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.**

Further to PUB-NLH-185, what in Dr. Haldar's opinion should be the appropriate return period and level of reliability for the LIL?

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

As outlined in response to PUB-NLH-184, the optimal Labrador-Island Link ("LIL") reliability level and design return period should be determined based on a probabilistic system model that considers both failure rate and repair rate to optimize the system unavailability. This reliability level expressed in terms of severity index is directly related to the severity of the line failure. The Haldar Report (2021) clearly showed the LIL failure rate (reliability level) in Table 6.2 under various scenarios. In our opinion, the return period under Case 1 is unrealistic because it fails to include not only the mutual exclusivity of the two hazards (glaze ice accretion versus rime ice accretion) and the impact of significantly different weather regions and exposures and the regional independence of POF along the line length. A simple "weak link" approach for the entire 1,100km line under an assumed harmonized weather exposure that ignores the mutually exclusivity of two hazard types (glaze and rime icing) and regional independence of various weather events at a macro level underestimates the expected LIL failure rate and overestimates the reliability level. The Haldar Report (2021) conducted a reliability assessment and identified four distinct regional zones for the LIL. The assumption of regional independence was later validated (refer to response to PUB-NLH-198). The LIL has already experienced one major icing storm failure in the three years' operational life that covered three distinct sections of the line in the Labrador region.

Billinton and Wangdee[1] provided guidelines for degrees of severity for BEPS (system minutes, Table 2.1 in Haldar Report). This severity index ("SI") is determined using two line parameters, failure rate (λ) and recovery rate (μ) under extreme weather conditions. The SI is defined as the ratio of EENS to Peak Load. A probabilistic planning model can be used[2] to determine the acceptable level of system disturbance in system minutes per year with appropriate failure rate and repair rate parameters of various key generating units and line components. Refer to Figures 7.1-7.11 in Reference 1. New data from Table 6.2 of Haldar Report can be used with the consideration of Maritime link to update these SI values for the current configuration of Newfoundland and Labrador Hydro's ("Hydro") system and the appropriate return period of LIL in terms of failure rate and level of reliability and availability (in terms of SI values) and "energy supply gap" for the LIL. What will be acceptable system minutes per year in terms of system disturbance (Severity Index) and "reliability worth" for LIL and the system should be decided after the system study has been completed using the data from Haldar Report and an appropriate consultation between the Board of Commissioners of Public Utilities ("Board") and Hydro.

Newfoundland and Labrador Hydro provides the following additional information.

To effectively determine the appropriate return period and level of reliability for the LIL, a comprehensive understanding of the future provincial electrical system is necessary. While a broader system review was beyond Dr. Haldar's scope of work, the commentary provided by Haldar and Associates in this response will be considered as part of Hydro's next update to the Reliability and Resource Adequacy Study to be filed with the Board in the summer of 2022.

[1] Billinton Roy and Wangdee, Wijarn 2006 Bulk Electric System Reliability assessment, 6p.
[2] Haldar, Asim 2009 Assessment of Optimum Design Return Period of a $\pm$ 450kv HVDC Line, Nalcor Report ##, WTO# 1081, Prepared for LCP project.