

**BC HYDRO**

**OPERATIONS SUPPORT**

**OPERATING ORDER 7T-25**

**BRIDGE RIVER 1 - SETON - CARQUILLE – 100 MILE HOUSE**  
**60 KV OPERATION**

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Indicates Revision ||

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## 1.0 GENERAL

This System Operating Order describes the operation of the 230/60 kV system from Bridge River #1 (BR1) to Hundred Mile House (HMH). This system has operating constraints and stability constraints that can cause this part of the BC Hydro system to collapse, if operated outside of limits.

The operating concerns within this system include:

- generation shedding schemes (refer to Section 4.9)
- switching within the BR1/LAJ/SON/CRQ/HMH loop (refer to Section 9.0)
- thermal and stability limits of the lines and equipment within the loop (refer to Section 3.0 and Section 8.0).

Line switching or permanent line faults, within the BR1/LAJ/SON/CRQ/HMH loop, may affect WDN/SON/LAJ/JME generation output.

Walden North (WDN) is an Independent Power Producer (IPP) located near Lillooet, B.C. (refer to OO 3T-WDN-01). WDN is responsible for the Cayoosh Creek fish water releases. If WDN is unable to provide discharge into Seton Lake during fish migration periods, WDN is obliged to provide the appropriate diversion discharge requirements.

Note that BC Hydro requested reductions of WDN energy must be assessed closely due to the penalties that may occur. According to the Electricity Purchase Agreement between BC Hydro and WDN, BC Hydro shall take and pay for all amounts of electricity made available, subject to forced outages, disconnections and reductions, as stipulated in the agreement. If the duration of such reductions or disconnections in any calendar month exceeds 24 hours (cumulative), then BC Hydro shall pay for all electricity made available except for that made available but not taken, during the first cumulative 24 hours of that month. Refer to the Electricity Purchase Agreement for further details.

Contact Operations Planning for details of winter and summer light and peak load concerns within this loop. Operations Planning should be consulted to for planned switching concerns that are not discussed within this order.

This operating order contains operating rules and procedures including RAS Arming requirements. These requirements cover the worst case operating conditions. Variations from these limits and arming conditions will be provided through additional Operating Plans for specific operating conditions on a case basis. Operating Plans are engineered to support outages and short term operating requirements, superseding as necessary **any** requirements in this order.

## 2.0 **RESPONSIBILITIES**

The BC Hydro Control Centre (BCHCC) is responsible for coordinating the operation of 60L20, 60L21 and 60L301. For 60L22 operations, the Grid Operator will direct the Plant Operator to adjust LAJ for area load operations.

BCHCC has supervisory control of:

- Seton (SON) with communication linked via microwave.
- LaJoie (LAJ) with communication linked via 60L22 power line carrier (LAJ to BR1) and microwave from Bridge River Terminal (BRT) to BCHCC. In the event of a PLC failure, LAJ is equipped with a Calgary Controls model 602E voice/alarm dialer. This backup system is armed by a PLC failure and will not normally be reporting alarms. See LOO 3P05-24F 4.02 for details.
- CRQ 60CB1, 60CB2, 60CB3 and alarms with the communication link via VHF from CRQ to Mount Savona (MSV) and microwave from MSV to BCHCC Control.

BCHCC has supervisory control of HMM with communication linked via 2L86 power line carrier (HMM to KLY) and microwave from KLY to NCC.

### 3.0 **OPERATING CONFIGURATON**

#### 3.1 **Normal Configuration – All Equipment Available**

Normal configuration is to have the 60 kV loop closed between BR1, SON, CRQ and HMH. LAJ, JME, SON and WDN are normally on-line, being operated as per DCM instructions from Generation Line of Business and to meet real-time requirements.

The following schemes are normally in service:

- HMH T6 protection to close 60GD6 on 60L301
- HMH undervoltage tripping scheme on 60L301 / HMH T6 (60B11) in service
- SON two-stage undervoltage load shedding (12F64 and 12F65) in service
- SON G1 generation shedding scheme in service
- SON 12CX1 cut in and 12VS1 controller in Manual mode
- SON 12VS2 controller in automatic, voltage only, control mode
- BR1 60 kV generation shedding scheme in service, if the output of JME plus LAJ is greater than 25 MW

Care must be exercised in the operation of the 60kV system because of:

- the 60 kV circuit thermal limits
- 60L20 stability limits
- BR1 T3 rating when BR1 T30 is out of service

Contact Operations Planning for estimated winter / summer peak and light loads for planned switching where telemetry is not readily available.

Refer to the appropriate detailed station and circuit one-lines for station, line disconnect and equipment details.

#### 3.2 **Operating Constraints**

The 60 kV system from BR1 to HMH has a limited transfer capacity and under certain conditions, such as an outage of 60L21, 60L20 or 60L301, operating constraints must be imposed. Summer temperatures can be expected to reach up to 40°C regularly, limiting transfer capability below Summer Normal ratings on transmission lines.

If any of 60L20, 60L21 or 60L301 is out of service, the remaining 60 kV system may not have the capacity to handle the generation from WDN, and SON.

