

**Ninth Quarterly Monitoring Report on the  
Integration of Power Supply Facilities to the  
Island Interconnected System**

**Presented to:**

**The Board of Commissioners of Public Utilities  
Newfoundland and Labrador**

**Presented by:**

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## 1. Summary

Our work this quarter began with issuance of a series of questions to management, followed by receipt of answers to them, and two days of meetings with Nalcor and Hydro management on February 11 and 12, 2020 (the “February 11 meetings”). We subsequently reviewed a February 25, 2020 Hydro letter filed with the board, (“Hydro’s February 25 letter”) captioned as *The Liberty Consulting Group Eighth Quarterly Monitoring Report on the Integration of Power Supply Facilities to the Island Interconnected System – Monthly Update*.

We found that the most recent past quarter continues the now long-sustained pattern of disappointment across a broad range of fronts in the transition to operations (TTO) of the Lower Churchill Project (LCP). The Labrador Island Link (LIL) that connects Muskrat Falls generation to the Island Interconnected System (IIS) failed to enter service this winter and its availability for operation in the next one has become less certain. The observations that cause the greatest concern this quarter include the following.

**Risk of LIL Unavailability Continuing into Next Winter:** For a number of quarters now, the scheduled time remaining until LIL operation has not changed, despite management’s efforts to secure its completion. Despite these efforts, each quarter seems to show completion scheduled roughly the same number of months away.

Management expressed optimism in the quarter before the one addressed by this report that a seven-week extension in General Electric’s interim software would produce its delivery by early January 2020. Instead, the materials reviewed at the February 11 meetings showed a later, March 20 delivery date. Hydro’s February 25 letter, coming about two weeks later, showed a further delay in interim software delivery to April 20, 2020. It is likely that the additional delay has been caused by GE now needing extra time to resolve ALL the errors found in the software

The February 11 meetings with management disclosed its view, as it expressed to General Electric, that LIL quality and reliability have greater importance than adherence to scheduled milestones for bringing the LIL into service. While quality and reliability are certainly important, circumstances make clear that Hydro now needs promptly to address means for assuring reliability of power supply for the IIS for the coming winter under the assumption that the LIL will not be available for some or all of that period.

Hydro’s February 25 letter not only announced a delay to April 20, 2020 in delivery of the interim software to the site, but, equally significantly, reported the risk for “further schedule slippage” as “high.” Hydro’s February 25 letter underscores and increases a concern we raised in last quarter’s report - - that significant risk exists that the LIL will not be operational at the beginning of the coming winter. Hydro’s February 25 letter posits a date of May 31, 2020 for commencement of dynamic commissioning and low-load testing (a 46-day delay from the schedule existing at December 20, 2019).

Hydro’s February 25 letter extends the December 20, 2019 scheduled date for the key milestone of commencement of high-power testing, which requires the final software, by a similar 46 days.

There is no information about the time required for High Power commissioning and testing, but typically, the higher the power transmitted, the longer the duration of testing, because of the need to safeguard the transmission network, in case testing is not successful. This is particularly relevant to the LIL, which has a very high rating relative to the installed generation.

The extension in the date of interim software delivery to site (as reflected in Hydro's February 25 letter) is a month longer (78 versus 46 days) than the reported delay in commencement of high-power testing. This difference indicates that Nalcor expects recovery of much of the time lost in getting the interim software to the site. The long history of software issues and delays does not inspire confidence that Nalcor will be able to move from delivery of the interim software to high-power testing in significantly less time than previously estimated.

The long history of delays, the further delays recently announced, the belief expressed by Hydro that significant risk accompanies the newly projected, April 20 date for interim software delivery, and the shortening of the duration between that milestone and high-power testing support a conclusion that the September 1 date for high-power testing is unduly aggressive (optimistic). Notably, further delays in that date push LIL operation ever closer to the start of the 2020/2021 winter season.

Accordingly, what had been a concern about LIL availability for at least portions of the coming winter must now be viewed as a contingency deserving of specific planning to assure reliable service to customers for the coming winter season. It is in our view not only prudent, but necessary for Hydro to plan in detail measures to ensure the availability of resources needed should the LIL not be fully operational for the 2020/2021 winter. The planned Fall 2020 winter readiness report, while important, will not provide sufficient time for stakeholders and the Board to ensure that all required actions will have been taken. Hydro's plans (including an assumption that the LIL will not be available at the start of and for the entire coming winter period (2020/2021) should be completed and incorporated as part of Hydro's coming, May 15, 2020 Near Term Generation Adequacy Report.

**Lack of Access to Independent Monitoring Reports:** Management has been receiving independent third party (ITP) oversight reports of General Electric for an extended period, as our quarterly reports have discussed. We urged this quarter, as we did last quarter, that the ITP reports be made available for our review. We continue to be denied access to them, reportedly based on an unwillingness on General Electric's part to waive confidentiality restrictions associated with them. The continuing inability of management and General Electric to resolve the issue of access, combined with continuing extension of the LIL schedule for reasons those reports address, makes access to them ever more important in ensuring that confidence in relatively near term completion of the underlying issues is well placed. Even so, the descriptions of oversight findings that management has provided are not encouraging. Many software problems requiring rectification have been found and more have continued to arise. We consider it necessary to recognize the potential for even more problems arising during Factory System Testing and we find steadily more discomfort with management's continuing expressions of confidence in ever lengthening dates for software delivery.

