

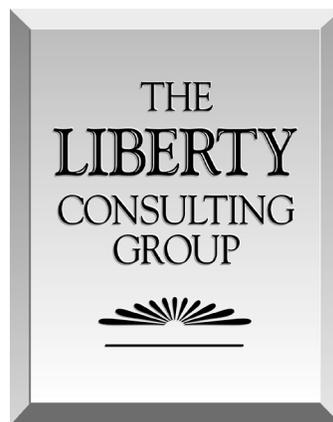
Eighteenth Quarterly Monitoring Report on the Integration of Power Supply Facilities to the Island Interconnected System

Presented to:

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

Presented by:

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February 9, 2023

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I. Purpose of this Report

This report examines fourth 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 also addresses a number of notable January 2023 events that raise implications for issues that have affected LCP completion and integration for a number of years. Continuing difficulties in producing suitable Labrador Island Link (LIL) protection and control software and converter station issues remain a focus of our quarterly reviews.

We also address a series of weather-related events that have caused the LIL’s overhead dc line to experience equipment failures at a very much greater than expected frequency. This report also addresses events that, while originating either to the west of Hydro’s Labrador transmission facilities or on the Maritime Link, have resulted in consequence to and perhaps contribution from the LIL and Island transmission facilities, some producing service disruptions for the province’s customers.

We continue as well to address progress in assessing and addressing potential sea electrode failures and on the now short list of matters transferred from the responsibility of the Transition to

Operation (TTO) organization about a year ago. Finally, we continue to address alert fatigue and operator response issues that we observed as an issue in earlier quarters of 2022.

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

- Review of Hydro's *Reliability and Resource Adequacy Study Review* – Labrador-Island Link Monthly Update reports (monthly LIL updates)
- Identification of recurring and emergent matters related to LCP completion and presentation to Hydro of a list of questions (issued on January 6) for response prior to meeting with its personnel by teleconference
- Review of the responses to those questions (received January 16)
- Teleconference between our monitoring team and Hydro's management team (January 23)
- Follow-up questions to Hydro (sent January 24)
- Review of Hydro's responses to those questions (received February 3).

II. Major Observations

LIL Commissioning

Our report for the previous quarter cited successful completion of the key LIL milestone of Trial Operations in November 2022. As required, the LIL operated for 30 consecutive days without interruption. It did so at low power levels, with operations restricted to 315MW for reasons that included the continuing synchronous condenser problems addressed later in this report. The last quarter did produce required testing at increased power flows, including verification of the capability of one pole to pick up the load carried by the other when that other fails during operation at 700MW (termed the "700MW overload test"). Like it has on first (and often multiple) occasions of key test milestones, the LIL failed this November 2022 overload test, due to yet further software failures.

General Electric's estimation that it can cure this round of software failings, perform testing, and secure completion of the 700MW overload test should, under the circumstances, generate the same level of substantial doubt as have its past predictions of LIL progress. The most recent failure also adds to concern about whether the LIL can reach in any definable time period an ultimate level of performance consistent with what its design has contemplated.

LIL testing has, however, generated some positive news recently. Results of at up to 475MW has opened the door to examining changes in near-term LIL operations plans with the Newfoundland and Labrador System Operator (NLSO).

Contractual versus Operational LIL "Completion"

Ironically, despite repeated testing failures, a lack of operation for extended periods at full or even high power levels in bipole mode, and continuing restrictions on the level at which the NLSO has permitted operation, the LIL has progressed steadily toward milestones that have consequence for measuring durations that obligate General Electric to fix continuing problems. Some dates that commence various periods that define General Electric performance and corrective action periods have already come and others loom. Within two years from now, as reported by Hydro, warranties will end. Thereafter, as Hydro has stated, it will rely for perhaps several more years on General

Electric “to support the software” whose flaws have for so long plagued project completion. It will take large improvement in the support shown to date to make that reliance comforting.

