MEETINGS IN ST. JOHN'S AND VISITS TO LOWER CHURCHILL PROJECT SITES, JULY 23 TO 28, 2017

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 attended project briefings at the Lower Churchill Project Delivery Office in St. John's on July 24, 27 and 28, 2017 and visited Muskrat Falls, Churchill Falls and Soldiers Pond construction sites between July 25 and 27, 2017. Joseph Krupski from Natural Resources Canada and Paul Carter from the Government of Newfoundland & Labrador also attended the briefings and site visits. NALCOR management and project team representatives accompanied the group on all site visits.

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

The trip itinerary was as follows:

July 23:

- Arrive in St John's NL.

July 24:

- Orientation meeting and Project Updates in Nalcor's LCP Delivery office.

July: 25:

- Commercial flight to Goose Bay.
- Site visit to North Spur, Muskrat Falls Generating Plant, Converter Station with AC and DC Yards, Gas Insulated Switchgear (GIS) building, AC Substation Control building.

July 26:

- Site visit to Churchill Falls AC Switchyard and GIS building.
- Site visit to Muskrat Falls RCC trial site.
- Charter flight from Goose Bay to St Johns.

July 27:

- Site visit to Soldiers Pond Site - Converter Station with AC and DC yards, AC Substation & Control building, Synchronous Condenser building.
- Meetings and information exchange in LCP office.

July 28:

- Recap meetings in LCP office.
- Depart St John's for home bases.

Transportation to and from all sites was by commercial and charter flights and by road.

2. MUSKRAT FALLS POWERHOUSE AND INTAKES

Photographs taken during the visit are presented in Appendix 1, Section A.

- At the time of the IE site visit, formwork, reinforcement and concrete placement activities were in progress at multiple locations of the powerhouse/intake works (Photos A.1, A.2, A.6 to A.9). Nalcor reported that about 78% of the concrete would be placed by the end of July 2017, and that substantial completion of planned concrete works for 2017 should be achieved by September. After that, the remaining concrete will be mostly second stage concrete to be placed around the generating units and steel liners.
- The powerhouse steel superstructure was complete above the South Service Bay. Steel erection is advancing towards the north, and was in progress above Unit 3 (Photos A.3 and A.4).
- Two overhead cranes of 10 MT and 200 MT capacity in the South Service Bay were commissioned in June 2017 and are now operational. (Photo A.5).
- Civil construction of the powerhouse drainage gallery was complete, and installation of piping was in progress (Photo A.10).
- It was reported that Unit 1 would be handed over from Astaldi to Andritz to commence turbine and generator installation by the end of July (Photos A.7 and A.8).
- Andritz has started assembly of the steel draft tube liner for Unit 1 in the South Service Bay (Photos A.11 and A.12).

3. MUSKRAT FALLS SPILLWAY

Photographs taken during the site visit are presented in Appendix 1, Section B.

- The spillway is effectively complete and has been operational since August 2016. The adjacent north transition dam is complete and the adjacent central transition dam is almost completed (Photos B.1 and B.2).
- At the time of the IE site visit, the water in the upstream reservoir pond was at approximately El. 20.33 m.
- All five spillway gates can be operated to release river flows and manage the upstream reservoir level. Three gates were partially open at the time of the site visit (Photos B.1 and B.3).

4. MUSKRAT FALLS NORTH RCC OVERFLOW DAM

Photographs taken during the visit are presented in Appendix 1, Section C.

Nalcor reported that grouting repairs of the upstream cofferdam completed during the 2016-17 winter season substantially reduced leakage from about 30 m^3/min to about 7 to 11 m^3/min. During the site visit the leakage was about 8 m^3/min, and was being readily managed by routine pumping (Photos C.1 and C.2).

- The roller compacted concrete (RCC) dam foundation footprint has been cleaned to sound bedrock. The foundation bedrock surface is quite irregular (Photos C.3 to C.5).
- Dental concrete placement in cavities and fractures in the bedrock foundation is almost complete.
- Placement of cast-in-place concrete leveling slabs is well advanced. The concrete is being placed against wooden formwork at the upstream and downstream sides of the leveling slabs, and at upstream-downstream construction joints.