Continuing delays that seemingly keep LIL completion the same number of months away, despite the passage of many quarters, diminish already low confidence in management's estimates for LIL milestone dates. They also heighten the value of the added transparency that direct access to what management and General Electric appear to consider the best information about schedule status would give us. Access to the reports for on-site review, and subject to appropriate confidentiality with respect to their details would promote that transparency.

**Unresolved synchronous condenser vibration and binding issues threaten high-power LIL testing and operation:** Causes remain uncertain. Should these issues continue beyond June of this year, they may prevent or significantly restrict power flows over the LIL during commissioning, and could have an impact on the power flows during the 2020/2021 winter. The severity of the problem and corrective actions remain under examination, making it impossible to determine their impacts and the methods and time it will take to address them. Hydro's February 25 letter makes clear the schedule threat that these problems impose. It offers new scheduled dates for the commissioning of the synchronous condensers, which are May, June and August for Units 3, 2 and 1, respectively. There is, however, a material risk that the schedule may extend beyond August 2020, which could impact on the commissioning of the LIL at high power.

These issues underscore the importance of Hydro's provision as part of its May 15, 2020 Near Term Generation Adequacy Report of plans for ensuring identification and completion of all activities required to ensure reliability for the coming winter period under the assumption that the LIL will not be in reliable operation when the period begins.

**The LIL's connection to Muskrat Falls Testing:** It had been assumed that the LIL would provide a path for first output from Muskrat Falls generators. As our Seventh Quarterly Report first reported, a delay in the LIL would require Nalcor to find an alternate path for this power flow. Delays in operation of the first of those generators has been identified, but it remains likely that first power from Muskrat Fall generation will have to flow west through the Hydro Quebec system, across the Labrador Transmission Assets. Without assurances that Muskrat Falls generation can add to Churchill Falls generation flowing through the Hydro Quebec system, it will be necessary to back down Churchill Falls generation. For some time, storage can preserve the ability to use the water not committed to generation. However, extended reductions in Churchill Falls generation would eventually require water spillage, and result in economic loss. Work remains underway to assess the degree to which incremental additions to power flows from Muskrat Falls through Hydro Quebec can be accommodated.

Since writing the first draft of this report, Hydro's February 25 letter shows new, delayed schedule dates for commissioning Muskrat Falls generation. The delay results from the need to replace generator rotor keys. Unit 1 is now expected to be in commercial operation in Mid-April 2020, and will be followed by Units 2, 3 and 4, with all four units being expected to be in service by the end of 2020.

**Stability of the Post-LIL Avalon Transmission System Remains Under Study:** A number of transmission technical concerns continue to remain open, leaving uncertain whether, even after operation of the LIL, contingencies on the transmission system will require substantial Avalon

Peninsula generation to remain available to avoid underfrequency load shedding and rolling outages.

**Training To Be Provided By General Electric Remains Far Behind Schedule, With No Clear Path To Completion:** As has been true for a number of quarters, such training continues to show very little progress. It remains constrained by General Electric resource availability, and is not subject to any clear plan or schedule for completion.

**Overall Schedule Performance, as Measured by Activity Completion Continues to Lag:** We agreed to a Nalcor re-baselining of the TTO schedule three quarters ago, in order to reflect substantial lag that had occurred by then and to incorporate management's revisions to schedule logic and activities. Despite that major re-baselining, we continue to observe this quarter, as we have since the re-baselining, a failure to sufficiently advance activity completion rates to provide confidence that such completion will support key overall project milestones. With ever less time remaining to complete them, continuing lags cause an increasing threat to overall project completion. Activity completion continues to occur at rates far less than scheduled. Management failed in this quarter to achieve the progress called for by its measures.

Note that our tracking requires management to designate an activity as fully complete. Management's approach permits subjective judgements about how much (*i.e.*, what percentage) of an activity is complete. Reliance on such subjective judgments, even before considering performance rates to date, is troubling when so many activities continue to have some work left to complete them. Objective measures of completion are always preferable - - all the more so as pressure on those who make judgments about "percentages" are under ever increasing pressure to show progress.

## 2. Introduction

### a. The Purpose of this Report

This report examines fourth quarter 2019 scheduled and completed activities undertaken as part of the TTO organization's role in integrating the LCP into the province's electrical system by planned in-service dates. The scope of this monitoring effort has generally excluded Muskrat Fall's construction activities, although we have considered the impacts of the scheduling of those activities on TTO work. Muskrat Falls construction continued to proceed under its own plans and schedules; progress against those construction milestones have continued to bear on and have material linkages to the TTO work streams and their schedules.

The four work streams of the TTO, each of which operate under dedicated teams, consist of:

- BTPO (Building the Production Organization) - - focused on operations and maintenance strategy, organization design and staffing, training, securing needed services from outside sources, and the development of operations and maintenance plans, systems, strategies, and procedures for the integration between the IIS and the LCP
- RFI (Ready for Integration) - - focused on system planning inputs for design and operational requirements, development of reliability standards, support for operational readiness, and participation in testing

- RCFI (Ready for Commercial Integration) - - focused on commercial, legislative, and regulatory matters
- RFO (Ready for Operations) - - functional oversight of a variety of requirements (*e.g.*, safety and environmental), contractor deliverables, and turnovers to operations. The transition schedule contains no RFO activities, which are embedded in the LCP.