Operating constraints will also be imposed if any circuit breakers or disconnect switches associated with 60L20, 60L21, 60L301, 2L19 or BR1 T3/T30 are out of service. Under certain conditions, such constraints may result in spill past generating plants within the area.

When 60L20 is out of service, SON, WDN, JME and LAJ are radially tied to the system via BR1 T3 and T30. WDN and SON total generation must be kept below the rating of 60L21.

When BR1 T3/T30 or 2L19 is out of service, the WDN, SON, JME and LAJ generation is radially tied to the system at HMH via 60L20 and 60L301. The 60L20 power transfer stability limit is 30 MW. For system stability concerns, the total generation at LAJ, JME, WDN and SON must not exceed 35 MW. This provides sufficient buffer to cover loss of Lillooet load (SON) and still retain stable power transfer on 60L20. Reduce the SON, LAJ, JME and WDN (total generation) to 18 MW for switching. If 60L22 is also out of service, the total generation at WDN and SON must not exceed 30 MW, and the total generation at SON and WDN must be reduced to 18 MW for switching.

**Note:** Reducing the total generation to 18 MW during switching is to ensure sufficient restoring torque is available when the power transfer on 60L20 changes during the switching process.

When the section of 60L21 from WDN tap to SON is out of service, SON generation is radially tied to the system via HMH. For system stability, the SON generation must not exceed 30 MW. Reduce the SON generation to 18 MW for switching.

When the section of 60L21 from BR1 to WDN tap section is out of service, WDN and SON generation are radially tied to the system via HMH. For system stability, the total generation at WDN and SON must not exceed 30 MW. Reduce the SON and WDN (total generation) to 18 MW for switching.

## 4.0 GENERATION AND LOAD SHEDDING

This section provides peak load and generation forecasted for operating purposes. (Reference: "2010 Operations Plan Load Assessment for 60kV Bridge Loop" provides further details)

### 4.1 BRR

BR1 generation (4 – 50 MVA units) and BR2 generation (4 – 65 MVA units) are tied to the 360 kV ring at BRT. For BRR generation shedding, refer to OO 7T-14.

### 4.2 WDN

There are six WDN generators, one 620 kVA and five 3555 kVA units, for a total of approximately 18.4 MVA. There is also a 500 kW standby emergency diesel for WDN station service. The maximum capacity of the WDN plant is 18 MW during the spring run-off period. The output during the winter is typically 3 MW. WDN generation will trip on loss of 60L21 but there is no direct generation shedding.

### 4.3 SON

SON G1 has a rated output of 42 MW with a maximum output 48 MW. The area load is approximately 18 MW. Lillooet is approximately 15 MW and the 60L20 bulk customers are approximately 3 MW.

### 4.4 LAJ

The capacity of LAJ varies from 10 to 24 MW depending on the reservoir elevation, which is normally low in the spring and high in the fall. The area load is 1.5 MW.

### 4.5 JME

The Jamie Creek IPP consists of two generators, each rated at 12.3 MVA. The maximum power that can be injected into the BC Hydro system is 20.9 MW.

### 4.6 60L20

Transmission Voltage Customer load (CLL) and PAV residential load is approximately 3 MW.

### 4.7 60L29

The area load for AFT and SBR is approximately 18 MW.

### 4.8 60L301

The area load for CLN, SMH and AWL is approximately 22 MW.

### 4.9 Generation Shedding

Refer to OO 2T-34.

Transient stability studies indicate that SON G1 (under heavy load conditions) will go unstable for various 60L21 faults and open-end trips at BR1 with the 60 kV loop closed. The purpose of this scheme is to detect BRT 2L19 opening under load but not mis-operate if LAJ, JME, SON or WDN generation is reduced.

**A generation shedding scheme is installed to shed SON G1 and should be armed at all times. Only block SON Generation Shedding when switching.**

Receipt of the Generation Shedding signal at SON will initiate a non-lockout trip. SON G1 must be re-started and re-synchronized to the system.



**Note:** The SON Generation Shedding trips off automatically after receipt of the Generation Shedding signal. This will prevent multiple trips of the SON generator in the event that the first reclose was unsuccessful and a second unsuccessful reclose is made once the SON unit is re-synchronized to the system.

**Note:** The SON Gen Shed will have to be manually re-armed by supervisory from BCHCC or locally at SON. The SON Gen Shed does not arm automatically.

#### **4.9.1 SON GENERATION SHEDDING**

The SON generation shedding scheme has been installed to prevent transient instability and maintain power flow on 60L20 and 60L301 within thermal ratings and stability limits.

