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Questions for Nalcor, request 4

HVDC Converter Stations and System

MHI-NALCOR-61 MHI is aware that a comprehensive reliability report for the entire project has been requested from Nalcor by the Board in a letter July 12, and this document was filed August 17, 2011.

Is there an operational based reliability report or conceptual design document considering the forced outage rate and scheduled outage rate? Have all equipment and systems been looked at from an operations and maintenance perspective using an N-1 criteria or considering the criteria required by Nalcor? Detailed areas to be covered should include but not be limited to:

a) Are there two or three auxiliary supply feeds (station service) for the bipole? Considering a potential extensive forced outage to one feed (station service) there would be an entire bipole feed from one station service transformer for an extended period. Is this acceptable? Is there a spare station service or other alterative feed? The same question applies to the battery banks and chargers.

b) How many relay buildings are being considered in the AC switchyard of the converter station? What is the physical separation between the buildings? Are there duplicate control and protections from different suppliers?

c) Has separation of equipment and controls supplies been considered to limit the amount of power lost for any event?

d) What is the Forced Outage Rate (FOR) and scheduled outage rate target?

e) Has a design report been issued detailing all these requirements? If so please provide.

f) Is there a contingency plan in place or being considered, if the reliability criteria cannot be met? For example, documents indicate that there is one synchronous condenser (SC) provisioned as a spare. If one SC is out of service for maintenance, and a second one trips off, what are Nalcor's operating plans?

MHI-NALCOR-62 Please provide a copy of the analysis that was carried out in June and July of 2010 which confirmed that the 900 MW HVDC link would require a minimum operating voltage of 320 kV as referenced in Exhibit 30, Section 4, paragraph 4.

MHI-NALCOR-63 In discussions with Nalcor, it was stated that the AC collector system at Muskrat Falls and associated transmission lines to Upper Churchill, was optimized at 345 kV. Please provide a document of that analysis.

MHI-NALCOR-64 Exhibit #30, page 24 shows a simplified single line diagram of the Muskrat Falls converter station. Please provide a complete single line diagram and major equipment data of the Muskrat Falls converter station.

MHI-NALCOR-65 Please provide a complete single line diagram and major equipment data for the Soldiers Pond converter station.

MHI-NALCOR-66 Please provide a copy of the study used to determine the technical requirements for the 3 – 300 MVar Synchronous Condensers.

Manitoba HYDRO INTERNATIONAL

MHI-NALCOR-67 In discussions with Nalcor, it was stated that the Voltage Source Converter (VSC) Option was discarded and the Line Commutated Converter (LCC) chosen. One reason the VSC option was discarded was because studies showed that the recovery from a DC fault was too slow at about 900 milliseconds, and also that the system still required an Effective Short Circuit Ratio (ESCR) of 1.5. Please provide copies of the studies performed by Siemens on the HVDC Plus fault recovery rate and the ABB PSS/E ESCR study.

MHI-NALCOR-68 The inverter system for a LCC requires 2 – 300 MVar (plus one spare) Toshiba Synchronous Condensers with an inertia of 7.2 to achieve an ESCR of 2.5 under worst case conditions. Please provide the study done to confirm this finding as referred to in Exhibit 30, Section 6.7, page 21, System Upgrades for Island Link.

MHI-NALCOR-69 Based on discussions with Nalcor and documents received to date, MHI understands that only $ 2.5 M has been allocated for HVDC equipment replacement / refurbishment over the 50 year life of the project. Please describe the components of this figure, and the rationale for its determination.

MHI-NALCOR-70 From discussions with Nalcor, it is understood that some recent algorithms and custom indices have been developed to escalate the converter and other equipment costs. Please provide information on the methodologies that were used to derive these.

HVDC Transmission Line

MHI-NALCOR-71 From discussions with Nalcor, MHI understands that the transmission line sections have been designed to different requirements due to varying geographical and environmental conditions. Please provide a copy of this design. Provide any transmission line design concept documents, detailed design reports, drawings, tower designs, cost estimates, line route selection details, transmission line reliability design criteria, risk analysis, for the HVDC overhead transmission line, and associated AC transmission lines from the Converter stations.

MHI-NALCOR-72 From discussions with Nalcor, MHI understands that a mechanical fuse concept has been adopted for the HVDC transmission line. The conductor design will drop the conductor to save the tower due to high icing and wind loading over ratings. Have sufficient investigations been done to prove the concept of the mechanical fuse to save the tower during a catastrophic event? Please provide supporting information why this technology was chosen. What is the risk of an incorrect mechanical fuse failure and how would this be prevented/mitigated?

Muskrat Falls GS

MHI-NALCOR-73 Describe the methods and details to benchmark and validate the cost estimates prepared by Nalcor for the entire Project to confirm their validity for the conditions at the site and regional construction markets?

MHI-NALCOR-74 Please describe whether the optimization of the installed capacity will differ with the Muskrat Falls project when developed in isolation from the Gull Island, Quebec river diversions, and Churchill Falls 2 plant in the 1999 report.

Optimization studies in the Feasibility Study had selected the installed capacity based on an integrated plant arrangement selling through the Upper Churchill Falls transmission system.