Our review of progress over the past quarter continued to focus on the five substantive areas we have addressed over the past twenty-seven months:

- Sufficiency of BTPO, RFI, and RCFI work stream plans and schedules in providing a sufficiently comprehensive, well-defined, logically sequenced and connected set of activities
- Progress made in the last quarter relative to schedules for these work streams
- Management familiarity with schedule drivers
- Management's identification of measures to minimize schedule slippage
- Key measures, actions, and results for coming months.

#### **b. LIL Readiness**

The dynamic commissioning of the LIL commenced on June 11, 2018 on a monopole basis, using Pole 1, as previously reported. A surprisingly large number of software problems became apparent during the commissioning process, indicating inadequate Factory System Testing before shipment to site. Pole 1 of the LIL did transmit recall power during the 2018-2019 winter period, but it was removed from service many months ago (in June 2019), awaiting installation of an interim bipole version of the software. Management expected this version to offer a significant update to the first control software delivered to site, but still lacking some required features. Thus, it was not expected, for example, to permit overload operation, frequency control, reverse power flow or loop power flow. The first two of these functions have more critical importance because operation at high power requires them.

The interim bipole software version underwent Factory System Testing (FST), which included 994 separate tests. With all tests been performed, only 581 tests (about 60 percent) passed. Work to remedy the causes of these many failures remains in progress. General Electric has proposed release of the software for Factory Acceptance Testing (FAT) before clearing all of the underlying issues. Management has not agreed to date, but may consider this approach after General Electric offers more information about the potential impact on the transmission system and customer reliability of any remaining known issues. FAT testing is expected to take a minimum of two weeks, but could extend significantly should the need arise to assess and analyze any remaining issues exposed by FAT testing. Accordingly, management does not offer a firm schedule for delivery of the interim bipole software, but considers it unlikely to happen earlier than end of March 2020.

The latest schedule (provided in Hydro's February 25 letter) projects delivery of interim software to the site by April 20, 2020, which will lead to resumption of power flow over the LIL, as part of testing and commissioning activities. In the absence of synchronous condensers, management will limit maximum power flow to 225MW. We consider the schedule for interim software delivery and subsequent activities leading to scheduled commencement of high-power LIL testing on

September 1 of this year unduly optimistic, given: (a) the status of the control software, and (b) the lack of “float” in the schedule for getting the LIL into commercial operation. The many failures to meet scheduled dates for software delivery, in our judgment makes delay past April 20, 2020 significantly more likely than not.

### 3. Major Findings

#### a. LIL Schedule

The LIL has remained out of service for almost nine months (since June 5, 2019), will remain out of service for at least another two months, and, in our view is likely to do so for several months more - - and possibly into the next winter period (now only another nine months or so away). It has remained out of service, as preparation for installation of bipole software continues. Awaiting General Electric’s delivery of the long-delayed interim bipole software remains the critical LIL schedule driver. When we met with management last in November, it recognized an expected seven-week delay in the delivery date of the software - - from late October to late December - - a delay that would push low-load testing back to January 2020. This quarter’s February 11 meetings with Nalcor and Hydro’s ensuing February 25 letter disclosed yet more delays in delivery of interim bipole software and subsequent, related activities. The lengths of the delays reported by management in recent quarters appear neither ending nor even shortening to the extent one would expect with completion so near, and despite the passage of many months of certainly highly-focused work on the software issues.

The significance of LIL delays now extend beyond the implications for short-term reliability in serving Hydro’s wholesale and retail customers. The schedule for Muskrat Falls first generation now leads that for LIL operation. The LIL’s unavailability to transmit initial power from Muskrat Falls will require Nalcor to secure a dependable delivery path for Muskrat Falls power across the LTA and into Quebec. Issues surrounding the ability of transmission through Quebec to support generation from both Churchill Falls and Muskrat Falls (in the absence of a path into and through the Island) remain unresolved and they may threaten at least economic loss to customers.

The interim bipole software will not include all features required by the contract. When available, this version will offer a significant update to the first control software delivered to site, including bipole operation and many other updates. It will not, however, permit overload operation, frequency control, reverse power flow or loop power flow - - important elements of LIL design. The first two of these functions have the greatest importance, because high-power LIL operation requires their availability. In particular, operation at overload power will prove essential for accommodating the loss of one pole when the LIL is operating at more than 450MW. We further understand that the interim software will restrict power transmission to a maximum level of 225MW. Reverse power and loop power flow control modes are required occasionally. Reverse power flow involves exporting power from the IIS to Labrador; loop power flow supports de-icing the HVDC overhead line, when necessary, when no or little power flow is needed on the LIL.

We view Nalcor’s current schedule for low load dynamic commissioning with interim software overly aggressive, given current circumstances and our need to make an assessment without direct access to the independent monitoring information that management can use in making its



assessment. Historical performance, the continuing emergence of new issues, continuing reports of General Electric resource availability issues, and schedules that continue to extend by large degrees so late in the project all command doubt, not confidence, in management's expectations. Following installation of the interim software at site operation of Pole 1 needs to be checked, and then Pole 2 will require dynamic commissioning. Thereafter, bipole commissioning can commence.

