2 If 5L31 is O.O.S. **OR**
if 5L31 **AND** one of 5L30 and 5L32 are O.O.S.
then all of the following 500 kV reactors may be unavailable:
- MSA 5RX2, and
- TIR 5RX4/5/6, 5RX14/15/16 and 5RX24/25/26, and
- DMR 5RX5, 5RX6, 5RX7 and 5RX8

8.3.3.11.3 if 5L30 or 5L32 is O.O.S. **AND**
if 5L29 and 5L31 and 5L98 are in service **AND**
If ING 12RX4, 12RX5, 2RX1, 2RX2 are available
Then
- one of (KLY 12RX1, 2RX2, on-line KLY SC2 with AVR) may be unavailable, **AND**
- one of the following 500 kV reactors may be unavailable:
  - MSA 5RX1 or 5RX2, or
  - TIR 5RX1/2/3 or 5RX11/12/13 or 5RX21/22/23 or 5RX4/5/6 , or
  - 5RX14/15/16 or 5RX24/25/26, or
  - DMR 5RX1 or 5RX2 or 5RX3 or 5RX4 or 5RX5 or 5RX6 or 5RX7 or 5RX8.

8.3.3.11.4 If 5L61 is O.O.S. then WSN 5RX1 and GLN 5RX5 and TKW 5RX1 may be unavailable.

8.3.3.11.5 If 5L91 is O.O.S. then one of (SEL 5RX3, ACK (5RX4, 5RX7, 5RX8) may be unavailable.

8.3.3.11.6 If 5L92 or 5L94 is O.O.S. then
- CBK 5RX4, or 5RX5 may be unavailable, AND
- SEL 5RX3 may be unavailable.

8.3.3.11.7 If 5L96 is O.O.S. then SEL 5RX2 and SEL 5RX3 may be unavailable.

8.3.3.11.8 If 5L98 is O.O.S. AND
If ING 12RX4, 12RX5, 2RX1, 2RX2 are available,
Then one of (NIC (5RX3, 5RX4, 5RX8, 5RX10, 5RX11) and ACK (5RX4, 5RX7, 5RX8)) may be unavailable

8.3.3.11.9 If 5L96 AND 5L98 are O.O.S. then
- SEL 5RX2 and SEL 5RX3 may be unavailable, **AND**
- If ING 12RX4, 12RX5, 2RX1, 2RX2 are available,

Then one of the NIC 5RX3 or 5RX4 or 5RX8 or 5RX10 or 5RX11 may be unavailable

8.3.3.11.10 If 5L94 AND 5L96 are O.O.S., then

- SEL 5RX2 and SEL 5RX3 may be unavailable, **AND**
- One of ACK (5RX4, 5RX7, 5RX8) may be unavailable, AND
- CBK 5RX4 or CBK 5RX5 may be unavailable**.**

8.3.3.11.11 If no 500 kV circuit is O.O.S. AND
if ING 12RX4, 12RX5, 2RX1, 2RX2 are available,
Then one of the following 500 kV reactor(s) may be unavailable:

- SEL 5RX2 or 5RX3 **OR**
- NIC 5RX3 or 5RX4 or 5RX8 or 5RX10 or 5RX11 **OR**
- CKY 5RX1 **OR**
- MSA 5RX1 or 5RX2 **OR**
- TIR 5RX1/2/3 or 5RX11/12/13 or 5RX21/22/23 or 5RX4/5/6 or 5RX14/15/16 or 5RX24/25/26 **OR**
- DMR 5RX1 or 5RX2 or 5RX3 or 5RX4 or 5RX5 or 5RX6 or 5RX7 or 5RX8.

8.3.3.11.12 If no 500 kV circuit is O.O.S. **AND**
If ING 12RX4, 12RX5, 2RX1, 2RX2 are available **AND**
If KLY 12RX1 is available **AND**
If KLY S/C2 with AVR is in service,
then two of (KLY 2RX2, 5RX1, 5RX2, 5RX3, 5RX4, 5RX5, 5RX6) may be unavailable

8.3.3.11.13 If 5L71 circuit is O.O.S., then

- MCA 5RX4 may be unavailable, AND
- One of the NIC 5RX3 or 5RX4 or 5RX8 or 5RX10 or 5RX11 may be unavailable, AND
- SEL 5RX3 may be unavailable, AND
- One of ACK (5RX4, 5Rx7, 5RX8) may be unavailable.

8.3.3.11.14 If 5L72 circuit is O.O.S., then

- MCA 5RX3 may be unavailable, AND
- One of the NIC 5RX3 or 5RX4 or 5RX8 or 5RX10 or 5RX11 may be unavailable, AND
- SEL 5RX3 may be unavailable, AND
- One of ACK (5RX4, 5Rx7, 5RX8) may be unavailable.

8.3.3.11.15 If 5L76 or 5L79 circuit is O.O.S., then

- SEL 5RX3 may be unavailable.

8.3.3.11.16 If 5L75 or 5L77 circuit is O.O.S., then no exception, i.e.

- All 500 kV shunt reactors (VAS 5CX1 excluded) must be available.

8.3.4 Operating Guidelines and Restrictions

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

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

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

8.3.6 NTL Tie O.O.S.

The system condition of "NTL Tie O.O.S." includes:

- 1L274/887L O.O.S., or
- 1L275/786L O.O.S., or
- 1L274/887L AND 1L275/786L O.O.S., or
- 2L113 O.O.S., or
- NTL T1 AND NTL T2 O.O.S., or
- NTL T3 AND NTL T4 O.O.S, or
- NTL 1VR1 O.O.S.