Contraction joints in the leveling slabs are created with embedded "Stayforms" which are thin rigid panels of expanded steel mesh. PVC waterstops are installed at the upstream ends of construction and contraction joints (Photos C.3 to C.6, C.8, C.9).

- Recently-placed leveling slabs were being green-cut with pressurized water (Photos C.6 and C.7).
- The IE observed preparations for RCC placement, and Nalcor reported that RCC placement commenced later in the week after the site visit (28 July). It is anticipated that construction of the RCC dam will extend over two seasons.
- The downstream side of the RCC dam above El. 12 m will have a steped or sloping face. RCC trials completed in 2016 included a trial placement with sloping formwork on one side to model this configuration. At the downstream sloping face of the trial section, there was poor bonding along horizontal lift joints and honeycombing due to insufficient compaction (Photo C.10). Another trial placement with a similar formwork configuration and modified placement techniques was recently carried out. The IE viewed the completed trial placement, but the formwork had not yet been stripped and the results of the trial were not known at the time of the site visit (Photo C.11).

5. MUSKRAT FALLS SOUTH EMBANKMENT DAM

Photographs taken during the visit are presented in Appendix 1, Section D.

- Nalcor reported that 44% of the south embankment dam fills were placed in 2016 prior to the winter shutdown. Approximately 60% of the fills had been placed by the time of the IE site visit, and construction of the dam is forecast to be completed in September 2017.
- The top of the fill was at about El. 36 m at the time of the IE site visit (Photos D.1 and D.2).
- The right (south) abutment will be entirely founded on bedrock. Final cleanup of the bedrock abutment was in progress. It was observed that the bedrock surface was being well cleaned (Photos D.3 and D.4).
- It was also observed that there appeared to be good control to maintain zone widths and boundaries during fill placement (Photos D.1, D.2, D.5).

6. NORTH SPUR

Photographs taken during the visit are presented in Appendix 1, Section E.

- Construction of the North Spur slope stabilization measures was substantially completed (98%) in late 2016. By the time of the IE site visit, work on the upstream side of the Spur was completed (Photos E.1 to E.4). On the downstream side, the contractor was in the final stages of finishing and grading roads and local finishing of slope cover (Photos E.5 to E.8).
- Fine-grained soil slopes were hydroseeded earlier in the summer and grass was starting to grow (Photos E.1 to E.8). Local erosion from surface runoff was observed in several locations of the upper slopes where vegetation cover was not fully established; local maintenance and repair of these areas may be required in future.
- The North Spur is monitored with piezometers, inclinometers and seepage measuring devices. Inclinometers are read manually, and other instruments are monitored with dataloggers that are downloaded daily. The IE viewed several typical instrument installations, which are well-protected with sturdy, locked housings (Photo E.9).
- SNC Lavalin reported that no significant changes in instrument readings have been recorded since the North Spur works were completed.
- It is expected that the contractor will be fully demobilized in August 2017.

7. DAM SAFETY

- The IE received a copy of a presentation summarizing an Independent Dam Safety Review and Audit performed during 29 January to 02 February 2017. The IE notes that the auditor is highly experienced in the design, construction and safety management of dams and that the audit was comprehensive. The audit concluded that the dam safety management program at the site meets and exceeds industry best practices. No material gaps in the program that would constitute a dam safety problem were identified. A few opportunities for improvement were noted.
- Nalcor's dam safety management program includes dam safety monitoring of reservoir and tailwater levels, all cofferdams, the North Spur, powerhouse, spillway, and separation wall. Monitoring includes visual inspections and measurements of piezometric levels, seepage flows and movements using instruments and surveys.
- Instrumentation data are collected automatically or manually, depending on factors such as the types of instruments and their locations. Data are regularly entered into a computer database and plots can be viewed on-line. During the site visit, the IE viewed sample on-line plots of recent data. To date, the instruments have not identified any unusual conditions and no dam safety concerns have been noted.
- Nalcor summarizes the results of the dam safety inspections and instrumentation data in Dam Safety Weekly Monitoring Reports. The IE expects to receive copies of these reports on a regular basis.

