


ronaldpower@

From: Richard Harding <rharding@schedulecorp.com>
Sent: Friday, June 3, 2016 3:33 PM
To: Scott O'Brien; ronaldpower@
Subject: Final Report_Optimization Schedule Study
Attachments: Power House Optimization Schedule v2 2016.06.01.docx

Ron / Scott: I have deleted the items in "Red" from the attached report for the final report and will issue today,

Regards

DICK Harding
ScheduleCorp

Nalcor Lower Churchill Project: Power House Optimization Schedule

May 30th, 2016

Purpose

The purpose of this engagement was to optimize the Muskrat Falls power house schedule in order to minimize contractor interfaces, enhance the sequencing and durations of construction activities, and reduce the risk of the project schedule critical paths.

Objectives

- Identify schedule improvements to minimize contractor interfaces.
- Enhance construction sequencing and durations of activities.
- Focus on critical concrete and steel erection activities to avoid further schedule delays.
- Seek out ways to improve the schedule, aiming at an earlier start of the turbine and generator (T&G) work and the intake gate installation, which would bring first power much earlier than what is currently indicated on the project control schedule (PCS).
- Postpone any non-critical concrete to after the 2016/17 winter season.
- Enclose the south service bay by the third quarter of 2016 to commence fabrication of T&G embed liners.
- Complete steel erection by the end of the year for Unit 1 to start the T&G liner embed installation and continue through the winter of 2016/17.
- Secure earlier access to the balance of plant (BOP) contractor to reduce the associated schedule risk to first power.

Basis

- Astaldi's construction schedule dated March 27th, 2016
- Project control schedule (PCS)
- Available contractors' detailed schedules
- Delivery status of major equipment and bulk materials

