

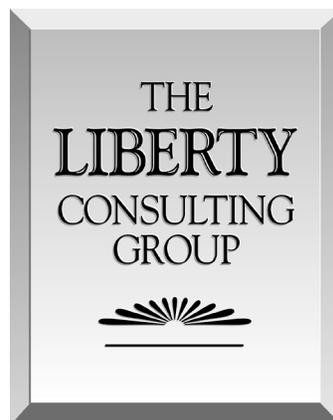
**Nineteenth Quarterly Monitoring Report on the
Integration of Power Supply Facilities to the
Island Interconnected System**

Presented to:

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

Presented by:

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Table of Contents

I. Purpose of this Report 1

II. Major Observations 2

III. Fourth Quarter Events and Circumstances 5

 a. The LIL 5

 1. Commissioning Progress 5

 2. LIL Performance During the Quarter 6

 3. Follow-up on Earlier Overhead Line Issues 6

 b. Electrode Sites 8

 c. Alert Fatigue 9

 d. Synchronous Condensers 9

 e. Muskrat Falls Generators 11

 f. Close-Out of Transitioned TTO Work Activities 12

 1. Staffing, Training, and Procedures 12

 2. Procedures and Training Implications of LIL Events 12

 3. Emergency Response Guidelines and Maintenance Manuals 13

 4. Open Agreements 13

 5. Muskrat Falls and Transmission Asset Performance Indicators 13

I. Purpose of this Report

This report examines first quarter 2023 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 provides updates on a number of events and circumstances reported earlier but pending ongoing examination or other review by or on behalf of Hydro.

The steps we undertook to address first quarter 2023 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 April 24) for response prior to meeting with its personnel by teleconference
- Review of the responses to those questions (received May 11)
- Teleconference between our monitoring team and Hydro’s management team (May 17)
- Follow-up questions to Hydro (sent May 17)
- Review of Hydro’s responses to those questions (received May 29).

II. Major Observations

LIL Commissioning: Soon after successful completion of Trial Operations in November 2022, the LIL failed in an attempt to reach its next major milestone - - successfully completing the 700MW overload test required to verify the ability of the remaining pole to pick up the load carried by the other pole on a trip of that other. General Electric released to the site a corrected software version on March 24, 2023. Use of this software enabled successful performance of the 700MW test on April 8, 2023 and completion of dynamic commissioning. These events prepared the facility for completing the steps formally required to assign it a commercial operation date.

Hydro reports that successful completion of the overload test fully demonstrates its ability to operate equally well at its fully rated capability of 900 MW. However, system load conditions will not enable the LIL to operate at 900MW until cold weather brings higher customer loads. Achieving the operational milestones required for commercial operation comprises a large step forward for the LIL under the circumstances. However, it is prudent to exercise caution in assuming that the software issues acknowledged to remain, the potential for others to lurk (given history), and stresses on the total Hydro system when the LIL operates at 900MW under high system loads will not expose new issues or bring back others back. After so many disappointments, however, it is correct to consider this quarter one of very significant achievement for the LIL.

LIL progress has consequence for defining and delimiting General Electric's responsibilities for correcting software and other issues (for example, continuing concern about the synchronous condensers, among others). Hydro will require performance from General Electric for a number of years. Warranties are well within two years of expiration, leaving a three to six year Performance Guarantee Assessment Period as the principal means for securing General Electric corrections for any design deficiencies or equipment defects encountered. Hydro will continue to require diligence and caution in addressing with General Electric issues that have the potential for long term performance impacts on the synchronous condensers and possibly other equipment. Reasons exist for attention to impacts that may not become apparent until well after the end of the Performance Guarantee Assessment Period.

LIL Overhead Line Performance: Our last report addressed the recurrence of weather-related and overhead line incidents with the return of winter last December and a number of other issues as well. Hydro continues engagement in a series of investigations to identify the immediate causes and their longer term significance. It remains appropriate to consider whether their nature and number continue to raise questions about actual versus designed-for reliability and about readiness for integration into the overall Hydro supply and transmission systems.

