Attachment 19

Proposed Bay d'Espoir Hydro Generating Unit 8 – Class 3 Cost Estimate and Project Execution Schedule

SNC-Lavalin Inc.

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NEWFOUNDLAND AND LABRADOR HYDRO

Proposed Bay d'Espoir Hydro Generating Unit 8

CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE

SLI Document No. 647756-0000-40ER-I-0002-00

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1 EXECUTIVE SUMMARY

1.1 Introduction

The Bay d'Espoir complex is comprised of (i) a reservoir including dams and a spillway, (ii) two adjacent powerhouses with an average gross head of 179 m and a total installed capacity of 600 MW, and (iii) a tailrace channel rejoining the Bay.

Powerhouse 1 has six (6) generating units each of 75 MW nominal capacity, three (3) individual intakes and penstocks each supplying two (2) units through a bifurcation near the powerhouse. The first four (4) units were commissioned in 1967 (phase 1) and the last two (2) units (phase 2) were commissioned in 1970. A single headrace channel provides water to the three intakes and the powerhouse discharges to approximately 4.5 km long tailrace channel reaching Fortune Bay.

Powerhouse 2 includes a single unit of 150 MW nominal capacity. Water is provided by a separate headrace channel, intake and penstock. This powerhouse discharges in its own tailrace channel connecting Powerhouse 2 to the tailrace channel of Powerhouse 1. This powerhouse was commissioned in 1977 (phase 3) and was constructed for the future installation of a second 150 MW unit. In this regard, rock excavation for the second unit as well as the downstream portion of the draft tube with the draft tube gates guides were built to prevent disturbing the operation of the existing Unit 7 when building Unit 8.

1.2 Description of the New Facility

The new facility will include the following elements:

- An enlarged headrace channel including a bifurcation excavated in the rock and supplying both the existing entrance channel to Unit 7 intake and the new entrance channel to Unit 8 intake.
- A new water intake similar to the existing Unit 7 intake.
- A new buried steel penstock connecting the new intake to the new generating unit.

- A new 150 MW generating Unit 8 with an additional service bay as part of Powerhouse 2 next to existing Unit 7. The new unit will be built in the existing excavations, upstream of the draft tube outlet, done in the seventies as part of the construction of Powerhouse 2.
- A high voltage 230 kV line from the Unit 8 step-up transformer to Terminal Station No 2 (TS-2) with the addition of a new breaker-and-a-half diameter to receive the new line.

Drawing 647756-0001-41DD-0004 shows the longitudinal profile of the new facility. The new facility will benefit from the existing powerhouse forebay and does not require the construction of any additional dams.

Unit 8 will use a draft tube similar to Unit 7 with a minor modification to reduce head losses. The generating unit equipment and auxiliaries will be improved to modern standards.

1.3 Project Execution Strategy

1.3.1 Feasibility Study

In June 2017, SLI was retained by Newfoundland & Labrador Hydro to perform an engineering study to add a 150 MW generating unit at the Bay d'Espoir power plant (RFP 2017-70845 JW). This will provide Hydro with an additional hydraulic generator however the annual water supply volume to power all generators at Bay d'Espoir in the future will remain the same. The additional generating unit will provide Hydro with the ability to increase total hydraulic MW generation output for periods of time throughout the year but total annual energy output will remain the same.

The objective of the study was to define the project scope of work,), prepare a master project execution schedule, and produce a class 3 cost estimate. Construction management will be based on Engineering, Procurement and Construction Management (EPCM). The EPCM firm will also perform commissioning on behalf of the owner. The feasibility study mandate included the following main activities:

- Basic engineering to produce a class 3 cost estimate. Study to be based on site condition information readily available in existing Hydro files when Unit 7 was constructed and a site walk through. No new site condition investigations were performed (i.e. geotechnical surveys) ;

- Preparation of turbine and generator technical specifications as well as technical sheets for other major equipment to get budgetary prices from suppliers;
- Development of a 3D model of the new powerhouse from headrace to tailrace channel;
- Production of general arrangement drawings;
- Class 3 estimate;
- Development of a project execution plan with a preliminary schedule;
- Feasibility Study Report.

This is the engineering report in accordance with Scope Item 2.

1.3.2 Execution Phase

The Execution Phase will be performed as an EPCM by the firm chosen by Newfoundland & Labrador Hydro. The chosen firm will be responsible for providing the following services under Newfoundland & Labrador Hydro's supervision:

- Investigations;
- Support to Environmental Impact Assessment and obtaining necessary permits;
- Detailed Engineering;
- Procurement;
- Planning, estimating and cost control;
- Health, Safety and Environment (HSE) ;
- Construction management;
- Quality control;
- Pre-commissioning;
- Commissioning and Start-Up Phase.

1.4 Project Execution Schedule

The study started on June 2, 2017 and was completed by late March 2018. As a bench mark the project cost estimate was based on receiving approval in late 2017 and it would take four years to construct Unit 8 and full production of the new unit would be achieved. If approval was given at a later time the estimate would need to be reviewed and possibly revised.

A Master Schedule was prepared and is shown in appendix B. This schedule provides an overview of the project and the objectives to be achieved. It includes the following key milestones:

- Project Start: January of Year 1;
- Temporary camp available: July of Year 2;
- Start powerhouse concreting: October of Year 2;
- Start turbine/generator erection: August of Year 3;
- Turbine/generator ready for operation December of year 4;

The new Unit 8 will be ready for operation by end of year 4. However, three more months will be required to complete as-built drawings, maintenance and operation manuals and close remaining contracts.

The environmental assessment process should be completed for March of year 2 at the latest to allow the main construction activities to start.

A partial notice to proceed (NTP) will be required in September of year 1 so that preliminary works can begin. Those works need to be completed before the start of the excavations. A full NTP shall be issued following the environmental assessment process so that the main construction activities can begin.

No specific delays caused by external considerations other than construction have been incorporated. See list of exclusion in section 3.21.

1.5 Impact of Unit 8 construction on Unit 7 operation

A number of mitigation measures have been considered in this study to mitigate the impact of unit 8 construction on unit 7 operation. Those measures include:

- Additional independent service bay for Unit 8;
- Upgrade of access road (midway up Penstock 4) to be used for Unit 7 operation and maintenance;
- Temporary aerial route for existing protection and control cables between PH-2 and TS-1 to maintain operation of Unit 7 during construction;
- Temporary concrete retaining wall to maintain operation of Unit 7 penstock during construction of Unit 8 penstock;
- Set of new stoplogs for Unit 8 so that the existing set can be used for operation and maintenance of Unit 7;
- Excavation of headrace channel wet excavation in summer to prevent disturbing any ice cover that would be present in winter.

Those mitigation measures are discussed in other sections of this study.

Nevertheless, some outages are expected for Unit 7 during construction of Unit 8. A provision of 15 (equivalent) days has been considered for those outages. The reasons for those outages are:

- Commissioning of temporary protection and control cables for Unit 7: 3 days (spring of year 2);
- Relocation of Unit 7 HV transmission line : 1 day (spring of year 2);
- Excavation of Unit 8 : 2 days (summer of year 2);
- Re-commissioning of permanent protection and control cables for Unit 7 : 3 days (spring of year 4);
- Commissioning of Unit 8 : 3 days (fall of year 4);
- Others (provision): 3 days.

The losses of production associated with those outages are estimated at 54 000 MWh (15 days x 24 hours x 150 MW).

These impacts should be reviewed during the next detailed design phase.

1.6 Capital Cost Estimate

The Capital Cost of the project is estimated CAN 393.7 $M (including capitalized interest costs) as shown below:

– Direct costs	:	[redacted]
– Construction Indirect costs	:	
– EPCM Costs	:	
– Owner's costs	:	
– Contingencies	:	
– Escalation	:	
– Capitalized Interests	:	
Total cost :		**393.7 $ M**

The total number of person-hours is estimated at 401 891.

The complete Capital Cost Estimate is available in Appendix A.

2 PROJECT DESCRIPTION

2.1 Project Facilities Overview

The Bay d'Espoir complex comprises a reservoir including dams and a spillway, two adjacent powerhouses with an average gross head of 179 m and a total installed capacity of 600 MW, and a tailrace channel rejoining the bay.

Powerhouse 1 has six (6) generating units, each with a nominal capacity of 75 MW, and three (3) individual intakes and penstocks, each supplying two (2) units through a bifurcation near the powerhouse. The first 4 units were commissioned in 1967 (phase 1) and the last 2 units (phase 2) were commissioned a few years later. A single headrace channel provides water to the three (3) intakes and the powerhouse discharges into a tailrace channel that stretches for approximately 4.5 km before reaching the bay.

Powerhouse 2 includes a single generating unit of 150 MW nominal capacity. Water is fed through a separate headrace channel, intake and penstock. Powerhouse 2 discharges in its own tailrace channel which connects to the tailrace channel of Powerhouse 1. Powerhouse 2 was commissioned in 1977 (phase 3) and the addition of a future 150 MW unit was considered back then during construction. In this regard, rock excavation for the second unit was completed, and the downstream portion of the draft tube, complete with the draft tube gates guides were constructed to minimize interfering with the operation of the existing Unit 7 during the addition of Unit 8.

The Long Pond reservoir dams were raised following the "Bay d'Espoir Flood Analysis and Alternatives Study" completed in 1985. The probable maximum flood (PMF) was found to be greater than the original design flood. This resulted in a crest elevation increase varying from 0.3 m to 2 m on the five dam structures and the construction of a small freeboard dam. The maximum flood level (MFL) also increased on all dams varying from 0.25 m to 1.47 m.

Both powerhouses are operated in parallel from the control room of Powerhouse 1.

The scenario considered in this feasibility study is to add a 150 MW unit with a 102 m^3/s design flow to Powerhouse 2. It comprises the following elements:

- An enlarged headrace channel including a bifurcation excavated in the rock and supplying both the existing entrance channel to Unit 7 intake and the new entrance channel to Unit 8 intake;
- A new water intake nearly identical to the existing intakes;
- A new buried steel penstock connecting the new intake to the new generating unit;

South of existing Unit 7, Powerhouse 2 will be extended to include the addition of Unit 8, including its own new service bay.

A high voltage line will be built from Unit 8 step-up transformer to Terminal Station No 2 (TS-2) as well as the addition of a new breaker-and-a-half diameter in the switchyard to receive the new line.

Drawing 647756-0001-41DD-0004 shows the longitudinal profile of the new facility. The new facility benefits from the existing powerhouse forebay and does not require the construction of any additional dams.

2.2 Site Geography Overview

The area of Bay d'Espoir power station is at the end of the bay of the same name in a forested region with few small communities.

2.3 Site Access

The Bay d'Espoir complex is located few kilometers from the provincial road 361 and can be accessed by a municipal road. It is the only permanent access to the site.

All equipment and materials can therefore easily be transported by boat and road to the site. Furthermore, the step-up transformer of Unit 7 was replaced last year and was transported by special truck to its base behind Powerhouse 2 through the road behind Powerhouse 1. Therefore, it can be assumed that there would be no weight constraints to bring all equipment to site.

The road between Powerhouse 1 and Powerhouse 2, which give access to the existing service bay of Powerhouse 2, and to the step-up transformer of Unit 7, will be closed from the beginning of the excavation works until the completion of Unit 8 first stage concrete, the closing of the building envelope (Powerhouse 2 superstructure extension) and the backfill of the downstream portion of the new penstock.

During this period, access to the plant would be possible from a bypass road starting before the control gate at the entrance of the complex which leads to the water intakes, and then join the road which runs along and crosses the penstocks, to finally reach Powerhouse 2. The condition of this road as well as the rest of the road to access the intakes will require at least a resurfacing with 30 cm of 0-100 mm crushed stone or equivalent, and drainage improvement, which will be part of the preparation work to allow efficient access to both the intake and Powerhouse 2.

For the excavation and construction of Powerhouse 2 extension, almost all the traffic will have to go through either the draft tube deck or the road behind Powerhouse 1. Both of these roads are single lane and the capacity of the tailrace deck is limited to 15 tons. Traffic will have to be controlled and will add to the challenge of the project. Moreover, the clearances in width and in height of the road behind Powerhouse 1 are quite limited due to cable trays near the south end of the powerhouse which may prevent the transport of larger pieces through that road. This might become problematic for the transportation of some of the larger pieces such as the runner. In this regard, in the next engineering phase, it would be wise to determine what can be done with these cable trays to enlarge and raise the clearance of the passage. An allowance of 300k$ has been included in the cost estimate to cover mitigation measures related to these cable trays.

2.4 Site Location

2.4.1 Site Climate Overview

According to Statistics Canada, the area where the Bay d'Espoir station is located is characterized by an annual average temperature of 4.9°C with normal daily minimum varying from -11.9 °C in February to 10.7 °C in August and normal daily maximum varying from -1.3 °C in January to 22.3 °C in August. Extreme temperatures can reach -33 °C in January and February and 33 °C from July to September.

Average total year precipitation is 1570mm, of which 84% falls in the form of rain. Even in January and February more than 50 % of precipitation falls in the form of rain. Precipitations are fairly distributed over the year with a slight increase during fall.

2.4.2 Population Profile and Social Infrastructure

The main communities in Bay d'Espoir are:, Milltown, Morrisville, St. Alban's (formerly Ship Cove), St. Joseph's Cove, St. Veronica's and Conne River (First Nation). The total population of the latter communities amounts to approximately 3000 inhabitants. Other communities are also within 50 km of the site for a total population nearing 5500 inhabitants.

As far as population is concerned, the region represents about 1% of the population of Newfoundland and Labrador.

Public and commercial services are minimal in the region and cannot support lodging and restauration for the work force required for a project of such a scale.

As for the work force, the great majority will have to come from elsewhere in the province and from outside of the province.

The nearest hospital is in Grand Falls Windsor, located at approximately 168 km from site, which is about a 2-hour drive.

2.5 General Infrastructure and Other Site Services

2.5.1 General Infrastructure

As far as the energy infrastructure is concerned, the region is serviced by an electrical distribution network. Further, gas stations are available in the precinct of the project site.

The Bay d'Espoir Power Plant has all the infrastructures required to supply the construction needs for electricity.

2.5.2 Transportation

A single road (Route 361) connects the region to the Trans-Canada Highway (Highway 1) to get to Gander and St.-Johns on the east side and Port-aux-Basque on the west side to get the ferry for North Sydney, Nova-Scotia. Local roads also link the project area to the different local communities.

The nearest major airport for regular commercial use is located in Gander, which is located approximately 220 km from site. There is also an airfield in Bay d'Espoir. Nevertheless, the latter can accommodate flights only during daylight and when there is no fog, which is rather rare in the region. The air field in Bay d'Espoir is therefore deemed unfit.

Most of the equipment will have to be brought by road from St.-Johns.

People from outside Newfoundland will most likely travel by plane through Gander.

2.5.3 Communications

Since the project site is located in a Newfoundland & Labrador Hydro facility, it is assumed that all communication facilities required for project execution (phone and Internet) will be easily implemented.

2.5.4 Housing

Due to the region's limited resources to meet the lodging and catering needs of the project, a project camp will be required to accommodate the construction staff.

2.5.5 Health

The nearest hospital is in Grand Falls Windsor, which is approximately 168 km from site, which is a 2-hour drive. First Aid and Ambulance services will need to be organized at site.

2.6 Headrace Channel

2.6.1 Existing Channel

The existing channel which feeds the intake of Unit 7 is divided in three (3) sections: (i) a funnelling entrance, (ii) an upstream portion excavated in overburden, (iii) and a downstream portion excavated in rock.

The invert of the funnelling entrance has been set at an elevation of 175.25 m with a width of 60.6 m upstream. The channel slopes down to an elevation of 172.2 m with a width of 24.4 m at its downstream end. The channel sides have been excavated in overburden with a 2H:1V slope.

The upstream portion, excavated in overburden, is 230 m long and has its invert set at el. 172.2 m with a width of 24.4 m and side slopes of 2H:1V. It includes, at its downstream end a transition of 39.6 m long, where the invert slopes down to an elevation of 171.6 m and the width reduces from 24.4 m to 15.25 m.

The downstream portion, excavated in rock, is 366 m long and has its invert at 171.6 m for most of its length with a width of 15.25 m. The channel side walls are excavated with a 1H:6V slope. At 93.1 m upstream of the intake, the invert gradually dives from 171.6 m to an elevation of 163.4 m at 12.2 m upstream of the intake. From there to the face of existing intake 4, the invert remains at an elevation of 163.4 m but gradually enlarges to 15.85 m while the walls become vertical.

The sizing of the headrace channel was originally designed and built to accommodate a single 150 MW unit when Powerhouse 2 was built. It was, at that time, planned that the headrace channel would be enlarged when building Unit 8 and that a new intake and a new penstock would also be required.

With the addition of Unit 8 and the headrace channel maintained to its present dimensions, maximum velocities (Unit 7 & 8 at maximum output) would, depending on reservoir water levels, range between 0.44 m/s and 0.86 m/s in the upstream portion of the channel and between 1.1 m/s and 1.75 m/s in the downstream portion of the canal. It is most probable that maintaining the present channel as is might introduce operating constraints in winter that may offset all the benefits associated with the addition of Unit 8.

In this regard, without knowing the future pattern of operation of Units 7 & 8 nor the future reservoir level management strategy, it is recommended to enlarge the headrace channel on its entire length to eliminate all negative operating constraints.

A detailed optimization of the enlargement required according to the future reservoir level management and future Unit 7 & 8 operating pattern (base production versus peaking production) is recommended in the next phase. This optimization could, in some conditions, yield to a substantial reduction in required excavation and may even eliminate the need for additional excavation.

From the upstream of the headrace channel, where the flow of Units 7 & 8 joins with the flow of Units 1 to 6, a 2D hydraulic model as well as a bathymetric survey would be required at the beginning of next phase to estimate the flow velocities and patterns, and assess that there is no impact on the ice cover in the reservoir following the addition of Unit 8 (and thus increasing the maximum overall flow from approximately 400 m^3/s to 500 m^3/s). The cost for this 2D hydraulic model is estimated at 30 000$ and is excluded from the current mandate. Impacts on the engineering following this analysis will be addressed when the investigations are completed.

2.6.2 New Enlarged Channel

The headrace channel will be enlarged to maintain velocities under 0.65 m/s in the funnel entrance and in the upstream portion of the channel excavated in overburden, where it may be difficult to install ice booms, and under 0.85 m/s (as current) in the downstream portion excavated in rock.

In this regard, the funnel entrance will be enlarged on the left (north) side by 27.45 m, while the upstream portion is enlarged on the left (north) side by 12.2 m and the downstream portion by 16.75 m on the right (south) side which as a result, straightens the original canal.

A bifurcation on the right side (south side) of the channel will also be introduced about 150 m upstream of the existing intake of Unit 7 to connect with the final entrance channel of the new intake of Unit 8. The width and profile of the new intake entrance channel for Unit 8 will be identical to the existing entrance channel of Unit 7. The channel of Unit 8 will be implemented 36.5 m south of Unit 7's channel, which allows to keep a rock pillar width of 21.5 m between the two channels. The new intake entrance channel will end at the new intake approximately 45 m upstream of the existing intake of Unit 7. This implementation of the new intake is necessary to ensure the closure of the reservoir within the rock walls of the new channel since the rock surface slopes down further downstream. The exact location of the intake will be optimized in the next phase, once the results of field investigations, such as the topography of the ground surface and rock surface as well as rock quality are available.

To allow for the construction of Unit 8 intake and to excavate the final entrance channel to the new intake in dry conditions, a temporary rock plug will be temporarily left in place downstream of the bifurcation. The rock plug will be excavated at the end of the construction period, with water on both sides of the plug, once the new intake has been commissioned.

It is anticipated that all headrace channel enlargement excavation upstream of the plug will be performed under water without interfering with the operation of Unit 7. The same assumption applies to the rock plug.

From upstream to downstream, the longitudinal section of the new headrace canal (Drawing 647756-001-41DD--0002) is characterized as follows:

- A triangular horizontal platform will be excavated in overburden at El. 175.25 m, 101.7 m long on the left side and 88.45 m wide at its downstream end, 535.7 m upstream of the bifurcation.
- A funneling section will be excavated in overburden, 72.1 m long narrowing from 88.45 m to 36.6 m with a 45.98 m long downslope from El. 175.25 m to El. 172.20 m and a 26.17 m long horizontal surface at El. 172.20 m.
- A 190.7 m long, 36.6 m wide, horizontal platform will be excavated in overburden at El. 172.2 m.
- A 39.6 m long transition where the channel goes from will be excavated in overburden to fully excavated in rock and where the width changes from 36.6 m to 32.0 m and the invert changes from El. 172.2 m and El. 171.6 m.
- A 233.27 m long horizontal platform will be excavated in the rock, 32.0 m wide at El. 171.6 m ending at the bifurcation.
- A 39.5 m long platform will be excavated from the bifurcation towards new intake, 15.25 m wide at El. 171.6 m, ending 80.8 m upstream of new intake face.
- A 60.4 m long at 13.6% will downslope from El. 171.6 m to El. 163.4 m.
- A 12.2 m long trash trap will be excavated ending at the upstream face of the water intake, with its floor set at El. 163.4 m.

2.7 New Water Intake

2.7.1 Civil Works

The new water intake shown on Drawings 647756-0001-41DD-0003 will be a reinforced concrete structure with 2 openings and a central pier ending before the gate. The structure will be totally embedded in a trench excavated in the rock and the penstock will be embedded in the downstream part of the intake. The upstream deck will be capable of accommodating a crane truck for debris removal.

The new water intake will use the same geometry as for the four (4) existing intakes with the same two shafts arrangement. However, minor changes will be introduced to adapt to the existing topography and to the new reservoir water levels:

- The new intake will be implemented about 45 m upstream of the current location of the intake of Unit 7 to ensure that the reservoir closure is maintained within the rock walls of the new entrance channel. South of the existing intake in the axis of the new intake, the rock is lower and therefore a concrete wall will be required on the right side of the channel to ensure the reservoir closure if the intake had been implemented at the same PM as for the intake of Unit 7. The exact location of the intake must be optimized in the next phase, once investigations providing a good topography of the ground surface and rock surface as well as rock quality are completed;
- The length of the new penstock embedded in concrete will be increased by 45 m downstream of the intake to have the end of the penstock embedment at the same PM as for Unit 7 and thus will allow building a deep fill above the penstock on a longer distance to maintain the access at an elevation of 184.4 m to the intake of Unit 7.

The water intake will thus be equipped with a gate that can interrupt the flow towards the powerhouse, as well as with two trash racks, separated by a concrete pier, to block off the debris carried by water. Moreover, grooves for stop logs will be located downstream from the trash racks, on both sides of the middle pier, to isolate the gate during inspection and maintenance.

The gate submergence is considered adequate and thus no air should be sucked in the penstock; an intermittent vortex with no consequences may however appear during minimum water level condition. The submergence of the new trash racks is marginally deficient at minimum water level. At this level, as for existing intakes, debris or floating ice may be prone to be sucked down on the trash racks. However, according to comments from NLH employees during the site visit, it does not seem to be a problem for the 4 existing intakes. The enlargement of the headrace channel will ensure a stable ice cover for all conditions and ensure that the trash racks do not get blocked by floating ice.

At the gate, the new sluice will be 5.18 m wide and 5.18 m high. Upstream from the gate, the waterway will be divided in two (2) by a central pier and will have the shape of a 7.3 m long funnel with a width of 12.00 m and a height of 12.80 m at the upstream face of the trash racks. Downstream from the gate, a 4.27 m long concreted transition will allow the flow to pass from a square section, 5.18 m x 5.18 m, to a circular section, 5.18 m in diameter. The penstock will start at the end of the transition, however, it is embedded in concrete and is considered as part of the intake for a length of 60.00 m. This length, results from the necessity to maintain closure of the reservoir to keep the downstream end of the penstock at the same location as for the existing intake of Unit 7. This is required in order to maintain the access road to the existing intake. This length may be reduced when the location of the intake is optimized in the next phase following a survey of the rock profile.

Above the new waterway, there will be three (3) shafts: one (1) for the vent, one (1) for the gate, and a third one for the stop logs. In the detail engineering phase, the shafts for the gate and the vent may be combined by changing the seals of the gate from downstream seals to upstream seals; this would result in cost savings.

A hoist with an electrical equipment room will be located in a hoist house on top of steel towers directly above the gate shaft. (not shown on drawings). The elevation of the hoist will be such that the gate can be lifted out of the intake for maintenance when required.

An air vent building will also be installed on top of the air vent shaft to accommodate air displacements produced by the de-watering and filling operations of the penstock while limiting the air flow speed at 30 m^3/s during the emergency de-watering.

2.7.2 Mechanical Equipment

The new water intake will include the following mechanical equipment:

- 2 sets of trash racks with embedded parts;
- 2 sets of embedded parts for the stop logs (the stop logs and the spreader beam of the existing 4 intakes will be used);
- A wheel gate with embedded parts;
- A cable hoist for gate operation with its tower and hoist house.

2.7.2.1 Trash Racks

A set of trash racks will protect the water intake entrance against floating debris in the river and will comprise eight panels that pile up one above the other in the embedded parts. Each panel can be handled with a 75 ton mobile crane and the spreader beam provided with the trash racks and will be stored on the water intake platform.

Each set of embedded parts of the trash racks will comprise two side guides, including the bearing blocks, as well as the guiding surfaces for the upstream, downstream and side shoes, and a pair of longitudinal beams at the sill supporting the trash racks.

2.7.2.2 Stop Logs

A new set of stop logs will be provided for the new Intake.

Each of the 2 sets of embedded parts for the stop logs will include:

- Two side guides, including the bearing block for the stop logs bearing pads, the sealing surface in stainless steel and the guiding faces for side shoes and upstream leaf spring and shoes;
- A sill beam with the sealing upper face machined in stainless steel;
- A lintel with the horizontal sealing face machined in stainless steel.

2.7.2.3 Gate

The water intake gate will be used to isolate the penstock or the generating unit from the upstream forebay for inspection or maintenance purposes. It will also be used as the emergency closing device to protect the generating unit in case of a closing default of the turbine wicket gates and to protect the powerhouse against an eventual flooding originating from the upstream forebay.

During normal operation of the power station, the water intake gate will remain open. It will be maintained in such a position that the bottom edge is located some 300 mm above the lintel, so as not to affect the flow.

During the inspection and maintenance of the penstock or spiral case, the gate will be lowered by the cable hoist at the normal lowering speed, to maintain hydrostatic balanced condition.

A fill valve will be provided for initial filling of the penstock. The gate will also be used in cracked position (about 200 mm opening) for filling completely the penstock.

The flat type water intake gate will be a shield plate welded to the main beams and side posts on which the main wheels with self-lubricating bearings will be mounted. The shield plate and sealing joints will be set downstream as for other intake gates. The opportunity of having shield plate and sealing joints located on the upstream side to get the gate shaft and vent shaft combined should be analysed in the next phase. The current estimate allows for the same two shaft arrangement at the intake.

The new set of embedded parts for the gate will include:

- Two side guides, including the stainless steel runway for the wheels, the sealing surface in stainless steel, the guiding faces for side wheels and shoes, as well as for upstream shoes;
- A sill beam with the upper sealing face machined in stainless steel;
- A lintel with the horizontal sealing face machined in stainless steel.

2.7.2.4 Cable Hoist

The water intake gate will be handled by a cable hoist at two lifting points.

The hoist design capacity will be sufficient to overcome the weight of the gate and accessories, as well as the frictional force of sealing joints and main wheels.

The cable hoist will include an electrical motor driving two bull wheels with an adequate gear reduction set, an electromagnetic brake with a torque corresponding to 150% of the motor design torque to maintain the gate in total or partial opening position, and a ventilator brake with adjustable louvers whose function will be to limit the free falling speed of the gate in case of emergency closure to stop the flow entering into the unit.

2.7.3 Electrical Supply

An existing 25 kV aerial distribution line coming from the powerhouse with 25 kV/600 V transformers ensures the electrical supply of the existing water intake for Unit 7.

For the new water intake, the 25 kV line will be extended to the new intake and a new set of 25 kV/600 V pole-mount transformers will be installed. The transformers will supply a 600 V distribution panel used as an electrical supply source for the various loads of the water intake.

A distribution transformer will lower the supply voltage of the water intake to permit a distribution at 208/120 V.

The motor and heating loads will be supplied from the 600 V distribution panel.

2.8 Steel penstock

The new steel penstock (Drawing 647756-0001-41DD-0004) will be buried into a trench in the ground. It will be 1092 m long for a horizontal length of 1072 m and a differential height of 168.1 m. There will be no surge tank tied to the penstock. The inside diameter will be 5.18 m for the first 324.87 m, then will reduce to 4.75 m for 393.57 m and 4.42 m for 355.61 m before ending with a diameter of 3.76 m for 17.76 m to connect with the spiral case with the same inlet diameter. Transition from one diameter to the next will be integrated in elbows.

In plan view, the two (2) penstocks, existing and new, will be 36.5 m apart at the intake. The new penstock will converge toward the existing one at an angle of 2.3° until it reaches a spacing of 18.44 m. From there, the new penstock will run parallel to the existing one until it connects to the spiral case steel liner.

The thickness of the steel lining will vary from 13 mm upstream to 40 mm at the junction with the spiral case. For the purpose of the present study and since the geometry of the new penstock is very similar to Unit 7 penstock and the head losses (5.65 m) as well as the water hammer (overpressure less than 30% of the gross head) were almost identical, the design of the existing penstock was used for the proposed new one with reductions in the thickness of some sections to account for a higher grade of steel easily available today.

The exact ground surface and rock profiles along the new penstock were not available so they were assumed to be similar to Unit 7 since the new penstock is located 36.5 m from the existing penstock at the intake and only 18.44 m from the powerhouse. For the purpose of this study, this is assumed to be a reasonable assumption.

As shown in the as built drawings of Unit 7, the required rock excavations near the powerhouse to lay the new penstock were executed at the same time as the rock excavations for the extension of powerhouse 2, which was part of a pre-investment during construction of Unit 7. Only minor rock excavation is thus anticipated at the powerhouse.

However, in order not to unearth and destabilise the penstock of Unit 7 near the powerhouse and because everything was designed to allow for the entire construction of Unit 8 without affecting the operation of Unit 7, a concrete wall will need to be constructed near the powerhouse between the existing and the new penstock. The cost of that wall is included in the cost estimate.

It is expected that the steel penstock will be delivered to site in half-moons 3.0 m to 3.6 m long (3.6 m being the normal largest width in which plates are delivered from mills) with their internal temporary spiders. These sections will then be assembled and welded together in a site shop to make sections about 18.0 m long before being placed by crane into the trench then welded together and buried.

LIDAR and bore holes as well as soil investigations along the axis of the new penstock are recommended at the beginning of next phase to define the ground surface and rock profile as well as the soil properties in order to proceed with the optimisation of the penstock profile.

2.9 Powerhouse

2.9.1 General

The initial construction phase of Powerhouse 2 was completed in 1977 and included a 14.0 m x 18.0 m service bay at El. 11.58 m and a 150 MW generating unit (Unit 7) with its generator on the generator floor at El. 7.92 m. The access to the service bay is on the north wall of the powerhouse and consists of a 6.1 m wide x 6.1 m high overhead door. The effective area of the existing service bay is limited by a low structural capacity 5.65 m x 8.5 m hatch cover. Moreover, the existing generator is in an hexagonal steel encasement resting on the generator floor at El. 7.92 m instead of being, as in modern powerhouses, encased in a square concrete room with the service bay slab extending all around that generator room, thus further limiting the surface of the service bay.

As a pre-investment and to prevent closure of Unit 7 for the major construction period of the addition of a second 150 MW unit (Unit 8), the rock excavation for the future Unit 8 and its penstock as well as the concreting of the outlet portion of the draft tube with the downstream wall of the powerhouse up to the draft tube deck were executed at the time of construction of Unit 7.

The major constraints regarding the 150 MW extension of Powerhouse 2 are imposed by the existing construction. While the pre-investment allows for continued operation of Unit 7, it also introduces the following constraints:

- The original draft tube geometry has to be maintained for the new unit despite the fact that it is not optimal according to modern standards. The draft tube cone geometry would be the only optimization possibility;
- Considering the very limited space in the existing service bay, the surface is not wide enough to simultaneously erect the rotor, the thrust bearing, the head cover with the cone and the stay ring, while allowing entry to a long-load dolly inside the building to bring in other powerhouse equipment. Therefore, the need of an additional service bay south of the new Unit 8 becomes obvious in order to mitigate the impacts of the construction on the operation of the unit 7. If no additional service bay is to be provided, Unit 8 can still be erected.

However, the existing bay will be completely occupied and unit 8 assembly time will be increased. Moreover, if any unplanned maintenance of Unit 7 requires space in the service bay, the repairs will have to be postponed until the erection of Unit 8 is almost complete, or the erection of Unit 8 will need to be delayed until Unit 7 is repaired with all the additional cost or loss of revenues implied. The addition of a second service bay will allow the partial construction of the new stator in one of the service bay simultaneously with the assembly and concreting of the spiral case, thus reducing the construction time by about a month and a half.

The new unit will be located adjacent (south) of the existing unit and will be embedded in rock upstream and south. The additional service bay, which has the same size as the existing service bay, will be located south of Unit 8 and will be accessed by a 6.1 m x 6.1 m multi-blades door on the new south wall. The existing access road behind the powerhouse will be temporarily dismantled at the beginning of the excavations and will be restored at the completion of the building and backfills around the powerhouse. Access to the existing powerhouse 2 Unit 7 during construction will be through the upgraded bypass road (midway up penstock 4). This bypass road was not considered for the construction of the Unit 8 as it would increase the project cost and schedule.

The only access to the powerhouse 2 Unit 8 extension during construction will be behind or on the draft tube deck of Powerhouse 1.

The 17.2 m wide and 38.1 m long powerhouse extension (Drawings 647756-0001-41DD-0010 to 0018) will include a concrete infrastructure going from the draft tube bottom at El. -10.36 m to the main floor at El. 11.58 m. From the level of the main floor to the roof parapet at El. 25.0 m, the building will consist of a steel superstructure with a conventional roof made of a steel deck covered by insulation and a modified bitumen membrane. The overall height of the powerhouse will be 35.4 m.

The step-up and auxiliary transformers will be located outside, upstream of the powerhouse, 0.6m above the main floor level.

2.9.2 Excavation

When erecting the existing Powerhouse 2 sheltering Unit 7, the rock excavations required for Unit 8 as well as the rock excavation required for the future penstock were done as a pre-investment together with the construction of the downstream outlet portion of the draft tube. The Unit 8's excavations were then filled with random fill material up to the draft tube deck (El. 4.27 m). Upstream as well as south of Unit 8, the fill was raised up to El. 11.6 m to provide an access road from Powerhouse 1 to the main door of Powerhouse 2 through the north side of the powerhouse.

Consequently, almost no major rock excavation is anticipated for construction of the new unit 8. Only minor rock excavation for the new oil separator under the new step-up transformer and for the additional bay at elevation 7.32 m south of Unit 8 under the additional service bay will be required. These rock excavations represent a volume of approximately 250 m^3.

The required excavations thus mainly consist of overburden excavations.

Because a new service bay is required south of Unit 8, overburden excavation will extend further south to build the additional service bay and to reinstate the access road behind the powerhouse after the construction completion. As a consequence, the embankment between Station Terminal 1 and Powerhouse 2 will be trimmed at a slope of 2H:1V and the access road between Powerhouse 1 and Powerhouse 2 will need to be lowered to elevation 11.6 m south of Powerhouse 2. This access road will be lowered by two or three meters over a distance of 50m

The following works are required to be completed before starting the excavation:

- The upgrade of the bypass road. The existing road behind Unit 7 will be unusable from the beginning of the excavation until completion of powerhouse first stage concrete and closing of the building, including completion and backfill of the downstream portion of the penstock;
- The permanent displacement of one (1) pylon of Unit 7 located within the excavation print of the new penstock;
- The temporary relocation to a temporary aerial route of all the underground cables between Powerhouse 2 and Terminal Station1. The existing concrete duct bank need to be

demolished and rebuilt to perform the required excavation and construction of the powerhouse extension. This temporary line will be replaced by a permanent duct bank. An allowance of 600k$ is included in the cost estimate for this temporary aerial route (construction and dismantlement).

- The construction of a temporary retaining wall to prevent unearthing and destabilizing the penstock of Unit 7 while excavating the trench for the new penstock;
- Mitigation plan for the cable trays area upstream of PH-1.

In total, the overburden excavation of the powerhouse will represent a volume of about 25,000 m³.

The permanent excavation will slope in the overburden are 2H:1V. The excavated slopes will be subsequently covered with a geotextile membrane and a 0.6 m thick layer of 0-300 mm rock fill, acquired from the rock excavations, to protect them against erosion.

The excavated material storage areas are not yet identified but were assumed to be less than a kilometer by road from site. Part of the excavated materials will be re-used to bury the penstock and for the backfills around the powerhouse.

2.9.3 Concrete Infrastructure (under El. 12.2 m)

The concrete infrastructure of the powerhouse is defined as everything that is under the main floor at El. 11.58 m and the step-up transformer floor at El. 12.2 m. It includes the draft tube elbow (the outlet has already been built at the time of construction of Unit 7), the draft tube cone, the embedded concrete around the spiral case and the generator foundation, as well as the different powerhouse floors, i.e. the main floor (El. 11.58 m), the generator floor (El. 7.32 m), the turbine floor (El. 3.71 m), the spiral case access floor (El. 0.30 m) and the draft tube cone access corridor (El. –2.74 m). The oil retaining basins and bases of the transformers, located behind the powerhouse, are also part of the powerhouse infrastructure, as well as the transformers firewalls.

Draft Tube

The new draft tube will include a cone, an elbow and an outlet. However, the outlet, together with the downstream wall of the powerhouse, up to the draft tube deck at El. 4.42 m, is already built. (See Drawing 647756-0001-41DD-0010 & 0018).

The draft tube cone will be steel lined and installed in second stage infill concrete.

The elbow will serve as a transition between the circular section of the cone and the rectangular section of the outlet.

The 9.5 m long draft tube outlet will be separated in the middle by a pier and its invert will be horizontal and set at El. -9.45 m. The draft tube outlet will also be closed by two gates located 10.26 m downstream of the unit centreline, with combined sections of 3.53 m high by 7.12 m wide and flow velocities of 4.05 m/s. At the downstream end, the combined section will be 4.80 m high by 7.12 m wide and the velocities will be 3.00 m/s.

According to modern standards, the draft tube geometry is not optimal, but it cannot be changed without demolishing the existing outlet and proceeding to major rock excavation that may destabilize the existing unit and require a downstream cofferdam, thus closing Unit 7 for more than 2 years (estimated). In this regard, the best and only option is to keep the actual draft tube geometry. The actual geometry generates an additional head loss of about 0.65 m compared to modern draft tube geometry. However, it is possible to gain back approximately 0.3 m of that head loss by adding a concrete wall downstream of the draft tube gates to prevent water recirculation through the gate slots in the roof of the draft tube. In this regard, it is planned to install precast panels on the downstream face of the draft tube piers to close the space between the draft tube roof and the draft tube deck. The solution could also be applied in retrofit to Unit 7 (excluded from current project).

Spiral Case Embedding Concrete

The embedding concrete of the spiral case will be poured as second stage reinforced concrete (see Drawings 647756-0001-41DD-0010 & 0016). It will be placed with the spiral case pressurized at 60% of its maximum internal service pressure including water hammer. The steel liner will however be designed to support the whole hydrostatic pressure and will be pressuretested at 125% of maximum service pressure including water hammer. The concrete will be designed to support equipment loads and to withstand the part of internal pressure exceeding initial pressurization of the steel lining during concreting.

The installation of the spiral case will be done after the closure of the building and the commissioning of the overhead crane rails and bus bars, so the existing 270 T overhead crane for Unit 7 can travel above Unit 8 and the new service bay. The downstream portion of the penstock, as well as the draft tube cone liner, will also need to be installed and concreted before installing the spiral case.

In spite of the fact that the generator floor cannot be entirely poured before the concreting of the spiral case is completed, part of the floor south and upstream of Unit 8 will be poured beforehand to permit the erection of the superstructure and the installation of the rails as well as the closure of the building.

Main Floor

The main floor (Drawing 647756-0001-41DD-0013), located at El. 11.58 m, will include the following structural elements:

- The new service bay, fed by a 6.1 m x 6.1 m overhead door located on the south wall;
- A walkway downstream of the unit connecting with the walkway of Unit 7;
- The exterior transformer floor with the transformer bases and transformer oil collecting basins upstream of the powerhouse building and set at El. 12.19 m, 0.61 m above the transformer floor of Unit 7.

The floor will be designed as a slab-beam assembly supported by a downstream wall and columns. Although a portion of the service bay slab will be poured on compacted soil, it is designed as if no soil was underneath to account for the possible settlement of the backfill.

The floor surface is not large enough to place the rotor, the thrust bearing, the head cover with the cone and the gate ring, as well as the runner simultaneously, while allowing entry to a long-load dolly inside the building. But considering the availability of the existing service bay, it is assumed that there will be sufficient space for the erection of the group simultaneously with the unloading of all auxiliary equipment with still some place remaining for the maintenance of Unit 7.

The design loads for the service bay area are as follows:

- Uniform load of 75 kPa;
- Point loads of 300 kN at 2.0 m c/c in each direction;
- The ring plate on which the rotor must be set will be located above a column to provide adequate structural support.

Generator Floor

The new generator floor (Drawing 647756-001-41DD-0014) will be located at El. 7.32 m and will be set 0.60 m lower than the existing generator floor. However, in the new layout, the floor underneath the step-up transformer and the station service transformer will be 0.60 m higher than in the existing layout in order to have the entire floor at the same elevation. (The exterior transformers floor is 0.60 m higher than the new service bay and the existing main floor.)

The generator floor will include the following structural elements:

- Generator floor around the generator housing;
- Generator housing, including stator bases and the brake pedestals bases for the brake-jacks of the rotor.

Between the concrete columns supporting the steel columns of the superstructure, the south concrete wall of the existing powerhouse building will be demolished down to El. 7.93 m corresponding to the elevation of the existing generator floor of Unit 7.

Within the bays of Unit 8, the floor will consist of a flat slab supported on walls on the sides and on the turbine shaft mass concrete, above the spiral case concrete encasement and having the same size as the generator housing. South, the floor will extend an extra bay under the service bay and it is designed as a slab on rock. Upstream the floor will extend under the transformers floor and is designed as a flat slab supported by columns and walls supported by the rock and the concrete mass embedding the spiral case.

Most electrical equipment will be installed on that level, as well as the oleo-pneumatic system of the governor and the compressed air system for the draft tube water depression system.

Two (2) hatches with large capacity covers will be incorporated in the floor design to bring material to lower floors with the overhead crane. The first one, 2.4 m x 3.0 m, will be located in the downstream north corner above the pressure relieve valve at the spiral case access floor. The second, 2.1 m x 1.8 m, will be located in the downstream south corner and will be used to lower material to the turbine shaft and the spiral case during maintenance as well as lower equipment to lower floors.

Turbine Floor

The turbine floor (Drawing 647756-0001-41DD-0015) will be set at El. 3.71 m and will be designed as a structural slab supported by concrete mass embedding the spiral case in the middle and by walls on the periphery. The floor will also extend upstream as a slab on rock. This floor will be mainly used for installing auxiliary mechanical equipment including all water services (cooling, fire protection, etc.).

The Turbine floor will also give access to the turbine shaft (El. 2.60 m) by a stairway located at 2 o'clock looking downstream.

The two (2) same hatches as on the generator floor will also be used to handle material to the spiral case access floor with the overhead crane.

At this level, there are actually two (2) doors on the south walls of the existing building giving access outside. Once Unit 8 is constructed, these doors will allow access from one turbine floor to the other one. It is planned to open a third door in the concrete wall to ease communication between both units.

Spiral Case Access Floor

The spiral case access floor (Drawing 647756-0001-41DD-0016) will be located at El. 0.31 m and will consist of either a slab on rock, south of the spiral case or mass concrete above the draft tube downstream of the spiral case. In addition to the spiral case access door located at 2 o'clock looking downstream, this floor will also support the pressure relieve valve connected to the spiral case at 10:30 o'clock.

An opening 3.0 m wide will be made near the downstream end of the south wall of the existing powerhouse to allow communication with the same floor of Unit 7.

This floor will also give access at its upstream end with a stair to a gallery at El. -1.83 m going under the penstock at the entrance of the spiral case where piping connects to the spiral case for unit cooling water and fire protection as well as for drainage of the penstock when it is emptied. Since this gallery is a dead end, a vertical shaft with a ladder at the end of the gallery will allow access to the turbine floor in case of emergency.

Cone Access Corridor

The cone access corridor (Drawing 647756-0001-41DD -0017) will be set at El. –2.74 m and will give access to the draft tube cone at 9 o'clock looking downstream through a 0.9 m x 0.9 m door located at El. –2.15 m. The access to that corridor will be from Unit 7 through a corridor planned in this regard at the time of construction of Unit 7. A concrete plug in the existing south wall of Unit 7 will need to be demolished to get access to the new corridor. The beams used as a base for the runner maintenance platform will be permanently stored on the floor on each side of the corridor, so that they can be rolled in place through 2 other openings when needed.

An existing drop shaft with hatch cover at each floors of Unit 7 will allow handling material to the draft tube gallery of Unit 8.

2.9.4 Steel Superstructure

Above El. 11.58 m, the building will be a steel superstructure covered by a concrete precast facing and a roof constructed on a steel deck.

The runway of the overhead travelling crane, located at El. 18.479 m, will be an extension of the existing runway and will be part of the superstructure. Its lateral and longitudinal stability will entirely be provided by the steel structure.

The superstructure will support all roof loads, including the loads of the different mechanical and electrical components (lights and ventilating units) as well as the loads incoming from the cables of the 230 kV power line.

The superstructure of the Powerhouse extension, to house Unit-8, will be, in structural terms, independent of the existing structure (which houses Unit-7), by the addition of a double column at the junction of the extension (axis 7b as shown on drawing 647756-0001-41DD-0011). The new superstructure will be designed in conformity with the actual codes and standards.

It is assumed that the structural integrity of the existing superstructure is adequate, and that the existing powerhouse does not require modifications. The new structure will be composed of 6 rigid frames and one braced end wall. The frames will be spaced at 6.1 m except for the northeast one adjacent to the existing structure (axis 7B) which is 5.08 m from new axis 8 and 1.02 m from existing axis 7. All frames will be made of double columns and deep girders.

The columns supporting the overhead travelling crane beam will be W360x162 (presently available sections equivalent to those of the existing building) while the columns supporting the roof will be W360x287 (10 col.) or W360x314 (4 col.) for the bay supporting the steel frame for the overhead lines to the existing 230 kV switchyard.

The roof beams will be W920x223 and will have a span of 16.56 m. The overhead travelling crane beam will have a depth of 1.1 m and will be built up with 2 different flange sizes.

The upstream-downstream stability of the building will mainly be provided by the rigid frames and bracings in the roof that ensure simultaneous participation of all frames to the lateral loads. The north-south stability will be provided by X bracings in the upstream and downstream walls of the powerhouse, as well as X bracings in the upstream and downstream columns supporting the crane beams. An expansion joint will be provided between the new and the existing structure.

2.9.5 Architecture

As per the existing powerhouse building, the exterior powerhouse walls of the new extension will be made of uninsulated precast concrete panels. The vertical load of the panels will be supported by panels bearing on each other while the lateral loads and stability of the panels will be ensured by having the panels tied to the steel columns.

The powerhouse roof will be made of steel deck on steel purlins. It will be covered by a roof made of a 13 mm thick gyp-lap, a 75 mm thick rigid insulating material, and a modified bitumen membrane.

The existing wall at the south end of the existing building will be dismantled when the walls and the roof of the extension are completed except for the expansion joint between both structures which will be completed after removal of the existing wall.

2.9.6 Generating Unit

The new Unit 8 will be equipped with a Francis type turbine with the following characteristics:

Rated flow:	102 m^3/s
Gross design head:	179.75 m
Net design head:	173.5 m
Rotating speed:	near 225 rpm
Firm capacity:	154 MW at generator terminals

The turbine will include a steel spiral case, with an inlet diameter of 3.76 m.

The drive mechanism of the stainless steel guide vanes will be actuated by two servomotors and a gate ring.