When 2L113 is OOS, 60L281 must be open end at NTL. Do not open 60L285 at NTL, as SPD load is radially supplied by 60L285 (60D21 on 60L281 at SPD is normally open).

8.3.7 5L44 Contingency

Refer to each table of Attachment 1 in OO 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 or 5L72 O.O.S with One MCA Unit On-Line

Refer to Section 7.3.2 of OO 7T-33 for pre-outage restrictions. These restrictions are not implemented in TSA-PM. Also, refer to Table 1.2 in Attachment 1 of OO 7T-34 for other pre-outage restrictions associated with contingencies 5L91 or 5L96 or 5L98 or 5L96 AND 5L98, or 5L91 AND 5L96.

8.4 Ingledow to Custer Transfer Limits - (Export from BCH System)

Note 1: Arm ECS RAS per Sections 5.2.

Note 2: If the actual transfer exceeds the following limit, the BCHCC Operator should adjust the generation and/or schedule to reduce the transfer to within the limit:
In 20 minutes, if the limit is a transient stability or voltage stability limit, or
In 30 minutes, if the limit is a thermal limit

The type of transfer limit is identified as follows:
* Indicates a transient stability or voltage stability limit
** Indicates a thermal limit

System Status	ING to CUS Transfer Limit (MW)	BC to US Transfer Limit (MW)	Remarks
System Normal, or 5L4 O.O.S., or 5L76 O.O.S., or 5L79 O.O.S., or NTL Tie O.O.S.	The least of: 1) 2850*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) Attachment 4*, or 5) VSA ING to CUS limit*	The least of: 1) 3150*, or 2) ING to CUS limit + 400 3) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4 Section 8.3.6
5L91 O.O.S.	The least of: 1) 2850*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) Attachment 7*, or 5) VSA ING to CUS limit*	The least of: 1) 3150*, or 2) ING to CUS limit + 400 3) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
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 4) VSA ING to CUS limit*	The least of: 1) 3150*, or 2) ING to CUS limit + 400 3) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
5L51 O.O.S.	The least of: 1) Attachment 2**, or 2) Attachment 3*, or 3) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3
5L52 O.O.S.	The least of: 1) Attachment 2**, or 2) Attachment 3*, or 3) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3
5L40 O.O.S., or 5L41 O.O.S., or 5L44 O.O.S., or 5L81 O.O.S., or 5L82 O.O.S.	The least of: 1) 1700**, or 2) Attachment 2**, or 3) Attachment 3*, or 4) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.4
5L42 O.O.S.	The least of: 1) 1300**, or 2) Attachment 2**, or 3) Attachment 3*, or 4) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2
5L87 AND (5L71 or 5L72) O.O.S.	The least of: 1) 2000*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.5
2L112 O.O.S.	The least of: 1) 2850*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) Attachment 5*, or 5) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit 2) VSA BC to US limit*	Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
2L293 O.O.S.	The least of: 1) 2850*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) Attachment 6*, or 5) VSA ING to CUS limit*	The least of: 1) 3150*, or 2) ING to CUS limit + 400 3) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
5L71 O.O.S., or 5L72 O.O.S.	If MCA on-line units >= 2, then the limit is the least of: 1) 2400*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) VSA ING to CUS limit*	If MCA on-line units >= 2, hen the limit is Lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
	If MCA on-line unit = 1, then the limit is lesser of: 1) 1000*, or 2) VSA ING to CUS limit*	If MCA on-line unit = 1, then the limit is lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.8
5L75 O.O.S., or 5L77 O.O.S.	The least of: 1) 2400*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.3 Section 8.3.4
5L71 AND 5L72 O.O.S.	The least of: 1) 2000*, or 2) Attachment 2**, or 3) Attachment 3*, or 4) VSA ING to CUS limit*	The lesser of: 1) ING to CUS limit + 400 2) VSA BC to US limit*	Note 1, Section 8.3.1 Section 8.3.2 Section 8.3.4

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 30-minute rating of ING CT (3300 A). The MW rating is equal to "1.732 x 0.99 x 515 kV x Amp rating /1000".

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.

DO NOT schedule 5L51 or 5L52 maintenance outage during high imports from US. Without 5L51 or 5L52 in service, the CUS to ING transfer limit may be very low. 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.

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

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

8.5.3 NTL Tie O.O.S.

The system condition of "NTL Tie O.O.S." includes:

- 1L274/887L O.O.S., or
- 1L275/786L O.O.S., or
- 1L274/887L AND 1L275/786L O.O.S., or
- 2L113 O.O.S., or
- NTL T1 AND NTL T2 O.O.S., or
- NTL T3 AND NTL T4 O.O.S, or
- NTL 1VR1 O.O.S.

When 2L113 is OOS, 60L281 must be open end at NTL. Do not open 60L285 at NTL, as SPD load is radially supplied by 60L285 (60D21 on 60L281 at SPD is normally open).

8.5.4 Operating Guidelines and Restrictions

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

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

Refer to Section 7.3.1 of OO 7T-33 for pre-outage restrictions. These restrictions are not implemented in TSA-PM. Also refer to Table 1.2 in Attachment 1 of OO 7T-34 for the pre-outage restriction associated with the contingency 5L91 AND 5L96.

8.6 Custer to Ingledow Transfer Limits - (Import into BCH System)

Note 1: Arm ECS RAS per Section 5.2.

Note 2: Arm AB TIE RAS per Section 6.2.