In the more immediate term, the 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, reports for the first quarter of 2023 include continuing events and newly identified causal factors involving software and equipment. Hydro expects in September 2023 reports addressing causes of recent weather-related outages and recommendations for addressing them. We had understood them to be expected in June; we have not had an opportunity yet to address the issue of the delay with Hydro. Those reports should also provide information important for assessing long-term overhead line reliability relative to earlier

expectations, which were very high. Continuing review appears to have resolved other incidents and identified if and what permanent solutions are expected to suffice. Fixes addressing the causes of those other incidents appear small in magnitude and consequence. Problems with so-called Direct Current Current Transformers may prove an exception; what should be a high performing component produced seven LIL trips from multiple causes over the first quarter. The permanent solution remains indeterminate, but Hydro expects no adverse operating circumstances or results in the interim.

Synchronous Condensers: All three synchronous condensers (SCs) are now in operation. SC3 commenced startup on February 27, 2023 but experienced a breaker issue that caused its shutdown. Subsequent investigation revealed that ice formation interfered with breaker operation. The unit returned to service on April 3, 2023. The previously reported December 2022 high pressure lift oil pump failures on SC1 and SC3 have been examined. General Electric has sourced their failure to increased oil viscosity resulting from machine hall temperatures below design levels. Resulting vacuum at the pump suction caused a loss of lubrication. Corrective actions have been implemented to address the hall temperatures.

The two longer-term issues we have been addressing in prior reports, bearing tilt and foundation vibration, remain open. Hydro plans anticipate the need for complete bearing re-design, expected to take about 12 months to complete. Work necessary to accommodate redesign thus awaits redesign, planning, and scheduling. For the time being, nine compensatory operational actions recommended by General Electric have been implemented to permit continued operation. Monitoring continues on the second long-standing issue - - foundation vibration. Mitigation measures taken some time ago seek to reduce vibration by compensating for them, not eliminating its source. Those measures have continued to produce vibration levels within applicable specifications and requirements in the first quarter of 2023. Hydro anticipates imminently the delivery of a report from an outside expert it has retained to analyze long-term risks from continuing to operate the units as now configured.

Electrode Sites: Upgrades scheduled for completion at the breakwater protecting the L'Anse aux Diable sea electrode site have suffered delays that appear to threaten scheduled completion for one additional winter season. Relying on the recently reported results of an engineering review of the corresponding Dowden's Point Grounding site, Hydro has decided that the site requires no current changes. The report may be useful in narrowing the risk involved, but we did not find its scope as described by Hydro sufficient to support a conclusion that the design comports with information now known or available to be known.

Alert Fatigue: Hydro clarified the methods used to categorize alarms and alerts that LIL operators have faced, but they remained through the first quarter of 2023 at levels that continue to warrant attention. General Electric is studying alarm sources and numbers, which may identify useful changes.

Muskrat Falls Generators: The generating units continued in the first quarter of 2023 to remain available for operation, with some restrictions for Units 1 and 2. Vibration issues observed as far back as September 2021 on Unit 2 constrain it to a fixed-blade operations mode, which limits its

load range to levels between 180 to 206MW. Hydro is reviewing a now completed root cause analysis of the Unit 2 vibration issue. There has, however, been no change to the anticipation that permanent corrective action will require full unit dismantling - - a significant undertaking. Planning and scheduling for the permanent solution remain pending.

Unit 1 experienced a first quarter 2023 forced outage due to a crack in the discharge ring flange. An earlier crack had occurred in the same area. A temporary remedy by Andritz permitted Unit 1 to return to service for 125 hours at a reduced power level 140MW, pending permanent repair expected by Hydro to be completed imminently.

Staffing, Training, and Procedures: Staff openings remain at minimum levels with only two positions not yet filled. Interviews are in progress for one with the other on hold pending a review of need to fill it. General Electric continues to provide contract support to the technical operators under a three-year contract whose term runs through late 2025.