The following conditions will initiate a generation shedding direct transfer trip (DTT) signal to SON causing SON G1 to trip when:

- BR1 60CB5 is closed and BR1 60L22 PY or SY PN phase fault detection is initiated, if the “BR1 60 kV Gen Shed” selector switch is in the “ON” position.
- BR1 60CB30 is open and 60CB5 closed, and BR1 60CB3 is open or protection trip is initiated from:
  - BRT T4 PY or SY PN
  - BRT 2L19 PY or SY PN
  - BR1 2L19 PN
  - BR1 T3 PY or SY PN
  - BR1 60B1 PN
  - BR1 60CB3 BFPN
  - BR1 60CB3 supervisory trip
  - BR1 60CB3 open (CB auxiliary contact)
- BR1 60CB3 is open and 60CB5 closed, or 60CB5 open, and BR1 60CB30 open or protection trip initiated from:
  - BRT T4 PY or SYPN
  - BRT 2L19 PY or SYPN
  - BR1 2L19 PN
  - BR1 T3 PY or SYPN
  - BR1 T30 PY or SYPN
  - BR1 60B2 PN
  - BR1 60CB30 BFPN
  - BR1 60CB30 supervisory trip
  - BR1 60CB30 open (CB auxiliary contact)
- BR1 60CB1 open or protection trip initiation from:
  - BR1 60L21 PY or SYPN
  - BR1 60CB1 BFPN
  - BR1 60B2 PN
  - BR1 60CB1 supervisory trip
  - BR1 60CB1 open (CB auxiliary contact)
- BRT 2L19 opens under load (via DTT from BRT)
- SON 60L20 PY or SYPN 3-phase fault or power swing detection
- SON 60L21 PY or SYPN
- SON 60CB21 opens as detected by CB auxiliary contact, if the SON “Gen Shed” selector switch is in the “ON” position.

**Note:** Whenever SON or BR-1 end of 60L21 is opened, and the associated circuit breaker is left open, the generation shedding scheme at SON cannot be armed.

SON Gen Shed scheme has two inputs:

- BR1 60CB1 open (in addition to various protection operations, supervisory trip) keys a Gen Shed DTT to SON, as described above.
- SON 60CB21 open (in addition to SON 60L21 protection operation)

As long as either terminal of 60L21 is open, a sustained input is applied to the SON generator shedding scheme. A cut-off timer limits the trip signal to SON G1 to 500 ms. A contact from the cut-off timer which remains asserted as long as there is an input to the gen-shed scheme, i.e. as long as either terminal of 60L21 is open) keeps the Gen Shed ON/OFF latching relay in the reset position and prevents SON generator shed from arming.

If 60L21 is out of service, which disarms generation shedding, a 60L20 protection operation will still trip SON G1. Tripping is direct and is not through the generator shedding scheme.

If 60L21 is open, there is no need to trip SON G1 for loss BRT T3, T4 or 2L19 (i.e. with 60L21 open, SON G1 is isolated from BR1/BRT), so leaving the SON gen-shed off during a 60L21 outage is acceptable.

#### **4.9.2 BR1 GENERATION SHEDDING**

The BR1 60 kV generation shedding scheme has been installed at BR1 to prevent transient instability of LAJ and JME generation, and also to maintain power flow on 60L20 and 60L301 within stable limits.

**Note:** The BR1 60 kV generation shedding scheme should only be armed if the combined output of JME and LAJ is more than 25 MW.

The following will initiate a trip of BR1 60CB2, and cause LAJ G1 and JME G1 and JME G2 to be shed by opening 60L22 at BR1:

- When 60CB5 is closed, and 60CB30 is open:
  - BR1 60CB1 trips via
    - BR1 60L21 PY or SYPN.
  - BR1 60CB3 trip or protection trip initiation from:
    - BRT T4 PY or SYPN
    - BRT 2L19 PY or SYPN
    - BR1 2L19 PN
    - BR1 T3 PY or SYPN
    - BR1 T30 PY or SYPN
    - BR1 60B1 PN
    - BR1 60CB3 BFPN
    - BR1 60CB3 supervisory trip
    - BR1 60CB3 open (CB auxiliary contact)
- When 60CB5 is closed, and 60CB3 is open:
  - BR1 60CB1 trips via
    - BR1 60L21 PY or SYPN.
  - BR1 60CB3 trip or protection trip initiation from:
    - BRT T4 PY or SYPN
    - BRT 2L19 PY or SYPN
    - BR1 2L19 PN
    - BR1 T3 PY or SY PN

- BR1 T30 PY or SY PN
  - BR1 60B2 PN
  - BR1 60CB30 BFPN
  - BR1 60CB30 supervisory trip
  - BR1 60CB30 open (CB auxiliary contact)
- 
- BRT 2L19 opening under load (via DTT from BRT)
  - When 60CB5 closed, simultaneous trip of BR1 60CB3 and BR1 60CB30

LAJ G1 will must be re-started and re-synchronized to the system, or to pick up local area load, if one of the following conditions trips G1:

- LAJ G1 over or under-frequency
- LAJ G1 overvoltage
- 60L22 line protection operation
- LAJ G1 over speed

A SON Gen Shed On/Off and BR1 Gen Shed On/Off switch, as well as a SON Gen Shed Local/Supervisory and BR1 Gen Shed Local/Supervisory transfer switch, is provided to allow both local and supervisory disabling or enabling of the shedding features. This allows for planned 60 kV switching (without tripping SON G1 or BR1 60L22) and allows the Grid Operator to arm the Gen Shed after the automatic disabling resulting from a generator shedding initiation.