Hydro's February 25 letter indicates delivery of the final bipole software to the site by July 29, 2020 (50 days after the June 9 date from the December 20, 2019 schedule). Nalcor expects the next version to include all the features required for bipole operation, including operation at overload power, frequency control, reverse power flow and loop power flow. Completion of low-load testing with the final bipole software as now scheduled is also unduly optimistic, considering past history and current circumstances, as best we can comprehend them from the information that management is willing to share.

The date of final, fully effective software delivery to the site will depend on the number of "bugs" associated with the new features and on the nature and number of software issues that may be identified during the commissioning using the interim software. Nalcor should expect all identified issues with the software to be rectified and solutions tested before or as part of the final software Factory System Test (FST) and the Factory Acceptance Test (FAT) testing at the General Electric facilities. General Electric should complete testing, issue resolution, and resolution testing prior to shipping the software to the site. We find the time estimated for commissioning of the bipole with the final software overly ambitious, and therefore much more likely than not to be further extended, perhaps by an extended period of time.

Required high-power testing must follow completion of low power testing. High-power testing will require availability of sufficient power from Churchill Falls and Muskrat Falls and the availability of at least two of the three Soldiers Pond synchronous condensers. High Power commissioning and testing typically require longer to perform, because of the need to safeguard the transmission network, should testing prove unsuccessful. This issue has particular relevance for the LIL; its high rating relative to the installed generation increases the risks that testing failure poses for the system. We explain below risks associated with availability of synchronous condenser operation.

Experience from LIL Pole 1 software commissioning in 2018 indicates the potential for significant slippage, potentially extending coming commissioning activities considerably. Across our two years of quarterly monitoring, management has continued to express optimism about improved General Electric performance. We do not find objective measures that improvement has happened. Management reports that it has General Electric's "attention" at senior levels, but it is late in the process to find that alone comforting. The coming months will require close and detailed monitoring of General Electric progress to accompany management's optimism, given circumstances that now implicate generator commissioning and begin to question the availability of the LIL when the winter of 2020/2021 commences.

## **b. Independent Third-Party Review**

General Electric agreed some time ago to employ an independent third party (ITP) to confirm satisfaction of system functionality requirements. Two firms have been monitoring General Electric's performance since the second quarter of 2019. Systematic was hired to assess software development progress and Amplitude was hired to assess conformance to HVdc functional requirements. We have been supportive of such a contribution - - particularly in getting at the root causes of delays and establishing more realistic dates for completion dates. Citing General Electric concerns, Nalcor has continued to decline to make the written report of the independent reviewers available, but has given us a verbal description of its contents.

Continuation of old problems and the emergence of new ones increase the importance and value of transparency. We therefore requested direct access to written reporting again, but again did not receive it. We therefore had to rely again on a Nalcor description. Management advised that the Systematic and Amplitude visited General Electric's facilities in early January for their monthly project status review. We understand their central findings to include:

- The interim bipole software was in the Factory System Test (FST) mode, a pre-requisite to the Factory Acceptance Test (FAT). (We have been informed by Management that the interim bipole software version was subjected to 994 separate tests during the FST. All tests have been performed, but only 581 tests passed.)
- The schedule is very compressed; there is no float in the schedule to handle any critical bugs found after Jan 9 without resulting in a delay to FAT
- To achieve the FAT date, General Electric needs best case scenario with limited number of bugs generated during remaining tests
- General Electric needs to increase bug fixing and test execution velocity significantly
- Software bugs are having an impact on core functionality.

Based on the January review, the ITP projected interim software release not later than February 26, 2020. However, at our monitoring meeting in February, Nalcor advised that a subsequent visit by the ITP in early February indicated their assessment had grown more pessimistic and based on what they observed, they were not able to make a current assessment as to when the software would be delivered. This is of significant concern, and casts further doubt on Nalcor's forecast of a late March delivery of the software. Note that awaiting the next quarterly report will make the most recent monitoring results unavailable until they are many months old.

## **c. Converter Station Control Issue**

Our last quarterly report addressed a control issue identified during TransGrid Solutions studies to identify the system performance during the loss of a pole, when operating in bipolar mode at high power. The studies had seemingly identified a problem that resulted from constraints within the model of the converter station of the firing angle of the converter. This problem would potentially mean that the LIL could not meet specified performance criteria requiring no under frequency load shedding in the event of the loss of one pole when operating at high power delivered to the IIS.

Following investigation of the problem and the involvement of General Electric, the "generic" model used by TransGrid underwent updating to reflect the actual performance of the LIL. Studies

using the updated model presented in an interim report show that the performance does conform with the LIL specification. The full report is scheduled for release in March.

#### **d. Soldiers Pond Synchronous Condenser Vibration and Binding**

The LCP's electrical connection of Labrador and Newfoundland requires three Synchronous Condensers (SCs). An SC operates effectively as a generator without a prime mover; it cannot deliver continuous power. The roles of the three LCP SCs consist of: (a) increasing the short circuit level at the connection point of the inverter station, allowing the LIL to continue operating in a stable manner, and (b) increasing the inertia of the IIS to prevent temporary faults within the IIS or on the LIL from producing a need for under frequency load shedding.