MHI-NALCOR-75 Does the change of the ac transmission interconnection to Churchill Falls used in the 1999 optimization report affect the optimal installed capacity needed to dispatch the energy available at Muskrat Falls under the current arrangement?

MHI-NALCOR-76 From discussions with Nalcor on the Muskrat Falls pumpwell system, it was suggested that it will be required only for the next ten years. Why would that be the limit since the system will be in operation for 30 or more years? When the MF project is commissioned, what is the expected life of the current system? Is there a backup supply system in place to provide power in case of a future catastrophic failure of the pumpwell system?

MHI-NALCOR-77 The following document of the Muskrat Falls study has not been made available but is needed to fully understand the analyses:

> Hatch Ltd. GI1141 – Upper Churchill PMF and Flood Handling Procedures Update. Prepared for Nalcor Energy – Lower Churchill Project, August 2009.

Isolated Island Option

MHI-NALCOR-78 The report "Studies for Island Pond Hydroelectric Project", (2006) by SNC-Lavalin presents no new data or analysis with respect to hydrology but relies on results from previous studies. The hydrological analysis would be contained in the Prefeasibility Study (1986), the re-optimization of Round Pond (1987), the Feasibility Study (1988) and possibly Island Pond and Granite Canal Final Feasibility Studies (1988), all studies executed by Shawmont Newfoundland. The relevant documents from these studies are required in order to evaluate the completeness of the hydrological analysis. Please provide.

MHI-NALCOR-79 Please provide "Appendix A Capital Cost Estimates - Backup" for Exhibit 5b - Studies for Island Pond Hydroelectric Project.

MHI-NALCOR-80 Please provide "Appendix F Geotechnical Site Investigations - Proposed Island Pond Hydro Electric Development (as prepared by AMEC)" for Exhibit 5b - Studies for Island Pond Hydroelectric Project.

MHI-NALCOR-81 Please provide "Appendix A Capital Cost Estimates – Backup" for Exhibit 5c - Feasibility Study for Portland Creek Hydroelectric Development.

MHI-NALCOR-82 Please provide backup for the summary capital cost estimate in Table 9.1 of Exhibit 5d - Round Pond Hydroelectric Development Feasibility Study.

AC Power System Performance

MHI-NALCOR-83 Please provide a project description and schedule for the systems improvements outlined in Section 2.4.3 of document DC1210_filed.pdf "HVDC Sensitivity Studies", July 2010 required to mitigate the 3 phase fault at Bay d'Espoir. The system improvements noted are a cross tripping/over frequency protection system, a new 230 kV circuit between Bay d'Espoir and Western Avalon, plus two new 230 kV circuits between Bay d'Espoir and Sunnyside.

MHI-NALCOR-84 Please provide project scoping documents, cost estimates, and relevant technical details of these system reinforcements referred to in MHI-NALCOR-86.

MHI-NALCOR-85 Are there any load/generation patterns on the Island where the system survives a 3 phase fault at Bay d'Espoir, and will implementing the system reinforcements listed in DC 1220, section 2.4.3 change this result?

MHI-NLACOR-86 Are any further system reinforcements planned or required to mitigate a 3 phase fault at Bay d'Espoir?

Wind Farms

MHI-NALCOR-87 The assumption of annual capacity factor of 40% for the 25 MW wind farm is based on the average of the two existing wind farms at St. Lawrence (44.3%), and Fermeuse (35.7%) capacity factors. Has any wind survey data been collected to validate the assumption of a 40% capacity factor at the proposed site of the 2014 3rd 25 MW wind farm? If so, please provide documentation to support the anticipated capacity factor.

MHI-NALCOR-88 Has a system study been performed that examines wind integration into the Newfoundland Island power system? If so, please provide this document.

MHI-NALCOR-89 What is the maximum wind capacity sustainable on the Island under both options (Muskrat Falls LIL HVDC and the Isolated Island)?

Load Forecast

MHI-NALCOR-90 Please provide all historical sales, generation and peak demand information for the period 1969-2010 for all sectors that are part of the Load Forecast. This would include the number of customers and energy (GW.h) for the following sectors: rural residential, NP residential, total residential, rural GS, small GS, large GS, electric heat GS, total GS, street & area lighting, industrial and total island sales.

MHI-NALCOR-91 Please provide all historical energy (GW.h) information for distribution & transmission losses, total utility requirements, total island requirements, NLH energy deliveries and NLH net generation.

MHI-NALCOR-92 Please provide all historical demand (MW) information for the non-coincident utility peak demand, non-coincident industrial peak demand, coincident Island peak demand, NLH transmission losses peak demand and coincident NLH peak demand.

MHI-NALCOR-93 Please provide the historical and forecast information for all variables used, but not provided (as yet), in the winter peak demand equation specified in Exhibit 45. This would include information on the following variables: WINDCHILL, NPTOTGSWA, NST and DECPEAK. The requested information should cover the 1967 – 2029 period similar to the information provided on page 7 of Exhibit 45.

Reliability Analysis

MHI-NALCOR-94 Please provide a copy of the report "Reliability of the Straits of Belle Isle HVDC Cable System" – PTI, Sept. 1988.

Strait of Belle Isle

MHI-NALCOR-95 Please provide a copy of the SOBI Technical Request for Proposal document for "Submarine Cable Design, Supply and Install".