8. MUSKRAT FALLS CONVERTER STATION

Photographs taken during the visit to Muskrat Converter Station and AC Switchyard (GIS and Control buildings) are presented in Appendix 1, Section F. The following observations were made during the site visit:

- The Converter building is being prepared for equipment installation.
- Epoxy has been applied to the converter building floors, raised floor foundations are essentially complete.

AC Yard

- Ground grid, cable ducts and concrete pads are in place (Photos F.1 and F2).
- Power apparatus and the structures are in the construction stage.
- 315kV Churchill Falls Transmission line and four powerhouse collector feeder towers have been erected (Photos F.3 and F.4).

DC Yard

- Transformer bays are complete awaiting arrival of the converter transformers.
- Power equipment concrete pads, ground grid and insulating fill are partially complete.
- Station Service transformers have been installed on their pads (Photo F.5).

9. MUSKRAT FALLS GIS BUILDING

- Wall bushings and collector cable facilities are in the construction stage (Photos F.6 and F.7).
- GIS equipment and Local Control cabinets have been installed, low voltage cables have been pulled in and are being connected (Photo F.8 and F.9).
- Converter transformer pads are complete. The transformers are expected to arrive by end of August.

10. MUSKRAT FALLS AC SUBSTATION CONTROL BUILDING

- AC Substation building was completed. Equipment installation is in progress.
- Protection panels have been moved into their position and cabling is prepared for installation.
- 25kV section is nearing completion (Photo F.10).
- 125VDC batteries, chargers and their controls have been installed. Batteries were under charge and the battery rooms could not be accessed at this time (Photo F.11).

11. CHURCHILL FALLS AC SUBSTATION AND EXTENSION SWITCHYARD

The following observations were made during the site visit to the Churchill Falls Switchyard (photographs of this site are presented in Appendix 1-Section G):

- 1st bus will be energized by end of July.
- Switchyard equipment is completely installed and commissioning is in progress (Photo G.1, G.2 and G.3).
- Substation P&C, auxiliary room, communication room wiring is in progress.
- Switchyard extension is essentially complete and will be energized by early August (Photo G.4).

12. CHURCHILL FALLS GIS BUILDING

- The SF6 ducting and power apparatus have been installed (Photo G.5).
- Most of the low voltage cables appear to have been pulled in and are being connected to the equipment control cabinets.

13. SOLDIERS POND SITE

At the time of the site visit the construction work was proceeding well with many activities underway. Photographs taken from this site are presented in Appendix 1, Section H. The following observations were made during the site visit:

13.1 Converter Station

- AC and DC wall bushings (WB) have been installed (Photos H.1 and H.2).
- Valve cooling equipment is being installed, main supply pipes and pumps are in situ in the Pole 1 section (Photos H.4 and H.5).
- Cooling Control cabinets are in place and being connected (Photo H.6).
- Floors have been epoxy sealed and building is ready for equipment installation (Photo H.7 and H.8).
- Pole 1 module installation can commence in 3 weeks.

DC Yard

- Ground grid and concrete pads have been installed (Photo H.9).
- Valve cooling heat exchangers have been erected (Photo H.3).
- Converter transformers are on their pads, Pole 1 and the Spare have their bushings installed and have been oiled (Photo H.10).

AC Yard

- Erection work and cabling installation is in progress.
- AC filter concrete foundations are complete.
- Power Apparatus testing is in progress.

13.2 Soldiers Pond AC Substation and Control building

- AC Substation works are nearing 100 percent completion. Equipment testing was ongoing (Photo H.11).
- Auxiliary room has been completed, it is test energized and under test permit. No access was possible at this time.
- Protection panels are in place and wired in. Relay testing is in progress (Photo H.12).
- Communication room panels are in place being wired. Communication battery was not inspected due to construction activities taking place.
- Battery 1 and Battery 2 are installed in their racks, main cables are ready for the final connections (Photo H.13).

13.3 Soldiers Pond Synchronous Condenser building

- UPS building extension completed (Photo H.14).
- Unit 1, 2 and 3 are on their pedestals. Installation of all rotors is complete, with bearing installation ongoing (Photos H.15 and H.16).
- Some of the cooling equipment has been installed (Photo H.17).
- Synchronous Condenser Power and Exciter Transformers are on their pads (Photo H.18).

