

**Eleventh 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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May 11, 2021

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Table of Contents

1. Purpose of this Report	1
2. Summary of Major Observations	2
3. Detailed Findings.....	4
a. LIL Schedule.....	4
b. Sea Electrode Issues.....	6
c. Muskrat Falls Generators.....	6
d. Synchronous Condensers.....	7
4. Major Findings	8
a. Staffing.....	8
b. Training.....	9
c. Schedule.....	9
d. Second Quarter 2021 Progress.....	10
e. Muskrat Falls Site Emergency Response Plans and Guidelines.....	10
f. O&M Contracts.....	10
g. Generation Corporate Health and Safety	11
h. Emera Agreements.....	11
i. Build Out of the Maintenance Programs	11
j. MPPA/IOA Progress.....	11

1. Purpose of this Report

This report examines first quarter 2021 scheduled and completed activities undertaken as part of the Transition to Operation (TTO) organization’s role in integrating the Lower Churchill Project (LCP) into the province’s electrical system. This report represents the resumption of quarterly monitoring efforts that became replaced in May of 2020 by monthly reviews. That increased frequency recognized LIL-related delays then threatening its availability as a supply resource across the recently-concluded winter. Delays in producing control software supportive of LIL commissioning continued, synchronous condenser vibration issues, problems arising from an August 2020 flashover incident in the LIL valve halls, and, more recently, emerging issues with Muskrat Falls generating unit design have contributed to LCP-completion uncertainty. Weather-related failures at the site of the LIL sea electrodes in January of this year and on Labrador portions of LIL overhead line structures and cabling in February added to immediate concerns - - not just about bringing the LIL to commercial operation, but in evaluating its long-term exposure to weather-related outages.

Our monthly monitoring efforts particularly focused on such threats and incidents. Our review of completion of the work of the TTO team responsible for activities necessary for turning LCP assets over to their permanent operators has continued, but with a lesser emphasis, as LIL and eventually Muskrat Falls generator problems continued and new ones arose. Continued strong performance by the Holyrood units contributed greatly to ensuring continued LIL unavailability did not produce supply problems.

Nalcor has had and continues to experience a large number of difficulties in LCP completion. Fortunately, Hydro's success in making Holyrood a continuing source of reliable supply has served well in the interim. From today's perspective, the continued advance of TTO activities in the past quarter has moved them much closer to completion, aided significantly by the added time made available by delays in LIL commissioning. Unfortunately, completion of the LIL still remains to be achieved, with the latest reports already beginning to show risk that it may not reach commercial operation by the start of next winter.

COVID-19 restrictions continued to foreclose in-person interaction with Nalcor and Hydro personnel. We conducted a teleconference on February 2 to address the sea electrode and overhead line failures in Labrador. We held further teleconferences on April 12, April 22, and May 4 to discuss status generally with Nalcor management and to question them on specific areas of interest. Hydro's April 8, 2021 monthly report provided foundational information which we used to formulate questions and topics to explore in discussions with Nalcor management; its report dated May 6 (issued as we were completing this report) provided additional details and updated timelines for project milestones. We also discussed issues and circumstances identified in our earlier monthly reports to the Board following the switch from quarterly to monthly monitoring.

2. Summary of Major Observations

Significant advances in LIL commissioning have occurred, including successful completion of a Trial Operations milestone. Nevertheless, uncertainty about getting the LIL into reliable, bi-pole commercial operation by the start of the coming winter has emerged. Hydro's April 8 monthly LCP status report to the Board proffers a completion date in mid-November 2021, just two or three weeks before the coming winter. However, subsequent information discloses risk in meeting this date.

The mid-November date, already uncomfortably close to the start of winter, lags by 23 days the October 22, 2021 date that Hydro offered in its March status report to the Board. Fortunately, it appears at this time, subject to completion of scheduled work, that even failing bi-pole commercial operation, the LIL will nevertheless prove able to deliver some 450MW of power during (and likely before) the coming winter.