Procedures and Training Implications of Recent Operating Events: Hydro continues to stress operator training focus on reviewing relevant training documents followed by a knowledge check by the appropriate supervisors. Some training does include practical applications designed to verify full operator understanding of the written material. A contract with General Electric provides for mentorship for operators and for review of alarm response circumstances and procedures. We have for some time addressed the question of supplementing these measures with drills and presentation of off-normal scenarios, having observed a number of earlier instances, added to in this quarter, where slow or inaccurate operator response and lack of a proactive approach to identifying risks has contributed to avoidable events, delayed response to others, or inhibited the ability to identify event causes.

We continue to believe that even Hydro's more experienced operators would benefit from being presented with desk-top drill or other challenge sessions that present circumstances requiring integrated equipment knowledge, involving multiple alarms, and combining the need to consult multiple data and support sources, including direct visual confirmation of condition configuration or condition. We acknowledge significant success in training completion, provision of mentoring, and the other work now being performed by General Electric, but continue not to see progress in this area.

Emergency Response Guidelines and Maintenance Manuals: Hydro has completed all emergency response guidelines. A contract with the Town of Holyrood provides for emergency response support in the event of a fire or medical emergency at Soldiers Pond.

Open Agreements: Expected in the near term since CF(L)Co Board May 2022 approval, the Multi-Party Pooling Agreement (MPPA) remains incomplete, with no apparent progress reported. With backward movement (new issues raised) occasionally reported in the past, it is not possible to assess where completion stands. Hydro now reports no schedule completion date for the 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 loomed as the next major testing milestone following successful completion of the LIL's 30-day Trial Operations period last fall. 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 should it fail. Following an unsuccessful overload test in November 2022, General Electric corrected the software, subjected it to Factory Acceptance Testing, and released a revised software version (Version 1.1.37e) to the site March 24, 2023. A successful repeat of the 700MW test on April 8, 2023 and completion of dynamic commissioning led to initiation of the steps necessary to establish a formal in-service date. Those steps included issuance to the Newfoundland Labrador System Operator (NLSO) of "Release for Service Certificate," endorsement by the NLSO of release into "Commercial Operation" and a "Commissioning Certificate" signed by the Canadian independent engineer.

Hydro has stated that final commissioning left a number of software correction issues for GE to address, none of them reportedly critical to LIL operation. Four issues have arisen since the 700MW test, three of them related to monitoring and one associated with a protection issue that causes an alarm to continue toggling. Hydro reports these issues as having no material operations impact either.

Information from the last quarter of 2022 showed a Pole 1 transfer of 450MW for one hour on September 2, 2022 and 12 hours on November 16, 2022 and a Pole 2 transfer of 450MW for one hour on September 1, 2022 and 12 hours on November 17, 2022. Bipole transfer of 700MW occurred on November 24, 2022 for one hour. Hydro continued to report for the first quarter of 2023 LIL operation transfers of up to 700MW in bipole mode, with operation at levels sufficient to establish full control functionality. Heat run tests included operation of each pole at 675MW (1.5pu) for 12 hours, sufficient according to Hydro to validate their maximum continuous ratings.

As anticipated previously, the LIL has reached this status without operating at its fully designed 900MW capacity in normal operations or while providing required overload support for a pole failure at that level. Hydro's willingness to declare the LIL in commercial operation relies in part on its conviction that overload performance demonstrated by recent testing at 700MW fully supports the conclusion that it will do so at 900MW.

We understand that logic at a nominal level. Nevertheless, LIL history teaches that more confidence in that conclusion will come under actual operation at 900MW, which will not occur until cold weather brings higher system loads. Operation at 900MW will more fully exercise LIL control systems that act to ensure stable interaction, for example, those that impact AC voltage stability, frequency and bus phase angle.

