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January 21, 2019

The Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Ms. Cheryl Blundon
Director Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: The Liberty Consulting Group Report – Analysis of Newfoundland Island Interconnected System Power Supply Adequacy for the Winter of 2018-2019 – Biweekly Update Report

In its correspondence of September 19, 2018, the Board of Commissioners of Public Utilities ("Board") requested that Newfoundland and Labrador Hydro ("Hydro") provide a biweekly report on Hydro's supply adequacy for winter 2018-2019, commencing October 1, 2018.

This biweekly report provides an update on the in-service of the Labrador-Island Link ("LIL") and how it relates to winter 2018-2019 supply adequacy, as well as details on Hydro's production facilities asset management.

The LIL In-Service Update

This report contains:

- an overview of the critical path tasks required for reliable operation of the LIL for winter 2018-2019;
- an overview of the highest risks being monitored and mitigated for the LIL in-service in winter 2018-2019;
- Hydro's updated modelled assumptions for winter 2018-2019 supply adequacy planning; and
- Hydro's proposed contingency plan to mitigate the consequences of unavailability or unreliability of the LIL for all or part of winter 2018-2019.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Senior Legal Counsel – Regulatory
SW/kd

Enc.

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey
Denis J. Fleming – Cox & Palmer
Dennis Browne, Q.C. – Brown Fitzgerald Morgan & Avis
Dean Porter – Poole Althouse

ecc: Van Alexopoulos – Iron Ore Company
Senwung Luk – Olthuis Kleer Townshend LLP
Benoît Pepin – Rio Tinto

Labrador-Island Link In-Service Update

January 21, 2019

A Report to the Board of Commissioners of Public Utilities

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Table of Contents

1. Introduction

Newfoundland and Labrador Hydro ("Hydro") closely monitors its supply-related assets and issues to ensure its ability to provide reliable service to customers. The availability of power over the Labrador-Island Link ("LIL") for winter 2018-2019 was identified in previous reports to the Board by both Hydro and Liberty as contributing to supply adequacy in advance of availability of the Muskrat Falls generation supply to the Island. Hydro is working closely with Nalcor's Power Supply leadership [Transition to Operations ("TTO"), Power Supply Transmission Operations, and the Lower Churchill Project ("LCP") Transmission Project] to monitor and mitigate the risks associated with the timing of the in-service of the LIL to supply off-Island capacity and energy to the Island Interconnected System. In each biweekly report, Hydro will also provide an update on supply adequacy for winter 2018-2019 with the most up-to-date in-service assumptions of the LIL, as required. The information in this report is current as of January 16, 2019 with the exception of the LIL in-services updates. It is noted that typical commissioning issues will be occurring as commissioning continues. Updates regarding those issues known to materially affect the assumptions of capacity and availability for the 2018-2019 winter season will be provided as they become known. Otherwise, any developments occurring after the preparation of the biweekly report will be included in the next biweekly report.

2. In-Service Activities Update

The following outlines the specific critical path activities required for operation of the LIL for winter 2018-2019,[1] as well as schedule or constraint information for those tasks. As this report is updated on a biweekly basis, Hydro will provide information on the key activities and the associated schedule to inform the Board if any potential supply issues arise from the delivery of those activities.

Due to the continuous operation of the LIL, the January 11, 2019 biweekly meeting was not held. The next biweekly meeting is scheduled to occur on January 25, 2019.

[1] This report discusses operational readiness for winter 2018-2019. The final in-service review of the LIL is undertaken separately with the Board's consultant, Liberty, on a quarterly basis with TTO.