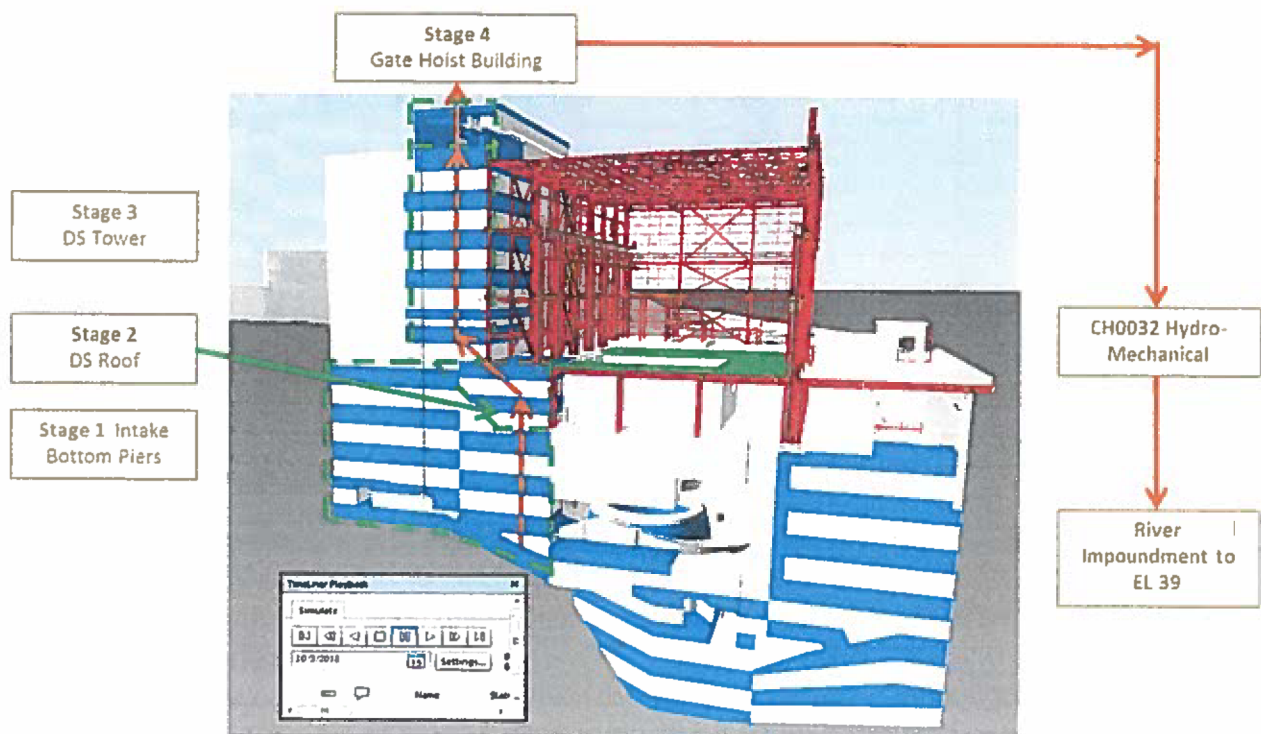
Criteria

- Prepare a level 2 power house construction schedule, including support line of balances and bar chart schedules to confirm sequencing and durations of construction activities.
- Identify improvement opportunities, focusing on the critical civil concrete and steel construction.
- Question construction activity durations.
- Challenge the sequencing of construction activities and evaluate respective contractor's access to their work fronts.
- Evaluate critical work activities to start earlier, such as the T&G installation, the gate contractor focusing on the intake gates to bring forward the water impoundment, and the BOP work.

Strategy

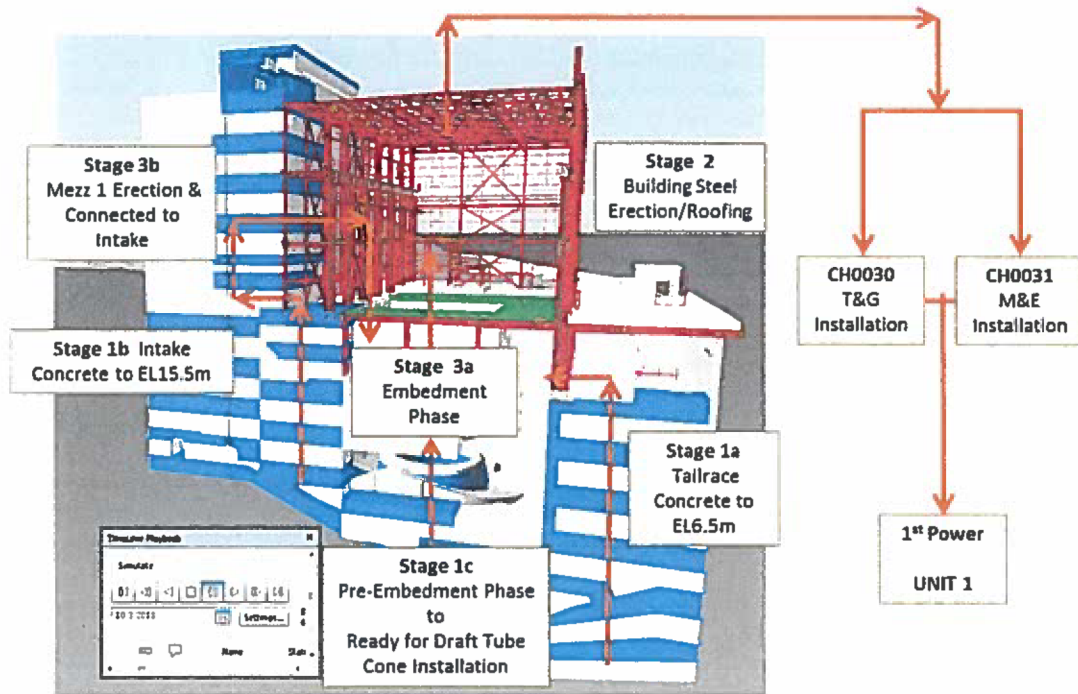
There are two critical paths identified to complete the construction of the Muskrat Falls power house. The “primary” critical path is through the intake structure for readiness for water impoundment, and the “secondary” critical path is through Unit 1 readiness for wet test and first power.

