BC HYDRO

T&D SYSTEM OPERATIONS

SYSTEM OPERATING ORDER 7T-33

SOUTH INTERIOR SUBSYSTEM

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1.0 GENERAL

This System Operating Order (SOO) describes the operation of major South Interior generation and, station equipment, and transmission circuits including inter-utility circuits.

The South Interior Subsystem is characterized by two “loops” through the BC Hydro (BCH) and FortisBC (FBC) systems. In general:

- The **Big Loop** is defined as the path BDY-NLY-SEL-NIC-ING-BDY and has two additional parallel paths.
- The **Small Loop** is defined as the path WAN-ESS-WTS-BTS-SEL-NLY-WAN and a parallel path.

These loops have significant operating impacts and are described in detail in Section 6.0 of this System Operating Order. For generation shedding requirements refer to SOO 7T-34.

With respect to loop operations and generation shedding requirements, the FortisBC System is normally configured with 2L277 / 71L connected to WAN to NLY. FortisBC cannot operate with “WAN connected to BDY” (71L South on load), as it requires all FBC-BC Hydro loops open at the tie points, and the current interconnection RAS schemes to be disabled/reconfigured for the open ties. There are currently no Operating Plans or RAS configurations to support operation in the “WAN connected to BDY” configuration.

The rules and procedures covered in this SOO address the worst-case operating conditions. Where conditions warrant variations from these rules and procedures, additional Operating Plans, for specific cases will be prepared. Operating Plans are developed to support outages and short-term operating requirements, superseding as necessary any requirements in this order.

References:

- SOO 1T-11A “Operating Responsibility and Operating Authority Assignment to Desks”
- SOO 2T-43 “AGC Mode, Status, Pause and Suspension”
- SOO 5T-01 “Seasonal Overload Protection Settings on Transmission Circuits”
- SOO 6T-26 “BC Hydro Restoration Plan”
- SOO 7T-16 “BC Hydro - FortisBC Procedures for Interconnection Operations”
- SOO 7T-17 “BC - Alberta Interconnection”
- SOO 7T-18 “BC - US Interconnection”
- SOO 7T-22 “System Voltage Control”
- SOO 7T-33 “South Interior Subsystem”
- SOO 7T-34 “South Interior Generation Shedding and Outage Requirements”
- SOO 7T-64 “Rotational Energy to Support Transfer Limits”
- OO 3T-AMC-01 “American Creek Capacitor Station Operation”
- OO 3T-RYC-01 “Ruby Creek Capacitor Station Operation”
- OO 3T-SYA-01 “Seymour Arm Capacitor Station Operation”
- LOO 3G-MCA-09 “Mica Generating Station (MCA) Protection and Control”
- LOO 3G-REV-09 “Revelstoke Generating Station (REV) Protection and Control”

Definitions:

ACK refers to Ashton Creek Substation
ALH refers to Arrow Lakes Hydro (an IPP in the FortisBC Operating Area dispatched by BC Hydro)
AMC refers to American Creek Series Capacitor Station
ASM refers to A.S. Mawdsley Station (operated by FortisBC)
BDY refers to Boundary Substation (operated by Bonneville Power Administration (BPA)
BEN refers to Bentley Substation (operated by FortisBC)

BKL refers to Brocklehurst Substation
BRD refers to Brilliant Dam Generating Station (operated by FortisBC)
COR refers to the Corra Lynn Generating Stations (operated by FortisBC)
DGB refers to D.G. Bell Substation (operated by FortisBC)
DUG refers to Douglas Substation
ESS refers to Emerald Switching Station (operated by FortisBC)
GFT refers to Grand Forks Terminal Substation (operated by FortisBC)
HLD refers to Highland Substation
ING refers to the Ingledow Substation located in the Lower Mainland
KCL refers to Kootenay Canal Generating Station
KET refers to Kettle Valley Substation (operated by FortisBC)
LBO refers to Lower Bonnington Generating Stations (operated by FortisBC)
LEE refers to Lee Substation (operated by FortisBC)
MDN refers to the Meridian Substation located in the Lower Mainland
MCA refers to Mica Creek Generating Station
NLY refers to Nelway Substation
OLI refers to Oliver Substation (operated by FortisBC)
REV refers to Revelstoke Generating Station
RGA refers to R.G. Anderson Station (operated by FortisBC)
SEL refers to Selkirk Substation
SEV refers to Seven Mile Generating Station
SLC refers to South Slocan Generating Station (operated by FortisBC)
SVA refers to Savona Substation
SYA refers to Seymour Arm Series Capacitor Station
UBO refers to Upper Bonnington Generating Stations (operated by FortisBC)
VAS refers to Vaseux Lake Substation (jointly operated by BC Hydro and FortisBC)
VNT refers to Vernon Terminal Substation
WAN refers to Waneta Generating Station
WAX refers to Waneta Expansion (a BCH IPP operated by FortisBC)
WHS refers to Waneta Hydro Station (a switching station operated by FortisBC)
WTS refers to Warfield Terminal Station (operated by FortisBC)

BPA refers to the Bonneville Power Administration – a US based Utility
SCL refers to Seattle City Light – A US based Utility
Teck-Cominco - refers to industrial loads supplied at Transmission voltages from FortisBC Emerald Switching Station (ESS)

Kootenay River Plants - refers to FortisBC's BRD, COR, LBO, and UBO Generating Stations.

SI - refers to South Interior or South Interior Subsystem and is used interchangeably in this Order.

SIW - refers to South Interior West which includes the sub transmission between Nicola, Ashton Creek and Kelly Lake Substations

ILM - refers to the Interior to Lower Mainland Path which consists of transmission lines: 5L41, 5L42, 5L81, 5L82, 5L83, and 5L87.

2.0 RESPONSIBILITIES

Refer to System Operating Order 1T-11A for Operating Responsibility and Operating Authority assignments for the BC Hydro Control Centre (BCHCC).

3.0 SYSTEM VOLTAGE CONTROL

3.1 Nominal Voltage

SOO 7T-22 provides voltage nominals and normal bus voltage operating limits/ranges for all BC Hydro stations in the SI.

Normally 500 kV voltages must be kept below 550 kV except for short times during switching if it cannot be avoided.

Normally, keep NLY 230 kV voltage between 240 to 242 kV (to help maintain BDY area stability).

3.2 SF6 Switchgear Voltage Ratings

The maximum continuous voltage at MCA, REV, and ACK, is 550 kV for the 500 kV and 242 kV for the 230 kV CGI switchgear. Transformer tap position may reduce either the high or low limits as the ratio changes.

3.3 Overvoltage Protection

Refer to Section 9.1 of SOO 7T-22 for tripping of 500 kV circuits by near-instantaneous (250 msec) uncoordinated 500 kV overvoltage protection.

Refer to Section 9.2 of SOO 7T-22 for tripping of 500 kV circuits by sequentially timed 500 kV overvoltage protections.

3.4 MCA & REV RMR for Voltage Control

Historically, when MCA generation output is reduced, either 5L71 or 5L72 was switched out of service to aid in system voltage control, allowing the units to be removed from service. For current MCA operations, to reduce equipment failure risks, Operators should minimize the switching of 5L71 or 5L72 for voltage control as much as possible.

- In System Normal, to control high system voltage, the standing Reliability Must Run (RMR) requirement is to keep up to 3 MCA units on-line (in Synchronous Condenser (SC) or Generation mode) during light load hours (LLH). This applies to operating with both 5L71 and 5L72 lines in-service, and after all other available reactive support actions are taken (i.e. all NIC reactors are inserted, for example).