14. LCP PROJECT OFFICE MEETINGS ON JULY 24, 27 AND 28, 2017

Discussions on Project issues and updates were carried out during the three sessions in the LCP Project office:

- Safety updates related to number of smaller incidents. While no major incidents were reported, safety remains a constant focus.
- Project protest activities may potentially impede the transformer offload and transport to Muskrat. Instructions from the Project Delivery Team are to carry on with the business as usual. RCMP officers will be at hand during the converter transformer handling and transportation.
- Converter transformers were transferred to offloading facility on July 21. Each transformer will take 1 day to off load and 5- 6 days to transport to the site.
- MF main spillway controller for remote control has been commissioned.
- Dam Safety (DS) program has been implemented. Electrical aspects of the DS have not been discussed and will be addressed during further review.
- Comprehensive presentation on Environmental Monitoring was given to the IE team.
- Status of Project risks was presented as follows:
  - The undersea cable installation is complete and commercial aspects have been settled. No Project risk has been identified.
  - LTA is 95% complete
  - LIL is 81% complete

- Project cost overruns have political implications.
- Risks of protesters' interference cannot be enumerated.
- The current reservoir level (EL.20.33) is too low to allow installation of the ice / log boom. If the reservoir level is not increased by the fall of 2017 and thus the ice boom does not get installed this will return the same project risk (ice damming in the tail race) as experienced in the last (2016 / 17) winter season.
- LCP capacitor failure presents a Project risk. Out of the total 3300-unit order for the total bi-pole approximately 1000 fused capacitors either experienced or are at risk of failures. The OEM has apparently been unable to determine the causes of failing internal fuses, bulging cans and oil leaks. GE developed screening tests and moved the refurbishment to factory in Florida. Pole 2 capacitors will be used for the Pole 1 in the interim period.
- P&C equipment commissioning delays of 5 weeks are expected due to uncertainty with the software implementation and testing at Stafford that is to commence on Aug. 3rd. Completion of this FAT is expected by end of September using the spare Pole 2 controls for joint pole (integrated systems) simulated testing.
- Software implementation on the site is scheduled to start at the end of Oct. 2017.
- In view of the present state of equipment installation and current state of software / calibration completeness, the time frame outlined during this meeting appears to be optimistic. There are at least three major blocks of the 'P&C' work. HVDC Protections and Control computers, AC yard and transmission line protections, and the data acquisition / communication links. Those systems are all interconnected and their correct functioning is critical to Pole 1 operations and the overall reliability of the HVDC link.
- To develop a realistic picture of the pending work load and time requirements for it, all the outstanding work for Pole 1 should be itemized and time / resource requirements be estimated in detail. This requires preparation of detailed Commissioning Plan in conjunction with the Contractors, site staff and external entities. Need for permanent site technical support staff during and after the commissioning stage was discussed. Such in-house technical expertise is typically required to provide ongoing technical support to the operations. This approach will also need to be implemented for bi-pole.
- For bi-pole operation, end-to-end testing program has yet to be developed / defined in cooperation with EMERA. The IE was advised that operational studies will be conducted. Commissioning of the above systems and end- to-end tests are typically the final and pacing components of the Project commissioning phase and any delay in those activities is likely to impact the Project timeframe.

15. CONCLUSIONS AND COMMENTS

- At the time of the July 27th site visit construction work at Soldiers Pond was at an advanced stage.
- The Muskrat Falls spillway was operational. The gates were open to pass the entire river flow and maintain the head pond at EL.20.33. This structure and related works are of acceptable quality and in compliance with current schedules.
- Powerhouse construction was at an advanced state at the time of the IE site visit. However, while construction rates have been significantly improving during the past year, the work disruptions caused by the civil demonstrations have contributed to a loss of schedule.
- Work at Soldier's Pond and Muskrat Falls switchyard is proceeding on schedule. Current work is focusing on construction of the facilities.
- The construction works viewed during the site visit were of good quality and in compliance with accepted standards.

Appendix 1

Site Photographs

Photo A.1: Panoramic view of upstream side of power intake structure.

Photo A.2: Panoramic view of downstream side of power intake structure.

Photo A.3: Southerly view of powerhouse steel superstructure from downstream side.