Note 3: If the actual transfer exceeds the following limit, then the BCHCC Operator should adjust the generation and/or schedule to reduce the transfer to within the limit"

- In 20 minutes, if the limit is a transient stability or voltage stability limit, or
- In 30 minutes, if the limit is a thermal limit

The type of transfer limit is identified as follows:

* Indicates a transient stability or voltage stability limit

** Indicates a thermal limit

System Status	CUS to ING Transfer Limit (MW)	US to BC Transfer Limit (MW)	Remarks
System Normal, or 5L4 O.O.S., or 5L51 O.O.S., or 5L75 O.O.S., or 5L77 O.O.S, or 5L76 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) 2000**, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000**, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	Note 1 Note 2 Section 8.5.1
NTL Tie O.O.S.	The least of: 1) 2000**, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000**, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	Note 1 Note 2 Section 8.5.1 Section 8.5.3
5L52 O.O.S.	The least of: 1) 2000**, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000**, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	Note 1 Note 2 Section 8.5.1
5L40 O.O.S., or 5L41 O.O.S., or 5L42 O.O.S., or 5L81 O.O.S., or 5L82 O.O.S.	The least of: 1) 2000**, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000**, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	Note 1 Note 2 Section 8.5.1 Section 8.5.4
5L44 O.O.S.	The least of: 1) 1500**, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 1900**, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	Note 1 Note 2 Section 8.5.1 Section 8.5.4
5L87 AND (5L71 or 5L72) O.O.S.	The least of: 1) 2000*, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000*, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	Note 1 Note 2 Section 8.5.1 Section 8.5.2
2L112 O.O.S.	The least of: 1) 2000**, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000**, or 2) CUS to ING limit 3) VSA US to BC limit*	Note 2 Section 8.5.1
5L71 O.O.S., or 5L72 O.O.S.	The least of: 1) 2000*, or 2) Attachment 2** 3) VSA CUS to ING limit*	The least of: 1) 2000**, or 2) CUS to ING limit + 400 3) VSA US to BC limit*	If MCA on-line units >= 2, then: • Note 1 • Note 2 • Section 8.5.1 If MCA on-line unit = 1, then: • Note 1 • Note 2 • Section 8.5.1 • Section 8.5.5

9.0 GENERATOR SHEDDING

9.1 Initiation

When B.C. Hydro is exporting to US, 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) 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 the U.S. 500 kV Pacific AC Intertie (BPA/PACI RAS).

For contingencies in (a), (b) and (c), TSA-PM automatically calculates and recommends generator-shedding requirement in the BCH control area. For contingencies in (d), BPA dispatcher will call to advise generator-shedding requirement.

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

Contingency	BPA Label	SCC EMS Label	BCH Generating Stations and ING Substation Label
(c)	Gen drop to BCH ckt 2	BPA/NW (cct #2)	BPA AC 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 (AC-A RAS controller) via ING. Another signal from Munroe (AC-B RAS controller) via KCL.
(d)	Two independent redundant signals from BPA. One signal from Dittmer (AC-A RAS controller). Another signal from Munroe (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 generation shedding is required at MCA for any contingencies in OO 7T-18, select the MCA unit(s) above 435 MW for shedding first. (To be implemented in TSA).

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:

- At MCA:
  - 2 MCA units for all system conditions with the exception of both 5L71 and 5L72 O.O.S. or one MCA unit & one line operation, or
  - 1 MCA unit for one MCA unit & one line operation, or
  - 0 MCA unit for both 5L71 and 5L72 O.O.S.

  AND
- 2 REV units, AND
- 2 SEV units, AND
- 1 & 2/3 equivalent SEV units if SEL 5RX3 is unavailable, or
  2/3 equivalent SEV units if SEL 5RX3 is available,
  AND
- 1 WAN unit if WAN generating shedding is required, AND
- at GMS and PCN:
  - 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)

If fewer units are at each plant than as specified above for the pre-disturbance condition, consult System Performance Assessment to do special studies.

Breaker failure protections on Waneta G1, G2, G3 and G4 have been commissioned and put into service (refer to Section 4.3 of OO 7T-34 for details). Hence the previous requirement to shed one extra WAN unit, to cover potential WAN circuit breaker failure problem, is no longer needed and has been removed.

WAN G4 shall not participate in any generation shedding requirement. This is a generic rule in TSA-PM implementation.

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

- If both 5L51 and 5L52 are in service, shedding is available at GMS, MCA, REV, KCL, SEV, ALH, BRX and WAN.
- If 5L51 or 5L52 is O.O.S., shedding is available at GMS, MCA and REV.
- 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 OO 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, MCA and REV)

Generation shedding for loss of 5L51 = 1.34 x (ING to CUS transfer – *B*)
Where, *B* = 5L52 ambient temperature-dependent 30-minute MW rating (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 9.2.

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

(Shedding available at GMS, MCA and REV)

Generation shedding for loss of 5L52 = 1.27 x (ING to CUS transfer - *B*)
Where, *B* = 5L51 ambient temperature-dependent 30-minute MW rating (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 9.2.

9.6 Shedding for Loss of Pacific Northwest Circuits (BPA/NW RAS)
(Shedding available at GMS, MCA, REV, KCL and SEV**)**

BCH calls this RAS the "BPA/NW RAS". BPA calls it the "Gen Drop to BCH Circuit 2" RAS.

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

This is called the "800 MW Arming Level". The EMS 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
-2000 to +800	None
+801 to +2850	1.5 x (ING to CUS transfer – 800). Maximum of 1850 MW shed

Note 1: Do not undershed.

Note 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.

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 "100 MW Arming Level". The EMS 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
-2000 to +100	None
+101 to +2850	0.95 x (ING to CUS transfer – 100). Maximum of 1850 MW shed

Note 1: Do not undershed.

Note 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.