An additional MCA or REV unit(s) on line may be required to support forced outages to reactive equipment at NIC or MCA to address system voltage. This should only be utilized after all other reactive support actions are taken.

Only switch out one of the two MCA lines If BC Hydro Generation System Operations (GSO) has insufficient SC capable units available or cannot make units available in generate mode. In this case, 2 MCA units must be kept on-line (in Synchronous Condenser (SC) or Generation mode).

4.0 SERIES CAPACITORS OPERATIONS

Three Series Capacitor Stations support ILM transmission operations, and power transfer capability from the MCA to the SI transmission network.

4.1 American Creek Series Capacitors

The AMC Series Capacitor banks (5CX1 and 5CX2) are each rated at 539 MVar, 2120 Amps and 84.8 kV. Each bank consists of 1 module per phase. Each bank is equipped with current and voltage power supplies and back-up batteries. 5CX1 provides series compensation support for the operation of 5L81 (NIC-ING). 5CX2 provides series compensation support for the operation of 5L82.

Note: When the line is de-energized the banks will be auto bypassed.

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Note: When the line is re-energized the banks will be auto inserted if minimum current (212 A) is present; otherwise insertion is blocked.

The bank will bypass and auto re-insert single phase for line contingencies. Each module will auto insert after a fault if the correct conditions (volts and amps) are met on an automatic reclose. The current must be above 212 amps or the bank will not re-insert, and a manual insert is required when the current levels are met. If the bank is not inserted immediately after 5 seconds the auto insert failure timer alarms and generates a permanent bypass. A manual insert (pulse only) is needed to put the bank into service. If the current is not high enough (212 amps) the bank will not go in and another manual insert is needed when the current levels are met.

Generation shedding signals are sent to MCA and REV only in the case of 3-phase bypass of the bank.

4.1.1 AMC MODS Switching

Switching of the 500 kV MODS at AMC 5CX1 and 5CX2 can be done with its associated circuit in service.

4.1.2 AMC Protection

The overload Protection (PN) for each bank is set at:

2332 Amps	88 hours	Bypass
2650 Amps	13.8 hours	Bypass
2862 Amps	45 minutes	Bypass
3180 Amps	11 minutes	Bypass
3180 Amps	10 minutes	Alarm

The AMC banks are also equipped with Metal Oxide Varistor (MOV) protection that shunts current around the capacitors for SLG external (lower level) faults. For internal circuit faults and multiphase external circuit faults (higher fault levels), an energy relay will initiate spark gap/BPCB operation to bypass the bank. Also, an energy accumulator may bypass the MOV to prevent overheating of the MOV. Figure 4.3.1 shows the MOV protection functions.

Failures to execute a PN bypass will transfer-trip the circuit and auto-isolate the bank. Failure of a manual bypass only alarms as “manual bypass fail”.

4.2 Ruby Creek Series Capacitor

RYC 5CX1 provides series compensation for 5L83, approximately 103 km from MDN. This is near the middle of the line from MDN to NIC. The bank is rated at 1080 MVAR (360 MVar/phase), at 3000A continuous, and 120.0 kV across the bank. Each phase is a self-contained unit consisting of capacitors, Metal Oxide Varistors (MOVs), Cap Thor, reactor, damping resistors and Optical Current Transducers (OCTs).

The Automatic Insert control feature allows all automatic re-insert protections to be enabled or disabled. This includes the automatic control which will insert the bank when 5BP1 is opened.

Note: Automatic Insert must be disabled prior to performing any switching.

Note: When energizing the line, Auto Insert should be **disabled**.

When Auto Insert is Enabled, the capacitor bank will be automatically reinserted after a temporary bypass. When Auto Insert is Disabled (or there is a Permanent Bypass), there is no automatic re-insertion and the bank can only can be inserted manually (see Section 4.2.2).

During the period of December - February, RYC 5BP1 must not be automatically closed by a protection operation. Ice and snow accumulation in the normally open jaws may prevent good electrical contact. The dc power supply to the bypass disconnect switch (5BP1) motors must be blocked (when the disconnect is in the open position). Prior to opening 5CX1 isolating disconnect switches, the bypass disconnect switch must be visually checked closed. Auto isolation must be turned “OFF” in the local HMI. Refer to OO 3T-RYC-01 Section 2.2 for more detail.

4.2.1 RYC 5CX1 Switching

Please refer to OO 3T-RYC-01 for details on switching.

Note: It is essential to block automatic control functions, by disabling Auto Insert, prior to performing any switching.

Note: If 5CX1 has a permanent lockout, field personnel are required to reset the lock out at the station in the HMI.

4.2.2 RYC 5CX1 Protection

Please refer to OO 3T-RYC-01 for details on Protection.

The protections can initiate Temporary Lockout, Permanent Bypass, and permanent Lockout, as well as initiate Direct Transfer Trips (DDT) to remote terminals.

A Temporary Lockout is activated by protective operations related to the system. Capacitor Overload, MOV Overload and Capacitor Discharge Function are the only protections that yield a Temporary Lockout. The lockout will reset after different pre-defined time, depending on the initiating condition. The bank will re-insert automatically when the lockout resets. The bank will only re-insert if both ends of the transmission line are closed.

A Permanent Bypass is activated by a manual close order or initiated by Capacitor Overload protection, after repeated bypasses. Re-insertion can be performed manually from Supervisory control.

A Permanent Lockout is activated by protective operations related to a severe fault in the series capacitor equipment. This will cause an auto isolation of the bank, **but the grounding disconnects will not be commanded to close.**

Direct transfer trip (DTT) will clear the remote line terminals whenever the bypass breaker fails to close within a specified time. A further 0.5 seconds after the breaker failure protection operates, the bank is auto isolated. Once the bank is auto isolated, DTT will reset allowing the line to be re-energized.

4.3 Seymour Arm Series Capacitors

SYA 5CX1 and 5CX2 provide series compensation for transmission lines 5L71 and 5L72 respectively.

Each bank is rated at 422 MVAR at 3000 A continuous and 140.7 kV across the bank. Each phase is a self-contained unit consisting of capacitors, Metal Oxide Varistors (MOVs), Cap Thor, reactor, damping resistors and Optical Current Transducers (OCTs).

The Automatic Insert control feature is provided for each bank and allows all automatic re-insert protections to be enabled or disabled. This includes the automatic control protection which will insert the bank when 5BP1 or 5BP2 are opened.

Note: Automatic Insert must be disabled prior to performing any switching.

Note: When energizing the line, Auto Insert should be **disabled.**

When Auto Insert is Enabled, the capacitor bank will be automatically reinserted after a Temporary Bypass. When Auto Insert is Disabled (or there is a Permanent Bypass), there is no automatic re-insertion and the bank can only be inserted manually (see Section 4.3.2)

The bypass and isolating disconnects are interlocked with each other such that the line cannot be open circuited or the bank switched in/out if the disconnects, circuit breakers and ground switches are in the wrong position.

During the period of October - May, SYA 5BP1 and 5BP2 must not be automatically closed by a protection operation. Ice and snow accumulation in the normally open jaws may prevent good electrical contact. The dc power supply to the bypass disconnect switch (5BP1 and 5BP2) motors must be blocked when they are in the open position. Prior to opening 5CX1 or 5CX2 isolating disconnect switches, the associated bypass disconnect switch must be visually checked closed (refer to OO 3T-SYA-01 Section 2.2 for detail).

4.3.1 SYA Switching

Please refer to OO 3T-SYA-01 for details on switching.