Studies have demonstrated the need for a minimum of two SCs to be in operation when the LIL is delivering the full power of 900MW to the IIS. Import of 225MW from Muskrat Falls (MF) has been achieved without any SCs in operation, but Holyrood and other generators were in service. Following the proposed retirement of the Holyrood generators (at dates not yet known) and conversion of one of them to synchronous condenser operation, it is expected that two of the new synchronous condensers will be in service for high power operation. The maximum import capability on the LIL with one SC in service, and without the Holyrood generators, is not known.

Commissioning work on the synchronous condensers identified high vibration levels on Unit 3 and binding on Units 1 and 2. These circumstances raise the possibility that, when Units 1 and 2 can rotate (after resolution of their binding issue) they too will experience a vibration issue similar to that observed on Unit 3. General Electric has made several modifications to Unit 1 and 2 bearings to address the binding issue. Nalcor reports some progress, with further testing still pending. There are no assurances that the solutions identified will be fully effective in addressing binding problems.

External consultants Ontario Power Generation (OPG) were engaged to assess the Unit 3 vibration issue. An Operation Deflection Shape test on synchronous condenser Unit 3 has been performed. General Electric retained FZA, LLC to perform a Soil Structure Interaction Analysis on the foundation for Unit 3. The consultants performed their work in December 2019. Final reports from both consultants remain pending. Early observations from the consultants (emphasizing their preliminary nature) indicate that: (a) axial vibration (parallel to the rotor shaft) is associated with the half-moon housing support structure and (b) lateral vibration (perpendicular to the rotor shaft) is associated with the foundation.

To remediate the axial vibration, a half-moon stiffener platform has been installed on Unit 3. General Electric has run the machine to test vibration levels at various start-up and operating regimes. Nalcor observed at our recent monitoring meeting that vibration levels have been somewhat improved as a result of this modification. Management is not, however, prepared to conclude that the level of improvement obviates concern about the vibration issue.

A conceptual design for the resolution of the lateral vibration related to the foundation from FZA, LLC, remains under review by General Electric. Nalcor has reported to us the identification of 22 potential modifications now under consideration as options to address this problem. General

Electric will decide about final resolution. Nalcor has categorized the foundation issue as a longer-term issue that should not impact near term commissioning of the units. That categorization begs the question of the degree to which the synchronous condensers will be capable of operating as designed post-commissioning.

In summary, there is no basis for concluding that actions taken and options identified will eliminate vibration as a source of limitation on synchronous condenser operations. There is also no current basis for determining what short- and long-range damage to the synchronous condensers the issues may cause (*e.g.*, the time to failure of the SC if solutions do not completely obviate the issues that exist). We also do not believe there exists at present a basis for making realistic projections of the time it will take to get the SCs to a point where binding and vibration issues will not delay their commissioning. The work in addressing foundation-related causes and solutions appears particularly open-ended at this point in time, both with respect to seriousness of the issue and means for addressing it. Management has not offered a basis that would support a realistic assessment of the impact of the foundation issue on near-term, higher power testing activities or the potential long-term impacts on future system reliability and performance. While some commissioning of the LIL can proceed in the absence of the SCs, operation of the LIL at full power will not be possible until at least two SCs are in operation

Management has expressed optimism that, despite the great uncertainty surrounding these issues, it will have identified and implemented solutions that will permit SC operation in June of 2020, as required to support high power testing of the LIL. Some solutions under consideration (*e.g.*, foundation modifications) appear destined, if ultimately required, to produce delay well beyond this spring. A delay into or past June 2020, well within reason if interim solutions or a fairly expeditious longer-term fixes do not prove feasible, may prove very problematic. We think that optimism about the lack of schedule impacts (both to commissioning and longer-term operation of the SCs) is premature.

#### **e. Dynamic LIL Performance**

We noted in our last quarterly report that Hydro Quebec (HQ) had raised yet-to-be-resolved concerns about the adequacy of LIL's dynamic performance during fault conditions. LIL faults and trips of Muskrat Falls generators can significantly affect power flows on the 320kV lines heading west. The September Stage 4C: Labrador Transfer Analysis report provided LIL transfer limits designed to ensure satisfaction of over- and under-voltage planning criteria in Labrador. We understand that Hydro Quebec has also performed studies on this topic, and has not identified any major concerns. We understand that Hydro Quebec will monitor actual LIL performance, presumably by examining traces of the events at CF and at Muskrat Falls.

#### **f. Securing Needed Personnel**

Management has made substantial progress in addressing long-standing delays in securing personnel to operate LCP facilities. An agreement to contract for experienced Muskrat Falls operator positions to supplement apprentice operating staff had alleviated many of the concerns we have had with respect to the full range of personnel required to operate and support LCP assets after commissioning. Our last quarterly report raised a concern that there was turnover among the group selected. That issue appears to have been resolved; Nalcor reports filling the open operator

positions before the fourth quarter of 2019. However, two key Muskrat Falls positions (Manager Production and Supervisor of Operations) remained open in the fourth quarter. Nalcor reports filling the Manager of Production position as of January 2020. The Supervisor of Operations remains open, but in the process of being filled.

Permanent staffing has principally been completed as the next table illustrates.

We previously reported the risk occasioned by limits on start-up resources to support converging commissioning activities. We would have expected moderation of that risk with LIL bipole and synchronous condenser commissioning in 2020. However, schedule lags discussed above continue to pose a significant resource availability risk to activities scheduled for the first half of 2020. Effective communication and coordination and aggressive action to fill positions resulting from employee turnover will be essential to avoid future schedule impacts on activities such as these.