Continued slippage in Final LIL Software remains the prime milestone in reaching full bi-pole commercial operation. This final version will deliver capabilities not available under the interim versions, which have supported and will continue for some time to support commissioning. For example, a key LIL capability missing until successful Final Software availability includes short- and long-term overload capability, which will allow operation at power higher than 450MW, frequency control, and other features. Current projections for completion of and delivery to Nalcor

by GE of the Final LIL Software drive continuing slippage of LIL completion. Nalcor continues to express uncertainty and observe risk in successful completion of this software.

Commencement of Trial Operations using the interim software began on March 19, 2021. Successful completion of this critical pre-commercial activity requires 30 days of operation without an unintended LIL trip. Following March 19, two such trips occurred - - one immediately and one later, on April 1. Trial Operations resumed following the April 1 trip, with successful completion reported as of May 1. Another 30-day Trial Operations period will follow delivery and installation of and operation under the Final Software.

The now distant, August 13, 2020 LIL valve hall flashover that disclosed flaws in support beams produced a large-scale beam replacement plan. That plan has also lost time to schedule. GE's sourcing of replacement beams has fallen one month behind earlier projections, due to slower-than-anticipated production and testing of the new beams. Nalcor now awaits a revised schedule from GE for beam installation, but reports that delays so far acknowledged will not postpone completion of Trial Operations under the Final Software. Nevertheless, prompt completion of beam manufacturing and installation remains important to maintaining the schedule for reaching LIL commercial operation under the Final Software.

We reported earlier that Nalcor experienced last December significant damage to sea electrodes, a critical component of the LIL, due to wave action during a weather event. Commencement of remedial work continues to await the easing of weather conditions. It will take outside expertise to assist in identifying the work needed to enable the site to withstand the weather-related stresses that may occur. These assessment efforts include a determination of the nature and extent and the return period of damage-causing events. These efforts will guide the measures necessary to ensure the high reliability required for this facility, on which the LIL depends at times of the outage of one of the poles. Similarly, determining the applicable return period and the required responsive actions to address the structure and wire failures affecting two Labrador portions of the LIL during weather events early this year remain pending.

Hydro's monthly LCP status reports to the Board appear to present what Nalcor has told it, not necessarily Hydro's own assessment of further delay risk and resulting reliability consequences. Hydro, not Nalcor, has responsibility for addressing customer supply risks created by LIL delay. The now long track record of continuing delays and inaccuracy in assessing their length requires that Hydro make its own assessment of risks and formulate plans to address their consequences for service delivery. Hydro's monthly reports to the Board need to begin and continue to offer its own assessment of schedule risks and plans for responding to them.

Given the results experienced to date, it would be rash to conclude that the threat of still lengthy LIL delays has passed into history. Hydro therefore needs now to begin to develop its own assessment of LIL completion risk and to assess actions that may be necessary for the next winter. The Board's interest in LCP delays and their potential consequences, particularly for the winter season, makes Hydro's views on these matters critical.

Issues requiring remediation have also occurred recently at the Muskrat Falls generators. Management believes that remediation work it has already identified will correct the issues without major delay. It plans post-installation testing to verify the sufficiency of corrective actions taken.

Work has progressed very substantially on assessing excessive vibration and planning to remediate it at the three Soldiers Pond synchronous condenser units. Uncertainty had existed about the sufficiency of the substitution of elliptical bearings to preclude the need for much more substantial and lengthy foundation enhancement. Nalcor had previously pressed for pursuing the foundation solution in parallel, should monitoring of vibration levels after installation of the new bearings not prove satisfactory.

Nalcor has reported GE's insistence on the sufficiency of the elliptical bearing solution. Not surprisingly, Nalcor has agreed to that as the preferred alternative, given that GE's position makes Nalcor responsible for consequences should it force a different (*e.g.*, foundation solution) that proves harmful in some way. GE has reported and Nalcor agrees that use of the elliptical bearing approach at LCP has produced contractually-compliant vibration levels to date. The elliptical bearing solution seeks to compensate for rather than eliminate the underlying issue - - convergence between operating and critical speeds.

Nalcor appears to believe that acceptance of GE's solution preserves any contract remedies Nalcor may have should a material issue arise during the warranty periods. The risk that appears to remain is whether the spinning of these machines over the longer term will or will not produce harm outside the scope of GE's contractual undertakings. Nalcor reported that it could not reach with GE an acceptable agreement on warranty extension.

