Q. What criteria does Hydro apply to the security and reliability of the Island Interconnected System to ensure successful recovery following a contingency covered by the N-1 planning criteria? How much time is allowed to return the system to an N-1 compliant operating condition?

A. Hydro uses the following criteria as part of its analysis to ensure successful system recovery following an N-1 contingency:

- The steady state transmission system bus voltages are between 90% and 110% of nominal prior to operator intervention at the Energy Control Centre. On the 230 kV transmission system bus voltage must be between 207 kV and 253 kV;
- The steady state equipment loadings must be at or below the equipment rating. For transmission lines, Hydro employs transmission line ratings based upon ambient temperature. Operation of standby generation such as the Hardwoods or Stephenville combustion turbines or Hawke's Bay and St. Anthony diesel plants behind the transmission line(s) or transformer(s) is permitted to remove steady state overloads within 10 minutes of the contingency, or during the restoration process;
- The steady state operating point of all generating units on the system are within the units capability curve;
- Dynamically the system response shall be stable and well damped;
- The transient under voltage shall not fall below 70% following fault clearing;
- The duration of the voltage below 80% following fault clearing should not exceed 20 cycles (333 msec);

- For the electrically isolated system, system frequency shall recover to greater than 59 Hz in less than 15 seconds following a generation loss;
- Following interconnection to the North American grid:
  - The system frequency shall not fall below 59 Hz,
  - Under frequency load shedding:
    - Shall not occur for loss of on Island generation with the Labrador Island Link in service,
    - Shall not occur for loss of a Labrador Island Link pole,
    - Shall not occur for a temporary bipole outage, and
    - Shall be permitted and controlled for a permanent bipole outage; and
  - There shall be no HVdc commutation failures[1] during post fault recovery[2].

Following an N-1 contingency event, the Energy Control Centre (ECC) will restore the Island Interconnected System to as secure a state as possible in a safe and timely manner. Depending on the event, return to an N-1 state may not be possible. While there are no specific timelines required for restoration to the more secure state, every attempt is made by the ECC to ensure the system is restored to a compliant operating condition as quick as possible, with safety being the first priority.

[1] Commutation failure is defined as the interruption of the HVdc converter's commutation process in effect temporally stopping the transfer of power from alternating current to direct current or vice versa. For ac system faults close to the line commutated converter, the voltage depression can be significant, resulting in the interruption of the converter's commutation process, thus commutation failure. In an HVdc system, commutation is the transfer of current between power electronic switches such as thyristors. The controlled switching of current allows for the conversion of power from ac to dc and from dc to ac.

[2] Post fault recovery period is defined as the time period of the transient stability simulation following detection of the fault and tripping of the faulted element during which the system should recover from the disturbance and regain a state of equilibrium.

The ECC will review the contingency event o determine the equipment where the event initiated. Based on their assessment, the ECC will either start the restoration process or dispatch field personnel to the affected station to investigate. If the contingency event is transmission related, the restoration time will vary depending on whether it can be completed directly from ECC or if there is field assistance required.

As an example, if a transmission line is outaged, the ECC, depending on weather conditions or other available information may attempt to restore the line. If there is not a permanent fault, the transmission line would be restored within minutes. In this case, if there is a permanent fault, the line would not be restored and field crews would be dispatched to investigate. Once the problem is identified, it would have to be addressed and proper safety measures taken to work on the transmission line. The restoration time to the N-1 condition in this case would take longer.

In the case of a generator outage, depending on the time of day, time of year and the amount of generating capacity out of service for maintenance, there may be sufficient reserve generation either synchronized or in standby mode that within a short period (15 to 30 minutes), the generation can be returned to the N-1 state. However, before the generator forced off due to the contingency can be returned to operation, plant personnel would need to investigate the problem before the generating unit is returned to service. Depending on the nature of the problem and in the case of remote plants, getting personnel on site, the generator outage time would vary.