Fourth Monthly Monitoring Report on Integrating LCP Facilities into the IIS and Hydro Preparations for Winter

Presented to:

The Board of Commissioners of Public Utilities
Newfoundland and Labrador

Presented by:

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1. Report Background and Purpose

This report addresses the progress and status in the transitioning of Lower Churchill Project (LCP) assets to operation and Hydro's progress in planned activities to optimize availability of its supply resources for the coming winter. This version is the fourth since the Board changed our reporting cycle from quarterly to monthly, in order to provide more current information about Labrador Island Link (LIL) availability and Hydro's efforts to prepare its supply resources for this coming winter. End-of-quarter monthly reviews, like that undertaken this month, address additional TTO activities.

2. Report Summary

a. LIL Commissioning Remains Troubled

We reported last month that prospects for LIL operation at levels materially contributing this winter to Island service reliability were dim, following:

- The August 13 Pole 2 trip (later occurring also on Pole 1, which had operated for some time in 2019), causing a halt in commissioning work
- Continuing unavailability of the next interim control software version (Interim B), which when we met recently with Nalcor, required still more changes after Factory Acceptance Testing (FAT).

Analysis and testing to identify the causes of the beam failures associated with the August trips still continue, but General Electric (GE) has made a preliminary determination that a manufacturing defect in the beams caused flashovers that resulted in the trips. While proposing replacement of over 300 affected beams as a permanent solution, GE also put forth an interim plan calling for the replacement of only the two beams that failed and the institution of risk-mitigating measures for others, after which commissioning activities could resume. Following such resumption, expected to occur in October (but again delayed for reasons addressed below), the LIL might eventually prove able to operate at a material level of power transfer capability this winter, provided that:(a) continuing testing and analysis not disclose any other material source of potential

beam failure, (b) commissioning be completed successfully, and (c) the 30-days of uninterrupted operation (Trial Operation) occur.

The LIL has a continuing history of poor control software delivery and of forecasts for correcting its defects. Nalcor must find a way to alter the trajectory suggested by that history. LIL completion and operation still depend on coming FAT, commissioning, and Trial Operation - - and perhaps operation this winter under temporary measures. The multiple remaining sources of uncertainty continue to make it appropriate to consider reasonably reliable operation of the LIL this winter unlikely:

- The ability to deliver an Interim B software version after a third, successive FAT failure
- The potential for remaining August-failure testing and analysis to disclose other issues
- The general level of pessimism that history now dictates with respect to trouble-free completion of post-FAT activities leading to and including Trial Operation.

Moreover, should the LIL nevertheless prove able to commence operation this winter, continuity of that operation will depend on the success of special measures taken to reduce the probability of further beam failures pending ultimate replacement.

b. Hydro's Preparation of Supply Resources for Winter

The inability to rely upon LIL operation through the winter heightens the importance of Hydro's completion of inspection and repair work designed to make its supply resources ready for operation this winter. We focused on Hydro's four Holyrood reliability capital projects, the inspection of the Penstocks for Bay d' Espoir, and overall progress on winter readiness work. Inspection work has substantially progressed, with much of the identified needed work already completed. We saw no further deferrals of work elements of planned work at Holyrood. Hydro's reporting to us also indicated that management remains on track to complete pre-winter work items identified in its annual maintenance winter readiness plans. Nevertheless, continued diligence will be necessary, given the significant number of still-open work items to be accomplished by December 1.

c. Synchronous Condenser Progress Continues

We reported last month that November would prove an important month in assessing the success of efforts so far made at the three Soldiers Pond synchronous condensers to address excessive vibration. If not, GE has identified foundation remediation as the next alternative solution. If required, foundation work will extend well into next year, at the earliest. However, even if required, such work will not delay possible LIL commissioning or operation this winter at a reduced level, but one still capable of materially contributing to system reliability. Nevertheless, these synchronous condensers remain important to long-term, full-power operation of the LIL.