The current schedule calls for completion of synchronous condenser Unit 3 this month, Unit 2 in July, and Unit 1 in September. Completion on such a schedule would not raise implications for LIL commissioning.

TTO accomplishments in addressing other major aspects of its performance have advanced well and do not appear to present major schedule threats, although important activities continue to await completion. Continued delays in reaching LCP completion continue to have given TTO breathing room to complete its work. Staffing the operations organization, developing and providing required training, Muskrat Falls site emergency planning, securing agreements with outside contractors, and building out ongoing maintenance programs have all proceeded at a pace supportive of turnover to operations.

MPPA/IOA completion remains a distant objective, but the parties appear at least to be substantively engaged in resolution of their differences. They have reportedly reached agreement on important principles, and have targeted a specific date for IOA completion.

3. Detailed Findings

a. LIL Schedule

The key factors affecting LIL schedule in the first quarter of this year have included:

- Final Software Status
- Commissioning Activities under the Interim Software
- Trial Operations under the Interim Software
- Beam Replacement Status.

Nalcor reported that it would commence functional factory testing of the Final Software in early May of this year, with some float in this planned start date possible. Testing will occur at GE's offices in Stafford. Hydro's report on overall LIL status, issued on April 8, 2021, indicated a one-month delay in the expected provision of the Final Software to the project site. A planned June 22, 2021 date (reported in the previous monthly update) for delivery to the site has moved 37 days later, to July 29, 2021. This last extension follows a similar delay (one of 33 days) in progress reported by Nalcor in the time between the previous two reports. Continuation of material Final Software completion delays will soon come to threaten substantially successful final Trial Operations completion before the coming winter. Management has already forecasted an extension of final LIL completion to November 15, 2021 and considers the risk of a further slip to as late as the end of December "high" and "now materializing".

Management did report completion of "Commissioning with the Interim Software" on March 19, 2021. This date produced a short, eight-day delay from the previously projected date. "Trial Operations with the Interim Software" commenced the same day. Within the first 24 hours of operations, one pole of the LIL tripped. No power loss resulted; the other pole compensated with increased output, as designed for such trips. A 60-day window exists for completing the 30-day Trial Operations run, but no limits restrict the number of times the 30-day period can re-commence within that overall, 60-day window.

After the March trip, another thirty-day Trial Operations began anew. Nalcor reported that the March 19 pole trip resulted from a GE operator's failure to follow an operating restriction procedure. The LIL switched to monopole operation on the occurrence of the trip. Another trip occurred on April 1, 2021. Nalcor reported that an incorrect automatic filter switching caused the April 1 trip - a flaw set for correction in the Final Software. Trial Operation recommenced on April 1 and Nalcor has reported successful completion of Trial Operations as of May 1, 30 days following the April 1 trip.

Nalcor advised that GE's root cause analysis of beam failure has reached the final determination that the flashover events of last August resulted from a manufacturing defect by one of the two beam manufacturers. Replacement beam manufacturing by the other provider has been underway for some time. Hydro's April 8 report set forth a revised date for the completion of beam manufacture. The beam supplier has fallen behind schedule in manufacturing at its German facility, with means to mitigate schedule consequences now underway.

Management now expects completion on all required replacement beams by the end of July 2021. This date reflects a one-month delay from previous expectations. Nalcor management was not privy to all details behind the delay, explaining that those matters represent a confidential, contractual matter between GE and the beam manufacturer. Nalcor believes, however, that a combination of longer-than-expected testing durations and slower beam production likely explain

the delay. GE will provide Nalcor with a revised installation schedule as manufacturing progresses. This development may delay the commissioning of the LIL with the Final Software, which will have an impact on completion of the date of Final Software commissioning and another required period of Trial Operations.