Note: It is essential to block automatic control functions, by disabling Auto Insert, prior to performing any switching.
Note: If a bank has a permanent lockout, field personnel are required to reset the lock out in the station MMI.

4.3.2 SYA Protection

The protections can initiate Temporary Lockout, Permanent Bypass, and permanent Lockout, as well as initiate Direct Transfer Trips (DDT) to remote terminals.

A Temporary Lockout is activated by protective operations related to the system. Capacitor Overload, MOV Overload and Capacitor Discharge Function are the only protections that yield a Temporary Lockout. The lockout will reset after different pre-defined time, depending on the initiating condition. The bank will re-insert automatically when the lockout resets. The bank will only re-insert if both ends of the transmission line are closed.

A Permanent Bypass is activated by a manual close order or initiated by Capacitor

Overload protection, after repeated bypasses. Re-insertion can be performed manually from Supervisory control.

A Permanent Lockout is activated by protective operations related to a severe fault in the series capacitor equipment. This will cause an auto isolation of the bank, **including the closing of grounding disconnects.**

Direct transfer trip (DTT) will clear the remote line terminals whenever the bypass breaker fails to close within a specified time. A further 0.5 seconds after the breaker failure protection operates, the bank is auto isolated. Once the bank is auto isolated, DTT will reset allowing the line to be re-energized.

5.0 NLY PHASE SHIFTING TRANSFORMER

5.1 General

The NLY phase shifting transformer (PST) is rated at 400 MVA and has 33 taps for a phase angle range of +/- 40°. The PST can:

- Reduce counterclockwise BCH/BPA loop flow, which will reduce losses, offload the SEL transformers and improve voltage stability on the SI to LM circuits.
- Improve transient stability in the NLY-BDY area by keeping 2L112 in-service.
- Increase transfer capability.

2L277/71L will only be connected from WAN to NLY instead of connecting WAN to BDY (refer to SOO 7T-16 and Section 6.0 of this document for operational details).

5.2 Methods of Control

In MW control mode, the taps will automatically change to maintain the selected MW flow. In TAP control mode, the tap is fixed until it is changed via supervisory control. TAP control mode is the normal mode to minimize wear on the tap changer.

5.3 NLY PST Overload Protection

Moderate overload (400 to 560 MW) is detected by an overcurrent relay (1008 amps) in series with the PST hot spot devices (120 deg C). Severe overload (greater than 560 MW (1500 amps)) is detected by an overcurrent relay and is time delayed.

For a moderate overload **in TAP control mode**, the controller switches to MW control setting (RAS runback to 200 MW), and **supervisory control will be blocked until the moderate overcurrent relay is reset**. The controller will remain in the MW mode until the Operator transfers it back to TAP control.

When a moderate overload occurs **in MW control**, a "MW Control Failure" alarm will be received. A severe overload will alarm and also block tap changer operation.

If both severe and moderate overload protections operate, then NLY 2CB4 and 2CB6 will trip after a time delay.

5.4 Switching of the NLY PST

The NLY PST can be energized and de-energized from either the NLY or BDY side **provided the metal oxide surge arresters** on **both ends of the PST are in service.**

BDY substation has no remote synchronizing (but there is a local synchroscope). Therefore 2L112 and the NLY PST are restored from BDY as follows:
With 2L112 circuit end CB's open at NLY and BDY:

- Open NLY 2CB8 to avoid simultaneously picking up the circuit and PST.
- Energize 2L112 from BDY.
- Energize the PST from NLY 2CB6 and 2CB4 (this will also energize SS1 at NLY).
- Minimize the phase angle across NLY 2CB8.
- Close NLY 2CB8.

With 2L112 in service, PST switching can proceed as follows:

The PST can be bypassed/inserted (i.e. close/open NLY 2CB7) without off-loading 2L112. Interlocks have been provided so that it can only be bypassed when the tap changer is in the zero shift position (tap position 17).
Use NLY 2CB8 to energize/de-energize the PST; 2D2 can only make or break a parallel current.

5.5 2L293/2L112 Overload RAS

Loss of generation or BCH generation shedding may cause overloading on 2L293 (from NLY to SEL) or 2L112 (from BDY to NLY), especially during high import from US. Similar overloading problems can occur during export to US on loss of large amount of system load (i.e. Vancouver Island separation). The 2L293/2L112 Overload RAS uses overcurrent detection on 2L112 and 2L293 to change the tap position of the NLY PST until the load on these circuits drop below a predetermined reset value, or the maximum / minimum tap position has been reached. The tap control mode must be selected in order to allow the RAS to change the tap position.

- If overloading on 2L112 is from BDY to NLY or on 2L293 from NLY to SEL, the tap position should be raised to reduce 2L112 BDY to NLY flow.

- If overloading on 2L112 is from NLY to BDY or on 2L293 from SEL to NLY, the tap position should be lowered to reduce 2L112 NLY to BDY flow.

When this RAS operates, an output from the PLC will block part of the existing NLY PST Runback RAS scheme.

Note: the NLY PST Runback scheme consists of a moderate overload scenario and a severe overload scenario.

When the 2L293/2L112 Overload RAS operates, only the moderate overload scenario is blocked. Specifically, it only blocks to prevent the phase shifter transformer from changing to MW control mode as the 2L293/2L112 O/L RAS uses tap change mode. The severe overload scenario will remain unchanged and the runback will not be blocked in the case of 2L293/2L112 O/L RAS operation.

The BCHCC will receive an alarm which indicates that the 2L293/2L112 O/L RAS has operated. If a tap change is unsuccessful for any reason or the maximum / minimum tap position has been reached and the phase shifter fails to relieve overload of the line, 2L112 will be tripped as a back-up after a 15 minute delay. In this situation, there will be a "2L293/112 RAS Tap Fail/Limit Reached" alarm to the BCHCC.

If this alarm comes, the Operator should check immediately the ambient temperature at SEL and the loadings on 2L112 and 2L293. The Operator needs to adjust the system to eliminate overload. If overload is above the reset setting and system cannot be adjusted in timely manner then line should be tripped manually. It should be noted that in this situation, the NLY PST cannot be adjusted anymore to reduce the loading as the PST already reached its max/min tap position or failed to move. The Operator can then only adjust generation pattern or curtail BC/US schedule etc., to reduce overload.

This RAS is implemented TSA-PM (Refer to SOO 7T-34 Attachment 1 Section 4.0**).** The BCHCC have local / remote control and indication to enable / disable this 2L293/2L112 O/L RAS. The Operator is responsible to enable / disable this RAS. **This RAS is to remain in service at all times except for the RAS maintenance or testing.**

5.5.1 Seasonal Settings

There are two local control switches (one for 2L112 PY/SY and one for 2L293 PY/SY) at NLY substation to enable local selection of the relay settings group. There are two groups of settings used for this RAS for each line. The "summer" settings are selected when the switch is off and the "winter" settings are selected when the switch is on. The BCHCC indicates the status of the setting group selection on the NLY one-line.

The “Summer” or Group 1 settings (the switch is off) should be selected from 01 May to 31 October each year (reference System Operating Order 5T-01).

The “Winter” or Group 2 settings (the switch is on) should be selected from 1 November to 30 April each year (reference System Operating Order 5T-01).