The activities needed to verify the sufficiency of fixes already identified slowed somewhat, but progressed well enough to allow November gathering of the needed data. However, a new, post-winter concern has arisen. GE now appears set to delay mobilization at the site until reaching 100 percent design completion. Nalcor's prior expectation called for mobilization start at the 60 percent design completion level, which GE reached recently. The reasons for the change and the schedule impact of later mobilization commencement date remain unclear. The uncertainty has bearing on assessing how far foundation work completion might extend past the previously-expected mid-

2021 date. A long extension could jeopardize synchronous condenser commercial operation into next winter.

d. Muskrat Falls Generation

We previously reported a small risk that generation at Muskrat Falls would not be available for LIL commissioning. However, the latest information from Nalcor indicated imminent commencement of a 72-hour operation test - - one of the last milestones leading to continuous operation. We therefore do not have reason to question its availability should it become necessary to support LIL commissioning this fall. Should it not, however, and should growing winter season loads in Labrador leave too little recall power available, Nalcor has reported no progress in securing transmission access through Quebec and use of other-than-recall power from Churchill Falls.

e. Overall TTO Progress

Our monthly reports have focused on high-level reviews of progress and delays in meeting the overall TTO schedule, which includes many detailed activities. For this quarter-ending month, our more detailed review shows, despite important progress this past quarter, continuation of a steady pattern of significant gaps in completing many activities required and in developing and delivering training. Securing generation-related O&M contracts and Muskrat Falls site emergency response plans highlight important areas of that progress.

f. LIL Restarts

We also continue to monitor progress in Hydro's efforts to address the conclusions of an outside expert that automatic LIL restart attempts following a temporary HVDC double line fault could produce underfrequency load shedding, absent restrictions on exports to Nova Scotia over the Maritime Link (ML).

3. LIL Status

August valve hall flashovers damaging fiberglass beams that support the HVdc converter assemblies halted LIL commissioning. Work that will verify GE's preliminary identification of causes continues, but GE has preliminarily identified a manufacturing defect in some beams as the root cause. The affected beams came from one of two suppliers - - the one who provided 90 percent of the total number of beams. Pending further findings from continuing testing and analysis, GE's preliminarily-identified, permanent solution involves replacement of about 300 beams. GE has ordered the beams, which form part of the structural part of the thyristor valves. The beams are expected to arrive in the second quarter of 2021, but Nalcor has not offered a specific plan for beam replacement. However, this schedule would appear to permit orderly replacement during periods of lower loads on the Island system.

Pending permanent replacement of the more than 300 beams involved, GE proposed to replace the two that failed in August and to mitigate the risk of additional failures by:

- Deep cleaning all beams
- Lowering the humidity level in the valve halls to well below the previously planned level
- Taking extra precautions to mitigate any damage, should a beam fail.

The environmental control system can serve to lower humidity sufficiently during winter months, but cannot do so in summer months. These measures may allow completion of LIL commissioning and operation this winter, but do not offer a permanent solution. We found the need for deep cleaning all beams surprising, given that over-pressurizing valve halls and using fine air filters should normally prevent ingress of dust and other contaminants. GE's plan for the immediate term included other measures as well, such as changing protection settings to make them more sensitive and quicker to react to threatening circumstances. Examples include:

- Tripping a pole on failure of a single valve thyristor, versus the two failures normally required
- Increasing the sensitivity of the fire and arc detection systems.

We do not have sufficient detailed information about GE's plans to assess possible concerns about the propriety of proceeding in this manner. Our questioning of Nalcor exposed no indication that it has concerns in doing so, given the value of expediting material and reliable power flows over the LIL. Our concern, for reasons noted earlier, lies in how to assess the likelihood that the LIL will function across the winter.

Commissioning was projected to commence using the Interim B software expected to have completed FAT as we met with Nalcor earlier this month. Successful completion would have led to a re-start of dynamic commissioning as early as October 18, 2020. Completion of those activities would in turn permit Trial Operation to begin in the latter half of November. A critical milestone in LIL completion, Trial Operation requires 30 days of continuous, uninterrupted operation.