As with other reported delays, Hydro's reports to the Board appear to relay the information and views that Nalcor has provided. With risk of full-scale LIL availability even next winter now emerging, Hydro's needs to make plans for addressing the reliability threats those risks impose. A long track record of continuing delays in Nalcor's provision of LCP capabilities to Hydro makes it necessary for Hydro to make and rely upon its own assessment of delay risks.

b. Sea Electrode Issues

The site of the sea electrodes on the Labrador side of the strait experienced significant damage from wave action during a December 2020 weather event. Completion of site clean-up and initial repairs that month permitted LIL commissioning to continue. Plans call for a start this month of work to repair remaining electrical and civil site damage. An RFP seeking a design review remains under preparation, with a list of potential consultants having coastal engineering experience identified. The selected consultant will report what measures, if any, management should take to ensure that final redesign, repair, and construction will allow for electrode operation during an appropriately determined "worst case" weather-condition. The work being undertaken will examine conditions during the weather event that caused the recent damage. That examination will determine the return period of the event.

c. Muskrat Falls Generators

Hydro's April 8 monthly report to the Board described the identification of an issue with the generation units discovered during overspeed testing of Unit 2. A previously reported design issue exists with the bolt arrangement between the turbine inner and the intermediate head covers. The bolts and certain welds are under-designed for the stresses that occur in an overspeed condition. Further analysis by Andritz, the equipment designer, revealed that bolted connections and miscellaneous welds require re-work to withstand these higher stresses.

Nalcor reported that the design issue may have resulted from less sophisticated modeling techniques available at the time of the original design. Management stated that Andritz has performed re-modeling of the design and additional fracture mechanics analyses to determine the necessary modifications for the overspeed scenario. Required Unit 2 modifications and overspeed testing have completed. Nalcor reported that it anticipates completion of a required inspection in the latter portion of this month. Modifications to Units 3 and 4 remain underway, with completion expected in May. Unit 1 work will require an outage, with its schedule as yet not determined.

All units will require subsequent overspeed testing. Unit 1, in service since December 2020, will undergo this modification after completion of similar work on the other three Units. Units 2, 3, and 4 have revised projected in service dates of May 31, July 31, and September 30, 2021, respectively.

d. Synchronous Condensers

Nalcor continued to address the long-standing, excessive vibrations experienced at the Soldiers Pond synchronous condensers. We have previously reported on efforts to identify the sources of the vibration, and the plans for employing elliptical bearings to bring vibrations within acceptable levels. We understood that a failure of the bearing solution would lead to much longer-duration foundation work (anchoring the floor concrete slab to the foundation), for which design work and even installation resources mobilization at the site had begun.

The April 8 update reported continued work to complete and commission the synchronous condensers using the elliptical bearings solution. We discussed with Nalcor management its reasons for no longer insisting on continuing to proceed in parallel with the foundation solution. Nalcor explained the work GE has done and its basis for considering the elliptical bearing issue less risky than the foundation solution, even though GE's approach will not resolve an underlying issue (the narrowness of the gap between operating and critical speeds), but will instead compensate for it.

GE and Nalcor report that experience so far at LCP under elliptical bearing use has produced vibration levels within applicable requirements. Nalcor's expert continues to find merit in the foundation solution, but Nalcor does not believe that it has a basis for taking the technical and contract risks of seeking to force the use of the foundation approach - - one presently supported only by modeling rather than demonstrably acceptable application and one that would, unlike the elliptical bearing alternative, prove irreversible. GE considers foundation remediation riskier because its results are only theoretical (demonstrated only through modeling and untestable), irreversible, and carrying the potential for worsening the convergence of operating and critical speed, thus exciting further vibration.

Nalcor has reported that GE's analysis of the two solutions identified the use of elliptical bearings as entailing less technical risk, and it can be reversed if necessary. While reporting GE's satisfaction with the results obtained under operation with the replacement elliptical bearings, Nalcor advised that the use of those bearings will not resolve the convergence between operating versus critical speed. Instead, it will compensate for that convergence.

Nalcor has observed that that its contract with GE makes the contractor responsible for the design and construction of the units. Nalcor also identified that contract is performance-based, requiring GE to provide synchronous condensers whose operations must meet specified performance standards; some of them addressing vibration levels. The contract reportedly contains a three-year general warranty on each unit and a 40,000 operating hours warranty on the rotor rim and flywheel, including an inspection of these latter two items after the warranty period. Performance based contracts such as this prove common and appropriate for large, complex design and construction projects. Nalcor indicated that the vibration levels of the synchronous condensers meet industry standards with the installation of the elliptical bearings.

