MEETINGS IN ST. JOHN'S AND VISITS TO LOWER CHURCHILL PROJECT SITES JUNE 13 TO 17, 2022

Prepared for: Natural Resources Canada and Nalcor Energy

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Quality Assurance Statement

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1. GENERAL

The Independent Engineer (IE) team visited Muskrat Falls Generating Station as well as the Soldiers Pond Station and attended project meetings in St. John's between June 14 and 16, 2022. Nalcor senior management and technical specialists as well as NRCan and NL government representatives participated both in person and by Webex. The purpose of the meetings was a Lower Churchill Project update for the IE and Governments representatives.

IE team: Nik Argirov (IE Team Lead)
Vlad Kahle (IE Electrical SME)
Hamdy Khalil (IE Transmission SME)
Tim Little (IE Geotechnical SME)

Nalcor Meetings and Site Visit Coordinator: Ms. Rosanne Williams

Trip itinerary:

June 13:

- Arrive and overnight in St John's

June 14:

- SOP Converter Station and Synchronous Condenser Building visit
- C3 Project Update
- Synchronous Condensers and LIL Commissioning Update
- E- Stop Update

June 15:

- Muskrat Falls Tour and Dam Safety Program Review

June 16:

- Commissioning Related Matters
- Commissioning/ Completion Certificates/ Punch List
- TL Operations Update
- ML Operations Update
- Wrap- up

2. SOP SITE VISIT AND TECHNICAL MEETING– JUNE 14, 2022

2.1 SOP CONVERTER AND SC BUILDINGS VISIT

- The site construction, clean-up, and synchronous condensers commissioning are complete.
- Converter software FAT is complete.
- SC1 elliptical bearing has been replaced and the synchronous condenser is scheduled for the first rotation.
- SC2 and SC3 synchronous condensers are operational and being monitored.
- Source of vibrations has not yet been determined. Axial and radial vibrations are monitored; GE proposes to introduce time delay to prevent spurious trips from the vibration detector(s). GE also advanced a theory that those trips may be caused by switching noises, without specifying the source of the noise. LCP has not accepted this noise theory yet. Solution to vibration problems is pending.

2.2 C3 PROJECT UPDATE

- Site Safety Program has now been rolled into the corporate tracking system.
- SOP SC2 and SC3 are operating and GE is reviewing the temperature and vibration data. Contamination was found in the glycol cooling system.
- SC1 reassembly is complete and the return to service is expected in July 2022. Glycol cooling system has to be flushed prior to return to service. The new elliptical bearing is tilting, and the titling has been attributed to low viscosity of lubricating oil. This is a GE theory not accepted by LCP at this time. To achieve increase in its viscosity, the technicians will attempt to provide additional oil cooling prior to returning the unit to service.
- LIL operated during most of the month of May. One DCCT has failed.
- LIL testing at high power is outstanding. At this time 700MW test may not be achievable due to system power transfer limit of 475MW. Discussion of heat run centered on GE's contractual obligation to test the system to the 'available power'.
- GE is about to commence with the converter Dynamic Commissioning tests. IE requested the testing schedule and list of the planned tests. The information was provided during the visit.

2.3 E- STOP

- IE comments on 'Basis of Design Document' were agreed to in principle by Nalcor.
- SNC Lavalin completed preliminary design in Q2 2022. IE requested courtesy copies of the final design drawings.
- Nalcor plans to modify the E- stop scheme in commercially reasonable time period. Unit 1 is to be completed in Oct./ Nov. 2022.
- The remaining units are to be done in 2023. The schedule may slip, and it may not be possible to carry out the required modifications within the one-year Punch List completion period.
- Andritz did not agree to this schedule yet. Potential impact on the equipment warranty precludes engaging another contractor for this work.
- In the interim period the current design will remain in service as is. Responsibility for the E- stop scheme performance rests with the engineer of record who initially approved it.