As reported previously, the LIL warranty period has less than two years to run. General Electric also has a responsibility for addressing certain LIL performance issues that may arise during its early commercial operations period under a Performance Guarantee Assessment Period. Hydro expects that period to commence in September 2023, and it has a minimum duration of three years. The period can extend for as much as another three years based the issues that may arise during the first three years. To the extent that certain performance targets are not met, General Electric and Hydro will use jointly performed annual appraisals of reliability performance to determine whether any design deficiency has contributed to a failure to meet them. Applicable performance metrics include:

- Pole Forced Outage Rate ≤ 5.0 per pole per year
- Bipole Forced Outage Rate ≤ 0.1 per bipole per year
- Forced Energy Unavailability $\leq 0.50\%$
- Scheduled Energy Unavailability $\leq 1\%$

2. LIL Performance During the Quarter

Hydro reported seven first quarter 2023 LIL trips (one a bipole trip) associated with issues involving the Direct Current Current Transformers (DCCTs) issues that control systems use. Failures of the DCCTs to act as required appear to have arisen from a number of sources, which included software issues, noisy signals and inaccurate performance at extremely low ambient temperatures. HVDC systems have employed DCCTS for over 30 years. They typically prove highly accurate, very fast responding, and very reliable. It is not clear why this surprising number of problems have occurred with General Electric-supplied devices. Normally, supply from an experienced provider, adequate specifications, and comprehensive testing prove successful in avoiding problems like those experienced here. General Electric has employed short-term mitigation measures while it investigates a permanent solution. The circumstances reflect a growing set of performance area concerns, adding to those from areas like LIL operating software and synchronous condenser performance. Hydro thus faces added challenges from them, which here include full rectification or replacements from another supplier and ensuring that resulting performance guarantees are sufficient.

3. Follow-up on Earlier Overhead Line Issues

We continued to follow efforts to examine causes and identify solutions to issues addressed in earlier reports, given concerns about the implications of the large number of weather-related overhead line incidents that have already occurred involving the LIL directly, or potentially indirectly. Our last report described Hydro’s intent to undertake what we understood to be comprehensive examinations of failure sources and searches for any causes or conditions with implications for other line locations. Hydro reports nearing completion on four failure investigations involving recent winter overhead line events, with plans to complete them in September 2023 (just recently delayed from the prior, June 2023 schedule). Hydro offers these investigations as responsive to the question of determining whether the events indicate “systemic any conditions from a LIL design or material perspective.”

These reports thus appear to have material significance in assessing LIL reliability in the context of the pending Board review of long term resource adequacy. Below we summarize recent

advances in Hydro's detailed examination of some of the recent transmission system events caused by or potentially affected by LIL operation.

September 2022 Ground Switch Failure: Hydro disclosed in its monthly LIL update for September a ground switch failure. It appears that a failure to maintain the ground switch effectively caused the failure. LIL equipment has remained longer than expected under General Electric control, placing in question whether that failure may extend to other areas. Verification by Hydro of robust performance of required and expected maintenance should, if it has not already happened, be performed in the coming months.

September 28, 2022 High Frequency Event: Hydro has confirmed that the event resulted from an excess of system generation that produced a sustained period of higher frequency. The LIL's contribution to circumstances resulted from its required minimum loading of 90 MW in bipole operation at the time. The lessons learned from this event have led management to reinforce the need for diligence in monitoring and where necessary acting outside prescribed generation guidelines where necessary to keep frequency within acceptable limits. Hydro has reported that it had not encountered the circumstances involved earlier.

November 14, 2022 Underfrequency Load Shedding Event: Hydro confirmed that the LIL made no contribution to our previously reported UFLS event in Newfoundland. A now-available Emera incident report confirms event origination from a faulty Maritime Link tap changer temperature transducer. Emera has reportedly put temporary measures in place, plans several permanent actions to be completed this year, and is reviewing a detailed root cause analysis report.

December 2022 Northern Peninsula Line Damage: Hydro has reported turnbuckle failure as the source of the trip previously reported, with damage similar to that found in connection with a 2021 event in southern Labrador. Hydro has observed galloping at various Labrador south coast and Long Range Mountains line locations since 2017 during construction, line patrols, and maintenance and repair activities. Hydro's now completed failure investigation showed excessive movement on the failed turnbuckles from both events, making galloping the likely cause. Corrective actions now under internal evaluation consist of selective installation of galloping mitigation devices (at a cost in the range of \$100,000 per span affected) or alternate turnbuckle hardware. Actions under evaluation also include monitoring to identify other locations for the existence of galloping. Hydro has examined the lines whole length to identify more likely galloping locations. Regular line inspections will look for indications of galloping. The ability to observe galloping conditions real time is constrained by weather circumstances that preclude on-site presence in conditions that create the greatest potential for galloping to occur. Hydro anticipates a report reflecting final engineering review of the failure investigation results and decisions on recommended actions in September 2023.