The bottom ring and head cover will be made of mild steel.

The turbine shaft will be mechanically welded and equipped with a guide bearing and a stainless steel sleeve at the sealing joint.

The digital speed governor, supplied with the turbine, will include a hydro pneumatic reservoir, a sump and an oil pumping system, as well as all required piping, valves, fittings and control mechanisms. Since there is no surge tank with the penstock, to limit the overpressure in the penstocks at the unit to 30% of the gross head, the closing time of the wicket gates, excluding the cushioning, will be set to 15 seconds minimum.

The draft tube cone will be covered with a mild steel lining in the zone where the average water speed is above 7.5 m/s.

The generator will be a vertical axis type with an output of 172 MVA and a power factor of 0.90; it will deliver 60 Hz current at 13.8 kV, 3 phases, star connected, with a high-resistance grounded neutral.

Stator windings will be of the bar type, with bus bars transposed by the Roebel method. Bar lifting and replacement will be possible without removing the rotor or other major component

The stator and rotor insulation will be class F and the operating temperature will be less than 105°C. The cooling will be provided through air-water heat exchangers.

The excitation system will be static type, including an excitation transformer and a Unitrol type voltage regulator. The excitation system and excitation transformer will be located on the generator floor.

A deluge-type fire protection system, with a pre-assembled Fireflex cabinet, will protect the generator.

Provision of a model test and site performance test are included in the estimate.

2.9.7 Pressure relief valve

To limit the overpressure in the penstock and the spiral case to 30% of the maximum gross head, as for Unit 7, a pressure relieve valve will be connected to the spiral case and will be capable of discharging 10.2 m^3/s corresponding to 10% of the maximum unit flow. It will be connected to the spiral case between 1 and 2 o'clock looking downstream and located in the north downstream corner of the unit. An opening in the downstream wall of Unit 8 with guides to install a gate for the discharge of the pressure relief valve has already been planned when constructing the draft tube diffuser and the downstream wall of Unit 8. In this regard, the location of the equipment is already imposed.

Preliminary water hammer simulations have shown that it may be possible to eliminate the pressure relief valve by imposing a closure time longer than 15 seconds (excluding the cushioning time). This should be reviewed in the next detailed engineering phase.

2.9.8 Overhead Travelling Crane

A 270 T overhead travelling crane equipped with two auxiliary hoist of respectively 40 T and 10 T is already in service in the existing powerhouse. The rails and bus bars will be extended in the new building extension so it can service Unit 8 as well as the new service bay.

2.9.9 Auxiliary Mechanical Systems

The auxiliary mechanical systems of the new powerhouse will include the following systems:

- Raw and cooling water system;
- Shaft seal water system;
- Fire protection system;
- Drainage system;
- Piezometers system;
- High pressure compressed air system;
- Depression compressed air system;
- Heating, Ventilation and Air Conditioning (HVAC) systems.

2.9.9.1 Raw and cooling water system

The schematic is presented on drawings 647756-DEMO-46DD-0001.

The raw water system will supply water to the following systems:

- Turbine/Generator (T/G) cooling water system;
- Shaft seal system.

The cooling water system will supply water to the following systems:

- Generator air coolers;
- Generator guide and thrust bearings.

Description of raw water system

The powerhouse cooling water will be provided from the raw water fed through embedded piping from one tap on the unit 8, taken off the top of the makeup piece between the pressure conduit and the spiral case.

The raw water tap will be equipped with an isolating valve, two pressure reducing valves, a self-cleaning motorized strainer, and a by-pass with a manually cleaned strainer. The raw water will be filtered to retain particles larger than 0.8 mm.

The backwash of the self-cleaning motorized strainer will be directed to the powerhouse drainage sump of Unit 7.

Description of the T/G cooling water system

Water for cooling the T/G Unit 8 will be fed from the raw water pipe with an independent branch for the generator air coolers and for turbine and generator bearings.

Cooling water supply to Unit 8 will be controlled by a motorized shut-off valve located on the main cooling water discharge of the T/G unit.

The discharged cooling water will be sent to the tailrace through embedded piping to discharge through the downstream wall of the Powerhouse below the minimum tailrace water level.

Raw water system operation

Normal operation:

- When Unit 8 is operational, the system will supply the flow for cooling the T/G Unit 8 and the shaft seal water system;
- Two stages of pressure reducing will be required. The first stage will reduce the pressure from 1750 kPa to 860 kPa to allow for adequate operation of the filtration. The second stage will reduce the pressure from 860 kPa to 350 kPa to supply adequate pressure to the T/G cooling system of the unit.

Strainer operation

- The self-cleaning motorized strainer will be the primary filter. If the self-cleaning motorized strainer is out of operation, the filtration can be performed by its parallel manually cleaned strainer.

Cooling water system operation

Normal operation:

- The cooling water will be fed from the raw water header;
- Flow meters and motorize valves, provided by T/G supplier, will be installed on the downstream side of each of the two banks of the generator coolers to modulate water flow in T/G cooling water system;
- For T/G unit shut down, a motorized shut-off valve will be located on the main cooling water discharge pipe.

2.9.9.2 Shaft seal water system

The schematic is presented on drawings 647756-0001-46DD-0001.

Description of shaft seal water system

The shaft seal water system will be fed from the raw water system through an independent branch.

Two sand filters will be provided to retain particles 25 microns and larger, with each filter capable of handling 100% of the water needs.

The shaft seal water system will supply water for the lubrication of the turbine generator shaft seal.

Shaft seal water system operation

Normal operation:

The two sand filters will be in operation. When one filter is in backwash mode, the other will be able to provide all the water required.

2.9.9.3 Fire protection system

The schematic is presented on drawing 647756-0001-46DD-0002.

Water Fire protection system will be provided to the following elements:

- Generator pit;
- Oil filled transformers (T8 and SST5);
- Governor areas (HPU);
- Fire hose stations;
- Wall hydrants.

Fire extinguishers will be installed at strategic points throughout the power station plant.

<u>Description of the fire protection system</u>

The powerhouse fire water will be fed from one tap taken off the side of the makeup piece between the pressure conduit of Unit 8 and the spiral case.

This tap will be equipped with an isolating valve, two pressure reducing valves and a manual cleaning strainer capable of retaining particles larger than 0.8 mm.

Generators and transformers will be protected by automatic water spray fixed systems (deluge).

An automatic wet pipe sprinkler system will be used to protect the generator HPU.

Fire protection system operation

Normal operation:

- The jockey pump, installed in Unit 7, will be used to maintain the pressure in the system for both units 7 and 8;
- Two pressure reducers with different diameters will be provided. The larger pressure reducer will be used to supply water when large fire protection flow is required (Generator deluge system) and the smaller pressure reducer will be used to supply water when low fire protection flow is required (Fire Hose Station).

Emergency operation:

- When the Unit 8 is shutdown, the fire protection water will come from Unit 7 via an interconnection pipe.

2.9.9.4 Drainage system

The schematic is presented on drawing 647756-0001-46DD-0003.

Description of the drainage system

The drainage water system will be designed to collect, drain and evacuate all water from all sources, both uncontaminated and containing oil, including those of a permanent, intermittent, emergency or accidental nature from the powerhouse (interior and exterior).

Clear water from roof drains will be drained by gravity below the minimum downstream water levels to a place where there is no risk of freezing.

Clear water from all drains inside the powerhouse will be drained by gravity to the drainage sump pit of Unit 7.

Oily water from the transformer T8 and SST5 will be directed to a concrete oil water separator. The oil will remain on the top of the water and the clean water will be sent to the tailrace. A sampling cock will be installed at the outlet of the oil separator for measurement of the concentration of oil in the water.

2.9.9.5 Piezometer system

The schematic is presented on drawing 647756-0001-46DD-0004.

Description of the piezometer system

A piezometer station will be provided in the draft tube of T/G Unit 8 for monitoring and operation of the turbine.

2.9.9.6 High pressure compressed air system

The schematic is presented on drawing 647756-0001-46DD-0005.

The high pressure compressed air system will supply air to the following equipment:

- Accumulator tank for the governor system of T/G Unit 8;
- Brake air system serving T/G Unit 8.

Two compressors will be provided to allow proper reliability of the air distribution (1 running / 1 standby).

A pressure reduction station will be used to reduce the pressure for the air brake system.

The depression compressed air system will be used as backup to the air brake system.

High pressure compressed air system operation

Normal operation:

- Two HP compressed air tanks will supply the required air to the governor and brake air systems;
- When the low pressure set point is reached on the air regulator tank, one compressor will start to rebuild the pressure in the governor system;
- One air brake tank will supply the required air to stop T/G Unit 8;
- When the low pressure set point is reached on the air brake tank, the pressure reducing station will rebuild the pressure in the brake air system.

Emergency operation:

- When one compressor is out of operation, the standby compressor will start automatically;
- If the reducing pressure station doesn't work, the air will be fed by the depression compressed air system.

2.9.9.7 Depression compressed air system

The schematic is presented on drawing 647756-0001-46DD-0006.

The depression compressed air system will supply air to dewater the T/G Unit 8 in order to use Unit 8 as a synchronous condenser.

One compressor and 2 tanks will be provided to allow the dewatering of Unit 8.

Depression compressed air system operation

Normal operation:

- The depression system will supply sufficient air to displace the draft tube water to clear the turbine runner of Unit 8;
- The compressor will start to rebuild the pressure in the system and to maintain the water level between the minimum and the maximum.

2.9.9.8 Heating, Ventilating and Air Conditioning (HVAC) systems

The schematic is presented on drawing 647756-0001-46DD-0007.

Description of the HVAC systems

Three HVAC systems will supply and exhaust air of Unit 8:

- Two fans mounted on the roof and louvers will be used to provide ventilation to the powerhouse. Fans will also be used in case of fire as a smoke exhaust;
- The battery room exhaust fans will be belt driven, centrifugal, inline fans and will be configured as 100% redundant;
- The lower galleries ventilation fan will be used to supply fresh air to the lower galleries. The system will also provide ventilation for the space through the transfer of air from the floor El. 7.32.

2.9.10 Hydro-mechanical equipment

Draft tube gates already exist for Unit 7. The gates are of flat type with shield plate and rubber joints located on the upstream side. A new set of stoplogs will be provided for Unit 8.

Both existing gates are actually piled up in a room under the existing service bay and they can be maneuvered with a monorail hoist that can actually service only the draft tube of Unit 7. The removal and insertion in their grooves is made at balanced pressure.

Once construction of Unit 8 is completed, the monorail beam will have to be extended to service Unit 8. However to put in place the gates before beginning excavation, gates will have to be removed from existing powerhouse and put in place with a mobile crane.

Embedded parts for Unit 8 already exist although their condition needs to be verified in the next phase before beginning construction.

2.9.11 Isolated Phase Bus

An isolated phase bus (IPB) assembly will connect the generator to the power transformers. The IPB and associated equipment will be located on the generator floor. The physical arrangement will be similar to Unit #7 equipment with the generator grounding switch, taps to the excitation transformer, main disconnect switch, potential transformer and surge protection cubicle located on the generator floor.

The IPB will then go up to the level of the generator step-up transformers outside the powerhouse, with also a tap connection to the station service transformer disconnect switch and station service transformer.

The IPB will be rated at 13.8kV, 8000A, 100kA short-circuit and are of the natural cooling type.

The potential and surge protection cubicle will also include a grounding switch and a main disconnect switch for the surge arresters and the surge capacitors.

2.9.12 Power Transformers

The generator step-up transformer (GSU) will be three phase, 129/172 MVA, ONAN/ONAF, with copper windings, 230kV–13.8 kV, with a wye connected winding on the high voltage side and a delta connected winding on the low voltage side. The transformer will also be equipped with a five taps de-energized type tap changer on the high voltage side, lightning arresters mounted on its tank, an oil expansion tank and a compartment on the low voltage side to connect to the IPB.

The transformer will be located outside, on the upstream side of the powerhouse. An oil recovery basin will be provided under the transformer with fire walls on two sides between Unit #7 GSU transformer and station service transformers.

2.9.13 Station service transformer, 600V switchboard and low voltage equipment

The SS5 transformer will be three phase, 750/1000kVA, ONAN/ONAF, with copper windings, 13.8kV-600V, with a delta connected winding on the high voltage side and a wye connected winding on the low voltage side, solidly grounded. The transformer will be of a sealed tank construction and will also be equipped with a five taps de-energised type tap changer on the high voltage side. The primary will be connected directly to the IPB. The secondary will be connected to the 600V switchgear with Teck cables. The station service transformer will be installed outside, upstream of the powerhouse with a physical arrangement similar to the existing SS3 transformer. The 600V, 1200A switchboard will consist of four cells, with two cells for the withdrawable incoming and tie breaker, one cell to include the power panel with molded case circuit breaker and one transition cell to connect to the existing station service switchboard.

The new incoming and tie breakers will be electrically interlocked with the existing mains and tie breaker, in order to provide redundancy.

The new system proposed will be solidly grounded on the 600V side, to follow NL Hydro standard practice. We do not recommend installing an ungrounded system like the existing system for safety reasons. It is therefore recommended that the existing ungrounded system be modified and upgraded to a solidly grounded distribution system to allow the tie-in of the new 600V system for Unit 8 to the existing system. The existing station service transformers SS3 and SS4 could be replaced with new transformers with a solidly grounded secondary to be compatible.

Four 600V power distribution panel boards will be provided, similar to the existing system, with each panel board provided with a manual transfer switch. One incoming side of the transfer switch will be connected to the new switchboard, and the other incoming side will be connected to existing circuit breakers. Unit 8 panel board will also be provided with an additional automatic transfer switch, connected to the existing Emergency Supply Panel, as is provided for Unit 7 panel board. Local starters will be provided to the motorized loads. The other low voltage generation and powerhouse auxiliary systems will be supplied from the four distribution panel boards, 600/347 V and 208/120 V distribution panels and associated distribution transformers connected to the distribution panel boards.

2.9.14 Normal and Emergency Lighting Systems

The lighting system will ensure an illumination sufficient for powerhouse operation and for performing maintenance works, while ensuring personnel security.

Outside illumination will be provided on the building extension, similar to the existing lighting.

Emergency lighting will be provided and exit signs will be used to indicate the emergency exits in case of personnel evacuation.

600 V and 120 V receptacles will be placed in the new building extension and outside to satisfy operation and maintenance needs.

2.9.15 Fire Detection

The new unit building extension will be equipped with an addressable fire detection and alarm system to match the existing system.

2.9.16 Wiring System

Power and control cables will be of the TECK FT-4 type. The cables will be installed in cable trays.

The openings in walls and floors will be sealed against fire propagation. The fire-resistance rating will be equivalent to that of the wall and floor.

2.9.17 Interface with Existing Powerhouse

Several services for Unit 8 will be provided by the existing powerhouses. These services include:

- Potable water;
- Wastewater treatment;
- Redundancy of the fire and raw water system;
- 25 kV emergency power supply ;
- Telecommunication.

All these services can be connected to the existing powerhouses without interrupting operations.

2.10 Tailrace Channel

The existing tailrace canal linking Powerhouse 2 to tailrace canal of Powerhouse 1 was partially excavated near the powerhouse to accommodate two 150 MW units. At the exit of the draft tubes, it is 30.5 m wide and excavated in rock with vertical side walls. It narrows from 30.5 m to 15.25 m and its invert drops from elev. 9.5 m to -3.0 m over approximately 40 m while the side walls remain vertical. On the next 70 m, the rock surface drops progressively down below the channel invert and side slopes vary from vertical in the rock to 2H:1V in the overburden. While the invert remains horizontal and 15.25 m wide at elev. -3.0 m.

From that point, about 110 m downstream of the powerhouse, the channel gradually narrows over approximately 100 m from 15.25 m to 6.10 m at invert elevation, which is the width required to transit with minimal head losses the flow of one unit (102 m^3/s). For the remaining 150 m, the tailrace channel remains horizontal with an invert 6.1m wide at elevation -3.0 m and lateral slopes of 2H:1V. No riprap was placed on the left side of the channel at the time of construction since it was assumed in the original plan that the channel would be enlarged on the left side and riprap to be placed a few years later, to accommodate the addition of Unit 8.

The water level in the channel is influenced by tides and varies from minimum normal elevation of 1.2 m to maximum elevation of 3.5 m at powerhouse 1. Head losses in the tailrace channel between powerhouse 2 and powerhouse 1 were estimated for one unit at full output (102 m^3/s) to vary from 0.05 m at high tide to 0.30 m at low tide for an average of approximately 0.20 m. Velocities ranged from 0.8 m/s to 2.1 m/s at low tide in the narrow section of the channel.

If the channel is left as is, there would be additional head losses of 0.20 m to 0.80 m for an average of approximately 0.50 m when both units are operating simultaneously at full output. Velocities would range from 1.6 m/s to 4.2 m/s. This represents an average loss of approximately 0.85 MW.

To limit future head losses for simultaneous units operation to resemble head losses for Unit 7 alone, the width of the channel needs to be enlarged to 15.25 m at invert elevation on its entire length. This represents an excavation of approximately 40 000 m^3 of overburden and the placing of 5000 m^3 of riprap. If the additional channel excavation is not done, the riprap would still have to be placed on the left side of the channel considering the increase in flow velocities the channel would have to endure.

For the present project cost estimate, the enlargement of the tailrace channel was considered. However, in the next phase, an economic analysis could be done to determine if it is economical to do the enlargement of the channel or if it is better just to place riprap on the left side of the channel.

2.11 230 kV Transmission Line

2.11.1 Location

The line route will be parallel to the existing line between Unit 7 and Terminal Station 2. The line length is approximately 1.9 km, with five transmission line crossings and one river crossing, as shown in Figure 2-1:

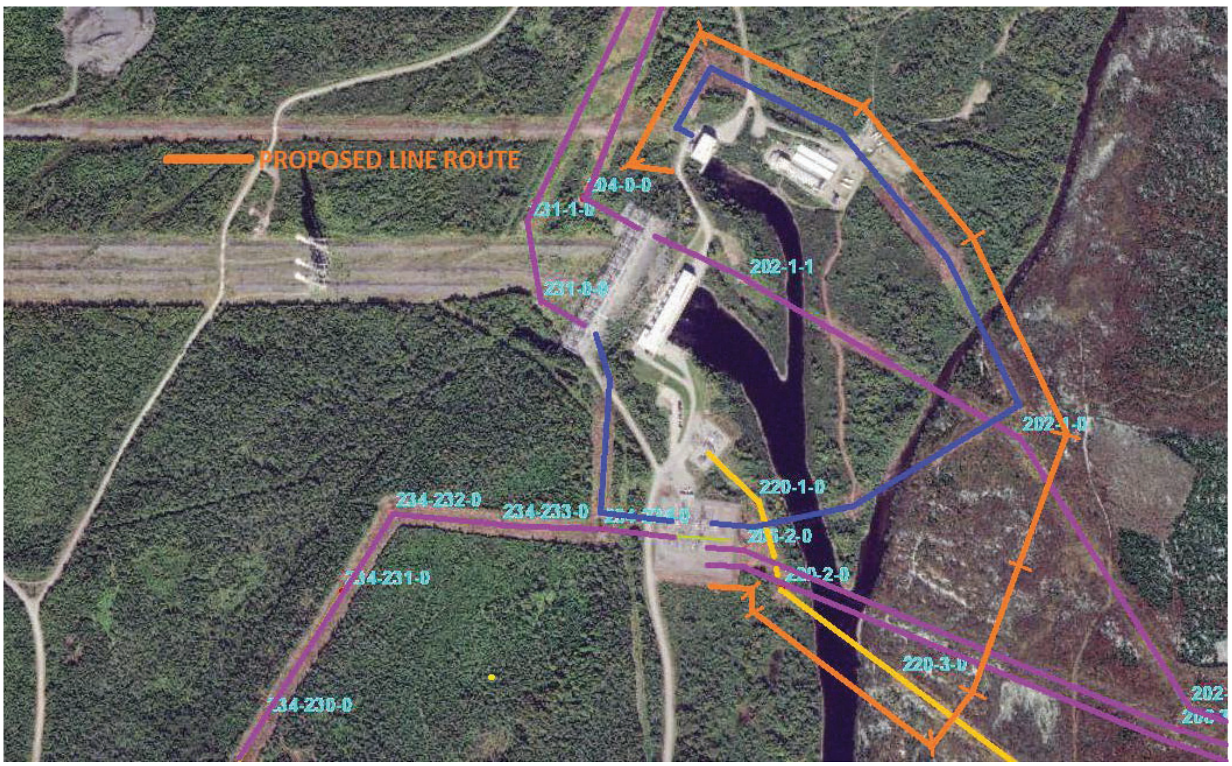


Figure 2-1 - Line Location

This line route will help facilitate access and construction over the numerous line crossings.

2.11.2 Concept

2.11.2.1 General

For the proposed line route, ten structures will be needed: four dead-end towers 45° - 90° (NDD), four dead-end towers 0° - 45° (DD) and two dead-end towers 0° - 30° (CC). In order to cross the existing transmission lines, there were assumed the following tower heights:

- Three dead-end towers 45° - 90° (NDD) with a height of 33.4m.
- One dead-end tower 45° - 90° (NDD) with a height of 28.3m.
- One dead-end tower 0° - 45° (DD) and one dead-end tower 0° - 30° (CC) with a height of 26.2m.
- Three dead-end tower 0° - 45° (DD) and one dead-end tower 0° - 30° (CC) with a height of 39.7m.

It was assumed that the foundations for these structures will be as follows:

- Steel grillage foundation types for six tower foundations; and
- Surface rock foundation types for four tower foundations.

The table below presents the list of quantities for structures and their foundations for the proposed transmission line route.

Table 2-1 - List of Quantities

Total Structures weight (kg)	FOUNDATIONS			TOTAL	
	On Soil	On Rock		Structures and Foundations	
	Steel (kg)	Steel (kg)	Concrete (m^3)	Steel (kg)	Concrete (m^3)
317260	155736	23320	14	496316	14

2.11.2.2 Conductor Selection

The selected conductor is an 804 kcmil AACR-TW with the properties outlined in the table below:

Table 2-2 - Conductor Properties

Conductor Type	Number of sub-conductors	Rated UTS (kN)	Diameter (mm)	Unit weight (N/m)
804kcmil AACR-TW	1	283	28.14	21.673

2.11.2.3 OHSW and OPGW selection

The selected overhead ground cables and their properties are presented in the table below:

Table 2-3 - Overhead Cables Properties

Cable Type	Number of sub-conductors	Rated UTS (kN)	Diameter (mm)	Unit weight (N/m)
19.05 mm OHSW (3/4") EHS 19 Strands Steel	1	259	19.05	16.856
OPGW designed for 135 mm ice	1	277	20.6	15.915

2.11.2.4 Tower selection

Three dead-end tower types will be designed for the line route: a rigid self-supported tower 45° - 90° (NDD), a rigid self-supported tower 0° - 45°(DD) and a rigid self-supported tower 0° - 30°(CC).

Sketches and quantities for these structures are presented below:

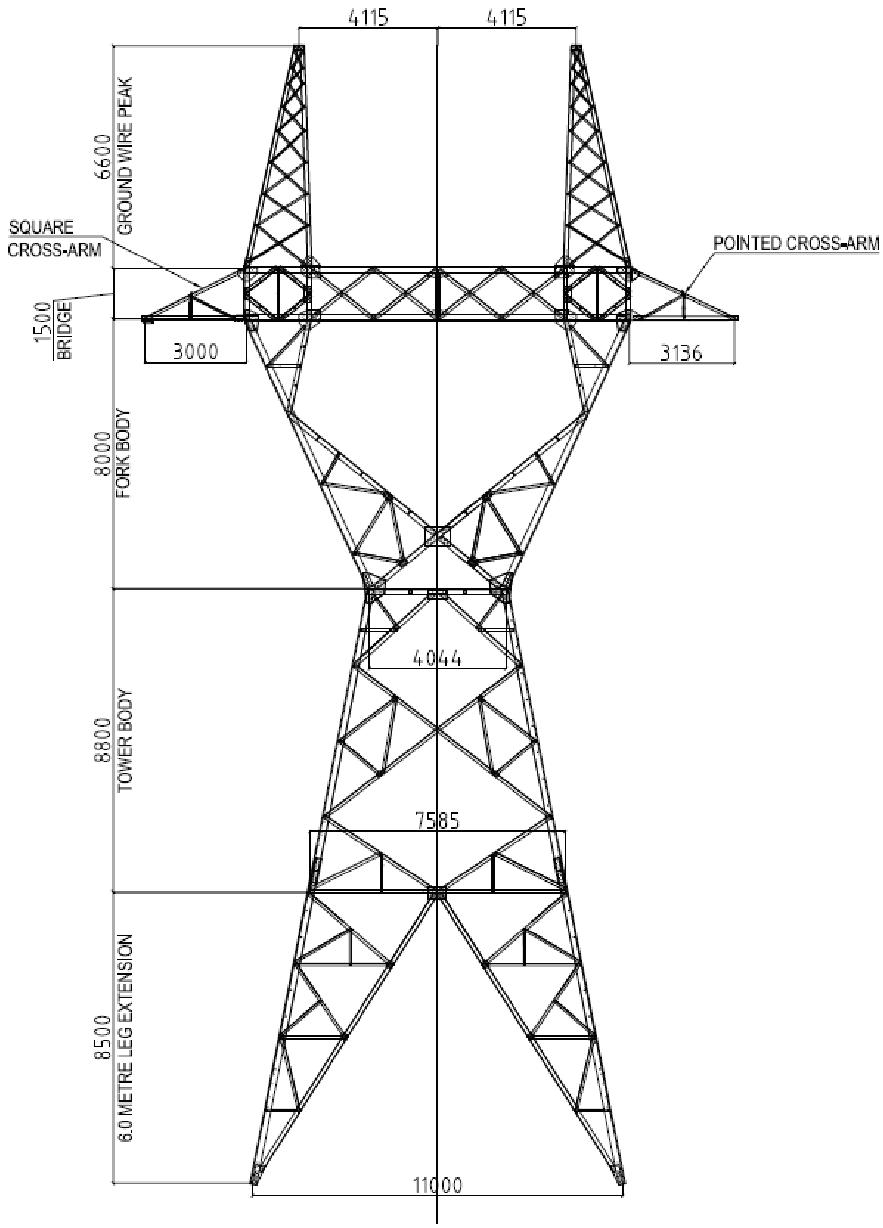


Figure 2-2 - Dead-end tower 45° - 90° (NDD)

Dead-End tower 45° - 90°	TOWER WEIGHT (kg)	HEIGHT (m)
Basic BODY + Four 6m Leg Extensions	34 560	33.4

Basic BODY + Four 1.5m Leg Extensions	29 800	28.3

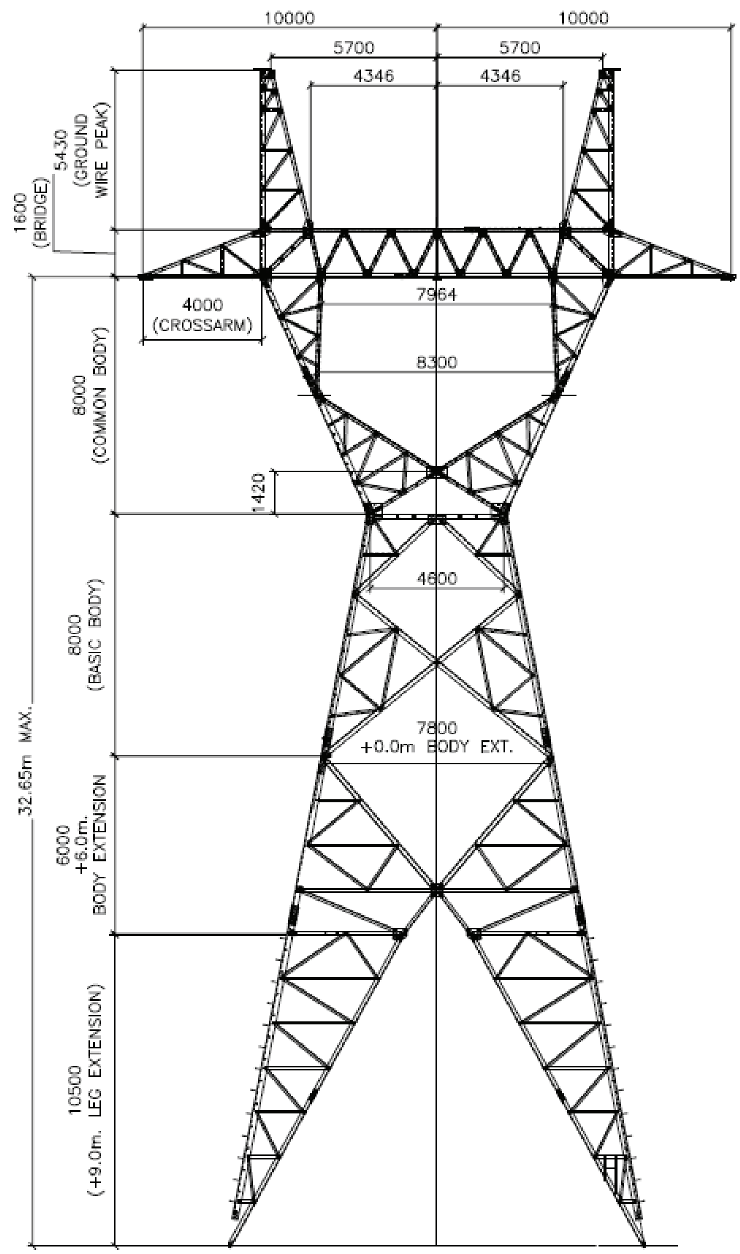


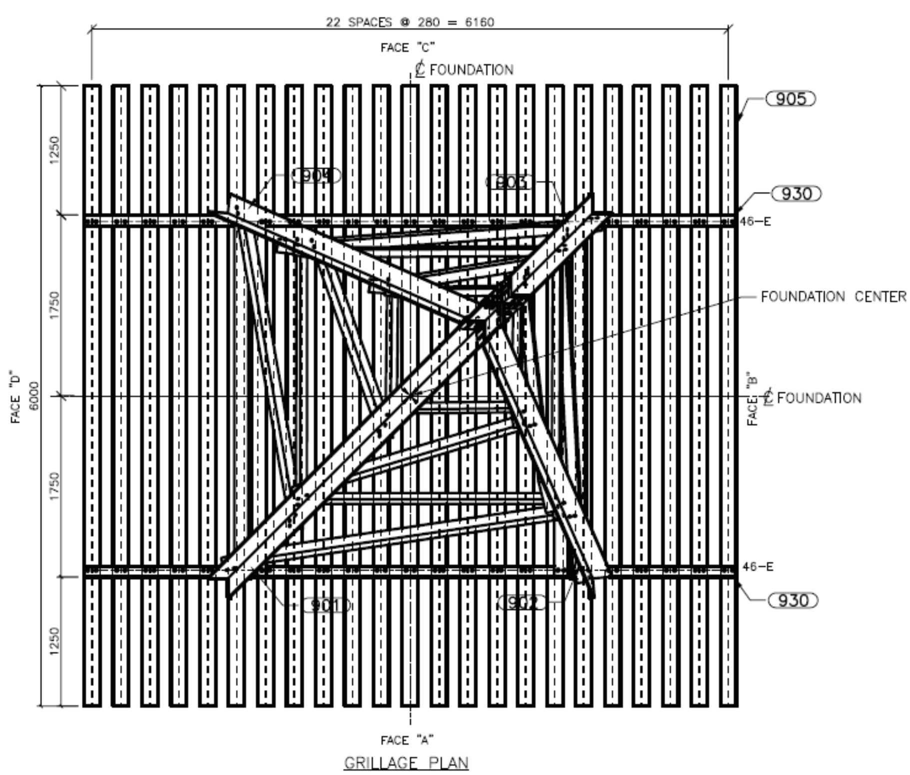
Figure 2-3 - Dead-end tower 0° - 45° (DD) and 0° - 30° (CC)

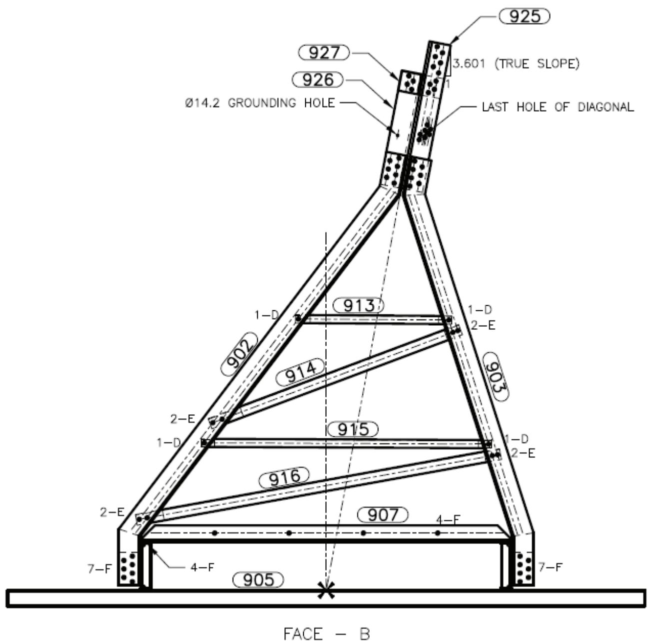
Dead-End tower 0° - 45°	TOWER WEIGHT DD/CC (kg)	HEIGHT (m)
Basic BODY + 6.0m Body extension +Four 9.0m leg extensions	34 800 / 32600	39.7
Basic BODY + Four 1.5m leg extensions	24 280 / 22500	26.2

2.11.2.5 Foundations

Two foundation types were considered for both dead-end towers: steel grillage foundation for a soil with bearing capacity of 100kPa and surface rock foundation. Sketches and quantities for these foundations are presented below:

Steel grillage foundation:





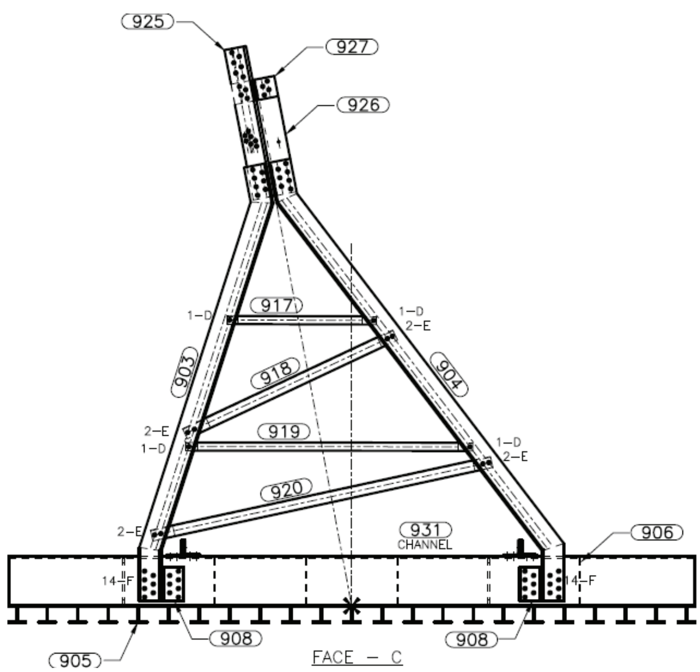


Figure 2-4 - Steel Grillage Foundation

Structure	STEEL WEIGHT per structure (kg)
Dead-End	25 956

Surface rock foundation:

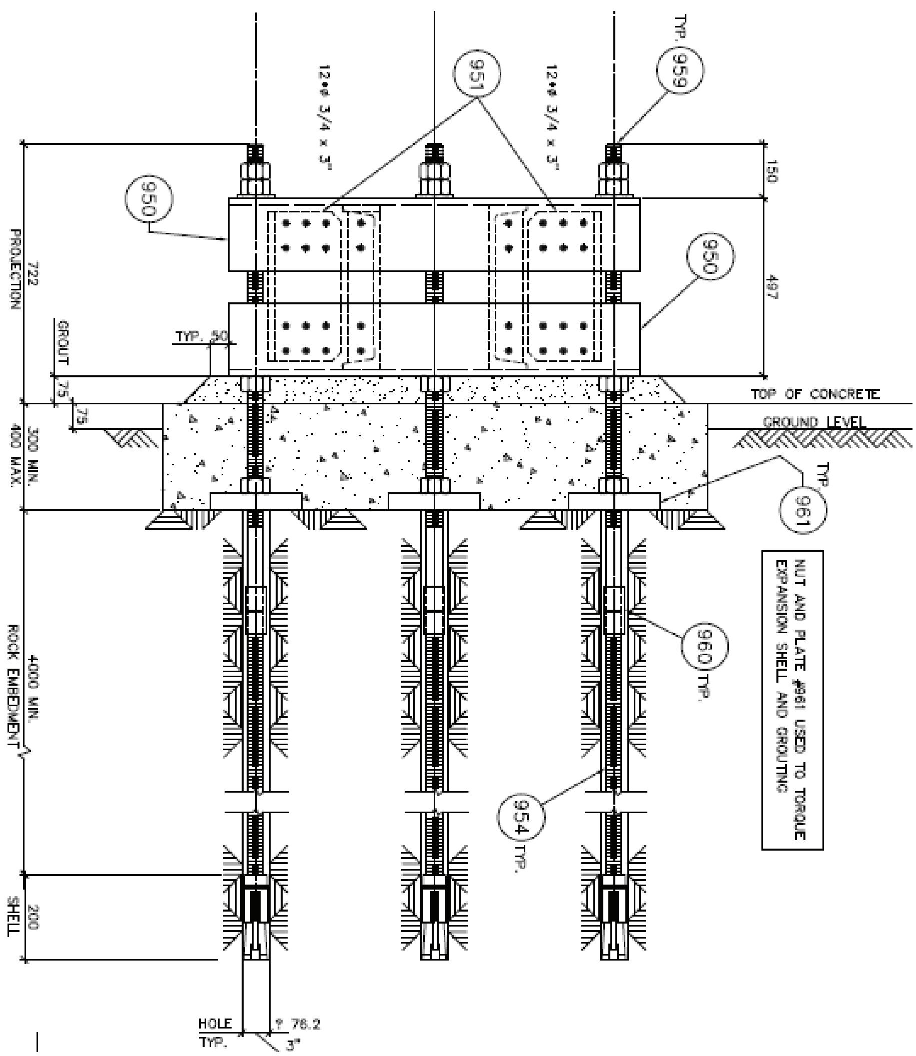


Figure 2-5 - Surface Rock Foundation

Structure	STEEL WEIGHT per structure (kg)	CONCRETE Volume per structure (m3)
Dead-End	5 830	3.5

2.11.2.6 Insulator Chains

Insulator chains and dead-end assemblies selection is presented in figures below:

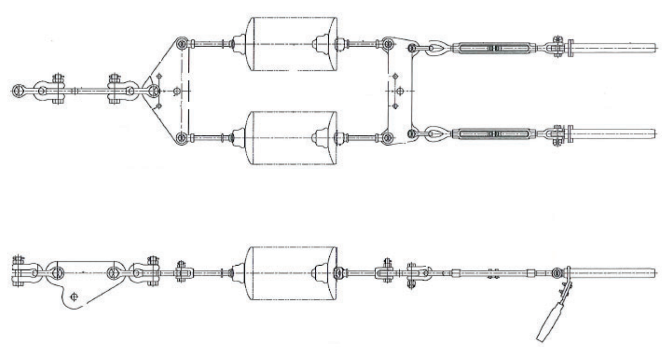


Figure 2-6 - Dead-End Assembly for conductor

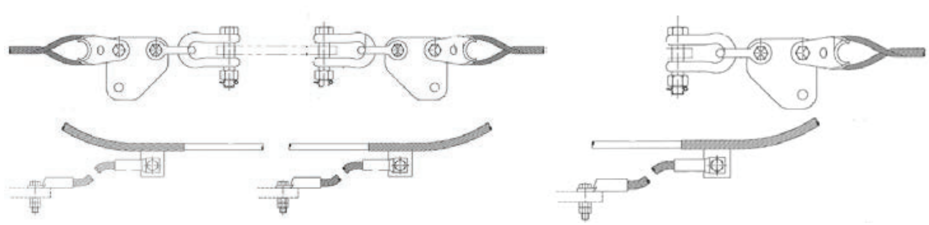


Figure 2-7 - Dead-End Assembly for OPGW

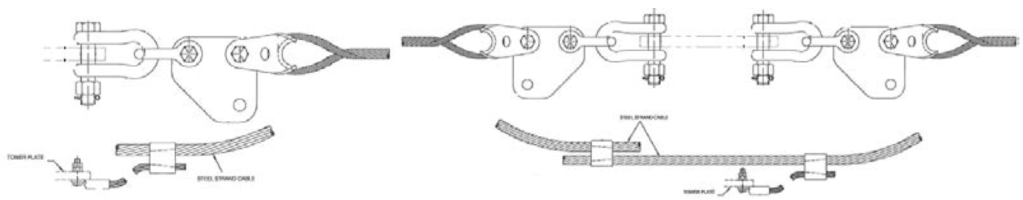


Figure 2-8 - Dead-End Assembly for OHSW

2.12 Modifications to Bay d'Espoir Terminal Station No 2 (TS-2)

2.12.1 General

The Bay d'Espoir Hydroelectric Station (BDE) has two high voltage substations or terminal stations for integration with the network, named Terminal Station No 1 (TS-1) and Terminal Station No 2 (TS-2).

Terminal Station No 1 (TS-1) has a ring bus configuration and connects to generating unit transformers (GSU) of Units 1 to 6. It also connects to the newer Terminal Station No 2 (TS-2).

The newer Terminal Station No 2 (TS-2) connects to TS-1 and also directly to the generating unit transformer (GSU) of Unit 7. TS-2 also connects to the new transmission line 267 (TL-267) connecting to Western Avalon Terminal Station (WAV).

TS-2 has a breaker-and-a-half bus configuration and is directly connected to the network. It has been decided that the new Unit 8 considered in this study shall also be connected to TS-2, as is Unit 7.

2.12.2 Unit 8 Integration

The new Unit 8 Generator Step-Up transformer will be connected to TS-2 by a 230 kV transmission line. For this connection, a new breaker-and-a-half diameter will be added to the station. Initially the diameter will contain two circuit breakers and their isolating switches. Space will be provided for the third breaker which can be added in the future.

The single line diagram and layout of the unit integration and TS2 is shown on the drawing included in Appendix C of this report.

647756-0001-47DD-0001	Hydro Generating Unit 8 Terminal Station No. 2 (TS2) Single Line Diagram
647756-0001-47DD-0002	Hydro Generating Unit 8 Terminal Station No. 2 (TS2) Electrical Layout

2.12.3 Substation layout

The addition of a new diameter will require modifications to the substation layout as follows:

- The substation will be extended by approximately 25 m;
- The main busses B7 and B9 will be extended by one bay each, by adding two new spans, thereby avoiding demolition of the existing dead-end structures and minimizing shut down time;
- A new diameter will be added with two circuit breakers and their related isolating switches, a new gantry structure for termination of the transmission line to Unit 8 powerhouse;
- Fencing, grounding and lighting will be extended accordingly;
- A new control building will be provided to house the protection and control equipment and power supplies.

2.12.4 Substation design

The substation design will follow NLH design guides and NLH Terminals Engineering standards.

The tables below summarizes the design criteria and applied parameters:

Table 2-4 – Design Criteria and Applied Parameters

Parameter Description	Unit	Value	Comment/Reference
Normal Operating Voltage	kV	230	IEEE Std C37.32
Maximum Temporary Voltage (30min)	kV	253	
Basic Lightning Impulse Insulation Level (BIL)	kV_{peak}	1050	
Recommended Clearance Metal to Metal ph-ph	m	2.67	
Recommended Clearance ph-ph Disconnect Switch	m	3.96	
Recommended Clearance Phase to Ground Metal to Metal (A)	m	2.3	
Phase to Phase Spacing Disconnect Switch Centers	m	4.00	As per NL Hydro Terminals Engineering Standards.
Distance from Structure to Fence	m	6.00	As per NL Hydro Terminals Engineering Standards.
Phase Spacing of Flexible Bus for main busses B7 and B9	m	4	As per NL Hydro Terminals Engineering Standards.
Length of ANSI Post Insulator	inches	92	conversion
	m	2.3	

Table 2-5 – Current Ratings

Parameter Description	Unit	Value	Comment/Reference
Requirement for Bus	A	2000	LCP-SN-CD-4000-EL-TS-0001-01 - AC Substations - General Technical Requirements
Requirement for Line Out	A	1200	
Short-Circuit current	kA	31.5	

Table 2-6 – Conductor Characteristics

Parameter Description	Characteristic	Comment/Reference
Tubular Bus	3" SPS Sch 40	N&L Hydro Doc. No. BWT-SN-CD-4910-EL-RP-0031-01 Bay d'Espoir Terminal Station No. 2 Electrical Design - Bus Work Design Technical Report
Flexible Leads and Line Out	CONDUCTOR 2 x 1272 kCMIL AAC, 61 STRAND, NARCISSUS	As per NL Hydro Terminals Engineering Standards.

2.12.5 Major Equipment Specifications.

The following major equipment outline specifications have been produced and extended to some suppliers to confirm budget pricing and dimensions:

A. MAJOR EQUIPMENT	QTY
CAPACITIVE VOLTAGE TRANSFORMER (CVT) · 230 kV, 1050 BIL BURDEN · 200 VOLT-AMPERES · ACCURACY: 0.6 WXYZ · RATIOS 2000-1200/1 VOLT · TERMINAL 4 HOLE NEMA PAD 4" X 4"	1

A. MAJOR EQUIPMENT	QTY
HIGH VOLTAGE OUTDOOR CIRCUIT BREAKER · SF6 DEAD TANK CIRCUIT BREAKER · Maximum voltage: 253 kV · Impulse withstand:1050 kV. · CREEPAGE DISTANCE 6680 mm · RATED CURRENT : 2000A · RATED SHORT CIRCUIT CURRENT: 31.5 KA · WITH THREE CURRENT TRANSFORMERS PER BUSHING ACCURACY: 2.5L800, ANSI MR: 2000-1200-800-600-400-200/5 A C/W SUPPORT STRUCTURE, EXTENDED TO HAVE 3500 mm FROM TOP OF CONCRETE TO NEUTRAL POINT OF BUSHING INSULATOR,	2
MOTOR OPERATED DISCONNECT SWITCH THREE POLE GROUP OPERATED DOUBLE BREAK HORIZONTAL MOUNTING 245 KV, 253kV MAX VOLTS IMPULSE WITHSTAND1050 KV BIL CREEPAGE DISTANCE, 6325 mm RATED CURRENT 2000 A RATED SHORT TIME WITHSTAND 44 Ka / 3 sec HV TERMINAL CONNECTOR 4 HOLE NEMA PAD 4"X4"; C/W SUPPORT STRUCTURE,HEIGHT 3500mm TOC TO INSULATOR NEUTRAL POINT	3
MOTOR OPERATED DISCONNECT SWITCH THREE POLE GROUP OPERATED DOUBLE BREAK HORIZONTAL MOUNTING C/W GROUNDING BLADES ON ONE SIDE, MANUALLY OPERATED 245 KV, 253kV MAX VOLTS IMPULSE WITHSTAND: 1050 KV BIL CREEPAGE DISTANCE, 6325 mm RATED CURRENT 2000 A C/W with GROUNDING BLADE ON ONE SIDE, Manually operated RATED SHORT TIME WITHSTAND 44 Ka / 3 sec HV TERMINAL CONNECTOR 4 HOLE NEMA PAD 4"X4" C/W SUPPORT STRUCTURE,HEIGHT 3500mm TOC TO INSULATOR NEUTRAL POINT	1
MOTOR OPERATED DISCONNECT SWITCH THREE POLE GROUP OPERATED DOUBLE BREAK HORIZONTAL MOUNTING C/W GROUNDING BLADES ON ONE SIDE, MANUALLY OPERATED 245 KV, 253kV MAX VOLTS IMPULSE WITHSTAND1050 KV BIL CREEPAGE DISTANCE, 6325 mm RATED CURRENT 2000 A C/W with GROUNDING BLADE ON ONE SIDE, Manually operated RATED SHORT TIME WITHSTAND 44 Ka / 3 sec HV TERMINAL CONNECTOR 4 HOLE NEMA PAD 4"X4" WITHOUT SUPPORT STRUCTURE, FOR MOUNTING ON GIRDER HEIGHT APPROX 12000 mm ABOVE TOC.	1

2.13 Protection and Control

2.13.1 Concept

The protection single line diagram No. 647756-0001-48DD-0001 has been proposed for the connection of generating Unit 8 to a new diameter of the Terminal Station 2 (TS2) at Bay D'Espoir.

