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Request IR-1:

With respect to Section 3 of Exhibit M2:

The proposed Maritime Link will consist of a hybrid arrangement of overhead and underground dc transmission which is connected to ac transmission at both ends. Ideally, high speed clearing of overhead line faults and rapid restart of the dc link would be desirable. However, fast fault suppression capability and high speed dc breakers are new and evolving technology for VSC HVDC.

(a) Please provide all stability and reliability studies carried out to determine the acceptability of clearing dc line faults with dc breakers and ac breakers, and slow restart with VSC-based HVDC.

(b) Also, please indicate how slow is considered acceptable when compared with LCC-based HVDC in which dc line faults are cleared rapidly and HVDC restarted without mechanical breakers.

Response IR-1:

High-speed clearing is not a requirement for the Maritime Link. Clearing of DC faults is by tripping the AC circuit breakers. In Newfoundland, the LIL controller responds to the rising frequency and ramps the import back. Operators then decide whether to re-instate and re-ramp the link within 10 minutes or commit reserves within Nova Scotia and the Maritime Area to make up the loss on the Eastern Interconnection.

(a-b) High-speed clearing is not required and will not be employed. Studies concerning speed requirements are therefore not relevant.

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Request IR-2:

With respect to Section 3 and 4 of Exhibit M2:

(a) Please provide brief technical and cost information obtained from Vendors for VSC-based HVDC.

(b) Please clarify whether the vendor information is for a system with dc line fault suppression and rapid restart (without mechanical breakers) for hybrid OH and cable transmission.

Response IR-2:

(a) Please refer to CA/SBA IR-147 and CA/SBA IR-148.

Early indicative cost estimates were secured from converter vendors to facilitate comparisons of LCC and VSC technology, through a process of consultation. The standalone cost of LCC is lower than VSC without the system upgrades LCC requires. Based on an evaluation of system development costs under each option, a decision was made to pursue only the VSC option. The decision is based upon the factors required to attain a cost-effective technical solution.

Subsequent design development at the conceptual and functional design stage included development of functional requirements for the VSC installations, and design of electrical interconnection requirements and civil/structural site development. This led to the preparation of the mini-spec included in Hingorani IR-10, which was issued to vendors for budget pricing. A summary of the budget pricing received from vendors is provided in Hingorani IR-10.

(b) The mini-spec did not include provision for dc fault suppression and rapid restart.

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Request IR-3:

With respect to Section 3and 4 of Exhibit M2:

(a) Please provide technical and cost information obtained from Vendors for LCC-based HVDC.

(b) Please clarify whether this vendor information is for a system with dc line fault suppression and rapid restart (without mechanical breakers) for hybrid OH and cable transmission.

Response IR-3:

(a) Please refer to UARB IR-2.

During the conceptual and functional design stage, further definition was prepared for the functionality of the converters, along with preliminary design of the electrical interconnections and the civil/structural works at the converter stations. Based on this work, the mini-spec was prepared for VSC technology only (provided in Hingorani IR-10) and issued to vendors for budget pricing. At this stage, the converter prices for VSC technology were found to be somewhat higher than the indicative pricing secured during vendor consultations (pricing information provided in Hingorani IR-10).

(b) For the Maritime Link there is no requirement for rapid restart.

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Request IR-4:

With respect to Section 3 of Exhibit M2:

To reduce the exposure to frequent faults on the overhead dc line,

(a) **Was any consideration given to a cable sea entry point near Bottom Brook so that a VSC-based HVDC with no overhead line in Newfoundland would result?**

(b) **Alternatively, was an underground cable from Bottom Brook to Cape Ray or relocating the converter station to Cape Ray considered?**

(c) **Were similar routing alternatives to minimize the amount of overhead line in Nova Scotia to Woodbine (i.e. cable landing site closer to Woodbine or greater use of underground cable) considered?**

(d) **Please provide information from Vendors on any all-cable based VSC-based alternatives (with no overhead dc line) provided.**

Response IR-4:

(a) Yes, an alternate landing further along the west coast was considered. Due to the cost of cabling, it was screened out as an option.