1. **Primary critical path through the intake structure to allow the water impoundment to support T&G wet testing:**



- Re-sequence the construction work to focus on the downstream intake towers after the bottom of concrete to elevation 15.5 to allow the machine hall building steel erection to commence for Unit 1.
- Focus on the downstream intake structure concrete to allow the erection of the mezzanine steel and decking at elevation 25.5 to allow for the 200 T crane load to take place for the installation of the stay ring, and to commence the associated architectural work and the BOP utility / services installation.
- Delay the upstream intake structure concrete until after the winter of 2016/17.
- Complete the upstream intake structure concrete to complete the hoist building and commence the intake gate installation.
- Evaluate ways to complete the intake gate installation earlier, and be ready to commence the water impoundment allowing for unit wet test to take place earlier. The improvement could be achieved by deploying an additional work platform to support additional work fronts.

2. Secondary critical path through Unit 1:



- Focus the concrete, steel erection, high bay lighting, and enclosure of the south service bay to commence the T&G embedment assembly work earlier.
- Install the overhead crane and load test to support the fabrication of the T&G liners and assembly of the T&G units.
- Focus the critical concrete for the intake downstream concrete to elevation 15.5 and tail race concrete to elevation 6.5 to commence steel erection for the power house machine room over Unit 1 by end of 2016 at the latest, followed by Unit 2.
- Focus on the critical concrete for the downstream intake structure concrete to allow the power house mezzanine steel erection to follow the main building steel, which allows the main building structure to support the overhead crane lifts, enclose the machine hall building, and commence the BOP work in the area earlier.
- Focus on the tail race concrete and steel for the draft tube gallery to open up the BOP plant work in the draft tube gallery, as well as in the service corridor where much of the critical electrical work will take place.