Settings for the RAS:

- Time delay to initiate the RAS: 10 sec.
- Time interval between two adjacent tap changes: 5 sec.
- Incomplete Tap Change time = 18s

Current settings for 2L112 circuit:

- Summer: pick-up at 1050 A; reset at 900 A
- Winter: pick-up at 1200 A; reset at 950 A

Current settings for 2L293 circuit:

- Summer: pick-up at 1050 A; reset at 900 A
- Winter: pick-up at 1200 A; reset at 1100 A

6.0 BIG LOOP AND SMALL LOOP OPERATION

6.1 Definitions

The **big loop** is defined as the path BDY-NLY-SEL-NIC-ING-BDY. Several sections of the big loop have parallel paths, notably:

- 2L293 in parallel with: 2L294 in series with CBK 500/230 kV transformers, 5L92, and SEL 500/230 kV transformers.
- 5L96 and 5L98 in parallel with: 5L79/5L76 in series with 5L91.

The **small loop** is defined as:

- The path BDY-WAN-ESS-WTS-BTS-SEL-NLY-BDY, when 2L277 / 71L connected WAN to BDY (This operation is not supported – is normally open WAN-BDY).
- The path WAN-ESS-WTS-BTS-SEL-NLY-WAN, when 2L277 / 71L connected to WAN to NLY (normal operation)
- The BTS – KCL (2L288 / 79L) – SEL (2L295 + 2L299) parallel path exists with BTS-SEL (2L289 / 82L) for both small loop configurations.

Both big and small loops are normally closed.

When scheduling or allowing any equipment outages in real-time at KCL Plant, all outages (lines, CB's, disconnects, bus connections or transformers) will be studied for all impacts from the next contingency. BCH will not permit two simultaneous non adjacent circuit breaker outages to be scheduled at the KCL plant, without scenarios having been analyzed and mitigated. The purpose is to prevent islanding conditions in the FBC area.

6.2 Big Loop Operation and Switching

The NLY PST can minimize the big loop closing angles and should be the first place to adjust to minimize that angle.

Closing the Big Loop:

To avoid damage to generators in the area, the maximum permissible closing phase angle should not be exceeded.

- Phase angle readout is available when a station or breaker is selected for closing.
- all CBK, KCL, NLY, NTL, VAS and SEL 500 and 230 kV CBs as well as NTL 1CB1, 2 and 60CB1, 2, 3, 4, 11, 12 have phase angle readouts.
- At ACK by a transducer connected between 5L76 and 5L91 B phase to ground potentials.
- If the big loop closure is done on 5L91, 5L96 or 5L98, the phase angle should be under 15°. The maximum acceptable angle is 40°.
  Action: Decreasing SEL area generation at KCL and SEV to 20 MW each, decreasing WAN and BDY generation, and increasing REV/MCA. Reducing AESO import may also help.
  NOTE: BDY changes should be requested of the BPA Operator because of a transmission wheeling agreement between BPA and SCL.
- If the big loop closure is done on 5L92, 2L294, 2L293, or 2L112, the phase angle should be under 15°. Maximum acceptable is 25°.
  Action: Increase generation at KCL/SEV.

6.3 Small Loop Operation and Switching

6.3.1 Small Loop with 2L277 / 71L connected WAN to BDY

This operation is not supported as there are no RAS applications currently in place to support the system configuration.

6.3.2 Small Loop with 2L277 / 71L connected WAN to NLY

The NLY PST has negligible effect on loop closing angles. To avoid damage to generators in the area, the maximum closing angle should not be exceeded. With the new 230 kV configuration, the small loop can remain closed with the big loop open. RAS schemes shall automatically trip 2L112 open loss of key Big Loop connections. It is recognized that 62L ESS-WTS is the limiting factor for small loop flow and should be observed when adjusting area generation in this configuration.

At FortisBC (FBC) request, the small loop may be opened on 62L ESS-WTS to prevent overloading FBC's transmission system.

Phase angle readout is available when a station or breaker is selected for closing.
- KCL, NLY, SEL, WAN, BTS have phase angle readouts.

To close the small loop, the phase angle should be under 15°. Maximum acceptable is 20°.
- **<u>Action</u>**: Adjust WAN/ALH or KCL/SEV

7.0 EQUIPMENT RESTRICTIONS

7.1 Equipment Rating

7.1.1 Selkirk 500/230 kV Transformer Ratings

The nominal ratings are:

	MVA rating at 0 degrees C ambient	MVA rating at 17 degrees C ambient	MVA Rating at 30 degrees C ambient
T1	1425	1298	1200
T2	858	767	697
T3	911	814	739
T4	1425	1298	1200

SOO 7T-34 Section 5.0 notes that transfer limits use these transformer ratings. And further, Diagrams 1 to 10 in Attachment 2 of SOO 7T-34 provide detail thermal limit diagrams for these transformers as a function of Daily Average Ambient Temperature. These diagrams are applicable from -10 to 40 deg C, and used by TSA-PM for RAS arming purposes.

7.1.2 Selkirk 500kV or 230kV Circuit Breaker OOS

Selkirk 500 kV or 230 kV circuit breaker outages should be scheduled when Selkirk transformer loading is low so that operating restrictions are minimized.

To reduce the SEL transformer loading without reducing KCL, SEV, WAN or ALH generation, utilize the NLY phase shifter.

If Selkirk 500 kV or 230 kV circuit breakers must be taken out-of-service during high SEL transformer loadings then refer to SOO 7T-34 Section 5.0 and Diagrams 1 to 10 in Attachment 2 of SOO 7T-34.

7.1.3 BDY-BELL Circuit Ratings (Refer to BPA Standing Order No. 308).

7.1.4 SEV SF6 Voltage Limit

The maximum voltage on the SEV SF6 bus should not exceed **242 kV**, due to the risk of damaging the transformers.

7.1.5 KCL T5 AND T6 RAS

Level I – 186 MVA for 20 sec. or 167 MVA and 120 deg winding temp for 0.5 sec and keys gen shed signal to FortisBC.
Level II – 221 MVA for 30 sec. or 186 MVA for 20.3 min or 167 MVA and 120 deg winding temp for 20 min or 167 MVA and 135 deg winding temp, and trips the associated line and keys the gen shed signal to FortisBC.

7.1.6 KCL Multiple Breaker Outages

Equipment outages in the KCL bus must be considered for the next possible contingency to prevent a possible FBC islanding condition. Where there are multiple breaker outages, or other equipment outages, that could lead to islanding of the FBC area from KCL, mitigation plans must be considered. TDSO Operations Planning can provide mitigation plans as required for each situation that may arise.

7.2 MCA SF6 Bus and Reactor Switching

There is a known risk at MCA due to the state of the insulation system. Precautions must be applied to protect the SF6 bus from flashover. Due to limitations of the SF6 disconnects and the potentially serious effects of high voltage transients, the following special restrictions apply:

- All 500 kV SF6 disconnects are normally operated only when de-energized on both sides.
- All Areva and MELCO 500kV SF6 disconnect switches, except 5D23, 5D33, 5D24 and 5D34, are normally locked closed but operated electrically via local control. 5D23, 5D33, 5D24 and 5D34 are normally in electrical (motor) position for auto isolation capability.
- All 500 kV Circuit Breakers are equipped with Point on Wave (POW) controllers, however, some are specifically configured to energize lines or transformers or both (refer to Section 7.5)
- 500 kV breakers, transformers and reactors do not auto-isolate.
- MCA 5RX3 and 5RX4 auto-isolation scheme is in service.
- Circuit ground switches are not to be used to make or break live-line or induced currents. Bus grounds may be used, only if they are connected to and disconnected from the de-energized circuit using a circuit breaker. Bus protection must be blocked when bus grounds are used.
- MCA 5RX3 and 5RX4 cannot be energized or de-energized unless tied to the respective circuit lightning arrester and circuit, due to inadequacies of the MCA bus breakers. Interlocks prevent energizing a reactor unless its line DS is closed. The reactors can be used as a line reactor on the alternate line positions, provided the breakers have been configured to operate as a piece of bus, and the protection zone revised to include the RX. However, it is only intended to be used in cases of a sustained line outage where the other line reactor becomes unavailable.
- MCA LS1 or LS2 or LS3 must not be energized from the system and left open-ended. They must have at least one unit transformer energized with them to avoid transient overvoltage. Refer to Section 9.0 for special considerations on the energizing transformers.