Hydro thus will soon have to make high stakes judgments about matters with significance in defining the nature and duration of responsibility for correcting LIL difficulties that survive commissioning. It appears that Hydro will have to make those judgments in an environment complicated by assumptions about other important triggering events. Those events include support for rate mitigation, substantial obligations to support the massive investment in LCP facilities, and how best to plan for use of an asset that may never reach the level of performance for which it has been designed. It will take great caution and likely substantial negotiation with General Electric to chart a course through an environment that has the potential for producing significant compromise in addressing potential long-term LIL operating issues having large cost or operating consequence.

LIL Overhead Line Performance

The return of winter weather beginning in the last quarter of 2022 has produced the recurrence of weather-related overhead line incidents of concern. Hydro has begun a series of investigations that appear designed to identify both the immediate causes and their longer term significance; *i.e.*, for other line segments that may operate in conditions or have physical similarities to those affected by events that recurred starting in December 2022.

Considering these events in combination with incidents occurring over the line’s short history, creates material doubt about the overhead line’s actual versus designed-for reliability, as measured by the expected durations (“return periods”) between events with potential reliability consequence. The LIL should experience decades without weather-related interruptions; it continues to experience them at yearly or greater frequencies. Moreover, other recent events have raised potential implications for how effectively LCP assets respond to chains of events triggered initially by conditions and circumstances on the Hydro Quebec system or the Maritime Link. Affected LCP assets include the LIL and the 735kV Labrador transmission circuits. Internal investigations and coordination with work by those representing those other systems have occurred; it is critical that they continue until they reach a reasonable level of certainty regarding the Newfoundland and Labrador system’s capabilities to respond effectively and promptly to mitigate their impacts.

For the immediate term, monthly LIL update for January 2023 reported completion of repairs to address recent damage to the LIL’s overhead line portions in Central Labrador and the Long Range Mountains. However, the monthly LIL update for January 2023 also indicates continuation of line incidents into early 2023. They include two LIL trips under investigation and an underfrequency load shedding that followed LIL response to a single pole Maritime Link failure as if it were a double pole failure.

Synchronous Condensers: This quarter brought continuation of two issues that have affected synchronous condenser operation (vibration and bearing failure) and the addition of a third (lift oil pump failures).

Our last report noted continuing monitoring of the long-standing vibration issue following the addition of measuring equipment just over a year ago. Measures taken to mitigate its effects

continued in the last quarter of 2022 to produce vibration levels within applicable specifications and requirements. The source of the vibration, common to all three synchronous condenser units remains, however, as does interest in continuing to examine the potential for impacts to the units, particularly over the longer term. There continues to be no final resolution of these issues with General Electric. Hydro has for a long time employed outside technical assistance in connection with the issue, but plans now to solicit additional outside assistance. Hydro has in preparation a draft Request for Proposals seeking that assistance. Management anticipates that a seven week process will follow its issuance, allowing for preparation, offering and reviewing bids.

We have reported previously the December 2021 bearing failure that occurred on Synchronous Condenser Unit 1. Data indicated bearing rub as the failure's source and the potential for future such failures on all three units. Root cause analysis has identified rubbing resulting from bearing tilt as the cause, indicating the need for more than moderate repairs. Current thinking considers a full redesign of the bearing and bearing support structure as necessary. No schedule yet exists for the re-design and subsequent repair effort, which we anticipate to require lengthy and resource intensive efforts.

Hydro has experienced another recent synchronous condenser issue - - December 2022 high pressure lift oil pump failures on Units 1 and 3. With pump replacements now completed under warranty, these units remain out of service pending root cause analysis by General Electric. Hydro has indicated an expectation that both units will have returned to service before the end of this month. With continued and perhaps growing issues involving the synchronous condensers, Hydro's monthly LIL update for January 2023 does report a positive immediate term development - - the NLSO has agreed to raise the LIL operating limit from 315MW to 450MW after reviewing vibration protection setting issues.

