Q. **Reference: Assessment of Labrador Island Transmission Link (LIL) Reliability in Consideration of Climatological Loads, March 10, 2021 (Haldar Report) by Dr. Asim Haldar, Ph.D., P. Eng, page 7, lines 152-159.**

In Dr. Haldar's opinion what factors should be considered in determining the appropriate return period and level of reliability for the LIL? In the response provide an explanation as to Dr. Haldar's view on the significance of the LIL line length, the weather zones it transverses and its role in supplying customers in assessing the appropriate level of reliability for the LIL.

A. *The following response has been provided by Haldar and Associates.*

The Labrador-Island Link's ("LIL") return period and reliability level should be determined using a probabilistic planning method (value-based planning, termed according to Prof. Roy Billinton)[1] that explicitly considers the factors that may influence the system performance and that balances the line cost against the future failure cost of the HVdc line. This concept provides a quantitative measure of "risk" in terms of system performance indices such as the probability, frequency, severity, and duration of unacceptable events. A comprehensive probabilistic planning approach developed by Billinton and Allan[2] was used in a 2009 study[3,4] to assess line reliability HVdc link by integrating Newfoundland and Labrador Hydro's existing 230 kV system at a high level with the HVdc overhead line system (LIL), excluding the Maritime Link (isolated system). This provided a quantitative measure of the various "risk indices" (severity indices in system minutes per year) to measure BEPS adequacies and a mechanism to integrate the expected system cost in the event of a line failure due to an extreme event. The SI is defined as

---

[1] Billinton, R and Allan, R 1996 Reliability Evaluation of Power Systems, SBN 978-1-4899-1860-4.

[2] Billinton, R and Allan, R 1996 Reliability Evaluation of Power Systems, SBN 978-1-4899-1860-4.

[3] Haldar, Asim 2009 Assessment of Optimum Design Return Period of a ± 450kv HVDC Line, Nalcor Report ##, WTO# 1081, Prepared for LCP project.

[4] Haldar, Asim 2011 Optimum Return Period of an Overhead Line Considering Reliability, Security and Availability with Respect to Extreme Icing Events, Proceeding International Workshop on Atmospheric Icing of Structures (IWAIS), Chongqing, China, May,8p.

the ratio of EENS and Peak Load. As a result, this cost could be integrated into with the initial line cost assessment and allowed for the selection of the optimum design return period of the load process based on the minimization of unavailability of the system. A deterministic planning approach is based on “subjective judgment” and is unable to produce a quantitative reliability measure, making it difficult to use in an objective economic analysis. The 2009 study[5] shows that an optimal design return period and reliability level (severity indices) are dependent on the expected number of repair days should the line fail under an extreme event. A lower return period level can be tolerated if the expected repair days are low and a significantly large system minutes/year (severity index) can be accepted (see Figures 7.1-7.11 in reference 5).

Table 6.2 in the Haldar Report details the significance of line length and the exposures to various weather zones when assessing LIL reliability under DLS criteria. It presents several scenarios: Case 1 considers the homogeneity of weather regions across the full line length (full correlation with harmonized one icing hazard type); Case 2 considers the line being exposed to two distinct icing hazards (glaze and rime), which are mutually exclusive and identifies that this should be addressed separately in the assessment of LIL reliability; and Case 4 included the impact of line length in determining the failure rate, λ, considering dependency and independency of the four regions that the LIL traverses. The impact of the line length on customers can only be assessed quantitatively through a sensitivity study of the various failure rates given in Table 6.2 of Haldar Report and the expected repair rates, μ, derived from repair days (1, 7, 14, and 21 days) based on a probabilistic planning model that was considered in the 2009 study (reference 5, see Figures 7.1-7.11). These repair days represent the degree of failure—low, medium, severe, and very severe—and a measure of the failure “foot prints” due to extreme weather events. Recent LIL failure in Labrador may provide some realistic indication of repair days that should be considered in assessing customer impact study. The 2009 study did not consider the line length impact nor did it consider the impact of Maritime Link. This can be included to get a more realistic picture of system severity index in terms of system minutes per year through a sensitivity study of key system parameters and therefore, a more realistic assessment of LIL reliability at the system level.

---

[5] Haldar, Asim 2009 Assessment of Optimum Design Return Period of a ± 450kv HVDC Line, Nalcor Report ##, WTO# 1081, Prepared for LCP project.