December 21, 2022 Sequential Pole Trip: Hydro reported that it has not employed LIL voltage reduction in anticipation of extreme weather events and that conductor heating analysis has only marginal conductor temperature change from reducing voltage. Moreover, while original LIL design included Loop Power, analysis showing that it would have minimal benefit in icing prevention caused removal of that feature.

December 24, 2022 Loss of its Hydro Quebec 735kV transmission Corridor: Hydro Quebec's loss of its corridor south of Arnaud Station created voltage issues that caused total loss of the Happy Valley system. Hydro had underway an investigation seeking to verify event causes and assess Hydro system changes to mitigate any future impacts. Hydro has indicated that LIL equipment at Muskrat Falls tripped due to high DC voltage on an internal 600V auxiliary power bus supply in the valve cooling system. This determination produced concern about the coordination between the internal DC bus connected equipment specifications and protection levels. Large changes in real and reactive power flow that can occur, make high AC bus voltages during network disturbances a predictable consequence. The issue experienced should not occur, making a review of 600V bus and the valve cooling equipment in order.

b. Electrode Sites

Scheduled work start of June 2023 brings completion of the L'Anse au Diable project closer to the onset of winter, with a resulting risk of delay. Hydro cited a number of factors affecting work start, including design work (begun in 2023) completion, and the extension of Labrador winter conditions in to June for this project, which involves seaside work.

Hydro has reported completion of the outside review of the other site involved, the Dowden's Point Grounding Station. That report does not appear to have fully considered now known and knowable site conditions that the seaside location may face, with Hydro stating the consultant's belief regarding the original design as follows:

the design was adequate in comparison to the knowable design parameters at the time of design and still with acceptable factors of safety.

Hydro has also reported that analysis has accounted for a sea level rise of one meter, and circumstances at this location are more favorable than those at the L'Anse au Diable, and that the fact that degradation in protection will occur over time will permit monitoring to identify any emerging needs for correction. Hydro has also stated that the consultant does not consider changes warranted at the present time. Asked specifically to provide its confidence level that the facility will prove sufficient to address potential wave and weather conditions across its expected life, Hydro did not answer directly, stating that:

Hydro accepts the conclusions from the ... report with respect to the Dowden's Point original design and will continue to monitor the locations during operations.

Consequently, it is not clear that the consultant's review did consider information now known and knowable, as opposed to those forming the basis for the initial design. Decisions about the facility should be based on current information. We have seen no information to suggest that design of the site that did suffer damage shortly into operation failed to consider and apply a suitable margin based on what was known at the time of its design. Moreover, monitoring did not prevent the significant damage that occurred there. As our last quarterly report described, Hydro needs to decide what to do at Dowden's Point using a forward looking study, not one overly dependent on retrospective analysis of decisions made in designing and installing the facility. That Hydro has declined to express a reasonably high level of confidence in the ability of the facility to withstand

forces that Hydro has described as considerable underscores the importance of ensuring a fully robust analysis of the facility in light of what is now known and knowable.

c. Alert Fatigue

The number of unique alarms appears to be trending down each month for the quarter, however, alarm repetitions appear high. March 2023 brought 456 “unique” alarms. Counting repetitions the total monthly number of 4,560 represented over 6 per hour. April 2023 unique alarms fell to 296, but counting repetition, totaled a still high 3,062. Repetitions still require operator recognition, even if not response, making them factors in assessing both alarm “fatigue” and attention diversion. Large numbers combined with repetition (on average 10 times here) are factors that tend to degrade alarm recognition and response. Moreover, the degree of repetition may indicate as well more substantive issues; *e.g.*, the underlying conditions generating them or the effectiveness in clearing them.