Even assuming successful FAT completion, we find Nalcor's statement of the expected duration for pre-Trial Operation pole commissioning and additional software function testing activities extremely ambitious. We also consider it sound to consider the risk that potential trips during Trial Operation, which will cause restarts of the 30-day uninterrupted operation requirement, may further extend the schedule.

In any event, we learned from Nalcor on October 16 that completion of the Interim B software FAT did not produce satisfactory results. Our request for information about the nature of the results has so far only produced a brief and very general statement that issues remain and that GE is addressing them. Nalcor has not provided us with a description of the issues disclosed by the latest FAT failures or of the time required to address and resolve them. Meanwhile, resumption of key activities leading to Trial Operation remain halted.

The circumstances appear destined to delay operation under the interim solution that GE has offered. GE's proposal for prompt resumption of commissioning offers a potential means for securing LIL operation this winter, but events this month do not change our view that LIL operation this winter (at a reduced, but still material power transfer capability) should not be considered more probable than not.

Nalcor anticipates GE's completion of work on the Final software version in 2021, after operation for some time using Interim B software. This Final version will bring additional functionality

essential for operation in full accord with LIL design. Once delivered, that Final version will also require FAT testing and commissioning, which will address the additional functionalities. Another 30-day Trial Operation period must follow. Our last report noted that Hydro's September 28, 2020 "Muskrat Falls Project Key Milestones" list moved completion of Converter Stations Bipole Dynamic Testing out to September 30, 2021, more than a year from the already past due date of August 31, 2020. How activities associated with permanent replacement of the valve beams will affect this schedule is not at present clear.

4. Synchronous Condensers

We have reported previously on continuing efforts to address binding, corrosion, and vibration issues affecting completion of the three Soldiers Pond synchronous condensers important to long-term LIL operation at its full capability of 900MW. The binding and bearing-corrosion issues continue to appear effectively resolved. Our last report described activities underway to permit observation of vibration under synchronous condenser operation after fixes identified to date.

GE has completed planned modification of the hydrogen system on the second of the synchronous condenser units (SC2), permitting hydrogen filling to start. SC2 will then be able to operate at full capacity while connected to the Island power system. Testing of SC2 during November will cover its full range of operation, with monitoring of vibration levels. GE has also completed modification of the SC3 bearing to address vibration issues. Should the elliptical bearing, as expected, reduce lateral vibrations to below the specified limit, GE will modify the other two synchronous condensers to incorporate that change. The current schedule for reassembly of SC3 with the elliptical bearing will support November testing of its vibration levels.

Should vibrations continue to exceed specified limits, foundation work, identified as the "backup" plan, remains the alternative for remediation. Design work has reached the stage (the 60 percent design review milestone) understood previously to be the point at which Nalcor expected GE to be ready and prepared to begin mobilization at the site for construction work. The plan had been to begin such mobilization should (as is now the case pending November vibration observations) the success of remedial measures to date remain less than certain. Nalcor has advised, however, that GE no longer stands ready to begin mobilization before reaching 100 percent design completion.

Therefore, a delay in eventual completion of commercial operation of all three synchronous condensers may loom. The schedule for their completion in August 2021 leaves time for some delay. Nevertheless, with design not completed, construction not started, and its duration subject to execution risk accompanying significant construction projects, we see a small, but as yet manageable threat to completion by the start of the 2021-2022 winter period. For the immediate term, however, GE, Nalcor, and Hydro continue to appear to see no material risk that system conditions during possible LIL commissioning activities this fall will require the availability of any of the three Soldiers Pond synchronous condensers. Furthermore, retaining generation availability at Holyrood will substantially mitigate the consequences from any continuing unavailability of these three synchronous condensers, permitting LIL commissioning activities to continue at power transfer levels up to 225MW.

5. Muskrat Falls Generators

LIL commissioning has anticipated the availability of generation from first Muskrat Falls units. We have reported management-identified issues creating the potential to delay first Muskrat Falls unit availability. We learned in meetings with Nalcor this month that work at the site had advanced to a point permitting imminent commencement of a key, 72-hour continuous operation test on Unit 1 at Muskrat Falls. Passing that test would support a release of Unit 1 for commercial operation by November, with Unit 2 expected to follow in December.