## 5.0 VOLTAGE CONTROL, FREQUENCY (U/F and O/F) and VOLTAGE PROTECTION

### 5.1 Seton (SON)

If SON G1 is loaded above 38 MW, ensure the unit voltage is at or above 13.8 kV for transient stability concerns. During winter peak conditions BR1 / SON / HMH 69 kV voltage levels should be maintained as high as possible (SON = 66 kV and HMH = 68.5 kV) to allow for forced outages. AFT and SON have distribution shunt capacitor banks installed.

Two-stage tripping has been installed to shed SON 12F65 below 56.4 kV and shed SON 12F63 below 55.8 kV.

SON 12CX1 and 12CX2 are shunt capacitors, each de-rated to 2.4 MVAR. Normally, 12CX1 control is in Manual mode and 12CX2 is set to Auto mode. 12CX2 switches in automatically at 12.78 kV and switches out at 13.72 kV. This voltage control scheme was installed to counteract the low voltage condition that could arise for certain contingencies, the worst of which will be the loss of 60L21 and SON G1 out of service. It is desirable to keep SON 12CX1 in service at all times.

SON 60 kV Bus under frequency protection trips SON 60CB1 (SON G1) at 56 Hz to protect customer loads.

SON 60 kV Bus over frequency trips SON G1. Whenever SON G1 connects to the system through one transmission connection loss of the other transmission connection may cause over-frequency, which trips SON G1 to protect customer loads.

### 5.2 LaJoie (LAJ)

If LAJ G1 is loaded above 2 MW, ensure unit voltage is  $\geq 13.8$  kV.

BR1 60L22 PN trips BR1 60CB2, if over frequency reaches 62 Hz.

**Note:** All manual and protection opening of BR1 60CB2, including local trip, 60L22 primary and standby protection trip, 60L22 over frequency protection trip, 60B1 protection trip, and 60CB2 breaker failure protection trip, will initiate a direct transfer trip to LAJ to trip LAJ 60CB3 via LAJ 60L55 protection.

### 5.3 100 Mile House (HMH)

The HMH 230 kV voltage is maintained from KLY and SCK between 243 and 248 kV. HMH T1 and T2 are equipped with 230 kV load tap changers, set to automatically maintain the 60 kV bus voltage at 67 kV +/- 1 kV. These tap changers are normally set to operate in Automatic Parallel mode. Although the 60 kV bus is normally operated between 66 kV to 68 kV, in an emergency it can be raised to 71.5 kV and operated in Supervisory Parallel mode. HMH T5 and T6 load tap changers maintain the 25kV voltage between 26 and 27 kV. HMH T5 and T6 do not have supervisory control.

HMH 25CX1 is shunt capacitor rated at 15 MVAR and can be manually inserted.

An undervoltage tripping scheme has been installed at HMH to ensure 60L301 is open-ended at HMH whenever the 60 kV voltage deteriorates to 55.8 kV for 5 seconds as measured on 60L301 (60B11) at HMH. This feature will ensure HMH load is dropped whenever HMH becomes separated from the 230 kV. The station load cannot be satisfactorily supplied via the 60 kV due to the extreme undervoltage condition that would result.

### 5.4 Ainsworth Lumber (AWL)

Ainsworth Lumber (AWL) is supplied from 60L301 near HMH station. If HMH 60L301 is open ended, AWL may experience low voltage and may have difficulty operating their equipment. Planned outages should be studied by Operations Planning and planned with AWL at a time when the customer can shut down.

## 6.0 SYNCHRONIZING

### 6.1 BR1 60CB1, 60CB2 or 60CB3

BR1 60CB1, 60CB2, 60CB3, 60CB5 and 60CB30 local and remote closing are supervised by a synch check relay.

The supervisory close command will result in breaker closure provided the phase angle across the breaker is less than 20 degrees for 1 second or if either incoming or running CVT or both CVTs are de-energized. BR1 / SON generation can be adjusted to reduce the phase angle. BCHCC has phase angle telemetry at BR1 for remote switching.

### 6.2 SON 60CB1, 60CB21 or 60CB22

Local and auto synchronizing facilities have been provided for SON 60CB1, 60CB21 and 60CB22.

For 60CB1, the normal remote supervisory close will auto synchronize the unit to the bus. For 60CB21 and 60CB22, the normal remote supervisory close will close the selected breaker, if the slip across the breaker is within limits and if the phase angle across the breaker is less than 40 degrees.

Synch bypass close should be used if one side of the breaker is de-energized. A synch bypass close is blocked, if the phase angle across the breaker is greater than 40 degrees.

### 6.3 LAJ 60CB1 or 60CB2

Local and auto synchronizing facilities have been provided for LAJ 60CB1.

Local and auto synchronizing facilities are **not** available for LAJ 60CB2. LAJ 60VT21 failed destructively in March 2012 and is permanently unavailable for service.

