

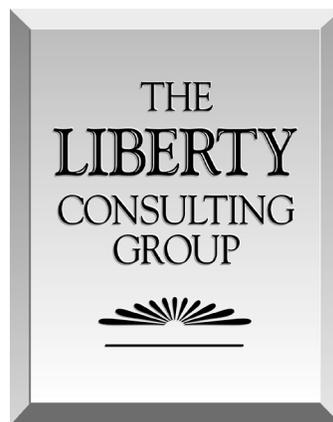
**Seventeenth Quarterly Monitoring Report on the
Integration of Power Supply Facilities to the
Island Interconnected System**

Presented to:

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

Presented by:

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I. Purpose of this Report

This report examines third quarter 2022 scheduled and performed activities undertaken as part of completing the Lower Churchill Project (LCP) assets and integrating them into the province’s electrical system. It examines progress in producing LIL protection and control software suitable for entering the Trial Operation phase necessary for successful project completion and in moving towards critical completion milestones. This report also continues to discuss progress in addressing converter station, synchronous condenser, overhead dc line, and sea electrode issues raised in previous reports, as well as what has remained a considerably smaller set of Muskrat Falls generating unit issues. It also provides a summary of progress in completing the activities transferred from the responsibility of the Transition to Operation (TTO) organization as 2021 ended.

The steps we undertook to address second quarter 2022 activities proceeded as follows:

- Review of Hydro’s monthly LIL update reports
- Identification of recurring and emergent matters related to LCP completion and presentation to Hydro of a list of questions (issued on October 13) for response prior to meeting with its personnel by teleconference
- Review of the responses to those questions (received October 20)
- Teleconference between our monitoring team and Hydro’s management team (October 27)
- Follow-up questions to Hydro (sent October 25 and October 27)



- Review of Hydro's responses to those questions (received November 4)
- Teleconference between our monitoring team and Hydro's management team to discuss subsequent November events (November 17).

II. Major Observations

Overall LIL Progress:

The LIL began Trial Operation on October 11, 2022 under "final" control software. Management has reported its successful completion, bringing the LIL past a major milestone in reaching commercial operation. Trial operation took place under comparatively low power flows, for example, with lingering synchronous condenser problems restricting power flows to 315MW. Plans call for increased flows (between 675 and 900MW) as system load increases with the onset of cold weather.

Electrode Sites:

Upgrades identified for the breakwater protecting the L'Anse aux Diable sea electrode site remain scheduled for 2022 completion. The study commissioned to address the Dowden's Point Grounding location on the Island's Avalon Peninsula continues to have an expected completion date of fourth quarter 2022. Hydro observed that an inspection by a Hydro Senior Engineer from Operations Engineering Support disclosed that passage of Hurricane Fiona through the Strait of Belle Isle produced no damage at the L'Anse Aux Diable Grounding station.

Alert Fatigue: There has been no change to the method used to evaluate alarms by the LIL operators. The operations team has noted there are less nuisance alarms in the latest version of the software.

Synchronous Condensers: Our previous reports have addressed a long-standing vibration issue common to all three synchronous condenser units and the more recent failure of the Unit 1 bearing. We noted little change in the third quarter with respect to the longer-term vibration issues; Hydro remains unwilling to accept GE's position that elliptical bearing modifications sufficiently addressed those issues. Commercial resolution continues to appear a likely outcome. Investigation of the bearing failure suggests bearing misalignment created by temperature and pressure changes during operation. A resulting reduction in the lubricating film layer appears to have caused rubbing that degraded the bearing to the point of failure. Indications at present indicate that a design issue common to all three units produced circumstances leading to this failure (so far limited to Unit 1) and the potential for future ones. Bearing failures from rubbing, particularly during early equipment life, are rare, and here appear to have resulted from a design issue the solution for which GE has yet to identify. Hydro has yet to question the potential for damage or risk to other equipment (the bearing shaft for example), as GE continues to analyze detailed testing results and consider changes to its root cause analysis. Hydro has expressed the view that remediation measures ultimately selected will involve all three synchronous condenser units.

Muskrat Falls Generators: All Muskrat Falls Units remain released to operations. Vibration issues affected Unit 2 last year. Corrective actions to address their causes remain unidentified, with the unit under limits restricting operation to power levels between 180 and 206MW pending further review. Hydro reports expected completion of root cause analysis of the vibration issue by

the end of this year, with detailed plans and schedules for corrective measures to follow later and that will likely require unit disassembly. The potential for impact on Units 1 and 3 is at present unknown.

Staffing, Training, and Procedures: Staff openings and incomplete training sessions have reached minimum levels. Manitoba Hydro no longer provides contract support for operators. GE provides contract support to the technical operators under a three year contract giving Hydro an option for two additional years of support. Procedure development has reached a well-advanced stage, with progress continuing to reduce what now comprises a small procedure backlog.