Photo A.4: Inside of powerhouse superstructure, viewed from south service bay.

Photo A.5: South Service Bay, with overhead cranes commissioned in June 2017: 10,000 kg (orange) and 200 MT (green) capacities.

Photo A.6: First stage concrete works nearing completion in Unit 4.

Photo A.7: Completed first stage concrete in Unit 1.

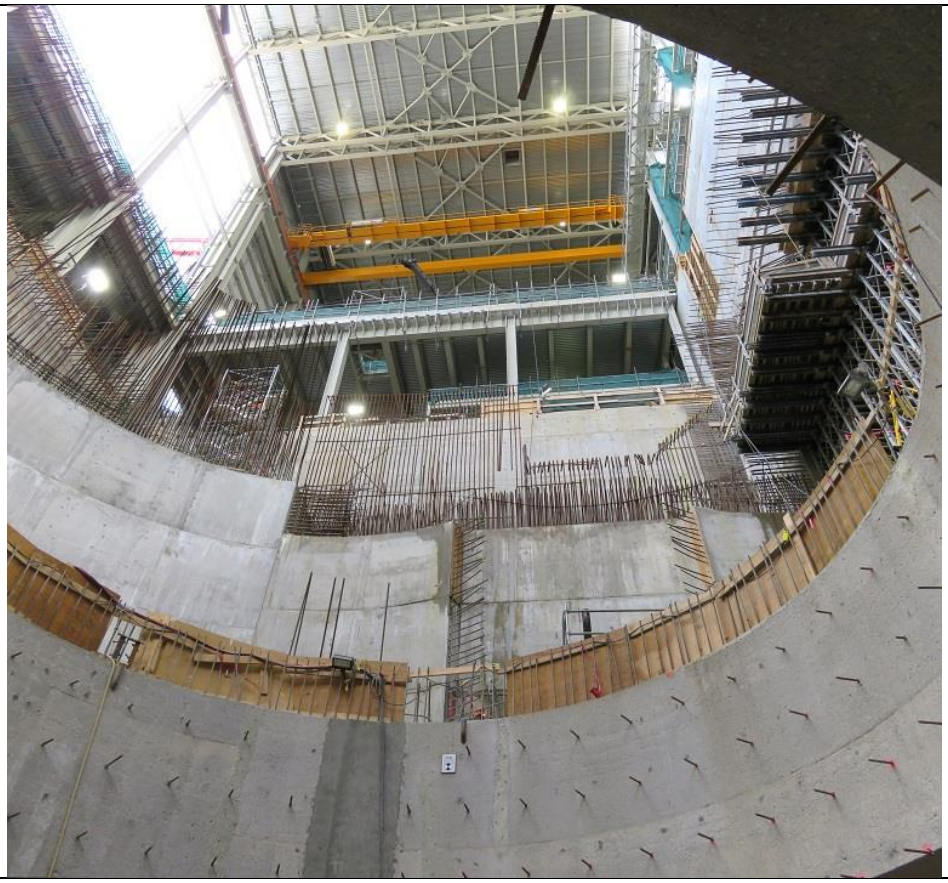


Photo A.8: View looking up from turbine level of Unit 1.