7.3 Operation with One MCA Unit

Sustained operation with one of 5L71 or 5L72 OOS and only one MCA generating unit in service are not supported. There are no plans to operate with one line–one unit configuration for future.

However, TSA-PM is permitted to arm RAS to shed down to one unit on line at MCA for contingency responses. This is acceptable in order to address the immediate operating risk posed by insufficient shedding.

Note: Operators must take action to resynchronize a shed unit immediately, returning a second unit to service. If it is not possible to achieve restoration of 2 units in service on the single line configuration, the plant/unit must be islanded (by opening the remaining 500 kV line) and only permitted to serve local load. This requirement prevents exposure to self-excitation (reduces risk). Upon the restoration of 2 units to service, MCA can be reconnected/synchronized to the system on a single line.

7.4 Special Restrictions and Limitations at REV

7.4.1 Generator Circuit Breakers

The REV generator breakers are not equipped with closing resistors and must not be used for energizing a 500 kV circuit directly from the generator.

7.4.2 Unit Transformer Switching

Surge arresters between the generators and unit transformers protect the transformers from severe switching surges in CGI switchgear. The arrester may be separated from its associated transformer via bus links or in the case of T1, via 16D1, in which case, do not switch the associated unit transformer.

7.4.3 Unit Transformer Cooling Capability

Each transformer has limited natural cooling capability and is therefore protected by tripping its generator and field breakers after loss of cooling oil flow.

7.4.4 SF6 Disconnect Switching

All 500 kV SF6 disconnects are normally operated only when de-energized on both sides. 5D7, 5D8, 5D21 and 5D22 are used for transformer or line position auto-isolation initiated by protective relays.

7.4.5 500 kV Circuit Isolation Requirement

After a bus fault is indicated for a circuit position (5B7 and 5B10) at Revelstoke, the associated circuit MODS will automatically open following a circuit kickout without reclosing. The circuit MODS at Ashton Creek must be opened prior to closing up the ring bus at Ashton Creek to prevent energizing onto a SF6 bus fault on the circuit side of the open MODS at Revelstoke.

7.5 MCA Point-On-Wave (POW) Restrictions for Energizing Equipment

MCA 500 kV circuit breakers are equipped with Point-on-Wave (POW) controllers. However, some of the controllers are known to be in a failed permanent alarm state. Others are configured specifically for energizing a transmission line, or a pair of unit transformers with its connected lead shaft, or both. Listed below are the preferred breakers for use when energizing equipment.

MCA 5CB6 – permanently failed controller. This circuit breaker can be used for interrupting, or for paralleling/closing with synch check.

MCA 5CB7 – is configured for energizing Lead Shaft 2, with T3 and/or T4; or energizing 5L72. This circuit breaker can also be used for interrupting, or for paralleling/closing with synch check.

MCA 5CB9 - is configured for energizing Lead Shaft 1, with T1 and/or T2; or energizing 5L72. This circuit breaker can also be used for interrupting, or for paralleling/closing with synch check.

MCA 5CB10 – is configured for energizing Lead Shaft 1, with T1 and/or T2; or energizing 5L71. This circuit breaker can also be used for interrupting, or for paralleling/closing with synch check.

MCA 5CB11 – is configured for energizing 5L71
– and configured for ***re-energizing*** Lead Shaft 3 with T5/T6 (i.e. cases where it was used to de-energized one or both transformers immediately prior).
– The breaker POW ***cannot be used for transformer energization***. It shall not be used to energize T5/T6.

8.0 GUIDELINES FOR ENERGIZING CIRCUITS

8.1 Normal Energization Procedures

Normal Energization procedures are applicable whenever the majority of transmission circuits and generators in the South Interior are in service, and all reactors are on line. The preferred terminals from which to energize the circuits are described below.

CIRCUIT	PREFERRED SOURCE TO ENERGIZE CIRCUIT
5L71	MCA or NIC (see Section 8.2.4)
5L72	MCA or NIC (see Section 8.2.4)
5L81	ING
5L82	MDN
5L83	MDN
5L75	ACK or REV
5L77	ACK or REV
5L79	ACK (NIC if 5L76 is OOS)
5L76	ACK (NIC if 5L79 is OOS)
5L87	KLY or NIC
5L91	SEL
5L92	SEL
5L94	CBK (see SOO 7T-17 for details)
5L96	SEL
5L98	NIC

The length of circuits 5L75, 5L77, 5L76 and 5L79 are relatively short and are not equipped with shunt reactors. 5L87 is also relatively short but does have a line end shunt reactor at KLY and there are two 500 kV bus shunt reactors at ACK. Voltage rise at the energizing stations and along the circuits will not be a problem unless there are many generators and/or 500 kV circuits out of service in the South Interior.

Note: 5L71 and 5L72 should not be energized with the associated SYA series capacitor inserted. The SYA series capacitors should be inserted only after the circuit is on load with MCA generator units synchronized to the system.

8.2 Circuit Energization - Abnormal Configurations

When many 500 kV circuits and/or generators are not available due to outages, the steady-state voltage rise at the energizing station will increase. This is caused by the weakened source strength at the energizing station.

The voltage rise at the open-end of a circuit will be the sum of the Ferranti effect plus the voltage rise at the energizing bus. The following table shows the Ferranti rise at the open-end of the 500 kV circuits in the South Interior, assuming the source end voltage is 525 kV. Note that on 5L87, with KLY 5RX6 connected to the line, there is no Ferranti rise at the KLY end due to the reactive compensation. If the source end voltage is substantially higher than 525 kV, the Ferranti rise can be calculated by the equation:

Ferranti rise = (Source voltage/525 kV) x Ferranti rise @ 525 kV.

Table: Voltage Rise Along 500 kV S.I. Circuits

CIRCUIT	Voltage Rise at Open End of the Energized Circuit	
	With Line-End Reactor	W/O Line-End Reactor
5L71 or 5L72	12 kV	37 kV
5L71 (or 5L72) with SYA 5CX1 (or SYA 5CX2) in service	11 kV	17 kV
5L75 or 5L77	-	3 kV
5L76 or 5L79	-	6 kV
5L81	9 kV	32 kV
5L82	5 kV	27 kV
5L83	5 kV	26 kV
5L87	-	11 kV
5L91	5 kV	25 kV
5L92	1 kV	14 kV
5L94	21 kV	46 kV
5L96	12 kV	23 kV
5L98	6 kV	18 kV

All 500 kV circuits will be cleared almost instantaneously if voltages exceed 625 kV. A sequential timed tripping scheme operates below 625 kV and above 560 kV (for details see SOO 7T-22).

8.2.1 Energizing the First Circuit from Nicola (5L81, 5L82, 5L83 or 5L87)

Can energize from NIC provided:

- at least 3 MCA, or 2 MCA and 2 REV units are tied to NIC,
- only one MCA-NIC circuit (with both of its reactors) is to be in service. If REV is also used, only one REV-ACK and one ACK-NIC circuit is to be in service,
- at least one NIC transformer is to be energized to provide a ground source,
- NIC voltage depressed to 495 kV or lower.