Overall Staffing Status as of December 31, 2019							
	***Total Planned	In Process	Hired-On-Board	Offers Accepted	*Total Secured	% Secured Fourth Quarter 2019	% Secured Third Quarter 2019
Transmission O&M Staff	60	0	57	1	58	97%	97%
Generation O&M Staff	28	1	26	0	26	93%	93%
Engineering Services Staff	41	0	41	0	41	100%	100%
Support Services Staff	14	0	14	0	14	100%	100%
BTPO Staff/Contractors	13	1	12	0	12	92%	92%
Total	156	2	150	1	151	97%	97%
* Secured = On-Board + Offer Accepted							
**In Process includes posted, screening, interview or offer stage							
***Total Planned reflects minor refinements to the Transmission, Generation and BTPO Resource plan since the fourth quarter, 2018.							
Note: Engineering Services reduced by 1 swince last update , 1 BTPO removed as no longer required							

### g. BTPO Training

Training remains an important concern, and like others, affected by General Electric resource availability and performance issues. The fourth quarter of 2019 saw only one training course competed. Eight (nearly 40 percent) of the 21 identified HVdc Station's General Electric Operator training courses in the TTO work plan have not been completed. A similar percentage (2 of 5) General Electric training courses on the four Synchronous Condensers have not been completed.

The rate of completion raises a material concern, compounded by the fact that management has no schedules or even sound estimates of completion dates for the training that remains. Delivery of the required courses remains dependent on General Electric personnel currently involved on other completion work that has higher priority. Management has turned to outside resources for some support of training development and execution. Management has established contingency plans to address course non-delivery. These measures seek to secure additional time to provide required training, by providing for operational coverage by General Electric until turnover, and by HVdc support services resources thereafter.

### h. Emergency Response/Restoration

Limited fourth-quarter progress occurred in completing emergency response and restoration plans and in conducting outage-related exercises for the LIL's long overhead line component traversing Labrador and the Island. In previous quarters, we observed (and management concurred), that 2019

brought limited progress in developing the needed Phase II Long-term OHTL response Plan. We recently learned of fourth quarter completion of tower assembly training exercises and a mock exercise testing emergency response and communications. As of yet, however, completion of an internal lessons-learned report from the mock exercise remains pending. We have requested a copy of this report when it is completed.

#### **i. Long-Term Agreement for the Optimization of Hydraulic Resources**

Our prior reports have discussed a Hydro-proposed Pilot Agreement that the company has addressed in an application to the Board. The application proposes to accumulate the proceeds from “optimized” hydro operations in a deferral account, pending a future application addressing disposition of resulting value (*i.e.*, the Hydro customers’ share of value produced by assets whose costs Hydro’s rates include) among the participating Nalcor entities. The Board approved the Pilot Agreement on December 18, 2018, deferring filing the Long-Term Agreement pending an assessment of Pilot Agreement effectiveness. Management indicated that delaying Long-Term-Agreement submittal would require rework on a number of affiliate and external contracts related to Muskrat Falls Units 1 and 2. Nalcor Energy Marketing (NEM) and Hydro management are drafting an amended and restated Pilot Agreement planned for filing with the Board in in the first quarter of 2020 (delayed from a planned December 2019 filing). The new interim agreement seeks to facilitate interim transmission access for NEM for exports prior to resolution of matters regarding the Long-Term Agreement.

### **4. Summary of Actual versus Scheduled Activity Completion**

#### **a. Overall Fourth Quarter Schedule Progress**

Nalcor re-baselined the TTO schedule as of May 01, 2019. The re-baseline resulted in a significant number of activities being rescheduled to the third and fourth quarter of 2019. Our previous quarterly report noted third quarter progress at levels less than anticipated. We observed similar results for the fourth quarter. As we have noted, continuing lags as work completion approaches can begin to have significant impacts on overall schedule.

As nominally reported, fourth quarter progress has slowed, and has continued to lag baseline expectations, even as measured by management. Fourth quarter completion dates have continued to move out into the first quarter of 2020 and beyond. General Electric’s inability to meet schedule commitments and the inability to dedicate sufficient resources to complete bulk work tasks have contributed to these lags. With ever less time remaining, the ability to accomplish the much-improved work rates needed to meet schedule should be questioned. We continue to emphasize the need, with ever less time remaining to complete activities, to turn the “corner” in completing critical work. Construction delays and ensuing schedule extensions have given the TTO team added time to complete its work. However, the team cannot continue to rely on being “gifted” with additional time as a result of such delays.

#### **b. Key Fourth Quarter Milestones**

Key milestones extracted from the LCP construction schedule provide the foundation for TTO’s baseline integration schedule. These LCP milestones provide a framework for TTO planning,

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scheduling, and tracking of activities to prepare fully for operations. TTO schedule milestones identify linkages between construction and integration activities. Milestone dates tracked in the transition schedule represent the earliest date that the transition team can be ready. The TTO schedule milestones may differ with milestone dates released to the public or those contained in the construction schedule.