It is proposed that the various protection, measurement and control systems will be located in the Powerhouse 2 and in a new control building in TS2. The protection systems will be separated in zones in order to minimize the lengths of secondary wiring from CTs. Fiber optic cable will also be used to reduce the required hardwired cabling. . For example, dedicated fibers will be required for the line current differential communication channel of the protection differential relay, at each end of the line, to protect/cover the short line.

The protection systems will be divided in three distinct overlapping zones as follows:

- Generating Unit Differential Zone: The unit differential zone will be delimited by the unit CTs (neutral and bus sides) to cover the generating unit only;
- Unit Step up Transformer Differential Zone: The step up transformer zone will cover the 13.8 kV bus and the step up transformer and overlap with the unit differential zone on the 13.8 kV side and with the short line differential zone on the 230 kV side;
- Short Line Differential Zone: The short line differential zone will cover the 230 kV line between PH2 and TS2 and overlap with the step up transformer zone and with the two existing B7 and B9 bus protection zones.

Due to space limitations inside Powerhouse 2, only one set of bus PTs can be installed on the 13.8 kV isophase bus. In order to allow the back feed of the auxiliary services through the unit step up transformer during prolonged outages of the generating Unit 8, the 13.8 kV bus PTs will be located on the step up transformer side of the motor-operated disconnect switch (MOD). In this way, ground fault protection (59N) will be implemented on the energized section of the bus in order to detect any ground fault on the ungrounded bus.

The same bus PTs will also be used for protection of the generating units, step up transformer and to provide for reference voltage to the exciter control system. Therefore, the location of the bus PTs may necessitate the removal of the flexible links between the isophase bus and the step up transformer in order to isolate the transformer during the early stage of generating unit commissioning tests.

2.13.2 Panel Grouping

The basic reliability requirements for generating units of similar size require fully separate dual, non-identical, protective systems for each protective zone together with circuit breaker fail, local backup to be able to detect and isolate any primary system electrical fault with any one protection system and/or communication link failed including the failure to trip of the circuit breaker. The protection panels have therefore been arranged to meet these requirements.

The generating unit and the step up transformer protection and the control systems will be located at the generator level floor of PH2 together with the short line differential protection panels.

The protection and the control systems of the new diameter at TS2 will be located in a new control building. The new control building is required as the protection and control systems of the new diameter equipment cannot be housed in the existing control building due to space limitations. The new control building will be large enough to house additional protection panels for future expansion or development. New 125 Vdc and 48 Vdc supply systems (battery and battery charger) will also be provided to supply the new protections and communication systems that will be housed in the new control building.

The following tables show the proposed grouping of the panels in their respective location are shown.

Table 2-7 – Powerhouse 2 Panels Grouping

Powerhouse 2			
No	**Protection panel**	**Group**	**Function**
1	Generating unit 8	A	Generator multifunction relay (21, 24, 27TN, 32, 40, 59N, 78, 81, 87)
2	Generating unit 8	B	Generator multifunction protection (21, 24, 27TN, 32, 40, 59N, 78, 81, 87)
3	Step up transformer	A	Transformer multifunction relay (24, 50, 51, 59N, REF, 87)
4	Step up transformer	B	Transformer multifunction relay (24, 50, 51, 59N, REF, 87)
5	Short line protection	A	Line differential relay (87L) Teleprotection unit

6	Short line protection	B	Line differential relay (87L) Teleprotection unit
7	Unit 8 bay control		Bay control unit Automatic Sync and Volt Check Relay
8	Unit 8 HMI		Unit 8 Control HMI

Table 2-8 – TS2 – New Control Building

TS2 – New Control Building			
No	**Protection Panel**	**Group**	**Functions**
1	Short Line Protection	A	Line differential Relay (87L) Teleprotection Unit
2	Short Line Protection	B	Line differential Relay (87L) Teleprotection Unit
3	G8B7 Bay Control		Bay control relay Breaker fail relay (50BF)
4	G8B9 Bay Control		Bay control relay Breaker fail relay (50BF)
5	HMI Unit		New Terminal Station Diameter Control HMI

2.13.3 Communication and LAN Network

The main communication and LAN systems for the generating Unit 8 and the new diameter at Bay D'Espoir will be by fibre optic cables. The short line between PH2 and TS2 will be provided with OPGW link for the connection of PH2 to the FO network being implemented at Bay D'Espoir under the WAV-BDE TL 267 project.

The main communication for the protection of the 230 kV short line between PH2 and TS2 will be by OPGW link.

Powerhouse 2 and the new control building in TS2 will each be provided with fibre optic junction panel (FO Rack) and communication cabinet to provide the necessary interconnections between the buildings. Within the Powerhouse 2 and the new control building in TS2 direct fibre optic cable pairs (patch cord) will be used to provide station LAN. Non-redundant GPS clock will also be provided to generate a central time reference, using IRIG-B, for all protection, metering and control devices.

For the new control, monitoring and metering system of Unit 8 in PH2 it is proposed to implement a station automation system in order to eliminate as much as possible the hardwired required at the powerhouse level and to rather use communication network (LAN) to collect and process status, metering, and control associated to Unit 8 equipment. Unless otherwise specified by Nalcor, the existing RTU at BDE-PH2 will be used to provide access for control and monitoring to Hydro's ECC. Station automation system will also be provided in the new control building of TS2 for control, monitoring and metering of the substation equipment. A new RTU will be provided for control and monitoring by Hydro's ECC.

Dependant on the final design of the Powerhouse 2 control systems, the synchronisation system of the 230 kV circuit breakers can be by hard wired (125 Vdc) or by remote modules connected by fibre optic pairs. However, considering the distance between the remote circuit breakers (B9G8 and B7G8) and the Powerhouse 2 it is likely that remote I/O devices (25A-R), one for each circuit breaker, will be required to send frequency and voltage correction pulses to the autosynchronisation device (25A) located in the Powerhouse 2 using relay-to-relay communication over fiber-optic link.

2.14 Preparatory works

2.14.1 Temporary concrete earth retaining wall

In order not to unearth and destabilise the penstock of Unit 7 near the powerhouse during excavation for the new penstock for Unit 8 and allow for the entire construction of Unit 8 without affecting the operation of Unit 7, a concrete earth retaining wall will need to be built near the powerhouse between the existing and the new penstock.

2.14.2 Control cables between powerhouse 2 and Terminal Station 1

During the preparation construction phase, major civil works will be done in the area between PH2 and TS1. The existing cable duct bank between those structures will need to be dismantled. Therefore the estimate covers the temporary P&C works require to maintain in operation the existing generating Unit 7 during the construction phase. Temporary cables comprising of copper and FO cables will be installed on temporary wood poles for interconnection between PH2 and PH1 for the control of Unit 7 and between PH2 and TS2 for the existing protection scheme.

Later during construction phase, a new cable duct bank will be built between PH2 and TS1 in order to restore the original cable routing. Once cables are installed, connected and commissioned, the temporary cables and poles will be removed.

The EPCM firm will do the commissioning using workforce from the contractor.

2.14.3 Relocation of first transmission line pole

The first pylon of Unit 7 is located within the excavation footprint of the new penstock. Therefore, it is required to permanently relocate this transmission line pole before starting penstock and powerhouse excavation.

2.14.4 Upgrade of bypass road

The road between Powerhouse 1 and Powerhouse 2, which provides access to the existing service bay of Powerhouse 2, and to the step-up transformer of Unit 7, will be closed from the beginning of the excavation works until the completion of the powerhouse 2 service bay.

During this period, access to the plant by vehicle would be possible only from a bypass road starting before the control gate at the entrance of the complex which leads to the water intakes, and then join the road which runs along and crosses the penstocks, to finally reach Powerhouse 2. The condition of this road as well as the rest of the road to access the intakes requires at least a resurfacing with 30 cm of 0-100 mm crushed stone or equivalent, and drainage improvement, which will be part of the preparation work to allow efficient access to both, the intake and Powerhouse 2. An access by foot will still be possible using the existing road between Powerhouse 1 and 2.

2.15 Geology

2.15.1 Geological considerations

The geological appraisal of conditions at the proposed Bay d'Espoir Unit 8 Extension is based on documents provided by N&L Hydro, as well as on information gathered during the June 20-21 site visit by SNC-Lavalin's civil and electrical engineers and review of data obtained on the web.

The available documents of geological interest essentially consist of drawings presenting past investigations done at the site of the existing Bay d'Espoir facility, adjacent to the site of Unit 8 Extension. These drawings indicate in plan view the topography as well as the location of seismic refraction surveys, test pits and boreholes done along the existing facility. The investigations done in the intake canal area are of special interest.

The drawings also present sections illustrating the ground profile as well as the rock profile obtained from the seismic refraction surveys. The survey results indicate the overburden thickness to be very variable, ranging from 50 m in the area of the head pond to a few meters and less at the site of the intake. Given the proximity of the Unit 8 structures to the existing facility, useful information can be obtained as to probable bedrock levels at the site of the planned Unit 8 structures.

The reference documents provide no data as to bedrock types or conditions.

According to the Geological Map of Newfoundland, a very large zone extending from the seashore South of St-Alban's to well North of the Bay d'Espoir area belongs to the Dunnage Zone consisting of stratified rocks of Cambrian to Ordovician age.

The larger scale updated geology of the St-Alban's map area 1M-13 indicates that, in the area of the project and close surroundings, the bedrock consists of siliclastic rocks. Siliclastic rocks are meta-sedimentary rocks composed of fragments of older rocks. The fragments mostly consist of silicates, especially quartz.

During the site visit, bedrock exposures were seen and these were photographed. The photos indicate the presence on the left bank of the existing intake canal of massive to thick bedded rock of visibly good quality and high strength; the canal walls are vertical. The rock has the appearance of being sedimentary but could be metamorphic.

The photos seem to indicate that the rock is similar on the right bank of the intake canal, although more fractured, probably due to blasting.

In the area of the tailrace canal, downstream of the powerhouse, the photos indicate the presence of sub-horizontally bedded rocks; the rocks are fractured at surface but forming small vertical canal walls on both banks of the canal. They appear of good quality, unaltered.

Based on present information, it appears that geological conditions at the Unit 8 project structures will be suitable and similar to those encountered during previous phases of the project. An important aspect will be rock levels in certain key areas such as the new intake. The planned investigations will primarily be aimed at providing bedrock levels but will also provide information on rock quality and soil properties as well as water depths in the forebay.

2.15.2 Required Site Investigations

The field investigations required in the next phase include the following:

- Topographic profiles and mapping using LIDAR survey from upstream of the headrace channel to the end of the tailrace channel including the corridor of the new high voltage line from Unit 8 to station terminal 2.
- Geological mapping.
- 3 to 4 diamond drill holes for a total length of 100 m at the intake and in the rock pillar between the existing intake entrance canal and the new intake entrance canal for the new intake.
- Test pits to determine soil properties.
- Percussion holes to determine bedrock contours in the area of the headrace channel, the intake and along the penstock as well as upstream and south of the rock excavation originally done for Unit 8 near existing powerhouse.
- Water pressure tests (Lugeon tests) in rock.

- Bathymetric survey in the forebay.

The cost for these investigations is estimated at 500 000$ and is included in the EPCM costs (50 M$) in the estimate.

2.16 Hydrology

2.16.1 System Description

As described in the Shawmont Newfoundland Limited Report[1], the Bay d'Espoir Development includes the drainage areas presented hereafter:

Salmon River :	2,694 km²	(1,040 mi²)
Gray River :	971 km²	(375 mi²)
White Bear River drainage area below Burnt Dam :	502 km²	(194 mi²)
White Bear River drainage area above Burnt Dam :	679 km²	(262 mi²)
Victoria River :	1,057 km²	(408 mi²)
TOTAL	5,903 km²	(2,279 mi²)

A potential diversion of the Lloyds River was considered to increase the overall drainage area by about 477 km² (184 mi²).

The inflows at the project site were not provided by N&L Hydro and were not available at the time of the preparation of this report on the Environment Canada's website. Neither energy analyses nor any other hydrological study are included in the present mandate.

2.16.2 Climate

The climate of Newfoundland is subject to the dominating influence of the sea.

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[1] Shawmont Newfoundland Limited, *Report on the Extension to the Power Generation Facility at Bay d'Espoir*, October 1974, Report No. SM-12-74

A meteorological station is located at Bay d'Espoir (Station No. 8400413 - Bay d'Espoir Gen Stn). The Climate Normals from Environment Canada on the period 1981-2010 give a good overview of the conditions in the area; Tables 2.4 and 2.5 present respectively the temperature and the precipitation observed at this station.

The average monthly temperature is normally above 0°C from April to November. However, the spring period is late and the maximum monthly temperature is normally observed in August. Winter conditions are relatively mild and the lowest temperature are observed in January and February; temperature below 0°C can be observed at any period of the year as shown on Table 2.4.

At Bay D'Espoir, precipitations appear to be abundant and well distributed over the year, since the average monthly precipitation exceeds 100 mm every month as shown on Table 2.5. Monthly precipitation reaches about 150 mm from October to February. Rainfall can occur throughout the year and snowfall can be observed from October to April (and sometimes in May).

Station 8400413 – Bay d'Espoir Gen Stn

Climate Normals 1981-2010 - Temperature

(from http://climat.meteo.gc.ca/climate_normals/index_f.html)

Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Daily Average (°C)	-6.4	-6.6	-2.9	2.7	8.0	12.1	16.0	16.5	12.5	7.3	2.4	-2.6	4.9	C
Standard Deviation	2.1	2.9	2.4	1.5	1.3	1.1	0.9	0.9	1.2	1.4	1.2	1.9	3.0	C
Daily Maximum (°C)	-1.3	-1.2	2.1	7.3	13.6	18.0	21.6	22.3	18.0	11.9	6.2	1.5	10.0	C
Daily Minimum (°C)	-11.5	-11.9	-8.0	-1.9	2.4	6.2	10.4	10.7	7.0	2.6	-1.4	-6.6	-0.2	C
Extreme Maximum (°C)	15.5	12.5	20.0	22.2	29.5	32.0	32.0	**33.5**	33.0	24.0	17.5	16.1		
Date (yyyy/dd)	2006/ 15	1984/ 05	1999/ 29	1979/ 29	1999/ 07	1995/ 24	1981/ 04	**1996/ 07**	2003/ 13	1987/ 01	2001/ 07	1969/ 05		
Extreme Minimum (°C)	-32.8	**-33.3**	-29.0	-20.5	-8.3	-3.9	-1.5	-2.0	-5.6	-10.0	-19.0	-31.1		
Date (yyyy/dd)	1975/ 31	**1975/ 04**	1990/ 09	1994/ 03	1972/ 02	1974/ 01	1992/ 05	1980/ 30	1972/ 29	1982/ 30	1986/ 24	1972/ 31		

Station 8400413 – Bay d'Espoir Gen Stn

Climate Normals 1981-2010 - Precipitation

(from http://climat.meteo.gc.ca/climate_normals/index_f.html)

Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Rainfall (mm)	92.3	84.8	88.4	94.7	103.1	112.2	123.9	102.8	131.7	148.0	136.8	99.1	1317.9	C
Snowfall (cm)	75.1	68.6	46.2	13.5	1.9	0.0	0.0	0.0	0.0	1.0	16.6	52.3	275.2	C
Precipitation (mm)	160.5	144.5	133.0	108.1	105.0	112.2	123.9	102.8	131.7	149.0	152.5	145.8	1569.0	C
Extreme Daily Rainfall (mm)	**125.5**	87.4	101.3	83.0	78.0	78.4	63.5	67.0	121.2	99.3	93.0	112.8		
Date (yyyy/dd)	**1983/ 13**	1973/ 03	1992/ 24	1986/ 10	1981/ 02	1985/ 06	1976/ 25	1983/ 07	1976/ 06	1973/ 27	1980/ 05	1967/ 05		
Extreme Daily Snowfall (cm)	39.0	40.0	**48.0**	35.0	22.0	0.0	0.0	0.0	0.0	8.5	35.0	37.6		
Date (yyyy/dd)	1995/ 23	1995/ 21	**1993/ 18**	1997/ 01	1990/ 06	1968/ 01	1968/ 01	1968/ 01	1968/ 01	1991/ 28	1988/ 21	2004/ 27		
Extreme Daily Precipitation (mm)	**125.5**	87.4	101.3	83.0	78.0	78.4	63.5	67.0	121.2	100.6	93.0	112.8		
Date (yyyy/dd)	**1983/ 13**	1973/ 03	1992/ 24	1986/ 10	1981/ 02	1985/ 06	1976/ 25	1983/ 07	1976/ 06	1973/ 27	1980/ 05	1967/ 05		
Extreme Snow Depth (cm)	84	140	**142**	98	3	0	0	0	0	15	20	58		
Date (yyyy/dd)	1982/ 31	2001/ 18	**1989/ 26**	1989/ 01	1972/ 04	1968/ 01	1968/ 01	1968/ 01	1968/ 01	1991/ 29	1982/ 30	1993/ 31		

2.16.3 Reservoir Levels

The Long Pond Reservoir was formed by the construction of three major dams: the Salmon River Dam on the Salmon River at the south end of Long Pond Reservoir; and the North West Cutoff Dam on the North West Brook at the eastern side of Long Pond Reservoir, and the Power Canal Embankment in the Long Pond Reservoir. The operation levels in the Long Pond Reservoir are:

- Extreme flood level: 184.2 m;
- Full supply level : 182.7 m (spring and summer), and between 180.25 m &182.25 m (Fall and Winter) depending on snow cover;
- Low supply level: 178.3 m.

2.16.4 Tailwater Level

The water level in the tailrace channel is influenced by tides and varies from a minimum normal elevation of 1.2 m to maximum elevation of 3.5 m at Powerhouse 1.

At full output of Units 7 & 8, water level at Powerhouse 2 will vary from 1.5 m to 3.55 m after enlarging the tailrace channel.

2.17 Hydraulics

2.17.1 Head losses

Head losses were estimated for Unit 7 (existing conditions) and for Units 7 & 8 (proposed layout – with excavation works at the headrace and at the tailrace channels). Table 2.6 presents a comparison of the overall head losses from the power intake to the tailrace channel. The evaluation was performed taking into account tailrace elevations of 3.5 m (H maximum) and 1.2 m (H minimum) at the exit of Powerhouse 2 tailrace channel.

Table 2-9 - Unit 7 & 8 – Head losses

	Existing conditions Unit 7	Proposed layout Unit 7 and 8
Power intake	0.05m	0.05m
Penstock	5.65 m	5.81 m
Draft tube exit	0.37m	0.37m
Tailrace channel (Hmax/Hmin)	0.05 m / 0.30 m	0.05 m / 0.30 m
TOTAL (Hmax/Hmin)	6.12 m / 6.37 m	6.28 m / 6.53 m

2.17.2 Submergence – Intake

As mentioned in section 2.7, the submergence at the power intake was verified using the Gordon's formula. The submergence is acceptable at the gate, but the submergence at the trash racks appears slightly deficient at the minimum operation level. However, it seems that no vortex, thrash or debris entrainment have been noticed by operators at the existing intake of Unit 7.

2.17.3 Transient Analyses

Since the proposed solution consists of independent hydraulic passages for Units 7 and 8, the transient analyses results for unit 7 and 8 will be almost identical.

Transient analyses were performed for a turbine shutdown of unit 7 with different effective closure times. The effective closure time is defined as the time required to move the gates from 100% to 0% at the maximum closing rate, neglecting dead time and cushioning time. The transient analysis was completed using the TAPS model which is an in-house model. The model is used to compute the flow velocity and the pressure in the hydraulic circuits during a restart and/or a load rejection of the system. For all simulations, the upstream water level is El. 182.70 m and the tailwater level is El. 2.88 m.

In the model, the hydraulic passages are expressed by the lengths and the section areas. The main characteristics of Unit 7 are given in the table below:

Table 2-10 – Unit 7 characteristics

Parameters	Units	BDE - Unit 8
Rated capacity	MW	150
Rated net head	m	173.5
Rated turbine discharge at 100% opening	m^3/s	102
Guaranteed weighted average generator efficiency	%	98%
Synchronous speed	rpm	225
Runner diameter	m	3.45
Inertia of the unit (turbine-generator)	$kg.m^2$	$2.36x10^6$
Elevation of distributer axis	m	1.22

To respect the overpressure design criteria of 30%, the results show that the wicket gates effective closure time should be about 15 seconds or more.

3 CAPITAL COST ESTIMATE

3.1 Type of Estimate

This section documents the criteria, assumptions and methodology that were was used to develop the Capital Cost Estimate.

The Capital Cost Estimate is an AACE Class 3 estimate with a target accuracy of -20% to +20%. Ninety-five percent (95%) of the Monte Carlo simulations falls between -20% and +20% @ P80.

Typical accuracy ranges for the AACE Class 3 estimates are -10% to -20% on the low side and +10% to +30% on the high side. These accuracy ranges depend on the technological complexity of the project and level of engineering achieved.

3.2 Cost Summary

The total cost to build an additional 150 MW power station at Bay d'Espoir (Unit 8) has been estimated at $ 394 M.

The cost estimate has been structured in a way that is compatible with the Work Breakdown Structure. The WBS has been developed according to the elements composing the facilities described in this report.

All sales taxes have been excluded from the estimate as they are refundable.

The following table reflects the costs as of August 2017 in $M CAD.

Table 3-1 – Costs August 2017

WBS	Description	Total ($M CAD)
	Direct Costs	
1	Preliminary Works	[redacted]
2	Temporary Works	
3	Headrace Channel	
4	Intake Structure	
5	Penstock from New Intake to New Unit 8	
6	Powerhouse	
7	Tailrace	
8	Modifications to Terminal Station # 2	
9	230kV Transmission Lines	
10	Indirect Costs	
11	Contingencies	
12	Escalation	
13	Capitalised Interest	
	TOTAL:	$393.7

The detailed costs estimate is presented in Appendix A1.

3.3 Base Currency and Exchange Rates

The base rate of the estimate is in Canadian dollars (CAD).

3.4 Base Date of Estimate

The base date of the Class 3 Estimate is August 25, 2017.

3.5 Estimate Milestone Dates

Construction work is planned to start in December 2018 and construction will end December 2021.

3.6 Construction Work Week

The construction work week is 10 hours per day, 7 days per week, for a total of 70 hours per week. The workers work for 14 days and are off on R&R for 7 days.

3.7 Units of Measure

The main units in the cost estimate are stated in SI metric system.

3.8 Cost and quantity basis

3.8.1 Labour Crew Rates

The craft labour wage rates for Bay d'Espoir, Newfoundland was developed using the trade agreements in the "COLLECTIVE AGREEMENT between Muskrat Falls Employer's Association Inc and the Resource Development Trades Counsel of Newfoundland and Labrador and assuming that a similar agreement would be applicable for the Bay d'Espoir unit # 8 extension.

For civil works it was decided that for ease and timeliness, an average rate for workers and one for crew leaders and foremen would be sufficient under the circumstances and therefore would not affect the precision of the estimate at this level of study.

Equipment rates, in majority, are based on the "Cost Reference Guide for Construction Equipment" published by Equipment Watch. Other equipment rates came from SNC-Lavalin's database.

The labour rates include the following costs:

- Craft base rates fringe benefits and overtime;
- Mobilization & demobilization of contractor items;
- Non-manual labour (general foreman, superintendent, project manager etc.);
- Indirect manual labour;

- Small tools;
- Consumables;
- Ownership and operational costs of construction equipment;
- Construction cranes up to 80 metric tons;
- Health, safety and environmental requirements;
- Site supervision and administration;
- Contractor temporary site facilities;
- Overhead and Profit.

Labour rates are based on straight time for 10 hours per day, Monday to Friday, for a 50 hour week.

Hours worked on Saturday are paid at time and a half (1.5 x).

Hours worked on Sunday are paid at double time (2.0 x).

There is only a day shift. No double shift has been foreseen at the moment.

It has been assumed that all workers travel from either St.-John's NL, St.-John NB or Halifax NS. The average round trip air fare cost is assumed at $500.

All construction workers, contractor site supervision and their indirect staff's transportation costs, by plane, to Gander airport is included separately in the estimate as well as the bus costs to take the workers from Gander Airport to the Bay d'Espoir site.

All construction workers, contractor site supervision and their indirect staff are paid 16 hours travelling time, 8 hours in and 8 hours out.

All site workers are paid 30 minutes a day to travel to and from the construction camp at St. Alban's to the site.

Camp and catering costs are included separately in the estimate for all workers.

3.8.2 Labour Person-hours and Productivity

Direct field labour is the skilled and unskilled labour required to install the permanent plant equipment and bulk materials at the project site. Direct field installation person-hours have been developed using estimated unit person-hours for each commodity multiplied by the quantity.

Installation hours have been adjusted to reflect local conditions which include: effective hour, extended overtime, weather conditions, access to work areas, overcrowded/tight work area, availability of skilled workers, tie-ins, material and equipment handling, inspection QA/QC and safety on a worker's performance.

3.8.3 Civil, Concrete, Steel and Architectural Works

3.8.3.1 Quantity Development

Engineering used a computerized 3D model (using CATIA software) of the major structures to develop the major quantities for earthworks and concrete works. These are:

- Overburden and rock excavations, divided in dry or under water excavations when the situation required it;
- Areas of rock requiring surface protection (close line drilling, wire mesh, rock bolts) and for earth surfaces subject to weathering degradation (rain, overflow), the use of excavated rock as is and/or processed excavated rock to take out the fines, for the wet or could be wet zones;
- Excavations quantities for Unit 8 include quantities for the service bay;
- Excavation material is reused for backfilling as overburden;
- For the concreting portion of the works, the quantities for the major types of formwork and for concrete. Re-steel quantities were calculated based on two general factors that they established: 100 kg per cubic meter for all structural items and 50 kg per cubic meter for any other structure except for some special areas;

- Hydro mechanical equipment quantities were based on the type, dimensions and functioning head of the various equipment needed; information was taken from drawings available.

Estimating did a detailed quantity take-off, for the new foundations in the extension of the Terminal Station 2, from "issued for construction" drawings. The foundations were provided for the following:

- 230kV Circuit Breaker CB-1;
- 230kV Disconnect Switch DS-1;
- 230kV Bus Post Insulator for PI-1;
- 230kV Bus Post Insulator for PI-2;
- 230kV Dead-end Gantry F1;
- 230kV Capacitive Voltage Transformer CVT-1 ;
- Cable trenches.

A detailed estimate was done for the new Control Room of 8m x 10m in the substation.

A new concrete duct bank is included from Powerhouse 2 to Terminal Station 1.

The seven kilometers of 6 metre wide permanent access roads exists and is asphalted.

Seven kilometers of permanent access roads will be upgraded by adding a 500 mm layer of 0-20 mm backfill to the existing 6 meter wide road.

Three kilometers of temporary access roads has been included for the construction of the headrace channel, conduit and Powerhouse 2 EXTENSION roads. The roads are 8 meters wide by 300 mm thick backfill.

5 kilometers of miscellaneous construction roads to the Powerhouse 2, Intake, pits, waste areas etc. is included. The roads are 8 meters wide by 1 meter thick layer of backfill with a 1V:2H slope on each side.

The construction camp will be located near St. Alban's. The camp will be assembled on a 600 mm granular platform and enclosed by a fence. There is also parking for 20 vehicles.

There is a pumphouse enclosing 2 water pumps to pump water from the outfall to the camp which will be treated. A sewage and grey water treatment skid is also included. The treated sewage and grey water is sent by gravity back to the outfall.

Platforms are constructed at the intake, switchyard and powerhouse areas to accommodate the contractor's trailers, lay down area and parking.

After the camp is demobilized and construction is complete, a dozer will be used to level and clean the camp platform, the Intake contractor platform, the permanent access roads, temporary access roads and the miscellaneous construction roads.

3.8.3.2 Pricing Development

Material costs were obtained from budgetary quotes specific to the Bay d'Espoir proposal and from other similar projects under study. Such material costs are:

- Concrete will be trucked-in from Grand-Falls in dry batch conditions. According to the supplier, this method has been accepted by N&L Hydro in the past. This method is cheaper than installing a small batch-plant on-site and therefore avoids the costs for concrete trucks and operators working or on standby time and having to provide the required facilities such as electricity, water, aggregates, room and board, mobilizing and demobilizing equipment and required workers. The 30MPa unit supply cost delivered to site was quoted at $277 per cubic meter. The supplier confirmed that he could deliver up to 250 m^3 per day;
- Precast concrete panels;
- Penney Paving, which has a quarry 35km from Camp Boggy, provided the following backfill supply costs delivered to site:
  - 0-22 mm aggregate $62 per cubic meter
  - 0-56 mm aggregate $60.75 per cubic meter
  - 0-112 mm aggregate $59.75 per cubic meter
  - Sand $22 per cubic meter

A request for budgetary quotes was issued for re-steel, structural steel, roofing and other major civil work materials. Either there was no response from the suppliers or prices were out of proportion compared to SNC Lavalin's in-house costs;

Hydro-Mechanical (embedded parts, stoplogs, gates and trashrack etc.) prices were also obtained from another similar project. Prices were analysed, compared to SNC Lavalin's in-house data bank prices and an acceptable average price was calculated and used.

All other pricing is based on SNC Lavalin's in-house cost data bank for materials.

Additional assumptions and clarifications:

- Use existing Unit 7 bridge crane and hoist for Unit 8;
- Embedded parts for Unit 8 were assumed installed during construction of Unit 7 and are excluded from the estimate.

3.9 Mechanical and Piping

3.9.1.1 Quantity Development

Engineering provided the scope of work and quantities for the following Powerhouse 8 services:

- Raw and cooling water system (including shaft seal);
- Fire protection;
- Drainage system;
- Depression system;
- High pressure compressed air system;
- Piezometer system;
- Ventilation system.

3.9.1.2 Pricing Development

The pricing for Powerhouse 2 extension services is based on in-house historical costs from a recent similar project.

Selected turbine suppliers provided a budget quotation for a turnkey package for the 150MW turbine and generator. The budgetary turnkey quote includes the following costs:

- Engineering;
- The complete supply and installation of the turbine and generator;
- Packaging and freight to the Bay d'Espoir site;
- Unloading and handling at site;
- Testing of the installed turbine and generator;
- Vendor representatives;
- Documentation;
- Pre-commissioning, commissioning and start-up;
- Trade assistance;
- Spare parts;
- Training of Owner's staff;
- Custom duties.

3.10 Electrical and Instrumentation

3.10.1 Quantity Development

Engineering provided the major quantities for the 230 kV Line, the Control and Protection and Terminal Station 2.

All major items for the additional Unit 8 located in extension of the Powerhouse 2, such as set-up transformer, isolated phase bus, auxiliary transformer, switchgear section and main distribution panels.

The electrical bulk materials such as distribution panels, distribution transformers, switches, local motors starters, cabling, etc. for the Auxiliary Services, listed in Section 3.8 Mechanical and Piping, were evaluated based on the single line diagram issued for the erection of the existing Unit 7 in the same Powerhouse 2.

An allowance has been added to cover the extension of a 25 kV line to feed the new Headrace installation.

An allowance has been added for the dismantling and reinstallation of the cables during the demolition of an existing cable trench between the Powerhouses 2 and 1 and its replacement by a new duct bank (see Civil Section).

An allowance has been added to cover the relocation of a pole.

3.10.2 Pricing Development

Informal quotes have been issued to major equipment suppliers for prices for the main set-up transformer 129/172 MVA, 230/13.8KV, the Isolated Phase Bus, Terminal Station 2 switches, dead bank breakers, high-bus and grounding material.

The price for the remaining bulk and low voltage distribution material are from in-house historical data from recent projects.

3.11 Building Services Works

3.11.1.1 Quantity Development

The cost of building services, for Terminal Station 2 Control Building, the Intake Gate Enclosure and Intake Gate Hoist building was done on a cost per square meter basis for the following services:

- HVAC (with no cooling) services;
- Plumbing services;
- Electrical services;
- Fire protection services.

3.11.1.2 Pricing Development

The pricing for the building service items is based on in-house historical costs per square meter.

3.12 Indirect costs

3.12.1.1 EPCM Costs

The costs of management, engineering, procurement and construction supervision have been based on a preliminary forecasted manpower loading.

The costs include all salaries, payroll burdens, overheads, transportation, room and board costs and all the direct costs associated with an EPCM's home and field office operations but exclude escalation.

The EPCM costs include activities from Notice to Proceed (NTP), detailed engineering and construction up to Pre-Operational Verification (POV). Commissioning, start-up and ramp-up are also included. Workforce for commissioning will be provided by contractors.

The estimated costs for the Geotechnical Survey, the Survey subcontract and the External Laboratory Testing has been included in EPCM costs.

It has been assumed that the EPCM staff will travel from outside Newfoundland.

EPCM staff transportation costs by plane to Gander airport are included separately in the estimate as well as the bus costs to take them from Gander Airport to the Bay d'Espoir site.

The EPCM staff is assumed to work 14 days and are on R&R 7 days. The staff is paid 16 hours travelling time, 8 hours in and 8 hours out.

Camp and catering costs are included separately in the estimate for the EPCM staff.

The EPCM Costs include an allowance of 500 000$ for the investigations.

3.12.1.2 Construction Camp & Catering

The construction camp cost has been developed using rates from a camp provider for the following:

- Monthly rental rates for rental dormitory units for a total of 100 private rooms with a shared washroom per 2 private rooms;
- Monthly rental rates for a kitchen, recreational center, staff office complex and laundry units;

- Transportation, installation and demobilization of above units;
- Man day rates for catering and operations;
- Man day rates for power and distribution;
- Man day rates for water and sewage.

The peak manpower is 102 workers. This includes all workers, EPCM staff, Owner staff, vendor representatives, contractor site supervision and their indirect staff.

The camp will include a fire fighting system and provision of appropriate water supply.

It is assumed the workers are replaced during their R&R.

The camp is located near St. Alban's.

3.12.1.3 Site Services and Temporary Facilities

Estimation has developed a detailed estimate for the costs for site services and temporary facilities.

Site Services and temporary Facilities include the following costs:

- Initial facilities such as fencing, gates, lay down areas and signage;
- Laydown areas at intake, powerhouse and switchyard;
- Temporary buildings such as 4 office trailers for EPCM and Owner staff, 1 toilet trailer, portable toilets and connections for 10 contractor trailers.
- Temporary utilities such as water supply pipe, sewage drainage and sewage treatment;
- Furniture and equipment such as computers, office furniture, network installation, photocopiers, kitchenette equipment and HSE meeting room equipment;
- Site services such as temporary electrical installation, office phones, cell phones, coffee, catering twice a week and bottled water for EPCM staff and Owner, janitorial service and courier services;
- Site maintenance such as snow removal, road and parking maintenance and site maintenance labour;

- Site operation such as stationary and office supplies, first aid and HSE supplies;
- 15 leased pickup trucks, for EPCM and Owner staff, including fuel, insurance and monthly maintenance costs for a duration of 36 months;
- 1 15 passenger bus, for worker and staff trips from Gander to site, includes a driver, fuel, insurance and monthly maintenance costs for a duration of 36 months;
- 2 – 30 passenger buses for worker and staff trips from the construction camp in St. Alban's to the site;
- Air medic insurance for workers at $950/person;
- 1 firefighting tanker.

Other construction indirects such as intermediate and final clean up, containers (recycling, garbage, and construction materials), videoconference, promotional gifts and progress photos.

Other assumptions and Clarifications:

- Sufficient parking made available for 20 vehicles;
- Owner's plant security will provide security during construction;
- Owner to provide access to an existing temporary on-site storage facility during construction if required.

3.12.1.4 Vendor Site Representation

The turbine suppliers provided a budgetary turnkey quote for the turbine and generator which includes Vendor representative support costs.

The costs are assumed to include salaries, expenses, airfares, meals and any room and board allowances.

A provision of 2% of the initial budgetary quote amount has been added to all other electrical equipment suppliers when applicable.

3.12.1.5 Pre-Commissioning Support (Trade Assistance)

The turbine suppliers provided a budgetary turnkey quote for the turbine and generator which includes the costs of trade assistance during pre-commissioning.

3.12.1.6 Freight Costs

All freight costs are included in the cost estimate.

3.12.1.7 Taxes

All taxes are excluded from the estimate as there are refundable and therefore not applicable to this project.

3.12.1.8 Spare Parts

All required spare parts are included in the cost estimate.

3.12.1.9 First Fill

The turbine suppliers provided a budgetary turnkey quote which includes the costs for first fill.

3.13 Contingencies

Contingency is an integral part of the estimate and can best be described as an allowance for undefined items or cost elements that will be incurred, within the defined project scope, but that cannot be explicitly foreseen due to a lack of detailed or accurate information.

It should not be considered as a compensation for estimating inaccuracy nor is it intended to cover any costs due to potential scope changes, "Acts of God", labour strikes, and labour disruptions outside the control of the project manager, fluctuations in currency or cost escalation beyond the predicted rates.

A "high-level" probabilistic analysis was performed using Monte Carlo simulation.

SNC-Lavalin's internal procedures recommend that contingency be based on amount corresponding to P80 (80% probability of under run).

The probabilistic contingency @ P80 has been assessed at 22.5% of the direct and indirect costs excluding escalation. The P80 contingency value is 59.5 M$.

The contingency analysis and recommended amount are independent of all potential risks.

The results and details of the analysis are shown in Appendix A5.

3.14 Escalation

The estimate is expressed in second quarter 2017 Canadian dollars (CAD$ 2Q2017).

Based on a developed cash flow, a percentage has been applied to the capital costs to cover for escalation on labour, equipment and material costs beyond 2Q2017 and up to project completion. The following escalation factors were provided by NL Hydro:

2018 : 2.7%

2019 : 2.9%

2020 : 2.8%

2021 : 2.8%

Escalation was applied to the Procurement and Installation of the Turbine and Generator for 2018 only.

3.15 Capitalised Interests

The capitalised interests were estimated with a factor provided by NL Hydro. The interest rate provided was 6.41% per year.

3.16 Risk Analysis

The estimate excludes all costs associated with risk and costs associated with risk mitigation. Exclusions are detailed in section 3.22.

3.17 Owner's Costs

Owner's cost was provided by Newfoundland and Labrador Hydro and is assumed to include for the following:

- Environment permits;

- Operating costs;
- Licenses and fees;
- Operations workforce required for construction, commissioning and start-up activities;
- Operational safety equipment supplies;
- Owner's team;
- Environmental studies, monitoring, noise study, water analysis, etc.;
- Deferred or sunk costs (spent study costs);
- Owner's Project Office (other than space provided by the EPC Contractor's site construction office) including rent, communications, furniture and equipment, and office supplies;
- Owner's travel, legal and other Corporate Office charges to the Project except those specifically indicated;
- Owner's consultants (legal, environments, etc.);
- Relationship with Government Authorities;
- Project insurance including Comprehensive general liability and insurance for construction equipment & tools, builder's all risk insurance;
- Performance bond premiums;
- Allowance for the upgrade of any offsite facilities;
- Removal and disposal of hazardous materials;
- Soil decontamination and its transportation;
- Landscaping to grade and hydraulic seeding (site rehabilitation);
- Supply of furniture, appliances, tools and shelving;
- Training of plant operating personnel;
- Owner's Contingency or Project Reserve;
- Licenses and fees, except those specifically indicated;

- Operational Safety equipment supplies;
- Containers/pallets for transport;
- Standardization of format or documentation of existing reports or drawings;
- Construction site security;
- Construction permit.

It has been assumed that the Owner's staff travels from Saint John's NL. The round trip air fare cost is $500.

The Owner's staff transportation costs by plane to Gander airport are included separately in the estimate as well as the bus costs to take them from Gander Airport to the Bay d'Espoir site.

The Owner's staff is assumed to work 14 days and are on R&R 7 days. The staff is paid 16 hours travelling time, 8 hours in and 8 hours out.

Camp and catering costs are included separately in the estimate for the Owner's staff.

3.18 OPEX

An OPEX estimate is excluded.

3.19 Customs and Duties

The cost of customs and duties are included in the estimate.

3.20 Energy for construction

NL Hydro will not be providing energy to construction activities and these cost have been included in the cost estimate.

3.21 Exclusions

The following items are excluded from the cost estimation:

- Unusual commodity escalation;
- Delays caused by local community public relations;
- Delays caused by Labour disputes;

- Delays caused by unusual weather conditions;
- Costs associated with schedule acceleration or deceleration;
- Taxes (HST, GST & PST);
- Currency fluctuations with the Canadian dollar;
- Legal services;
- Financial analysis;
- Allowance for industrial dispute or lost time arising from industrial actions;
- The cost of Working Capital;
- Winter concrete work has been reduced to a strict minimum, even though local temperatures are considered mild in the winter season;
- Training, documentation & license fees costs (other than those specified above);
- Furniture, fixtures, appliances, tools, shelving;
- Relocation of existing hidden underground services and other buried obstacles (excluding control cables for Unit 7);
- The cost for current and future studies prior to project execution;
- Provision for adverse soil conditions beyond those assumed based on available data;
- Costs associated with a plant area shutdown;
- Cost variations caused by a change in scope;
- Additional environment mitigation measures required following the environment assessment process.

4 ENVIRONMENT

Legal Requirements Pursuant to Newfoundland and Labrador Environmental Protection Act and to the Canadian Environmental Assessment Act.

4.1 NL – Environmental Assessment Process

In accordance with the Newfoundland and Labrador Environmental Protection Act (EPA), and Environmental Assessment Regulations, "[...] *anyone who plans a project*[2] *that could have a significant effects on the natural, social or economic environment*" is required to submit a Project Registration to the Department of Municipal Affairs and Environment for examination.

The key steps of the Environmental Assessment Process are[3]:

1) Project registration and public and governmental review.
2) Minister's decision[4].
3) Government preparation of guidelines for an Environmental Preview Report (EPR) or an Environmental Impact Statement (EIS) (if required).
4) Proponent preparation of EPR or EIS and ;
5) EPR/EIS review and Minister's decision.

The Part 3 of the Environmental Assessment Regulations lists the projects that require registration and review. As currently defined, the Proposed Bay D'Espoir Hydro Generating Unit 8 project is subject to the NL Environmental Assessment Process and is required to be registered with the Department of Environment and Climate Change.

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[2] Refers to an "Undertaking" as per the NL-EPA.

[3] Minister of Environment and Climate Change (2016). Environmental Assessment... A Guide to the Process, Government of Newfoundland and Labrador.

[4] The Minister shall determine whether (a) an environmental preview report is required (b) an environmental impact statement is required or (c) the undertaking may be released.

The Minister's decision to request an EPR or an EIS, and the duration of the overall environmental process, will mainly depend on the scale of the undertaking and its potential negative environmental effects.

The duration of the environmental process will vary significantly between an EPR and an EIS.

<u>Excluding the time required for the proponents to prepare the project registration and the EPR or EIS</u>, the Minister, under the Environmental Assessment Regulations (2003), could require, through the EPR process, a total of 5 months before making a final decision and, through the EIS process, a total of 9 months before taking a final decision. If public hearings are requested after the submission of an EIS an additional 6 months could be required before a final decision is made.

The time required for the proponent to prepare the project registration and the EPR or EIS is variable. The project registration and the EPR usually don't involve detailed field surveys. The preparation of the EIS could be much longer if the Minister request the Proponent to prepare component studies (fish, rare plants, birds, etc.). Since some component studies can only by conducted during a specific period of time (spring, summer, fall), they can also have an impact on the overall schedule of the project.

For some components studies that the Minister commonly requires, it is usually recommended to carry out these studies as early as possible (during the registration phase for example) in order to reduce the impact on the project schedule.

The duration of the environmental process, as per the Environmental Assessment Regulations (2003), is shown in the table below.

Step	EPR	EIS
Project registration	Variable	Variable
Minister decision	45 days	45 days
Guidelines issued by the Minister	60 days	120 days
Public review of guidelines	n/a	40 days
Proponent preparation and submission to the Minister (EPR or EIS)	Variable	Variable
Minister Decision	45 days	70 days
Public Hearings (decision)	n/a	120 days
Public Hearings	n/a	Variable
Public Hearings Report	n/a	45 days
Decision	n/a	60 days

Source: http://www.assembly.nl.ca/Legislation/sr/Regulations/rc030054.htm

Environment mitigation measures during construction have been considered in the cost estimate. Other mitigation measures will be reviewed once the EIA report is available.

4.2 Federal Environmental Assessment Process

The Proposed Bay d'Espoir Hydro Generating Unit 8 project could be subject to the Federal Environmental Assessment Process. The Federal government in accordance with the Canadian Environmental Assessment Act (CEAA) usually reviews the undertakings that are subject to the NL – Environmental Protection Act. If the federal environmental assessment process applies, usually one set of guidelines is produced by the federal and the provincial government.

4.3 Potentially applicable permits and authorizations

In addition to the federal and provincial environmental assessment process, the Project will also require a number of authorizations.

The potentially applicable permits and authorizations are:

REGULATION	REQUIREMENTS
Provincial	
Water Resources Act, SNL 2002 c W-4.01	• Part 1 - Water Use Licence • Section 36-37 - Permit to Construct Drinking Water and Wastewater Infrastructure • Section 38 - Permit to Operate Public Drinking Water and Wastewater Systems • Section 39 - Permits for Development Activity in a Protected Public Water Supply Area • Section 48 - Permit for Alterations to a Body of Water • Section 56-57- Water Well Drilling Licence • Section 58 - Permit for Constructing a Non-Domestic Well • Section 61 - Permit for Development Activity in a Wellhead Protected Water Supply Area • Certificate of approval for Instream Activity • Certificate of Approval for Construction Site Drainage • Certificate of Approval for a Water Withdrawal System
Environmental Protection Act, SNL 2002 c E-14.2	• Section 33 - Pesticides Control • Section 16 - Waste Management (Certificate of Approval for a waste Management System) • Section 83 - Industrial Compliance • Section 20 (Host Regs) - Petroleum Storage and Management • Certificate of Approval for Storing and Handling Gasoline and Associated Products • Fuel Cache Permit • Certificate of Approval for Septic Systems
Lands Act	• License to Occupy Crown Land
Urban and Rural Planning Act	• Application to develop land
Occupational Health and Safety Act	• Compliance
Health and Community Services Act	• Certificate of Approval for Installation of a Sewage System • Certificate of Approval for Installation of Water Supply System • Food Establishment Licence –Temporary Facility Permit
Policy for Development in Wetland	• Work in wetland (compliance)
Quarry Materials Act and Regulations	• Quarry Permit
Services and Transportation Act	• Access to Highway Permit
Forestry act and cutting of timber regulations	• Operating Permit

REGULATION	REQUIREMENTS
	• Cutting Permit • Permit to Burn
Fire Prevention Act	• Permit for Storage, Handling, • Use or Sale of Flammable and • Combustible Liquids
Dangerous Goods Transportation Act	• Compliance
Federal	
Fisheries Act, 1985, DFO	• Section 35 of FA - Letter of Advice or Authorization for Works or Undertakings Affecting Fish Habitat • Section 36(3) of FA - Compliance Standard / letter of acceptance
Migratory Birds Convention Act, 1994, EC	• Compliance
Species at Risk Act, 2002, EC	• Compliance
Federal Policy on Wetland Conservation, EC	• Compliance
Transportation of Dangerous Goods regulations	• Compliance
Navigation Protection Act and Regulations	• Permit for Construction • Within Navigable Waters
Explosives Act	• Temporary Magazine Licence • Explosives Purchase and Possession Permit • Explosives Transportation Permit

4.4 Recommendations regarding the environmental authorization process

If not already underway:

- Initiate discussion with the Department of Municipal Affairs and Environment and the Federal government to confirm the applicable environmental assessment process for the project and clarify their expectations regarding the Undertaking. Identify the components studies that the provincial and/or federal authorities could require;
- In order to reduce the impact on the overall project schedule, identify and plan the requested field component studies for year 2018 considering some field work (fauna & flora) can only by conducted during a specific period of time (spring, summer or fall).

4.5 Potential environmental and social impacts

Negative effects should mainly occur during the construction phase where most effects will be localized, short-term and intermittent. The main benefits of the project should occur during the operation and maintenance phase.