8.2.2 Energizing the First Circuit to ACK (When 5L76 AND 5L79 Are OOS)

Energize 5L76 or 5L79 from NIC. Station voltage rise should be less than 10 kV at NIC.

8.2.3 Energizing the First Circuit to SEL (When 5L91, 5L96 and 5L98 Are OOS)

8.2.3.1 Energize 5L98 from NIC when both circuit reactors are in service. Station voltage rise should be less than 10 kV at NIC, or 20 kV if the NIC line reactor is unavailable. Energize 5L96 from VAS with SEL 5RX2 connected. There is no synchronizing at VAS, only synch check on reclosing. Synchronization will be done at Selkirk. If 5L91 is in service then energize 5L96 from SEL with SEL 5RX2 and close the loop at VAS.

The maximum 5L96 / 5L98 steady state transfer is 1300 MW until the second 500 kV path from SEL to NIC is established to avoid thermal overload of lower voltage parallel circuits.

8.2.3.2 Energize 5L96 from SEL if SEL 5RX2 is OOS.
Switch in 5L91 prior to energizing 5L96 from SEL.

8.2.3.3 Normally energize 5L91 from SEL with:

- At least three units at KCL/BDY/SEV connected to SEL, and
- 2L293 and 2L112 in service, and
- With SEL below 500 kV.

Note: Add one unit if 2L293 or 2L112 are OOS or if the ACK 5L91 line reactor is OOS.

- SEL voltage will rise 20 kV if the ACK line reactor is in-service.
- SEL voltage will rise 35 kV if the ACK line reactor is out of service.

8.2.3.4 If forced to energize from ACK, THEN first reduce ACK to 510 kV with bus reactors if the line reactor is unavailable.

- ACK may rise 25 kV.
- The Ferranti effect will raise the open end of 5L91 a further 5 kV if the 5L91 reactor is in service.
- The Ferranti effect will raise the open end of 5L91 a further 25 kV if the 5L91 reactor is out of service.

8.2.4 Energizing the First Circuit to MCA (When 5L71 and 5L72 Are OOS)

When energizing 5L71 or 5L72 with MCA generation off line, do not energize with the associated SYA series capacitor inserted. Refer also to Section 9 for notes on energizing MCA transformers (for preventing ferroresonance).

Note: The SYA series capacitors should be inserted only after the circuit is on load with MCA generator units synchronized to the system.

Note: No attempt should be made to energize a line with more than two MCA transformers connected,

The following **general** procedures for energization of two transformers at a time at MCA are preferred (assumes 5L71 will form the radial connection to MCA but Steps 2 to Step 6 can be adapted for 5L72).

Initial Conditions:
Both 5L71 and 5L72 are out of service,
SYA 5CX1 and 5CX2 are bypassed,
NIC 5CB8 and 5CB18 and MCA 5CB6, 7, 9, 10, 11, 5D23, 5D33 are all open.
NIC 5D24 is closed and 5RX4 is connected to the line.

Step 1: Lower NIC 500 bus voltage to 530 kV or below.

Step 2: Ensure that SYA 5CX1 is bypassed and that it will NOT auto-insert once 5L71 is energized. Close NIC end of 5L71, to energize the line, 5RX3 and 5B10.

Step 3: Close 5CB10 to energize Lead Shaft #1 and T1 and T2 (refer to Section 7.5).

Step 4: Bring up MCA G1 then synchronize it to its bus as per present operating procedures and regulate the MCA 500 bus voltage to its normal range.

Step 5: Bring up MCA G2 and synchronize it to its 16kV bus.

Step 6: With this operating configuration at MCA, the operators can energize two more transformers - Lead Shaft #2 (T3 and T4) or Lead Shaft #3 (T5 and T6) (refer to Section 7.5).

Note: With MCA 5RX4 in service and SYA 5CX1 bypassed, the Ferranti rise at MCA end is about +16 kV. With NIC brought down to 530 kV prior to energizing the line, the voltage at MCA will not exceed 550 kV (with 4 kV margin). With MCA 5RX4 out of service and SYA 5CX1 bypassed, the Ferranti rise at MCA end is about +37 kV, then NIC needs to be brought to 510 kV to create margin.

8.3 Circuit Energization with Line Reactors OOS

8.3.1 5L71 (or 5L72) - With One Line End Reactor OOS

Energize the circuit from the end without a reactor.

At least two MCA units must be on line if MCA is the energizing end and the associated SYA CX may be inserted (recommended) or by-passed.

Single pole auto-reclosing shall be used but faults remote from the reactor may not clear.

8.3.2 5L71 (or 5L72) - With Both Line Reactors OOS

The circuit may only be energized if:

- a reactor can be “borrowed” from the NIC end of the circuit (for 5L71 or 5L72).
- the circuit is energized from MCA with at least 3 units on line at minimum voltage. The associated SYA CX may be inserted (recommended) or by-passed.
- Refer to Section 7.5 for preferred MCA breaker.

Emergency protection settings are not required.

8.3.3 5L81 or 5L82 or 5L83 - With No Line Reactor

Emergency settings are not required. Energize from ING or MDN respectively after lowering the bus voltage as required.

If reactors NIC 5RX9 (or 5RX8) are not available on 5L82 (or 5L83) respectively with MDN voltage at 527 kV, then a voltage rise of approximately 9 kV is expected at MDN end after the line being energized from MDN. A line open-end voltage of approximately 563 kV is expected at NIC. The Ferranti rise is approximately 26-27 kV. The synchronizer at NIC has delta V primary L-L setting of 39 kV and phase angle of approximately 28 degrees. The BCHCC Operator should attempt to match voltage across the station 500 kV circuit breaker before synchronizing. This will prevent a large voltage swing from LM to SI.

8.3.4 5L91 - With No Line Reactor

Energize 5L91 preferably from ACK. Depress ACK voltage to 510 kV prior to energizing.

If the circuit must be picked up from SEL; then the AESO tie and the NLY and WAN ties must be in service, and 2/3 of the generation at SEV, KCL, and BDY must be on line. The SEL voltage must be depressed to 510 kV prior to energizing.

8.3.5 5L96 / 5L98 - With all Reactors OOS

5L98 can only be energized from NIC. The NIC voltage must be depressed to 510 kV prior to energizing.

9.0 ENERGIZING MCA TRANSFORMERS

MCA may be energized in one of two ways:

- From the system.
- From the generator at zero voltage (for this procedure refer to 3G-MCA-01 MCA Generation Station – Station General and Operations, Section 1.1.3, Page 3 (Dead Bus Closing/Synchronizer Bypass).

There are known ferroresonance characteristics associated with configurations of the transformers, reactors, line inductance, and series capacitors. The following special restrictions apply:

- **NO attempt should be made to energize more than two MCA transformers simultaneously from a single circuit from NIC.**
- When energizing two or fewer MCA transformers on a single radial line from NIC (either 5L71 or 5L72), the SYA Series Capacitor associated with circuit **must <u>not</u>** be inserted.

When energizing MCA transformers from the system, follow the general steps in Section 8.2.4.

10.0 MCA OUTPUT LIMITS

10.1 Conditions for Normal Operation

5L71, 5L72, 5L81, 5L82, 5L83 and 5L87 circuits are in service. Output limits are identified by TSA-PM for a variety of outage configurations (refer to SOO 7T-34).

10.2 Output Limits

BCH Generation System Operations issues periodic updates to gate limits based on present elevations, as unusual conditions in the CROW.