Nalcor has reported that observed vibration levels have in recent months fallen below the specified levels and expressed confidence that the same will prove true when all three synchronous condensers have been fitted with the elliptical bearings.

It does not appear that Nalcor at present has a substantiated alternative to what GE has proposed. Certainly, there appears no reason for concluding that an override of GE’s decision and the risk transferring consequences that override make sense. However, why Nalcor had pressed for a number of months for an option it now questions for reasons apparently known to it for some time is unclear. In any event, one would expect GE to have chosen a path that it considers best suited to complying with its obligations under the contract.

4. Major Findings

a. Staffing

TTO has largely completed its LCP staffing work, making it now appropriate to examine staffing based on the organization as now designed, rather than the plan to which TTO had been working. The original TTO staffing commitment called for the following numbers:

- Transmission O&M Staff: 58
- Generation O&M Staff: 28
- Engineering Services Staff: 41
- Support Services Staff: 14.

From this original plan total of 141 (excluding BTPO staff), only one position remains unfilled (a contract coordinator), with its status reported as in progress. The next chart shows complements and vacancies using the current Nalcor organization structure and alignment.

Organization Title	Complement	Vacancies
Transmission Operations Work Mgmt. and MF	24	1
Transmission Operations Soldiers Pond	41	5
Power Supply Production & Energy Marketing	38	8
Engineering Services	5	0
Engineering Services Operations Support	24	1
Engineering Services Project Execution Gen.	27	1
Eng. Services Business Services	26	3
Portfolio Asset Mgmt.	11	1
Totals	196	20

Five positions recorded as vacancies are actually held by contractors - - hydro plant operators provided under a services contract with MHI. The other vacancies reflect unfilled positions and all other filled positions are occupied by employees. We asked about the status of the 15 vacancies. Several have been filled and some represent positions it does not plan to fill or involve seasonal work. Some others are now filled by temporary employees pending an assessment of future needs

for the position. Active recruitment is underway for the remainder. We observed no reason for concern about the nature or number of the vacancies remaining at this time.

b. Training

Some 12 TTO training activities remain below 100 percent completion. The percentage completion of these open items ranges from 0 percent to 91 percent complete with the majority about 50 percent complete. Training program activities include about 50 training sessions divided into two phases. Phase I encompasses training necessary for asset release for service and Phase II for detailed maintenance program training. Nalcor has indicated that all Phase I training is complete except for two training sessions. Naclor has also indicated that some Phase II training may likely be delayed until the third quarter of 2021.

Recent specific accomplishments and plans include:

- Delivery of two GE HVDC training courses brought the total through April to 11 of 13 planned for completion, with the remaining two requiring hands-on training after full systems commissioning
- ATCO's delivery of dc operations training has moved to 91 percent complete with targeted completion scheduled for this quarter
- Completion of all five TTO synchronous condenser courses
- Completion of all Phase 1 turbine and generator sessions by the end of 2020
- Plans for Phase II sessions and Phase 1 refreshers by the end of 2021
- Completion of 14 of 16 Muskrat Falls balance of plant courses (with 8 delivered in the first quarter of this year)
- Balance of plant Phase 1 refreshment and 27 detailed, Phase II maintenance training sessions await scheduling, with those having been scheduled for this quarter delayed due to COVID 19 restrictions
- MFG spillway intake and gate systems courses remained at 8 of 12 completed, with none planned for this past quarter and two refresher sessions planned for the second quarter.

c. Schedule

We have been measuring overall schedule status using activity progress and an overall cumulative percent complete S-curve metric. The S-curves graphically depicted cumulative progress of the TTO project on a percent complete basis (actual percent complete versus planned percent complete). TTO reached 96.3 percent completion in March 2021 versus a planned 96.7 percent. The following table summarizes the planned vs. actual status by work stream.

