Q. **Reference: CA-NLH-081:** The response addresses the double contingency assuming the total loss of the LIL and one circuit in the Bay d'Espoir to Western Avalon transmission corridor. What is the probability of occurrence of this double contingency? Further, the LIL and Bay d'Espoir to Western Avalon transmission corridors appear to be very close geographically where they cross into the Avalon Peninsula. What is the probability of loss of both corridors; i.e., loss of all transmission into the Avalon Peninsula?

A. Supply to the Avalon Peninsula will consist of four transmission paths between off Avalon Peninsula resources and on Avalon Peninsula load and resources including:

- TL203 (230 kV) connecting Sunnyside[1] and Western Avalon Terminal Stations;
- TL207/237 (230 kV) connecting Sunnyside and Western Avalon Terminal Stations via Come By Chance Terminal Station;
- TL267 (230 kV) connecting Bay d'Espoir and Western Avalon Terminal Stations; and
- Labrador – Island HVdc Link (LIL – L3501/3502).

For the area west of the Sunnyside Terminal Station, failures in the Bay d'Espoir – Western Avalon and Labrador - Island HVdc Link corridors are expected to be independent as the transmission corridors are separated geographically.

[1] The Sunnyside Terminal Station is connected to the Bay d'Espoir Terminal Station via two parallel 230 kV transmission lines TL202 and TL206.

Table A.2 found in CAN/CSA 22.3 No. 60826-10 (reproduced below) estimates the failure rate of a transmission line in relation to its return period.

Table A.2 – Relationship between reliability levels and return periods of limit loads

Return period of limit loads, T		50	150	500
Yearly minimum reliability	P_{s1}	0,98 to 0,99	0,993 to 0,997	0,998 to 0,999
Yearly failure probability	P_{f1}	0,02 to 0,01	0,0067 to 0,0033	0,002 to 0,001
Reliability during 50 years life cycle	P_{s50}	0,36 to 0,61	0,71 to 0,86	0,90 to 0,95
Theoretical probability of failure during 50 years life cycle	P_{f50}	0,64 to 0,39	0,29 to 0,14	0,10 to 0,05

The probability of two failures occurring during the same two-week period would be assessed as follows:

Step 1

The base yearly failure probability is taken from the CAN/CSA 22.3 No. 60826-10 Table A.2 for each of the transmission lines under consideration. The LIL probability is based upon the 150-year return period. The parallel path consists of three 230 kV transmission lines. Both TL202 and TL206 have a return period of at least 25 years, while TL267 will have a design return period of at least 50 years.

	High	Low
$P_{\text{yearly failure}}$(150 year return period - LIL)	0.0067	0.0033
$P_{\text{yearly failure}}$(50 year return period –TL267)	0.02	0.01
$P_{\text{yearly failure}}$(25 year return period – TL202/206)[2]	0.04	0.02

[2] A 25 year return period has a yearly failure probability of 4%. The low value in the range is taken as one-half the higher probability.

Step 2

The probability of a line failure within a two-week period is derived by dividing the annual failure probability by 26.

	High	Low
$P_{2\ week\ failure}$(150 year return period - LIL)	0.00026	0.00013
$P_{2\ week\ failure}$(50 year return period –TL267)	0.00077	0.00038
$P_{2\ week\ failure}$(25 year return period – TL202/206)	0.00154	0.00077

Step 3

To calculate the probability of a double line failure during a two-week period one must select the two lines to be considered for the double failure if all lines do not have equal probability of failure. The probability of failure of the two lines in separate corridors is calculated by multiplying the individual line failure probabilities given that the failure modes are independent for geographically separate corridors.

For the double contingency loss of TL202 or TL206 and LIL the probability of failure for the two week period is estimated to be between 4×10^{-6} (i.e., 0.00026 * 0.00154) and 1×10^{-6} (i.e., 0.00013 * 0.00077).

For the double contingency loss of TL267 and LIL the probability of failure for the two week period is estimated to be between 2×10^{-6} (i.e., 0.00026 * 0.00077) and 4.9×10^{-8} (i.e., 0.00013 * 0.00038).

On the Isthmus of Avalon, the three 230 kV transmission lines (TL203, TL207/237 and TL267) and the LIL will be located in the same transmission corridor. When all

lines are in the same corridor, one cannot discount the possibility that a weather event of sufficient severity would damage all lines in the corridor. In other words, consideration must be given to a common mode event. As a minimum the event must exceed the LIL design in this region of a 500-year return period. As such, the yearly failure probability for all four lines in the corridor would be estimated to be between 0.002 and 0.001. Previous operational experience, as described in Exhibit 85 of the Muskrat Falls Review, indicates that damage is often localized, and that all structures on the corridor may not be affected equally. These micro-level effects cannot be quantified probabilistically.