The permanent required land for the project (hydropower components) is estimated at 5 ha. With a length of 1.6 km, approximately 8 ha will also be required for the new high voltage line and its right-of-way. A minimum of 1.5 ha will be temporarily required for the construction phase (hydropower components) as well as approximately 8 ha for the temporary access roads needed for construction (total length of 15 km).

Disturbed areas not required for the operation will be restored and revegetated and the drainage will be re-established.

Considering the following the project should not result in significant adverse environmental effects:

- The new hydropower facility will be integrated to the existing facilities operation ("brownfield") with limited changes to the actual operations;
- The reservoir level and its management will remain the same;
- The project will be compliant with relevant environmental legislation, regulations and permits;
- The project design will be prepared in accordance with best practices, guidelines and standards;
- The project is located within a remote area and with the exception of wildlife, is far from the main sensitive receptors;
- Best practices and standard mitigation measures will be put in place during construction and operation and maintenance phases.

Once the construction phase of the project is completed, the adverse effects on the environment should be limited. The operation will be characterized by the continued operation and periodic maintenance activities, which are usually not subject to generate significant negative effects on the environment.

4.5.1 Source of impacts

The main project activities (sources of impacts) that are subject to have adverse effect on the environment are:

4.5.1.1 Construction

- Preconstruction activities;
- Construction of temporary access roads and/or upgrade of existing roads;
- Closing of portion of existing access road;
- Temporary construction area/laydown area;
- Construction camp (and presence of workers);
- Transport (heavy vehicles, material, staff);
- Enlargement of the existing headrace channel;
- Construction of new entrance channel;
- Construction of new intake (no.5);
- Construction of new buried steel penstock to Unit 8;
- Enlargement of the existing tailrace;
- Powerhouse "upgrade";
- Construction of new high voltage line & connection to existing substation;
- Excavations, management and disposal of materiel (cut and fills);
- Management of (new or existing) borrow pits/quarry (if needed);
- Removal of temporary rock plug;
- Blasting (if needed);

- Water works (headrace channel & tailrace);
- Waste management;
- Health & safety.

4.5.1.2 Operation and maintenance

- Presence of the new structure (new enlarged headrace channel, new entrance channel, new intake, etc;
- Operation and maintenance;
- Production of energy (from hydropower).

The excavations, management and disposal of materiel (cut and fills) will be an important source of impact and standard and specific mitigation measures will be required to minimize the environmental impact.

The main environmental components that could be potentially affected are described below as well as potential mitigation measures. The standard and specific mitigation measures, and related costs, will be detailed during the environmental assessment of the project.

4.5.2 Atmospheric Environment

4.5.2.1 Air Quality and GHG Emissions

The project is not likely to result in significant adverse environmental effects on air quality and greenhouse gases (GHG) emissions considering:

- The temporary and localized nature of the construction activities;
- The project is located in a remote area far from potentially sensitive receptors (communities, permanent residences, recreational activities and other);
- Standard activities will occur and best practices will be applied during construction;
- Levels are expected to remain below applicable regulatory standards and guidelines.

The main potential sources of air pollutants will be generated from fuel combustion in equipment and dust generation during construction phase. Greenhouses gases (GHGs) produced during construction will be from the combustion of fossil fuels in equipment. GHG emissions are cumulative but the levels to be generated by the construction are considered negligible relative to Newfoundland and Labrador levels and considering the short duration of the construction phase. During its operation, the project (hydropower) will also generate less GHGs than if the energy was produced from a fossil source.

Standard mitigation measures will allow minimizing the negative effect during construction such as: regular inspection and maintenance of equipment, use of a dust control agent (water or other) to mitigate fugitive dust emissions, etc.

4.5.2.2 Noise and vibrations

Noise and vibrations will be generated during construction activities (from the use of equipment and vehicles, blasting etc.). Located in a remote area and far from the potential sensitive receptors, the project is not likely to result in significant adverse environmental effects related to noise and vibrations. However, noise and vibrations might temporarily disturb the wildlife during construction. Standard mitigation measures, such as maintaining all equipment in good condition, will contribute to reduce the potential negative effect generated by noise and vibrations.

4.5.3 Terrestrial Environment

4.5.3.1 Soils and Erosion

The Project will require the excavation of a significant volume (approx. 495,000 m^3) of soil and rock. Some excavations will occur on steep slopes (construction of new penstock) potentially subject to erosion. The excavation and the management of soils will need to be carefully executed in order to minimize soil erosion and adverse impact on the environment.

Standard mitigation measures will minimize the negative effect during construction, such as:

- Implementation of an erosion management plan to minimize erosion;

- Minimize work footprint during construction;
- Implementation of erosion control measures to protect aquatic habitats, reduce ground disturbance to protect sensitive areas;
- Manage soils per category;
- Control and manage drainage;
- Discharge water into a settling basin or vegetated area;
- Rehabilitate site after construction (re-vegetation/natural restoration/return to a comparable land use capability);
- Monitoring of erosion during construction.

4.5.3.2 Vegetation and wetland

The clearing of approx. 23 ha of vegetation, mostly coniferous trees and open scrub forest, will be required for the project. .

An inventory of wetlands, vegetation and potential plant species at risk should be conducted in order to assess the effect of the project on the vegetation and wetlands. The wetlands are subject to various federal, provincial and municipal policies, agreements and legislation given their hydrologic, ecological and anthropogenic functions.

During construction, avoiding sensitive areas and habitats and minimizing the extent of vegetation clearing are amongst the standards mitigation measures recommended.

4.5.4 Terrestrial Fauna and Habitats

The clearing of vegetation (approx. 23 ha), which provide habitat for wildlife, the noise, vibrations, lightning and presence of workers are the main source of impact on terrestrial fauna and habitats.

A fauna inventory and potential plant species at risk[5] should be conducted in order to assess the effect of the project on the fauna with a special attention on those which are protected under the NL ESA and/or SARA and the Migratory Birds Convention Act.

Standard mitigation measures will minimize the negative effect during construction, such as:

- No harvesting of wildlife by project staff;
- Optimization of construction schedule to avoid sensitive period for fauna (i.e. most sensitive time for birds are between mid-May to mid-August);
- Ensure proper waste management.

4.5.5 Aquatic Environement

4.5.5.1 Hydrology

The flow and current speed could be modified due to increase in peaking production resulting in lower minimum flows and maximum peak flow passing from 400 m³/s to 500 m³/s with both powerhouses at full capacity.

The modification of the outflow at the power station might result in bank erosion and could also locally affect the aquatic environment.

4.5.5.2 Aquatic Fauna and Habitats

The construction of the new entrance channel, the new intake and the enlargement of the existing headrace channel and tailrace will be conducted in or near waterbodies that potentially support fish habitat. Construction activities might interact with fish habitat.

[5] Legal protection under provincial (NL ESA) and/or federal (SARA) legislation.

Construction might induce an increase in suspended solids in the river, which could potentially impact fish communities. A surveillance program including water quality measurements that will focus on turbidity and suspended solids will need to be developed.

Potential spills of fuel or other deleterious substances and sedimentation resulting from construction activities (vegetation clearing, excavation, etc.) could also result in potential effects on water quality and fish communities.

The operation and maintenance is not likely to result in significant adverse environmental effects on the aquatic fauna and habitats. However, the modification on flow and current speed due to increase in peaking production will result in increased lower minimum flow and maximum peak flow. The potential adverse effects on aquatic fauna need to be addressed.

The following standard mitigation measures will contribute to reduce these potential effects:

- Optimize schedule to avoid construction during sensitive period for fish and its habitat;
- Implementation of erosion control measures to protect aquatic habitats, reduce ground disturbance and to protect sensitive areas;
- Accidental event prevention and response.

4.5.6 Socioeconomic Environment

4.5.6.1 Local, Regional and National Economy

The project construction will require goods and services and should result in the creation of employment opportunities. Direct economic benefits, as well as indirect or induced benefits, should be expected at the local, regional and national levels but need to be assessed.

During the operation, the addition of 150 MW could also contribute to optimize the existing provincial generation grid and to secure induced economic benefits.

4.5.6.2 Infrastructure and public services

Given the small size of the construction workforce, the short-term duration of the project and the availability of infrastructures and services in the project area, the interaction of the project with the existing community services and infrastructure should be limited.

4.5.6.3 Historic, Cultural and Archeological Resources

The construction activities could potentially disturb or destroy historic, cultural and archeological Heritage Resources. An historical, cultural and archeological study (and potentially pre-construction surveys) should be completed to identify any known resources and identify the archaeological potential within the proposed project site. During construction, standard precautionary and reporting procedures will need to be in place.

4.5.6.4 Landscape and visual aesthetic effects

The project might have potential effects on landscape.

4.5.6.5 Recreational land use activities

Construction activities will mainly occur on Hydro's property (site of industrial vocation) and the potential effects on recreational land use activities and recreational resource users should be limited.

4.5.6.6 Human Health and Well-Being (workers and local population)

Possible disturbances due to traffic, noise, dust, presence of workers or potential accidents could occur during construction. However, considering the remote location of the project, and its distance with the closest community, the construction activities should have a limited effect on nearby communities and their residents.

On-going communications with local communities and stakeholders throughout the project construction will contribute to mitigate the potential adverse effect. For example, the communication of planned transportation of large equipment and the mitigation measures in place for potential traffic and/or safety concerns.

4.5.7 Cumulative Environmental Effects

Based on the information available, potential residual effects of the project could accumulate with those of other projects and activities. The potential cumulative environmental effects will need to be assessed.

APPENDIX A – COST ESTIMATE

REDACTED
IN FULL

Appendix A1 – Detailed Cost Estimate

Appendix A2 – Cash Flow

Appendix A3 – Quarterly Average Man Month Analysis

Appendix A4 – Quarterly Labor Hours

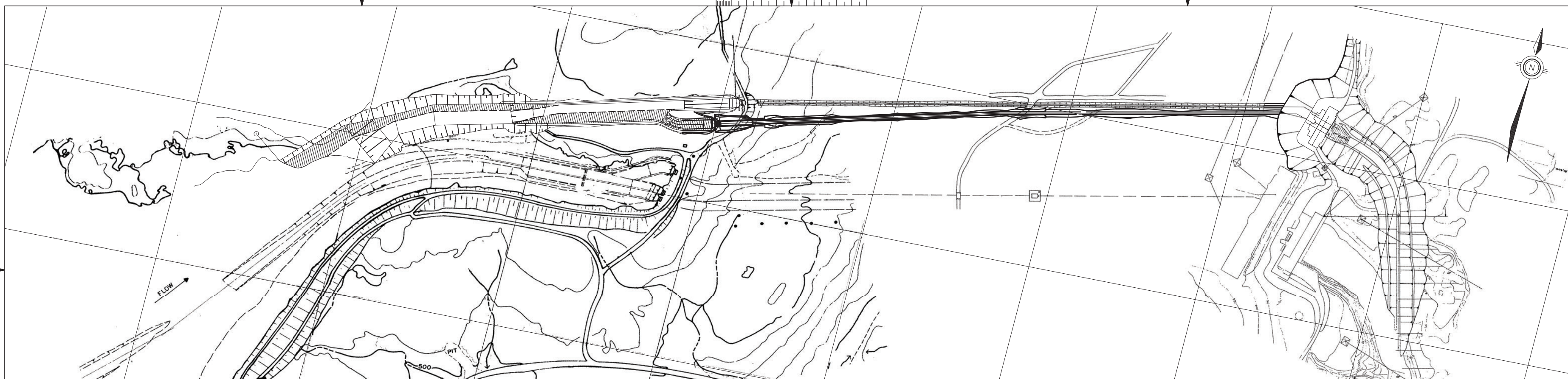
Appendix A5 – Contingency

REDACTED

APPENDIX B - SCHEDULE

IN FULL

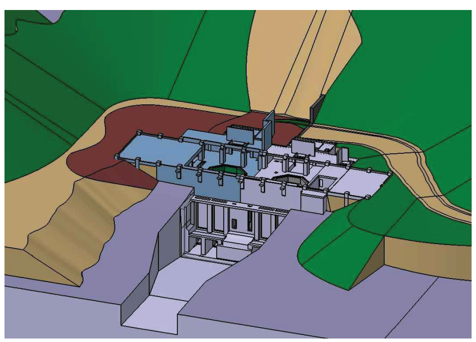
APPENDIX C - DRAWINGS



NEWFOUNDLAND AND LABRADOR HYDRO

PROPOSED BAY D'ESPOIR HYDRO GENERATING UNIT 8 FEASIBILITY STUDY

MARCH 22, 2018



CIVIL

DWG NUMBER	TITLE
647756-0001-41DD-0019_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT
647756-0001-41DD-0001_00	PROPOSED HYDRO GENERATING UNIT 8 GENERAL LAYOUT LIST OF DRAWINGS
647756-0001-41DD-0002_00	HYDRO GENERATING UNITS 7 & 8 HEADRACE CHANNEL PLAN, PROFILE & SECTIONS
647756-0001-41DD-0003_00	HYDRO GENERATING UNIT 8 INTAKE 5 PLAN & SECTIONS
647756-0001-41DD-0004_00	HYDRO GENERATING UNIT 7 & 8 INTAKE, PENSTOCK & POWERHOUSE PLAN, PROFILE & SECTIONS
647756-0001-41DD-0005_00	HYDRO GENERATING UNIT 7 & 8 GENERAL ARRANGEMENT POWERHOUSES 1 & 2 PLAN
647756-0001-41DD-0006_00	HYDRO GENERATING UNITS 7 & 8 TAILRACE PLAN, SECTIONS & DETAIL
647756-0001-41DD-0007_00	HYDRO GENERATING UNIT 7 GENERAL ARRANGEMENT TRANSVERSE SECTION PLAN
647756-0001-41DD-0008_00	HYDRO GENERATING UNIT 7 GENERAL ARRANGEMENT ROOF PLAN
647756-0001-41DD-0009_00	HYDRO GENERATING UNIT 7 GENERAL ARRANGEMENT GENERATOR FLOOR, EL. 7.925 PLAN
647756-0001-41DD-0010_00	HYDRO GENERATING UNIT 8 GENERAL ARRANGEMENT TRANSVERSE SECTION
647756-0001-41DD-0011_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT LONGITUDINAL SECTION
647756-0001-41DD-0012_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT ROOF PLAN
647756-0001-41DD-0013_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT MAIN FLOOR PLAN AT EL. 11.582
647756-0001-41DD-0014_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT GENERATOR FLOOR PLAN AT EL. 7.925 AND 7.315
647756-0001-41DD-0015_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT TURBINE FLOOR PLAN AT EL. 3.708
647756-0001-41DD-0016_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT SPIRAL CASE ACCESS FLOOR PLAN AT EL. 0.305
647756-0001-41DD-0017_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT DRAFT TUBE CONE ACCESS FLOOR PLAN AT EL. -1.829
647756-0001-41DD-0018_00	HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT DRAFT TUBE FLOOR PLAN AT EL. -9.449

TERMINAL STATION

DWG NUMBER	TITLE
647756-0001-47DD-0001_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) SINGLE LINE DIAGRAM
647756-0001-47DD-0002_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) ELECTRICAL LAYOUT
647756-0001-47DD-0003_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) SECTIONS L-L & M-M
647756-0001-47DD-0004_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) BURIED GROUNDING
647756-0001-47DD-0005_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) SURFACE GROUNDING
647756-0001-47DD-0006_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) GROUNDING DETAILS MAJOR EQUIPMENT
647756-0001-47DD-0007_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) GROUNDING DETAILS BURIED AND SURFACE
647756-DEMO-47DD-0002_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) ELECTRICAL LAYOUT (DEMOLITION)
647756-DEMO-47DD-0004_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) BURIED GROUNDING (DEMOLITION)

ELECTRICAL

DWG NUMBER	TITLE
647756-0001-47DD-0009_00	HYDRO GENERATING UNIT 8 POWERHOUSE SINGLE LINE DIAGRAM PREFEASIBILITY STUDY

P & C

DWG NUMBER	TITLE
647756-0001-48DD-0001_00	HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) SINGLE LINE DIAGRAM

MECHANICAL

DWG NUMBER	TITLE
647756-0001-46DD-0001_00	HYDRO GENERATING UNIT 8 PIPING COOLING AND SHAFT SEAL WATER SYSTEMS SCHEMATIC
647756-0001-46DD-0002_00	HYDRO GENERATING UNIT 8 PIPING FIRE PROTECTION SYSTEM SCHEMATIC
647756-0001-46DD-0003_00	HYDRO GENERATING UNIT 8 PIPING DRAINAGE SYSTEM SCHEMATIC
647756-0001-46DD-0004_00	HYDRO GENERATING UNIT 8 PIPING PIEZOMETER SYSTEM SCHEMATIC
647756-0001-46DD-0005_00	HYDRO GENERATING UNIT 8 PIPING HIGH PRESSURE COMPRESSED AIR SYSTEM SCHEMATIC
647756-0001-46DD-0006_00	HYDRO GENERATING UNIT 8 PIPING DEPRESSION SYSTEM SCHEMATIC
647756-0001-46DD-0007_00	HYDRO GENERATING UNIT 8 PIPING HVAC SYSTEMS SCHEMATIC
647756-0001-46DD-0008_00	HYDRO GENERATING UNIT 8 PIPING EQUIPMENT CODE
647756-0001-46DD-0009_00	HYDRO GENERATING UNIT 8 PIPING ABBREVIATIONS AND SYMBOLS
647756-0001-46DD-0010_00	HYDRO GENERATING UNIT 8 PIPING EQUIPMENT SYMBOLS

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
3	PC	2018/03/08	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/08/16	ISSUED FOR SLI INTERNAL REVIEW.	

REVISION REGISTER — No | REVISION DESCRIPTION | DATE (Y/M/D) | * | ** — INITIALS: * DESIGNED ** APPROVED

No | REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

SNC-LAVALIN
SNC•LAVALIN Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED D. KASSIS/R. GRAVEL	PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
DRAWN Y. TREGUER	PROJECT ENGINEER R. GRAVEL
CHECKED D. KASSIS/S. MOUSSEAU	PROJECT MANAGER S. PERRON
DATE 2017-07-17	CLIENT A. FORHAD
SCALE N.T.S.	

CLIENT: hydro

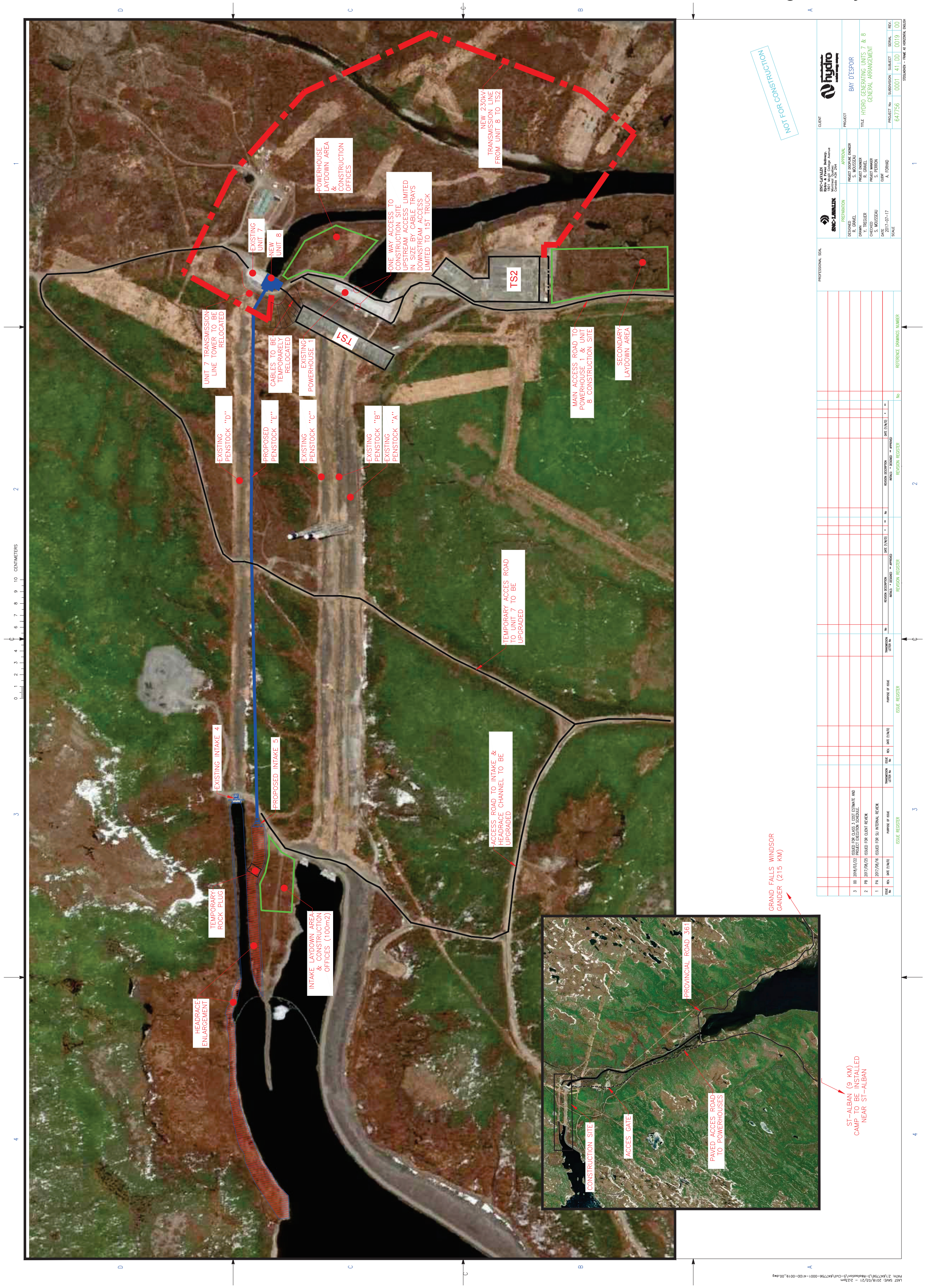
PROJECT: BAY D'ESPOIR

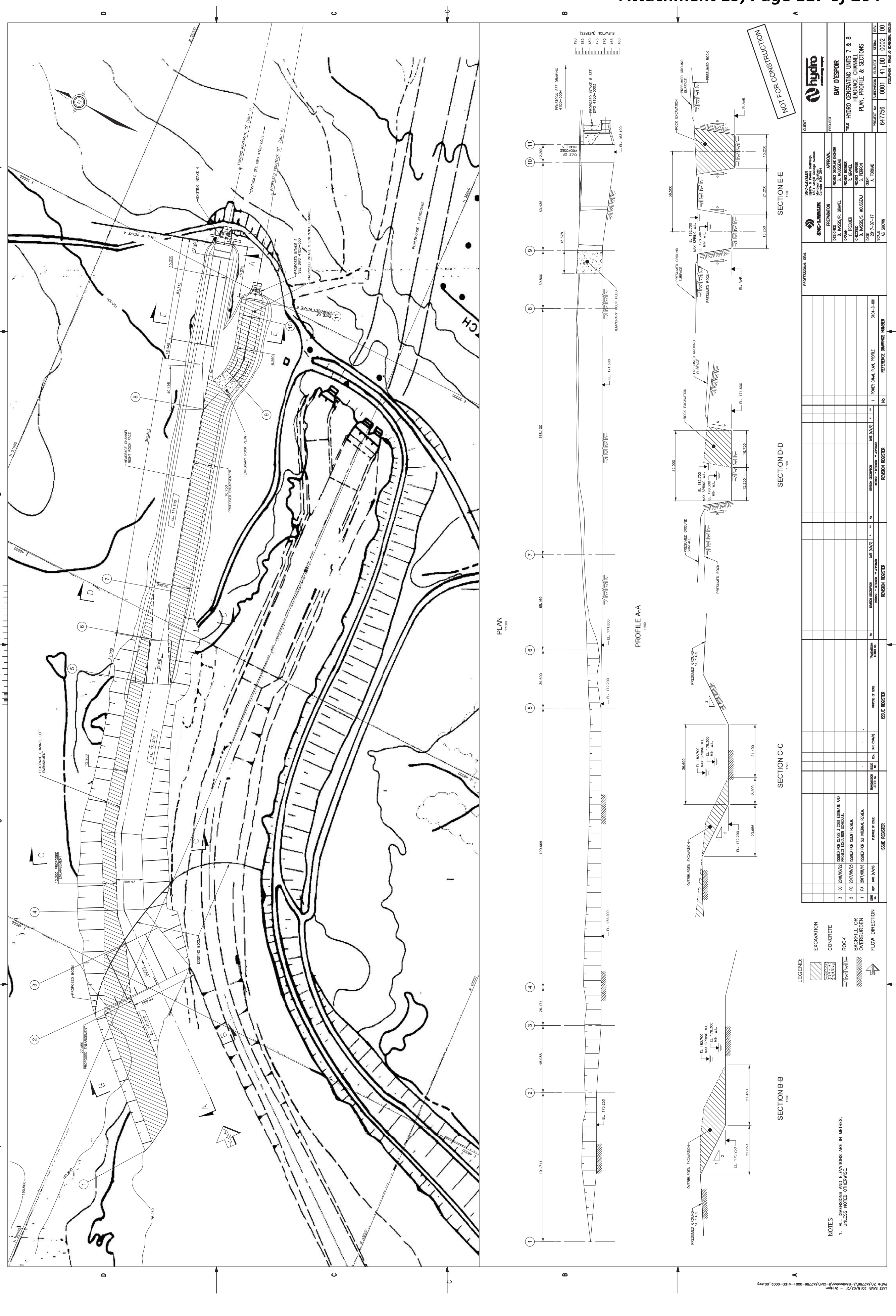
TITLE: PROPOSED HYDRO GENERATING UNIT 8 GENERAL ARRANGEMENT LIST OF DRAWINGS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	41 DD	0001	00

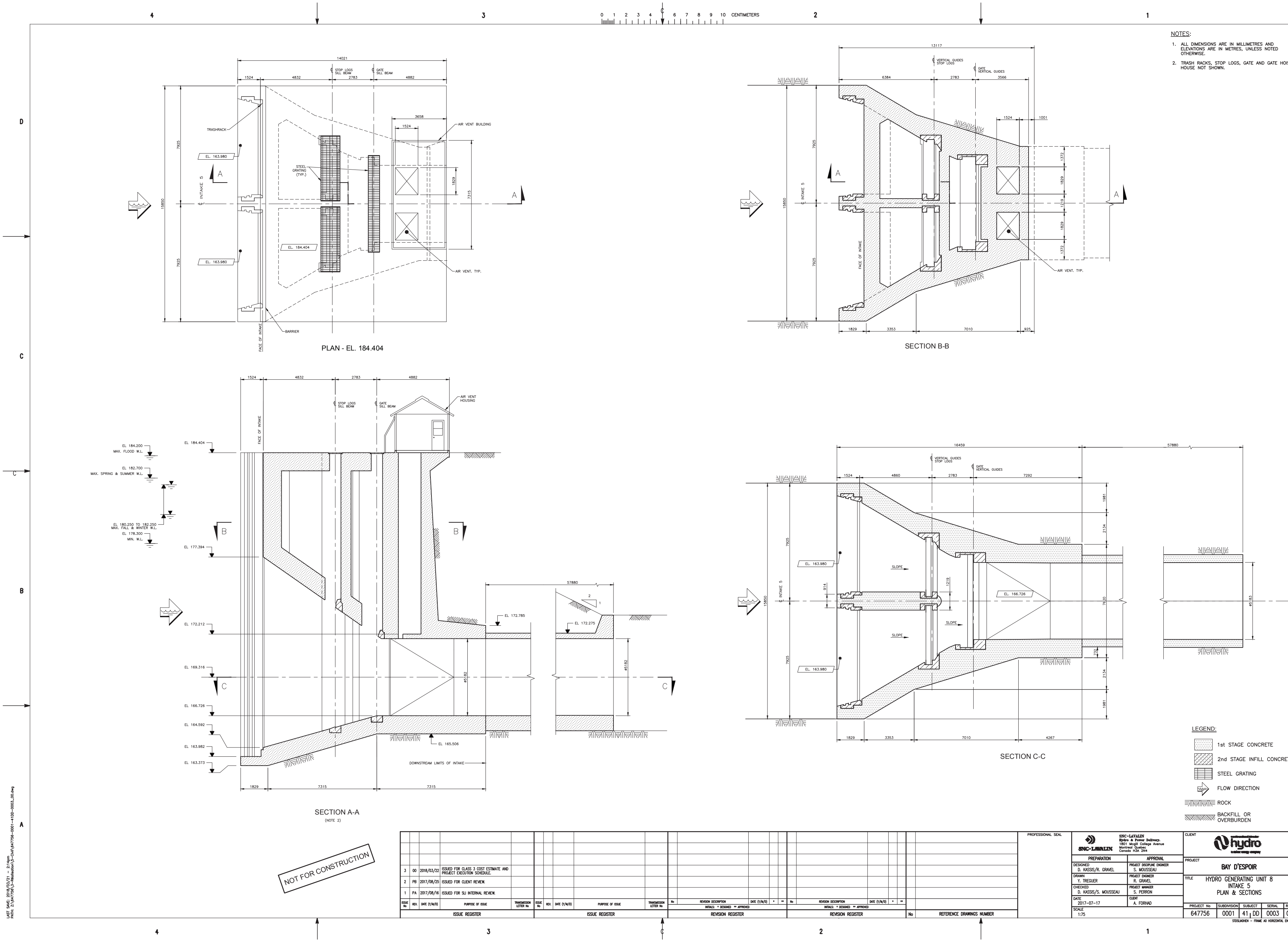
STDSLIAOHEN - FRAME A0 HORIZONTAL ENGLISH

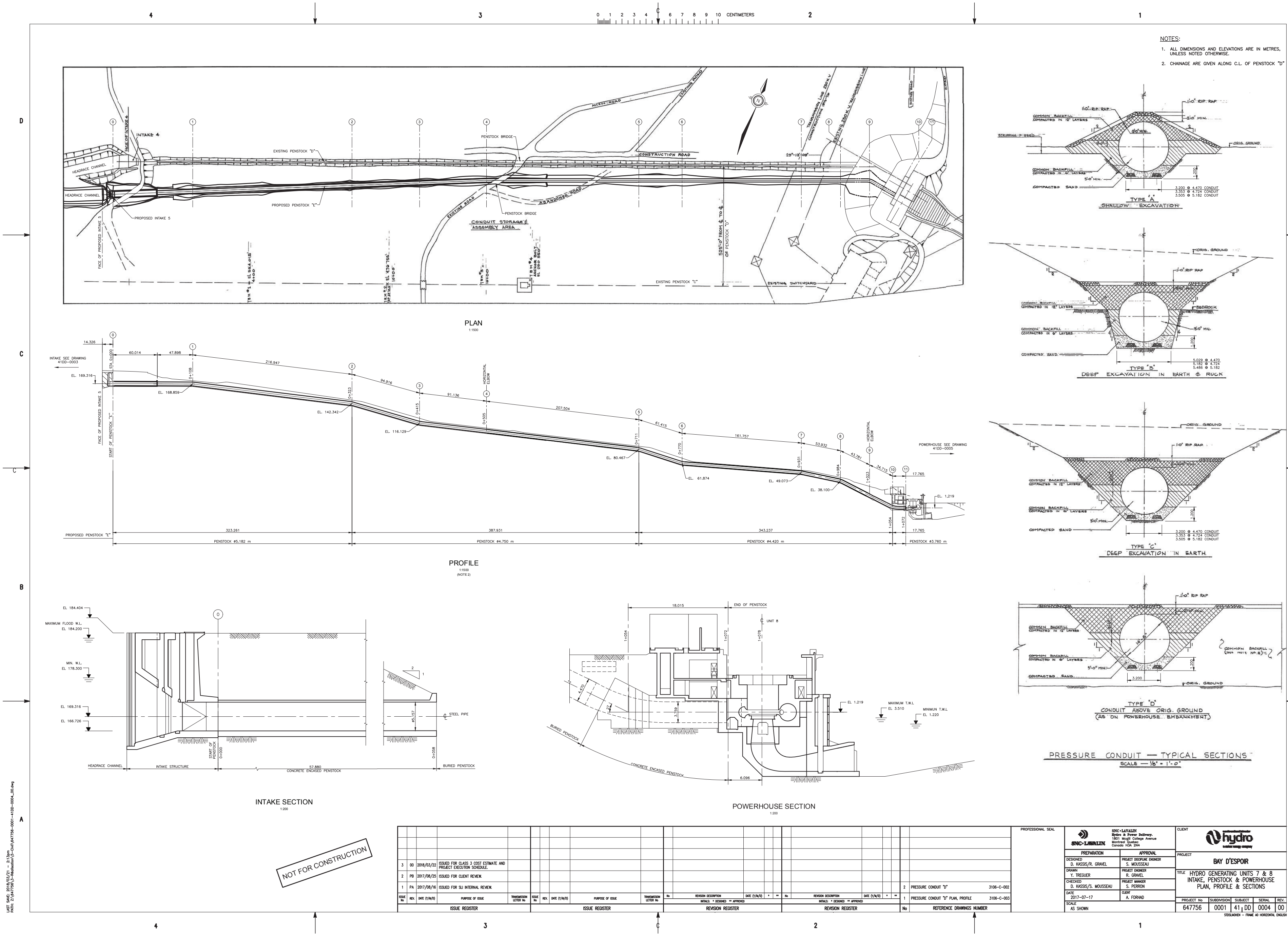
LAST SAVE: 2018/03/22 - 10:29am
PATH: Z:\647756\3-Réalisation\5-Civil\647756-0001-41DD-0001_00.dwg

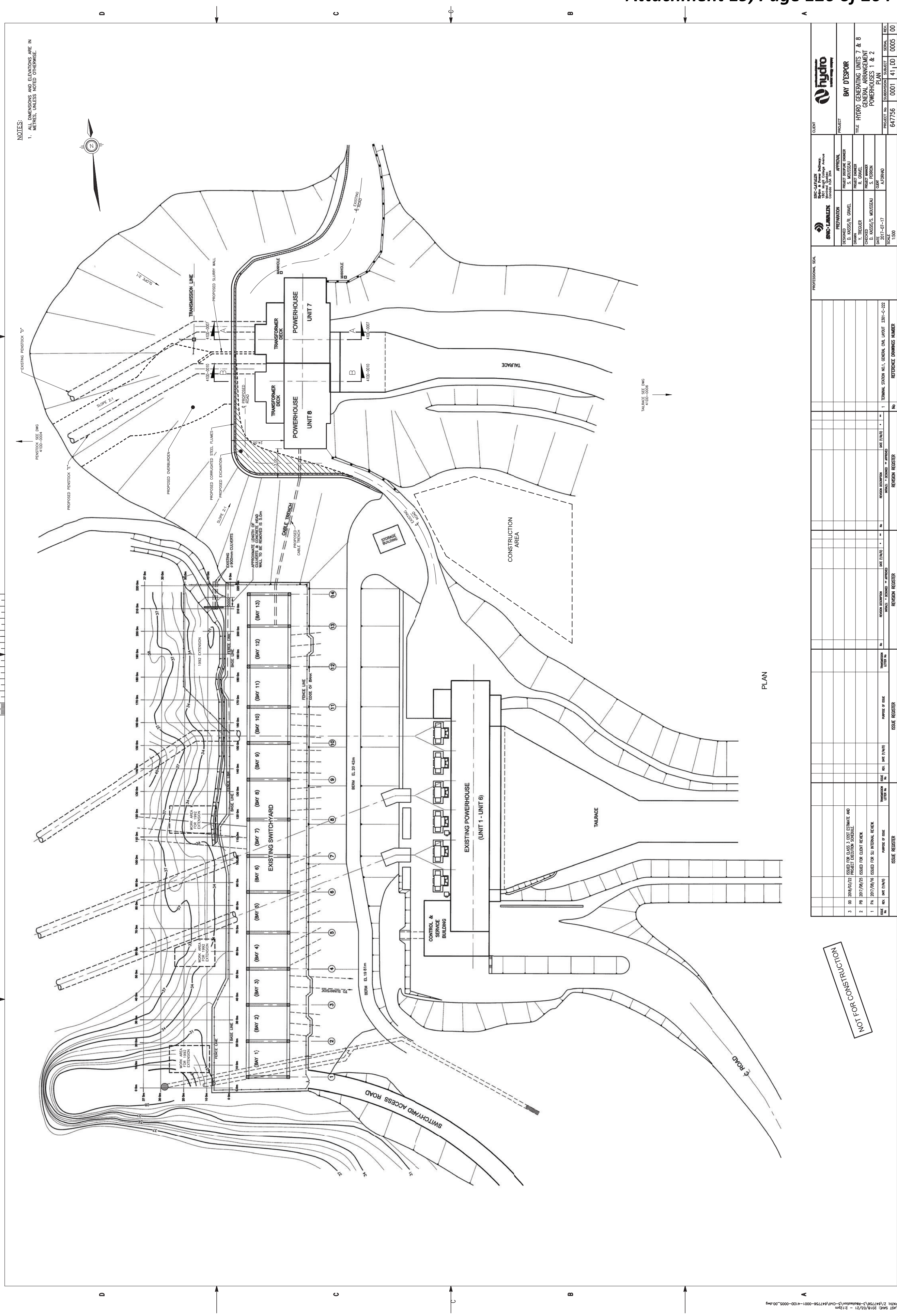

NOT FOR CONSTRUCTION
NEW 230kV TRANSMISSION LINE FROM UNIT 8 TO TS2
POWERHOUSE LAYDOWN AREA & CONSTRUCTION OFFICES
ONE WAY ACCESS TO CONSTRUCTION SITE UPSTREAM ACCESS LIMITED IN SIZE BY CABLE TRAYS DOWNSTREAM ACCESS LIMITED TO 15T TRUCK
EXISTING UNIT 7
NEW UNIT 8
TS2
TS1
UNIT 7 TRANSMISSION LINE TOWER TO BE RELOCATED
CABLES TO BE TEMPORARELY RELOCATED
EXISTING POWERHOUSE 1
MAIN ACCESS ROAD TO POWERHOUSE 1 & UNIT 8 CONSTRUCTION SITE
SECONDARY LAYDOWN AREA
EXISTING PENSTOCK "D"
PROPOSED PENSTOCK "E"
EXISTING PENSTOCK "C"
EXISTING PENSTOCK "B"
EXISTING PENSTOCK "A"
TEMPORARY ACCES ROAD TO UNIT 7 TO BE UPGRADED
EXISTING INTAKE 4
PROPOSED INTAKE 5
ACCESS ROAD TO INTAKE & HEADRACE CHANNEL TO BE UPGRADED
TEMPORARY ROCK PLUG
INTAKE LAYDOWN AREA & CONSTRUCTION OFFICES (100m2)
HEADRACE ENLARGEMENT
GRAND FALLS WINDSOR GANDER (215 KM)
PROVINCIAL ROAD 361
CONSTRUCTION SITE
ACCES GATE
PAVED ACCES ROAD TO POWERHOUSES
ST-ALBAN (9 KM) CAMP TO BE INSTALLED NEAR ST-ALBAN
BAY D'ESPOIR
HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT
647756 0001 41 DD 0019 00

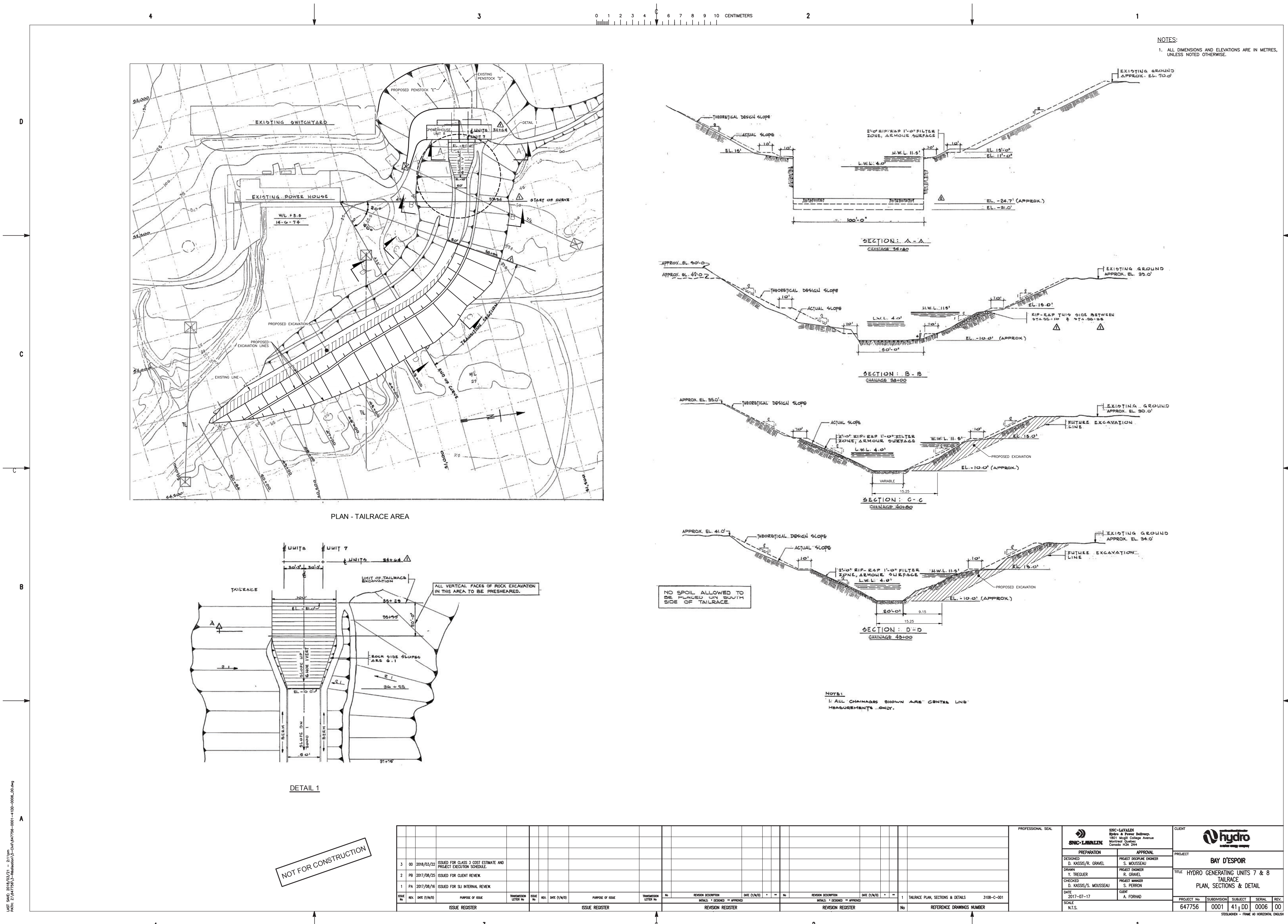


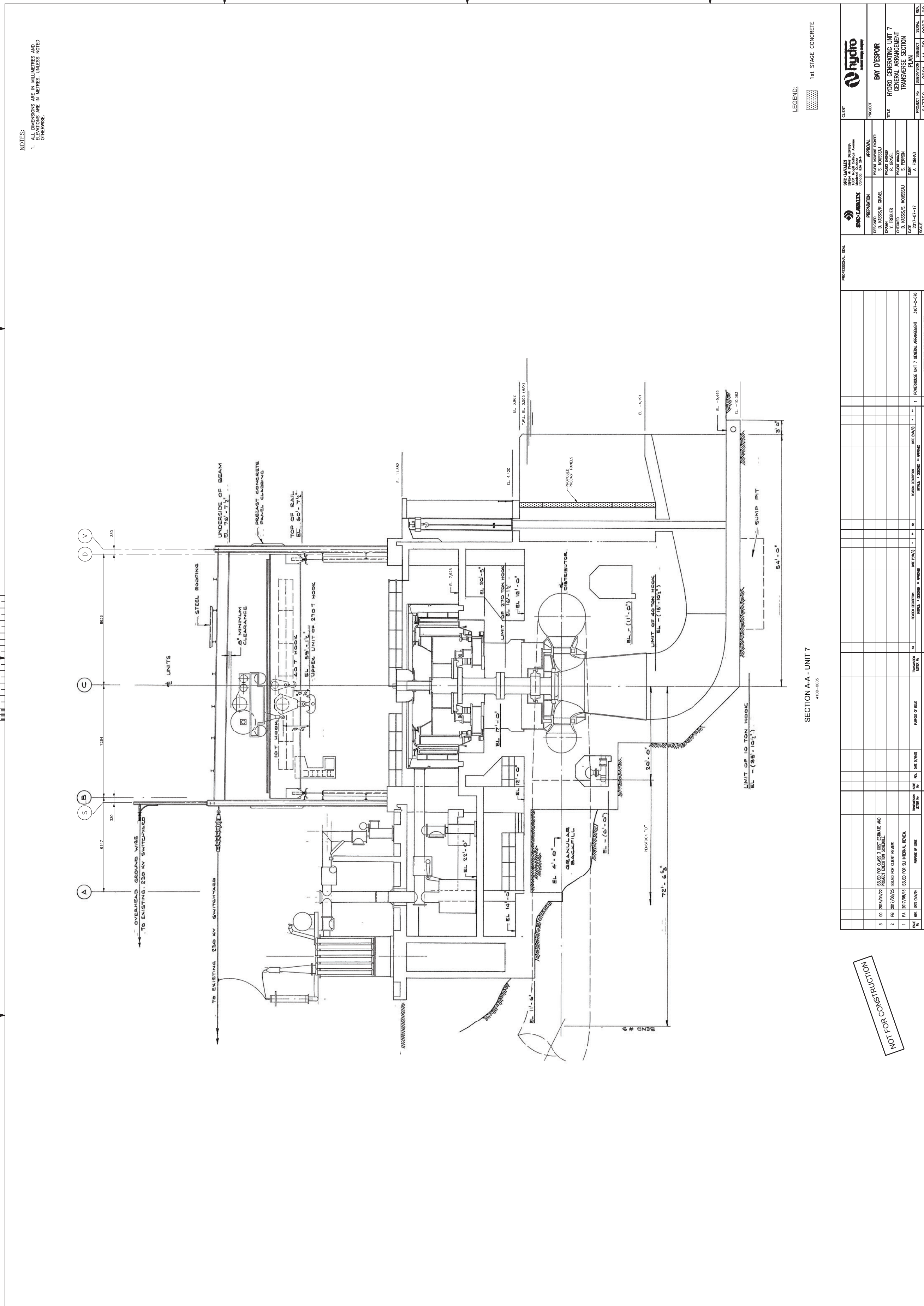
NOT FOR CONSTRUCTION
PLAN
PROFILE A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
LEGEND
EXCAVATION
CONCRETE
ROCK
BACKFILL OR OVERBURDEN
FLOW DIRECTION
NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE
ISSUED FOR CLIENT REVIEW
ISSUED FOR SLI INTERNAL REVIEW
ISSUE REGISTER
REVISION REGISTER
POWER CANAL PLAN, PROFILE 3104-C-001
REFERENCE DRAWINGS NUMBER
PROFESSIONAL SEAL
SNC-LAVALIN Hydro & Power Delivery. 1801 Mcgill College Avenue Montreal Quebec Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED D. KASSIS/R. GRAVEL
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
DRAWN Y. TREGUER
PROJECT ENGINEER R. GRAVEL
CHECKED D. KASSIS/S. MOUSSEAU
PROJECT MANAGER S. PERRON
DATE 2017-07-17
CLIENT A. FORHAD
SCALE AS SHOWN
CLIENT
hydro
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNITS 7 & 8 HEADRACE CHANNEL PLAN, PROFILE & SECTIONS
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 41 DD
SERIAL 0002
REV. 00


NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. TRASH RACKS, STOP LOGS, GATE AND GATE HOIST HOUSE NOT SHOWN.
PLAN - EL. 184.404
SECTION B-B
SECTION A-A
(NOTE 2)
SECTION C-C
TRASHRACK
BARRIER
FACE OF INTAKE
STEEL GRATING (TYP.)
AIR VENT BUILDING
AIR VENT, TYP.
AIR VENT HOUSING
STOP LOGS SILL BEAM
GATE SILL BEAM
VERTICAL GUIDES STOP LOGS
GATE VERTICAL GUIDES
INTAKE 5
SLOPE
EL. 184.200 MAX. FLOOD W.L.
EL. 182.700 MAX. SPRING & SUMMER W.L.
EL. 180.250 TO 182.250 MAX. FALL & WINTER W.L.
EL. 178.300 MIN. W.L.
EL. 184.404
EL. 177.394
EL. 172.212
EL. 169.316
EL. 166.726
EL. 164.592
EL. 163.982
EL. 163.373
EL. 172.785
EL. 172.275
EL. 165.506
EL. 163.980
EL. 166.726
DOWNSTREAM LIMITS OF INTAKE
LEGEND:
1st STAGE CONCRETE
2nd STAGE INFILL CONCRETE
STEEL GRATING
FLOW DIRECTION
ROCK
BACKFILL OR OVERBURDEN
NOT FOR CONSTRUCTION
3 | 00 | 2018/03/22 | ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 | PB | 2017/08/25 | ISSUED FOR CLIENT REVIEW.
1 | PA | 2017/08/16 | ISSUED FOR SLI INTERNAL REVIEW.
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
PROFESSIONAL SEAL
SNC·LAVALIN
SNC-LAVALIN Hydro & Power Delivery. 1801 McGill College Avenue Montreal Quebec Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED D. KASSIS/R. GRAVEL
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
DRAWN Y. TREGUER
PROJECT ENGINEER R. GRAVEL
CHECKED D. KASSIS/S. MOUSSEAU
PROJECT MANAGER S. PERRON
DATE 2017-07-17
CLIENT A. FORHAD
SCALE 1:75
hydro
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNIT 8 INTAKE 5 PLAN & SECTIONS
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 41 DD
SERIAL 0003
REV. 00
LAST SAVE: 2018/03/21 - 2:14pm
PATH: Z:\647756\3-Réalisation\3-Civil\647756-0001-41DD-0003_00.dwg


NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. CHAINAGE ARE GIVEN ALONG C.L. OF PENSTOCK "D"
PLAN
1:1500
EXISTING PENSTOCK "D"
PROPOSED PENSTOCK "E"
EXISTING PENSTOCK "C"
HEADRACE CHANNEL
INTAKE 4
PROPOSED INTAKE 5
PENSTOCK BRIDGE
CONSTRUCTION ROAD
ACCESS ROAD
ABANDONED ROAD
EXISTING ROAD
CONDUIT STORAGE & ASSEMBLY AREA
EXISTING SWITCHYARD
PROFILE
1:1500
(NOTE 2)
INTAKE SEE DRAWING 4100-0003
POWERHOUSE SEE DRAWING 4100-0005
HORIZONTAL ELBOW
EL. 169.316
EL. 168.859
EL. 142.342
EL. 116.129
EL. 80.467
EL. 61.874
EL. 49.073
EL. 38.100
EL. 1.219
PROPOSED PENSTOCK "E"
323.261
387.931
343.237
17.765
PENSTOCK #5 182 m
PENSTOCK #4 750 m
PENSTOCK #4 420 m
PENSTOCK #3 760 m
INTAKE SECTION
1:200
EL. 184.404
MAXIMUM FLOOD W.L. EL. 184.200
MIN. W.L. EL. 178.300
EL. 169.316
EL. 166.726
STEEL PIPE
HEADRACE CHANNEL
INTAKE STRUCTURE
CONCRETE ENCASED PENSTOCK
BURIED PENSTOCK
57.880
POWERHOUSE SECTION
1:200
END OF PENSTOCK
UNIT 8
18.015
6.096
MAXIMUM T.W.L. EL. 3.510
MINIMUM T.W.L. EL. 1.220
EL. 1.219
CONCRETE ENCASED PENSTOCK
BURIED PENSTOCK
TYPE "A" SHALLOW EXCAVATION
TYPE "B" DEEP EXCAVATION IN EARTH & ROCK
TYPE "C" DEEP EXCAVATION IN EARTH
TYPE "D" CONDUIT ABOVE ORIG. GROUND (AS ON POWERHOUSE EMBANKMENT)
PRESSURE CONDUIT — TYPICAL SECTIONS
SCALE — 1/8" = 1'-0"
COMMON BACKFILL COMPACTED IN 12" LAYERS
COMMON BACKFILL COMPACTED IN 6" LAYERS
COMPACTED SAND
ORIG. GROUND
BEDROCK
1'-0" RIP RAP
NOT FOR CONSTRUCTION
ISSUE REGISTER
3 | 00 | 2018/03/22 | ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 | PB | 2017/08/25 | ISSUED FOR CLIENT REVIEW.
1 | PA | 2017/08/18 | ISSUED FOR SLI INTERNAL REVIEW.
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
2 | PRESSURE CONDUIT "D" | 3106-C-002
1 | PRESSURE CONDUIT "D" PLAN, PROFILE | 3106-C-003
SNC-LAVALIN
Hydro & Power Delivery
1801 McGill College Avenue
Montreal Quebec
Canada H3A 2N4
DESIGNED D. KASSIS/R. GRAVEL
DRAWN Y. TREGUER
CHECKED D. KASSIS/S. MOUSSEAU
DATE 2017-07-17
SCALE AS SHOWN
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
hydro
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNITS 7 & 8 INTAKE, PENSTOCK & POWERHOUSE PLAN, PROFILE & SECTIONS
PROJECT No 647756 | SUBDIVISION 0001 | SUBJECT 41 DD | SERIAL 0004 | REV. 00
LAST SAVE: 2018/03/21 - 2:13pm

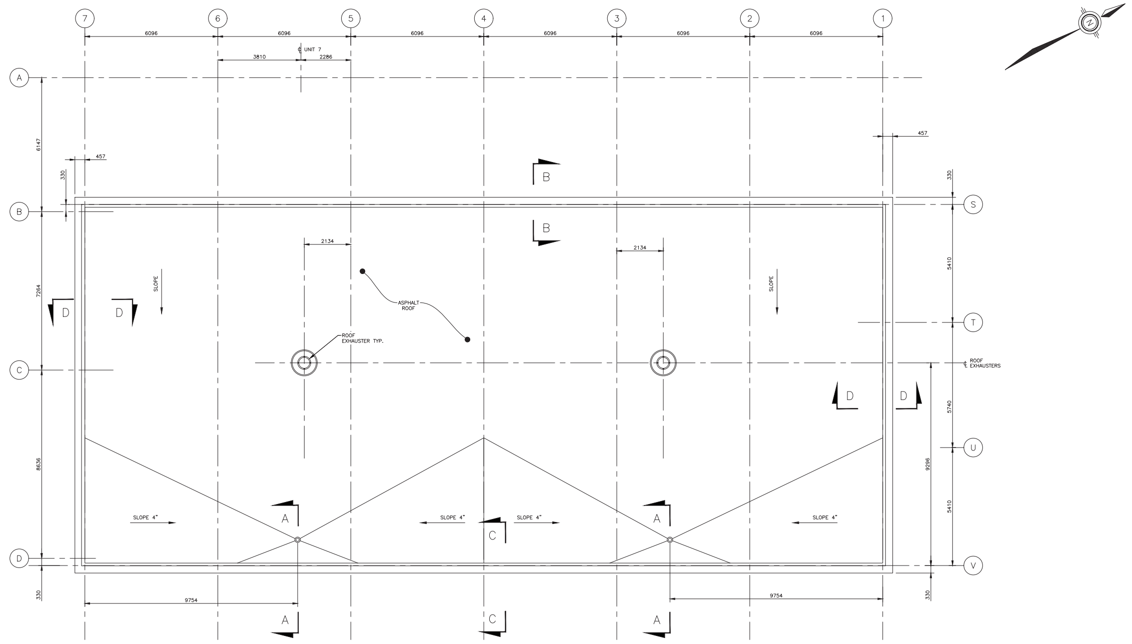

NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
POWERHOUSE UNIT 7
POWERHOUSE UNIT 8
TRANSFORMER DECK
TRANSMISSION LINE
TAILRACE
CONSTRUCTION AREA
STORAGE BUILDING
CABLE TRENCH
EXISTING SWITCHYARD
EXISTING POWERHOUSE (UNIT 1 - UNIT 6)
CONTROL & SERVICE BUILDING
SWITCHYARD ACCESS ROAD
℄ ROAD
PLAN
NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT POWERHOUSES 1 & 2 PLAN
647756 0001 41 DD 0005 00


NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
PLAN - TAILRACE AREA
EXISTING SWITCHYARD
EXISTING POWER HOUSE
PROPOSED PENSTOCK "E"
EXISTING PENSTOCK "D"
DETAIL 1
START OF CURVE
END OF CURVE
TRANSITION SECTION
PROPOSED EXCAVATION
PROPOSED EXCAVATION LINES
EXISTING LINE
DETAIL 1
TAILRACE
ALL VERTICAL FACES OF ROCK EXCAVATION IN THIS AREA TO BE PRESHEARED.
LIMIT OF TAILRACE EXCAVATION
ROCK SIDE SLOPES ARE 6:1
SECTION: A-A
CHAINAGE 34+80
EXISTING GROUND APPROX. EL. 70.0'
THEORETICAL DESIGN SLOPE
ACTUAL SLOPE
2'-0" RIP-RAP 1'-0" FILTER ZONE, ARMOUR SURFACE
H.W.L. 11.5'
L.W.L. 4.0'
EL. -24.7' (APPROX.)
EL. -31.0'
100'-0"
SECTION: B-B
CHAINAGE 38+00
APPROX. EL. 50-0
APPROX. EL. 42-0
EXISTING GROUND APPROX. EL. 35.0'
RIP-RAP THIS SIDE BETWEEN STA 36+10 & 47+06.25
EL. -10.0' (APPROX.)
50'-0"
SECTION: C-C
CHAINAGE 40+80
APPROX. EL. 35.0'
EXISTING GROUND APPROX. EL. 30.0'
FUTURE EXCAVATION LINE
PROPOSED EXCAVATION
VARIABLE
15.25
SECTION: D-D
CHAINAGE 43+00
APPROX. EL. 41.0'
EXISTING GROUND APPROX. EL. 34.0'
20'-0"
9.15
15.25
NO SPOIL ALLOWED TO BE PLACED ON SOUTH SIDE OF TAILRACE
NOTE:
1. ALL CHAINAGES SHOWN ARE CENTRE LINE MEASUREMENTS ONLY.
NOT FOR CONSTRUCTION
3 | 00 | 2018/03/22 | ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 | PB | 2017/08/25 | ISSUED FOR CLIENT REVIEW.
1 | PA | 2017/08/18 | ISSUED FOR SLI INTERNAL REVIEW.
ISSUE REGISTER
REVISION REGISTER
1 | TAILRACE PLAN, SECTIONS & DETAILS | 3108-C-001
REFERENCE DRAWINGS NUMBER
PROFESSIONAL SEAL
SNC-LAVALIN Hydro & Power Delivery. 1801 McGill College Avenue Montreal, Quebec Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED D. KASSIS/R. GRAVEL
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
DRAWN Y. TREGUER
PROJECT ENGINEER R. GRAVEL
CHECKED D. KASSIS/S. MOUSSEAU
PROJECT MANAGER S. PERRON
DATE 2017-07-17
CLIENT A. FORHAD
SCALE N.T.S.
CLIENT hydro
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNITS 7 & 8 TAILRACE PLAN, SECTIONS & DETAIL
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 41 DD
SERIAL 0006
REV. 00


NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
LEGEND:
1st STAGE CONCRETE
SECTION A-A - UNIT 7
UNDERSIDE OF BEAM
PRECAST CONCRETE PANEL CLADDING
TOP OF RAIL
STEEL ROOFING
MINIMUM CLEARANCE
UPPER LIMIT OF 270T HOOK
10T HOOK
40T HOOK
℄ UNITS
LIMIT OF 270 TON HOOK
DISTRIBUTOR
LIMIT OF 40 TON HOOK
LIMIT OF 10 TON HOOK
SUMP PIT
GRANULAR BACKFILL
PENSTOCK "D"
OVERHEAD GROUND WIRE TO EXISTING 230 KV SWITCHYARD
TO EXISTING 230 KV SWITCHYARD
PROPOSED PRECAST PANELS
BEND #6
BAY D'ESPOIR
HYDRO GENERATING UNIT 7
GENERAL ARRANGEMENT
TRANSVERSE SECTION
PLAN
647756 0001 41 DD 0007 00
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
NOT FOR CONSTRUCTION

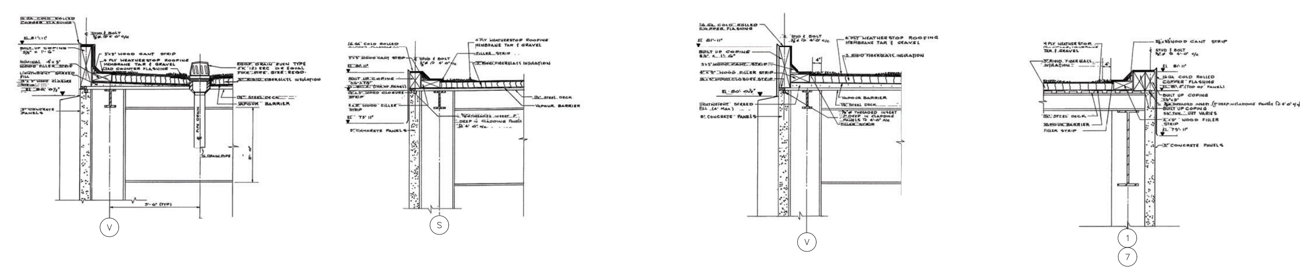
NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.



PLAN AT ROOF - UNIT 7

1:75



SECTION A-A

1:20

SECTION B-B

1:20

SECTION C-C

1:20

SECTION D-D

1:20

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
3	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/08/16	ISSUED FOR SLI INTERNAL REVIEW.	

ISSUE REGISTER

No	REFERENCE DRAWINGS NUMBER
1	POWERHOUSE UNIT-7 ROOF PLAN AND SECTIONS 3107-A-302

PROFESSIONAL SEAL

SNC-LAVALIN Hydro & Power Delivery. 1801 Mcgill College Avenue Montreal Quebec Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED D. KASSIS/R. GRAVEL	PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
DRAWN Y. TREGUER	PROJECT ENGINEER R. GRAVEL
CHECKED D. KASSIS/S. MOUSSEAU	PROJECT MANAGER S. PERRON
DATE 2017-07-17	CLIENT A. FORHAD
SCALE AS SHOWN	

CLIENT: hydro

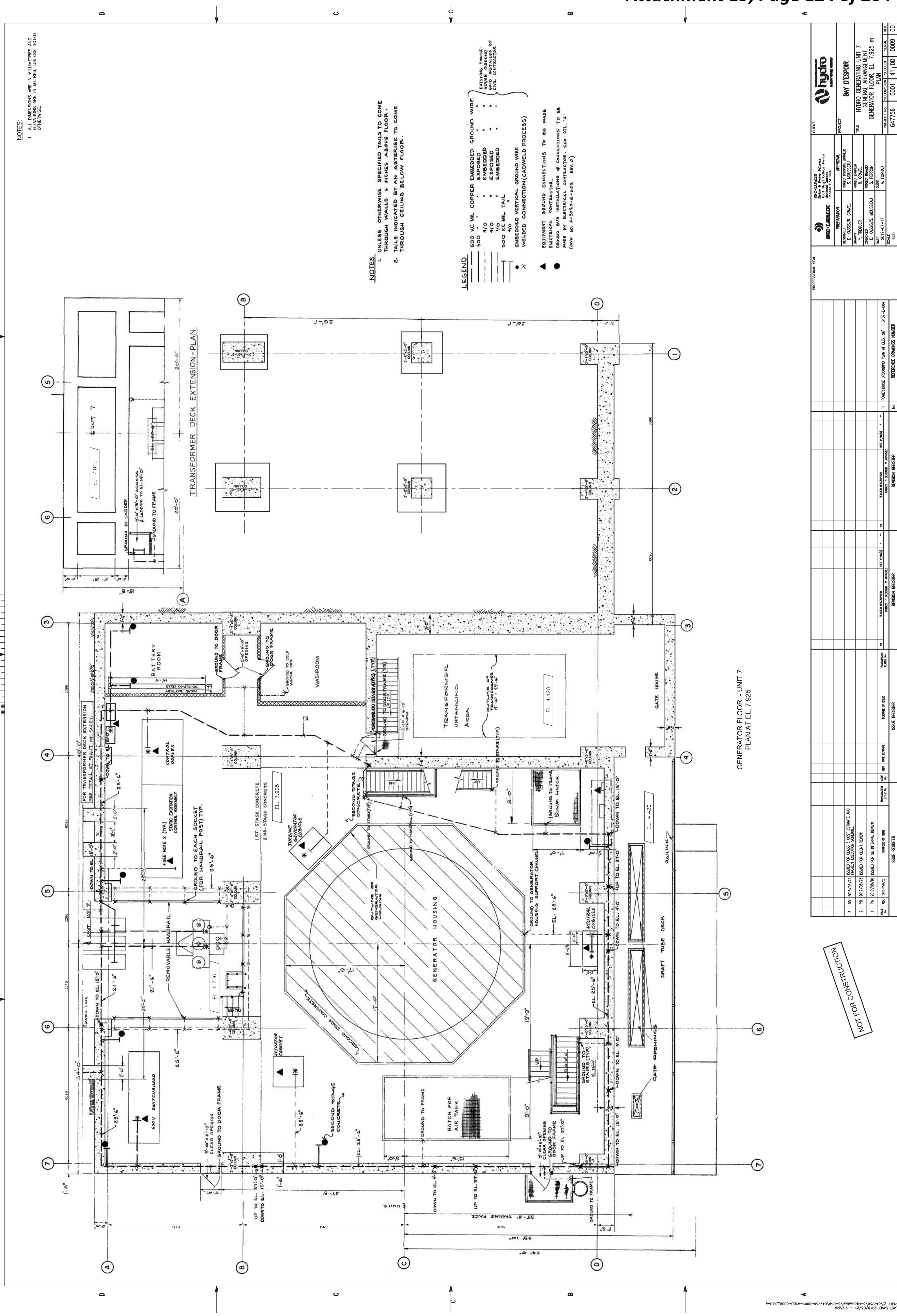
PROJECT: BAY D'ESPOIR

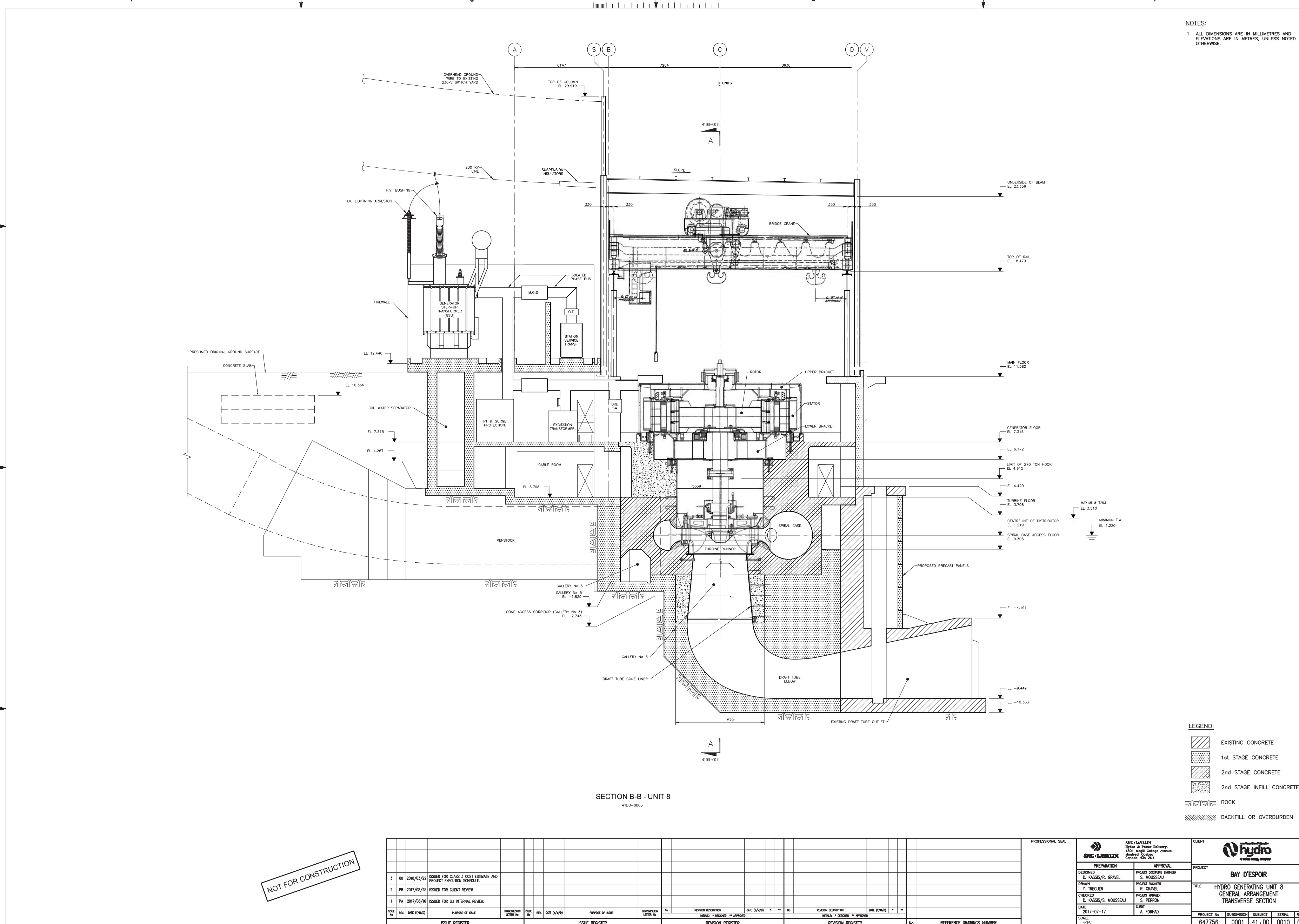
TITLE: HYDRO GENERATING UNIT 7 GENERAL ARRANGEMENT ROOF PLAN

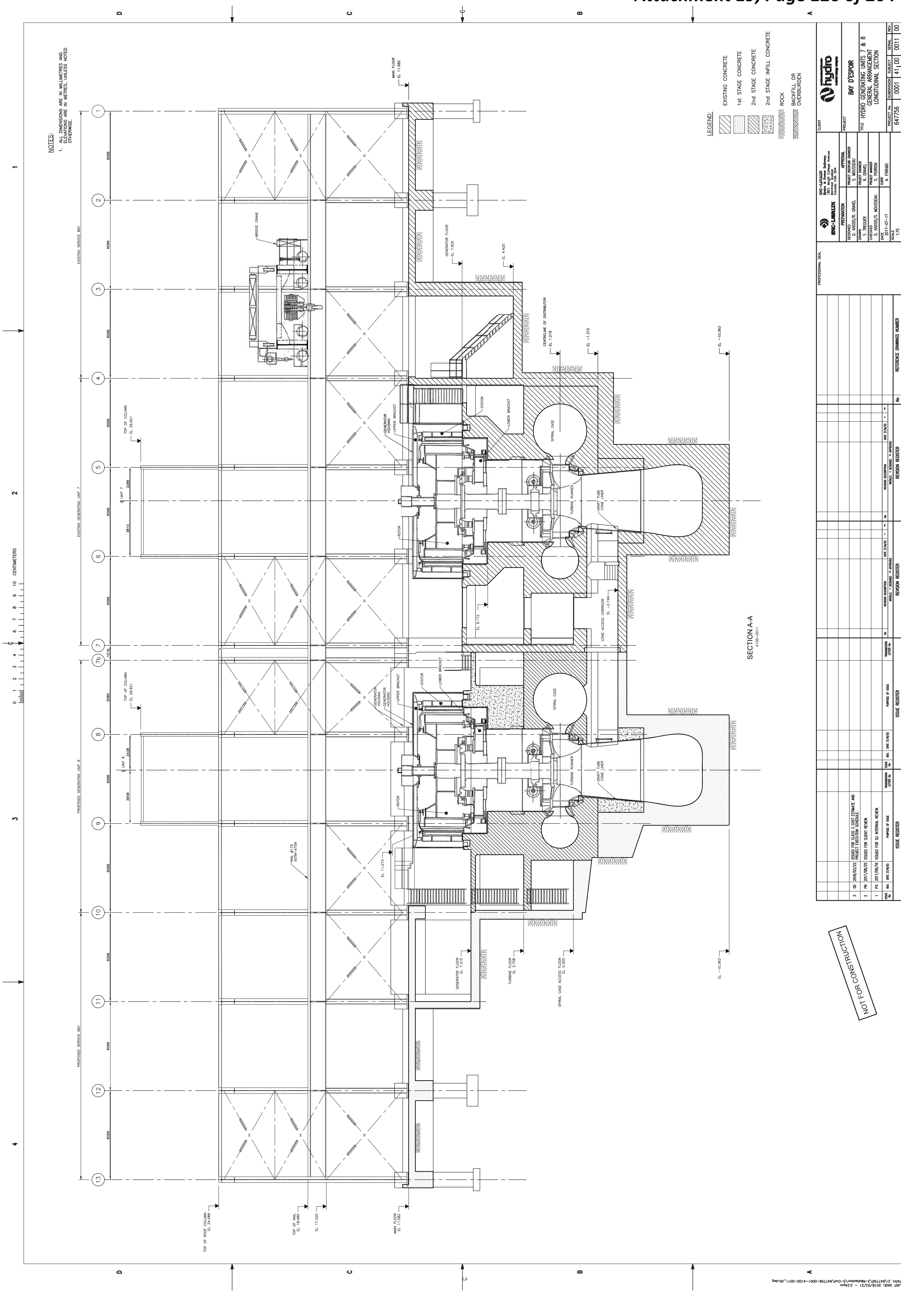
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	41 DD	0008	00

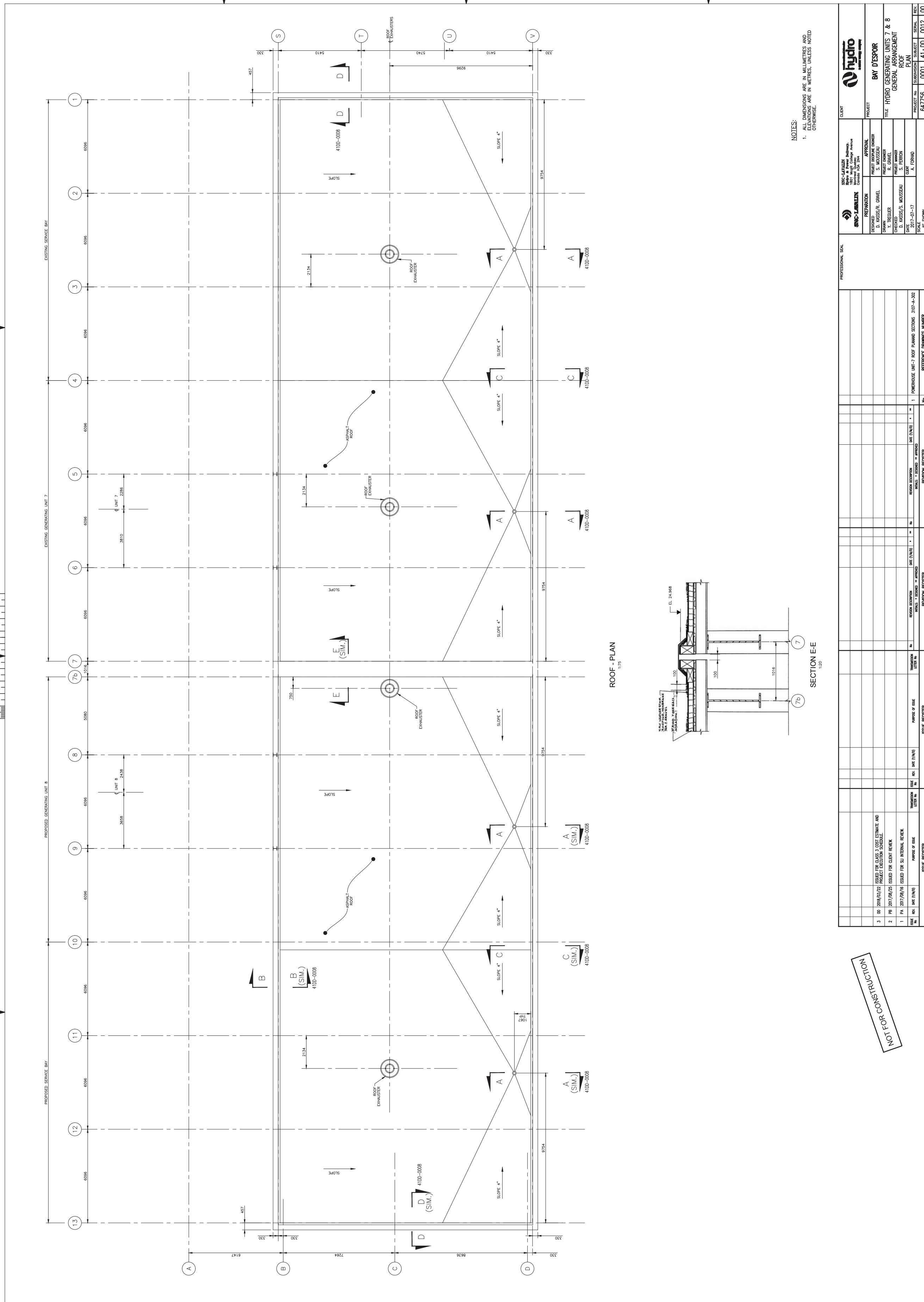
STDSLIAOHEN – FRAME A0 HORIZONTAL ENGLISH

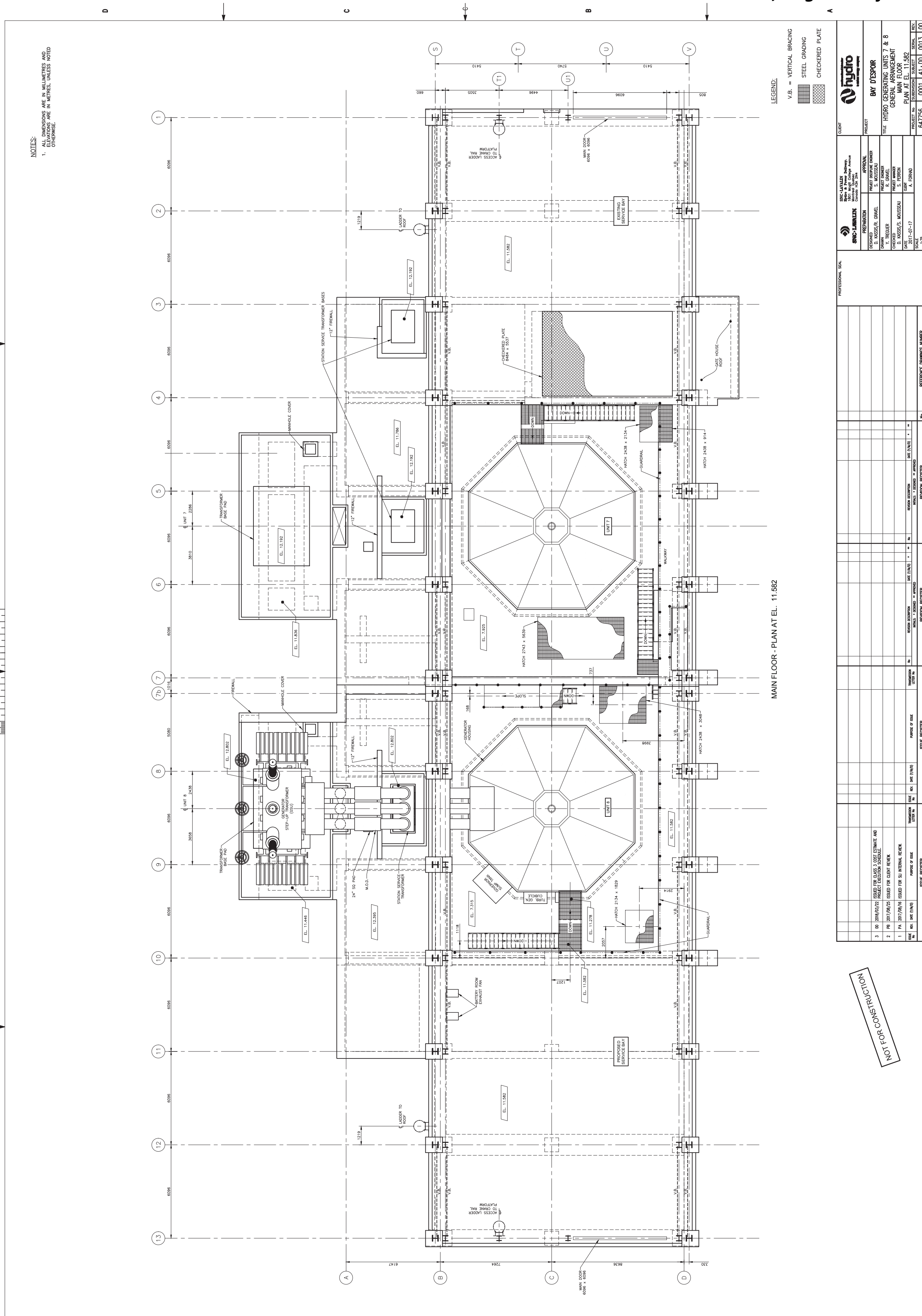
LAST SAVE: 2018/03/21 – 2:40pm PATH: Z:\647756\3-Réalisation\5-Civil\647756-0001-41DD-0008_00.dwg

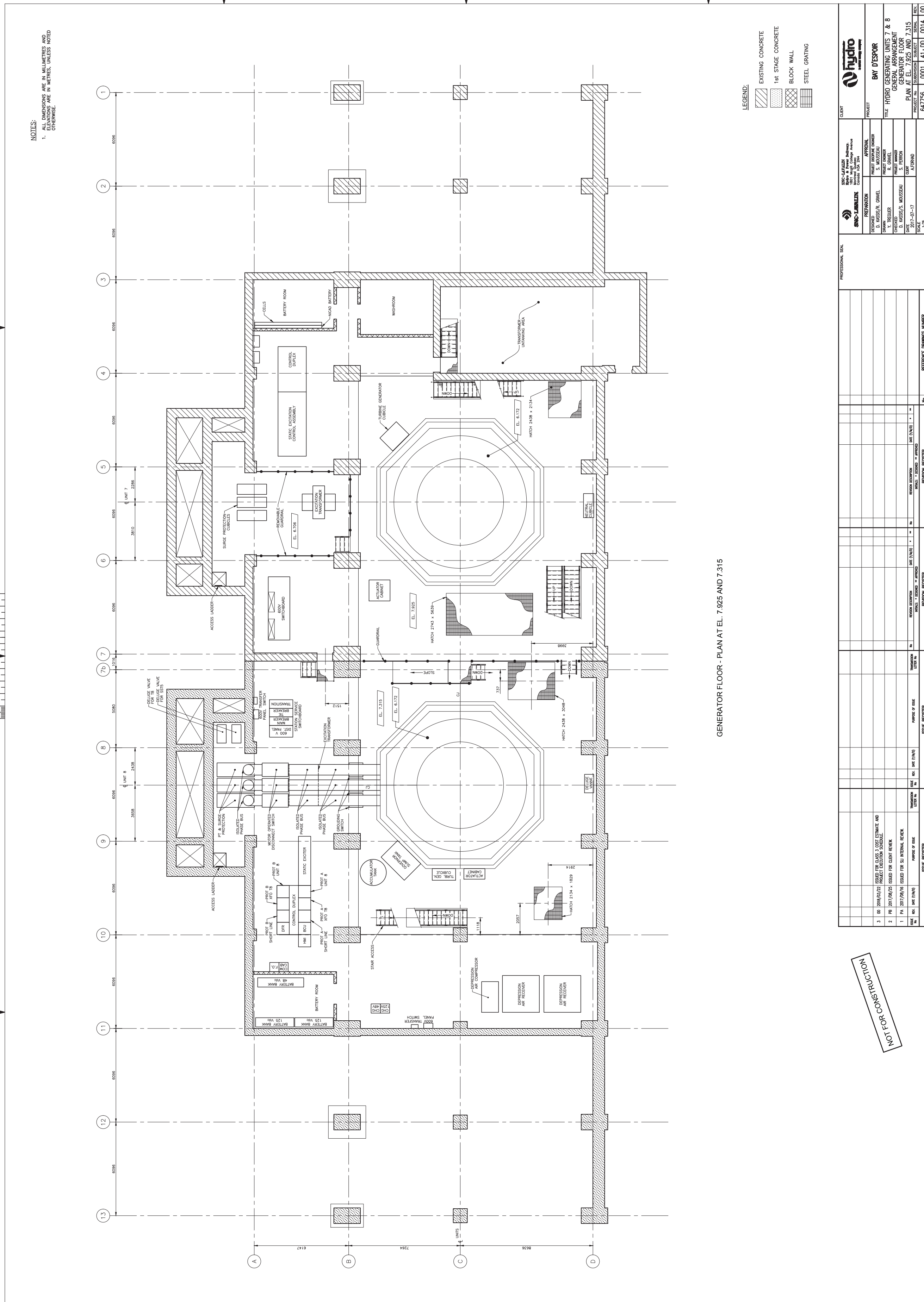

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
NOTES
1. UNLESS OTHERWISE SPECIFIED TAILS TO COME THROUGH WALLS 6 INCHES ABOVE FLOOR.
2. TAILS INDICATED BY AN ASTERISK TO COME THROUGH CEILING BELOW FLOOR.
LEGEND
500 KC MIL COPPER EMBEDDED GROUND WIRE
EMBEDDED VERTICAL GROUND WIRE
WELDED CONNECTION (CADWELD PROCESS)
TRANSFORMER DECK EXTENSION-PLAN
EL. 7.010
BATTERY ROOM
WASHROOM
TRANSFORMER UNTANKING AREA
EL. 4.420
GATE HOUSE
CONTROL DUPLEX
STATIC EXCITATION CONTROL ASSEMBLY
REMOVABLE HANDRAIL
EL. 6.706
EL. 7.925
GENERATOR HOUSING
OUTLINE OF GENERATOR HOUSING
TURBINE GENERATOR CUBICLE
NEUTRAL CUBICLE
HATCH FOR AIR TANK
600V SWITCHBOARD
ACTUATOR CABINET
SECOND STAGE CONCRETE
DRAFT TUBE DECK
RAILING
GENERATOR FLOOR - UNIT 7
PLAN AT EL. 7.925
NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNIT 7
GENERAL ARRANGEMENT
GENERATOR FLOOR, EL. 7.925 m
PLAN
647756 0001 41DD 0009 00
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER

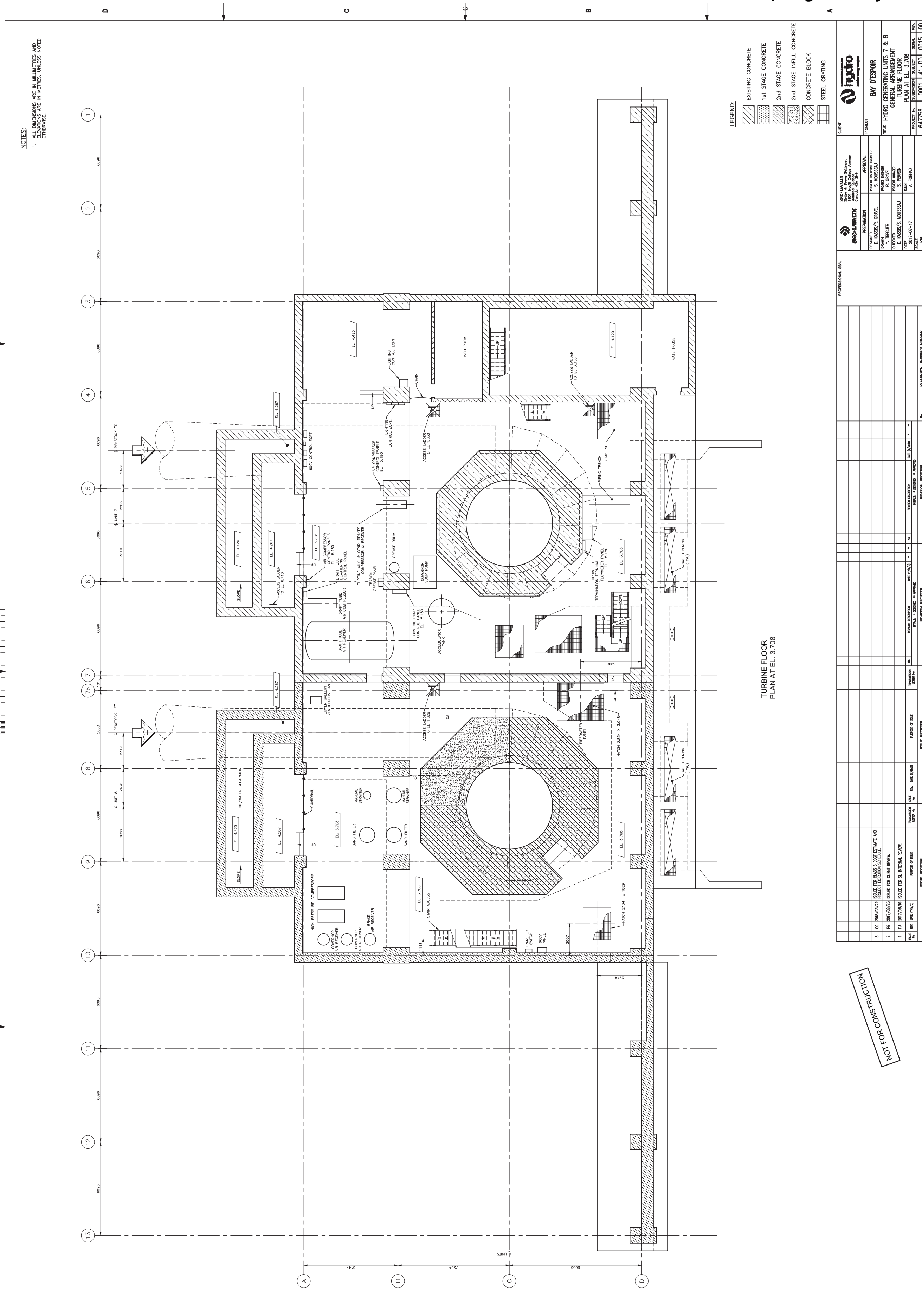

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
0 1 2 3 4 5 6 7 8 9 10 CENTIMETERS
6147
7264
8636
℄ UNITS
OVERHEAD GROUND WIRE TO EXISTING 230kV SWITCH YARD
TOP OF COLUMN EL 29.919
230 KV LINE
SUSPENSION INSULATORS
SLOPE
H.V. BUSHING
H.V. LIGHTNING ARRESTOR
UNDERSIDE OF BEAM EL 23.356
BRIDGE CRANE
TOP OF RAIL EL 18.479
ISOLATED PHASE BUS
M.O.D
C.T.
FIREWALL
GENERATOR STEP-UP TRANSFORMER (GSU)
STATION SERVICE TRANSF.
PRESUMED ORIGINAL GROUND SURFACE
CONCRETE SLAB
EL 12.446
EL 10.366
MAIN FLOOR EL 11.582
ROTOR
UPPER BRACKET
STATOR
LOWER BRACKET
OIL-WATER SEPARATOR
PT & SURGE PROTECTION
EXCITATION TRANSFORMER
GRD SW
GENERATOR FLOOR EL 7.315
EL 7.315
EL 4.267
EL 6.172
CABLE ROOM
LIMIT OF 270 TON HOOK EL 4.915
EL 4.420
EL 3.708
5639
TURBINE FLOOR EL 3.708
MAXIMUM T.W.L EL 3.510
CENTRELINE OF DISTRIBUTOR EL 1.219
MINIMUN T.W.L EL 1.220
SPIRAL CASE
SPIRAL CASE ACCESS FLOOR EL 0.305
PENSTOCK
TURBINE RUNNER
PROPOSED PRECAST PANELS
GALLERY No 5
GALLERY No 5 EL -1.829
CONE ACCESS CORRIDOR (GALLERY No. 3) EL -2.743
EL -4.191
GALLERY No 3
DRAFT TUBE CONE LINER
DRAFT TUBE ELBOW
EL -9.449
EL -10.363
5791
EXISTING DRAFT TUBE OUTLET
SECTION B-B - UNIT 8
4100-0005
LEGEND:
EXISTING CONCRETE
1st STAGE CONCRETE
2nd STAGE CONCRETE
2nd STAGE INFILL CONCRETE
ROCK
BACKFILL OR OVERBURDEN
NOT FOR CONSTRUCTION
3 00 2018/03/22 ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 PB 2017/08/25 ISSUED FOR CLIENT REVIEW.
1 PA 2017/08/16 ISSUED FOR SLI INTERNAL REVIEW.
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
PROFESSIONAL SEAL
SNC-LAVALIN Hydro & Power Delivery. 1801 McGill College Avenue Montreal Quebec Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED D. KASSIS/R. GRAVEL
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
DRAWN Y. TREGUER
PROJECT ENGINEER R. GRAVEL
CHECKED D. KASSIS/S. MOUSSEAU
PROJECT MANAGER S. PERRON
DATE 2017-07-17
CLIENT A. FORHAD
SCALE 1:75
CLIENT
hydro
PROJECT
BAY D'ESPOIR
TITLE
HYDRO GENERATING UNIT 8
GENERAL ARRANGEMENT
TRANSVERSE SECTION
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 41 DD
SERIAL 0010
REV. 00

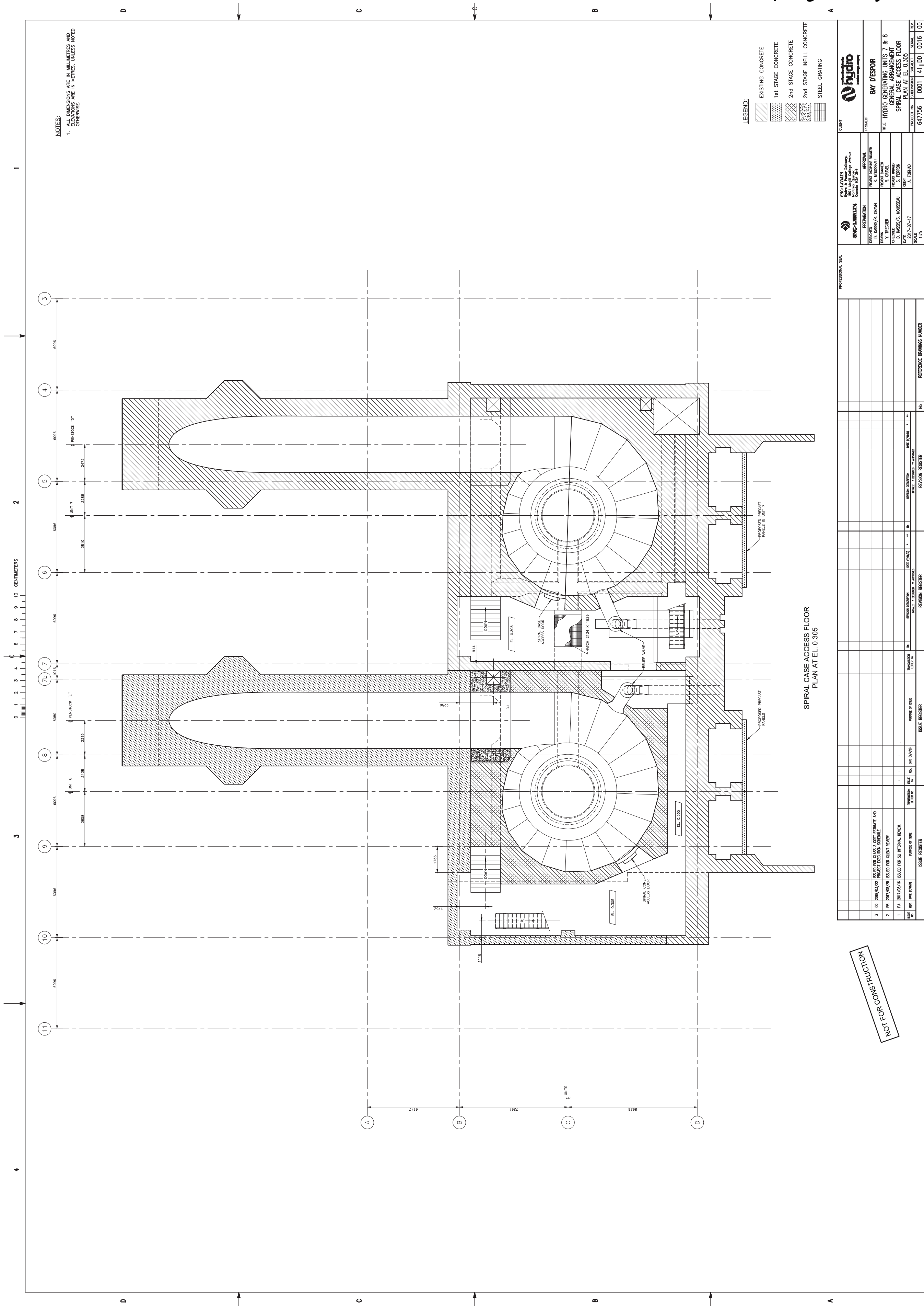

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
LEGEND:
EXISTING CONCRETE
1st STAGE CONCRETE
2nd STAGE CONCRETE
2nd STAGE INFILL CONCRETE
ROCK
BACKFILL OR OVERBURDEN
EXISTING SERVICE BAY
EXISTING GENERATING UNIT 7
PROPOSED GENERATING UNIT 8
PROPOSED SERVICE BAY
BRIDGE CRANE
MAIN FLOOR EL. 11.582
GENERATOR FLOOR EL. 7.925
EL. 4.420
CENTRELINE OF DISTRIBUTOR EL. 1.219
EL. -1.372
EL. -10.363
STATOR
LOWER BRACKET
UPPER BRACKET
GENERATOR HOUSING
ROTOR
SPIRAL CASE
TURBINE RUNNER
DRAFT TUBE CONE LINER
CONE ACCESS CORRIDOR EL. -2.749
EL. 6.172
TOP OF COLUMN EL. 29.921
SECTION A-A
GENERATOR FLOOR EL. 7.315
TURBINE FLOOR EL. 3.708
SPIRAL CASE ACCESS FLOOR EL. 0.305
TOP OF ROOF COLUMN EL. 24.589
TOP OF RAIL EL. 18.480
EL. 17.220
RAIL #175 ASTM-A759
EL. 11.273
NOT FOR CONSTRUCTION
hydro
BAY D'ESPOIR
HYDRO GENERATING UNITS 7 & 8
GENERAL ARRANGEMENT
LONGITUDINAL SECTION
647756 0001 41 D0 0011 00
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
CENTIMETERS