3. MUSKRAT FALLS PROJECT SITE – JUNE 15, 2022

3.1 DAM SAFETY

- Dam safety aspects were discussed with Operations Dam Safety staff during the site visit, which included a visit to the North Spur. Ongoing dam safety surveillance continues with regular visual inspections and monitoring of instruments that measure piezometric pressures, seepage flows, displacements, and seismic shaking. The surveillance frequencies are consistent with those shown in the Muskrat Falls Dam Safety Instrumentation Operations Manual dated July 30, 2020. Dam safety monitoring observations and recorded instrumentation data continue to be reported in Dam Safety Weekly Monitoring Reports.

- No dam safety concerns, and no anomalous or unusual conditions have been identified since reservoir filling. Dam Safety staff advised that a comprehensive review of post-filling dam safety performance is currently being carried out and will be presented in a report later this year.
- Most dam safety instruments in the dams and their foundations have continued to show stable conditions with some small cyclic trends that appear to be related to seasonal temperature variations. Seepage flows in the dam drainage galleries remain very low. Thermistors in the North Dam indicate that the roller compacted concrete dam has continued to cool, and the temperature in the centre of the dam is now approaching a stable level.
- At the North Spur, visual observations indicate that there have been no significant changes to the slopes on the upstream and downstream sides since the previous IE site visit in November 2021. Small vegetation and brush continue to become more established in local areas, but areas of the slopes that are steeper and more exposed to wind erosion remain mostly bare. The riprap along the upstream and downstream shorelines remains stable.
- Instrumentation in the North Spur continues to indicate generally stable conditions. A few piezometers in the intermediate aquifer continue to show slowly increasing levels that are interpreted to reflect long term response of groundwater levels both to reservoir impoundment in September 2019, and to the shutdown of pump wells in February 2019. A flow meter that monitors Kettle Lake outflows was reported to have been repaired and recently reinstalled after an extended out-of-service period.
- The dam safety monitoring reports note that road access to the North Spur is not maintained during winter, and that the inclinometers, which are read manually, are not read during that period. The IE suggests that consideration be given to reducing the number of inclinometer readings during the summer season and carrying out at least one set of readings during the winter season.

3.2 POWERHOUSE TOUR

- IE viewed Intake gates MCC's and PLC controller panels. Both will be subject to E- stop revisions.
- Discussions were held with the shift operator in the Control Room. Stations Service Load Management System and black start on select units were apparently tested. *Post visit note: LCP confirmed that the ATS/LMS has been commissioned.*
- Minor display anomalies on Unit Control Board HMI's were communicated to the shift operator.
- Generator and turbine floor are both clear of tools, spares, and construction equipment.
- Along the upstream wall of the turbine floor between units 1 and 2, it was observed that minor seepage from hairline cracks in the concrete is depositing what appears to be calcareous material on the lower wall and the floor. Such seepage is not unusual in hydro facilities but can be a nuisance issue. The calcareous deposits may eventually self-seal the cracks; alternatively epoxy or chemical grout could potentially be injected into the cracks.
- Site staff reported that reservoir debris management has not been an issue to date. At the time of the IE site visit, there was a small number of woody debris pieces floating above the power intake trash racks and minimal debris deposited along the upstream side of the North Spur.
- The safety boom was installed across the reservoir upstream of the dam on June 14.

3.3 GIS BUILDING

- Over the past 2 years three Voltage Transformers (VT's) failures occurred in CF and MF GIS buildings. The failures do not follow any particular pattern, so this issue has been addressed by keeping one spare VT on site.
- Time to replace failed VT will apparently be contingent on the availability of GE technicians.

4. COMMISSIONING AND O&M MEETING – JUNE 16, 2022

4.1 COMMISSIONING/ COMPLETION CERTIFICATE/ PUNCH LISTS

- The balance of completion certificates as well operating and maintenance manuals need to be submitted to IE, when available. Availability of documents is pending.
- Conditions precedent to commissioning as outlined in the LIL Project Finance Agreement dated May 10, 2017are to be completed.

- Issuance of Commissioning Certificate (Section 4.2 below provides additional details).