6. Temporary LIL Faults

Our last report addressed the potential for automatic LIL restart following a temporary HVDC double line fault to produce a bipole outage that should activate restrictions of exports over the ML. Absent such an ML runback, underfrequency load shedding could result, depending on the number of synchronous condensers in service. Hydro management agreed to examine means to avoid this result.

Hydro, after consultation with Nalcor, has advised that it considers the current HVdc line fault protection system appropriate, but plans to incorporate into a promised report on Under Frequency Load Shedding (scheduled for the first quarter of 2021) its proposed methods to ensure stable response and controlled load shedding in these circumstances. Our discussions with Hydro about its findings to date continue.

7. Overall TTO Schedule Performance

a. Quarter Schedule Performance Highlights

Overall TTO activity progress has regularly and significantly fallen below expectations since we began our monitoring efforts in early 2018. That gap continues. We reviewed detailed TTO schedule information as part of this quarter-ending monthly review. However, we have observed substantial progress in some areas during the third quarter. The next paragraphs highlight a number of areas on which our prior detailed TTO progress has focused.

Nalcor suspended updates of the ***Integrated Project Schedule*** following the inception of COVID-related work restrictions, but resumed updating it in late September. That resumption allows for more detailed review of schedule status. We have observed a continued lag in ***Bulk Work Progress***. The now long-standing slow pace continued this quarter, with efforts focused on completing generation-related items, including spare parts identification, balance-of-plant training, and development of low frequency preventative maintenance. Nominal advancement occurred in populating low frequency preventive maintenance items and check sheets for HVdc assets in September, operating procedures, and verification functions that have lagged following issues impairing LIL commissioning.

HVDC Training Development and Delivery continue to lag substantially, with continued gaps in GE resource availability and performance. We observed no progress this month, with 24 percent of HVDC operator training and 40 percent of synchronous condenser training courses not completed.

Substantial progress has occurred in two areas. ***Manpower*** progress has found all key positions filled, with one support position remaining open, but expected to be filled imminently. ***Contracting*** progress now finds 41 of 61generation-related O&M contracts addressed, with the other 20 in development. ***Muskrat Falls Emergency Response Plan*** discussions continue about using O&M staff as first responders.

Progress on agreements addressing two areas has been minimal. ***Limited MPPA/IOA Progress*** has led Nalcor now to forecast completion at the end of 2021; *i.e.*, after full commissioning of all LCP assets. The Multi-Party Pooling Agreement (MPPA) and the Interconnection Operators Agreement (IOA), address transmission access issues for power flows into and out of Labrador through Quebec. Nalcor now expects filing of the ***Agreement for Optimization of Hydraulic Resources*** (which accumulates the proceeds from such activities in a deferral account, pending a future application addressing disposition of resulting value among the participating Nalcor entities) in the first quarter of 2021. Nalcor noted that input from the Province regarding rate mitigation remains pending. Nalcor now expects to manage Muskrat Falls exports separately at their outset, with plans to file by the end of the year a request to extend the existing pilot agreement, rather than to employ an amended one.

b. Integrated Schedule Milestone Update

Key milestones extracted from the LCP Integrated Project Construction schedule have provided the foundation for TTO's baseline integration schedule. During the halt in LCP schedule updates, however, Nalcor continued to update the TTO project schedule. The May 2019 baseline schedule we previously used to measure progress is no longer useful, calling for completion of all milestones already - - by the end of September 2020. We will henceforth use a more meaningful baseline for reporting - - the latest milestone information Nalcor has been reporting to us at our monthly meetings. The next chart displays our current understanding of key milestones. We learned on October 16 that completion of the Version B FAT completion (a precedent to Pole 1 dynamic commissioning commencement on October 18) remains unconfirmed. At last word to us, GE continues to examine issues disclosed by that testing.