ROOF - PLAN
1:75
SECTION E-E
1:20
EL 24.968
NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
PROPOSED SERVICE BAY
PROPOSED GENERATING UNIT 8
EXISTING GENERATING UNIT 7
EXISTING SERVICE BAY
ROOF EXHAUSTER
ASPHALT ROOF
SLOPE 4°
NOT FOR CONSTRUCTION
3 | 00 | 2018/03/22 | ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 | PB | 2017/08/25 | ISSUED FOR CLIENT REVIEW.
1 | PA | 2017/08/16 | ISSUED FOR SLI INTERNAL REVIEW.
ISSUE REGISTER
REVISION REGISTER
1 | POWERHOUSE UNIT-7 ROOF PLANAND SECTIONS | 3107-A-302
REFERENCE DRAWINGS NUMBER
PROFESSIONAL SEAL
SNC-LAVALIN
DESIGNED D. KASSIS/R. GRAVEL
DRAWN Y. TREGUER
CHECKED D. KASSIS/S. MOUSSEAU
DATE 2017-07-17
SCALE AS SHOWN
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORNAD
hydro
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT ROOF PLAN
PROJECT No 647756 | SUBDIVISION 0001 | SUBJECT 41 DD | SERIAL 0012 | REV. 00


NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
LEGEND:
V.B. = VERTICAL BRACING
STEEL GRADING
CHECKERED PLATE
MAIN FLOOR - PLAN AT EL. 11.582
UNIT 7
UNIT 8
EXISTING SERVICE BAY
PROPOSED SERVICE BAY
GENERATOR STEP-UP TRANSFORMER (GSU)
TRANSFORMER BASE PAD
STATION SERVICE TRANSFORMER BASES
MANHOLE COVER
MAIN DOOR 6096 x 6096
LADDER TO ROOF
WALKWAY
GUARDRAIL
GATE HOUSE ROOF
BAY D'ESPOIR
HYDRO GENERATING UNITS 7 & 8 GENERAL ARRANGEMENT MAIN FLOOR PLAN AT EL. 11.582
647756
NOT FOR CONSTRUCTION

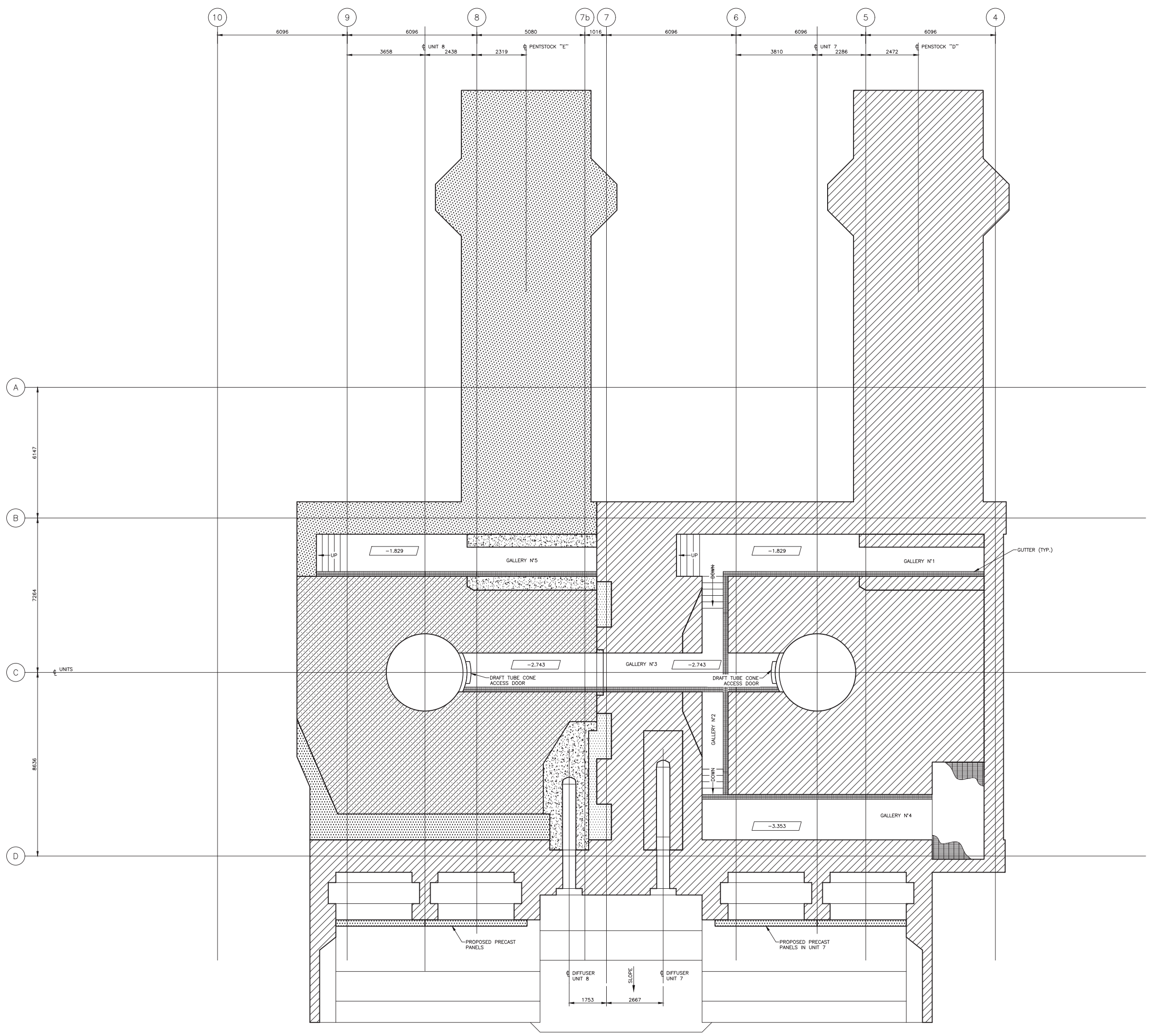

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
LEGEND:
EXISTING CONCRETE
1st STAGE CONCRETE
BLOCK WALL
STEEL GRATING
GENERATOR FLOOR - PLAN AT EL. 7.925 AND 7.315
NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNITS 7 & 8
GENERAL ARRANGEMENT
GENERATOR FLOOR
PLAN AT EL. 7.925 AND 7.315
647756
REVISION REGISTER
ISSUE REGISTER
REFERENCE DRAWINGS NUMBER


NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
LEGEND:
EXISTING CONCRETE
1st STAGE CONCRETE
2nd STAGE CONCRETE
2nd STAGE INFILL CONCRETE
CONCRETE BLOCK
STEEL GRATING
TURBINE FLOOR
PLAN AT EL. 3.708
NOT FOR CONSTRUCTION
SNC·LAVALIN
Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED D. KASSIS/R. GRAVEL
DRAWN Y. TREGUER
CHECKED D. KASSIS/S. MOUSSEAU
DATE 2017-07-17
SCALE 1:75
PROJECT DISCIPLINE ENGINEER S. MOUSSEAU
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
PROFESSIONAL SEAL
CLIENT
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNITS 7 & 8
GENERAL ARRANGEMENT
TURBINE FLOOR
PLAN AT EL. 3.708
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 41 DD
SERIAL 0015
REV. 00
STDSLIAOHEN - FRAME A0 HORIZONTAL ENGLISH
ISSUE No | REV. | DATE (Y/M/D) | PURPOSE OF ISSUE
3 | 00 | 2018/03/22 | ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 | PB | 2017/08/25 | ISSUED FOR CLIENT REVIEW.
1 | PA | 2017/08/16 | ISSUED FOR SLI INTERNAL REVIEW.
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
LUNCH ROOM
GATE HOUSE
OIL/WATER SEPARATOR
HIGH PRESSURE COMPRESSORS
ACCUMULATOR TANK
DRAFT TUBE AIR RECEIVER
GOVERNOR SUMP PUMP
SAND FILTER
MANUAL STRAINER
STAIR ACCESS
PIEZOMETER PANEL
CENTIMETERS


NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
LEGEND:
EXISTING CONCRETE
1st STAGE CONCRETE
2nd STAGE CONCRETE
2nd STAGE INFILL CONCRETE
STEEL GRATING
SPIRAL CASE ACCESS FLOOR
PLAN AT EL. 0.305
SPIRAL CASE ACCESS DOOR
HATCH 2134 X 1829
RELIEF VALVE
PROPOSED PRECAST PANELS IN UNIT 7
PROPOSED PRECAST PANELS
EL. 0.305
DOWN
PENSTOCK "D"
PENSTOCK "E"
UNIT 7
UNIT 8
CENTIMETERS
NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNITS 7 & 8
GENERAL ARRANGEMENT
SPIRAL CASE ACCESS FLOOR
PLAN AT EL. 0.305
647756
0001
41DD
0016
00
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE
ISSUED FOR CLIENT REVIEW
ISSUED FOR SLI INTERNAL REVIEW
2017-07-17
1:75

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.



DRAFT TUBE CONE ACCESS FLOOR
PLAN AT EL. -1.829

LEGEND:

- EXISTING CONCRETE
- 1st STAGE CONCRETE
- 2nd STAGE CONCRETE
- 2nd STAGE INFILL CONCRETE
- STEEL GRATING

NOT FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
3	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/08/16	ISSUED FOR SLI INTERNAL REVIEW.	

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

SNC-LAVALIN
Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED: D. KASSIS/R. GRAVEL	PROJECT DISCIPLINE ENGINEER: S. MOUSSEAU
DRAWN: Y. TREGUER	PROJECT ENGINEER: R. GRAVEL
CHECKED: D. KASSIS/S. MOUSSEAU	PROJECT MANAGER: S. PERRON
DATE: 2017-07-17	CLIENT: A. FORHAD
SCALE: 1:75	

CLIENT: newfoundland labrador hydro — a nalcor energy company

PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNITS 7 & 8
GENERAL ARRANGEMENT
DRAFT TUBE CONE ACCESS FLOOR
PLAN AT EL. −1.829

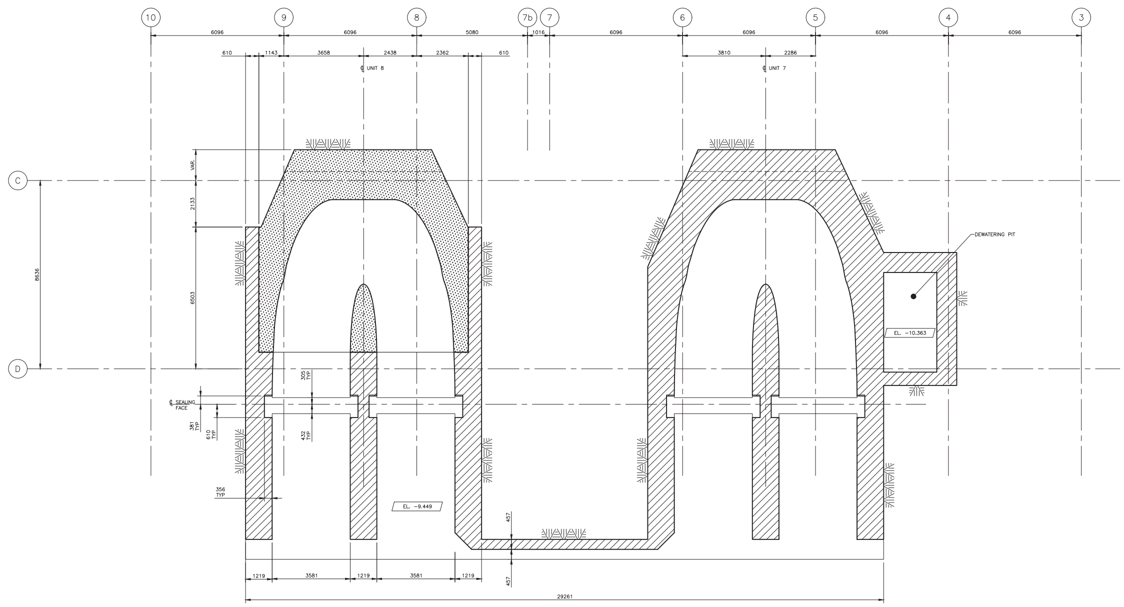
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	41 DD	0017	00

STDSLIAOHEN – FRAME A0 HORIZONTAL ENGLISH

LAST SAVE: 2018/03/21 - 2:23pm
PATH: Z:\647756\3-Réalisation\3-Civil\647756-0001-41DD-0017_00.dwg

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.



DRAFT TUBE FLOOR
PLAN AT EL. -9.449

LEGEND:

EXISTING CONCRETE

1st STAGE CONCRETE

ROCK

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
3	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/08/16	ISSUED FOR SLI INTERNAL REVIEW.	

ISSUE REGISTER

ISSUE REGISTER

REVISION REGISTER

REVISION REGISTER

No | REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

SNC·LAVALIN
Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED: D. KASSIS/ R. GRAVEL	PROJECT DISCIPLINE ENGINEER: S. MOUSSEAU
DRAWN: Y. TREGUER	PROJECT ENGINEER: R. GRAVEL
CHECKED: D. KASSIS/ S. MOUSSEAU	PROJECT MANAGER: S. PERRON
DATE: 2017-07-17	CLIENT: A. FORHAD
SCALE: 1:75	

CLIENT: hydro

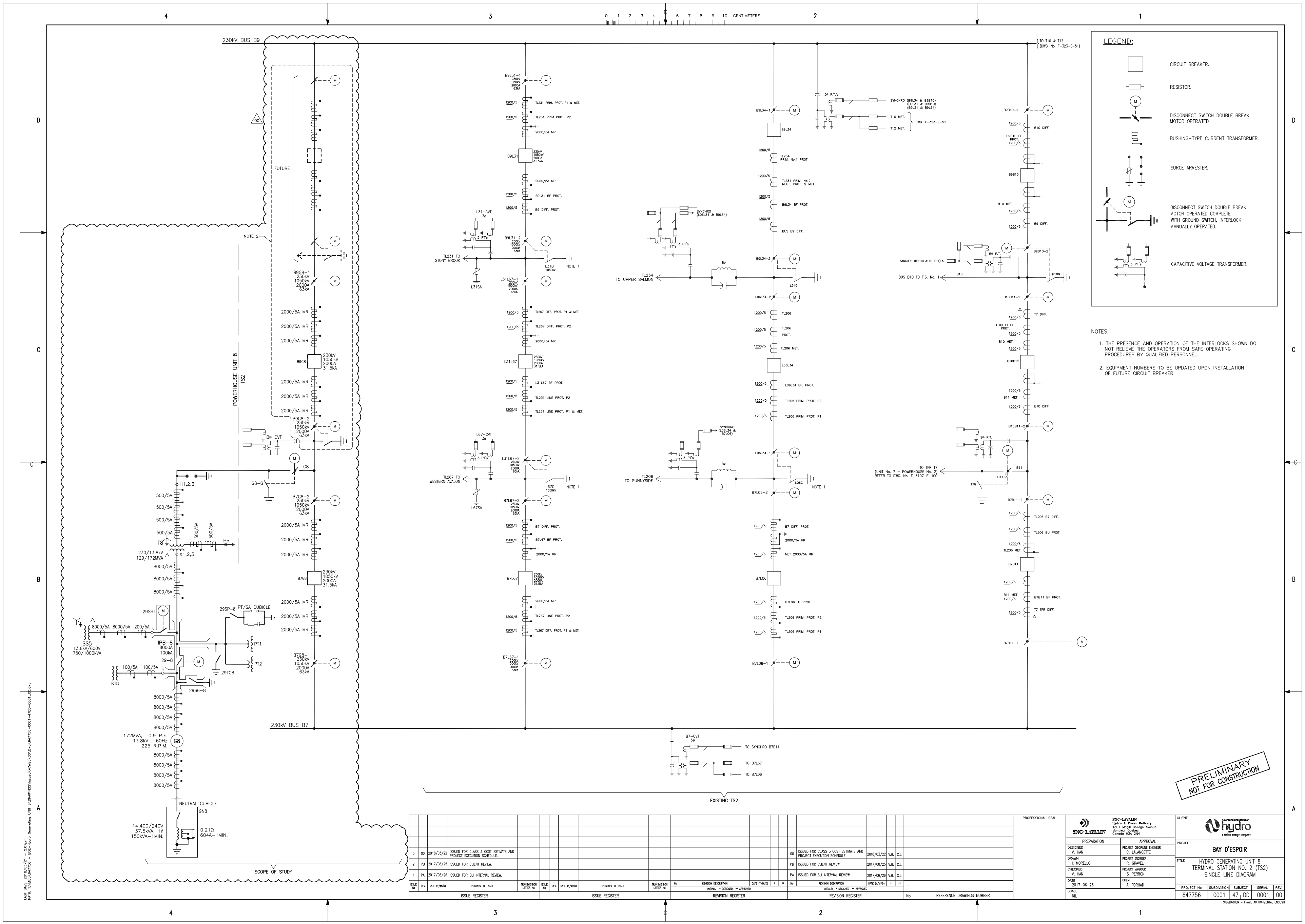
PROJECT: BAY D'ESPOIR

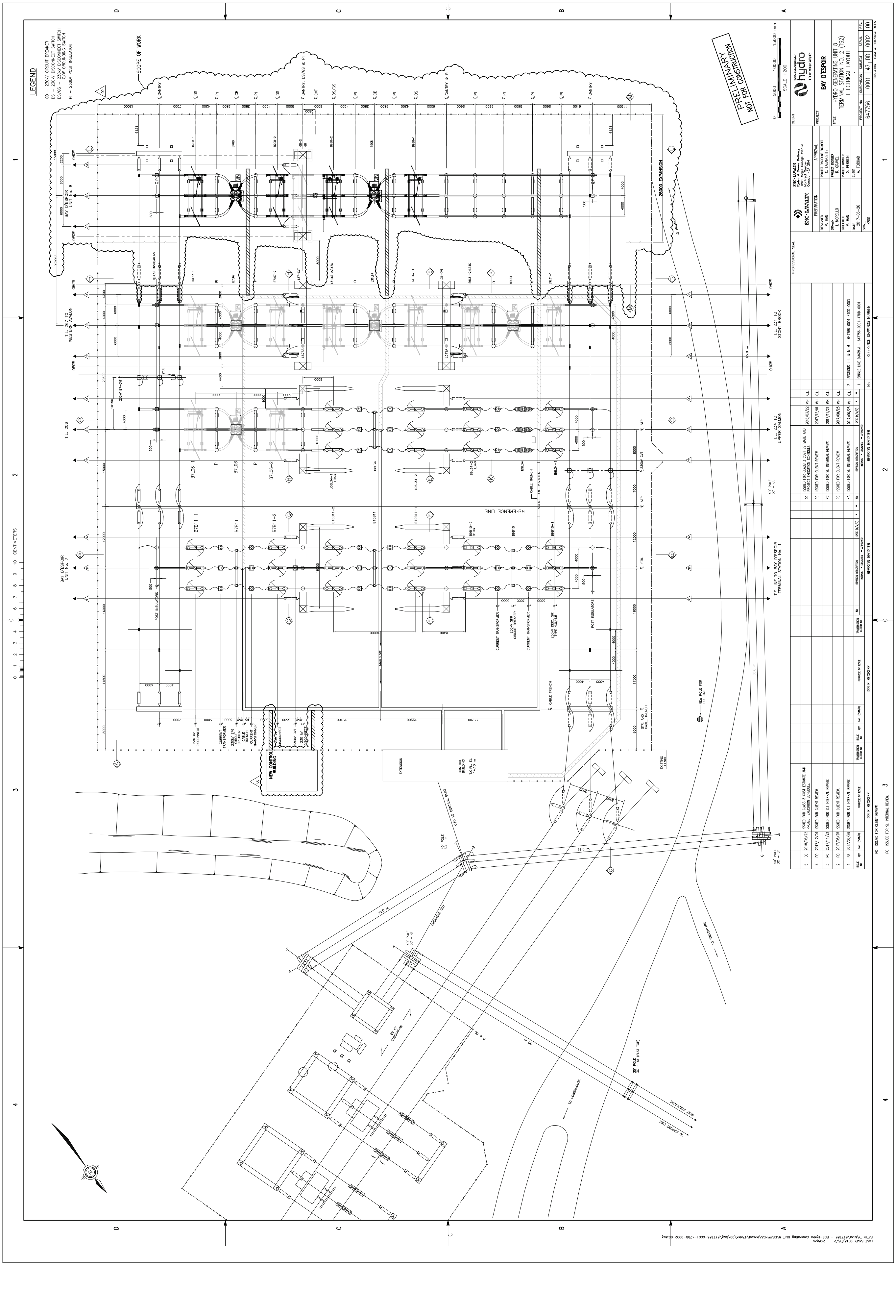
TITLE: HYDRO GENERATING UNITS 7 & 8
GENERAL ARRANGEMENT
DRAFT TUBE FLOOR
PLAN AT EL. -9.449

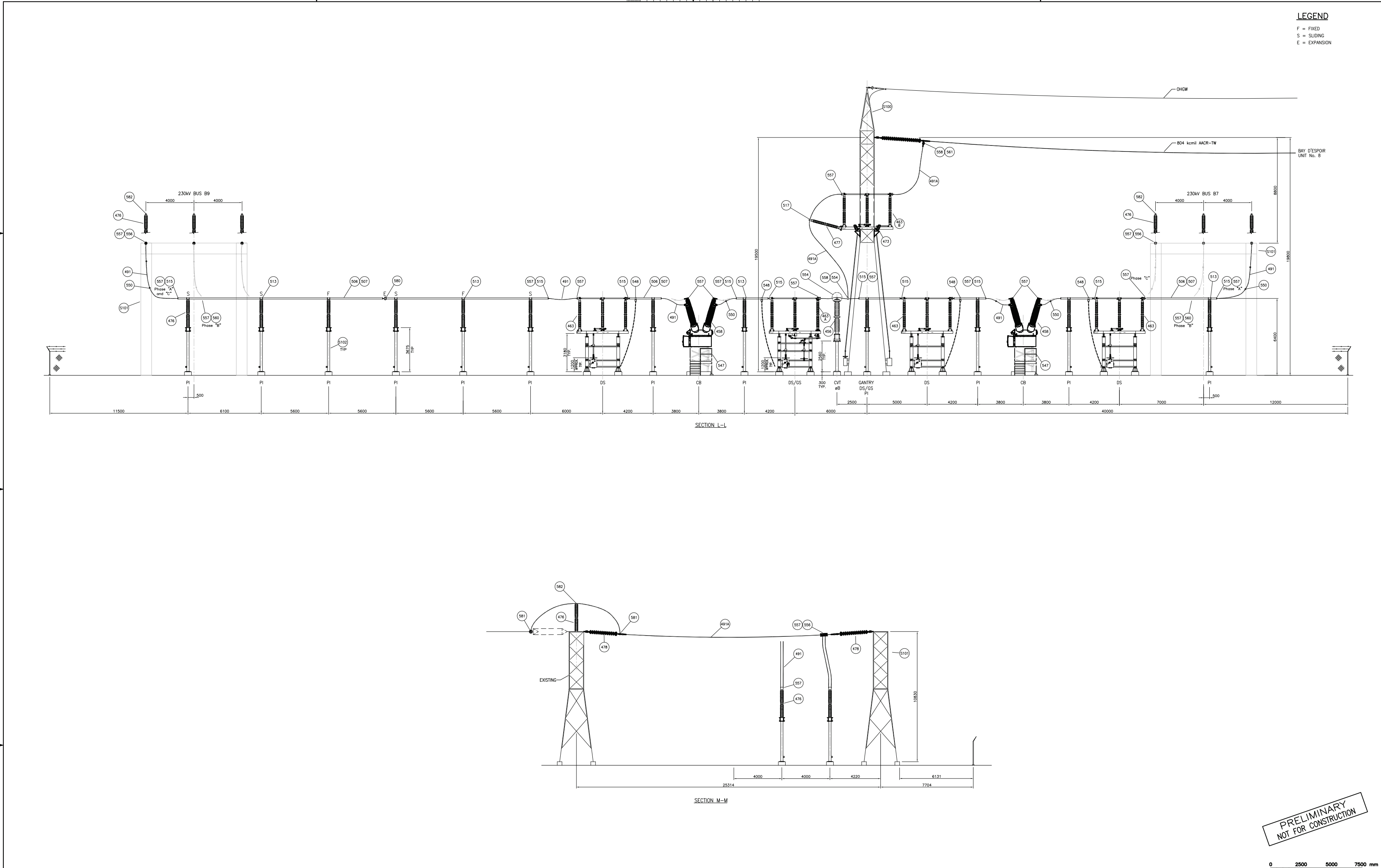
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	41 DD	0018	00

STDSLIAOHEN - FRAME A0 HORIZONTAL ENGLISH

LAST SAVE: 2018/03/21 - 2:23pm
PATH: Z:\647756\3-Realisation\3-Civil\647756-0001-41DD-0018_00.dwg


LEGEND:
CIRCUIT BREAKER.
RESISTOR.
DISCONNECT SWITCH DOUBLE BREAK MOTOR OPERATED
BUSHING-TYPE CURRENT TRANSFORMER.
SURGE ARRESTER.
DISCONNECT SWITCH DOUBLE BREAK MOTOR OPERATED COMPLETE WITH GROUND SWITCH, INTERLOCK MANUALLY OPERATED.
CAPACITIVE VOLTAGE TRANSFORMER.
NOTES:
1. THE PRESENCE AND OPERATION OF THE INTERLOCKS SHOWN DO NOT RELIEVE THE OPERATORS FROM SAFE OPERATING PROCEDURES BY QUALIFIED PERSONNEL.
2. EQUIPMENT NUMBERS TO BE UPDATED UPON INSTALLATION OF FUTURE CIRCUIT BREAKER.
230kV BUS B9
230kV BUS B7
TO T10 & T12 (DWG. No. F-323-E-51)
TL231 TO STONY BROOK
TL267 TO WESTERN AVALON
TL234 TO UPPER SALMON
TL206 TO SUNNYSIDE
BUS B10 TO T.S. No. 1
TO TFR T7 (UNIT No. 7 - POWERHOUSE No. 2) REFER TO DWG. No. F-3107-E-100
POWERHOUSE UNIT 8
TS2
FUTURE
SCOPE OF STUDY
EXISTING TS2
NEUTRAL CUBICLE
172MVA, 0.9 P.F. 13.8kV, 60Hz 225 R.P.M.
230/13.8kV 129/172MVA
SS5 13.8kV/600V 750/1000kVA
IPB-8 8000A 100kA
14,400/240V 37.5kVA, 1ø 150kVA-1MIN.
0.21Ω 604A-1MIN.
PRELIMINARY NOT FOR CONSTRUCTION
3 | 00 | 2018/03/22 | ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
2 | PB | 2017/08/25 | ISSUED FOR CLIENT REVIEW.
1 | PA | 2017/06/26 | ISSUED FOR SLI INTERNAL REVIEW.
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
SNC-LAVALIN Hydro & Power Delivery. 1801 McGill College Avenue Montreal Quebec Canada H3A 2N4
DESIGNED V. HAN
DRAWN I. MORELLO
CHECKED V. HAN
DATE 2017-06-26
SCALE NIL
PROJECT DISCIPLINE ENGINEER C. LALANCETTE
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
newfoundland labrador hydro a nalcor energy company
BAY D'ESPOIR
HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) SINGLE LINE DIAGRAM
647756 | 0001 | 47 | DD | 0001 | 00


LEGEND
CB – 230kV CIRCUIT BREAKER
DS – 230kV DISCONNECT SWITCH
DS/GS – 230kV DISCONNECT SWITCH C/W GROUNDING SWITCH
PI – 230kV POST INSULATOR
SCOPE OF WORK
PRELIMINARY
NOT FOR CONSTRUCTION
REFERENCE LINE
NEW CONTROL BUILDING
CONTROL BUILDING
EXTENSION
T.L. 267 TO WESTERN AVALON
T.L. 206
T.L. 231 TO STONY BROOK
T.L. 234 TO UPPER SALMON
BAY D'ESPOIR UNIT No. 8
BAY D'ESPOIR UNIT No. 7
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
TERMINAL STATION NO. 2 (TS2)
ELECTRICAL LAYOUT
SNC-LAVALIN
hydro
REVISION REGISTER
ISSUE REGISTER
REFERENCE DRAWINGS NUMBER
647756 0001 47 D0 0002 00



ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
5	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
4	PD	2017/12/01	ISSUED FOR CLIENT REVIEW.	
3	PC	2017/11/21	ISSUED FOR SLI INTERNAL REVIEW.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/06/26	ISSUED FOR SLI INTERNAL REVIEW.	

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
00	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	2018/03/22	V.H.	C.L.
PD	ISSUED FOR CLIENT REVIEW.	2017/12/01	V.H.	C.L.
PC	ISSUED FOR SLI INTERNAL REVIEW.	2017/11/21	V.H.	C.L.
PB	ISSUED FOR CLIENT REVIEW.	2017/08/25	V.H.	C.L.
PA	ISSUED FOR SLI INTERNAL REVIEW.	2017/06/26	V.H.	C.L.

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER
2	BOM – MAJOR EQUIPMENT – 647756-0001-47ES-0001
1	ELECTRICAL LAYOUT – 647756-0001-47DD-0002

PROFESSIONAL SEAL

SNC·LAVALIN
Hydro & Power Delivery.
1801 Mcgill, Montreal Que.
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED V. HAN	PROJECT DISCIPLINE ENGINEER C. LALANCETTE
DRAWN I. MORELLO	PROJECT ENGINEER R. GRAVEL
CHECKED V. HAN	PROJECT MANAGER S. PERRON
DATE 2017-06-26	CLIENT A. FORHAD
SCALE 1:100	

CLIENT: newfoundland labrador hydro, a nalcor energy company

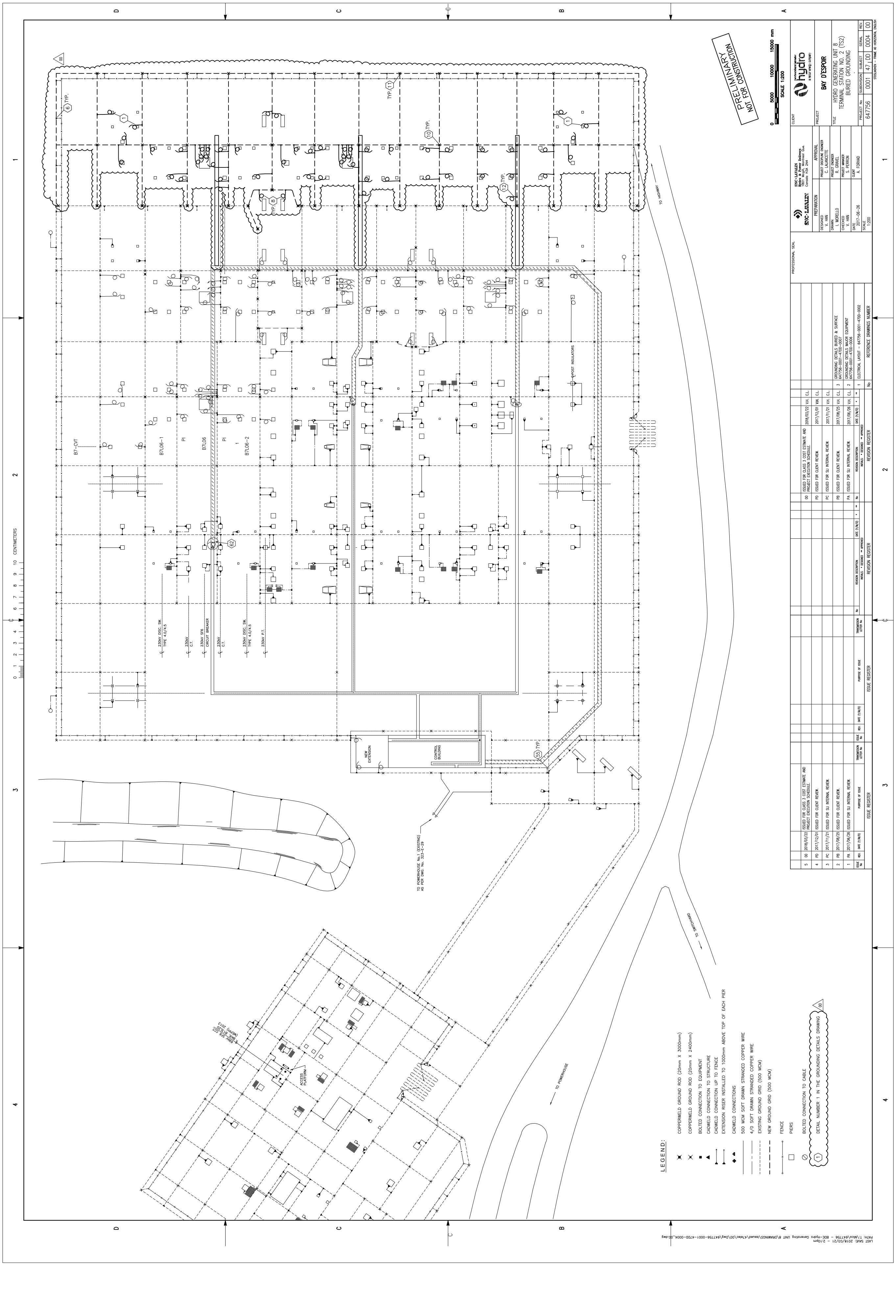
PROJECT: BAY D'ESPOIR

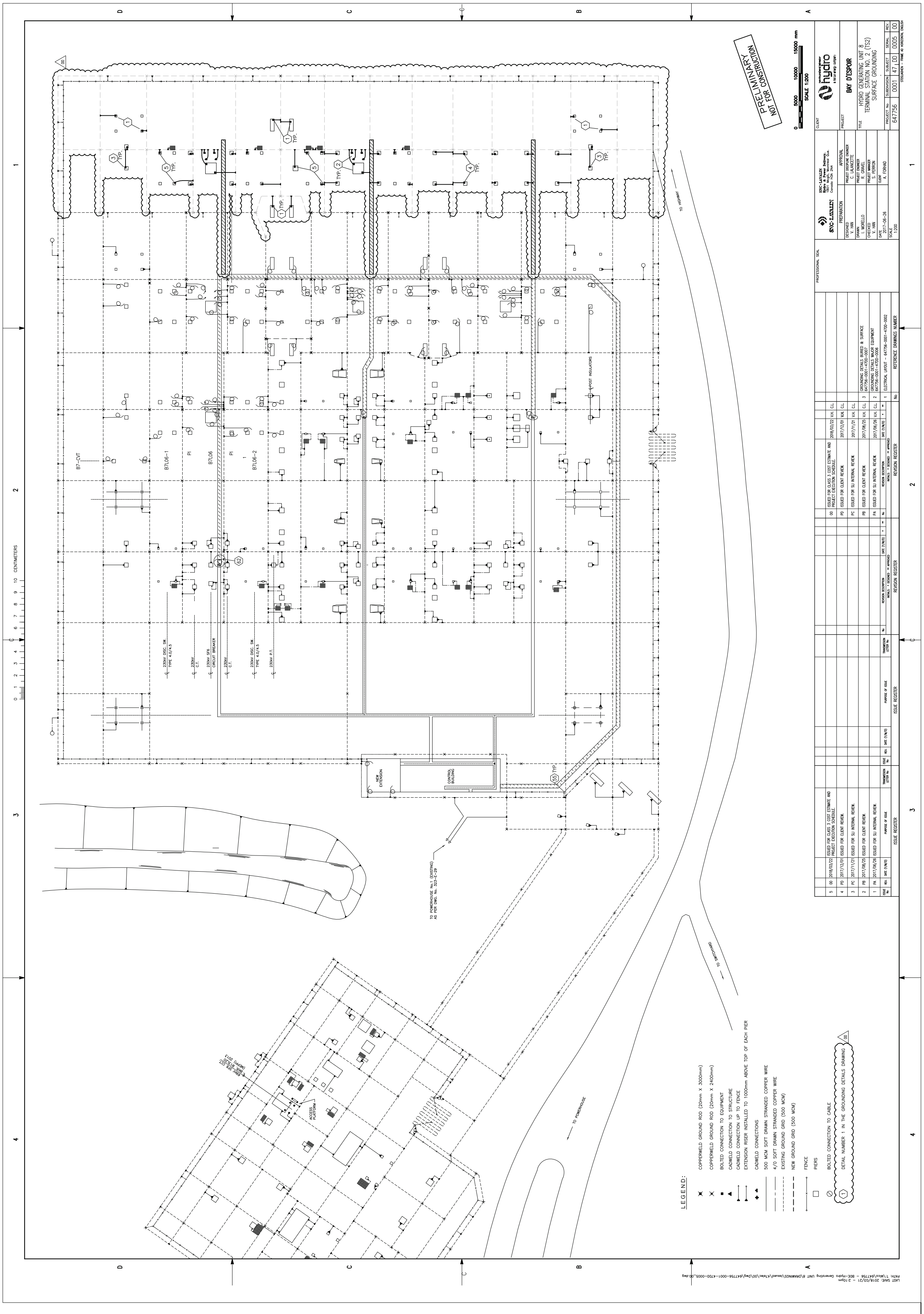
TITLE: HYDRO GENERATING UNIT 8
TERMINAL STATION NO. 2 (TS2)
SECTIONS L-L & M-M

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	47 DD	0003	00

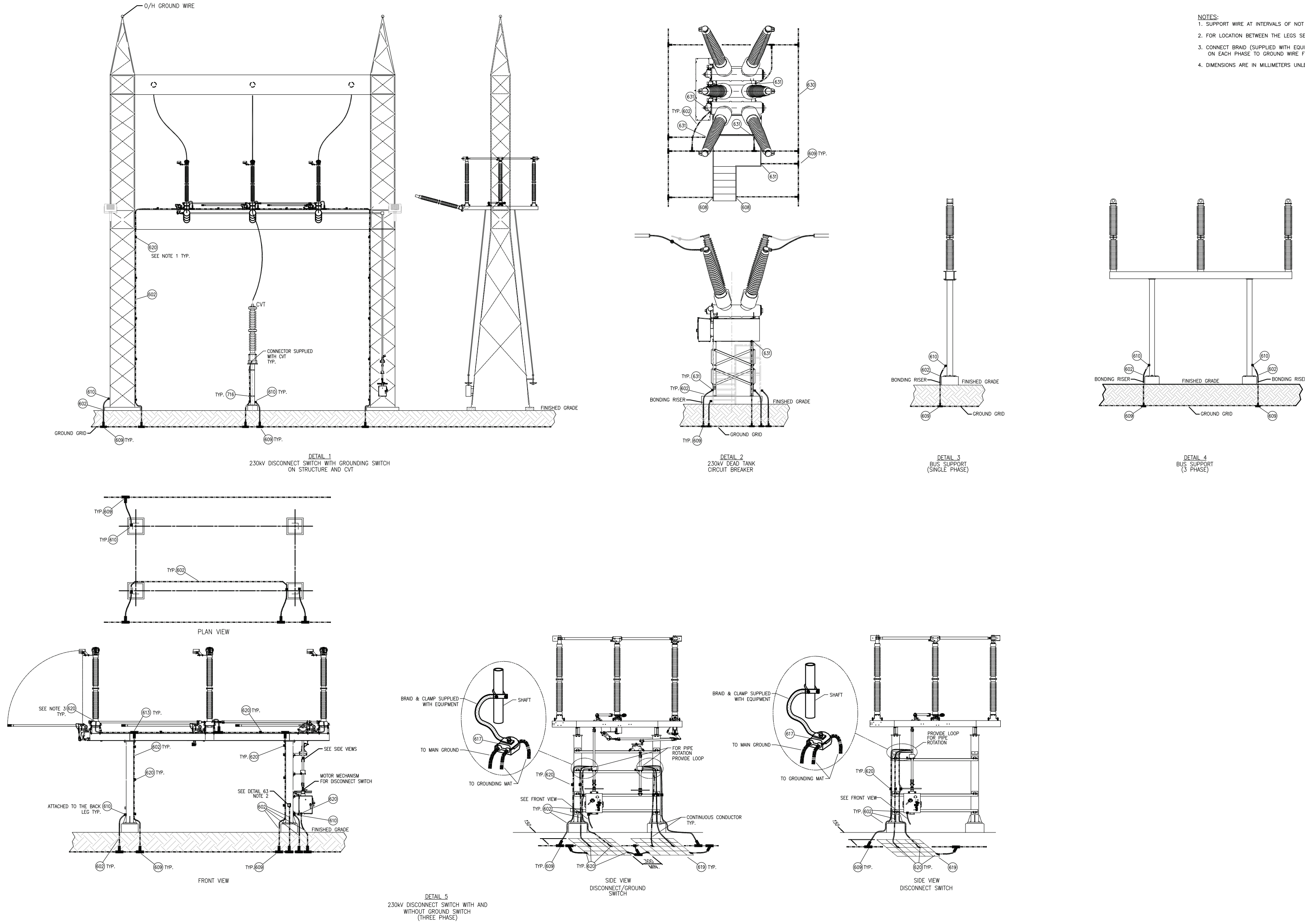
STDSLIAOHEN – FRAME A0 HORIZONTAL ENGLISH

LAST SAVE: 2018/03/21 – 2:09pm
PATH: T:\Mtl\647756 – BDE–Hydro Generating UNIT 8\DRAWINGS\Issued\47elec\00\Dwg\647756-0001-4700-0003_00.dwg


PRELIMINARY
NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
TERMINAL STATION No. 2 (TS2)
BURIED GROUNDING
647756
CONTROL BUILDING
NEW EXTENSION
LEGEND:


PRELIMINARY
NOT FOR CONSTRUCTION
0 5000 10000 15000 mm
SCALE 1:200
LEGEND:
COPPERWELD GROUND ROD (20mm X 3000mm)
COPPERWELD GROUND ROD (20mm X 2400mm)
BOLTED CONNECTION TO EQUIPMENT
CADWELD CONNECTION TO STRUCTURE
CADWELD CONNECTION UP TO FENCE
EXTENSION RISER INSTALLED TO 1000mm ABOVE TOP OF EACH PIER
CADWELD CONNECTIONS
500 MCM SOFT DRAWN STRANDED COPPER WIRE
4/0 SOFT DRAWN STRANDED COPPER WIRE
EXISTING GROUND GRID (500 MCM)
NEW GROUND GRID (500 MCM)
FENCE
PIERS
BOLTED CONNECTION TO CABLE
DETAIL NUMBER 1 IN THE GROUNDING DETAILS DRAWING
NEW EXTENSION
CONTROL BUILDING
TO POWERHOUSE No.1 (EXISTING) AS PER DWG. No. 323-E-29
TO POWERHOUSE
TO SWITCHYARD
TO HIGHWAY
ACCESS PLATFORM
B7-CVT
B7L06-1
B7L06
B7L06-2
230kV DISC. SW. TYPE 4.0/4.5
230kV C.T.
230kV SF6 CIRCUIT BREAKER
230kV P.T.
POST INSULATORS
PROFESSIONAL SEAL
SNC·LAVALIN
Hydro & Power Delivery.
1801 Mcgill, Montreal Que.
Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED V. HAN
DRAWN I. MORELLO
CHECKED V. HAN
DATE 2017-06-26
SCALE 1:200
PROJECT DISCIPLINE ENGINEER C. LALANCETTE
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
CLIENT newfoundland labrador hydro a nalcor energy company
PROJECT BAY D'ESPOIR
TITLE HYDRO GENERATING UNIT 8
TERMINAL STATION NO. 2 (TS2)
SURFACE GROUNDING
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 47 DD
SERIAL 0005
REV. 00
STDSLIAOHEN – FRAME A0 HORIZONTAL ENGLISH

NOTES:
1. SUPPORT WIRE AT INTERVALS OF NOT LESS THAN 1500mm (MIN.).
2. FOR LOCATION BETWEEN THE LEGS SEE DWG: 323-E-057 & 323-E-108
3. CONNECT BRAID (SUPPLIED WITH EQUIPMENT) FROM GROUND SWITCH ON EACH PHASE TO GROUND WIRE FROM GRID (ALL THREE PHASES).
4. DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.



ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
3	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/06/26	ISSUED FOR SLI INTERNAL REVIEW.	

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
00	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	2018/03/22	V.H.	C.L.
PB	ISSUED FOR CLIENT REVIEW.	2017/08/25	V.H.	C.L.
PA	ISSUED FOR SLI INTERNAL REVIEW.	2017/06/26	V.H.	C.L.

INITIALS: * DESIGNED ** APPROVED

No	REFERENCE DRAWINGS NUMBER
4	BOM – GROUNDING – 647756-0001-47ES-0002
3	SURFACE GROUNDING – 647756-0001-47DD-0005
2	BURIED GROUNDING GRID – 647756-0001-47DD-0004
1	ELECTRICAL LAYOUT – 647756-0001-47DD-0002

PROFESSIONAL SEAL

SNC·LAVALIN
Hydro & Power Delivery.
1801 Mcgill, Montreal Que.
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED V. HAN	PROJECT DISCIPLINE ENGINEER C. LALANCETTE
DRAWN I. MORELLO	PROJECT ENGINEER R. GRAVEL
CHECKED V. HAN	PROJECT MANAGER S. PERRON
DATE 2017-06-26	CLIENT A. FORHAD
SCALE N.T.S.	