4.2 DYNAMIC COMMISSIONING

- New Software (Revision 1.1.35) will be tested at 450MW and above, including loss of 1 pole and overload tests. Testing up to 700MW and 900MW will be carried out later, contingent on the grid conditions:

  Potential schedule (June 2022)

  - Level 1- up to 450MW (June 14th and 29th)
  - Level 2- 450MW to 675MW (late June 2022)
  - Level 3- 675MW to 900MW (grid conditions permitting in late fall)

- Dynamic Commissioning results will permit assessment of link reliability when operating with the Revision 1.1.35 of control and protection software.
- It is understood that contractually GE is required to test the link to the 'available power'.
- Due to current grid conditions, Level 2 commissioning will be performed at lower power level (max of 475MW). Successful completion of this Level 2 commissioning (including heat run test at monopole mode up to 475MW) will be followed by commencement of the Trial Operations period. According to NL Hydro and Newfoundland and Labrador System Operator (NSLO) it is highly unlikely that higher than tested (475MW) power level will be needed during Trial Operations, which could occur during the summer season. High Power testing (above 475MW) is likely to occur in the fall of 2022. Nevertheless, the IE recommends that operational restrictions be put in place that will limit the maximum power level to the tested power level achieved. In the very unlikely situation of higher (above 475MW level) power demand, the IE recommends that equipment temperatures be monitored for the specified times in accordance with the heat run testing procedures. The order should also be executed with a slow ramping rate in monopole mode.
- High power (Level 3) testing, which will trigger issuance of the Commissioning Certificate and NLSO acceptance, cannot be completed until the island grid conditions are suitable which will likely be during fall 2022. If the available load would be less than 900MW, equipment heat runs will not be conducted at the full nameplate and overload power.
- Operational requirements and basis of design for 900MW capability and short term/ long term overloads of LIL HVDC were derived at and justified through due planning process. Verification of the HVDC equipment and control systems capability at 900MW is required to satisfy good utility practice. High power (Level 3) testing at lower power levels due to grid limitations may permit issuance of the IE Confirmation of Commissioning Certificate for the actual power achieved. In such case formal operational restriction limiting the load to the tested level should be placed on the LIL HVDC.

4.3 CF AND MF LTA MAINTENANCE UPDATE

- Major punch items include spurious alarms, Low Voltage Spark Gap CT (LV SG CT) replacement and firmware.
- Major warranty claims include alarms, battery monitoring, SF6 leaks in GIS buildings, GIS VT failure (see above), 735kV VT failure and air handling unit malfunction.

4.4 TRANSMISSION LINE MAINTENANCE

- Planned Maintenance Activities include:

  - Routine quarterly aerial patrols.
  - Extreme weather patrols.
  - Climbing and ground inspections: inspections every 10 years. i.e., 10% of the inspections will be completed each year.
  - Guy wire tension verification (every 10 years).
  - Bring all guy wires on the Labrador section of the LIL into the specified tension during 2023 using external contractor.

- Completed Maintenance:
  - As-built LiDAR survey of entire HVDC line was completed in 2020/ 2021.
  - Construction drawings for the HVDC line were updated with 'construction' records.

- Vibration damper failures attributed to manufacturing defects were occurring since 2017. Spiral dampers were installed in the affected areas.
- Real time weather station is being installed to monitor conditions during extreme weather.
- Repairs were completed on OPGW, corona rings, dampers, and electrode line. Fewer insulator and corona ring failures were experienced than in the past 2 years.
- Some OPGW pulled through connection due to freezing rain. To be corrected in Q2 2022.
- Conductors at L'Anse- au- Diable in Labrador were damaged by galloping "wave action". Galloping study is in progress for the NL site.