Please note:

1) The following activities are complete:
   a. Item 1.a) Churchill Falls Terminal Station Breaker Upgrade (735kV scope)
   b. Item 1.b) Churchill Falls Terminal Station Breaker Upgrade (315kV scope)
   c. Item 2. Muskrat Falls Terminal Station 315kV GIS Voltage Transformer Replacement (1 unit)
   d. Item 3.a) Churchill Falls Terminal Station 315kV GIS Voltage Transformer Replacement (1st campaign, 5 units)
   e. Item 3.b) Churchill Falls Terminal Station 315kV GIS Voltage Transformer Replacement (2nd campaign, 2 units)
   f. Item 4. ERP/ERR: Interim Emergency Response Plan/ERR in place for all Sites/Assets
   g. Item 5. Contracts: Support services in place & resources onboard
   h. Item 6. Assets: Operationalize High Frequency Preventative Maintenance Program
   i. Item 7. Contracts: Operations, Maintenance & Administrative Services for Monopole
   j. Item 8. Inventory: Pre Winter 2018 readiness
   k. Item 10.a & b) People: Implement 24x7 staffing model for Muskrat Falls
   l. Item 11. Re-Energize Labrador-Island Link on 01-Nov-2018

Figure 1: The LIL In-Service Critical Path Activities

Project Delivery

Activity 1 – Churchill Falls Breaker Upgrade

Status: Completed, no further updates.

Activities 2 and 3 – 315 kV GIS Voltage Transformer[2] Replacements

Status: Completed, no further updates.

Transitions to Operations Delivery

Activity 4: Emergency Response Plan ("ERP")/Emergency Restoration and Recovery ("ERR"): Interim ERP/ERR in place as required at all sites/assets

Status: Completed, no further updates.

Activity 5 – Contracts: Support Services in Place and Resources on Board

Status: Completed, no further updates.

Activity 6 – Assets: Operationalize High Frequency Preventive Maintenance Program

Status: Completed, no further updates.

Activity 7 – Contracts: Operations, Maintenance, and Administrative Services for Monopole

Status: Completed, no further updates.

- The HVAC services contract has been awarded and the contract has been signed. All identified operations, maintenance and administrative support and services contracts for monopole operations have now been secured

Activity 8 – Inventory: Pre-Winter 2018 Readiness

Status: Identification, inspection and verification of winter readiness spares completed, ongoing procurement. No change from previous update.

- Completed the winter readiness spares inventory requirement for the overhead transmission lines and submarine cables.

- All critical spares for the overhead transmission lines and submarine cables are in place. Deficiencies have been identified and procurement activities will continue until all items

[2] 315 kV instrument transformers.

received. Spares for HVdc assets will remain in contractors care, custody and control until they are transferred to the project/operations upon completion of bi-pole low power trial operation.

Activity 9 – Newfoundland and Labrador System Operator ("NLSO"): Operational Acceptance Criteria Received

Status: On track with remaining item to be delivered at conclusion of Activity 12.

- Four of the five NLSO requirements have been met. The operational readiness document has been delivered in draft and will be updated as final along with the release for service form at the conclusion of the monopole commissioning activities.

A description of the five NLSO requirements and status is as follows:

- Item 1: Ability to monitor the AC equipment associated with the converter stations (including filter banks) remotely from the ECC for system reliability considerations. **Status: Completed/Accepted.**
- Item 2: Asset owner contact details (to be responsive 24/7). **Status**: **Completed/Accepted.**
- Item 3: Redundant communications paths (voice, tele-protection and SCADA) between the ECC and all stations. **Status: Completed/Accepted.**
- Item 4: Provide a technical resource in the NLSO control room to support the Energy Control Centre during the initial start-up period. **Status**: **Completed/Accepted.**
- Item 5: Documentation including an Operational Readiness document (outlining commissioning / testing activities, operating limits / restrictions, and identified risks / plans for mitigation), and a completed/updated release for service form outlining remaining deficiencies and expected timelines for completion. **Status**: **In Progress.** The operational readiness document has been delivered in draft and will be updated as final along with the release for service form at the conclusion of the monopole commissioning activities.

Activity 10 – People: Implement Interim 24/7 Staffing Model for Muskrat Falls

Status: Completed, no further updates.