CLIENT: newfoundland labrador hydro, a nalcor energy company

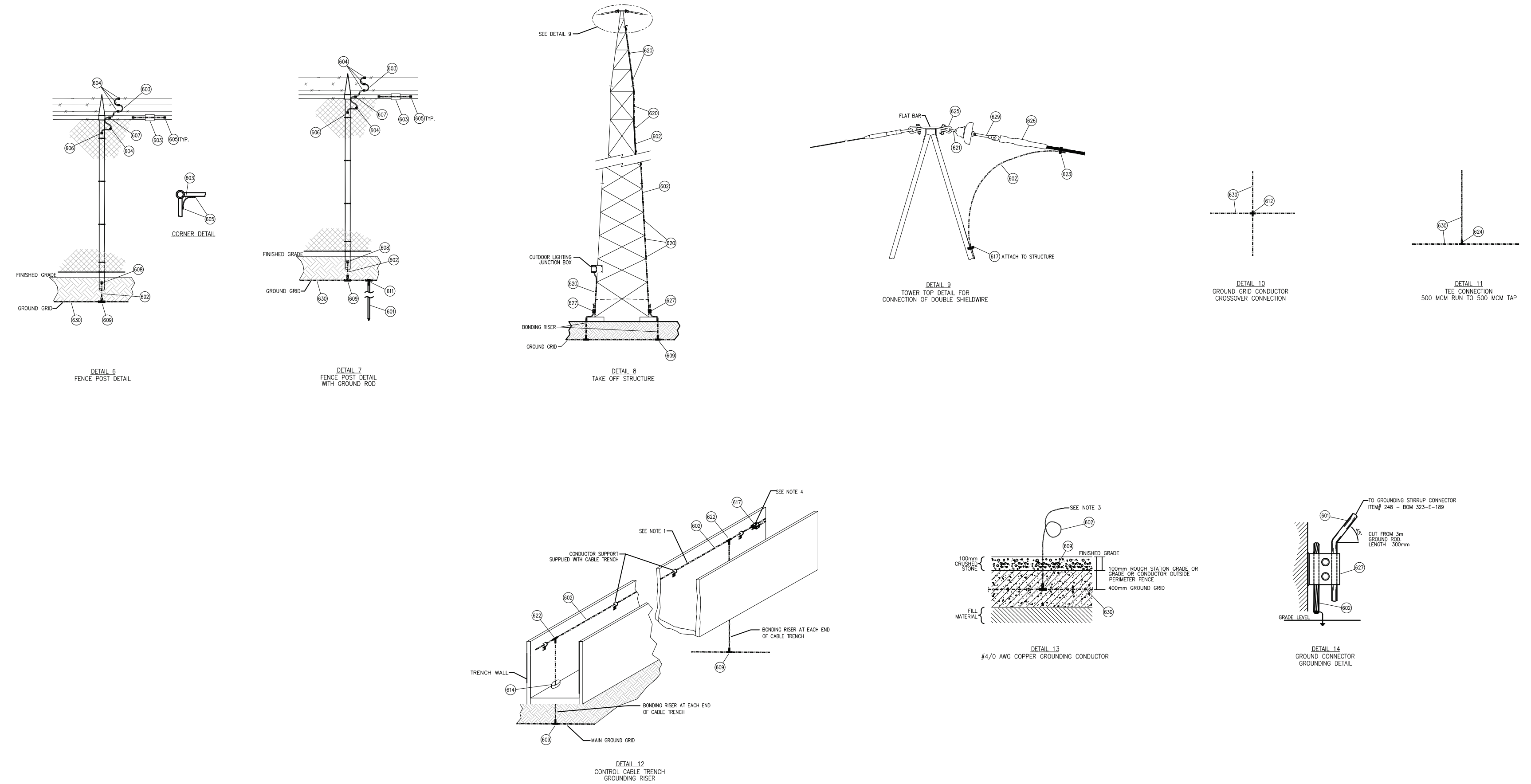
PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) GROUNDING DETAILS MAJOR EQUIPMENT

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	47 DD	0006	00

STDSLIADHEN – FRAME A0 HORIZONTAL ENGLISH

NOTES:
1. INSTALL A 4/0 AWG COPPER GROUND CONDUCTOR AT THE TOP OF THE CONTROL CABLE TRENCH AND CONNECT TO BONDING RISERS AT EACH END OF CABLE TRENCH.
2. LIGHTING DOWN LEAD INSTALLED ON TOWER MEMBERS WITHOUT CLIMBING BOLTS.
3. LEAVE 3m RISER FROM CONNECTION.
4. CONNECTION BETWEEN EXISTING GROUNDING CONDUCTOR & NEW ADDED CONDUCTOR IN NEW TRENCH.



DETAIL 6
FENCE POST DETAIL

DETAIL 7
FENCE POST DETAIL WITH GROUND ROD

DETAIL 8
TAKE OFF STRUCTURE

DETAIL 9
TOWER TOP DETAIL FOR CONNECTION OF DOUBLE SHIELDWIRE

DETAIL 10
GROUND GRID CONDUCTOR CROSSOVER CONNECTION

DETAIL 11
TEE CONNECTION
500 MCM RUN TO 500 MCM TAP

DETAIL 12
CONTROL CABLE TRENCH GROUNDING RISER

DETAIL 13
#4/0 AWG COPPER GROUNDING CONDUCTOR

DETAIL 14
GROUND CONNECTOR GROUNDING DETAIL

PRELIMINARY
NOT FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
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2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/06/26	ISSUED FOR SLI INTERNAL REVIEW.	

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
00	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	2018/03/22	V.H.	C.L.
PB	ISSUED FOR CLIENT REVIEW.	2017/08/25	V.H.	C.L.
PA	ISSUED FOR SLI INTERNAL REVIEW.	2017/06/26	V.H.	C.L.

INITIALS: * DESIGNED ** APPROVED

REFERENCE DRAWINGS NUMBER

No	REFERENCE DRAWINGS NUMBER
4	BOM - GROUNDING - 647756-0001-47ES-0002
3	SURFACE GROUNDING - 647756-0001-4700-0005
2	BURIED GROUNDING GRID - 647756-0001-4700-0004
1	ELECTRICAL LAYOUT - 647756-0001-4700-0002

PROFESSIONAL SEAL

SNC-LAVALIN
SNC-LAVALIN Hydro & Power Delivery, 1801 Mcgill, Montreal Que. Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED: V. HAN	PROJECT DISCIPLINE ENGINEER: C. LALANCETTE
DRAWN: L. MORELLO	PROJECT ENGINEER: R. GRAVEL
CHECKED: V. HAN	PROJECT MANAGER: S. PERRON
DATE: 2017-06-26	CLIENT: A. FORHAD
SCALE: N.T.S.	

CLIENT: newfoundland labrador hydro, a nalcor energy company

PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNIT 8 TERMINAL STATION NO. 2 (TS2) GROUNDING DETAILS BURIED AND SURFACE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	47 DD	0007	00

STDSLHDEN - FRAME A0 HORIZONTAL ENGLISH

LAST SAVE: 2018/03/21 - 2:11pm
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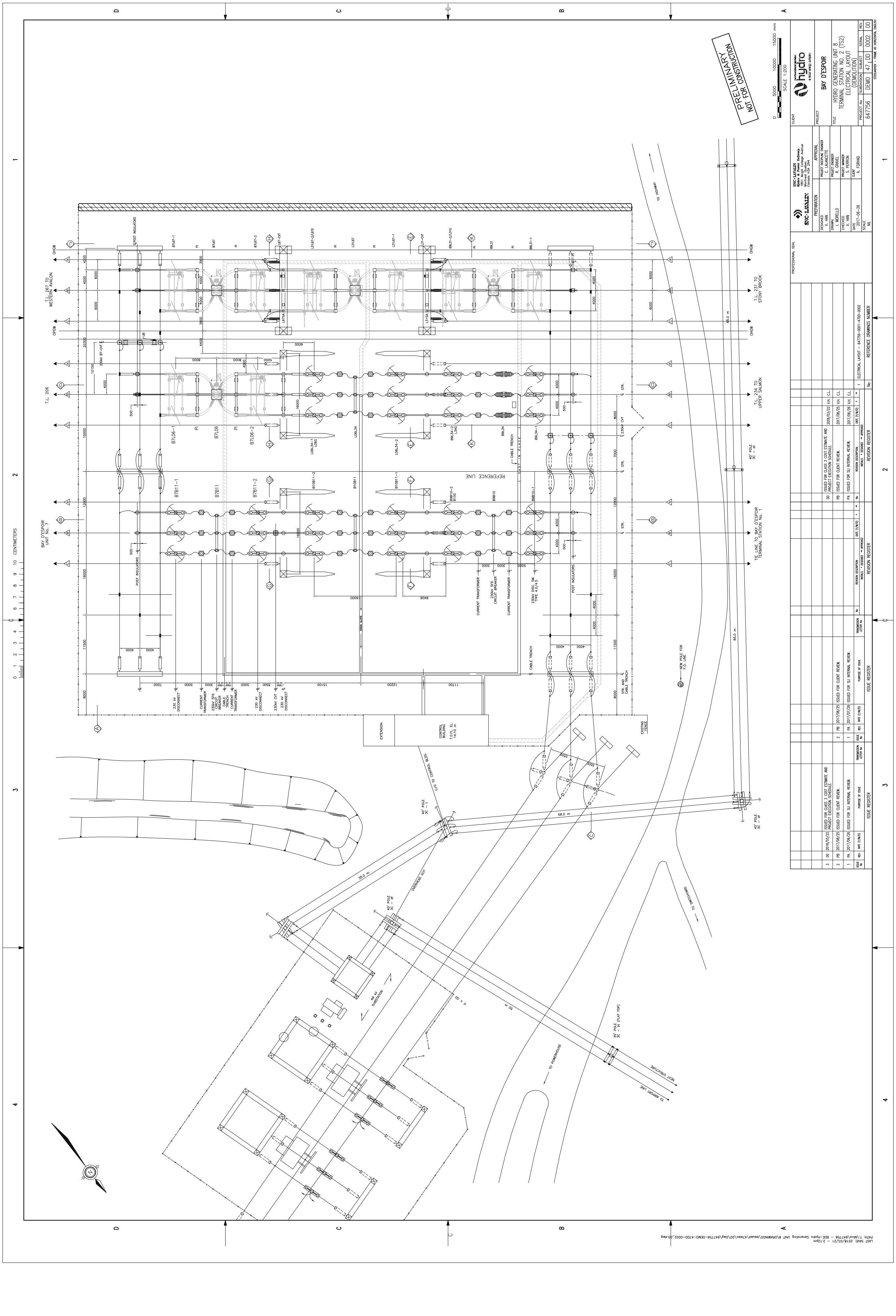
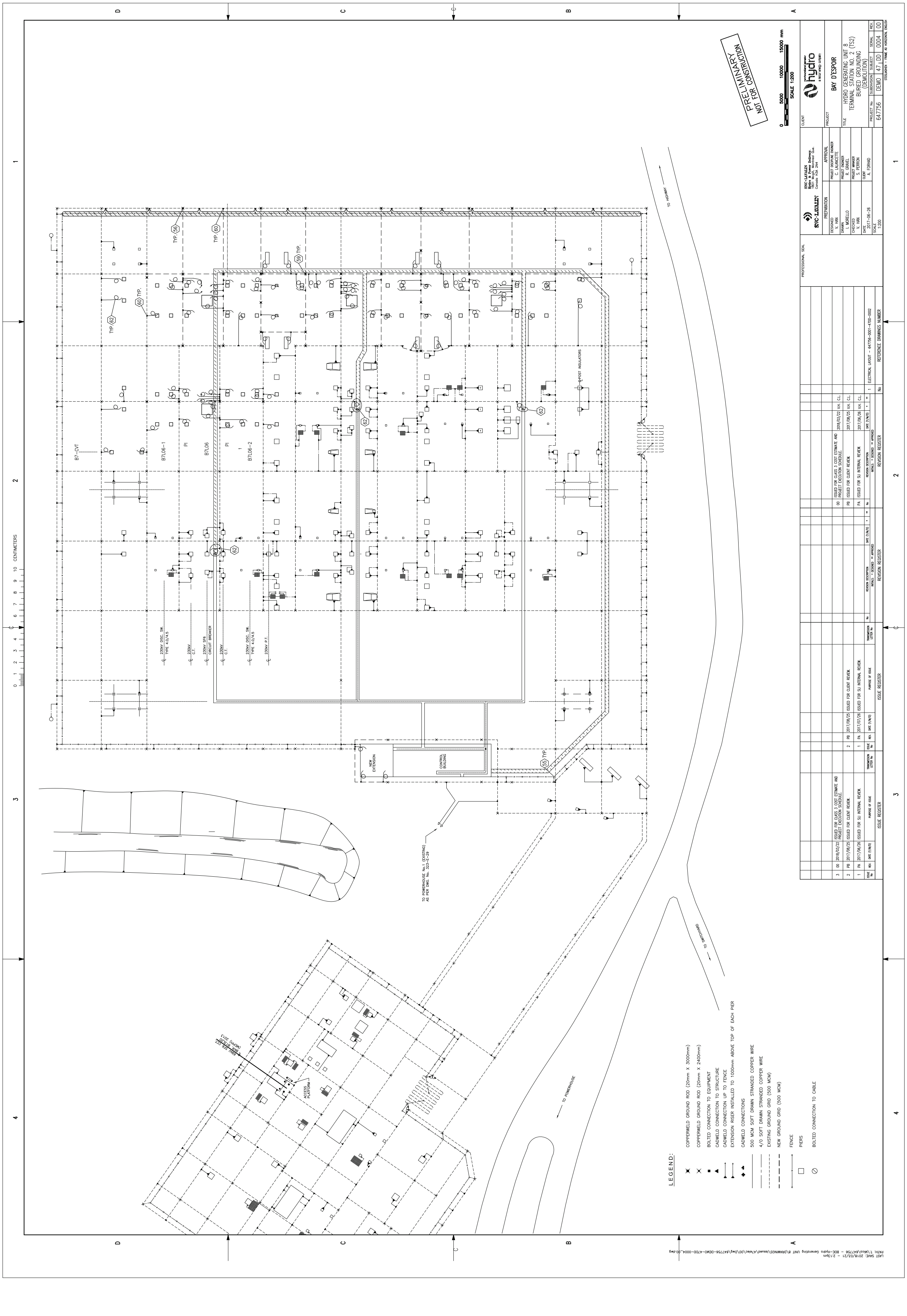
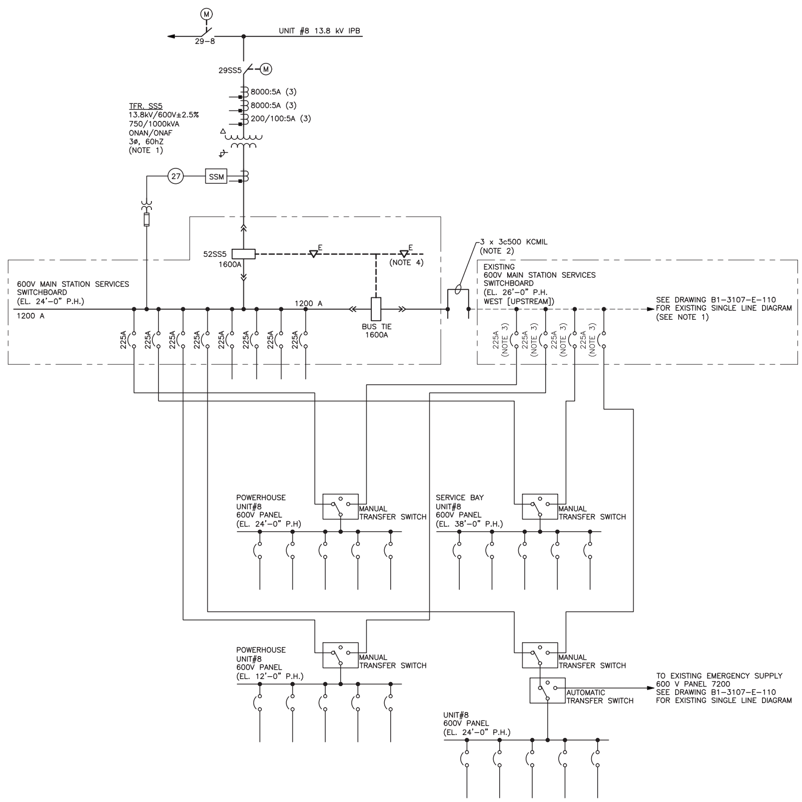

PRELIMINARY
NOT FOR CONSTRUCTION
SCALE 1:200
0 5000 10000 15000 mm
SNC·LAVALIN
Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED V. HAN
DRAWN I. MORELLO
CHECKED V. HAN
DATE 2017-06-26
SCALE NIL
PROJECT DISCIPLINE ENGINEER C. LALANCETTE
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
CLIENT
newfoundland labrador hydro
a nalcor energy company
PROJECT
BAY D'ESPOIR
TITLE
HYDRO GENERATING UNIT 8
TERMINAL STATION NO. 2 (TS2)
ELECTRICAL LAYOUT
(DEMOLITION)
PROJECT No 647756
SUBDIVISION DEMO
SUBJECT 47_DD
SERIAL 0002
REV. 00
PROFESSIONAL SEAL
T.L. 267 TO WESTERN AVALON
T.L. 231 TO STONY BROOK
T.L. 206
T.L. 234 TO UPPER SALMON
BAY D'ESPOIR UNIT No. 7
TIE LINE TO BAY D'ESPOIR TERMINAL STATION No. 1
REFERENCE LINE
CONTROL BUILDING
EXTENSION
REVISION REGISTER
ISSUE REGISTER
ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
ISSUED FOR CLIENT REVIEW.
ISSUED FOR SLI INTERNAL REVIEW.
REFERENCE DRAWINGS NUMBER
ELECTRICAL LAYOUT - 647756-0001-47DD-0002
TO HIGHWAY
TO SWITCHYARD
TO POWERHOUSE


PRELIMINARY
NOT FOR CONSTRUCTION
SCALE 1:200
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
TERMINAL STATION NO. 2 (TS2)
BURIED GROUNDING
(DEMOLITION)
647756 DEMO 47 D00 0004 00
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
ELECTRICAL LAYOUT - 647756-0001-47D0-0002
ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
ISSUED FOR CLIENT REVIEW.
ISSUED FOR SLI INTERNAL REVIEW.
CONTROL BUILDING
NEW EXTENSION
TO POWERHOUSE No. 1 (EXISTING) AS PER DWG. No. 323-E-29
TO POWERHOUSE
TO HIGHWAY
LEGEND:
COPPERWELD GROUND ROD (20mm X 3000mm)
COPPERWELD GROUND ROD (20mm X 2400mm)
BOLTED CONNECTION TO EQUIPMENT
CADWELD CONNECTION TO STRUCTURE
CADWELD CONNECTION UP TO FENCE
EXTENSION RISER INSTALLED TO 1000mm ABOVE TOP OF EACH PIER
CADWELD CONNECTIONS
500 MCM SOFT DRAWN STRANDED COPPER WIRE
4/0 SOFT DRAWN STRANDED COPPER WIRE
EXISTING GROUND GRID (500 MCM)
NEW GROUND GRID (500 MCM)
FENCE
PIERS
BOLTED CONNECTION TO CABLE



NOTES :

1. 600 V DISTRIBUTION SYSTEM TO BE SOLIDLY GROUNDED FOR UNIT #8 BUILDING EXTENSION. ASSUMPTION IS THAT EXISTING BUILDING SERVICES WILL BE MODIFIED / UPGRADED WITH A SOLIDLY GROUNDED SYSTEM.
2. CABLES WILL BE USED TO CONNECT NEW SWITCHBOARD TO EXISTING MAIN STATION SERVICES SWITCHBOARD.
3. EXISTING SPARE BREAKERS IN EXISTING MAIN STATION SERVICES SWITCHGEAR.
4. ELECTRICAL INTERLOCK WITH EXISTING MAIN AND TIE BREAKERS.
5. LOADS TO BE DETERMINED DURING DETAILED DESIGN.

LEGEND:

- MOTOR OPERATED DISCONNECT SWITCH
- STAR-DELTA POWER TRANSFORMER
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMER
- SSM STATION SERVICE METERING
- 27 UNDERVOLTAGE SUPERVISION RELAY
- E ELECTRICAL INTERLOCK
- DRAW OUT CIRCUIT BREAKER
- CIRCUIT BREAKER
- MANUAL OR AUTOMATIC TRANSFER SWITCH

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
4	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.
3	PC	2017/12/01	ISSUED FOR CLIENT REVIEW
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW
1	PA	2017/08/16	ISSUED FOR SLI INTERNAL REVIEW

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)		
PC	ADDED NOTE 1 TO EXIST. SWBD CHANGE TITLE UNIT #8 PANEL	2017/12/01	B.M.	C.L.

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER
1	230kV SINGLE LINE DIAGRAM - 323-E-110

PROFESSIONAL SEAL

SNC-LAVALIN
Hydro & Power Delivery.
1801 McGill College Avenue
Montreal Quebec
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED B. MARCHAND	PROJECT DISCIPLINE ENGINEER C. LALANCETTE
DRAWN B. THERRIEN	PROJECT ENGINEER R. GRAVEL
CHECKED G. TCHAKEDJIAN	PROJECT MANAGER S. PERRON
DATE 2017-07-19	CLIENT A. FORHAD
SCALE NIL	

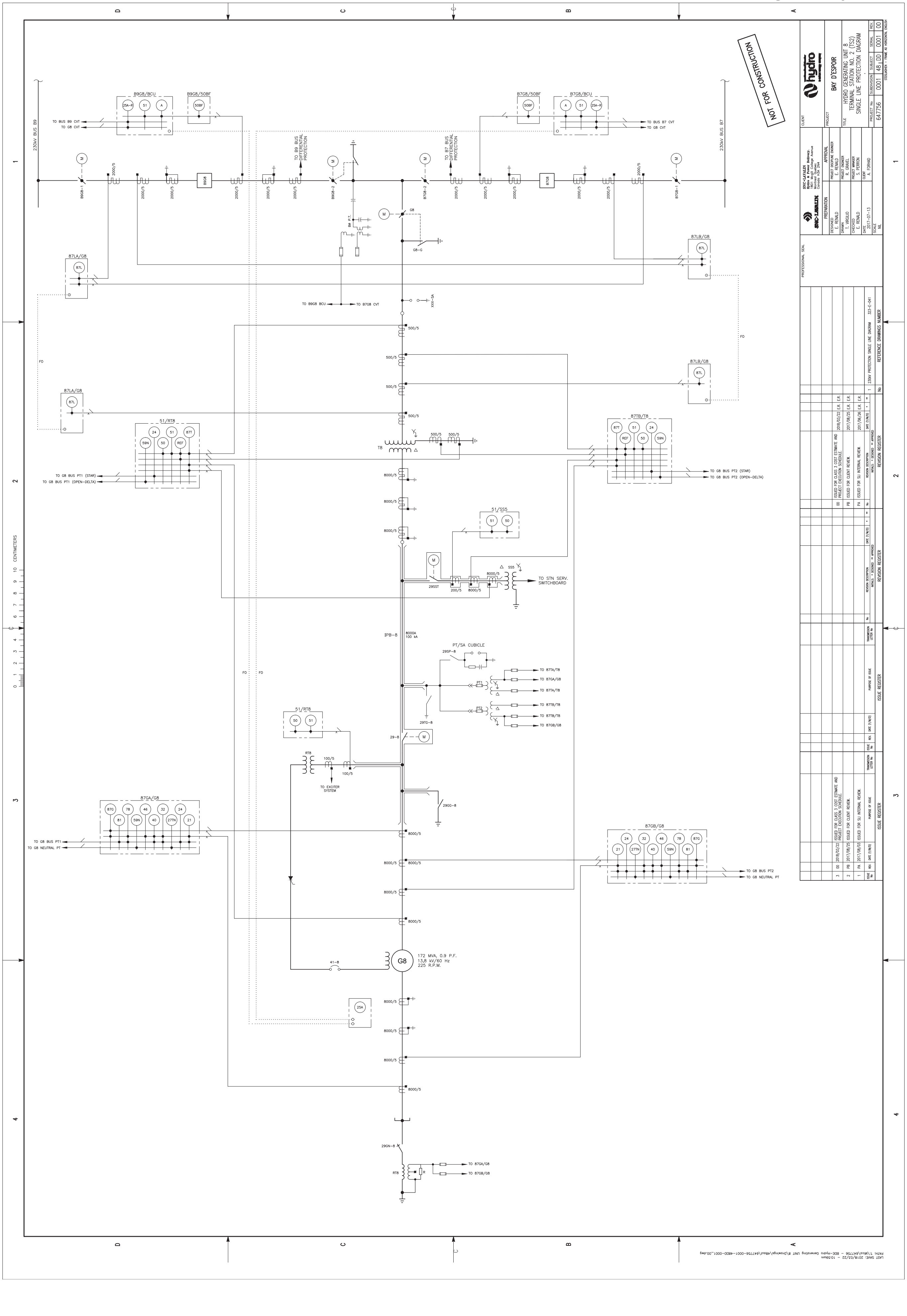
CLIENT: hydro

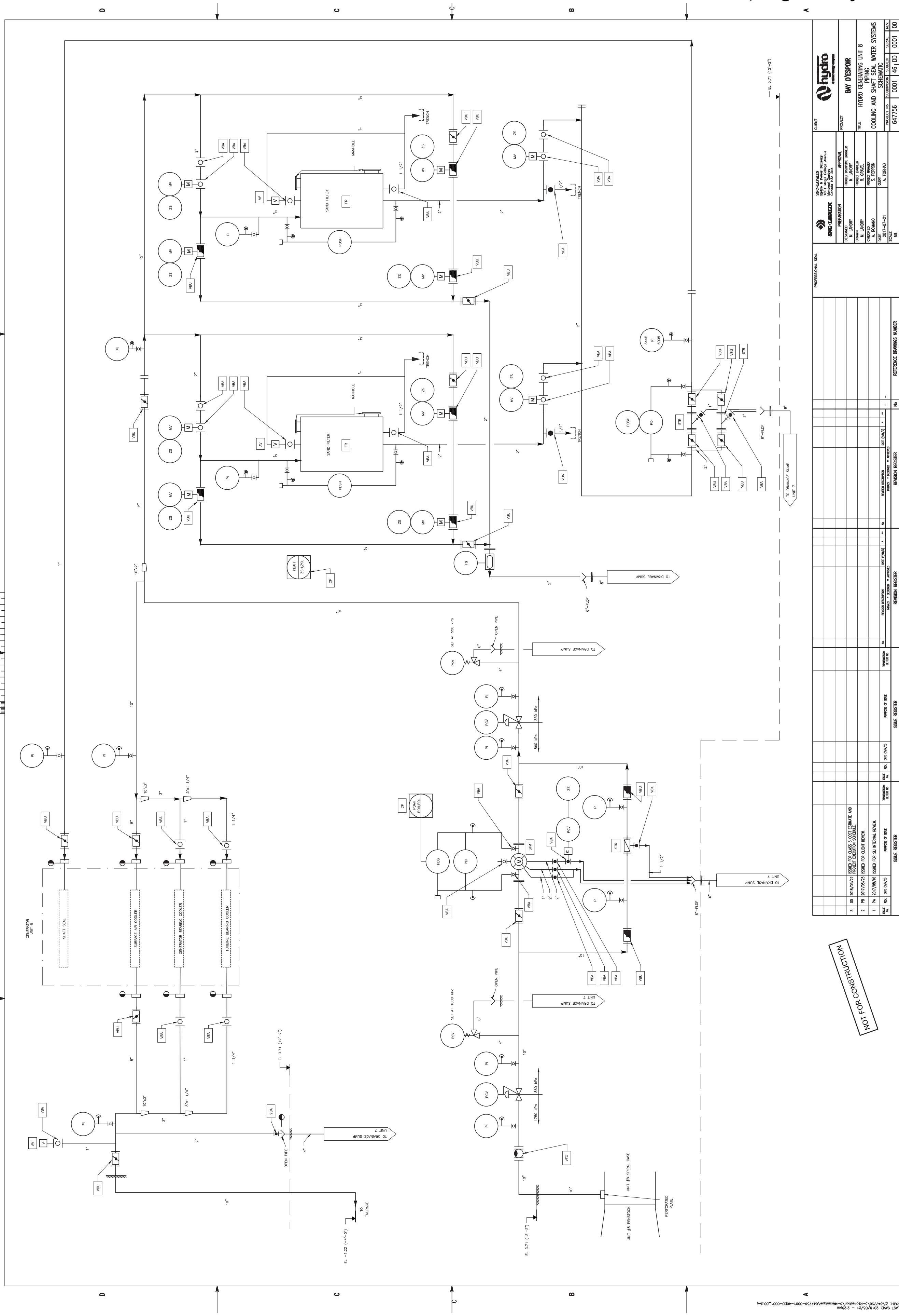
PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNIT 8 POWERHOUSE SINGLE LINE DIAGRAM PREFEASIBILITY STUDY

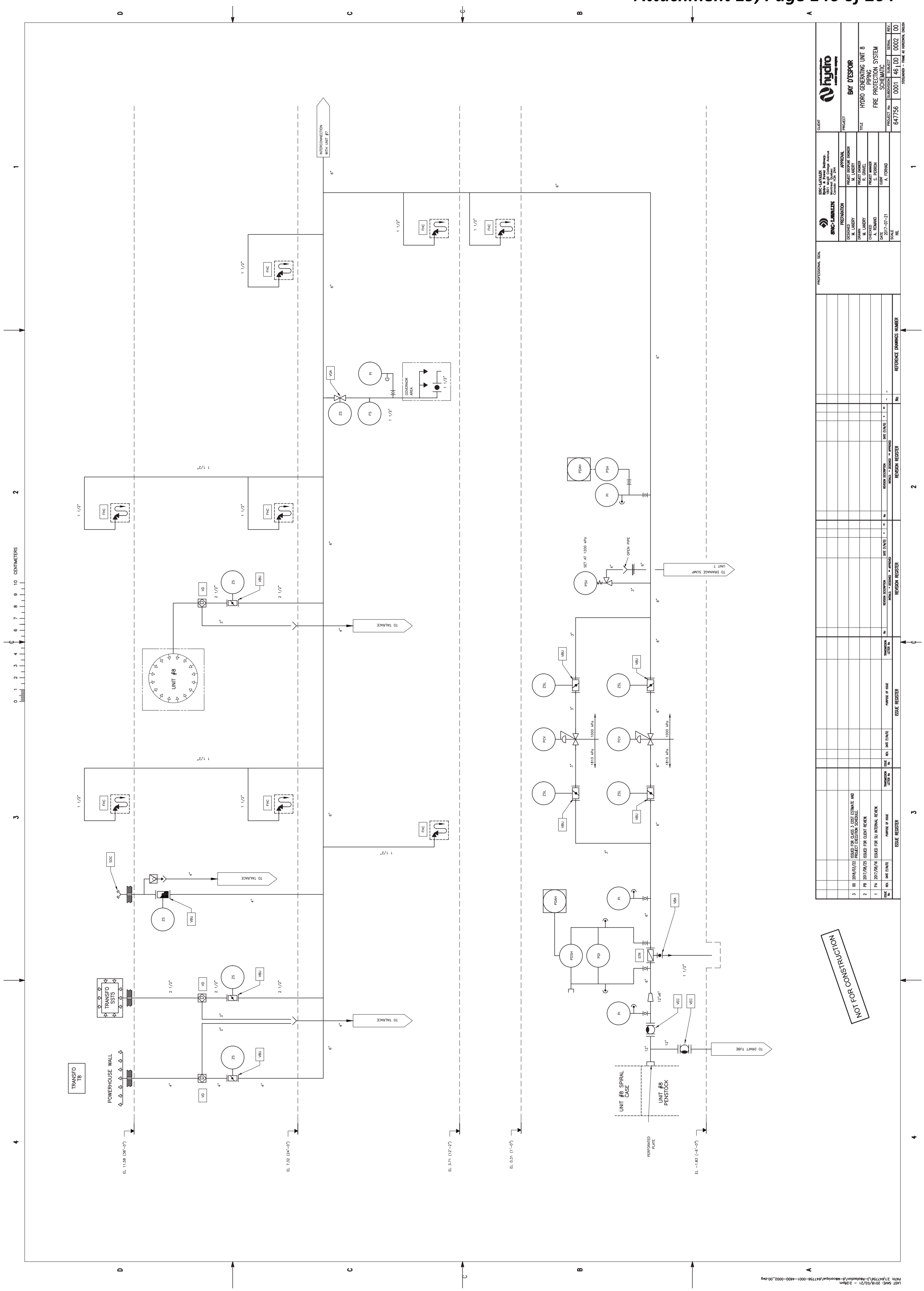
PROJECT No	SUBDIVISION	SUBJECT		SERIAL	REV.
647756	0001	47	DD	0009	00

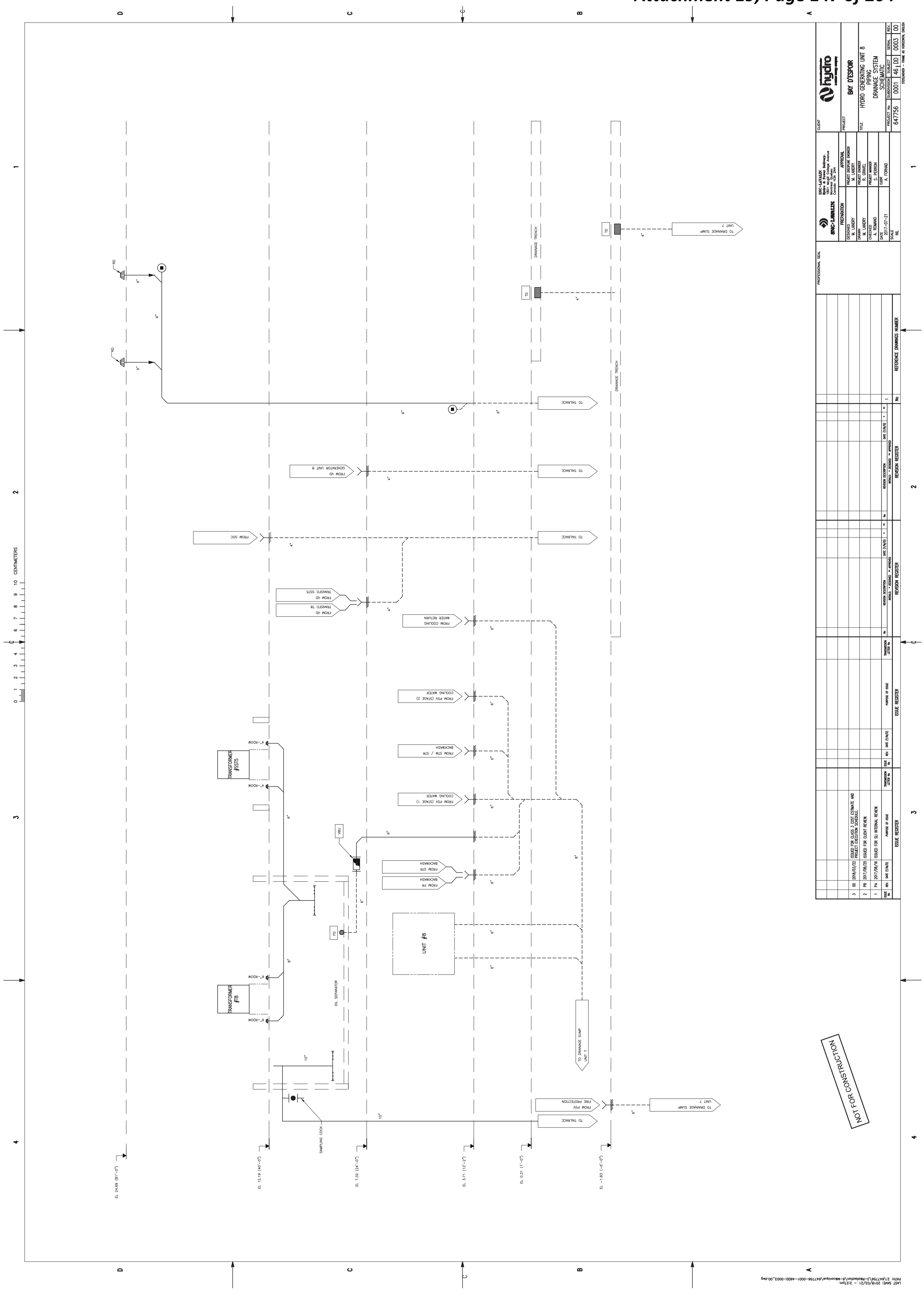
LAST SAVE: 2018/03/22 - 10:34am
PATH: Z:\647756\3-Réalisation\7-Electrique\647756-0001-47DD-0009_00.dwg


NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
TERMINAL STATION NO. 2 (TS2)
SINGLE LINE PROTECTION DIAGRAM
647756
0001 48 DD 0001 00
230kV BUS B9
230kV BUS B7
B9G8/BCU
B9G8/50BF
B7G8/50BF
B7G8/BCU
TO BUS B9 CVT
TO G8 CVT
TO BUS B7 CVT
TO B9 BUS DIFFERENTIAL PROTECTION
TO B7 BUS DIFFERENTIAL PROTECTION
87LA/G8
87LB/G8
TO B9G8 BCU
TO B7G8 CVT
51/RT8
87TB/T8
T8
TO G8 BUS PT1 (STAR)
TO G8 BUS PT1 (OPEN-DELTA)
TO G8 BUS PT2 (STAR)
TO G8 BUS PT2 (OPEN-DELTA)
51/SS5
TO STN SERV. SWITCHBOARD
IPB-8
8000A
100 kA
PT/SA CUBICLE
29SP-8
TO 87TA/T8
TO 87GA/G8
TO 87TB/T8
TO 87GB/G8
29TG-8
29-8
51/RT8
TO EXCITER SYSTEM
87GA/G8
87GB/G8
TO G8 BUS PT1
TO G8 NEUTRAL PT
TO G8 BUS PT2
29GG-8
41-8
G8
172 MVA, 0.9 P.F.
13.8 kV/60 Hz
225 R.P.M.
29GN-8
TO 87GA/G8
TO 87GB/G8

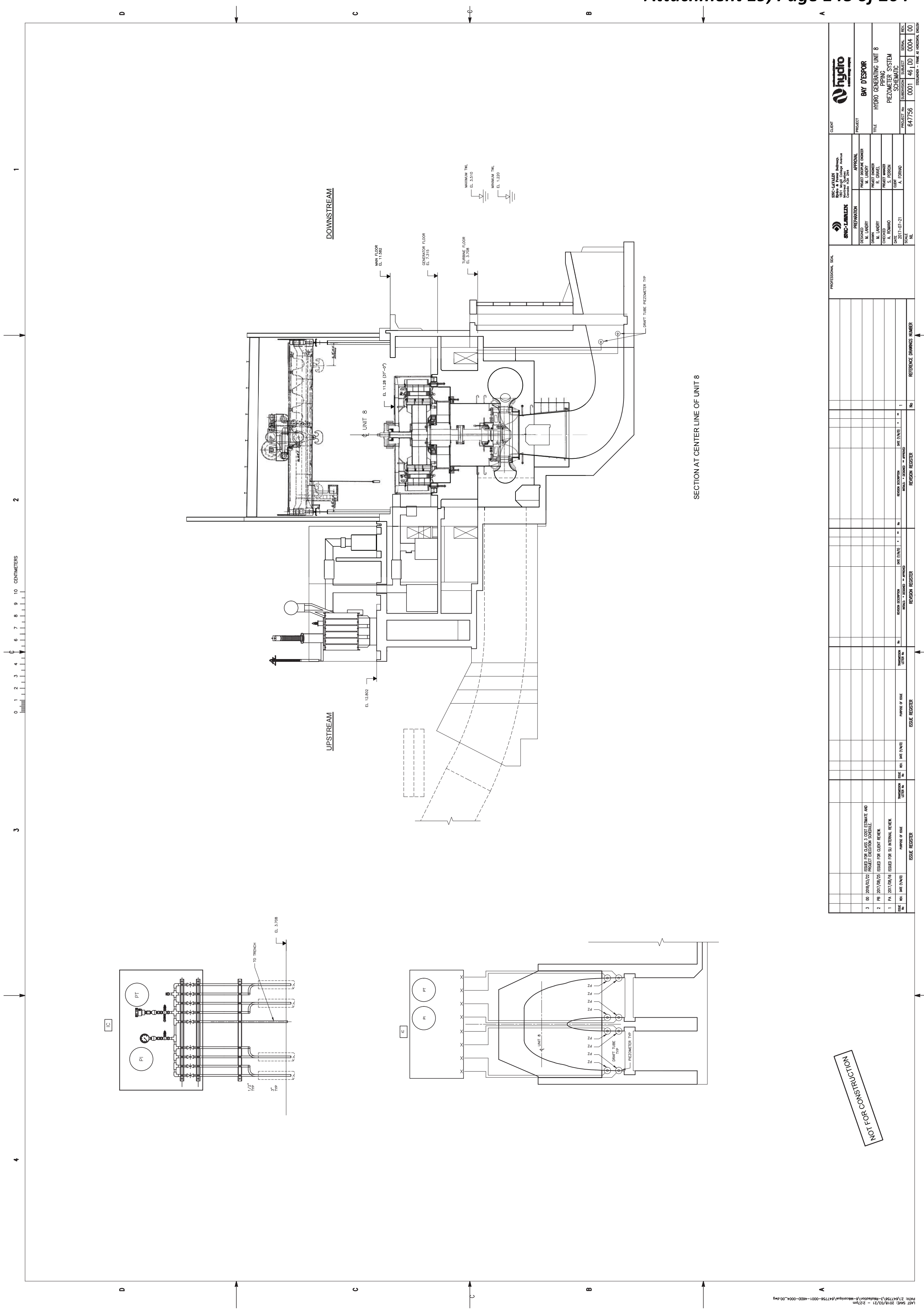


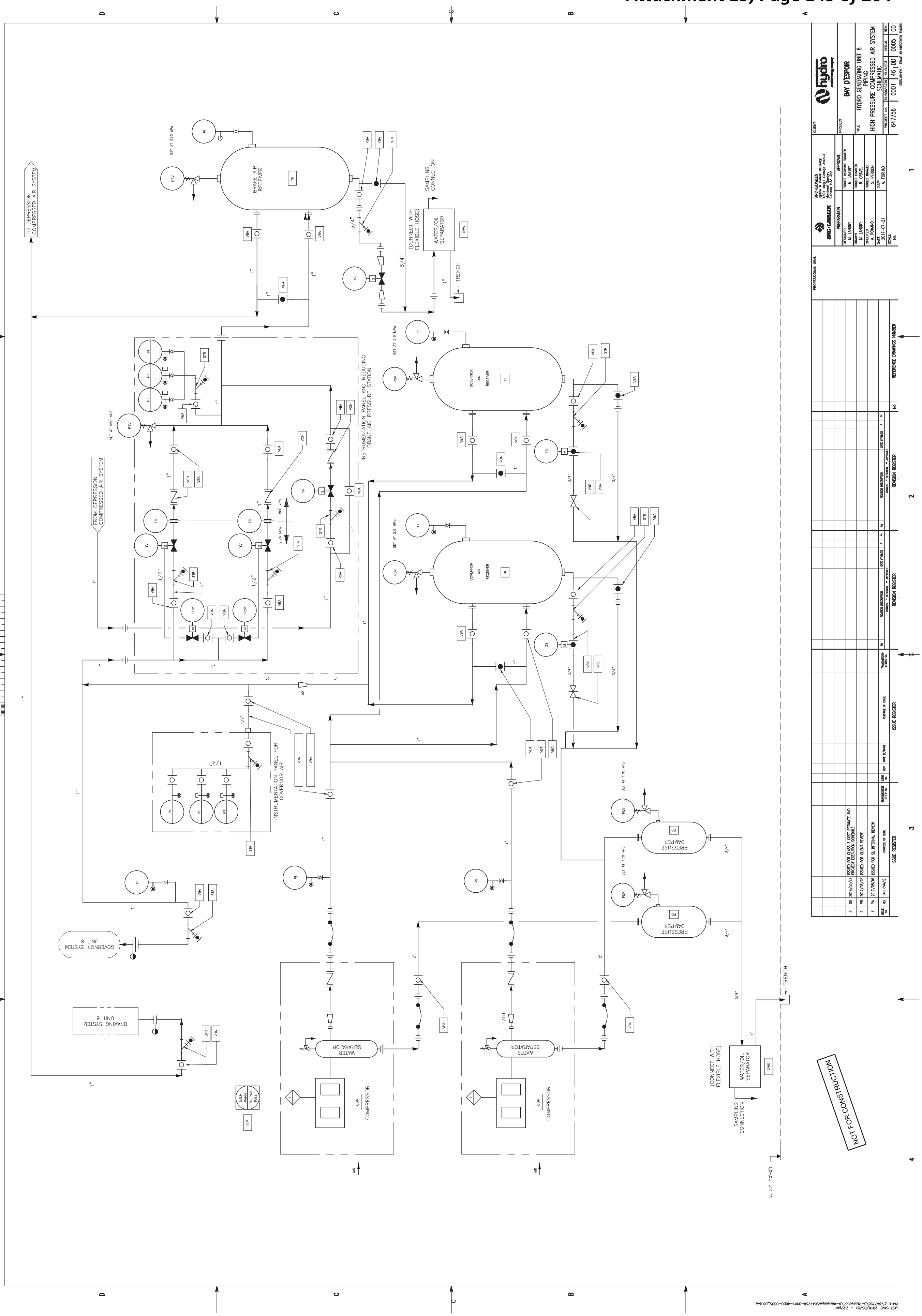
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
PIPING
COOLING AND SHAFT SEAL WATER SYSTEMS
SCHEMATIC
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 46DD
SERIAL 0001
REV. 00
SNC-LAVALIN
Hydro & Power Delivery,
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4
DESIGNED M. LANDRY
DRAWN M. LANDRY
CHECKED A. ROMANO
DATE 2017-07-21
SCALE NIL
PROJECT DISCIPLINE ENGINEER M. LANDRY
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
PROFESSIONAL SEAL
REFERENCE DRAWINGS NUMBER
REVISION REGISTER
ISSUE REGISTER
NOT FOR CONSTRUCTION
SAND FILTER
SHAFT SEAL
SURFACE AIR COOLER
GENERATOR BEARING COOLER
TURBINE BEARING COOLER
GENERATOR UNIT 8
TO DRAINAGE SUMP
TO TAILRACE
UNIT #8 PENSTOCK
UNIT #8 SPIRAL CASE
PERFORATED PLATE
OPEN PIPE
SET AT 550 kPa
SET AT 1000 kPa

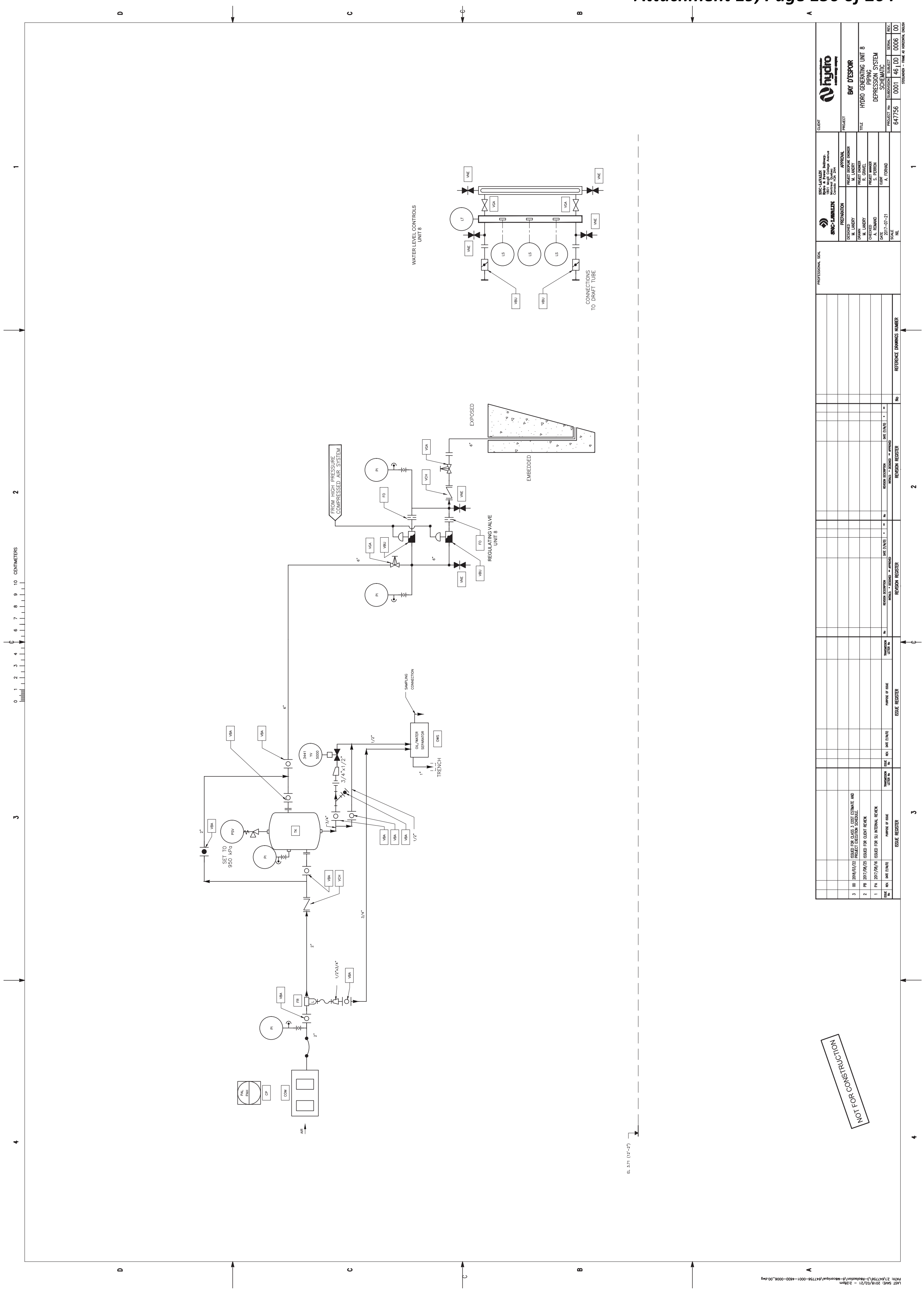

INTERCONNECTION WITH UNIT #7
GOVERNOR AREA
UNIT #8
TO TAILRACE
TO TAILRACE
TO TAILRACE
TRANSFO SST5
TRANSFO T8
POWERHOUSE WALL
SET AT 1200 kPa
OPEN PIPE
TO DRAINAGE SUMP UNIT 7
TO DRAFT TUBE
UNIT #8 SPIRAL CASE
UNIT #8 PENSTOCK
PERFORATED PLATE
NOT FOR CONSTRUCTION
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
PIPING
FIRE PROTECTION SYSTEM
SCHEMATIC
647756
0001
46
DD
0002
00