The chart below shows nominally reported milestone progress measured from the new May baseline schedule. Significant changes have occurred since the third quarter update; We find particularly concerning the continued slippage in witnessing and verification activities for the Soldiers Pond Synchronous Condensers -- delays resulting from the vibration and binding issues described earlier in this report. Continuing delay in LIL bipole commissioning activities presents another primary concern. Timing and quality of General Electric bipole control and protection software drive this delay.

The following milestone chart illustrates at a high-level the status of TTO remaining activities related to power delivery to the IIS. The revised baseline dates as of the May 01, 2019 show in blue and actual/forecast dates in red (behind) or green (ahead). The dates shown reflect targets for completion of TTO team activities in support of related LCP completion milestones. Non-TTO activities, like those associated with bipole software are what actually drives LIL completion into 2020. Our last quarterly report showed nine of the ten remaining milestones shown below in red. The last became red in the fourth quarter of 2019.

	Baseline 5/01/19	2019	2020
<b>Labrador Island Link Assets</b>			
SP Synchronous Condensers- Ready for Operations	10/25/19	▲	▲ 6/29/20
LITL 1 <sup>st</sup> Power Transfer Labrador to Newfoundland (Pole 2/Bipole)	12/11/19	▲	▲ 3/23/20
LITL Bi-pole Commissioning (Initial Low Load)	01/07/20	▲	▲ 4/30/20
<b>Muskat Falls</b>			
Power House Unit 1- Ready for Operation	11/29/19	▲	▲ 2/28/20
Power House Unit 2 Ready for Operation	02/21/20		▲ 3/24/20
MFG First Power	12/09/19	▲	▲ 3/13/20
Power House Unit 3- Ready for Operation	05/06/20		▲ 5/13/20
Power House Unit 4- Ready for Operation	07/20/20		▲ 7/17/20
MFG Full Power	07/15/20		▲ 8/13/20
MFG Full Impoundment	08/14/19	▲ 09/4/19 Actual	

*Note: Labrador Island Link dates have been modified to reflect the latest information provided at the fourth quarter monitoring meeting held on 2/11-2/12.*

**c. Fourth Quarter Activity Progress**

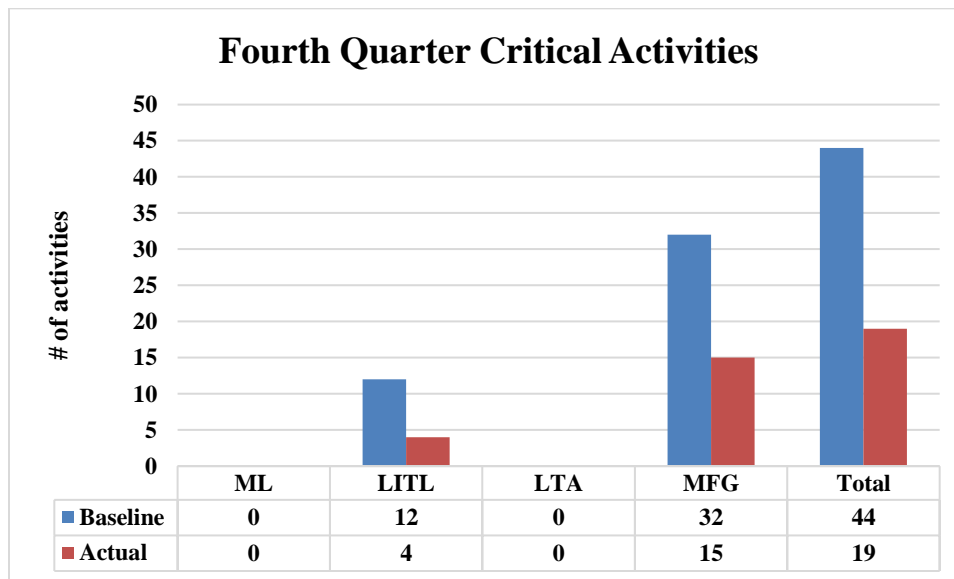
Completion of planned activities for the fourth quarter continued to lag. The table below shows 116 activities scheduled for completion in the fourth quarter of calendar 2019. Management completed less than half of them (43 in total). The transition team did complete an additional fifteen activities mainly targeted for completion in prior quarters.

<b>Fourth Quarter 2019-Performance Summary</b>			
<b>Baseline Activities Scheduled</b>	<b>Baseline Activities Scheduled and Completed</b>	<b>Unscheduled Activities Completed</b>	<b>Total Activities Completed</b>
<b>116</b>	<b>43</b>	<b>15</b>	<b>58</b>

A significant number of activities originally scheduled for completion in the fourth quarter 2019 or earlier have now moved into 2020. The table’s activities slated for completion in the fourth quarter fell into two categories:

- Critical activities - - those having an impact on critical path milestones
- Bulk activities - - those just requiring completion by the end of the project.

The chart below summarizes third-quarter progress on activities that schedules show as critical to completion.



The May re-baseline called for the completion of 44 critical activities in the fourth quarter of 2019. Again, management’s completion of only 19 reflects less than half the planned number. The fourth quarter also brought completion of one critical activity targeted for later completion. A considerable number of outstanding activities originally targeted for completion in prior quarters remains to be completed. As we have reported for some time, continuation of a large number of outstanding activities increases in importance the schedule threat as overall project completion approaches.