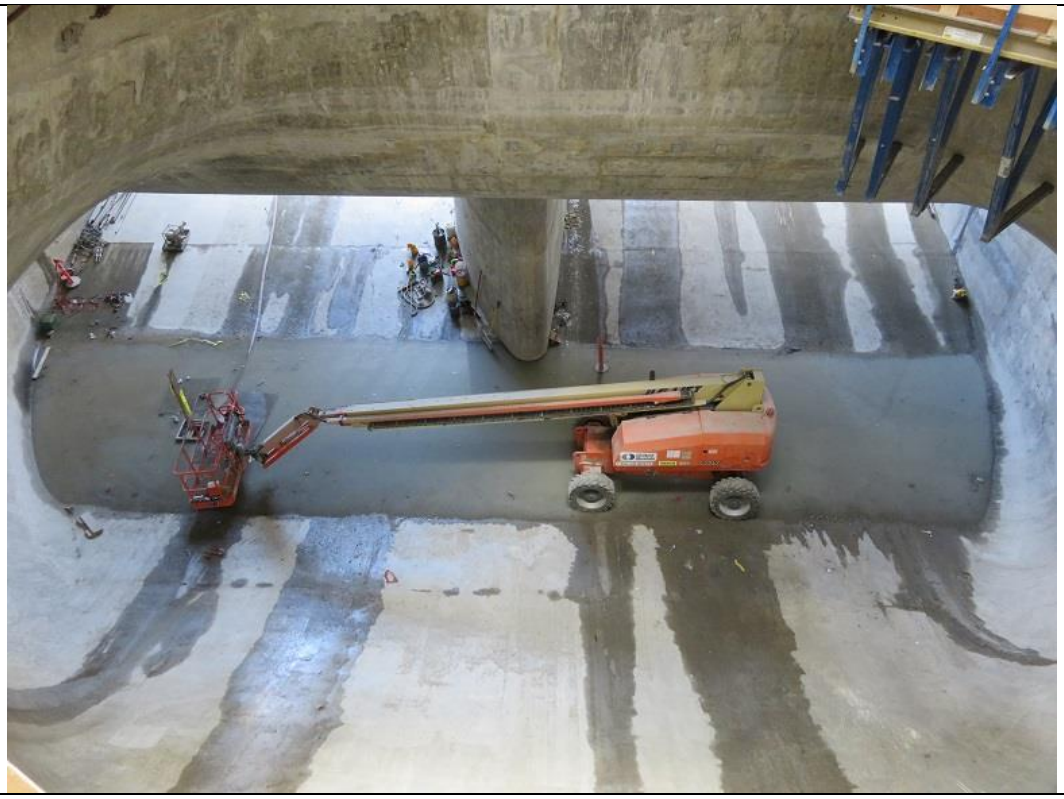


Photo A.9: Looking down into Unit 1 draft tube outlets.

Photo A.10: Powerhouse drainage gallery.

Photo A.11: Unit 1 draft tube liner segments being assembled in South Service Bay.

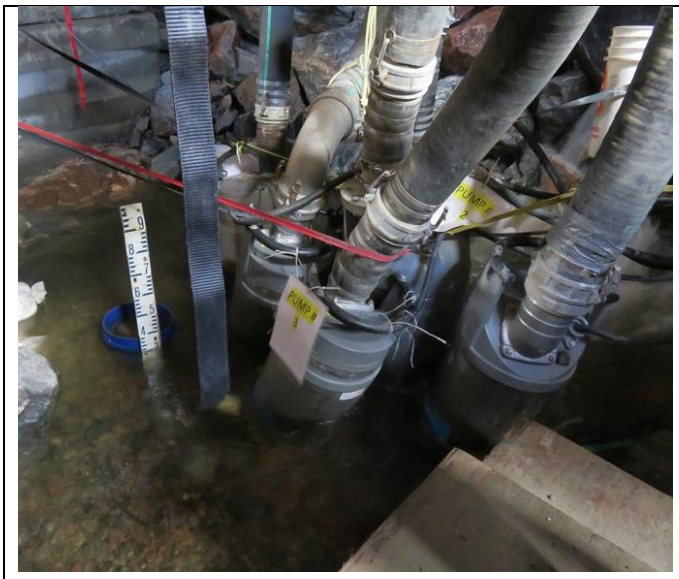
Photo A.12: Bolting details for draft tube liner segments.

Photo B.1: Panoramic view of upstream side of spillway structure and approach channel, viewed from south end of temporary access bridge.

Photo B.2: Central transition dam nearing completion on south side of spillway structure.

Photo B.3: Spillway release viewed from North Spur.

Photo C.1: Northerly view along toe of upstream cofferdam.