Power Transfer

Activity 11 – Re-Energize Labrador Island Link

Status: Completed as planned on November 1, 2018.

- The LIL was re-energized on November 1, 2018 at 45 MW using the existing version (version 15) of GE software. Another version (16) has been delivered to site and factory acceptance testing ("FAT") of the next release (17) has been completed in Stafford. A decision has been made to remain on version 15 for the remainder of the winter season. The decision was based on the ongoing satisfactory performance of version 15 and the impact during the peak winter demand period of a multi-week outage to the LIL required to implement a new version, which would have to undergo additional testing.

Activity 12 – Transmission Link Monopole Commissioning

Status: Initiated November 1, 2018 and ongoing.

- Following a planned outage to address several items, the LIL was returned to service on December 7, 2018 at 60 MW. Over the course of the following six days, the LIL was operated at various levels and taken offline for various durations to work through identified items, as is typical for assets going in service. As noted in the January 7, 2019 report, the LIL was placed into continuous service on December 13, 2018, and ran uninterrupted at various power transfer levels until a trip on January 13, 2019. This trip was the result of a ground switch operation at the Muskrat Falls Converter Station, which was quickly identified and resolved. The LIL was returned to service the same day, operating up to the maximum available recall power from Churchill Falls, and achieving 140 MW (delivered to Soldier's Pond) on January 15, 2019. The LIL then tripped on January 16, 2019 due to a common neutral area protection device operation and again on January 17, 2019 due to a Transition Compound Current Differential ("TTCD"). The LIL was returned to service shortly after each of these trips, but was limited to 60 MW while the investigation into the cause was initiated. Investigations on both of these recent

trips are ongoing, but preliminary results indicate that the cause of these issues will not be present at levels below 130 MW, and therefore the LIL has been limited to this level since these preliminary results were received.

- Monitoring of the valve leak issue is ongoing since it was identified on November 7, 2018. The leak has not reoccurred.

- GE has implemented a manual process that enables a manual lane change over when some specific software events occur. Previously, this required a shutdown of the LIL to reset the issue. This has the potential to increase the reliability of the link during this winter.

- Punch list items are continually being addressed and closed by the project team. While punch list resolution shall continue in an effort to improve system reliability, this effort is not considered critical for power transfer.

- Monopole commissioning at power levels of 60 MW (delivered to Soldier's Pond) and below has now concluded. Testing of the LIL at higher power levels (between 60 MW and the technical limit for monopole operations, approximately 214 MW delivered) continues, and deliveries of up to 140 MW have been achieved to date. Hydro and Nalcor are monitoring available capacity in Labrador to maximize deliveries over the LIL up to the technical limit. Achieving deliveries up to the technical limit is not necessarily required to constitute monopole commissioning at higher power transfer levels. As power transfers have increased in recent weeks, Hydro and Nalcor are assessing the LIL performance and are determining when higher power transfer commissioning is concluded. Hydro will inform the Board once this determination is made.

Despite the fact that the LIL remains in the testing phase and the current version of software limits how it can be operated, the mitigating measures that have been put in place in recent weeks allow Hydro to incorporate LIL deliveries in its system dispatch. In

fact, Hydro has implemented a scheduling process for the Recapture Energy delivered to the Island over the LIL and the scheduled quantities are included in spinning and available reserve forecasts.

3. Key Risks

There has been no change in the key risks since the October 1, 2018 report. In addition to the activities described in Section 2, Hydro acknowledges that the reliability of the current GE software implementation is currently being witnessed as the LIL is now online 24 hours a day and will inform the reliability assumptions of the LIL. Alternative software versions have been received from GE and are under consideration for future implementation.

Dynamic commissioning with power transfer activities recommenced as scheduled on November 1, 2018 with existing software. The software issues remain unresolved in the currently installed software version; however, successful power transfer using the currently installed software occurred throughout December 2018, and remains ongoing, as part of testing and commissioning activities. A further software version has been completed including testing at the vendor's facility. As installation of updated software will require a multiple week outage to the LIL, installation is currently planned to occur after the winter season to minimize the effect on power transfer during Hydro's peak loading period.