4.5 OPERATIONS UPDATE

- MF is in full operation since Q3 2021.
- Safety targets and environmental milestones were met with no reportable incidents in 2021.
- Performance of the equipment was as expected during a post- commissioning period with the exception of U2.
- U2 vibration problems Will be investigated by Andritz during the maintenance outage. Resolution time TBD.
- Units unplanned trips were:
  - U2 turbine bearing Low- Low Oil that was attributed to low temperature. Time delay will be added.
  - U2 vibration investigation did not yet produce conclusive results. Andritz plans to drop the turbine cone for visual inspection.
  - U3 testing of a watchdog relay resulted in the unit trip.
  - U4 brakes were inadvertently applied at higher speed level. There was no damage to the equipment and the unit was placed back in operation in less than an hour. The cause has not yet been determined.
- Insurance Items: PH concrete, spillway guides, spillway heater tubes all agreed to settle.
- Outstanding Warranty Items: U1(7), U2 (7), U3 (3), U4 (2) and Balance of Plant (2).
- Maintenance Activities- Units
  - Maintenance contract remains in force.
  - 102 out of 110 activities were completed.
  - Besides U2 vibrations there were no major operational issues.
  - Scheduled maintenance outages of 7 to 9 weeks are planned for all 4 units.
  - Efficiency testing will follow the preventive maintenance program. IE requested description of those tests. (See Note 1)
- Maintenance Activities- Balance of Plant
  - No major maintenance was done in 2021.
  - Hydro- mechanical systems did not experience any significant issues.
  - Trash racks were inspected by an ROV.
  - Development of civil structure preventive maintenance program will commence in Q2 2022.
  - Dam Safety department from CF will manage the preventive maintenance inspections of the dams and the North Spur, with maintenance to be carried out by MF Operations. Assignment of those responsibilities will be reviewed in the future.
  - Punch list items were prioritized and included in 2022 annual work plan. Of the 40 items, 13 will be addressed by NL Hydro, 24 by Andritz and 3 by ABB/ HG.

4.6 IE ITEMS

- MF Station Service Tests
  - Manual black start of U4 was tested in Nov. 2021. Specifically, Emergency diesel was started in manual and station service was manually switched off.
  - Load Management System was tested in Q1 2022. Following that, automatic transfer switching for U3/ U4 and U1/ U2 was tested separately.
  - Black start operational testing (in auto mode) was done on U3 only.

- IE and Operations agree that in consideration of their importance, full operational tests of the black start sequences should be carried out on the remaining units. *Post visit note: IE was advised that this will be scheduled by Operations as part of their maintenance plan when resources are available and when suitable power system conditions permit.*
- Discussions were held on forced outage reporting. IE requested to be given technical details on all outages that impact reliability of the transmission grid or have tangible financial consequences. (See Note 1)

5. FOLLOW UP ITEMS

5.1 SOP SYNCHRONOUS CONDENSRS

- Vibration issues are yet to be satisfactorily resolved. IE suggests that while the switching surges are a real phenomena, those typically do not affect instruments powered from 125 VDC. More information is requested on the type and configuration of vibration trip detectors.
- Solution to SC1 elliptical bearing tilting is pending.

5.2 C3 ROJECT

- LIL testing at high power is outstanding. (The relevant IE position is outlined under Section 4.2 Dynamic Commissioning).

5.3 E- STOP

- IE requests courtesy copies of the final design drawings.

5.4 OPERATIONS UPDATE

- U2 vibration investigation did not yet produce conclusive results. IE requests updates on the ongoing investigation.
- The cause of U4 brakes spurious operation has not yet been determined. IE requests updates on the ongoing investigation.

5.5 DYNAMIC COMMISSINING

- IE requests the testing schedule and list of the planned Dynamic Commissioning tests(Provided during the visit).

5.6 IE ITEMS

- Black start operational testing (in auto mode) was done on the U3 only. In IE's opinion the tests should be carried out on the remaining units as well. LCP to advise if such those tests are planned. *Post visit note: See post visit note under Section 4.6.*
- IE requests outage reports on disturbances that affect reliability of the grid or have a potential fiscal impact. This requires establishing organizational responsibility and reporting protocol. (See Note 1)
- IE requests a copy of the report on post-filling dam safety performance when it is available.

Note 1: LCP advised (post visit) that this information will be included in the quarterly reports.

APPENDIX - SITE PHOTOGRAPHS

Photo 1: Cooling fins recently added to lubricating oil lines on synchronous condenser, Soldiers Pond.

Photo 2: Muskrat Falls power intake deck and spillway with small number of woody debris pieces in front of intakes.

