Q. Please describe all efforts prior to 2014 to formally examine the transmission system for N-2 contingency conditions (including but not limited to a coincidental transformer and 230kV breaker failure) including the actions identified to take to minimize the effects of N-2 events. If no studies or analyses were completed, state whether Hydro concludes that all N-2 events are too unlikely to warrant mitigating measures, even if they may cause cascading outages.

A. Prior to 2014, formal examinations of the transmission system for N-2 contingency conditions were limited. Analysis related primarily to impacts associated with single element contingencies that resulted in multiple element outages. An example of such a contingency would involve the loss of a double-circuit 230 kV transmission structure.[1]

Hydro's standard bulk transmission system planning is performed in accordance with an N-1 criterion as per the following:

- Hydro's bulk transmission system shall be capable of sustaining the single contingency loss of any transmission element without loss of system stability;
- In the event a transmission element is out of service, power flow in all other elements of the power system shall be at, or below, normal rating;
- The Hydro system is planned to be able to sustain a successful single pole reclose for a line to ground fault based on the premise that all system generation is available; and

[1] Prior to transmission line upgrades on the Avalon Peninsula that were completed in 2002, 230 kV transmission lines TL218 and TL236 were in a double-circuit configuration over a distance of approximately 10 km between Hardwoods Terminals Station and Oxen Pond Terminal Station.

- Transformer additions at all major terminal stations (i.e., two or more transformers per voltage class) and looped systems are planned on the basis of being able to withstand the loss of the largest unit.

In meeting this criterion, there is to be no customer load loss under any forecast load condition for the loss of any individual system element.

Hydro's consideration of N-2 events has traditionally been limited due to the low perceived risk of such events impacting bulk transmission system elements including power transformers, transmission lines, and generators.

Prior to January 2014, Hydro had never experienced a catastrophic failure of an in-service transformer. The justification of a capital expenditure for additional or spare transformer capacity to withstand the loss of multiple units would have been in contrast to operational history. In this context, the risk of multiple failures or the risk of a catastrophic event causing a common mode failure to multiple units was deemed to be acceptably low so as to not justify the additional expenditure.

With respect to transmission lines, upgrades performed on the Avalon Peninsula between the years 2000 and 2002 were such that each 230 kV corridor contained a minimum of one steel transmission line designed to withstand extreme ice and wind loadings from the perspective of meteorological loading. The robustness of the reinforced bulk transmission network was such that risks associated with N-2 events were also deemed to be acceptably low so as to not justify the additional expenditure. It should be noted that recent transmission system reinforcements such as the 230 kV transmission line between Bay d'Espoir Terminal Station and

Western Avalon Terminal Station[2] were justified without consideration of N-2 contingencies.

Further discussion of Hydro's assessments of reliability consideration associated with station configurations and breaker failures are discussed in Hydro's response to PR-PUB-NLH-026.

It should be noted that Hydro will develop and activate contingency plans in the event of a sustained outage to a bulk transmission system element. This was the case in 2014 following delays in the delivery of a replacement transformer following the failure of 230/138 kV transformer Sunnyside T1. As was the case for this event, Hydro's approach would involve the investigation of alternatives, the assessment of risk, and the execution of system planning studies. The objective of this approach is to identify solutions that can be executed safety and effectively while minimizing exposures to customers.

[2] This project was approved in 2014 and is scheduled for completion in 2018.