(b) Due to the high cost of underground cable, plus the number of river crossings along the route, the underground option was eliminated. Relocation of the converter to Cape Ray was considered, and was dismissed due to the higher cost of AC transmission construction from Bottom Brook to Cape Ray.

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(c) Yes, initial development considered a converter station at Lingan. This was abandoned due to cost and difficulty of crossing TransAtlantic telecommunications cables, 230 kV GIS substation requirements and system transmission costs.

(d) No vendor pricing was solicited for an all-cable option for the reasons noted above.

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Request IR-5:

With respect to P41 Line 7-11 of Exhibit M2:

Preamble: Power reversal capability is a disadvantage for LCC Converter based Link because the cable and transformers have to be designed with voltage reversal capability which would be more expensive. VSC does not have polarity reversal. Two way transfer capability therefore costs more than one-way capability particularly for LCC-based technology.

Please provide information on the value of Power Reversal capability.

Response IR-5:

The Maritime Link is being designed for use of VSC technology, and the cost premiums applicable to LCC technology for power reversal are not applicable for voltage source converters. The systems on both ends of the Maritime Link are being upgraded initially to accommodate the 500 MW forward flow from Newfoundland to Nova Scotia. With these upgrades in place, system studies have indicated that reverse power flow of 100-250 MW can be accommodated subject to transmission system conditions, and NSPML does not plan to make any investments in system upgrades to facilitate expansion of these reverse flow limits.

The value of power reversal capability principally accrues to Nalcor, in low-probability contingency events involving loss of both poles of the Labrador-Island Link. Under such circumstances, it may be possible for Nova Scotia to provide emergency support for the resulting capacity shortage in Newfoundland.

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Request IR-6:

With respect to P43 Line 8-15 of Exhibit M2:

(a) Please provide information on the approximate AC Effective Short-Circuit Capacity at each converter connection point.

(b) How much additional dynamic reactive power would be needed for LCC option?

Response IR-6:

(a) At the Woodbine 345 kV terminal, the minimum short-circuit capacity with transmission normal conditions is 1900 MVA. The effective short -circuit capacity will be just below 1900 MVA. At Bottom Brook the minimum short-circuit ratio with transmission normal conditions is just below 900 MVA. All reactive support will be provided by the VSC with the exception of any low capacity high-frequency filter included with the converter.

(b) At Woodbine 345 kV, the LCC itself requires approximately 300 MVAr. Options to provide this include shunt capacitors and filters and converting Lingan units for synchronous condenser operation. At Bottom Brook, in addition to the reactive power required to supply the converter, there is also a requirement to supply dynamic reactive support to the 230 kV system on contingency (contingency reserves) of over 200 MVAr. These factors considered Bottom Brook is not considered a viable terminal for a conventional LCC converter alone.

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Request IR-7:

With respect to Section 3 of Exhibit M2:

Please provide information obtained from Vendors on dc breakers and high speed clearing of dc line faults for VSC–based HVDC with OH or Hybrid OH-Cable line.

Response IR-7:

As indicated in Hingorani IR-1, high-speed clearing for dc faults is not a requirement. Faults are cleared by the AC circuit breaker. During the final design, any requirements for default clearing will be assessed with vendors. NSPML is aware of the industry developments in this area.

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Request IR-8:

With respect to Section 3 of Exhibit M2:

Preamble: LCC would have lower losses compared to VSC.

Please provide information on the value of losses for NSPI and value given to Vendors for procurement purposes.

Response IR-8:

The request for proposals (RFP) from vendors is currently being assembled and therefore cannot be provided at this time. The value of losses are being finalized and will be included in the comparison of proposals. The converter losses for the VSC is higher than LCC with the extent depending on the technology. Current VSC technologies can achieve losses at rated load which are an additional 0.2 percent more than the LCC technology.

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Request IR-9:

With respect to P41 Line 1-6 of Exhibit M2:

Please provide information on the estimated losses which would be deducted from NSPI share of 170 MW.

Response IR-9:

Please refer to footnote 17 on Page 33 of the Application, and to NSUARB IR-13.