If LAJ G1 is supplying area load while 60L22 is out of service, 60CB2 **cannot** be used to re-synchronize LAJ G1 to 60L22.

### 6.4 CRQ 60CB1 or 60CB3

No synchronizing facilities have been provided at CRQ.

A normal supervisory close will result in the circuit breaker closing provided phase angle across the breaker is less than 60 degrees or if either but not both incoming and running CVTs are de-energized.

## 7.0 **LINE RECLOSING**

### 7.1 **60L20**

SON 60CB22 is the lead end for reclosing. CRQ 60CB3 is the follow end for reclosing. SON 60L20 reclosing can be blocked remotely by BCHCC. CRQ 60CB3 will reclose if within phase angle limits ( $60^\circ$  for 3 seconds, see Section 6.0). Automatic reclosing is in service at SON and CRQ. This reclosing consists of lead-end reclosing at the SON terminal, initiated by line protection and supervised by loss of line potential, and of follow-end reclosing at the CRQ terminal, initiated by loss and subsequent restoration of line potential, and supervised by a synchroverifier relay.

### 7.2 **60L21**

BR1 60CB1 is the lead end for reclosing. BR1 60L21 reclosing can be blocked remotely by BCHCC. SON 60CB21 follow end reclosing is not in service with the DC pulled. SON 60CB21 can be reclosed by supervisory if within phase angle limits (see Section 6.0). If SON G1 has been tripped by generation shedding, it must be restarted and either re-synchronize or dead bus close to pick up SON area load.

### 7.3 **60L22**

BR1 60CB2 is the lead end for reclosing. LAJ 60CB2 follow end reclosing is not in service with the DC pulled. BR1 60L22 reclosing can be blocked remotely by BCHCC.

Upon a 60L22 trip, LAJ G1 must be re-started and either re-synchronized to the bus if 60L22 is re-energized successfully or dead bus close to pick up area load if 60L22 remains out-of-service.

**Note:** All manual and protection opening of BR1 60CB2 will initiate a direct transfer trip (DTT) from BR1 to LAJ and trip LAJ 60CB3 via LAJ 60L55 protection.

### 7.4 **60L29**

Automatic reclosing is installed at CRQ on 60CB2. CRQ 60L29 reclosing can be blocked remotely by BCHCC.

### 7.5 **60L301**

HMH 60CB12 and 25CB6 are the lead end circuit breakers for reclosing. HMH 60CB11 must be closed by supervisory, as it is not part of the reclosing scheme. CRQ 60CB1 is the follow end for reclosing. HMH 60L301 reclosing can be blocked remotely by BCHCC. CRQ 60CB1 will reclose, if within phase angle limits (less than  $60^\circ$  for 5 seconds, see Section 6.0).

In the event of a HMH T6 transformer protection operation, 60GD6 will close to ensure that the 60L301 remote terminal trips and T6 will auto isolate. 60L301 automatic reclosing will be blocked. 60L301 can be re-energized from HMH by supervisory control.

## 8.0 LINE AND STATION EQUIPMENT RATINGS

Refer to OO 5T-10 for line tap ratings.

### 8.1 BR1 T3

T3 is rated at 66.6 MVA. The rating can be increased by 0.75% for every degree Celsius below 25°C ambient. At 0°C ambient, T3 is rated 78.6 MVA.

### 8.2 BR1 T30

T30 is rated at 84 MVA. The rating can be increased by 0.75% for every degree Celsius below 25°C ambient. At 0°C ambient, T3 is rated 99.75 MVA.

### 8.3 60L20

The 60L20 thermal rating is:

- **400 amps** Summer rating at ambient 30°C
- **525 amps** Winter rating at ambient 10°C.

The power transfer through 60L20 is normally constrained by stability limits (approximately 30 MW) rather than thermal limits. Under normal closed loop conditions, load on 60L20 will not exceed 20 MW. The 60L20 power transfer will only approach 30 MW, if 60L21 is out-of-service and the area generation (SON + WDN) is greater than 35 MW.

Refer to Section 1.0 regarding WDN generation reduction concerns.

### 8.4 60L21

Circuit rating was increased in 1999 to allow for 90 degree C operation. The ratings are:

- **493 amps** Summer rating at ambient 30°C
- **447 amps** Summer rating at ambient 40°C. This is a pro-rated rating in accordance with OO 5T-10 Section 1.5.
- **590 amps** Winter rating at ambient 10°C.

SON (Lillooet) temperature is telemetered to the BCHCC to ensure local generation at WDN and SON is reduced to keep 60L21 within its current rating.

Refer to Section 1.0 regarding WDN generation reduction concerns.

### 8.5 60L301

The circuit rating is:

- **265 amps** Summer rating at ambient 30°C
- **441 amps** Winter rating at ambient 10°C.

Line switches 60D7L301, 60D8L301, 60D9L301 and 60D10L301 are capable of making and breaking the parallel between SON and HMM provided SON and WDN generation has been adjusted to provide minimum current in 60L301 (as measured at HMM). Refer to OO 5T-03.

Refer to Section 1.0 regarding WDN generation reduction concerns.