An additional risk being monitored is the Maritime Link (“ML”) frequency response to the LIL initiated disturbances when the LIL is in service. The frequency controller has remained in operation using the settings that were investigated in operational studies. These settings help to avoid underfrequency load shedding and provide support to the Nova Scotia system.

To avoid frequent operation of the frequency controller, it has been equipped with a deadband of +/- 0.5 Hz. As such, there will be a frequency controller activation if frequency drops below 59.5 Hz or goes above 60.5 Hz. When the LIL is switched on, the instant injection of 45 MW to the Island triggers overfrequency controller responses. Blocking (i.e., shutting off) the LIL results in an underfrequency response. To reduce the number of responses, the current operating

philosophy is to disable the frequency converter just prior to LIL startups (for a period of approximately five minutes) to minimize the overall number of frequency controller activations. This is completed to satisfy Nova Scotia Power and New Brunswick Power System Operators regarding the number of activations. When the ML frequency response is turned off, the LIL contribution to the Island's power supply is similar to a generator, and the reliability of the LIL will be the major factor in the decision on loading level. The NLSO continues to work with Nova Scotia Power and New Brunswick Power Service Operators to keep them informed of testing plans so as to understand and mitigate the risk from their perspective.

4. Modelled Assumptions

Table 1 of Hydro's December 21, 2018 biweekly report included results consistent with the results in Volume II of the Reliability and Resource Adequacy Study filed on November 16, 2018. Hydro acknowledges that the revised tables should have been included in its November 26, 2018 and December 10, 2018 filings and apologizes for any confusion that the omission has caused.

There has been no significant change in the modelled assumptions since this report. These results showed increased LOLH and EUE over values previously shared as part of Hydro's analysis. The change in the LOLH and EUE is largely due to a change in the modelling methodology rather than a change in the underlying system conditions. As discussed in the November 2018 report, the new model is more conservative, and as a result the LOLH and EUE numbers produced by the model are higher. Many factors contribute to the increase in LOLH and EUE between the two models but the two that have the largest impact are dynamic loss modelling and the inclusion of load forecast uncertainty:

1. Dynamic modelling of losses - The previous model used a fixed value for losses. The current model calculates losses based on system conditions, which has the effect of increasing losses when there are units out of service on the Avalon, thus increasing the frequency and severity of outages.
2. Load forecast uncertainty - The previous model used a fixed load shape with a 60 MW adjustment on peak to represent the P90 condition. In the current model, a

random variation is applied to the load shape in each hour in the model to reflect the variation in load due to weather. On average, this increases the frequency and severity of outages.

As a result, the model is showing violations in the LOLH criteria for Holyrood forced outage rates above 15%. There is expected to be a significant increase in system reliability once the first Muskrat Falls unit is available in late 2019.

It is important to note that, based on the performance of Hydro's generation assets thus far for winter 2018-2019 the analysis represents a conservative view of system conditions. The DAFOR for Holyrood was 8.1% in November and 5.8% in December, below the 15% DAFOR which was considered as the base assumption. While the Holyrood plant DAFOR is not yet available for January 2019, continued high availability of all units for the first half of the month indicate sustained good performance. The performance of the LIL has also been better than expected in terms of both capacity and availability. In the analysis, the LIL was assumed to have a capacity of 110 MW and a forced outage rate of 30%. Since mid-December 2018 there have been four interruptions in the availability of the LIL and it has recently been operating above 110 MW on a regular basis.

A detailed description of the modelling assumptions and process for the current system model can be found in Volumes I and II of the Reliability and Resource Adequacy Study. All results reflect the implementation of the contingency plan as described in Section 5.