The BCH Transmission Coordinator can select the "800 MW Arming Level" or "100 MW Arming Level" by toggling a switch on the EMS shedding display. The BPA RAS Dispatcher will call the SCC Transmission Dispatcher 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 SCC Transmission Dispatcher when the status of the "Circuit #2 Gen Drop RAS" is changed, i.e. from armed to disarmed, or from disarmed to armed.

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

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

Provided that BCH is exporting to the U.S. Southwest using the PACI and/or the Pacific HVDC Intertie, 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 HVDC.

10.0 AUTOMATIC GENERATION CONTROL (AGC) SUSPENSION

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

11.0 TSA-PM IMPLEMENTATION

With respect to OO 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.

The EMS Transient Stability Analysis (TSA-PM) advanced application normally arms/disarms the ECS RAS, the RX RAS, and the AB Tie RAS.

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

The following alarms have been implemented in TSA-PM:

ALSTOM EMS AOR	ALARM DESCRIPTION	ALARM PRIORITY	PI Tag	REMARKS
TRANSMSN .	TSA-PM 7T-18 - ING_CUS 2850 - REQD 500KV CCTS NOT I/S	2	To be implemented	Section 8.3.3 Conditions required for increasing the ING to CUS transfer above 2000 MW
TRANSMSN	TSA-PM 7T-18 - NO 500 KV CONNECTION TO VI	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850 - REQUIRED SERIES CAPS OOS	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - /NG_CUS 2850: REQD ING CAPS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: ING REQD LV RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD KI2 RX NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: KLY 2RX2 NOT AVAILABLE	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: MSA 12RX1 & 2 NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD VIT SCS/SAT PIK RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: KLY_SC2 OR 12RX1 NOT AVAL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850:DMR SVC REQRMNTS NOT MET	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD 500KV RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD ACK RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD CBK RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: MDN REQD LV RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - TBY 2RX1 MUST IN SERVICE WHEN 2L129 ENERGIZED	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850:TBY/ING REQD LV RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: TBY/ING/MDN REQD LV RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: TBY/MDN REQD LV RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD ACK/SEL RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING AUTO-VAR MUST BE IN SERVICE	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - MDN AUTO-VAR MUST BE IN SERVICE	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ACK AUTO-VAR MUST BE IN SERVICE	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - WSN AUTO-VAR MUST BE IN SERVICE	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - SEL AUTO-VAR MUST BE IN SERVICE	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - BGS 230KV BUS VOLTAGE REQRMNT NOT MET	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: KLY RX - SC2 REQ NOT MET	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: REQD KLY RXS NOT AVAIL	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_CUS 2850: 1 MSA 12KV RX AVAIL REQ	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_EXP_CUS PRE_OUTAGE LIMIT VIOLATED	2	To be implemented	Section 8.4 ING to CUS Transfer Limits
TRANSMSN	TSA-PM 7T-18 - BCH_EXP_BPA PRE_OUTAGE LIMIT VIOLATED	2	To be implemented	

ALSTOM EMS AOR	ALARM DESCRIPTION	ALARM PRIORITY	PI Tag	REMARKS
TRANSMSN	TSA-PM 7T-18 - LOAD > 7000! CHECK VSA FOR ING_EXP_CUS	2	To be implemented	Attachment 3
TRANSMSN	TSA-PM 7T-18 - REDUCE BUT VAR ABSORPTION	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - INSUFF EQUIV BUT UNITS	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - ING_IMP_CUS PRE_OUTAGE LIMIT VIOLATED	2	To be implemented	Section 8.6 CUS to ING Transfer Limits
TRANSMSN	TSA-PM 7T-18 - BCH_IMP_BPA PRE_OUTAGE LIMIT VIOLATED	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - <CTG NAME> -MIN UNITS ONLINE VIOLATION	2	To be implemented	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
TRANSMSN	TSA-PM 7T-18 - <CTG NAME> - INSUFFICIENT GEN SHED ARMED	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - MIN#UNIT ONLINE VIOL. FOR 5L4 OOS	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - C5L51_52 GEN SHED > 3450MW	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - C5L52 GEN SHED > 3450MW	2	To be implemented	
TRANSMSN	TSA-PM 7T-18 - C5L51 GEN SHED > 3450MW	2	To be implemented	