## 9.0 SWITCHING PROCEDURES

Prior to any switching within this system, refer to:

- Section 1.0 for concerns with WDN generation reductions
- Section 3.2 for operating constraints
- Section 4.9 for Generation Shedding requirements

Prior to any switching:

- block the appropriate Generation Shedding.
- raise the supply voltages as high as possible.

**Caution:** Voltage levels must be maintained above 60 kV. If voltage levels cannot be maintained after an outage (distribution VR's may be at max boost), load shedding may have to be considered.

### 9.1 BR1 T3 and T30

BR1 consists of two transformers, BR1 T3 and BR1 T30, converting voltage from 230 kV to 60 kV. In the normal station configuration, T30 supplies 60L21 while T3 supplies 60L22. Either T3 or T30 can be taken out of service with the remaining transformer supplying to both 60L21 and 60L22. Care must be taken when opening the 60kV loop between HMH and SON as the WDN/SON output may exceed 60L21 ratings.

BR1 60CB5 must normally be open when BR1 T3 and BR1 T30 are in service and carrying load.

When switching BR1 T3 or T30 out of service:

- ensure SON and BR1 60 kV Gen Shed are enabled
- match T3 and T30 taps to equivalent tap ratio
- close BR1 60CB5 to make the parallel
- open BR1 60CB3 or 60CB30 to off load the particular transformer
- open BR1 2D3 or 2D30 to de-energize the particular transformer

When switching to restore BR1 T3 or T30 to normal configuration:

- ensure SON and BR1 60 kV Gen Shed are enabled
- match T3 and T30 taps to equivalent tap ratio
- close BR1 2D3 or 2D30 to energize the particular transformer
- close BR1 60CB3 or 60CB30 to parallel the transformers
- open BR1 60CB5 to break the parallel

### 9.2 2L19 Out of Service

**Caution: Block SON Gen Shed prior to switching.**

When 2L19 is being off-loaded:

- match BR1 T3 and BR1 T30 taps to equivalent tap ratios
- close BR1 60CB5 (parallel T3 and T30)
- open BR1 60CB3 (preferred) or 60CB30 (offload T3 or T30)
- adjust LAJ and SON unit voltages to reduce the MVAR flow through the in-service BR1 transformer to zero. Failure to do so may result in a WDN plant trip on high 60 kV voltage, when 2L19 is off loaded.
- reduce the SON, LAJ, JME, WDN (total generation) to approximately 18 MW.
- SON 66kV voltage should be kept below 68 kV as generation is reduced. This may mean reducing the SON generator and/or LAJ generator voltage to 12.5 - 13kV.
- open 60CB30 or 60CB3 to off load 2L19 and the BR1 transformer

Prior to switching to restore 2L19 to service, reduce the SON, LAJ, JME, WDN (total generation) to approximately 18 MW. Ensure the SON Gen Shed is re-armed before 60L20 power transfer exceeds 30 MW.



During winter peak load conditions, the loss of 2L19, and subsequent SON Gen Shed operation (and SON G1 tripping), SON voltage is expected to drop below 60 kV; possibly as low as 55 kV. SON G1 should be restored as soon as possible to 10 MW and adjusted to support the 60 kV voltages at all stations within the loop.

### **9.3 WDN**

The 60 kV line from WDN to the tap point on 60L21 is 1 km long. WDN 60D21 is the isolating point between WDN and 60L21 (BCH).

WDN entrance protection will separate WDN from the system by tripping WDN 60CB1 for 60L21 line faults (see Section 9.6). WDN may re-start any units that have tripped and synchronize them to the WDN bus but will wait for BCHCC approval prior to re-synchronizing the WDN plant to the system (across WDN 60CB1).

### **9.4 HMH**

Whenever lengthy 230 / 60 kV transformer outages occur (where isolation is at the transformer disconnects) consideration should be given to block the tripping of the associated 60 kV circuit breakers for a 2L86 or 2L352 fault. A 2L86 or 2L352 fault will trip the associated 25 kV and 60 kV CB's even though the line is separated from the 230 kV system. Other 25 kV or 60 kV equipment outages within the station may cause inadvertent outages, or connect 60L301 through the 25 kV bus, if the station is not configured to prevent this.

Whenever 60CB12 is open and 2L352 trips, 2L86 becomes connected to 60L301 through the 25 kV bus. It is expected that the U/V tripping on 60B11 will protect the station for this condition.

### **9.5 60L20**

The 60L20 total circuit length is 74.8 km.

#### **9.5.1 60L20 Out of Service**

Care must be taken to not exceed 60L21 thermal limit.

Refer to 5T-03 for line switch capability.

The normal method to isolate 60L20 or portion is as follows:

- Notify Transmission Voltage Customers that will be affected.
- Ensure SON T3 is not supplying the SON distribution load.
- Reduce SON G1 to approximately 10 MW and 0 MVARs.
- Break parallel current on 60L20 by opening a line switch or SON breaker.

#### **9.5.2 Permanent Fault on 60L20**

60L20 is equipped with Schweitzer fault locating relays at SON terminal only.