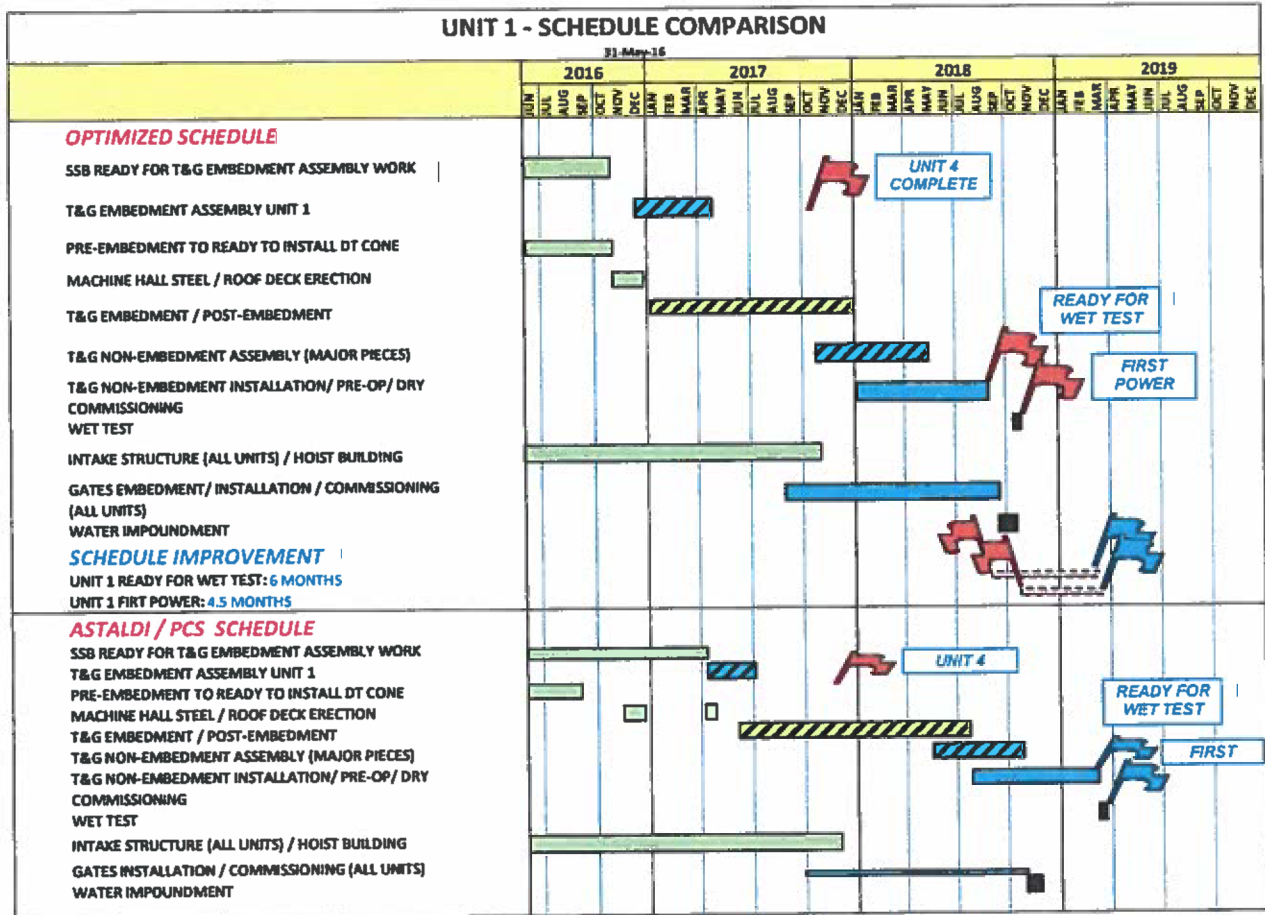
Final Results of the Project Schedule Analysis

The schedule task force working with the Nalcor project team validated the potential benefits from the recommendations included in the schedule optimization report issued at the end of March, 2016. The major benefit in implementing the optimized schedule is de-risking the overall power house schedule through re-sequencing the construction activities through the two major critical paths of the project. Additionally, this schedule also results in advancing the completion of the power house, with a “ready for wet test” achieved 6 months earlier, with opportunities for further reductions by focusing on reducing the intake gate installation

Nalcor Lower Churchill Project: Power House Optimization Schedule

work with additional work platforms and crews. The following summary schedule and milestone chart show the comparisons between the project control schedule and the optimized schedule.

Schedule comparison summaries:



MILESTONE	ASTALDI OR PCS	OPTIMIZATION	VAR. (MTHS)
START SSB STEEL (INCL. MEZZANINE)	15-Jul-16	01-Jul-16 (*)	-0.5
COMPLETE SSB STEEL ERECTION	31-Oct-16	30-Sep-16	-1
CRANE LOAD TEST	8-Apr-17	28-Oct-16	-5.25
START T&G EMBEDMENT ASSEMBLY	9-Apr-17	2-Dec-16	-4.25
START MH STEEL ERECTION - SUPERSTRUCTURE	1-Nov-16	1-Nov-16	0
START MH STEEL ERECTION - MEZZANINE	24-Aug-17 (**)	25-Feb-17	-6
SUPERSTRUCTURE READY FOR STAY RING LOAD	30-Sep-17 (***)	24-Mar-17	-6.25
COMPLETE T&G EMBEDMENT INSTALLATION	3-Dec-17	12-May-17	-6.75
PIT FREE	23-Jul-18	23-Dec-17	-7
START T&G ASSEMBLY WORK IN SSB	15-May-18	21-Oct-17	-6.75
UNIT 1 READY FOR WET TEST	5-Mar-19	30-Aug-18	-6
INTAKE READY FOR WATER IMPOUNDMENT	4-Nov-18	18-Sep-16	-1.5
FIRST POWER	19-Mar-19	30-Oct-18	-4.5