Key Milestone Dates

LIL	Complete Version B FAT Test	***DELAYED***
LIL	Commence Pole 1Dynamic Commissioning	10/18/2020
LIL	Commence Pole 1, 2, Bi-pole Dynamic Commissioning	11/30/2020
LIL	Start Low Power Trial Operations	12/1/2020
LIL	Deliver and Replace Fiberglass Beams	Q2 2021
SC	Complete 100% Design on Foundations	Oct., 2020
SC	Start Testing on SC3 (Elliptical Bearing)	11/6/2020
SC	All Synchronous Condensers Ready for Operation	8/31/2021
MFG 1	Released for Commercial Operation	Oct. 2020
MFG 2	Released for Commercial Operation	Dec. 2020

c. Quarterly TTO Schedule Progress

The baseline schedule called for completion of 68 activities during the third quarter of this year:

- Management completed only 13 of the 68
- Management completed 31 other activities, not scheduled for completion in this quarter
- Crediting the 31 unscheduled activities completed produces 44 activities completed
- Measured this way, management completed two thirds of number of activities scheduled for completion.

These 68 activities slated for third quarter completion included both ***critical*** (having an impact on critical path milestones) and ***bulk*** activities (merely requiring completion by the end of the project). The baseline schedule slated only one critical item for third quarter completion and management completed it. However, a more holistic view of progress produces a less sanguine view of progress. For example, many activities (some of them critical) targeted for completion in prior quarters remain unfinished.

d. S-Curve Activity Completion

We initiated at the outset of our monitoring activities measurement of progress against a cumulative percent-complete "S-curve," 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.

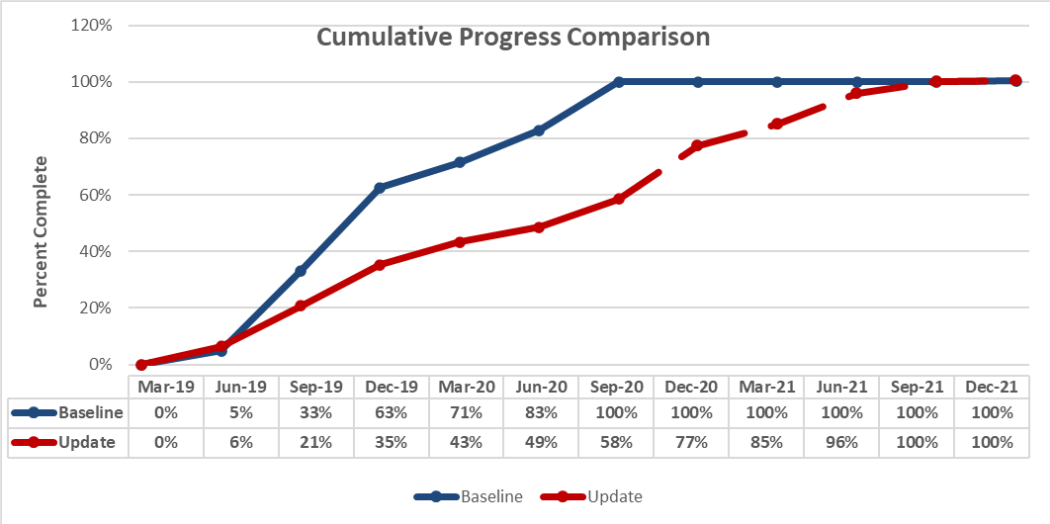
The next chart summarizes progress measured this way through the third quarter 2020. Management has completed 58 percent of total outstanding activities, versus a targeted completion of 100 percent. As noted, the baseline we have been using assumed all activities (the 100 percent measure) complete by the end of last month. We will explore with Nalcor prior to the next report a new baseline for S-curve progress measurement.

In any event, the chart below shows the continuing slow pace of overall activity completion. Significant improvement will be required to manage overall schedule completion effectively

- In the immediate term to meet fourth quarter 2020 projections of 77 percent complete
- In the intermediate term to reach whatever realistic TTO completion milestone should replace September 2020.