Electrode Sites:

Upgrades scheduled for completion at the breakwater protecting the L'Anse aux Diabes sea electrode site have suffered delays that appear to threaten scheduled completion. Delay impacts at present however, appear limited to loss of availability for one additional winter season. Hydro has reported results of an engineering review of the corresponding Dowden's Point Grounding site. It is not clear, however, that this study answered the right question; *i.e.*, whether the site can withstand now known and knowable environmental conditions, as opposed to those known and knowable at the time of the original design.

Alert Fatigue: Hydro again reported no change to the methods used to evaluate alarms and alerts by the LIL operators. While Hydro does not utilize standards or metrics to evaluate alarms and alerts, it reports fewer nuisance alarms since operation under the latest version of protection and control software.

Muskrat Falls Generators: The generating units at Muskrat Falls Units continued in the last quarter of 2022 to perform comparatively more effectively than the LIL-related portions of the LCP. All units have remained available for normal operation. Unit 2, however, remains limited to a load range of 180 to 206MW, due to the vibration issues observed as far back as September 2021. This delay raises a concern, given identification of the issue now well more than a year ago.

There has been a delay in completion of a root cause analysis, previously expected by the end of 2022, but now having no reported completion date. Hydro expected completion of the analysis by the end of last year, anticipating detailed plans and schedules for corrective measures to follow later. It is concerning that the root cause analysis has not yet been completed for the issue identified in September of 2021 and no definitive completion date as of this time.

Staffing, Training, and Procedures: Staff openings have reached minimum levels. General Electric continues to provide contract support to the technical operators under a three year contract. Only two staffing vacancies exist one for a Muskrat Falls stores worker and one for a stores worker for Soldiers Pond. Procedures are essentially complete. Management reported the completion of all training sessions.

Procedures and Training Implications of Recent Operating Events: We have reported before that Hydro has experienced overhead line events (originating both on and outside its system) stressing the limits of operator knowledge, familiarity, and promptness. Experience during the last quarter of 2022 continues to evidence the need for a programmatic approach to identifying operating circumstances and events that create threats, in order to ensure (a) that operating procedures contain sufficient breadth and detail to address them, and (b) development of scenarios effective in ensuring clarity and ease of operator actions required to address them and operator knowledge and familiarity with them. We have not observed progress in that development. Hydro should not over-rely solely on success in procedure development, circulation, and training, but should consider training in off-normal operational scenarios and move toward 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: Hydro has completed all emergency response guidelines. Management expects to phase out by the middle of this year contractor support now provided to in-house personnel.

Open Agreements: Hydro has for some time reported expectations of near term completion of the Multi-Party Pooling Agreement (MPPA), following the CF(L)Co board's May 2022 approval. Execution of an agreement has still not occurred, despite continuing Hydro reports that no substantive disagreements remain. Circumstances now suggests otherwise, given the eight months that have passed since expected completion. Execution of the Interconnection Agreement (IOA), still reported as finalized continues to require prior execution of the MPAA. Hydro now reports no schedule completion date for Regulation Service Agreement with Emera - - a change from its previously stated expectation of finalization in the first quarter of 2023. The Andritz services agreement remains the last open major contract, with still no completion date provided, but with Hydro now under undertaking what may prove a final review of items on which comments have been made. The agreement had been scheduled for finalization by now.

III. Fourth Quarter Events and Circumstances

a. The LIL

1. Commissioning Progress

The 700MW overload test forms a next major testing milestone following successful completion of the 30-day Trial Operations period. This overload testing seeks to verify the ability of the second pole to compensate for the loss of the first pole by picking up its load. The overload test took place in November 2022. Pole 2 initially compensated fully for the planned emergency stop of Pole 1. However, Pole 2 continued to operate successfully for only approximately 44 seconds, failing after Pole 2 blocked as a result of several commutation failures in rapid succession. Thus, the LIL did not operate as required under the test circumstances. This failure appears to reflect another control software failure - - the latest in what is now a long series of disappointments and one that shows that substantial work may remain to reach full LIL completion.