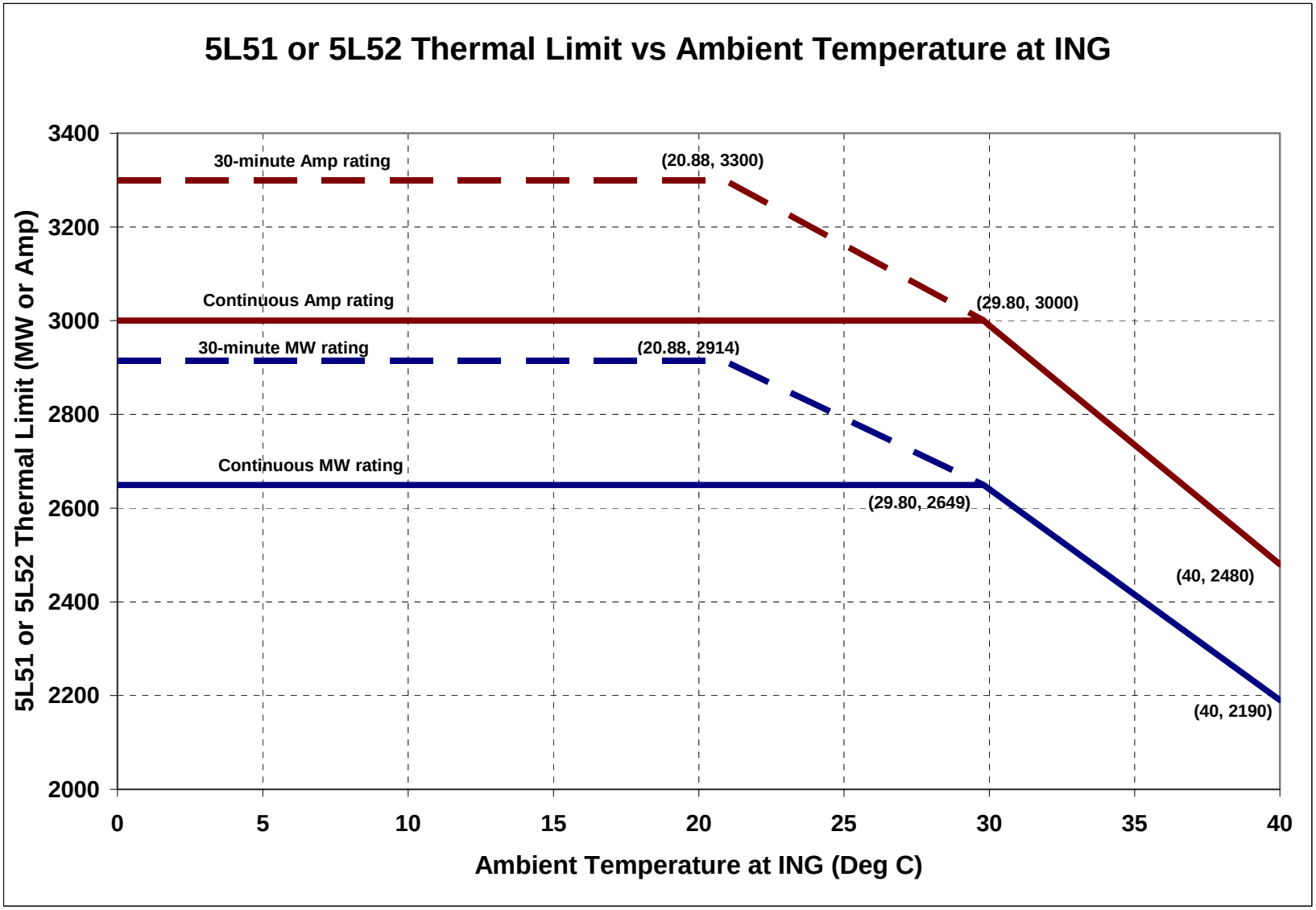
12.0 TSA BACKUP IMPLEMENTATION

TSA-BACKUP application is no longer supported and should not be used.

13.0 REVISION HISTORY

Revised By	Revision Date	Summary of Revision
JS	22 July 2008	• Update the BC to US limit for 5L71 or 5L72 OOS to 2800 MW Update Attachment 6 to increase BC/AB limits for 2L293 OOS
JS	12 February 2009	To accommodate VITR and VITR RAS I/S: • Section 8.3.3.6: add TBY 2RX1. • Section 8.3.3.7: add SAT 2RX1. • Attachments 2A-2 and 2B-2: item C is removed.
PZ/JS/R. Reyes	05 August 2010	• Updated Attachments 2A-1, 2A-2 and Sections 1.5 and 9.5 with new 5L51 thermal limits. • Updated Attachments 2B-1 and 2B-2 and Section 9.5 • Changed KI2 12RX2 for KI2 12RX1. KI2 12RX2 does not exist. Changed BCTC to BCH
JS/RAC	15 November 2010	To accommodate the additions of SI four projects (REV5, ACK 5CX1 & 5CX2, SEL 5RX3 and FBC OTR7) and 5L52 uprating: • Section 4.0: Added ACK RX RAS, SEL RX RAS, ACK Auto-Var scheme and SEL Auto-Var scheme. Excluded MDN 2RX1 from MDN RX RAS. Changed the frozen time for ING / MDN Auto-Var schemes when their RX RAS operates to 10 seconds from 40 seconds. • Section 8.3.3: Added the requirement on ING / MDN / ACK / WSN / SEL auto-var schemes. Allowed 5L75 or 5L77 OOS for the ING to CUS transfer above 2000 MW. Provided operating flexibility for ACK / SEL reactors. • Sections 8.4 and 8.6: Added 5L40 OOS, (5L75 or 5L77) OOS in the export/import tables. Increased the BC to US transfer limit for 5L75 or 5L77 OOS to 2800 MW from 2400 MW. • Section 9.2: Updated minimum units on-line (MUO) in SIE related to the SEL 5RX3 status. • Sections 9.3.3 and 9.3.4: updated gashed requirement for loss of 5L51 & 5L52. Added DTT 1L274 and DTT 1L275 when 5L94 is OOS. • Sections 1.5, 8.3.1, 8.5.1, 9.4, 9.5 and Attachments 1 and 2: Updated 5L51 and 5L52 thermal ratings.
RAC / JS	18 April 2011	• Revised to remove SCC/LMC/SIC references. Updated TSA-PM references for consistency, corrected labeling for Transmission Coordinator and Operator • For MCA shut down: (1) Added the system condition of 5L71 & 5L72 OOS in the Export / Import transfer limit tables in Sections 8.4 and 8.6. (2) Section 9.2: updated MCA minimum unit on-line post-shedding

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



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

Assuming:
B = 5L51or5L52_30Minute_MW_Rating = 1.732 * 0.99 * 515kV * 5L51or5L52_30Minute_Amp_Rating/1000 (see Attachment 1)
A = 5L51or5L52_Continous_MW_Rating = 1.732 * 0.99 * 515kV * 5L51or5L52_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 * *A*

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

ING to CUS transfer limit is the lesser of:

- *A*, or
- *B* – 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:

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

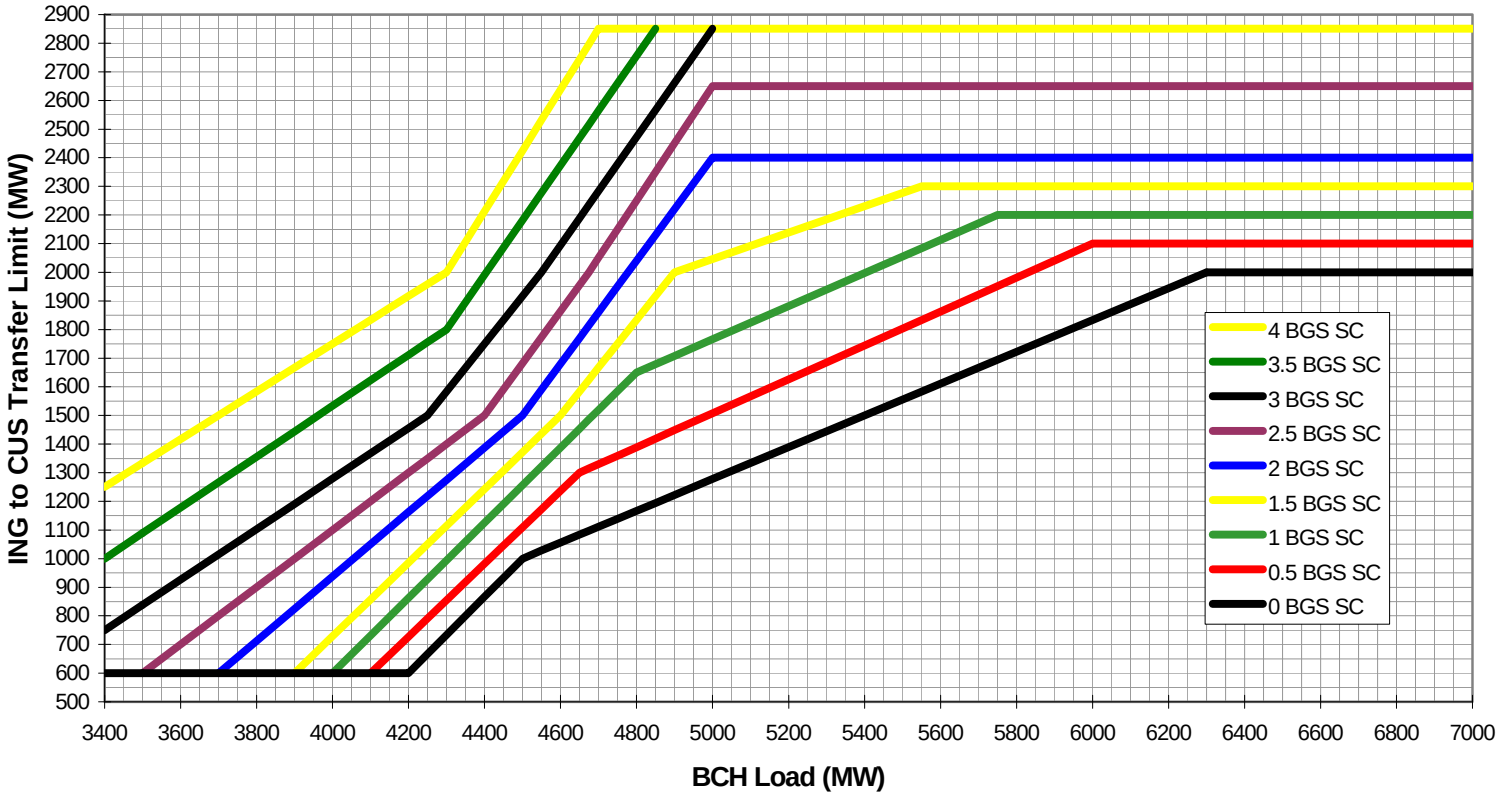
5L51 or 5L52 O.O.S:

CUS to ING transfer limit is the least of:

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

Attachment 3: **ING to CUS Transfer Limit versus BCH Load and Number of On-Line Equivalent Burrard Synchronous Condensers (All System Conditions)**



Notes:

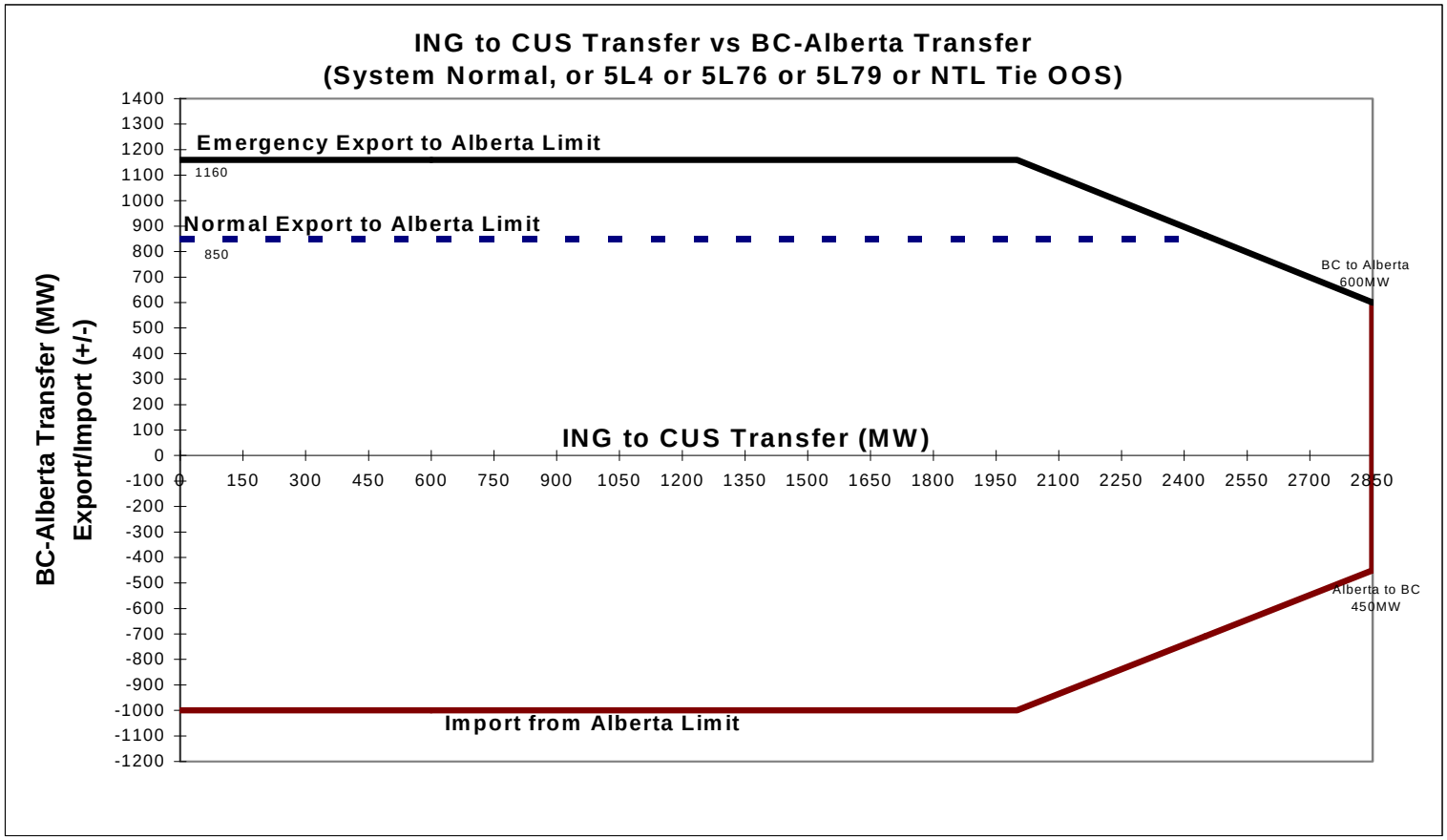
1. For BC Hydro loads greater than 7000 MW use the limits for 7000 MW. At loads in excess of 7000 MW VSA limits may be more restrictive

2. BGS SC and generator units must have AVR in automatic mode.
   If LDC is available, put LDC in service.
   Var absorption capability: A BGS generator at 50 MW or less is equivalent to one BGS SC
   A BGS generator at greater than 50 MW, it is equivalent to half of a BGS SC
   If the BC Hydro load is less than 6000 MW then:
   BGS plant var absorption must be less than (the number of equivalent BGS SC units with AVR) times (50 Mvars).

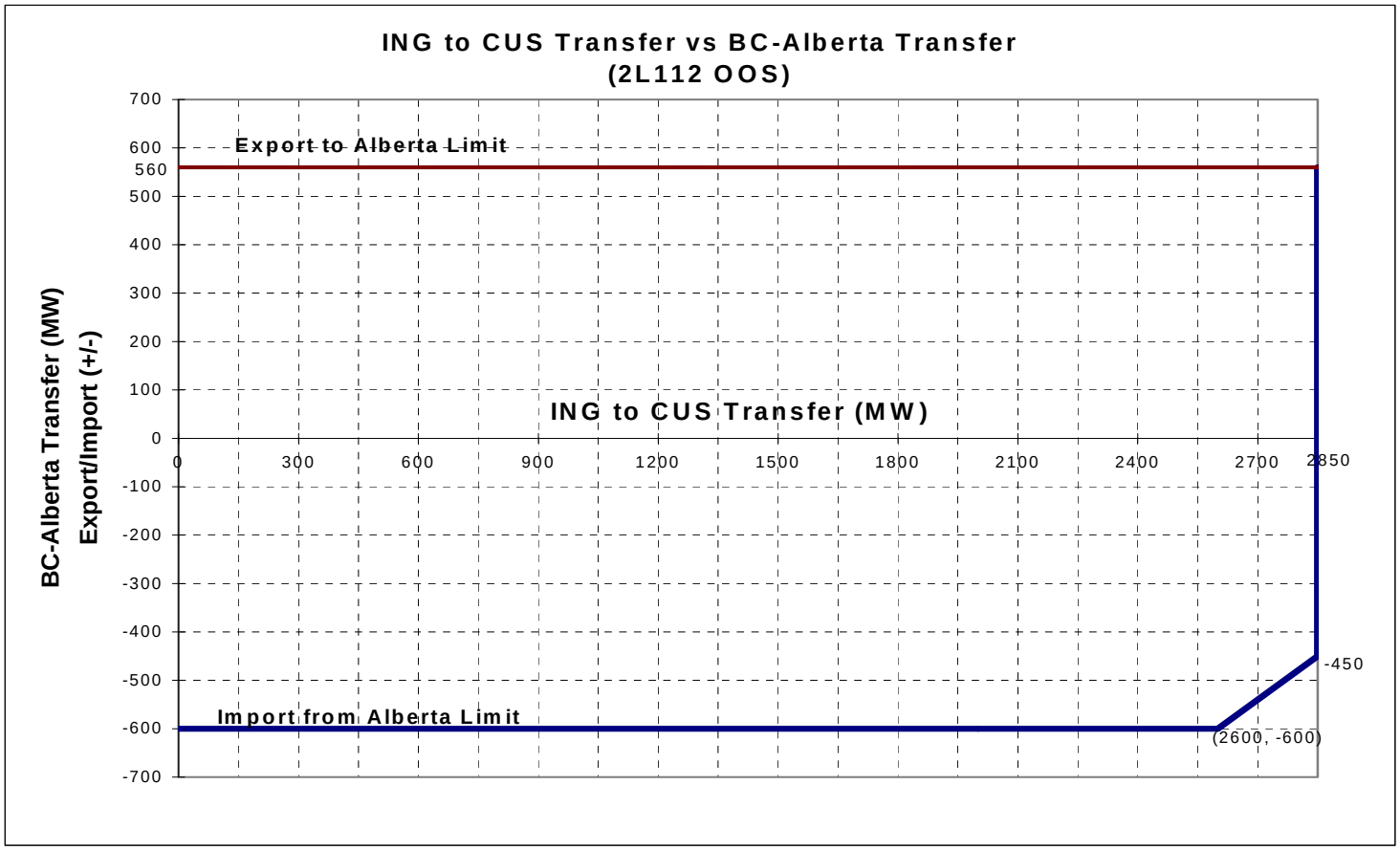
3. Operating above these transfer limits will result in high voltages that can damage underground cables in the Lower Mainland for the loss of 5L51 AND 5L52 during light load condition. Reduce ING-CUS transfer to be within the transfer limit.