Table 1: Supply Adequacy Modelling Results for Updated Assumptions

Reliability Metric	LOLH	EUE	Normalized EUE
Base Load Forecast, HRD DAFOR = 15%	2.21	118	11.0
Base Load Forecast, HRD DAFOR = 18%	3.31	184	17.0
Base Load Forecast, HRD DAFOR = 20%	4.13	230	21.2

5. Contingency Plan

In light of the current LIL winter 2018-2019 transfer assumptions, Hydro developed and implemented a two-phased contingency plan for the 2018-2019 winter season that includes incremental internal and external system support. Phase I of Hydro's contingency plan contains items that can be secured and incorporated into Hydro's base planning assumptions for the 2018-2019 winter operating season. Details and the status of items in Phase I of Hydro's contingency plan are contained in Table 2.

Table 2: Phase I of Hydro's Contingency Plan

Item	Description	Incremental System Benefit	Parties Involved	Status	Notes
1	Increase of Capacity Assistance from 90 MW to 105 MW[3]	+15 MW	Hydro, Corner Brook Pulp and Paper ("CBPP")	Ongoing	CBPP has indicated that up to 105 MW is available. The proposed agreement was approved by the Board on November 22, 2018.
2	Re-instatement of Capacity Assistance Program	+7.6 MW	Hydro, Vale	Ongoing	Vale has indicated they are in agreement with Hydro's proposed Capacity Assistance Agreements; one for diesel generation (8 MW) and one for load curtailment (6 MW). The proposed agreement was approved by the Board on November 30, 2018.
3	Re-instatement of Load Curtailment Program	+6 MW	Hydro, Vale	Ongoing	
4	Voltage Reduction	+20 MW	Hydro, Newfoundland Power	Complete	Hydro has confirmed that it is reasonable to assume availability of 20 MW of Peak Voltage Reduction for the coming winter season. Voltage reduction is forecast on a week-ahead basis by the NLSO.
Potential Incremental System Benefit on peak		**48.6 MW**			

[3] Hydro has now confirmed there is 105 MW available as compared to the 110 MW reported in the previous Biweekly Report. Given the relatively small change in magnitude of the available assistance, Hydro has not run the model for this 5 MW difference. Hydro presented the full analysis of its supply adequacy for winter 2018-2019 in its November 16, 2018 filing to the Board regarding supply adequacy.

Hydro notes that voltage reduction is not what is publically known as "brown out". Voltage reduction is a measured and controlled process whereby there is minimal reduction in the delivery point voltages to customers. This process, utilized by utilities across North America as a typical system management tool, has been used for peak demand management in almost every year on the Island system. Customers see no impact to their service during a period of voltage reduction (typically up to four hours) and equipment is not harmed.

In addition to the items listed in Phase I of Hydro's contingency plan, Hydro has also identified elements that can provide additional system benefit, but will only be enacted if absolutely required. These items form Phase II of Hydro's contingency plan and are detailed in Table 3.

Table 3: Phase II of Hydro's Contingency Plan

Item	Description	Incremental System Benefit	Parties Involved	Status	Notes
5	Increased output of Holyrood Gas Turbine ("GT") beyond current base assumption	+10 MW	Hydro	Complete	The ability to increase the capability of the unit is available on a temporary basis subject to atmospheric and system conditions. The GT has been previously safely demonstrated to operate to 134 MW.
6	Temporary increased output of Holyrood Diesels	+1.5 MW	Hydro, Department of Environment	Complete	Hydro met with the Department of Municipal Affairs and Environment and provided an overview of the potential upgrading requirements.
Potential Incremental System Benefit on peak		**+11.5 MW**			

6. Conclusion

Hydro is actively monitoring the availability of supply as it relates to the LIL and associated impact on reliability of the Island Interconnected System for the 2018-2019 winter season. Hydro's contingency plans described above are in place in the event that the LIL does not meet the current assumed capacity and reliability parameters.

Through its biweekly report, Hydro will keep the Board informed on developments related to the operation of the LIL should its performance impose material changes impacting supply adequacy for the Island Interconnected System.