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. pages 62-63.**

Explain how topographical effects are considered under industry best practices for transmission line design and how they could impact the reliability of a line and explain the degree to which topographical effects are considered in the LIL design.

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

Consideration of topographical effects in overhead transmission line design is critical because strong wind may cause unexpected damage to the power transmission systems. CSA 60826 provides guidance on the selection of terrain categories and the adjustment of the design synoptic wind speeds. CSA 60826 does not provide any guidance on the impact of topographic effects that can significantly influence the design wind speed that the transmission structures may experience on tops of mountains, hills, or ridges. Several national and international standards developed for buildings and antenna structures provide guidance and methodologies for computing the wind speed up effects on a 2D ridge and/or a 3D hill. In addition, Computational Fluid Dynamics analysis can be done to simulate the wind speed up effect along the line route by dividing the line into smaller grids (regions) and using a numerical model for the flow pattern. A CEATI Study[1] referenced in the Haldar Report summarizes the methodologies for computing the wind profile of a tower located on the top of a hill. Some studies have shown that the wind speed could be twice as fast at the top of the hill than at the bottom of the hill. This sudden change in the local topography affects the design wind speed which influences the wind loading on the structure and the tower reliability as a result. Initially, the Labrador-Island Link ("LIL") design did not explicitly consider this speed up effect. The Haldar Report identified

[1] Bitsuamlak, Girma et al. 2015 Application Guide for wind Speed Up Factors for Transmission Line Towers, CEATI report, T123700-3289, Western University.

this "gap," and recommended follow up work to identify all the "hot spots" along the LIL route. This work is currently on going. Similarly, the impact of wind speed up in combination with wind and ice loads may significantly impact the reliability of key line components (e.g., towers, foundations, conductors/optical ground wires, and insulators). It is our understanding that Newfoundland and Labrador Hydro ("Hydro") will assess the impact on the reliability (or POF) of towers and line components located in these "hot spots" and can compare the results to the "baseline reliability level" provided in Table 6.2 of the Haldar Report.

Newfoundland and Labrador Hydro provides the following additional information.

Topographical effects have not been studied in detail in past Hydro designs; typically, adjustments are made to specific areas based on local knowledge only. CSA provides limited direction on topographical effects; it is unclear how widely practiced such an approach is in the utility industry for other transmission lines. In addition, this occurrence would only impact specific locations throughout the line and is not systematic; therefore, it would be more practical to improve overall system reliability by mitigating risk in these specific areas. Hydro has undertaken additional work related to wind speed to both better understand the overall reliability impacts and to be informed on potential areas of concern that may require additional mitigation or increased requirements for emergency response purposes.