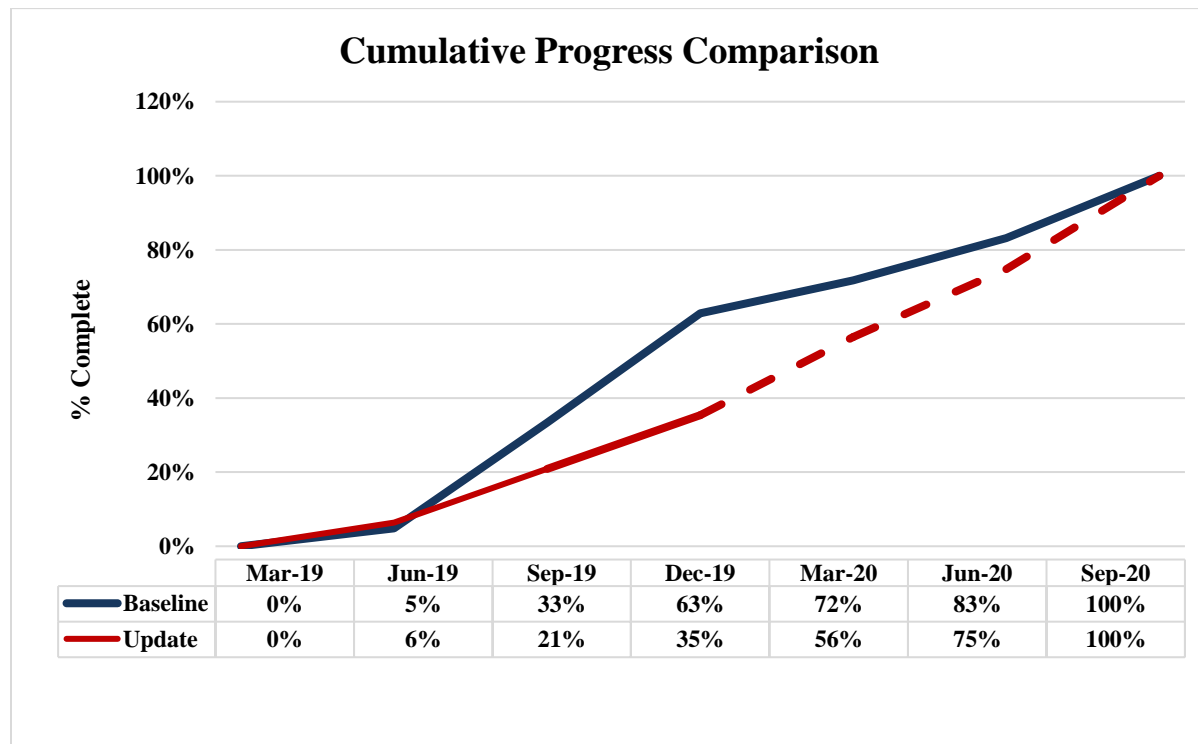


**d. Completion S-Curves**

We have been measuring progress against a cumulative percent-complete “S-curve,” initiated at the outset of our monitoring activities due to gaps in management’s schedule construction and reporting. Percent complete as we have measured it equals cumulative number of activities scheduled for completion divided by total outstanding activities.

The May re-baseline caused us to re-initialize our curve to begin measurement of progress starting with the second quarter of 2019. The re-initialized curve shows 14 percent of total outstanding activities completed in the fourth quarter, versus a targeted completion of 30 percent. In essence, only about half as many items were completed as compared to the plan for the quarter. Significant improvement will be required to meet the forecast projections expectations for the first quarter 2020 (56 percent). Even with the accomplishment of this very unlikely level of achievement, it would still fall short of the first quarter baseline target of 72 percent which was established in May. Past performance suggests that attaining this level of achievement will be extremely challenging and very unlikely.

The next chart shows the increase in the gap between planned (Baseline) and actual (Update) through the second half of 2019. The chart also shows the much accelerated rate of performance required to complete remaining work. With progress impaired by a number of major issues (like LIL software, synchronous condenser vibration and binding, and the impacts of activity convergence on resource availability) we find the growing gap over the past three quarters grounds for further concern about TTO work completion schedule.



However, delays outside the scope of its work have given TTO more time to complete its activities. As time passes, confidence is lessening that this breathing room will remain sufficient. Issues like: (a) new scope, (b) continued failure to meet targets, (c) persistent identification of new and substantial problems, and (d) the ability to command the resources to complete all required work tasks remain as threats to schedule.

## 5. Follow-Up Action Items

The following is a list of action items resulting from the recent discussions at the monitoring meeting:

- Prepare and incorporate into Hydro's May 15, 2020 Near Term Generation Adequacy Report a detailed Hydro plan and schedule detailing all activities required to ensure winter 2020/2021 service reliability under the assumption that the LIL will not be available during some or all of that period.
- Continue to provide monthly updates to the Board and Liberty with regard to progress being made on LIL software development, testing and commissioning, and on the synchronous condenser vibration and binding issues.
- Provide a copy of internal lessons learned report for the mock exercise testing emergency response and communications completed in December.
- Provide to the Board and Liberty the currently pending reports on work to assess synchronous condenser vibration and binding issues.
- Within 30 days of completion of those reports, provide the Board and Liberty an exposure analysis regarding the synchronous condenser vibration and binding issues, estimating the range of likely schedule and operating consequences, bounded as much as is reasonably possible based on the information known and risks identified.