The LIL has thus so far proved unable to repeat the accomplishment of its long delayed but finally successful October 11 through November 10, 2022 Trial Operations period. This failure consigns the LIL to yet another set of measures to correct the failing, to assure the introduction of no new failings, to undergo comprehensive testing, and ultimately to pass the overload test failed in November. History commends pessimism regarding GE's estimate that it can complete all the work required to ready the LIL for passing the overload test during the first quarter of this year. The failure also underscores the concern we have now expressed for some time about the LIL's longer-term ability to reach a state of reliable operation at full power with all of the capabilities of its design requirements. Amid continuing bad news, however, it does remain the case that the LIL software has on a net basis advanced, however, slowly and however marred by significant failures.

2. Physical Versus Contractual LIL Status

Hydro has provided a schedule that calls for completion of Dynamic Commissioning in the first quarter of 2023. That date conforms to the completion of the 700MW overload test. Hydro will, upon completion of Dynamic Commissioning, issue to the NLSO a "Release for Service Certificate" that requires endorsement by the NLSO for release into "Commercial Operation." A "Commissioning Certificate" will then issue to the Canadian independent engineer for signature - - making the process similar to that applicable to completion of other LCP assets.

From a LIL operations or performance point of view, it appears that these releases and signatures can occur with the LIL having operated at no greater than 700MW of its designed-for 900MW capability, provided it has passed the 700MW overload test. Moreover, continuation of operating limits in the range of 450 (for example, as synchronous condenser conditions remain) can further mean only limited operation above that level.

The issuance of the Release for Service Certificate and the Commissioning Certificate comprise major milestones in determining General Electric's obligations with respect to LIL operations performance assurance. However, a critical, six-month "Burn In" period already began with completion of Trial Operations, which took place last November. The LIL met Trial Operations despite operating at power levels roughly a third of those of full power on a design basis and at roughly half of those required for the 700MW overload test. Hydro reports that General Electric's

contractual obligations require it to resolve all open items (existing at Trial Operations and discovered through the Burn In period). Within 30 days of the end of the six month Burn In period, General Electric, according to Hydro, must deliver “Full Function Bipole software.” Successful completion of the 30-day Trial Operations occurred about three months ago. Four months remain for the LIL to complete Dynamic Commissioning (including the 700MW overload test already failed), to close all punch list items, and to deliver Full Function Bipole software. Moreover, continuation of significant limits on LIL power levels may create circumstances that do not call upon the LIL to perform at near the robust levels called for by its design.

Hydro has reported that General Electric has a continuing responsibility to “support the software” that provides protection and control over LIL operation for a period of at least three years. That period can extend by an additional three years should performance requirements not be achieved. Hydro also reports that warranties extend for approximately two years from now - - until April 2025. General Electric’s degree of success in software support to date does not inspire confidence in how it will do so after its obligations are “on the clock.”

Thus, significant performance assurance measures exist, but do not come without notable uncertainties. One source of those uncertainties lies in the stance Hydro will take in exercising its judgment (in the context of NLSO and Canadian independent engineer review as noted above) in determining when to issue its Release for Service Certificate. Hydro will also need to exercise judgment in determining whether the Burn In Period has resolved all open items - - no small matter given the many and continuing problems the LIL has experienced to date and the major 700MW overload test it must still meet. Another uncertainty concerns the differing level of reliance to be placed on General Electric’s obligation to, as Hydro puts it, “... continue to support the software ...” for three to six years, as compared with a warranty that has only two years remaining from today.