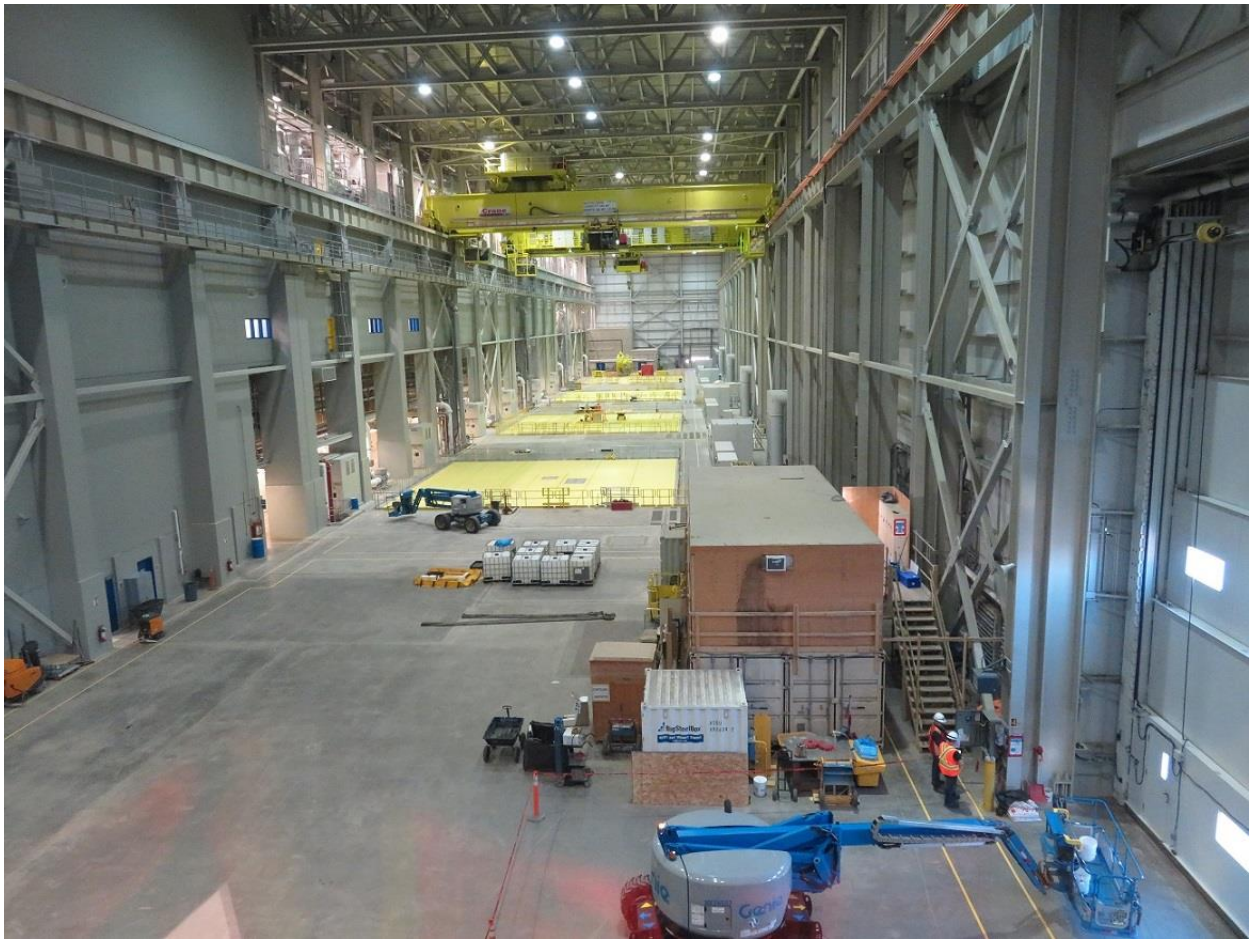

Photo 3: Muskrat Falls powerhouse generator floor viewed from control room.

Photo 4: Calcareous material deposited below hairline crack on upstream wall of turbine floor between Units 1 & 2.

Photos 5 & 6: Upstream side of North Spur looking northerly (left photo) and southerly (right photo).

Photo 7: Downstream side of North Spur showing vegetation cover becoming established in sheltered areas.