Either way, work in which General Electric is now engaged with respect to examining and analyzing alarms is clearly timely. Moreover, continuing declines in alarm numbers lends support to the possibility that diminishing software problems will reduce them further. A total of several thousand alarms for a given month still appears to be a large amount of alarms. The fact that unique alarms keep repeating themselves is also concerning. A robust examination by General Electric and follow-up by Hydro will be important in ensuring that signals do not present a longer-term source of alarm fatigue, that they continue to support prompt operator recognition of and reaction to them, and that they do not reflect substantive underlying issues or concerns.

d. Synchronous Condensers

All three synchronous condensers are in operation, but the first quarter of 2023 brought disruption due to a breaker performance issue on SC3. Subsequent investigation revealed ice formation interfered with the breaker performance for the unit. There was significant water accumulation and subsequent ice formation found in the breaker operating arm linkage for each pole. This ice formation interfered with the breaker operation. The source of the water intrusion has not been definitively determined; however, General Electric has recommended corrective actions to prevent the issue in the future. A permanent fix is under study at this time. The water in the breaker cabinet was removed and the enclosure was cleaned.

Progress has occurred on another issue addressed in our last quarterly report - - a synchronous condenser December 2022 high pressure lift oil pump failure. General Electric has determined that the failures resulted from an increase in oil viscosity as machine-hall temperatures remained below design levels. Cold ambient temperatures in the hall caused a vacuum at the pump suction, which led to a loss of lubrication and metal-to-metal contact at pump port plates and pump rotor sides. Corrective actions implemented include ensuring machine-hall air handling unit functionality and installation of a portable heater.

All three units are now in operation, but large project and continuing concerns remain with respect to two fairly long standing issues - - bearing tilt and the foundation-caused vibration.

The bearing replacement to correct the damage as a result of the bearing tilt issue for Unit 1 is now complete. Comprehensive testing after bearing replacement established suitability for

returning the unit to service, with a permanent solution under development. General Electric continues to monitor data for all three units. In addition, Hydro now has the ability to measure the bearing tilt on SC1 as a result of installing additional proximity probes on this unit.

A complete bearing re-design remains the long term corrective action to resolve the bearing tilt issue. General Electric has submitted a preliminary specification for a portion of the redesign required. It remains at Hydro for review and comment. Hydro has reported an expectation that the complete re-design effort will take about 12 months to complete, but no firm schedule yet exists for re-design and subsequent repair. The permanent correction appears destined to comprise a major effort. Hydro reports its retention of an outside consultant to review General Electric's re-design process. Hydro also reports the soliciting of proposals from consultants with expertise in the design of large rotating equipment to aid in the review. General Electric has recommended a comprehensive set of mitigating actions to guide operations pending execution of the permanent solution. Our last quarterly report describes these actions, which Hydro has implemented.

The second longer term synchronous condenser issue, foundation caused vibration also continues without resolution. Base vibration measurements expanded more than a year ago to monitor foundation induced vibrations post installation of the elliptical bearings, continue to show levels within ISO 20816-5 specifications. Nevertheless, solutions in place now mitigate vibration levels without addressing the cause of elevated levels. Hydro correctly considers appropriate a continuing review and analysis of long term operability and reliability of the machines. Hydro has secured a third party consultant to gather enhanced vibration data on a quarterly basis for analysis. The consultant completed the first field data collection during the week of April 24 ,2023, with a report anticipated imminently.

We see Hydro's engagement on and use of outside expertise on a continuing basis as important under the circumstances; it adds an important level of review. The synchronous condensers, among problems of lesser magnitude, have now encountered two major sources of operating conditions that not only require correction, but involve the need for extended operation under temporary "fixes" and possible implications for long-term degradation of the units in ways or at rates not expected. The units continue to face consequence of longer term issues and to experience newly emerging ones. Significant uncertainties surround the ability to count on their performance at levels expected.