3. LIL Performance During the Quarter

Hydro has reported General Electric work on a new software version that will incorporate corrections for this issue. The corrected software version will require thorough testing before its return to the site, including Factory System Testing (FST) followed by another Factory Acceptance Test (FAT). Release to the site will follow, at which time regression testing and another 700MW overload test MW will require successful completion. Other measurement checks (e.g., extinction angle) will occur as well. A check of extinction angle measurement will also occur to ensure protection against multiple commutation failures. General Electric reports planned readiness for testing the revised software in time to complete the 700MW overload test by the end of the current quarter. This latest in a now long extended series of testing failures calls for caution, if not skepticism, in both release for testing and successful completion of the 700MW overload test.

Several outages initiating on the LIL’s overhead portion occurred in December of 2022, but did not disrupt service to customers. Line loadings of less than 335MW at the time of these outages left remaining supply resources sufficient to compensate for the LIL’s loss. Icing in particular appears the underlying cause, with line galloping (an issue we have long considered a risk to LIL operation) contributing.

The large number of weather related overhead line incidents across so short a LIL life clearly raise long term issues about LIL reliability - - issues presumably best addressed in the Board's current review of long term reliability and resource adequacy. However, incident frequency also raises questions about how well the LIL has been completed. The uncertainties raised include equipment quality, installation effectiveness, and targeted placement of devices such as anti-galloping devices, for example. Our questions about them disclosed an intent to undertake comprehensive, but not yet fully designed or resourced measures to examine the specific reasons for failures to date and to assess whether the results show isolated causes or conditions endemic to large overhead segments or numerous locations. We consider such a comprehensive approach necessary and timely. The next two paragraphs summarize some of the events that have contributed to Hydro's planned and ongoing examinations.

Hydro discovered overhead line damage on December 2, 2022 on the Northern Peninsula. A broken turnbuckle on tower 1872 caused the Pole 2 conductor to fall from the tower to the ground, but without breaking. Root cause investigation remains on-going, with a report expected imminently. Hydro has observed conductor galloping in certain regions, installing airflow spoilers to mitigate the phenomenon in one southern Labrador location. Plans also exist to install air spoilers at other overhead line locations.

A Pole 2 trip shortly followed a December 21, 2022 Pole 1 trip. A line patrol observed heavy icing on the towers and insulators between Northern Peninsula structures 1460 and 1485. No measures currently prevent the snow accumulation presumed to have generated the icing conditions. Successful open line tests and visual observation of overhead line "health" preceded re-energization and return to bipole operation shortly thereafter, on December 23. We plan to follow up with Hydro on the viability of unbalancing the two poles during heavy snow conditions to allow higher load on one pole to remove icing, alternating the load balance between the two poles.

The longer term measures Hydro has begun to address outage causes and future threats more generally include four failure investigations. These investigations, augmented by the use of outside resources not yet retained seek to identify root causes through review of failure mechanisms, structural behaviors, and site and damage material. Hydro plans to engage a third party engineering consultant to review the investigations and their findings. The investigations will extend through the middle of 2023, with the last (a structure failure investigation) scheduled for June completion.

4. Other LCP-Related Transmission System Issues

December 2022 also witnessed an incident that came to involve transmission facilities in Labrador. Loss of Hydro Quebec's 735kV transmission corridor south of Arnaud Station created voltage issues on the morning of December 24, 2022. A total loss of the Happy Valley system resulted. The events isolated the 735kV portion north of Arnaud and the Labrador Interconnected System (LIS) from the Hydro Quebec system. Sudden reductions in 735kV flow between Churchill Falls and Hydro Quebec caused LIS system frequency to increase to approximately 61Hz, with abnormal voltage conditions experienced on the Muskrat Falls 315kV bus and the Churchill Falls 735kV bus. A Muskrat Falls unit and the Happy Valley terminal tripped soon thereafter. Loss of Hydro Quebec's 735kV corridor triggered the following events, but the circumstances raise the question of how effectively the LIS facilities responded. Hydro has underway an investigation

seeking to verify the causes of the series of events involved and to assess whether changes in Hydro's system can mitigate the impacts in the future.