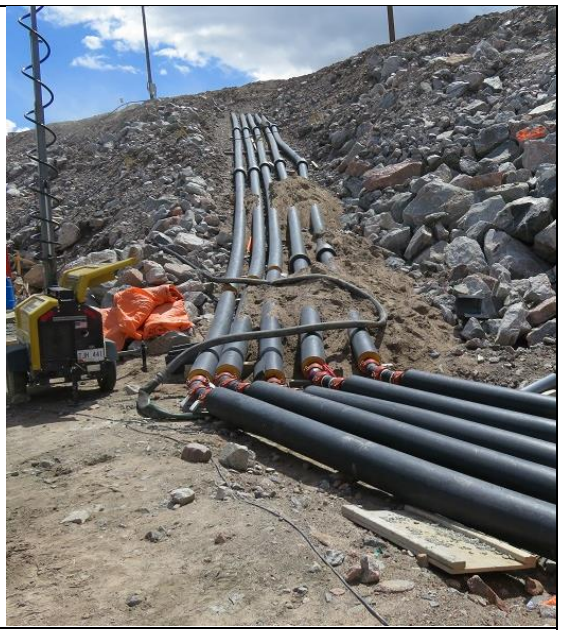


Photo C.2: Pumps and piping for upstream cofferdam dewatering system. Water is being pumped back to the reservoir.

Photo C.3: Southerly view along RCC dam foundation, between downstream (left) and upstream (right) cofferdams. Formwork along sides indicates extent of dam footprint. Cast-in-place leveling concrete has been placed along upstream side.

Photo C.4: Northerly view along RCC dam foundation. Area stripped to rock in background indicates future top of dam. Area at centre-left is recently-placed cast-in-place leveling concrete, covered with wet burlap for initial curing period.

Photo C.5: Typical formwork details on irregular rock surface, with recently-placed leveling concrete in foreground.

Photo C.6: Typical equipment to be used for RCC placement. Equipment is parked on cast-in-place concrete leveling slab which has been "green cut" with pressurized water.

Photo C.7: Surface of leveling concrete slab after green cutting, which removes laitance and leaves exposed aggregate to provide a good bonding surface for the next layer of concrete or RCC.

Photo C.8: Typical contraction joint in leveling slab, created with embedded "Stayform", with waterstop at upstream end of joint (left photo). Details of typical waterstop at upstream side of a contraction joint (right photo).

Photo C.9: Upstream side of levelling concrete after formwork removal, showing good contact with bedrock and good compaction of concrete.

Photo C.10: Initial 2016 RCC trial placement, showing poor bonding along horizontal lift joints and honeycombing due to insufficient compaction at downstream sloping face.

Photo C.11: Recently-placed 2017 RCC trial.

Photo D.1: Southerly view along south embankment dam towards right abutment.

Photo D.2: Northerly view along south embankment dam towards south transition dam which forms the left abutment. Boundaries between zones of different materials are well-defined.

Photo D.3: Final cleanup of foundation bedrock surface by hand methods at right abutment of south embankment dam.

Photo D.4: Cleaned bedrock surface on lower right abutment, ready for dental concrete. Note concrete infill for local shaping of core contact zone in centre of photo.

Photo D.5: Neatly-placed riprap along upstream side of south embankment dam.

Photo E.1: Northerly view along upstream side of North Spur slope stabilization works. Group is standing on maintenance road at El. 43 m.

Photo E.2: Southerly view along upstream side of North Spur slope stabilization works.

Photo E.3: Southerly view along maintenance road on upstream side of North Spur slope stabilization works. The top of the till blanket is just below the recently-seeded ditch on the inside of the road.

Photo E.4: Southerly view showing log boom platforms at El. 43 m and E. 27 m. Reservoir level is El. 20.33 m. Yellow log boom sections are visible on shore in upper centre and upper right of photo.

Photo E.5: Southerly panorama view along downstream side of North Spur slope stabilization works.

Photo E.6: Northerly panorama view along downstream side of North Spur slope stabilization works. Kettle Lakes discharge channel is at far right. Note local surface erosion (rolling) of upper slope.

Photo E.7: Northwesterly panorama view looking upstream along Kettle Lake discharge channel.

Photo E.8: Southerly view along access road at toe of downstream side of North Spur slope stabilization works.

Photo E.9: Typical instrument installations installed inside protective CMP collars with locked steel lids. Inclinometer at left and dual vibrating wire piezometers with remote readout system at right.

Photo F1: AC yard

Photo F2: AC yard precast cable ducts and grounding detail

Photo F.3: Powerhouse to GIS building collector feeder lines

Photo F.4: Incoming Churchill Falls 315 kV AC Transmission Lines

Photo F.5: Station Service Transformer with power connections led underground.