Procedures and Training Implications of Recent Operating Events: The circumstances surrounding underfrequency load shedding following the recent Maritime Link runback underscore the importance of development of a programmatic approach to identifying operating circumstances and events that create threats, in order to (a) ensure that operating procedures are sufficiently broad and detailed to address them, and (b) develop scenarios effective in ensuring clarity and ease of operator actions required to address them and operator knowledge and familiarity with them.

Hydro has, as events have required, addressed a number of events that test operator knowledge, familiarity, and promptness. We continue to believe that the number and nature of those events and their continuing nature warrant a more proactive approach; *i.e.*, one that moves past procedure development, circulation, and training and into testing to validate the effectiveness of those procedures and of those who need to execute them timely and completely.

Muskrat Falls Site Emergency Response Guidelines and Maintenance Manuals: Management has completed all emergency response standard operating guidelines with in-house and contractor personnel now implementing them. Contractor personnel have a lead role at this time.

Open Agreements: We reported earlier that the CF(L)Co board approved an amended MPPA in May 2022, making it appear that execution of it was approaching. However, the agreement still remains incomplete, surprising given the previous statements about its status. The Andritz services agreement remains the last open major contract, with Hydro not offering an anticipated finalization date, despite previous plans to finalize the agreement by now.

III. Second Quarter Events and Circumstances

a. The LIL

1. Commissioning Progress

A long period of disappointing commissioning events and results has given way to grounds for more optimism in recent months. We have reported over an extended period setbacks experienced in the conduct of continuing Factory Acceptance Tests (FATs). Those tests had continued to expose defects preventing the start of the 30 day period across which the LIL must operate in bipole mode without interruption to pass the critical Trial Operations milestone. Our last report noted that a June 2022 FAT initially appeared more successful, but operation under the new software version supporting it soon thereafter led to significant disruptions. The third quarter

began with efforts to make further software corrections, as the LIL operated under an earlier software version reinstalled.

Completion of Trial Operation confirms the view that the LIL appears likely to deliver material energy through this winter. Substantial testing at higher power levels remains for the remainder of this year. Low load conditions during the fall Trial Operation period did not offer circumstances suitable for that testing. There continue to be substantial doubts about both its short- and long-run ability to operate in a fashion that will permit reliance on its availability from a planning perspective. Nevertheless, completion of Trial Operation does represent a significant step forward in reaching LIL operation at power levels and in the configuration contemplated by its design.

2. LIL Performance During the Quarter

Early in the third quarter, the LIL experienced outages due to the failure of a ground switch. The ground switch failure occurred during the cable switching sequence of the 475MW overload test. The switch failed on energization, and the LIL control system responded correctly. Observed issues associated with lower than 50MW/minute ramp rates required investigation and rectification.

Unplanned, August 27, 2022 trips of lines 401L, 405L and 407L occurred at the Stephenville substation during “runback” testing on the Maritime link and the LIL. Over-voltages on these lines, which reached 11.38 percent when the Maritime Link STATCOM controller tripped, caused the line trips. Hydro found the failure procedural, with no more malfunctions occurred during further testing. Total, unexpected loss of the STATCOM at a low loading period (nighttime in summer) comprises the worst case event, potentially producing a similar issue at the Stephenville Substation under certain circumstances.

A high-frequency event occurred during the late evening and early morning hours of September 28. The event resulted from an excess of on-Island generation relative to load. Generating asset restrictions and water management guidelines resulted in low levels of generation contribution to power and energy dispatch. The LIL was scheduled in bipole mode with exports to Nova Scotia over the Maritime Link for part of the night. The LIL is included in the overall dispatch and operates subject to reductions/increases as required, but subject to a minimum operating level of 45MW.

The LIL enables exports to Nova Scotia across the Maritime Link. Circumstances and conditions involving the Maritime Link resulted in abnormally high power flow into Newfoundland across the Maritime Link. Control of those circumstances produced a November 14, 2022, underfrequency load shedding (UFLS) event that began at about 6:40 am. Fifty-one Newfoundland Power distribution feeders lost power due to the activation of the UFLS scheme. Accompanying high voltage conditions occurring in the Stephenville area caused protection and control equipment to open transmission line breakers at the Stephenville (STV) and Gallants (GAL) substations that caused the loss of power over an additional 13 Newfoundland Power distribution feeders. In all, 57,298 Newfoundland Power customers lost power due to the event.

Newfoundland Power began customer restoration at 6:48 am and by 6:58 am had restored power to all affected customers except for those served on a feeder affected by substation

communications issues. Newfoundland Power completed restoration of customers on that feeder at 7:40 am.