For permanent faults on 60L20, BCHCC will initiate a patrol of the circuit and perform the necessary switching to isolate the fault and restore customer loads.

## 9.6 60L21

The 60L21 total circuit length is 26.5 km.

### 9.6.1 60L21 Out of Service

#### **Block SON generation shedding prior to switching.**

SON generation must be reduced to minimize the power swing when off-loading 60L21. This will require SON generation reduction to  $\approx 18$  MW before switching.

**Note:** If SON G1 is not available, and 60L21 is required open, SON distribution may experience very low voltage when supplied from HMM only. SON, AFT and SMH capacitors should be in service and HMM 60 kV voltage should be increased before switching is started.

Operations Planning should perform studies to determine if area loads, at the time of the outage, will depress the voltage below SON U/V feeder trip settings.

When switching portions of 60L21 out of service, it is recommended that the parallel be broken with the respective circuit breakers and then de-energize the portion of the circuit with the line disconnect (60D1L21 or 60D2L21).

If either 60L20 or 60L301 should trip, while a section of 60L21 is open, synchronizing back to the system can be accomplished at SON 60CB22. A short outage to customers may be required in order to energize back to SON and allow synchronizing at SON 60CB22.

### 9.6.2 60L21 (WDN tap to BR1) Out of Service

#### **Block SON generation shedding prior to switching.**

SON generation must be reduced to approximately 18 MW prior to switching. BR1 60CB1 is opened to break the parallel and then 60D2L21 is opened to de-energize the line to BR1.

**Note:** The combined WDN and SON generation must not exceed 30 MW due to system stability constraints. This will result in typical power flow to CRQ of  $\approx 24$  MW (summer light load) and 16 MW (winter peak load). Refer to Section 1.0 regarding WDN generation reductions.

### 9.6.3 60L21 (WDN tap to SON) Out of Service

#### **Block SON Gen Shed prior to switching.**

There is no WDN generation restriction. WDN capacity is below 60L21 thermal rating (summer or winter) and the combined LAJ/WDN generation will not exceed BR1 T3 rating.

SON generation must be curtailed to approximately 18 MW prior to switching. SON 60CB21 is opened and 60D1L21 then opened to de-energize the line to SON.

The SON unit output is restricted to 30 MW after switching is completed. See Section 3.2.

#### **9.6.4 Fault on 60L21**

BR1 and SON 60L21 line protections will trip BR1 60CB1 and SON 60CB21. WDN entrance protection will trip WDN 60CB1.

SON G1 will be shed to prevent 60 kV system instability and must be re-started and re-synchronized to the system.

The fast acting governors and excitation systems at WDN should prevent WDN unit breakers from tripping. WDN will wait for approval from BCHCC before closing WDN 60CB1 (re-synchronizing WDN to the system).

60L21 is equipped with Schweitzer fault locating relays. If the fault is permanent, BCHCC will sectionalize the line by directing the opening of the appropriate line switch. BCHCC will notify WDN that sectionalizing is under way and that they will be notified when they can re-synchronize to the system.

Either of the two line switches on 60L21 can be used to isolate a faulted section of line to allow restoration of WDN generation. When restoring a partial line section to service, energize with the respective disconnect switch and make parallel with circuit breaker.

**Note:** 60D2L21 and 60D1L21 are approximately 4.8 km west of SON.

The Grid Operator will have to enable SON Gen Shed, by supervisory control, once 60L21 is restored to service and the 60 kV loop closed.

#### **9.6.5 Faults on 60L21 with 60L301 Out of Service**

For permanent faults on 60L21 with 60L301 out of service, the SON and WDN units will be islanded and supplying local area load (SON, 60L20 and 60L29). Voltage and frequency must be closely monitored and adjusted by the BCHCC Operator.

For temporary faults on 60L21, the BR1 end of 60L21 will have attempted an auto reclose. Once 60L21 is successfully energized from BR1, SON may be synchronized to the system across SON 60CB21. BCHCC will notify WDN that sectionalizing is under way and that they will be notified once it is okay to re-synchronize to the system. There may be maximum generation restrictions of SON and WDN combined with 60L301 OOS.

#### **9.7 60L22**

Total circuit length is 60.7 km.

Tyax Lake Substation (TXL) is tapped off 60L22 approximately 9 km from LAJ. There are two sectionalizing switches between the TXL tap and BR1. Faults between TXL and BR1 may be isolated and TXL supplied from LAJ. If the fault is between TXL (60D2L22) and LAJ consideration should be given to making a line cut and restoring TXL from BR1. See OO 5T-60L22 for detailed 60L22 outage restoration procedures.

## 9.8 **60L29**

The total 60L29 circuit length is 56.8 km.

60CB2 (line CB) supervisory close is not supervised.

### 9.8.1 **CRQ 60L29 Line CB OOS (60CB2 OOS and 60BP2 Closed)**

During the time that 60CB2 is out of service, with 60BP2 closed, it is essential that 60L29 PY PN and 60CB2 breaker failure protection remain in service as it is relying on 60CB2 breaker failure protection to clear 60L29 faults. While the CTs that feed 60L29 SY PN are located in the bushings of 60CB2, those that feed 60L29 PY PN and 60CB2 breaker failure protection are contained in 60CB1 and 60CB3 bushings.