Our last quarterly report also described a late evening and early morning September 28, 2022 high frequency event caused by an excess of Island generation relative to load. The LIL was then scheduled for bipole mode with exports to Nova Scotia over the Maritime Link for part of the night. Hydro responded to our query about measures to avoid over frequency in similar circumstances by noting that discussions with system operators have sought to ensure their diligence in monitoring and taking actions to keep frequency within acceptable limits.

Our last quarterly report also addressed a November 14, 2022, underfrequency load shedding (UFLS) following Maritime Link circumstances and conditions that produce abnormally high power flow onto the Island. The events ultimately disrupted power to more than 60 Newfoundland Power distribution feeders and outages for 57,298 Newfoundland Power customers. Operators restored most of them within 20 minutes and the remainder in about an hour. Hydro's response to our queries about the events indicated that Emera's examination attributed the initiating cause to a combination of a faulty tap changer transducer and the absence of certain overmodulation protection. That combination produced uncontrolled power flows over Maritime Link Pole 2. Hydro also reported that Emera considers responsive actions identified as sufficient to prevent recurrence.

We also described a ground switch failure in our last quarterly report that Hydro disclosed in its monthly LIL update for September 2022. Hydro has now reported completion of a causal investigation by Hydro and General Electric technical experts, with no design issues identified. The examination did identify inconsistent ramp rates that General Electric has addressed through software changes, testing at its laboratory, and subsequent site implementation. We also inquired into the August 27, 2022 tripping of both poles of the Maritime Link STATCOM, which led to outages (restored in nine minutes) of some Newfoundland Power customers. A test of LIL runback under monopole and bipole trips of the Maritime Link initiated the events leading to the outages. Upon successful completion of the test, an operator opened both system breakers, causing a trip of the STATCOM function. Hydro has determined that bipole trips of the Maritime Link will expose lines connected to the Stephenville substation to trips in the future. However, Hydro considers bipole trips of the Maritime link both extremely rare and outside the range of events covered by its planning criteria. Therefore, it considers the risk acceptable. Hydro does not anticipate unacceptable performance of the LIL at higher power levels, but in the event that this does occur, reports plans for close consultation and coordination between Nova Scotia Power and Emera, to ensure issue understanding and resolution.

We asked Hydro to provide a timeline of activities to identify, assess, plan for, and execute repairs in connection with events like those that the overhead line has recently experienced. Hydro provided a timeline, most of whose steps it described as "typical for any line faults." The activities Hydro addressed included site assessment of the failure, gaining access, removal of icing, repair planning, identifying and securing contractor and material and equipment resources, mobilization at the site, and performance of repairs. The minimum duration calculable is in the range of a week. The maximum begins at roughly a month, with potential significant expansion to address extended

ice removal requirements (up to two weeks), and lengthier repair times (characterized as possibly requiring “weeks”).

5. Electrode Sites

The schedule for completion of work following the December 2020 washouts experienced at the L’Anse au Diable Grounding Station Phase 2 Breakwater site has experienced delay. Hydro has reported that still needed to complete project approval, detail design, and procurement has moved the start of work to end of June 2023, leaving less time to complete work prior to the onset of the following winter.

Some time ago, we recommended design review at Dowden’s Point Grounding Station electrode site located at Conception Bay. Hydro has reported that an engineering study since conducted found conditions at the site “good.” Hydro also reported the study as finding the wave heights considered in the design and the factors used for other wave-height parameters supportive of a “valid design decision.” Our recommendation did not seek a retroactive assessment of the validity of the design when first performed, but a review of design sufficiency against a now known and knowable range of operating conditions across its life. Hydro appears satisfied that no work at the site is necessary, but it does plan to monitor operations.

We did not find convincing the apparent focus of the engineering report on assessing design on what used to be (versus what is now) known and knowable. For example, Hydro cited the report as stating (emphasis added) that, “...the *design* life of breakwater *was* 100-year minimum and the breakwater *was designed* to withstand the expected worst-case conditions.” The site that experienced failure on the other side of the strait may have passed that same test, which is not one that prudence dictates. Thus, pending further review of the engineering report and what further opinions the engineering firm that produced it may stand ready to express, we believe that the adequacy of the Dowden’s Point Grounding Station remains an open question.