As LCP assets move well into their commercial operations period, it becomes important to set regular measures for gauging their performance. Many utilities that operate HVDC links provide annual performance reporting to CIGRE (an international agency based in Paris). The LCP synchronous condensers classify as AC and Auxiliary Equipment under that reporting system. Performance measures reported include number of Forced Outages (each year) and the Equivalent Outage Duration (adjusted for the output at the time of the outage). The second measure corresponds to the DAFOR performance measure used for generating plants. These two measures lie among those appropriate for Hydro to consider as it continues development of comprehensive set of metrics for LCP assets.

e. Muskrat Falls Generators

Units 3 and 4 remained available for normal operation during the quarter. Unit 2, however, remained in a fixed blade mode of operation due to vibration and Unit 1 experienced a crack that shut it down for review and temporary repair.

Unit 1 remained limited to an operating range of 180 to 206MW, following the previously reported vibration issue that caused multiple trips of this unit. The manufacturer has completed and submitted to Hydro a root cause analysis for review. The report of this analysis noted an increase in vibration during a closing motion of runner blades while reducing unit power output. One runner blade was out of synchronization with the others. A 2022 annual maintenance evolution revealed that a pin retaining ring on the blade mechanism failed, allowing movement of the pin to produce contact with the internals of the runner hub causing that blade to fall out of synchronization. Damage to five retaining rings resulted.

Analysis showed that three of the five rings failed due to suspected hydrogen embrittlement (deterioration of metal structural properties due to the presence of hydrogen in the metal). The other two rings failed from contact of the runner linkage with the runner hub. Embrittlement of metal under stress can eventually lead to cracks in the metal structure.

Hydro has stated that it cannot identify how hydrogen got introduced in the metal, but noted that it could have come during manufacturing process, site storage, assembly, or operation. The resulting uncertainty has implications for the existence of the phenomenon at the other three generating units, which Hydro considers possible. Replacement of all the retaining rings comprises the recommended final corrective action. Replacement will require a full unit dismantling, which have not yet undergone planning and scheduling. In the meantime, vibration monitoring at those units will seek to identify vibration signatures similar to those that affected Unit 1, which will not prevent damage, but identify it as soon as possible as damaging circumstances approach or after damage has occurred.

Until full resolution of the hydrogen embrittlement issue identified on the Unit 2 retaining rings, it remains prudent to consider the potential for material challenges to the short- term operation and longer-term accelerated degradation of all the Muskrat Falls units. Hydro is for the present actively engaged in ensuring full study and identification of remediation potentially found to be required.

A new performance issue involving Units 1 and 3 arose in the first quarter of 2023. A forced outage took the unit off line on March 21, 2023, due to a discharge ring flange crack that occurred in the same area as a previously discovered crack. Actions to address the prior event include installation of a crack arrestor to prevent further propagation. Following discovery of the second crack, the manufacturer implemented a temporary fix to allow Unit 1 to return to service for 125 hours at a power output below 140MW until permanent repair completion. Discharge ring flange cracking resulted from increased stress levels associated with welds used to retain locating pins used to facilitate unit assembly during manufacturing. Repairs at Unit 1, now completed, included removing or repairing cracks and removing areas causing stress concentration. Plans call for similar Unit 3 repairs during its next planned maintenance outage.

One other operational generating issue has arisen as well. Unit 3 tripped during routine synchronization evolution. Following unit shutdown, investigation found damage to resistors and cabling. Replacement of the damage equipment and subsequent post maintenance testing have been completed. The incident led to the discovery that equipment presumably in continuous use to record and trend data had not been operating, thus precluding determination of underlying causes of the damage observed. The manufacturer has characterized the failure as having low probability and therefore unlikely to pose risk for the other units. Installation of a transient data trend recorder allows for data analysis in the event of issue recurrence.

We found surprising operation, apparently for a multi-month period, without knowing that a system designed to record material operating data was not functioning properly. It would appear that proper diligence with respect to such a system necessarily includes verification that it is operating correctly. It is also not clear how confidence in the lack of risk to the other units can be high given the lack of helpful data that would presumably have been available had the system been operating. At a minimum, greater diligence in ensuring operability of such systems appears to be in order. That this incident comes in the same time period as the failure to observe threatening machine hall temperatures underscores the need for attention to matters great and small.

f. Close-Out of Transitioned TTO Work Activities

Our report for the last quarter identified that 11 tasks transferred by TTO to Hydro in December 2021 remained open. That number dropped to 5 open items at the time of this report. Hydro plans completion of all remaining open items by the third quarter of 2023.