MCA G1 is a 526 MVA machine, 16.0 kV and 0.95 pf. G1 has hydraulic stability concerns limiting the Turbine to 456 MW. Further, the unit output is limited by the unit transformer continuous current rating of 457 MVA.

MCA G2 is a 526 MVA machine, 16.0 kV and 0.9 5 pf. G2 has hydraulic stability concerns limiting the Turbine to 456 MW. Further, the unit output is limited by the unit transformer continuous current rating of 457 MVA.

MCA G3 is a 526 MVA machine, 16.0 kV and 0.95 pf. G3 has hydraulic stability concerns limiting the Turbine to 478.5 MW. Further, the unit output is limited by the unit transformer continuous current rating of 457 MVA.

MCA G4 is a 526 MVA machine, 16.0 kV and 0.95 pf. G4 has hydraulic stability concerns limiting the Turbine to 478.5 MW. Further, the unit output is limited by the unit transformer continuous current rating of 457 MVA.

MCA G5 & G6 are 570 MVA machines, 16 kV and 0.9 pf. There are no documented hydraulic restrictions or transformer limitations noted in WECC Test reports for the units. Unit transformers are rated at 630 MVA continuously.

11.0 PROTECTION REQUIREMENTS AND SPECIAL FEATURES

11.1 Open Terminal Keying

To prevent possible overvoltage when a particular terminal is open, an instantaneous non-reclose transfer-trip is keyed to trip the remote terminal of that circuit (5L75, 5L76, 5L77, 5L79, 5L81, 5L82, 5L83, 5L91, 5L92, 5L94, 5L96 and 5L98).

11.2 Out of Step Protection (OOSP)

OOSP tripping is provided on:

- SEL T2, T3, 2L221, 2L222
- KCL 2L295, 2L299, 60L225 and 60L227
- CBK 5L94 (with reclose blocking).

11.3 Overfrequency Protection

An overfrequency relay at REV trips and blocks automatic reclosing of 2L253.

11.4 Expanded MCA Lead Shaft Tripping

Expanded protection tripping is automatically implemented within bus protection relay logic. MCA 5B5, 5B6, 5B9 have dynamic zone compensation when lead shafts are tied together.

If MCA 5D7 and 5D8 are closed, then it is necessary to have this expanded tripping to clear infeed to a fault from either side of 5D7 or 5D8. Similarly, if MCA 5D9 and 5D10 are closed then it is necessary to have expanded tripping to clear infeed to a bus fault from either side of MCA 5D9 or 5D10 (refer to 3G-MCA-09).

11.5 Expanded REV Lead Shaft Tripping

The REV Lead Shafts can be tied together by closing 5D38 and 5D39. When these disconnects are closed, expanded tripping is automatically implemented in the 5MB1 and 5MB2 bus protection zones. For bus faults, this is necessary in order to clear in-feed from either side of REV 5D38 or D39 (refer to 3G-REV-09).

11.6 NIC 500/230 kV Transformers

At least one NIC 500/230 kV transformer should be energized from the high side whenever there are less than six 500 kV circuits energized into NIC to ensure adequate ground fault protection.

A NIC 500/230 kV transformer should not be left energized from the low side unless the parallel bank is in service to provide sufficient fault capacity for reliable relay operation.

11.7 NIC 1L244 Extended Tripping

An extended tripping is installed at NIC designed to trip 1L244 and drop the WBK load under conditions, such as a loss of the 500 kV and/or 230 kV injection to the NIC 138 kV bus, which could result in unacceptable low voltage.

The scheme is normally not enabled. The extended tripping scheme is available at NIC and selectable locally on the NIC 1L244 PY and NIC 1L244 SY panels (refer to 3T-NIC-01)

For planned outages, which that could lead to a next contingency loss of the 500 kV and/or 230 kV injection to the NIC 138kV bus, TDSO Operations Planning may identify, the requirement to enable the 1L244 extended tripping.

Under forced outages of either NIC T2/T6/5MB4 or NIC T3/T5/5MB2, a real time study should be undertaken by the Transmission coordinator. TDSO may identify the need to enable extended tripping in the performance of their Real time Assessments, or upon receipt of an identified SOL exceedance from the BCRC. In such cases Operators should dispatch an electrician to enable the 1L244 extended tripping.

When the scheme is enabled, the FVO Grid 1B Operator will receive an informational P6 alarm: NIC 718 1L244 EXTENDED TRIPPING ENABLE

When the 1L244 extended tripping scheme is enabled, additional tripping to NIC 1CB15 and NIC 1CB16 is provided via the following
protective relays:

NIC 1CB15 is tripped when the PN elements operate:
- NIC T3 PY and SY PN
- NIC T5 PY and SY PN
- NIC 5MB1/2 PY and SY PN
- NIC 5MB3/4 PY and SY PN

NIC 1CB16 is tripped when the following PN elements operate:
- NIC T2 PY and SY PN
- NIC T6 PY and SY PN
- NIC 5MB1/2 PY and SY PN
- NIC 5MB3/4 PY and SY PN

12.0 AUTOMATIC RECLOSING

12.1 General

Reclosing supervision must be in service at all times. There is no parallel circuit reclose supervision for SI 500 kV circuits whenever there are more than two circuits connecting two parts of the system. Therefore, 5L76, 5L79 and 5L87 are not provided with parallel circuit reclose supervision at either end. 5L81 and 5L82 reclose supervision is provided by parallel circuit (or 5L87) current flow. Voltage supervision is provided at each end of 5L76, 5L79, 5L81, 5L82 and 5L87.

5L71, 5L72, 5L91, and 5L96 are equipped with master end parallel circuit current reclose supervision.

5L76, 5L79, 5L91, 5L92, 5L96 and 5L98 have synch-check follow end reclose supervision for 3-phase trip and auto-reclose. ACK 5L91 synch check is provided from a bus CVT or a VT on a transformer tertiary winding (5CVT8 or12PT2). If the transformer is out of service, the voltage signal will not be available and three phase auto reclose will be blocked.

Remote reclose blocking on most 500 kV lines can be switched by supervisory at the BCHCC.

An unsuccessful single pole reclose will trip 3 phase by pole disagreement tripping inherent in the CBs. Further automatic reclosing is blocked.

12.2 Positions for Trip and Reclose Selector Switch - 79 CS

5L71, 5L72, 5L75, 5L76, 5L77, 5L79, 5L81, 5L82, 5L83, 5L92, 5L94, 5L96 and 5L98 are equipped with single-pole trip and reclose. Available reclose options are:

Position 2	SLG Fault Multi-Phase Fault	Trip 3P & RCL Trip 3P & Non-RCL
Position 3	Any Fault	Trip 3P & RCL
Position 4	SLG Fault Multi-Phase Fault	Trip 1P & RCL Trip 3P & Non-RCL
Position 5	SLG Fault Multi-Phase Fault	Trip 1P & RCL Trip 3P & RCL

The reclose selection must be in the same position at both ends of the circuit normally. Alternatively, it is acceptable to operate with one end set to Position 4 and the other end set to Position 5.

If a circuit is operated with:

- no line-end reactor connected, **OR**
- if the neutral reactor is removed from service,
  then the reclosing should be selected to Position 3 (trip and reclose 3-pole only) since single-pole reclosing will likely be unsuccessful.

5L71/72 have parallel line current reclose supervision. In the case of one circuit OOS, the selector switch should be left in Position 5 for the remaining circuit.

12.3 5L75 and 5L77 Auto Reclosing with REV 500 kV Ring Open

If REV 5CB9 is open, REV 5CB8 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked.