6. Alert Fatigue

We continued our review of the large number of alerts (alarms and automatic notifications) occurring. Management continues to report a reduction in “nuisance” alarms and alerts under the latest software in use but no use of standards, metrics, or regular reporting to monitor factors affecting “alarm fatigue.” Lack of measurement and reporting continues to conflict with best industry practice.

b. Synchronous Condensers

Hydro reported Synchronous Condenser Unit 1 bearing failure and resulting damage in its monthly LIL updates dating back to 2021. Hydro has also reported discovery of small amounts of babbitt material in a December 2022 Unit 2 oil analysis. General Electric attributes the failure to a bearing tilt causing the surface of the bearing to rub. Babbitt metal, a friction-easing and corrosion-preventing alloy, commonly forms the surface of bearings in applications like those at issue here. A recent update to General Electric’s root cause analysis of the circumstances now indicates that rubbing has been present since first assembly of the synchronous condensers. However, measurement and analysis had previously led to rubbing acceptance “as not being harmful at the time.”

General Electric has continued to take actions designed to correct the tilt issue. These actions included several tests of the unit to determine if a rapid start would develop sufficient hydrodynamic force to form an oil film more quickly to lubricate the bearing and prevent a bearing tilt. The theory underlying this measure held that quickly developing an oil wedge to overcome the friction forces between the bearing sleeve and housing could prevent bearing tilt. This measure proved ineffective. General Electric has now determined that bearing and bearing support re-design and subsequent machine changes are required. General Electric has yet to provide a schedule for re-design and subsequent execution of that design. We anticipate a time and resource intensive effort involving all three units.

Pending these activities, interim efforts now focus on returning the unit to commercial operation in a safe manner. General Electric identified a comprehensive set of interim actions to aid in preventing the issue. They include adjusting glycol temperatures, reducing unit ramp-up time from rest to full speed, reducing shutdown time at slow speed, continuing the working of Units 2 and 3 at 900 rpm even at zero power, setting a minimum oil film thickness as a precondition to unit start, filtering oil using the oil filtration cart every two months for the next year, drawing oil samples and performing a particle analysis every 3-4 months, adjusting the unit trip and alarm setpoints of the units, and continuing to monitor oil film thickness to confirm bearing alignment. While comprehensive these compensatory actions cannot guarantee non-recurrence of bearing tilt. General Electric has also requested that Hydro provide operating hour, unit load, hydrogen gas cooling system, lubricating oil system, hydrogen seal oil system, and unit vibration and temperature data.

In parallel with the bearing tilt issue, the long-standing, foundation vibration issue involving the synchronous condensers also continues without resolution, warranting in Hydro's view continuing review and analysis of long term operability and reliability of the machines. The commitment to a design review addressing the bearing tilt issue creates in our view an opportunity for assessing a review that will consider as well the foundation issues in search of holistic solutions to a growing list of synchronous condenser issues. Circumstances also warrant consideration of Hydro's retention of outside expertise to monitor General Electric's design review activities. As planning and execution of that review advances, these two questions should undergo continuing review.

Vibration measurements expanded more than a year ago to monitor foundation induced vibrations continue to show levels within specifications. A solicitation to secure outside expertise to review additional vibration data remains under development. Retaining that expertise is moving at a pace that may threaten results availability in time for consideration of any ramifications it may have for General Electric's pending bearing redesign effort.

A third synchronous condenser issue arose in the last quarter of 2022. Hydro's December 2022 monthly report noted the removal of service of Units 1 and 3 following mechanical failures of their high pressure lift oil pumps. Pending root cause analysis by General Electric, the reasons for the pump failures remain undetermined. However, Hydro expects both units to return to service in February 2023.