CONFIDENTIAL (attachments only)

Request IR-10:

With respect to P40 line 11-18 of Exhibit M2:

Please provide:

(a) Information on preliminary Technical Specifications shown to HVDC Converter Vendors (ABB, Siemens, Alstom)

(b) Please provide technical and cost information from Vendors for both VSC and LCC options.

Response IR-10:

(a) Please refer to Confidential Attachment 1.

(b) Please refer to Confidential Attachment 2. Cost information on an LCC option was not requested.

UARB-Hingorani IR-10 Attachment 1 has been removed due to confidentiality.

UARB-Hingorani IR-10 Attachment 2 has been removed due to confidentiality.

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Request IR-11:

With respect to Section 3 of Exhibit M2:

Preamble: VSC Converters do not have significant overload capability. For loss of one pole, LCC-based HVDC converters can provide 33% overload, for very small additional cost and even 100% overload for reasonable time with modest extra cost.

Please provide information on overload capability needed for loss of one pole, including information from Vendors on overload capability of their VSC and LCC converters.

Response IR-11:

No additional overload capability is required. Depending on ML loading at the time of a pole outage, the remaining pole is available to ramp to its full 250 MW rating on the sending end. Any shortfalls realized at that time can be met in the short term via system interconnections and in the longer term through generation redispatch or suspension of exports.

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Request IR-12:

With respect to Figure 4-1, page 76 of Exhibit M2:

Please provide information on how the cost of $450 M for converters was derived including information from Vendors or other prior projects.

Response IR-12:

The $450 M covers the cost of the work scope associated with the two converters. It includes all infrastructure related to the integration of the two converters, which includes: site preparation, converter equipment, substations, grounding systems, buildings, site protection, storage facilities. For the converter stations alone, a "mini-specification" was developed to provide high-level functional specifications for the converters, which was sent to three international vendors for budget quotations. In parallel with this vendor pricing, the project engineering consultants prepared an independent estimate based on past projects implemented using VSC technology. The base EPC cost for the converter island was chosen based on consideration of the three vendor prices and the consultant's estimate.

The balance of the converter cost category was estimated by the engineering consultant, based on completed engineering, vendor equipment price quotations and construction cost quotations. The design development for the balance of plant was consistent with a DG2 level plan, where plan drawings and layouts were developed to facilitate preparation of bills of materials and construction quantities that were used to solicit vendor and contractor estimates. All estimates included appropriate contingency based on the level of uncertainty at the conclusion of the design development.

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Request IR-13:

With respect to Section 3 of Exhibit M2:

Was VSC-based HVDC with all cable transmission considered as a competitive procurement option and if not please explain why not?

Response IR-13:

Please refer to NSUARB IR-39.

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Request IR-14:

With respect to Section 3 of Exhibit M2:

Was LCC-based HVDC with needed reactive power and filters considered for competitive procurement option and if not please explain why not?

Response IR-14:

Please refer to Hingorani IR-6 and Hingorani IR-4.

In the initial planning stage, indicative cost estimates were secured from LCC and VSC vendors, and system studies were undertaken to identify system requirements for integration of both LCC and VSC technology into the system. These studies identified requirements under the LCC scenario for dynamic VAr support in Cape Breton (not needed in the VSC scenario), additional dynamic VAr support in Newfoundland, and a prospective requirement to relocate the Bottom Brook converter. Considering the capital costs for the alternative converter technologies, the capital costs for the corresponding system upgrades, and costs of losses for the two systems, a decision was made to proceed with VSC technology. LCC pricing was not requested as part of the “mini-specification” and vendor pricing solicitation.

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Request IR-15:

With respect to Section 3.3.3 Exhibit M2:

Please explain what measures will be taken to prevent fish from entering the electrode pond or being attracted to the barrier for the pond.

Response IR-15:

The grounding system will be designed in accordance with all pertinent standards and regulations, and methods of addressing concerns for aquatic wildlife are well established in application of shore grounding sites around the world. Details of measures to protect fish and wildlife are part of the Environmental Assessment process, and the final design of the grounding site will be consistent with all requirements identified in the EA process.