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

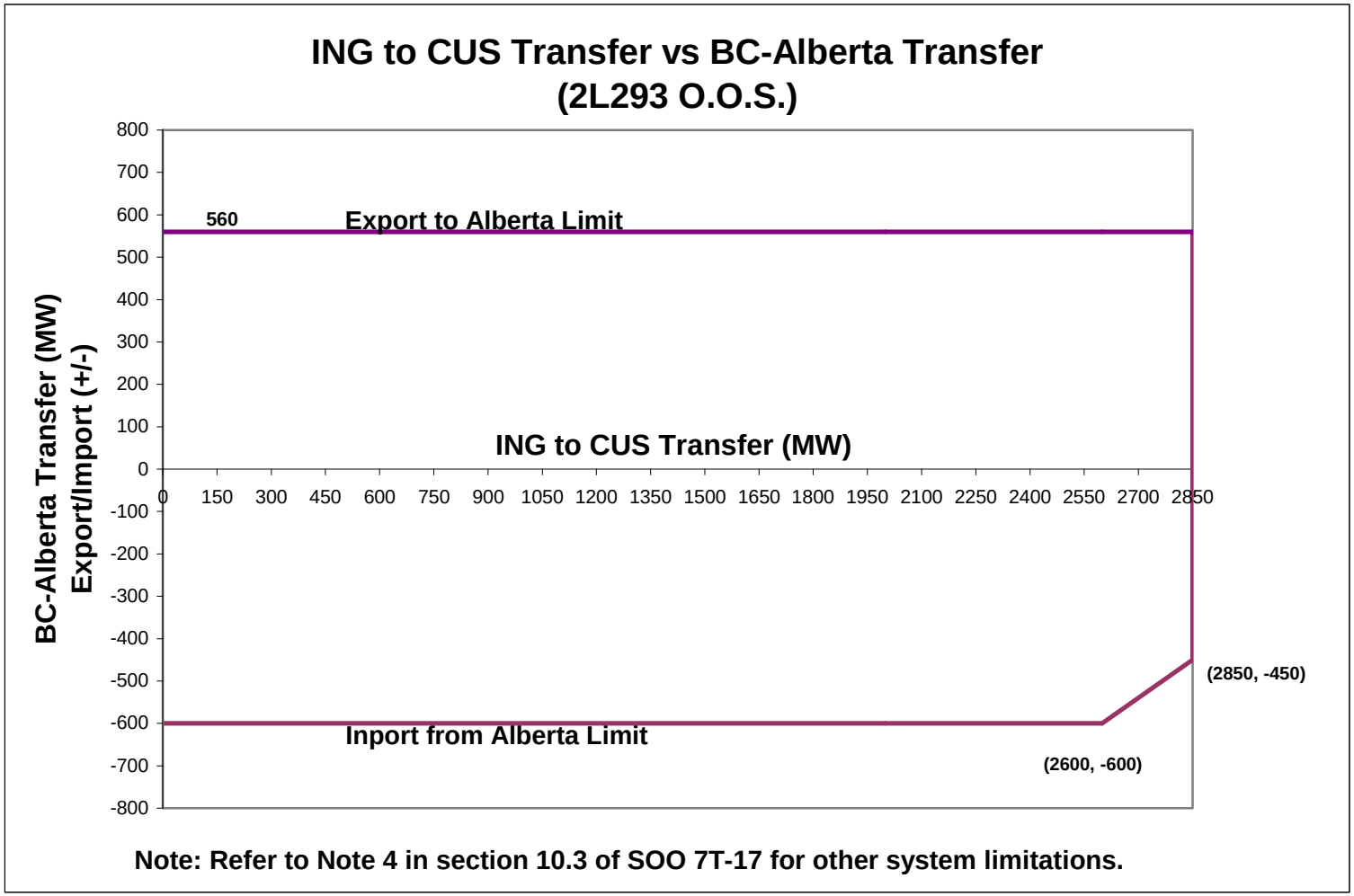
Attachment 4: **ING to CUS Transfer versus BC-Alberta Transfer (System Normal or 5L4 or 5L76 or 5L79 or NTL Tie OOS)**



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



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



Note: Refer to Note 4 in section 10.3 of SOO 7T-17 for other system limitations.

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