Hydro reported a December 2022 unintentional coast down of Synchronous Condenser Unit 2. Investigation by General Electric determined that a failure to retain fault codes on certain cards precluded the ability to isolate the cause of the communications issues underlying the events. Hydro reports that fault code retention has been addressed. Investigation has also determined that the cards used previously did not come from the time period during which the manufacturer acknowledged that it had manufacturing issues in card production. Moreover, the addition of monitoring capability now provides operator workstation alarms in the event of equipment operation anomalies. These events and responsive actions continue to demonstrate that systems and equipment have not reached a mature stage.

Over their brief commissioning and operating durations, the units have suffered a number of issues, with three significant ones not fully resolved and with some posing significant uncertainties about when Hydro can count on them as reliable.

c. Muskrat Falls Generators

Units 1, 3, and 4 remained available for normal operation. Limiting Unit 2 to a fixed blade mode of operation within a load range of 180 to 206MW continued, following the previously reported vibration issued that caused multiple trips of this unit. A root cause analysis of the Unit 2 vibration issue remains outstanding, well more than a year following the September of 2021 observation of the issue. A preliminary causal analysis came to Hydro in April of 2022, pending a final root cause analysis intended to address corrective actions. No date for completing that analysis existed at the time of our last quarterly report and none has been reported since. The long duration for release of the expected report now raises concern about the potential significance of the circumstances and the extent of possible corrective actions.

d. Close-Out of Transitioned TTO Work Activities

Our report for the last quarter identified that 12 tasks transferred by TTO to Hydro in December 2021 remained open. That number dropped to 11 by the close of the fourth quarter of 2022.

1. Staffing, Training, and Procedures

Changes to the organization remained the responsibility of Hydro's Human Resources organization. The two vacancies reported involve the same stores positions reported for the last quarter. Recruiting is underway for the Muskrat Falls open position, with the Soldiers Pond position on hold pending an engineering evaluation of the structures at the site. General Electric 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. The two training sessions outstanding at the end of last quarter have been completed.

2. Procedures and Training Implications of LIL Events

Management has reported that it does not require a qualification card type training program and that it does not require creation of test scenarios to test operator or maintenance personnel knowledge of the equipment or operator actions in unexpected scenarios. The training process consists of a number of training documents produced by ATCO for both operators and to a lesser extent the maintenance personnel. Hydro described its use of procedures to train operators on LIL assets. Each employee reviews the relevant training documents and then the supervisor performs a knowledge check with the employee. A set of standard questions guides knowledge checks. In

addition, practical factors to some training elements ensures employees understand the steps to perform various tasks. It did not appear, from reviewing the list of the title of the training documents, that documents exist to train operators on abnormal operations scenarios. Hydro should not over-rely solely on success in procedure development, circulation, and training. Management should consider training in off-normal operational scenarios and move toward testing to validate the effectiveness of those procedures and of those who need to execute them timely and completely.

3. Muskrat Falls Site Emergency Response Guidelines and Maintenance Manuals

Hydro reports standard operating guidelines are now complete and in use. The emergency response plans continue to be implemented by on-site personnel supplemented with contractor support with a goal to phase out contractor support by the middle of 2023.

4. Open Agreements

Hydro reported that another quarter has passed without completion of the MPPA between NLSO and CF(L)Co. Our last report described the agreement's status as in late stages with no expected material changes. This quarter Hydro reported that work continues to reach a solution on a "small change" proposed by Emera. With execution of Interconnection Agreement (IOA) contingent on MPPA, the former continues to remain open. The Regulation Service Agreement with Emera also remains open, with the previously- reported scheduled completion in the first quarter 2023 now apparently no longer expected. Hydro reported no specific schedule for its completion and noted that LIL and ML operation do not require the execution of this agreement.

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 remained open last quarter among 61 agreements planned for generation O&M services. Hydro has since received and is reviewing Andritz's 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.