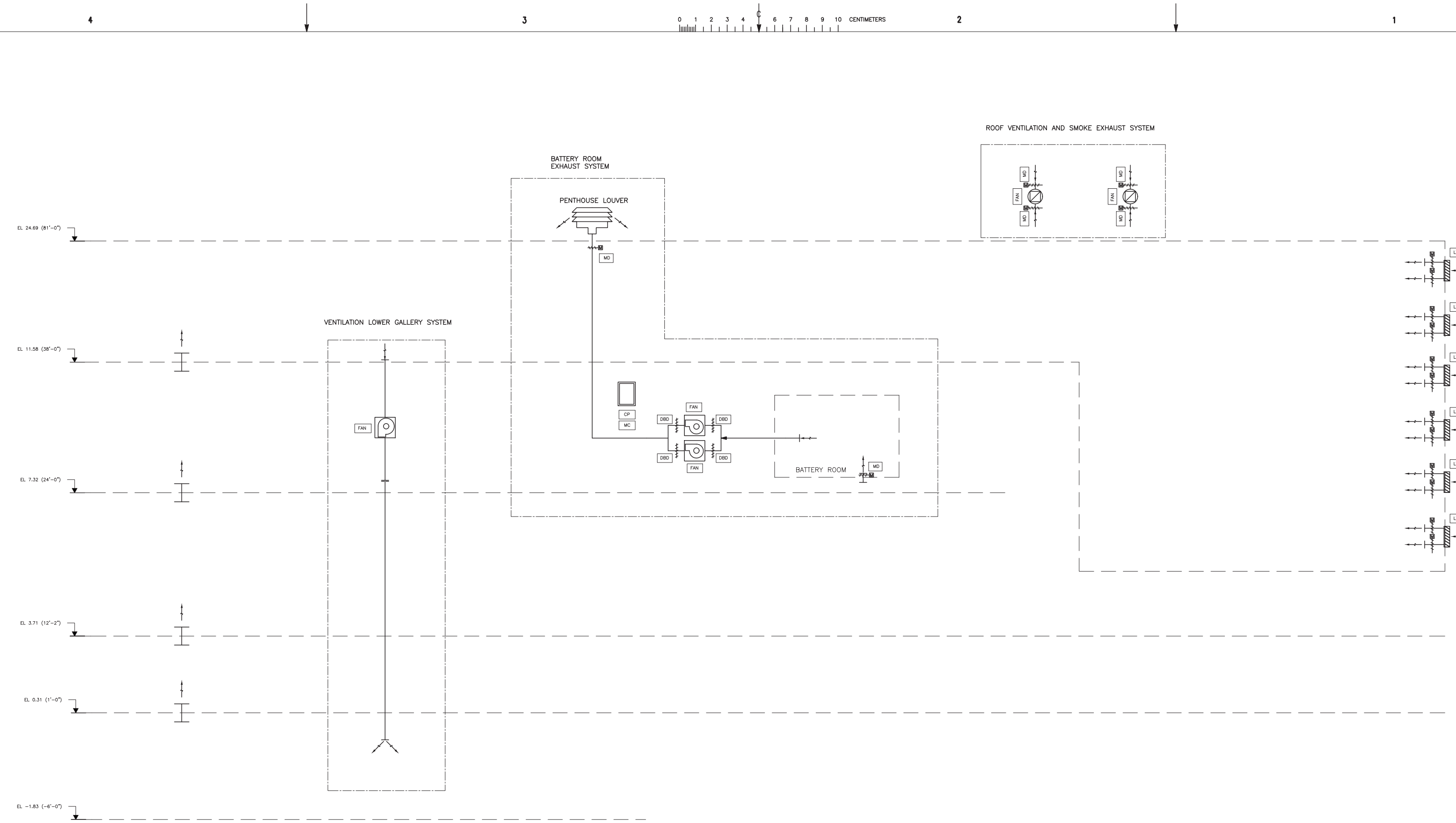
hydro
SNC-LAVALIN
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
PIPING
DRAINAGE SYSTEM
SCHEMATIC
647756 0001 46 DD 0003 00
PREPARATION
APPROVAL
M. LANDRY
R. GRAVEL
S. PERSON
A. FORNAD
A. ROMANO
2017-07-21
NIL
PROFESSIONAL SEAL
REFERENCE DRAWINGS NUMBER
REVISION REGISTER
ISSUE REGISTER
3 00 2018/03/22 ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE
2 PB 2017/08/25 ISSUED FOR CLIENT REVIEW
1 PA 2017/08/18 ISSUED FOR SLI INTERNAL REVIEW
NOT FOR CONSTRUCTION
TO DRAINAGE SUMP UNIT 7
TO TAILRACE
FROM VD GENERATOR UNIT 8
FROM SOC
FROM VD TRANSFO SST5
FROM VD TRANSFO T8
FROM COOLING WATER RETURN
FROM PSV (STAGE 2) COOLING WATER
FROM STM / STR BACKWASH
FROM PSV (STAGE 1) COOLING WATER
FROM STR BACKWASH
FROM FR BACKWASH
FROM PSV FIRE PROTECTION
DRAINAGE TRENCH
TRANSFORMER #SST5
TRANSFORMER #T8
UNIT #8
OIL SEPARATOR
SAMPLING COCK
EL. 24.69 (81'-0")
EL. 12.19 (40'-0")
EL. 7.32 (24'-0")
EL. 3.71 (12'-2")
EL. 0.31 (1'-0")
EL. -1.83 (-6'-0")
CENTIMETERS


DOWNSTREAM
UPSTREAM
SECTION AT CENTER LINE OF UNIT 8
UNIT 8
DRAFT TUBE PIEZOMETER TYP
NOT FOR CONSTRUCTION
SNC-LAVALIN
Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4
PREPARATION
APPROVAL
DESIGNED M. LANDRY
DRAWN M. LANDRY
CHECKED A. ROMANO
DATE 2017-07-21
SCALE NIL
PROJECT DISCIPLINE ENGINEER M. LANDRY
PROJECT ENGINEER R. GRAVEL
PROJECT MANAGER S. PERRON
CLIENT A. FORHAD
PROFESSIONAL SEAL
REFERENCE DRAWINGS NUMBER
REVISION REGISTER
ISSUE REGISTER
CLIENT
PROJECT
BAY D'ESPOIR
TITLE
HYDRO GENERATING UNIT 8
PIPING
PIEZOMETER SYSTEM
SCHEMATIC
PROJECT No 647756
SUBDIVISION 0001
SUBJECT 46 DD
SERIAL 0004
REV. 00


BAY D'ESPOIR
HYDRO GENERATING UNIT 8
PIPING
HIGH PRESSURE COMPRESSED AIR SYSTEM
SCHEMATIC
647756 0001 46 DD 0005 00
BRAKE AIR RECEIVER
GOVERNOR AIR RECEIVER
WATER/OIL SEPARATOR
(CONNECT WITH FLEXIBLE HOSE)
SAMPLING CONNECTION
TRENCH
TO DEPRESSION COMPRESSED AIR SYSTEM
FROM DEPRESSION COMPRESSED AIR SYSTEM
INSTRUMENTATION PANEL AND REDUCING BRAKE AIR PRESSURE STATION
INSTRUMENTATION PANEL FOR GOVERNOR AIR
GOVERNOR SYSTEM UNIT 8
BRAKING SYSTEM UNIT 8
PRESSURE DAMPER
WATER SEPARATOR
COMPRESSOR
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
NOT FOR CONSTRUCTION



SNC-LAVALIN
hydro
BAY D'ESPOIR
HYDRO GENERATING UNIT 8
PIPING
DEPRESSION SYSTEM
SCHEMATIC
647756 0001 46 DD 0006 00
3 00 2018/03/22 ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE
2 PB 2017/08/25 ISSUED FOR CLIENT REVIEW
1 PA 2017/08/18 ISSUED FOR SLI INTERNAL REVIEW
ISSUE REGISTER
REVISION REGISTER
REFERENCE DRAWINGS NUMBER
PROFESSIONAL SEAL
NOT FOR CONSTRUCTION
WATER LEVEL CONTROLS UNIT 8
CONNECTIONS TO DRAFT TUBE
REGULATING VALVE UNIT 8
FROM HIGH PRESSURE COMPRESSED AIR SYSTEM
EXPOSED
EMBEDDED
SET TO 950 kPa
OIL/WATER SEPARATOR
SAMPLING CONNECTION
TRENCH
CENTIMETERS



NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
3	00	2018/03/22	ISSUED FOR CLASS 3 COST ESTIMATE AND PROJECT EXECUTION SCHEDULE.	
2	PB	2017/08/25	ISSUED FOR CLIENT REVIEW.	
1	PA	2017/08/16	ISSUED FOR SLI INTERNAL REVIEW.	

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

SNC-LAVALIN
Hydro & Power Delivery.
1801 Mcgill College Avenue
Montreal Quebec
Canada H3A 2N4

PREPARATION	APPROVAL
DESIGNED M. LANDRY	PROJECT DISCIPLINE ENGINEER M. LANDRY
DRAWN M. LANDRY	PROJECT ENGINEER R. GRAVEL
CHECKED A. ROMANO	PROJECT MANAGER S. PERRON
DATE 2017-07-21	CLIENT A. FORHAD
SCALE NIL	

CLIENT hydro

PROJECT BAY D'ESPOIR

TITLE HYDRO GENERATING UNIT 8 HVAC SYSTEMS SCHEMATIC

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
647756	0001	46 DD	0007	00

STDSLIAOHEN – FRAME A0 HORIZONTAL ENGLISH

LAST SAVE: 2018/03/21 - 2:28pm
PATH: Z:\647756\3-Réalisation\6-Mécanique\647756-0001-46DD-0007_00.dwg

EQUIPMENT CODES

ACCC	ACCESS CONTROL
ACD	AIR HANDLING UNIT – AIR CONDITIONING
ACU	AIR HANDLING UNIT – COOLING UNIT
AD	AIR DRYER
AHV	AIR HANDLING UNIT – HEATING/VENTILATING
ANN	ANNUNCIATOR PANEL
AOA	AIR OPERATED ACTUATOR
AS	AIR SEPARATOR
ATD	ANGLE TRENCH DRAIN
ATS	AUTOMATIC TRANSFER SWITCH
AV	AUTOMATIC AIR VENT
AVR	AUTOMATIC VOLTAGE REGULATOR
BANDS	BAND SAW
BAT	BATTERY
BD	BUS DUCT
BDD	BI–DIRECTIONAL DAMPER
BGNR	BENCH GRINDER
BH	BASEBOARD HEATER
BP	BACK–FLOW PREVENTER
BS	BELT SANDER
BV	BREATHER VENT
C	CONTACTOR
CABL	BULK CABLE
CASS	COMPRESSED AIR SERVICE STATION
CB	CIRCUIT BREAKER
CBCP	CIRCUIT BREAKER CONTROL CABINET
CC	COOLING COIL
CCTV	CLOSED CIRCUIT SECURITY CAMERA
CCTVM	CLOSED CIRCUIT SECURITY MONITOR
CDTF	CONDUIT, FLEXIBLE
CDTR	CONDUIT, RIGID
CFR	CYCLONE FILTER
CGM	CRANE – GANTRY
CH	CONVECTOR HEATER
CHL	CHLORINATOR
CHR	BATTERY CHARGER
CO	CLEAN–OUT
COM	COMPRESSOR
CP	CONTROL PANEL
CRN	CRANE – OVERHEAD
CSB	CRANE – SPREADER BEAM
CRP	CREEP DETECTOR
CT	CURRENT TRANSFORMER
CU	CONDENSING UNIT
DAM	PNEUMATICALLY ACTUATED DRAIN
DBD	BACK–DRAFT DAMPER
DF	DRINKING FOUNTAIN
DG	DIESEL GENERATOR
DGT	GUTTER DRAIN TRENCH
DP	DRILL PRESS
DPB	LV DISTRIBUTION PANEL BOARD
DS	DOSING SIPHON
DSD	DUCT SMOKE DETECTOR
DW	DISHWASHER
DY	DRYER
ELV	ELEVATOR
ELT	EMERGENCY LIGHTING FIXTURE COMBINE WITH RECHARGEABLE BATTERY UNIT
ES	EMERGENCY SHOWER
ESY	EMERGENCY SHOWER AND EYEWASH
EXC	EXCITATION SYSTEM CUBICLE
EXT	EXCITATION TRANSFORMER
EY	EMERGENCY EYEWASH
FA	FLAME ARRESTER
FAN	FAN
FAP	FIRE ALARM PANEL
FBH	FLEXIBLE BRAIDED HOSE
FD	FIRE DAMPER
FFH	FAN FORCED HEATER
FH	HYDRAULIC SELF–CLEANING FILTER
FHC	FIRE HOSE CABINET
FHY	FIRE HYDRANT
FLD	FLOOR DRAIN
FLDF	FLOOR DRAIN WITH FUNNEL
FLDSH	FLOOR DRAIN FOR SHOWER
FLDSOA	FLOOR DRAIN SIDE OUTLET AREA
FP	FILTER PRESS
FPC	FIRE ALARM CABINET
FR	FILTER
FSL	FULL SUPPLY LEVEL
FU	FUSE
FX	FIRE EXTINGUISHER
G	GENERATOR
GBS	GATE – BULKHEAD / STOPLOG
GCP	GOVERNOR CONTROL PANEL
GD	GUTTER DRAIN
GEB	GATE EMBEDDED SILL BEAM
GEG	GATE EMBEDDED GUIDES
GFAP	GENERATOR FIRE ALARM PANEL
GFPC	GENERATOR FIRE PROTECTION CABINET
GIN	GATE–INTAKE EMERGENCY CLOSURE
GLB	GATE–LIFT BEAM
GNC	GENERATOR NEUTRAL CABINET
GOV	GOVERNOR – HYDRAULIC
GR	GRILLE / DIFFUSER
GRD	GROUNDING MATERIAL
GSAC	GENERATOR SURGE ARRESTOR CUBICLE
GSP	GATE – SPILLWAY
GSUT	GENERATOR STEP–UP TRANSFORMER
HC	HEATING COIL
HE	HYDROEJECTOR
HGB	HOIST BRIDGE STRUCTURE
HGE	HOIST–GATE–ELECTRIC
HGH	HOIST–HOUSE–GATE
HGT	HOIST–TOWER–GATES
HN	HORN
HO	HOIST
HS	HEAT AND FIRE SENSOR
HTC	HEAT TRACE CONTROLER
HTCAB	HEAT TRACING CABLE
HTK	HYDROPNEUMATIC TANK
HTL	HANDLING TROLLEY
HU	AIR HUMIDIFIER
HYDP	HYDRAULIC PRESS
IB	INSULATED BRUSH
IC	INSTRUMENT CABINET
INTA	INTRUSION ALARM
INV	INVERTER
IP	INSTRUMENTATION PANEL
IPB	ISOLATED PHASE BUS
IRF	INTERMITTENT RECIRCULATION FILTERS
IT	CURRENT TRANSMITTER
IW	IRON WORKER
JB	JUNCTION BOX
JIBC	JIB CRANE
L	LATHE
LA	LIGHTNING ARRESTOR
LANJ	COMPUTER JACK
LAV	LAVATORY
LBS	LOAD BREAK SWITCH
LF	LIGHTING FIXTURE
LG	LEVEL GAUGE
LS	LEVEL SENSOR
LSP	LOUDSPEAKER
LU	LUBRICATOR
LV	LOUVER
M	MOTOR
MC	MAIN CONTROLLER
MCC	MOTOR CONTROL CENTER
MD	MOTORIZED DAMPER
MF	MUFFLER
MFH	MOBILE FIRE HOSE
MS	MOP SINK
MST	MOTOR STARTER
MTS	MANUAL TRANSFER SWITCH
MV	MOTORIZED VALVE
NGC	NEUTRAL GROUNDING CUBICLE
NPB	600V NON–SEGREGATED BUSWAY
ODR	OIL STORAGE DRUM
OFR	MOBILE OIL FILTER
OI	OIL INTERCEPTOR
OLTC	ON–LOAD TAP CHANGER
OPM	OIL MOBILE PUMPING UNIT
OR	OILER
OS	OIL SKIMMER
OTK	OLEOPNEUMATIC VALVE
OWS	OIL/WATER SEPARATOR
P	PUMP
PAD	PARKING AREA DRAIN
PADD	PUBLIC ADDRESS
PAT	PISTON ACCUMULATOR TANK
PCV	PRESSURE CONTROL VALVE
PD	PRESSURE DAMPER
PDBV	PIT DRAIN WITH BACKWATER VALVE
PEC	PHOTO ELECTRIC CELL
PEV	PRESSURE EXPANSION VALVE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLAC	PLASMA ARC CUTTER
PO	POWER OUTLET
PP	PROTECTION PANEL
PPT	PIPE PREP TOOL
PR	PRESSURE REGULATOR
PRA	PIPE RACK
PS	POWER SUPPLY
PSD	PUMP SUCTION DIFFUSER
PSV	SAFETY OR RELIEF VALVE
PT	POTENTIAL TRANSFORMER
PTHDR	PIPE THREADER
PZ	PIEZOMETER
QD	QUICK DISCONNECT
QDF	QUICK DISCONNECT–FEMALE
QDM	QUICK DISCONNECT–MALE
RAD	RADIAL DRILL
RC	CONVENIENCE RECEPTACLE
RCT	RECTIFIER
RD	ROOF DRAIN
RDIM	ROOF DRAIN FOR INVERTED MEMBRANE
RDOW	ROOF DRAIN FOR OIL/WATER DRAINAGE SYSTEM
RES	RESISTOR
RH	RADIANT HEATER
RIS	REMOVABLE INSERT SCREEN
RJC	ROTOR JACKING CART
RP	RELAY PANEL
SA	SURGE ARRESTER
SDT	SEPTIC DOSING TANK
SEB	STOPLOG EMBEDDED SILL BEAM
SEG	STOPLOG EMBEDDED GUIDES
SEP	SEPARATOR
SF	FLOOR SINK
SFR	SAND FILTER
SGB	SHAFT GROUNDING BRUSH
SH	SHOWER
SK	SINK
SKD	SKID
SKM	MULTI–STATION SINK
SL	SILENCER
SM	STATIC MIXER
SOC	SIAMESE OUTLET CONNECTION
SPS	SEPTIC PUMPING STATION
SRA	STEEL RACK
SRN	SIREN
SS	SERVICE SINK
SST	STATION SERVICE TRANSFORMER
STF	FIRE STRAINER
STM	SELF CLEANING STRAINER
STR	STRAINER
STS	SUCTION STRAINER
SW	SWITCH
SWG	SWITCHGEAR
SYNC	SYNCHRONIZER
T	TRANSFORMER
TCH	OFF–LOAD TAP CHANGER
TD	TRENCH DRAIN
TDOW	TRENCH DRAIN FOR OIL/WATER DRAINAGE SYSTEM
TEL	TELEPHONE
TELJ	TELEPHONE JACK
TK	TANK
TP	TELECOMMUNICATION PANEL
TR	CABLE TRAY
TRC	TRASH CLEANING SYSTEM
TRK	TRASHRACK
TS	TEMPERATURE SENSOR
TSQ	SEPTIC TANK
TU	VARIABLE AIR VOLUME TERMINAL UNIT
TUR	TURBINE–VERTICAL KAPLAN
UCP	UNIT CONTROL PANEL
UH	UNIT HEATER
UM	ULTRASONIC MEASUREMENT
UPS	UNINTERRUPTIBLE POWER SUPPLY
UR	URINAL
UV	ULTRAVIOLET STERILIZER
VA	VALVE ACTUATOR
VAS	ADJUSTABLE ANTI–SIPHON VALVE
VAV	VACUUM AIR VENT
VBA	BALL VALVE
VBL	BLEED VALVE
VBR	VACUUM BREAKER
VBU	BUTTERFLY VALVE
VCH	CHECK VALVE
VD	DELUGE VALVE
VEC	ECCENTRIC VALVE
VFC	FLOW CONTROL VALVE
VFO	DOUBLE POPPET FOOT VALVE
VGA	GATE VALVE
VGL	GLOBE VALVE
VKG	KNIFE GATE VALVE
VM	VERTICAL MILL
VNE	NEEDLE VALVE
VP	PLUG VALVE
VSD	VARIABLE SPEED DRIVE
V2W	TWO–WAY VALVE
V3W	THREE–WAY VALVE
V4W	FOUR–WAY VALVE
W	WELDER
WA	WATER ANALYSER
WC	WATER CLOSET
WFE	WELDING FUME EXTRACTOR
WH	WELDING HOOD
WHTR	WATER HEATER
WM	WASHING MACHINE
WT	WORKING TABLE

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PROFESSIONAL SEAL

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DRAWN: M. LANDRY	PROJECT ENGINEER: R. GRAVEL
CHECKED: A. ROMANO	PROJECT MANAGER: S. PERRON
DATE: 2017-07-21	CLIENT: A. FORHAD
SCALE: NIL	

CLIENT: Newfoundland Labrador hydro — a nalcor energy company

PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNIT 8 EQUIPMENT CODE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
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ABBREVIATIONS

AD	ACCESS DOOR		
AFF	ABOVE FINISHED FLOOR	MOL	MAX OPERATING LEVEL
BO	BY OTHERS	NC	NORMALLY CLOSED
BOD	BOTTOM OF DUCT	NO	NORMALLY OPEN
BOP	BOTTOM OF PIPE	NF	NORMALLY FUNCTIONING
℄	CENTRE LINE	NI	NORMALLY IDLE
CO	CLEAN OUT	NTS	NOT TO SCALE
CONTRJ	CONTRACTION JOINT	OA	OUTSIDE AIR
CJ	CONSTRUCTION JOINT	PMF	PROBABLE MAXIMUM FLOOD
DIA	DIAMETER	R	RADIUS
DG	DOOR GRILLE	REF	REFERENCE
DN	DOWN	SD	SMOKE DETECTOR
EJ	EXPANSION JOINT	SOL	SOCKET WELD FITTING SOCKOLET
EL	ELEVATION	SYM	SYMMETRICAL
EMB	EMBEDDED	TOL	LATERAL THREADED FITTING THREADLET
EXP	EXPOSED	TOD	TOP OF DUCT
FC	FAIL CLOSED	TOP	TOP OF PIPE
FO	FAIL OPENED	TOS	TOP OF STEEL
FOR	FUEL OIL RETURN	TWL	TAIL WATER LEVEL
FOS	FUEL OIL SUPPLY	TYP	TYPICAL
FOV	FUEL OIL VENT	UP	UP
GR	GRILLE	UOS	UNLESS OTHERWISE SPECIFIED
INV	INVERT	UNO	UNLESS NOTED OTHERWISE
MAX	MAXIMUM	WOL	LATERAL WELDED FITTING WELDOLET
MIN	MINIMUM	WP	WORKING POINT

GENERAL SYMBOLS

DESCRIPTION	SYMBOL
LIMIT OF SUPPLY	OTHERS
SPECIFICATION CHANGE	CB11 SB11
CUT PIPE	
INSULATED PIPE	SYSTEM
EMBEDDED/EXPOSED PIPE LIMIT	EXPOSED EMBEDDED
HEAT TRACING	
ELECTRIC SIGNAL	
ELEVATION	EL XXX.XX
CONSTRUCTION NORTH	
TRUE NORTH	
COLD WATER	
HOT WATER	
VENT PIPE	
ANALOG INPUT	AI
ANALOG OUTPUT	AO
DIGITAL INPUT	DI
BENCH MARK	

INSTRUMENTATION SYMBOLS (ISA)

CURRENT

INDICTIVE PROXIMITY SWITCH	IPS
CURRENT TRANSMITTER	IT
VOLTAGE, CAPACITOR	EC

FLOW

FLOW ALARM	FA
HIGH FLOW ALARM	FAH
LOW FLOW ALARM	FAL
FLOW CONTROL TRANSDUCER	FCT
FLOW CONTROL VALVE	FCV
FLOW ELEMENT	FE
FLOW SIGHT GLASS	FG
FLOWMETER INDICATOR	FI
FLOW INDICATOR TRANSMITTER	FIT
RESTRICTION ORIFICE FOR FLOW MEASUREMENT	FO
INTEGRATING FLOWMETER	FQI
FLOW SWITCH	FS
HIGH FLOW SWITCH	FSH
LOW FLOW SWITCH	FSL
FLOW TRANSMITTER	FT

GENERAL ALARM & OTHER FUNCTIONS

MULTIPLE ALARM	UAH	UALH
ALARM FOR CLOSED ELEMENT		ZAL
ALARM FOR OPENED ELEMENT		ZAH
MOTORIZED VALVE		MV
SPEED PICK-UP		SE
SERVO VALVE		SV
WATER DETECTOR		WD
SOLENOID VALVE		YV
ACTUATOR		Z
POSITION TRANSDUCER		ZT

LEVEL

HIGH LEVEL ALARM	LAH
LOW LEVEL ALARM	LAL
EXTREME HIGH LEVEL ALARM	LAHH
EXTREME LOW LEVEL ALARM	LALL
LEVEL CONTROL VALVE	LCV
LEVEL ELEMENT	LE
LEVEL GAGE GLASS	LG
LEVEL INDICATOR	LI
LEVEL SWITCH	LS
LEVEL TRANSMITTER	LT
HIGH LEVEL SWITCH	LSH
EXTREME HIGH LEVEL SWITCH	LSHH
HIGH/LOW LEVEL SWITCH	LSLH
LOW LEVEL SWITCH	LSL
EXTREME LOW LEVEL SWITCH	LSLL

MOISTURE

MOISTURE TRANSMITTER	MT
MOISTURE LIMIT SWITCH	MSL
HIGH MOISTURE SWITCH	MSH
MOISTURE ALARM	MA

PRESSURE

DIFFERENTIAL PRESSURE CONTROLER	DPC
HIGH PRESSURE ALARM	PAH
EXTREME HIGH PRESSURE ALARM	PAHH
LOW PRESSURE ALARM	PAL
EXTREME LOW PRESSURE ALARM	PALL
PRESSURE CONTROL VALVE	PCV
HIGH DIFFERENTIAL PRESSURE ALARM	PDAH
DIFFERENTIAL PRESSURE INDICATOR	PDI
DIFFERENTIAL PRESSURE SWITCH	PDS
HIGH DIFFERENTIAL PRESSURE SWITCH	PDSH
PRESSURE INDICATOR	PI
PRESSURE SWITCH	PS
HIGH PRESSURE SWITCH	PSH
VERY HIGH PRESSURE SWITCH	PSHH
HIGH/LOW PRESSURE SWITCH	PSLH
LOW PRESSURE SWITCH	PSL
VERY LOW PRESSURE SWITCH	PSLL
SAFETY OR RELIEF VALVE	PSV
PRESSURE TRANSMITTER	PT

TEMPERATURE

HIGH TEMPERATURE ALARM	TAH
LOW TEMPERATURE ALARM	TAL
TEMPERATURE CONTROLLER	TC
TEMPERATURE CONTROL VALVE	TCV
TEMPERATURE ELEMENT	TE
TEMPERATURE INDICATOR THERMOMETER	TI
TEMPERATURE INDICATOR/TRANSMITTER	TIT
TEMPERATURE SWITCH	TS
HIGH TEMPERATURE SWITCH	TSH
LOW TEMPERATURE SWITCH	TSL
HIGH/LOW TEMPERATURE SWITCH	TSLH
TEMPERATURE TRANSMITTER	TT
TEMPERATURE WELL	TW

SWITCH

HAND SWITCH		HS
HAND VALVE		HV
POSITION SWITCH		ZS
POSITION SWITCH OPENED / CLOSED	ZSH	ZSL

INSTRUMENT PANEL

DUPLEX INSTRUMENT
FIRE DETECTION PANEL
REMOTE CONTROL PANEL
LOCAL CONTROL PANEL
LOCAL INSTRUMENT
LOCAL PANEL MOUNTED INSTRUMENT
CONTROL CIRCUIT

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PROFESSIONAL SEAL

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DATE 2017-07-21	CLIENT A. FORHAD
SCALE NIL	

CLIENT: newfoundland labrador hydro — a nalcor energy company

PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNIT 8 ABBREVIATIONS AND SYMBOLS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
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VALVE

DESCRIPTION	SYMBOL N.O.	SYMBOL N.C.
GATE VALVE		
GLOBE VALVE		
NEEDLE VALVE		
ANGLE VALVE (PLAN VIEW)		
ANGLE VALVE (SIDE VIEW)		
BUTTERFLY VALVE		
BALL VALVE		
ECCENTRIC VALVE		
PLUG VALVE		
3-WAY FLOW CONTROL VALVE		
4-WAY VALVE		
PRESSURE RELIEF VALVE		
MANUAL BLEEDER		
CHECK VALVE		
GATE VALVE WITH HOSE BIB		
DELUGE VALVE		
DIAPHRAGM ACTUATOR		
MOTOR ACTUATOR	M	
SOLENOID ACTUATOR	S	
PRESSURE REGULATING VALVE (SELF ACTING)		
PRESSURE REGULATING VALVE (REMOTE CONTROL)		
REGULATING VALVE		
GATE VALVE OS & Y		
AUTOMATIC AIR RELEASE VENT OR HEADER VENT PLUG	V	
ATMOSPHERIC VENT		
AUTOMATIC AIR VENT AND VACUUM BREAKER	V	
BALL DRIP		
AUTOMATIC LIQUID DRAIN TRAP	T	
FUSIBLE LINK BALL VALVE		
ADJUSTABLE ANTI-SYPHON VALVE		
FOOT VALVE		

PIPING EQUIPMENT

DESCRIPTION	SYMBOL
QUICK CONNECT	
QUICK CONNECT WITH CAP	
FLANGE	
CAP (BUTT WELDED)	
CAP (SOCKET WELD)	
SUCTION STRAINER	
T STRAINER	S
Y STRAINER	
Y STRAINER WITH BALL VALVE	
Y STRAINER WITH GATE VALVE	
BASKET STRAINER (SINGLE)	
IMMERSION HEATER	
BASKET STRAINER (DUPLEX)	
SELF CLEANING STRAINER (ELECTRIC MOTOR)	M
SELF CLEANING STRAINER (HYDRAULIC MOTOR)	H
CARTRIDGE FILTER	
AIR FILTER WITH MUFFLER	
FLOW RECTIFIER	
FIRE DEPARTMENT CONNECTION	
PRESSURE VESSEL	
ATMOSPHERIC TANK	
VERTICAL PUMP	
CENTRIFUGAL PUMP	
PORTABLE SUBMERSIBLE PUMP	
SUBMERSIBLE PUMP	
GEAR PUMP	
DIAPHRAGM PUMP	
PUMP SUCTION DIFFUSER	
COMPRESSOR	
PIPE ANCHOR	
LIQUID SEPARATOR (WATER OR OIL)	S / L
FLAME ARRESTOR	

PIPING EQUIPMENT

DESCRIPTION	SYMBOL
DRESSER COUPLING	
EXPANSION TANK	
ORIFICE PLATE	
EXPANSION JOINT	
FLEXIBLE CONNECTION	
MECHANICAL COUPLING	
BLEEDER	
VENTURI	
ROTAMETER	
INSULATED PIPE	
FIRE HOSE CONNECTION	
MUFFLER (AIR LINE)	
CONSTANT FLOW REGULATOR	
BALANCING VALVE	
ALARM VALVE	
FIRE HOSE CONNECTION	
PITOT TUBE	
SIGHT GLASS	
FIRE EXTINGUISHER (PORTABLE)	
UNION	
BACK-FLOW PREVENTER	
FROST-PROOF EXTERIOR BUILDING ANGLE VALVE WITH HOSE BIBB	
FIRE HOSE AND STOP VALVE	
FIRE HOSE AND STOP VALVE IN CABINET	
SPRINKLER (OPEN TYPE)	
SPRINKLER (FUSE)	
SPRINKLER (AUTOMATIC)	
AUTOMATIC SPRINKLER (WET)	
FIRE STRAINER	
AIR CHAMBER	
TRAP PRIMER	TP
CLEAN AGENT DISCHARGE NOZZLE (FIRE SUPRESSION)	
CLEAN AGENT GAS CYLINDER (FIRE SUPPRESSION)	

PIPING EQUIPMENT

DESCRIPTION	SYMBOL
CONCENTRIC REDUCER	
ECCENTRIC REDUCER	
SELF-RETRACTING HOSE AND REEL	
POSITIVE DISPLACEMENT PUMP	
VACUUM PUMP	
FLOW TOTALIZER	FQI
ULTRASONIC MEASUREMENT	
STATIC MIXER	
DRUM	
OIL SKIMMER	
ABORT STATION FOR INERGEN SYSTEM	AS
INERGEN MAINTENANCE SWITCH (LOCK-OFF BOX TO DISABLE SYSTEM)	MS
INERGEN MAIN/RESERVE SELECTION SWITCH	M/R
EMERGENCY VENT WITH VENT CAP	

PLUMBING EQUIPMENT

DESCRIPTION	SYMBOL
WATER-HAMMER ARRESTER	A
FLOOR DRAIN (BOTTOM OUTLET/SIDE OUTLET)	
TRENCH DRAIN (BOTTOM OUTLET/SIDE OUTLET)	
FLOOR DRAIN WITH FUNNEL	
ROOF DRAIN	
EMERGENCY SHOWER	
EMERGENCY EYEWASH	
COMBINATION EMERGENCY SHOWER AND EYEWASH	
KNIFE GATE VALVE	
VACUUM BREAKER	VBR
WATER HEATER TANK	
IN-LINE WATER HEATER	
UV STERILIZER	
CENTRIFUGAL SEPARATOR	
FLOOR SINK	
ELECTRIC TOILET	E
URINAL	
TOILET	
DISHWASHER	DW
MOBILE EYEWASH	
DRINKING FOUNTAIN	
LAVATORY	
SHOWER	
SINK	S
GUTTER DRAIN	
GROOVED COUPLING	
CLEAN OUT	
WASHING MACHINE	
DRYER	
MULTI STATION SINK	

0 1 2 3 4 5 6 7 8 9 10 CENTIMETERS

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PROFESSIONAL SEAL

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CHECKED: A. ROMANO	PROJECT MANAGER: S. PERRON
DATE: 2017-07-21	CLIENT: A. FORHAD
SCALE: NIL	

CLIENT: newfoundland labrador hydro — a nalcor energy company

PROJECT: BAY D'ESPOIR

TITLE: HYDRO GENERATING UNIT 8 EQUIPMENT SYMBOLS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
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APPENDIX D – BUDGET QUOTES

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Asselin Industriel Porte Dorion 1948

SERIES 901/902/903
MULTISECTION VERTICAL LIFT DOOR

General: The multiblade door comprises of three or more sliding vertical blades on rails fixed on each side of the opening. The blades are connected to a stabilizing device. The drive mechanism comprises essentially of an electric operator connected to the driving blade by a chain system. The system is highly safe and reliable for up to 1,000,000 cycles, and ideal for industrial applications.

Blades: The steel frame of each blade is typically made of 51mm steel profiles welded together. The exterior face is covered of satin steel sheets 1.52mm (16-gauge) for the outside and 0.92mm (20-gauge) for the inside. The total thickness of the blade is approximately 53mm. The sliders that serve to guide the blades in the rails are made of steel angles of thickness 6.4mm and of length 305mm. The dimensions of these angles is proportional to the angles utilized to build the guiding rails.

Insulation: Each blade is garnished of a 51mm thick thermal insulation built out of polyurethane foam panels. The panels are CFC-free and conform to norm ASTM C-518 for thermal resistance. The thermal resistance factor RSI is 2.9 (R16). The exterior parts of the counterweight-boxes and door guides are insulated with the same product and with the same process as the blades. Exposed parts of the foams are protected by satin steel sheets 1.52mm (16-gauge).

Guiding rails: The rail guides comprise of steel angels made of 44W steel 50mm x 50mm x3.2mm welded to a support steel plate. One of the rails is fixed to the counterweight-box while the other is fixed to a 6.4mm thick support plate which is in turn fixed to steel stiffeners spaced 1.25m apart at maximum. The whole is provided with a bottom plate 6.4mm utilized for anchoring to the floor and is attached with the adjacent frame of the door. The superior extremities of the guiding device and counterweight-box are linked by a square tube insuring the alignment and the rigidity of the whole. Finally, the guiding device is equipped with adjustable limit switch pushbuttons.

Couterweightbox : The counterweight-box is built with a support steel plate 6.4mm and comprises a cage that serves the purpose of guiding and incorporating the counterweight elements. A removable protector covers the bottom part of the box at the desired height to open the possibility of removing the counterweight elements without congestion. The facade and the sides of the box are covered with steel sheets of 1.6mm thickness and up to 2.4m of height. The box comprises of horizontal stiffeners disposed at a maximum of 1.25m between each other. The whole also has a steel plate 6.4mm at its bottom for anchoring to the floor and is solidly fixed to the adjacent steel frame of the door. All elements are to be disposed so that the service loads can be taken by the counterweight and the guiding device.

Lintel : The lintel is made of a steel frame 1.9mm thick.

Finish : The finish comprises of one coat of anti-rust primer and two coats of paint finishes. The paint color is at the choice of the purchaser.

Balancing mechanism: The balancing mechanism is composed of a series of cables and counterweights. It has two frictionless devices localised on the superior part of the guiding mechanism. The device links the blades with its counterweight through two steel cables. The mechanism is connected to the electric operator via a driving chain of size 60. The driving blade is jointed to its counterweight by the means of two roller chains #60 and two cables in galvanized steel of diameter 6.4mm.

Each safety corner is composed of machined pulleys and steel sprockets mounted on a 32mm of diameter cold laminated steel keyed shaft. The diameter of the pulleys on the guide and counterweight sides are typically of 203mm. The cables utilized have a diameter of 6.4mm to give the necessary alignment to the counterweight elements inside the counterweightbox. The shafts are disposed on ball bearings. The pulleys are locked in place via shaft collars.

Safety mechanisms : To prevent the door from abruptly sliding down in the event of a break in the balancing mechanism, the driving blade is fitted with safety locking devices. The devices are maintained in open position by the existing tension in the chains linking the driving blade to its counterweight. In conjunction with this avant-garde safety innovation, Asselin also builds the door with an integrated pneumatic safety system on the bottom blade which shuts down the motion if an object conflicts with the closing path. A third safety system is also put in place which consists of a photoelectric detector which also makes the door re-open if someone was to cross the path while it is closing.

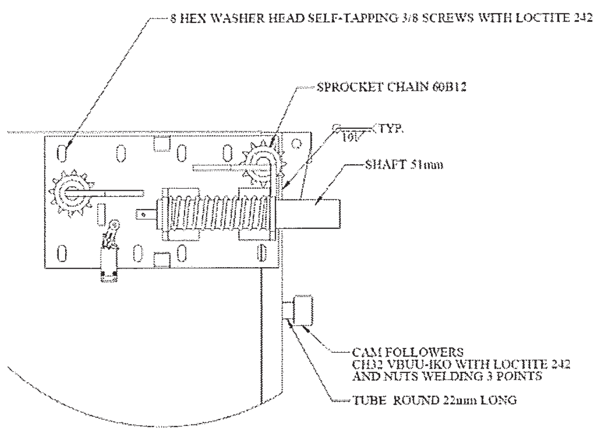
Weatherstrip : The lintel holds a neoprene weatherstrip. This provides a sealed horizontal joint while the door is closed. To ensure lateral joints seal, the rail guides are also fitted with weaterstrips with flexible neoprene garnishing. The inside border of the driving blade is fitted with an AGDS model pneumatic safety system procuring a safety border as well as a weatherstrip.

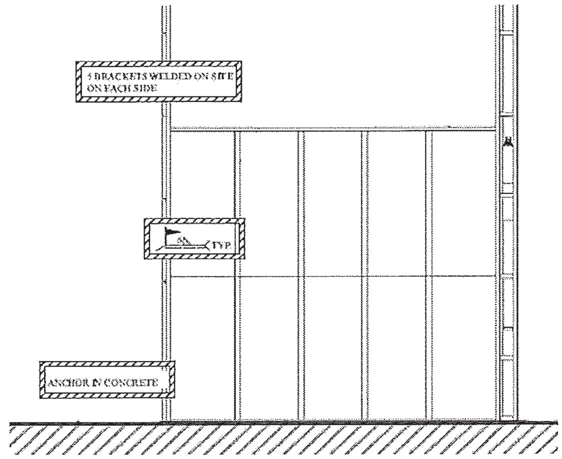
Electric operator : The electric operator, model GH, has a secondary shaft reduced by a ratio of 40:1 and is typically mounted laterally. It also has a chain hoist with manual disconnect function which allows for manual operation in the event of an electric outage.

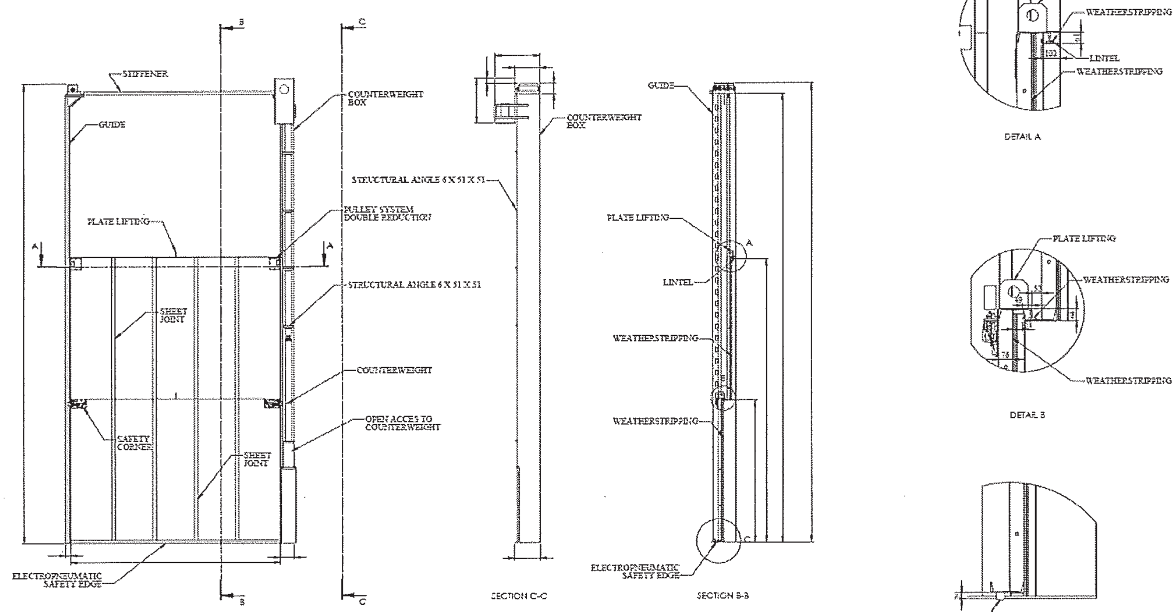
The motor's power may vary, but for most project a 1-1/2 Hp unit is utilized, with voltage usually at 575 but possibly down to 240. The motor is also three phased, and rated NEMA premium or IE3 premium efficiency. The command unit, pushbuttons, relays, switches and other electrical hardware are conform to ACNOR and under box type EEMAC 1.

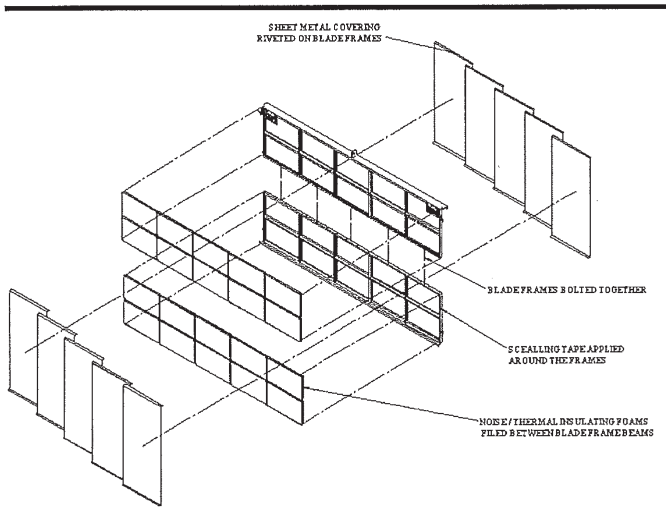
Finally, the control unit also has an integrated motor inverter as well as a thermal protection device to prevent overheating and overloading.

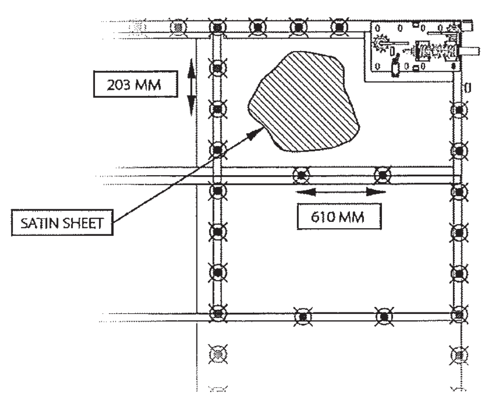
Waranty : The warranty for the product is valid for a period of twelve months from the date of installation by or supervised by our personnel.


8 HEX WASHER HEAD SELF-TAPPING 3/8 SCREWS WITH LOCTITE 242
SPROCKET CHAIN 60B12
TYP.
SHAFT 51mm
CAM FOLLOWERS
CH32 VBUU-IKO WITH LOCTITE 242
AND NUTS WELDING 3 POINTS
TUBE ROUND 22mm LONG


5 BRACKETS WELDED ON SITE ON EACH SIDE
TYP
ANCHOR IN CONCRETE


STIFFENER
GUIDE
PLATE LIFTING
SHEET JOINT
SAFETY CORNER
ELECTROPNEUMATIC SAFETY EDGE
COUNTERWEIGHT BOX
STRUCTURAL ANGLE 6 X 51 X 51
PULLEY SYSTEM DOUBLE REDUCTION
COUNTERWEIGHT
OPEN ACCES TO COUNTERWEIGHT
SECTION C-C
LINTEL
WEATHERSTRIPPING
SECTION B-B
DETAIL A
DETAIL B


SHEET METAL COVERING RIVETED ON BLADE FRAMES
BLADE FRAMES BOLTED TOGETHER
SCEALLING TAPE APPLIED AROUND THE FRAMES
NOISE / THERMAL INSULATING FOAMS FILED BETWEEN BLADE FRAME BEAMS


203 MM
SATIN SHEET
610 MM

[redacted]

[redacted]

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