We have at present seen no reports of LIL performance issues material to the circumstances, but Emera Newfoundland and Labrador has underway a root cause examination following a number of changes it has identified.

3. Electrode Sites

We reported earlier on a Tiller Engineering Inc. (TEI) study finding that washouts experienced at the L'Anse au Diable Grounding Station Phase 2 Breakwater site in December 2020 resulted from a breakwater insufficiently high to protect against extreme conditions. Hydro instructed TEI to proceed with the recommendations offered. Detailed engineering and planning of the changes continued in the third quarter, with Hydro continuing to expect the start of physical work imminently and completion by the fourth quarter of 2022.

Design review of the Dowden's Point Grounding Site location on the Island's Avalon Peninsula has commenced under the direction of an outside consultant. It will include a wave study similar to that completed for the Labrador Site and will evaluate the continued sufficiency of the breakwater's original design. Hydro projects a fourth quarter 2022 study completion date, after which it will assess next steps.

4. Alert Fatigue

We have been reporting on the large number of alerts (alarms and automatic notifications) occurring. Management has reported reduction in "nuisance" alarms under the latest software in use. Hydro continues, however, not to employ standards, metrics, or regular reporting to monitor factors affecting "alarm fatigue." Best industry practice recognizes the need for such measures and reporting, in order to ensure that operator response to alerts requiring confirmation or action remains timely and effective. Assuring operational readiness continues to require management's attention to adopting and applying standards, metrics for applying them, and actions to respond to high numbers. Management has not demonstrated a commitment to doing so.

b. Synchronous Condensers

Our last report addressed a bearing failure and resulting damage at Synchronous Condenser Unit 1. GE has completed replacement of the Unit's bearings, using spares. On-site testing has focused attention on the impact of unit temperature and pressure on the "tilt" observed on the unit's bearing. Temperature changes during unit operation cause the unit's shaft to expand when heat increases and to contract as temperatures cool as the shaft spins. Resulting friction between the shaft and the bearing sleeve causes the shaft to drag the bearing in a sideways direction. A resulting sliding and rotational movement between the bearing shell and its housing deforms the bearing support structure. Subsequent energization of the high pressure oil system eliminates friction between the shaft and bearing housing, which allows the bearing support to return to the original position. However, the bearing sleeve remains in the rotated position producing misalignment with the shaft.

Pressure adds to the effects of temperature on bearing alignment. The bearing support bracket connects to the stator frame. A bearing support bracket supports the bearing housing. With

pressurization, expansion of the stator frame/pressure vessel causes deformation of the bearing support bracket. This deformation produces movement of the bearing housing and the bearing sleeve. Resulting friction between the shaft and the bearing sleeve contributes to tilt of the bearing sleeve relative to the shaft.

This tilt reduces the oil film at the collector end inboard side to an insufficient thickness. The insufficient lubrication between bearing and shaft produces metal-to-metal contact with the bearing. This conduct at low revolution rates at Unit 1 eroded bearing babbitt material enough to require bearing replacement. Babbitt metal finds typical use in bearings because of its resistance to heat and its durability. Testing lubricating oil for the presence of babbitt comprises an important measure of identifying friction causing events and circumstances.

GE sent the damaged bearing to a bearing manufacturer for repair. Elemental spectroscopy of Unit 2 and 3 oil samples did not initially indicate the presence of babbitt, but Hydro questioned the significance of metal particles found in the samples. Analysis of those particles showed them to be babbitt. Oil sampling is continuing at cycles beyond manufacturer-recommended levels. Sampling occurs at locations that include pump strainers, in-line filters and the main lube oil tank.

GE tests at unit standstill designed to correct the bearing tilt phenomenon did not prove successful. Further test plans, though not yet scheduled, will address other means for correction. An outside bearing design and operation expert engaged by Hydro will assist in evaluating the bearing tilt issue. GE has reached the seventh revision of its reporting of root cause analysis, with further work planned for imminent conduct.

GE's analyses have noted the presence of "some binding" since assembly of the synchronous condensers, at levels "measured, analyzed and accepted as not being harmful at the time." GE has recommended operation of the high pressure oil pump at 550RPM to ensure an acceptable bearing oil film thickness and setting a lower glycol temperature setpoint to provide cooler lubricating oil.

The circumstances warrant attention to what appears to involve a design issue with consequences (qualitatively, if not quantitatively) potentially common to all three units. Moreover, we cannot discount from what we have been provided the potential for damage to non-wear components (e.g., the machine shaft in a high-consequence, worst case scenario). Damage to non-wear components would result in long, expensive repairs

Hydro does not believe that the long-standing synchronous condenser vibration issues have any connection with Synchronous Condenser Unit 1's bearing failure. GE continues to maintain that the elliptical bearing modifications have adequately addressed the vibration issue, leaving the machines fit for purpose. Steady state vibration levels remain within specification requirements per ISO 7919-5. However, expert analysis of vibration signatures remains unchanged regarding specification non-conformances relating to the critical shaft speed, foundation size, and resonance.