Longer-term past performance, reinforced by that attained this quarter, does not suggest optimism about advancing the pace of performance.

With more recent progress impaired by a number of major issues (like coronavirus-related work restrictions, LIL software, synchronous condenser vibration, and the impacts of activity convergence on resource availability) we find the persistent gap over the past several quarters grounds for concern about TTO work completion schedule.



	Mar-19	Jun-19	Sep-19	Dec-19	Mar-20	Jun-20	Sep-20	Dec-20	Mar-21	Jun-21	Sep-21	Dec-21
Baseline	0%	5%	33%	63%	71%	83%	100%	100%	100%	100%	100%	100%
Update	0%	6%	21%	35%	43%	49%	58%	77%	85%	96%	100%	100%

However, TTO continues as an unintended beneficiary of delays in work outside its scope of responsibility - - delays that continue to provide TTO more time to complete its activities. Nevertheless, attention is required to ensuring the resources needed to complete that work, whatever the end date.

8. Hydro's Preparations for Winter

We continued to review Hydro's efforts to prepare its supply resources for reliable winter operation.

a. Water Availability

Management reported a substantial supply of water for these facilities this month, with a storage level 260 GWh above the minimum target. The storage levels have roughly reached the 20-year average level. Hydro, therefore, continues to see minimal risk with regard to energy in storage.

b. Bay d'Espoir Penstocks

Penstock failures continue to impose risks to unit availability. We reported last month efforts to address those risks; *e.g.*, weekly visual observations and annual inspections, expedited repair plans in case of a failure, and operations guidelines to minimize deleterious effects on Penstock 1. Hydro has also planned an October inspection of Penstock 2. Management has scheduled no further inspections this year. Inspections will address previously repaired areas and other selected areas. We plan to examine the results for Penstock 2 when complete.

We learned last month about two additional Bay d'Espoir risks (a) failure of a 230 kV dead tank circuit breaker at the terminal station, and (b) higher than expected vibration of Unit 1 during operation between loads of 55MW and 65MW. We reported then about three available spare circuit breakers. Hydro reported this month a two to three-day repair time should failure occur. Hydro determined out-of-tolerance clearance of the generator bearing as the cause of high Unit 1 vibration. Management believes it has made corrections needed to meet applicable tolerances.

c. Holyrood Capital Projects

We continued to review the status of four Holyrood projects scheduled for completion prior to the coming winter: Unit 1, 2, and 3 boiler assessment and repair, overhaul of Unit 3's main boiler feed pump, overhaul of the Unit 2 main generator, and overhaul of the Unit 2 turbine control valves. Hydro made substantial progress in the last month, essentially completing work on all four projects.

This month brought no deferrals of work on these projects beyond those discussed in our last report as resulting from COVID-related work restrictions. Management has continued to examine those deferrals. It may seek to reinstate pre-winter inspection of the main steam turbine terminal on Unit 3, targeting completion in October.

d. Corrective and Preventive Maintenance

Hydro continued this month to operate under its integrated annual work plan for O&M activities. Management reported completion of 94 percent of the activities it planned to complete in September. Total progress against plan stands at 69 percent. Hydro reports work continues to remain on schedule.

e. Winter Readiness Checklist

We continued to inquire into the status of Hydro's winter readiness work plan. Management reported that it completed 94 percent of planned September activities. Total completion for the season stood at 67 percent. Hydro has placed 105 of 106 planned contracts critical to winter operation, an increase of one over last month. Management reported that supply of critical parts and equipment remains on track for December 1 completion.

f. Our Plans for Next Month

We plan to secure the following as part of our inquiries for the coming month:

- Review the request for information regarding the minimum wall calculations for the Unit 3 main steam terminal.
- Copies of any interim or final vendor inspections reports for the Holyrood Capital projects as they become available
- A deeper review of the CM, PM, and Winter Readiness Work Items should progress lag schedule. The overall status of 69 percent begins to take on more significance, particularly in light of performance of less than 100 percent of monthly plans for August and September.