If REV 5CB12 is open, REV 5CB11 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked.

For System Reliability, with one Circuit Breaker out of service, it is preferred to have the single pole reclosing in service.

12.4 5L71 and 5L72 Auto Reclosing with MCA 500 kV Ring Open

5L71 and 5L72 reclosing do not need to be changed if the MCA 500kV ring is open. Proper interlocks have been installed such that:

- If MCA 5CB6 is open, MCA 5CB7 and MCA 5CB11 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked.
- If MCA 5CB7 is open, MCA 5CB11 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked.
- If MCA 5CB9 is open, MCA 5CB10 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked.
- If MCA 5CB10 is open, MCA 5CB9 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked
- If MCA 5CB11 is open, MCA 5CB7 three pole auto-reclosing is automatically blocked. Single pole auto reclosing is not blocked

For System Reliability with one Circuit Breaker out of service it is preferred to have the single pole reclosing in service.

12.5 Removed

12.6 2L113, 2L295 and 2L299 Single Pole Auto Reclosing

2L113 is equipped with single pole auto-reclosing only. Three phase faults will not auto-reclose.

2L295 and 2L299 are equipped with single pole and three pole auto-reclosing. The first breaker to close at each line terminal is equipped with single-pole trip and auto-reclose, the second circuit breaker is a three-pole trip and auto-reclose.

1. When the first (single pole) breaker is out-of-service, all protection tripping at that line end is converted to 3 pole trip and auto-reclose.

2. When all breakers associated with 2L295 or 2L299 are in-service, the second (three-pole) breaker will trip three-pole for single-phase faults and not auto-reclose. Supervisory reclosing of these CBs will be required after the line is restored following the auto-reclosing by the single-pole breakers at both terminals.

   Note: Circuit breaker outages for single pole auto-reclosing CBs with DS open require auto-reclosing be turned off or three pole line auto-reclosing may fail. At Selkirk the 'Supervisory Blocking/Reclose Off' switch for the 230kV breaker that is OOS must be turned 'OFF'. At KCL the output of the 52Z relay for each line breaker provides to the line protection relay the CB status (which includes the CB DS). It is still recommended that at KCL the circuit breaker OOS have the "Recloser ON/OFF" switch is turned 'OFF' at the circuit breaker if it is OOS with DS open.

13.0 RESTORATION PROCEDURES

The worst restoration scenario is for the separation of NIC from the system, with 5L81, 5L82, 5L83 and 5L87 opened. Other 500 kV circuits in the South Interior will likely trip on overvoltage and some lower voltage inter-area circuits would also be lost.

If MCA and REV are both available, use Procedure 1 for system restoration. Otherwise, use Procedure 2.

13.1 Restoration Procedure 1 (MCA or REV Available)

The following restoration sequence is preferred if MCA or REV is available.

Step 1: Energize one of either 5L81 or 5L82 or 5L83 from ING or MDN. Expect a 10 kV rise.

Step 2a: Energize 5L71 or 5L72 from MCA with 2 units on the same lead shaft. Expect a 10 kV rise. Synchronize at NIC,

OR

Step 2b: Energize 5L75 or 5L77 from REV with 2 or more units on the same lead shaft if possible (use only one unit if forced to). Expect a 10 kV rise with 2 REV units (note restriction in Section 7.3.1 of this Order).

- Reduce the ACK voltage to 520 kV.
- Energize 5L76 or 5L79 from ACK and synchronize at NIC. Expect a 10 kV rise at NIC.

Step 3: Load up the connected generators and restore the transmission system into NIC.

13.2 Restoration Procedure 2 (MCA and REV Unavailable)

Step 1: Energize 5L87 from KLY and either 5L81 or 5L82 from ING or MDN. Expect a voltage rise of 15 kV.

- If 5L87 is not available, energize 5L81 AND 5L82 but expect an extra 5 kV.

Step 2a: Energize 5L71 or 5L72 from NIC only if MCA line reactor is in service.

- With both line reactors in service, the NIC rise will be about 15 kV.
- With the NIC reactor OOS, the NIC rise will be 25 kV.
- Put 2 or more MCA units on line.

OR

Step 2b: Energize 5L76 or 5L79 from NIC. Station rise will be 15 kV.

- Switch in 2 ACK reactors. Borrow 5L91 reactor if necessary.
- Then energize 5L75 or 5L77 from ACK. Expect a 25 kV rise.
- Put 1 or more REV units on line.

Step 3: Before restoring the system towards SEL, gradually load up the generators at MCA and/or REV.

Refer to SOO 6T-26 for priorities for a total outage in the East Kootenay area.

14.0 PLANT BLACK-START CAPABILITY

14.1 Revelstoke

The Revelstoke units have a remote black-start capability. The generator breaker must be closed and the station service energized within 3-6 minutes following field flashing, depending on the unit selected, to ensure that the transformers have adequate cooling. Timed tripping will shut the units down again, after expiry of these time intervals. Refer to LOO 3G-REV-18.

14.2 Mica

MCA has been designed to have full black-start capability. Cooling water valves must be opened locally. Refer to LOO 3G-MCA-18.

14.3 Seven Mile

The emergency diesel is connected to the spillgate station service. Manual local black-start capability is provided with extensive switching required to establish essential AC station service from the diesel generator. Refer to LOO 3G-SEV-18.

Remote dead bus closing is not provided.

14.4 Kootenay Canal

Black-start capability is available at KCL but extensive manual switching is required to shed all non-essential DC loads, and to establish the 150 kW diesel generator to supply AC to the lift and governor pumps. Refer to LOO 3G-KCL-18.

15.0 LOSS OF MICROWAVE

The basic circuit protection on the South Interior 500 kV circuits utilizes microwave channels. To cover a catastrophic failure of the microwave system (e.g. a microwave tower falling down), over-reaching backup circuit protection is provided. This backup protection is channel independent and operates slower for a total communication failure. For 5L71, 5L72, 5L81 and 5L82, there is only ground channel independent backup in the PY PN, but the SY PN provides both ground and phase channel independent backup. The microwave and tone channels carry transfer-trip signals for breaker failure protection and reactor protection.

Due to slow clearing times and no transfer-trip facility for reactor faults, it is desirable that affected circuits or reactors be de-energized for a total communication failure.

16.0 REVISION HISTORY

Revised By	Revision Date	Summary of Revision
Brett Hallborg/ Bob Cielen	22 May 2020	Section 3.4 – MCA & REV RMR for voltage control added.
Kelvin Foo/ Bob Cielen	16 September 2020	Section 3.4 – MCA & REV RMR for voltage control clarified Section 5.5 – reference to TSA-PM implementation and 7T-34 Attachment 1 Section 4.0
Yingwie Huang/ Kelvin Foo	13 October 2020	Section 3.4 – revised to identify more than one unit may be required for forced outages to reactors. Revised to clarify taking lines out of service if generating unit requirements can not be met. Section 5.5.1 – revised OL PU setting for 2L112 Section 7.5 – Revised on POW capability
Kelvin Foo	09 March 2021	Section 11.6 removed NIC DS PN limitations/requirements as no longer valid.
Shah Faisal, Lawrence Ryan, Bob Cielen	27 April 2022	Section 3.4 – clarification of MUO when only one MCA line is in service Section 7.5 – Revised on POW capability Section 11.1 – replaced with contents from Section 11.1.1 for Open Terminal Keying Section 11.1.2 – is moved to become Section 11.6 Section 11.7 – New - content on 1L244 extended tripping

*last 5 revisions only