Photo F.6: GIS Building - Wall bushings

Photo F.7: GIS Building - Powerhouse collector feeder cable supports

Photo F.8: GIS Equipment and control cabinets installation

Photo F.9: GIS Equipment - Local Control Cabinets.

Photo F.10: AC Substation 25kV switchgear arc flash vent detail.

Photo F.11: 125 VDC controls and monitoring detail

Photo G.1: CF Single Phase Transformer

Photo G.2: CF Switchyard - grade completion

Photo G.3: CF Switchyard equipment installation completed.

Photo G.4: CF Switchyard Extension essentially completed.

Photo G.5: CF GIS equipment installed. Cable terminations ongoing.

Photo H.1: Converter Station AC Wall Bushings.

Photo H.2: Converter Station AC Wall Bushings inside Valve Hall.

Photo H.3: Converter Station Cooling Equipment – Heat Exchangers.

Photo H.4: Converter Station Valve Cooling - Interior Ducting.

Photo H.5: Converter Station Valve Cooling - Cooling Pumps.

Photo H.6: Converter Station Valve Cooling - Motor Control Centre.

Photo H.7: Converter Station Valve Hall - Sealed floors and DC Wall Bushings are ready for equipment installation.

Photo H.8: Converter Station - suspended floor support and cable trays.

Photo H.9: Converter Station DC Yard - Ground grid cad-weld joint detail.

Photo H.10: Converter transformer annunciator and control paned detail.

Photo H.11: AC Substation construction has been completed with testing in progress.

Photo H.12: AC Substation Control Building - relay panels in place undergoing testing.

Photo H.13: AC Substation Control Building - Battery #2 Cabling.

Photo H.14: Synchronous Condensers Power and Exciter Transformers.

Photo H.15: Synchronous Condenser Unit 1 fully installed on concrete pedestals.

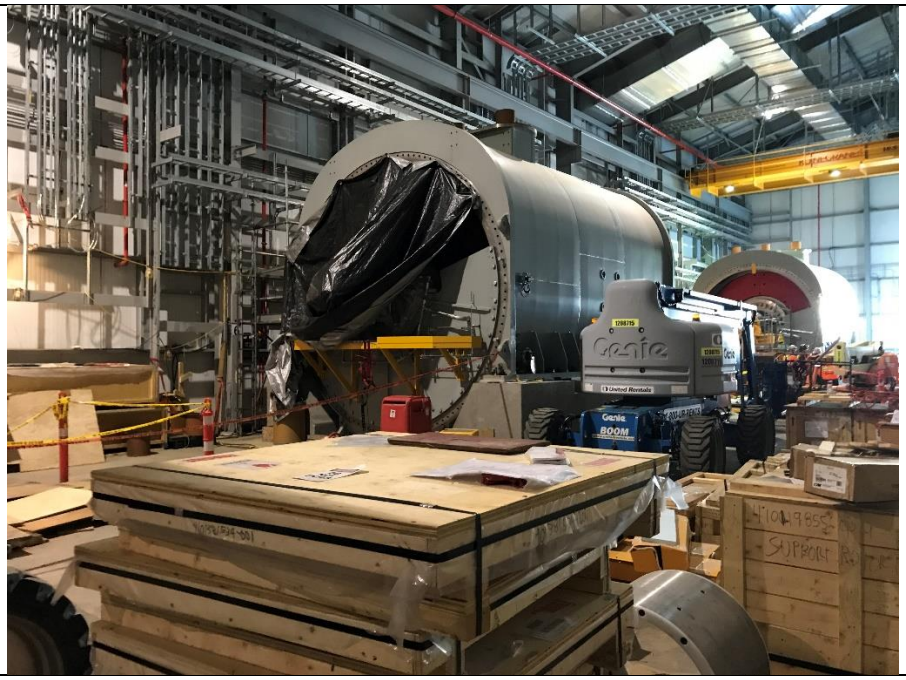


Photo H.16: Synchronous Condensers Units 2 and 3 installed on their pedestals.

Photo H.17: Synchronous Condensers Cooling System - exterior heat exchangers

Photo H.18: Synchronous Condensers Power and Exciter Transformers.