There appears to have been no substantial change in the third quarter in Hydro's views that insufficient data exists to draw conclusions regarding vibration issue trends at this time; efforts to collect vibration monitoring data from a newly installed vibration trending software system

continue. Hydro has reported delivery of training on the new vibration trending equipment and has started to work on a monitoring program targeted for initiation by the end of 2022. It remains important to assess risk and likely consequences of long-term consequences in determining how best to apportion risk and responsibility.

Hydro has described detailed information regarding the underlying issues as confidential, citing contractual reasons. Underlying issues of critical shaft speed, foundation size, and resonance issues continue, as we reported earlier, to create an unknown, non-quantified risk of long-term implications (e.g., outage rates, repair needs, early unit retirement), whether or not they provide Hydro (on the basis of its current knowledge) a basis for immediate change from the current configuration.

c. Muskrat Falls Generators

High vibrations during power reductions caused Unit 2 to experience multiple trips. An assessment by the installation contractor did produce an interim means for addressing the circumstances, but produced a decision to return Unit 2 to service on October 14, 2021 under restrictions that required operation between 180 and 206MW, pending further investigation. A root cause analysis remains in progress and Hydro anticipates receipt of it for review before the end of the year. At present, no limitations have been placed on operation of the other three units, but the analysis underway includes their susceptibility to vibration issues. Plans and schedules for required corrections thus will remain pending for some time, with management anticipating that required activities will require unit dismantling.

d. Close-out of Transitioned TTO Work Activities

Our report for the second quarter identified that 24 tasks transferred by TTO to Hydro in December 2021 remained open. That number dropped to 12 by the close of the third quarter of 2022.

1. Staffing, Training, and Procedures

Changes to the organization remained the responsibility of Hydro's Human Resources organization. Vacancies remained minimal and limited to Engineering Business Services positions, where vacancies dropped from three to two in the third quarter.

GE continues to provide technical operators support pursuant to a three-year contract that gives Hydro the option to extend for as much as two years. Hydro anticipates continuing needs for technical support for five years and possibly longer.

Five training sessions remained outstanding at the end of the third quarter - - two for load management systems, two line fault training sessions (deferred with no immediate scheduled date) and one HVDC control and protection training session with no definitive scheduled date as of now.

Last quarter's three incomplete O&M manuals now number two. The number of completed manuals under review dropped from 18 to 6 in the third quarter.

2. Procedures and Training Implications of LIL Events

Our last report discussed the importance of supplementing sound procedures and base training in

their application and execution with: (a) establishment of a test bed of key procedures warranting periodic testing of at-hand knowledge and immediate understanding of where to turn for details, and (b) efficiently executable tests of the ability to react quickly and properly to unexpected circumstances. The underfrequency load shedding that followed a recent Maritime Link runback event underscores these needs. Management has not reported its position on or actions to address these two needs. We will continue to monitor and report on progress in this area.

3. Muskrat Falls Site Emergency Response Guidelines and Maintenance Manuals

Hydro has adopted the use of a voluntary team to exercise responsibility for site emergency response coordination. Contracted consulting resources numbering five have taken the lead role on an interim basis for the exercise of Site Emergency Response responsibilities operative since late 2021. Management anticipates a continuing contractor role through mid-2023. Long-term plans call for phasing out contractor support over time as internal resources complete training supporting current roles and increased responsibilities within the voluntary team approach that Hydro expects to continue indefinitely. Hydro has provided entry level training to 11 individuals and ongoing work with the contractor seeks to provide additional training. Hydro reports standard operating guidelines (SOGs) as now complete and in use. Planned 2022 and 2023 emergency response drills will test guideline effectiveness and execution to determine any modifications needed.

e. Open Agreements

Hydro reported no changes in the status of the amended Multi-Party Pooling Agreement (MPPA) between NLSO and CF(L)Co, approved by the CF(L)Co Board approval on May 18, 2022, but still not finally executed. Hydro continues not to expect any material changes from a draft circulated for late stage review. Execution of the Interconnection Agreement (IOA) thus continues to remain pending MPPA completion. The Regulation Service Agreement with Emera remains open, with scheduled completion in the first quarter 2023.

We previously reported completion and turnover to operations of the TTO plan's 56 transmission O&M contracts. Only the Andritz O&M Services Agreement remains open among the 61 agreements planned for generation O&M services. Hydro awaits Andritz's response to comments on agreement scope, terms, and conditions. Management had expected agreement completion in the third quarter, but now does not offer an expected completion date. The contractor continues to offer services on an interim basis, but completion of a final agreement remains important.