## 9.9 **60L301**

The total 60L301 circuit length is 101.32 km.

### 9.9.1 **Planned Switching on 60L301**

If any portion of 60L301 is out-of-service then the SON/WDN generation is radially tied to the system via BR1 T30.

Prior to switching 60L301 (or part) out-of-service, voltage levels at stations within the loop will have to be assessed. Where possible the 60 kV system voltage should be as high as possible (close to or just above 70 kV) prior to switching. All shunt capacitors should be in service.

Care must be taken to not exceed the thermal limit of 60L21 (493 amp summer rating).

Approximate 60 kV area loads are:

- SON area (including 60L20 bulk customers) approximately 10 to 17 MW
- 60L29 load approximately 10 to 12 MW
- 60L301 load (SMH, CLN, AWL) approximately 13 to 18 MW

There are five line switches on 60L301 (60D1L301, 60D7L301, 60D8L301, 60D9L301, 60D10L301) to allow sectionalizing as required.

The normal method to isolate 60L301 or portion is as follows:

- Adjust SON G1 so that 60L301 line current as measured at HMM is minimal.
- Break parallel current on 60L301 by opening the appropriate line switch or breaker. Refer to OO 5T-03 for disconnect switch capability.
- HMM 60D21 is a quick-break disconnect and capable of making and breaking the parallel between SON and HMM, provided that generation has been adjusted.

### 9.9.2 **Faults on 60L301 with 60L21 Out of Service**

BCHCC will initiate patrols from both ends of the circuit and perform the necessary switching to isolate the fault.

For **permanent faults on 60L301**, with 60L21 OOS, the SON and WDN units will be supplying area load of SON, 60L20 and 60L29. Voltage and frequency should be closely monitored and adjusted by the BCHCC dispatcher.

For **temporary faults on 60L301**, the HMH end of 60L301 will be energized first. Due to the lack of auto synchronizing facilities at CRQ, the islanded generation (SON and WDN) must be re-synchronized as follows:

- 60L301 re-energized from HMH to CRQ.
- WDN plant separated from system.
- Ensure SON T3 is not supplying SON distribution load.
- Notify customers as required.
- Open SON 60CB22 to de-energize 60L20 / 60L29 (CLL, PAV, SBR, CCW and AFT).
- Close CRQ 60CB1, re-energize 60L20 / 60L29 (CLL, PAV, SBR, CCW and AFT).
- Synchronize SON generation to system across SON 60CB22.
- WDN plant re-synchronized to system.

**10.0 ALARMS IMPLEMENTED IN TSA PM**

ALARM MESSAGE	REFERENCES
SON TOTAL MUST BE LESS THAN 30 MW	Section 9.6.3 60L21 (WDN tap to SON) OOS Section 9.6.1 60L21 OOS
SON/WDN TOTAL MUST BE LESS THAN 30 MW	Section 9.6.2 60L21 (WDN tap to BR1) OOS
JME/LAJ/SON/WDN TOTAL MUST BE LESS THAN 35 MW	Section 9.2 2L19 OOS
SON GENSHED IS REQUIRED	Section 4.9.1 SON Generation Shedding
BR-1 60KV GENSHED IS REQUIRED	Section 4.9.2 BR1 Generation Shedding
BR-1 60KV GENSHED IS NOT REQUIRED	Section 4.9.2 BR1 Generation Shedding
JME TOTAL MUST BE LESS THAN 20.9 MW	Section 4.5 JME generation

**11.0 REVISION HISTORY**

Revised By	Revision Date	Summary of Revision
RDB	21 Jun 2005	60L21 rating added to reflect pro-rated for 40 degree C summer temperatures.
RDB	15 Mar 2007	Remove references to SON G1 and LAJ G1 auto-restart schemes.
MPP / RAC / DAC / SSS / WWC	27 Aug 2010	Reviewed and updated. Removed requirement to turn reclosing off when any portion of 60L21 is O.O.S. Load sizes in Section 4.0 revised. Section 9.4 revised. Control centre references changed to BCHCC.
MPP	09 Sep 2010	Deleted SIC references.
RAC / AML/PH/DS M	29 Jan 2014	Added Section 3.2 generation restrictions for outages on sections of 60L21. Section 4.9.1 and 4.9.2 SON and BR1 generation shedding for BR1 T30 addition and JME IPP integration. Updated Section 9.0 Switching Procedures with the BR1 T30 Addition. Added Section 10.0 Alarms - Implemented in TSA-PM.
RAC/LBU	16 Oct 2014	Update Section 1.0 for operating plan use. Updated Section 3.1 SON capacitor banks control mode. Updated Section 4.9.1 and 4.9.2 SON and BR1 gen shedding – blocking is no longer required.

### TYPICAL BR1-SON-CRQ-HMH POWER FLOW

