Q. The report DC1210 HVdc Sensitivity Studies dated July 2010 filed by Hydro with its Application for Approval of the Upgrade of the Transmission Line Corridor included PSSE validation studies which did not include any results of a two terminal configuration Muskrat Falls (or Gull Island) Rectifier to Soldiers Pond inverter and also did not include any studies of a dc line fault or a pole trip. Has Hydro or Nalcor performed validation studies of a two terminal configuration and of a fault on the dc line? If yes, provide the studies. If no, why not?

A. The PSS®E validation studies provided in the report DC1210 HVdc Sensitivity Studies dated July 2010 and filed with the Application for Approval of the Upgrade of the Transmission Line Corridor – Bay d'Espoir to Western Avalon were completed to update the PSS®E multi-terminal HVdc model given the change in the HVdc configuration between Taylor's Brook in western Newfoundland and the Maritime Provinces. The report DC1020 Volume 1 HVdc System Integration Study dated May 2009 and filed with the above-mentioned application provides the original PSS®E model validation for the multi-terminal HVdc scheme that included a 480 km long HVdc cable between Newfoundland and Salisbury, New Brunswick. The rationale for the development of a user written multi-terminal HVdc model with validation using PSCAD™ is stated on page 7-1 of the DC1020 report as:

> *The existing multi-terminal HVdc PSSE stability models which are available from the standard library provided with the PSSE software are "response" models. They require the user to provide voltage and current recovery characteristics to model recovery from converter blocks. These characteristics are very system dependent and must be obtained from the response of a good*

detailed electromagnetic transients model or from the response of the actual system. Detailed models will capture the interaction of the HVdc and ac systems, an important factor with weak ac systems, and will also capture the critical response of the dc line and cable network.

TransGrid Solutions has developed a user written HVdc model for PSSE that allows the representation of the closed-loop HVdc controls as well as the HVdc line L/R dynamics. This custom developed model uses a two time-step approach in which the HVdc model is run at a smaller time-step than the rest of the PSSE solution, thereby allowing the dynamics of the fast HVdc controls and of the HVdc line to be modeled. This model has been shown to provide far superior results when compared to the standard library HVdc models available in PSSE and other transient stability software packages.

The validation study completed as part of the DC1210 report was intended to adjust the multi-terminal HVdc model to account for a modification on the Taylor's Brook to Salisbury, New Brunswick section of the scheme which includes a shorter 180 km long cable between Newfoundland and Nova Scotia and an overhead line section 475 km long between Nova Scotia and Salisbury, New Brunswick instead of the 480 km cable in the DC1020 report. The converter requirements at Soldiers Pond did not change between the two-model validation exercises.

The two terminal configuration of the multi-terminal model (i.e., Gull Island and Soldiers Pond on with Salisbury off) was not verified independently as the relatively long cable section between Newfoundland and the Maritimes was found to be the

critical component in setting the restart times of the Gull Island converter due to the time delays required to fully charge the "long" cable to the Maritimes. The DC1210 report does state that validation testing was performed for solid faults only in the two-terminal case.

The integration studies for the two-terminal HVdc scheme between Muskrat Falls and Soldiers Pond was completed in PSS®E. The PSS®E model was not validated against detailed PSCAD™ models in the two-terminal case. It is Hydro's opinion that the two-terminal HVdc models in the PSS®E library are more advanced than the multi-terminal HVdc models within the library, and as such are sufficient for system integration studies necessary to define the ac system additions and high level performance requirements of the HVdc scheme necessary to develop a performance specification for vendor review, particularly given the assistance of experienced HVdc consultants to set two-terminal HVdc model parameters in PSS®E.

Hydro recognizes the importance of having a validated PSS®E model of the Labrador-Island HVdc Link as designed and implemented by the vendor for continued use in its future power system analysis efforts. To this end the Labrador-Island HVdc Link vendor is required to provide Hydro with a PSCAD™ model of the link following final design, as well as a final validated PSS®E model for future system stability studies.