* COULD BE 4 WEEKS LATER BUT SHOULD FINISH BY 30SEPG16
 ** 01OCT16 IN PCS
 *** 19MAY17 IN PCS

Action Items

1. Finalize internal Nalcor management approvals to proceed with implementing the proposed optimization schedule.
2. Commence negotiations with Astaldi to re-focus their work to support the optimization schedule. Suggest revising their contract commercial conditions to add performance financial incentives to support the optimization schedule.
3. Prepare the revised Astaldi contract's commercial conditions to include performance incentives and schedule milestone dates based on the optimization schedule requirements.
4. Following confirmation of Astaldi's commitment to the optimization schedule (concrete and PH steel contract), commence negotiation with the following contractors to support the optimized schedule for first power: crane contractor, T&G contractor, electrical / mechanical BOP contractor (whose scopes of work also includes architectural for the offices, warehouse and workshops), the gate installation contractor, the elevator contractor, etc.
5. Evaluate the suggested recommendations in the optimization schedule report findings to further improve the overall project schedule to first power, specifically through the critical path work for the intake structure and gate installation, to ensure an earlier readiness for impoundment, in concert with Unit 1 readiness for wet test. This would help take full benefit of the optimization schedule improvement shown in the machine hall.
6. Establish negotiating teams for revising the commercial terms as necessary to support the optimized schedule and respective milestone dates. Suggest the team include: the package lead, the site contract package supervisor, a contract administrator, a cost engineer, and scheduling support.
7. Finalize the quantities and associated man-hours by contractor for comparing an evaluation against historical unit rates by commodity / contractor to confirm to-go man-hours and duration of activities. From this review, complete an overall project manpower curve for the power house schedule to assess camp requirements.
8. Once negotiations with Astaldi have confirmed their commitment to support the optimized schedule, revise the P-6 PCS to include the optimization schedule, add the respective quantities and man-hours, and complete the overall project manpower curves and commodity curves for the entire project to support the management of the project.
9. Complete the final cost impact (both reductions and additions) to support the optimization schedule and trend the project cost estimate (EAC) to completion accordingly.
10. Establish project schedule review meetings with the project management team at least twice monthly to status the respective contractors schedule and address any further actions required to support the optimization schedule.

Team Participants

Nalcor:

- Mike Collins: Manager – Civil Coordination
- Frank Gillespie: Area Manager Electrical & Mechanical
- Tony Scott: Sr. Project Planner – Disputes Avoidance
- Richard Severs: Package Lead Manager for Turbines and Generators
- Bruce Drover: Package Lead Manager for Hydro-mechanical Works and OH Crane
- Scott O'Brien: Project Manager
- Ron Power: General Project Manager

Westney / ScheduleCorp:

- Dick Harding: ScheduleCorp – Senior Partner
- Youcef Stambouli: ScheduleCorp – Lead Task Force Manager
- Parmod Kumar: ScheduleCorp – Task Force Scheduler
- Pete Oppenheim: Westney – Senior Executive Consultant

Attachments

- Power house level 2 schedule
- Power house optimization schedule (high-level summary schedule)
- Schedule comparison schedule: PCS / Astaldi schedule compared to optimized schedule approach
- Overall construction sequence summary
- Machine hall mezzanine summary bar chart schedule
- South and north services bays bar chart schedule
- Concrete and steel readiness for embedment work schedule
- Embedment assembly and installation schedule with supporting line of balance schedule
- Turbine and generator assembly and installation schedule and supporting line of balance
- Intake structure and gates installation line of balance schedule
- Tailrace summary bar chart schedule
- Tailrace services and corridor bar chart schedule
- Service bay line of balance