Work Stream	Planned	Actual
BTPO	95.7	95.2
RFI	98.5	98.3
RFCI	98.3	97.7
Total	96.7	96.3

The now very high level of completion of TTO activities makes it appropriate to transition the project monitoring metrics to an activity completion metric versus a percent complete metric using

S-curves. We focus therefore on remaining completion on an activity basis. In addition, the original TTO schedule contained about 32 milestones of which only 12 remain open. Only 10 of those milestones tie to TTO activities. The TTO activities associated with those 10 milestones are now only 36 in number. These 36 form part of the 129 TTO Activities in total that remain open of the approximately 1,400 in the original TTO schedule.

d. Second Quarter 2021 Progress

Some 47 activities are scheduled for completion in the second quarter of this year. These activities tie to the following work categories:

- Staffing and Recruiting (discussed separately above)
- Training (discussed separately above)
- ERP Documents
- O&M Contracts
- Generation Corporate Health and Safety
- Emera Agreements.

Note that open activity numbers do not present the only measure of progress - - one activity can consist of several sub-activities such as training sessions or preventative maintenance items. Therefore, as appropriate we will also track completion of the total items to reflect a more accurate status of schedule completion.

e. Muskrat Falls Site Emergency Response Plans and Guidelines

Development of site emergency response standard operating guidelines and plans are behind schedule, but reportedly not at risk of being incomplete on the transition to operations. The 18 guidelines described as key for the Muskrat Falls switchyard and powerhouse have been issued for use, with the current focus on completing those for the dams and spillway. Some 20 interim emergency response plans remain in place under the LCP.

Recruiting of the Muskrat Falls volunteer Emergency Responses team has begun, with presentations and continuing follow-up meetings with supervisors and staff. Management has also conducted two sessions with the union to describe the volunteer approach. Management has secured facilities for delivery of Emergency Response training, and has scheduled initial training sessions for April and May.

Six Emergency Response Plan related activities are scheduled for completion in the second quarter of this year. TTO reported 20 of the 62 standard operating guidelines complete, with the remainder expected to be complete by the end of the third quarter of 2021.

f. O&M Contracts

Five service contracts are scheduled for completion this quarter. Nalcor reports that it is on track to finish all by the end of this coming June, with one perhaps slipping to a later date. TTO completed nine O&M support services contracts for generation in the first quarter, making overall completion at 45 of the 61 required. Work is underway on 15 others with the remaining one (for pest control) awaiting initiation. One key generation services contract remains to be secured. This

contract for services support with Andritz is currently behind schedule, with management now reviewing the contractor's proposed scope of services. TTO has addressed all transmission O&M services support contracts.

g. Generation Corporate Health and Safety

Four activities are scheduled to be complete this quarter. Nalcor reports two of the four on track with one possibly moving to the third quarter of this year and one not required until after unit commissioning. Here too, we observed no material schedule issues at present.

h. Emera Agreements

Two activities are scheduled for completion this quarter. One activity, the Regulation Service Agreement is not required until later and may be rescheduled to the third quarter of this year. We found no major schedule issues in this area either.

i. Build Out of the Maintenance Programs

This category of activities consists largely of preventative maintenance (PM) activity scope and definition and equipment check list activities. Thirteen activities are scheduled for completion this quarter. TTO divides the work into two categories to support prioritization of the more critical activities. The higher priority addresses PMs that must be performed frequently, with the second priority on PMs repeatable over a longer cycle. The high frequency PMs comprise those typically performed on a daily, weekly, or monthly basis. Lower frequency PMs may occur on cycles of perhaps once a year, or less frequently. Nalcor has reported all high frequency PMs as complete, with work now focusing on completing the low frequency ones. We find this division of the PM efforts reasonable and progress to date encouraging, and without material issues at present.

j. MPPA/IOA Progress

Management has turned to an alternate approach to ending the long-delayed completion of these two agreements. Hydro Quebec and Nalcor began the use of a mediator to address the outstanding issues. Meetings took place from February 22 to February 26 and then again on April 19 and April 20. Reporting "progress made on key issues," Nalcor believes that agreement has been reached on some of the material principles involved. Agreement has reportedly been reached to move now to "ironing out the operational details of the IOA." A January 2022 date has been set for ratifying the IOA.