1. Staffing, Training, and Procedures

The two vacancies reported involve the same stores positions reported for the last quarter. Interviews are underway for the Muskrat Falls open position, with the Soldiers Pond position still 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 support under the General Electric contract started on November, 28 2022.

2. Procedures and Training Implications of LIL Events

Liberty inquired about the extent to which Hydro's training and measurement of training effectiveness includes drills, exercises, or scenarios to which operators may be required to respond. Hydro indicated that it follows participation in modules and offerings to train operators on each system with supervisor follow-up. A set of questions ensures that operators understand key training elements. Hydro has also reported an ongoing General Electric reviews of alarms that may require operator response under both under normal and less common circumstances. This review will support prioritization of alarm types and development of operating instructions to support effective indicator recognition by operators and appropriate response.

Without criticizing the need for focus on training, success in imparting knowledge, operating procedures, and alarm recognition and response, however, we continue to observe operator responses to live circumstances that appear to call for something more. The recent instances of machine hall ambient temperature drop and unawareness of the failure of a data monitoring system to function across an extended period of time add to a list of previous instances in which faster or

more accurate response to live circumstances may have changed results. What these occasions have in common is their implications for the degree to which Hydro has emphasized operator ability either to synthesize the full body of information to act quickly and effectively or to demonstrate awareness of threatening conditions that may lie under the “radar” that normal observation or reliance on the absence of clearly threatening or adverse circumstances can produce.

Hydro continues to lack use of desk top drilling or challenge sessions to broaden operator view of risks, of proactive means to identify and address them, and of the full range of data sources (sometimes including “eyes on” physical configurations and conditions in some cases) needed to process quickly). That lack continues for us to represent an issue that should be addressed.

3. Emergency Response Guidelines and Maintenance Manuals

Implementing emergency response plans continues to rely on-site personnel supplemented with a contract with the town of Holyrood to provide support at Soldiers Pond in the event of a fire or medical emergency. That five-year contract has a renewal date of September 2024.

4. Open Agreements

Hydro continued to report the MPPA between NLSO and CF(L)Co remained unfinished despite open items limited to the same, Emera-proposed “small change” we included in our last report. The MPPA has a projected completion date sometime in the third quarter of this year. With execution of Interconnection Agreement (IOA) contingent on MPPA, the former also remains open. Monitoring efforts this quarter disclosed that Emera now reportedly has lost interest in the Regulation Service Agreement due to the rate structure included. Hydro has reported that LIL and ML operation do not require the execution of this agreement.

Our last report noted no anticipated completion date for the Andritz O&M Services Agreement. This quarter saw the parties reach agreement on the agreement, which now awaits completion of legal review and approval by Hydro. Management reports imminent completion of the agreement.

5. Muskrat Falls and Transmission Asset Performance Indicators

With LCP assets moving to commercial operation, establishment of ongoing metrics for measuring and benchmarking their performance become relevant. Hydro cited the use of outage metrics such as total numbers of outages per component, component outage frequency, total outage time and component unavailability for the transmission assets. Hydro cited plans to track performance of the HVdc assets following the second quarter of 2023. Hydro has reported that its measurement of transmission asset performance for 2023 places them in line with expectations for newly commissioned assets. The synchronous condenser units have experienced the highest unavailability percentages for this period - - 16.57 percent for Unit 1, 4.15 percent for Unit 2, and 29.68 percent for Unit 3. Unavailability rates for all other transmission assets fell below 3 percent.

Hydro collects Muskrat Falls performance data under Electricity Canada guidelines, consistent with how it measures the performance of its other hydro assets. Hydro tracks Derated-Adjusted Forced Outage Rate (DAFOR) and Capability Factor (CbF), providing measures for each unit and a capacity weighted plant total. Hydro benchmarks performance using Electric Canada averages.